APPENDIX 1-1: Information Requirements Table – Springer Expansion

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
1. INTRODUCTION AND PROJECT OVERVIEW			
1.1. Application Background	Required ☒ Methods ☐	The scope of this application includes the following activities: • SERDS extension • Springer Pit expansion • Quesnel Lake Discharge [Operational] • Northwest PAG Stockpile Disposal Date • Alternative discharge concepts (Upstream Drain) (possibly; to be determined) • Reducing the NPR from 2 to 1.6 for Springer Deep and WX zones • Updating ML/ARD management procedures to account for the effects of mineral partitioning during blast fractionation for Springer Deep and WX zones. The effects assessment for this application will include: • surface water quantity – Include surface water quality in this section as well. • The methodology by which a reduction in NPR from 2 to 1.6 is developed. • Information on potential changes to material handling procedures for placing material from Springer Deep and WX zones with an NPR between 1.6 and 2 in Not Potentially Acid Generating (NAG) storage facilities. • Information on potential changes to material handling procedures to account for the effects of mineral partitioning during blast fractionation for material from Springer Deep and WX zones.	1.1 Application Background
1.2. Proponent Information	Required ☒ Methods ☐		1.2 Proponent Information
1.3. Project Overview			
1.3.1. Project History	Required ☒ Methods ☐		1.3.1 Project History
1.3.2. Overview of Products and Markets, and Projected Project Benefits	Required ☒ Methods ☐	Project benefits will be discussed	1.3.2 Overview of Products and Markets, and Projected Project Benefits
1.3.3. Location, Access, and Land Use	Required ☒ Methods ☐	A summary description of the Project location and access, including a figure, will be included in the Application. Coordinates for the location of the Project will be provided in the Application. Figures will be developed to illustrate the following: • The location of Mount Polley Mine • Mount Polley Mine layout • Project Footprint • Relevant infrastructure	1.3.3 Location, Access, and Land Use
1.3.4. Mine Components and Off-Site Infrastructure	Required ☒ Methods ☐	The components of the Project will be described in the Application. A figure will be provided for context.	1.3.4 Mine Components and Off-Site Infrastructure
1.3.5. Mine Development and Operations	Required ☒ Methods ☐	Details regarding how the Project fits into permitted mine plan will be provided in the Application.	1.3.5 Mine Development and Operations
1.3.6. Mine Design and Assessment Team	Required ☒ Methods ☐		1.3.6 Mine Design and Assessment Team
1.3.7. Spatial Data	Required ☒ Methods ☐	Relevant spatial data will be provided as maps, including maps of Project and Project component locations. Maps of environmental monitoring and sampling stations will be provided in relevant baseline and monitoring sections.	1.3.7 Spatial Data
1.3.8. Concordance with Environmental Assessment Conditions	Required ☒ Methods ☐	For context discussion of conditions and commitments in the existing EAC will be included in the Application. If there are no relevant commitments, then a statement will be included in the Application indicating that there are no applicable commitments.	1.3.8 Concordance with Environmental Assessment Conditions
1.4. Regulatory Framework	Required ☒ Methods ☐	A summary of authorizations / approvals required for the Project will be provided. Existing authorizations that govern aspects of the Project will be identified.	1.4 Regulatory Framework
1.5. Indigenous Engagement			
1.5.1. Background	Required ☒ Methods ☐	MPMC operates in the territory of the William's Lake First Nation and the Xatśūll First Nation. Summary of previous and planned engagement activities with these First Nations will be provided.	1.5.1 Background
1.5.2. Asserted and Established Rights and Interests	Required ☒ Methods ☐	See 1.5.1	1.5.2 Asserted and Established Rights and Interests

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
1.5.3. Engagement Efforts	Required ☒ Methods ☐	See 1.5.1.	1.5.3 Engagement Efforts
2. BASELINE INFORMATION			
2.1. Summary	Required ☒ Methods ☐	Baseline conditions will be described and will focus on parts of the environment that may be affected by the Project. The scope of the baseline information will be to support assessment consistent with the scope of this Application. Baseline information will be summarized from existing monitoring programs.	2.1 Summary
2.2. Meteorology and Climate	Required ☒ Methods ☐	A summary of relevant meteorological and climate information will be provided, based on existing monitoring data. The baseline information will include parameters relevant for the design and construction of the Project, such as precipitation, snowpack, temperature, and evapotranspiration. The Application must include an assessment of historic climatic conditions at the Project and include general short- and long-term predictions or assumptions related to precipitation, snowpack, temperature, and evapotranspiration that may impact water quantity and quality modelling results.	2.2 Meteorology and Climate
2.3. Geology			
2.3.1. Regional Geology	Required ☒ Methods ☐		2.3.1 Regional Geology
2.3.2. Deposit (Ore) Geology	Required ☒ Methods ☐	A summary of the geological setting will be provided. .	2.3.2 Deposit (Ore) Geology
2.3.3. Surficial Geology, Terrain, and Geohazard Mapping	Required ☒ Methods ☐	A geotechnical evaluation, including assessment of terrain stability and description of natural hazards relevant to the Project activities will be provided.	2.3.3 Surficial Geology, Terrain, and Geohazard Mapping
2.3.4. Natural and Seismic Hazards Assessments	Required ☒ Methods ☐	See 2.3.3	2.3.4 Natural and Seismic Hazards Assessments
2.3.5. Soil Survey and Soil Characterization for Reclamation	Required ☒ Methods ☐	The Project will occur within the M-200 permit boundary. Soil disturbance is anticipated for a small portion of natural ground. Soil survey and soil characterization will be provided for natural areas that may be disturbed.	2.3.5 Soil Survey and Soil Characterization for Reclamation
2.4. Geochemical Characterization and Source Terms	Required ☒ Methods ☐	A QP assessment outlining the estimated time to onset of acid rock drainage and how it relates to the proposed timeline of the Project and the rehandling of PAG material to the existing pit will be provided. The Application will include available static and kinetic laboratory analytical results for PAG material encountered to date and anticipated to be excavated from Phase 4 of the Cariboo-Springer Pit mining operations.	2.4 Geochemical Characterization and Source Terms
2.4.1. Geochemical Characterization	Required ☒ Methods ☐	A QP discussion regarding geochemical characterization of PAG material will be provided. The Application must include a breakdown of geochemical characteristics of previously mined zones as well as zones that may be mined as part of the Springer Pit Expansion.	2.4.1 Geochemical Characterization
2.4.2. Geochemical Source Terms	Required ☒ Methods ☐	Source terms have been updated based on the Springer Pit Expansion (considers more recent data and zones that will be mined as part of the expansion). Source terms for the NAG waste rock dumps will be reviewed by SRK based on the modified NPR.	2.4.2 Geochemical Source Terms
2.5. Topography and Surface Drainage Features	Required ☒ Methods ☐	Existing topography and surface drainage features relevant to the Project components addressed in this Application will be described. A figure showing an overview of surface drainage will be provided.	2.5 Topography and Surface Drainage Features
2.6. Water Quantity			

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	**Requirements**	**Comments**	**Location in Final Application**
2.6.1.Surface Water Quantity	Required ☒ Methods ☐	The hydrology baseline information for the Project will be provided, with references to existing studies, where applicable, and previously published hydrological datasets. The baseline information will be summarized from data collection programs already in place. The Application will include historic and current surface water quantity for the PAG Stockpile. The Application will include information on surface water quantity of NAG storage facilities that are intended to receive material with an NPR between 2 and 1.6.	2.7.1 Surface Water Quantity
2.6.2.Groundwater Quantity	Required ☒ Methods ☐	The groundwater baseline information for the Project will be provided, with references to existing studies, where applicable, and previously published groundwater datasets. The baseline information will be summarized from data collection programs already in place.	2.6.2 Groundwater Quantity
2.7. Water Quality			
2.7.1.Surface Water Quality	Required ☒ Methods ☐	A summary of relevant surface water quality baseline information will be provided. This section will be prepared by summarizing available data and from reports associated with the sites water quality monitoring programs. This section will include receiving environment, Quesnel Lake, data from 2015 to present, and compare it with reference, baseline data. Additionally: - parameters used to calculate guidelines will be provided in table foot notes - presenting graphs will indicate applicable water quality guidelines on the graph itself - where chronic water quality guideline is not applicable to any sampling locations due to monthly sampling, the results will still be compared with chronic guideline - raw data will be provided in an additional appendix For additional reference, this section will provide a summary of data described above for Hazeltine Creek or note where this information has been presented/addressed for reference. The Application will include historic and current surface water quality for the PAG Stockpile. The Application will include an assessment of current surface water quality as it compares to established water quality predictions and timeframes of ML/ARD onset and characteristics. The Application must include information on surface water quality of NAG storage facilities that are intended to receive material with an NPR between 2 and 1.6.	2.7.1 Surface Water Quality
2.7.2.Groundwater Quality	Required ☒ Methods ☐	A summary of relevant groundwater quality baseline information will be provided. This section will be prepared by summarizing available data from reports associated with the site's existing monitoring program.	2.7.2 Groundwater Quality
2.8. Sediment Quality	Required ☒ Methods ☐	In support of the Quesnel Lake Operational Discharge Extension, a summary of relevant sediment quality data from the receiving environment, Quesnel Lake, will be provided. This section will include data from 2015 to present, and compare it with reference, baseline data. Additionally, all sediment toxicity data available to present will be provided along with a comparison to reference conditions. For additional reference, this section will provide a summary of data described above for Hazeltine Creek or note where this information has been presented/addressed for reference.	2.7.3 Sediment Quality
2.9. Fisheries and Aquatic Resources			

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
2.9.1. Periphyton and Benthic Invertebrate Community Measures	Required ☒ Methods ☐	A summary of relevant biological monitoring data from the receiving environment, Quesnel Lake, monitoring locations will be provided. This will include a summary of all relevant periphyton and benthic invertebrate, plankton community measurements from the receiving environment from 2015 to present, along with a comparison to reference, pre-breach/baseline data will be provided. This section will also include all available tissue quality data to present from the applicable receiving environment locations. For additional reference, this section will provide a summary of data described above for Hazeltine Creek or note where this information has been presented/addressed for reference.	2.9.1 Periphyton and Benthic Invertebrate Community Measures
2.9.2. Fish and Fish Habitat	Required ☒ Methods ☐	A summary of the receiving environment, Quesnel Lake, fish habitat condition and use of this habitat by fish populations will be provided.	2.9.2 Fish and Fish Habitat
2.9.3. Tissue Residues	Required ☒ Methods ☐	A summary of all available tissue residue data to present from the applicable sampling location from the relevant receiving environment will be provided.	2.9.3 Tissue Residues
2.10. Ecosystems and Wildlife	Required ☒ Methods ☐	The Project will occur within the M-200 permit boundary. A summary of terrestrial biodiversity will be provided to characterize the baseline conditions, with cross-references to existing reports.	2.10 Ecosystems and Wildlife
2.11. Land Status and Use	Required ☒ Methods ☐	A summary of land status and use will be provided.	2.11 Land Status and Use
2.12. Archaeology	Required ☒ Methods ☐	The Project will occur within the M-200 permit boundary. A summary of relevant archaeological resources will be provided, with cross-references to existing reports.	2.12 Archaeology
2.13. Cultural Use	Required ☒ Methods ☐	The application will contain a brief statement that there is no current cultural resource use of the area, based on existing studies.	2.13 Cultural Use
3. MINE PLAN		This section will include a detailed discussion on the mine plan for the Project. It will include figures outlining development, estimated material volumes, and a discussion on the potential implications of an extended temporary shutdown. No change to the permitted mine boundary is anticipated as part of the Project.	3. MINE PLAN
3.1. Mine Plan Overview	Required ☒	A high-level overview of current mining in the area will be provided in the Application. A description of how the Project will interact with mining will be provided. A description of the Project will be presented to provide context for the assessment of potential effects of the Project and support regulatory review of the Application. Figures will be included.	3.1 Mine Plan Overview
3.2. Existing Development	Required ☒	The existing site conditions described in the Application. The existing environment will be described in Section 2 in the context of the Project. Integration of the Project with the mine site will be described in other sections.	3.2 Existing Development
3.3. Life of Mine Plan	Required ☒		3.3 Life of Mine Plan
3.4. Detailed Five Year Mine Plan	Required ☐		3.4 Detailed Five Year Mine Plan
3.5. Mine Facility Designs and Development	Required ☒		
3.5.1. Open Pits	Required ☒	A QP assessment outlining the estimated time to onset of acid rock drainage and how it relates to the proposed timeline of the Project and the rehandling of PAG material to the existing pit will be provided.	3.5.1 Open Pits
3.5.2. Underground Workings	Required ☐		3.5.2 Underground Workings
3.5.3. Processing Plant (Mill) and Associated Facilities	Required ☐	Existing mill and associated facilities will be used to support the Project. No changes.	3.5.3 Processing Plant (Mill) and Associated Facilities
3.5.4. Tailings Storage Facility and Associated Infrastructure	Required ☐	Modifications needed to support the expansion of the TSF needed to support the Project will be covered under a separate application. A description of this project linkage will be provided in the application.	3.5.4 Tailings Storage Facility and Associated Infrastructure

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
3.5.5. Waste Rock Dumps	Required ☒	This will include discussion from a QP assessment outlining the estimated time to onset of acid rock drainage and how it relates to the proposed timeline of the Project and the rehandling of PAG material to the existing pit will be provided. A description of the permitted Temporary NW PAG Stockpile will be provided.	3.5.5 Waste Rock Dumps
3.5.6. Water Management Structures	Required ☒	A description of existing water management structure relevant to the Project will be provided.	3.5.6 Water Management Structures
3.5.7. Ore, Overburden, Soil and Construction Stockpiles	Required ☒	A description of material stockpiles associated with the Project will be provided in the Application.	3.5.7 Ore, Overburden, Soil and Construction Stockpiles
3.5.8. Mine Access and Mine Haulage Roads	Required ☒	An overview of the access roads and the mine haulage roads relevant to the Project will be provided. The majority of activity will occur using existing infrastructure.	3.5.8 Mine Access and Mine Haulage Roads
3.5.9. Power Supply and Distribution Infrastructure	Required ☒	A summary of the existing facilities to be used will be described.	3.5.9 Power Supply and Distribution Infrastructure
3.5.10. Explosives Storage Facilities	Required ☒	A summary of the existing facilities to be used will be described.	3.5.10 Explosives Storage Facilities
3.5.11. Ancillary Facilities and Support Infrastructure	Required ☒	A summary of the existing facilities to be used will be described.	3.5.11 Ancillary Facilities and Support Infrastructure
4. RECLAMATION AND CLOSURE PLAN			
4.1. End Land Use and Capability Objectives	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project. The footprint and capacity of the Temporary NW PAG Stockpile is not being modified as part of this Project. No change to the reclamation and closure plan presented in the 2017 Mine Reclamation and Closure Plan is required. Disposal of PAG will still occur in pit.	4.2 End Land Use and Capability Objectives
4.2. Reclamation Approaches			
4.2.1. Soil Resources	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.3.1 Soil Resources
4.2.2. Landform Design and Erosion Control	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.3.2 Landform Design and Erosion Control
4.2.3. Revegetation Strategy	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.3.3 Revegetation Strategy
4.2.4. Progressive Reclamation/Sequencing	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.3.4 Progressive Reclamation/Sequencing
4.2.5. Reclamation Research	Required ☐	Reclamation research will not be possible, as these areas will be continuously disturbed during the 8 years of operation.	4.3.5 Reclamation Research
4.2.6. Reclamation Monitoring	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.3.6 Reclamation Monitoring
4.2.7. Habitat Compensation Works	Required ☐	All work will be within the M-200 permit boundary. Habitat offsets, if needed to offset impacts on Bootjack Creek habitat will be handled directly by DFO.	4.3.7 Habitat Compensation Works
4.3. Trace Element Uptake in Soils and Vegetation	Required ☐ Methods ☐		4.4 Trace Element Uptake in Soils and Vegetation
4.4. Contaminated Sites, Human Health and Ecological Risk Assessment	Required ☒ Methods ☐	Human Health and Ecological Risk Assessments that have been done on performed on site will be summarized.	4.5 Contaminated Sites, Human Health and Ecological Risk Assessment
4.5. Disposal of Chemicals, Reagents, Hazardous Materials and Contaminated Materials	Required ☒ Methods ☐	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.6 Disposal of Chemicals, Reagents, Hazardous Materials and Contaminated Materials
4.6. Groundwater Well Decommissioning	Required ☐ Methods ☐	No additional groundwater wells are currently expected as part of the Project.	4.7 Groundwater Well Decommissioning
4.7. Reclamation and Closure Prescriptions-			
4.7.1. Structures and Equipment	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.8.1 Structures and Equipment
4.7.2. Waste Rock Dump Reclamation	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.8.2 Waste Rock Dump Reclamation
4.7.3. Tailings Storage Facility Reclamation	Required ☐		4.8.3 Tailings Storage Facility Reclamation
4.7.4. Open Pit Reclamation Prescriptions	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.8.4 Open Pit Reclamation Prescriptions

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
4.7.5. Watercourse Reclamation Prescriptions	Required ☒	A description for reclamation of Bootjack Creek will be provided in the Application if it will be impacted the SERDS expansion. However, if Bootjack Creek habitat cannot be avoided then it will be buried by the SERDS. It would be addressed through habitat offsets rather than reclamation.	4.8.5 Watercourse Reclamation Prescriptions
4.7.6. Road Reclamation	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.8.6 Road Reclamation
4.7.7. Schedule	Required ☒	An updated schedule for reclamation and closure will be provided based on Project schedule. No change to the reclamation and closure plan presented in the 2017 Mine Reclamation and Closure Plan is required.	4.8.7 Schedule
4.8. Detailed Five-Year Mine Reclamation Plan	Required ☒		4.9 Detailed Five-Year Mine Reclamation Plan
4.9. Temporary Shutdown	Required ☒	A discussion on the potential implications of an extended temporary shutdown or care and maintenance of the mine as it relates to management of surface water quality, quantity and the estimated onset of acid rock drainage in the temporary NW PAG stockpile will be provided. Additionally, this section will also include a contingency management plan for PAG material stored on site that cannot be backfilled into existing pits during extended temporary shutdowns. If additional mitigation measures are required during a temporary shutdown, details and associated cost estimates will also be provided.	4.10 Temporary Shutdown
4.10. Post-Closure Monitoring and Maintenance	Required ☒	Will be included in the Conceptual Reclamation and Closure Plan for the Project.	4.11 Post-Closure Monitoring and Maintenance
4.11. Reclamation Cost Estimate			
4.11.1. Conventional Reclamation and Closure	Required ☒	Reclamation cost estimates for closure scenario will be provided under separate cover.	4.12 Reclamation Cost Estimate
4.11.2. Post-Closure Monitoring	Required ☒	Reclamation cost estimates for closure scenario will be provided under separate cover.	4.12 Reclamation Cost Estimate
4.11.3. Post-Closure Maintenance (excluding Water Treatment)	Required ☒	Reclamation cost estimates for closure scenario will be provided under separate cover.	4.12 Reclamation Cost Estimate
4.11.4. Life of Mine Water Treatment	Required ☒	Reclamation cost estimates for closure scenario will be provided under separate cover.	4.12 Reclamation Cost Estimate
5. MODELLING, MITIGATION, AND DISCHARGES			
5.1. Summary	Required ☒	Qualitative hydrology and water quality assessments of the potential effects of the Project will be provided.	5.1 Summary
5.2. Conceptual Site Model	Required ☐ Methods ☐		5.2 Conceptual Site Model
5.3. Site-Wide Water Balance Model	Required ☒ Methods ☐	Quantitative model will be updated to reflect new LOM schedule. Updates include revisions to catchment boundaries, storage, and runoff impacted by mine development. Results will include facility level water volume and level projections and estimated discharge quantities from the site. Details on the operational efficiency and reliability of the WTP and a model sensitivity scenario that reflects recent operational data will be provided. No change to the site-wide water balance is associated with result of the Project. The capacity and surface area of the Temporary NW PAG Stockpile will not change. Water quantity will be discussed to provide context (Section 2.6.1).	5.3 Site-Wide Water Balance Model

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	**Requirements**	**Comments**	**Location in Final Application**
5.4. Surface Water Quality Model	Required ☒ Methods ☐	Details on the operational efficiency and reliability of the WTP and a model sensitivity scenario that reflects recent operational data will be provided. Updating the Surface Water Quality Model is not currently anticipated. However, the need for a site-specific excel based water quality model will be determined based on an evaluation of source terms by a QP. The Application must include an assessment on the potential changes of contaminant loading from the PAG Stockpile by lowering the cut-off for PAG classification from an NPR of 2 to 1.6. The Application must include an assessment on the potential changes of contaminant inputs originating from NAG storage facilities caused by the storage of material with an NPR between 2 and 1.6.	5.4 Surface Water Quality Model
5.5. Groundwater Model			
5.5.1.Conceptual Hydrogeologic Model	Required ☒ Methods ☐	As a component of the site-wide conceptual groundwater model, the application will confirm the understanding regarding the groundwater divide between Bootjack Lake and Springer Pit.	5.5.1 Conceptual Hydrogeologic Model
5.5.2.Numeric Hydrogeologic Model	Required ☒ Methods ☐	The application will include an update to the site-wide numerical hydrogeological model and a summary report which describes the model and its ability to simulate the current and future (both operational and closure) groundwater flow conditions that are relevant to this application. Model simulations must be used in the application to support a groundwater impact assessment and inform the groundwater monitoring, management, and mitigation efforts at the mine. If no update to the existing model is needed, supporting rationale from a QP will be provided.	5.5.2 Numeric Hydrogeologic Model
5.6. Mitigation Methods	Required ☐		
5.6.1.Best Available Technology Evaluation	Required ☐ Methods ☐		5.6.1 Best Available Technology Evaluation
5.6.2.Volume and Quantity Control Methods	Required ☐ Methods ☐		5.6.2 Volume and Quantity Control Methods
5.6.3.Geochemical Attenuation Processes	Required ☐ Methods ☐		5.6.3 Geochemical Attenuation Processes
5.6.4.Water Treatment		Information/discussions on the anticipated changes to water quantity and quality as informed by the Surface Water Balance and Surface Water Quality Models, and how it these predictions relate to the water treatment effectiveness and capacities will be provided. An update on water treatment technology and research development will be provided in the updated Water Management Plan submitted with the Application. This will include an implementation plan and schedule for water treatment technology development. current surface water monitoring program intended and that there are no proposed changes in the trigger values arising from the amendment application.	5.6.4 Water Treatment
5.6.4.1. Description	Required ☒	A description of the existing water treatment system will be provided in the Application. A discussion developed by a QP noting the existing WTPs ability to manage the potential impact of the Project will be included in the Application.	5.6.4.1 Description
5.6.4.2. Location	Required ☒	The location of the existing water treatment system will be provided in the Application.	5.6.4.2 Location
5.6.4.3. Detailed Design	Required ☐		5.6.4.3 Detailed Design
5.6.4.4. Treatment Effectiveness	Required ☒	Details on the operational efficiency and reliability of the WTP and a model sensitivity scenario that reflects recent operational data will be provided.	5.6.4.4 Treatment Effectiveness
5.6.4.5. Performance Risks	Required ☐		5.6.4.5 Performance Risks

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	**Requirements**	**Comments**	**Location in Final Application**
5.6.4.6. Influent and Effluent Water Quality	Required ☒	Predictions for changes to WTP influent volume and quality resulting from the Project will be provided. Additionally, this section will provide details on proposed mitigation, including WTP capacity, performance, and adequacy in mitigating the discharge.	5.6.4.6 Influent and Effluent Water Quality
5.6.4.7. Waste and By-Products	Required ☒		5.6.4.7 Waste and By-Products
5.6.4.8. Maintenance	Required ☐		5.6.4.8 Maintenance
5.6.4.9. Emergency Response Plans	Required ☐		5.6.4.9 Emergency Response Plans
5.6.4.10. Monitoring Plans	Required ☒	Existing monitoring plans and their relevance to the Project will be discussed in the Application. The Application will include: • Information on potential changes to material handling procedures for placing material from Springer Deep and WX zones with an NPR between 1.6 and 2 in Not Potentially Acid Generating (NAG) storage facilities. • Information on potential changes to material handling procedures to account for the effects of mineral partitioning during blast fractionation for material from Springer Deep and WX zones.	5.6.4.10 Monitoring Plans
5.6.4.11. Schedule	Required ☒		5.6.4.11 Schedule
5.6.4.12. Cost Estimate	Required ☐		5.6.4.12 Cost Estimate
5.7. Domestic Water/Sewage Treatment	Required ☐ Methods ☐		5.7 Domestic Water/Sewage Treatment
5.8. Effluent Discharge	Required ☒ Methods ☐	A description of effluent discharge will be included in the Application. This will be informed by updates to the Surface Water Balance, Surface Water Quality Models, and Water Management Plan. The potential for non-point discharge seepages to occur will be assessed, if identified a focused monitoring/mitigation program would be reviewed if required.	5.8 Effluent Discharge
5.9. Initial Dilution Zone	Required ☒ Methods ☐		5.9 Initial Dilution Zone
6. ENVRIONMENTAL ASSESSMENT PREDICTIONS			
6.1. Aquatic Resources	Required ☒ Methods ☐		6.1 Aquatic Resources
6.2. Terrestrial Resources	Required ☒ Methods ☐		6.2 Terrestrial Resources

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
7. ENVIRONMENTAL MONITORING		A list of the required changes to the existing Comprehensive Environmental Monitoring Plan based on the proposed Project and associated changes to water management on site will be provided. A summary of any new information and science available including but not limited to publications from QRCC will be provided and considered in the context of the proposed expansion project and the review of the CEMP. An interim update to the Water Management Progress Report required by condition 2.12 of PE-11678 will be provided with the Application. Updates will be provided for: - Site-wide water quality model; - Site-wide water balance model; - Water Management Plan (Mine Operations); - Annual Discharge Plan; - Any other plans that will require updates to reflect the proposed Springer Expansion. Revisions to the Flocculant Management Plan will be completed if necessary. Additional monitoring requirements will be noted, including those related to Bootjack Lake.	7. ENVIRONMENTAL MONITORING
7.1. Environmental Monitoring Program Design	Required ☒ Methods ☐	The existing Comprehensive Environmental Monitoring Plan will be discussed in the Application.	7.1 Environmental Monitoring Program Design
7.2. Mine Site Water Monitoring Program	Required ☒ Methods ☐	The existing Comprehensive Environmental Monitoring Plan will be discussed in the Application.	7.2 Mine Site Water Monitoring Program
7.3. Discharge Monitoring Program	Required ☒ Methods ☐	The existing Comprehensive Environmental Monitoring Plan will be discussed in the Application.	7.3 Discharge Monitoring Program
7.4. Environment Monitoring Program	Required ☒ Methods ☐	The existing Comprehensive Environmental Monitoring Plan will be discussed in the Application.	7.4 Environment Monitoring Program
7.5. Post-Closure Environmental Monitoring Program	Required ☒ Methods ☐	As informed by the 2022 Mine Plan and Reclamation Program.	7.5 Post-Closure Environmental Monitoring Program
7.6. Aquatic Effect Monitoring Program	Required ☒ Methods ☐	The existing Comprehensive Environmental Monitoring Plan will be discussed in the Application.	7.6 Aquatic Effect Monitoring Program
8. HEALTH AND SAFETY			
8.1. Occupational Health and Safety Program			
8.1.1. Occupational Health Risk Assessment	Required ☐		-
8.1.2. Ergonomics	Required ☐		-
8.1.3. Emergency Wash Facilities	Required ☐		-
8.1.4. Hazardous Dust	Required ☐		-
8.1.5. Lunchrooms, Mine Dry, and Sanitary Conveniences	Required ☐		-
8.2. Post Permitting Requirements			
8.2.1. Issued for Construction Plans	Required ☐		-
8.2.2. Letters of Assurance	Required ☐		-
8.2.3. Occupational Health Programs	Required ☐		-
8.2.4. Workplace Hazardous Materials Information System (WHMIS)	Required ☐		-
8.2.5. Additional Information and Certifications	Required ☐		-
9. MANAGEMENT PLANS			

Information (refer to "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits" for additional info on each section)	**Requirements**	**Comments**	**Location in Final Application**
9.1. Environmental Management System	Required ☒		9.1 Environmental Management System
9.2. Surface Erosion Prevention and Sediment Control Plan	Required ☒	Relevant information for surface erosion prevention and sediment control will be included in the Application.	9.2 Surface Erosion Prevention and Sediment Control Plan
9.3. Soil Management Plan	Required ☒	The existing Soil Management Plan will be used to inform the soil salvage and stockpile management.	9.3 Soil Management Plan
9.4. Construction Environmental Management Plan	Required ☐		9.4 Construction Environmental Management Plan
9.5. ML/ARD Management Plan	Required ☒	The ML/ARD Management Procedure Manual will be updated to reflect the reduced NPR. This update will be approved by QP.	9.5 ML/ARD Management Plan
9.6. Mine Site Water Management Plan	Required ☒	Information related to construction water management and the existing Mine Site Water Management Plan will be included in the Application.	9.6 Mine Site Water Management Plan
9.7. Discharge Management Plan	Required ☒		9.7 Discharge Management Plan
9.8. Vegetation Management Plan	Required ☐		9.8 Vegetation Management Plan
9.9. Invasive Plant Management Plan	Required ☒		9.9 Invasive Plant Management Plan
9.10. Wildlife Management Plan	Required ☒		9.10 Wildlife Management Plan
9.11. Archaeological Management and Impact Mitigation Plan	Required ☒		9.11 Archaeological Management and Impact Mitigation Plan
9.12. Mine Emergency Response Plan	Required ☒		9.12 Mine Emergency Response Plan
9.13. Mine Site Traffic Control Plan	Required ☒		9.13 Mine Site Traffic Control Plan
9.14. Fuel Management and Spill Control Plan	Required ☒		9.14 Fuel Management and Spill Control Plan
9.15. Combustible Dust Management Plan	Required ☐		9.15 Combustible Dust Management Plan
9.16. Chemicals and Materials Storage, Transfer, and Handling Plan	Required ☐		9.16 Chemicals and Materials Storage, Transfer, and Handling Plan
9.17. Waste (Refuse and Emissions) Management Plan	Required ☐		9.17Waste (Refuse and Emissions) Management Plan

APPENDIX 1-2: Information Requirements Table – TSF Interim Raise to 974 m

Joint Information Requirements Table

for

Mines Act and *Environmental Management Act* Permits

Prepared by:

British Columbia Ministry of Energy, Mines and Petroleum Resources

&

British Columbia Ministry of Environment and Climate Change Strategy

January 2024

Introduction

The Information Requirements Table (IRT) serves as the single list of information requirements for a *Mines Act* (MA) permit application, issued by the Ministry of Energy, Mines and Low Carbon Innovation (EMLI), and an effluent discharge permit application under the *Environmental Management Act* (EMA), by the Ministry of Environment and Climate Change Strategy (ENV). The IRT is intended to:

- Be used in conjunction with the document entitled, "Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits"[1] and is intended for use in the development of both new and/or permit amendment applications. The information contained within the IRT will be developed to meet the unique nature of each project.
- It is also to be used in conjunction with all other guidance provided by either ENV or EMLI.
- Inform clients of the detailed information required to support MA and EMA permit applications and ensure all the information necessary to support the MA and EMA applications is provided; and
- Aid ENV and EMLI technical staff during the screening phase.

Overview

The IRT is intended to aid proponents and reviewers through the coordinated authorizations review process: during the pre-application stage to determine the information requirements, prior to submitting an application, and in screening, to ensure the required information has been included in the application submission.



It is recommended that proponents carefully review the entire Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits and consider any possible information requirements that may apply to their project proposal. If a specific methodology from the Joint Application Information Requirements guidance document is being proposed, this should be identified in the IRT and initially be described at a high level by proponents during the pre-application stage. More detail or specific Information Requirements can be added by adding in new lines into the IRT in the appropriate section.

After proponents have created a first draft of the IRT, reviewers will carefully review the project proposal and draft IRT prior to meeting with proponents to identify any missing information requirements or areas that require further discussion. The pre-application phase is most often an iterative set of discussions between the proponent and technical reviewers, regarding the information requirements and any specifics and/or methodologies that may be required in a joint

MA/EMA permit application.

Once complete, the province will send the final IRT to proponents for their use in preparing their application. A copy of the IRT must accompany the application submission by proponents and must indicate the locations of each information requirement within the application (far right-hand column).

It is important to note that changes in a project proposal may occur during the pre-application, screening, and/or review phases of the process. These changes may require a reassessment of the information required for an application. Proponents and reviewers will work together to discuss these changes and identify any revisions or additional information requirements.

Abbreviations

CEMP	Construction Environmental Management Plan
CSM	Conceptual Site Model
EMA	*Environmental Management Act*
EMPR	Ministry of Energy, Mines and Petroleum Resources
ENV	Ministry of Environment and Climate Change Strategy
IFC	Issued for Construction
IRT	Information Requirements Table
MA	*Mines Act*
ML/ARD	Metal Leaching and Acid Rock Drainage
WHMIS	Workplace Hazardous Materials Information System

Application Sign-Off

Project: TSF Interim Raise to elevation 974 m

Applicant Representative:

Name: Mathieu O'Leary

Title: Water and TSF Superintendent, Mount Polley Mining Corporation

Applicant Signature to indicate Agreement with Requirements

_____ Date signed: _____

Ministry of Environment and Climate Change Strategy, Environmental Protection Division

Application (AMS Tracking #: _____), Tentative Authorization #: _____

Ministry Representative:

Name: _____

Title: _____

Ministry Representative Signature to indicate Agreement with Requirements

_____Date signed: _____

Ministry of Energy, Mines, and Petroleum Resources, Major Mines Office

Ministry Representative:

Name: _____

Title: _____

Ministry Representative Signature to indicate Agreement with Requirements

_____Date signed: _____

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
1. INTRODUCTION AND PROJECT OVERVIEW			
1.1. Application Background	Required ☒ Methods ☐	The scope of this application includes the following construction activities: • Extension of portions of the existing buttresses along the Main and Perimeter embankments • Resloping of the South, Main and Perimter embankments to 2H:1V. • Extension of the embankments at the south and north abutments • Construction of an upstream drain upstream of the till core along portions of the Main and Perimeter embankments.	
1.2. Proponent Information	Required ☒ Methods ☐		
1.3. Project Overview			
1.3.1. Project History	Required ☒ Methods ☐		
1.3.2. Overview of Products and Markets, and Projected Project Benefits	Required ☒ Methods ☐	Project benefits will be discussed.	
1.3.3. Location, Access, and Land Use	Required ☒ Methods ☐	A summary description of the Project location and access relative to MPMC, including a figure, will be included in the Application. Coordinates for the location of the Project will be provided in the Application. Figures will be developed to illustrate the following: • The location of MPMC • MPMC layout • Project Footprint • Relevant infrastructure	
1.3.4. Mine Components and Off-Site Infrastructure	Required ☒ Methods ☐	The components of the Project will be described in the Application. Stamped and signed (Issued for Permitting) engineering drawings will be provided at a suitable level of detailed design.	
1.3.5. Mine Development and Operations	Required ☒ Methods ☐	Details regarding how the Project fits into the permitted and future mine plan will be provided in the Application.	
1.3.6. Mine Design and Assessment Team	Required ☒ Methods ☐		
1.3.7. Spatial Data	Required ☒ Methods ☐	Relevant spatial data will be provided as maps, including maps of Project and Project component's locations.	
1.3.8. Concordance with Environmental Assessment Conditions	Required ☒ Methods ☐	Information relevant to the proposed Project will be provided in the Application. If no relevant commitments, then a statement will be included in the Application indicating that there are no applicable commitments.	
1.4. Regulatory Framework	Required ☒ Methods ☐	A summary of authorizations / approvals required for the Project will be provided. Existing authorizations that govern aspects of the Project will be identified.	
1.5. Indigenous Engagement			
1.5.1. Background	Required ☒ Methods ☐	MPMC operates in the territory of the William's Lake First Nation and the Xatśūll First Nation. Summary of previous and planned engagement activities with these First Nation's will be provided.	
1.5.2. Asserted and Established Rights and Interests	Required ☒ Methods ☐	See 1.5.1	
1.5.3. Engagement Efforts	Required ☒ Methods ☐	See 1.5.1.	
2. BASELINE INFORMATION			

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
2.1. Summary	Required ☒ Methods ☐	Baseline conditions will be described and will focus on parts of the environment that may be affected by the Project. The scope of the baseline information will be to provide information to support assessment consistent with the scope of this Application. Baseline information will be summarized from existing monitoring programs.	
2.2. Meteorology and Climate	Required ☒ Methods ☐	A summary of relevant meteorological and climate information will be provided, based on existing monitoring data. The baseline information will include parameters relevant for the design and construction of the Project, such as precipitation, snowpack, temperature, and evapotranspiration.	
2.3. Geology			
2.3.1. Regional Geology	Required ☒ Methods ☐	A foundation characterization report that meets the intent of the EGBC site characterization for dam foundation guidelines will be provided.	
2.3.2. Deposit (Ore) Geology	Required ☐ Methods ☐		
2.3.3. Surficial Geology, Terrain, and Geohazard Mapping	Required ☒ Methods ☐	See 2.3.1	
2.3.4. Natural and Seismic Hazards Assessments	Required ☒ Methods ☐	See 2.3.1	
2.3.5. Soil Survey and Soil Characterization for Reclamation	Required ☒ Methods ☐	The TSF expansion is expected to occur in a largely disturbed area within the M-200 permit boundary; however, the associated water management infrastructure will extend beyond the M-200 permit boundary requiring a boundary extension. Soil survey and soil characterization will be provided for all natural areas that may be disturbed.	
2.4. Geochemical Characterization and Source Terms	Required ☐ Methods ☐		
2.4.1. Geochemical Characterization	Required ☒ Methods ☐	The existing geochemical characterization results used for the tailings will be provided.	
2.4.2. Geochemical Source Terms	Required ☒ Methods ☐	The existing geochemical source terms used for the tailings will be provided.	
2.5. Topography and Surface Drainage Features	Required ☒ Methods ☐	Existing topography and surface drainage features relevant to the Project components addressed in this application will be described. A figure showing an overview of surface drainage will be provided.	
2.6. Water Quantity			
2.6.1. Surface Water Quantity	Required ☒ Methods ☐	The hydrology baseline information for the Project will be provided, with references to existing studies, where applicable, and previously published hydrological datasets. The baseline information will be summarized from data collection programs already in place. Project-related effects on the surface water environment and site water management will be developed based on the results of existing modelling analyses. Relevant maps will be provided.	
2.6.2. Groundwater Quantity	Required ☒ Methods ☐	Existing groundwater conditions relevant to the Project will be provided, with references to existing studies, where applicable, and previously published hydrological datasets. The baseline information will be summarized from data collection programs already in place.	

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
2.7. Water Quality			
2.7.1. Surface Water Quality	Required ☒ Methods ☐	A summary of relevant surface water quality baseline information will be provided. This section will be prepared by summarizing available data and from reports associated with the sites water quality monitoring programs.	
2.7.2. Groundwater Quality	Required ☐ Methods ☐	Existing groundwater conditions relevant to the Project will be provided, with references to existing studies, where applicable, and previously published hydrological datasets. The baseline information will be summarized from data collection programs already in place.	
2.8. Sediment Quality	Required ☐ Methods ☐		
2.9. Fisheries and Aquatic Resources			
2.9.1. Periphyton and Benthic Invertebrate Community Measures	Required ☐ Methods ☐		
2.9.2. Fish and Fish Habitat	Required ☐ Methods ☐		
2.9.3. Tissue Residues	Required ☐ Methods ☐		
2.10. Ecosystems and Wildlife	Required ☒ Methods ☐	The Project TSF expansion is expected to occur in a largely disturbed area within the M-200 permit boundary; however, the associated water management infrastructure will extend beyond the M-200 permit boundary.	
2.11. Land Status and Use	Required ☒ Methods ☐	A summary of land status and use will be provided.	
2.12. Archaeology	Required ☒ Methods ☒	The Project TSF expansion is expected to occur in a largely disturbed area within the M-200 permit boundary; however, the associated water management infrastructure will extend beyond the M-200 permit boundary.. Archaeological resources for the site have previously been identified and will be summarized based on that report.	
2.13. Cultural Use	Required ☒ Methods ☐	The application will contain a brief statement that there is no current cultural resource use of the tailings storage area.	
3. MINE PLAN			
3.1. Mine Plan Overview	Required ☒	A high-level overview of current mining will be provided in the Application. A description of how the Project will interact with mining will be provided. The following figures are planned: • Site General Arrangement Plan • Project Overall Plot Plan	
3.2. Existing Development	Required ☒	The existing environment will be described in Section 2 in the context of the Project. Integration of the Project with the mine site will be described in other sections.	
3.3. Life of Mine Plan	Required ☒	An overview of the permitted life of mine plan will be provided,.	
3.4. Detailed Five Year Mine Plan	Required ☒		
3.5. Mine Facility Designs and Development	Required ☐		
3.5.1. Open Pits	Required ☐		
3.5.2. Underground Workings	Required ☐		
3.5.3. Processing Plant (Mill) and Associated Facilities	Required ☒	A high-level description of the processing plant, as it relates to the production of tailings, will be provided in the Application.	
3.5.4. Tailings Storage Facility and Associated Infrastructure	Required ☒	A detailed design report for the TSF interim raise to elevation 974 m will be provided in the Application.	
3.5.5. Waste Rock Dumps	Required ☐		

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
3.5.6. Water Management Structures	Required ☒	A description of how the Project will interact with existing water management structures will be provided. Designs for modifications to these structures will be included in the Application.	
3.5.7. Ore, Overburden, Soil and Construction Stockpiles	Required ☒	Descriptions of the soil and construction materials associated with the Project will be provided in the Application.	
3.5.8. Mine Access and Mine Haulage Roads	Required ☒	An overview of the access to the Project will be provided.	
3.5.9. Power Supply and Distribution Infrastructure	Required ☐		
3.5.10. Explosives Storage Facilities	Required ☐		
3.5.11. Ancillary Facilities and Support Infrastructure	Required ☐		
4. RECLAMATION AND CLOSURE PLAN			
4.1. End Land Use and Capability Objectives	Required ☒	The Application will include reclamation and closure information for the Project based on the latest update to the Mine Reclamation and Closure Plan	
4.2. Reclamation Approaches			
4.2.1. Soil Resources	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.2.2. Landform Design and Erosion Control	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.2.3. Revegetation Strategy	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.2.4. Progressive Reclamation/Sequencing	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.2.5. Reclamation Research	Required ☐		
4.2.6. Reclamation Monitoring	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.2.7. Habitat Compensation Works	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.3. Trace Element Uptake in Soils and Vegetation	Required ☐ Methods ☐		
4.4. Contaminated Sites, Human Health and Ecological Risk Assessment	Required ☐ Methods ☐		
4.5. Disposal of Chemicals, Reagents, Hazardous Materials and Contaminated Materials	Required ☐ Methods ☐		
4.6. Groundwater Well Decommissioning	Required ☐ Methods ☐		
4.7. Reclamation and Closure Prescriptions			
4.7.1. Structures and Equipment	Required ☐		
4.7.2. Waste Rock Dump Reclamation	Required ☐		
4.7.3. Tailings Storage Facility Reclamation	Required ☒	The Application will include reclamation and closure information for the Project and based on the latest update to the Mine Reclamation and Closure Plan	
4.7.4. Open Pit Reclamation Prescriptions	Required ☐		
4.7.5. Watercourse Reclamation Prescriptions	Required ☒		

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
4.7.6. Road Reclamation	Required ☐		
4.7.7. Schedule	Required ☒		
4.8. Detailed Five-Year Mine Reclamation Plan	Required ☒	The Application will include reclamation and closure information for the Project.	
4.9. Temporary Shutdown	Required ☒		
4.10. Post-Closure Monitoring and Maintenance	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.11. Reclamation Cost Estimate			
4.11.1. Conventional Reclamation and Closure	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.11.2. Post-Closure Monitoring	Required ☒	As informed by the Mine Reclamation and Closure Plan	
4.11.3. Post-Closure Maintenance (excluding Water Treatment)	Required ☒		
4.11.4. Life of Mine Water Treatment	Required ☒		
5. MODELLING, MITIGATION, AND DISCHARGES			
5.1. Summary	Required ☒		
5.2. Conceptual Site Model	Required ☐ Methods ☐		
5.3. Site-Wide Water Balance Model	Required ☒ Methods ☐	An updated water balance will be provided with the Application.	
5.4. Surface Water Quality Model	Required ☒ Methods ☐	An updated water quality model will be provided with the Application.	
5.5. Groundwater Model			
5.5.1. Conceptual Hydrogeologic Model	Required ☐ Methods ☐		
5.5.2. Numeric Hydrogeologic Model	Required ☒ Methods ☐	Existing numerical model for the TSF will be updated	
5.6. Mitigation Methods	Required ☐		
5.6.1. Best Available Technology Evaluation	Required ☐ Methods ☐		
5.6.2. Volume and Quantity Control Methods	Required ☒ Methods ☒		
5.6.3. Geochemical Attenuation Processes	Required ☐ Methods ☐		
5.6.4. Water Treatment			
5.6.4.1. Description	Required ☒	A brief description of the existing water treatment system will be provided in the Application. A high-level description of the proposed modifications will be provided as part of the Application.	
5.6.4.2. Location	Required ☒	A brief description of the existing water treatment system will be provided in the Application. A high-level description of the proposed modifications will be provided as part of the Application.	
5.6.4.3. Detailed Design	Required ☒		
5.6.4.4. Treatment Effectiveness	Required ☒		
5.6.4.5. Performance Risks	Required ☒		
5.6.4.6. Influent and Effluent Water Quality	Required ☒		

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
5.6.4.7. Waste and By-Products	Required ☒		
5.6.4.8. Maintenance	Required ☒		
5.6.4.9. Emergency Response Plans	Required ☒		
5.6.4.10. Monitoring Plans	Required ☒	Existing monitoring plans and their relevance to the Project will be discussed in the Application.	
5.6.4.11. Schedule	Required ☒		
5.6.4.12. Cost Estimate	Required ☒		
5.7. Domestic Water/Sewage Treatment	Required ☐ Methods ☐		
5.8. Effluent Discharge	Required ☐ Methods ☐		
5.9. Initial Dilution Zone	Required ☐ Methods ☐		
6. ENVRIONMENTAL ASSESSMENT PREDICTIONS			
6.1. Aquatic Resources	Required ☐ Methods ☐		
6.2. Terrestrial Resources	Required ☒ Methods ☐	The Project TSF expansion is expected to occur in a largely disturbed area within the M-200 permit boundary; however, the associated water management infrastructure will extend beyond the M-200 permit boundary..	
7. ENVIRONMENTAL MONITORING			
7.1. Environmental Monitoring Program Design	Required ☐ Methods ☐		
7.2. Mine Site Water Monitoring Program	Required ☒ Methods ☐	The existing Mine Site Water Monitoring Program will be discussed in the Application.	
7.3. Discharge Monitoring Program	Required ☐ Methods ☐		
7.4. Environment Monitoring Program	Required ☐ Methods ☐		
7.5. Post-Closure Environmental Monitoring Program	Required ☒ Methods ☐	As informed by the Mine Reclamation and Closure Plan	
7.6. Aquatic Effect Monitoring Program	Required ☐ Methods ☐		
8. HEALTH AND SAFETY			
8.1. Occupational Health and Safety Program			
8.1.1. Occupational Health Risk Assessment	Required ☒	The existing site wide Construction Environmental Management Plan will be used to support the Project.	
8.1.2. Ergonomics	Required ☐		
8.1.3. Emergency Wash Facilities	Required ☐		
8.1.4. Hazardous Dust	Required ☐		
8.1.5. Lunchrooms, Mine Dry, and Sanitary Conveniences	Required ☐		

Information (refer to "Joint Application Information Requirements for Mines Act and Environmental Management Act Permits" for additional info on each section)	Requirements	Comments	Location in Final Application
8.2. Post Permitting Requirements			
8.2.1. Issued for Construction Plans	Required ☒		
8.2.2. Letters of Assurance	Required ☐		
8.2.3. Occupational Health Programs	Required ☐		
8.2.4. Workplace Hazardous Materials Information System (WHMIS)	Required ☐		
8.2.5. Additional Information and Certifications	Required ☐		
9. MANAGEMENT PLANS			
9.1. Environmental Management System	Required ☐		
9.2. Surface Erosion Prevention and Sediment Control Plan	Required ☒	Relevant information for surface erosion prevention and sediment control will be included in the Application.	
9.3. Soil Management Plan	Required ☒	The existing Soil Management Plan will be used to inform the soil salvage and stockpile management	
9.4. Construction Environmental Management Plan	Required ☒	Management of materials to be used on site during construction will be addressed through the Construction Environmental Management Plan.	
9.5. ML/ARD Management Plan	Required ☒		
9.6. Mine Site Water Management Plan	Required ☒	Information related to construction water management will be included in the Application.	
9.7. Discharge Management Plan	Required ☐		
9.8. Vegetation Management Plan	Required ☒		
9.9. Invasive Plant Management Plan	Required ☒		
9.10. Wildlife Management Plan	Required ☒		
9.11. Archaeological Management and Impact Mitigation Plan	Required ☒		
9.12. Mine Emergency Response Plan	Required ☒		
9.13. Mine Site Traffic Control Plan	Required ☒		
9.14. Fuel Management and Spill Control Plan	Required ☒		
9.15. Combustible Dust Management Plan	Required ☐		
9.16. Chemicals and Materials Storage, Transfer, and Handling Plan	Required ☐		
9.17. Waste (Refuse and Emissions) Management Plan	Required ☐		

APPENDIX 1-3: Tailings Storage Facility - Detailed Design to Elevation 974 m

REPORT

Tailings Storage Facility - Detailed Design to Elevation 974 m

Mount Polley Mine

Submitted to:

Mount Polley Mining Corporation

Submitted by:

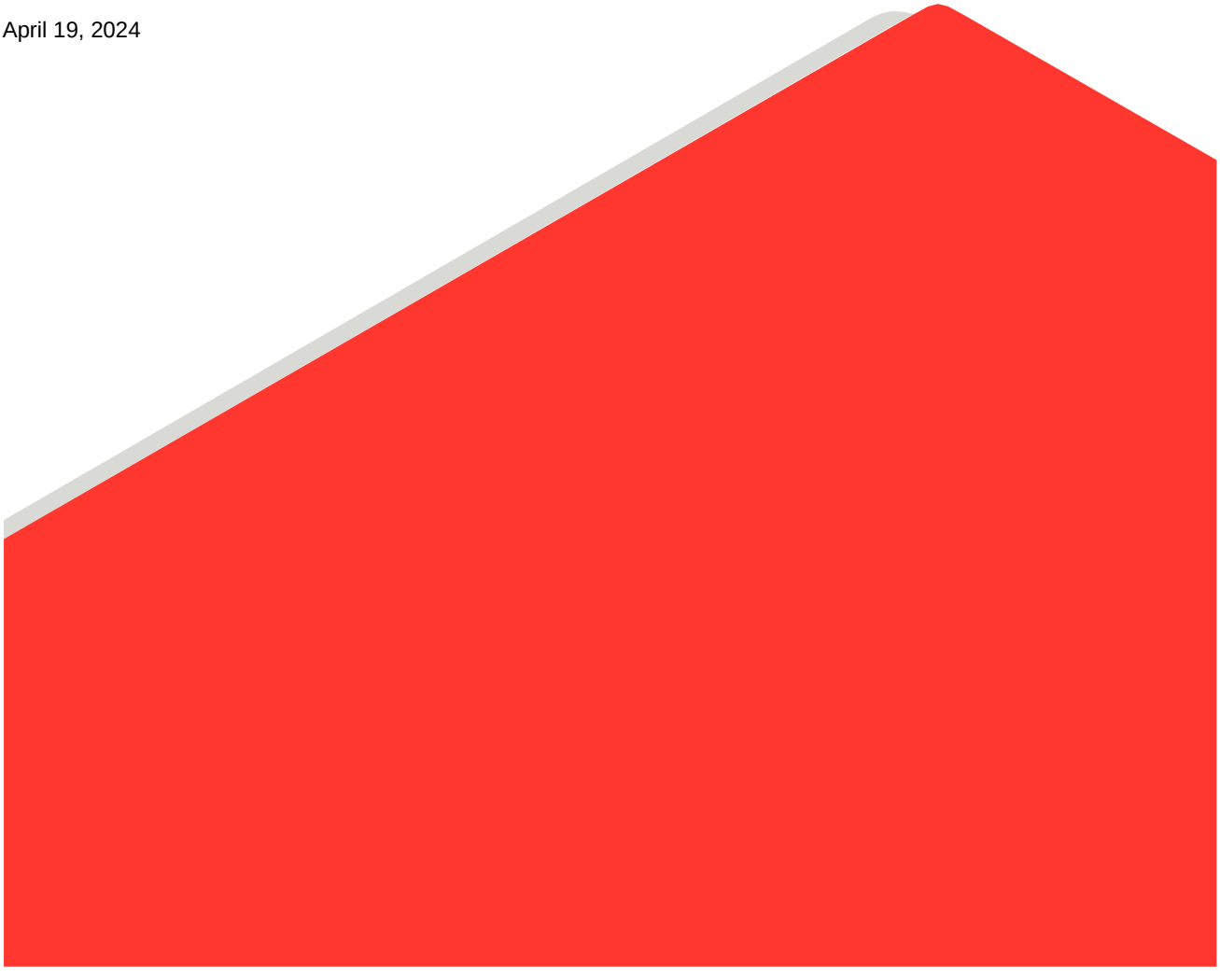
WSP Canada Inc.

840 Howe Street, Suite #1000, Vancouver, BC, V6Z 2M1 Canada

+1 604 685-9381

Reference No. CA0020527.4505-014-R-Rev0-51394

April 19, 2024



Distribution List

Electronic Copy: Mount Polley Mining Corporation

Electronic Copy: WSP Canada Inc.

STUDY LIMITATIONS

WSP Canada Inc. (WSP) has prepared this document in a manner consistent with the level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by WSP for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP's professional judgment based on the knowledge and information available at the time of completion. WSP is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to MPMC, and are not applicable to any other project or location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by WSP, are considered its professional work product and shall remain the copyright property of WSP. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document

Table of Contents

STUDY LIMITATIONS ..... **ii**

1.0 INTRODUCTION **1**

2.0 BACKGROUND **2**

3.0 BASIS OF DESIGN **3**

3.1 Design and Operation Philosophy 3

3.2 Design Basis and Criteria 3

4.0 SITE CONDITIONS **7**

4.1 Site Location and Geomorphology 7

4.2 Climate 7

4.3 Hydrology 8

4.4 Geology 8

4.5 Seismicity 9

4.6 Geotechnical Conditions 9

4.7 Hydrogeology 10

4.8 Groundwater Geochemical Conditions 11

5.0 TAILINGS CHARACTERIZATION **12**

5.1 Geotechnical Characterization 12

5.2 Tailings Chemistry 13

6.0 DESIGN DESCRIPTION **15**

6.1 Overview of Embankment Raise 15

6.2 Embankment Materials and Zoning 15

6.3 Foundation Preparation 17

6.3.1 North and South Abutments 18

6.4 Water Management 18

6.5 Tailings Management and Deposition 19

6.6 Upstream Drain 19

7.0 DESIGN ANALYSES AND ASSESSMENTS **20**

7.1 Siting and Deposition Technology 20
7.1.1 Objectives 20
7.1.2 Site Alternatives and Available Deposition Technologies 21
7.1.3 Findings and Recommended Site and Deposition Technology 22
7.2 Tailings Storage Facility Water Balance 23
7.3 Tailings Storage Capacity 25
7.4 Internal Erosion 26
7.4.1 Till Core – Filter Compatibility 26
7.4.2 Filter – Transition Compatibility 28
7.4.3 Transition – Rockfill Compatibility 28
7.5 Seepage Analysis 29
7.5.1 Material Properties Calibration 30
7.5.2 Boundary Conditions 31
7.5.3 Seepage Analysis Results 32
7.5.3.1 Phreatic Level and Hydraulic Gradient 32
7.5.3.2 Flow Rates through Upstream Drain 34
7.5.3.3 Seepage Rates through Embankment and Foundation 35
7.6 Upstream Drain Design 36
7.6.1 Pipe Sizing 37
7.7 Stability Analysis 38
7.7.1 Design Criteria for Slope Stability 38
7.7.2 Material Properties 39
7.7.2.1 Embankment Fill Materials 39
7.7.2.2 Foundation Soils 39
7.7.3 Liquefaction Potential of Foundation Soils 42
7.7.4 Method and Scenarios Assessed 42
7.7.5 South Embankment Stability Analysis Results 45
7.7.6 Main Embankment Stability Analysis Results 45
7.7.7 Perimeter Embankment Stability Analysis Results 47

7.7.8 Upstream Stability Analysis Results 49
7.8 Static Deformations 49
7.9 Stress Deformation Modelling 49
7.9.1 Static Analysis 50
7.9.2 Seismic Analysis 50
7.10 Water Management Infrastructure 51
7.10.1 Tailings Storage Facility Freeboard and Emergency Spillway 51
7.10.2 Tailings Storage Facility Seepage Collection Channels and Ponds 54
7.11 Tailings Storage Facility Closure and Reclamation 55
7.12 Geotechnical Risk Review and Design Controls 55
8.0 INSTRUMENTATION 63
9.0 MATERIAL QUANTITIES 65
10.0 CONSTRUCTION 67
10.1 Construction Schedule 67
10.2 Construction Sequence 69
11.0 CLOSURE 69

TABLES

Table 1: Design Basis and Criteria 4
Table 2: Summary of Key Climate Parameters for Mount Polley Mine 7
Table 3: Peak Ground Accelerations (5%-damped) for Selected Annual Exceedance Probabilities at the Mount Polley Tailings Storage Facility Site (V_{S30} = 849 m/s) 9
Table 4: Characteristics of Existing Tailings 12
Table 5: Embankment Zoning 15
Table 6: Tailings Storage Facility Water Volume (m^3) – Springer Expansion Life of Mine Plan 24
Table 7: Parameters Adopted for Tailings Storage Facility Deposition Modelling 25
Table 8: Tailings Capacity vs Tailings Discharge Elevation for Tailings Storage Facility Crest Elevation 974 m 26
Table 9: Material Properties Used for Seepage Modelling 30
Table 10: Phreatic Level against the Till Core and Hydraulic Gradient across the Till Core 33
Table 11: Flow through Upstream Drains at Tailings Storage Facility Elevation 974 m 34
Table 12: Flow through the Embankment and Foundation 35

Table 13: Flow through Upstream Drains at Tailings Storage Facility Elevation 987 m with a 50 m Beach 37
Table 14: Slope Stability Analysis Design Criteria 38
Table 15: Embankment Material Properties for Stability Analysis.....39
Table 16: Foundation Material Parameters for Stability Analysis.....41
Table 17: Stability Analysis Results – South Embankment.....45
Table 18: Stability Analysis Results – Main Embankment 46
Table 19: Stability Analysis Results – Perimeter Embankment.....48
Table 20: Summary of the Emergency Spillway Arrangement and Flood Routing Results for Inflow Design Flood 52
Table 21: Summary of the Emergency Spillway Channel Design.....53
Table 22: Spillway Stilling Basin Length.....54
Table 23: Summary of Tailings Storage Facility Failure Modes Assessment 56
Table 24: Failure Modes Required to Be Assessed.....61
Table 25: Existing and Proposed Instrumentation for Monitoring of Tailings Storage Facility Failure Modes 64
Table 26: Material Quantities for Tailings Storage Facility Raise to Elevation 974 m.....65

FIGURES

Figure 1: Gradation of Existing Tailings.....13
Figure 2: Typical Cross-Section 16
Figure 3: Embankment Construction Material Particle Size Distribution Envelopes.....17
Figure 4: Tailings Storage Facility Water Volume from Operations to 10 Years after Post-closure – Springer Expansion Life of Mine Plan.....24
Figure 5: Filter Compatibility between Till Core and Filter Materials Constructed Prior to August 2014 27
Figure 6: Filter Compatibility between Filter and Transition Materials Constructed Prior to August 2014.....28
Figure 7: Filter Compatibility between Transition and Rockfill Materials Constructed Prior to August 2014 29
Figure 8: Main Embankment (Stn. 2+055) Total Seepage through Toe/Foundation 36
Figure 9: Stability Model Cross-Section Locations.....44
Figure 10: Tailings Storage Facility Embankment Tailings Deposition and Construction Schedule.....68

APPENDICES

APPENDIX A
Design Drawings

APPENDIX B
Technical Specifications

APPENDIX C
Design Criteria

APPENDIX D
Siting and Technology Study

APPENDIX E
Tailings Deposition Models

APPENDIX F
Seepage Models

APPENDIX G
Stability Models

APPENDIX H
Stress Deformation Models

APPENDIX I
Water Management Design

APPENDIX J
Type I Independent Review Checklist and Signoff

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) has retained WSP Canada Inc. (WSP) to complete a detailed design to raise the tailings storage facility (TSF) at Mount Polley Mine. This report presents the detailed design to support raising the TSF from its currently permitted elevation of 970 m to a crest elevation of 974 m. The design crest elevation 974 m is an interim design to enable the TSF to be raised while design efforts for a potential raise of the TSF to contain the life of mine (LoM) tailings is advanced. The following are included in this report:

- design of the TSF raise to elevation 974 m, including the following design assessments:
  - site and deposition technology
  - storage capacity
  - seepage through the embankment and foundation
  - filter compatibility
  - upstream drain capacity
  - slope stability and deformation
  - water balance
  - risk review and design controls
- review and update of the TSF pond management, spillway design, and freeboard requirements
- construction drawings and technical specifications
- material quantities
- closure considerations

This report should be read in conjunction with the most recent TSF site characterization report (WSP 2023).

This design supports regulatory permit application, and hence satisfies the BC Ministry of Energy, Mines and Low Carbon Innovation requirements outlined in the Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2022). Design drawings of the TSF raise are provided in Appendix A, and the construction technical specification is provided in Appendix B.

MPMC defined and uses the coordinate system tailings grid for the TSF. All coordinates and elevations are presented in tailings grid.

2.0 BACKGROUND

Mount Polley Mine is a copper and gold mine near Williams Lake, British Columbia (BC), operated by MPMC, a subsidiary of Imperial Metals Corporation. The TSF is located about 3 km southeast of the mill and includes one embankment that is approximately 4.8 km in length (Drawing 02, Appendix A). The embankment is subdivided into three sections: the Main Embankment, Perimeter Embankment, and South Embankment (Drawing 03, Appendix A). The embankment has incorporated a staged expansion design utilizing modified centreline and centreline construction methods. The general zoning of the TSF embankment consists of the following:

- upstream fill comprising tailings sand and select fill (e.g., rockfill)
- low-permeability till core
- filter zone
- transition zone
- rockfill

Rockfill forms the downstream wedge of the embankments and the downstream buttress along the Perimeter and Main embankments.

Mount Polley Mine began production in 1997 and operated until October 2001 when operations were suspended for economic reasons. In March 2005, the mine restarted, and was in operation up to the time of the TSF breach in August 2014. The embankment crest was near elevation 968 m at the time.

In 2015, the Freshet Embankment was constructed to elevation 950 m through the breach area to allow the capture and temporary storage of the 2015 and 2016 freshet flows. The construction of buttresses along the Perimeter and Main embankments was completed in October 2016 (Golder 2015a, 2017a).

The June 23, 2016, amendment of *Mines Act* Permit M-200 authorized the return to full operations at the mine, including construction of the TSF to elevation 970 m (Golder 2015b) and deposition of tailings. Construction to raise the Freshet Embankment at Corner 1 to elevation 970 m started in June 2016. By September 2018, construction had been completed to elevation 968 m (Golder 2019b).

Mining operations at Mount Polley Mine were halted between May 2019 and Q4 2021 for economic reasons. In June 2022, the mill restarted operations and tailings deposition into the TSF resumed. Construction to raise the South, Main, and Perimeter embankments to elevation 970 m was restarted in July 2022 and was completed in 2023.

A feasibility design for raising the embankment of the TSF to an elevation of 984 m was completed in 2014 (Golder 2015c). The aim of the feasibility assessment was to identify potential considerations, constraints, or conflicts that may limit the elevation to which the TSF could be raised. The results of the study indicated that a raise of the facility is feasible. In 2021, MPMC updated the LoM plan, and a crest elevation of approximately 987 m was determined to be required to store the LoM tailings. An additional geotechnical investigation and laboratory testing is ongoing to assess potential strength gains from reconsolidation of the upper glaciolacustrine unit (UGLU) that sheared during the breach in 2014. This interim design to elevation 974 m was developed assuming no strength gains of the UGLU that sheared in 2014. A remoulded undrained shear strength equal to the average minus one standard deviation of the measured values as part of the forensic investigation in 2014 was adopted as in previous analyses and designs (Golder 2015b,e). An interim design elevation of 974 m was selected to enable short-term operations of the TSF.

3.0 BASIS OF DESIGN

The design basis for the raise of the TSF is summarized in this section, including the design and operation philosophy and key design criteria. The design of the TSF raise is consistent with applicable regulatory documents and guidelines from MPMC, WSP, and national and international organizations, where applicable (e.g., Canadian Dam Association [CDA], International Commission on Large Dams). The following regulations apply to this study:

- *Health, Safety and Reclamation Code (HSRC) for Mines in British Columbia* (EMLI 2022).
- Guidance Document for Revisions to Part 10 of the HSRC for Mines in BC (BC MEM 2016).

The design of the TSF is also consistent with the following guidelines, where applicable:

- CDA *Dam Safety Guidelines* (CDA 2013).
- *Technical Bulletin: Application of CDA Dam Safety Guidelines to Mining Dams* (CDA 2019).
- *Global Industry Standard for Tailings Management* (Global Tailings Review 2020).
- Mining Association of Canada *Guide to the Management of Tailings Facilities* (MAC 2021).

The complete design basis and design criteria are included in Appendix C.

3.1 Design and Operation Philosophy

The design of the TSF follows the principles set out by the Mining Association of Canada in its Towards Sustainable Mining program and the recommendations made by the Independent Expert Engineering Investigation and Review Panel (IEEIRP 2015). The following approaches have been used for the design of the TSF:

- **Limit the amount of surface water to that required for operation**—This will be achieved through maintaining storage capacity within the external water management ponds and ongoing discharge of water from the mine site.
- **Promote unsaturated conditions in the tailings**—Wide sub-aerial beaches will be maintained upstream of the embankments, and upstream drains will be constructed to create a zone of unsaturated tailings adjacent to the embankments.
- **Promote consolidation of tailings upstream of the TSF embankment**—Upstream drains will be constructed to create a zone of unsaturated tailings adjacent to the embankments.
- **Reduce the hydraulic gradient across the till core**—This will be achieved through maintaining wide sub-aerial beaches along the embankments and the construction of upstream drains.

Operation of the TSF is to follow the above philosophy. Quantitative performance objectives (QPOs) have been defined to confirm that operation of the TSF follows the operation philosophy.

3.2 Design Basis and Criteria

Key design basis and criteria are summarized in Table 1. The complete design basis and criteria are included in Appendix C. Specific design criteria for each design component are provided within those sections in the report.

Table 1: Design Basis and Criteria

Criteria	Unit	Value	Source/Comment
General			
Nominal Tailings Production Rate	t/day	20,000	MPMC (2021)
TSF storage capacity	-	minimum to allow continuity of operation until 2026	Includes the remaining storage capacity of the permitted 970 m raise based on the 2019/2020 survey of the tailings surface 8.0 Mt deposited between June 2022 and December 2023
Dam classification	-	Significant	Refer to Appendix C
Design earthquake event	AEP	1:2,475	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) Other criteria include: ▪ Between 1:100 and 1:1,000 AEP (CDA 2019) ▪ 1:1,000 AEP recommended by GISTM (Global Tailings Review 2020) Consistent with WSP's best practice, an earthquake event of 1:10,000 AEP will be used to assess sensitivity of the analyses
Static (long term)	FoS	1.5	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) CDA (2019) Table 3-4
Static (during or at end of construction)	FoS	1.5	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) Other criteria include: >1.3 recommended by CDA (2019) Table 3-4
Pseudo-static	FoS	1.0	Informed by Table 3-5 of CDA (2019)
Post-earthquake	FoS	1.2	Informed by Table 3-5 of CDA (2019)
Overall downstream slope no steeper than	-	2H:1V	HSRC Guidance Document Section 3.3.1 (BC MEM 2016)

Table 1: Design Basis and Criteria

Criteria		Unit	Value	Source/Comment
Tailings Characteristics				
Solids content of tailings slurry discharged to TSF		%wt	Nominally ~35	Provided by MPMC
Tailings average dry density after deposition		t/m^3	1.35	Assumed by WSP 1.36 t/m^3 by KP (2005)
Tailings beach slope		%	Sub-aerial – 0.5% Sub-aqueous – 2%	Based on available topographic and bathymetric surveys since 2016
Water Management				
IDF	Operations	-	72-hour PMF	PMF runoff volume will be estimated considering the annual 72-hour PMP rainfall plus snowmelt, which was selected consistent with WSP's best practice. Other criteria include: ▪ 1/3 between 1-in-975-year and PMF for a minimum duration of 72 hours required by HSRC Guidance Document Section 3.3.1 (BC MEM 2016). ▪ Between 1-in-100 and 1-in-1,000-year return period recommended by CDA (2019). ▪ 1-in-1,000-year return period recommended by GISTM (2020).
EDF	Operations	years	24-hour 1:200 year precipitation and snowmelt	Typical EDF return periods range from 1-in-50 years to 1-in-200 years (CDA 2019).

Table 1: Design Basis and Criteria

Criteria		Unit	Value	Source/Comment
Freeboard	Normal	-	No overtopping by 95% of waves caused by the most critical wind with a frequency of 1:1,000 year with reservoir at maximum normal elevation	CDA (2013)
	Minimum	-	No overtopping by 95% of waves caused by the most critical wind when the reservoir is at its maximum level during the IDF	CDA (2013)
Water Management				
Operating pond volume range		million m^3	1.5 to 1.7	Minimum provided by MPMC for operation of the mill Maximum adopted to maintain wide sub-aerial beaches
Beach width		m	100	Minimum during normal operating conditions Portion of beach above operating pond level

TSF = tailings storage facility; Mt = million tonnes; HSRC = Health, Safety and Reclamation Code; AEP = annual exceedance probability; GISTM = Global Industry Standard for Tailings Management; FoS = factor of safety; %wt = weight percent; IDF = inflow design flood; EDF = environmental design flood; PMF = probable maximum flood; PMP = probable maximum precipitation.

4.0 SITE CONDITIONS

The Mount Polley TSF site characterization report (WSP 2023) presents the TSF site conditions with respect to climate, geology, seismicity, geotechnical, hydrogeology, and geochemistry.

The Engineers and Geoscientists British Columbia (formerly The Association of Professional Engineers and Geoscientists of British Columbia, APEGBC) site characterization for dam foundation guidelines (APEGBC 2016) were followed during the preparation of the Mount Polley TSF site characterization report. It is intended that the TSF site characterization report be updated with data from future site investigations, and with observations and data from construction and operation of the TSF. Should the understanding and interpretation of site conditions change with time, then the TSF design will be reassessed incorporating the site condition changes.

A summary of the TSF site conditions is presented in this section to provide context for the design and to define conditions and design parameters for analyses including climate and earthquake events. Foundation material properties adopted for seepage and stability modelling are presented in Sections 7.5 and 7.7.

4.1 Site Location and Geomorphology

Mount Polley Mine is located approximately 56 km northeast of Williams Lake, BC, between Polley Lake and Bootjack Lake.

The region is located on the eastern edge of the Interior Plateau, at the boundary between the Quesnel Highlands and the Fraser Plateau. Terrain and geomorphology of the region comprises flat and gently rolling topography with hummock bedrock exposures, dissected by a network of streams and lakes. Surface drainage patterns are influenced by bedrock topography; most of the stream valleys in the region have a northwest orientation and drain southward toward the lowland area north of the western arm of Quesnel Lake (Bichler and Bobrowsky 2003).

In the TSF area, the gentle topography and surface expression of the lowland area at the head of the west arm of Quesnel Lake is the result of glacial advance followed by glacial retreat and inundation by meltwater. The regional surficial geology is dominantly the result of erosion and deposition associated with the most recent glaciation (WSP 2023).

4.2 Climate

The site experiences high summer precipitation due to summer storms, and the lowest monthly precipitation occurs in February. Precipitation typically occurs as snowfall starting in November, which accumulates until March. Average annual precipitation at the site is estimated to be 612 mm, with a standard deviation of 118 mm based on precipitation records for the site from 1974 to 2021. Typically, the increase of temperatures over 0°C starts in March, leading to freshet until June.

A summary of the baseline climate parameters is provided in Table 2. An evaluation of future climate change projections indicates future climate at the site will likely be warmer and wetter, with larger variations throughout the months.

Table 2: Summary of Key Climate Parameters for Mount Polley Mine

Parameter	Value
Mean annual total precipitation (mm)	612
1:2-year 24-hour rainfall (mm)	33
1:10-year 24-hour rainfall (mm)	47
1:200-year 24-hour rainfall (mm)	69
Projected annual total precipitation anomaly from baseline for 2050s (%)	+5

Table 2: Summary of Key Climate Parameters for Mount Polley Mine

Parameter	Value
Projected annual total precipitation anomaly from baseline for 2080s (%)	+8
Mean annual temperature (°C)	3.9
Average winter season (sub-zero mean monthly temperatures)	November to March
Mean snow water equivalent for the month of March (mm)	185
Projected annual air temperature anomaly from baseline for 2050s (°C)	+1.8
Projected annual air temperature anomaly from baseline for 2080s (°C)	+2.7
Mean annual shallow lake evaporation (mm)	673
Mean annual potential evapotranspiration (mm)	863

Note: Statistics are based on reviewed historical records from multiple climate stations and measured and derived data (where applicable).

The five-year update of the climate baseline for the site is presented in WSP Golder (2022a) and includes precipitation, air temperature, relative humidity, solar radiation, evaporation, snow depths, wind speed and direction, and updated climate change projections.

4.3 Hydrology

The mine site is drained by three main watersheds: Hazeltine Creek, Edney Creek, and Morehead Lake. The Hazeltine Creek watershed includes Polley Lake and conveys all water from Polley Lake, the east side of Mount Polley, and the area surrounding the TSF. In general, the hydrology of Hazeltine Creek (and by extension, the mine area and TSF) can be described as snowmelt driven, with the majority of annual runoff occurring during the spring snowmelt in April and May freshet (KP 2014).

4.4 Geology

The regional surficial geology is predominantly the result of erosion and deposition associated with the late Pleistocene (Wisconsinan) glacial episode referred to as the Fraser Glaciation (Clague 1987, 1988). The stratigraphic sequence identified in the area of the TSF can be generalized in order of increasing depth as follows:

- fill and anthropogenic materials
- ablation till, including glaciolacustrine and glaciofluvial sub-units
- basal till, including glaciolacustrine and glaciofluvial sub-units
- bedrock

This stratigraphic sequence is generally applicable to the mine area and TSF, with local variations associated with the depositional and erosional history of a particular area. The surficial geological units of the TSF area are interpreted to represent two main stages of the Fraser Glaciation: the advance stage and the recessional stage (Bichler and Bobrowsky 2003). Basal till is punctuated by glaciofluvial and glaciolacustrine deposits that typify the early stages of deposition (the advance stage), represented in the TSF area by basal till and associated sub-units. The ablation till and some layers of the glaciofluvial and glaciolacustrine sub-units were likely deposited during the recession stage of glaciation.

Available mapping indicates the TSF area is underlain by altered, deformed, and brecciated volcanic and intrusive igneous rocks of the Late Triassic Nicola Group, with local sandstone and conglomerate of the Kamloops Group, Dragon Mountain Formation and some unnamed sediment groups (Logan et al. 2007).

4.5 Seismicity

The site is located in an area of relatively low seismicity for BC. WSP developed a site-specific seismic hazard model for the Mount Polley Mine site based on source models developed for the 6th Generation Canadian National Seismic Hazard Model (Canada SHM6) and a review of geological and paleoseismological features (WSP 2023a). Both near-field, moderate-magnitude crustal earthquakes and far-field subduction interface earthquakes contribute to the site seismic hazard. The shallow crustal earthquake sources are dominated by moderate-magnitude earthquakes (**M**6.0 to **M**6.5) close to the site (i.e., less than 60 km) at all annual exceedance probabilities (AEPs). The contribution to hazard at the site from the Cascadia subduction zone is from large earthquakes (**M**8+) at 450 to 550 km from the site at all AEPs and spectral periods of interest.

Probabilistic analysis results from site-specific hazard model are listed in Table 3.

Table 3: Peak Ground Accelerations (5%-damped) for Selected Annual Exceedance Probabilities at the Mount Polley Tailings Storage Facility Site (V_{S30} = 849 m/s)

Annual Exceedance Probability (AEP)	Mean Acceleration (g)
1:1,000	0.026
1:2,475	0.048
1:5,000	0.076
1:10,000	0.116

V_{S30} = time-averaged shear-wave velocity (VS) to a depth of 30 m.

For dams impounding tailings with a Significant consequence classification, the HSRC Guidance Document (BC MEM 2016) defines a minimum earthquake design ground motion with a 1:2,475 AEP.

4.6 Geotechnical Conditions

A detailed description of geotechnical conditions in the area of the TSF embankment is provided in WSP (2023a). Typically, the stratigraphic units in the foundations of the TSF can be characterized as follows:

- **Till**—The till is generally a mixture of gravel, sand, and low plastic fines ranging from silt to silty clay. The material is generally cohesive with a consistency from firm to hard.
- **Glaciofluvial units**—The glaciofluvial units are generally gravelly sandy silt to silty sand with trace gravel. The fines content ranges from about 4% to 100% and are generally non-plastic. The material is generally non-cohesive with a compactness ranging from compact to very dense.
- **Glaciolacustrine units (GLUs)**—The GLUs are generally silty clay to clay with trace to some sand. The fines are generally low to high plasticity. The material is generally cohesive with a consistency ranging from firm to very stiff. The sensitivity of the glaciolacustrine soil interpreted from the cone penetration testing (CPT) data generally ranges between 2 and 3.
    - **Main Embankment**—A semi-continuous layer of glaciolacustrine soil is present at an elevation of approximately 900 to 910 m and extends along the length of the Main Embankment. A shallower layer of glaciolacustrine soil near elevation 920 m was identified near Stn. 2+455 and 2+695. The Main Embankment glaciolacustrine soil generally has a low to intermediate plasticity (silt to silty clay). The average water content is approximately 26%.

Consolidation tests indicate a range of preconsolidation pressures from 1,100 kPa to 4,000 kPa and CPT data generally indicates a minimum preconsolidation pressure of about 1,200 kPa at the elevation of the semi-continuous layer of glaciolacustrine soil. CPT data at the higher elevation glaciolacustrine soil layer shows an interpreted minimum preconsolidation pressure of about 850 kPa. The maximum excess pore pressures generated when rockfill was stockpiled on the Main Embankment in 2022 was equivalent to a B-bar of 0.13.

- **Perimeter Embankment**—The glaciolacustrine soil deposits along the Perimeter Embankment are not continuous, and their elevations generally range from about 885 to 935 m. The Perimeter Embankment glaciolacustrine soil generally has a low to intermediate plasticity (silt to silty clay). The average water content is approximately 21%. Consolidation tests indicate a range of preconsolidation pressures from 900 to 3,800 kPa.
- **Perimeter Embankment at Corner 1**—Upper and lower glaciolacustrine soil deposits are present at Corner 1.
  - The upper glaciolacustrine (UGLU) deposit is a semi-continuous layer between approximate elevation 918 and 925 m from approximately Stn. 4+000 to 4+285. The UGLU generally consists of silty clay to high plasticity clay, with trace to some sand, and is firm to stiff. The fines are generally an intermediate to high plastic material and range from silty clay to clay. The average water content of the UGLU is approximately 31% and is generally greater compared to the glaciolacustrine material encountered in the foundation of the other embankments. Consolidation tests indicate a range of preconsolidation pressures from about 300 kPa to 590 kPa. The maximum excess pore pressures generated during the construction of the 2015 Freshet Management Embankment were equivalent to a B-bar of 0.46. Excess pore water pressures take approximately one year to dissipate based on the rate of consolidation measured in the laboratory and the field.
  - The lower glaciolacustrine (LGLU) deposit is also a semi-continuous layer between approximate elevation 900 and 918 m. The LGLU fines generally consist of a low to intermediate plastic material and range from silty clay-clayey silt to silty clay. The average water content of the LGLU is approximately 22%. Consolidation tests indicate a range of preconsolidation pressures in the order of 700 to 1,200 kPa.
- **South Embankment**—A layer of low plasticity silty clay interpreted to have deposited in a glaciolacustrine environment was encountered directly above bedrock near Stn. 1+095 at the South Embankment; however, the geotechnical testing completed on the material is not representative of the intermediate or high plasticity GLUs found within the footprint of the Perimeter Embankment at Corner 1.

- **Highly weathered bedrock**—Generally weathered volcaniclastic conglomerate, volcanic debris or completely weathered bedrock.

Material properties for limit equilibrium stability analysis are presented in WSP (2023a) and included in Section 7.7.2.

4.7 Hydrogeology

The groundwater flow direction prior to the development of the TSF was inferred to be from the west and northwest towards the east and southeast. The water table was observed to be near ground surface, with artesian pressures measured within the TSF basin upstream of Corner 4 and upward groundwater flow gradients measured along the Main Embankment and Perimeter Embankment at Corner 1.

The current groundwater flow direction in the area of the TSF is inferred to be partly dependent on the existing TSF Pond level. Provided that surface water level elevations within the TSF are above the surrounding shallow groundwater level, groundwater flow will be radial from the TSF towards the southwest, southeast, and northeast. However, when the TSF pond level falls below the shallow groundwater levels on the west side of the TSF, then the TSF area becomes a flow-through environment, similar to pre-development conditions, with groundwater flow directed across the TSF from the west and northwest towards the east and southeast.

Based on in situ and laboratory testing, the hydraulic conductivity of the foundation till (ablation till and basal till) is variable, ranging from 1×10^{-5} m/s to 2×10^{-8} m/s. The range in hydraulic conductivity for the glaciofluvial units, 8×10^{-4} m/s to 2×10^{-6} m/s, confirms that these units are more permeable and may act as preferential pathways for seepage from the TSF. Conversely, the range in hydraulic conductivity for the glaciolacustrine deposits, 7×10^{-8} m/s to 2×10^{-10} m/s, confirms that these units have a low permeability and may act as barriers for seepage migration and/or as confining units where they occur directly above glaciofluvial units, and could potentially cause artesian pressures in the underlying glaciofluvial units.

Material properties for seepage analysis are included in Section 7.5.

4.8 Groundwater Geochemical Conditions

Baseline groundwater quality conditions are generally characterized by low concentrations of dissolved metals, sulphate, and nitrate and low to moderate hardness.

Over the last decade or so, although there were increasing parameter of interest concentration trends at some locations, significant changes to groundwater quality at the perimeter of the TSF has not been identified except with respect to sulphate. The concentration of sulphate in groundwater downgradient of the TSF at the Perimeter Embankment between Corner 1 and Corner 2 and at the South Embankment near Corner 3 approached or reached levels observed in the TSF pond water. The concentration of sulphate does not exceed the BC Ministry of Environment and Climate Change Strategy Contaminated Sites Regulation (BC ENV 1997) standards for protection of freshwater aquatic life and is monitored quarterly or semi-annually depending on location.

5.0 TAILINGS CHARACTERIZATION

5.1 Geotechnical Characterization

Typical characteristics of the tailings that have been deposited in the TSF are included in Table 4.

Table 4: Characteristics of Existing Tailings

Parameter		Value	Source/Comment
Gradation	Sand	31%–38%	Available particle size distributions are shown in Figure 1 In 2014, three particle size tests were undertaken on tailings samples collected from within the TSF near the Perimeter Embankment. The data indicate the tailings deposited near the embankment are generally silty sand/sandy silt (fines content 20% to 58%), likely due to varying degrees of segregation during deposition as conventional slurry
	Fines	62%–69%	
Plasticity		Non-plastic	Based on visual classification
Specific gravity of solids		2.7–2.8	Estimated based on KP (1990) and Golder (2015d)
Hydraulic conductivity		1×10^{-6} to 1×10^{-5} m/s	Considered to be representative of tailings deposited near the embankment Based on falling head laboratory testing (Golder 2015e) and estimated from available particle size distribution curves
Sub-aerial beach slope		0.5%–1%	Based on available topographic and bathymetric surveys since 2016
Sub-aqueous beach slope		2%–3%	Based on available topographic and bathymetric surveys since 2016
Average dry density after deposition		1.35 t/m^3	Assumed by WSP Assumed as 1.36 t/m^3 by KP (2005)

Three CPTs (CPT16-20, -21, and -22) were undertaken on the tailings beach in 2016 to maximum depths of up to 35 m below the tailings surface (Golder 2017b). The three tests were undertaken within 100 m of the upstream crest of the embankment. Using the Robertson (1990) soil behaviour type classification, the tailings materials were predominantly classified as interlayered silty sand, sandy silt, clayey silt, and silty clay. This classification is generally consistent with the findings of particle size tests undertaken on the tailings. The state parameter estimated for all CPTs was between about -0.2 and -0.1 for the first upper 5 to 10 m, and between about -0.1 and 0 below that depth, with the exception of a few thin layers with positive state parameter (Golder 2017b).

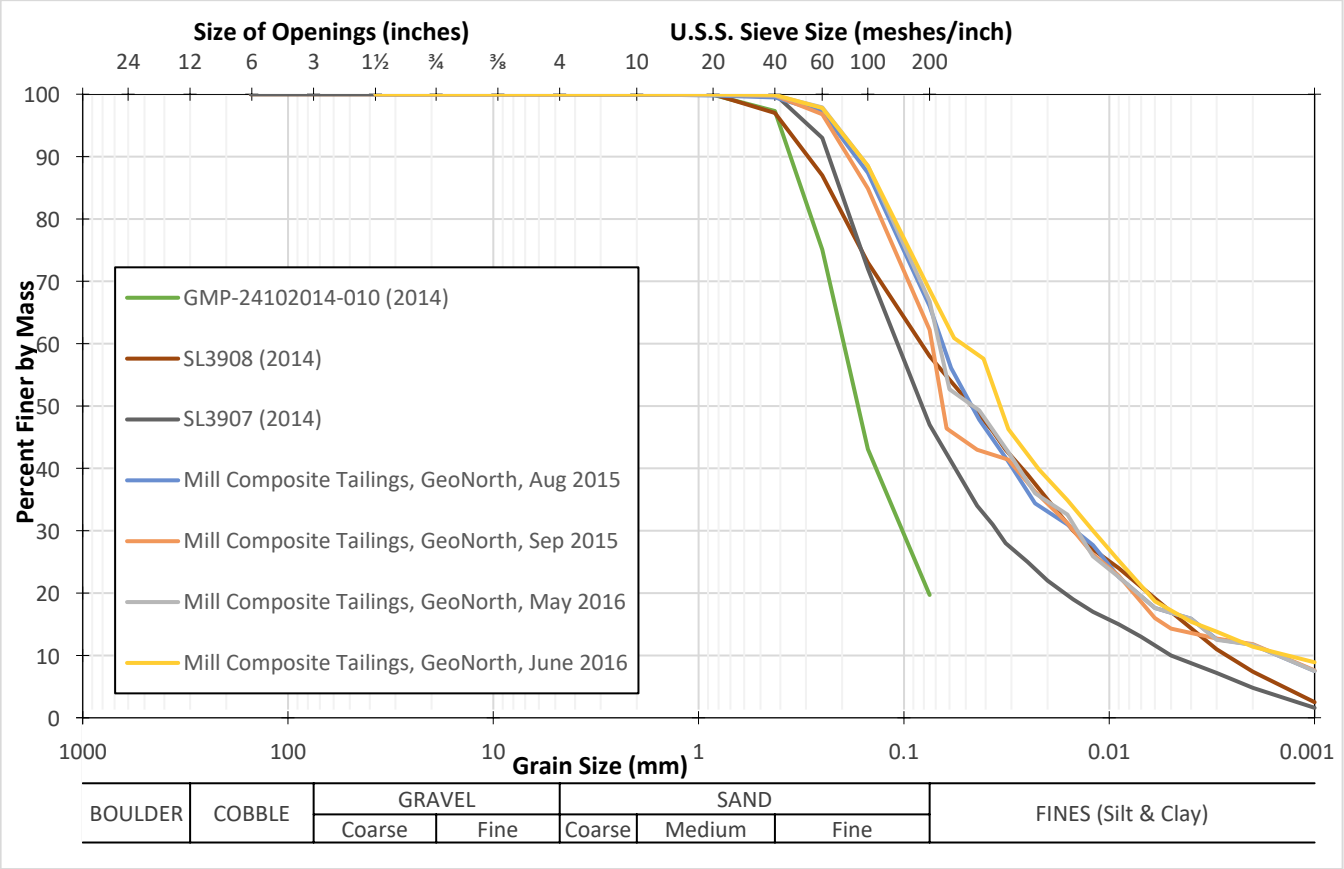


Figure 1: Gradation of Existing Tailings

5.2 Tailings Chemistry

The Mount Polley copper-gold porphyry deposit is classified as an alkalic porphyry copper gold deposit. The mined mineralized zones are enriched in copper and selenium relative to global norms. The tailings are lower in sulphide mineral content compared to the ore because most of the copper sulphides are removed through ore processing. In addition, mill process reagents, with the exception of lime, are not expected to be present within the tailings. Processing changes over time have been minimal and are not expected to affect the geochemical reactivity of the tailings; therefore, tailings geochemistry can be considered generally consistent over time (Kennedy et al. 2016; SRK 2022).

Mount Polley tailings are classified as non-acid generating based on operational monitoring and testing of tailings spilled into Hazeltine Creek in August 2014.

The leachate quality from humidity cell tests and column tests is described below:

- pH typically between 8.0 and 8.2
- sulphate concentrations initially on the order of 1,000 mg/L, with decreasing concentrations over time that reached lower stabilized values
- highest copper concentration of 0.15 mg/L in one test, but with typical maximum concentrations of 0.02 mg/L in humidity cell test leachates and 0.05 mg/L in column test leachates

- highest selenium concentrations were 0.01 mg/L in humidity cell test leachates and 0.06 mg/L in column test leachates
- molybdenum concentrations initially between 2 and 3 mg/L in column leachates

The measured concentrations at the TSF supernatant pond are generally below Permit limits, with the exceptions for total copper, total phosphorous, total arsenic, total zinc, and dissolved aluminium (WSP 2023d). The source of the increased concentrations in the monitoring data for these parameters is thought to be due to the discharge of leachate to the TSF from the onsite test heap leach facility in 2018 (Golder 2022), which has since been decommissioned. These concentrations were not observed throughout the operational phases of the mine and are considered atypical. These conditions are not expected to persist during future operational phases as the leachate will be managed exclusively through the milling process.

6.0 DESIGN DESCRIPTION

This section includes a description of the design, materials and zoning, surface and foundation preparation, abutment details, water management, and details of the upstream drains and tailings management.

6.1 Overview of Embankment Raise

The TSF embankment (Main, Perimeter, and South embankments) is constructed to a maximum elevation of 970 m. The design of the TSF to elevation 974 m provides storage capacity for tailings production of approximately 24 million tonnes (Mt; based on current beach slopes and includes the remaining storage capacity of the permitted 970 m raise based on the 2019/2020 survey of the tailings surface).

The embankment raise to elevation 974 m includes:

- extension of portions of the buttresses along the Main and Perimeter embankments
- resloping of the South, Main, and Perimeter embankments to 2H:1V
- extension of the embankments at the south and north abutments
- construction of a drain upstream of the till core along the embankments

The facility will require a rate of rise of about 2 m per year (i.e., to about elevation 972 m in 2024 and to 974 m in 2025) to accommodate the planned tailings production.

6.2 Embankment Materials and Zoning

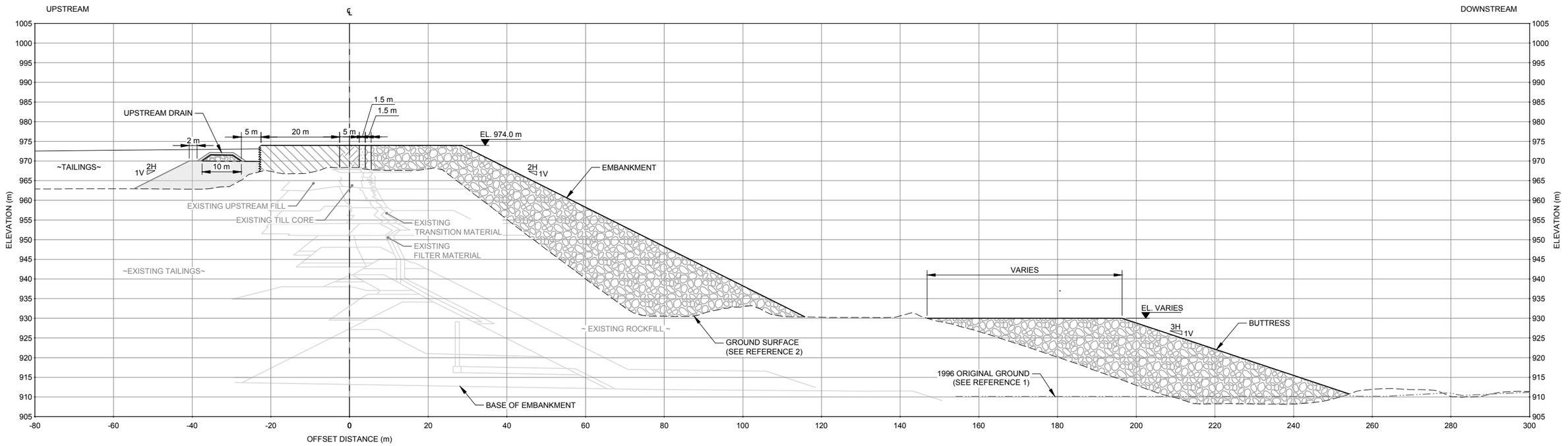
The embankment raises will consist of the components detailed in Table 5. A typical section is shown in Figure 2. Technical specifications detailing placement and compaction and quality assurance and quality control requirements for the materials listed in Table 5 are included in Appendix B.

Table 5: Embankment Zoning

Name	Zone	Description and Purpose
Upstream fill	U	Minimum 20 m wide fill zone to provide upstream support to Zone S (till core)
Till core	S	Minimum of 5 m wide low hydraulic conductivity element, placed upstream of Zone F (filter)
Filter	F	Minimum of 1.5 m wide, placed upstream of Zone T (transition) and downstream of Zone S (till core). Zone F is designed to be filter compatible with Zone S and the foundation till and prevent erosion of Zone S and foundation till into the voids of Zone T
Transition	T	Minimum of 1.5 m wide, placed upstream of Zone C (compacted embankment rockfill) and downstream of Zone F (filter). Zone T is designed to be filter compatible with Zone F and prevent erosion of Zone F into the voids of Zone C
Compacted embankment rockfill	C	Minimum 10 m wide, placed downstream of Zone T (transition) and compacted in 1 m layers
Embankment rockfill	-	13 m wide at elevation 974 m, placed downstream of Zone C (compacted embankment rockfill). The downstream face of the embankment rockfill will be 2 horizontal to 1 vertical (2H:1V)
Buttress rockfill	-	3H:1V downstream face, which will impose a low shear stress on the foundation soils due to the flatter downstream slope and increase the length of potential slip surfaces passing through the foundation soils, thereby resisting force and improving stability

Note: Materials are listed in order from upstream to downstream of the embankment. Materials for construction of the upstream drain are included in Section 6.6.

- = not applicable.



TYPICAL CROSS-SECTION

SCALE 1:500 m

0 20 40

1:500 METRES

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP CANADA INC.

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- NON-WOVEN GEOTEXTILE
- ROCKFILL (ZONE C)
- TRANSITION MATERIAL (ZONE T)
- FILTER MATERIAL (ZONE F)
- TILL CORE (ZONE S)
- UPSTREAM FILL (ZONE U)
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, REFER TO DESIGN DRAWINGS.
4. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT, FILE NAME: "2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf", DATED: 12 MARCH 2014.
5. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
6. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

CLIENT: MOUNT POLLEY MINING CORPORATION

CONSULTANT: wsp

YYYY-MM-DD	2024-04-18
DESIGNED	S. BAINBRIDGE
PREPARED	T. KLASSEN
REVIEWED	S. BAINBRIDGE
APPROVED	G. PIZARRO

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
TYPICAL CROSS-SECTION

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
CA0020527.4505	51300/51395/014	0	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds.golder.com\le-vdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\CA0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Figures\ | File Name: CA0020527_4505-51300-51395-014-02.dwg | Last Edited By: lyklassen Date: 2024-03-22 Time:3:25:12 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:47:30 PM

The gradation envelops of embankment construction materials are presented in Figure 3. All fill materials will be non-acid generating.

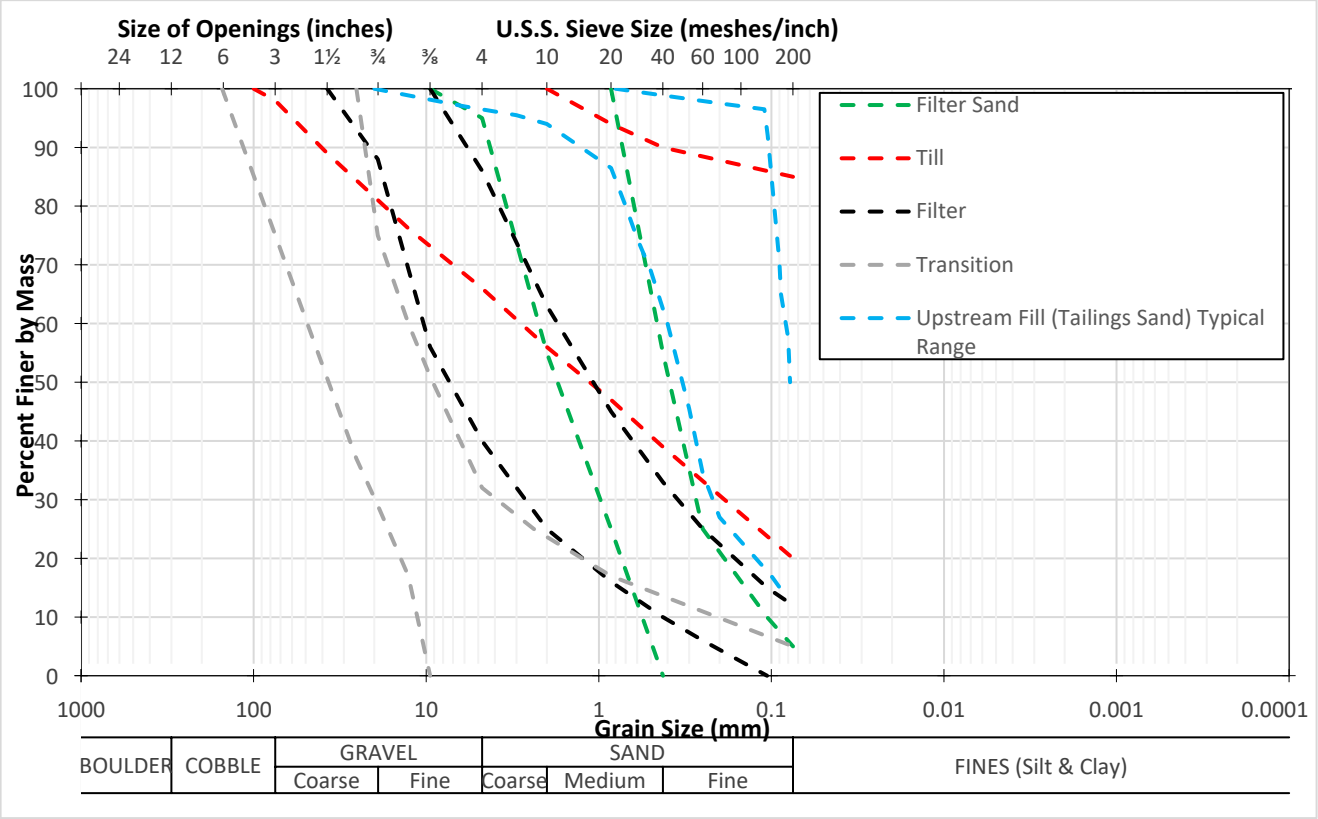


Figure 3: Embankment Construction Material Particle Size Distribution Envelopes

The filter, filter sand, and transition materials have been designed to meet modern filter criteria (USBR 2011; FEMA 2011; Fell et. al 2015; USDA 2017) with a modification on the maximum sand content (i.e., 40%) in the filter band based on laboratory testing (Eldridge and Gilmer 2002). The laboratory testing was carried out on crushed aggregates with a similar gradation under hydraulic gradients much greater than those expected in the Mount Polley TSF.

The filter, filter sand, and transition gradation envelope requirements for construction of the embankment to elevation 974 m remain unchanged from the filter, filter sand, and transition gradation envelopes specified for construction of the embankment to elevation 970 m (Golder 2015b). Fill materials will be produced, stockpiled, hauled, and spread in a manner to minimize segregation. Materials not complying with the specification will not be used in the construction.

6.3 Foundation Preparation

Foundation preparation is required at the following locations prior to any fill placement:

- at the north and south abutments
- along the foundation of the South Embankment reslope
- along the foundation of the Main and Perimeter embankments buttress extension

Stockpiled material, vegetation, and topsoil is to be stripped along the footprint of the abutments, South Embankment reslope, and buttress extensions. Stripped material will be managed in accordance with MPMC soil management programs. The extent of the foundation preparation is shown in Drawings 05, 09, 15, and 20 (Appendix A), and details are provided in the technical specification (Appendix B).

6.3.1 North and South Abutments

The embankment will extend onto natural ground at the north and south abutments (i.e., Corner 4 and Corner 5). The abutment details will consist of the till core tied into competent till or onto bedrock. A filter blanket is to be placed downstream of the till core, along the till foundation. The embankment design at the abutments is shown in Drawing 25, Appendix A. Foundation preparation will consist of removal of topsoil, organics, and soft or loose soil to expose competent till. Where the till foundation is greater than 2 m thick, the till core will be keyed into the till. Where the till is less than 2 m, the till core is to extend down to competent bedrock. The depth of the till foundation will be confirmed by the excavation of test pits.

Where excavation is required to bedrock, highly fractured and weathered bedrock overlying sound bedrock is to be removed. The surface of the exposed bedrock is to be cleaned of all soil and loose bedrock. Depending on the condition of the bedrock and the opinion of the geotechnical engineer, additional treatment may be required, which may consist of the placement of bentonite, shotcrete, or slush grout.

The biosolids stockpile at the north abutment is to be excavated to the extents necessary for foundation preparation. The final limits of foundation preparation at the abutments will be confirmed by the geotechnical engineer during construction.

Placement of a till blanket may be required at the south abutment after foundation preparation is completed to grade the surface so it drains downstream from the till core.

6.4 Water Management

The Mount Polley Mine site has an annual net water surplus, and discharge from the mine site is necessary to manage the mine site water and to prevent accumulation of water on the mine site year over year.

Water management will be consistent with practice to date. Temporary detention of water is necessary in the TSF to manage runoff volumes generated during the freshet; however, the fundamental basis of the water management plan is to not accumulate water on site (including the TSF) by treating and discharging water and to not carry over water from year to year even under extreme wet conditions.

The majority of water inflows into the TSF are pumped and are therefore in the direct control of the operator. The inflows into the TSF are as follows:

- water discharged with the tailings slurry, at approximately 35% solids by weight
- water pumped from the site water management structures for temporary detention in the TSF during freshet or high precipitation events

The water inflows to the TSF that are not pumped, and therefore not in the direct control of the operator, are as follows:

- precipitation on the direct footprint of the TSF (approx. 2.38 km^2)
- runoff from the catchment directly above the TSF (approx. 1.19 km^2)

Outflows from the TSF consist of the following:

- reclaim water pumped to the mill or Perimeter Embankment Till Borrow Pond by means of a floating barge within the TSF pond
- seepage through the embankment, upstream drains and foundation to the seepage collection ponds
- evaporation losses from the TSF pond and wet tailings beaches
- water retained in the newly placed tailings

The TSF will be managed by maintaining the pond volume within the normal operating range (i.e., 1.5 to 1.7 million m^3) for reclaim water and make-up water.

6.5 Tailings Management and Deposition

Tailings management and deposition will be consistent with practice to date. Tailings will be deposited as a slurry with approximately 35% solids by weight. The tailings will be discharged along the embankment crest and will form an average beach slope of approximately 0.5% to 1%. The sub-aqueous tailings will form a steeper slope of approximately 2% to 3%. It is assumed that the maximum pond depth during normal operation is about 4 m at the location of the reclaim barge.

Deposition of the tailings will be planned to maintain the pond near the centre of the facility and against the natural topography on the western perimeter. A minimum beach length of 100 m will be maintained between the TSF pond and the embankment during normal operations. To enable management of the pond against the natural ground and to maintain a minimum beach length of 100 m, the barge will need to be relocated to a central location between Corner 4 and Corner 5.

The location of the pond over the period of operations up to elevation 974 m for the TSF is shown in the tailings deposition figures in Appendix F.

6.6 Upstream Drain

The hydraulic head imposed on the embankments will be controlled by the construction of an upstream drain along the upstream side of the embankments. The upstream drain will be constructed at about elevation 970 m along the Main Embankment and from Corner 1 to Corner 2 at the Perimeter Embankment. Along the South Embankment and at the Perimeter Embankment at Corner 1, the upstream drain may be constructed higher up to elevation 972 m.

The upstream drain will collect water from the tailings in the TSF and will discharge the water outside of the TSF into the downstream water management infrastructure. The upstream drain will also promote drainage and consolidation of newly placed tailings.

The upstream drain has been sized to convey flows for a crest elevation of 987 m. Details for the upstream drain are included in Section 7.6.

7.0 DESIGN ANALYSES AND ASSESSMENTS

The design of the Mount Polley TSF raise to elevation 974 m was informed by the studies and assessments presented in this section:

- site and deposition technology selection
- water balance
- storage capacity analysis
- filter compatibility assessment
- seepage analysis
- upstream drain design
- slope stability analysis
- stress-deformation analysis
- freeboard and spillway design
- closure considerations
- risk review and design controls

7.1 Siting and Deposition Technology

Typically, a single consolidated TSF is preferred over multiple smaller TSFs; however, there are cases where multiple TSFs may be a preferred option. This section provides a summary on the selection of a site for tailings management at the Mount Polley Mine site and on best available technology and best applicable practices for tailings deposition as it relates to Mount Polley Mine. The study is provided in Appendix D.

7.1.1 Objectives

In selecting potential locations and technologies for the storage of tailings, the following objectives are to be met (BC MEM 2016):

- Provide secure and permanent storage facility.
  - physical stability
  - chemically and biologically stable, or be designed to mitigate transport of contaminants into the receiving environment
- Minimize additional land disturbance (i.e., additional footprint of the facility).
- Maximize in-pit or underground backfill.
- Minimize impacts to receiving environment.
- Minimize social impact (e.g., negative public perceptions, disruption of traditional land use).
- Minimize cost, including the costs for investigation, design, procurement, construction, operation, and closure.

- Incorporate post-closure land use objectives.
- Limit the amount of free water within the impoundment.

7.1.2 Site Alternatives and Available Deposition Technologies

A siting and deposition technology assessment was completed as part of the Mount Polley TSF elevation 984 m LoM feasibility design (Golder 2015c). The study included a review of available tailings deposition technologies; a review of potential sites to deposit tailings; and an assessment of the alternatives based on environmental, social, technical, and economic indicators. Deposition of the remaining LoM tailings (i.e., about 70 Mt at the time) as a slurry within the existing TSF was identified as the best available option in 2015 (Golder 2015c).

The site and deposition technology assessment was revisited in 2022 to incorporate updated conditions, including tailings deposition since the restart of operation in 2016 (i.e., about 20 Mt), and remaining LoM production (i.e., 62.8 Mt) and to assess the alternative of co-disposal of hydro-cyclone underflow in the southeast rock disposal site. This is included in Appendix D.

The potential sites identified for the TSF included:

- existing TSF
- new TSF location (four potential locations were identified)
- lake deposition (e.g., Polley Lake, Bootjack Lake, Quesnel Lake)
- open pit deposition (e.g., Springer Pit, Cariboo Pit, Wight Pit, Bullion Pit)
- underground deposition
- co-disposal with waste rock (e.g., southeast rock disposal site)

The existing Mount Polley open pits and underground working were eliminated from further consideration as these are either active mining areas or used for site water management.

The available tailings management technologies are differentiated primarily by the water content of the tailings, which determines the transportation method and the deposition method. The following technologies are available and were included in the 2022 assessment:

- low solids content tailings slurry (i.e., conventional tailings or unthickened tailings)
- thickened (non-segregating) tailings
- paste tailings
- filter tailings
- hydro-cyclone classified tailings

7.1.3 Findings and Recommended Site and Deposition Technology

The findings from the 2022 siting and deposition assessment regarding the range of options considered were as follows:

- The best available option is to store the tailings produced in the remaining LoM within the existing TSF as conventional slurry. This is because:
  - The existing TSF has the best-studied foundation conditions of any of the potential TSF locations. A new land-based TSF footprint is unlikely to offer advantages over the existing TSF footprint. Using a different land-based site would require significant investigation, add to the disturbed area of the mine, and require more closure work at the completion of mining.
  - Conventional tailings can be operated in a manner that reduces both the likelihood (conservative assessment of soil strength and adoption of conservative design criteria resulting in wide buttresses along the embankments) and consequence of failure (wide beaches, relatively dense tailings, and a small pond volume) provided accumulation of water does not occur.
- Separating the tailings into fine (overflow) and coarse (underflow) fractions with hydro-cyclones could reduce the amount of tailings to be stored in the TSF by 10% to 30% if the coarse fraction is placed in the southeast rock disposal site; however, a separate water management pond with a storage capacity of about 4 million m^3 to manage the 1:200-year freshet volume would be required. A separate water management pond would require significant investigation (foundation conditions would be required to be characterized to a sufficient level to enable appropriate design), add to the disturbed area of the mine, and require more closure work at the completion of mining.
- Thickened tailings offer limited advantages over conventional tailings as the mine site has an overall positive water balance and the TSF or a new dam would be required to manage freshet water.
- The high capital cost of a filter plant may not be economic given the relatively short remaining LoM. A separate water management pond with a storage capacity of about 4 million m^3 to manage the 1:200-year freshet volume would also be required.
- Deposition of tailings in deep lakes provides numerous advantages in terms of the physical and chemical stability of tailings; however, the permitting of such facilities is difficult, particularly when the lakes provide habitat for fish.
- The only advantage to using the Bullion Pit is that an area with significant historical mining disturbance could be restored to a landscape similar to the pre-mining condition. The delay to the mine operation related to the investigation and design of the containment structures and the seepage control system to minimize water loss to the Quesnel River, coupled with the increased costs for transporting the tailings to the Bullion Pit and water from the Bullion Pit to the mine and the need for an environmental impact assessment, make this alternative unattractive, and, likely would prevent continuation of operations.

The study recommends that the tailings produced in the remaining LoM be transported as conventional (slurry) tailings to the existing TSF and be managed using best applicable practices, including:

- routine and sustained discharge of mine water such that the volume of water stored in the TSF is maintained low

- managing the pond in the TSF such that beaches are maintained upstream of the embankments throughout the operational life of the TSF
- providing drainage to promote the desaturation and densification of the tailings

7.2 Tailings Storage Facility Water Balance

The SWWBM (site-wide water balance model) supports water management planning and the assessment of water quality and associated water treatment and discharge options. The last SWWBM was updated to reflect the Springer Expansion LoM plan during the operational phase and incorporates closure and post-closure phases for Mount Polley Mine (WSP 2023c), which include a hypothetical raise of the TSF to elevation 987 m.

The stage-storage curves projected up to a crest elevation of 987 m constitute a snapshot that changes with time as tailings are deposited.

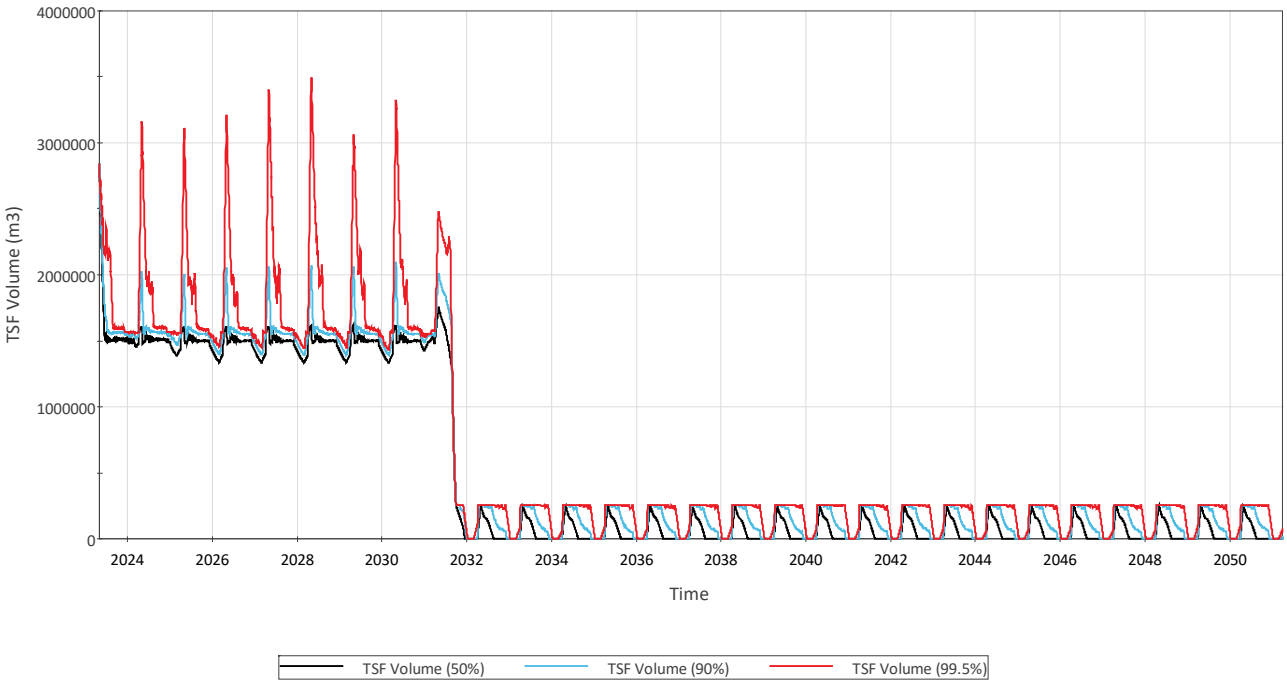
The SWWBM was run with probabilistic monthly climate inputs for this assessment. To develop probabilistic inputs, monthly precipitation data in the *Mount Polley Mine Climate Baseline Update* (Golder 2022) were fitted to a log-normal probability distribution.

The minimum and maximum operational water volumes set in the SWWBM for the TSF under normal conditions are 1.5 million m^3 and 1.7 million m^3, respectively. The TSF pond volume in the SWWBM is set at 1.5 million m^3 prior to freshet. When the maximum normal operating volume of 1.7 million m^3 is exceeded the model starts pumping water out of the TSF to return the pond volume to the specified normal operating range after freshet.

During closure and post-closure, the TSF pond is modelled to discharge annually via a spillway, and the TSF pond volume will vary seasonally, limited by the spillway invert, to a maximum of approximately 0.25 million m^3.

Results of the SWWBM presented in Figure 4 show the water volume in the TSF throughout future operations and into closure until 10 years after post-closure. The TSF volume pattern shown for the 2041 to 2051 post-closure period is continued for the remaining 80 years of post-closure (until 2131).

It is important to point out that the SWWBM was run for the Springer Expansion LoM plan, which includes raising the TSF to 987 m. The TSF raise to elevation 974 m is expected to be reached by 2026. If the TSF were to initiate closure at elevation 974 m, the closure scenario, with the pond reduced to 0.25 m^3, is applicable and the results presented for closure and post-closure are expected to be similar.



TSF = tailings storage facility.

Figure 4: Tailings Storage Facility Water Volume from Operations to 10 Years after Post-closure – Springer Expansion Life of Mine Plan

Table 6 shows tabulated minimum, average, and maximum bounds for the three percentile trends shown in Figure 4. The bounds presented represent the minimum, average, and maximum values for each percentile during the operational period: TSF operation to crest elevation 987 m (2023–2031), closure period (2031–2041), and post-closure period (from 2041).

Table 6: Tailings Storage Facility Water Volume (m^3) – Springer Expansion Life of Mine Plan

Phase	Bound	50th Percentile	90th Percentile	99.5th Percentile
Operations	Minimum	1,331,000	1,392,000	1,434,000
	Average	1,478,529	1,562,418	1,796,559
	Maximum	1,624,000	2,097,000	3,504,000
Closure	Minimum	0	0	0
	Average	119,426	188,747	266,028
	Maximum	1,762,000	2,030,000	2,507,000
Post-closure	Minimum	0	0	0
	Average	50,748	115,988	182,703
	Maximum	252,571	252,571	252,571

7.3 Tailings Storage Capacity

Tailings storage capacity analysis was undertaken for the TSF to determine the volume of tailings that can be stored in the TSF with a crest elevation of 974 m and provide input to the embankment raise construction schedule. The tailings deposition was modelled using Muk3D v2022.1.1 developed by MineBridge Software Inc. The base surface used for the deposition modelling was generated by combining a topographic survey completed on October 18, 2019, and a bathymetric survey completed on June 17, 2020. Deposition of tailings into the TSF was halted prior to the topographic survey in October 2019 and resumed in June 2022.

The parameters adopted for the deposition model are presented in Table 7.

Table 7: Parameters Adopted for Tailings Storage Facility Deposition Modelling

Parameter	Value	Notes
Tailings slope	0.5% sub-aerial 2% sub-aqueous	Range based on available topographic and bathymetric surveys since 2016
	1% sub-aerial 3% sub-aqueous	
Operational pond volume	1.5 million m^3	Pond volume to be maintained during normal operating conditions
Pond depth	4 m (beneath the reclaim barge)	Estimated for normal operation conditions based on available bathymetric surveys since 2016

Modelling of the deposition was conducted such that the pond is maintained away from the embankments and against the natural topography on the western perimeter of the TSF. To enable management of the pond against the natural ground and to maintain a minimum beach length of 100 m, the reclaim barge will need to be relocated to a central area between Corner 4 and Corner 5. It is important to note that maintaining a minimum beach length of 100 m, as required by the quantitative performance objectives, becomes more challenging with shallow tailings slopes and it is not a desired condition.

The tailings storage capacity (tonnage) versus tailings discharge elevation for the adopted range of tailings slopes is presented in Table 8. Selected stages of the deposition modelling are presented in Appendix E. Deposition timelines and construction scheduling based on these tonnages are discussed in Section 10.0.

As discussed in Section 7.10, a tailings freeboard (i.e., elevation difference between the top of tailings and the crest of the embankment) of 0.9 m is required to maintain adequate water storage capacity for temporary retention of site water generated from large freshet or precipitation events. This tailings freeboard is based on a 0.5% sub-aerial beach slope, which is what has been achieved with recent operations. Tailings freeboard may be increased or reduced during operations based on actual tailings deposition slopes; the tailings freeboard will be included as part of the quantitative performance objectives and changes must be agreed upon with the Engineer of Record.

Table 8: Tailings Capacity vs Tailings Discharge Elevation for Tailings Storage Facility Crest Elevation 974 m

Tailings Elevation (m)	Tailings Slope: 0.5% Sub-aerial, 2% Sub-aqueous		Tailings Slope: 1% Sub-aerial, 3% Sub-aqueous	
	Volume (million m^3)	Tonnage (Mt)	Volume (million m^3)	Tonnage (Mt)
970.0	12.06	16.28	9.33	12.59
972.0	16.02	21.63	13.14	17.74
973.1	17.78	24.01	14.90	20.11

Mt = million tonnes.

It is important to note that shallow tailings slopes are not a desired condition as meeting the quantitative performance objectives will be increasingly challenging. Introduction of a tailings freeboard is a result of the approximate 0.5% sub-aerial beach slopes achieved during recent operations. The tailings freeboard could be reduced, and larger tailings storage capacity made available, if steeper beach slopes were achieved.

7.4 Internal Erosion

The purpose of the filter, filter sand, and transition zones is to prevent erosion of the till core and till foundation into the voids of the rockfill shell.

The specified gradations of filter, filter sand, and transition materials have been designed to meet modern filter criteria (USBR 2011; FEMA 2011; Fell et al. 2015; USDA 2017) with a modification to the maximum sand content (i.e., 40%) in the filter band based on laboratory testing (Eldridge and Gilmer 2002). The filter, filter sand, and transition gradation envelope requirements for construction of the embankment to elevation 974 m remain unchanged from the filter, filter sand and transition gradation envelopes specified for construction of the embankment to elevation 970 m (Golder 2015b).

A detailed assessment of the adequacy of the embankment filter and transition constructed prior to August 2014 is presented in Golder (2016b). A summary of the assessment is included in Sections 7.4.1 to 7.4.3.

7.4.1 Till Core – Filter Compatibility

The filter compatibility assessment between the till core and filter materials was carried out following the criteria presented in Fell et al. (2015) and representative envelope of grain size distribution curves for all stages of construction. Figure 5 shows the filter compatibility criteria and the grain size distribution envelopes for the till core and filter material. The results show a portion of the till core and filter grain size distributions as constructed do not meet filter compatibility criteria.

To assess filters on existing dams, Foster and Fell (2001) developed a method based on laboratory tests and analysis of dams that have experienced piping incidents, defining erosion boundaries:

- “No erosion – practically no erosion; i.e., <10 g of base material for cohesionless soils and no visible erosion of the preformed hole in cohesive soils.”
- “Some erosion and excessive erosion – filter seals after ‘some’ erosion of the base material.”
- “Continuing erosion – for the cases where the filter was too coarse to allow the eroded base materials to seal the filter, resulting in unrestricted erosion of the base soil.”

The no erosion, excessive erosion, and continuing erosion boundaries for the compatibility of the till core–filter materials are presented in Figure 5. In this case, the no erosion criteria coincide with the filter criteria. The results show that a portion of the filter grain size distributions as constructed is in between the no erosion and some erosion boundaries, and therefore the filter would seal after “some” erosion of the till core.

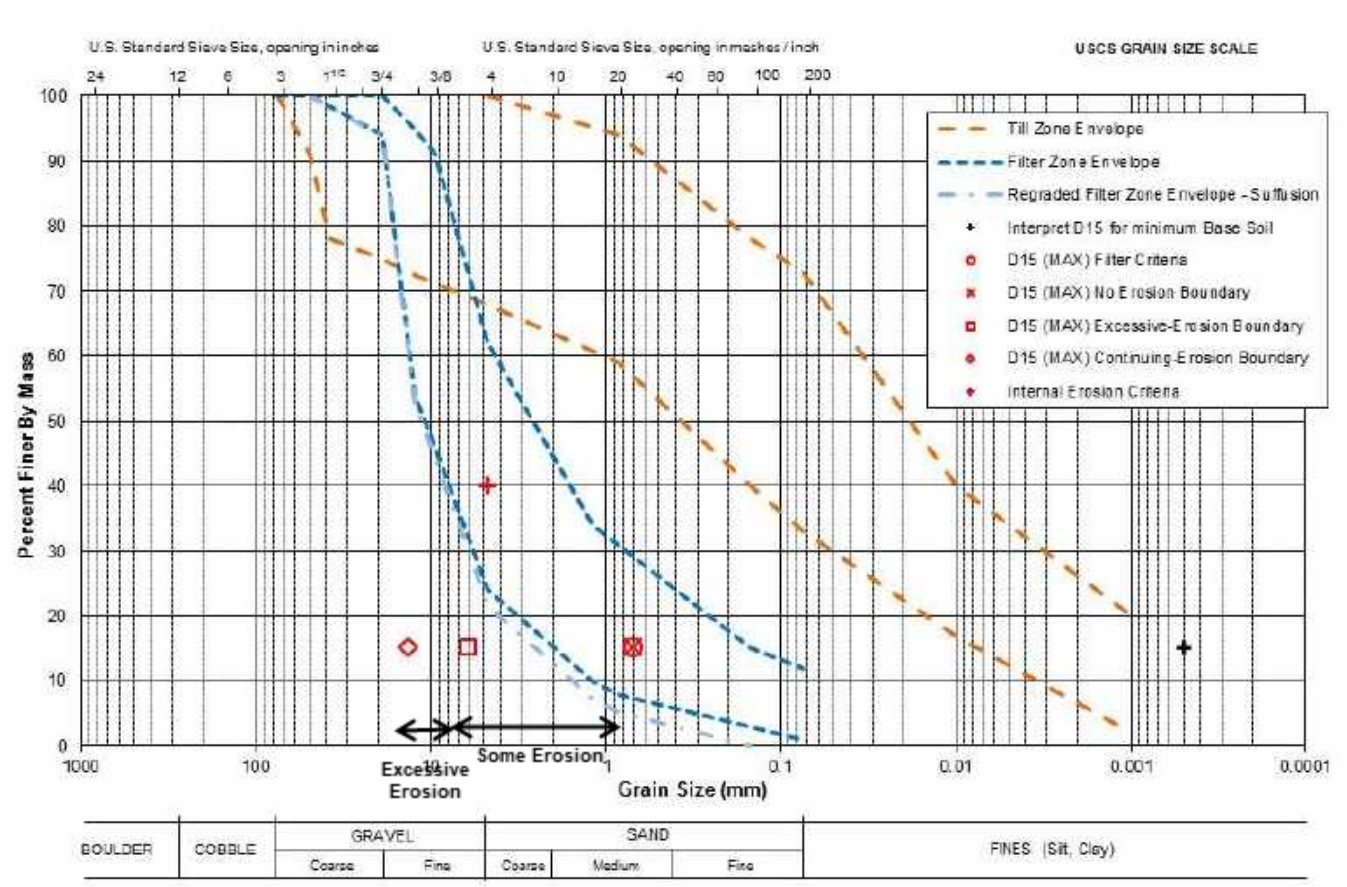


Figure 5: Filter Compatibility between Till Core and Filter Materials Constructed Prior to August 2014

Prior to the breach of the Perimeter Embankment, no signs of erosion or sinkholes were reported and the maximum hydraulic gradient imposed on the till core of the embankment was in the order of 5. As noted in International Commission on Large Dams (ICOLD) Bulletin 164, “The available evidence on the occurrence of global backward erosion (see Figure 2.7 in Section 2.3.2.2) in central core dams is that this internal erosion mode will only occur at relatively high gradients except when the core consists of cohesionless, internally unstable soil subject to suffusion.” The till core is considered not to be susceptible to suffusion due to its plasticity. As noted in Bulletin 164, “for practical purposes Fell et al. (2008) have concluded that based on the data described available soils with Plasticity Index > 7 should be considered not subject to suffusion at the gradients usually experienced in dams and their foundations” (ICOLD 2013).

Based on the filter criteria results and observations prior to the breach, if the hydraulic gradients were to raise to a level sufficient to initiate backward erosion of the till core, some erosion of the till core could be expected before the filter seals it.

To reduce the hydraulic gradient through the till core, minimum 100 m beaches are maintained upstream of the embankments and the size and depth of the pond are limited to the minimum required to operate the process plant. These operational requirements are part of the design and operational philosophy and are included in the QPOs of the TSF.

The TSF raise from elevation 970 to 974 m will result in a small increase of the hydraulic gradient imposed on the till core (i.e., less than 1); however, in consideration of potential future raises, the design includes upstream drains between elevation 970 and 972 m to control the hydraulic head upstream of the embankment and therefore the hydraulic gradient across the till core. The design of the upstream drains is presented in Drawings 25 to 28 in Appendix A.

7.4.2 Filter – Transition Compatibility

The filter and transition grain size distributions as constructed meet filter compatibility criteria. Figure 6 presents the filter compatibility criteria and the grain size distribution envelopes for the filter and transition materials. The no erosion boundary is also included in Figure 6.

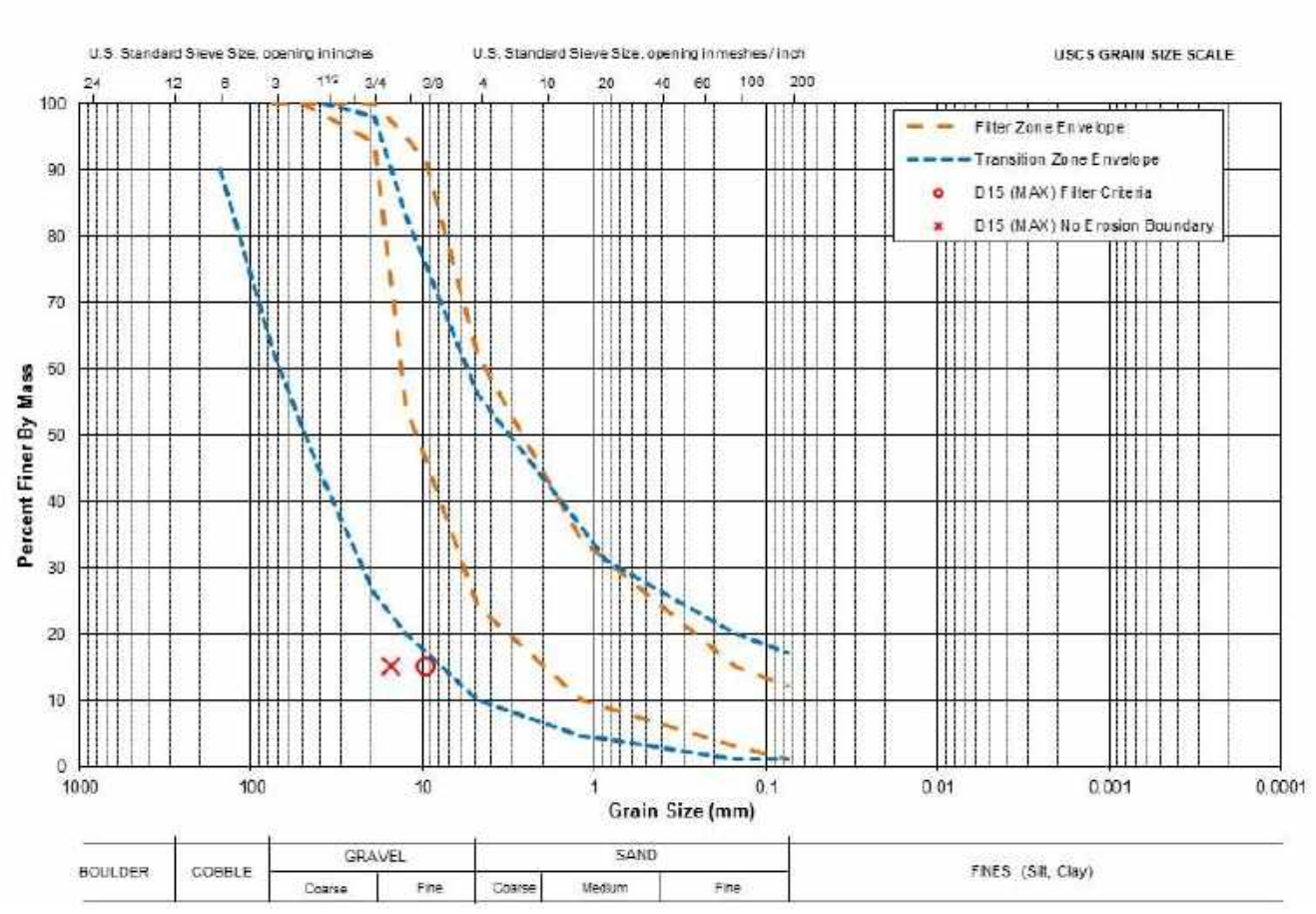


Figure 6: Filter Compatibility between Filter and Transition Materials Constructed Prior to August 2014

7.4.3 Transition – Rockfill Compatibility

The transition and rockfill grain size distributions as constructed meet filter compatibility criteria. Figure 7 presents the filter compatibility criteria and the grain size distribution envelopes for the transition and rockfill materials.

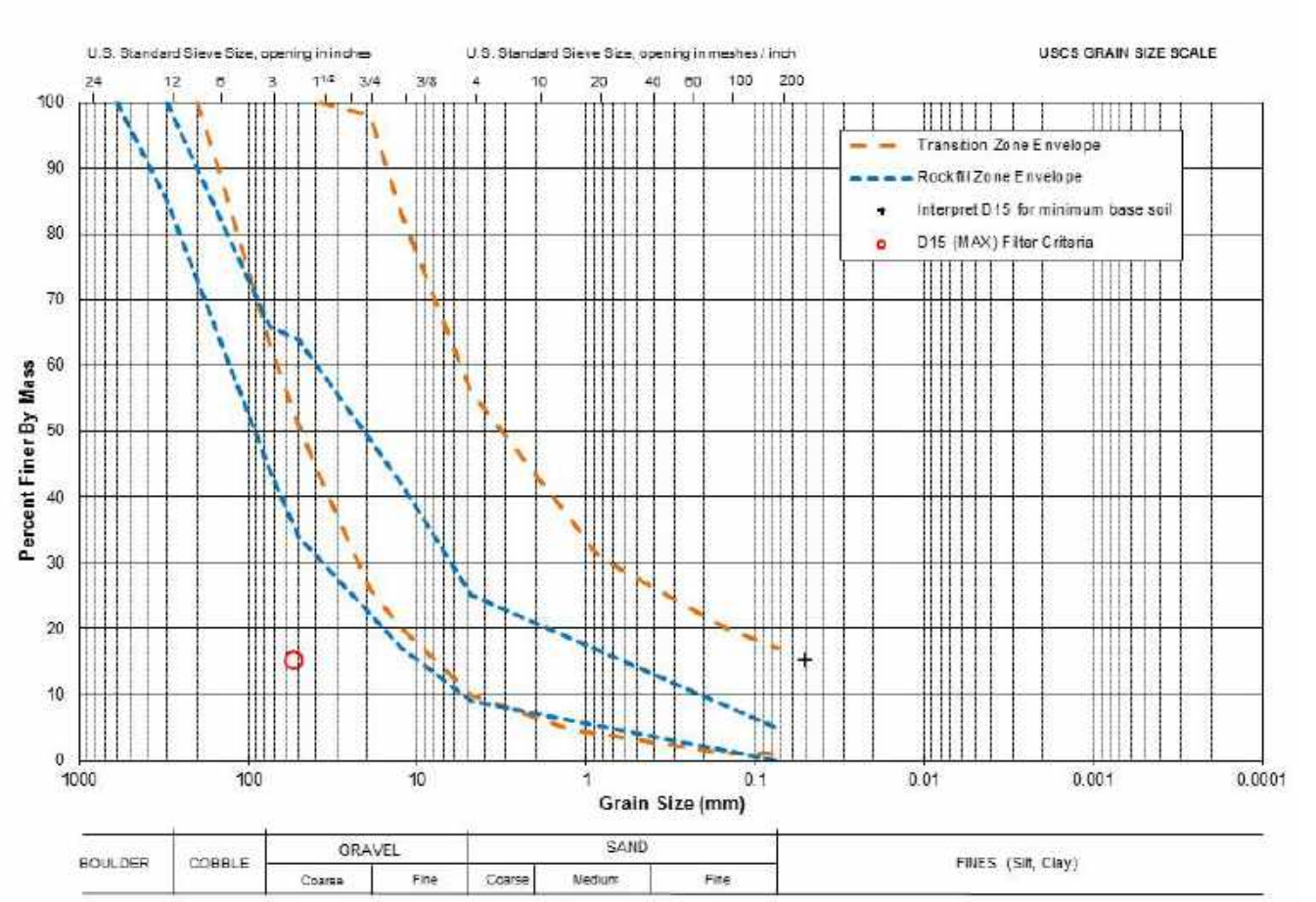


Figure 7: Filter Compatibility between Transition and Rockfill Materials Constructed Prior to August 2014

7.5 Seepage Analysis

Seepage analyses were carried out for typical sections of the elevation 974 m configuration of the South Embankment (Stn. 0+725), Main Embankment (Stn. 2+055), Perimeter Embankment (Stn. 3+765), and Perimeter Embankment at Corner 1 (Stn. 4+255) under steady-state conditions. The section at Corner 1 was analyzed to represent the portion of the embankment that includes a cut-off wall below elevation 950 m (from Stn. 3+996 to 4+464).

The analyses were conducted using GeoStudio 2023.1 from GEOSLOPE International Ltd. The objectives of the seepage analyses were as follows:

- to quantify anticipated seepage rates through the foundation, embankment, and proposed upstream drains
  - to assess sensitivity of the seepage rate through the embankment and foundation and the flow rate through the upstream drain for a range of beach widths (i.e., distance from the embankment to the pond: 0, 50, 100, 200 and 300 m)
- to determine phreatic surface geometries for use in stability analyses

Sensitivity analyses were undertaken to assess the flow rate through the upstream drain for the anticipated range of tailings hydraulic conductivity.

7.5.1 Material Properties Calibration

The tailings and foundation material properties were calibrated using available monitoring data at Corner 1 of the Perimeter Embankment (Stn. 4+255) and near the middle section of the Main Embankment (Stn. 2+055).

Section 4+255 (old Stn. 20+265; Golder 2015a) was selected for calibration of the hydraulic conductivity of the tailings using the estimated upstream drain flows and associated beach width and piezometric data. The hydraulic conductivity of the tailings was calibrated within a range of 1.0×10^{-4} m/s to 1.0×10^{-6} m/s, estimated from laboratory hydraulic conductivity tests and estimations based on particle size distribution (Section 5.1). Tailings anisotropy was estimated to have a horizontal to vertical permeability ratio of kh/kv = 0.1 based on interlayering typical of slurry-deposited tailings.

Section 2+055 (old Stn. 2+060) was selected for the calibration of the hydraulic conductivity of foundation materials and tailings using available vibrating wire piezometer (VWP) data and associated beach width. Material properties for both tailings and foundation materials were calibrated using various combinations to obtain a reasonable comparison between the available VWP data and the calculated phreatic surface in the model.

A distinction is made in the calibration model between tailings materials above and below elevation 960 m to reflect tailings that drained and consolidated following the 2014 embankment breach and tailings deposited since 2016.

The hydraulic conductivities assigned to foundation materials were calibrated within the ranges reported in the site characterization report (WSP 2023a).

The recorded seepage reporting to the Main Embankment Seepage Collection Pond was only used as reference in the calibration as reported flows include a combination of seepage through the embankment, flow through an upstream drain, flow from depressurization wells, and runoff.

The results of the calibration modelling are illustrated in Figures F-2 and F-3 in Appendix F. Calibrated material properties for the seepage analyses are presented in Table 9.

Table 9: Material Properties Used for Seepage Modelling

Name	Material Model	Saturated Hydraulic Conductivity K (m/s)	Anisotropy Ratio K_x'/K_y'	Notes
Foundation – glaciofluvial and till	Saturated only	1×10^{-6}	0.1	Adopted based on foundation characterization (WSP 2023a) and model calibration Glaciofluvial: 8×10^{-6} to 2×10^{-4} m/s Ablation till: 6.4×10^{-8} to 2×10^{-6} (mean 2×10^{-7}) Basal till: 4×10^{-8} to 2×10^{-6} (mean 3×10^{-7})
Foundation – glaciolacustrine	Saturated only	5×10^{-10}	1	Adopted based on foundation characterization (WSP 2023a) and model calibration HydrogeoSieveXL: 2×10^{-10} to 7×10^{-8} (mean 7×10^{-9}) From CPT: 3×10^{-9} to 6×10^{-8} (mean 2×10^{-8})
Rockfill	Saturated only	1×10^{-2}	1	Assumed by WSP

Table 9: Material Properties Used for Seepage Modelling

Name	Material Model	Saturated Hydraulic Conductivity K (m/s)	Anisotropy Ratio K_x'/K_y'	Notes
Tailings deposited since 2016	Saturated / unsaturated	1×10^{-5}	0.1	Estimated based on model calibration
Tailings deposited prior to August 2014	Saturated / unsaturated	1×10^{-6}	0.1	Estimated based on model calibration Available permeability test on tailings sample collected upstream of Corner 1 in 2014 = 2×10^{-6} m/s Estimated hydraulic conductivity using Hazen and Kozeny-Carman for a range of tailings gradations near the embankment = 4×10^{-5} to 8×10^{-6} m/s
Till core	Saturated / unsaturated	1×10^{-8}	1	Based on forensic investigation data and characterization of foundation till (WSP 2023a)
Filter, transition and upstream drain rock	Saturated / unsaturated	1×10^{-2}	1	Assumed by WSP
Upstream fill	Saturated / unsaturated	1×10^{-5}	1	Estimated based on model calibration of tailings
Cut-off wall	Saturated only	1×10^{-8}	1	Upper bound based on the hydraulic conductivity testing of samples taken from the cut-off wall (Golder 2015a)

Kx'/Ky' = horizontal hydraulic conductivity over vertical hydraulic conductivity

7.5.2 Boundary Conditions

The following boundary conditions were used:

- total head boundaries within the facility to define pond elevations for various beach length configurations
- zero-pressure boundaries along the ground surfaces beyond the buttress toe
- zero-flow boundaries within the upstream drain
  - A zero-flow boundary within the upstream drain acts as a sink, pulling water out of the model. This assumes the drain has enough capacity to maintain the phreatic surface at the elevation of the drain.
  - The flow rate at the point of zero-flow within the upstream drain does not report to the embankment buttress toe.
  - The upstream drain at elevation 950 m at Corner 1 was assumed to not be operating.

7.5.3 Seepage Analysis Results

The results of the seepage analyses are presented in Appendix F and summarized in Sections 7.5.3.1 to 7.5.3.3. The analyses were undertaken using the calibrated material properties in Table 9 and considering a range of beach widths (i.e., 0, 50 and 100, 200, and 300 m) to reflect variations in operational and upset conditions. The maximum beach width of 300 m represents a scenario where the operational (1.5 to 1.7 million m^3) pond is against the natural ground to the west of the TSF and there is even beach distributed across each of the embankments.

7.5.3.1 Phreatic Level and Hydraulic Gradient

Table 10 presents the phreatic level of the pond against the till core and the hydraulic gradient through the till core. The results presented are for a scenario where no upstream drain is constructed and with an upstream drain at elevation 970 m.

Table 10: Phreatic Level against the Till Core and Hydraulic Gradient across the Till Core

Embankment	Configuration	Phreatic Level and Hydraulic Gradient (K) at Till Core									
		No Beach		50 m Beach		100 m Beach		200 m Beach		300 m Beach	
		Phreatic Level (elev., m)	K	Phreatic Level (elev., m)	K	Phreatic Level (elev., m)	K	Phreatic Level (elev., m)	K	Phreatic Level (elev., m)	K
South Embankment	Without drains	973.6	4.5	972.0	4.2	970.4	3.9	967.1	3.2	963.6	2.5
	With drain at elev. 970 m	971.2	4.0	970.0	3.8	970.0	3.8	-	-	-	-
Main Embankment	Without drains	973.4	7.3	971.4	6.9	969.4	6.5	964.7	5.5	957.6	4.1
	With drain at elev. 970 m	970.7	6.7	970.0	6.6	970.0	6.6	-	-	-	-
Perimeter Embankment	Without drains	972.7	6.3	969.4	5.7	965.8	5.0	956.1	3.0	946.3	1.1
	With drain at elev. 970 m	970.2	5.8	-	-	-	-	-	-	-	-
Perimeter Embankment at Corner 1	Without drains	972.4	3.9	970.3	3.5	968.6	3.1	964.3	2.3	959.1	1.2
	With drain at elev. 970 m	971.0	3.6	970.0	3.4	-	-	-	-	-	-

Note: Till core elevation corresponds to 5 m till core width at elevation 951 m for the South Embankment, elevation 937 m for the Main Embankment and elevation 941 m for the Perimeter Embankment. The Perimeter Embankment at Corner 1 elevation 953 m is used where cut-off wall transitions to a 5 m wide till core.

Grey shaded cells indicate where phreatic level and hydraulic gradient are not reported for cases with drain at elevation 970 m where the phreatic level is lower than the drain.

The results show that the phreatic level and hydraulic gradient can be managed by maintaining wide tailings beaches upstream of the embankments and that the hydraulic gradient remains relatively low for normal operating and upset conditions.

The analyses also show that the upstream drains will start capturing water when the pond encroaches the embankment (i.e., 100 m beach or less). As discussed in Section 7.4, the upstream drains have been included in the design in consideration of potential future raises above elevation 974 m that would increase the hydraulic gradient imposed on the till core of the embankment. Changes to the hydraulic gradient through the till core will be relatively small (< 1) for the TSF raise from elevation 970 to 974 m. The intent of the upstream drains is to limit increases to hydraulic head upstream of the embankment, and hydraulic gradient through the till core, for crest elevations above 974 m and up to elevation 987 m.

7.5.3.2 Flow Rates through Upstream Drain

Seepage analyses were undertaken to quantify anticipated flows through the upstream drain at elevation 974 m to inform the design of downstream water management infrastructure. The results of the seepage analyses for flow through the upstream drain per embankment are summarized in Table 11.

The upstream drain has been designed to consider potential future raises of the TSF, up to elevation 987 m. Flows used to size the upstream drain are presented in Section 7.6.

Table 11: Flow through Upstream Drains at Tailings Storage Facility Elevation 974 m

Embankment	Total Flow through Upstream Drain per Embankment									
	No Beach		50 m Beach		100 m Beach		200 m Beach		300 m Beach	
	m^3/s	L/s	m^3/s	L/s	m^3/s	L/s	m^3/s	L/s	m^3/s	L/s
South Embankment	3.7×10^{-2}	36.9	5.7×10^{-3}	5.7	1.3×10^{-3}	1.3	-	-	-	-
Main Embankment	3.8×10^{-2}	38.3	5.1×10^{-3}	5.1	2.3×10^{-4}	0.2	-	-	-	-
Perimeter Embankment	5.1×10^{-2}	51.0	2.6×10^{-3}	2.6	-	-	-	-	-	-
Perimeter Embankment at Corner 1	1.3×10^{-2}	13.2	1.1×10^{-3}	1.1	-	-	-	-	-	-

Total flow through upstream drain per embankment calculated based on total length of upstream drains at each embankment:
South Embankment drain length of 1,050 m used to calculate flows.
Main Embankment drain length of 1,200 m used to calculate flows.
Perimeter Embankment drain length of 1,600 m used to calculate flows (includes section west of Corner 1 to Corner 5).
Perimeter Embankment at Corner 1 drain length of 400 m used to calculate flows.
Grey shaded cells indicate that the phreatic level is lower than the drain and negligible flows are observed through the upstream drains.

The existing upstream drain at elevation 950 m at Corner 1 was assumed to not be operational in the analyses to assess the potential flows that the upstream drain at elevation 970 m could experience.

The analysis shows that little to no flow is expected through the upstream drains for beach widths greater than 50 m. The upstream drain has been incorporated to account for future raises above 974 m and is not a critical control for managing hydraulic gradient at TSF elevation 974 m.

7.5.3.3 Seepage Rates through Embankment and Foundation

Seepage analyses were undertaken to quantify seepage rates through the embankment and foundation and to inform the design of downstream water management infrastructure. The results of the seepage analyses for seepage through the embankment and foundation are summarized in Table 12 and shown for the Main Embankment in Figure 8. The seepage values reported do not include flows through upstream drains.

Table 12: Flow through the Embankment and Foundation

Embankment		Total Seepage through Embankment and Foundation per Embankment									
		No Beach		50 m Beach		100 m Beach		200 m Beach		300 m Beach	
		m^3/s	L/s	m^3/s	L/s	m^3/s	L/s	m^3/s	L/s	m^3/s	L/s
South Embankment	Without drain	4.6×10^{-3}	4.6	4.3×10^{-3}	4.3	4.1×10^{-3}	4.1	3.6×10^{-3}	3.6	3.1×10^{-3}	3.1
	With drain	4.3×10^{-3}	4.3	4.1×10^{-3}	4.1	4.0×10^{-3}	4.0	3.6×10^{-3}	3.6	3.1×10^{-3}	3.1
Main Embankment	Without drain	8.4×10^{-3}	8.4	8.1×10^{-3}	8.1	7.8×10^{-3}	7.8	7.1×10^{-3}	7.1	6.1×10^{-3}	6.1
	With drain	8.1×10^{-3}	8.1	7.9×10^{-3}	7.9	7.8×10^{-3}	7.8	7.1×10^{-3}	7.1	6.1×10^{-3}	6.1
Perimeter Embankment	Without drain	1.5×10^{-2}	15.5	1.5×10^{-2}	14.6	1.4×10^{-2}	13.5	1.1×10^{-2}	10.9	8.4×10^{-3}	8.4
	With drain	1.5×10^{-2}	14.8	1.4×10^{-2}	14.4	1.4×10^{-2}	13.5	1.1×10^{-2}	10.9	8.4×10^{-3}	8.4
Perimeter Embankment at Corner 1	Without drain	9.4×10^{-3}	9.4	9.0×10^{-3}	9.0	8.6×10^{-3}	8.6	7.6×10^{-3}	7.6	6.3×10^{-3}	6.3
	With drain	9.1×10^{-3}	9.1	8.9×10^{-3}	8.9	8.6×10^{-3}	8.6	7.6×10^{-3}	7.6	6.3×10^{-3}	6.3

South Embankment length of 1,050 m used to calculate total toe seepage in L/s.

Main Embankment length of 1,200 m used to calculate total toe seepage in L/s.

Perimeter Embankment length of 1,300 m used to calculate flows (section west of Corner 1 to Corner 2). The Perimeter Embankment section modelled includes the Perimeter Embankment Till Borrow Pond and is considered an upper bound for seepage and not representative of the full length of the embankment.

Perimeter Embankment at Corner 1 length of 450 m used to calculate flows (one drainage panel).

The upstream drain has been modelled at elevation 970 m.

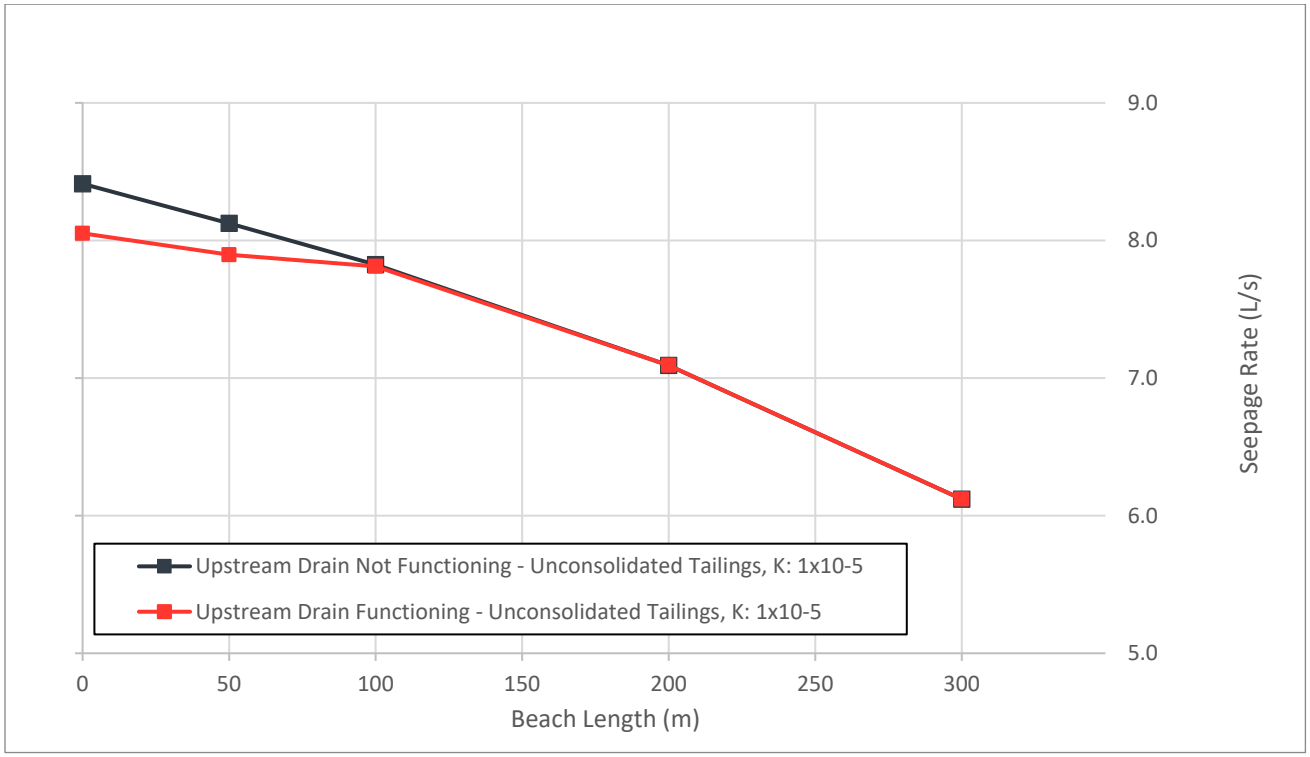


Figure 8: Main Embankment (Stn. 2+055) Total Seepage through Toe/Foundation

The seepage analyses carried out on typical sections of the embankment show that seepage from the TSF will not significantly increase by raising the TSF from elevation 970 to 974 m (WSP 2023b). The seepage rate will be dependent on the length of the tailings beach.

7.6 Upstream Drain Design

This section presents the upstream drain design capacity and layout. Design objectives for the upstream drain system are primarily for potential future raises above elevation 974 m and are to:

- control the hydraulic gradient across the till core by limiting the hydraulic head upstream of the embankment
- promote unsaturated conditions in the tailings above the drain
- promote consolidation of tailings above the drain and upstream of the TSF embankment

These objectives will be met by providing passive drainage of water from the tailings deposited upstream of the till core to the downstream water management infrastructure.

The upstream drainage system design is based on the configuration of the existing Perimeter Embankment upstream drain at Corner 1 and will consist of the following:

- A minimum of 1 m thick and 10 m wide layer of drain rock wrapped on a non-woven geotextile and placed on general fill. Bedding material will be placed under the geotextile at the base and over the drain rock.

- A series of pipe “panels” installed within the drain rock. Each panel consists of six to eight perforated high-density polyethylene (HDPE) drainpipes that connect to a solid HDPE connector pipe, which then conveys flow in one central solid HDPE pipe through the till core and to the downstream water management structures.
  - Each perforated drainpipe (sized as 6-inch DR9 HDPE) will be 10 m long and will be placed 50 m apart and perpendicular to the embankment. The drainpipes will be installed at a grade of 0.5% to 1%.
  - The solid HDPE connector pipe (sized as 12-inch DR17 HDPE) will be installed within the drain rock, parallel to the embankment and at a grade of 0.5% to 1%.
  - The solid HDPE collector pipe (also sized as 12-inch DR17 HDPE) will be installed at a minimum grade of 1% and maximum of 12%.

The upstream drain will be offset 25 m from the till core.

Filter sand will be placed around the HDPE collector pipe on the upstream and downstream side of the till core.

Tailings deposition above the upstream drains must occur in a way to prevent erosion of the constructed upstream drains, either through pipeline discharge location, erosion control measures, spigots, or some combination.

Details of the upstream drain panel are shown in Drawings 25 to 28 in Appendix A and included in the technical specifications in Appendix B.

7.6.1 Pipe Sizing

The drain, connector, and collector pipes were sized to accommodate the estimated flow for an elevation 987 m TSF configuration. Pipe flow capacities were calculated using Manning’s equation with a Manning’s coefficient equal to 0.01 for the HDPE pipes.

The design flow for each pipe was estimated from 2D seepage modelling for the TSF at elevation 987 m. The results of the analyses are presented in Table 13. The criteria adopted to estimate the design flow were a tailings hydraulic conductivity of 1×10^{-5} m/s and a 50 m beach width. A factor of safety (FoS) of 3 was applied to the estimated design flow.

Table 13: Flow through Upstream Drains at Tailings Storage Facility Elevation 987 m with a 50 m Beach

Embankment	Flow per Drain Pipe[(a)] (m^3/s)	Flow per Drain Pipe[(a)] (L/s)
South Embankment Stn. 0+725	1.6×10^{-3}	1.63
Main Embankment Stn. 2+055	1.6×10^{-3}	1.57
Perimeter Embankment Stn. 3+765	1.4×10^{-3}	1.42
Perimeter Embankment at Corner 1 Stn. 4+255	2.0×10^{-3}	2.02

(a) Reported flows consider a lateral catchment area of 50 m per drain pipe.

As shown in Table 13, the results of the 2D seepage model ranged between 1.42 and 2.02 L/s. Considering an applied FoS of 3, the upstream drain pipes require a capacity up to 6.1 L/s. The adopted design flow for sizing of drain pipes installed with 50 spacing was 6.8 L/s.

A typical drainage panel comprises eight upstream drain pipes, which are routed through a singular discharge pipe. The adopted design flow for sizing of the discharge pipe was 54 L/s.

7.7 Stability Analysis

Two-dimensional limit equilibrium slope stability analyses were conducted using GeoStudio 2023.1. The objective of the stability analyses was to confirm that the FoS for short-term and long-term stability meet the design criteria presented in Section 7.7.1.

7.7.1 Design Criteria for Slope Stability

The minimum FoS criteria are summarized in Table 14.

Table 14: Slope Stability Analysis Design Criteria

Criteria	Unit	Value	Source
Static (long term)	FoS	1.5	HSRC Guidance Document Section 3.3.1 (BC MEM 2016), CDA (2019) Table 3-4
Static (during or at end of construction)	FoS	1.5	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) Other criteria include: >1.3 recommended by CDA (2019) Table 3-4
Pseudo-static	FoS	1.0	Informed by Table 3-5 of CDA (2019)
Post-earthquake	FoS	1.2	Informed by Table 3-5 of CDA (2019)
Design earthquake event	-	1:2,475 AEP	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) Other criteria include: ▪ Between 1:100 and 1:1,000 (CDA 2019) ▪ 1:1,000 AEP recommended by GISTM (Global Tailings Review 2020) Consistent with WSP's best practice, an earthquake event of 1:10,000 AEP is used to assess sensitivity of the analyses
Design earthquake peak ground acceleration	g	0.048	For earthquake event of 1:2,475 AEP 0.116 g for earthquake event of 1:10,000 AEP
Seismic coefficient for limit equilibrium pseudo-static analysis	-	0.5	Hynes-Griffin and Franklin (1984) 20% strength reduction applied to GLUs as recommended by Hynes-Griffin and Franklin (1984) for clays

FoS = factor of safety; HSRC = Health, Safety and Reclamation Code; AEP = annual exceedance probability; GISTM = Global Industry Standard for Tailings Management; GLU = glaciolacustrine unit.

7.7.2 Material Properties

7.7.2.1 Embankment Fill Materials

Strength parameters to be used in the stability analyses for embankment fill materials have been selected based on interpretation of the available field and laboratory test data and are consistent with strength parameters adopted for previous design analyses (i.e., Golder 2015b,c, 2017c).

Table 15: Embankment Material Properties for Stability Analysis

Material	Unit Weight (kN/m^3)	Shear Strength	Notes
Rockfill	21.5	$T = 1.726\ \sigma'_n{}^{0.899}$	Based on Leps (1970) average rockfill (Golder 2016a)
Transition	20		
Tailings	17	Drained: $\phi' = 25°$ c = 0 kPa Undrained: $T/\sigma_v' = 0.1$	Assumed by Golder (2015b, 2017c) Undrained shear strength adopted for post-earthquake analysis. Assumes liquefied tailings.
Upstream fill	20	$\phi' = 32°$ c = 0 kPa	Assumed by Golder (2015b, 2016a) based on Campaña (2011)
Till core	20.5	$\phi' = 33°$ c = 0 kPa	Based on triaxial testing of two recompacted samples of till (KP 1995) and triaxial testing (KCB 2015a, 2015b)
Filter and cut-off wall aggregate	20	$\phi' = 30°$ c = 0 kPa	Based on triaxial testing (Golder 2015e)

T = shear strength; σ_v' = effective vertical stress; ϕ' = friction angle; σ'_n = effective normal stress; c = cohesion.

Post-earthquake analyses use an undrained strength ratio for the tailings, which is representative of a liquefied strength. The relatively small magnitude of ground acceleration anticipated during the design earthquake event is unlikely to trigger widespread liquefaction in the tailings. Thus, using a post-liquefied undrained strength for the tailings represents a worst-case scenario for post-earthquake tailings strength.

7.7.2.2 Foundation Soils

Strength parameters used to represent foundation soils in the stability analyses are presented in Table 16.

Till and glaciofluvial materials vary in gradation depending on location, elevation, and depositional history; however, the results of the laboratory testing show a relatively consistent high strength. The shear strength parameters selected for the foundation till and glaciofluvial layers represent an average for the materials. The strength parameters are consistent with the parameters used in previous design analyses, testing results and analyses of the Perimeter Embankment breach at Corner 1 carried out by the IEEIRP (2015), and the results of laboratory testing completed by KCB (2015b).

Glaciolacustrine soils were analyzed using total stress (undrained) strength parameters. The total stress approach uses the SHANSEP (Stress History and Normalized Soil Engineering Properties) model that accounts for the stress history of the soil. The preconsolidation pressure that was selected for modelling the strength of each of the glaciolacustrine soil layers is based on data collected for the specific layer and soils in the immediate area. The data used include the results of laboratory strength testing, CPT profiles, the response of the soils during in situ testing and sampling (e.g., not being able to push a shear vane into the soil layer and bending of Shelby tubes during sampling), and correlation with index testing. Along the Perimeter and Main embankments, the preconsolidation pressure values selected for the analyses were at or below the lower bound of the values obtained from the laboratory consolidation tests and estimated from the CPT profiles. The undrained shear strength ratio function used to characterize glaciolacustrine materials was refined from $\tau = 0.22\ \sigma'_v\ OCR^{0.8}$ (where τ = shear strength, σ'_v = effective vertical stress, and OCR = overconsolidation ratio) to $\tau = 0.22\ \sigma'_v\ OCR^{0.71}$ based on laboratory testing completed as part of the 2021/2022 investigation. The undrained shear strength ratio functions are presented in Figure G-2, Appendix G.

A remoulded undrained shear strength continues to be adopted to characterize the UGLU at Corner 1 in these analyses. The remoulded undrained shear strength was selected as the average minus one standard deviation of the measured values from field vanes and CPTs as part of the forensic investigation in 2014. Since then, the embankment was repaired and constructed to elevation 970 m (approx. 40 m high) over the area of UGLU that sheared. Potential strength gains from reconsolidation of the UGLU have not been included in the characterization and stability analyses.

The sensitivity (strain weakening) of the GLU was not incorporated into the limit equilibrium analyses. Stress- deformation analyses were completed to assess potential redistribution of stresses due to strain weakening of glaciolacustrine units. The results are presented in Section 7.9.

A layer of low plasticity silty clay interpreted to have deposited in a glaciolacustrine environment was identified directly above bedrock near Stn. 1+095 at the South Embankment; however, the geotechnical testing completed on the material showed that it is not representative of the intermediate or high plasticity GLUs found at the Main and Perimeter embankments, including Corner 1. For the purposes of stability modelling, this layer was assigned the same shear strength and preconsolidation pressure (1,200 kPa) as the GLU at the Main Embankment.

B-bar values (i.e., change in pore pressure over the change in confining stress [Skempton 1954]) were assigned to the till and the glaciofluvial and glaciolacustrine soils to account for the excess pore pressures that may be generated during construction (WSP 2023a). The B-bar values determined for each material are based on the maximum pore pressure response measured during construction since 2014.

A detailed summary of available geotechnical data and characterization of the TSF foundation is presented in the TSF dam site characterization report (WSP 2023a). The TSF dam site characterization report will be updated with data from future site investigations, and with observations and data from construction and operation of the facility over the life of the TSF. Should the understanding and characterization of foundation soils change with time, then required changes will be documented in future revisions of the TSF dam site characterization report and incorporated into this design report.

Table 16: Foundation Material Parameters for Stability Analysis

Material	Unit Weight (kN/m^3)	Shear Strength	Pore Pressure Coefficient B-bar	Notes
Foundation till	22	ϕ' = 34° c = 0 kPa	0.2	Triaxial testing of samples of till by IEEIRP (2015) and KCB (2015b)
Glaciofluvial	22	ϕ' = 34° c = 0 kPa	0.2	Triaxial testing of undisturbed glaciofluvial samples by Golder (2015d)
UGLU (Perimeter Embankment at Corner 1)	18	Peak: $T = 0.22\ \sigma_v' OCR^{0.71}$ Where σ_p' = 400 kPa Remoulded: S_{ur} = 22 kPa	0.46	Field and laboratory test programs by IEEIRP (2015) and KCB (2015a,b) including vane shear tests, CPT, direct simple shear, direct shear, and triaxial testing Remoulded undrained shear strength selected as the average minus one standard deviation of the measured undrained shear strength values
LGLU (Perimeter Embankment at Corner 1)	20	$T = 0.22\ \sigma_v' OCR^{0.71}$ Where σ_p' = 700 kPa	0.2	Field and laboratory test programs by IEEIRP (2015), KCB (2015a.b), and Golder (2017b, 2019a) including vane shear tests, CPT, direct simple shear, direct shear, and triaxial testing
GLU (Perimeter Embankment)	20	$T = 0.22\ \sigma_v' OCR^{0.71}$ Where σ_p' = 900 kPa	0.2	Consolidation testing by Golder on samples from boreholes GA15-06, GA21-03 and GA21-11 at Perimeter Embankment indicate preconsolidation stress from 900 to 3,600 kPa (excluding the samples assessed to be of very poor quality)
GLU (Main Embankment)	20	$T = 0.22\ \sigma_v' OCR^{0.71}$ Where σ_p' = 1,200 kPa	0.2	Field and laboratory test programs by KP (2007), AMEC (2012), Golder (2015d), and WSP Golder (2022b) including vane shear tests, CPT, direct simple shear, direct shear, and triaxial testing Consolidation tests indicate a range of preconsolidation pressure from 2,500 kPa to 4,000 kPa (excluding the samples assessed to be of very poor quality) and CPT data indicate a minimum preconsolidation pressure of about 1,200 kPa
		$T = 0.22\ \sigma_v' OCR^{0.71}$ Where σ_p' = 850 kPa (GLU at approx. elev. 922 Stn. 2+400 and 2+750)		Field and laboratory test programs by AMEC (2012), Golder (2015d), and WSP Golder (2022b) CPT21-07 data indicate a minimum preconsolidation pressure of about 850 kPa

Table 16: Foundation Material Parameters for Stability Analysis

Material	Unit Weight (kN/m^3)	Shear Strength	Pore Pressure Coefficient B-bar	Notes
Low plasticity silty clay (Stn. 1+095 South Embankment)	20	$T = 0.22\ \sigma_v' OCR^{0.71}$ Where $\sigma_p' = 1{,}200$ kPa	0.2	Index laboratory testing by Golder (2017b)

Source: WSP 2023a.
T = Shear strength; σ_v' = Effective vertical stress; ϕ' = Peak friction angle; OCR = overconsolidation ratio; σ_p' = Preconsolidation stress; c = cohesion; UGLU = upper glaciolacustrine unit; GLU = glaciolacustrine unit; LGLU = lower glaciolacustrine unit; CPT = cone penetration test; S_{ur} = Remolded Undrained shear strength.

7.7.3 Liquefaction Potential of Foundation Soils

Till and glaciofluvial materials vary in gradation, with the majority being a mixture of gravel, sand, and low plastic fines. A portion of glaciofluvial materials have a larger portion of sand (up to 85%) with some fines. While localized portions of the glaciofluvial units could be susceptible to seismic induced strength loss, these materials are typically laterally non-continuous and in a dense state and are not considered to be susceptible to liquefaction or cyclic softening.

7.7.4 Method and Scenarios Assessed

Nineteen sections, identified to represent the variability of the foundation and embankment conditions over the length of the TSF embankment, were chosen for stability analysis (Figure 9). Eighteen of these sections were used for previous stability modelling for the 970 m detailed design (Golder 2015b), design update (Golder 2017c) and Stn. 20+458 stability assessment (Golder 2018), and one section has been added at Stn. 0+725 in this assessment.

All sections were modelled for an embankment with a crest elevation of 974 m and a downstream slope of 2H:1V extending onto natural ground, or buttress. All sections were run for both normal operating conditions (i.e., minimum 100 m beach width and upstream drain functioning) and upset conditions (i.e., 0 m beach width and upstream drain not functioning). The upstream drain is included in the design for future raises of the TSF (Section 7.6) and has little effect for the raise of the TSF to elevation 974 m unless the pond encroaches to the embankment.

Where the design criteria presented in Table 7.7.1 were not met without modifications to the buttresses, iterative analyses were conducted to design a buttress that would meet the minimum FoS criteria. Where required, stability analyses were then re-run for the design configuration of the embankments and buttress.

The following scenarios were analyzed:

- static (end of construction)
  - In this case, the foundation soils are partially consolidated due to the applied load of the rockfill used for raising and resloping the embankment to elevation 974 m and buttress extension. B-bar values were assigned to the till and the glaciofluvial and glaciolacustrine units to account for the excess pore water pressures that may be generated during construction. The B-bar values used are based on measured pore pressure response during construction since 2014.

- Tailings were modelled to an elevation of 969 m.

- static (long term)
  - In this case, any excess pore water pressures generated during construction are considered to have dissipated and no B-bar values were assigned to the model.
  - Tailings were modelled to an elevation of 973 m.
- pseudo-static
  - A peak ground acceleration of 0.048 g corresponding to a 1:2,475 AEP was used for pseudo-static analyses. A seismic coefficient of 0.5 was selected for the pseudo-static analyses as recommended by Hynes-Griffin and Franklin (1984).
  - A 20% strength reduction factor was applied to glaciolacustrine deposits as recommended by Hynes-Griffin and Franklin (1984) for clays to account for strength loss during cyclic loading.
  - Tailings were modelled to an elevation of 973 m.
- post-earthquake
  - The post-earthquake case used an undrained strength for the tailings, which is representative of a liquefied strength.
  - A 20% strength reduction factor was applied to glaciolacustrine deposits to account for strength loss during cyclic loading.
  - Tailings were modelled to an elevation of 973 m.



LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE, BUTTRESS AND SPILLWAY DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 5)
- GA22-01 — SONIC DRILLING, PIEZOMETER INSTALLATION - CORNER 1 (WSP GOLDER, 2022)
- GA21-10 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1, PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- CPT21-09 — CPT - PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- GA18-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 (GOLDER, 2018)
- GA16-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- CPT16-04 — CPT - TAILINGS, CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- GW16-2A — SONIC DRILLING, MONITORING WELL INSTALLATION (GOLDER, 2016)
- GA15-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION (GOLDER, 2015)
- BGC-TP-2014 — TEST PIT (BGC / GOLDER, 2014)
- SI12-01 — ODEX, SI INSTALLATION - PERIMETER EMBANKMENT (AMEC, 2012)
- VW11-01 — SONIC DRILLING, PIEZOMETER INSTALLATION (AMEC, 2011)
- SI11-01 — SONIC DRILLING, SI INSTALLATION (AMEC, 2011)
- KP08-01 — SONIC DRILLING, SPT, BORROW PROGRAM (KP, 2008)
- SI06-01 — ODEX, SPT, SI INSTALLATION - MAIN EMBANKMENT (KP, 2006)
- SI01-01 — ODEX, SPT - MAIN EMBANKMENT (KP, 2001)
- DH01-01 — DRILLING, BORROW PROGRAM (KP, 2001)
- GW00-01 — ODEX, SPT, MONITORING WELL INSTALLATION - SOUTH EMBANKMENT (KP, 2000)
- CPT 96-1 — CPT - MAIN EMBANKMENT (KP / CONETEC, 1996)
- 96-A1 — SOLID/HOLLOW STEM AUGER, SPT, PIEZOMETER INSTALLATION - MAIN EMBANKMENT (KP / R.E. GRAHAM ENG., 1996)
- PRW96-01 — SOLID STEM AUGER, PRESSURE RELIEF WELL - MAIN EMBANKMENT (KP, 1996)
- GW96-1 — AIR ROTARY, SPT, MONITORING WELL INSTALLATION (KP, 1996)
- MP89-230 — CONDEMNATION BOREHOLES, PIEZOMETER INSTALLATION (KP, 1989)
- STA. 0+725 — STABILITY CROSS-SECTION LOCATION

0 200 400
1:6,000 METRES

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP CANADA INC.

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2014-2023 (SEE REFERENCES 1-4).
5. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: 03 SEPTEMBER 2014.
2. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
4. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
5. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 5 SEPTEMBER 2014.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-18
DESIGNED	S. BAINBRIDGE
PREPARED	T. KLASSEN
REVIEWED	S. BAINBRIDGE
APPROVED	G. PIZARRO

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY MODEL CROSS-SECTION LOCATIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
CA0020527.4505	51300/51395/014	0	9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds.golder.com\gdsdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\CA0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Figures\ | File Name: CA0020527_4505-51300-51395-014-09.dwg | Last Edited By: tyklassen Date: 2024-03-22 Time:3:36:36 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:46:07 PM

7.7.5 South Embankment Stability Analysis Results

One section, at Stn. 1+095 (old Stn. 1+100), was used in previous stability analyses (Golder 2015a, 2017c) to represent the South Embankment in terms of geometry and foundation conditions (i.e., layer of low plasticity silty clay). No additional geotechnical investigations have been required at the South Embankment and the foundation characterization remains as per the design update in 2017 (Golder 2017c).

An additional section was analyzed at the tallest section of the South Embankment at Stn. 0+725. No GLUs were identified in the foundation along the South Embankment.

The results of the analyses are summarized in Table 17 and Figures G-3 to G-10 in Appendix G.

The results of the slope stability analyses show that the design criteria FoS are achieved for both normal operating conditions (i.e., 100 m beach width and upstream drain functioning) and upset conditions (i.e., 0 m beach width and upstream drain not functioning) for elevation 974 m with a 2H:1V downstream slope for the South Embankment.

Table 17: Stability Analysis Results – South Embankment

Section	Static (end of construction)		Static (long term)		Pseudo-static		Post-earthquake	
	0 m beach	100 m beach	0 m beach	100 m beach	0 m beach	100 m beach	0 m beach	100 m beach
0+725	2.0	2.0	2.1	2.1	2.0	2.0	2.1	2.1
1+095	1.8	1.8	1.8	1.8	1.4	1.5	1.5	1.6

7.7.6 Main Embankment Stability Analysis Results

Five sections, identified to represent the variability of the foundation and embankment conditions over the length of the Main Embankment, were previously chosen for stability analysis. The foundation characterization has been updated for the section at Stn. 2+455 based on results of the 2021/2022 geotechnical investigation. No revisions to the foundation characterization in other areas of the Main Embankment were required, and the other four analyzed sections remain as per the elevation 970 m TSF detailed design (Golder 2015b). The sections and details of the foundation characterization adjustments are as follows:

- Stn. 1+845 (old Stn. 1+850).
- Stn. 2+055 (old Stn. 2+060).
- Stn. 2+235 (old Stn. 2+240).
- Stn. 2+455 (old Stn. 2+460): A glaciolacustrine layer, about 0.5 to 1.6 m thick at about elevation 922 m was included in this section. The GLU was modelled with an 850 kPa preconsolidation value based on CPT data (WSP 2023b).
- Stn. 2+695 (old Stn. 2+700).

The results of the analyses are summarized in Table 18 and Figures G-11 to G-33 in Appendix G.

Table 18: Stability Analysis Results – Main Embankment

Section	Static (end of construction)		Static (long term)		Pseudo-static		Post-earthquake	
	0 m beach	100 m beach	0 m beach	100 m beach	0 m beach	100 m beach	0 m beach	100 m beach
1+845	1.5	1.5	1.5	1.5	1.1	1.1	1.2	1.2
2+055	1.5	1.6	1.5	1.5	1.2	1.2	1.3	1.3
2+235	1.5	1.5	1.5	1.5	1.1	1.1	1.1	1.2
2+455	1.5	1.6	1.5	1.6	1.1	1.2	1.3	1.3
2+695	2.6	2.6	2.5	2.6	2.3	2.4	2.5	2.5

The slope stability analyses required extending the buttress along the majority of the Main Embankment to meet the minimum FoS criteria described in Section 7.7.1. The FoS results presented in Table 18 are for the design buttress. The buttress design was controlled by the stability requirements of Stn. 1+845 through Stn. 2+455. The buttress geometry was maintained from Stn. 2+455 to Corner 2 and resulted in FoS values that largely exceed the minimum design criteria.

The sensitivity (strain weakening) of the GLU was not incorporated into the limit equilibrium analyses; however, as discussed in Section 7.9, the stress deformation model shows that strain-weakening of GLU is not predicted to occur at the Main Embankment.

In addition to the analyzed scenarios presented in Table 18, the following sensitivity analyses were performed on Main Embankment design sections:

- The undrained strength of the GLU layer at elevation 922 m between about Stn. 2+455 and 2+695 was characterized with an 850 kPa preconsolidation value based on CPT data. Sensitivity analyses were carried out for the section at Stn. 2+455, reducing the preconsolidation value to 700 kPa and 400 kPa. A preconsolidation of 700 kPa is representative of the LGLU at Corner 1 and 400 kPa is representative of the UGLU at Corner 1.
  - With a preconsolidation value of 700 kPa, the FoS remained at 1.5.
  - With a preconsolidation value of 400 kPa, the FoS reduced from 1.5 to 1.4. Even with the lowest preconsolidation stress identified in the area of the TSF (400 kPa), the FoS reduced slightly and the section was stable (FoS > 1.0).
- Artesian conditions were applied to the glaciofluvial foundation material at Stn. 2+055 (5 m artesian pressure elevation), Stn. 2+235 (8 m artesian pressure elevation), and Stn. 2+455 (11 m artesian pressure elevation) to represent a scenario where the existing Main Embankment vertical drain wells fail and artesian pressures are generated in the foundation. The FoS slightly decreased but remained at 1.5 at the three sections.
- A peak ground acceleration of 0.116 g, corresponding to an earthquake event of 1:10,000 AEP, was applied to Stn. 2+235 for the pseudo-static long-term, 100 m beach scenario. The FoS reduced from 1.2 to 1.0 and still met the minimum design criteria with a significantly larger seismic load.

7.7.7 Perimeter Embankment Stability Analysis Results

Eleven sections, identified to represent the variability of the foundation and embankment conditions over the length of the Perimeter Embankment, including Corner 1 (approx. Stn. 3+920 to 4+650), were previously chosen for stability analysis.

The foundation characterization was updated for five sections at Stn. 2+850, 3+270, 3+395, 3+765, and 4+255 based on results of the 2021/2022 geotechnical investigation (WSP Golder 2022b).

The foundation characterization was also updated on the west side of Corner 1 based on results of the 2018 geotechnical investigation, and an additional section at Stn. 4+410 was analyzed (Golder 2018). The section at Stn. 4+540 was modified based on the changes at Stn. 4+410 for the current analysis.

No revisions to the foundation characterization in other areas of the Perimeter Embankment were required, and the sections at Stn. 3+185, 3+530, 4+000, 4+175, and 4+285 remain as per the elevation 970 m TSF detailed design (Golder 2015a, 2017c).

The sections and details of the foundation characterization adjustments are as follows:

- Stn. 2+850 (old Stn. 2+850): The GLU, approximately 3 m thick, at about elevation 913 to 916 m, was truncated downstream of the toe of the existing buttress based on borehole GA21-06 completed as part of the 2021/2022 geotechnical investigation.
- Stn. 3+185 (old Stn. 3+190).
- Stn. 3+270 (old Stn. 3+275): The thickness of the GLU was increased to 4 m based on boreholes GA21-03 and GA21-11 completed downstream of the existing buttress.
- Stn. 3+395 (old Stn. 3+400): The two closely spaced GLUs were combined into a single unit between approximate elevation 903 and 909.5 m based on borehole GA21-02.
- Stn. 3+530 (old Stn. 3+535).
- Stn. 3+765 (old Stn. 3+770): A 0.3 m thick GLU was included under the buttress and downstream at elevation 912.5 m based on borehole GA21-01.
- Stn. 4+000 (old Stn. 20+005).
- Stn. 4+175 (old Stn. 20+180).
- Stn. 4+255 (old Stn. 20+265): The UGLU near elevation 920 m at Stn. 4+230 (old Stn. 20+240 in Golder 2015a) was added to the section at Stn. 4+255 (Golder 2017c) to combine both sections.
- Stn. 4+285 (old Stn. 20+295).
- Stn. 4+410 (old Stn. 20+458).
- Stn. 4+540 (old Stn. 4+525): The GLU near elevation 930 m at Stn. 4+410 was added to the section at Stn. 4+540.

The results of the analyses are summarized in Table 19 and Figure G-34 to G-82 in Appendix G.

Table 19: Stability Analysis Results – Perimeter Embankment

Section	Static (end of construction)		Static (long term)		Pseudo-static		Post-earthquake	
	0 m beach	100 m beach	0 m beach	100 m beach	0 m beach	100 m beach	0 m beach	100 m beach
Perimeter Embankment								
2+850	1.7	1.7	1.7	1.7	1.3	1.3	1.5	1.5
3+185	1.8	1.8	1.9	1.9	1.7	1.7	1.9	1.9
3+270	1.6	1.6	1.5	1.6	1.1	1.2	1.2	1.2
3+395	1.5	1.5	1.5	1.5	1.2	1.2	1.3	1.3
3+530	1.5	1.5	1.5	1.5	1.2	1.2	1.3	1.3
3+765	1.6	1.6	1.6	1.7	1.4	1.4	1.5	1.5
Perimeter Embankment at Corner 1								
4+000	2.4	2.4	2.5	2.5	1.9	1.9	2.3	2.3
4+175[(a)]	1.6	1.7	1.6	1.9	1.1	1.3	1.3	1.6
4+255[(a)]	1.9	2.2	1.9	2.1	1.5	1.8	1.6	2.0
4+285[(a)]	2.0	2.2	2.0	2.3	1.5	1.6	1.7	1.9
4+410	1.9	1.9	2.1	2.1	1.7	1.7	1.8	1.9
4+540	1.8	1.8	1.8	1.9	1.4	1.4	1.5	1.6

(a) Corner 1 upstream drain at elevation 950 m operational for 100 m beach normal operational case. The 0 m beach case assumes an upset condition where upstream drain is not functional.

The slope stability analyses required extending the buttress from about Stn. 3+200 to 3+450 and within the Perimeter Embankment Till Borrow Pond from about Stn. 3+580 to 3+920 to meet the minimum FoS criteria described in Section 7.7.1. The FoS results presented in Table 19 are for the design buttress.

The buttress design at Corner 1, from about Stn. 3+920 to 4+650 is controlled by the results of the stress-deformation modelling (Section 7.9). The stress-deformation analyses undertaken at Stn. 4+175 showed that strain weakening in the UGLU propagates under the embankment and buttress if the buttress is designed to meet the FoS criteria using limit equilibrium analyses assuming peak undrained shear strength. As such, the buttress configuration at Corner 1 was designed using the stress-deformation model and result on higher FoS using limit equilibrium analyses assuming peak undrained shear strength.

In addition to the analyzed scenarios presented in Section 7.7.3, the following sensitivity analyses were performed on Perimeter Embankment design sections:

- Additional analyses were carried out to determine the sensitivity of the FoS to the peak undrained shear strength of the GLU. Analysis was undertaken for the Perimeter Embankment section at Stn. 3+395, with lower preconsolidation pressures only identified at Corner 1 (i.e., 400 and 700 kPa). An FoS of 1.4 was achieved when the preconsolidation pressure was reduced from 900 kPa to 700 kPa, for the long-term, 0 m beach scenario and 1.3 when the FoS was reduced to 400 kPa. Even with the lowest preconsolidation stress identified in the area of the TSF (400 kPa), the FoS reduced to 1.3 and the section was stable (FoS > 1.0).
- A peak ground acceleration of 0.116 g, corresponding to an earthquake event of 1:10,000 AEP was applied to Stn. 3+395 and 4+175 for the pseudo-static long term, 100 m beach scenario. The FoS reduced from 1.2 to 1.1, and from 1.3 to 1.1, for the two sections respectively, and still met the minimum design criteria with a significantly larger seismic load.

7.7.8 Upstream Stability Analysis Results

A post-earthquake analysis was performed for upstream embankment stability, which assumes the tailings (excluding the upstream fill) has liquefied. The tailings were modelled with an undrained shear strength of $T/\sigma_v' = 0.1$. The analysis was conducted considering a 3 m elevation difference between the crest of the embankment and the tailings beach. The pond was modelled to be against the embankment (0 m beach) to represent an upset operations case. The result of the analysis is presented in Figure G-32 in Appendix G and shows an FoS of 1.2, which meets the minimum post-earthquake design criteria.

Potential seismic deformations of the upstream fill are discussed in 7.9.2.

7.8 Static Deformations

Vertical deformations resulting from consolidation/settlement of embankment fill materials under static conditions were monitored with a survey monument during construction of the Perimeter Embankment raise from elevation 966 to 970 m at Corner 1 (from 2017 to 2023). The recorded settlement at the crest of the rockfill shell has been in the order of 10 cm, which is within the expected range for a 40 m high rockfill structure. Future raises are anticipated to be consistent with previous annual raise rates (i.e., 2 to 3 m per year), and it is anticipated that settlements will remain low within the previously recorded range. Considering the freeboard allowance (Section 7.10), overtopping of the TSF due to settlement is considered to be a non-credible hazard. It is also noted that any settlements are corrected as part of yearly embankment raises.

Horizontal deformations are anticipated to be minor and distributed along the embankment crest broadly proportionally to the height of the embankment (i.e., would not occur as horizontal shear at a single location). Anticipated deformations would not compromise the integrity of the 5 m wide till core or continuity of the 1.5 m filter and transition zones.

7.9 Stress Deformation Modelling

A stress-deformation analysis was carried out on section 2+055 of the Main Embankment and section 4+175 of the Perimeter Embankment at Corner 1 using the commercially available computer code FLAC Version 8.1 (Cundall 2012). The section at the Main Embankment represents the tallest section of the facility and includes the semi-continuous layer of glaciolacustrine soil in the foundation. The section at the Perimeter Embankment includes the portion of the foundation that failed in 2014 and that has the GLU with lower preconsolidation stress.

These sections also correspond to those controlling the design of the buttress at each embankment based on limit equilibrium analyses.

The analyses were performed to assess the stability and potential deformations of the embankments at elevation 974 m (static analysis) and under the 2,475-year earthquake load (seismic analysis), including the potential for strain-weakening of GLUs. One crustal motion and one subduction interface motion were used as input ground motions in the seismic analysis.

The analysis procedure, characterization of the foundation and embankment materials for modelling purposes, and the static and seismic deformation analyses results are included in Appendix H. A summary of the findings of the analyses is presented in Sections 7.9.1 and 7.9.2.

7.9.1 Static Analysis

Section 2+055 of the Main Embankment and section 4+175 of the Perimeter Embankment at Corner 1 are predicted to be stable at the end of construction up to elevation 974 m under the analyzed conditions. The FoS computed at the end of construction is 1.6 for section 2+055 and 1.7 for section 4+175.

Strain-weakening is not predicted to be initiated in the GLU at section 2+055 of the Main Embankment during construction up to elevation 974 m.

Assuming a constant 22 kPa remoulded undrained shear strength for the UGLU that sheared during the failure in 2014 (i.e., no inclusion of potential strength gains from reconsolidation), a shear band about 3 m long with a maximum plastic shear strain of about 10% is predicted to develop below the downstream slope of the Perimeter Embankment at Corner 1 at section 4+175. However, the predicted degree of strain-weakening is relatively low (about 6% strength reduction in a 3 m long shear band) and does not have a significant impact on the stability of the elevation 974 m embankment.

7.9.2 Seismic Analysis

Section 2+055 of the Main Embankment and section 4+175 of the Perimeter Embankment at Corner 1 are predicted to be stable under the action of the 2,475-year earthquake ground motion.

The maximum permanent horizontal displacement in the downstream direction is less than 5 cm in the embankments and buttresses of both analysed sections.

Strain-weakening is not predicted to be initiated in the GLU at section 2+055 of the Main Embankment under the action of the 2,475-year earthquake ground motion.

Assuming a constant 22 kPa remoulded undrained shear strength for the UGLU that sheared during the failure in 2014 (i.e., no inclusion of potential strength gains from reconsolidation), a relatively low level of strain-weakening (less than 1.5% strength reduction) is predicted in the UGLU under the downstream slope of the Perimeter Embankment at section 4+175 during the 2,475-year earthquake ground motion. This degree of weakening is relatively low (less than 1.5% strength reduction) and does not have a significant impact on the seismic stability of the embankment.

Settlement of the upstream fill (up to 0.5 m) may occur if the phreatic surface upstream of the till core is relatively shallow (e.g., 100 m beach width and phreatic surface at the elevation of the drain) and the seismic loading is enough to trigger liquefaction in the tailings and upstream fill. This deformation mechanism was predicted under the action of the subduction interface motion; the crustal motion was not sufficient to trigger liquefaction. The maximum permanent horizontal and vertical displacements predicted at the centreline of the embankment in both analyzed sections are less than 4 cm at the end of the 2,475-year earthquake ground motion. The serviceability of the till core is not expected to be affected by this level of displacement; however, the displacements associated with this deformation mechanism could potentially affect the serviceability of the upstream drain at elevation 970 m. As indicated in Section 7.5, the seepage analyses show that little to no flow is expected through the upstream drains during normal operations (i.e., beach widths greater than 100 m) to elevation 974 m. The upstream drains have been incorporated to account for future raises above 974 m and are not a critical control for managing hydraulic gradient at TSF elevation 974 m.

7.10 Water Management Infrastructure

7.10.1 Tailings Storage Facility Freeboard and Emergency Spillway

The inflows that directly contribute to the TSF are from precipitation on the footprint of the TSF and runoff from the catchment directly upstream of the TSF. The major contribution to TSF supernatant volume is pumped from the site contact water facilities including the Central Collection Sump and Perimeter Embankment Till Borrow Pond.

A freeboard is required to prevent overtopping of the TSF embankment. The freeboard calculations follow the procedures and equations discussed in the CDA (2013, 2019) guidelines. Wind speeds, pond depth, and embankment slope geometry were considered to determine the greatest wave uprush value for the normal and minimum freeboard scenarios. The calculated minimum freeboard is 0.7 m and controls the freeboard requirement. Freeboard calculations are included in Appendix I.

The TSF emergency spillway will be constructed on the north side of the TSF to protect the embankment during the inflow design flood (IDF) event, which considers the probable maximum flood (PMF). The emergency spillway invert elevation has been calculated to prevent exceedance of the required minimum freeboard during passage of the design IDF event. Hydrologic calculations are included in Appendix I.

Inflow volumes to the TSF were estimated using the United States Department of Agriculture Soil Conservation Service method. Rainfall-runoff models were developed using the Conservation Service method implemented with Hydrologic Engineering Center – Hydrologic Engineering Center (HEC-HMS) software (version 4.11) (USACE 2023).

The PMF for the TSF was estimated using the annual 72-hour probable maximum precipitation (PMP) rainfall plus snowmelt. The runoff volume generated by the IDF was 1.3 million m^3. The peak IDF discharge conveyed by the emergency spillway assumed that the TSF has no storage capacity at the beginning of the event, therefore will discharge all of the IDF runoff volume.

The design of the emergency spillway has a broad-crested weir geometry, with a cross-section that includes a base width of 6 m and 7H:1V side slopes to allow a trafficable surface, and a slope of 0.3% across the embankment crest. The spillway invert is required to be 1.1 m below the embankment crest for conveyance of the peak IDF discharge plus minimum freeboard. Table 20 summarizes the spillway invert, resulting water levels, and peak discharge during the passage of the IDF at an embankment crest elevation of 974 m.

Table 20: Summary of the Emergency Spillway Arrangement and Flood Routing Results for Inflow Design Flood

Embankment Crest Elevation (m)	Spillway Invert Elevation (m)	Spillway Base Width (m)	TSF Peak Discharge (m^3/s)	Peak Water Level Elevation (m)	Minimum Freeboard (m)
974.0	972.9	6.0	2.8	973.3	0.7

The emergency spillway location and alignment was selected considering potential future embankment raises above elevation 974 m and closure.

The emergency spillway is to be constructed for each interim embankment raise between elevation 970 m and 974 m. The emergency spillway entrance and chute will need to be raised as the embankment is raised.

The general layout, plan, profile, and typical sections of the emergency spillway are included in Appendix A. The emergency spillway technical specifications are included in Appendix B.

Emergency Spillway Channel Sizing

The spillway channel was sized using the Manning's equation assuming uniform flow conditions and accounting for superelevation in the curves. The channel conveys the peak flow with 0.3 m of freeboard. Flow velocities were estimated using the Manning's equation to size erosion protection.

The spillway channel material was selected based on the normal flow velocity for the stability scenario and maximum permissible velocity of the lining material. The Manning's roughness coefficients, channel dimensions, normal flow depth, and normal flow velocity for each segment are summarized in Table 21.

Superelevation for each curve of the spillway channel alignment was estimated using the US Army Corps of Engineers (USACE 1972) method and results from the Manning's equation.

Table 21: Summary of the Emergency Spillway Channel Design

Spillway Channel Segment (Approximate Station PVI [m])	Design Consideration	Max Slope (%)	Channel Bed Material	Manning's Roughness Coefficient ($s/m^{1/3}$)		Side Slopes (XH:1V)	Bottom Width (m)	Channel Depth (m)	Normal Flow Depth[a] Including Superelevation (m)	Normal Flow Velocity[b] (m/s)	Freeboard (m)
				Capacity	Stability						
Entrance/crest (10+031–10+122)	Trafficable side slopes	0.3	Granular Road Gravel	0.030	0.022	7H:1V	6.00	1.1–1.4	0.4	1.00	0.7–1.0
Chute (10+122–10+142)	Maximum slope	16.7	100 kg Class Riprap[c]	0.044	0.039	2H:1V	6.00	0.6	0.3	2.9	0.3
Stilling basin (10+142–10+145)	Contain hydraulic jump	0	100 kg Class Riprap[c]	0.044	0.039	2H:1V	6.00	1.0	0.5[d]	n/a	0.5
Stilling basin to road crossing (10+145–10+174)	Channel capacity	0.5	10 kg Class Riprap[c]	0.038	0.034	2H:1V	6.00	1.0	0.4	1.0	0.6
Road crossing (10+174–10+240)	Trafficable side slopes	0.5	Granular Road Gravel	0.030	0.022	10H:1V	6.00	0.7	0.3	1.1	0.4
Outlet Channel (10+242–10+800)	Topographic slope	4.0	10 kg Class Riprap[c]	0.038	0.034	2H:1V	2.00	1.0	0.5	2.6	0.5
		10.0	50 kg Class Riprap[c]	0.042	0.037				0.4	3.3	0.6
Discharge apron (10+800-10+817)	Topographic slope	2.0	10 kg Class Riprap[c]	0.038	0.034	2H:1V	2.00-20.0	0.3-1.0	0.14-0.50[e]	1.00-1.85	0.2-0.5[e]

(a) Normal flow depth for capacity scenario.

(b) Normal flow velocity for stability scenario.

(c) BC MOTI 2020.

(d) Flow depth is representative of the hydraulic jump estimated to be developed within the stilling basin structure.

(e) Flow depth at station 10+817 is calculated using Manning's equation assuming normal flow conditions. However, the flow depth will be less and the freeboard will be greater due to the steep natural slope (33%) beginning at station 10+817.

PVI = Point of Vertical Intersection; n/a = not applicable.

The spillway chute was designed to convey flow from the embankment crest to existing ground with a maximum slope of 6H:1V. A precast concrete weir with a 6.0 m base width and 2H:1V side slopes will be installed at the chute entrance. The spillway chute has a base width of 6.0 m and will be lined with 900 mm of 100 kg class riprap.

The stilling basin structure was sized using the results from the Manning's equation and three hydraulic design methods: Department of the Interior Bureau of Reclamation (USBR 1984), USACE (1977), and Prairie Farm Rehabilitation Administration (PFRA 1979). The length of the stilling basin and the depth of the channel were designed to contain the hydraulic jump (conjugate depth) expected to occur at the outlet of the spillway chute. The conjugate depth was calculated using the Manning's equation and is estimated to be 0.45 m. The resulting length of the stilling basin for each method is provided in Table 22.

Table 22: Spillway Stilling Basin Length

Hydraulic Design Method	Stilling Basin Length (m)
USBR (1984)	2.16
USACE (1977)	2.20
PFRA (1979)	2.52

The stilling basin length was selected as 3.0 m for increased energy dissipation prior to discharge into the spillway channel downstream and improve constructability of the structure. The stilling basin base width will be 6.0 m with 2H:1V side slopes and it will be lined with 900 mm of 100 kg class riprap.

The segment of the spillway from the stilling basin to the road crossing was designed with a 6.0 m base width for continuation between the stilling basin and the road crossing and will be lined with 400 mm of 10 kg class riprap.

The road crossing was designed to convey flow across the haul road as a shallow ford. The road crossing has a base width of 6.0 m, with 10H:1V side slopes to provide adequate crossing geometry for haul trucks. The road crossing will be lined with 200 mm of angular road gravel (75 mm minus) above 400 mm of 10 kg class riprap.

The spillway outlet channel base width, from the road crossing to the discharge apron, will be 2.0 m with 2H:1V side slopes. The spillway outlet channel will be lined with 400 mm of 10 kg class or 680 mm of 50 kg class riprap based on the slope as presented in Table 21.

The discharge apron was designed to disperse flow and reduce energy prior to discharge into Bootjack Creek. The discharge apron channel depth will transition from 1.0 m to 0.3 m and the base width will widen from 2.0 m to 20.0 m at the crest of the natural steep slope. The discharge apron will be lined with 400 mm of 10 kg class riprap. The discharge apron will convey flow onto riprap placed at grade down Bootjack Creek's left downstream bank. The riprap placed at grade shall be field fit and will continue to widen down the bank and terminate prior to Bootjack Creek's main channel.

7.10.2 Tailings Storage Facility Seepage Collection Channels and Ponds

Diversion and collection channels and ponds are currently in place around the TSF. The elevation 974 m TSF raise design will affect portions of the existing surface collection and diversion channels and structures around the TSF. These channels and structures will be partially or fully covered by the TSF embankment or buttress. The following modifications to existing water management infrastructure around the TSF will be required:

- relocation of the South Embankment Seepage Collection Pond and Main Embankment Seepage Collection Pond, as well as relocation of portions of the collection channels that feed these ponds
- expansion of the Perimeter Embankment Till Borrow Pond and relocation of portions of the channels that feed this pond

The inflow to the ponds includes seepage, runoff and flow from the upstream drains that will be collected by the collection channels and direct precipitation to the ponds. New ponds are designed to store the peak flow generated from the 1:10-year 24-hour rain plus snowmelt event and will include 0.5 m of dead storage and 0.5 m of freeboard above the storm event water surface elevation.

The collection channels are proposed to convey the peak flow generated from 1:200-year 24-hour storm event plus seepage and upstream drain flow rates. The channels include a minimum of 0.3 m freeboard.

A diversion channel is required at Corner 4 to capture surface runoff from a relatively small catchment upstream of the TSF. The diversion channel is to be sized to convey the peak flow generated from 1:200-year 24-hour storm event, while maintaining a minimum 0.3 m freeboard.

The design report for the TSF diversion channel, collection channels and ponds will be provided in a separate document.

7.11 Tailings Storage Facility Closure and Reclamation

The closure philosophy will be consistent with the most recent Mine Reclamation and Closure Plan (MPMC 2022). The TSF will remain a permanent structure, which will be reclaimed and given productive land use.

Prior to cover soil placement on the 2H:1V embankment slopes, an assessment will be conducted to determine which species can successfully revegetate the TSF embankments. This assessment will also investigate which species and revegetation/reclamation techniques will maximize overall cover soil stability and minimize erosion and future maintenance requirements.

Following cover soil placement, the TSF will be revegetated. A spillway, sized with capacity for the probable maximum flood, will also be constructed during active closure, so that a desirable long-term pond level will be maintained.

7.12 Geotechnical Risk Review and Design Controls

Potential failure mechanisms that must be addressed in the design of a tailings storage facility are summarized in Table 23 with the designer's assessment of each mechanism. The designer's assessment was made against typical dam failure modes presented in the ICOLD tailings dam safety bulletin (ICOLD 2022).

The design and operational philosophy and controls incorporate the findings and recommendation of the IEEIRP (2015) *Report on Mount Polley Tailings Storage Facility Breach*. These are to limit the amount of surface water to only that required for operation, promote unsaturated conditions in the tailings with drainage provisions, and promote consolidation of tailings upstream of the embankments.

Mount Polley Mine has an active failure modes and effects analysis for the TSF that is updated annually with the Engineer of Record. The failure modes and effects analysis includes a likelihood and risk review for failure modes and effects related to dam safety, environment, health and safety, and mine operations. Table 23 incorporates failure modes that could result in a potential breach of the TSF.

Failure modes presented in Table 23 have been assessed as credible or non-credible. A credible failure mode has been defined as a feasible failure mode that could result in a potential breach of the TSF with controls in place. A non-credible failure mode is a failure mode that cannot be triggered by the design criteria external loading conditions and/or operational upset conditions.

Table 23: Summary of Tailings Storage Facility Failure Modes Assessment

Failure Modes (adapted from ICOLD 2022)		Designer's Assessment		
Mechanism	**Typical Failure Mode**	**Discussion**	**Identified Controls**	**Assessment (if constructed as designed with operational mitigative controls)**
Instability due to foundation failure	Undetected weak foundation materials	Multiple field investigations have been completed along the foundation of the embankments and buttresses to delineate the extent and characterize the foundation materials. Golder/WSP has carried out four geotechnical investigations since 2014 along the South, Main, and Perimeter embankments (Golder 2015d, 2017b, 2018; WSP Golder 2022b). Two site investigations were undertaken by others following the breach in 2014 (KCB 2015; IEEIRP 2015). Prior investigations include KP (1990, 1995, 1997) and AMEC (2012). Foundation characterization has been completed per EGBC guidelines (WSP 2023a). The design criteria factors of safety for limit-equilibrium stability are met for all embankments.	Design of the elevation 974 m TSF raise has been undertaken incorporating a 2H:1V minimum overall downstream slope and wide buttresses are constructed along the Perimeter and Main embankments. Buttress width and height has been maintained along portions of the embankment irrespective of limit equilibrium analyses (i.e., FoS greater than minimum criteria along portions of the embankment). Instrumentation has been installed to monitor foundation response (SI, IPI, SAA and VWPs). Quantitative performance objectives (QPOs) including trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elevation 970 m.	Credible
	Incorrect strength characterization	Multiple field investigations have been completed along the foundation of the embankments and buttresses to characterize the foundation materials. Golder/WSP has carried out four geotechnical investigations since 2014 along the South, Main, and Perimeter embankments (Golder 2015d, 2017b, 2018; Golder WSP 2022). Two site investigations were undertaken by others following the breach in 2014 (KCB 2015; IEEIRP 2015). Prior investigations include KP (1990, 1995, 1997) and AMEC (2012). Foundation material properties have been assigned based on in situ and laboratory testing. Shear strength parameters selected for the foundation till and glaciofluvial layers represent an average for the materials. Glaciolacustrine soils have been analyzed using total stress (undrained) strength parameters. The preconsolidation pressure values selected for the analyses are at or below the lower bound of the values calculated from the laboratory consolidation tests and estimated from the CPT profiles. Foundation characterization has been completed per EGBC guidelines (WSP 2023a). The design criteria FoS for limit-equilibrium stability are met for all embankments. Limit equilibrium analyses completed for a range of GLU strengths to assess sensitivity to potential variability. Stress-deformation analyses completed to assess potential redistribution of stresses due to strain weakening of GLU.	Design of the elevation 974 m TSF raise has been undertaken incorporating a 2H:1V minimum overall downstream slope and wide buttresses are constructed along the Perimeter and Main embankments. Buttress width and height has been maintained along portions of the embankment irrespective of limit equilibrium analyses (i.e., FoS greater than minimum criteria along portions of the embankment). Instrumentation has been installed to monitor foundation response (SI, IPI, SAA and VWPs). QPOs, including trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elevation 970 m.	Credible
	Unexpected pore pressure generation	Excess pore water pressures may develop in the foundation under the buttress and embankment reslope during construction. However, extensive field and laboratory investigations have been completed to characterize the foundation, and the pore pressure response has been monitored during construction of the embankment and buttresses since 2014. The measured maximum pore pressures responses were used in the short-term stability analyses (e.g., during or at the end of construction). The design criteria FoS for limit-equilibrium stability are met for all embankments. The annual embankment crest raise is small, in the order of 2 to 3 m per year.	Construction sequence (buttress extension and embankment reslope prior to raising the embankment) Instrumentation (VWPs) has been installed to monitor foundation response. QPOs, including trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elevation 970 m.	Not credible

Table 23: Summary of Tailings Storage Facility Failure Modes Assessment

Failure Modes (adapted from ICOLD 2022)		Designer's Assessment		
Mechanism	**Typical Failure Mode**	**Discussion**	**Identified Controls**	**Assessment (if constructed as designed with operational mitigative controls)**
Instability due to foundation failure continued	Artesian pore pressure generation	Upward gradients and artesian pressures are present at glaciofluvial units in the Main Embankment foundation. Four vertical drain wells installed under the Main Embankment help relief some of the artesian pressure. Limit equilibrium analyses completed with artesian pressures show little sensitivity to artesian pressures (if vertical drain wells were to fail and pore pressures increase).	Vertical drain wells have been installed in the foundation of the Main Embankment. Instrumentation (VWPs) has been installed to monitor pore pressure in the foundation. QPOs, including trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elevation 970 m.	Not credible
	Liquefaction of cohesionless soils and cyclic softening of cohesive soils	The site is in an area of relatively low seismicity (peak ground acceleration equal to 0.048g for design earthquake event with a 1:2,475 AEP). Laboratory testing has been completed on glaciolacustrine samples to characterize the cyclic response (WSP 2023a). A 20% strength reduction factor has been applied in the pseudo-static and post-seismic limit equilibrium analyses to glaciolacustrine deposits to account for potential strength loss during cyclic loading. The dense till foundation materials are considered to not be susceptible to liquefaction or cyclic softening. The glaciofluvial foundation materials are typically not continuous layers.	Design of the elevation 974 m TSF raise has been undertaken incorporating a 2H:1V minimum overall downstream slope and wide buttresses are constructed along the Perimeter and Main embankments. Buttress width and height has been maintained along portions of the embankment irrespective of limit equilibrium analyses (i.e., FoS greater than minimum criteria along portions of the embankment).	Not credible
	Incorrect seismic hazard/response analysis	The site is in an area of relatively low seismicity. A site-specific probabilistic seismic hazard assessment undertaken for the TSF in 2022 (WSP 2023a). Limit equilibrium analyses were completed for an earthquake event with a 1:10,000 AEP to assess sensitivity to potential variability. Results show FoS equal to or greater than 1. Stress-deformation analyses were completed to confirm stability of the facility due to seismic loading.	Design of the elevation 974 m TSF raise incorporates sensitivity analysis to extreme earthquake event (1:10,000 AEP).	Not credible
	Erosion at the toe due to nearby water courses	Hazeltine Creek is over 200 m away from the toe of the embankment; its flow can be regulated by a weir. Hazeltine Creek is not considered an erosion risk to the buttress and embankment. The elevation 974 m South Embankment will extend across an unnamed creek at Corner 4. The catchment of the creek is small (approx. 0.15 km^2) and its flow is not considered an erosion risk to the embankment. Foundation preparation and potential till blanket placement will be completed so water drains away from the till core. The design includes diversion of water away from the embankment (refer to water management design).	Design of the elevation 974 m TSF raise has been undertaken incorporating Corner 4 creek catchment and diversion. Construction quality assurance / quality control (QA/QC) will be performed to confirm foundation preparation and potential till blanket placement is completed so water drains away from the till core and water is diverted away from the south abutment.	Not credible
	Excavation at the toe for seepage collection ditches or sumps	Water management infrastructure will be relocated in some areas to near the toe of the embankment and buttress; however, seepage collection ditches are shallow (approximately 1 m deep) and ponds are offset from the toe of the embankment and buttress.	Construction QA/QC will be performed. Inspections will be carried out by MPMC and the EoR.	Not credible
	Landslide at an abutment	Foundation at abutments comprises competent till and bedrock. Glaciolacustrine deposits have not be encountered at the abutments. Additional test pits are excavated as part of foundation preparation to confirm foundation conditions. Surficial organic or weak soils are removed as part of foundation preparation. Natural slope grades at the abutments and upstream are gentle (less than 30%). No evidence of historical landslides has been observed.	Construction QA/QC will be performed.	Not credible

Table 23: Summary of Tailings Storage Facility Failure Modes Assessment

Failure Modes (adapted from ICOLD 2022)		Designer's Assessment		
Mechanism	**Typical Failure Mode**	**Discussion**	**Identified Controls**	**Assessment (if constructed as designed with operational mitigative controls)**
Instability of the TSF slope	Inclusion of weak materials in the structural portion of the TSF, possibly due to lack of compaction and/or poor drainage	Design of the TSF raise is consistent with previous raises. Rockfill forms the downstream wedge of the embankments and the downstream buttress along the Perimeter and Main embankments. Rockfill is mainly fresh, intrusive rock with a relatively high internal friction angle (Golder 2016a). Construction of safety berms at different stages of construction may have resulted in localized slivers of loose rockfill or finer rockfill. Some ravelling has been observed on the angle of repose slope; however, the slope will be resloped to 2H:1V as part of the raise using a bottom-up construction method.	Design of the elevation 974 m TSF raise has been undertaken incorporating a 2H:1V minimum overall downstream slope, and wide buttresses are constructed along the Perimeter and Main embankments. Construction QA/QC will be performed.	Not credible
	Liquefaction of non-cohesive soils and cyclic softening of cohesive soils	Tailings upstream of the embankment are susceptible to liquefaction. The upstream fill consists of compacted tailings sand. The upstream fill below approx. elev. 968 m includes layers of rockfill and has undergone consolidation due to dewatering of the TSF in 2014. Post-earthquake limit equilibrium analyses indicate an FoS equal to 1.2 for the upstream slope. Stress-deformation analyses indicate that the till core would experience minor deformations (< 4 cm) if the tailings and upstream fill liquefy. No loss of containment is expected. The till core, filter, transition, and rockfill are mechanically placed and compacted and are not susceptible to liquefaction or cyclic softening.	The amount of surface water is limited to only that required for operation (i.e., lower phreatic surface upstream of the embankment). Construction QA/QC will be performed.	Not credible
Overtopping	Large flood that exceeds capacity of spillway	The spillway is designed to pass the 72-hour annual PMP plus snowmelt. The catchment reporting to the TSF is small and well defined. The majority of water inflows into the TSF are pumped and are therefore in the direct control of the operator.	QPOs, including freeboard trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elevation 970 m. Design includes a freeboard contingency of 0.3 m.	Not credible
	Large flood with blocked spillway (by debris, ice or pipelines)	The spillway invert is wide; the design includes a 6 m invert width and 7:1 side slopes. Freeboard contingency of 0.3 m	Inspection of the facility by owner and EoR team is planned. Design includes a freeboard contingency of 0.3 m. QPOs are in place for the existing TSF and will be updated for the TSF above elevation 970 m. Inspections will include assessment of spillway conditions.	Not credible
	Wave action	Deposition of the tailings is planned to maintain the pond near the centre of the facility and against the natural topography on the western perimeter. The TSF is managed by maintaining the pond volume within the operating range for reclaim water and make-up water. During large freshet events, the pond could encroach onto the upstream fill of the embankment. A minimum of 20 m of upstream fill is compacted upstream of the embankments. Progression of erosion has been slow and can be addressed before it reaches the core.	The pond is maintained away from the embankments, near the centre of the facility against the natural topography. There is 20 m wide compacted fill upstream of the till core. Design includes a freeboard contingency of 0.3 m. QPOs, including minimum beach width trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elev. 970 m.	Not credible

Table 23: Summary of Tailings Storage Facility Failure Modes Assessment

Failure Modes (adapted from ICOLD 2022)		Designer's Assessment		
Mechanism	**Typical Failure Mode**	**Discussion**	**Identified Controls**	**Assessment (if constructed as designed with operational mitigative controls)**
Overtopping continued	Operational upset (improper water management)	The majority of water inflows into the TSF are pumped and are therefore in the direct control of the operator. The catchment reporting to the TSF is small and well defined. Water can be temporarily stored in open pits if required.	Design of the elev. 974 m TSF raise incorporates a spillway and upstream drains to draw down phreatic surface as pond approaches the embankment. Inspections of the facility and water management infrastructure by the owner are planned. QPOs, including minimum beach width, freeboard and pond volume trigger levels and monitoring frequency, are in place for the existing TSF and will be updated for the TSF above elevation 970 m.	Not Credible
	Uncontrolled rupture of a tailings slurry delivery or water reclaim pipeline	The tailings pipeline is located in ditches and along upstream crest of embankments in the TSF.	Inspections of the facility and water management infrastructure by owner are planned.	Not credible
	Landslide into reservoir (rock, snow, or soil)	The slope above the TSF is less than 30 degrees and heavily vegetated. No rock outcrop is present. There is no evidence of historical landslides.	-	Not credible
	Settlement of crest (due to static and/or seismic deformations)	Minor settlement will mainly occur after TSF raises as a result of consolidation of the embankment and foundation. Construction to raise the embankment to elev. 974 m is expected to occur in 2 to 3 consecutive years. Any settlements are corrected as part of construction. Stress-deformation analyses completed to assess deformation due to static and seismic loading show relatively small deformations due to earthquake loading (< 4 cm).	Freeboard contingency is included. Topographic surveys of the facility are completed twice per year.	Not credible
Internal erosion (piping)	Material incompatibility between low and high hydraulic conductivity zones of the embankment	A portion of the filter constructed before 2014 does not meet modern filter criteria. The till core is not expected to initiate backward erosion for the gradients that will be imposed on the core, and that if backward erosion were initiated, the filter as constructed prior to 2014 would prevent ongoing erosion. Pond elevation prior to 2014 reached a maximum elevation of 966.45 m and the pond was in contact with the embankments in some areas. No signs of erosion or sinkholes were reported prior to the breach. The filter and transition zones designed and constructed since 2014 follow modern filtering criteria. Filter extends 25 m downstream in area of breach where foundation cracking/disruption is known to have occurred. Deposition of the tailings is planned to maintain the pond near the centre of the facility and against the natural topography on the western perimeter. The TSF is managed by maintaining the pond volume within the operating range for reclaim water and make-up water. The existing upstream drain at elev. 950 m limits the hydraulic head against the Perimeter Embankment at Corner 1.	Construction of an upstream drain at an elevation of 970 m along the Main and Perimeter embankments and 972 m along the South Embankment and at Corner 1. QPOs (trigger levels, monitoring frequency and actions): - minimum beach width - pond volume - toe drain flow - toe drain turbidity - piezometric levels	Credible

Table 23: Summary of Tailings Storage Facility Failure Modes Assessment

Failure Modes (adapted from ICOLD 2022)		Designer's Assessment		
Mechanism	**Typical Failure Mode**	**Discussion**	**Identified Controls**	**Assessment (if constructed as designed with operational mitigative controls)**
Internal erosion (piping) continued	Elevated pore water pressures and increased hydraulic gradient	Pond elevation prior to 2014 reached a maximum elevation of 966.45 m, and the pond was in contact with the embankments in some areas. During normal operation, the pond will reach a maximum elevation of 971.4 m and will be a minimum 100 m from the embankments.	The existing upstream drain is at elevation 950 m at Corner 1. An upstream drain will be constructed at an elevation of 970 m along the Main and Perimeter embankments and 972 m along the South Embankment and at Corner 1. QPOs (trigger levels, monitoring frequency and actions): - minimum beach width - pond volume - toe drain flow - toe drain turbidity - piezometric levels	Credible
	Hydraulic fracturing due to stress distribution within the TSF, differential settlement, or resulting from deformations due to seismic events	Foundation conditions do not rapidly vary along the embankment. GLUs are typically thin (<1 to 2 m) or overconsolidated (>1,200 kPa at the Main Embankment) Stress-deformation analyses completed to assess deformation due to seismic loading show relatively small deformations due to earthquake loading (< 4 cm). The cut-off wall is designed to allow deformation. Plastic concrete is resistant to erosion. Cutoff aggregate upstream of the wall has fines that will migrate into a crack and plug it.	QPOs (trigger levels, monitoring frequency and actions): - minimum beach width - pond volume - toe drain flow - toe drain turbidity - piezometric levels	Not credible
	Pipes through the TSF, including decant towers and pipes (seepage along the pipe, collapse of the pipe)	Design of upstream drains at elevation 970 and 972 m incorporate uniformly graded filter sand around conduits upstream and downstream of the till core. Upstream drain at Corner 1 at elevation 950 m incorporates uniformly graded filter sand around conduits downstream of the till core. Older upstream drains between about elevation 936 and 950 m incorporate filters around the conduits downstream of the till core. Pond elevation prior to 2014 reached a maximum elevation of 966.45 m, and the pond was in contact with the embankments in some areas. During normal operation, the pond will be a minimum 100 m from the embankments and the phreatic level against the embankment is expected to be at or below the elevation of the new upstream drains and pipe crossings at elevation 970 to 972 m. The new drains will limit the hydraulic head upstream of the pipe crossings. Monitoring data at the upstream drain at Corner 1 at elevation 950 m show that the drain is effective maintaining the pore pressures upstream of the till core at the elevation of the drain. HDPE pipes can accommodate the extra load of the facility raise to elevation 974 m.	Construction of upstream drains at an elevation of 970 m along the Main and Perimeter embankments and 972 m along the South Embankment. Uniformly graded filter sand around conduits upstream and downstream of the till core. QPOs (trigger levels, monitoring frequency and actions): - minimum beach width - pond volume - toe drain and upstream drain flow - toe drain and upstream drain turbidity - piezometric levels	Credible
	Underground features that could cause internal erosion	Development of preferential flow pathways in the foundation soils (e.g., glaciofluvial layers) or bedrock lead to increased seepage through the foundation. Foundation layers are typically non-continuous, with a wide range of hydraulic conductivity. Foundation check (test pits/trenches) are completed during foundation preparation at the Corner 4 and 5 abutments. Filter blanket is installed over the foundation along the embankment downstream of the till core.	QPOs (trigger levels, monitoring frequency and actions): - minimum beach width - pond volume - toe drain flow - toe drain turbidity - piezometric levels	Not credible

EGBC = Engineers and Geoscientists British Columbia; TSF = tailings storage facility; SI = slope inclinometer; IPI = in-place inclinometer; SAA = shape acceleration array; VWP = vibrating wire piezometer; QPOs = Quantitative Performance Objectives; CPT = cone penetration test; FoS = factor of safety; GLU = glaciolacustrine unit; AEP = annual exceedance probability; QA/QC = quality assurance / quality control; MPMC = Mount Polley Mining Corporation; EoR = Engineer of Record; PMP = probable maximum precipitation.

BC MEM (2016) requires assessment of failure modes by specific analyses, which are listed in Table 24 with references to report sections and the designer's assessment.

Table 24: Failure Modes Required to Be Assessed

Failure Modes	Report Section	Assessment
Geotechnical		
Slope stability	7.7 and 7.9	Design meets criteria
Seepage	7.5	Seepage is not a credible failure mode; design raise is 4 m and seepage rates are expected to be slightly higher than for the existing TSF
Internal erosion and piping	7.4	Design includes mitigation of internal erosion and piping by limiting the hydraulic gradient across the till core with operational controls and the use of upstream drains
Static and dynamic liquefaction	7.7 and 7.9	Design meets criteria for stability assuming tailings liquefy under seismic loading
Characterization of the footprint area as well as upstream areas	4.0	Included
Site-specific seismic hazards	4.5 and 7.7	Design meets criteria for stability considering the site-specific seismic hazard
Minimum acceptable factors of safety	7.7.1 and 7.9	Design meets criteria for stability
Long-term consolidation settlements	7.7.8	Consolidation is not a credible failure mode
Short-term and long-term deformations	7.9	Deformation of the embankment is not a credible failure mode
Hydrotechnical		
Flow capacity	7.10	Spillway designed to pass the 72-hour PMF
Surface erosion	-	Not a credible failure mode during operation if OMS controls are implemented. Closure design to consider erosion.
Water balance	6.4 and 7.10	Included
Hydrogeological		
Hydraulic fracturing	-	Not a credible failure mode; design includes management of the hydraulic gradient across the foundation and till core
Seepage through the foundation and abutments	7.5	The 4 m embankment raise is not expected to significantly increase the current seepage rates at the TSF
Geochemical		
Acid generation from tailings or dam construction materials	5.2	Assessment of geochemistry is excluded from the scope of this report. Refer to Kennedy et al. (2016) and SRK (2022).

Table 24: Failure Modes Required to Be Assessed

Failure Modes	Report Section	Assessment
Metal leaching from tailings or dam construction materials	5.2	Assessment of geochemistry is excluded from the scope of this report. Refer to Kennedy et al. (2016) and SRK (2022).
Water treatment effectiveness and capacity	-	Not a credible failure mode because the design does not rely on water treatment to prevent failure and is not anticipated to influence the effectiveness or capacity of the treatment plant
Mechanical		
Tailings transport pressure and flow capacity	-	Assessment of tailings transport is undertaken by MPMC and excluded from the scope of this report.
Water conveyance pressure and flow capacity	6.6	Upstream drain pipes have been sized for expected flows for a TSF crest at elevation 987 m. Flow is by gravity only. Assessment of other water conveyance in pipelines is excluded from the scope of this report (e.g., reclaim barge; conveyance from Perimeter Embankment Till Borrow Pond to TSF
Loading conditions that should be considered in stability analyses include		
Initial and interim and long-term construction stages	7.7	The design meets stability criteria for short- and long-term construction stages
Impounding of water	7.7	The design meets stability criteria assuming an upset condition with no tailings beach (i.e., the pond against the embankment)
Impoundment of tailings	7.7	The design considers impounded tailings to elev. 973 m
Rapid drawdown (if possible, for the facility)	-	Not a credible failure mode; no mechanism to rapidly draw down the pond
Earthquake impact on dam	7.7	Design meets stability criteria considering the site seismic hazard
Earthquake induced liquefaction of retained tailings	7.7	Design meets stability criteria assuming tailings liquefy
Extreme climatic events (precipitation, temperature, and wind)	3.2 and 7.10	IDF design criteria is the 72-hour annual PMP plus snowmelt

Source: BC MEM 2016.

TSF = tailings storage facility; IDF = inflow design flood; PMP = probable maximum precipitation; - = not applicable.

The Engineers and Geoscientists British Columbia (EGBC) guide to the standard for documented independent review of high-risk professional activities or work (EGBC 2023) were followed and a Type I independent review was completed. The independent review checklist and signoff is included in Appendix J.

8.0 INSTRUMENTATION

A geotechnical instrumentation and monitoring system is in place for the Mount Polley TSF in conjunction with established QPOs to monitor performance of the facility.

The monitoring system has been established, and is reviewed on a regular basis, based on failure modes and critical controls identified as part of risk reviews and the design and operational philosophy. The intention of the monitoring system is to provide early warning indications of changing conditions that may affect the safe and effective management of the TSF.

The TSF instrumentation is monitored and assessed against the QPOs by MPMC staff. The Engineer of Record team reviews and interprets the instrumentation data provided by MPMC periodically. MPMC personnel is responsible for implementation of specific actions and responses in the event of anomalous data or QPO exceedances, including informing the Engineer of Record when the QPO thresholds are triggered.

As part of the design for the raise of the TSF to elevation 974 m, the existing TSF instrumentation monitoring system will be retained. Instrumentation, where required, will be relocated or extended during construction.

Geotechnical instrumentation and monitoring will follow the requirements set out in the existing Operation, Maintenance and Surveillance Manual for the TSF. The Operation, Maintenance and Surveillance Manual is reviewed annually and updated as required to reflect changing conditions for the TSF.

Slope inclinometer casing and VWP and shape acceleration array cables will be extended and raised as part of the construction to reslope and raise the embankment. Raising inclinometer casings and standpipe wells through the rockfill buttress can be challenging, and some of the existing inclinometers and standpipes may be damaged during construction. Instrumentation coverage will be reviewed if existing instrumentation is damaged. The need to replace instrumentation will be assessed in a case-by-case basis.

The survey monument installed at the crest of the Perimeter Embankment at Corner 1 was decommissioned during construction of the embankment in 2023. Readings of the remaining survey monument (SM17-02) installed on the Perimeter Embankment buttress at Corner 1 have been unreliable, and the survey monument should be decommissioned prior to raising the embankment above elevation 970 m.

Existing and proposed new instrumentation for the TSF is presented in Table 25. Specifications for the instrumentation are included in Appendix B, and coordinates and typical details are presented in Drawings 29 and 30 in Appendix A.

Table 25: Existing and Proposed Instrumentation for Monitoring of Tailings Storage Facility Failure Modes

Failure Mode	Existing Instrumentation to be Retained	New Instrumentation	Comment
Instability due to foundation failure	■ Twenty-two SIs are to be extended vertically and protected from damage (SI16-15, SI15-10, SI15-14, SI15-17, SI15-18, SI16-01, SI16-03, SI16-06, SI18-01, SI18-03, SI18-04, SI23-01, SI23-02, SI15-01, SI15-02, SI21-01, SI21-02, SI21-03, SI12-02, SI15-07, SI15-08, and SI21-06). ■ Four SAA cables (SAA15-01, SAA15-02, SAA16-01, and SAA16-02) are to be extended and protected from damage. ■ One hundred and twenty-three VWPs installed in the foundation are to be extended and protected from damage.	■ Five SAAs are to be installed in new boreholes in the foundation under the South and Main embankments. ■ VWPs are to be installed in boreholes drilled to install new SAAs. Elevations will be confirmed by the EoR. ■ Seven SAAs are to be retrofitted within existing SI casing on the Main and Perimeter embankments (SI15-12, SI15-15, SI23-03, SI15-04, SI15-06 and SI21-05). SAAs may not be able to be retrofitted in all proposed SIs due to consolidation of the existing casing. Drilling an adjacent borehole may be required in some cases.	■ Installation of SAAs in new boreholes is to be planned so the embankment can be adequately monitored during construction. SIs to be retrofitted with SAAs prior to the bulk of rockfill placement for embankment resloping. New SAAs to be installed within 2 months of completion of resloping of each embankment, or within 3 months of decommissioning of SIs. ■ The following SIs will need to decommissioned as they will be inaccessible to safely read following resloping of the embankments: SI15-19, SI15-20, SI16-16, SI15-03, SI15-05, and SI15-09. ■ SIs within footprint of ramp (SI15-10 and SI15-18) may be decommissioned, if required.
Overtopping	■ Freeboard and pond volume are monitored by survey of the pond level and tailings surface. ■ Minimum beach width and general location of the pond are monitored by visual inspection and satellite images.		
Internal erosion (piping)	■ Thirty-two VWPs installed in the embankment and upstream tailings are to be extended and protected from damage.	■ Forty-six VWPs are to be installed upstream of the till core to monitor the phreatic surface upstream of the till core and the performance of the upstream drains. ■ Manual flow rate and turbidity readings are to be taken on upstream drain discharge points.	■ VWPs to be installed during construction of the upstream drains. ■ Manual flow rate and turbidity readings are to continue for the Perimeter Embankment at Corner 1 upstream drain, South Embankment toe drain, and east and west Main Embankment toe drains. Turbidity readings are to continue at the Freshet Embankment seepage collection ditch and the north and south diversion ditches.

TSF = tailings storage facility; VWP = vibrating wire piezometer; SI = slope inclinometer; SAA = shape acceleration array; EoR = Engineer of Record.

9.0 MATERIAL QUANTITIES

The estimated material quantities required for construction of the embankments and emergency spillway to a crest elevation of 974 m are summarized in Table 26. Quantities include construction of the upstream drain. The estimated fill volumes are based on the August 25, 2023, survey. All fill quantities are estimated after spreading and compaction. No allowances for constructability or bulking factors have been included in the material quantity estimates. All geotextile and pipe quantities are for after installation only and do not include any allowances. Actual quantities may vary based on conditions encountered in the field.

Table 26: Material Quantities for Tailings Storage Facility Raise to Elevation 974 m

Task	Unit	Quantity
Embankment		
Foundation preparation	m^2	140,000
Till core	m^3	104,000
Filter[(a)]	m^3	32,000
Transition[(a)]	m^3	30,000
Raise and reslope rockfill	m^3	3,576,000
Buttress rockfill	m^3	1,609,000
Upstream fill	m^3	378,000
General fill for upstream drain and upstream fill below 970 m[(b)]	m^3	421,000
Drain rock	m^3	50,000
Drain rock transition	m^3	15,000
Filter sand	m^3	100
Geotextile 800 g/m^2	m^2	60,000
Geotextile 340 g/m^2	m^2	68,000
6-inch diameter perforated, SDR 9 HDPE pipe, PE4710	m	850
12-inch diameter solid, SDR 17 HDPE pipe, PE4710[(c)]	m	4,900
12-inch by 12-inch by 12-inch tee, SDR 17 HDPE, PE4710	ea	11
12-inch by 12-inch by 6-inch reducing tee, HDPE, PE4710	ea	85
12-inch end cap, SDR 17 HDPE, PE4710	ea	22
6-inch end cap, SDR 9 HDPE, PE4710	ea	85
Spillway[(d)]		
Riprap (10 kg class)	m^3	1,400
Riprap (50 kg class)	m^3	2,400
Riprap (100 kg class)	m^3	200
Geotextile 340 g/m^2	m^2	300
Granular Road Gravel	m^3	600
Till Liner	m^3	1,200
Fine Bedding	m^3	2,200
Coarse Bedding	m^3	100

Table 26: Material Quantities for Tailings Storage Facility Raise to Elevation 974 m

Task	Unit	Quantity
Native Fill	m^3	1,700
Rockfill	m^3	5,600
Excavation	m^3	13,600

(a) Filter and transition quantities around drainpipes downstream of till core and within the upstream drain are not included.

(b) Based on topographic survey completed in August 2023. Ongoing tailings deposition has filled some of this volume.

(c) The length of pipe required from the downstream crest of the embankment to the downstream water management infrastructure is not included in the quantities in the table.

(d) Rounded up to the nearest 100.

SDR = standard dimension ratio; HDPE = high-density polyethylene.

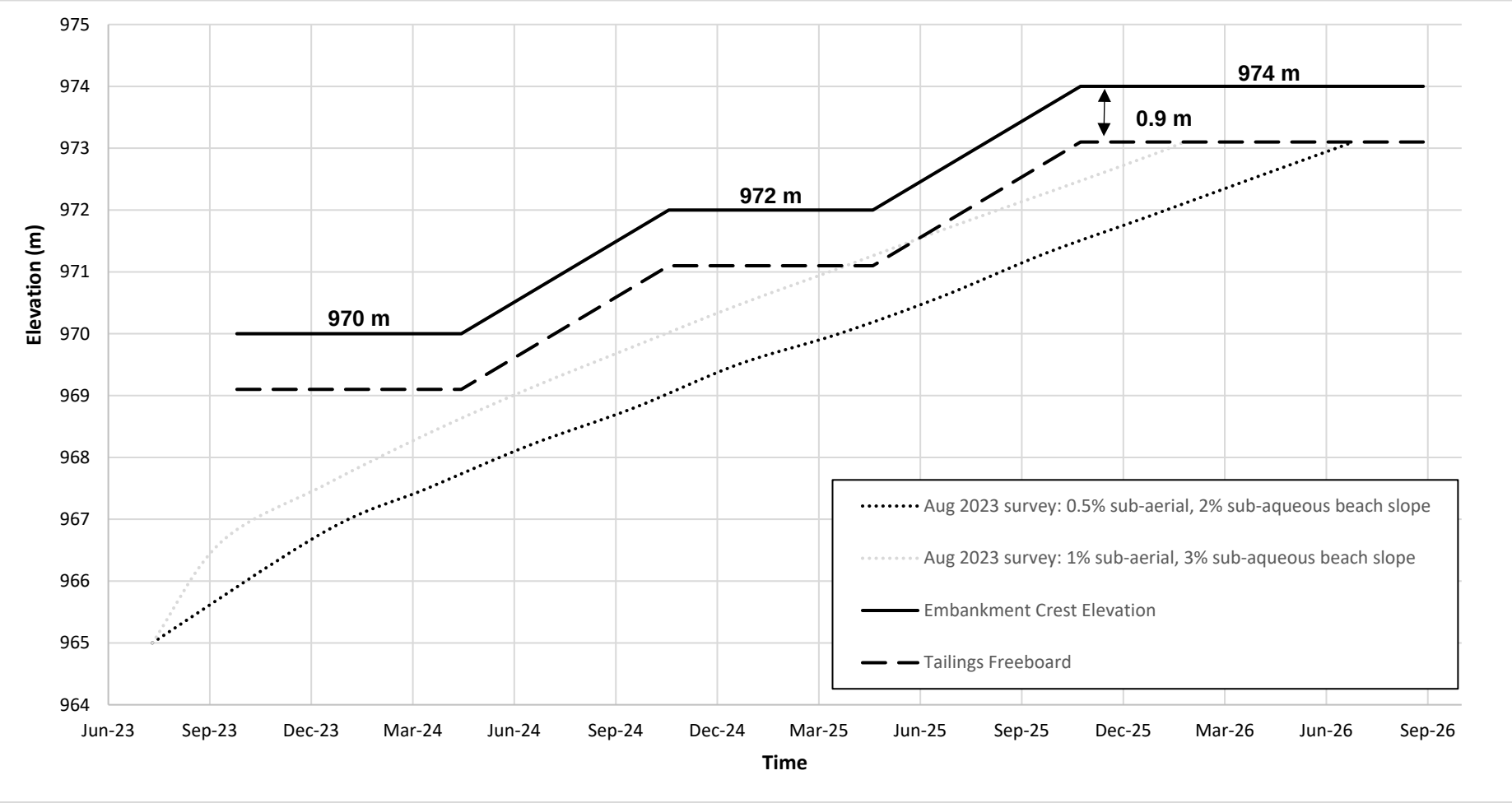
10.0 CONSTRUCTION

10.1 Construction Schedule

Construction of the till core should be limited to when temperatures are above freezing. Generally, that is from April to October. Construction of the rockfill buttresses and rockfill shell can occur year round provided measures are taken to manage snow, ice, and surface water. A minimum tailings freeboard of 0.9 m (top of tailings surface to crest of embankment) is to be maintained.

The base surface used for the deposition modelling was generated by combining a topographic and bathymetry survey completed on August 25, 2023. Tailings deposition from August 2023 was modelled using actual production values from August to December 2023 and MPMC mine plan tonnages reported in the Design Basis from January 2024 onwards (Appendix C).

Figure 10 shows the embankment construction sequence to 974 m crest elevation from the current crest elevation of 970 m, along with the planned tailings deposition schedule considering a 0.5% and a 1% sub-aerial tailings beach slope. The construction sequence assumes that the construction season is limited to the period between May and October each year due to weather conditions. Note that this figure is based on actual production and the time frame differs from the mine plan presented in Appendix C.



Tailings freeboard is based on a 0.5% sub-aerial beach slope, which is what has been achieved with recent operations. Tailings freeboard may be increased or reduced during operations based on actual tailings deposition slopes; the tailings freeboard will be included as part of the quantitative performance objectives and changes must be agreed upon with the Engineer of Record.

Figure 10: Tailings Storage Facility Embankment Tailings Deposition and Construction Schedule

10.2 Construction Sequence

The following construction sequence is proposed for construction of the TSF to elevation 974 m, although some activities will be performed simultaneously:

- **Instrumentation**—relocation and/or protection of all existing geotechnical instrumentation that may be affected during construction.
- **Foundation preparation**—removal of any unsuitable material.
- **Toe buttress extension**—buttress construction must be completed prior to raising the embankment.
- **Embankment reslope and crest widening at elevation 970 m**—rockfill placement to reslope the embankment to 2H:1V. Buttress extension construction must be completed prior to resloping of the embankment.
- **Abutment foundation preparation**—removal of unsuitable materials and excavation to the underlying competent native till or bedrock to provide suitable tie-in for the till core.
- **Upstream drain construction**—till core crossing must occur at the elevations indicated in the drawings and specifications.
- **Raise of embankment**—till core construction from elevation 970 m, including surrounding upstream fill, filter transition, and rockfill.
- **Spillway construction**—spillway invert to be constructed 1.1 m below embankment crest elevation. Spillway to be constructed after each embankment raise and before freshet.

Sufficient construction material must be stockpiled or available during the construction to allow the sequential raising of the embankment with upstream fill, till, filter, transition, and rockfill.

The quality assurance and quality control requirements are described in detail in the *Embankment Construction to Elevation 974 m Technical Specification* (Appendix B). The Quality Assurance Manager will be present full time on site during construction activities and will be responsible for the quality assurance activities.

11.0 CLOSURE

The reader is referred to the Study Limitations, which precedes the text and forms an integral part of this report. We trust the above information is sufficient for your needs at this time. Should you have any questions or require clarification, please do not hesitate to contact the undersigned.

Signature Page

WSP Canada Inc.

Sophie Bainbridge, P.Eng.
Geotechnical Engineer

Don Kidd, P.Eng.
Senior Water Resources Engineer



2024-04-19

Engineers & Geoscientists BC Permit # 1000200

Germán Pizarro, M.Eng., P.Eng.
Principal Geotechnical Engineer

SB/DK/GP/lt/anr/ar

https://golderassociates.sharepoint.com/sites/10023g/ca00205274505 deliverables/002_issued/014-r-51394-tsf 974 m design/rev0/ca0020527.4505-014-r-rev0-51394-974 m tsf detailed design 19apr_24.docx

REFERENCES

AMEC (AMEC Environment & Infrastructure, a division of AMEC Americas Limited). 2012. Mount Polley Mine Project: Tailings Storage Facility 2011 geotechnical site investigation – FINAL. Prepared for Mount Polley Mining Corporation. Doc. No. VM00560.200.3. March 28, 2012.

APEGBC (The Association of Professional Engineers and Geoscientists of British Columbia). 2016. The professional practice guidelines – site characterization for dam foundations in BC. Version 1.2.

BC ENV (British Columbia Ministry of Environment and Climate Change Strategy). 1997. Contaminated sites regulation. BC Reg. 375/96, OC. 1480/96, under the *Environmental Management Act*. Includes amendments up to BC Reg. 179/2021, updated to July 7, 2021. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/375_96_00.

BC MEM (British Columbia Ministry of Energy and Mines). 2016. Guidance document – health, safety and reclamation code for mines in British Columbia. Version 1.0. Updated July 2016.

BC MOTI (British Columbia, Ministry of Transportation and Infrastructure). 2020. 2020 standard specifications for highway construction. Volume 1. ISBN 978-0-7726-7953-6. Adopted November 1, 2020.

Bichler AJ, Bobrowsky PT. 2003. Quaternary geology of the Hydraulic map sheet, British Columbia (NTS 93A/12). British Columbia Geosciences, Research and Development Branch. Open File 2003-7. Scale 1:50,000.

Blench T. 1969. Mobile-bed fluviology. University of Alberta Pres.

Campaña J. 2011. Comportamiento de arenas de relave a altas presiones. Master's Thesis. Geotechnical Engineering, University of Chile.

CDA (Canadian Dam Association). 2013. Dam safety guidelines 2007 (Revised 2013).

CDA. 2019. Technical bulletin: application of CDA dam safety guidelines to mining sams.

Clague JJ. 1987. Quaternary stratigraphy and history, Williams Lake, British Columbia. Canadian Journal of Earth Science 24:147-158.

Clague JJ. 1988. Quaternary stratigraphy and history, Quesnel, British Columbia. Géographie physique et Quaternaire 42(3):279-288.

Cundall P. 2012. FLAC software, Version 8.0. ITASCA Consulting Group Inc., Minneapolis, U.S.A.

EGBC (Engineers and Geoscientists British Columbia). 2023. Guide to the standard for documented independent review of high-risk professional activities or work. Version 2.0.

Eldridge T, Gilmer B. 2002. Large scale laboratory filter tests. Geotechnical News 20(3):41-43.

EMLI (Ministry of Energy, Mines and Low Carbon Innovation). 2022. Health, safety and reclamation code for mines in British Columbia. Victoria, British Columbia. Revised November 2022. ISBN 978-0-7726-6011-4.

Fell R, Foster M, Davidson R, Cyganiewicz J, Sills G, and Vroman N. 2008. A unified method for estimating probabilities of failure of embankment dams by internal erosion and piping. UNICIV Report R 446, The School of Civil and Environmental Engineering, University of New South Wales, Sydney, Australia.

Fell R, MacGregor P, Stapledon D, Bell G, Foster M. 2015. Geotechnical engineering of dams. 2nd Edition. Leiden, The Netherlands: CRC Press.

FEMA (Federal Emergency Management Act). 2011. Filter for embankment dams – best practices for design and construction. October 2011.

Foster M, Fell R. 2001. Assessing embankment dam filters that do not satisfy design criteria. Journal of Geotechnical and Geoenvironmental Engineering 127(5):398, May 2001.

Global Tailings Review. 2020. Global industry standard for tailings management. August 2020.

Golder (Golder Associates Ltd.). 2015a. Mount Polley mine 2015 freshet management embankment as-built construction. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-065-R-Rev0-2000. September 4, 2015.

Golder. 2015b. Mount Polley mine tailings storage facility detailed design to elevation 970 m. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-074-R-Rev0-3000. November 3, 2015.

Golder. 2015c. Tailings storage facility life of mine feasibility design. Document prepared for Mount Polley Mining Corporation. Golder Doc No. 1413803-072-R-Rev0-9000. November 3, 2015.

Golder. 2015d. 2015 geotechnical investigation factual report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-061-R-RevB-2000. July 7, 2015.

Golder 2015e. Mount Polley Mine 2015 Freshet Management Embankment design. Mount Polley Tailings Storage Facility. Prepared for Mount Polley Mining Corporation. Document No. 1413803-008-R-Rev3-2000. May 8, 2015.

Golder. 2016a. Response to screening comments – rockfill and upstream fill properties. Document prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-084-TM-Rev0-8000. January 8, 2016.

Golder. 2016b. Response to screening comments – existing embankment filter adequacy. Golder Doc. No. 1413803-088-TM-Rev0-8000. January 29, 2016.

Golder. 2017a. 2016 Main Embankment buttress and Perimeter Embankment buttress extension construction record report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-071-R-Rev0-52291. January 30, 2017.

Golder. 2017b. 2016 TSF geotechnical investigation factual report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-114-R-Rev0-51121. March 10, 2017.

Golder. 2017c. Tailings storage facility detailed design to elevation 970 m update. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-132-R-Rev0. April 25, 2017.

Golder. 2018. Tailings Storage Facility Corner 1 Embankment station 20+458 stability analyses. Prepared for Mount Polley Mining Corporation. Document No. 1894924-006-TM-Rev0-51100. December 20, 2018.

Golder. 2019a. 2018 TSF geotechnical investigation factual report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-210-R-Rev0-51121. March 8, 2019.

Golder. 2019b. 2018 tailings storage facility construction record report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1894924-075-R-Rev0-52292. March 27, 2019.

Golder. 2022. 2021 annual groundwater monitoring report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-022-R-Rev0-32100. March 31, 2022.

Golder. 2022. Mount Polley Mine climate baseline update. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-066-R-Rev0-31547. August 30, 2022.

Hynes-Griffin M E, Franklin AG. 1984. Rationalizing the seismic coefficient method. Miscellaneous Paper GL-84-13, Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, MI.

ICOLD (International Commission on Large Dams). 2013. Internal erosion of existing dams, levees and dikes, and their foundations. Bulletin 164, Volume 1: Internal erosion processes and engineering assessment. Paris: International Commission on Large Dams.

ICOLD. 2022. Committee on tailings dams and waste lagoons, Bulletin 194, Volume 1.0: Tailings dam safety. Final version submitted for publishing. November 16, 2022.

IEEIRP (Independent Expert Engineering Investigation and Review Panel). 2015. Report on Mount Polley Tailings Storage Facility breach. January 30, 2015.

KCB (Klohn Crippen Berger). 2015a. Mount Polley Dam Failure – Site Investigation Progress Report No. 2. Prepared for BC Ministry of Energy and Mines. Doc. No. M09954A02.730. January 21, 2015.

KCB. 2015b. Mount Polley Dam Failure – advanced laboratory testing program progress report No. 4. Prepared for BC Ministry of Energy and Mines. Doc. No. M09954A02.730. February 12, 2015.

Kennedy CB, Anglin CD, Day SJ. 2016. Geochemistry of tailings from the Mount Polley Mine, British Columbia. In: Proceedings Tailings and Mine Waste 2016; October 2-5, 2016; Keystone, Colorado, USA.

KP (Knight and Piésold Ltd.). 1990. Geotechnical and tailings disposal studies. Feasibility study, Volume 3 of 5, Appendix XI. Mount Polley Project, Williams Lake, BC. Wright Engineers Limited. Prepared for Imperial Metals Corporation. June 1990.

KP. 1995. Mount Polley Project: Tailings Storage Facility design report. Volumes I and II. Prepared for Imperial Metals Corporation. May 26, 1995.

KP. 1997. Mount Polley Project – Tailings Storage Facility updated design report. Prepared for Mount Polley Mining Corporation. Reference No. 1627/2. June 6, 1997.

KP. 2005. Mount Polley Mine design of the Tailing Storage Facility to ultimate elevation. Reference No. VA101-001/08-1. Prepared for Mount Polley Mining Corporation. March 14, 2005.

KP. 2007. Mount Polley Stage 6 TSF design. Letter to Mr. Chris Carr, Geotechnical Mines Inspector, Ministry of Energy, Mines and Petroleum Resources. Ref. No. VA101 1/18 A.01. December 19, 2007.

KP. 2014. Hazeltine Creek hydrologic Aanalysis (Rev 1). Prepared for Mount Polley Mining Corporation. Ref. No. VA101-1/32-1. May 14, 2014.

Leps TM. 1970. Review of shearing strength of rock fill. Proceedings of the ASCE, Journal of the Soil Mechanics and Foundations Division. Vol. 96, SM4:1159-1170, July 1970.

Logan JM, Bath A, Mihalynuk MG, Rees CJ, Ullrich TD, Friedman R. 2007. Regional geology of the Mount Polley Area, central British Columbia. Geological Survey of Canada, Geoscience Map 2007-1. Scale 1:50,000.

MAC (Mining Association of Canada). 2021. A guide to the management of tailings facilities. Ver. 3.2. March 2021.

MPMC (Mount Polley Mining Corporation). 2022. Mine Plan and reclamation program update 2022. Prepared for The Ministry of Energy, Mines, and Low Carbon Innovation. Mines Act Permit: M-200. December 22, 2022.

Pemberton EL, JM Lara. 1984. Computing degradation and local scour. Technical Guideline for Bureau of Reclamation – US Department of the Interior.

PFRA (Prairie Farm Rehabilitation Administration). 1979. Hydraulic design of rock armoured overflow control structures. Desing Bulletin No. 13. Regina, Saskatchewan.

Robertson PK. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal 46:1-19.

Skempton AW. 1954. The pore pressure coefficients A and B. Geotechnique 4:143-147.

SRK (SRK Consulting). 2022. Review of geochemical source terms – Mount Polley Mine. Ref. No. CAPR001713. May 4, 2022.

USACE (US Army Corps of Engineers). 1972. Supercritical flow in curved channels: hydraulic model investigation. Report No. 1-109. March 1972.

USACE. 1977. Hydraulic design criteria. Volume 1.

USACE. 2023. Hydrologic Engineering Center hydrologic modeling system. Version 4.11 [software]. Davis CA: Hydrologic Engineering Center. July 14, 2023.

USBR (United States Department of the Interior Bureau of Reclamation). 1984. Hydraulic design of stilling basins and energy dissipators. Engineering Monograph No. 25.

USDA (United States Department of Agriculture). 2009. Small watershed hydrology. WinTR–55 User Guide. January 2009.

WSP Golder (Golder Associates Ltd., a member of WSP). 2022a. Climate baseline update. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-066-R-Rev0-31547. August 30, 2022.

WSP Golder. 2022b. 2021/2022 Tailings Storage Facility geotechnical investigation factual report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-011-R-Rev0-51300. October 18, 2022.

WSP (WSP Canada Inc.). 2023a. Tailings Storage Facility site characterization report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. 22514095-034-R-Rev0-51392. September 22, 2023.

WSP. 2023b. 2022 annual dam safety inspection for Tailings Storage Facility Embankment – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. 23590671-004-R-Rev0-52391. March 29, 2023.

WSP. 2023c. Mount Polley Mine water balance model Springer Expansion life-of-mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. 23590671-084-R-Rev0-31182. December 4, 2023.

APPENDIX A

Design Drawings

MOUNT POLLEY MINING CORPORATION
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

DRAWING LIST				
DRAWING NUMBER	DRAWING TITLE	REVISION NUMBER	PURPOSE OF ISSUE	DATE OF ISSUE
01	DRAWING LIST AND PROJECT LOCATION PLAN	0	ISSUED FOR CONSTRUCTION	2024-04-18
02	SITE PLAN	0	ISSUED FOR CONSTRUCTION	2024-04-18
03	PRE-CONSTRUCTION CONDITIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
04	GENERAL ARRANGEMENT - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
05	SOUTH EMBANKMENT - FOUNDATION PREPARATION	0	ISSUED FOR CONSTRUCTION	2024-04-18
06	SOUTH EMBANKMENT - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
07	SOUTH EMBANKMENT - TYPICAL CROSS-SECTION AND DETAIL	0	ISSUED FOR CONSTRUCTION	2024-04-18
08	SOUTH EMBANKMENT - CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
09	MAIN EMBANKMENT BUTTRESS - FOUNDATION PREPARATION	0	ISSUED FOR CONSTRUCTION	2024-04-18
10	MAIN EMBANKMENT AND BUTTRESS - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
11	MAIN EMBANKMENT AND BUTTRESS - TYPICAL CROSS-SECTION AND DETAIL	0	ISSUED FOR CONSTRUCTION	2024-04-18
12	MAIN EMBANKMENT - CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
13	MAIN EMBANKMENT BUTTRESS - CROSS-SECTIONS (SHEET 1 OF 2)	0	ISSUED FOR CONSTRUCTION	2024-04-18
14	MAIN EMBANKMENT BUTTRESS - CROSS-SECTIONS (SHEET 2 OF 2)	0	ISSUED FOR CONSTRUCTION	2024-04-18
15	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2-CORNER 1) - FOUNDATION PREPARATION	0	ISSUED FOR CONSTRUCTION	2024-04-18
16	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2-CORNER 1) - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
17	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2-CORNER 1) - TYPICAL CROSS-SECTION AND DETAIL	0	ISSUED FOR CONSTRUCTION	2024-04-18
18	PERIMETER EMBANKMENT (CORNER 2-CORNER 1) - CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
19	PERIMETER EMBANKMENT BUTTRESS (CORNER 2-CORNER 1) - CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
20	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1-CORNER 5) - FOUNDATION PREPARATION	0	ISSUED FOR CONSTRUCTION	2024-04-18
21	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1-CORNER 5) - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
22	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1-CORNER 5) - TYPICAL CROSS-SECTION AND DETAIL	0	ISSUED FOR CONSTRUCTION	2024-04-18
23	PERIMETER EMBANKMENT (CORNER 1-CORNER 5) - CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
24	PERIMETER EMBANKMENT BUTTRESS (CORNER 1-CORNER 5) - CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
25	SOUTH AND PERIMETER EMBANKMENT ABUTMENTS - PLAN VIEW AND TYPICAL CROSS-SECTIONS	0	ISSUED FOR CONSTRUCTION	2024-04-18
26	UPSTREAM DRAIN - SOUTH AND MAIN EMBANKMENT - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
27	UPSTREAM DRAIN - PERIMETER EMBANKMENT - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
28	UPSTREAM DRAIN - TYPICAL CROSS-SECTIONS AND DETAILS (SHEET 1 OF 2)	0	ISSUED FOR CONSTRUCTION	2024-04-18
29	UPSTREAM DRAIN - TYPICAL CROSS-SECTIONS AND DETAILS (SHEET 2 OF 2)	0	ISSUED FOR CONSTRUCTION	2024-04-18
30	INSTRUMENTATION - PIEZOMETERS - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
31	INSTRUMENTATION - SLOPE INCLINOMETERS AND SAAS - PLAN VIEW	0	ISSUED FOR CONSTRUCTION	2024-04-18
32	TSF SPILLWAY - PLAN AND PROFILE	0	ISSUED FOR CONSTRUCTION	2024-04-18
33	TSF SPILLWAY - TYPICAL DETAILS	0	ISSUED FOR CONSTRUCTION	2024-04-18
34	TSF SPILLWAY - TYPICAL CROSS-SECTIONS (SHEET 1 OF 2)	0	ISSUED FOR CONSTRUCTION	2024-04-18
35	TSF SPILLWAY - TYPICAL CROSS-SECTIONS (SHEET 2 OF 2)	0	ISSUED FOR CONSTRUCTION	2024-04-18

SPECIFICATIONS			
SPECIFICATION NUMBER	SPECIFICATION TITLE	REVISION NUMBER	DATE OF ISSUE
CA0020527.4505-014-R-Rev0-51312	MOUNT POLLEY MINE TAILINGS STORAGE FACILITY EMBANKMENT CONSTRUCTION TO ELEVATION 974 m TECHNICAL SPECIFICATIONS	0	2024-04-18



PROJECT LOCATION PLAN
NOT TO SCALE

ISSUED FOR
CONSTRUCTION

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

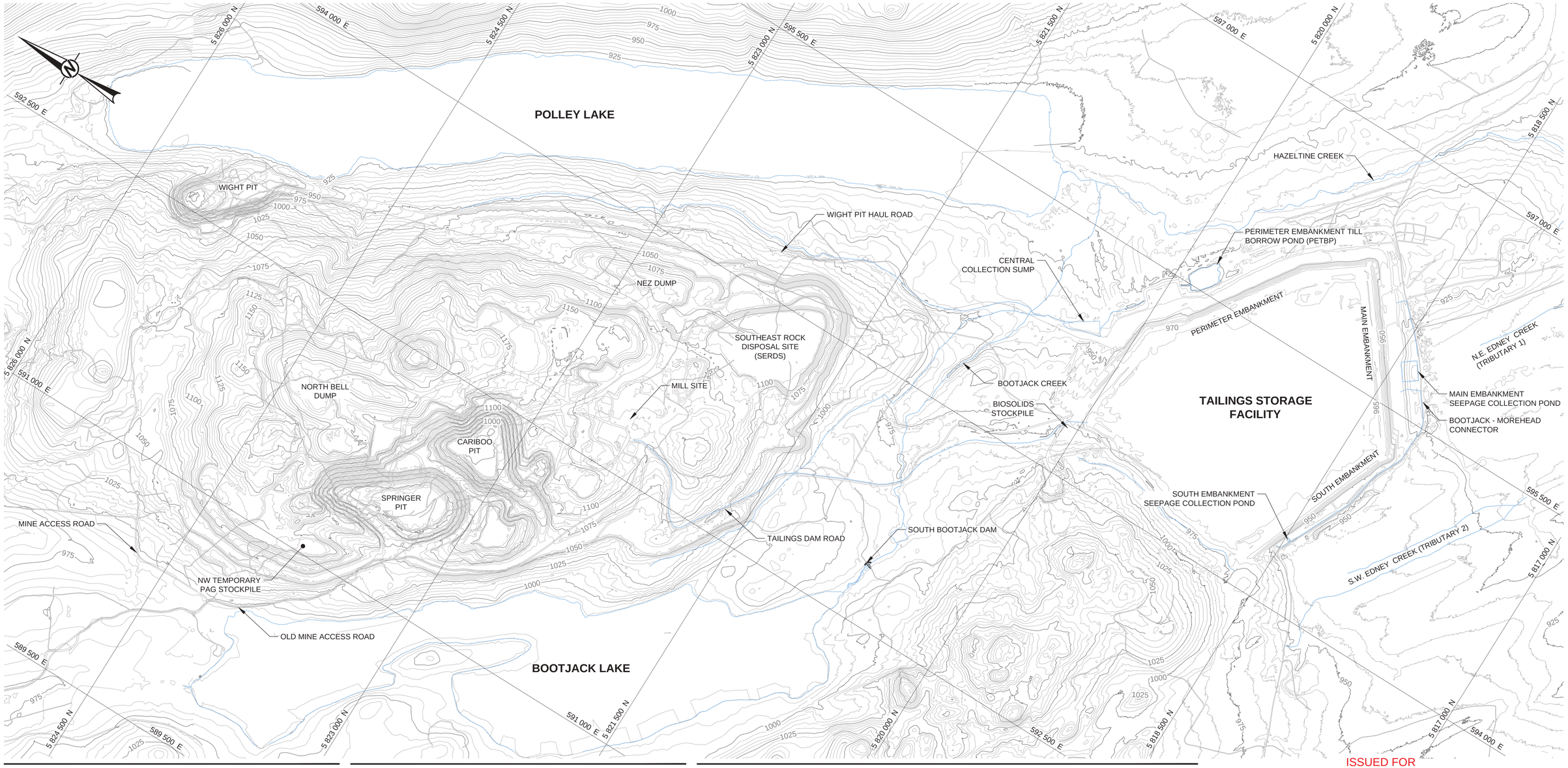
TITLE
DRAWING LIST AND PROJECT LOCATION PLAN

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	01 of 35	01

Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-001.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time:12:39:39 PM | Printed By: TYKlassen Date: 2024-04-17 Time:8:54:50 PM

0 25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\complexdata\toffice\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-002.dwg | Last Edited By: tyklassen Date: 2024-03-18 Time:11:58:47 AM | Printed By: TYKlassen Date: 2024-04-17 Time:8:56:26 PM



LEGEND

- GROUND CONTOURS (SEE NOTE 4)
- SHORELINE (SEE REFERENCE 6)
- WATERCOURSE (SEE REFERENCE 6)
- SITE ACCESS ROADS (SEE REFERENCE 6)

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES RELATIVE TO UTM, NAD83 AND ELEVATIONS OF MINE SITE REPRESENT GEODETIC DATUM, AND TAILINGS STORAGE FACILITY ARE RELATIVE TO TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 25 m MAJOR AND 5 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2013-2023 (SEE REFERENCES 1-5).

REFERENCES

1. 2013 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MTPOLLEY2013-DTM.dwg", SURVEYED: 2013, RECEIVED: 1 OCTOBER 2014.
2. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: SEPTEMBER 3, 2014.
3. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
4. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
5. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
6. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", SURVEYED: 2013, RECEIVED: 5 SEPTEMBER 2014.

ISSUED FOR

CONSTRUCTION

0 500 1,000

1:12,500 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

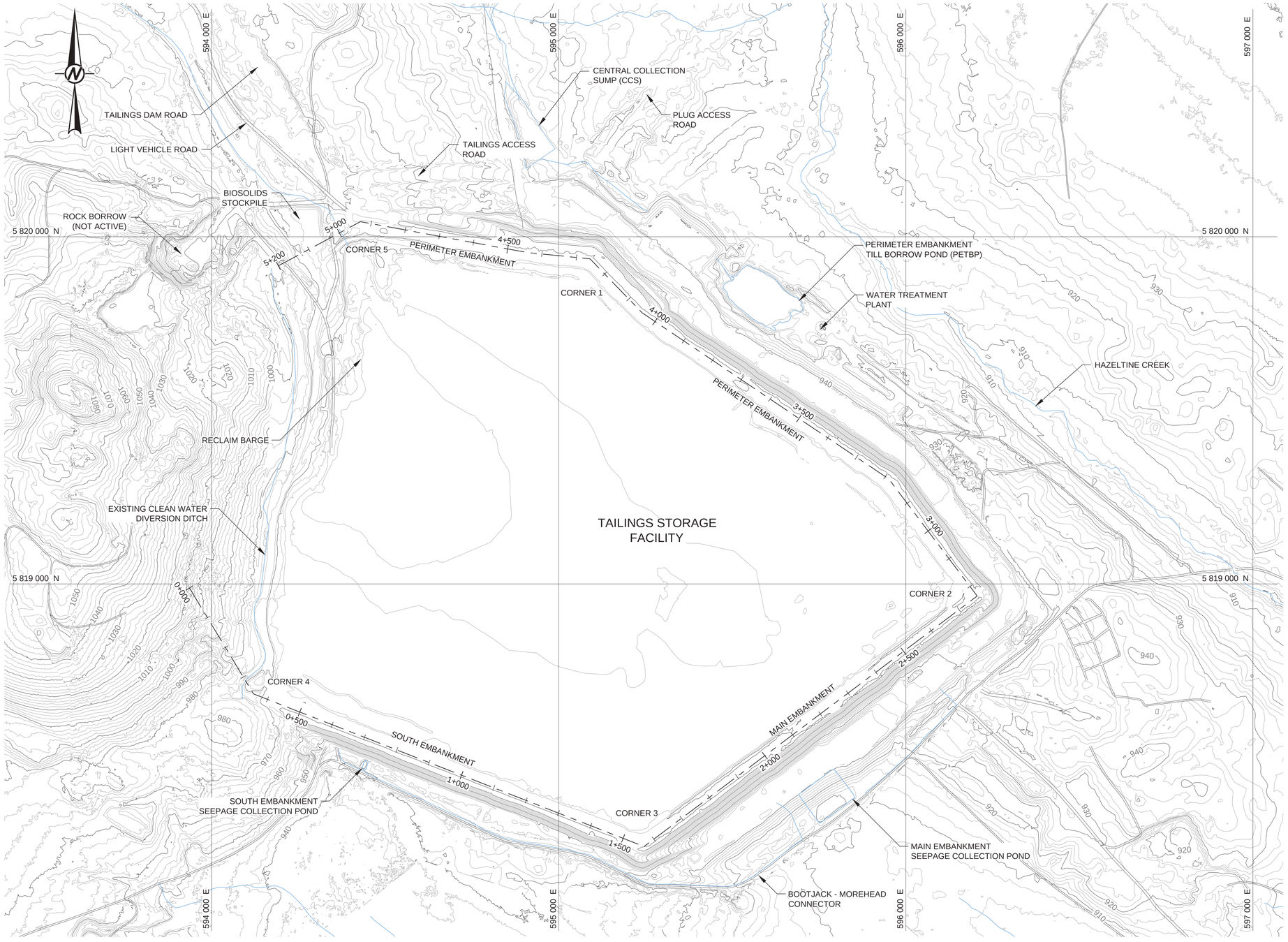
SITE PLAN

PROJECT NO.	PHASE/TASK/DOC.	REV.	02 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		02

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-003.dwg | Last Edited By: tyklassen Date: 2024-03-18 Time:11:58:00 AM | Printed By: TYKlassen Date: 2024-04-17 Time:8:57:42 PM



LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- SITE ACCESS ROADS (SEE REFERENCE 5)
- WATERCOURSE (SEE REFERENCE 5)

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2014-2023 (SEE REFERENCES 1-4).
5. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: 03 SEPTEMBER 2014.
2. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
4. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
5. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 5 SEPTEMBER 2014.

ISSUED FOR

CONSTRUCTION

0 200 400

1:6,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

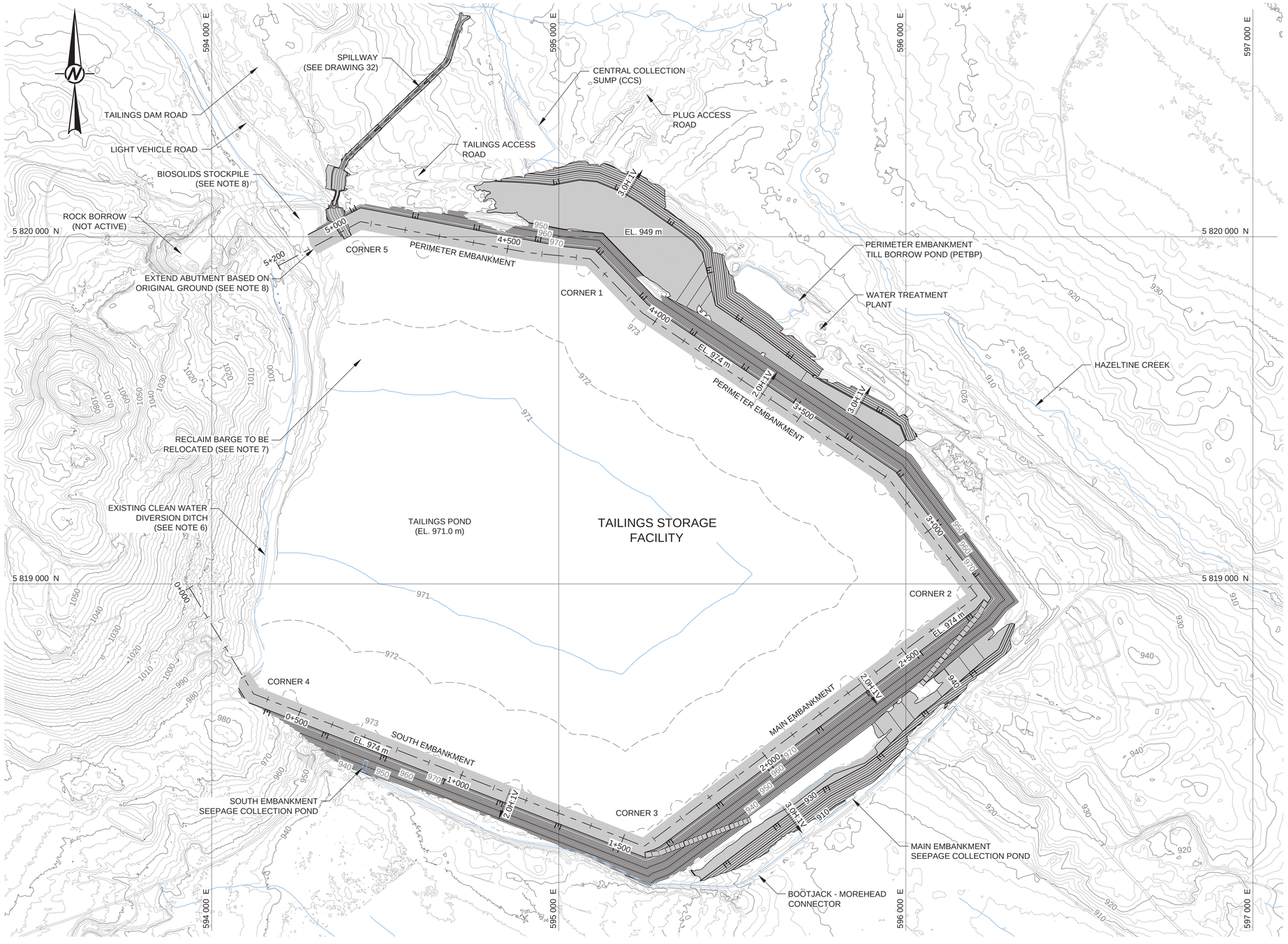
TITLE

PRE-CONSTRUCTION CONDITIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	03 of 35	03

0 25 mm

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE, BUTTRESS AND SPILLWAY DESIGN CONTOURS
- TAILINGS SURFACE CONTOURS (SEE NOTE 10)
- TAILINGS POND (EL. 971.0 m)
- SITE ACCESS ROADS (SEE REFERENCE 5)
- WATERCOURSE (SEE REFERENCE 5)

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR, TAILINGS DEPOSITION CONTOUR INTERVAL SHOWN AT 5 m MAJOR AND 1 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2014-2023 (SEE REFERENCES 1-4).
5. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
6. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
7. RECLAIM BARGE TO BE RELOCATED TO A CENTRAL LOCATION BETWEEN CORNER 4 AND 5.
8. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
9. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.
10. TAILINGS SURFACE SHOWN FOR REFERENCE ONLY, AND IS EXTRACTED FROM DEPOSITION MODEL AND ADJUSTED TO A MAXIMUM TAILINGS ELEVATION OF 973.1 m.

REFERENCES

1. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: 03 SEPTEMBER 2014.
2. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
4. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
5. SITE FEATURES PROVIDED BY MPMC, FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

ISSUED FOR

CONSTRUCTION

0 200 400

1:6,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

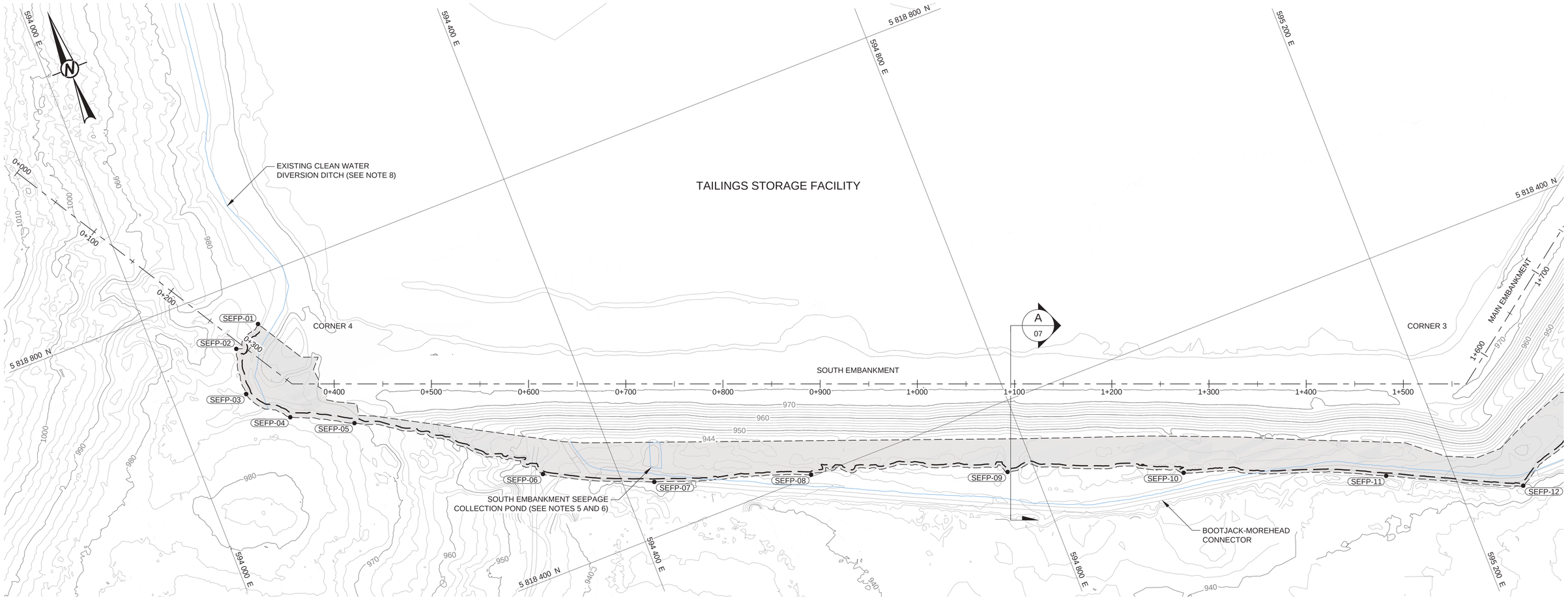
TITLE

GENERAL ARRANGEMENT
PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	04 of 35	04

Path: \\golder.gds\complexdata\toffice\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc.014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-004.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:19:02 PM | Printed By: TYKlassen Date: 2024-04-17 Time:8:58:57 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SOUTH EMBANKMENT - FOUNDATION PREPARATION

SCALE 1:2 000 m

LEGEND

- 4+400 — TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE DESIGN TOE
- FOUNDATION PREPARATION FOOTPRINT (SEE NOTES 5 AND 6)
- SITE ACCESS ROADS (SEE REFERENCE 4)
- WATERCOURSE (SEE REFERENCE 4)
- SEFP-12 — SOUTH EMBANKMENT FOUNDATION PREPARATION SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-3).
5. EXTENT AND DEPTH OF FOUNDATION PREPARATION TO BE CONFIRMED BY QA MANAGER.
6. NO FOUNDATION PREPARATION IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH CLEAN WATER DIVERSION DITCH, SOUTH EMBANKMENT SEEPAGE POND, AND SEEPAGE COLLECTION DITCHES UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
9. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
3. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
4. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

SOUTH EMBANKMENT FOUNDATION PREPARATION SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
SEFP-01	594110.20	5818753.44	977.52
SEFP-02	594080.05	5818737.76	974.58
SEFP-03	594072.68	5818690.81	973.00
SEFP-04	594106.25	5818652.08	974.92
SEFP-05	594165.54	5818622.42	970.35
SEFP-06	594327.19	5818503.10	943.35
SEFP-07	594430.90	5818453.87	939.47
SEFP-08	594583.88	5818402.09	943.32
SEFP-09	594773.21	5818331.18	944.59
SEFP-10	594941.58	5818264.49	944.29
SEFP-11	595134.56	5818185.74	942.54
SEFP-12	595262.17	5818124.96	940.92

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT. ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE. THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

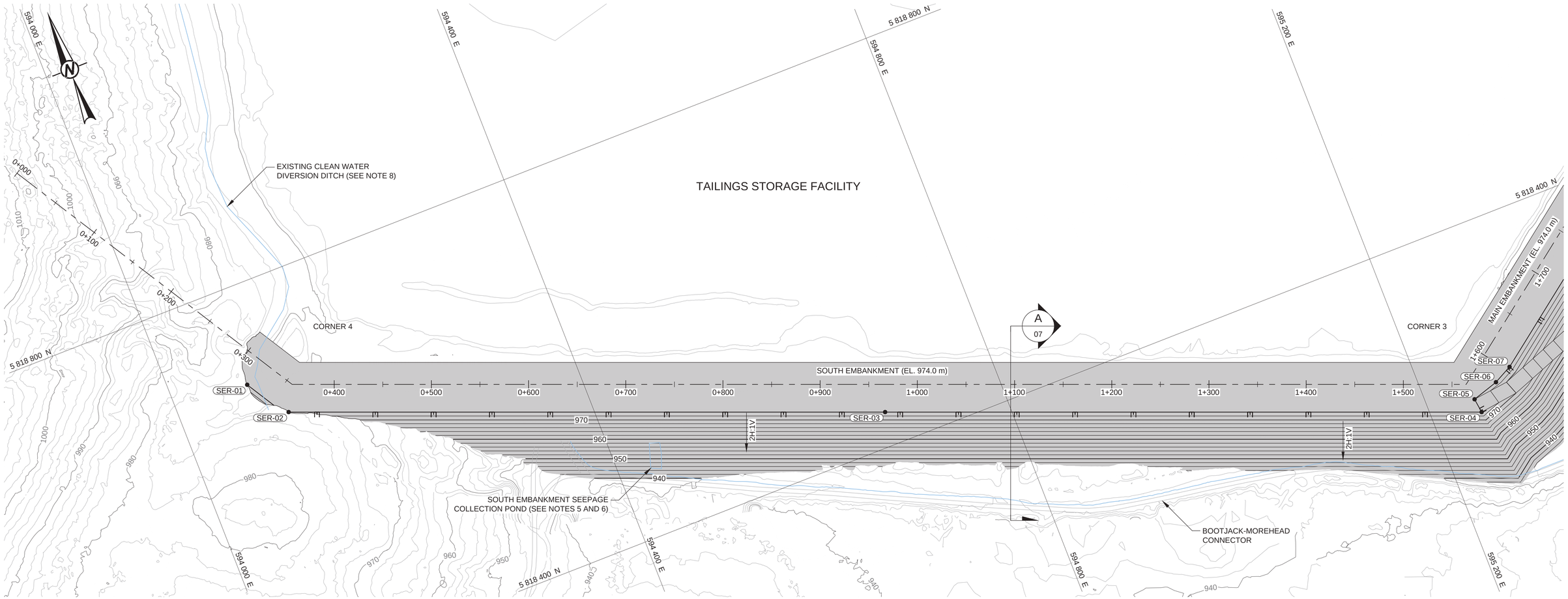
SOUTH EMBANKMENT FOUNDATION PREPARATION

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	05 of 35	05

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-005.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:18:17 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:02:44 PM



SOUTH EMBANKMENT - PLAN VIEW

SCALE 1:2 000 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 4)
- WATERCOURSE (SEE REFERENCE 4)
- SER-07 — SOUTH EMBANKMENT RAISE SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-3).
5. EXTENT OF ROCKFILL PLACEMENT TO BE CONFIRMED BY QA MANAGER.
6. NO ROCKFILL PLACEMENT IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH THE CLEAN WATER DIVERSION DITCH, SOUTH EMBANKMENT SEEPAGE COLLECTION POND, AND SEEPAGE COLLECTION DITCHES UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
9. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
3. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
4. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

SOUTH EMBANKMENT RAISE SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
SER-01	594077.27	5818699.68	974.00
SER-02	594106.78	5818658.03	974.00
SER-03	594678.40	5818434.75	974.00
SER-04	595250.03	5818211.47	974.00
SER-05	595248.07	5818226.34	974.00
SER-06	595274.96	5818234.72	974.00
SER-07	595293.70	5818244.30	974.00

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

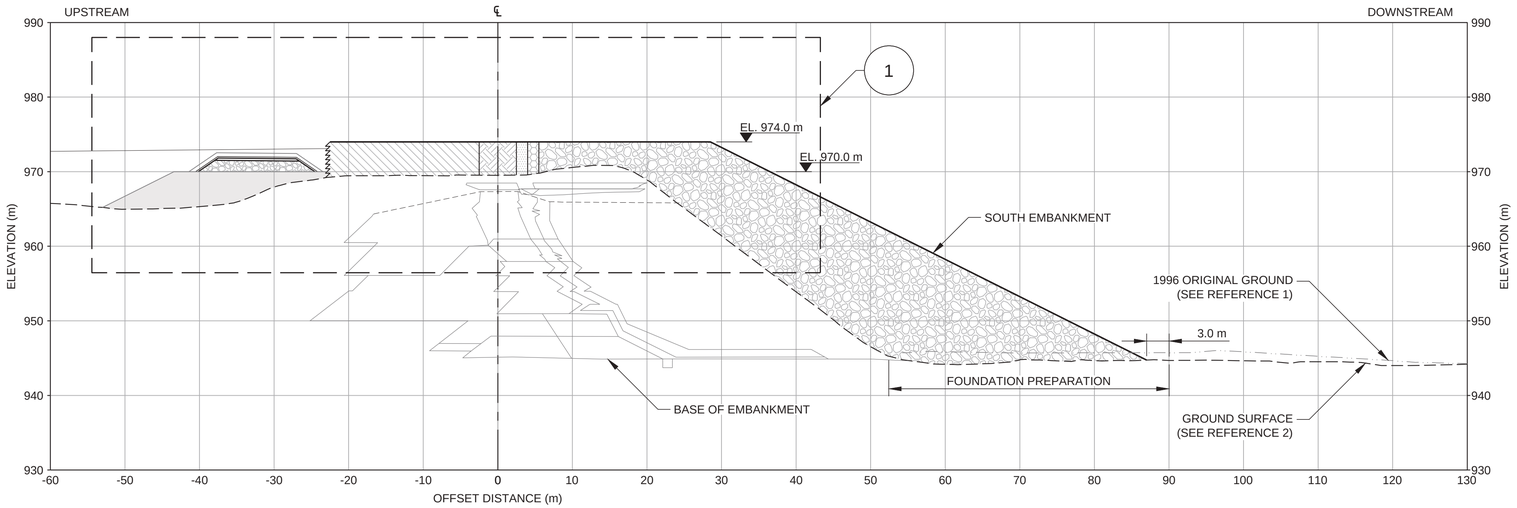
SOUTH EMBANKMENT PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	06 of 35	06

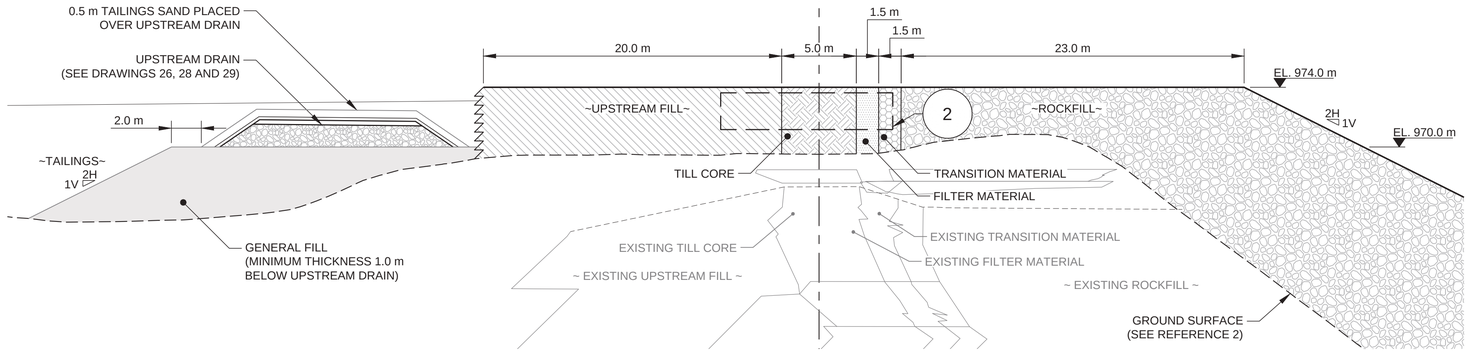
Path: \\golder.gds\comp\edata\vff\cn\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-006.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time:9:02:11 PM | Printed By: TYKlassen Date: 2024-04-18 Time:12:28:25 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm



SCALE 1:400 m — A 05/06 — SOUTH EMBANKMENT - TYPICAL CROSS-SECTION (STA. 0+298 TO 1+566)



SCALE 1:200 m — 1 — SOUTH EMBANKMENT - TYPICAL DETAIL

LEGEND

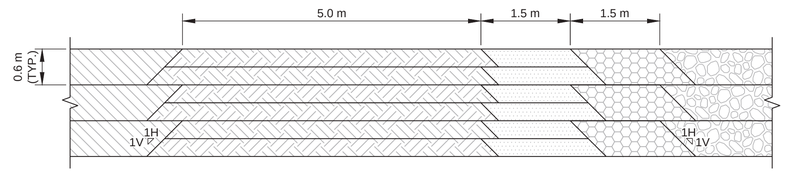
- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- 2013 CONSTRUCTION (SEE NOTE 5)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE SOUTH EMBANKMENT UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE CAN VARY BETWEEN ELEVATION 970 - 972 m, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT,
   FILE NAME: "2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf",
   DATED: 12 MARCH 2014.
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.



SCALE 1:50 m — 2 — TILL CORE - TYPICAL DETAIL

ISSUED FOR

CONSTRUCTION

0 2 4
1:50 METRES

0 10 20
1:200 METRES

0 20 40
1:400 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

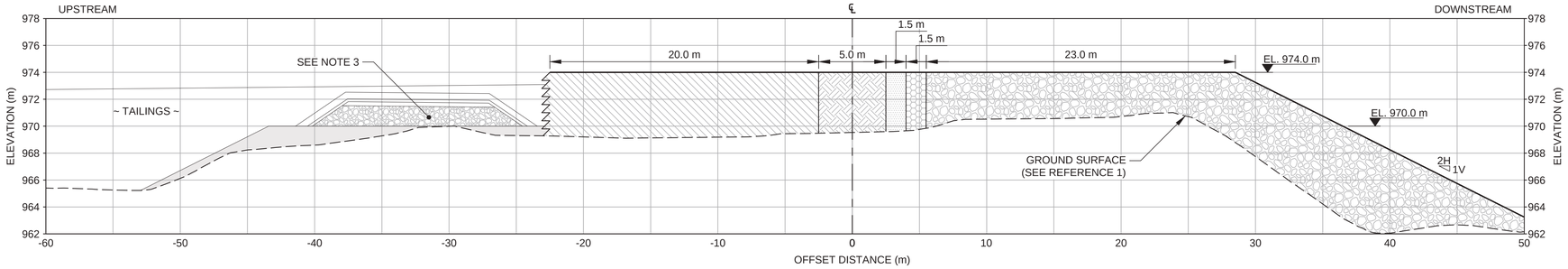
SOUTH EMBANKMENT
TYPICAL CROSS-SECTION AND DETAIL

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	07 of 35	07

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

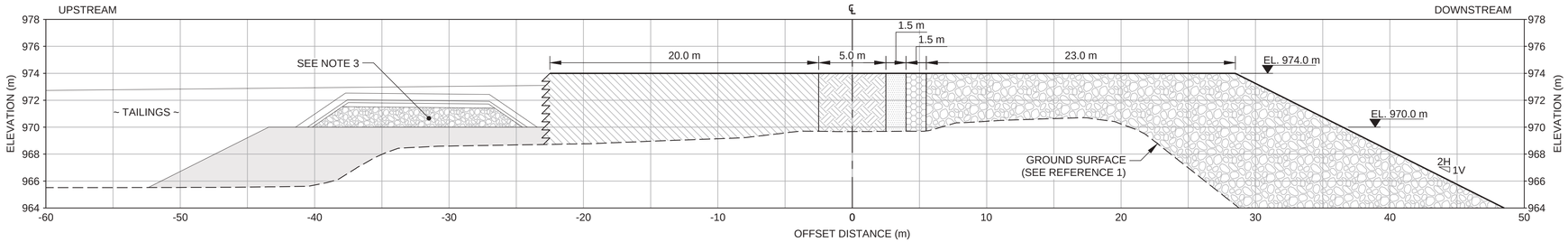
0 25 mm

Path: \\spl4dir.qld\complexdata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Dxc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-007.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time:9:01:39 PM | Printed By: TYKlassen Date: 2024-04-18 Time:12:26:40 PM



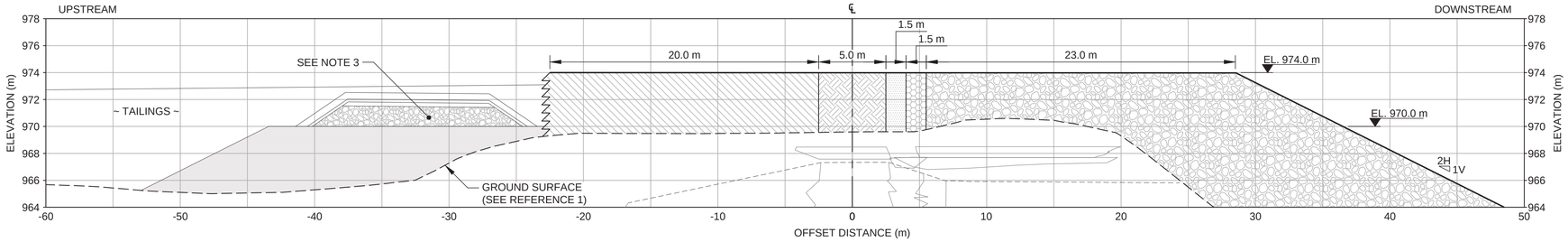
SOUTH EMBANKMENT CROSS-SECTION (STA. 0+500)

SCALE 1:200 m



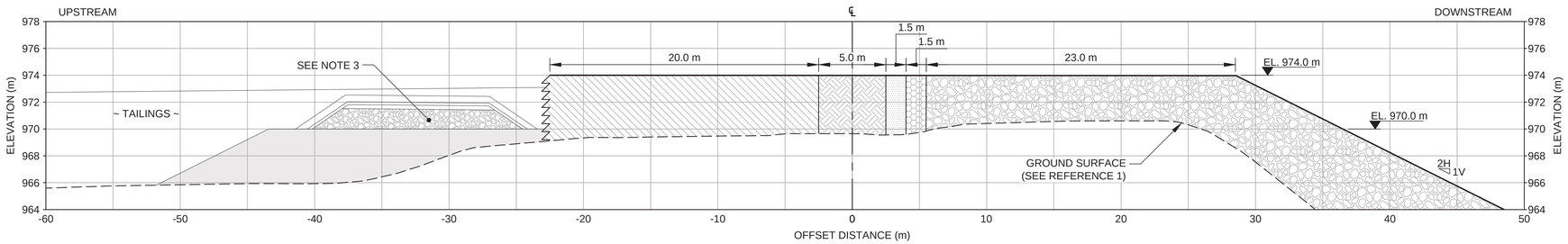
SOUTH EMBANKMENT CROSS-SECTION (STA. 0+800)

SCALE 1:200 m



SOUTH EMBANKMENT CROSS-SECTION (STA. 1+100)

SCALE 1:200 m



SOUTH EMBANKMENT CROSS-SECTION (STA. 1+400)

SCALE 1:200 m

LEGEND

- GROUND SURFACE (SEE REFERENCE 1)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- 2013 CONSTRUCTION (SEE NOTE 5)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE SOUTH EMBANKMENT UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE CAN VARY BETWEEN ELEVATION 970 - 972 m, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT,
   FILE NAME: "2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf",
   DATED: 12 MARCH 2014.
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCE

1. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20

1:200 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

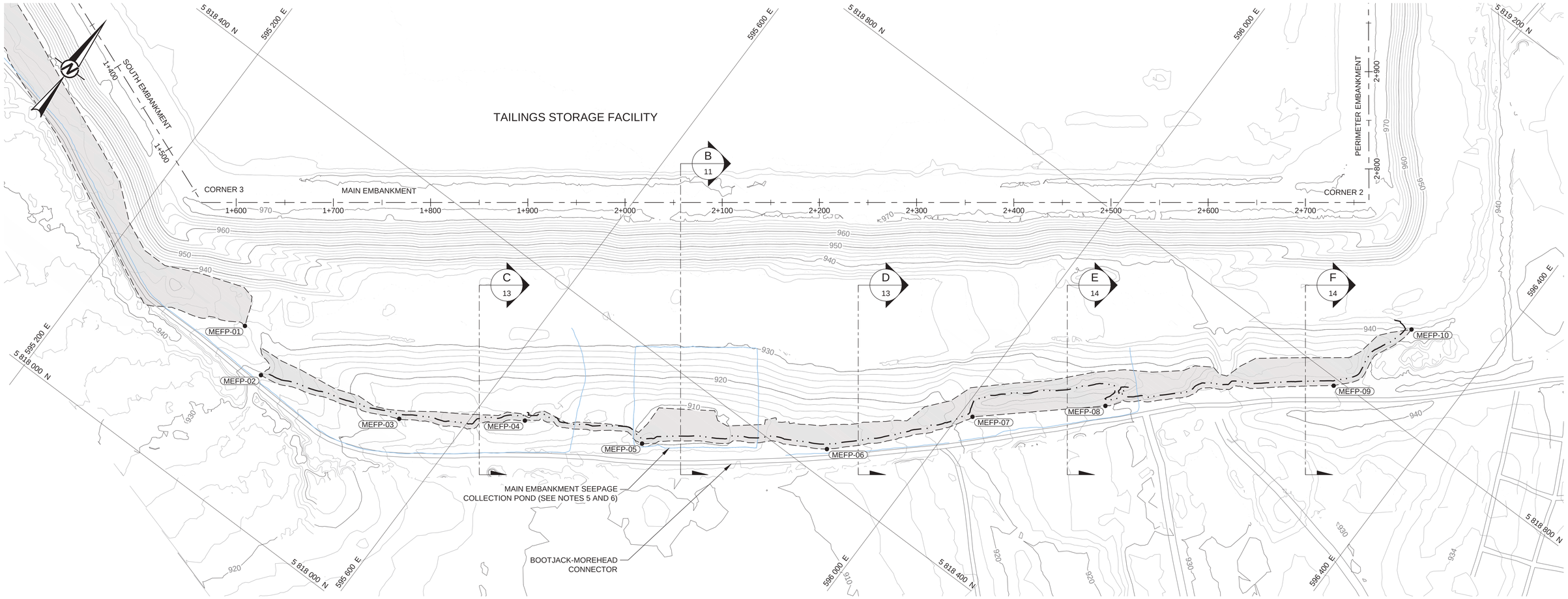
TITLE

SOUTH EMBANKMENT CROSS-SECTIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	08 of 35	08

0 25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-0008.dwg | Last Edited By: tyklassen Date: 2024-04-11 Time:8:50:25 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:00:22 PM



MAIN EMBANKMENT - FOUNDATION PREPARATION

SCALE 1:2 000 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE DESIGN TOE
- TSF EL. 974 m BUTTRESS DESIGN TOE
- FOUNDATION PREPARATION FOOTPRINT (SEE NOTES 5 AND 6)
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- (MEFP-10) MAIN EMBANKMENT FOUNDATION PREPARATION SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. EXTENT AND DEPTH OF FOUNDATION PREPARATION TO BE CONFIRMED BY QA MANAGER.
6. NO FOUNDATION PREPARATION IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH MAIN EMBANKMENT SEEPAGE POND, AND SEEPAGE COLLECTION DITCHES UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

MAIN EMANKMENT FOUNDATION PREPARATION SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
MEFP-01	595357.37	5818168.95	932.26
MEFP-02	595400.93	5818138.37	929.11
MEFP-03	595541.61	5818187.93	916.01
MEFP-04	595646.09	5818264.17	916.05
MEFP-05	595756.62	5818317.71	909.12
MEFP-06	595912.09	5818427.43	912.51
MEFP-07	596011.89	5818543.96	922.97
MEFP-08	596114.46	5818635.08	928.74
MEFP-09	596289.68	5818792.73	937.10
MEFP-010	596318.99	5818887.12	939.54

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT. ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

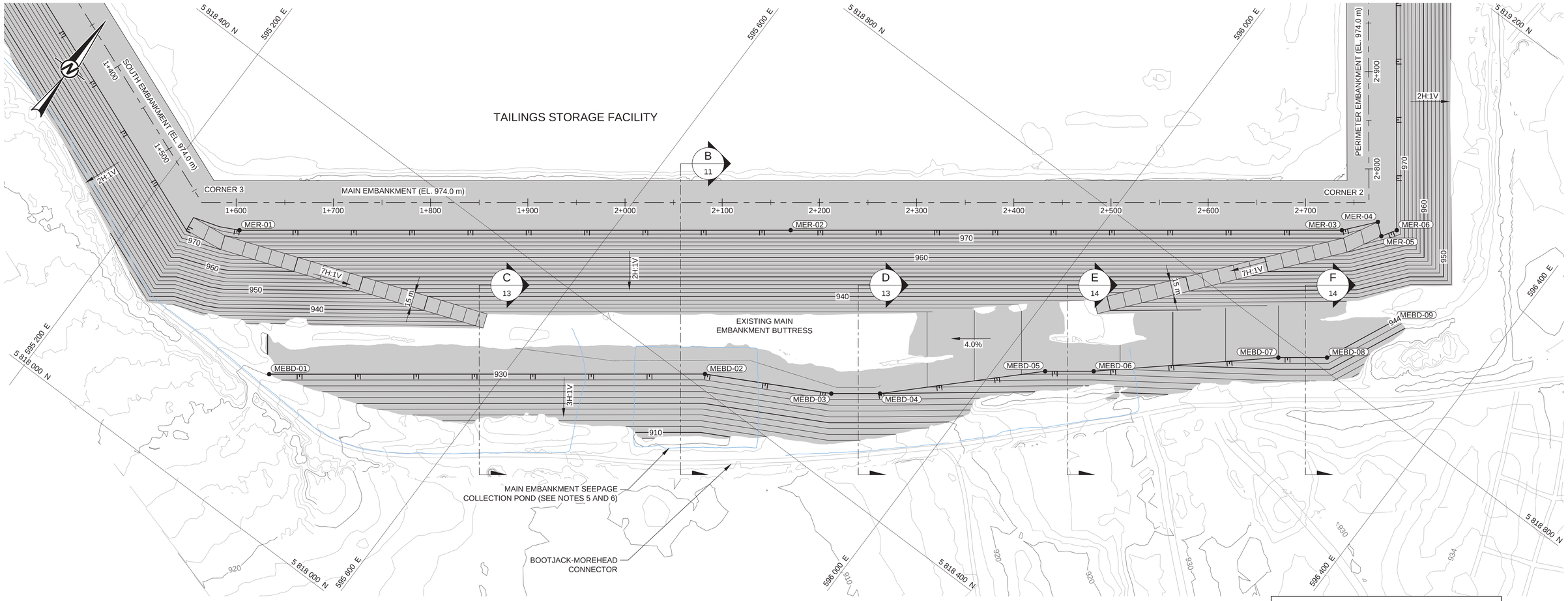
MAIN EMBANKMENT BUTTRESS FOUNDATION PREPARATION

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	09 of 35	09

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-009.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:17:38 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:06:23 PM



MAIN EMBANKMENT - PLAN VIEW

SCALE 1:2 000 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- MER-06 — MAIN EMBANKMENT RAISE SETOUT POINT
- MEBD-09 — MAIN EMBANKMENT BUTTRESS DESIGN SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. EXTENT OF ROCKFILL PLACEMENT TO BE CONFIRMED BY QA MANAGER.
6. NO ROCKFILL PLACEMENT IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH THE MAIN EMBANKMENT SEEPAGE COLLECTION POND, AND SEEPAGE COLLECTION DITCHES UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

MAIN EMBANKMENT BUTTRESS DESIGN SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
MEBD-01	595407.09	5818144.29	930.00
MEBD-02	595765.41	5818413.79	930.00
MEBD-03	595881.37	5818475.81	930.00
MEBD-04	595921.33	5818505.86	930.00
MEBD-05	596043.39	5818626.36	937.00
MEBD-06	596083.36	5818656.40	937.00
MEBD-07	596226.84	5818781.75	944.00
MEBD-08	596266.81	5818811.79	944.00
MEBD-09	596299.83	5818884.25	944.00

MAIN EMBANKMENT EL. 974 m RAISE SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
MER-01	595293.71	5818244.30	974.00
MER-02	595747.04	5818585.01	974.00
MER-03	596200.37	5818925.72	974.00
MER-04	596224.82	5818954.73	974.00
MER-05	596236.44	5818945.25	974.00
MER-06	596245.50	5818959.66	974.00

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

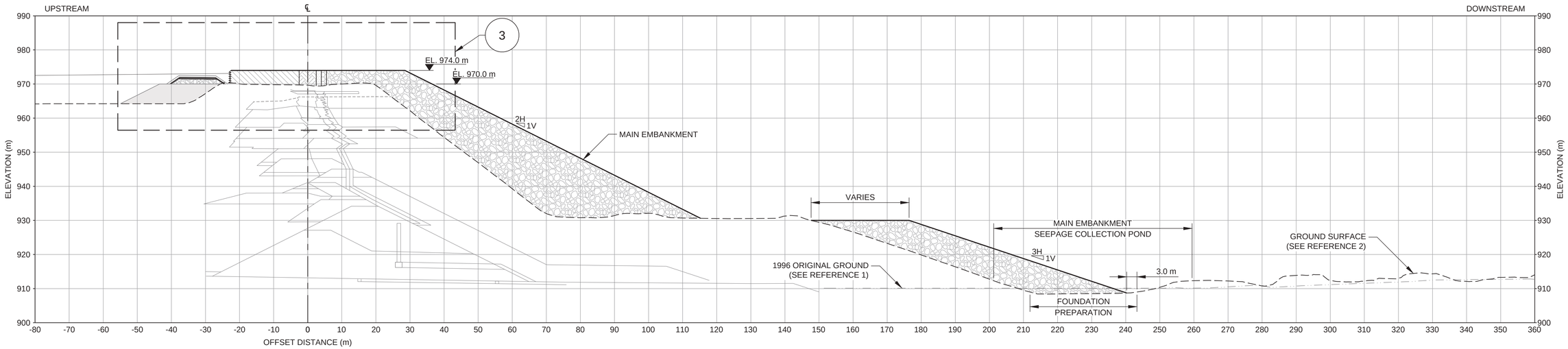
MAIN EMBANKMENT AND BUTTRESS PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.	10 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		10

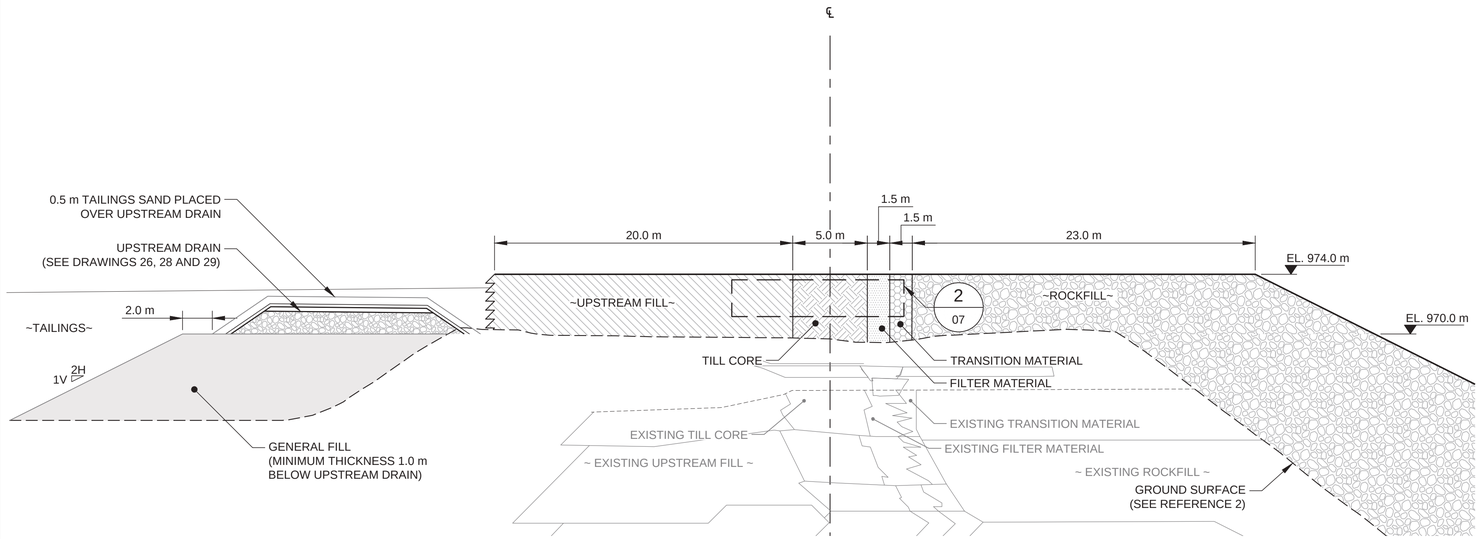
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014-010.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:17:14 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:06:03 PM
DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-010.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:17:14 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:06:03 PM
Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-010.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:17:14 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:06:03 PM



SCALE 1:600 m — B (09/10) — MAIN EMBANKMENT - TYPICAL CROSS-SECTION (STA. 1+566 TO 2+756)



SCALE 1:200 m — 3 — MAIN EMBANKMENT - TYPICAL DETAIL

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- 2013 CONSTRUCTION (SEE NOTE 5)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE MAIN EMBANKMENT UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE TO BE AT ELEVATION 970 m, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT,
   FILE NAME: "2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf",
   DATED: 12 MARCH 2014.
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.

REFERENCES

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC,
   FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES,
   SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20
1:200 METRES

0 20 40
1:600 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

Engineers & Geoscientists BC Permit #1000200

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

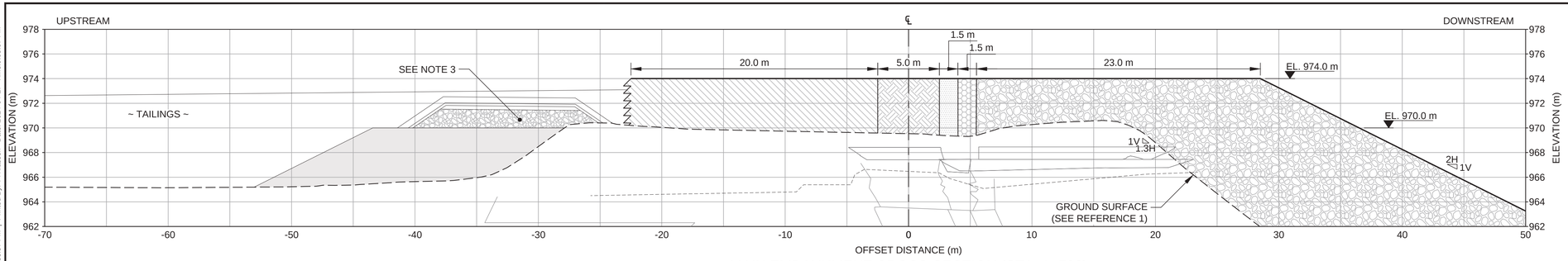
TITLE

MAIN EMBANKMENT AND BUTTRESS TYPICAL CROSS-SECTION AND DETAIL

PROJECT NO.	PHASE/TASK/DOC.	REV.	11 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		11

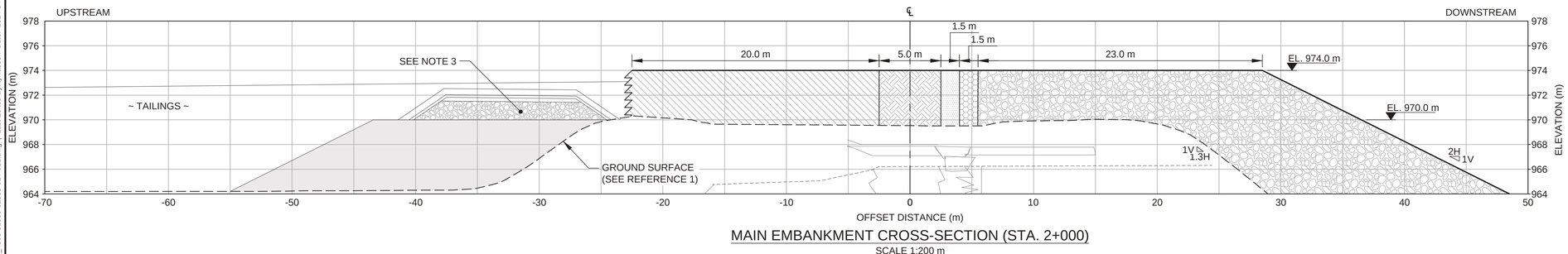
0 25 mm — IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\comp\edata\vff\cn\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-011.dwg | Last Edited By: tyklassen Date: 2024-04-11 Time:8:51:38 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:05:33 PM



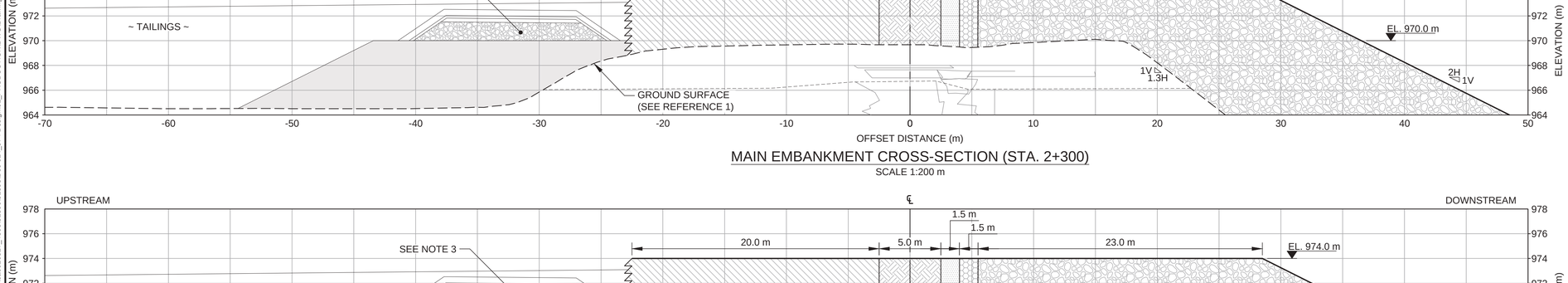
MAIN EMBANKMENT CROSS-SECTION (STA. 1+700)

SCALE 1:200 m



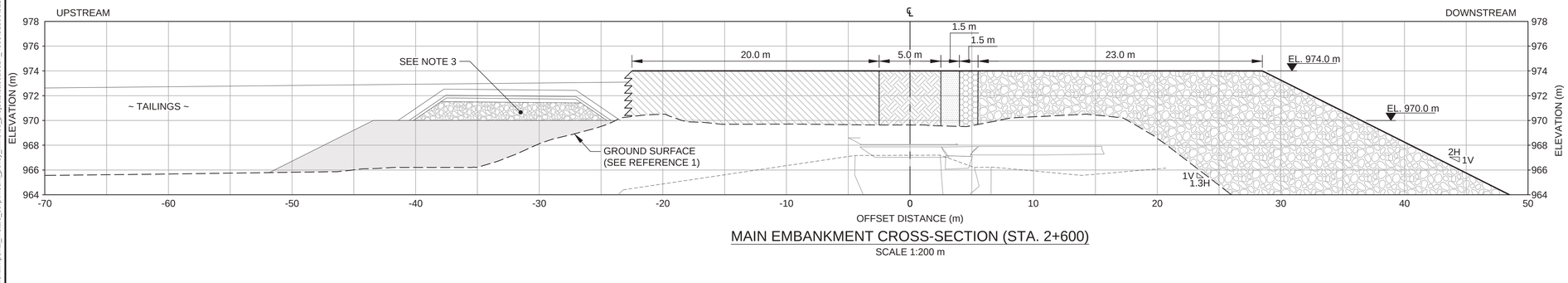
MAIN EMBANKMENT CROSS-SECTION (STA. 2+000)

SCALE 1:200 m



MAIN EMBANKMENT CROSS-SECTION (STA. 2+300)

SCALE 1:200 m



MAIN EMBANKMENT CROSS-SECTION (STA. 2+600)

SCALE 1:200 m

LEGEND

- GROUND SURFACE (SEE REFERENCE 1)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- 2013 CONSTRUCTION (SEE NOTE 4)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE MAIN EMBANKMENT UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE TO BE AT ELEVATION 970 m, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT,
   FILE NAME: “2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf”,
   DATED: 12 MARCH 2014.
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCE

1. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20

1:200 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK.
WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

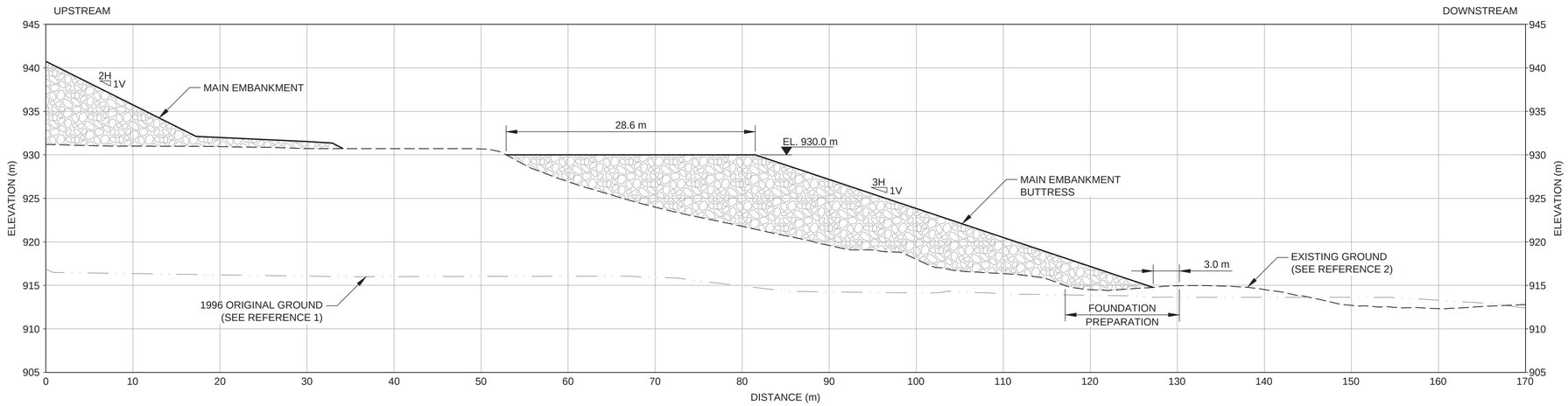
MAIN EMBANKMENT CROSS-SECTIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	12 of 35	12

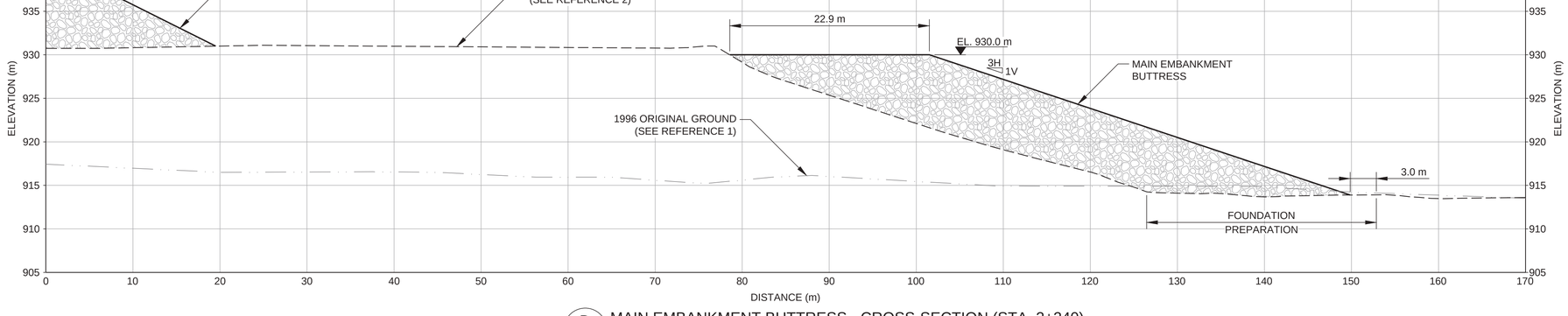
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4595\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-012.dwg | Last Edited By: tyklassen Date: 2024-04-11 Time:8:53:37 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:05:07 PM



SCALE 1:300 m — C / 09 / 10 — MAIN EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 1+850)



SCALE 1:300 m — D / 09 / 10 — MAIN EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 2+240)

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- EXISTING GROUND (SEE REFERENCE 2)
- ROCKFILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.

REFERENCE

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20
1:300 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT: MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

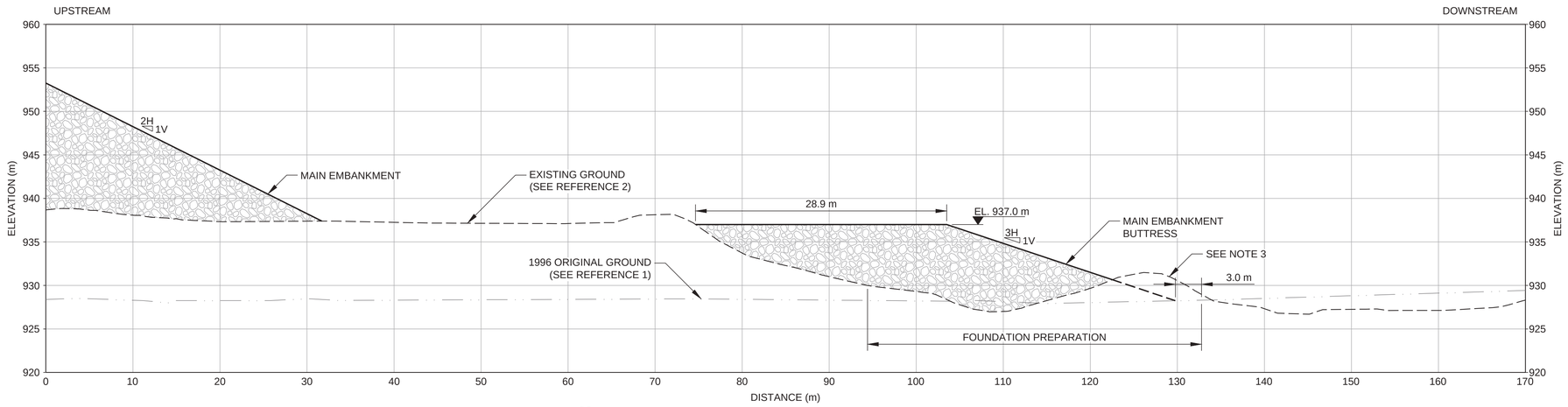
TITLE
MAIN EMBANKMENT BUTTRESS CROSS-SECTIONS (SHEET 1 OF 2)

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	13 of 35	13

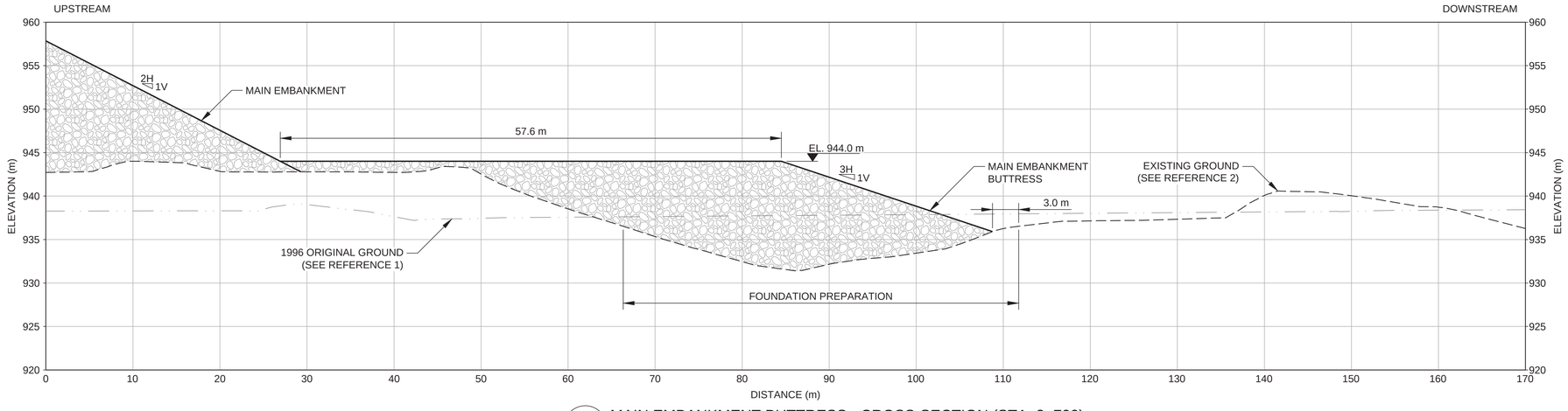
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

25 mm

Path: \\golder.gds\completed\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014\013_014.dwg | Last Edited By: tyklassen Date: 2024-03-18 Time:12:10:21 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:04:34 AM



SCALE 1:300 m — E (09 / 10) — MAIN EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 2+450)



SCALE 1:300 m — F (09 / 10) — MAIN EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 2+700)

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- EXISTING GROUND (SEE REFERENCE 2)
- ROCKFILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. STOCKPILE MATERIAL TO BE REMOVED AS PART OF FOUNDATION PREPARATION. BUTTRESS TO EXTEND TO NATURAL GROUND. EXTENT AND DEPTH OF FOUNDATION PREPARATION TO BE CONFIRMED BY QA MANAGER.

REFERENCE

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20
1:300 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

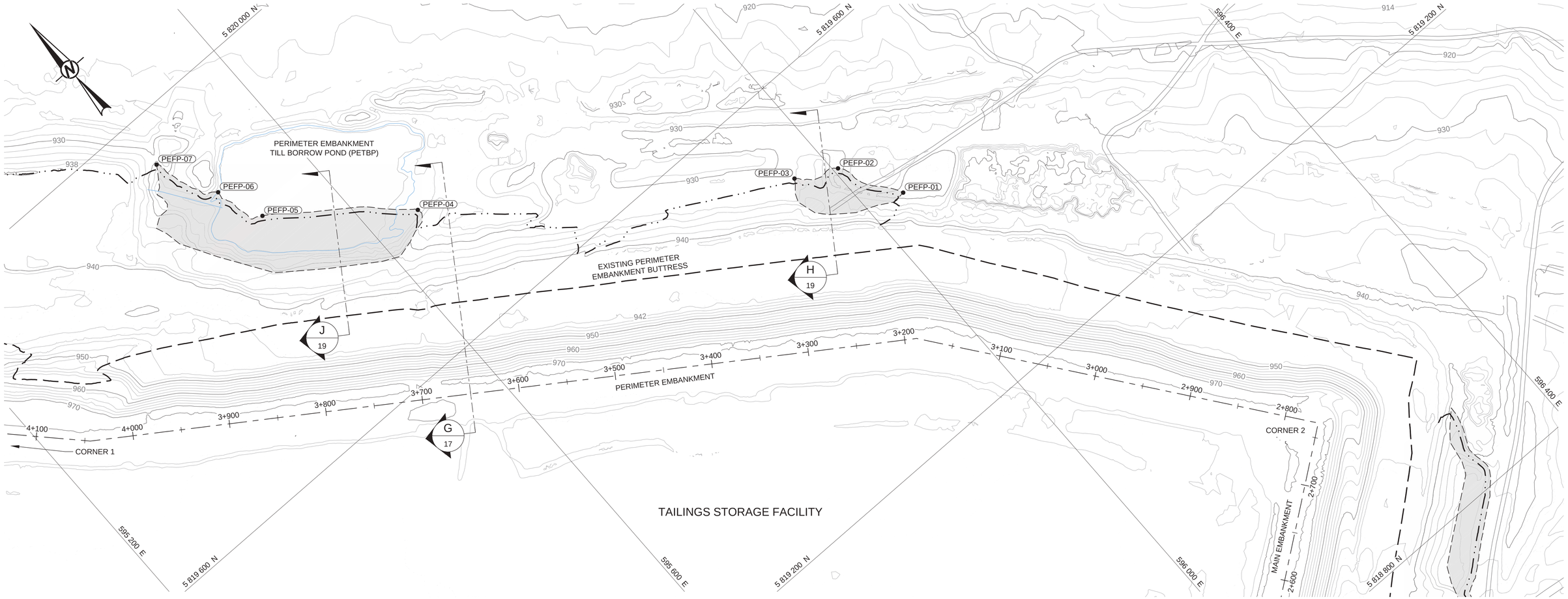
MAIN EMBANKMENT BUTTRESS
CROSS-SECTIONS (SHEET 2 OF 2)

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	14 of 35	14

Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-013_014.dwg | Last Edited By: tyklassen Date: 2024-03-18 Time:12:10:21 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:04:19 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm



PERIMETER EMBANKMENT (CORNER 2-CORNER 1) - FOUNDATION PREPARATION

SCALE 1:2 000 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE DESIGN TOE
- TSF EL. 974 m BUTTRESS DESIGN TOE
- FOUNDATION PREPARATION FOOTPRINT (SEE NOTES 5 AND 6)
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- PEFP-07 — PERIMETER EMBANKMENT FOUNDATION PREPARATION SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. EXTENT AND DEPTH OF FOUNDATION PREPARATION TO BE CONFIRMED BY QA MANAGER.
6. NO FOUNDATION PREPARATION IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH PERIMETER EMBANKMENT TILL BORROW POND UNTIL RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

PERIMETER EMBANKMENT FOUNDATION PREPARATION SETOUT TABLE (1 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PEFP-01	596039.02	5819424.35	929.25
PEFP-02	596004.84	5819487.13	929.48
PEFP-03	595964.12	5819508.68	931.77
PEFP-04	595650.73	5819738.76	922.85
PEFP-05	595526.13	5819839.12	920.88
PEFP-06	595507.70	5819887.39	922.39
PEFP-07	595478.52	5819950.38	929.38

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

Engineers & Geoscientists BC Permit #1000200

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

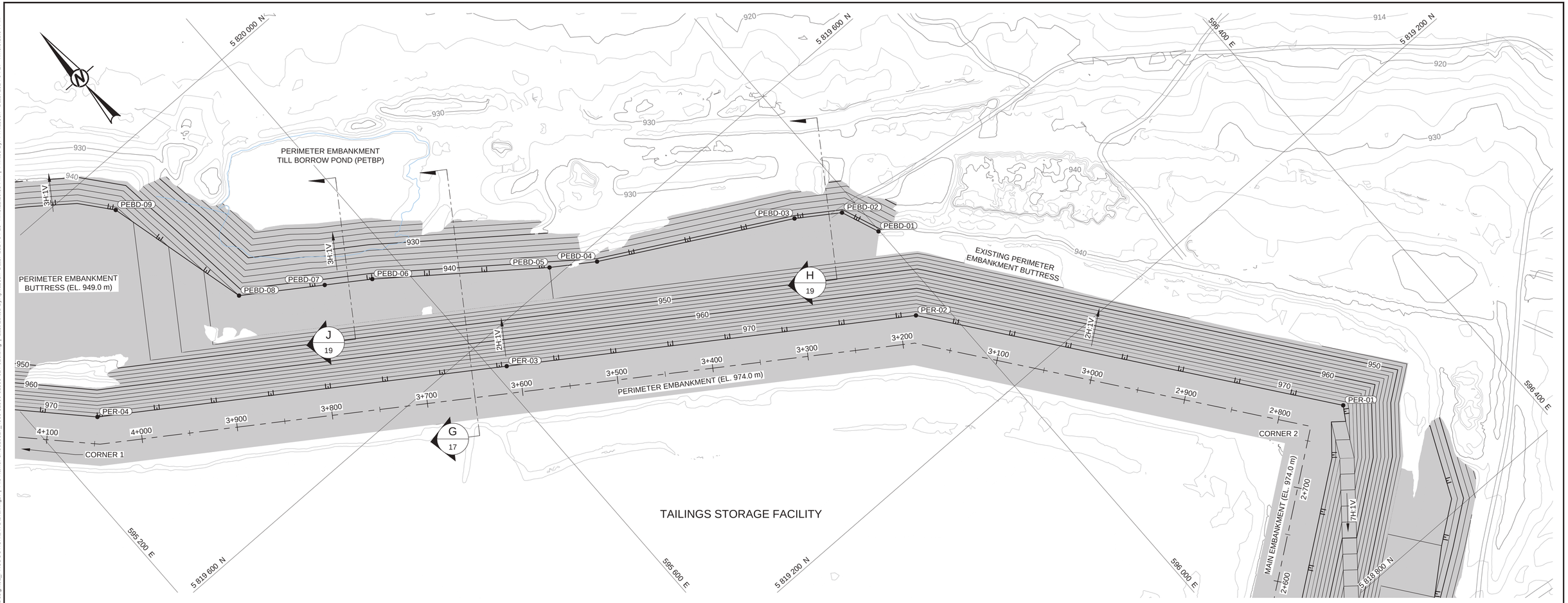
TITLE

PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2-CORNER 1) - FOUNDATION PREPARATION

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	15 of 35	15

0 25 mm — IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\com\edata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-015.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:16:58 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:20:50 PM



PERIMETER EMBANKMENT (CORNER 2-CORNER 1) - PLAN VIEW

SCALE 1:2 000 m

LEGEND

- 4+400 — TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- PER-04 — PERIMETER EMBANKMENT RAISE SETOUT POINT
- PEBD-09 — PERIMETER EMBANKMENT BUTTRESS DESIGN SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. EXTENT OF ROCKFILL PLACEMENT TO BE CONFIRMED BY QA MANAGER.
6. NO ROCKFILL PLACEMENT IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH THE MAIN EMBANKMENT SEEPAGE COLLECTION POND, AND SEEPAGE COLLECTION DITCHES UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

PERIMETER EMBANKMENT BUTTRESS DESIGN SETOUT TABLE (1 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PEBD-01	595999.02	5819414.94	941.00
PEBD-02	595983.19	5819454.66	941.00
PEBD-03	595941.72	5819482.59	941.00
PEBD-04	595756.80	5819583.96	941.00
PEBD-05	595715.33	5819611.89	942.00
PEBD-06	595567.92	5819724.19	942.00
PEBD-07	595526.45	5819752.12	942.00
PEBD-08	595451.75	5819802.44	942.00
PEBD-09	595413.37	5819954.30	949.00

PERIMETER EMBANKMENT EL. 974 m RAISE SETOUT TABLE (1 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PER-01	596245.50	5818959.65	974.00
PER-02	595970.85	5819323.11	974.00
PER-03	595613.99	5819563.48	974.00
PER-04	595257.14	5819803.85	974.00

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

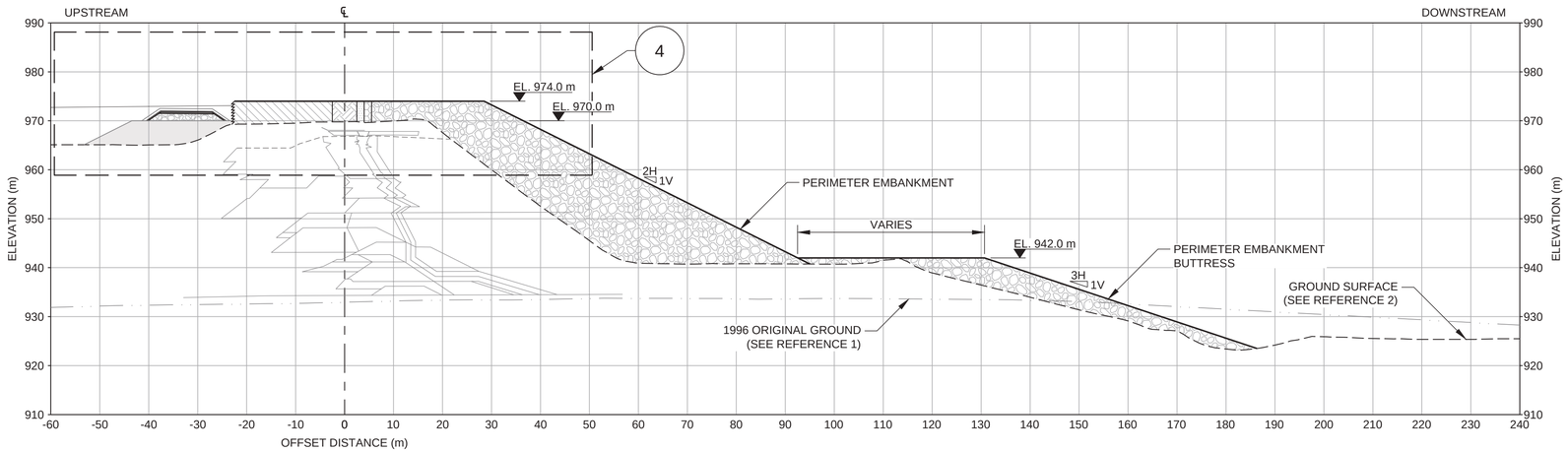
PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2-CORNER 1) - PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	16 of 35	16

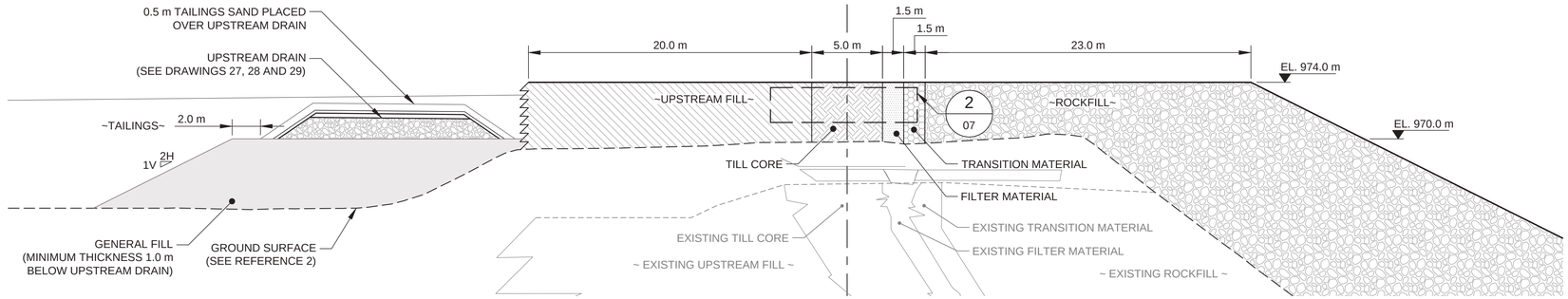
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gtt\sc\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-016.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:16:35 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:20:04 PM



SCALE 1:600 m — G 15 16 — PERIMETER EMBANKMENT - TYPICAL CROSS-SECTION (STA. 2+756 TO 4+000)



SCALE 1:200 m — 4 — PERIMETER EMBANKMENT - TYPICAL DETAIL

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- 2013 CONSTRUCTION (SEE NOTE 5)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE PERIMETER EMBANKMENT (CORNER 2 TO CORNER 1) UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE TO BE AT ELEVATION 970 m, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT,
   FILE NAME: "2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf",
   DATED: 12 MARCH 2014.
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC,
   FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES,
   SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20
1:200 METRES

0 20 40
1:600 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK.
WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

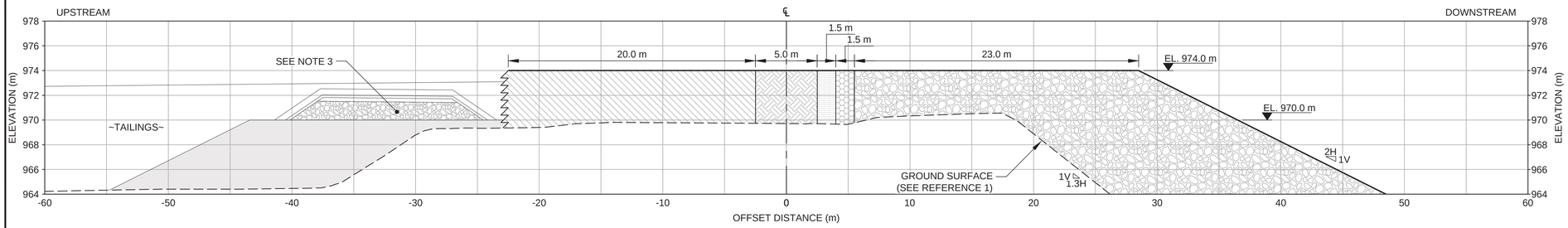
PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2-CORNER 1) - TYPICAL CROSS-SECTION AND DETAIL

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	17 of 35	17

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

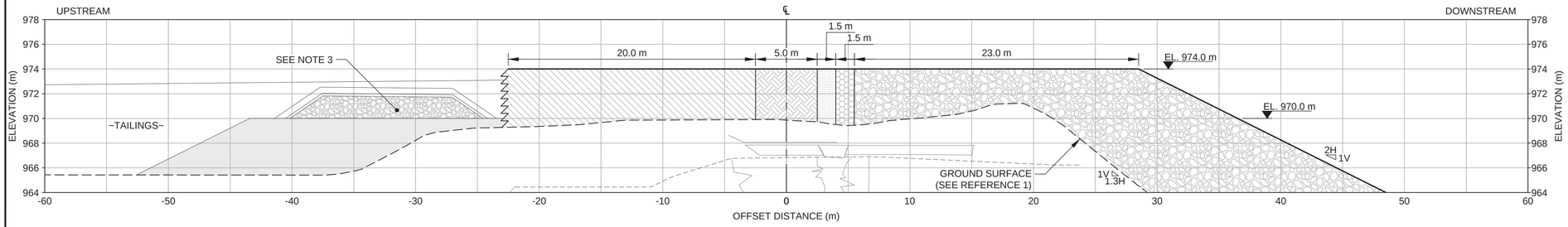
0 10 20 25 mm

Path: \\pl0der.qdsicomplexdata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-017.dwg | Last Edited By: tyklassen Date: 2024-04-11 Time:8:54:53 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:18:13 PM



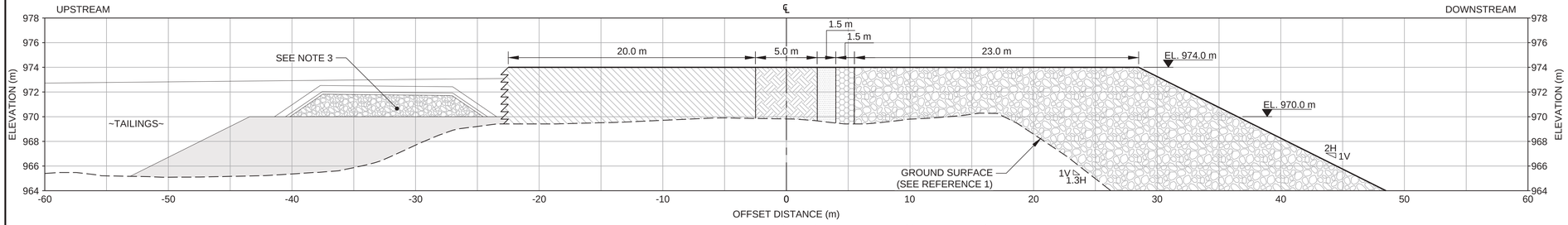
PERIMETER EMBANKMENT CROSS-SECTION (STA. 2+900)

SCALE 1:200 m



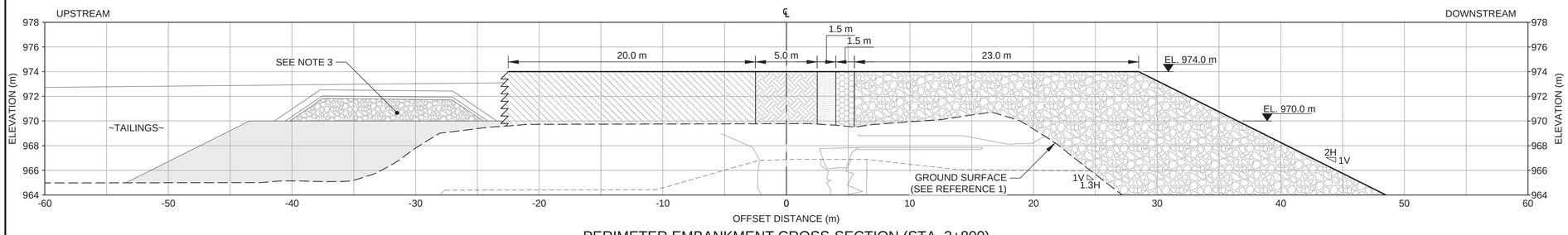
PERIMETER EMBANKMENT CROSS-SECTION (STA. 3+200)

SCALE 1:200 m



PERIMETER EMBANKMENT CROSS-SECTION (STA. 3+500)

SCALE 1:200 m



PERIMETER EMBANKMENT CROSS-SECTION (STA. 3+800)

SCALE 1:200 m

LEGEND

- GROUND SURFACE (SEE REFERENCE 1)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- 2013 CONSTRUCTION (SEE NOTE 5)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 26, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE PERIMETER EMBANKMENT (CORNER 2 TO CORNER 1) UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE TO BE AT ELEVATION 970 m, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT,
   FILE NAME: “2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf”,
   DATED: 12 MARCH 2014.
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCE

1. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20

1:200 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK.
WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

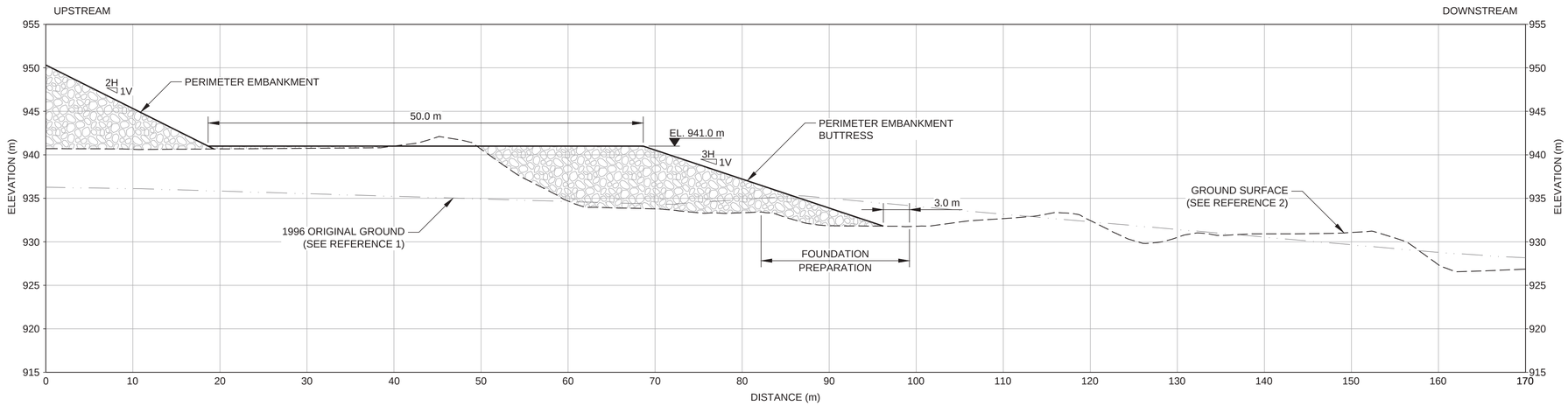
PERIMETER EMBANKMENT (CORNER 2-CORNER 1) CROSS-SECTIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	18 of 35	18

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

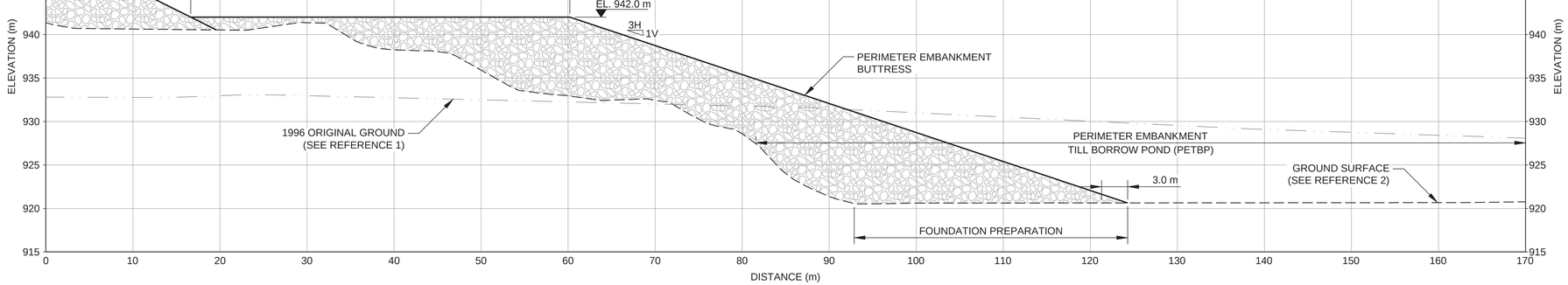
0 25 mm

Path: \\golder.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\CA0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-018.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time: 9:17:56 PM | Printed By: TYKlassen Date: 2024-04-18 Time: 11:39:59 AM



SCALE 1:300 m

PERIMETER EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 3+260)



SCALE 1:300 m

PERIMETER EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 3+766)

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- ROCKFILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.

REFERENCE

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20

1:300 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT. ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

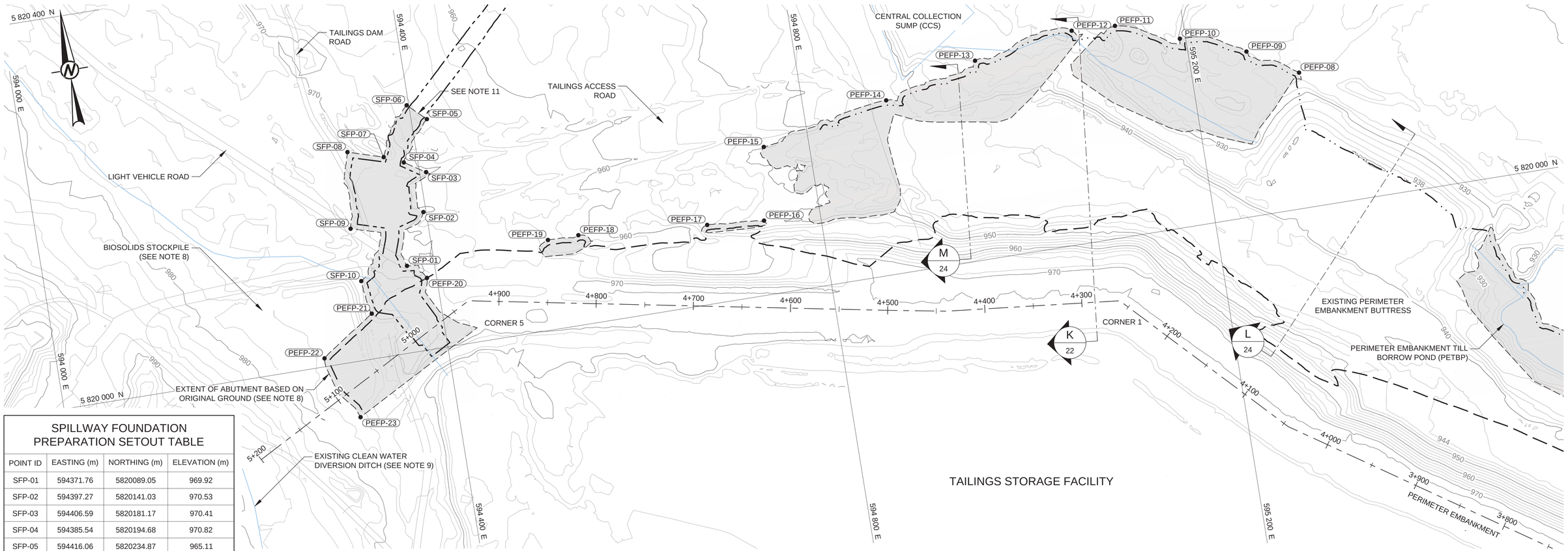
PERIMETER EMBANKMENT BUTTRESS (CORNER 2-CORNER 1) CROSS-SECTIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	19 of 35	19

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\pl0der.ad5\complexdata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\drawings\ | File Name: CA0020527_4505-51300-51395-014-019.dwg | Last Edited By: tyklassen Date: 2024-03-18 Time:12:28:28 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:16:25 PM



PERIMETER EMBANKMENT (CORNER 1-CORNER 5) - FOUNDATION PREPARATION

SCALE 1:2 000 m

SPILLWAY FOUNDATION PREPARATION SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
SFP-01	594371.76	5820089.05	969.92
SFP-02	594397.27	5820141.03	970.53
SFP-03	594406.59	5820181.17	970.41
SFP-04	594385.54	5820194.68	970.82
SFP-05	594416.06	5820234.87	965.11
SFP-06	594397.83	5820252.29	965.17
SFP-07	594365.96	5820203.38	970.00
SFP-08	594329.98	5820214.42	972.56
SFP-09	594320.58	5820136.06	973.81
SFP-10	594322.82	5820081.11	972.11

LEGEND

- 4+400 — TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE DESIGN TOE
- TSF EL. 974 m BUTTRESS DESIGN TOE
- TSF EL. 974 m SPILLWAY DESIGN FOOTPRINT
- FOUNDATION PREPARATION FOOTPRINT (SEE NOTES 5 AND 6)
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- PEFP-22 — PERIMETER EMBANKMENT FOUNDATION PREPARATION SETOUT POINT
- SFP-10 — SPILLWAY FOUNDATION PREPARATION SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. EXTENT AND DEPTH OF FOUNDATION PREPARATION TO BE CONFIRMED BY QA MANAGER.
6. NO FOUNDATION PREPARATION IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH CLEAN WATER DIVERSION DITCH, SEEPAGE COLLECTION DITCHES AND PERIMETER EMBANKMENT TILL BORROW POND UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
9. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
10. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.
11. SPILLWAY LOCATION DOWNSTREAM OF ROAD CROSSING TO BE FIELD FIT AND CONFIRMED BY QA MANAGER.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

PERIMETER EMBANKMENT FOUNDATION PREPARATION SETOUT TABLE (2 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PEFP-08	595309.54	5820138.69	924.28
PEFP-09	595259.57	5820168.81	925.60
PEFP-10	595194.08	5820192.75	929.31
PEFP-11	595130.25	5820216.53	930.23
PEFP-12	595085.48	5820218.73	932.17
PEFP-13	594982.43	5820204.11	933.04
PEFP-14	594885.62	5820178.46	943.09
PEFP-15	594753.71	5820151.22	950.43
PEFP-16	594741.82	5820076.35	951.14
PEFP-17	594683.39	5820081.30	954.73
PEFP-18	594550.84	5820092.05	960.46

PERIMETER EMBANKMENT FOUNDATION PREPARATION SETOUT TABLE (2 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PEFP-19	594519.18	5820092.18	963.81
PEFP-20	594390.08	5820073.51	969.44
PEFP-21	594328.12	5820046.28	970.55
PEFP-22	594272.74	5820008.64	977.91
PEFP-23	594299.72	5819942.96	976.51

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

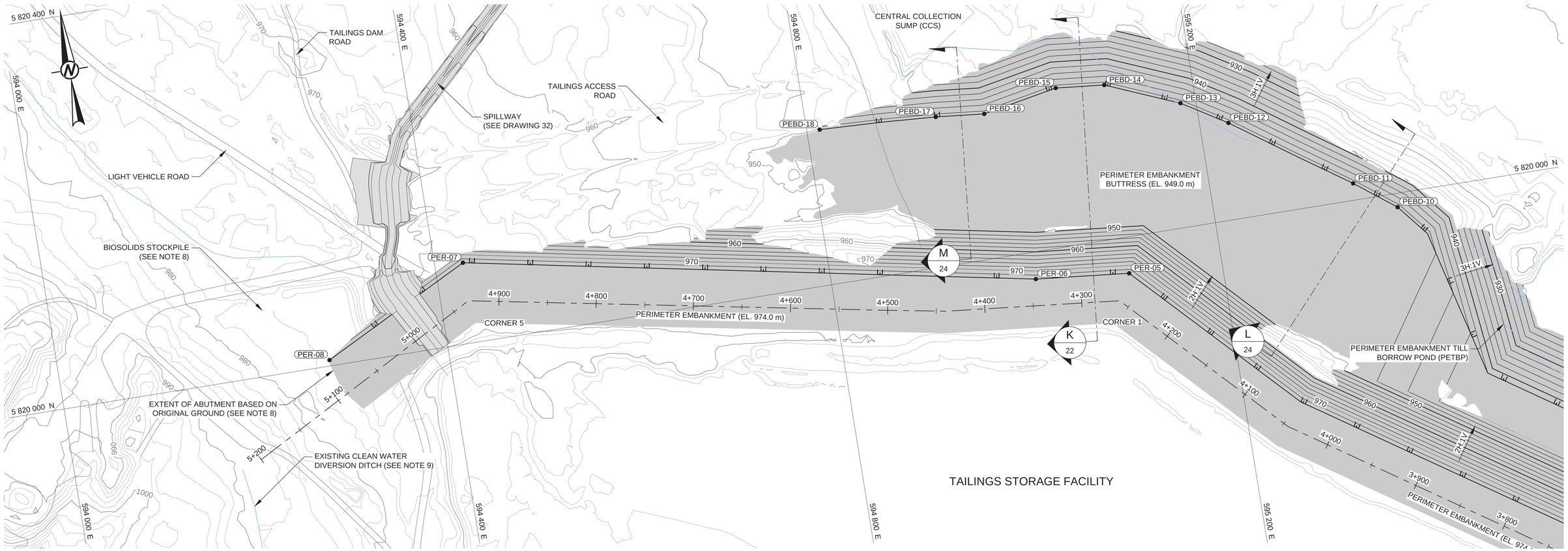
TITLE

PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1-CORNER 5) - FOUNDATION PREPARATION

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	20 of 35	20

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-020.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:15:55 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:15:55 PM

0 25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



PERIMETER EMBANKMENT (CORNER 1-CORNER 5) - PLAN VIEW

SCALE 1:2 000 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- TSF EL. 974 m SPILLWAY DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- PER-08 — PERIMETER EMBANKMENT RAISE SETOUT POINT
- PEBD-18 — PERIMETER EMBANKMENT BUTTRESS DESIGN SETOUT POINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. EXTENT OF ROCKFILL PLACEMENT TO BE CONFIRMED BY QA MANAGER.
6. NO ROCKFILL PLACEMENT IS TO BE CARRIED OUT IN AREAS THAT OVERLAP WITH THE MAIN EMBANKMENT SEEPAGE COLLECTION POND, AND SEEPAGE COLLECTION DITCHES UNTIL THEY ARE RELOCATED.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
8. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
9. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
10. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

PERIMETER EMBANKMENT BUTTRESS DESIGN SETOUT TABLE (2 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PEBD-10	595387.51	5819985.83	949.00
PEBD-11	595346.24	5820017.27	949.00
PEBD-12	595229.56	5820099.26	949.00
PEBD-13	595184.09	5820127.15	949.00
PEBD-14	595109.61	5820158.16	949.00
PEBD-15	595059.85	5820163.07	949.00
PEBD-16	594983.06	5820148.53	949.00
PEBD-17	594933.30	5820153.44	949.00
PEBD-18	594813.26	5820159.62	949.00

PERIMETER EMBANKMENT EL. 974 m RAISE SETOUT TABLE (2 OF 2)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
PER-05	595104.00	5819962.77	974.00
PER-06	595008.29	5819972.21	974.00
PER-07	594429.05	5820083.02	974.00
PER-08	594277.57	5820006.11	974.00

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

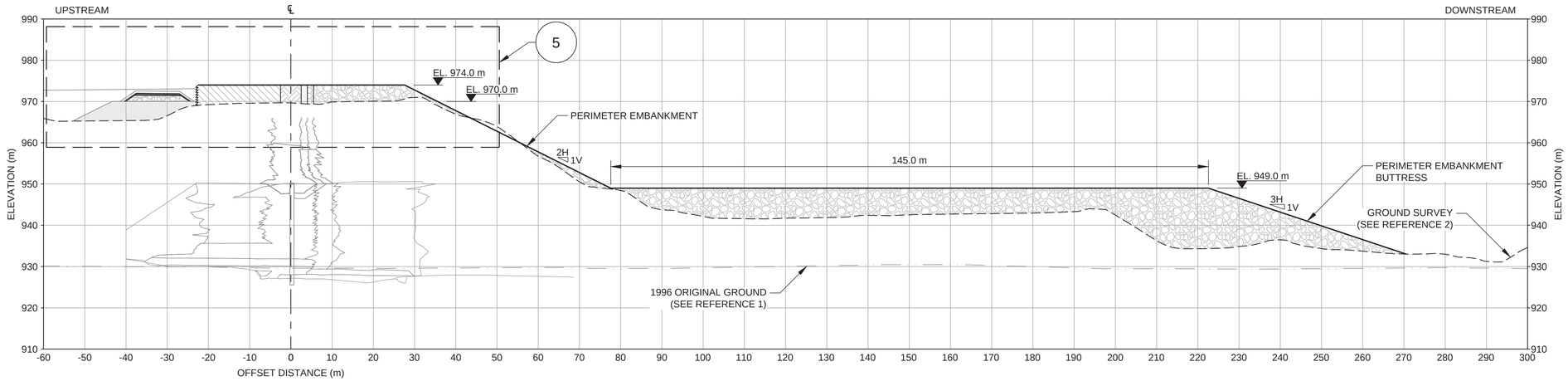
PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1-CORNER 5) - PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	21 of 35	21

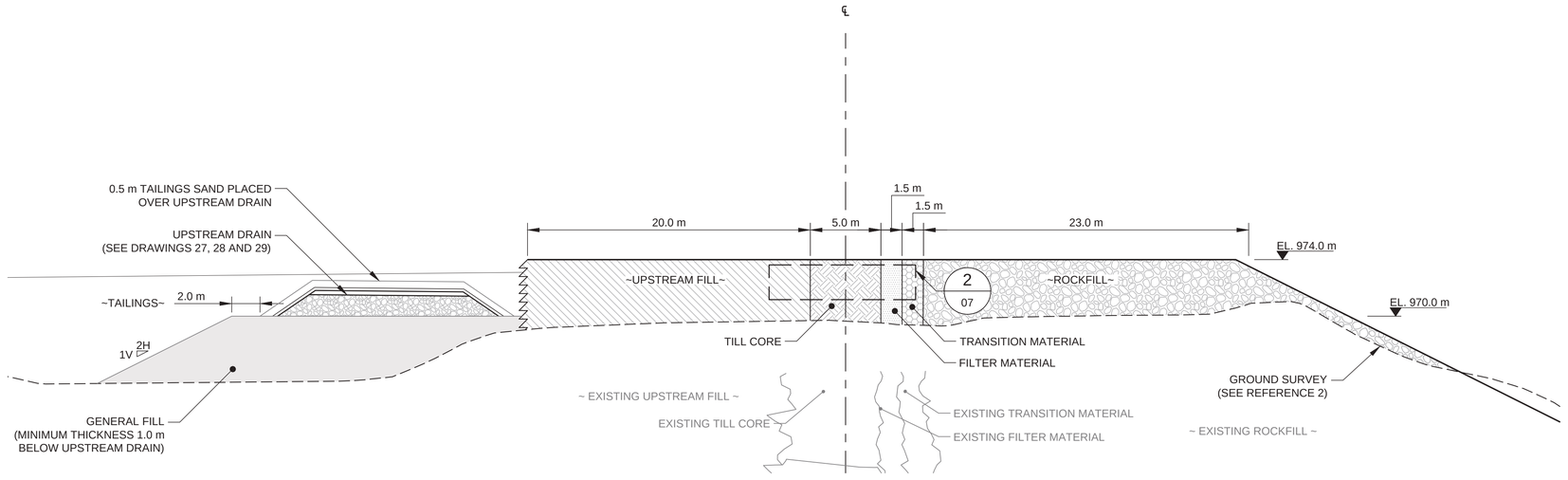
Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-021.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:14:38 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:14:47 PM

0 25 mm — IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014-022.dwg | Last Edited By: tyklassen Date: 2024-04-11 Time:8:58:58 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:12:21 PM



SCALE 1:600 m — K 20/21 — PERIMETER EMBANKMENT - TYPICAL CROSS-SECTION (STA. 4+000 TO 5+200)



SCALE 1:200 m — 5 — PERIMETER EMBANKMENT - TYPICAL DETAIL

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE PERIMETER EMBANKMENT (CORNER 1 TO CORNER 5) UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE CAN VARY BETWEEN ELEVATION 970 - 972 m, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
5. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
6. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20
1:200 METRES

0 20 40
1:600 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

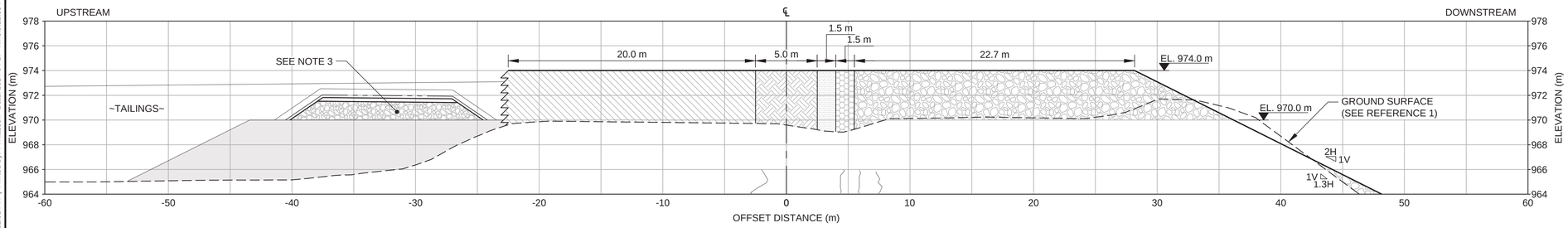
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1-CORNER 5) - TYPICAL CROSS-SECTION AND DETAIL

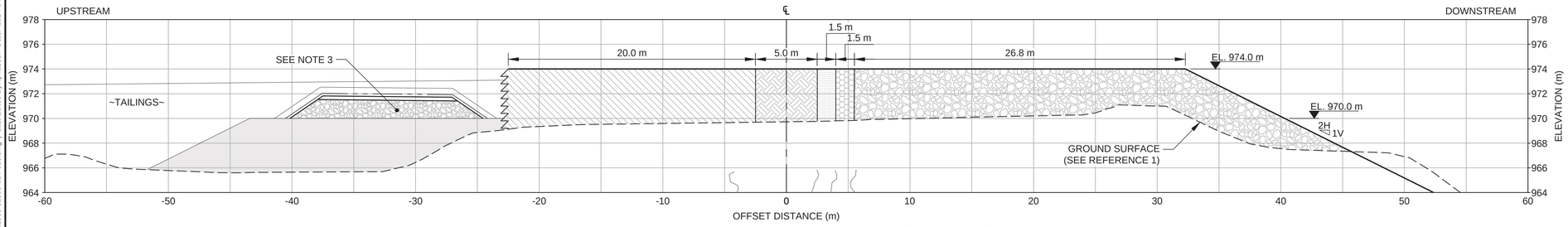
PROJECT NO.	PHASE/TASK/DOC.	REV.	22 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		22

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 25 mm



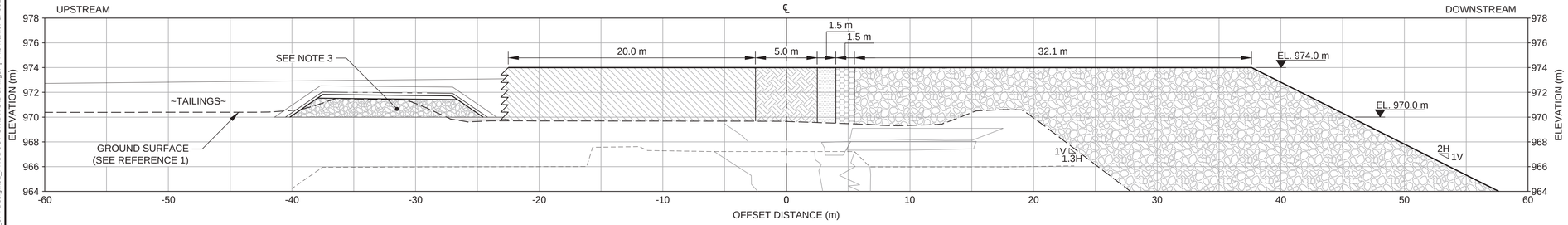
PERIMETER EMBANKMENT CROSS-SECTION (STA. 4+100)

SCALE 1:200 m



PERIMETER EMBANKMENT CROSS-SECTION (STA. 4+400)

SCALE 1:200 m



PERIMETER EMBANKMENT CROSS-SECTION (STA. 4+700)

SCALE 1:200 m

LEGEND

- EXISTING GROUND (SEE REFERENCE 1)
- PREVIOUSLY CONSTRUCTED MATERIAL BOUNDARY
- 2013 CONSTRUCTION (SEE NOTE 5)
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- UPSTREAM FILL
- DRAIN ROCK
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE NOT SHOWN, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
4. THE ELEVATION OF THE PERIMETER EMBANKMENT (CORNER 1 TO CORNER 5) UPSTREAM DRAIN PIPE CROSSING THROUGH THE TILL CORE CAN VARY BETWEEN ELEVATION 970 - 972 m, SEE DRAWINGS 27, 28 AND 29 FOR DETAILS.
5. SECTION INFORMATION WAS DIGITALIZED USING THE AMEC 2013 RECORD SURVEY AND ANNUAL REVIEW REPORT, FILE NAME: “2014 03 12 - 2013 AS-BUILT & ANNUAL REVIEW REPORT (AMEC).pdf”, DATED: 12 MARCH 2014,
6. DIGITALIZED SECTION WAS UPDATED WITH THE 2014 AS-BUILT SURVEY PROVIDED BY MPMC ON 14 SEPTEMBER 2015 AND MAY 2015 SURVEY.
7. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCE

1. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 10 20

1:200 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

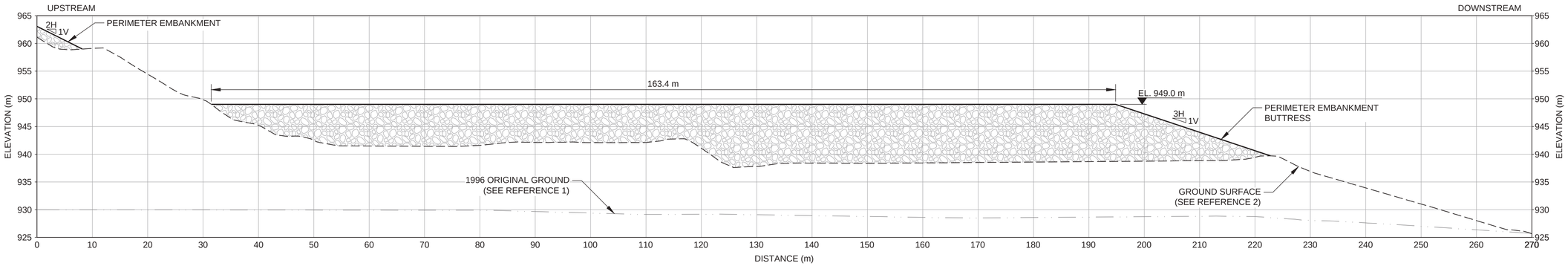
TITLE

PERIMETER EMBANKMENT (CORNER 1-CORNER 5) CROSS-SECTIONS

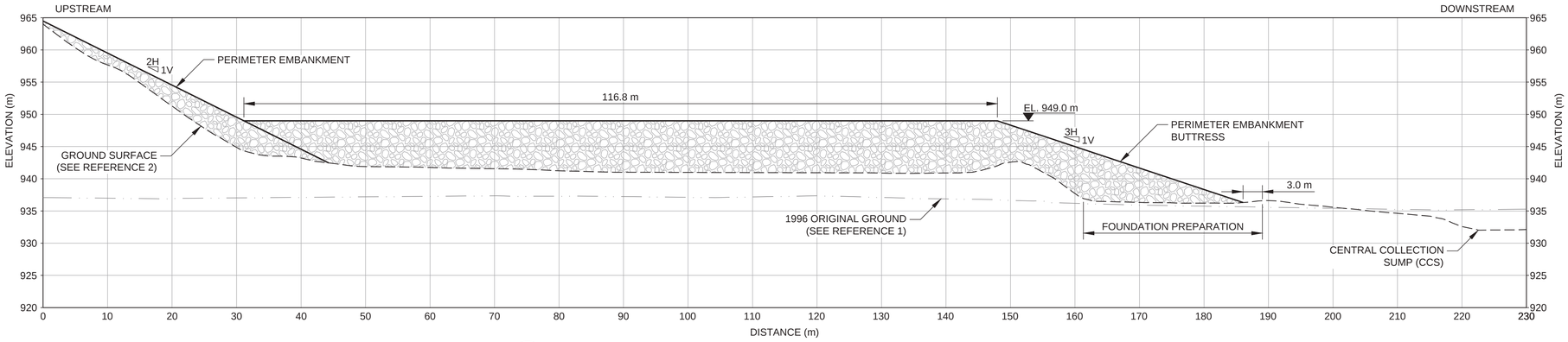
PROJECT NO.	PHASE/TASK/DOC.	REV.	23 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		23

0 25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\gldfor.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4595\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-023.dwg | Last Edited By: tyklassen Date: 2024-04-11 Time:9:02:01 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:11:55 PM



SCALE 1:400 m — L 20/21 — PERIMETER EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 4+100)



SCALE 1:400 m — M 20/21 — PERIMETER EMBANKMENT BUTTRESS - CROSS-SECTION (STA. 4+410)

LEGEND

- 1996 ORIGINAL GROUND (SEE REFERENCE 1)
- GROUND SURFACE (SEE REFERENCE 2)
- ROCKFILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.

REFERENCES

1. 1996 ORIGINAL GROUND PROVIDED BY MPMC, FILE NAME: "1996 TSF Topo.dxf", RECEIVED: 11 MARCH 2015.
2. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 20 40

1:400 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK.
WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

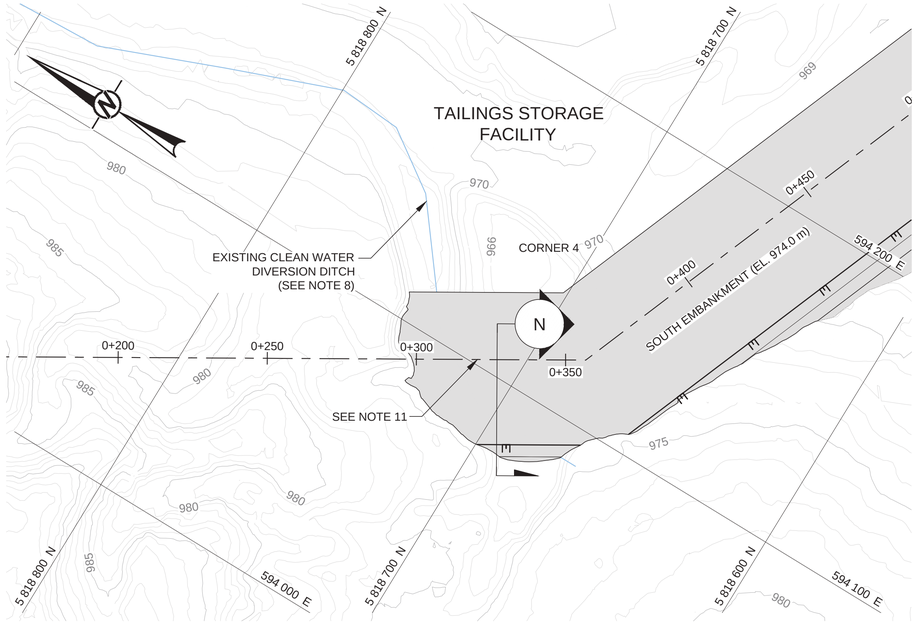
PERIMETER EMBANKMENT BUTTRESS (CORNER 1-CORNER 5) CROSS-SECTIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.	DRAWING
CA0020527.4505	51300/51395/014	0	24 of 35 — 24

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

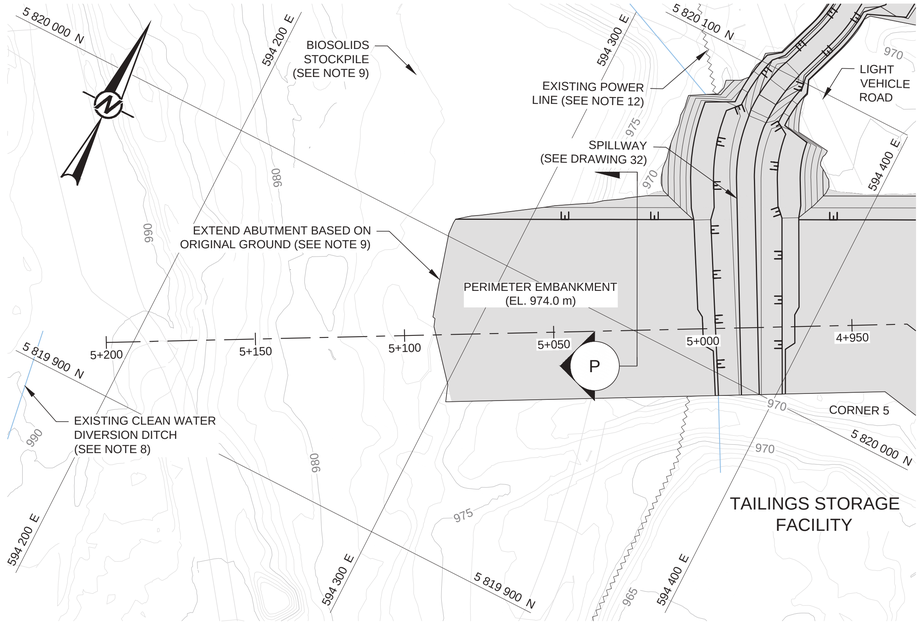
0 25 mm

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial _metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-024.dwg | Last Edited By: tyklassen Date: 2024-03-18 Time:1:13:10 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:10:52 PM



SOUTH EMBANKMENT ABUTMENT DETAIL

SCALE 1:1 000 m



PERIMETER EMBANKMENT ABUTMENT DETAIL

SCALE 1:1 000 m

LEGEND

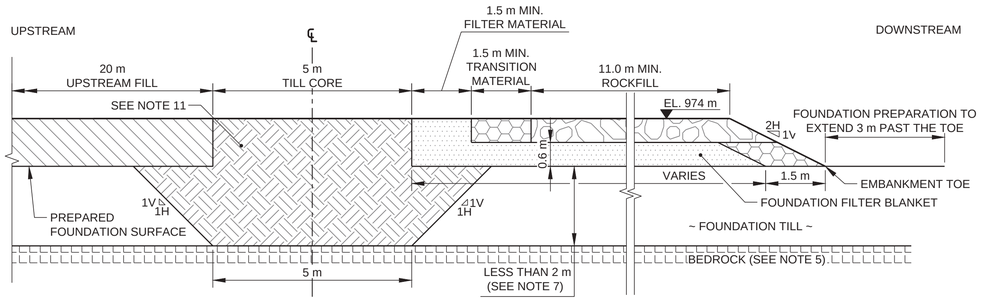
- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE, BUTTRESS AND SPILLWAY DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- EXISTING POWERLINE (SEE NOTE 12)
- UPSTREAM FILL
- ROCKFILL
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- BEDROCK

NOTES

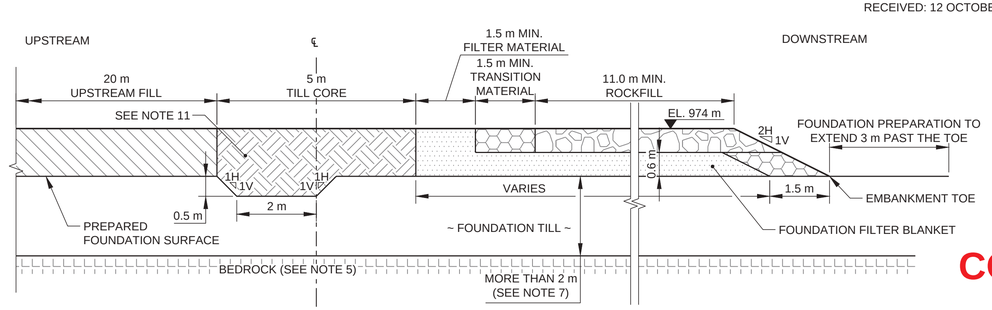
1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. MAJOR CONTOUR INTERVAL 5 m, MINOR CONTOUR INTERVAL 1 m.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2023 (SEE REFERENCES 1-2).
5. DEPTH TO BEDROCK TO BE CONFIRMED BY THE QA MANAGER.
6. EXTENT OF EXCAVATION AND FOUNDATION PREPARATION TO BE CONFIRMED BY THE QA MANAGER.
7. EXTEND TILL CORE TO BEDROCK IF FOUNDATION TILL THICKNESS IS LESS THAN 2.0 m.
8. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
9. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
10. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
11. TILL BLANKET TO BE PLACED OVER FOUNDATION TILL BETWEEN APPROXIMATELY STATION 0+300 TO CORNER 4 TO RE-GRADE AREA TO DRAIN AWAY FROM EMBANKMENT.
12. EXISTING POWER LINE TO BE RELOCATED PRIOR TO FOUNDATION PREPARATION (SEE REFERENCE 4).

REFERENCES

1. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.
4. POWER LINES PROVIDED BY MPMC, FILE NAME: "211012 SERD Site Plan.dxf", RECEIVED: 12 OCTOBER 2021.



SCALE 1:75 m — N — TYPICAL TILL CORE TIE-IN TO FOUNDATION BEDROCK CROSS-SECTION



SCALE 1:75 m — P — TYPICAL TILL CORE TIE-IN TO FOUNDATION TILL CROSS-SECTION

ISSUED FOR

CONSTRUCTION

0 2.5 5
1:75 METRES

0 50 100
1:1,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

Engineers & Geoscientists BC Permit #1000200

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

SOUTH AND PERIMETER EMBANKMENT ABUTMENTS PLAN VIEW AND TYPICAL CROSS-SECTIONS

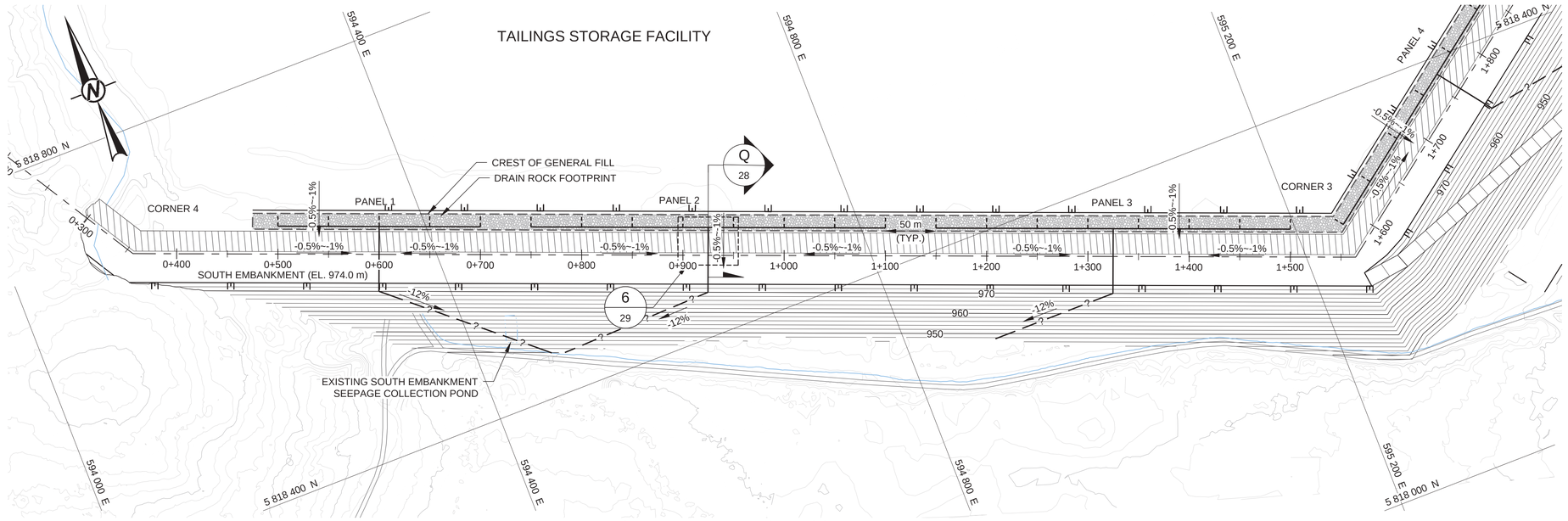
PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	25 of 35	25

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

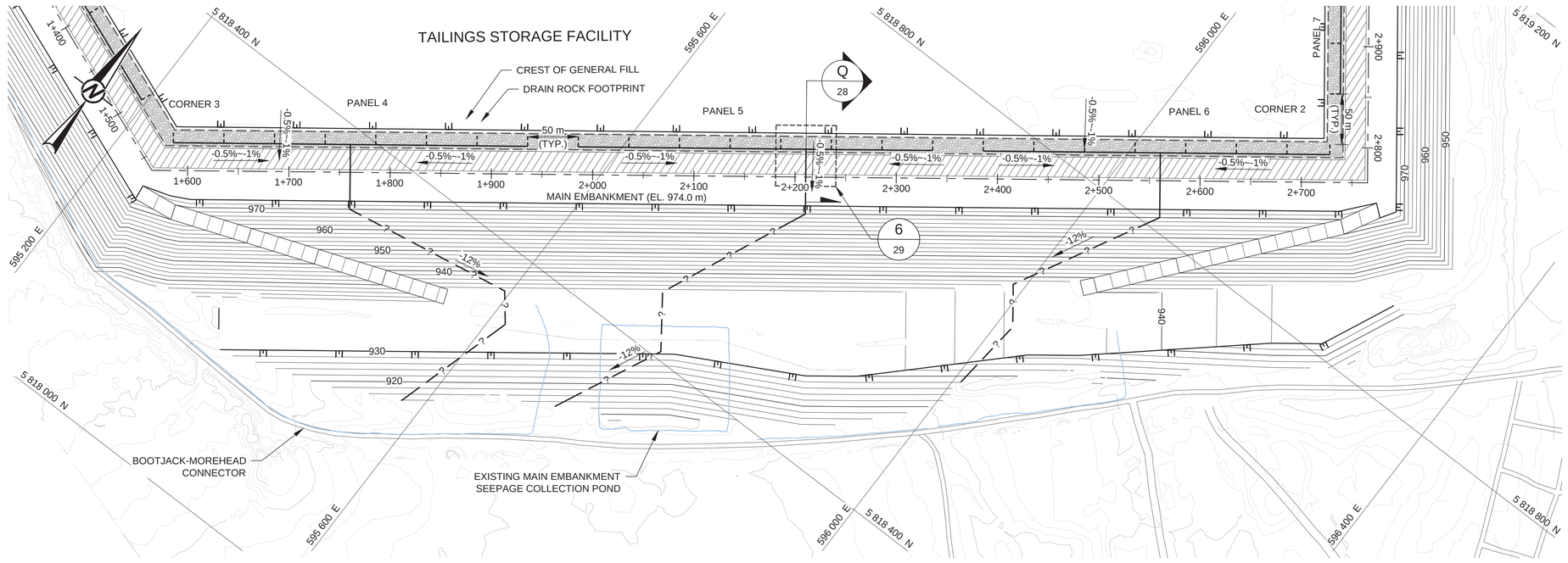
Path: \\golder.gds\comp\edata\vff\cn\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-025.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:14:11 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:10:19 PM

Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-026.dwg | Last Edited By: tyklassen Date: 2024-04-16 Time:3:57:21 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:39:29 PM



UPSTREAM DRAIN LAYOUT - SOUTH EMBANKMENT

SCALE 1:2 500 m



UPSTREAM DRAIN LAYOUT - MAIN EMBANKMENT

SCALE 1:2 500 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- 300 mm Ø SOLID HDPE DRAIN PIPE
- 300 mm Ø SOLID INFERRED DISCHARGE PIPE (SEE NOTE 5)
- 150 mm Ø PERFORATED HDPE DRAIN PIPE
- UPSTREAM FILL
- DRAIN ROCK FOOTPRINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. REPORT TO DOWNSTREAM WATER MANAGEMENT INFRASTRUCTURE CONSIDERATION WILL NEED TO BE MADE TO EXTENDING DISCHARGE PIPE AS THE TSF IS RAISED.
6. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
7. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,500 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

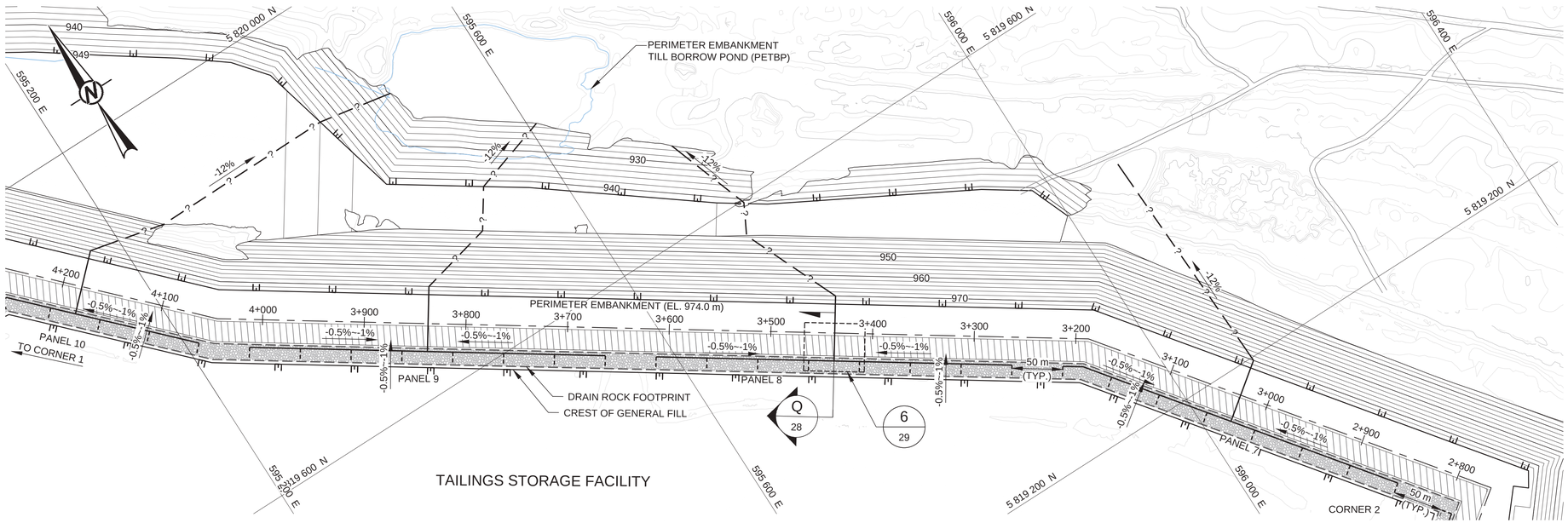
TITLE

UPSTREAM DRAIN - SOUTH AND MAIN EMBANKMENT PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.	DRAWING
CA0020527.4505	51300/51395/014	0	26 of 35 — 26

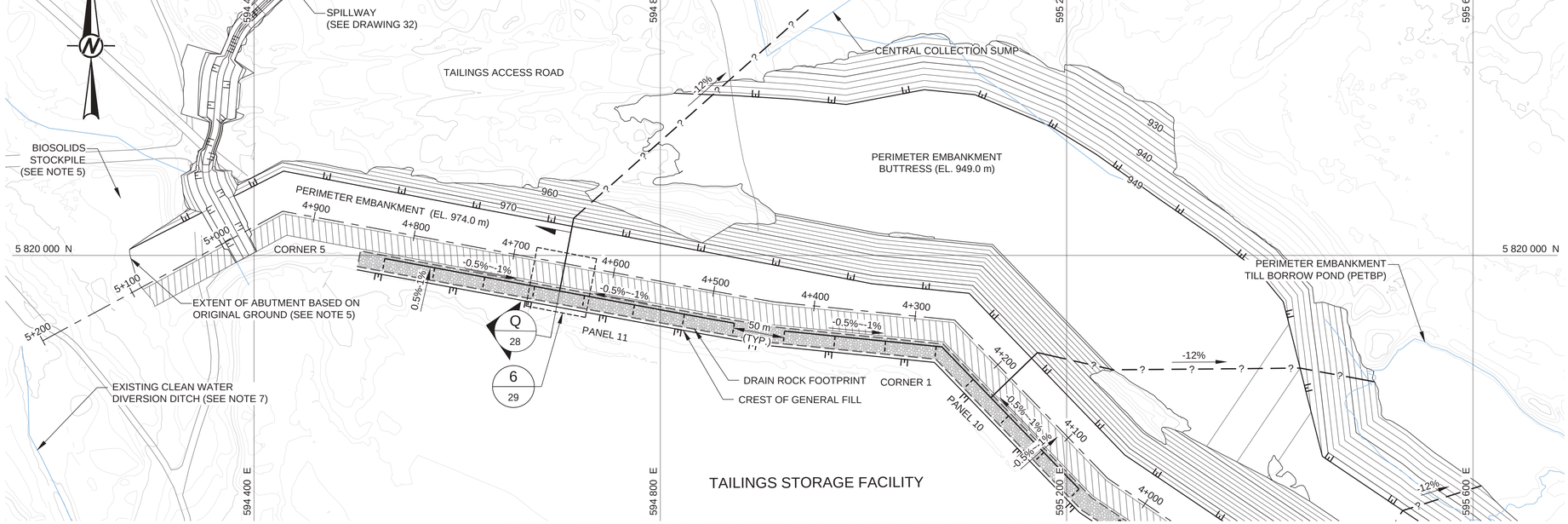
0 25 mm — IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-027.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:12:38 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:37:51 PM



UPSTREAM DRAIN LAYOUT - PERIMETER EMBANKMENT (CORNER 2 - CORNER 1)

SCALE 1:2 500 m



UPSTREAM DRAIN LAYOUT - PERIMETER EMBANKMENT (CORNER 1- CORNER 5)

SCALE 1:2 500 m

LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE, BUTTRESS AND SPILLWAY DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 3)
- WATERCOURSE (SEE REFERENCE 3)
- 300 mm Ø SOLID HDPE DRAIN PIPE
- 300 mm Ø SOLID INFERRED DISCHARGE PIPE (SEE NOTE 6)
- 150 mm Ø PERFORATED HDPE DRAIN PIPE
- UPSTREAM FILL
- DRAIN ROCK FOOTPRINT

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2019-2023 (SEE REFERENCES 1-2).
5. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
6. REPORT TO DOWNSTREAM WATER MANAGEMENT INFRASTRUCTURE CONSIDERATION WILL NEED TO BE MADE TO EXTENDING DISCHARGE PIPE AS THE TSF IS RAISED.
7. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
8. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
9. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
2. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
3. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

ISSUED FOR

CONSTRUCTION

0 100 200

1:2,500 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

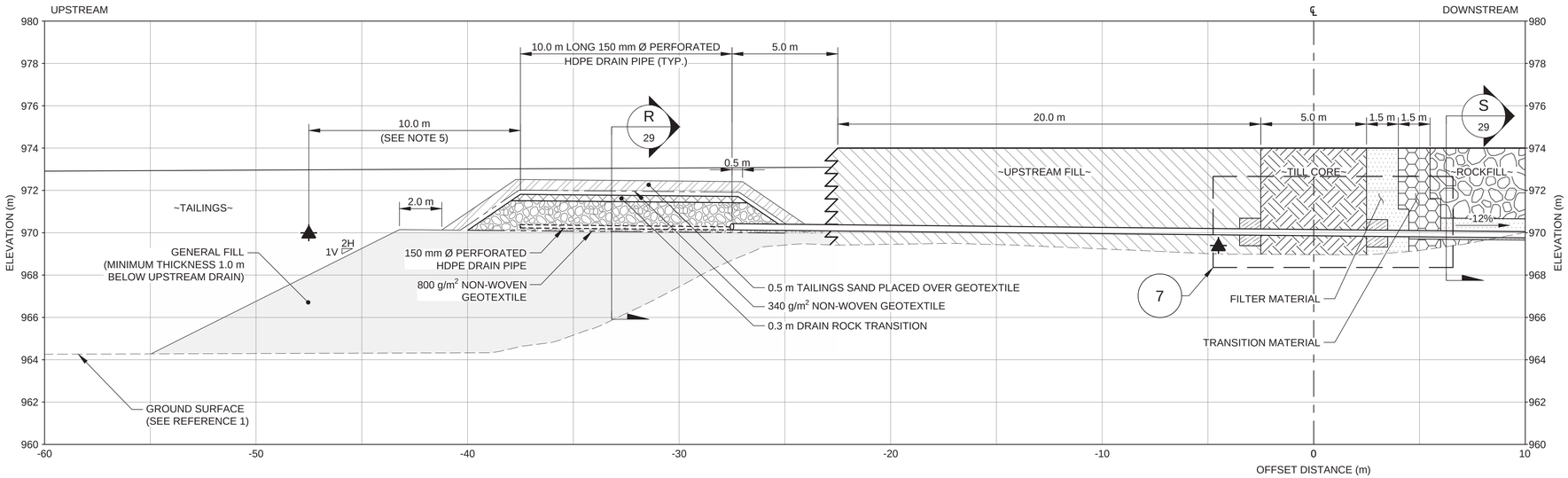
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

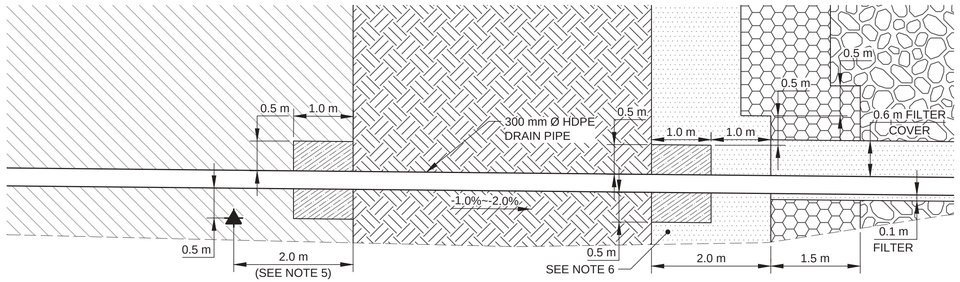
UPSTREAM DRAIN - PERIMETER EMBANKMENT PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.	27 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		27

0 25 mm
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE 1:125 m — Q (26 / 27) — UPSTREAM DRAIN TYPICAL CROSS-SECTION



SCALE 1:50 m — 7 — PIPE THROUGH EMBANKMENT TYPICAL DETAIL

LEGEND

- GROUND SURFACE (SEE REFERENCE 1)
- 340 g/m^2 NON-WOVEN GEOTEXTILE
- 800 g/m^2 NON-WOVEN GEOTEXTILE
- 300 mm Ø SOLID HDPE DRAIN PIPE
- 150 mm Ø PERFORATED HDPE DRAIN PIPE
- UPSTREAM FILL
- ROCKFILL
- DRAIN ROCK
- DRAIN ROCK TRANSITION
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- TAILINGS SAND
- FILTER SAND
- GENERAL FILL
- 2024 VIBRATING WIRE PIEZOMETER INSTALLED IN UPSTREAM FILL AND TAILINGS BEACH (SEE NOTE 5)

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. REFER TO TILL CORE CROSSING CONTROL POINTS IN DRAWING 26 AND 27.
4. A MAXIMUM TILL CORE CROSSING ELEVATION AT 972 m IS ALLOWED FOR PANEL 1 TO 3 AND 10 TO 11.
5. SEE DRAWING 30 FOR VIBRATING WIRE PIEZOMETER PLACEMENT.
6. RECORD DRAWINGS FOR TSF CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS. ZONE F AND ZONE T CONNECTION TO EXISTING FILTER AND TRANSITION TO BE CONFIRMED BY QA MANAGER DURING CONSTRUCTION. A MINIMUM 2.0 m WIDE ZONE F IS REQUIRED TO AT LEAST 0.5 m BELOW THE ELEVATION OF THE BOTTOM OF THE FILTER SAND. A MINIMUM 2.0 m WIDE ZONE T IS REQUIRED TO AT LEAST 0.5 m BELOW THE ELEVATION OF THE BOTTOM OF THE 2.0 m WIDE ZONE F.

REFERENCE

1. 2023 TSF TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.

ISSUED FOR

CONSTRUCTION

0 2 4
1:50 METRES

0 5 10
1:125 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT. ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

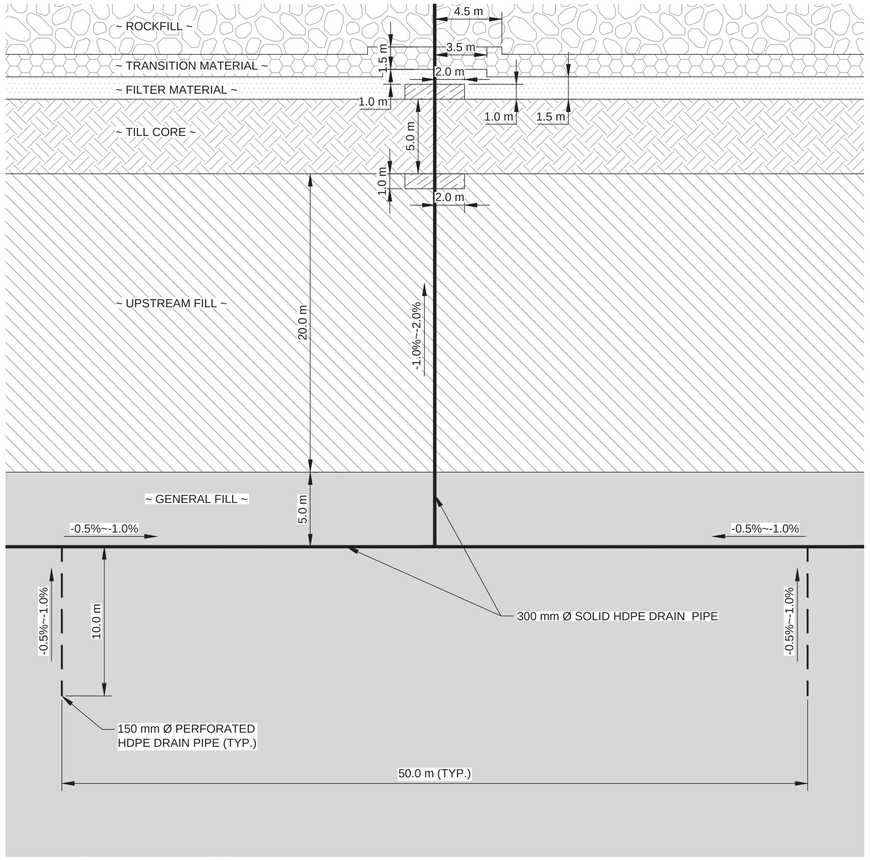
TITLE

UPSTREAM DRAIN
TYPICAL CROSS-SECTIONS AND DETAILS (SHEET 1 OF 2)

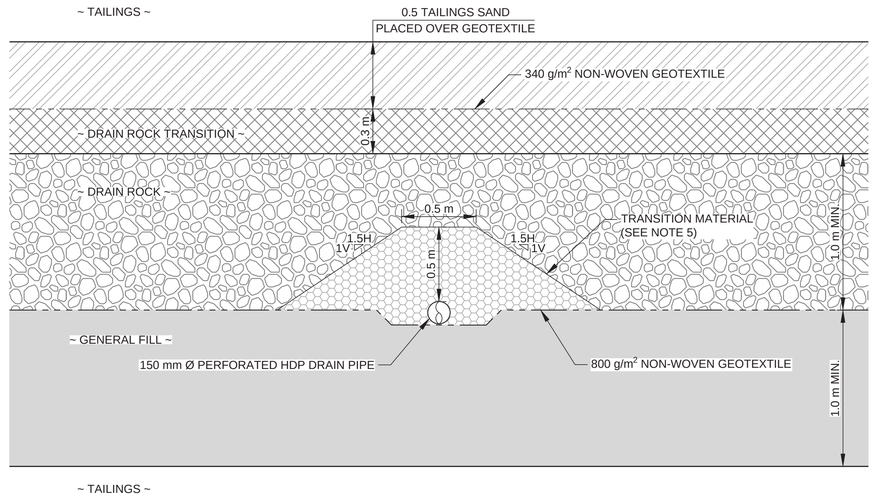
PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	28 of 35	28

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 25 mm

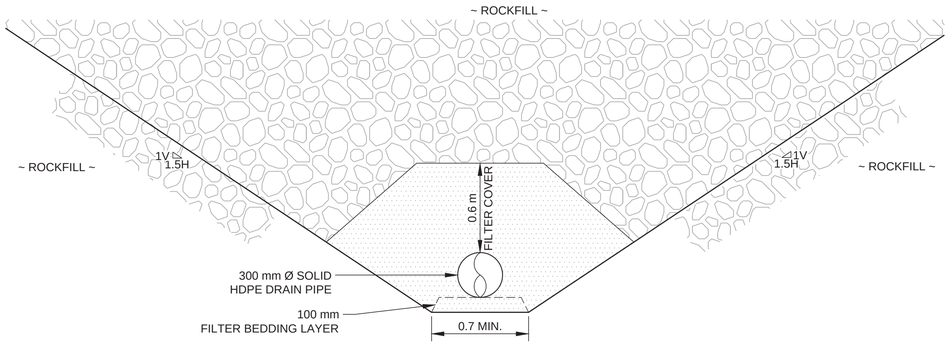
Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\98_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-028_029.dwg | Last Edited By: tyklassen Date: 2024-04-14 Time:9:54:46 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:55:00 PM



SCALE 1:200 m — 6/26 27 — PIPE THROUGH EMBANKMENT MATERIALS TYPICAL DETAIL



SCALE 1:20 m — R/28 — PIPE THROUGH UPSTREAM DRAIN TYPICAL CROSS-SECTION



SCALE 1:20 m — S/28 — PIPE THROUGH ROCKFILL TYPICAL CROSS-SECTION

LEGEND

- 300 mm Ø SOLID HDPE DRAIN PIPE
- 150 mm Ø PERFORATED HDPE DRAIN PIPE
- 340 g/m^2 NON-WOVEN GEOTEXTILE
- 800 g/m^2 NON-WOVEN GEOTEXTILE
- UPSTREAM FILL
- ROCKFILL
- DRAIN ROCK
- DRAIN ROCK TRANSITION
- TRANSITION MATERIAL
- FILTER MATERIAL
- TILL CORE
- TAILINGS SAND
- FILTER SAND
- GENERAL FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. REFER TO TILL CORE CROSSING CONTROL POINTS IN DRAWING 26 AND 27.
4. A MAXIMUM TILL CORE CROSSING ELEVATION AT 972 m IS ALLOWED FOR PANEL 1 TO 3 AND 10 TO 11.
5. TRANSITION MATERIAL TO BE PLACED ALONG THE PERFORATED DRAIN PIPES AND FILTER MATERIAL IS TO BE PLACED AROUND THE SOLID DRAIN PIPES WITHIN THE UPSTREAM DRAIN.

ISSUED FOR

CONSTRUCTION

0 1 2
1:20 METRES

0 10 20
1:200 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK.
WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

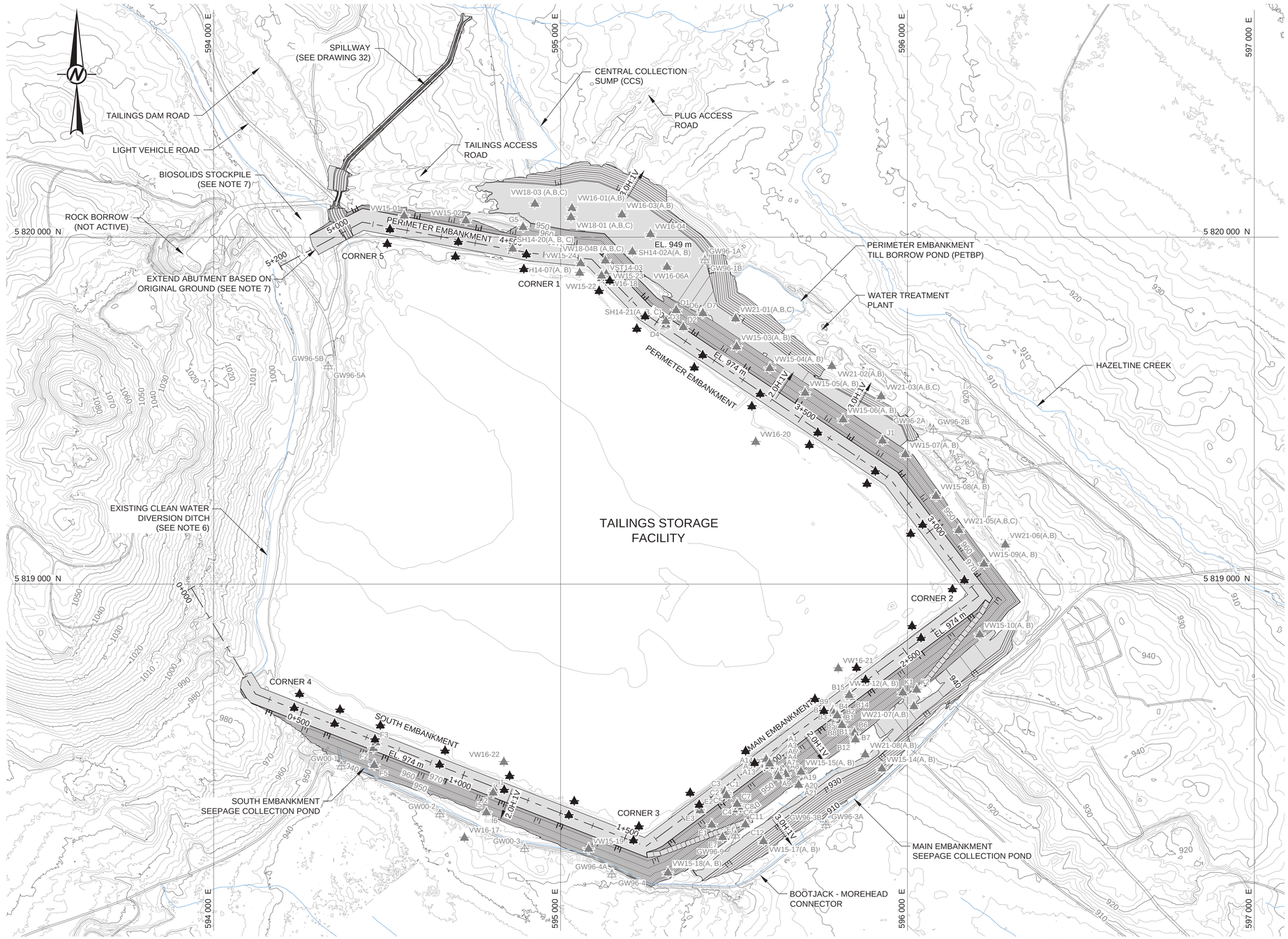
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

UPSTREAM DRAIN
TYPICAL CROSS-SECTIONS AND DETAILS (SHEET 2 OF 2)

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	29 of 35	29

Path: \\golder.gds\completedata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_-4505-51300-51395-014-028_029.dwg | Last Edited By: tykiassen Date: 2024-04-14 Time:9:54:46 PM | Printed By: TYKiassen Date: 2024-04-17 Time:9:34:25 PM
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 25 mm



LEGEND

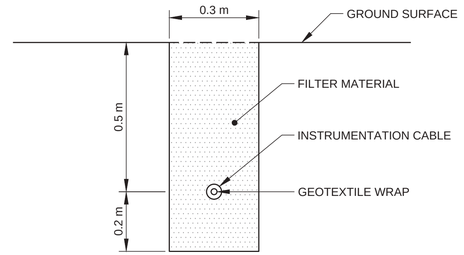
- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE, BUTTRESS AND SPILLWAY DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 5)
- WATERCOURSE (SEE REFERENCE 5)
- 2024 VIBRATING WIRE PIEZOMETER INSTALLED IN UPSTREAM FILL AND TAILINGS BEACH (SEE NOTE 9)
- EXISTING VIBRATING WIRE PIEZOMETER
- EXISTING MONITORING WELL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2014-2023 (SEE REFERENCES 1-4).
5. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
6. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
7. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
8. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.
9. 2024 VIBRATING WIRE PIEZOMETERS TO BE INSTALLED IN PAIRS AS SHOWN IN CROSS-SECTIONS ON DRAWING 28. TWO PAIRS OF VIBRATING WIRE PIEZOMETERS TO BE INSTALLED AT EACH UPSTREAM DRAIN PANEL. LOCATIONS TO BE CONFIRMED BY QA MANAGER.

REFERENCES

1. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: 03 SEPTEMBER 2014.
2. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
4. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
5. SITE FEATURES PROVIDED BY MPMC, FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.



NOT TO SCALE 8 INSTRUMENTATION CABLE EXTENSION TYPICAL DETAIL

ISSUED FOR

CONSTRUCTION

0 200 400

1:6,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

Engineers & Geoscientists BC Permit #1000200

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

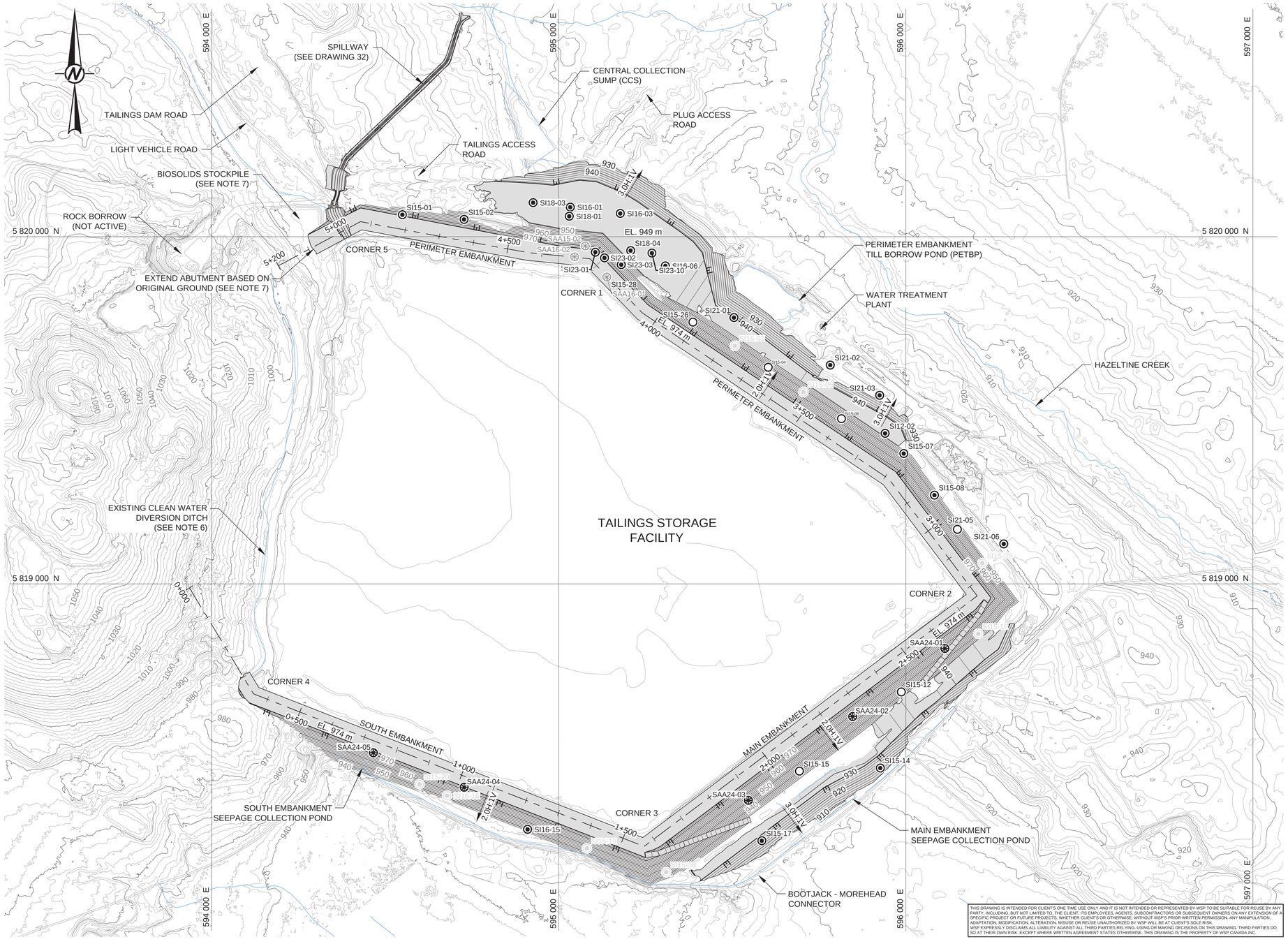
INSTRUMENTATION - PIEZOMETERS
PLAN VIEW

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	30 of 35	30

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Dec 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-030.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time:9:06:58 AM | Printed By: TYKlassen Date: 2024-04-17 Time:9:33:34 PM



LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE, BUTTRESS AND SPILLWAY DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 5)
- WATERCOURSE (SEE REFERENCE 5)
- PROPOSED SHAPE ACCEL ARRAY (SAA)
- EXISTING SHAPE ACCEL ARRAY (SAA)
- SLOPE INCLINOMETER (SI) TO BE RETROFITTED WITH SHAPE ACCEL ARRAY (SAA)
- SLOPE INCLINOMETER (SI) TO BE EXTENDED/MAINTAINED
- SLOPE INCLINOMETER (SI) TO BE DECOMMISSIONED

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2014-2023 (SEE REFERENCES 1-4).
5. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
6. EXISTING CLEAN WATER DIVERSION DITCH TO BE DECOMMISSIONED PRIOR TO CONSTRUCTION.
7. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
8. WATER MANAGEMENT INFRASTRUCTURE SHOWN FOR REFERENCE ONLY.

REFERENCES

1. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: 03 SEPTEMBER 2014.
2. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
4. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .dxf FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
5. SITE FEATURES PROVIDED BY MPMC, FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 05 SEPTEMBER 2014.

2024 PROPOSED SHAPE ACCEL ARRAY (SAA)

POINT ID	EASTING (m)	NORTHING (m)	ELEVATION (m)
SAA24-01	596112.3	5818813.9	955.8
SAA24-02	595846.7	5818617.8	957.2
SAA24-03	595546.1	5818376.6	951.1
SAA24-04	594727.4	5818414.0	970.0
SAA24-05	594465.7	5818513.6	970.0

ISSUED FOR

CONSTRUCTION

0 200 400
1:6,000 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	Y.J.	T.A.K.	S.B.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

INSTRUMENTATION - SLOPE INCLINOMETERS AND SAAS PLAN VIEW

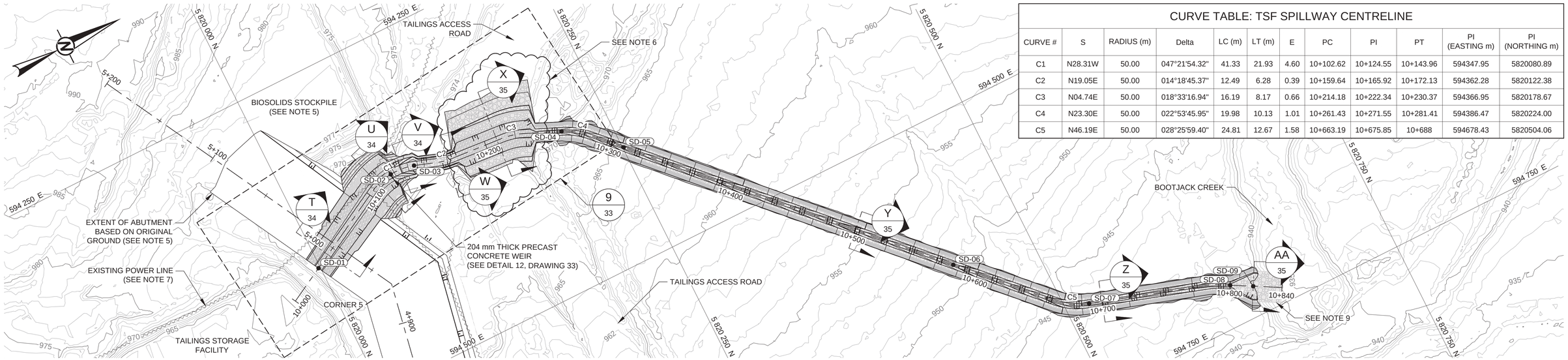
PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	31 of 35	31

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\toffice\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-031.dwg | Last Edited By: tyklassen Date: 2024-04-15 Time:12:10:03 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:32:25 PM

Path: \\golder.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\09_PROJECTS\CA0020527_4505\51300-51395-014-032.dwg | File Name: CA0020527_4505-51300-51395-014-032.dwg | Last Edited By: lyklassen Date: 2024-04-17 Time/9:28:50 PM | Printed By: TYKlassen Date: 2024-04-18
Time/ 12:49:59 PM

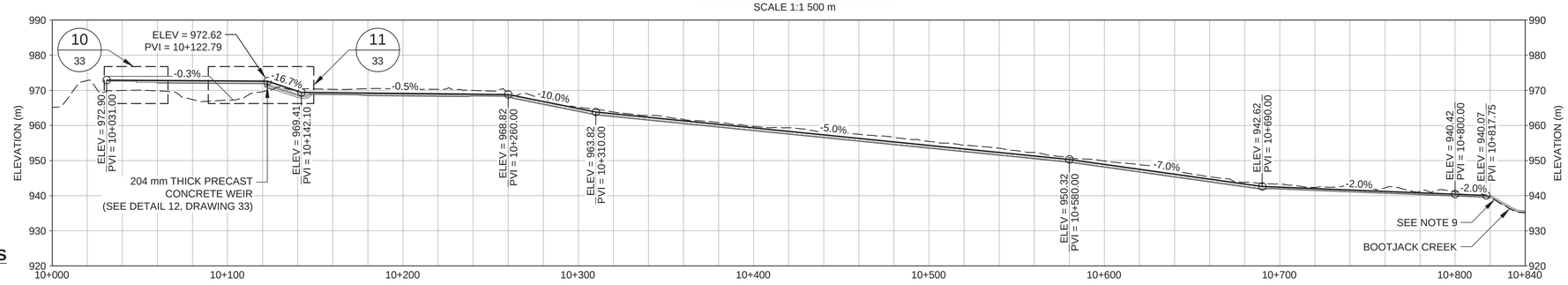


CURVE TABLE: TSF SPILLWAY CENTRELINE

CURVE #	S	RADIUS (m)	Delta	LC (m)	LT (m)	E	PC	PI	PT	PI (EASTING m)	PI (NORTHING m)
C1	N28.31W	50.00	047°21'54.32"	41.33	21.93	4.60	10+102.62	10+124.55	10+143.96	594347.95	5820080.89
C2	N19.05E	50.00	014°18'45.37"	12.49	6.28	0.39	10+159.64	10+165.92	10+172.13	594362.28	5820122.38
C3	N04.74E	50.00	018°33'16.94"	16.19	8.17	0.66	10+214.18	10+222.34	10+230.37	594366.95	5820178.67
C4	N23.30E	50.00	022°53'45.95"	19.98	10.13	1.01	10+261.43	10+271.55	10+281.41	594386.47	5820224.00
C5	N46.19E	50.00	028°25'59.40"	24.81	12.67	1.58	10+663.19	10+675.85	10+688	594678.43	5820504.06

TSF SPILLWAY - PLAN VIEW

SCALE 1:1 500 m

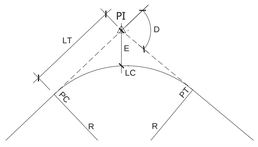


TSF SPILLWAY - PROFILE

HORIZ. SCALE 1:1 500 m
VERT. SCALE 1:750 m

N: *PI AND CONTROL POINT NUMBER*
S: *DIRECTION (BEARING)*
R: *RADIUS*
D: *DEFLECTION ANGLE*
LC: *LENGTH OF CURVE*
LT: *LENGTH OF TANGENT*
E: *EXTERNAL SECANT*
PC: *POINT OF CURVATURE*
PI: *POINT OF INTERSECTION OF TANGENTS*
PT: *POINT OF TANGENCY*

HORIZONTAL CURVE PARAMETERS



LEGEND

- SPILLWAY DESIGN CENTRELINE (10+100)
- GROUND CONTOURS (SEE REFERENCE 1)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- SPILLWAY DESIGN CONTOURS
- EXISTING POWER LINE - SEE NOTE 7 (SEE REFERENCE 2)
- SD-09 SPILLWAY DESIGN SETOUT POINT
- TILL LINER
- FINE BEDDING
- COARSE BEDDING
- ROCKFILL
- RIPRAP
- GRANULAR ROAD GRAVEL
- NATIVE FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. GROUND CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR, SPILLWAY DESIGN CONTOUR INTERVAL SHOWN AT 5 m MAJOR AND 1 m MINOR.
4. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
5. BIOSOLIDS STOCKPILE TO BE REMOVED AS PART OF ABUTMENT FOUNDATION PREPARATION.
6. ROAD CROSSING DESIGN TO BE CONFIRMED PENDING CONFIRMATION OF FOUNDATION CONDITION AND ACTIVE ROADS BY MPMC.
7. POWER LINES TO BE RELOCATED PRIOR TO CONSTRUCTION.
8. INTERIM EMBANKMENT CREST RAISES BETWEEN ELEVATION 970 AND 974, THE ELEVATION OF SPILLWAY DESIGN SETOUT POINTS SD-01 AND SD-02 IS TO BE ADJUSTED BASED ON EMBANKMENT CREST ELEVATION.
9. RIPRAP APRON (400 mm THICK) UNDERLAIN BY FINE BEDDING (200 mm THICK) TO BE FIELD FIT AT NATURAL GRADE ON PREPARED SURFACE (SEE TECHNICAL SPECIFICATIONS FOR REQUIREMENTS).

REFERENCES

1. 2023 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "231030-TSF Lidar Contour 0.1.dxf", SURVEYED: 30 OCTOBER 2023, RECEIVED: 01 FEBRUARY 2024.
2. POWER LINES PROVIDED BY MPMC, FILE NAME: "211012 SERD Site Plan.dxf", RECEIVED: 12 OCTOBER 2021.

TSF SPILLWAY DESIGN SETOUT TABLE

POINT ID	EASTING (m)	NORTHING (m)	FINISHED GROUND ELEVATION (m)	STATION
SD-01	594392.32	5819998.53	972.90	10+031.00
SD-02	594352.58	5820080.76	972.62	10+122.79
SD-03	594354.54	5820099.85	968.21	10+142.10
SD-04	594381.90	5820213.39	968.81	10+260.00
SD-05	594414.41	5820250.80	963.82	10+310.00
SD-06	594609.26	5820437.71	950.32	10+580.00
SD-07	594682.90	5820518.03	942.62	10+690.00
SD-08	594718.98	5820621.72	940.42	10+800.00
SD-09	594727.58	5820637.25	940.07	10+817.75

ISSUED FOR

CONSTRUCTION

0 25 50
1:750 VERTICAL METRES

0 50 100
1:1,500 HORIZONTAL METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE. THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	N.H./D.M.	T.A.K.	D.A.K.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

Engineers & Geoscientists BC Permit #1000200

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

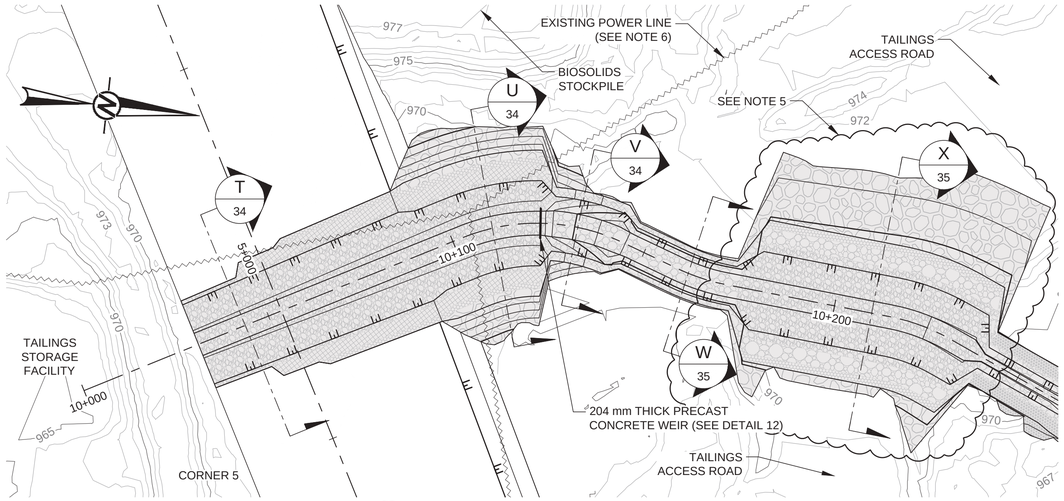
TITLE

TSF SPILLWAY
PLAN AND PROFILE

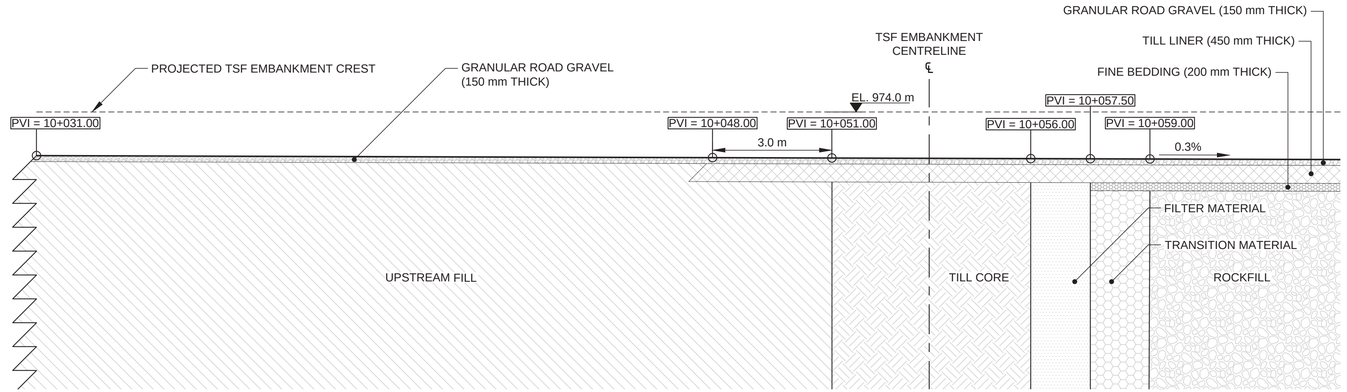
PROJECT NO.	PHASE/TASK/DOC.	REV.	32 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		32

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

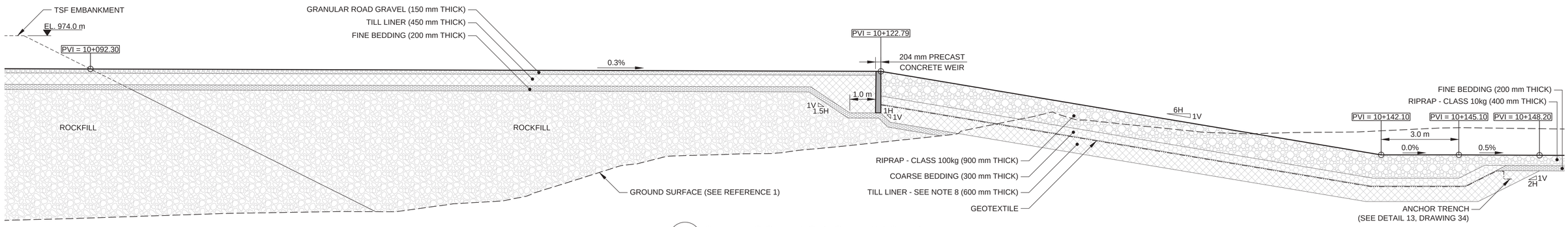
0 — 25 mm



SCALE 1:750 m — 9/32 — SPILLWAY, CHUTE AND ROAD CROSSING - DETAIL



SCALE 1:75 m — 10/32 — SPILLWAY PROFILE - TYPICAL DETAIL



SCALE 1:75 m — 11/32 — CHUTE TO STILLING BASIN - TYPICAL DETAIL

LEGEND

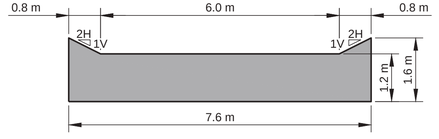
- SPILLWAY DESIGN CENTRELINE (10+100)
- GROUND CONTOURS (SEE REFERENCE 1)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- SPILLWAY DESIGN CONTOURS
- EXISTING POWER LINE - SEE NOTE 6 (SEE REFERENCE 2)
- GEOTEXTILE
- PRECAST CONCRETE WEIR
- UPSTREAM FILL
- FILTER MATERIAL
- TILL CORE
- TILL LINER
- FINE BEDDING
- COARSE BEDDING
- ROCKFILL
- RIPRAP
- GRANULAR ROAD GRAVEL
- NATIVE FILL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. GROUND CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR, SPILLWAY DESIGN CONTOUR INTERVAL SHOWN AT 5 m MAJOR AND 1 m MINOR.
4. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.
5. ROAD CROSSING DESIGN TO BE CONFIRMED PENDING CONFIRMATION OF FOUNDATION CONDITION AND ACTIVE ROADS BY MPMC.
6. POWER LINES TO BE RELOCATED PRIOR TO CONSTRUCTION.
7. PRECAST CONCRETE WEIR TO BE PRECON'S PRECAST PANEL WALL OR EQUIVALENT WEIR TO BE APPROVED BY QA MANAGER.
8. TILL LINER MAY NOT BE REQUIRED IF GROUND SURFACE IS TILL MATERIAL. GROUND SURFACE CONDITIONS TO BE INSPECTED AND APPROVED BY QA MANAGER.

REFERENCES

1. 2023 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "231030-TSF Lidar Contour 0.1.dxf", SURVEYED: 30 OCTOBER 2023, RECEIVED: 01 FEBRUARY 2024.
2. POWER LINES PROVIDED BY MPMC, FILE NAME: "211012 SERD Site Plan.dxf", RECEIVED: 12 OCTOBER 2021.



SCALE 1:75 m — 12/32 — PRECAST CONCRETE WEIR - TYPICAL DETAIL (SEE NOTE 7)

ISSUED FOR
CONSTRUCTION

0 2.5 5
1:75 METRES

0 25 50
1:750 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	N.H./D.M.	T.A.K.	D.A.K.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT: MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

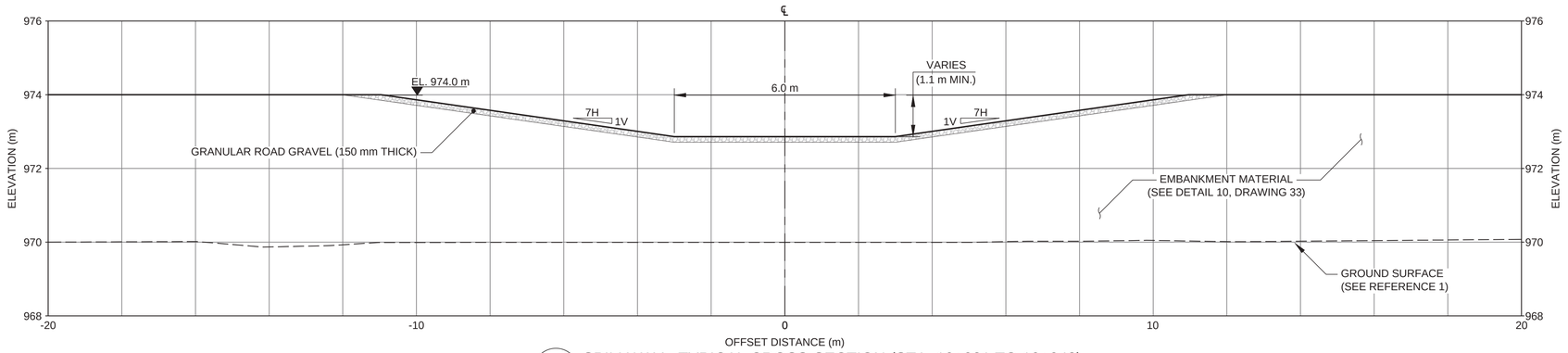
TITLE
TSF SPILLWAY
TYPICAL DETAILS

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	33 of 35	33

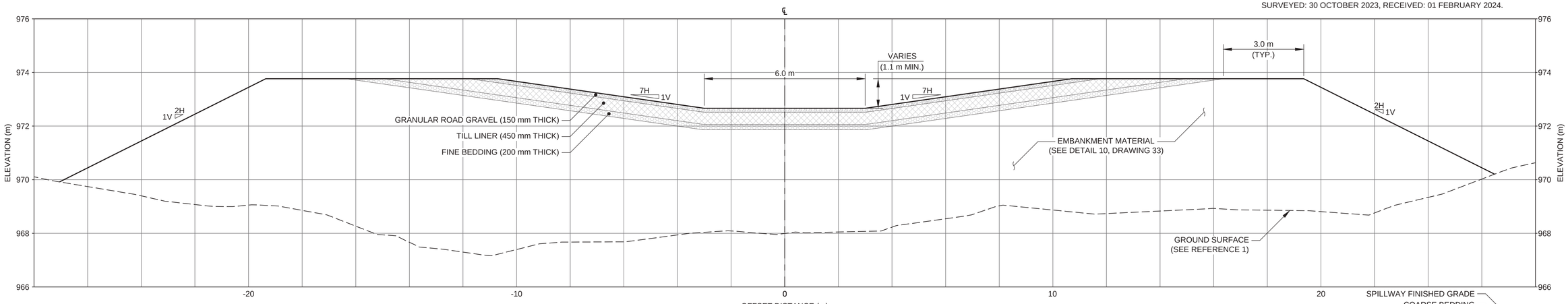
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

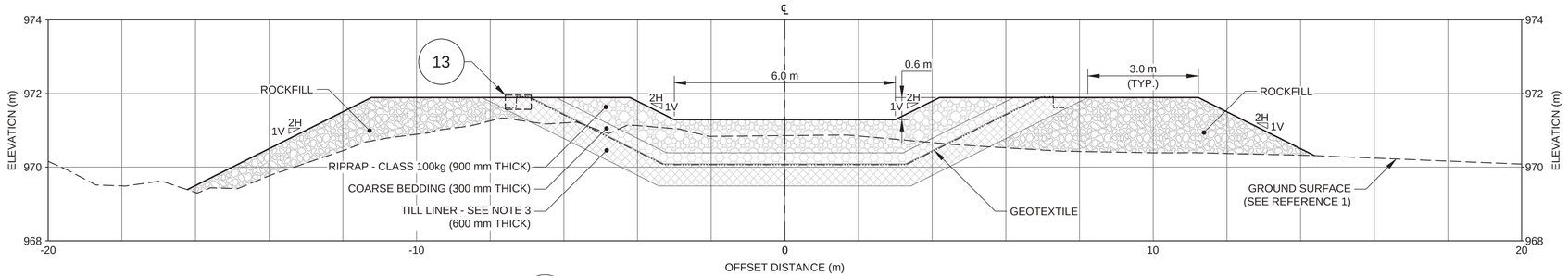
Path: \\golder.gds\comp\edata\office\vancouver\CAD-GIS\Client\imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-033.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time:9:24:42 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:30:18 PM



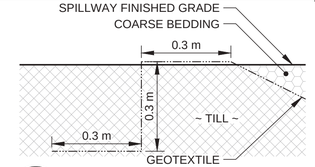
SCALE 1:75 m — T (32 / 33) — SPILLWAY - TYPICAL CROSS-SECTION (STA. 10+031 TO 10+048)



SCALE 1:75 m — U (32 / 33) — SPILLWAY - TYPICAL CROSS-SECTION (STA. 10+048 TO 10+122.79)



SCALE 1:75 m — V (32 / 33) — CHUTE - TYPICAL CROSS-SECTION (STA. 10+122.79 TO 10+142.10)



SCALE 1:10 m — 13 — ANCHOR TRENCH - TYPICAL DETAIL

LEGEND

- GROUND SURFACE (SEE REFERENCE 1)
- SPILLWAY FINISHED GRADE
- GEOTEXTILE
- TILL LINER
- FINE BEDDING
- COARSE BEDDING
- ROCKFILL
- RIPRAP
- GRANULAR ROAD GRAVEL

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. TILL LINER MAY NOT BE REQUIRED IF GROUND SURFACE IS TILL MATERIAL. GROUND SURFACE CONDITIONS TO BE INSPECTED AND APPROVED BY QA MANAGER.

REFERENCE

1. 2023 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "231030-TSF Lidar Contour 0.1.dxf", SURVEYED: 30 OCTOBER 2023, RECEIVED: 01 FEBRUARY 2024.

ISSUED FOR

CONSTRUCTION

0 0.5 1
1:10 METRES

0 2.5 5
1:75 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	N.H./D.M.	T.A.K.	D.A.K.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

Engineers & Geoscientists BC Permit #1000200

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

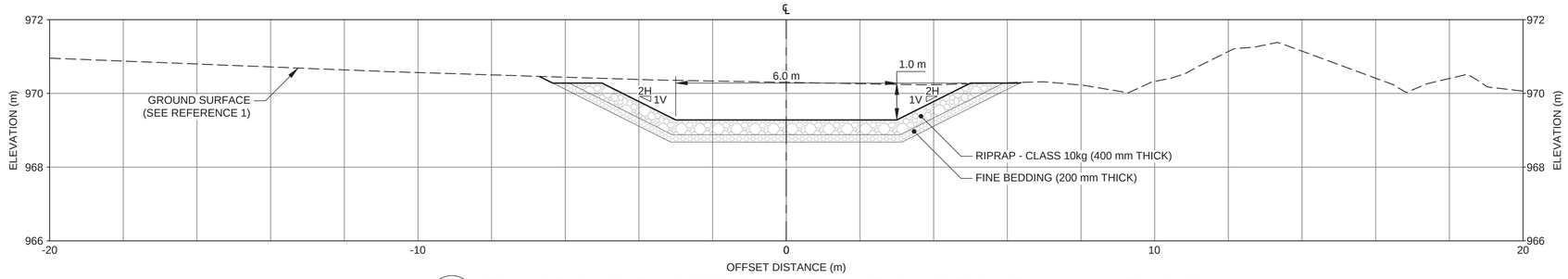
TSF SPILLWAY
TYPICAL CROSS-SECTIONS (SHEET 1 OF 2)

PROJECT NO.	PHASE/TASK/DOC.	REV.		DRAWING
CA0020527.4505	51300/51395/014	0	34 of 35	34

Path: \\golder.gds\complexdata\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\98_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505 51300 51395 014-034_035.dwg | Last Edited By: nyklassen Date: 2024-04-17 Time:12:38:27 PM | Printed By: TYKlassen Date: 2024-04-17 Time:9:24:03 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm



SCALE 1:75 m — W 32/33 — STILLING BASIN TO ROAD CROSSING - TYPICAL CROSS-SECTION (STA. 10+142.10 TO 10+174)

LEGEND

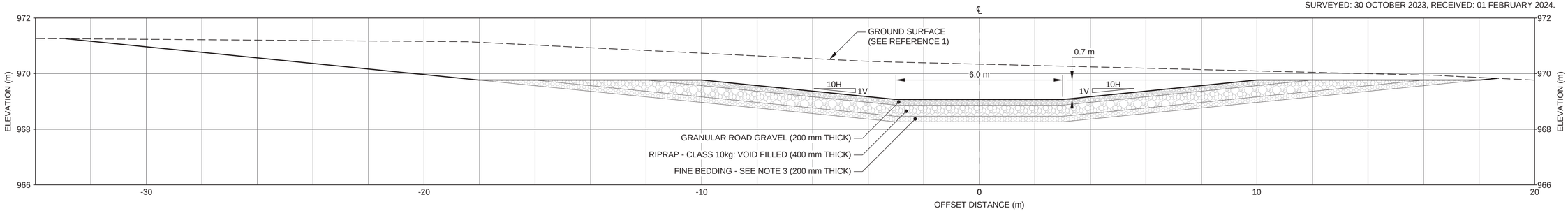
- GROUND SURFACE (SEE REFERENCE 1)
- SPILLWAY FINISHED GRADE
- FINE BEDDING
- RIPRAP
- GRANULAR ROAD GRAVEL
- NATIVE FILL

NOTES

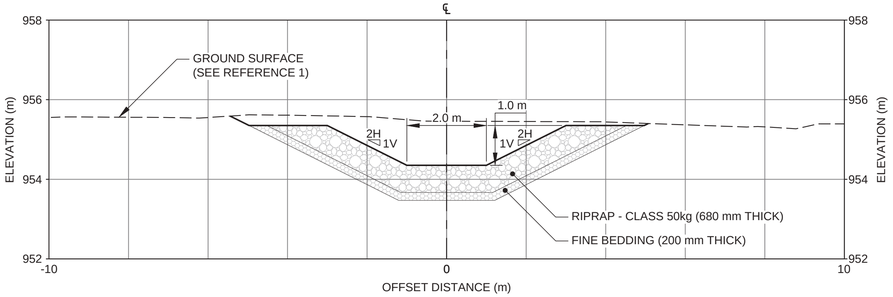
1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. SUBGRADE MATERIAL TO BE INSPECTED BY QA MANAGER. OVER EXCAVATION AND GREATER DEPTH OF FINE BEDDING MAY BE REQUIRED IF WEAK SUBGRADE MATERIAL FOUND.
4. ROAD CROSSING DESIGN TO BE CONFIRMED PENDING CONFIRMATION OF FOUNDATION CONDITION AND ACTIVE ROADS BY MPMC.

REFERENCE

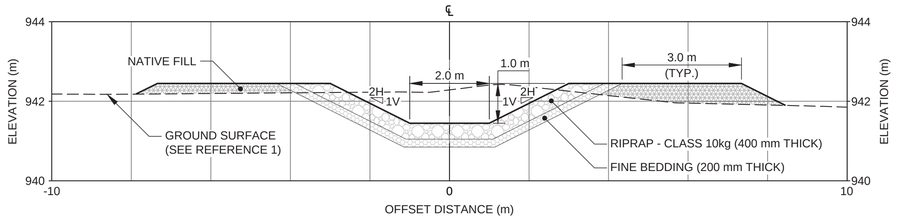
1. 2023 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "231030-TSF Lidar Contour 0.1.dxf", SURVEYED: 30 OCTOBER 2023, RECEIVED: 01 FEBRUARY 2024.



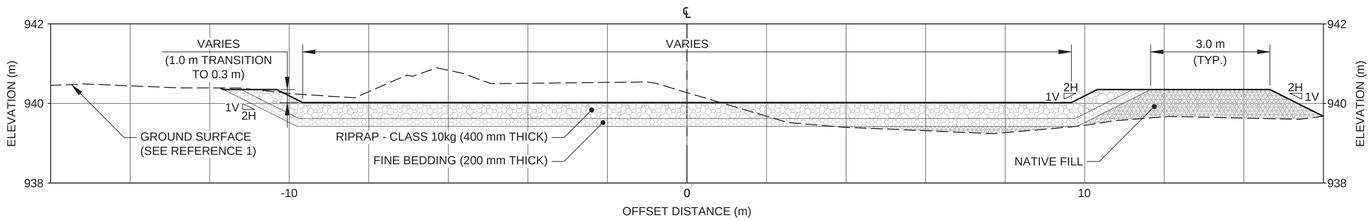
SCALE 1:75 m — X 32/33 — ROAD CROSSING - TYPICAL CROSS-SECTION (STA. 10+174 TO 10+240) (SEE NOTE 4)



SCALE 1:75 m — Y 32 — OUTLET CHANNEL - TYPICAL CROSS-SECTION (STA. 10+260 TO 10+690)



SCALE 1:75 m — Z 32 — OUTLET CHANNEL - TYPICAL CROSS-SECTION (STA. 10+240 TO 10+260 AND 10+690 TO 10+800)



SCALE 1:75 m — AA 32 — DISCHARGE APRON - TYPICAL CROSS-SECTION (STA. 10+800 TO 10+817.75)

ISSUED FOR

CONSTRUCTION

0 2.5 5
1:75 METRES

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS THE PROPERTY OF WSP CANADA INC.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
0	2024-04-18	ISSUED FOR CONSTRUCTION	N.H./D.M.	T.A.K.	D.A.K.	G.P.

SEAL

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — G. E. PIZARRO SALA # 40077

2024-04-18

Engineers & Geoscientists BC Permit #1000200

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

WSP CANADA INC.
840 HOWE STREET, SUITE 1000
VANCOUVER, BC
V6Z 2M1
[+1] (604) 685 9381

PROJECT

MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

TSF SPILLWAY
TYPICAL CROSS-SECTIONS (SHEET 2 OF 2)

PROJECT NO.	PHASE/TASK/DOC.	REV.	35 of 35	DRAWING
CA0020527.4505	51300/51395/014	0		35

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\com\tex\data\office\vancouver\CAD-GIS\Client\Imperial_metals_corp\mount_polley_mine\99_projects\ca0020527_4505\51300\51395\Doc 014_974 Design\02_PRODUCTION\DWG\Drawings\ | File Name: CA0020527_4505-51300-51395-014-034_035.dwg | Last Edited By: tyklassen Date: 2024-04-17 Time:9:24:12 PM | Printed By: TYKlassen Date: 2024-04-18 Time:10:16:15 AM

APPENDIX B

Technical Specifications

PREPARED FOR:

MOUNT POLLEY MINING CORPORATION

PREPARED BY:

REV.	DATE	REASON FOR REVISION	CHK	APP
0	18 APRIL 2024	ISSUED FOR CONSTRUCTION	SB	GP
A	23 FEBRUARY 2024	ISSUED FOR REVIEW	SB	GP

TABLE OF CONTENTS

1.0 SCOPE 7

2.0 GENERAL 7

2.1 Definitions 7

2.2 Drawings 9

2.3 Standards 10

2.4 Roles and Responsibilities 12

3.0 CARE OF WATER 14

3.1 Scope 14

3.2 General 14

4.0 SURFACE AND FOUNDATION PREPARATION 15

4.1 Scope 15

4.2 General 15

4.3 Clearing and Stripping 15

4.4 Foundation Preparation 16

4.5 Surface Preparation Along the Crest of the Embankments 16

4.6 Perimeter and South Embankments Abutments 16

4.7 Designated Waste Areas 17

5.0 FILL PLACEMENT 17

5.1 Scope 17

5.2 General 17

5.3 Fill Materials 18

5.3.1 Till (Zone S) 18

5.3.2 Filter Material (Zone F) 19

5.3.3 Transition Material (Zone T) 20

5.3.4 Upstream Fill (Zone U) 20

5.3.5 Embankment Rockfill (Zone C) and Buttress Rockfill 20

5.3.6 Drain Rock 21
5.3.7 Filter Sand 21
5.3.8 General Fill 21
5.4 Placement and Compaction 21
5.4.1 Till (Zone S) 22
5.4.2 Filter Zone (Zone F) 22
5.4.3 Transition Zone (Zone T) 23
5.4.4 Upstream Fill (Zone U) 23
5.4.5 Compacted Embankment Rockfill (Zone C) 24
5.4.6 Embankment Rockfill 24
5.4.7 Buttress Rockfill 24
5.4.8 Drain Rock 25
5.4.9 Filter Sand 25
5.4.10 Pipe Bedding and Backfill Material 25
5.5 Compaction Requirements 26
5.5.1 Compaction Equipment 27
5.5.2 Special Compactors 27
5.6 Protection and Maintenance 27
5.7 Quality Control and Quality Assurance 27
6.0 UPSTREAM DRAIN 30
6.1 Scope 30
6.2 General 30
6.2.1 Tolerances 30
6.2.2 Handling and Storage 30
6.3 Materials 30
6.3.1 Polyethylene Pipe and Fittings 30

6.3.2 Pipe Bedding and Backfill Material 31
6.3.3 Drain Rock Transition Material 31
6.3.4 Geotextile 31
6.4 Execution 32
6.4.1 Trench Excavation 32
6.4.2 Fill Placement 32
6.4.3 Piping 32
6.4.4 Handling and Placement 32
6.4.5 Pipe Installation 33
6.4.6 Joints and Connections 33
6.4.7 Geotextile Installation 33
6.5 Quality Assurance 34
7.0 SPILLWAY 34
7.1 Scope 34
7.2 Materials 34
7.2.1 Rockfill 34
7.2.2 Native Fill 34
7.2.3 Till Liner 35
7.2.4 Riprap 35
7.2.5 Fine Bedding 36
7.2.6 Coarse Bedding 36
7.2.7 Granular Road Gravel 36
7.2.8 Geotextile 36
7.2.9 Precast Concrete Weir 36
7.3 Execution 37
7.3.1 Spillway Surface and Foundation Preparation 37

7.3.2 Rockfill Placement and Compaction 37
7.3.3 Native Fill Placement and Compaction 37
7.3.4 Fine Bedding Placement and Compaction 37
7.3.5 Coarse Bedding Placement and Compaction 37
7.3.6 Till Liner Placement and Compaction 37
7.3.7 Riprap Placement 38
7.3.8 Granular Road Gravel Placement 38
7.3.9 Geotextile Installation 38
7.3.10 Repair and Replacement of Damaged Precast Concrete Weir 39
7.4 Spillway Quality Control and Quality Assurance 39
8.0 INSTRUMENTATION 41
8.1 Scope 41
8.2 General 41
8.3 Submittals 41
8.4 Installation Procedures 41
8.5 Electrical Protection and Safety 42
8.6 Voltage and Electrical Frequency 42
8.7 Protection 42
8.8 Grout Mix 42
8.9 Vibrating Wire Piezometers 43
8.9.1 General 43
8.9.2 Installation 44
8.9.3 Extension of Vibrating Wire Piezometer Cables 44
8.10 Shape Acceleration Array Systems 45
8.10.1 General 45
8.10.2 Installation 45

8.11 Inclinometers 47

8.11.1 General 47

8.11.2 Installation 47

8.11.3 Inclinometer Extensions 48

8.11.4 Inclinometers Decommissioning 48

1.0 SCOPE

These Specifications provide the technical information for construction of the TSF embankments from elevation 970 m to 974 m, at the Mount Polley Mine near Likely, British Columbia. The scope of this Work includes but is not limited to the following:

- Foundation preparation
- South, Main and Perimeter embankments re-slope
- South, Main and Perimeter embankments raise
- Extension of the rockfill buttress along the Main and Perimeter embankments
- Sourcing and placement of fills for the upstream drain
- Sourcing and placement of fills for the spillway
- Supply and installation of pipe materials
- Supply and installation of instrumentation
- Control of water during construction.

These Specifications shall be read in combination with the latest revision of the Drawings. The work is to be constructed in accordance with and to the lines and grades shown on the Drawings, and as directed by the MPMC Construction Manager and the Geotechnical Engineer's QA Manager.

2.0 GENERAL

2.1 Definitions

The definitions used in this Specification are given in Table 2-1.

Table 2-1:List of Definitions

Term	Definition
Approval	A written engineering or geotechnical opinion, concerning the progress and completion of the work.
ASTM	ASTM International
Drain Rock	Screened rockfill used within the upstream drain and meeting the requirements of these Specifications.
Drawings	The most recent revision of the Issued for Construction (IFC) Tailings Storage Facility Drawings prepared by the Geotechnical Engineer.
General Fill	Fill consisting of mainly tailings and meeting the Specifications.

Table 2-1:List of Definitions

Term	Definition
Geotechnical Engineer	WSP Canada Inc.
Fill	A general terminology to describe soil or rockfill materials placed during the construction.
Filter (Zone F)	Material produced from crushing or screening NPAG rockfill to be placed in contact with the till core, filter sand and transition, and meeting the requirements of these Specifications.
Filter Sand	Granular material to be placed upstream in contact with the upstream fill and till core and downstream in contact with the till core and filter where the upstream drain pipes pass through the till core, and meeting the requirements of these Specifications.
NPAG	Non-Potentially Acid Generating.
Owner	Mount Polley Mining Corporation (MPMC).
PAG	Potentially Acid Generating.
Quality Assurance	Planned and systematic activities that provide confidence to the Owner (MPMC) and various stakeholders that quality control is being implemented effectively.
Quality Control	A planned system of inspection and testing carried out according to accepted standard specifications to ensure the quality of the work meets the design requirements.
Riprap	Armour rock used for erosion protection within water infrastructure
Rockfill or Zone C	Run-of-Mine NPAG rock material meeting the Specifications.
Specifications	The most recent revision of the Tailings Storage Facility technical specifications prepared by the Geotechnical Engineer.
TSF	Tailings Storage Facility.
Till (Zone S)	Soil consisting of sizes ranging from clay to cobbles that will be placed and compacted to form a low hydraulic conductivity layer, and meeting the requirements of these Specifications.
Till Foundation	Natural soil layer consisting of sizes ranging from clay to cobbles that form the foundation of the facility.
Transition (Zone T)	Material produced from crushing or screening NPAG rockfill to be placed in contact with the filter and rockfill, and meeting the requirements of these Specifications.
Upstream Fill (Zone U)	Fill consisting of mainly tailings and meeting the Specifications.
Work	The construction works, or additional work, required to complete construction of the Tailings Storage Facility as defined in the Drawings and Specifications.

2.2 Drawings

Table 2-2 presents a list of the Drawings.

Where a discrepancy exists between these Specifications and the Drawings, the Geotechnical Engineer shall be notified upon discovery of the discrepancy, and a formal written Request for Information (RFI) shall be issued to the Geotechnical Engineer to clarify the design intent.

The user is responsible to confirm that they are using the most recent version of the Specifications and Drawings.

Table 2-2: List of Drawings

Drawing No.	Drawing Title	Revision
01	DRAWING LIST AND PROJECT LOCATION PLAN	0
02	SITE PLAN	0
03	PRE-CONSTRUCTION CONDITIONS	0
04	GENERAL ARRANGEMENT - PLAN VIEW	0
05	SOUTH EMBANKMENT - FOUNDATION PREPERATION	0
06	SOUTH EMBANKMENT - PLAN VIEW	0
07	SOUTH EMBANKMENT - TYPICAL CROSS-SECTION AND DETAIL	0
08	SOUTH EMBANKMENT - CROSS-SECTIONS	0
09	MAIN EMBANKMENT - FOUNDATION PREPARATION	0
10	MAIN EMBANKMENT AND BUTTRESS - PLAN VIEW	0
11	MAIN EMBANKMENT AND BUTTRESS - TYPICAL CROSS-SECTION AND DETAIL	0
12	MAIN EMBANKMENT - CROSS-SECTIONS	0
13	MAIN EMBANKMENT BUTTRESS - CROSS-SECTIONS (1 OF 2)	0
14	MAIN EMBANKMENT BUTTRESS - CROSS-SECTIONS (2 OF 2)	0
15	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2 – CORNER 1) - FOUNDATION PREPARATION	0
16	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2 – CORNER 1) - PLAN VIEW	0
17	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 2 – CORNER 1) - TYPICAL CROSS-SECTION AND DETAIL	0
18	PERIMETER EMBANKMENT (CORNER 2 – CORNER 1) - CROSS-SECTIONS	0
19	PERIMETER EMBANKMENT BUTTRESS (CORNER 2 – CORNER 1) - CROSS-SECTIONS	0
20	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1 – CORNER 5) - FOUNDATION PREPARATION	0

Table 2-2: List of Drawings

Drawing No.	Drawing Title	Revision
21	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1 – CORNER 5) - PLAN VIEW	0
22	PERIMETER EMBANKMENT AND BUTTRESS (CORNER 1 – CORNER 5) - TYPICAL CROSS-SECTION AND DETAIL	0
23	PERIMETER EMBANKMENT (CORNER 1 – CORNER 5) - CROSS-SECTIONS	0
24	PERIMETER EMBANKMENT BUTTRESS (CORNER 1 – CORNER 5) - CROSS-SECTIONS	0
25	SOUTH AND PERIMETER EMBANKMENT ABUTMENTS – PLAN VIEW AND TYPICAL CROSS-SECTIONS	0
26	UPSTREAM DRAIN – SOUTH AND MAIN EMBANKMENT – PLAN VIEW	0
27	UPSTREAM DRAIN – PERIMETER EMBANKMENT – PLAN VIEW	0
28	UPSTREAM DRAIN – TYPICAL CROSS-SECTIONS AND DETAILS (SHEET 1 OF 2)	0
29	UPSTREAM DRAIN – TYPICAL CROSS-SECTIONS AND DETAILS (SHEET 2 OF 2)	0
30	INSTRUMENTATION – PIEZOMETERS – PLAN VIEW	0
31	INSTRUMENTATION – SLOPE INCONOMETERS AND SAAS – PLAN VIEW	0
32	TSF SPILLWAY – PLAN AND PROFILE	0
33	TSF SPILLWAY – TYPICAL DETAILS	0
34	TSF SPILLWAY – TYPICAL CROSS-SECTIONS (SHEET 1 OF 2)	0
35	TSF SPILLWAY – TYPICAL CROSS-SECTIONS (SHEET 2 OF 2)	0

2.3 Standards

Work shall conform to, but not be limited to, the requirements of the latest edition of the standards listed in Table 2-. Work included in this Specification shall conform to the applicable provisions in these publications, except as modified by the requirements specified herein or as indicated in the Drawings. Each publication shall be the most recent revision in effect at the time of issue of the bid package for this work.

Table 2-3: List of Standards

Standard	Description
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
ASTM D2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D5240	Standard Test Method for Evaluation of the Durability of Rock for Erosion Control Using Magnesium Sulfate.
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
ASTM D6241	Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50 mm Probe.
ASTM D6473	Standard Test Method for Specific Gravity and absorption of rock for erosion control.
ASTM D6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D6928	Standard Test Methods for resistance of coarse aggregate to degradation by abrasion in the micro-deval apparatus

If materials are offered which conform to a standard other than that specified then the standard offered shall be equal to or superior, when tested, to the specified standard and full details of the difference between the standard offered and the standard specified shall be given.

2.4 Roles and Responsibilities

Table 3 presents a summary of the key roles and associated responsibilities and authorities. The roles and responsibilities of each position shall be reviewed, documented, and agreed upon prior to the start of work for each stage of the project.

Table 2-4: Table of Responsibilities

Role	Responsibility	Authority
MPMC TSF Construction Team		
MPMC TSF Qualified Person	▪ Coordinates the design, construction and overall management of the TSF with the EoR and MPMC construction manager, as well as internal and external resources.	▪ Designated by mine manager for safe management of the TSF.
MPMC Construction Manager	▪ Defines the scope of the project. ▪ Provides all materials, including water, and site access. ▪ Obtains all relevant permits. ▪ Provides reasonable access to the general open areas around the work site. ▪ Provision of survey for set-out and for construction record. ▪ Coordinates all project communications. ▪ Arranges coordination and progress meetings, as required. ▪ Leads problem resolution meetings for all QA and QC issues.	▪ Retains the Contractor to complete the project. ▪ Directs the scope of work to complete the project. ▪ Has the authority to stop work due to non-compliance (which shall resume only after a plan for corrective action has been approved by the MPMC Construction Manager and QA Manager).
Contractor	▪ Retained by the MPMC Construction Manager. ▪ Assigned tasks by the MPMC Construction Manager to bring the Work, or additional work, to final completion. ▪ Ensure that the Work is done in accordance with the Drawings and Specifications. ▪ Follows the QC Plan. ▪ Reports to the MPMC Construction Manager. ▪ Request information, as necessary, to clarify the design intent.	▪ Directs work.

Table 2-4: Table of Responsibilities

Role	Responsibility	Authority
Quality Control Laboratory	▪ Reports to the MPMC Construction Manager. ▪ Responsible for performing the QC laboratory and in-situ tests outlined in Section 5.0.	▪ Reports test results to the MPMC Construction Manager and the QA Manager.
Engineering Team		
Engineer of Record (Engineer)	▪ Ensures that the works are constructed in accordance with the design intent. ▪ Conducts site visits at key points to check on progress of work and support the QA team. ▪ Responsible to oversee the QA program to confirm that the works are constructed in accordance with the design intent. ▪ Responsible for the design and preparation of the Drawings and Specifications. ▪ Responsible for all design changes through updates to the Drawings and Specifications, including modifications or clarifications required during construction. ▪ Responsible for review of the construction record report. ▪ Prepares deviance accountability report. ▪ Fulfils the requirements of the Engineer of Record as defined in 10.1.5 of the Code.	▪ Overall supervision and coordination of QA team. ▪ Evaluates the adequacy of the as-built facility relative to the design as well as applicable standards, criteria and guidelines. ▪ Signs construction record.
Quality Assurance (QA) Manager	▪ Reports to the Engineer and represents the Engineer on site. ▪ Responsible for performing the QA tasks outlined in Section 5.0.Responsible for monitoring the Quality Control program to confirm that the works are constructed in accordance with the design intent. ▪ Review of QC data and sign-offs provided for compliance with the design intent, Drawings and Specifications. ▪ Attends site meetings and conducts site inspections. ▪ Assesses site design and construction issues or non-compliances and prepares recommendations for review by the Engineer. ▪ Prepares draft site documentation for review by the Engineer.	▪ Approves work as meeting the design intent, as set out in the Drawings and Specifications. ▪ Rejects work which fails to meet the design intent as set out in the Drawings and Specifications. ▪ Signs as the QA Manager on the construction checklists. ▪ Reports non-conformance of Work to the MPMC Construction Manager and the Engineer.

3.0 CARE OF WATER

3.1 Scope

This Section describes Care of Water during the construction, which consists of all work required to control water from any sources, including groundwater, surface water, snowmelt and precipitation, in order to complete the Work in accordance with the Drawings and Specifications, and in accordance with all environmental and safety controls established by MPMC. Care of water shall include the following:

- Managing water before, during and after excavating, preparing, placing, and compacting embankment fill material. Water management is also to be conducted in designated waste areas, access roads, stockpiles, and when undertaking any other part of the Work.
- Dewatering foundations and associated working areas. Providing, operating and maintaining any channels, flumes, drains, sumps, pumps and other drainage facilities and equipment necessary to divert or to remove water from construction areas.
- Constructing and maintaining any embankments and other protective works required to divert water away from areas required for the Work, and where applicable, removing such structures upon completion of the Work.

3.2 General

Surface water shall be temporarily diverted and managed during construction of the Work. Appropriate channel, ditch, dike and other facilities required to divert surface water from any area required to complete the Work shall be constructed.

Pumps, hoses, culverts and any other equipment required to dewater and maintain all parts of the construction site free from water shall be furnished, installed, maintained, and operated.

Temporary diversion and protective works and pumping stations shall be adequately operated and maintained. These shall also be readily accessible at all times.

Temporary dikes and other temporary works shall be removed promptly when they are no longer required at the direction of the Owner's Construction Manager. Materials from such removal shall be hauled to disposal areas designated by the Owner's Construction Manager.

Excavations shall be dewatered prior to performing work in the excavations, to the extent determined acceptable by the QA Manager. This includes the Perimeter Embankment Till Borrow Pond, Main Embankment till borrow area, Main Embankment Seepage Collection Pond, South Embankment Seepage Collection Pond and seepage collection ditches.

4.0 SURFACE AND FOUNDATION PREPARATION

4.1 Scope

This Section provides the requirements for surface and foundation preparation for raising the TSF embankments. The surface and foundation preparation for the South, Main and Perimeter embankments includes:

- expose and prepare the surface of the Till Core, Filter, and Transition materials along the crest of the embankments
- expose and prepare the surface of the buttress within the embankment re-slope footprint
- clearing, stripping and preparing the foundation within the embankment re-slope and buttress extension footprint
- clearing, stripping and preparing the foundation at the embankment abutments
- loading, hauling, dumping, and disposing of excavated materials.

4.2 General

Excavation shall be carried out in accordance with the Drawings and Specifications using ground support and water control measures required for safe and effective operation. Excavation procedures shall be such that the stability of adjacent fill or cut slopes or of completed Work shall not be at risk.

The excavation shall be laid out, subject to inspection by the QA Manager, prior to commencing any excavation. Excavation shall not start on any part of the Work until the proposed methodology and construction sequence has been approved by the Owner's Construction Manager.

Survey shall be performed to confirm the elevations and coordinates shown on the Drawings.

Excavation work may begin only after the necessary infiltration and runoff control measures have been completed in accordance with Section 3.0, and the necessary equipment, elements and materials for protection of surface excavations are available at the site. Temporary drainage and pumping systems shall be provided, operated and maintained, as required, to direct water away from the excavation areas, as specified in Section 3.0.

The location of the exposed material boundaries and exposed surface shall be surveyed.

4.3 Clearing and Stripping

Any area to be cleared and stripped shall require prior approval by the Owner's Construction Manager and the MPMC Environmental Department.

Clearing and stripping shall consist of removing stockpile material, topsoil, vegetation and other deleterious materials, including trees, brush, stumps, roots, and debris, and loading, hauling and dumping such materials into stockpiles within designated waste areas.

Competent foundation material, as determined by the QA Manager, shall be exposed. Foundation material considered unsuitable by the QA Manager shall be excavated and removed.

Vegetation shall not be disturbed beyond the boundaries shown on the Drawings unless so directed by the Owner's Construction Manager. Waste materials shall not be deposited into any riverbed or other water channel.

The QA Manager will determine if the fill material, containing organics, along the toe of the South Embankment needs to be progressively excavated in 20 m wide panels perpendicular to the embankment. In this case, the fill in each panel is to be removed down to competent foundation material, and Embankment Rockfill (Zone C) placed to replace the excavated material, prior to the excavation of the adjacent panel.

4.4 Foundation Preparation

Following clearing and stripping, the surface of the foundation shall be proof-rolled, as directed by the QA Manager. Where movements are observed which are deemed unacceptable by the QA Manager, the area shall be excavated, as directed by the QA Manager.

The foundation preparation and proof-rolling may be adjusted in the field to suit actual conditions, as defined by the QA Manager.

Fill placement shall not commence until preparation works have been completed, and written approval to proceed has been provided by the QA Manager.

4.5 Surface Preparation Along the Crest of the Embankments

The existing Till Core, Filter and Transition material along the crest of the embankments are to be exposed, as directed by the QA Manager. All deleterious materials are to be removed and hauled to a designated waste area.

Frost affected material along the crest of the Till Core shall be removed as directed by the QA Manager. After removal of frost affected material, the exposed surface of the till core shall be re-compacted with a sheep’s foot roller. The exposed till core may need to be moisture conditioned, as directed by the QA Manager.

Loose upstream fill material along the crest of the embankment shall be moisture conditioned and re-compacted as directed by the QA Manager.

4.6 Perimeter and South Embankments Abutments

Stockpiled material, topsoil, vegetation, and other deleterious materials, including trees, brush, stumps, roots, and debris is to be removed at the South Embankment abutment and Perimeter Embankment abutment. The material is to be loaded, hauled and dumped into stockpiles within designated waste areas.

The thickness of competent till is to be confirmed by the excavation of test pits, as directed by the QA Manager. The test pits are to be excavated along the Till Core and Upstream Fill footprint.

Where a minimum of 2 m of competent till exists above bedrock, the Till Core will be keyed into the foundation till by the excavation of a 0.5 m deep and 2.0 m wide trench.

Where the depth of foundation till to bedrock is less than 2 m, the Till Core shall be placed directly onto bedrock. The bedrock surface will be prepared to receive Till by the removal of all residual soil to fully expose the bedrock. Relatively loose, diggable bedrock is to be excavated and the surface cleaned by high pressure jets. Depending

on the condition of the bedrock surface, the QA Manager may request additional preparation which could include placement of bentonite, shotcrete or slush grout.

Foundation preparation at the abutment shall be completed in such a way that water drains away from the Till Core. This may require placement of a till blanket downstream of the Till Core.

4.7 Designated Waste Areas

Surplus and unsuitable materials shall be disposed of at waste areas designated by the Owner's Construction Manager. Such materials shall be loaded, hauled and placed into such waste areas, and shaped into waste piles. Waste piles shall be constructed such that drainage of surface water and groundwater is not impeded, and such that the piles are stable as defined by the Owner's Construction Manager.

Vegetation, topsoil and other materials resulting from clearing and stripping operations shall be stockpiled separately from other soil or rock materials at designated waste areas, avoiding obstruction of any natural or man- made water flows. All vegetation beyond the limits of such storage areas shall be preserved.

Upon completion of the work, the designated waste area shall be shaped in accordance with the requirements of the Owner's Construction Manager.

5.0 FILL PLACEMENT

5.1 Scope

This section comprises the requirements for placement of fills in the Works to the lines and grades shown on the Drawings, or as directed by the Owner's Construction Manager and QA Manager.

5.2 General

Fill placement shall be to the lines, grades and cross-sections shown on the Drawings and in accordance with the Specifications.

Dam embankment materials shall not encroach upon adjacent zones any further than allowed by the tolerances shown on the Drawings.

Water control measures such as temporary drainage and pumping systems shall be operated and maintained as required to direct water away from the fill placement areas as specified in Section 3.0.

Access to the Work will be provided and coordinated by the Owner's Construction Manager.

No fill shall be placed on any portion of the Works until excavation and surface and foundation preparation, as specified in Section 4.0, has been completed and such portions have been approved in writing by the QA Manager.

Fill shall not be placed on a surface where ice, snow or excessive moisture has accumulated. A previously approved foundation or fill surface, which in the opinion of the QA Manager, has deteriorated shall be repaired prior to any fill placement.

Fill shall consist of unfrozen material that is free of organic or other deleterious material, as approved by the QA Manager.

Fill which, while acceptable at the time of selection has, in the opinion of the QA Manager, deteriorated for any reason such that it no longer meets the Specifications for that material shall not be incorporated in the Works.

Construction traffic shall be routed such that no ruts are formed on the surface of excavated or placed fill areas. If ruts are formed, the ruts shall be graded level and re-compacted to the relevant degree of compaction for the particular fill type as required by the Specification.

5.3 Fill Materials

The material zones of the embankment are shown on the Drawings and described in this Specification.

Materials used in the construction are to be non-potentially acid generating (NPAG). Acceptance of all fill materials based on geochemical properties shall be the responsibility of the Owner's Construction Manager.

The particle size envelopes shown in these Specifications shall apply to the as-placed materials and in the stockpile.

Fill materials shall be well-graded within the specified gradation limits; i.e., they shall contain an even distribution of all sizes of particles within the designated envelope, without significant deficiency in any sizes. Fill material gradations shall meet the specification gradation within the envelope drawn between the specified points and not just at the specified points. Any unsuitable material from the fill shall be excavated and removed.

5.3.1 Till (Zone S)

The Till (Zone S) shall be a well graded Till with a minimum fines content of approximately 20% by weight (particles finer than 0.075 mm). The Till will be sourced from designated borrow areas. The Till shall have a minimum plasticity index (PI) of 7.

The Till shall meet the gradation in Table 5-1.

Table 5-1: Gradation Limits for the Till (Zone S)

Size (mm)	Sieve Size (USS)	Percent Passing (%)
100	4”	100
75	3”	98–100
37.5	1.5”	89–100
19	0.75”	81–100
12.5	0.5”	76–100
4.75	#4	66–100
2	#10	56–100
0.85	#20	47–94
0.425	#40	39–90
0.075	#200	20–85

Particles larger than 150 mm shall be removed from the material prior to compaction.

USS = United States Standard Sieve Size.

5.3.2 Filter Material (Zone F)

The Filter (Zone F) material is to be placed downstream of the till core. The material shall consist of hard, durable mineral particles, without organic matter, clay, soft particles, snow, ice, or any other unsuitable material.

The Filter shall meet the gradation in Table 5-2.

Table 5-2: Gradation Limits for the Filter Material (Zone F)

Size (mm)	Sieve Size (USS)	Percent Passing (%)
37.5	1.5”	100
19.1	0.75”	88-100
9.5	3/8”	56-100
4.75	#4	40-86
2	#10	25-63
0.85	#20	16-45
0.425	#40	10-33
0.25	#60	6-25
0.106	#140	0-15
0.075	#200	0-12

USS = United States Standard Sieve Size.

5.3.3 Transition Material (Zone T)

The Transition (Zone T) material shall be used as a transition zone between the Filter and Rockfill. The material shall consist of a mix of processed boulders, cobbles, gravel and sand produced by crushing or screening rockfill. The material shall consist of hard, durable mineral particles, without organic matter, clay, soft particles, snow, ice, or any other unsuitable material.

The Transition material shall meet the gradation in Table 5-3.

Table 5-3: Gradation Limits for the Transition Material (Zone T)

Size (mm)	Sieve Size (USS)	Percent Passing (%)
152.4	6”	100
25.4	1”	37-100
19.1	0.75”	29-75
12.7	0.5”	17-60
9.5	3/8”	0-51
4.75	#4	0-32
2.38	#8	0-25
0.85	#20	0-17
0.075	#200	0-5

USS = United States Standard Sieve Size.

5.3.4 Upstream Fill (Zone U)

The Upstream Fill (Zone U) shall consist of sandy tailings material or other granular material approved by the Engineer. The upstream fill is to be excavated from within the TSF and placed mechanically in lifts or by depositing the tailings into cells.

Till may be used if conditions allow compaction, and subject to the approval of the QA Manager. Filter material, Transition material or Rockfill may be used in select locations subject to the approval of the QA Manager.

5.3.5 Embankment Rockfill (Zone C) and Buttress Rockfill

Rockfill used in construction of the Embankment (Zone C) and Embankment Buttresses are to be non-potentially acid generating (NPAG). Acceptance of all fill materials based on geochemical properties shall be the responsibility of the Owner's Construction Manager.

The rockfill shall consist of well graded material with a maximum diameter of 1 m, obtained from run-of-mine NPAG rockfill. The material shall consist of hard, durable mineral particles, without organic matter, clay, soft particles, or any other unsuitable material. Any unsuitable materials from the rockfill shall be excavated and removed.

Select coarser rockfill, to be placed within the Main Embankment Seepage Collection Pond and Perimeter Embankment Till Borrow Pond, shall be uniformly graded with only a small proportion of gravel, sand and silt size particles, as approved by the QA Manager.

5.3.6 Drain Rock

The Drain Rock shall consist of screened rockfill with uniform particle sizes between 300 mm and 150 mm.

The material shall consist of hard, durable mineral particles, without organic matter, clay, soft particles, or any other unsuitable material.

5.3.7 Filter Sand

The Filter Sand shall be placed between the Till Core (Zone S) and Filter (Zone F) and between the Upstream Fill (Zone U) and Till Core (Zone S) where the upstream drain pipe crosses through the till core.

The material shall consist of hard, durable mineral particles, without organic matter, clay, soft articles, snow, ice, or any other unsuitable material.

The Filter Sand shall meet the gradation in Table 5-4.

Table 5-4: Gradation Limits for the Filter Sand

Size (mm)	Sieve Size (USS)	Percent Passing (%)
9.5	3/8”	100
4.75	#4	95-100
2	#10	55-100
0.85	#20	25-100
0.425	#40	0-55
0.25	#60	0-25
0.106	#140	0-10
0.075	#200	0-5

5.3.8 General Fill

General Fill material can be used to backfill the TSF tailings beach where the upstream drain will be constructed. If required by construction sequence, the General Fill can also be used to laterally support the 20 m wide Zone U Upstream Fill. General Fill shall consist of sandy tailings material or other granular material approved by the Engineer. General fill is to be placed mechanically in lifts.

5.4 Placement and Compaction

Fill materials shall be placed to the lines and elevations shown on the Drawings.

The placement of fill materials for the various zones of the embankment shall be scheduled as directed by the Owner's Construction Manager. To achieve this, the various fill materials shall be stockpiled so that they are available at the location of the fill placement when required.

The Owner's Construction Manager may require modifications to the fill construction program, depending upon conditions encountered during construction.

The embankments shall be constructed such that lenses, pockets, streaks and layers of materials differing substantially in gradation from the surrounding material within each zone are avoided.

Filter and Transition shall be hauled, placed and spread in such a manner as to prevent segregation. Any material placed which, in the opinion of the QA Manager, does not meet the specified requirements shall be removed or remixed, blended or otherwise reworked to produce a material which meets the specified requirements, whether or not such material has been covered by other fill material.

The fill shall be leveled prior to compaction by means of a tracked dozer, excavator or other suitable approved equipment to obtain an even surface with no depressions.

5.4.1 Till (Zone S)

The Till material shall be spread parallel to the axis of the embankment in horizontal lifts of uniform thickness not exceeding 0.3 m prior to compaction. Thinner lifts may be required if till compaction is carried out in freezing conditions.

Till shall only be placed in contact with the existing Till Core, Upstream Fill, Filter and Filter Sand. Till shall not be placed in direct contact with Transition material or Rockfill.

Precautions shall be taken to avoid any presence of particles greater than 150 mm. Oversize material shall be removed to the satisfaction of the QA Manager. Affected zones of Till material shall be removed at the direction of the QA Manager.

The Till shall be compacted with a sheep's foot drum roller to achieve a dry density of at least 95% of the Standard Proctor maximum dry density, as determined by ASTM D698 and within plus or minus 2% of the optimum moisture content.

Where the moisture content is outside these limits, the lift must be either dried or wetted as directed by the QA Manager. The compacted till surface shall be graded to prevent ponding water.

When placing Till adjacent to a slope of existing Till, the slope of the existing fill shall be benched, the bench height being equal to the fill lift thickness, to achieve a suitable contact surface between the ground and the new fill.

5.4.2 Filter Zone (Zone F)

The Filter (Zone F) material shall be placed in loose lift thicknesses of 0.3 m or less (prior to compaction).

Precautions shall be taken to prevent any contamination of the material. Any contaminated materials shall be removed and replaced. Contaminated material shall be removed to the satisfaction of the QA Manager prior to additional material being placed. Precautions shall be taken to prevent segregation of the Filter material during placement and spreading. Visibly segregated zones of Filter material shall be removed at the direction of the QA Manager.

Filter material shall only be placed in contact with compacted Till Core, Transition material, Filter Sand and existing Filter. Filter material shall not be placed in direct contact with Rockfill.

The Filter material shall be compacted with a smooth-drum roller to achieve a dry density of 95% of the Standard Proctor maximum dry density, as determined by ASTM D698. Over-compaction of the Filter is to be avoided to minimize particle breakage and production of fine particles.

The Filter (Zone F) material shall be raised simultaneously with the Till (Zone S), with no more than 0.6 m elevation difference between both zones. When the elevation difference is larger than 0.3 m, the downstream slope of the till is to be cut after compaction of the lifts. The Till (Zone S) layer shall be raised ahead of the Filter (Zone F) layer.

5.4.3 Transition Zone (Zone T)

The Transition (Zone T) material shall be placed in loose lift thicknesses of 0.6 m or less (prior to compaction).

The Transition material shall be compacted with six (6) passes of a smooth drum vibratory compactor having a static weight of at least twelve (12) tonnes.

The Transition (Zone T) and Filter (Zone F) material shall be raised with no more than one (1) Transition lift thickness between the elevations of both zones. The Zone F is to be placed ahead of the Zone T.

Transition material shall only be placed in contact with Filter and Rockfill. Transition shall not be placed in direct contact with the Till Core.

5.4.4 Upstream Fill (Zone U)

The Upstream Fill (Zone U) shall be placed within the 20 m wide zone adjacent to the Till Core.

The Zone U upstream fill shall be placed in nominal 0.6 m thick layers or less and compacted with a smooth-drum roller. The sandy tailings shall be compacted with a smooth drum vibratory compactor having a static weight of at least twelve (12) tonnes to achieve a dry density of at least 95% of the Standard Proctor maximum dry density, as determined by ASTM D 698.

Alternatively, Upstream Fill (Zone U) shall be tailings deposited in cells. A confining berm shall be constructed on the outside edges of the cells. A culvert is to be constructed through the berm at the end farthest from the tailings discharge point. The culvert will drain the water and finer tailings material into the TSF. Constant reworking of the tailings by a dozer shall be required to provide uniform distribution of the tailings within the cells.

5.4.5 Compacted Embankment Rockfill (Zone C)

The Rockfill (Zone C) next to the Transition (Zone T) shall be placed in a loose lift thickness of 1 m or less. The Zone C shall extend a minimum of 10 m downstream of the Zone T. Oversize boulders (greater than 1 m) shall not be incorporated in the fill. Such oversize materials shall be broken to size or moved to the downstream edge of the embankment.

The Rockfill shall be raised ahead of the Transition with no more than 1 m lift thickness between the elevation of both zones.

The Rockfill (Zone C) shall be compacted with six (6) passes of a smooth drum vibratory compactor having a static weight of at least twelve (12) tonnes.

5.4.6 Embankment Rockfill

The Rockfill shall be placed downstream of the compacted rockfill in a loose lift thickness of 3 m or less (prior to compaction). Routing of the loaded haul truck traffic on the rockfill shall be carried out such that compaction is obtained across the entire width of the fill.

Oversize boulders (greater than 1 m) shall not be incorporated in the fill. Such oversize materials shall be broken to size or moved to the downstream edge of the embankment.

All ramps constructed in rockfill shall be submitted to the Owner's Construction Manager for review. Ramp slopes for haul trucks shall not exceed 10%.

5.4.7 Buttress Rockfill

The rockfill shall be placed in a single lift, and dumped/pushed from the crest to toe, resulting in segregation of the rockfill. Coarser rockfill should collect along the base of the buttress. Select coarse rockfill is to be placed in a single lift within the Main Embankment Seepage Collection Pond and Perimeter Embankment Till Borrow Pond.

The rockfill placement for the buttress is to advance parallel to the existing buttress or where there is no existing buttress, to the downstream toe of the embankment, with the downstream crest overbuilt to allow re-slope of the downstream face of the buttress. A tracked dozer is to grade the downstream face of the placed rockfill to the required 3 horizontal: 1 vertical (3H:1V) grade as placement advances. The distance from the advancing rockfill face and the completed downstream reslope shall not exceed 100 m.

The completed rockfill surface shall be leveled by means of a tracked dozer or other suitable approved equipment to obtain an even surface with no depressions. All necessary steps shall be taken to avoid ponding of water on the fill.

All ramps constructed in rockfill shall be submitted to the Owner's Construction Manager for review. Ramp slopes shall not exceed 10%.

The existing instrumentation is to be raised and/or protected from damage during construction, as specified in Section 7.1 of this Specification.

The upstream toe drains are to be protected from damage.

The Main Embankment Toe Drain Collection Sump is to be relocated or extended.

The piping and pumping infrastructure at the Main Embankment Seepage Collection Pond is to be relocated or protected from damage during the construction.

5.4.8 Drain Rock

The Drain Rock shall be used for the construction of the upstream drain and within the breach pond channel.

The Drain Rock shall be placed in a single lift of 1.0 m (minimum). Traffic of construction equipment over the Drain Rock shall be limited to only what is required for placement of the material.

5.4.9 Filter Sand

The Filter Sand material shall be placed in loose lift thicknesses of 0.3 m or less (prior to compaction).

Precautions shall be taken to prevent any contamination of the material. Any contaminated materials shall be removed and replaced. Contaminated material shall be removed to the satisfaction of the QA Manager prior to additional material being placed. Precautions shall be taken to prevent segregation of the Filter Sand material during placement and spreading. Visibly segregated zones of Filter Sand material shall be removed at the direction of the QA Manager.

Filter Sand will only be placed in contact with Upstream Fill, Till Core and Filter material.

The Filter Sand material shall be compacted with a smooth-drum roller to achieve a dry density of 95% of the Standard Proctor maximum dry density, as determined by ASTM D 698. Over-compaction of the Filter Sand is to be avoided to minimize particle breakage and production of fine particles.

5.4.10 Pipe Bedding and Backfill Material

Till (Zone S), Filter (Zone F), Filter Sand, or Upstream Fill (Zone U) shall be used as pipe bedding and backfill material for the solid HDPE pipe. The bedding and backfill material to be used is as shown on the Drawings.

Where Till (Zone S) is used as pipe bedding and backfill:

- Particles greater than 20 mm shall be removed and the Till shall be wet of optimum (i.e., plus 2% of the optimum moisture content).
- The trench through the Till Core shall be sufficient width to allow proper placement and compaction of the bedding and backfill material.
- The pipe bedding shall be placed in a single minimum 0.1 m thick loose lift. The pipe haunch backfill shall be placed in a 75 mm loose lift. The embedment material shall be worked and tamped within the haunches of the pipe.
- The Till backfill shall be placed in 0.15 m minimum loose lifts. The 0.15 m loose lift shall be carried out after the backfill material has reached the pipe crown. The backfill material shall extend to a minimum of 0.6 m above the crest of the pipe.

- Compact Till bedding and backfill to achieve a dry density of at least 95% of the Standard Proctor maximum dry density, as determined by ASTM D 698 and at plus 2% of the optimum moisture content.

Where Filter Material (Zone F), Filter Sand, and Upstream Fill (Zone U) is used as pipe bedding and Backfill:

- The pipe bedding shall be placed in a single minimum 0.15 m thick loose lift and nominally compacted.
- The pipe haunch backfill shall be placed in a 75 mm loose lift and shall be nominally compacted. The embedment material shall be worked and tamped within the haunches of the pipe.
- Pipe backfill material shall be placed in 0.3 m loose lifts and compacted with a minimum of four (4) passes using hand-held compaction equipment. The 0.3 m loose lift shall be carried out after the backfill material has reached the pipe crown. The backfill material shall extend to a minimum of 0.6 m above the crest of the pipe.

A minimum 0.15 m thick layer of backfill material is to be placed over any pipe before hand-held equipment is operated above the pipe. A minimum 1.0 m thick layer of fill material is to be placed over any pipe before ride-on equipment or construction vehicles are operated above the pipe.

Transition Material (Zone T) shall be placed around the perforated corrugated polyethylene pipe (PCPE), unless directed otherwise.

- The pipe haunch backfill shall be placed in a 0.15 m loose lift and shall be nominally compacted. The embedment material shall be worked and tamped within the haunches of the pipe.
- Pipe backfill material shall be placed in 0.3 m loose lifts and compacted with a minimum of four (4) passes using hand-held compaction equipment. The 0.3 m loose lift shall be carried out after the backfill material has reached the pipe crown. The backfill material shall extend to a minimum of 0.5 m above the crest of the pipe.

5.5 Compaction Requirements

Each layer of spread fill material shall be compacted in a systematic, orderly and continuous manner to ensure that the entire fill is properly compacted. Layer thickness is defined as the thickness of the loose fill before compaction.

Compaction equipment shall generally travel parallel to the axis of the embankment being constructed, except where such routing is not practical, such as at turning areas or adjacent to instrumentation. In such areas, the compaction equipment shall be routed such that the best compaction can be attained.

Materials that cannot be adequately compacted by the specified compaction equipment because of location or space limitations shall be compacted with specified special compactors. Where such special compactors are required, fill layer thickness shall be modified, as required by the QA Manager.

One (1) pass shall mean a single traverse of a compactor across the surface of a layer in one direction. An overlap of at least 0.5 m shall be maintained between adjacent passes.

Vibratory rollers shall travel at an operating speed of no more than 70 m per minute. The operating speed of the compaction equipment is subject to review by the QA Manager, and will depend on the type of fill.

The compaction traffic pattern at fill zone boundaries or construction ramp joints shall be carried out such that the full number of roller passes extends completely across such boundaries.

5.5.1 Compaction Equipment

Sufficient compaction equipment of the types and sizes specified, as necessary for compaction of the various fill materials, shall be provided. This equipment shall be available and shall be maintained in good condition at all times.

Alternative compaction equipment may be used only if it can be demonstrated to the satisfaction of the QA Manager that such alternative equipment will compact the fill materials as effectively as the specified equipment, and also that the material after compaction meets the requirements of the Specifications.

5.5.2 Special Compactors

Special compactors shall include loaded dump trucks, hand-operated mechanical tampers and vibratory rollers, and any other compaction equipment not specified, subject to the approval of the QA Manager.

Special compactors shall be capable of producing the required compaction within a reasonable number of passes.

Hand-operated heavy-duty mechanical tampers shall be used under restricted space and access conditions. The operating frequency shall be such that previously compacted material is not disturbed. Operation shall proceed continuously until the specified level of compaction has been achieved.

A sufficient number of special compactors shall be available to compact inaccessible areas.

5.6 Protection and Maintenance

Any fill placed shall be maintained in a condition satisfactory to the QA Manager until completion of the Work. All necessary steps shall be taken to avoid ponding of water on the fill, or contamination of the fill by traffic or other causes. The surface and slopes shall at all times be kept free from rejected or unsuitable fill, or waste materials.

Should slides or erosion occur within or onto any placed fill, such materials and all other materials affected shall be removed, and the portion rebuilt as required.

5.7 Quality Control and Quality Assurance

Quality Control (QC) will be performed to ensure that the Work is constructed in accordance with the Drawings and Specifications.

Quality Assurance (QA) monitoring and testing will be carried out by the Engineer through their QA Manager, to satisfy themselves and MPMC that the Work is being carried out in accordance with the Drawings and Specifications.

The QC and QA testing requirements and frequency are listed in Table 5-5. At a minimum, all the required testing shall be performed to document the construction quality. The material testing listed in Table 5-5 shall be completed on record samples taken from placed material on the embankment to evaluate suitability of material and segregation during placement.

All necessary inspections, sampling and testing shall be performed to ensure that only materials of the specified composition, gradation and moisture content are supplied to the construction area. A sufficient number of control samples from the stockpile are to be tested prior to use to confirm the suitability of the material used.

The Owner's Construction Manager shall identify material stockpiles available for use in the construction.

Table 5-5: QA/QC Testing of Fill Placement

Material	Testing[a]		
	Test	QC Frequency	QA Frequency
Perimeter and South Embankment Abutment Foundation[b]	Water Content (ASTM D2216)	1 every 250 m^2 [c]	1 every 5 QC Tests
	Atterberg Limits (ASTM D4318)	1 every 250 m^2 [c]	1 every 5 QC Tests
	Gradation and Hydrometer (ASTM D422 & D6913)	1 every 250 m^2 [c]	1 every 5 QC Tests
Zone S Till Core Material	Water Content (ASTM D2216)	1 every 1,000 m^3	1 every 10 QC Tests
	Atterberg Limits (ASTM D4318)	1 every 2,000 m^3	1 every 10 QC Tests
	Gradation (ASTM D6913)	1 every 4,000 m^3	1 every 10 QC Tests
	Hydrometer (ASTM D422)	1 every 12,000 m^3	1 every 10 QC Tests
	Standard Proctor Maximum Dry Density (ASTM D698)	1 every 8,000 m^3	1 every 10 QC Tests
	In Situ Density by Portable Nuclear Gauge (D6938)	1 per each lift completed in a day and 1 every 300 m^3	1 every 10 QC Tests
	Lift Thickness	Measured continuously	Measured periodically
Zone F Filter Material	Water Content	1 every 1,000 m^3	1 every 10 QC Tests
	Wash Sieve Gradation (ASTM C136 & C117)	1 every 1,000 m^3	1 every 10 QC Tests
	Standard Proctor Maximum Dry Density (ASTM D698)	1 every 5,000 m^3	1 every 10 QC Tests
	In Situ Density by Portable Nuclear Gauge (D6938)	1 per each lift completed in a day and 1 every 100 m^3	1 every 10 QC Tests
	Lift Thickness	Measured continuously	Measured periodically

Table 5-5: QA/QC Testing of Fill Placement

Material	Testing[a]		
	Test	QC Frequency	QA Frequency
Zone T Transition Material	Wash Sieve Gradation (ASTM C136 & C117)	1 every 3,000 m^3	1 every 2 QC Tests
	Lift Thickness	Measured continuously	Measured periodically
	Number of Passes of Compactor	Measured continuously	Measured periodically
Zone C Rockfill	Lift Thickness	Measured continuously	Measured periodically
	Visual Gradation	Measured continuously	Periodical visual inspection
Zone U Upstream Fill (Tailings Sand)	Wash Sieve Gradation (ASTM C136 & C117)	1 every 10,000 m^3	1 every 10 QC Tests
	Standard Proctor Maximum Dry Density (ASTM D698)	1 every 20,000 m^3	1 every 10 QC Tests
	In Situ Density by Portable Nuclear Gauge (D6938) [d]	1 per each lift completed in a day and 1 every 2,500 m^3	1 every 10 QC Tests
	Lift Thickness	Measured continuously	Measured periodically
Filter Sand	Water Content	1 test per pipe installation	1 test
	Wash Sieve Gradation (ASTM C136 & C117)	2 tests per provider	1 test
	Standard Proctor Maximum Dry Density (ASTM D698)	2 tests per provider	None required
	In Situ Density by Portable Nuclear Gauge (D6938)	1 per lift	1 every 10 QC Tests
	Lift Thickness	Measured continuously	Measured periodically
Drain Rock	Visual Gradation	Continuously	Continuously

a) Frequencies based on in-place compacted volumes.
b) Samples for testing shall be collected from the foundation within the Till Core and Upstream Fill footprint. Frequency based on area defined by the Till Core and Upstream Fill footprint.
c) Minimum of two tests per abutment per construction year.
d) Small excavations may be required to test the in situ density of the bottom portion of the 0.6 m lifts as required by the QA Manager.

6.0 UPSTREAM DRAIN

6.1 Scope

This Section comprises all requirements for construction of the upstream drains, which includes the placement of Drain Rock and drain rock transition materials, and installation of geotextile and pipeline, according to the lines and grades shown on the Drawings or as directed by the Owner's Construction Manager and QA Manager.

6.2 General

6.2.1 Tolerances

Excavation limits are defined by the lines and elevations shown on the Drawings. Uniform gradients shall be maintained between adjacent spot elevations shown on the Drawings. The excavation shall be in a manner so that piping can be laid straight at a uniform grade, without sags or humps. The tolerances for the pipeline, unless otherwise approved by the QA Manager, shall be as follows:

- Line ± 150 mm; and
- Grade ± 30 mm.

6.2.2 Handling and Storage

Pipe and pipe fittings shall be stored on clean level ground, free of sharp objects which could damage these materials. Stacking shall be limited to a height that shall not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

During delivery to site, the geotextile shall be wrapped to protect it from ultraviolet (UV) light exposure, precipitation, mud, dirt, dust, puncture, or other damaging or deleterious conditions. Upon delivery at the job site, the geotextile rolls shall be handled and stored in accordance with the manufacturer's instructions to prevent damage, and in particular is to be protected from UV light exposure.

The QA Manager shall inspect the pipe, pipe fittings and geotextile prior to use, to verify that the proper material has been received. The material shall also be inspected to ensure they are free of flaws or damage occurring during manufacturing, shipping, or handling.

6.3 Materials

6.3.1 Polyethylene Pipe and Fittings

Pipes and fittings shall be homogenous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

Fittings at the ends of pipes shall consist of polyethylene end cap.

The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Fittings supplied by manufacturers other than the manufacturer of the pipe shall not be permitted without the approval of the QA Manager.

The polyethylene pipe is to be perforated, where perforated pipe is shown on the Drawings. The perforations shall be drilled into the pipe after manufacture at the manufacturing plant.

The following pipe will be required for the works:

- 150 mm diameter perforated SDR 9 high-density polyethylene pipe (HDPE), PE4710 or equivalent approved, with smooth interior wall. The HDPE pipe shall be joined with split corrugated couplings.
- 300 mm diameter solid, SDR 17 HDPE pipe, PE4710.

6.3.2 Pipe Bedding and Backfill Material

Pipe bedding and backfill material shall meet the requirements of Section 5.4.10 of these Specifications.

6.3.3 Drain Rock Transition Material

Drain rock transition material shall meet the requirements of Section 5.4.10 of these Specifications.

6.3.4 Geotextile

An 800 g/m^2 non-woven needle punched geotextile shall be placed along the base of the Drain Rockfill and a 340 g/m^2 non-woven needle punched geotextile shall be placed over the Drain Rock transition. The geotextile shall be manufactured from prime quality virgin polymer. The geotextile shall meet or exceed all material properties listed in Table 6-1 and Table 6-2.

Table 6-1: Properties of 800 g/m^2 non-woven Geotextile

Property	Standard	Unit	Value
Mass per Unit Area	ASTM D 5261	g/m^2	812
Grab Tensile Strength	ASTM D 4632	N	2,000
Grab Elongation	ASTM D 4632	%	50
CBR Puncture Strength	ASTM D 6241	N	1,100
Trapezoidal Tear Strength	ASTM D 4533	N	890
UV Resistance	ASTM D 4355	% retained after 500 hours	70

Table 6-2: Properties of 340 g/m^2 non-woven Geotextile

Property	Standard	Unit	Value
Mass per Unit Area	ASTM D 5261	g/m^2	340
Grab Tensile Strength	ASTM D 4632	N	1,020
Grab Elongation	ASTM D 4632	%	50
CBR Puncture Strength	ASTM D 6241	N	530
Trapezoidal Tear Strength	ASTM D 4533	N	420
UV Resistance	ASTM D 4355	% retained after 500 hours	70

All rolls of the geotextile shall be identified with permanent marking on the roll or packaging, with the manufacturers name, product identification, roll number and roll dimensions.

6.4 Execution

6.4.1 Trench Excavation

The trench excavations shall be performed to the lines and grades shown on the Drawings or as directed by the QA Manager. Trench excavations shall not begin until the Surveyor has provided construction staking for the proposed work. The exposed subgrade along the trench shall be inspected by the QA Manager and approved prior to any fill being placed. Final surface shall be free of loose materials, clods, and other debris including grade stakes and hubs.

The trench excavations shall be graded and properly maintained to provide adequate drainage at all times. Work shall be suspended when, in the opinion of the QA Manager, the site is overly wet, muddy, or otherwise unsuitable for proper maintenance, until directed otherwise by QA Manager.

6.4.2 Fill Placement

All fill placement, including Drain Rockfill, drain rock transition, pipe bedding and backfill, shall be in accordance with Section 5.0 of these Specifications.

6.4.3 Piping

6.4.4 Handling and Placement

Care shall be exercised when transporting, handling and placing pipe and fittings, such that they are not cut, kinked, twisted, or otherwise damaged.

The pipe manufacturer’s recommendations for handling, storage, and installation of all polyethylene pipe fittings shall be complied with.

Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Slings and straps shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches, or dragged over sharp objects.

The maximum allowable depth of cuts, gouges or scratches on the exterior surface of pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. All pipe and fittings shall be carefully examined for cracks, damage or defects before installation. The QA Manager shall inspect all pipes. Sections of pipe with excessive cuts, gouges or scratches shall be rejected and the rejected pipe shall be removed and replaced.

Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

6.4.5 Pipe Installation

All pipe and fittings shall be installed in accordance with this Specification, the pipe manufacturer's instructions, and ASTM D2321. All pipe and fittings shall be laid or placed to the grades and elevations shown in the Drawings with bedding and backfill as shown in the Drawings.

The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.

Field-cutting of pipes, where required, shall be made with a machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cutter ends shall be tapered and sharp edges filed off smooth. Flame cutting shall not be allowed.

No pipe shall be laid until the QA Manager has observed the condition of the pipe.

No pipe shall be brought into position until the preceding length has been bedded and secured in its final position. Blocking under piping shall not be permitted unless specifically accepted by the QA Manager for special conditions.

Placement of overlying pipe backfill shall be carried out such that pipe is not damaged. The QA Manager may periodically request to prove that covered pipe has not been crushed.

The location and final elevation of the invert of the pipes shall be surveyed. The pipes shall be surveyed at ends and at approximately 20 m intervals between the ends.

6.4.6 Joints and Connections

All HDPE pipe shall be joined with thermal butt-fusion joints. All joints shall be made in strict compliance with ASTM D2657 and the pipe manufacturer's recommendations.

6.4.7 Geotextile Installation

The geotextile shall be installed in accordance with this Specification and the manufacturer's instructions. The geotextile shall be laid to the lines shown in the Drawings. The geotextile shall be placed after the drain rock transition has been placed, compacted and approved by the QA Manager.

The geotextile shall be handled in such a manner as to minimize damage during installation.

The geotextile panels are to overlap a minimum of 450 mm. No direct equipment trafficking over geotextile is permitted. The geotextile shall not be exposed to rain or snow precipitation prior to being installed and shall not be left exposed for more than 15 days after installation.

Damaged areas in the geotextile shall be repaired to the satisfaction of the QA Manager. Prior to repair, any soil or other materials that has penetrated the damaged geotextile shall be removed. The geotextile shall be repaired by placing a patch of the same type of geotextile that extends a minimum of 300 mm beyond any edge of the area to be repaired. Geotextile that cannot be repaired shall be replaced with new geotextile that complies with the project requirements.

6.5 Quality Assurance

QA monitoring will be carried out by the Geotechnical Engineer through their QA Manager, to satisfy themself and MPMC that the Work is being carried out in accordance with the Drawings and Specifications.

7.0 SPILLWAY

7.1 Scope

The emergency spillway during operations will be constructed on the north side of the TSF and will discharge to Bootjack Creek. Access to the Work will be provided and coordinated by the Owner's Representative.

This section comprises the requirements for construction of the emergency spillway during operations, which includes the placement and compaction of construction materials described in Section 7.3, according to the lines and grades shown on the Drawings or as directed by the Owner’s Construction Manager and QA Manager.

Surveys shall be performed to confirm the elevations and coordinates shown on the Drawings.

The locations of the exposed material boundaries and exposed surfaces shall be surveyed.

7.2 Materials

The materials to be used for spillway construction are shown on the Drawings and described in Sections 7.2.1 to 7.2.9.

7.2.1 Rockfill

Rockfill shall meet the requirements of Section 5.3.5 of these Specifications.

7.2.2 Native Fill

Native excavated material from the emergency spillway excavation can be used, as needed, for the construction of the emergency spillway channel between the Tailings Access Road and Bootjack Creek. Native Fill shall be free of organics, high plasticity clay, frozen or otherwise deleterious materials. Native Fill material shall be visually assessed by the QA Manager prior to placement to ensure it is suitable for placement. Soils with high moisture contents (i.e., saturated) shall not be placed without prior aeration and drying.

7.2.3 Till Liner

The Till Liner shall be a well graded till with a maximum particle size of 150 mm and a fines content between 20% and 70% by weight (particles finer than 0.075 mm). The Till Liner shall be sourced from designated borrow areas. Till Liner material shall be free of organics, high plasticity clay, frozen or otherwise deleterious materials.

7.2.4 Riprap

Riprap material shall be placed for the construction of the emergency spillway and meet the following standards. Riprap shall consist of well-graded, hard, durable, and angular rock which meets the gradation requirements set out in Table 7-1 and Table 7-2. Riprap material properties shall conform with requirements set out in Table 7-3). Riprap material is to be non-potentially acid generating (NPAG). Acceptance of all fill materials based on geochemical properties shall be the responsibility of the Owner's Construction Manager. Riprap is subject to the approval of the QA Manager prior to placement. Riprap QC and QA requirements are provided in Section 7.4.

Table 7-1: Mass Gradation for Riprap

Class of Riprap (kg)	Rock Gradation Percentage Smaller Than Given Rock Mass (kg)			
	15%	50%	85%	100%
10	1	10	1	10
50	5	50	5	50
100	10	100	10	100

Table 7-2: Dimension Gradation for Riprap

Class of Riprap (kg)	Approximate Average Dimension (Sg = 2.5) Equivalent Diameter (mm)			
	15%	50%	85%	100%
10	90	200	285	350
50	155	340	485	600
100	200	425	610	750

Table 7-3: Rip Rap Material Properties

Property	ASTM Test Designation	Allowable Value
Specific Gravity	D6473	≥2.50
Absorption	D6473	≤2%
Soundness By Use Of Magnesium Sulphate	D5240	≤10 % (Following 5 Cycles)
Micro-Deval Abrasion Loss Factor	D6928	≤20%

7.2.5 Fine Bedding

Fine Bedding shall be placed between the Ground Surface and Riprap with D_{50} less than or equal to 400 mm (10 kg Class Riprap, and 50 kg Class Riprap), as shown on the Drawings. Fine Bedding shall be well graded sand and gravel with maximum particle size of 100 mm and less than 12% passing 0.075 mm.

Fine Bedding used in construction of the emergency spillway is to be non-potentially acid generating (NPAG). Acceptance of all fill materials based on geochemical properties shall be the responsibility of the Owner's Construction Manager. The material shall consist of hard, durable mineral particles, without organic matter, clay, soft particles, or any other unsuitable material.

Fine Bedding QC and QA requirements are provided in Section 7.4.

7.2.6 Coarse Bedding

Coarse Bedding shall be placed below Riprap with D_{50} greater than 400 mm (100 kg class Riprap), as shown on the Drawings. The Coarse Bedding shall consist of well graded material with a maximum diameter of 0.2 m , less than 30% sand and less than 5% fines. Granular Bedding material is to be non-potentially acid generating (NPAG). Acceptance of all fill materials based on geochemical properties shall be the responsibility of the Owner's Construction Manager.

Coarse Bedding QC and QA requirements are provided in Section 7.4.

7.2.7 Granular Road Gravel

Granular Road Gravel shall consist of granular material approved by the QA Manager and the Owner's Construction Manager.

7.2.8 Geotextile

A 340 g/m^2 non-woven needle punched geotextile shall be placed along the base of the Coarse Bedding. The geotextile shall be manufactured from prime quality virgin polymer. The geotextile shall meet or exceed all material properties listed Table 6-2.

7.2.9 Precast Concrete Weir

Precast Concrete Weir to be Precon’s precast panel wall or equivalent weir to be approved by QA Manager.

7.3 Execution

Construction to raise the TSF embankment to elevation 974 m is expected to occur over 2 or more construction seasons. The emergency spillway shall be constructed before the end of the first construction season and then raised each season in accordance with the embankment raise.

7.3.1 Spillway Surface and Foundation Preparation

The spillway stripping, clearing, excavations, and foundation preparation shall meet the requirements of Section 4.2, 4.3, and 4.4.

7.3.2 Rockfill Placement and Compaction

The Rockfill placement and compaction for the emergency spillway shall be in accordance with Section 5.4.6.

7.3.3 Native Fill Placement and Compaction

Native Fill shall be placed in loose lift thicknesses of 0.3 m or less (prior to compaction).

Precautions shall be taken to prevent any contamination of the material. Any contaminated materials shall be removed and replaced. Contaminated material shall be removed to the satisfaction of the QA Manager prior to additional material being placed.

Native Fill material shall be compacted with a sheep's foot drum roller to achieve a dry density of at least 95% of the Standard Proctor maximum dry density, as determined by ASTM D698. The final surface of the Native Fill shall be compacted with a smooth drum vibratory roller to achieve an even surface.

7.3.4 Fine Bedding Placement and Compaction

The Fine Bedding shall be placed in loose lifts of 0.3 m or less (prior to compaction) to the extents shown in the Drawings.

The Fine Bedding material shall be compacted with six (6) passes of a smooth drum vibratory compactor having a static weight of at least twelve (12) tonnes.

7.3.5 Coarse Bedding Placement and Compaction

The Coarse Bedding shall be placed in loose lift of 0.3 m or less (prior to compaction) to the extents shown in the Drawings.

The Coarse Bedding material shall be compacted with six (6) passes of a smooth drum vibratory compactor having a static weight of at least twelve (12) tonnes.

7.3.6 Till Liner Placement and Compaction

The Till Liner material shall be spread parallel to the axis of the spillway in horizontal lifts of uniform thickness not exceeding 0.3 m prior to compaction.

Precautions shall be taken to avoid any presence of particles greater than 150 mm. Oversize material shall be removed to the satisfaction of the QA Manager. Affected zones of Till Liner material shall be removed at the direction of the QA Manager.

The Till Liner shall be compacted with a sheep's foot drum roller to achieve a dry density of at least 95% of the Standard Proctor maximum dry density, as determined by ASTM D698.

The compacted till surface shall be graded to prevent ponding water.

7.3.7 Riprap Placement

Riprap shall be placed in lifts, with the average thickness of each lift not to exceed the median rock diameter (D_{50}) of the riprap class being placed. Nominal riprap layer thickness at right angles to the slope shall be a minimum of 0.4 m for 10 kg Class riprap and 0.68 m for 50 kg Class riprap and 0.9 m for 100 kg Class riprap.

Riprap shall be placed with care to ensure adequate interlocking of the particles is achieved. Riprap placed adjacent to the pre-cast concrete weir shall be placed carefully to ensure the concrete is not damaged.

Riprap placed for the road crossing shall be void-filled after each lift washing in granular road gravel. Alternatively, void filling may be accomplished by pre-mixing the riprap with the granular road gravel and carefully placing the mix to ensure adequate interlocking of the riprap.

Riprap shall be placed to the extents, grades, and slopes indicated on the Drawings.

Riprap shall not be placed by end dumping, chutes, or being dropped from a height greater than 1.0 m from its final position.

7.3.8 Granular Road Gravel Placement

Granular Road Gravel shall be washed into the road crossing riprap. Placement and compaction requirements shall be determined by the QA Manager and the Owner's Construction Manager during construction.

7.3.9 Geotextile Installation

The geotextile shall be installed in accordance with this Specification and the manufacturer's instructions. The geotextile shall be laid to the lines shown in the Drawings. The geotextile shall be placed after the Till Liner transition has been placed, compacted and approved by the QA Manager.

The geotextile shall be handled in such a manner as to minimize damage during installation.

The geotextile panels are to overlap a minimum of 450 mm. No direct equipment trafficking over geotextile is permitted. The geotextile shall not be exposed to rain or snow precipitation prior to being installed and shall not be left exposed for more than 15 days after installation.

Damaged areas in the geotextile shall be repaired to the satisfaction of the QA Manager. Prior to repair, any soil or other materials that has penetrated the damaged geotextile shall be removed. The geotextile shall be repaired by placing a patch of the same type of geotextile that extends a minimum of 300 mm beyond any edge of the area to be repaired. Geotextile that cannot be repaired shall be replaced with new geotextile that complies with the project requirements.

7.3.10 Repair and Replacement of Damaged Precast Concrete Weir

For the repair and replacement of damaged concrete the following sequence of steps shall be followed:

- Replace any element that suffers structural damage including cracking or other damage that in the opinion of the QA Manager, compromises its strength, performance, or durability.
- Examine all concrete surfaces and clearly mark out spalled or other areas to be repaired. Obtain the QA Manager's authorization of the delineated repair areas and the proposed method and equipment to be used for the repairs prior to commencing the work.
- Completely remove all damaged concrete down to sound concrete. Remove microfractured surfaces resulting from the initial concrete removal process.
- Sawcut the perimeter perpendicular to the surface to a minimum depth of 25 mm. Do not use any repair method that produces a featheredge.
- Prior to placing repair mortar, clean and dampen the surfaces to obtain a saturated surface dry condition except where the repair technique requires a dry surface.
- Place the polymerized cementitious mortar in accordance with the manufacturer's written instructions. Treat the surface of the concrete to be repaired with a compatible acrylic bonding agent as authorized by the QA Manager prior to mortar filling.
- Construct the repair area slightly proud of the general surface and then grind it to match.
- Following repairs, promptly initiate curing and protection in accordance with CAN / CSA- A23.1.
- Provide completed repair areas that are tightly bonded to the underlying concrete and are free of shrinkage cracks or hollow void areas.

7.4 Spillway Quality Control and Quality Assurance

Quality Control (QC) will be performed to ensure that the Work is constructed in accordance with the Drawings and Specifications.

Quality Assurance (QA) monitoring and testing will be carried out by the Engineer through their QA Manager, to satisfy themselves and MPMC that the Work is being carried out in accordance with the Drawings and Specifications.

The QC and QA testing requirements and frequency for the emergency spillway materials are listed in Table 7-. At a minimum, all the required testing shall be performed to document the construction quality. The material testing listed in Table 7- shall be completed on record samples taken from placed material on emergency spillway to evaluate suitability of material and segregation during placement.

All necessary inspections, sampling and testing shall be performed to ensure that only materials of the specified composition, gradation and moisture content are supplied to the construction area. A sufficient number of control samples from the stockpile are to be tested prior to use to confirm the suitability of the material used.

The Owner's Construction Manager shall identify material stockpiles available for use in the construction.

Table 7-4: Spillway QA/QC Testing

Materials	Testing[a]		
	Test	QC Frequency	QA Frequency
Rockfill	Lift Thickness	Measured continuously	Measured periodically
	Visual Gradation	Measured continuously	Periodical visual inspection
Native Fill	Lift Thickness	Measured continuously	Measured periodically
	Visual Gradation	Measured continuously	Measured periodically
	Standard Proctor Maximum Dry Density (ASTM D698)	1 every 8,000 m^3	-
	In Situ Density by Portable Nuclear Gauge (D6938)	2 per each lift completed in a day	1 every 5 QC Tests
Till Liner Material	Water Content (ASTM D2216)	2 per borrow location and 1 every 1,000 m^3	Periodical visual inspection
	Gradation (ASTM D6913)	2 per borrow location and 1 every 4,000 m^3	1 every 5 QC Tests
	Standard Proctor Maximum Dry Density (ASTM D698)	1 per borrow location and 1 every 8,000 m^3	-
	In Situ Density by Portable Nuclear Gauge (D6938)	2 per each lift completed in a day	1 every 5 QC Tests
	Lift Thickness	Measured continuously	Measured periodically
Riprap	Visual Gradation	Measured continuously	Periodical visual inspection
	Lift Thickness	Measured continuously	Measured periodically
Fine Bedding and Coarse Bedding	Wash Sieve Gradation (ASTM C136 & C117)	1 every 3,000 m^3	1 every 2 QC Tests
	Lift Thickness	Measured continuously	Measured periodically
	Number of Passes of Compactor	Measured continuously	Measured periodically

a) Frequencies based on in-place compacted volumes.

8.0 INSTRUMENTATION

8.1 Scope

This Section describes the requirements for the supply, installation, testing, data acquisition and protection of instrumentation. The requirements include equipment and application software for the data acquisition, transmission and processing system.

The main items include installation of:

- vibrating-wire piezometers (VWPs);
- ShapeAccelArray (SAA) within existing inclinometers and new SAA installation; and
- data acquisition and processing equipment.

Also included is the extension of existing slope inclinometer casing and VWP and SAA cables that will be buried as part of the construction works.

The work shall include all labour, materials and equipment to complete the design as shown on the Drawings.

8.2 General

The locations for the instrumentation are shown in the Drawings, and installation procedures provided in this Specification. The location of all instruments and installation will be subject to approval by the QA Manager.

New instrumentation will be installed as shown in the Drawings. The existing instrumentation integrity shall be kept unless otherwise shown in the drawings.

The instrumentation and all materials required for the installation shall be brought to site at least 15 days in advance of installation, and the QA Manager shall review and approve them.

8.3 Submittals

A list of all instruments, cable, and casing lengths are to be submitted to the Geotechnical Engineer. A method for marking and identifying cables for individual instruments are to be included.

Manufacturer calibration sheets for all instruments to be installed are to be submitted to the Geotechnical Engineer.

Installation data including the installed location, the instrument identification number, the instrument serial number, and the installation date and time is to be provided to the Geotechnical Engineer. The data is to include the SAA azimuth corrections for software, and azimuth direction of X-marks.

8.4 Installation Procedures

Installation of the instruments shall be carried out in accordance with the Drawings, Specification and the instructions of the equipment manufacturer.

Readings of each instrument shall be taken to verify correct functioning. Backfill shall not be placed over the instruments or cable leads until the instruments have been tested and initial readings have been taken. An initial set of readings shall be taken immediately after installation.

Sufficient cable to route to the SAA and VWP data loggers or VWP connector boxes shall be purchased. The cable shall be long enough to provide adequate strain relief. Existing instrumentation shall be extended.

All cables shall be marked with identification tags at intervals of 15 m, or closer if required. In addition, each instrument shall be marked with the identification given to it on the Drawings or as identified by the QA Manager.

All instruments, cables, and connectors shall be protected from damage and displacement during progress of the work, and markers and barricades shall be provided as necessary.

Cables from the instruments to the SAA and VWP data loggers or VWP connector boxes shall be wrapped in geotextile and installed into trenches, as shown on the Drawings or as directed by the QA Manager. The instrumentation cables shall be protected from impact and damage during construction by hand-tamped sand backfill.

No traffic or equipment shall pass over any part of any instrument, cables or connections until at least 600 mm thickness of compacted material cover has been installed.

8.5 Electrical Protection and Safety

New and existing instrumentation shall be connected to the data acquisition system and it shall be confirmed that the system provides the following minimum protection for all electrical equipment:

- over-voltage peak suppressor;
- alternating current filter to eliminate interference; and
- Grounding system for lightning protection.

8.6 Voltage and Electrical Frequency

Facilities requiring permanent electrical power, including battery chargers and space heaters, shall be configured to operate at 110 V, alternating current at 60 Hz.

8.7 Protection

The instrumentation shall be protected with end caps and protective casing.

Cabins, supports and accessories necessary for the installation and protection of the instruments shall be provided.

8.8 Grout Mix

The grout mix in Table 8-1 shall be used for the VWP, inclinometer casing, and SAA installation.

Table 8-1: Grout Mix for Vibrating Wire Piezometer, SAA and Inclinometer Installation

Material	Quantity	Ratio by Weight
Portland Cement	42.5 kg	1
Water	107.5 L	2.5
Bentonite Powder	12.8 kg	0.3

The above quantities shall be adjusted to match the cement weight such that the mix comprises a unit number of bags of cement.

Mixing shall be carried out by first introducing the water into the mixer followed by the cement. The water cement mixture shall be thoroughly mixed before the bentonite is added. Bentonite powder and not pellets shall be used. Mixing shall continue until a stable, uniform slurry is achieved.

Grout shall be continuously agitated during pumping and grouting.

Instrumentation shall be backfilled from the bottom up. Grout shall be delivered into the hole by a threaded tremie PVC pipe.

8.9 Vibrating Wire Piezometers

8.9.1 General

Vibrating wire piezometers shall include the piezometer sensors, leads, the connector box, and all associated equipment and materials, including waterproof junction boxes, universal lead connectors, electrical protection systems and conduits, necessary for installation, testing, and operation. All such equipment shall be provided by the same manufacturer.

Data reading and recording shall be carried out manually during construction of the Work, and automatically thereafter.

Each piezometer shall have a sensor measuring range of up to 1 MPa, with a sensitivity of 0.025% and accuracy of ±0.1% of full-scale pressure (FS).

The following piezometers may to be installed:

- Model VW2100 manufactured by RST Instruments, or approved equivalent; or
- Model 4500S manufactured by Geokon Incorporated, or approved equivalent.

The connector boxes shall have capacity for simultaneous installation of all leads from the piezometers shown on the Drawings.

Additional piezometer cables may be required to connect to the existing piezometers, which will be buried as part of construction, to the connector boxes.

A read-out unit shall be provided to process signals from VWPs and to display the results.

8.9.2 Installation

Piezometers shall be installed according to the manufacturer's instructions, within the embankment fill, general fill (or tailings beach) and foundation at elevations shown on the Drawings or as directed by the QA Manager. Piezometers will be installed at the same time the inclinometer casing is been installed.

Prior to installation, the piezometer shall be immersed in de-aired water in accordance with the manufacturer's instructions.

The VWPs shall be attached, filter facing upward, to the outside of the inclinometer casing using duct or electrical tape.

The vibrating wire piezometer filter shall not be covered with the tape. An initial reading is required right after the readings have stabilized in the hole and before the hole is backfilled with grout.

Following installation, the hole shall be grouted with cement-bentonite from bottom to top using a tremie pipe. The grout mix to be used is defined in Section 8.9.

Installation of the piezometers shall be completed by connecting the leads to the connector boxes within the instrumentation cabin. The leads from the instruments to the connector boxes shall be wrapped in geotextile and installed into trenches, as shown on the Drawings or as directed by the QA Manager.

8.9.3 Extension of Vibrating Wire Piezometer Cables

As part of the embankment raise construction activities it will be necessary to relocate/extend the cable of VWP instrumentation so that they can be accessed from the raised embankment crest or buttress, as shown on the Construction Drawings, and specified in this section.

- Existing excess cable can be used where available and suitable
- All cable shall be inspected for suitability and tested, using a handheld read-out unit, prior to extension
- All extended VWP cables shall be laid horizontally or vertically within the embankment construction material
    - Cable shall be realigned so that it is a minimum of 0.75 m below the existing surface and/or lowest elevation of the till core, as shown in the construction drawings
    - At the initial location of cable realignment (i.e., initial 90-degree turn) the VWP cable shall be backfilled with a cement-bentonite mix to form a minimum 2 m long plug, as shown in the construction drawings
    - VWP cable shall be placed on a minimum bed of 0.1 m of hand placed bedding material (Section 5.4.10) with a maximum particle size of 20 mm and nominally compacted with hand operated equipment
    - VWP cable shall be backfilled to a minimum depth of 0.3 m above the cable with bedding material
    - The remaining 0.45 m above the cable shall be backfill with transition material and nominally compacted with light-duty compactor approved by the QA Manager.
- Where required, new cable shall be spliced in accordance with manufacturers instructions

- Spliced cable sections shall be placed horizontal so that they are located a minimum of 0.5 m from any cable bends, in any direction
- Spliced cable sections shall be backfilled with cement-bentonite mix

All relocated/extended cable shall be tested, using a handheld read-out unit, following relocation/extension to confirm it is operational.

8.10 Shape Acceleration Array Systems

8.10.1 General

This section covers furnishing and installing ShapeAccelArrays (SAAs) systems.

The SAA system shall be an SAAV, as manufactured by Measurand Inc. or approved equivalent. The SAA system shall have segment lengths of 500 mm. The lengths of each SAA system will be confirmed after drilling of the boreholes is completed.

A data acquisition system (DAS) shall be installed to collect data from the SAA instruments. Options include the DAS-1 and DAS-5. Both contain Campbell Scientific Inc. loggers, interface modules, and other components to automate data collection. Refer to the manufacturer for specific and additional components for each DAS. Batteries are not included with the DAS and shall be selected based on the manufacturer's specifications. Maximum cable lengths for SAAV vary; refer to the manufacturer for details. An SAA Surge Protection Device (SAASPD) shall be installed to protect the SAA from electrical surges caused by nearby lightning strikes. Refer to the manufacturer for details.

Twelve SAAs will be installed. Seven SAAs shall be installed on existing inclinometer casing located along the Main and Perimeter embankments. Drilling new boreholes will be required to install five SAAs along the South and Main embankments.

Only SAA splice kits, manufactured by Measurand Inc. shall be used for splicing SAA cables. Other splicing kits can only be used with SAA Manufacturer approval.

8.10.2 Installation

The SAA systems shall be installed in accordance with the manufacturer's handling and installation specifications. The vertical installation shall be done in accordance with the following procedure:

- The installation depth for the SAA shall be confirmed and documented by the QA Manager.
- A 70 mm SAA casing cap shall be placed on the inclinometer casing.
- The SAAV reel shall be set on the reel stand such that it unreels from the top. The reel shall be placed 1.0 m to 1.5 m away from the borehole. For SAAVs longer than 50 m, a sufficiently large reel stand (e.g., jack stands) shall be used to place the reel directly above the borehole.
- The insertion of the SAAV shall be done by at least two people: one person to guide the SAA instrument into the borehole, and the other to control the rate of descent by handling the reel.

- One extension tube shall be detached from the SAAV reel and attached to the springbox assembly. The X-mark on the extension tube should be in line with the X-mark on the SAAV. In cases where the SAAV is shorter than the borehole, several extension tubes may be required. See manufacturer's instructions for more details.
- Once the extension tube has been attached and the SAAV is resting on the bottom of the borehole, the SAAV shall be settled into the inclinometer casing (see manufacturer's instructions for more details):
  - The SAAV installation verification tool included in the Measurand SAA recorder software shall be used by connecting a computer to the SAA.
  - The casing cap shall be removed and set aside with enough slack cable to avoid interference with the settling process.
  - The SAAV shall be lifted until it is hanging in the casing with one segment touching the bottom. The angle reported by the SAAV Installation Verification tool should be 4-6 degrees.
  - Once the SAAV is resting on the bottom of the casing, the SAAV shall be dropped such that it falls straight into the casing. Approximately 5 lbs of downward pressure shall be applied to compress the SAAV within the casing. The compression value shall be recorded in the SAAV installation verification tool and sample data from the SAA recorder shall be collected.
  - The SAAV shall be lifted so only the last segment is resting on the bottom of the casing and dropped repeatedly until three sequential readings of compression do not change by more than 1 mm (10-15 drops).
  - The casing cap shall be replaced over the extension rods onto the top of the casing.
- The azimuth offset shall be determined using the X-mark protractor and methods described in the manufacturer's instructions.
- The SAAV casing cap shall be attached to the inclinometer casing using the method outlined in the manufacturer's instructions.
- The extension tube shall be cut by an amount determined by compressing the SAAV with 11 lbs of mass, and with the use of the extension tube anchor, the cutting location shall be marked.
- After cutting, the extension tube anchor shall be inserted into the top of the tube, and the extension tube shall be compressed until the bolt can be screwed into place.
- The SAAV cable shall be inserted into the cable grommet in the SAAV casing cap. The SAAV casing cap shall be closed and secured. See manufacturer's instructions for more details.

8.11 Inclinometers

8.11.1 General

A 70 mm diameter inclinometer casing manufactured by RST instruments or Durham Geo Slope Indicator (DGSI), or approved equivalent, shall be installed. The corresponding casing coupling manufactured by RST instruments or DGSI, or approved equivalent, shall be used to connect the inclinometer casings.

8.11.2 Installation

The borehole diameter should be large enough to accommodate the inclinometer casing and a tremie pipe so that grout can be pumped into the annulus from the bottom up.

Installation should closely follow the following procedure:

- Once the hole has been drilled to the required depth, the first length of casing shall be inserted, complete with bottom cap, anchor and attached tremie pipe. Additional lengths of casing are added until the desired depth is reached.
- Once the slope inclinometer casing is lowered into the hole to the required depth, a pair of grooves should be aligned in the expected direction of ground movement. This should be done only if it can be accomplished without applying excessive torque to the casing.
- Grout should be pumped through the tremie pipe into the hole, displacing any groundwater within the borehole.
- During casing installation, groundwater, drilling fluid, or fluid grout within the borehole may exert an uplift buoyancy force on the casing, lifting the casing out of the borehole. The following measures shall be used to prevent this uplift:
  - Anchor the casing at the bottom of the borehole prior to grouting by special accessory “casing anchors”.
  - Fill the inclinometer casing with water prior to grouting.
  - Grout the borehole in stages.
  - Blow all water from the inclinometer casing.
- Where there are no special constraints, the casing should stick up about 0.5 to 0.75 m.
- Spiral twisting of the grooves should not exceed 0.75 degrees per metre length of the tubing. Where considered necessary by the QA Manager (e.g., on very deep installations, typically >60 m) a spiral survey of the casing grooves shall be carried out after installation and an appropriate correction applied by the data reduction software.
- Upon completion of the installation, the inside of the casing should be kept clean so that the probe can travel accurately in the grooves all the way in and out of the casing. If the grooves become contaminated by grout, they should be cleaned by flushing with water and gentle brushing, and a dummy probe can be lowered to the bottom to check that the grooves are clear.

- After installation and curing of the grout, two sets of inclinometer readings should be taken to provide a reliable baseline. If the two sets show any apparent movement, additional readings should be taken.

8.11.3 Inclinometer Extensions

Existing inclinometer casings shall be extended. Inclinometer casing extensions shall be protected with fine crushed material before rockfill is placed around them. Inclinometer casing ends shall be capped while material is being placed to avoid clogging. Extension pipes, caps and fittings shall be provided in advance. The inclinometer casings shall be extended above the buttress construction surface.

8.11.4 Inclinometers Decommissioning

Eight inclinometer casings along the embankment will be decommissioned by backfilling the casing with grout. Grout mix is defined in Section 8.9.

The inclinometer casing shall be backfilled from the bottom up. Grout shall be delivered into the hole by a threaded tremie PVC pipe.

SB/RG/GP

APPENDIX C

Design Criteria

TECHNICAL MEMORANDUM

DATE March 21, 2024 **Reference No.** 23590671-067-TM-Rev0-51393

TO Matt O'Leary
Mount Polley Mining Corporation

CC Don Parsons

FROM Sophie Bainbridge, Don Kidd, and Germán Pizarro **EMAIL sophie.bainbridge@wsp.com; don.kidd@wsp.com; german.pizarro@wsp.com**

MOUNT POLLEY MINE, BRITISH COLUMBIA – BASIS OF DESIGN AND DESIGN CRITERIA FOR TAILINGS STORAGE FACILITY RAISE TO ELEVATION 974 M

1.0 INTRODUCTION

WSP Canada Inc. (WSP) has developed this technical memorandum as part of a design to support the permit to raise the Mount Polley Mining Corporation (MPMC) tailings storage facility (TSF). This document presents the basis for design and the associated design criteria to be used by WSP for the issued for permit design for raising the existing TSF from its currently permitted elevation of 970 m to 974 m. This document provides the following:

- **project description**—Section 2.0
- **scope of work**—Section 3.0
- **design basis**—Section 4.0
- **design philosophy**—Section 5.0
- **design criteria**—Section 6.0

The reader is referred to the Study Limitations section, which follows the text and forms an integral part of this memorandum.

2.0 PROJECT DESCRIPTION

The Mount Polley Mine is a copper and gold mine operated by MPMC, a subsidiary of Imperial Metals Corporation. The site is located approximately 56 km northeast of Williams Lake, British Columbia, between Polley Lake and Bootjack Lake. The Mount Polley Mine began production in 1997 and operated until October 2001 when operations were suspended for economic reasons. In March 2005, the mine restarted and was in operation up to the time of the TSF breach in August 2014.

In 2015, the Freshet Embankment was constructed to elevation 950 m through the breach area to allow the capture and temporary storage of the 2015 and 2016 freshet flows. The construction of buttresses along the Perimeter and Main embankments was completed in October 2016 (Golder 2015a, 2017a).

The June 23, 2016 amendment of the *Mines Act* Permit M-200 authorized the return to full operations at the mine, including construction and operation of the TSF design to elevation 970 m (Golder 2015b). Construction to raise the Freshet Embankment at Corner 1 to elevation 970 m started in June 2016. By September 2018, construction of the Corner 1 Embankment had been completed to elevation 968 m (Golder 2019). The raise of the Freshet Embankment was referred to as the Corner 1 Embankment. Construction to raise the embankment to elevation 970 m was started in July 2022 and was completed in 2023.

Mining operations at the Mount Polley mine were halted between May 2019 and Q4 2021 for economic reasons. Deposition of tailings generated at the process plant into the TSF was resumed in June 2022. Dredging of tailings from the Springer Pit and deposition into the TSF started in March 2018 and was halted in October 2019.

The TSF is located about 3 km southeast of the mill and includes one embankment that is approximately 4.8 km in length. The embankment is subdivided into three sections: the Main Embankment, Perimeter Embankment, and South Embankment. The embankment has incorporated a staged expansion design utilizing modified centerline and centerline construction methods. The general zoning of the TSF embankment includes the following:

- upstream fill comprising select fill or tailings sand
- low-permeability till core
- filter zone
- transition zone

Rockfill forms the downstream wedge of the embankment and the downstream buttress along the Perimeter and Main embankments (sandy tailings reclaimed from Hazeltine Creek were also used in the construction of the downstream buttress at Corner 1).

The TSF Clean Water Ditch is located upstream of the TSF between Corner 4 and Corner 5 and diverts runoff into a small wetland downstream of the South Embankment.

In 2014, WSP, formerly Golder Associates Ltd. (Golder), completed a feasibility design for raising the embankment of the TSF to a maximum elevation of 984 m (Golder 2015c). The aim of the feasibility assessment was to identify potential considerations, constraints, or conflicts that may limit the elevation to which the TSF could be raised. The results of the study indicated that a raise of the facility is feasible. The life of mine (LoM) plan was updated in 2021 and a crest elevation of approximately 987 m is estimated to be required to contain the LoM tailings.

3.0 SCOPE OF WORK

The scope of work includes the following:

- update of site selection and technology review
- foundation characterization
- site-specific seismic hazard assessment
- 2D steady-state seepage analysis

- 2D limit equilibrium stability analysis
- 2D stress-deformation modelling
- filter compatibility assessment
- tailings deposition modelling
- review and update of the TSF pond management, spillway design, and freeboard requirements
- detailed design reporting including construction drawings and technical specifications

The battery limits for the study are assumed as:

- discharge of tailings into the TSF
- return water at the existing TSF
- the footprint boundaries of the existing TSF
- tie-in points to infrastructure and utilities (e.g., electrical power, access roads, data and communication, and network)

4.0 DESIGN BASIS

This basis of design is established in accordance with relevant design codes, standards, and guidelines.

4.1 Regulations, Standards, and Guidelines

The assessment of the TSF will be consistent with applicable regulatory documents and guidelines from Mount Polley, WSP, and national and international organizations, where applicable (e.g., Canadian Dam Association, International Commission of Large Dams). Regulations applicable to this study comprise the following:

- Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2022).
- Guidance Document for Revisions to Part 10 of the Health, Safety and Reclamation Code for Mines in British Columbia (BCMEM 2016).

The assessment of the TSF will also be consistent with the following guidelines, where applicable:

- Canadian Dam Association (CDA) Dam Safety Guidelines (2013).
- Technical Bulletin: Application of CDA Dam Safety Guidelines to Mining Dams (2019).
- Global Industry Standard for Tailings Management (GISTM 2020).
- Mining Association of Canada – A Guide to the Management of Tailings Facilities (2021)

Other internationally recognized codes and standards may be used, provided these codes and standards meet or exceed the referenced codes herein.

4.2 Dam Classification

Guidelines for the classification of dams are presented in the Canadian Dam Association (CDA) *Dam Safety Guidelines* (CDA 2013), *Technical Bulletin: Application of CDA Dam Safety Guidelines to Mining Dams* (CDA 2019) and *Technical Bulletin: Revision to Consequences of Failure – Environmental Consequence Classification* (CDA 2023). Tailings dams in British Columbia are regulated under the Health, Safety and Reclamation Code for Mines in British Columbia (BCMEM 2016; EMLI 2022), which references the 2013 CDA guidelines.

Consequence categories are based on the incremental losses that a failure of the dam might inflict on downstream or upstream areas or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. Infrastructure and economic consequences are based on third party losses. The consequences of a dam failure are ranked as Low, Significant, High, Very High, or Extreme for each of the loss categories. The classification assigned to a dam is the highest rank determined among the loss categories.

Table 1 presents the dam classification criteria by the CDA (2013, 2019).

Table 1: Dam Classification in Terms of Consequence of Failure

TS	Population at Risk[a]	Loss of Life[b]	Incremental Losses	
			Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	▪ Minimal short-term loss. ▪ No long-term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	**Temporary Only**	**Unspecified**	▪ **No significant loss or deterioration of fish or wildlife habitat.** ▪ **Loss of marginal habitat only.** ▪ **Restoration or compensation in kind highly possible.**	**Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes.**
High	Permanent	10 or fewer	▪ Significant loss or deterioration of important fish or wildlife habitat. ▪ Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transportation and commercial facilities.
Very High	Permanent	100 or fewer	▪ Significant loss or deterioration of critical fish or wildlife habitat. ▪ Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	▪ Major loss of critical fish or wildlife habitat. ▪ Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA 2013, 2019.

(a) Definition for population at risk: None – there is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure; Temporary – people are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities); Permanent – the population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents). Three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

(b) Implications for loss of life: Unspecified – the appropriate level of safety required for a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

The TSF is located between the Hazeltine Creek watershed (north of the TSF) and Edney Creek watershed (south of the TSF). Both watersheds flow on an approximate northwest to southeast direction to Quesnel Lake. The topographical features along the South edge of the Edney Creek watershed are up to 40 m higher than Edney Lake, and the topography along the north edge of the Hazeltine Creek watershed are up to about 30 m higher than Hazeltine Creek. The topography to the south and north of the TSF discourage the inundation extending outside of the Hazeltine Creek watershed and the Edney Creek watershed.

A dam breach and inundation study was carried out considering a flood-induced and sunny-day hypothetical failure of the Main Embankment and South Embankment with a crest elevation of 970 m (Golder 2017b).

- In the event of a breach at the Main Embankment, the runoff would flow southeast along Hazeltine Creek and Edney Creek to Quesnel Lake.
- In the event of a breach at the South Embankment, the runoff would flow south to Edney Lake and southeast along Hazeltine Creek and Edney Creek to Quesnel Lake.
- The runoff from a breach of the Perimeter Embankment would flow southeast along Hazeltine Creek or Edney Creek to Quesnel Lake, depending on the location of the breach.

The water treatment plant is the only permanent structure in these areas. The TSF South, Main, and Perimeter embankments have been evaluated according to the loss criteria.

- The loss of life is considered unspecified based on the limited exposure time of the general population and mine staff.
    - The area at risk for the general population is limited to the section of Gavin Lake Road downstream of the TSF, the bridge crossings on Edney Creek, and the area at the confluence of Hazeltine Creek and Edney Creek with Quesnel Lake. There is no permanent population in these areas.
    - The area at risk for mine staff is limited to the TSF (i.e., embankment crest and buttress) and the downstream water management infrastructure (i.e., WTP, SESCP, and MESCP). Mine staff conduct periodic inspections and maintenance activities at these locations but are not permanently in the area.
- Restoration of the fish habitat is possible, as demonstrated by the rehabilitation works that have been completed to date in the Hazeltine Creek channel.
- Third-party economic losses would be low.

The TSF would therefore be ranked as a significant consequence of failure facility.

As the TSF is raised there is an incremental increase in the volume and peak flow of tailings that could runout in the event of an embankment breach; however, the proposed embankment height raise from about 50 to 54 m (from elevation 970 to 974 m) is not expected to significantly impact the run-out zone and therefore the consequence classification.

4.3 Foundation Conditions

The geological setting of the Mount Polley TSF has been extensively investigated and a dam foundation characterization report has been developed for the TSF (WSP 2023). The foundation characterization report interprets all available information for the TSF foundation conditions. The stratigraphic sequence identified in the area of the TSF can be generalized in order of increasing depth as follows:

- fill and anthropogenic materials
- till, interpreted to represent materials deposited by meltwater and ice (ablation till)
- glaciolacustrine sediments
- glaciofluvial sediments
- basal till
- bedrock

4.4 Climate Data

Climate conditions for the site were estimated based on data from several meteorological stations in the region and at the site. MPMC has operated climate stations on site since 1995, although records are not continuous. Climate parameter statistics for the site were prepared using data from the three on-site climate stations (Mill Site Weather Station, Weather Station #1, Weather Station #2) and five regional climate stations operated by Environment and Climate Change Canada (Likely, Williams Lake A, Spokin Lake 4E, Barkerville, Quesnel A, Prince George A). The climate data were processed and analyzed to obtain a baseline climate information (Golder 2022b).

The Site experiences high summer precipitation due to summer storms, with the lowest monthly precipitation occurring in February. Precipitation typically occurs as snowfall starting in November and accumulates until March. Average annual precipitation at the Site is estimated to be 612 mm with a standard deviation of 118 mm based on precipitation records for the Site from 1974 to 2021. Typically, the increase of temperatures over 0°C starts in March, leading to freshet until June.

Table 2, Table 3 and Table 4 summarize the precipitation, evaporation, and temperature at the site, for different weather scenarios. These are results from a monthly frequency analysis considering data from 1974 to 2021.

Table 2: Monthly Precipitation Depths for the Site, 1974 to 2021

Month	Precipitation (mm)				
	Average	1:200 Year Wet	1:25 Year Wet	1:25 Year Dry	1:200 Year Dry
January	49.4	207	117	17.5	12.4
February	35.8	185	101	8.3	4.7
March	29.7	71	57	9.6	5.0
April	44.7	199	118	8.7	4.3
May	49.9	104	88	17.8	9.4
June	70.8	152	131	18.9	7.7
July	63.6	254	172	7.7	2.4

Table 2: Monthly Precipitation Depths for the Site, 1974 to 2021

Month	Precipitation (mm)				
	Average	1:200 Year Wet	1:25 Year Wet	1:25 Year Dry	1:200 Year Dry
August	50.6	178	120	11.8	5.7
September	52.3	133	111	9.5	3.1
October	58.1	141	111	19.6	10.7
November	49.8	146	110	11.0	4.7
December	57.6	232	135	20.5	14.3
Annual	**612**	**960**	**836**	**421**	**349**

Table 3: Estimated Monthly and Annual Shallow Lake Evaporation Statistics for the Site, 1974 to 2001

Month	Shallow Lake Evaporation (mm)					
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile
January	0	1	4	0	0	1
February	1	7	12	4	7	10
March	24	32	43	29	32	34
April	52	66	79	59	67	72
May	86	105	140	96	102	115
June	95	122	155	110	121	132
July	110	138	173	123	136	153
August	80	115	137	107	113	130
September	37	61	80	54	60	70
October	18	22	28	20	21	23
November	0	4	8	1	4	6
December	0	0	3	0	0	1
Annual	**606**	**673**	**762**	**648**	**670**	**699**

Table 4: Derived Air Temperature (°C) Statistics for Mount Polley Mine, 1974 to 2021

Month	Temperature (°C)							
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile	Daily Maximum	Daily Minimum
January	-16.0	-6.7	-0.3	-8.7	-6.3	-4.0	11.2	-39.4
February	-13.0	-4.8	0.7	-7.7	-4.3	-2.1	13.6	-35.4
March	-6.7	-1.0	3.2	-2.2	-0.8	0.5	18.4	-32.7
April	-0.7	3.7	12.0	2.8	3.7	4.3	27.5	-16.7
May	5.2	8.5	13.1	7.5	8.3	9.6	33.1	-7.9
June	8.6	12.2	15.5	11.1	12.2	13.2	38.1	-4.9
July	11.8	15.1	21.2	13.3	14.8	16.4	36.0	0.6
August	11.0	14.6	17.1	13.6	14.8	15.7	33.0	-4.1
September	6.8	10.0	14.2	8.7	9.6	11.2	36.3	-7.1

Table 4: Derived Air Temperature (°C) Statistics for Mount Polley Mine, 1974 to 2021

Month	Temperature (°C)							
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile	Daily Maximum	Daily Minimum
October	0.8	4.1	8.7	3.4	4.1	4.7	31.1	-26.4
November	-13.7	-2.4	2.6	-3.8	-2.1	-0.4	17.3	-36.9
December	-13.7	-6.6	-1.2	-9.5	-5.5	-3.9	11.3	-39.8
Annual	**1.7**	**3.9**	**6.3**	**3.2**	**3.9**	**4.5**	**-**	**-**

Annual maximum series for 24-hour precipitation from the derived historical dataset was used to undertake a frequency analysis to provide rainfall design values (Table 5). The 24-hour, 3-day, and 10-day annual, spring, and summer probable maximum precipitation (PMP) depths (Table 6) were estimated using the Hershfield method (Golder 2022b).

Table 5: 24-hour Precipitation Depths for the Site, 1974 to 2021

Return Period (yr)	Depth (mm)
2	33
10	47
25	54
100	64
200	69
1,000	80

Table 6: Annual, Spring, and Summer Probable Maximum Precipitation Depths for the Site, 1974 to 2021

Period	Annual PMP (mm)	Spring PMP[(a)] (mm)	Summer PMP[(b)] (mm)
24-Hour	224	192	191
3-Day	339	272	294
10-Day	562	295	486

(a) Spring = March, April, and May.

(b) Summer = June, July, and August.

PMP = probable maximum precipitation.

4.5 Site Seismicity

Mount Polley is located in an area of relatively low seismicity for British Columbia. WSP developed a site-specific seismic hazard model for Mount Polley based on historical seismicity and a review of geological and paleoseismological features (WSP 2023). Probabilistic analysis results from site-specific hazard model are listed in Table 7.

Table 7: Site Seismic Hazard Values

Exceedance Probability	Return Period (years)	Peak Ground Acceleration (g)
5% in 50 years	1,000	0.026
2% in 50 years	2,475	0.048
1% in 50 years	5,000	0.076
½% in 50 years	10,000	0.116

Return periods are not exact representations of annual exceedance probabilities; rounding per Canadian Dam Association guidelines (CDA 2013, 2019) is shown.

5.0 DESIGN AND OPERATION PHILOSOPHY

The design and operation of the TSF will follow the principles set out by the Mining Association of Canada in its Towards Sustainable Mining program and the recommendations made by the IEERP (2015). The following approaches have been used for the design and operation of the TSF:

- Limit the amount of surface water to only that required for operation – this will be achieved through maintaining storage capacity within the external water management ponds and ongoing discharge of water from the mine site.
- Promote unsaturated conditions in the tailings – wide sub-aerial beaches will be maintained upstream of the embankments and upstream drains will be constructed to create a zone of unsaturated tailings adjacent to the embankments.
- Promote consolidation of tailings upstream of the TSF embankment –upstream drains will be constructed to create a zone of unsaturated tailings adjacent to the embankments.
- Reduce the hydraulic gradient across the till core – this will be achieved through maintaining sub-aerial beaches along the embankments and the construction of upstream drains.

Operation of the facility is to follow the above philosophy. The existing quantitative performance objectives will be revisited as part of the design to raise the TSF to elevation 974 and will be used to confirm that operation of the facility follows the operation philosophy.

6.0 DESIGN CRITERIA

The project-specific design criteria are detailed in Table 8.

Table 8: Design Criteria

Criteria	Unit	Value	Source/Comment
General			
Nominal Tailings Production Rate	t/day	20,000	MPMC (2021)
TSF Storage Capacity	-	Minimum to allow continuity of operation until 2026	Includes the remaining storage capacity of the permitted 970 m raise based on the 2019/2020 survey of the tailings surface 8.0 Mt deposited between June 2022 and December 2023
Dam classification	-	Significant	Refer to section 4.2
Coordinate system	-	Tailings grid	MPMC
Units	-	Metric	-
Design earthquake event	-	1:2,475 Annual Exceedance Probability (AEP)	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) Other criteria include: ■ Between 1:100 and 1:1,000 (CDA 2019) ■ 1:1,000 AEP recommended by GISTM (2020) Consistent with WSP's best practice, an earthquake event of 1:10,000 AEP will be used to assess sensitivity of the analyses.
Design earthquake peak ground acceleration	g	0.048	for earthquake event of 1:2,475 AEP 0.116 g for earthquake event of 1:10,000 AEP
Seismic coefficient for limit equilibrium pseudo-static analysis	-	0.5	Hynes-Griffin and Franklin (1984) 20% strength reduction applied to glaciolacustrine deposits as recommended by Hynes-Griffin and Franklin (1984) for clays.
Static (long term)	FoS	1.5	HSRC Guidance Document Section 3.3.1 (BC MEM 2016), CDA (2019) Table 3-4
Static (during or at end of construction)	FoS	1.5	HSRC Guidance Document Section 3.3.1 (BC MEM 2016) >1.3 recommended by CDA (2019) Table 3-4
Pseudo-static	FoS	1.0	Informed by Table 3-5 of CDA (2019)
Post-earthquake	FoS	1.2	Informed by Table 3-5 of CDA (2019)

Table 8: Design Criteria

Criteria	Unit	Value	Source/Comment
Embankment Details			
TSF construction method	-	Centreline	Adopted
Low hydraulic conductivity element	-	Compacted till	Adopted
Overall downstream slope no steeper than	-	2H:1V	HSRC Guidance Document Section 3.3.1 (BC MEM 2016)
Embankment fill material	-	Non-acid generating	MPMC
Tailings Characteristics			
Solids content of tailings slurry discharged to TSF	%wt	Nominally ~ 35	Provided by MPMC
Tailings solids specific gravity	-	2.7	Estimated based on laboratory testing
Tailings average dry density after deposition	t/m^3	1.35	Assumed by WSP 1.36 t/m^3 in Knight Piesold (2005)
Tailings beach slope	%	sub-aerial – 0.5% Sub-aqueous – 2%	Estimated based on available topographic and bathymetric surveys since 2016

TSF = tailings storage facility; FoS = factor of safety.

A tailings deposition plan has been developed by MPMC from the restart of operations in July 2022. Annual tailings deposition into the TSF and cumulative tonnage for restart of operations until Q2 2026 (by which date storage capacity of the elevation 974 m facility will have been achieved, based on the tailings production plan) is included in Table 9.

Table 9: Tailings Production Plan July 2022 to Q2 2026

Period	Tailings Production (tonnes)	Cumulative Total Tonnage
July 2022	470,469	470,469
August 2022	620,000	1,090,469
September 2022	600,000	1,690,469
October 2022	620,000	2,310,469
November 2022	600,000	2,910,469
December 2022	620,000	3,530,469
January 2023	620,000	4,150,469
February 2023	560,000	4,710,469
March 2023	620,000	5,330,469
April 2023	600,000	5,930,469
May 2023	620,000	6,550,469
June 2023	600,000	7,150,469
July 2023	620,000	7,770,469
August 2023	620,000	8,390,469
September 2023	600,000	8,990,469
October 2023	620,000	9,610,469
November 2023	600,000	10,210,469
December 2023	620,000	10,830,469
January 2024	620,000	11,450,469
February 2024	560,000	12,010,469
March 2024	620,000	12,630,469
April 2024	600,000	13,230,469
May 2024	620,000	13,850,469
June 2024	600,000	14,450,469
July 2024	620,000	15,070,469
August 2024	620,000	15,690,469
September 2024	600,000	16,290,469
October 2024	620,000	16,910,469
November 2024	600,000	17,510,469
December 2024	620,000	18,130,469
Q1 2025	1,800,000	19,930,469
Q2 2025	1,820,000	21,750,469
Q3 2025	1,840,000	23,590,469
Q4 2025	1,840,000	25,430,469
Q1 2026	1,800,000	27,230,469
Q2 2026	1,820,000	29,050,469

Note: Some of this material is being deposited within the permitted 970 m TSF configuration. Cumulative total tonnage dates vary based on actual production quantities from July 2022 to date.

Ref. MPMC 2021.

6.1 Water Management Criteria

The Mount Polley Mine site has an annual net water surplus, and discharge from the mine site (after treatment) is necessary to manage the mine site water and to prevent accumulation of water on the mine site on a year over year basis. Temporary detention of water will be necessary to manage the large runoff volumes generated during the freshet; however, the fundamental basis of the water management plan is to not accumulate water on site (including the TSF) by treating and discharging water and to not carry over water from year to year even under extreme wet conditions.

The majority of water inflows into the TSF are pumped and are therefore in the direct control of the operator. These inflows are as follows:

- water discharged with the tailings slurry, at approximately 35% solids by weight
- excess water pumped from the water management structures for temporary detention in the TSF during the freshet and high flow events

Catchment areas directly contributing to the TSF are provided in Figure 1 and Table 10. This catchment delineation is the basis for the TSF spillway design. The water inflows to the TSF that are not pumped, and therefore not in the direct control of the operator, are as follows:

- precipitation on the direct footprint of the TSF
- potential runoff from the catchment directly above the west side of the TSF (catchment B and C in Figure 1) .
- potential runoff from the upstream catchment (catchment A in Figure 1) depending on the updates to the tailings pipeline ditch.

Outflows from the TSF consist of the following:

- reclaim water pumped to the mill by means of a floating barge within the TSF pond
- seepage through the embankment and foundation, including upstream drains, to the seepage collection ponds
- evaporation losses from the TSF pond and TSF wet tailings beaches
- water retained in the newly placed tailings

The TSF will be managed by maintaining the pond volume within the operating range for reclaim water and make-up water.

Deposition of the tailings will be planned in a manner that maintains the pond near the centre of the TSF facility and against the natural topography on the western perimeter.

Relevant parameters used as design criteria are summarized in Table 11.



Figure 1: TSF Catchment Areas

Table 10: TSF Catchment Areas

Catchment	Watershed Area (km^2)
TSF upstream contact A[(a)]	0.43
TSF upstream contact B	0.24
TSF upstream contact C	0.52
TSF	2.38

(a) The catchment area is to be refined as per update to the tailings pipeline ditch.

Table 11: Design Criteria for Tailings Storage Facility Water Levels and Emergency Spillway

Design Criteria		Value	Source / Comment
IDF	Operations	72-hour PMF	PMF runoff volume will be estimate considering the annual 72-hour PMP rainfall plus snowmelt, which was selected consistent with WSP's best practice. Other criteria include: • 1/3 between 1-in-975-year and PMF for a minimum duration of 72 hours required by HSRC Guidance Document Section 3.3.1 (BC MEM 2016). • Between 1-in-100 and 1-in-1,000-year return period recommended by CDA (2019). • 1-in-1,000-year return period recommended by GISTM (2020).
EDF	Operations	24-hour 1:200 year precipitation and snowmelt	Typical EDF return periods range from 1-in-50 years to 1-in-200 years (CDA 2019).
Freeboard	Normal	No overtopping by 95% of waves caused by the most critical wind with a frequency of 1:1000 year with reservoir at maximum normal elevation.	CDA (2013)
	Minimum	No overtopping by 95% of waves caused by the most critical wind when the reservoir is at its maximum level during the IDF.	CDA (2013)
Operating pond volume	Normal operating water level range	1.5 to 1.7 million m^3 (Mm^3)	Minimum provided by MPMC for operation of the mill. Maximum adopted to maintain wide sub-aerial beaches.
	Maximum prior to freshet	1.5 Mm^3	Lowest achievable volume provided by MPMC for operation of the mill.

Table 11: Design Criteria for Tailings Storage Facility Water Levels and Emergency Spillway

Design Criteria		Value	Source / Comment
Beach width	Minimum during normal operating conditions	100 m	Portion of beach above operating pond level.
Emergency Spillway during Operations	-	Spillway to pass the IDF; TSF to store the EDF.	CDA 2019
Climate change consideration	-	Not considered due to design life of the emergency spillway during operations.	The potential variation in precipitation under climate change is expected to be within the range of uncertainty in the PMP estimate. Therefore, the PMP will not be modified further to account for potential climate change effects.
Annual 72-hour PMP	-	339 mm	Section 4.4.
72-hour PMP snowmelt depth	-	54 mm	Snowmelts are determined using an energy balance method (Dunne and Leopold 1978) using 72-hour PMP rainfall and mean April temperature and wind speed.
24-hour 1:200-year precipitation and snowmelt	-	69 mm	Golder (2022b)
72-hour snowmelt distribution	-	Evenly distributed over 72-hour duration as baseflow.	Adopted
Erosion protection requirements	Emergency Spillway during operation	Specific erosion protection materials selected using peak velocities along the spillway alignment as calculated in the hydraulic calculations.	BC MOTI 2007
Upstream drain	Flow capacity	To maintain the phreatic level at the elevation of the drain when the pond encroaches 50 to100 m from the elevation 987 m TSF configuration	Adopted
Upstream drain pipelines capacity	FoS	3	Adopted

IDF = inflow design flood; EDF = environmental design flow; PMF = probable maximum flood; TSF = tailings storage facility; MPMC = Mount Polley Mining Corporation; FoS = factor of safety.

7.0 CLOSURE PHILOSOPHY

The closure philosophy will be consistent with the most recent Mine Reclamation and Closure Plan (*Mines Act* Permit M-200). The TSF will remain a permanent structure, which will be reclaimed and given productive land use. The final configuration of the TSF will include a small permanent pond and wetland area on the surface, with maximum 2H:1V embankment slopes and a spillway for pond water level control. The principal activities and areas for reclamation of the TSF will be as follows:

- removal of all infrastructure
- re-sloping and reclamation of embankments
- spillway construction to limit the pond volume to about 0.25 Mm^3
- reclamation of tailings surface (beach and pond)
- reclamation of till borrow pits, as required

Implementation of closure and its philosophy is feasible for the TSF with a 974 m crest elevation; however, the TSF is planned to be raise above elevation 974 m to provide storage capacity for the LoM.

8.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this memorandum.

We trust that this technical memorandum provides sufficient information for your present needs. Please do not hesitate to contact us if you require any further elaboration or clarification.

WSP Canada Inc.





2024-03-21

Sophie Bainbridge, P.Eng
Geotechnical Engineer

Germán Pizarro, M.Eng., P.Eng
Principal Geotechnical Engineer

Engineers & Geoscientists BC Permit #1000200



Don Kidd, P.Eng.
Principal Water Resources Engineer

SB/NH/DK/GP/anr

https://golderassociates.sharepoint.com/sites/10023g/23590671 deliverables/002_issued/067-tm-design criteria for tsf 974 m raise/rev 0/23590671-067-tm-rev0-51393-design criteria 21mar_24.docx

REFERENCES

BC MEM (British Columbia Ministry of Energy and Mines). 2016. Guidance Document – Health, Safety and Reclamation Code for Mines in British Columbia. Version 1.0. Updated July 2016.

BC MOTI (British Columbia Ministry of Transportation and infrastructure) (formerly MOT). 2007. BC Supplement to TAC Geometric Design Guide, 2007 edition.

CDA (Canadian Dam Association). 2013. Dam Safety Guidelines 2007 (Revised 2013).

CDA. 2019. Technical Bulletin: Application of CDA Dam Safety Guidelines to Mining Dams.

EMLI. 2022. Health, Safety and Reclamation Code for Mines in British Columbia. Victoria, British Columbia. Revised November 2022. ISBN 978-0-7726-6011-4.

GISTM (Global Industry Standard for Tailings Management). 2020. Global Tailings Review Board.

Golder (Golder Associates Ltd.). 2015a. Mount Polley mine 2015 freshet management embankment as-built construction. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-065-R-Rev0-2000; September 4, 2015.

Golder. 2015b. Mount Polley mine tailings storage facility detailed design to elevation 970 m. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-074-R-Rev0-3000; November 3, 2015.

Golder. 2015c. Tailings storage facility life of mine feasibility design. Document prepared for Mount Polley Mining Corporation. Reference No. 1413803-072-R-Rev0-9000. Submitted November 3, 2015.

Golder. 2016. Tailings Storage Facility – Emergency Spillway Inflow Design Flood. Document prepared for Mount Polley Mining Corporation. Reference No. 1662612-019-TM-RevB-51100. Submitted October 14, 2016.

Golder. 2017a. 2016 main embankment buttress and perimeter embankment buttress extension construction record report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-071-R-Rev0-52291; January 30, 2017.

Golder. 2017b. Mount Polley Tailings Storage Facility dam breach analysis and inundation study. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-169-R-Rev0-51134; October 13, 2017.

Golder. 2019. 2018 tailings storage facility construction record report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1894924-075-R-Rev0-52292; March 27, 2019.

Golder. 2022a. Tailings storage facility engineering 2022; work plan no. 013. Document prepared for Mount Polley Mining Corporation. Reference No. 21452039-078-WP-Rev0-50000. Submitted January 28, 2022.

Golder. 2022b. Climate Baseline Update. 22514095-000-R-RevA-Climate Baseline Update, Submitted pending 2022.

Hynes-Griffin ME, Franklin AG. 1984. Rationalizing the seismic coefficient method. U.S. Army Corps of Engineers. July 1984.

IEERP (Independent Expert Engineering Investigation and Review Panel). 2015. Report on Mount Polley Tailings Storage Facility Breach. January 30, 2015.

Knight Piesold. 2005. Mount Polley Mine Design of the Tailing Storage Facility to Ultimate Elevation. Reference No. VA101-001/08-1. Prepared for Mount Polley Mining Corporation. Submitted March 14, 2005.

MAC (The Mining Association of Canada). 2021. A Guide to the Management of Tailings Facilities. Version 3.2.

MPMC (Mount Polley Mining Corporation). 2021. 0.711 – MP 2021 LOM Plan Post CM New DDH v6 CMAG – mod.xlsx. Email from M. O'Leary (MPMC) to G. Pizarro (WSP Canada Inc.). June 8, 2021.

WSP (WSP Canada Inc.). 2023. Tailings Storage Facility Site Characterization Report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. 22514095-034-R-RevB-51392; February 8, 2023.

STUDY LIMITATIONS

WSP Canada Inc. (WSP) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by WSP for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP's professional judgement based on the knowledge and information available at the time of completion. WSP is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to WSP by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

APPENDIX D

Siting and Technology Study

TECHNICAL MEMORANDUM

DATE 27 October 2022 **Reference No.** 22514095-070-TM-Rev0-51343

TO Matt O'Leary
Mount Polley Mining Corporation

FROM Germán Pizarro and Ben Wickland **EMAIL German.Pizarro@wsp.com; Ben.Wickland@wsp.com**

SITE SELECTION AND TECHNOLOGY MEMO – MOUNT POLLEY MINE TAILING STORAGE FACILITY

In 2015, Golder Associates Ltd. (Golder), now a member of WSP (WSP Golder), completed a siting and deposition technology review as part of the Mount Polley tailings storage facility (TSF) elevation 984 m life of mine feasibility design (Golder 2015). The study included a review of available tailings deposition technologies, a review of potential sites to deposit tailings and an assessment of the alternatives based on environmental, social, technical, and economic indicators. Deposition of the remaining life of mine tailings (about 70 million tonnes) as a slurry within the existing TSF was recommended with operation using best applicable practices (BAP) of reduced water storage, maintaining beaches against the dams, and providing drainage to promote desaturation and drainage of the pond (Golder 2015).

Deposition of tailings as a slurry in the TSF re-started in June 2016 and continued until May 2019 when mining operations were halted due to economic reasons. A portion of the tailings in Springer Pit was dredged and deposited in the TSF from March 2018 to October 2019. From the restart of operations in June 2016 to October 2019, a total of about 20 million tonnes of tailings were deposited in the TSF. Construction of the TSF Corner 1 embankment was completed to elevation 968 m in 2018 (Golder 2019). Construction activities to raise the embankment to the permitted elevation of 970 m and deposition of tailings were restarted in July 2022.

As part of the restart of mining operations in 2022, Mount Polley Mining Corporation (MPMC) requested WSP Golder to advance studies to support the co-disposal of tailings excavated from Springer Pit in the Southeast Rock Disposal Site (SERDS) and to advance the design of a raise of the TSF embankment above elevation 970 m. Approximately 63 million tonnes of tailings are planned to be produced till the end of operations at Mount Polley mine (approximately 8.5 years of production at about 20,000 tonnes per day). This represents about 13 million tonnes more (about 18% more) than the life of mine plan considered at the time of preparation of the 2015 siting and deposition technology review.

The Health, Safety and Reclamation Code (HSRC) for mines in British Columbia (EMLI 2021) requires that an alternatives assessment for storage of tailings be submitted as part of the mine permit application. This technical memorandum has been prepared to update the alternatives assessment completed in 2015 and includes co-disposal of hydro-cyclone underflow in the SERDS as an alternative for tailings storage.

1.0 SITE AND TECHNOLOGY SELECTION OBJECTIVES

In selecting potential locations and technologies for the storage of tailings, the following objectives are to be met (BCMEM 2016):

- Provide secure and permanent storage facility
  - Physical stability
  - Chemically and biologically stable, or be designed to mitigate transport of contaminants into the receiving environment
- Minimize additional land disturbance (additional footprint of the facility)
- Maximize in-pit or underground backfill
- Minimize impacts to receiving environment
- Minimize social impact (e.g., negative public perceptions, disruption of traditional land use)
- Minimize cost, including the costs for investigation, design, procurement, construction, operation, and closure
- Incorporate post-closure land use objectives
- Limit the amount of free water within the impoundment

Typically, a single consolidated TSF is preferred over multiple smaller TSFs; however, there are cases where multiple TSFs may be the preferred option. Reasons to consider multiple TSFs include:

- Separation of tailings streams with different geochemical characteristics
- Using tailings as mine backfill (i.e., maximize in-pit or underground backfill)
- Location (e.g., relative to property boundaries, proximity to downstream receptors, ore body)

2.0 POTENTIAL SITES

The potential locations identified for tailings include surface disposal in the existing TSF or in a newly constructed TSF, co-disposal with waste rock (e.g., SERDS or TSF buttress), disposal in the underground mine workings, disposal in an open pit, or lake deposition. The following is a list of potential sites which can be considered for tailings deposition. The potential locations are shown in Figure 1.

- **Existing TSF**—Provide capacity by raising the facility to about elevation 987. The primary advantages of using the existing TSF are:
  - A relatively small additional footprint will be required.
  - The foundation conditions at the TSF have been thoroughly investigated and are well understood.
  - Limited additional infrastructure is needed.

- The primary disadvantages of using the existing TSF are:
  - Negative social perception due to raising the existing TSF.
  - Risk of failure due to internal erosion can be managed by constructing upstream drains, maintaining the pond away from the embankments, and limiting the amount of free water within the facility.
  - Some of the downstream infrastructure (i.e., seepage collection ponds, water treatment plant, powerlines, and access roads) may need to be relocated.
- **New TSF location**—Construct a new TSF at one of the identified potential locations shown in Figure 1. The size and configuration of a new TSF would be dependent on the tailings deposition technology; however, in general, the required area for any technology would be similar. Considering that about 49 million tonnes of tailings will require storage (assumes that about 14 million tonnes are deposited within the permitted elevation 970 m TSF), and that the achieved dry density will be in the range from about 1.35 t/m^3 for slurry deposition to 1.7 t/m^3 for filtered tailings, the volume of tailings to be stored would be in the range of 29 to 36 million m^3. Assuming an average tailings thickness of 20 m for an embankment height of about 30 m, the new TSF would require an area of about 150 to 180 ha. The primary advantages of developing a new TSF are:
  - Positive social perception due to not raising the existing TSF.
- The primary disadvantages of developing a new TSF are:
  - A large footprint would be required for the new TSF, in the order of 65 to 80% the size of the existing TSF.
  - Additional land disturbance will be required for the new borrow areas for dam construction materials, for access roads, for tailings and water conveyance corridors, and for seepage collection and water management ponds.
  - Increased catchment area and volume of water to be managed and treated.
  - A detailed site investigation will be required to characterize the foundation conditions at the new TSF location, which will likely also be partially underlain by glaciolacustrine soils.
  - Costs of construction and closure of a new facility and associated infrastructure (e.g., powerlines, access roads, tailings and water conveyance corridors, seepage collection and water management ponds).



Figure 1: Potential locations for a future tailings storage facility

- **Co-disposal with waste rock**—Disposal of tailings and waste rock in one facility or area. There are many different forms of co-disposal with varying degrees of mixing, physical arrangement, and mixture ratio of tailings to waste rock. Options include the paste rock blended concept, thickened tailings in cells in the waste rock dump, or cyclone underflow (coarse tailings) in the waste rock dump with the cyclone overflow (fine tailings) in a separate TSF.

As part of plans to restart mining operations, MPMC requested WSP Golder to advance studies to support the co-disposal of tailings from Springer Pit in the SERDS (Golder 2022). A similar concept could be considered for placement of the cyclone underflow within the SERDS or TSF buttress; however, the cyclone overflow would still require to be stored within an alternate location (e.g., existing TSF). The cyclone underflow to be co-disposed with waste rock could account for approximately 10% to 30% of the total tailings and will be dependent on the tailings gradation and the underflow gradation requirements. The advantages/disadvantages of co-disposal of tailings and waste rock depend on the tailings technology (e.g., hydro-cycloned tailings, filtered tailings) and are discussed in Sections 4.2 and 4.5.

- **Lake deposition**—Tailings deposition into an existing lake such that the tailings remain below the lake level. Nearby lakes include Polley Lake, Bootjack Lake and Quesnel Lake. This alternative results in a physically stable facility. Acid generation is prevented, which is not a concern for the Mount Polley tailings. The primary advantages of depositing the tailings in a lake are:
  - Minimal additional infrastructure required.

  The primary disadvantages of depositing the tailings in a lake are:
  - Increased footprint and loss of fish habitat.

- Impact on recreational area and negative social perception.
- Increased catchment area and volume of water to be managed and treated.
- a detailed site investigation will be needed to characterize the foundation conditions where retaining embankments will be required, which will likely also be partially underlain by glaciolacustrine soils.

- **Open pit deposition**—Deposition of tailings into an inactive, mined-out pit. The tailings are typically placed sub-aqueously (i.e., deposited under water). After deposition, the solids settle out and the supernatant water can be recycled for use within the mill or treated and discharged from the site. This is a favorable alternative providing a physically stable location without increasing the disturbed footprint.

  Three open pits exist at the Mount Polley mine site; however, Springer and Cariboo pits are part of the active mining operation and Wight Pit is used as part of the site-wide water management. Bullion Pit is a potential site for disposal of tailings from Mount Polley, which would allow to restore the pit to a more natural landform than the present condition. A dam would be required to form a closed perimeter around Bullion Pit. The primary advantages of depositing the tailings in an open pit are:

  - Uses footprint of previously mined area.

  The primary disadvantages of depositing the tailings in an open pit are:

  - Bullion pit is considered a heritage site and tourist attraction in the area.
  - Additional land disturbance will be required for the new borrow areas for dam construction materials, for tailings and water conveyance corridors, and for seepage collection and water management ponds.
  - Increased catchment area and volume of water to be managed and treated.
  - A detailed site investigation will be needed to characterize the foundation conditions where a retaining embankment will be required.
  - Costs of construction and closure of a new facility and associated infrastructure (e.g., powerlines, tailings and water conveyance corridors, seepage collection and water management ponds).

- **Underground disposal—**Tailings may be placed underground in mined-out areas as a means of tailings disposal only, or tailings may be incorporated in the mining process as a backfill material. The required strength of the backfill can vary from negligible (where the only objective is to fill voids) to several megapascals (where the backfill is required to provide structural support to allow for ongoing underground mining). In active mining environments, a maximum of about 50% of the tailings can be placed underground because of the higher porosity of the tailings relative to rock. The current Mount Polley mine plan does not include underground mining and the current underground at Wight Pit could only take a small proportion of the tailings generated. This alternative is not further assessed given the current plans at Mount Polley Mine.

3.0 TAILINGS MANAGEMENT TECHNOLOGIES

The available tailings management technologies are differentiated primarily by the water content of the tailings, which determines the transportation method and the deposition method. Mineral processing commonly results in tailings with solids contents in the range of 30% to 50%. Dewatering of the tailings can be carried out to increase the solids contents of the tailings. This may be done for water management reasons or for tailings management reasons. Similarly, tailings can be sorted into coarse and fines portions to reduce the volume of tailings to be stored in a tailings dam and potentially using the coarse fraction for construction. Examples of dewatering and sorting technologies are shown in Table 1. A summary of the difference between the technologies according to operational criteria is shown in Table 2.

Each technology is explained in more detail in the sub-sections below.

Table 1: Technology, Tailings Consistency, and Conveyance Technology

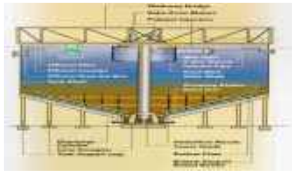
Dewatering/Sorting Technology	Tailings Consistency	Conveyance Technology
Conventional thickener 	Slurry 30% to 80% solids 	Gravity pipeline or launder, low pressure pipeline, with or without centrifugal pumps 
High-rate thickener 	High density slurry 55% to 65% solids 	Centrifugal pumps or piston diaphragm pumps 
Deep bed thickener, deep cone thickener 	Low density paste 60% to 70% solids 	Piston diaphragm pumps (high pressure) 
Filter 	High density paste 65% to 75% solids 	Dual positive displacement pumps with high-pressure steel pipelines 
Filter 	Filter cake >80% solids 	Truck or conveyor 
Hydro-cyclone 	Underflow: low to high density paste Overflow: slurry	Underflow: mechanically placed or positive displacement pumps. Can be diluted and conveyed in low pressure pipeline. Overflow: gravity pipeline, low pressure pipeline, with or without centrifugal pumps

Table 2: Comparison of Tailings Technologies According to Operational Criteria

Criteria	Conventional Slurry	Hydro-cycloned tailings (overflow ~70-90%)	Thickened Tailings	Paste	Filtered Tailings
Pumpability / Conveyance	Gravity flow or centrifugal pumps	Overflow: gravity flow or centrifugal pumps Underflow: mechanically placed or positive displacement pumps. Can be diluted and conveyed in low pressure pipeline.	Gravity flow or centrifugal pumps to piston diaphragm pumps	High pressure positive displacement pumps	Not pumpable, can be transported on trucks or conveyors
In-situ density after deposition	Tailings segregate during deposition resulting in areas with fine tailings and low density	Overflow: Deposition of slurry with low solids content and fine tailings results in low density Underflow: Can be mechanically compacted to achieve highest density	Possible to deposit tailings without segregation and achieve a more uniform deposit with higher density	Tailings can be deposited without segregation and achieve a uniform deposit with higher density	Can be mechanically compacted to achieve highest density
Supernatant water	Low solids content and tailings sedimentation, settlement, and consolidation releases highest volume of water during deposition	Hydro-cyclone does not recover water from the tailings. Highest volume of water remains in the overflow and is released during deposition.	Water recovered from the tailings in the thickener; thickened tailings release less water during deposition	More water recovered from the tailings in the thickener; paste tailings release less water during deposition	Highest amount of water recovered from the tailings in the filter plant; no water released from the tailings during deposition
ARD management	ARD management depends on the specific design of the facility				
Technology and conveyance costs	Lower	Low	Medium	High	Highest
Tailings beach slopes	Flatter 0.3% to 1.5%	Overflow: Flatter < 1% Underflow: can be mechanically placed and compacted at stable angles	Steeper 0.7% to 2%	Steeper 1% to 10%	Tailings mechanically placed and compacted at stable angles

Note: Green cells represent a favorable condition, while red cells represent a less favorable condition. The darker the shade of green or red, the more or less favorable the condition.
ARD = acid rock drainage.

3.1 Low Solids Content (Conventional) Slurry Deposition

Transport and deposition of tailings as a slurry (mixture of water and tailings solids) is commonly used in combination with wet ore mineral processing techniques. This method has been used at the Mount Polley Mine to deposit tailings into the TSF and Springer Pit.

The tailings are transported from the mill to the TSF in a pipeline or open launder chutes and deposited from a single point discharge or from multiple spigots. The deposition can be subaqueous or subaerial, but typically a subaerial beach is developed during the deposition sequence. The coarser fraction of tailings drops out near the discharge to form a beach and the finer fraction is carried to the supernatant pond. The tailings beach slopes typically range between 0.3% and 1.5%. At the Mount Polley TSF, the tailings beach slope has been surveyed to be in the order of 0.5% to 1.0%.

A supernatant pond is typically present within the facility, from which water is decanted by means of a floating barge or decant tower. The pond is maintained on the tailings and is necessary for sedimentation and settling. The size of the pond can be limited to that needed for operation of the water reclaim system. The process water requirements can be supplemented by an alternative source or by having an independent process water pond. Since the restart of operation at the Mount Polley TSF in 2016, the supernatant pond has been maintained on the northwest side of the facility, towards the natural ground and away from the embankments.

The consolidation process increases the density of the tailings, releasing water to the pond, internal drainage in the facility or to the foundation. The typical achieved settled average dry density is in the range of 1.3 to 1.7 t/m^3, depending on the tailings (e.g., mineralogy, grind, and clay content). At the Mount Polley TSF, the average density of the tailings deposited as a slurry is estimated to be about 1.35 t/m^3.

Containment dams can be constructed of earthfill, rockfill (potentially mine waste rock), or sand separated from the tailings using hydro-cyclones, with the design of the dams carried out to suit the characteristics of the site and the mining operation.

3.2 Hydro-cyclone Classified Tailings

Hydro-cyclones are used to separate the tailings into a fine (overflow) and coarse (underflow) fractions. The hydro-cyclones can be selected to produce a coarse fraction with a specified gradation (e.g., sand). The coarse fraction can be transported in pipelines and deposited from spigots or spreader bars and it can be compacted to achieve a dilative, non-liquefiable material. The sand can also be dewatered on screens and transported by truck or by conveyor belt. The fine fraction is typically transported by pipeline and deposited as a low solids content slurry in an impoundment.

The advantages of separating the coarse and fine fractions of the tailings include reducing the volume of tailings to be stored behind a tailings dam and potentially using the coarse fraction for construction of the dam. The disadvantages include flatter beach slopes, lower hydraulic conductivity and lower strength of the fine tailings deposited on the tailings dam. If hydro-cyclones are used at Mount Polley, the underflow would be disposed in the SERDS or TSF buttress and the overflow is deposited in the existing TSF.

The tailings beach slope in the TSF is expected to be flatter and the capacity to maintain a pond away from the embankments would be reduced and possibly eliminated. Assuming an average 0.5% tailings slope above and below water, it is estimated that:

- A maximum 100 m tailings beach could be maintained around a 1.5 Mm^3 TSF pond with a high level of deposition control.
- A pond with a size on the order of 2 Mm^3 would encroach onto the embankments.

The hydraulic conductivity of the fine tailings deposited in the TSF would be lower; therefore, the effectiveness of the upstream drain to control the water level and limit the hydraulic gradient across the embankments would be reduced and reliance on high-quality site-wide water management and tailings deposition would increase. It is estimated that the hydraulic conductivity of the fine fraction of the tailings could be 2 orders of magnitude lower (10^{-8} m/s) than the hydraulic conductivity of the tailings that have deposited near the embankment during deposition of the combined coarse and fine fractions of the tailings.

The change to hydro-cyclones would likely require a change to site water management practices. Based on challenges to manage site water in recent years, uncertainties on the actual tailings beach slope and capacity to maintain the pond away from the embankments, it is the opinion of the Mount Polley TSF EoR that alternative locations to manage site water outside of the TSF would be required if hydro-cycloning was implemented.

Dams constructed from cycloned sand include: the Gibraltar and Highland Valley Copper LL tailings dams in BC; Cerro Verde in Peru; and El Mauro, Las Tortolas, and Ovejeria dams in Chile. The Caserones Copper project in Chile places cyclone sand in a separate sand stack area and contains the cyclone overflow fines behind a rockfill dam.

3.3 Thickened (Non-Segregating) Tailings

Thickening of tailings involves placing slurry tailings in a tank, allowing the solids to settle to the bottom and be removed while water is removed from the top of the tank. Mechanical rakes and/or chemical additives are often required to increase the settling rate of the solids. The additives may be flocculants, coagulants, or a combination of both.

The tailings are typically deposited down a slope from several discharge points, with the tailings confined by a retaining dyke at the foot of the slope. Thickened tailings are generally non-segregating when deposited and form a homogenous mass.

Thickened tailings will bleed some water when deposited, but much of the process water is retained as part of the thickening process. Although a supernatant pond may not be formed, the TSF will still require surface water runoff and seepage management systems. A secondary facility for re-circulation of water may still be required.

The advantages of thickened tailings over conventional tailings typically include higher water recovery before transport and deposition and lower losses (relevant to sites with negative water balances, not surplus conditions as present at Mount Polley), increased storage capacity due to slightly higher settled density and steeper tailings slopes. The disadvantages include higher operational costs (processing and pumping). In areas with large earthquakes, structures to contain all the tailings may be required if liquefaction of the tailings can occur.

Examples of thickened tailings discharge include Kidd Creek Mine, Timmons, Ontario; Peak Mine, Australia; Century zinc mine, Australia; Osborne Mine, Australia; Falconbridge Strathcona mine, Sudbury, Ontario; Musselwhite mine, northwest Ontario; Essakane, Burkina Faso; and the Porgera Gold Mine, Papua New Guinea.

3.4 Paste

Paste tailings typically have solids contents of between 60% and 70% and are pumpable using high pressure pumps, are non-segregating, and typically do not release water. Paste tailings are achieved by a combination of mechanical devices (such as deep cone thickeners) and chemical additives including flocculants.

Paste tailings are frequently used for backfilling underground mine workings (often combined with cement and/or fly ash), but surface disposal of paste tailings is also possible.

Paste tailings can be transported using pressure pipelines to the storage area. Containment facilities are still required for the management of surface water from precipitation, although due to the increased density and increased slope of deposition of the tailings, the size and/or height of the facilities may be reduced compared to slurry type methods of disposal.

Paste tailings have typically been more considered for surface disposal in arid climates with limited water availability. Careful control of the thickener is required to obtain consistent rheology that will give consistent deposited slopes. Changes in the mineralogy, grind, and temperature can affect the rheology. Steeper deposition slopes can be achieved. These steeper slopes can produce inefficient filling for valley containment systems.

Examples of mines that use the paste technology for tailings deposition include Bulyanhulu, Tanzania; Myra Falls, BC; Esparanza, Chile; and Cobriza mine, Peru.

3.5 Filtered Tailings

Filtered tailings are produced using mechanical devices (e.g., high-capacity vacuum and pressure belt filters), often in combination with chemical additives. The tailings are usually dewatered in a high rate thickener to feed the filters. After filtration the tailings have about 80% to 85% solids and are too thick to pump. Instead, they are transported by truck or conveyor system and then stacked. Filtered tailings that are stacked are not dry, but rather have moisture contents at or near saturation.

Typically, filtered tailings are placed, spread, and compacted to form an unsaturated dense and stable stack. No additional containment structures, such as dams, are required to retain the tailings, though waste rock is typically used on the outer slopes to reduce erosion. These facilities may result in a smaller footprint area due to their increased density. Containment structures may be required to manage runoff and sediment from precipitation. If the stack is placed with bottom-up construction, concurrent reclamation of the tailings can be carried out.

The nature of the tailings produced, both the grain size and mineralogy, can play an important role in determining the effectiveness of filter processing. Tailings with a high percentage of clay-sized particles and with clay mineralogy reduce the efficiency of the filtering process and may result in high energy consumption.

The energy consumption and costs associated with filtration and transportation of filtered tailings are considerably higher than those related to slurry and thickened tailings disposal. Truck transport of the tailings increases the carbon footprint relative to methods using transport in pipelines. This method has mostly been utilized in specific conditions where water conservation is critical or only a small footprint is available.

Liners may be installed under the stack if groundwater contaminant could be a problem. Consolidation and downward drainage of the water in the tailings and climate conditions may result in saturated conditions at the base of the stack. Compaction is used to create a non-liquefiable material that will be stable in earthquakes.

Examples of dry stack tailings facilities are Greens Creek mine, Alaska; Raglan, Quebec; Mineral Hill, Montana; La Coipa, Chile; Pogo mine, Alaska; and Cerro Lindo, Peru. The Cerro Lindo tailings facility has a 30 m high water management dam located downstream of the tailings area.

4.0 ASSESSMENT OF TAILINGS MANAGEMENT ALTERNATIVES

The term BAT (best available technology) does not represent any one specific technology that can be applied to every situation. Rather, the technology must match the specific site conditions and the mining situation. The purpose of evaluating alternative technologies in this instance is to identify the preferred method of providing reliable containment of the tailings that will be produced from the remaining life of the Mount Polley Mine (approximately 8.5 years at about 20,000 tonnes per day). Chemical stability of the tailings is less of a concern due to the nature of the Mount Polley tailings. The conservation of water, which is a benefit of thickened and filtered tailings, is not an advantage at Mount Polley due to the net water surplus on the mine site that requires ongoing discharge of water from the site.

The open pits at the Mount Polley Mine are still being actively mined or used for water management and are, therefore, not available for tailings storage. The underground workings could only take a small proportion of the tailings and are used as part of the site water management.

The potential sites, and the potential technologies that could be applied to each site, are summarized in Table 3.

Table 3: Applicability of Tailings Technology to Potential Locations

Site	Conventional Slurry	Hydro-Cycloned Tailings	Thickened Tailings	Paste	Filtered Tailings
Existing TSF	●	●	●	●	●
New TSF	●	●	●	●	●
SERDS co-disposal		● (only underflow, after dewatering by screening)			●
Polley/Bootjack/Quesnel Lakes	●		●		
Bullion Pit	●	●	●	●	●

The options that could accommodate the required volume of tailings were evaluated against the following criteria:

- Environmental
  - Overall affected land footprint size of facility, including related infrastructure (e.g., borrow areas, access roads, power, tailings and water conveyance corridors, seepage collection and water management ponds)
  - Aquatic habitat
- Technical
  - Understanding of foundation conditions

- Socio-economic
  - Public perception as it relates to TSF failure in 2014
  - Maintenance of traditional lifestyle and land use (e.g., loss of access, loss of fishing area, recreation/tourism)
- Project economics
  - Life of mine cost, including construction, operation, and closure
  - Economic risks (e.g., time to start operation)

The five groups of sites have been evaluated based on the required objectives identified, as shown in Table 4.

Physical stability has not been included as a criterion because all potential alternatives can be designed to have a similarly low likelihood of failure. The consequence of failure is related to downstream receptors and the amount of water and eroded tailings that could be released in the event of a failure.

The advantage of paste or filtered tailings is to reduce the consequence of failure by eliminating the supernatant pond that forms when water is released from the tailings, and to increase the placed density of the tailings which reduces the mobility of the tailings in the event of a failure.

If conventional tailings are deposited within the existing TSF, the risk and consequence of failure can similarly be reduced. This can be achieved by implementing BAP (best applicable practices), and following the principles set out in the Independent Expert Engineering Investigation and Review Panel (IEERP) report of January 2015:

- Limit the amount of surface water to only that required for operation – The supernatant pond volume can be maintained within defined limits by having a water management plan, a secondary water storage facility for excess water if required, and water discharge through a spillway. These measures will reduce the risk of overtopping and limit the consequence if failure occurs.
- Promote unsaturated conditions in the tailings with drainage provisions – A minimum beach width is maintained between the embankment and the pond and an upstream drain can be constructed upstream of the embankment. This will result in a portion of the tailings being in an unsaturated condition. The upstream drain at the Corner 1 embankment has performed as intended allowing seepage and maintaining the tailings above the elevation of the drain in an unsaturated condition.
- Achieve dilatant conditions throughout the tailings deposit – The existing tailings within the TSF drained and consolidated after the TSF breach in 2014. Construct drainage through the embankment raise to allow seepage from the facility and promote consolidation of the tailings.

Based on the above, it is considered that tailings management with the goal to improve stability can be realized with tailings slurry deposition, as with alternative technologies such as thickened tailings, paste or filtered tailings. The tailings breach on 4 August 2014 was due to inadequate characterization of the foundation conditions. The foundation conditions and material strengths are now well understood. Implementation of the BAP and the ability to discharge water will limit the volume of water in the TSF.

Table 4: Evaluation of Tailings Storage and Disposal Alternatives

Location	Technology	Environmental Aspects (Additional Disturbed Footprint)	Technical Aspects (Understanding of Foundation Conditions)	Social Impact (Public perception and maintenance of traditional land use)	Economic Impact (Life of mine cost and time required for implementation)
Existing TSF	Low density slurry tailings	**Small footprint change (<50 ha)** Use of existing footprint	**Foundation conditions well understood** Considerable geological interpretation, investigation, and laboratory testing has been performed	**Negative perception** Use of the same facility and technology as prior to the breach	**Low cost** Limited additional infrastructure required Buttresses needed to achieve target levels of stability
	Thickened tailings			**Better perception** Use of the same facility but reducing surface water	**Increased capital and operating costs; longer time required for implementation** Procurement, construction, and operation of thickener Increased pumping cost Buttresses needed to achieve target levels of stability
	Filtered tailings	**Small footprint change (<100 ha)** Use of existing footprint but new water management pond required outside of TSF		**Better perception** Use of the same facility but reducing surface water	**Highest capital and operating cost; longest time required for implementation** Construction costs of new water management pond Procurement, construction, and operation of filter plants Trucks to haul tailings; dozers and graders to spread tailings Buttresses needed to achieve target levels of stability
Existing TSF and SERDS co-disposal	Hydro-cyclone underflow (SERDS/TSF buttress), overflow (TSF)	**Small footprint change (<100 ha)** Use of existing footprint but new water management pond required outside of TSF	**Foundation conditions well understood** Considerable geological interpretation, investigation, and laboratory testing has been performed at the existing TSF. Additional SERDS foundation investigation in progress.	**Negative perception** Reduction of tailings to be stored but uses the same facility	**Increased capital cost** Construction costs of new water management pond Buttresses needed to achieve target levels of stability Dozers to spread tailings
New TSF	Low density slurry tailings	**Large footprint increase (>200 to 300 ha)** Use of undisturbed area for new TSF, access roads, water management ponds, pipeline corridors, and surface water diversion ditches	**Limited information of foundation conditions** Foundation conditions likely to be geologically similar to those at existing TSF. Detailed investigation required to characterize foundation, in particular location and characteristics of glaciolacustrine soils.	**Positive perception** New facility; failed embankment not part of future TSF	**Increased capital cost** Construction, operation, and closure costs for new facility
	Hydro-cyclone overflow and underflow				
	Thickened tailings			**Positive perception** New facility and reduced surface water stored in the TSF	**Increased capital and operating costs; longer time required for implementation** Construction, operation, and closure costs for new facility Procurement, construction, and operation of thickener Increased pumping cost
	Filtered tailings				**Highest cost; longest time required for implementation** Time and cost for site investigation and design. Construction, operation, and closure costs for new facility Procurement, construction, and operation of filter plants Trucks to haul tailings; dozers and graders to spread tailings Construction costs of new water management pond

Table 4: Evaluation of Tailings Storage and Disposal Alternatives

Location	Technology	Environmental Aspects (Additional Disturbed Footprint)	Technical Aspects (Understanding of Foundation Conditions)	Social Impact (Public perception and maintenance of traditional land use)	Economic Impact (Life of mine cost and time required for implementation)
Bullion Pit	Low density slurry tailings	**Medium to large footprint increase** Use of an existing footprint disturbed by previous mining activities but new borrow areas, access roads, power, tailings and water conveyance corridors, surface water diversion ditches, seepage collection and water management ponds would be required	**Limited information of foundation conditions** Detailed investigation to characterize foundation where retaining embankments will be required; however, geological conditions are expected to be more favorable.	**Negative perception** Bullion pit considered a heritage site and tourist attraction for Likely	**Increased cost** Construction of new infrastructure, including tailings and water pumps and pipelines, high dam, seepage cutoff, and collection system to prevent water loss to Quesnel River
Quesnel, Bootjack or Polley Lake	Low density slurry tailings	**Large footprint increase and loss of aquatic habitat** Use of undisturbed or partially undisturbed aquatic habitat.	**Limited information of foundation conditions** Foundation conditions likely to be geologically similar to those at existing TSF. Detailed investigation to characterize foundation where retaining embankments will be required, in particular location and characteristics of glaciolacustrine soils.	**Negative perception** Loss of fish habitat; loss of recreational area	**Low cost** Minimal additional infrastructure required
SERDS co-disposal	Filtered tailings	**Minimal footprint change** Potential footprint increase of waste dump.	**Foundation conditions reasonably well understood** Additional SERDS foundation investigation and characterization in progress. Investigation of footprint expansion required.	**Positive perception** New facility and technology that reduces surface water.	**Highest cost; longest time required for implementation** Procurement, construction, and operation of filter plants Trucks to haul tailings; dozers and graders to spread tailings

5.0 FINDINGS

The following observations have been made regarding the range of options considered:

- The best available option is to store the tailings to be produced in the remaining life of mine within the existing TSF as conventional slurry.
  - The existing TSF has the best-studied foundation conditions of any of the potential TSF locations.
  - Conventional tailings can be operated in a manner that reduces both the likelihood (conservative assessment of soil strength and adoption of conservative design criteria resulting in wide buttresses along the embankments) and consequence of failure (wide beaches, relatively dense tailings, and a small pond volume) provided that accumulation of water does not occur.
- Separating the tailings into fine (overflow) and coarse (underflow) fractions with hydro-cyclones could reduce the amount of tailings to be stored in the TSF by 10 to 30% (i.e., in the order of 2 to 6 m embankment height) if the coarse fraction is placed in the SERDS or TSF buttress; however, a separate water management pond with a storage capacity of about 4 Mm^3 to manage the 1-in-200-year freshet volume would be required (e.g., facility with a dam height in the range of 20 m). A separate water management pond would require significant investigation (foundation conditions would be required to be characterized to a sufficient level to enable appropriate design), add to the disturbed area of the mine, and require more closure work at the completion of mining.
- Thickened tailings offer limited advantages over conventional tailings. The mine site has an overall positive water balance, and freshet water management would be carried out using the TSF, similar to the conventional tailings option. The maximum pond size is controlled by run-off during freshet and not by the needs of the mine operation (i.e., saving water at the mill by thickening does not offer an advantage).
- The high capital cost of a filter plant may not be economic given the relatively short remaining life of the mine. A separate water management pond with a storage capacity of about 4 Mm^3 to manage the 1-in-200-year freshet volume would also be required (e.g., facility with a dam height in the range of 20 m).
- A new land-based TSF footprint is unlikely to offer advantages over the existing TSF footprint. The failure that occurred in the existing TSF was caused by a combination of inadequate understanding of the foundation conditions, inappropriate analysis of the range of loading conditions, and the construction of steep fill slopes. The foundation conditions of the existing TSF can accommodate additional dam construction, providing that the slopes of the dams are matched to the foundation strengths. Each of these issues can therefore be addressed by appropriate design at the existing TSF site. Using a different land-based site would require significant investigation (foundation conditions would be required to be characterized to a sufficient level to enable appropriate design), add to the disturbed area of the mine, and require more closure work at the completion of mining.
- The only advantage to using the Bullion Pit is that an area with significant historical mining disturbance could be restored to a landscape similar to the pre-mining condition. The delay to the mine operation related to the investigation and design of the containment structures and the seepage control system to minimize water loss to the Quesnel River, coupled with the increased costs for transporting the tailings to the Bullion Pit and water from the Bullion Pit to the mine and the need for an environmental impact assessment, make this alternative unattractive, and, likely would prevent continuation of operations.
- Deposition of tailings in lakes provides numerous advantages in terms of the physical stability of tailings. Deposition of tailings in lakes is an appropriate option for some situations; however, the permitting of such facilities is difficult, particularly when the lakes provide habitat for fish. This is the case for all of the potential

lakes that could be considered. Polley Lake is judged to be more likely to be considered for tailings deposition than other lakes in the area but given the trout population in Polley Lake it is considered to be a less favorable site than an on-land site.

6.0 RECOMMENDATIONS

It is recommended that the tailings produced in the remaining life of the Mount Polley mine be transported as conventional (slurry) tailings to the existing TSF and be managed using BAPs. These would include the following:

- Routine and sustained discharge of mine water such that the volume of water stored in the TSF is maintained low
- Managing the pond in the TSF such that beaches are maintained against the containing embankments throughout the operational life of the TSF
- Providing drainage to promote the desaturation and densification of the tailings.

7.0 CLOSURE

The reader is referred to the Study Limitations section, which follows the text and forms an integral part of this document.

Golder Associates Ltd.



Germán Pizarro, M.Eng., P.Eng.
Principal Geotechnical Engineer

Ben Wickland, Ph.D., P.Eng.
Senior Principal Geotechnical Engineer

GP/BW/ca/jc/ss

https://goldenassociates.sharepoint.com/sites/10023g/22514095 deliverables/002_issued/070-tm-51343-site selection and technology memo/22514066-070-tm-rev0-51343-site selection and technology 27oct_22.docx

PERMIT TO PRACTICE #1003064
Engineers & Geoscientists BC

REFERENCES

BCMEM (British Columbia Ministry of Energy and Mines). 2016. Guidance document – Health, Safety and Reclamation Code for Mines in British Columbia. Version 1.0. Updated July 2016. Victoria BC: British Columbia Ministry of Energy and Mines.

EMLI (British Columbia Ministry of Energy, Mines and Low Carbon Innovation). 2021. Health, Safety and Reclamation Code for Mines in British Columbia. April 2021.

Golder (Golder Associates Ltd.) 2015. Mount Polley Mine Tailings Storage Facility Life of Mine Feasibility Design. Prepared for Mount Polley Mining Corporation. Submitted 3 November 2015. Document No. 1413803-072-R-Rev0-9000.

Golder. 2019. 2018 Tailings Storage Facility Construction Record Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Submitted 27 March 2019. Document No. 1894924-075-R-Rev0-52292.

Golder. 2022. Southeast Rock Disposal Site – Tailings Co-disposal Detail Design. 24 October 2022. Reference No. 22514095-035-R-Rev2-91315.

IEERP (Independent Expert Engineering Investigation and Review Panel). 2015. Report on Mount Polley Tailings Storage Facility Breach. Province of British Columbia. 30 January 2015.

STUDY LIMITATIONS

Golder Associates Ltd., a member of WSP (WSP Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, has been prepared by WSP Golder for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP Golder's professional judgement based on the knowledge and information available at the time of completion. WSP Golder is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations, and opinions expressed in this document.

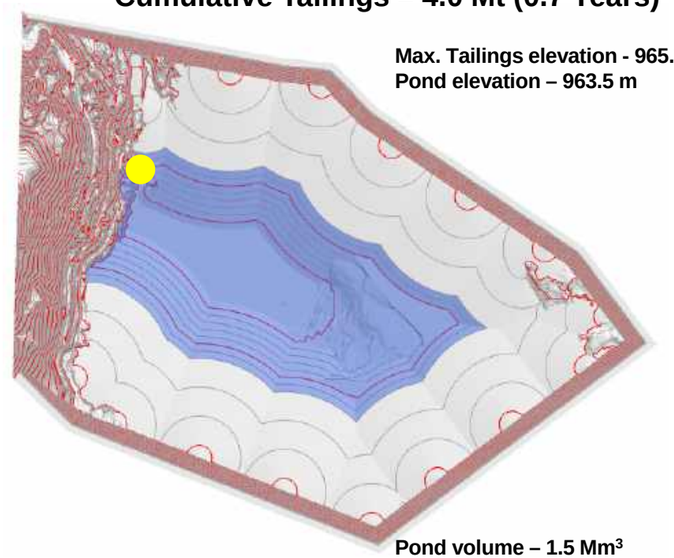
pertain to the specific project, site conditions, design objective, development and purpose described to WSP Golder by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations, and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, as well as all electronic media prepared by WSP Golder are considered its professional work product and shall remain the copyright property of WSP Golder. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration, and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

APPENDIX E

Tailings Deposition Models

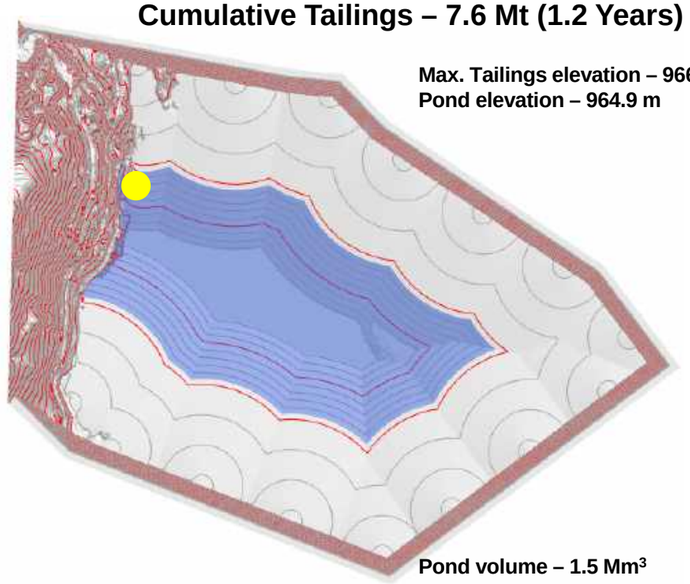
Cumulative Tailings – 4.0 Mt (0.7 Years)



Max. Tailings elevation - 965.2 m
Pond elevation – 963.5 m

Pond volume – 1.5 Mm^3

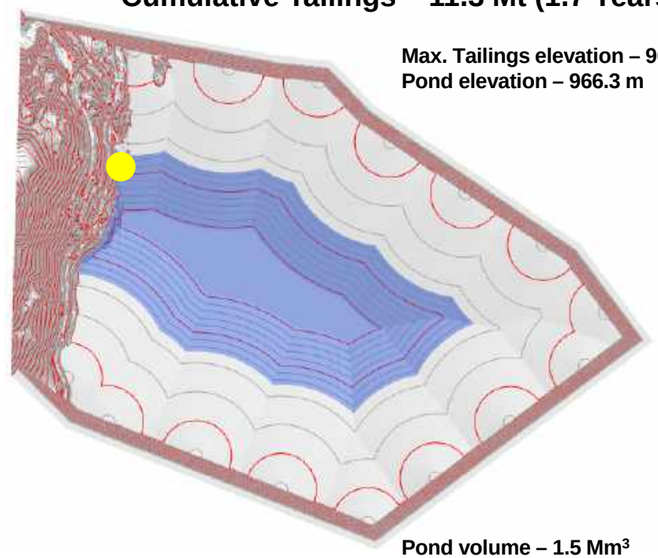
Cumulative Tailings – 7.6 Mt (1.2 Years)



Max. Tailings elevation – 966.7 m
Pond elevation – 964.9 m

Pond volume – 1.5 Mm^3

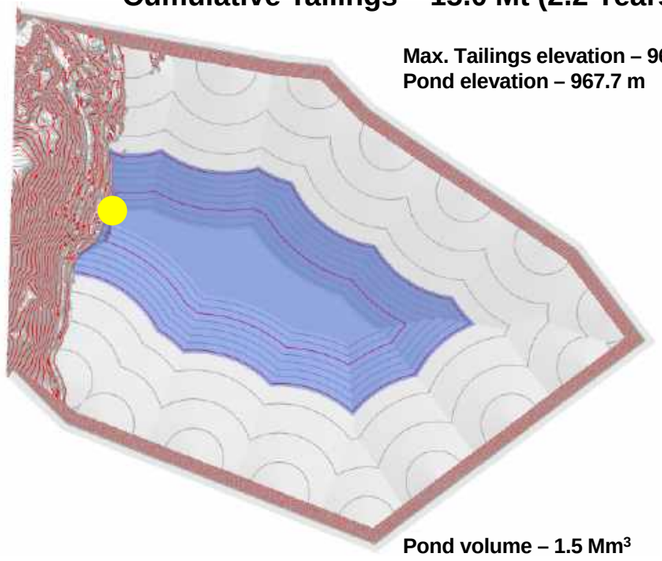
Cumulative Tailings – 11.3 Mt (1.7 Years)



Max. Tailings elevation – 968.1 m
Pond elevation – 966.3 m

Pond volume – 1.5 Mm^3

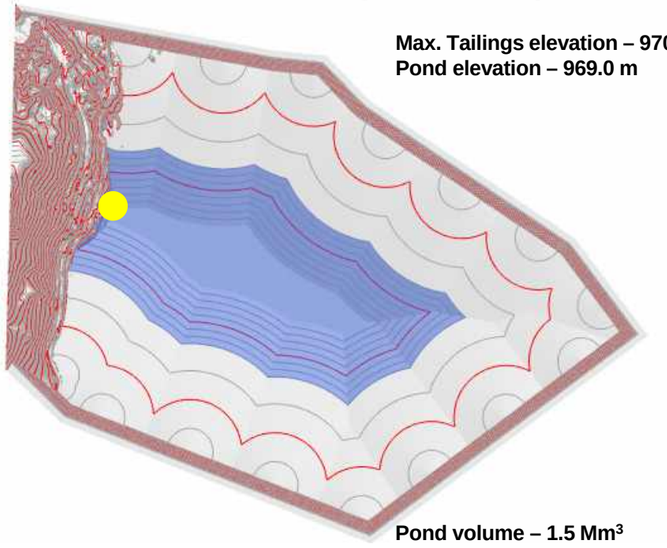
Cumulative Tailings – 15.0 Mt (2.2 Years)



Max. Tailings elevation – 969.5 m
Pond elevation – 967.7 m

Pond volume – 1.5 Mm^3

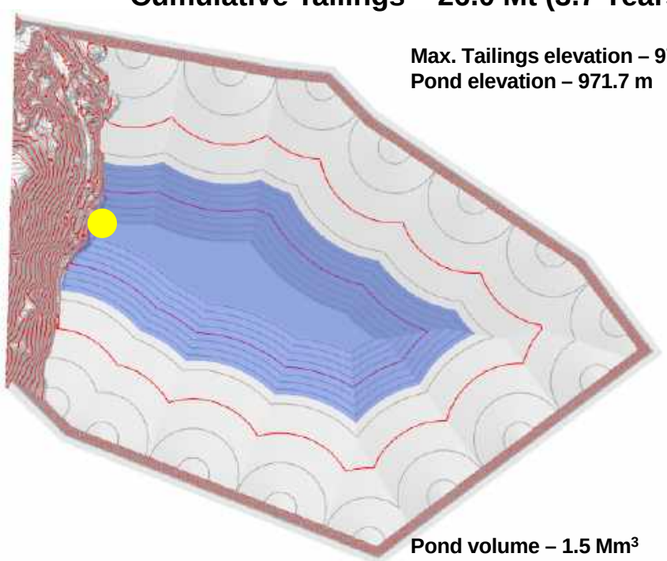
Cumulative Tailings – 18.6 Mt (2.7 Years)



Max. Tailings elevation – 970.9 m
Pond elevation – 969.0 m

Pond volume – 1.5 Mm^3

Cumulative Tailings – 26.0 Mt (3.7 Years)



Max. Tailings elevation – 973.6 m
Pond elevation – 971.7 m

Pond volume – 1.5 Mm^3

LEGEND:

Pond

Approximate Barge Location

NOTES:

1. Sub-aerial beach slope = 0.5%; sub-aqueous beach slope = 2%.
2. Maximum pond depth = 4 m.
3. Timeline is based on mine plan as reported in 23590671-067-TM-Rev0-51393
4. In place dry density of 1.35 tonnes/m^3 assumed.
5. Barge to be relocated in 2024.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

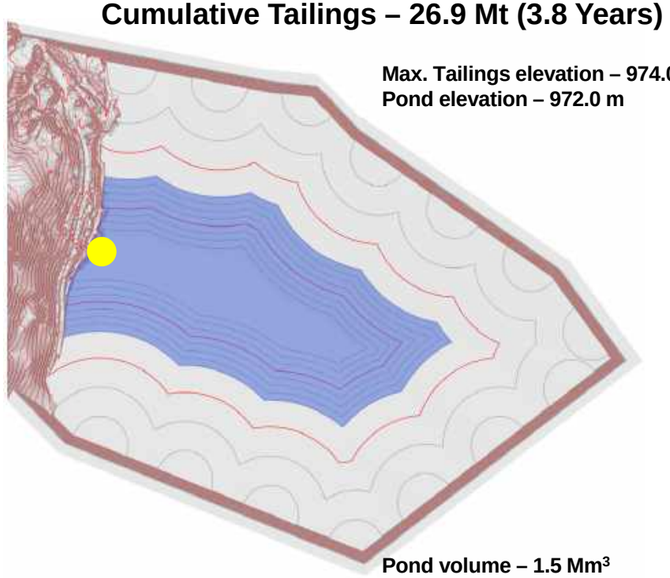
YYYY-MM-DD	2023-04-16
PREPARED	SPC / FG
DESIGN	EW
REVIEW	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
TAILINGS DEPOSITION MODELLING RESULTS (Mine Plan; June 2019 Survey) 0.5% sub-aerial; 2% sub-aqueous

PROJECT No.	Phase/Task	Rev.	Figure No.
CA0020527.4505	51300/51394	0	E-1

Cumulative Tailings – 26.9 Mt (3.8 Years)



Max. Tailings elevation – 974.0 m
Pond elevation – 972.0 m

Pond volume – 1.5 Mm^3

LEGEND:

- Pond
- Approximate Barge Location

NOTES:

1. Sub-aerial beach slope = 0.5%; sub-aqueous beach slope = 2%.
2. Maximum pond depth = 4 m.
3. Timeline is based on mine plan as reported in 23590671-067-TM-Rev0-51393
4. In place dry density of 1.35 tonnes/m^3 assumed.
5. Barge to be relocated in 2024.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

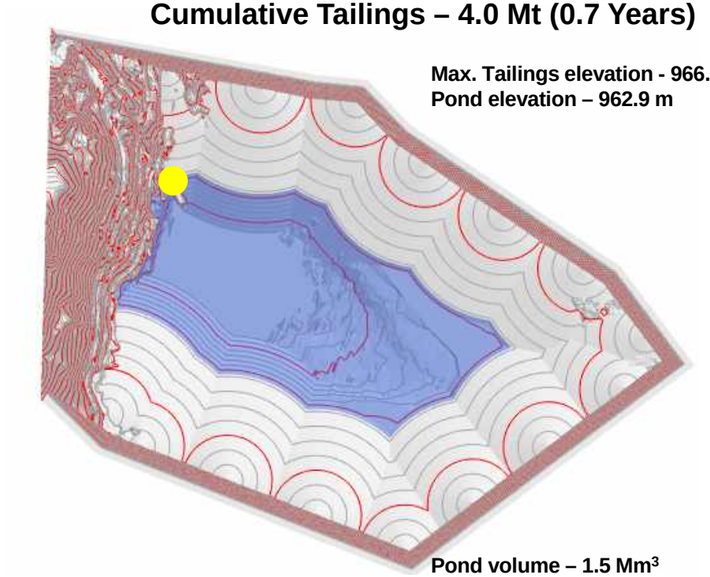
YYYY-MM-DD	2023-04-16
PREPARED	SPC / FG
DESIGN	EW
REVIEW	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
TAILINGS DEPOSITION MODELLING RESULTS (Mine Plan; June 2019 Survey)
0.5% sub-aerial; 2% sub-aqueous

PROJECT No.	Phase/Task	Rev.	Figure No.
CA0020527.4505	**51300/51394**	**0**	**E-2**

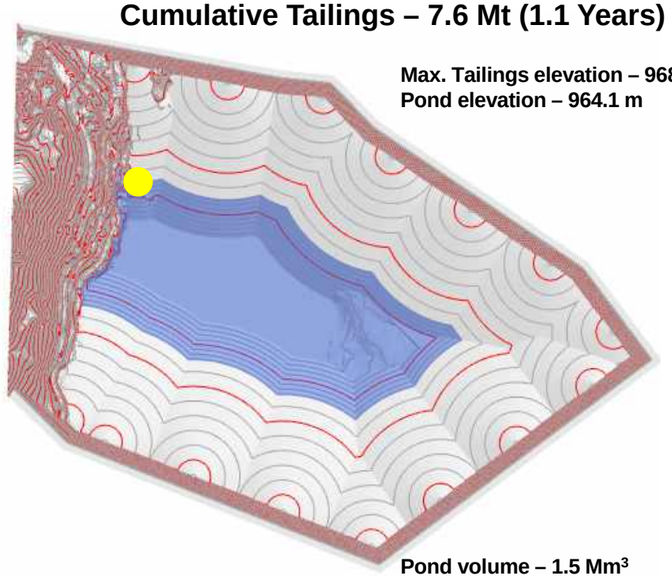
Cumulative Tailings – 4.0 Mt (0.7 Years)



Max. Tailings elevation - 966.5 m
Pond elevation – 962.9 m

Pond volume – 1.5 Mm^3

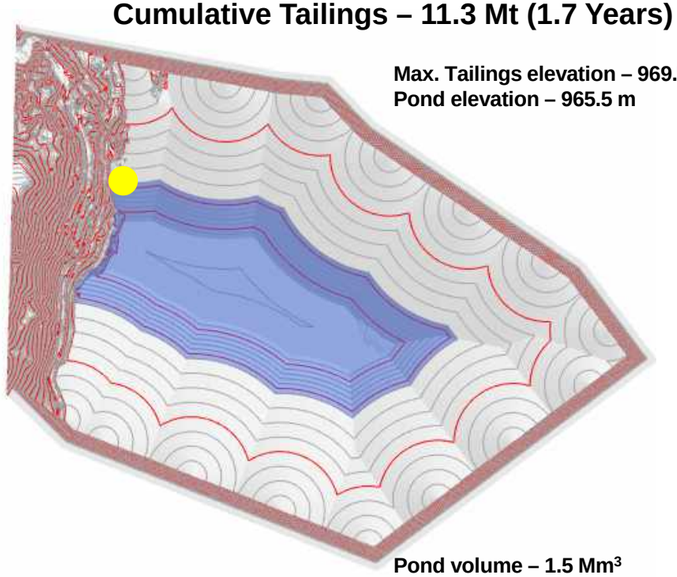
Cumulative Tailings – 7.6 Mt (1.1 Years)



Max. Tailings elevation – 968.1 m
Pond elevation – 964.1 m

Pond volume – 1.5 Mm^3

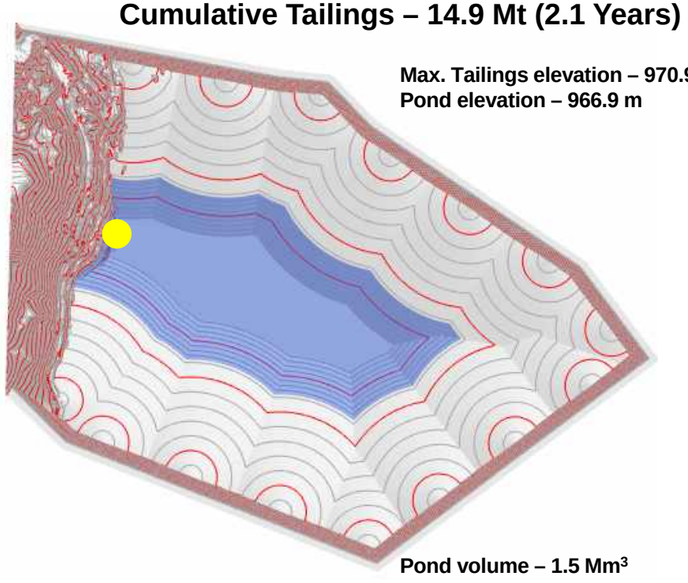
Cumulative Tailings – 11.3 Mt (1.7 Years)



Max. Tailings elevation – 969.5 m
Pond elevation – 965.5 m

Pond volume – 1.5 Mm^3

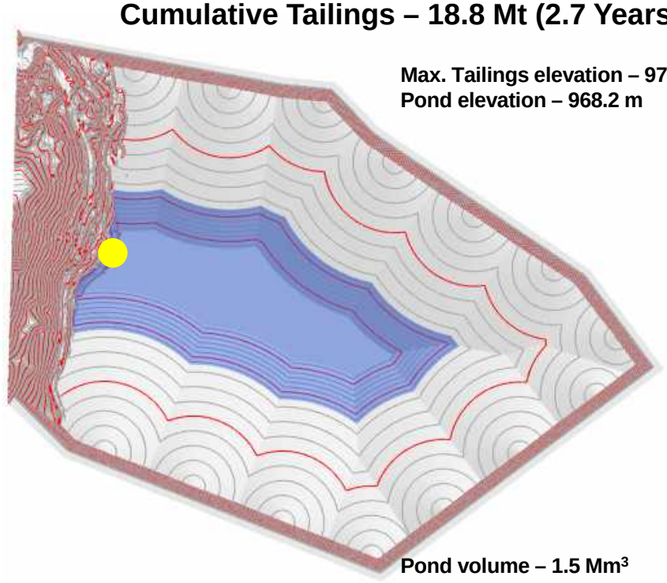
Cumulative Tailings – 14.9 Mt (2.1 Years)



Max. Tailings elevation – 970.9 m
Pond elevation – 966.9 m

Pond volume – 1.5 Mm^3

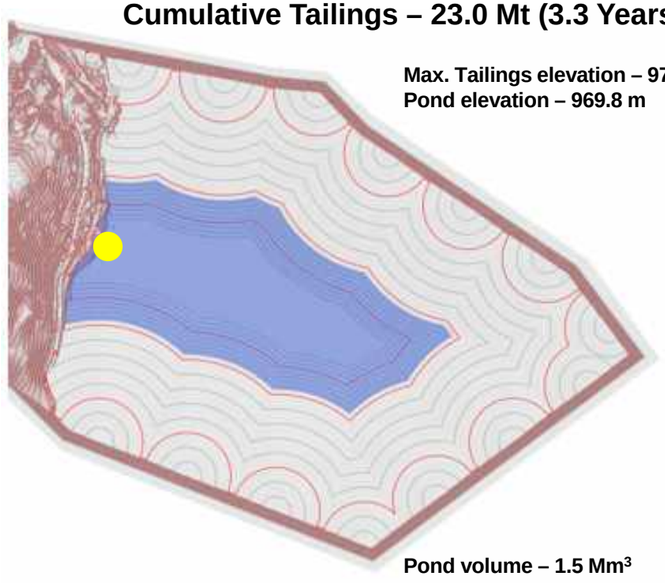
Cumulative Tailings – 18.8 Mt (2.7 Years)



Max. Tailings elevation – 972.4 m
Pond elevation – 968.2 m

Pond volume – 1.5 Mm^3

Cumulative Tailings – 23.0 Mt (3.3 Years)



Max. Tailings elevation – 974.0 m
Pond elevation – 969.8 m

Pond volume – 1.5 Mm^3

LEGEND:

Pond

Approximate Barge Location

NOTES:

1. Sub-aerial beach slope = 1%; sub-aqueous beach slope = 3%.
2. Maximum pond depth = 4 m.
3. Timeline is based on mine plan as reported in 23590671-067-TM-Rev0-51393
4. In place dry density of 1.35 tonnes/m^3 assumed.
5. Barge to be relocated in 2024.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-04-16
PREPARED	SPC / FG
DESIGN	EW
REVIEW	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
TAILINGS DEPOSITION MODELLING RESULTS (Mine Plan; June 2019 Survey)
1% sub-aerial; 3% sub-aqueous

PROJECT No.	Phase/Task	Rev.	Figure No.
CA0020527.4505	51300/51394	0	E-3

APPENDIX F

Seepage Models

(INPUT LOCATION OF SEEPAGE FILES)

Material Properties

Materials	Color	Material Model	Saturated Hydraulic Conductivity (m/s)	Anisotropy
Foundation Till / Glaciofluvial		Saturated Only	1×10^{-6}	0.1
Glaciolacustrine		Saturated Only	5×10^{-10}	1
Upstream Fill		Saturated / Unsaturated	1×10^{-5}	1
Till Core		Saturated / Unsaturated	1×10^{-8}	1
Filter		Saturated / Unsaturated	1×10^{-2}	1
Transition		Saturated / Unsaturated	1×10^{-2}	1
Rockfill		Saturated Only	1×10^{-2}	1
Tailings deposited since 2016		Saturated / Unsaturated	1×10^{-5}	0.1
Tailings deposited prior to 2014		Saturated / Unsaturated	1×10^{-6}	0.1
Tailings Sand		Saturated / Unsaturated	1×10^{-5}	1
Cutoff Wall		Saturated Only	1×10^{-8}	1
Upstream Drain		Saturated / Unsaturated	1×10^{-2}	1
Bedrock		None	-	-

REFERENCES/NOTES

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

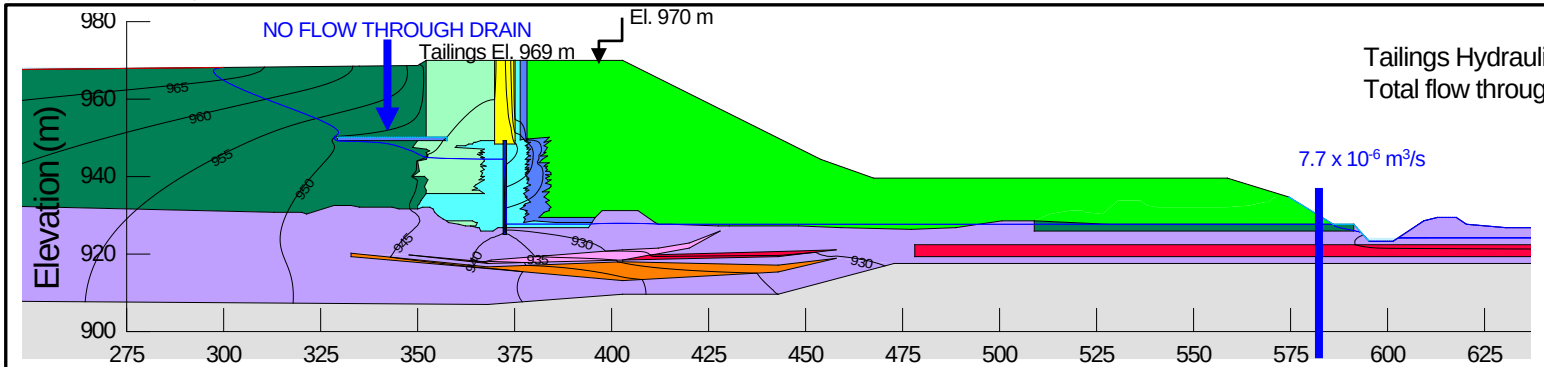
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

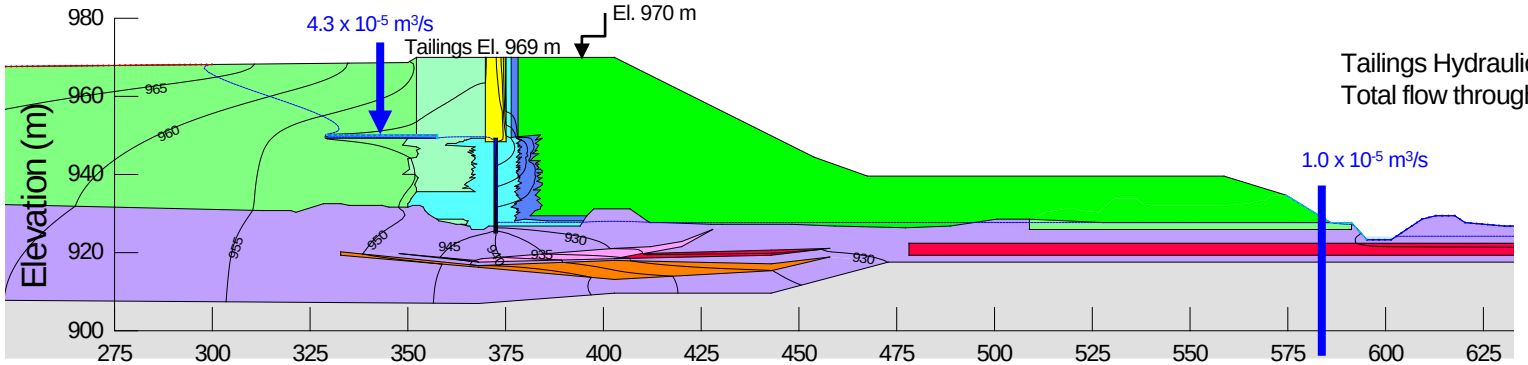
TITLE
SEEPAGE ANALYSIS
MATERIAL PROPERTIES

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-1

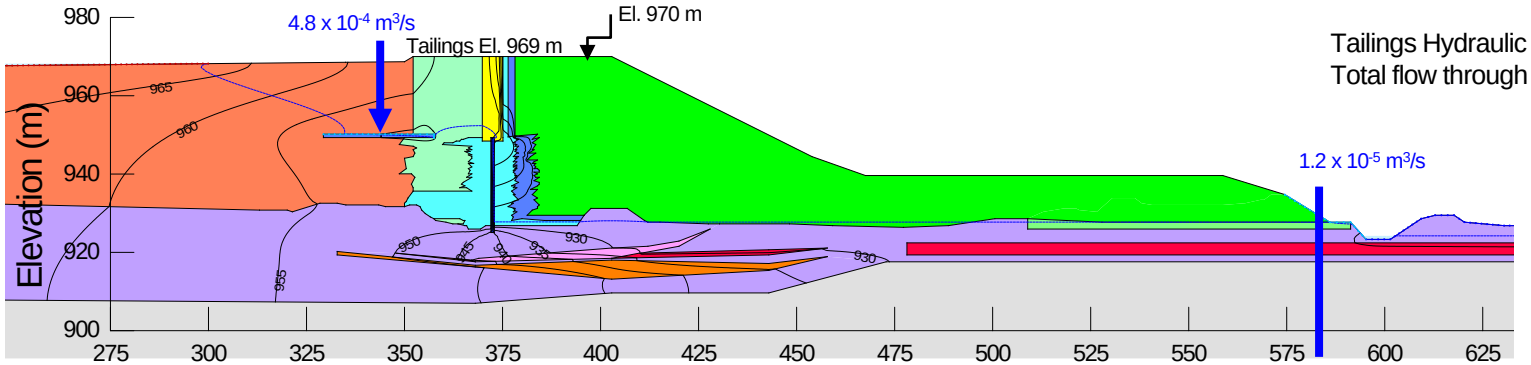
(INPUT LOCATION OF SEEPAGE FILES)



Tailings Hydraulic Conductivity: 1.0 x 10^{-6} m/s
Total flow through upstream drain discharge pipe: 0 L/s



Tailings Hydraulic Conductivity: 1.0 x 10^{-5} m/s
Total flow through upstream drain discharge pipe: 15 L/s



Tailings Hydraulic Conductivity: 1.0 x 10^{-4} m/s
Total flow through upstream drain discharge pipe: 167 L/s

Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Contours show total head, 5 m intervals.
2. Beach width: 50 m.
3. Zero flow boundary applied for the drain.
4. Tailings Anisotropy: 0.1
5. Upstream flow rate reported by MPMC has varied between approximately 20 L/s to 45 L/s with beach widths ranging from 0 m to approximately 200 m.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

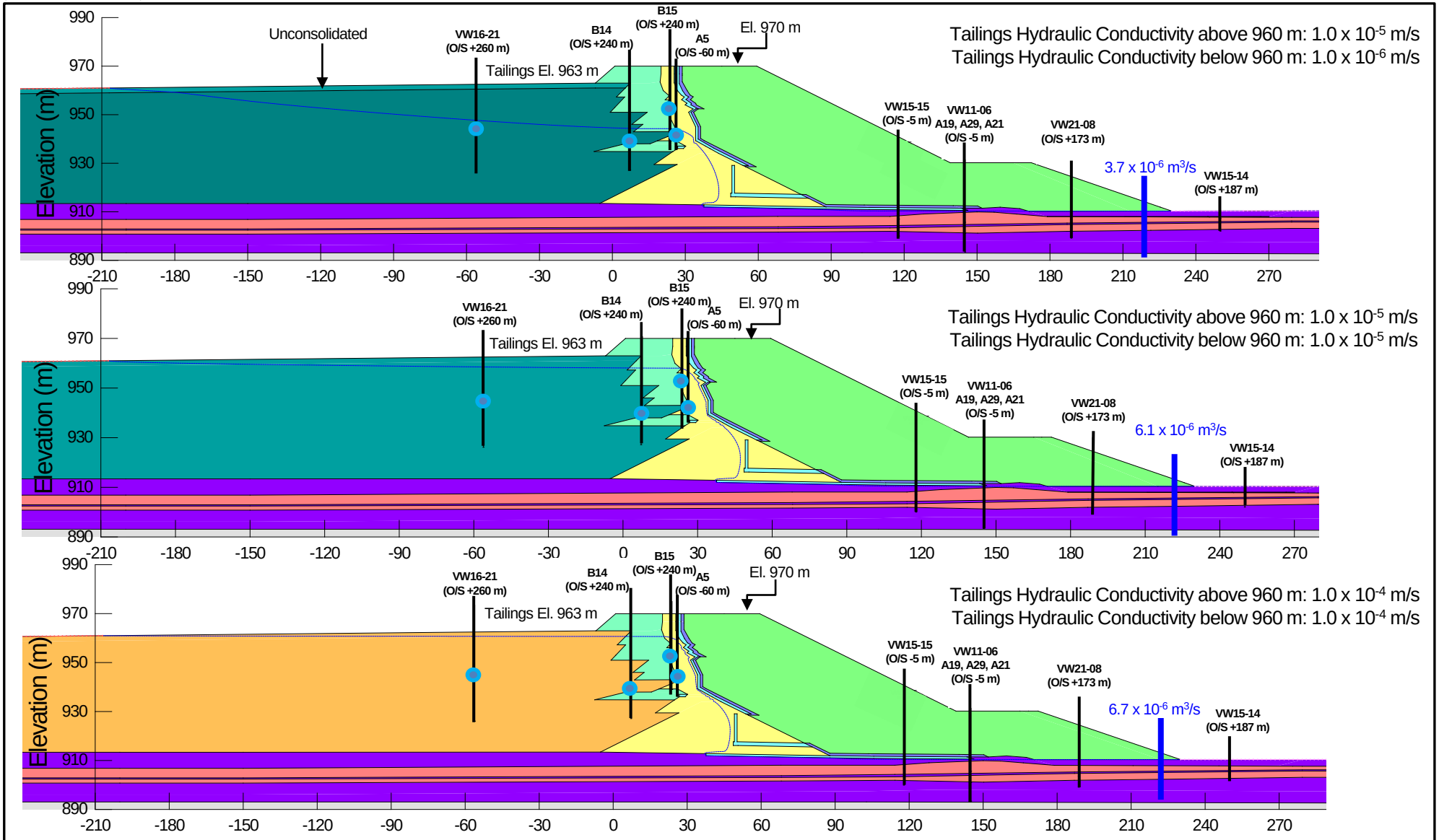
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS
CORNER 1 CALIBRATION

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-2

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Tailings Anisotropy: 0.1
2. Beach width: 200 m.
3. Hydraulic conductivity of Foundation till and Glaciofluvial calibrated to 1x10-6 m/s.

VWP Pressure Reading

Piezometric Line

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT

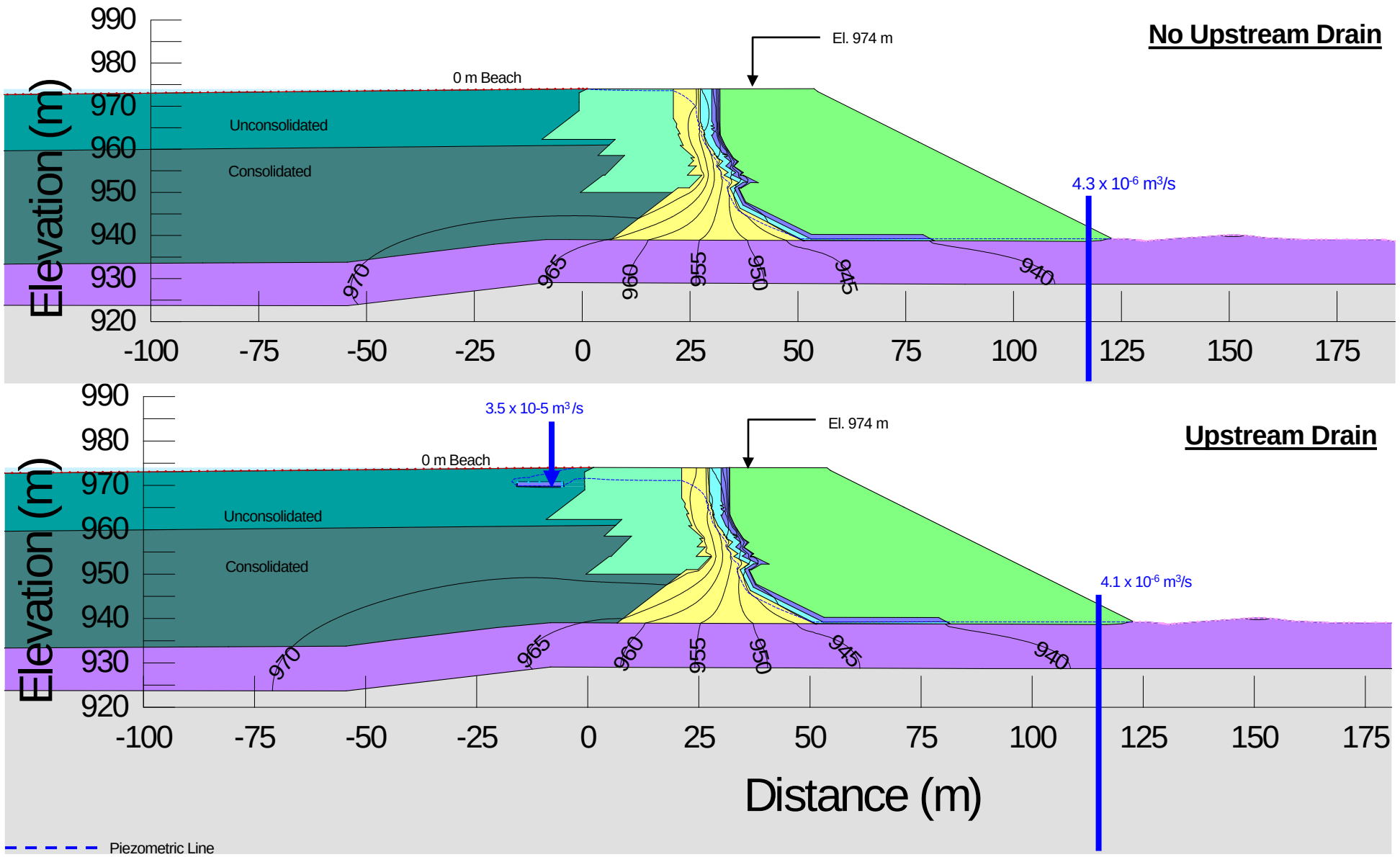
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE

SEEPAGE ANALYSIS
MAIN EMBANKMENT CALIBRATION

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-3

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 5 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 27 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

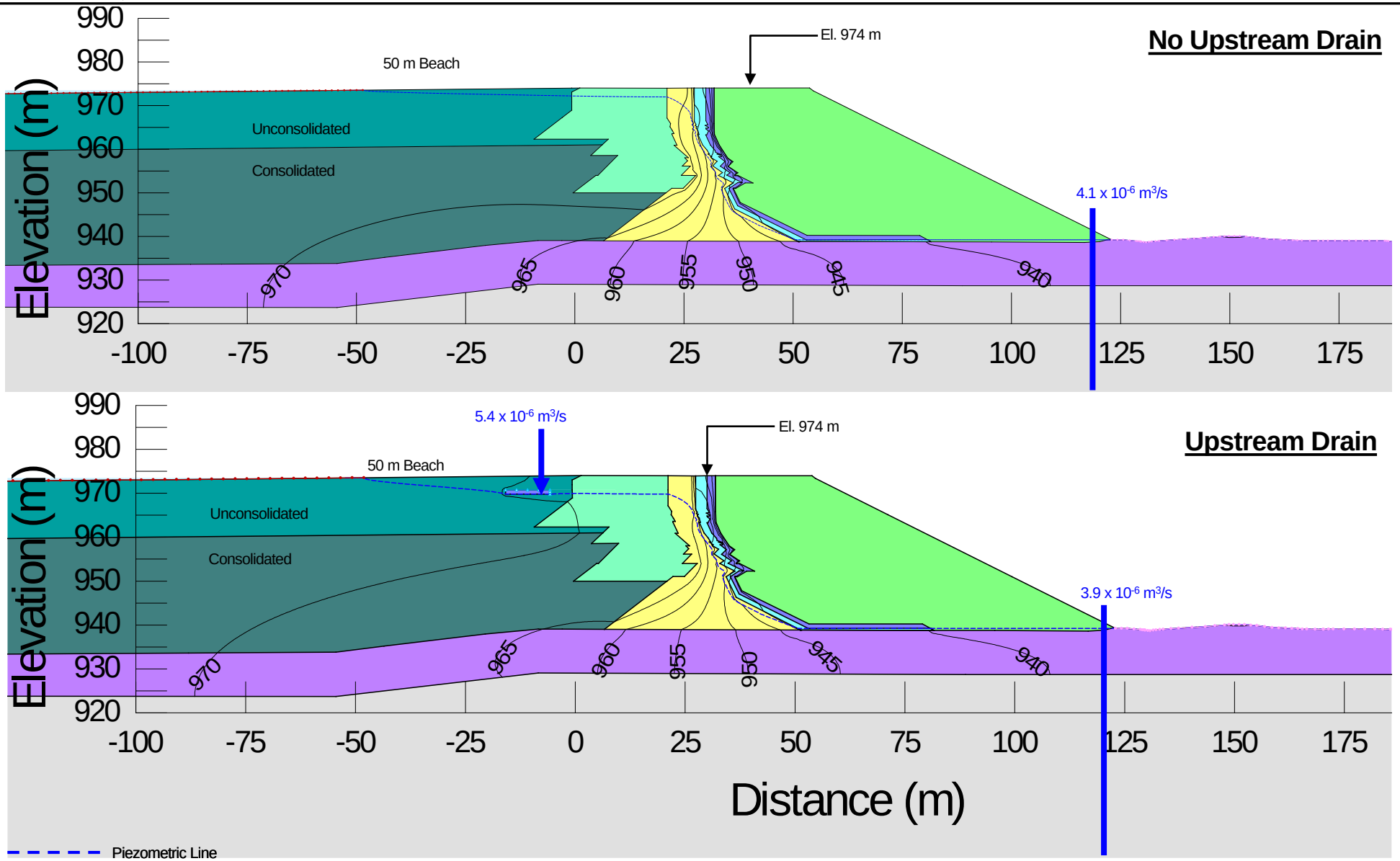
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
NO SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-4

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 5 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 27 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

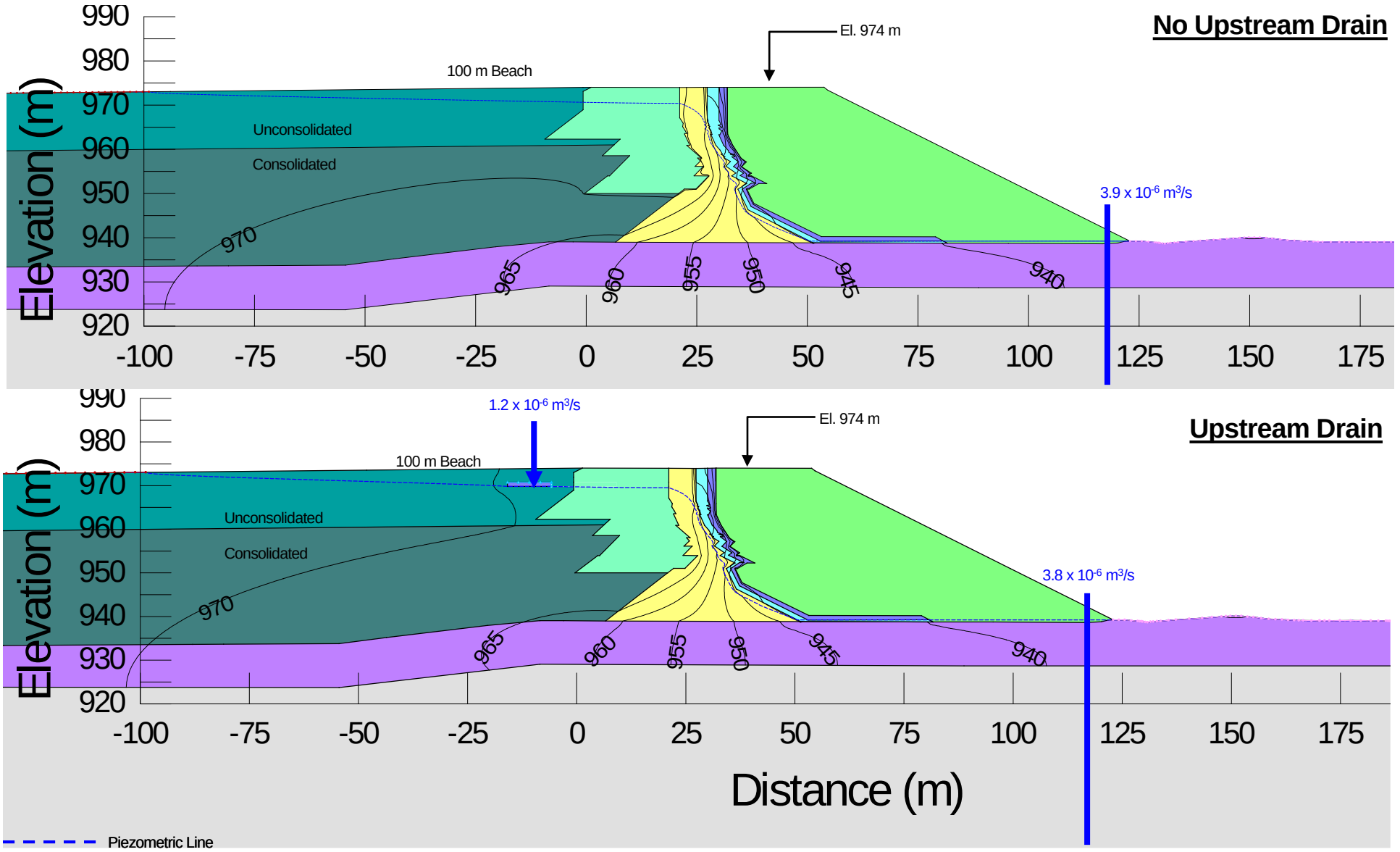
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
50 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-5

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 5 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 27 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

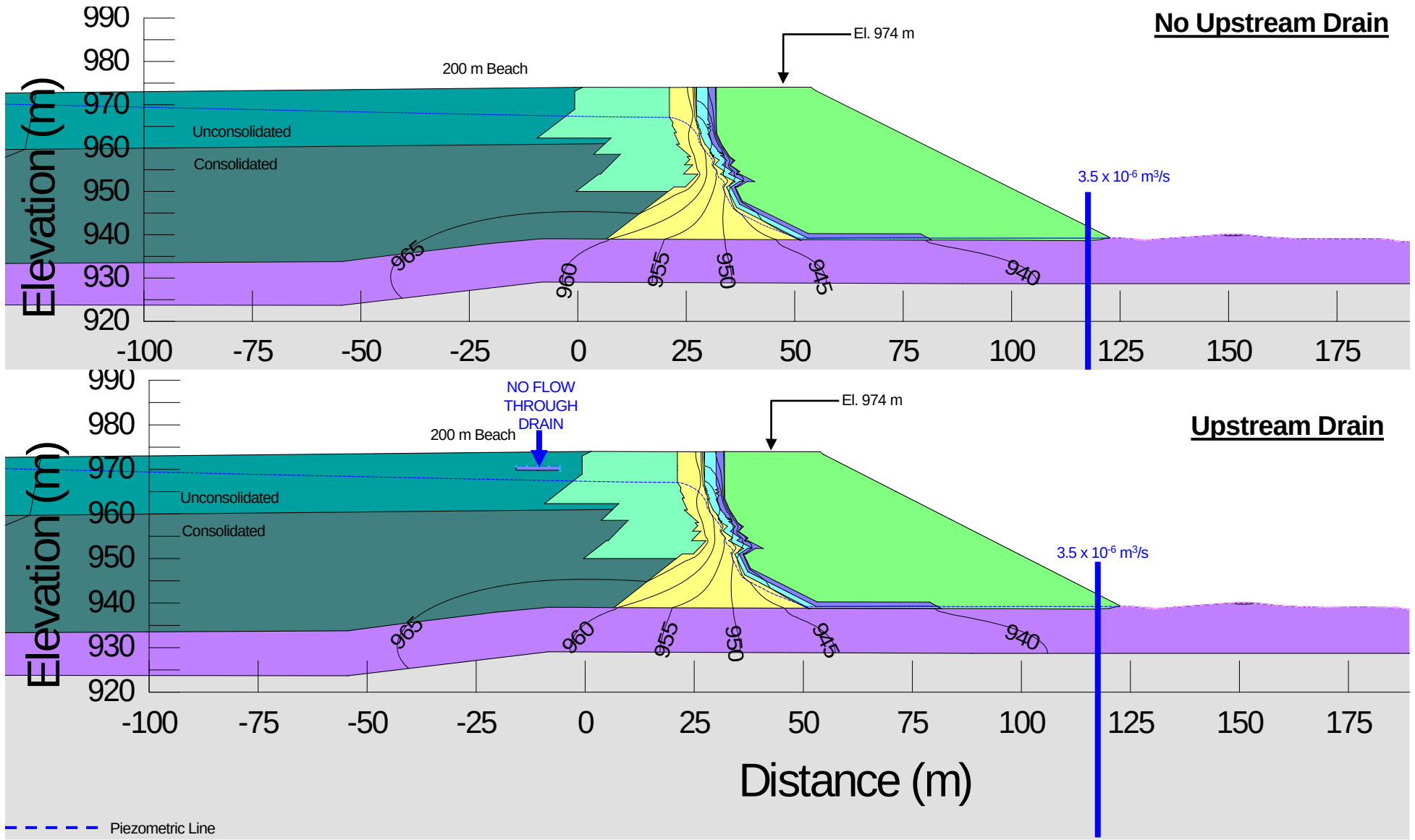
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
100 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-6

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 5 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 27 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

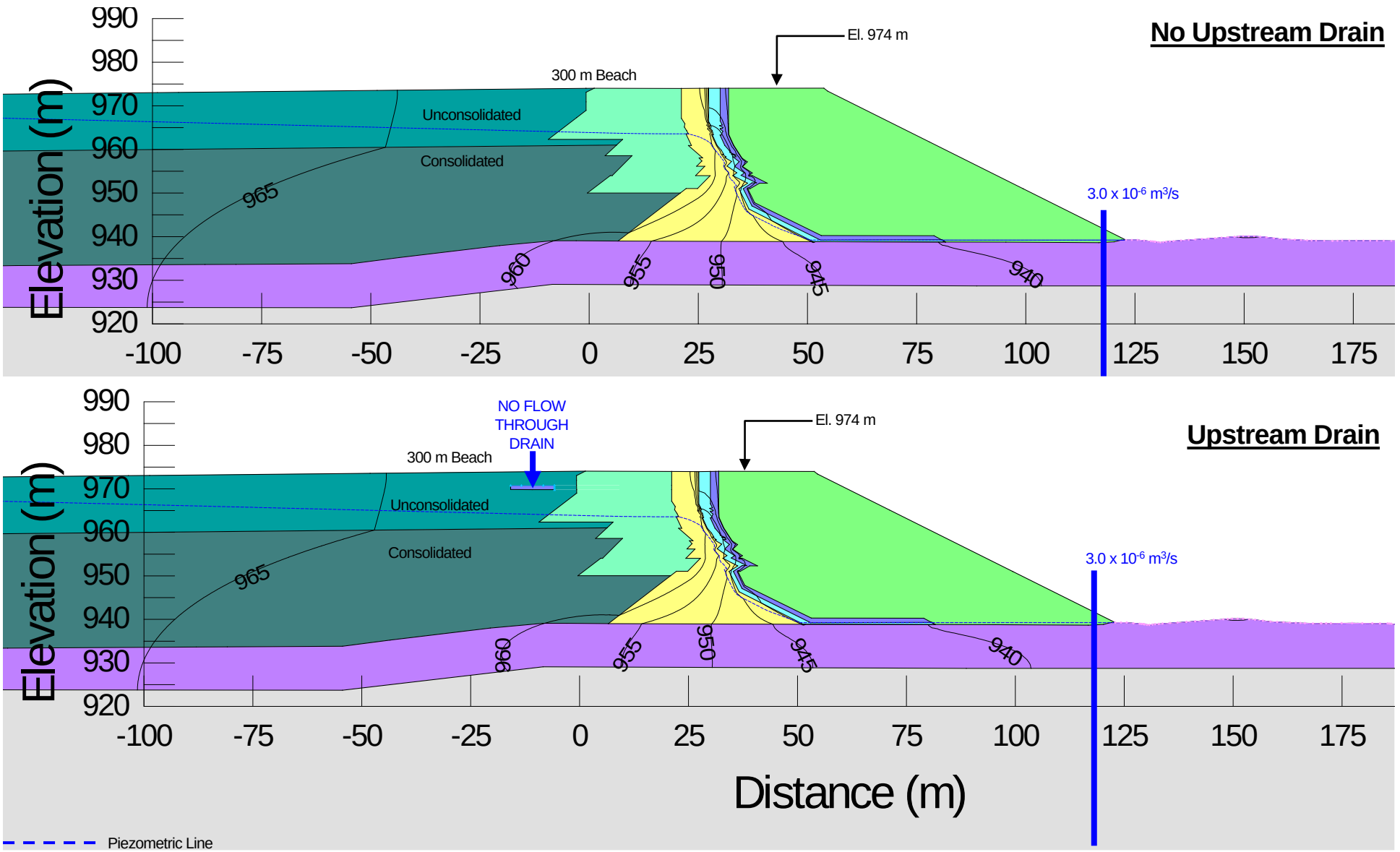
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
200 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-7

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 5 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 27 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

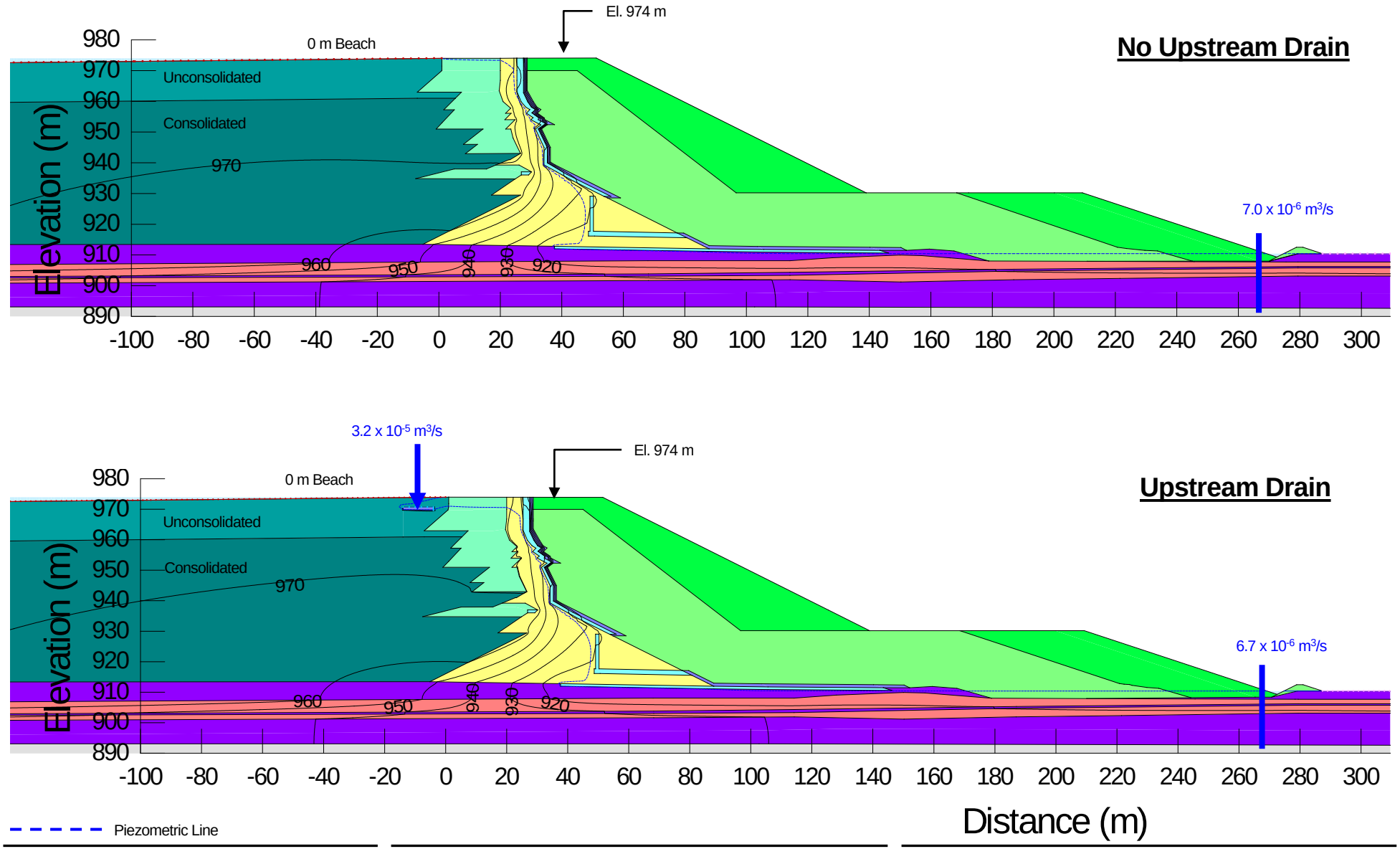
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
300 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-8

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 24 m from till core

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

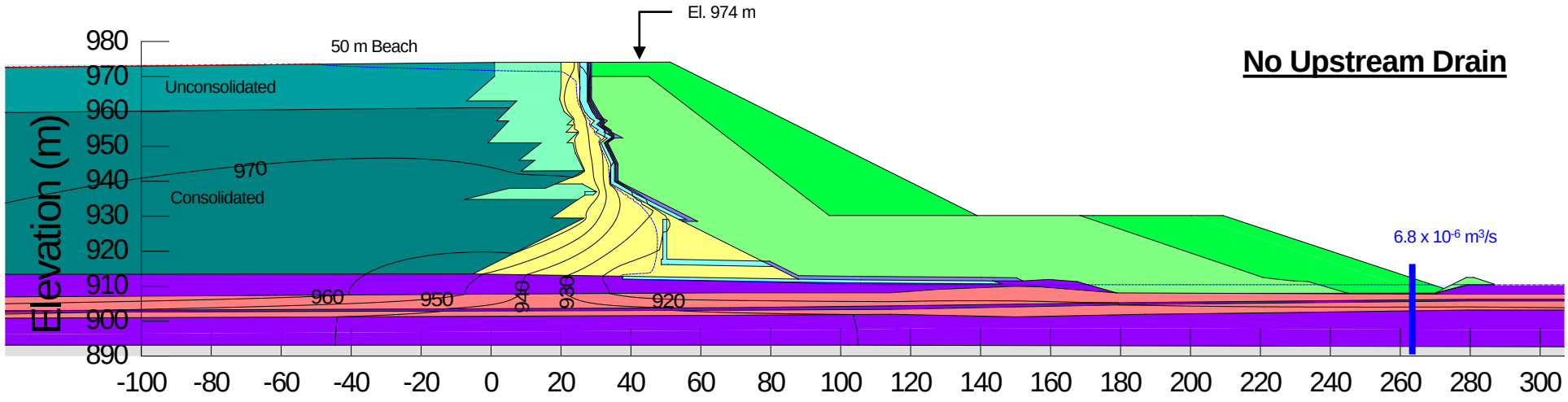
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

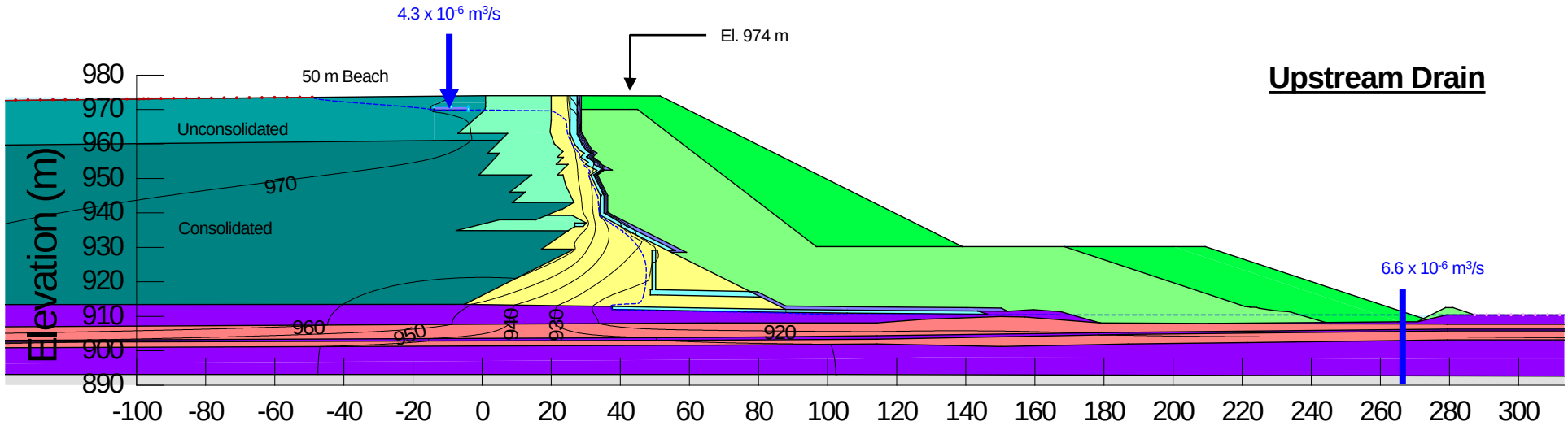
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
NO SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-9

(INPUT LOCATION OF SEEPAGE FILES)





Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 24 m from till core

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

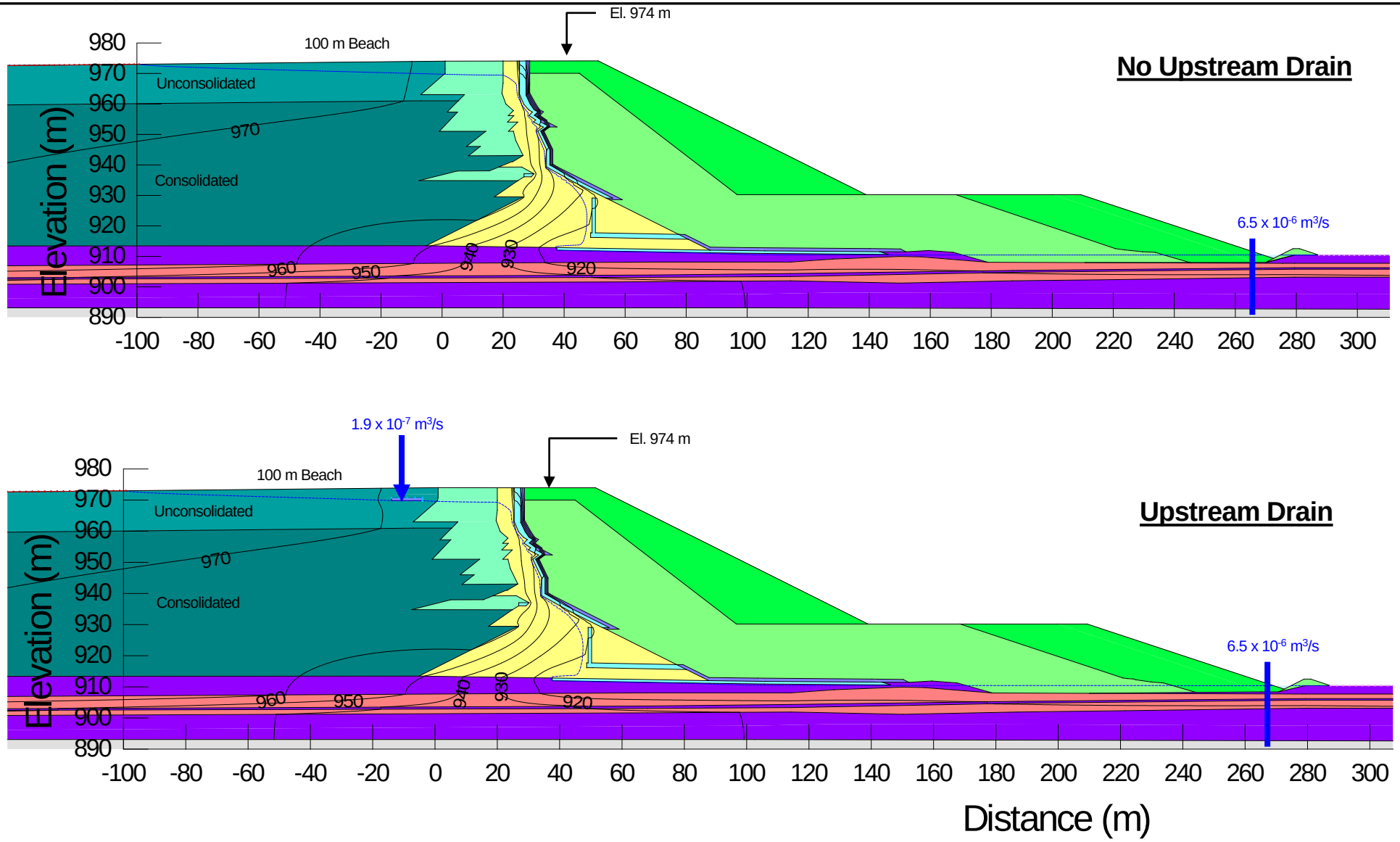
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
50 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-10

(INPUT LOCATION OF SEEPAGE FILES)



Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 24 m from till core

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

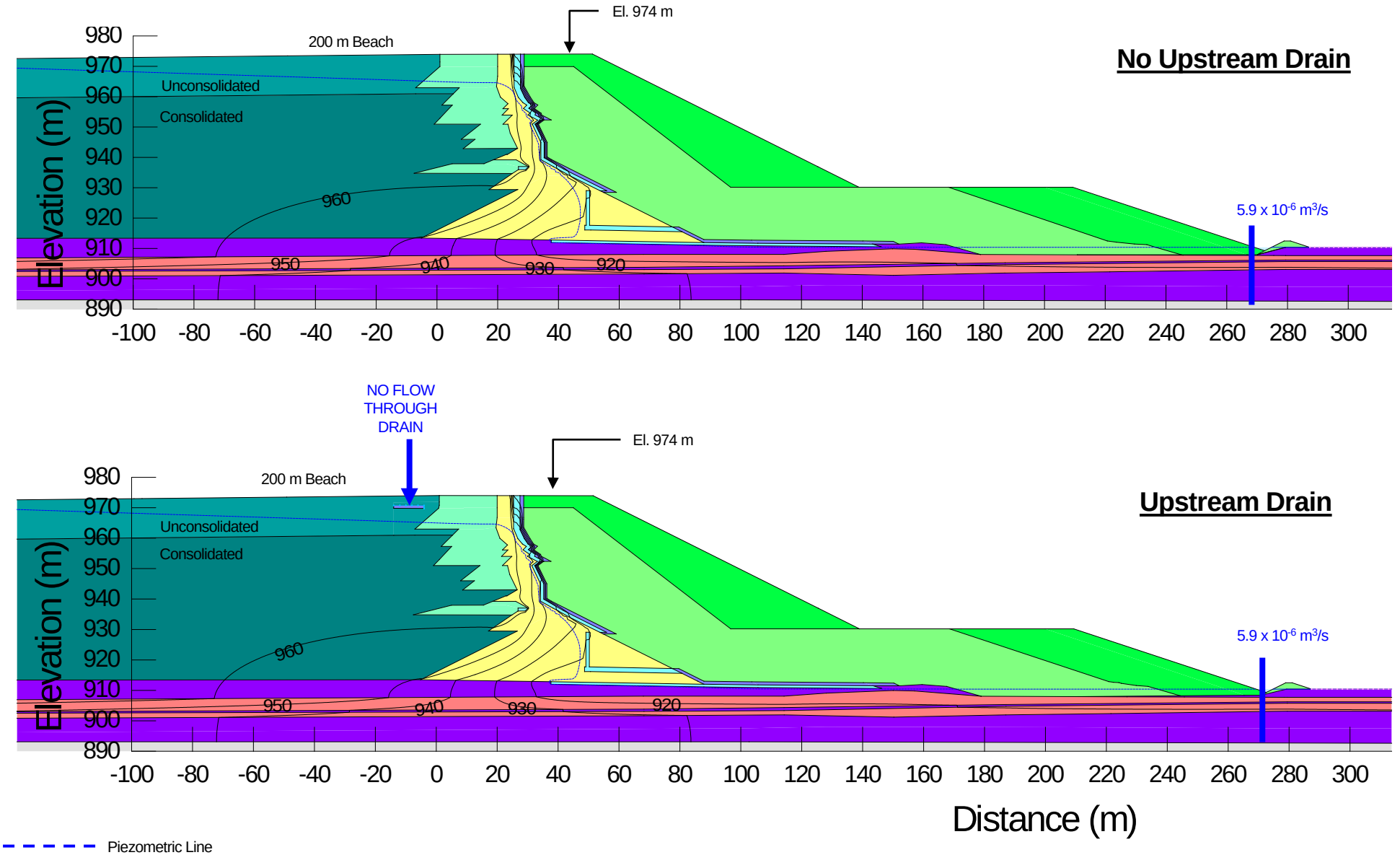
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
100 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-11

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 24 m from till core

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

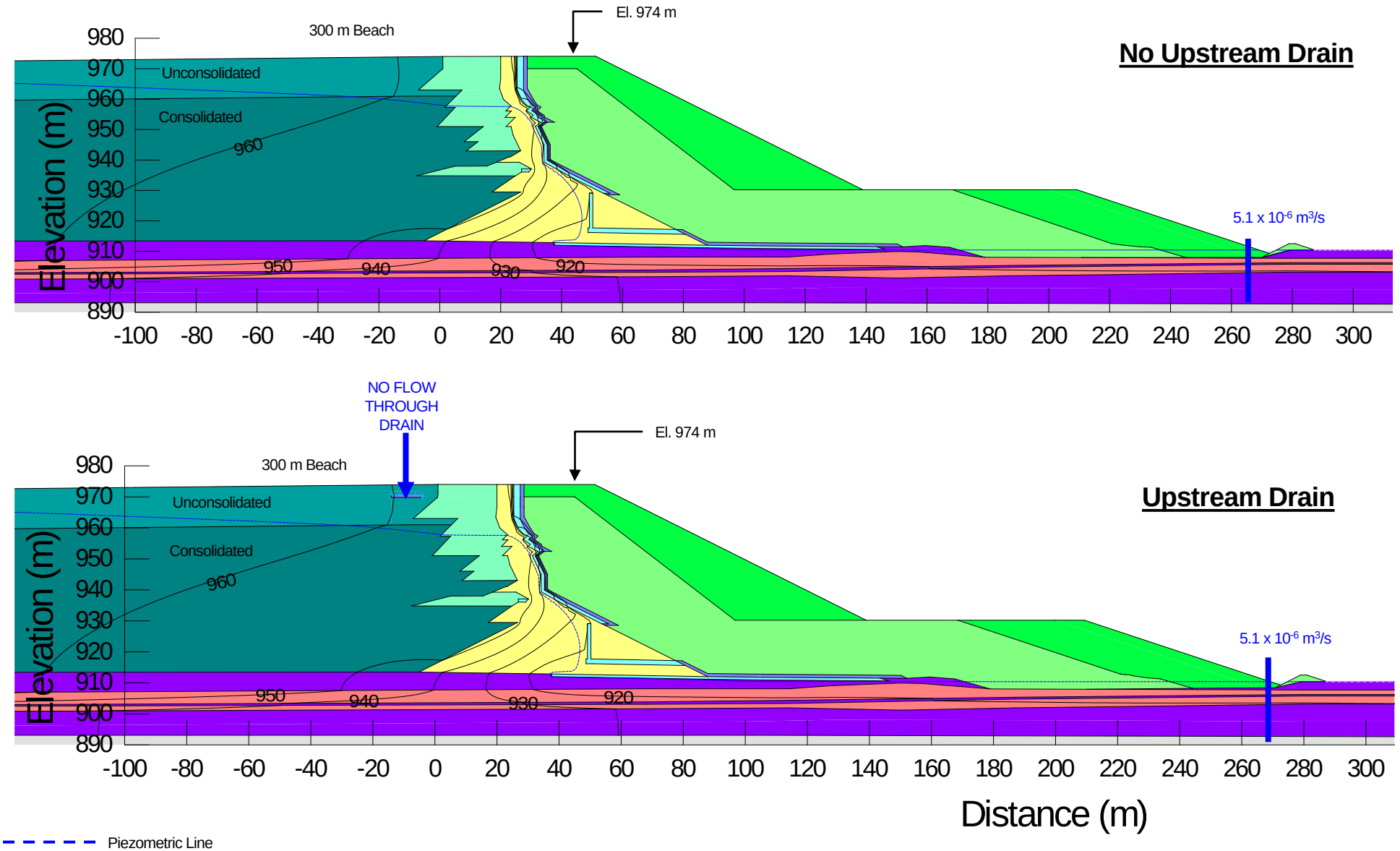
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
200 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-12

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 24 m from till core

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

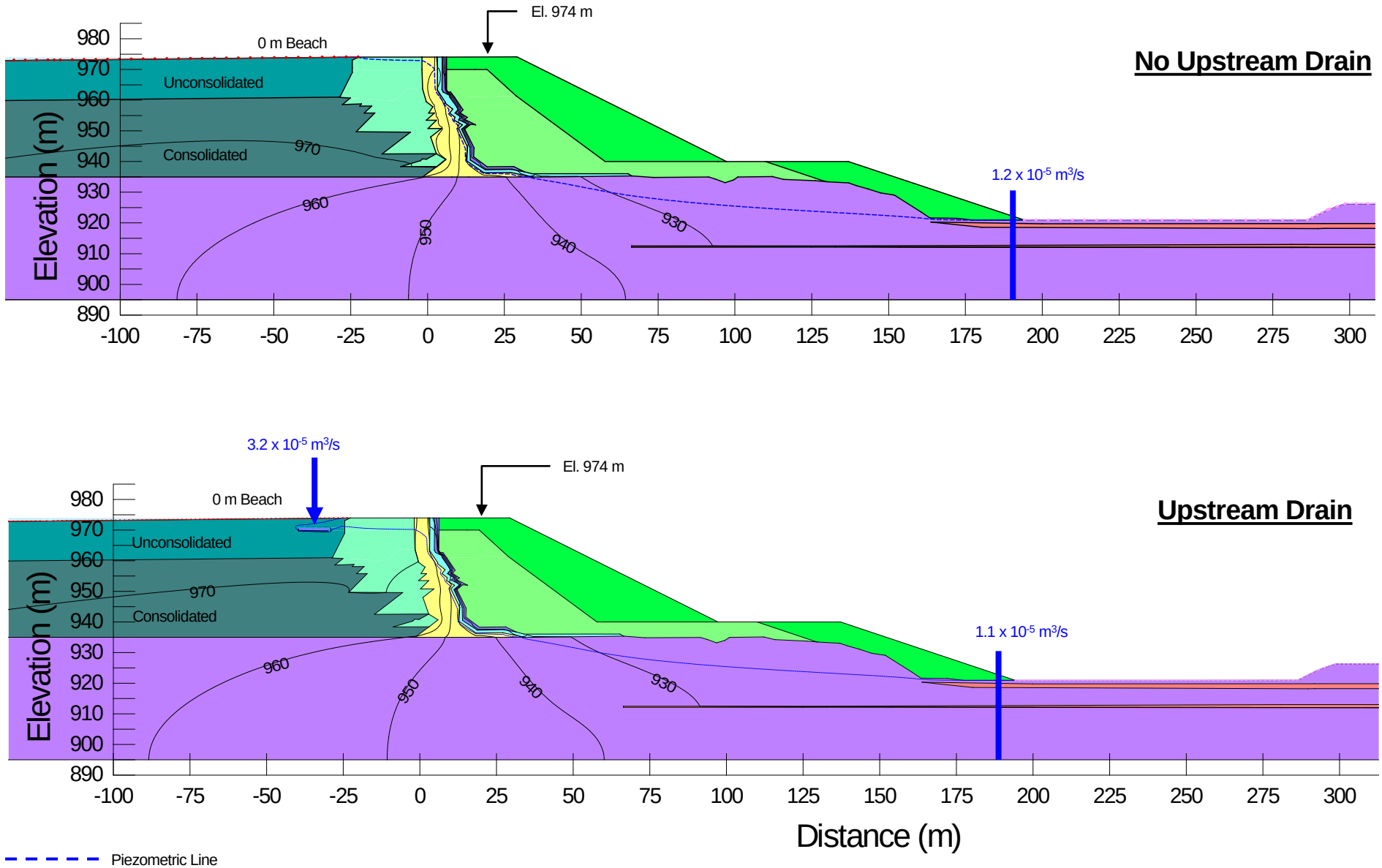
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
300 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-13

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 28 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

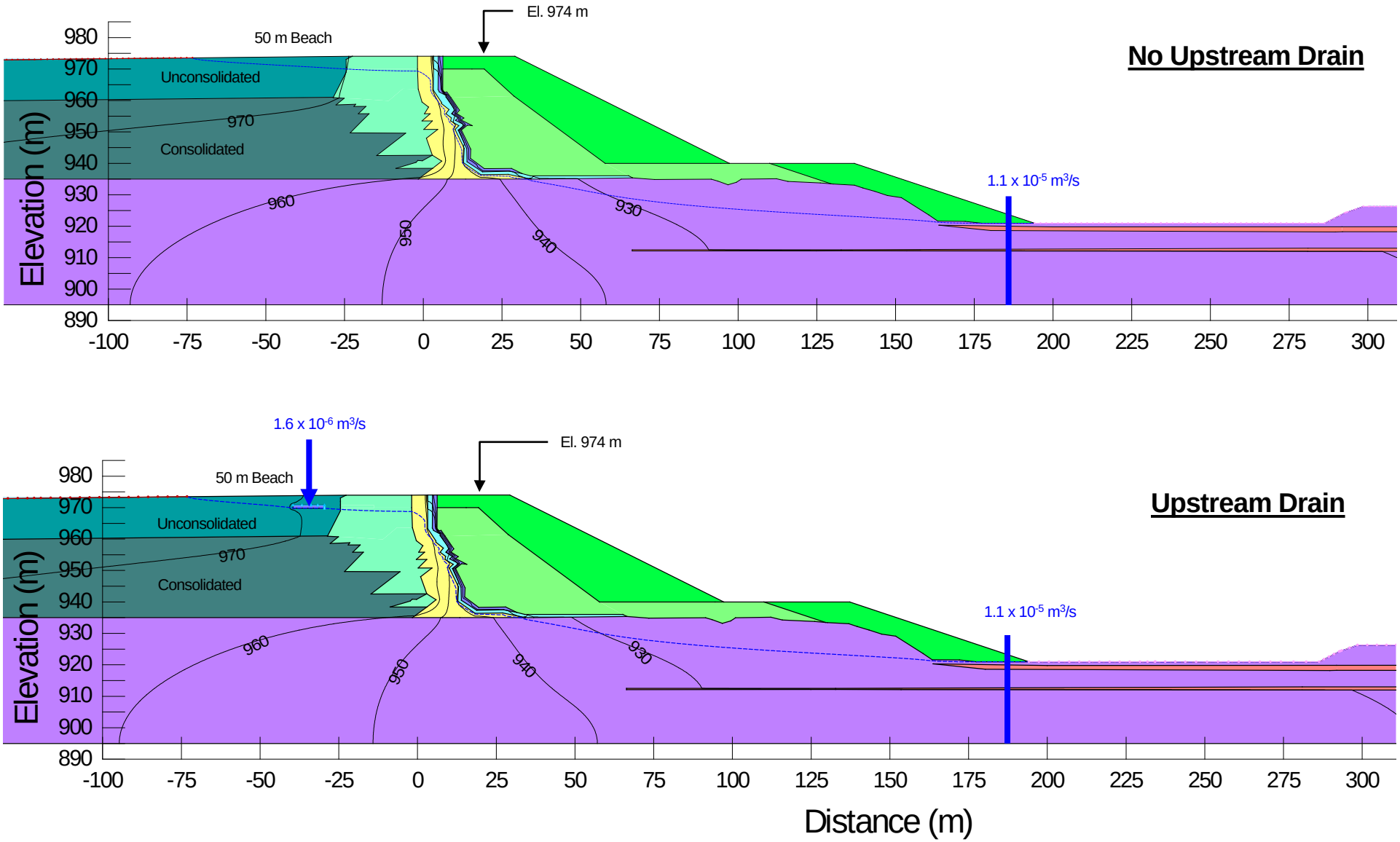
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
NO SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-14

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 28 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

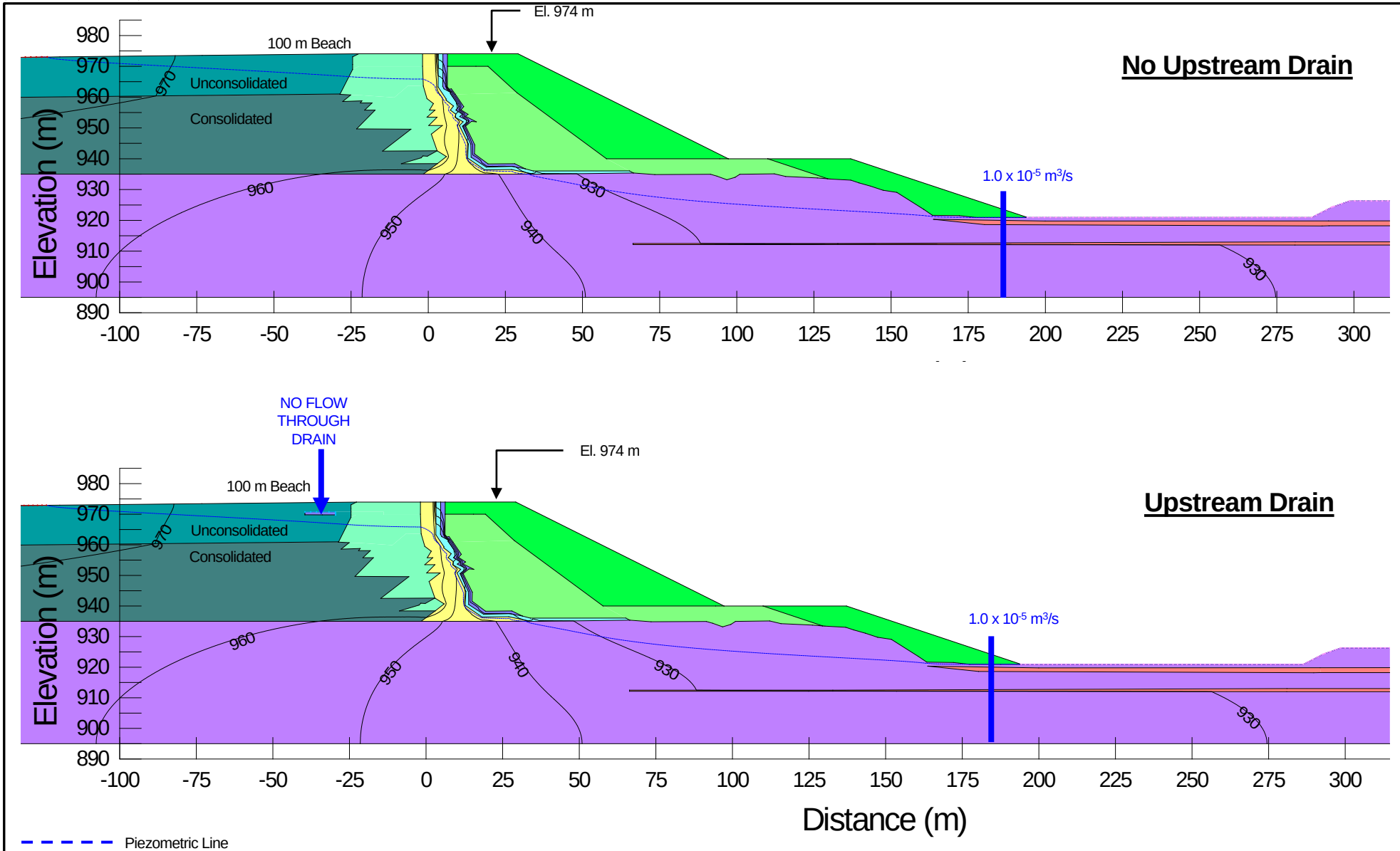
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
50 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-15

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 28 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

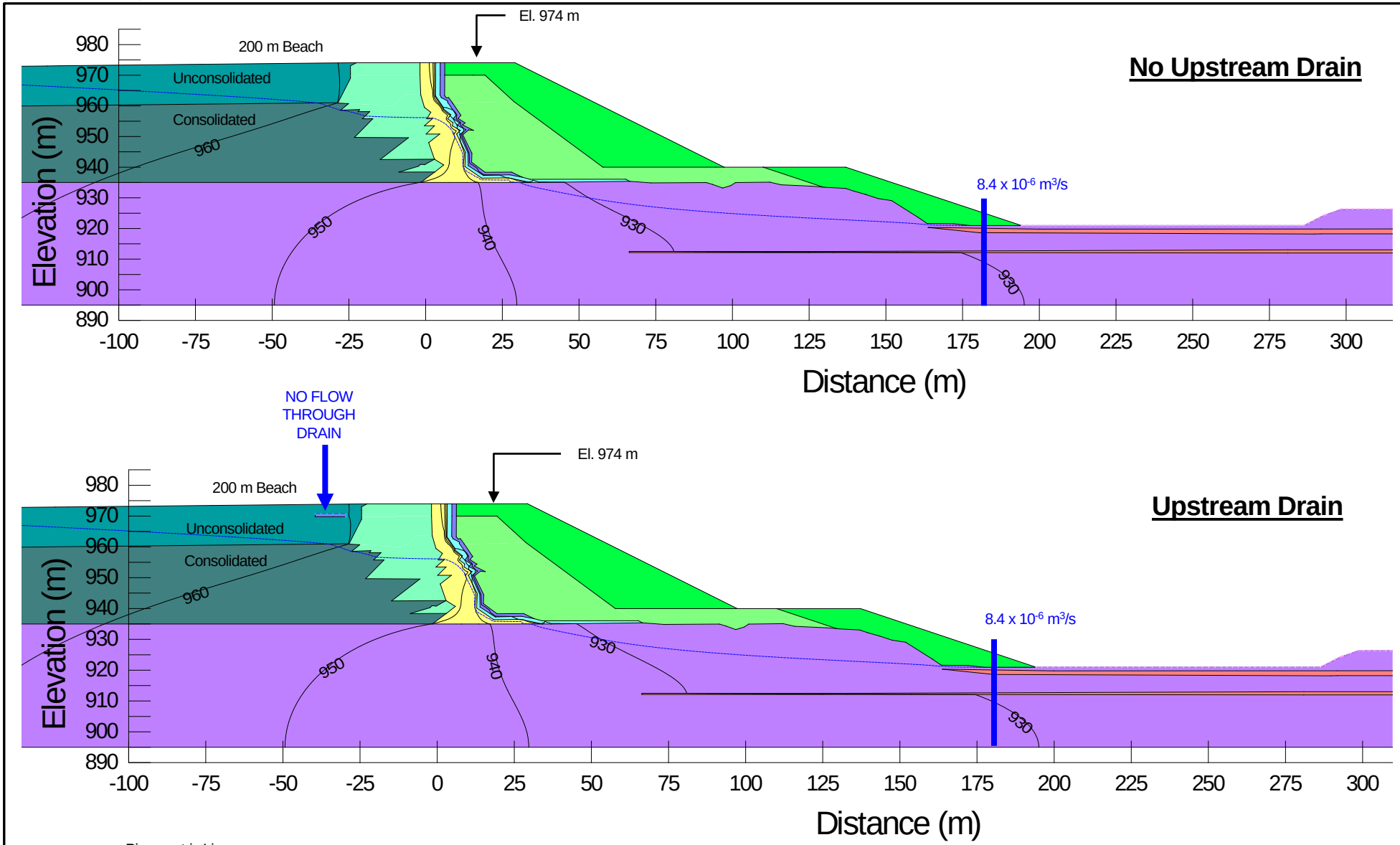
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
100 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-16

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 28 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

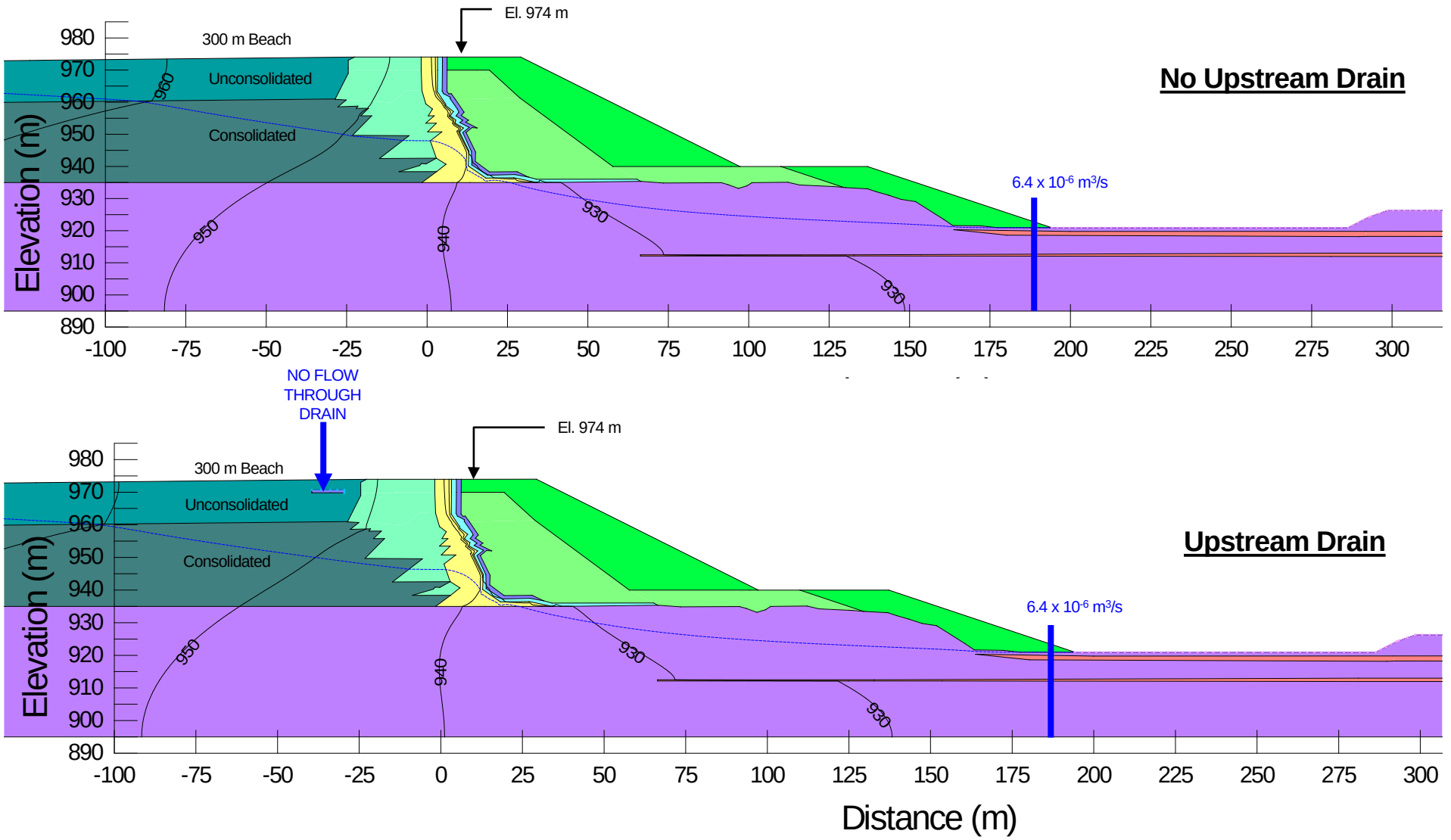
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
200 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-17

(INPUT LOCATION OF SEEPAGE FILES)



Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 28 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

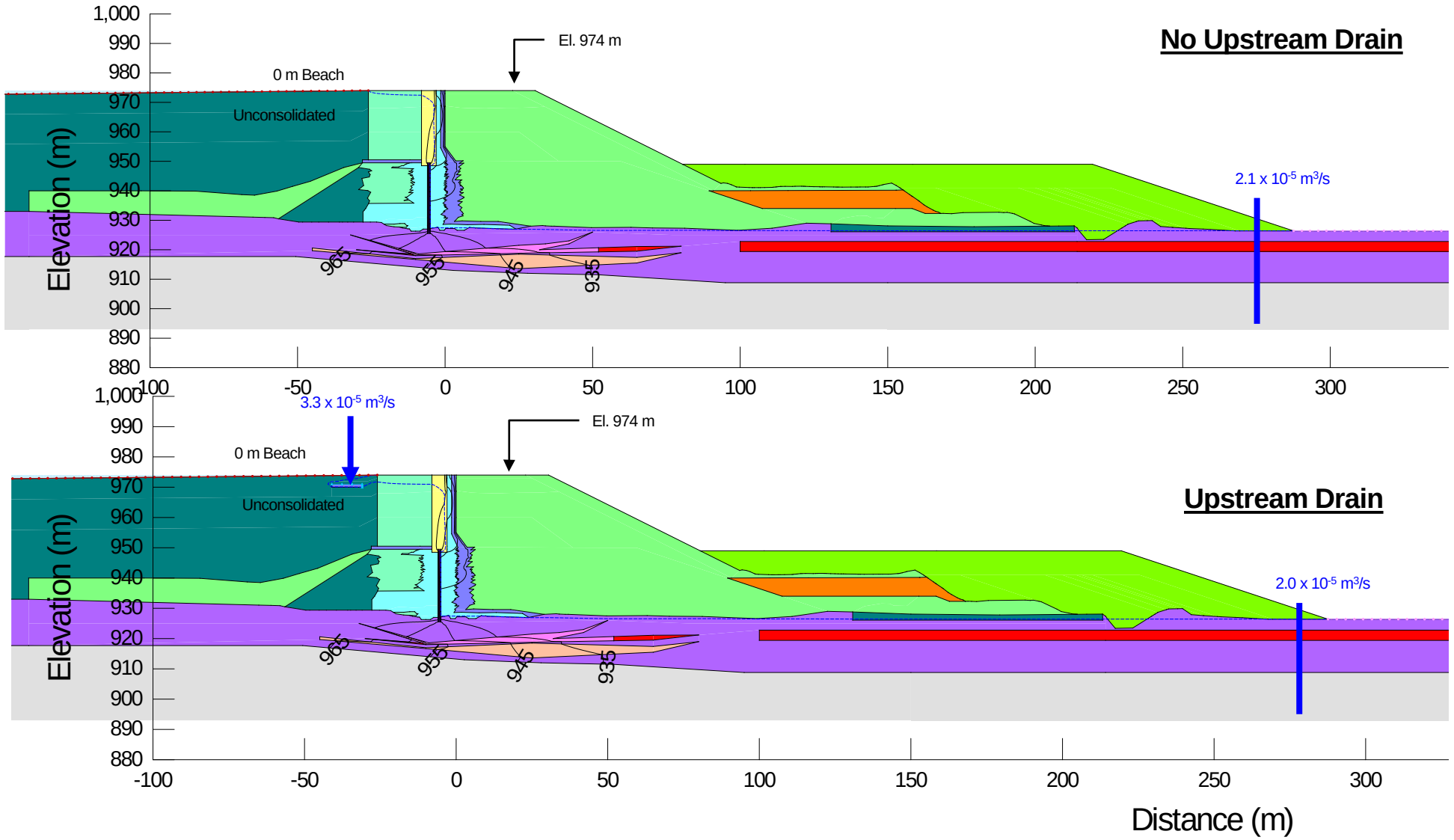
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
300 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-18

(INPUT LOCATION OF SEEPAGE FILES)



Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero flow boundary applied for the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 23 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

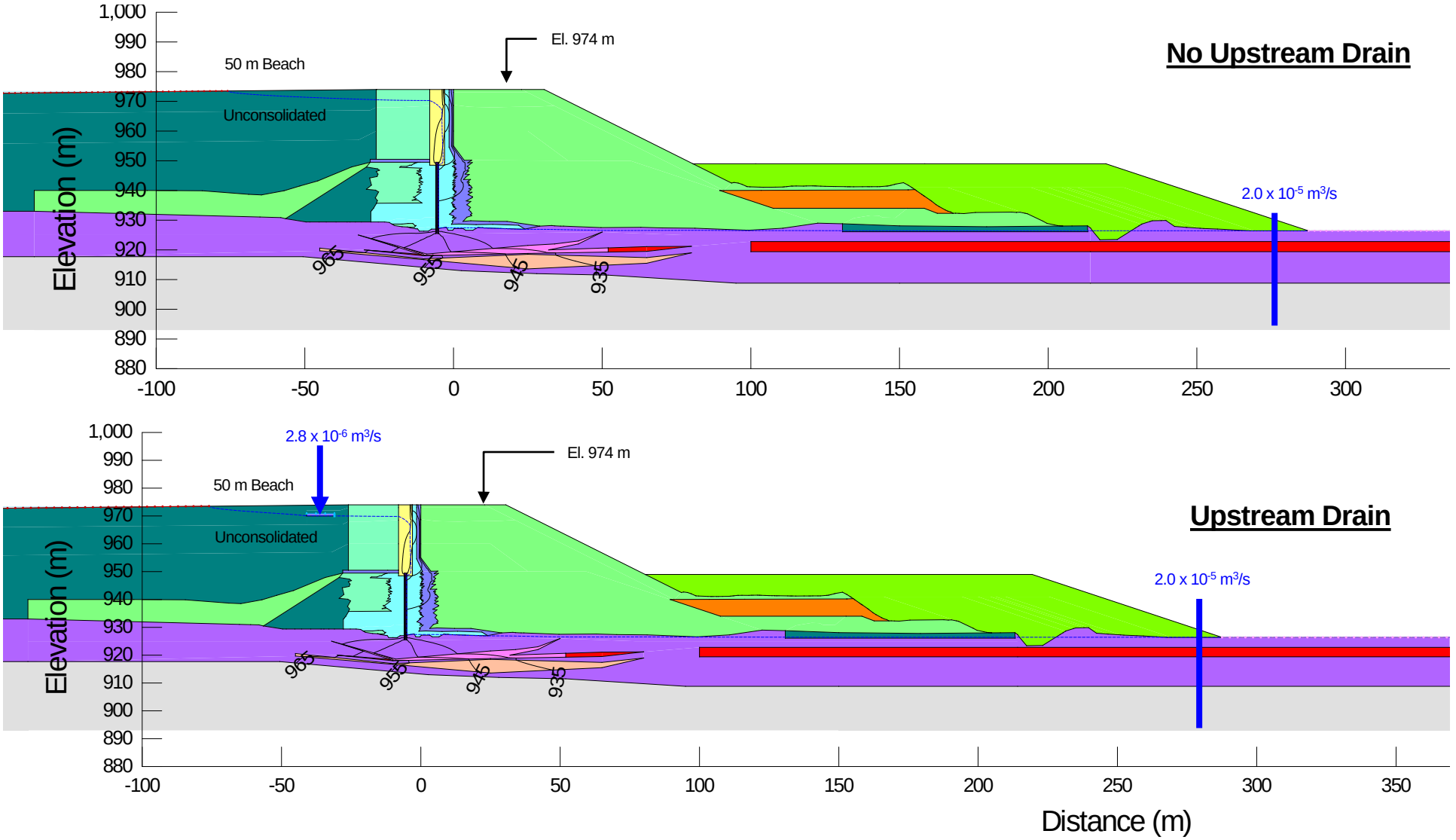
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
NO SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-19

(INPUT LOCATION OF SEEPAGE FILES)



REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero pressure point boundary applied within the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 23 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

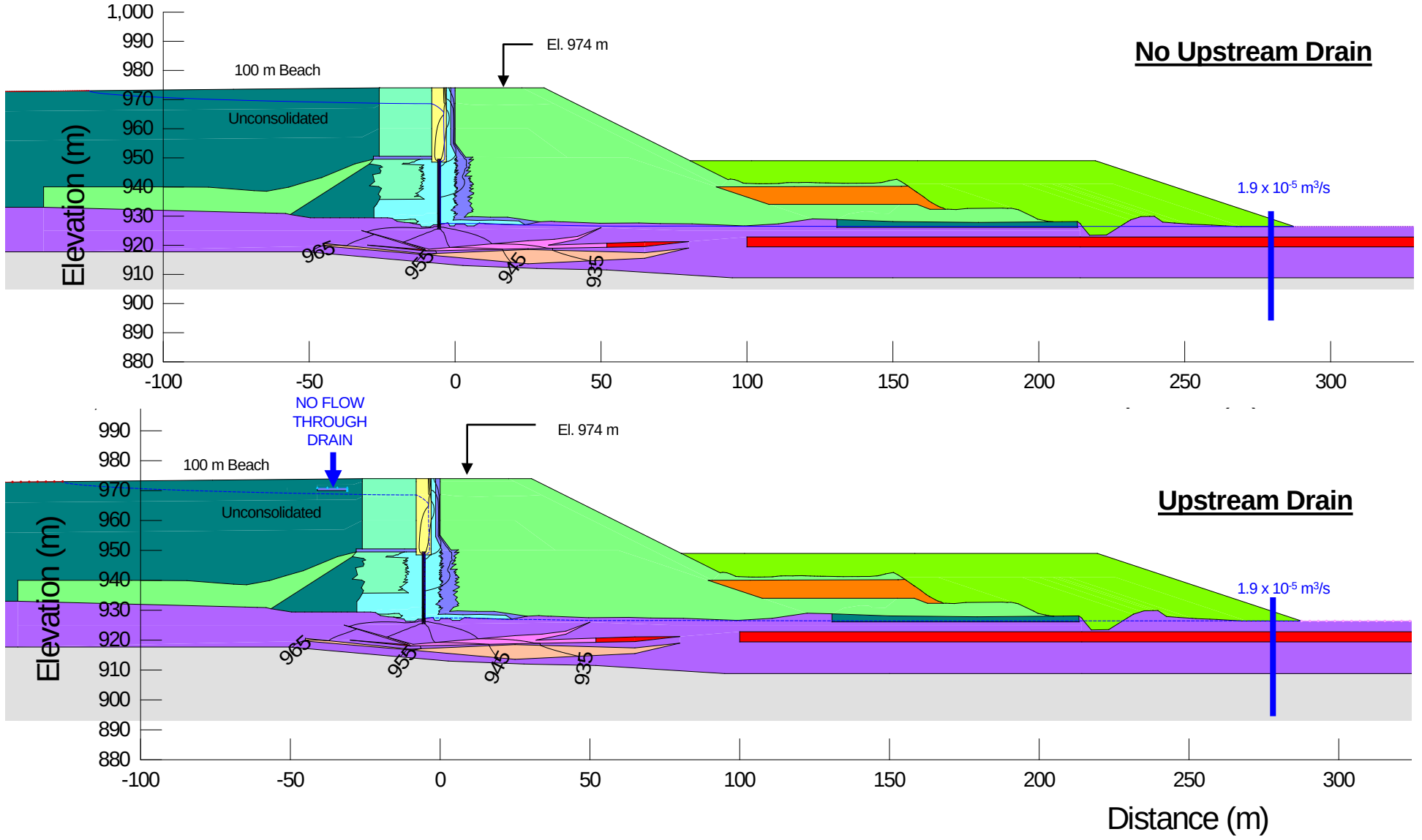
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
50 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-20

(INPUT LOCATION OF SEEPAGE FILES)



Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero pressure point boundary applied within the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 23 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

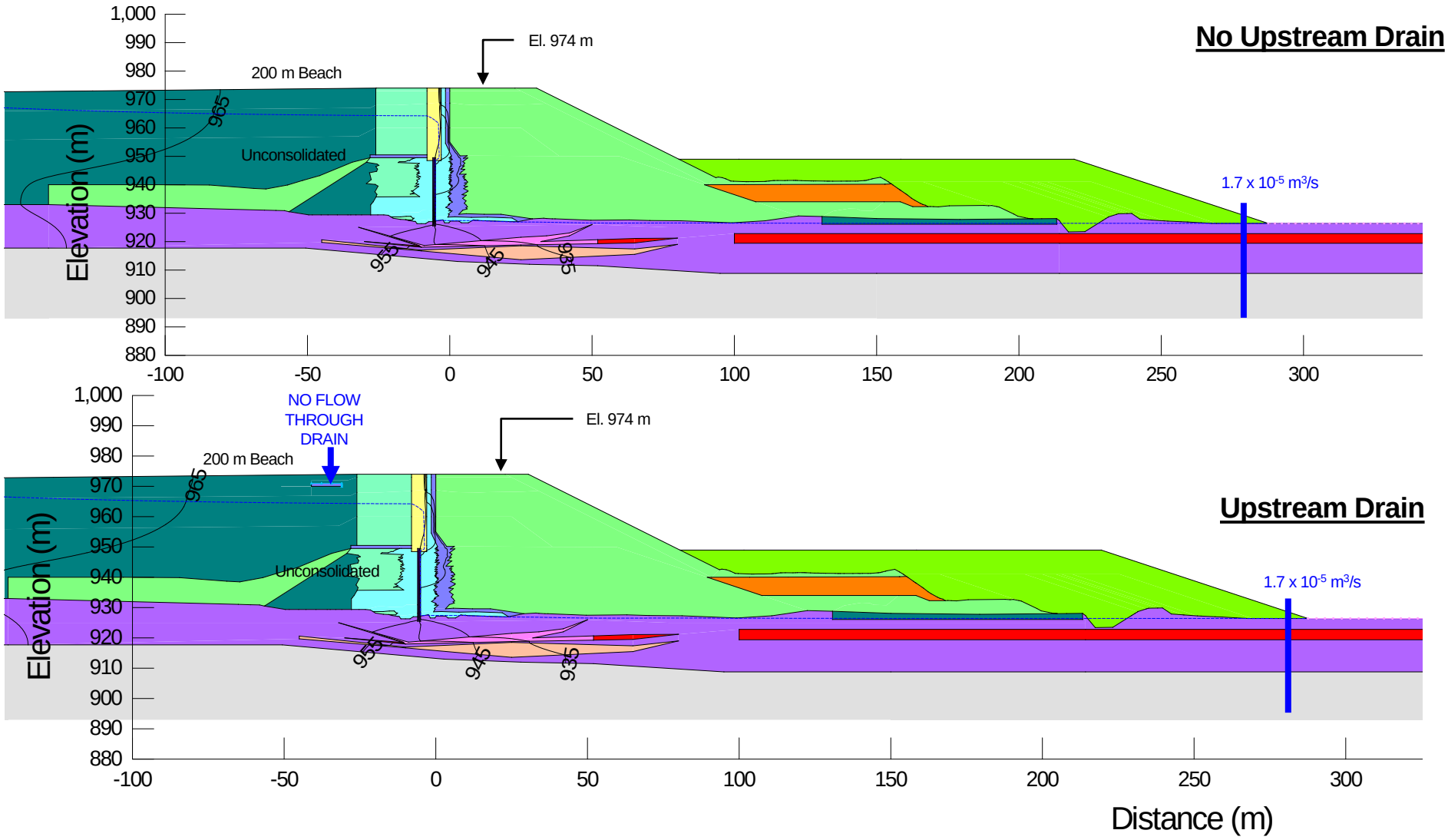
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
100 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-21

(INPUT LOCATION OF SEEPAGE FILES)



Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero pressure point boundary applied within the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 23 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

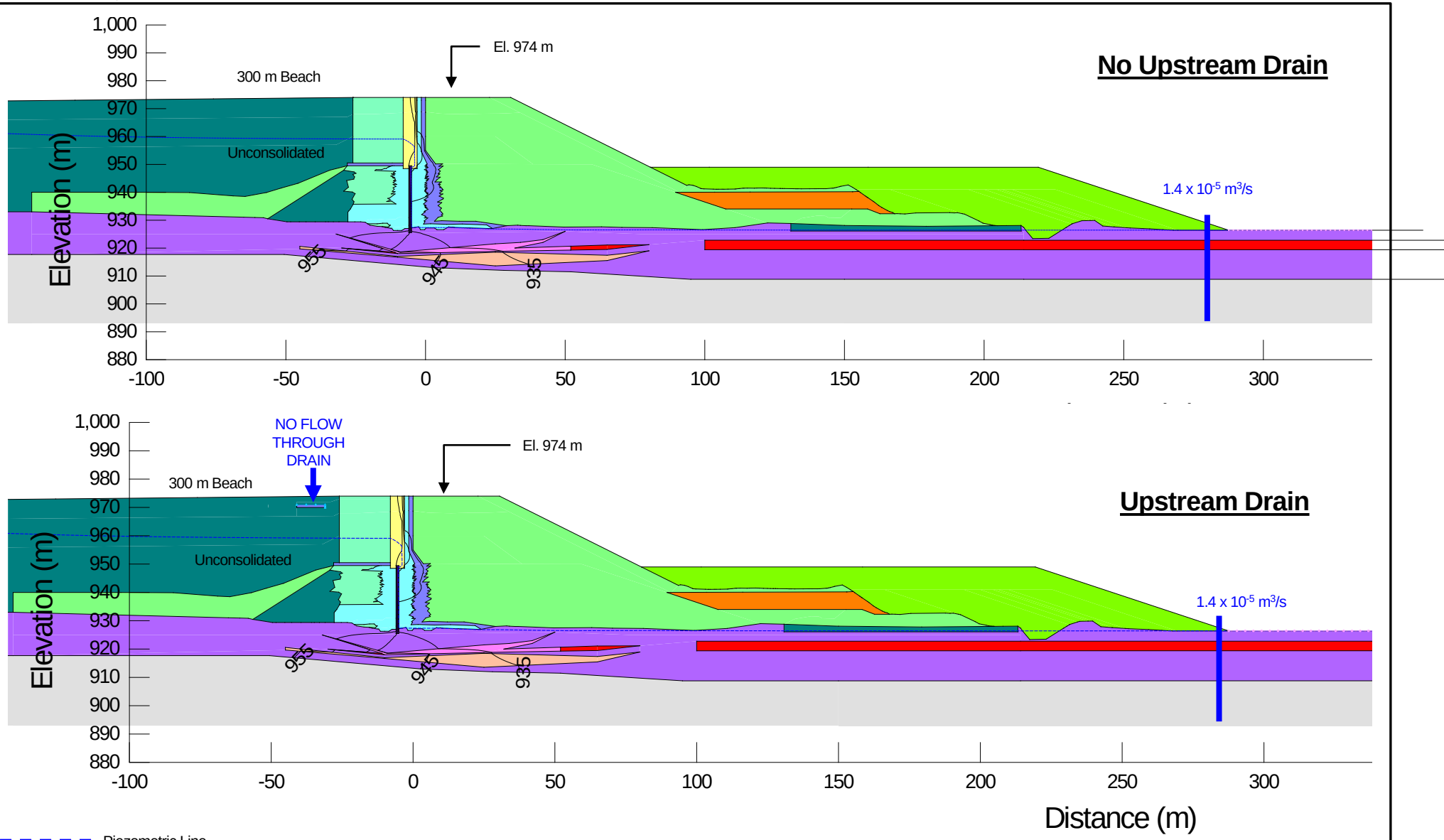
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
200 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-22

(INPUT LOCATION OF SEEPAGE FILES)



Piezometric Line

REFERENCES/NOTES

1. Contours show total head, 10 m intervals.
2. Zero pressure point boundary applied within the drain.
3. Zero pressure applied to the downstream foundation surface.
4. Upstream Drain offset 23 m from till core.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
SEEPAGE ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
300 m SUB-AERIAL BEACH

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	F-23

APPENDIX G

Stability Models

(INPUT LOCATION OF STABILITY FILES)

Material Properties

Glossary: φ = friction angle; *c* = cohesion

Materials	Colour	Unit Weight (kN/m³)	Pore Pressure Coefficient B-bar(1)	Strength Parameters[2]
Foundation Till		22	0.2	Mohr-Coulomb: φ = 34°; *c* = 0 kPa
Glaciofluvial		22	0.2	Mohr-Coulomb: φ = 34°; *c* = 0 kPa
Upper Glaciolacustrine (Perimeter Embankment at Corner 1)		18	0.46	Peak: $T = 0.22\ \sigma_v' \ OCR^{0.71}$, where σ_p' = 400 kPa Remolded: S_{ur} = 22 kPa
Lower Glaciolacustrine (Perimeter Embankment at Corner 1)		20	0.2	Peak: $T = 0.22\ \sigma_v' \ OCR^{0.71}$, where σ_p' = 700 kPa
Glaciolacustrine (Perimeter Embankment)		20	0.2	Peak: $T = 0.22\ \sigma_v' \ OCR^{0.71}$, where σ_p' = 900 kPa
Glaciolacustrine (Main Embankment) and low plasticity silty clay (South Embankment)		20	0.2	Peak: $T = 0.22\ \sigma_v' \ OCR^{0.71}$, where σ_p' = 1,200 kPa
Glaciolacustrine (Main Embankment - approx. El. 922 m Stn. 2+400 and 2+750)		20	0.2	Peak: $T = 0.22\ \sigma_v' \ OCR^{0.71}$, where σ_p' = 850 kPa
Upstream Fill		20	-	Mohr-Coulomb: φ = 32°; *c* = 0 kPa
Till Core		20.5	-	Mohr-Coulomb: φ = 33°; *c* = 0 kPa
Filter		20	-	Mohr-Coulomb: φ = 30°; *c* = 0 kPa
Transition		20	-	Shear-Normal Function: $T = 1.726\ \sigma'^{0.899}_n$
Rockfill		21.5	-	Shear-Normal Function: $T = 1.726\ \sigma'^{0.899}_n$
Tailings		17	-	Mohr-Coulomb: φ = 25°; *c* = 0 kPa Undrained: $\tau / \sigma'_v = 0.1$

REFERENCES/NOTES

1. B-bar values were assigned to the till, glaciofluvial and glaciolacustrine for the short-term static case to account for excess pore water pressures that may be generated during construction.
2. For pseudo-static loading condition, GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

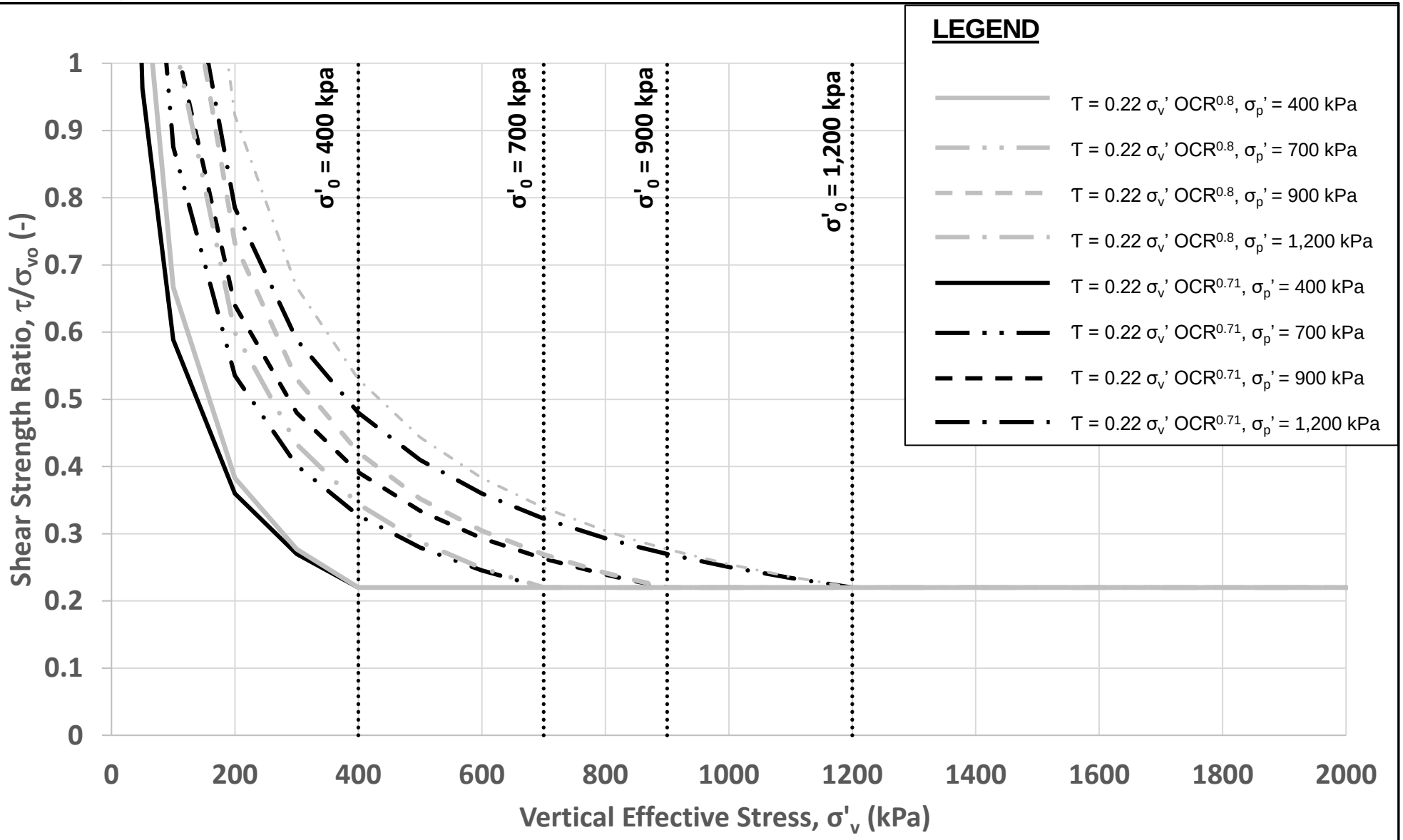
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS
MATERIAL PROPERTIES

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-1

(INPUT LOCATION OF STABILITY FILES)



REFERENCES/NOTES

1. Grey curves depict undrained shear strength functions used in El. 970 m detailed design (Golder 2015b).
2. Black curves depict undrained shear strength functions refined for El. 974 m detailed design.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

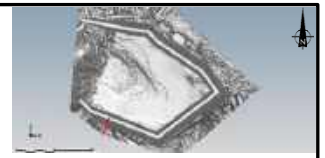
TITLE
STABILITY ANALYSIS
UNDRAINED SHEAR STRENGTH FUNCTION
GLACIOLACUSTRINE UNITS

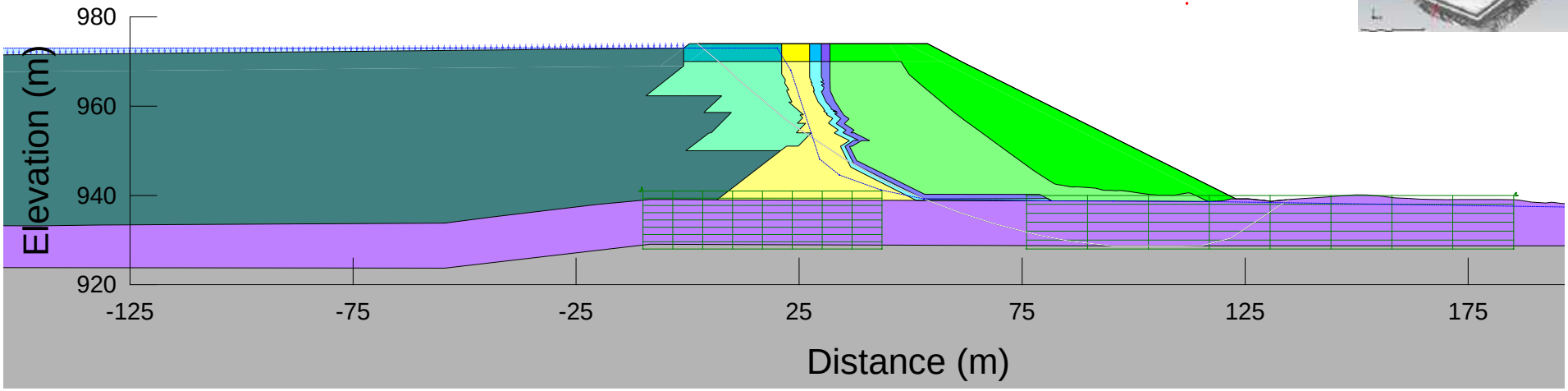
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-2

(INPUT LOCATION OF STABILITY FILES)

0 m beach

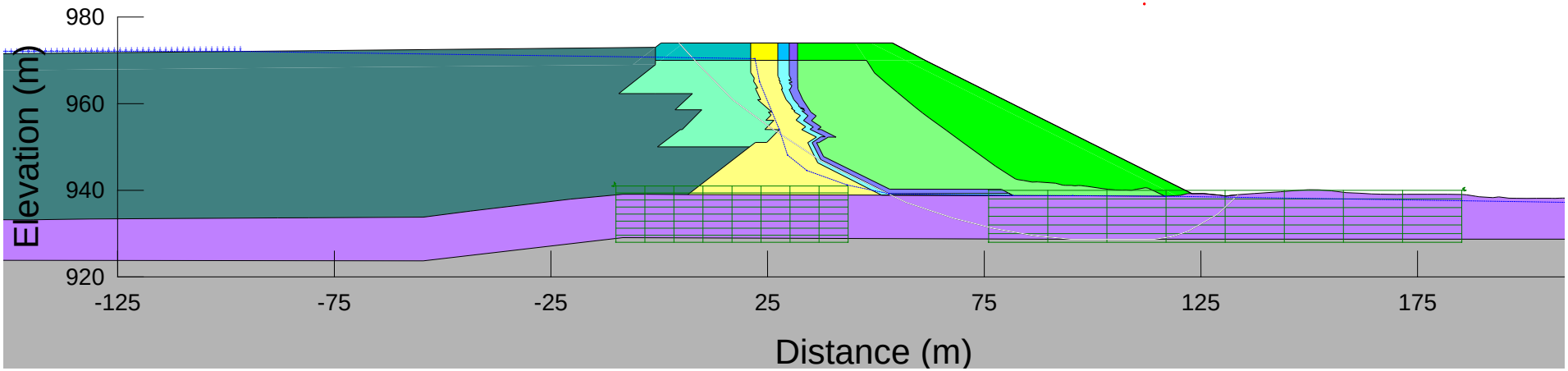
2.1





100 m beach

2.1



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

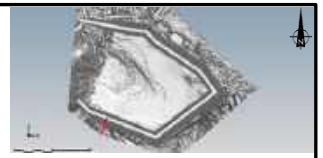
TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
LONG-TERM

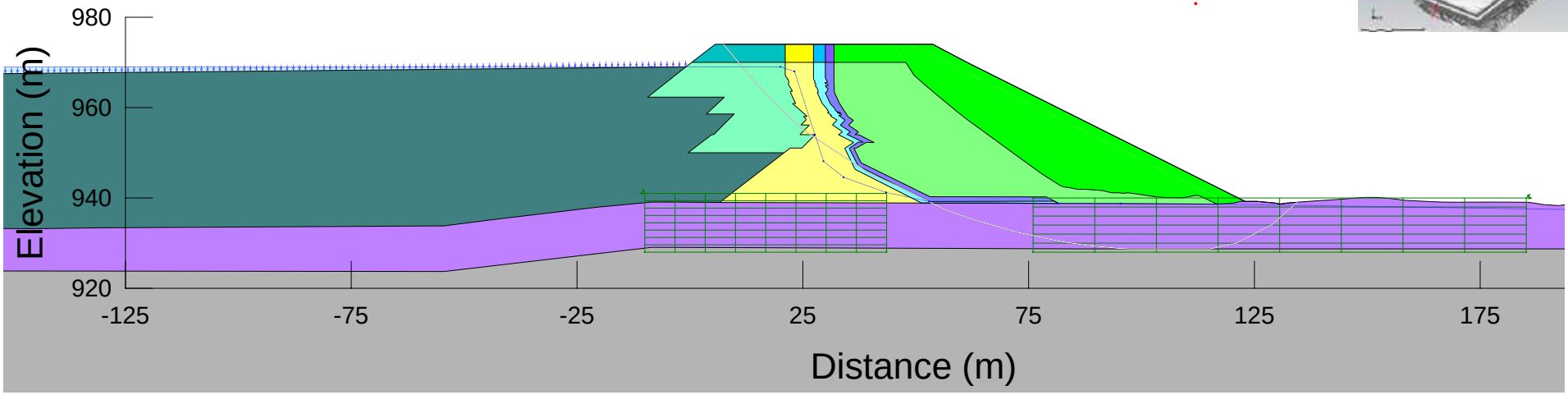
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-3

(INPUT LOCATION OF STABILITY FILES)

0 m beach

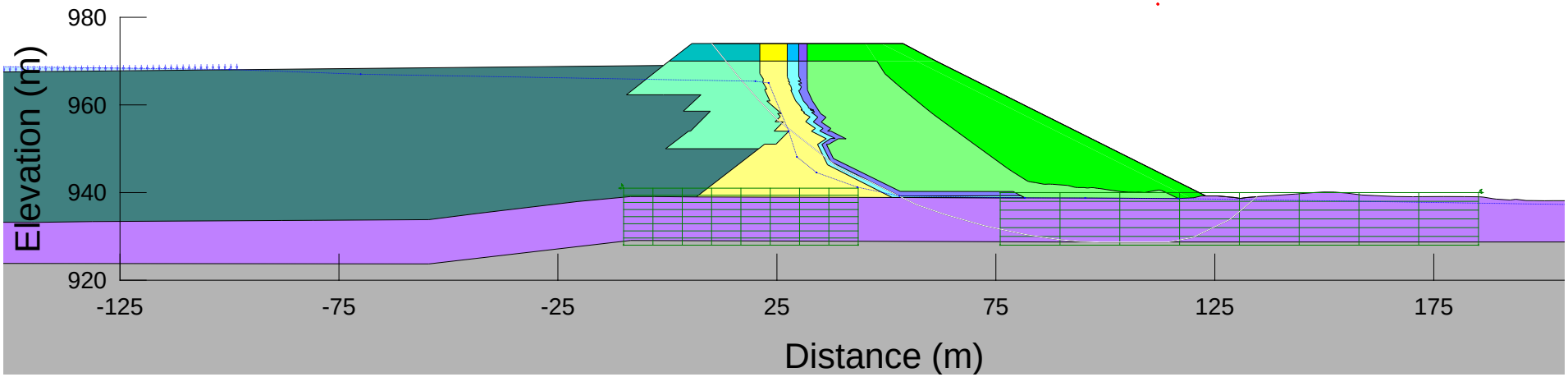
2.0





100 m beach

2.0



REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

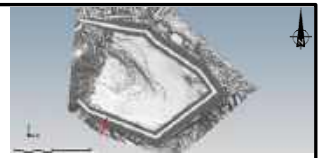
TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
SHORT-TERM

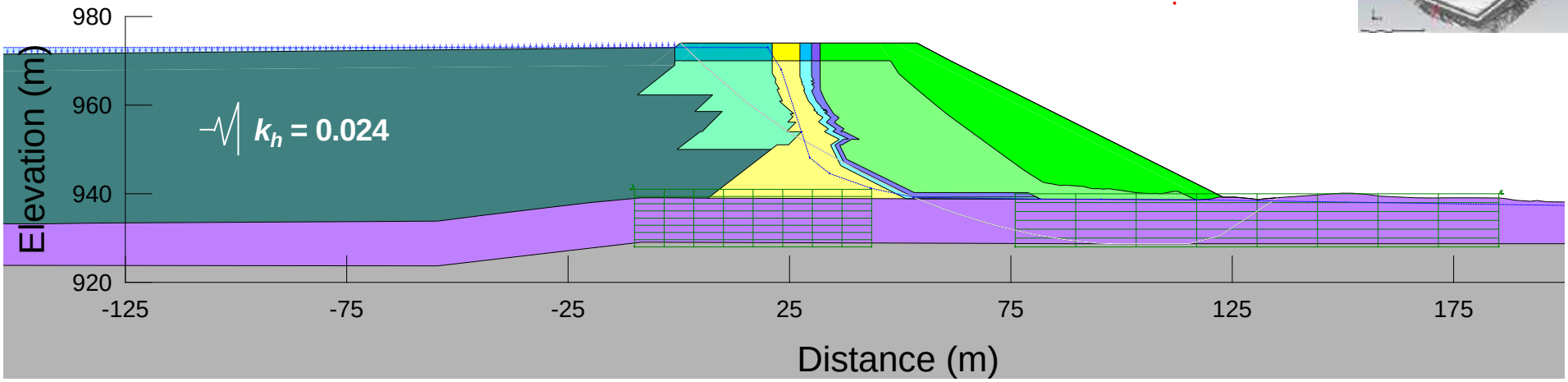
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-4

(INPUT LOCATION OF STABILITY FILES)

0 m beach

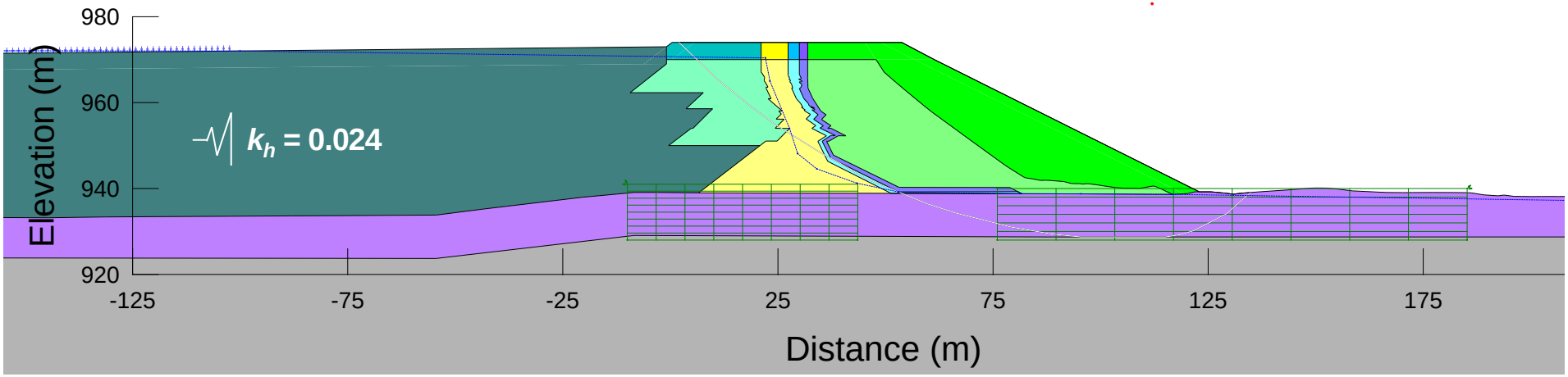
2.0





100 m beach

2.0



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

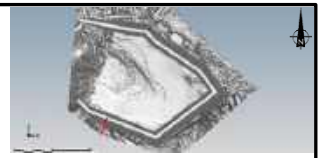
TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
PSEUDO-STATIC LOADING

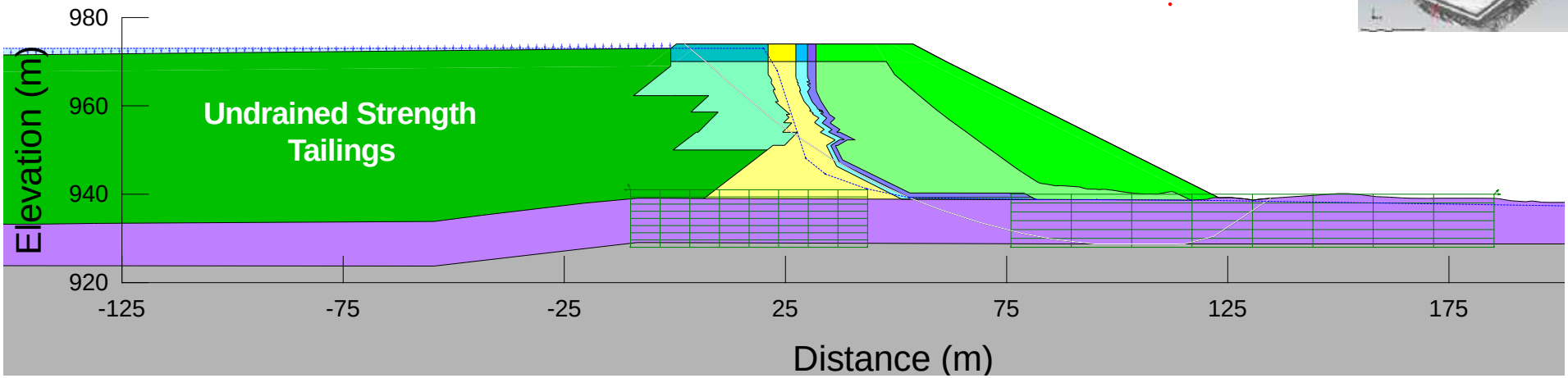
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-5

(INPUT LOCATION OF STABILITY FILES)

0 m beach

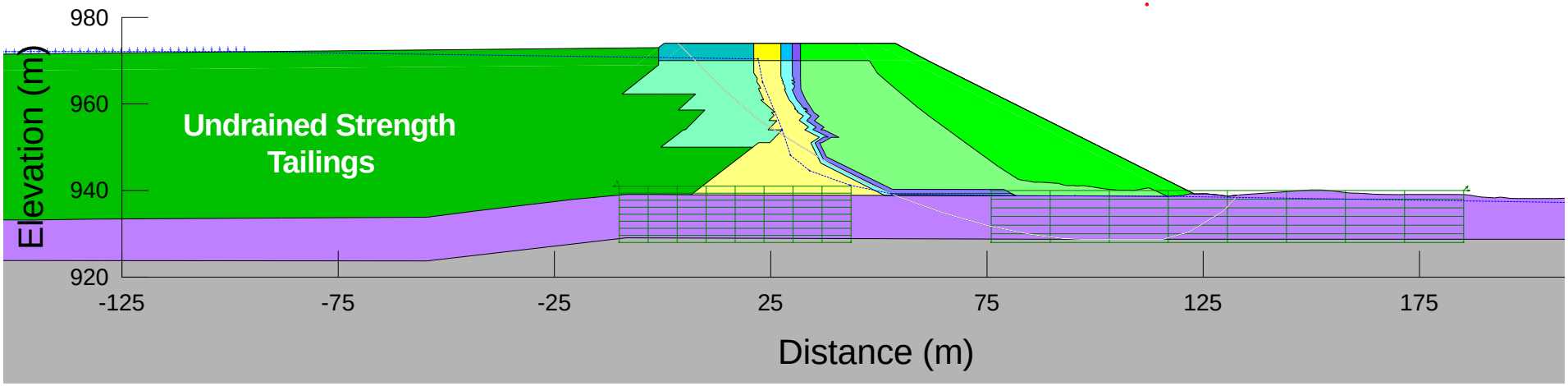
2.1





100 m beach

2.1



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

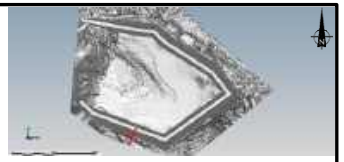
TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 0+725 *(Old Stn. 0+720)*
POST-EARTHQUAKE

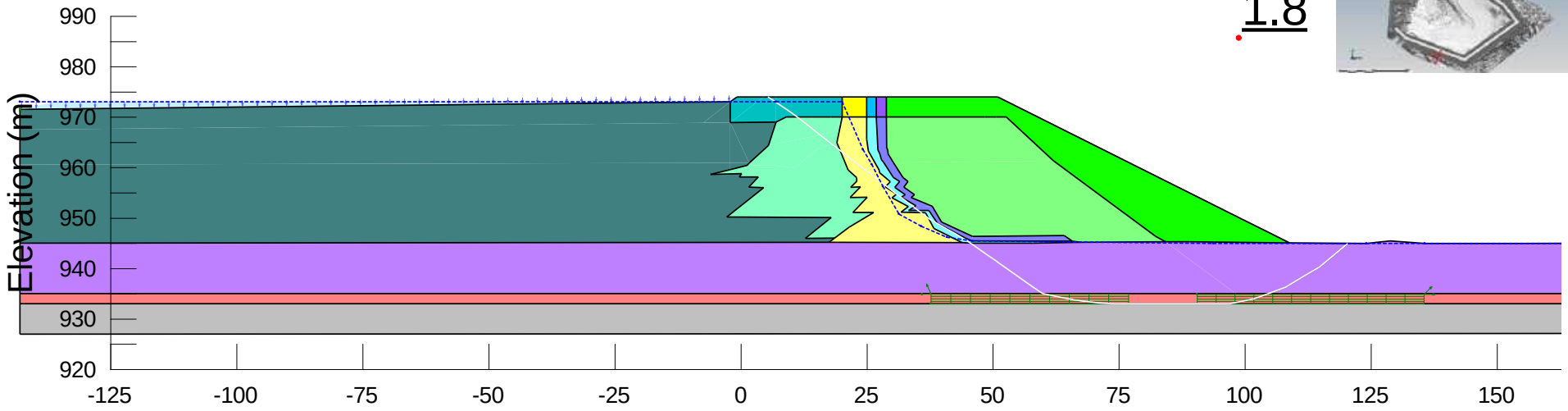
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-6

(INPUT LOCATION OF STABILITY FILES)

0 m beach

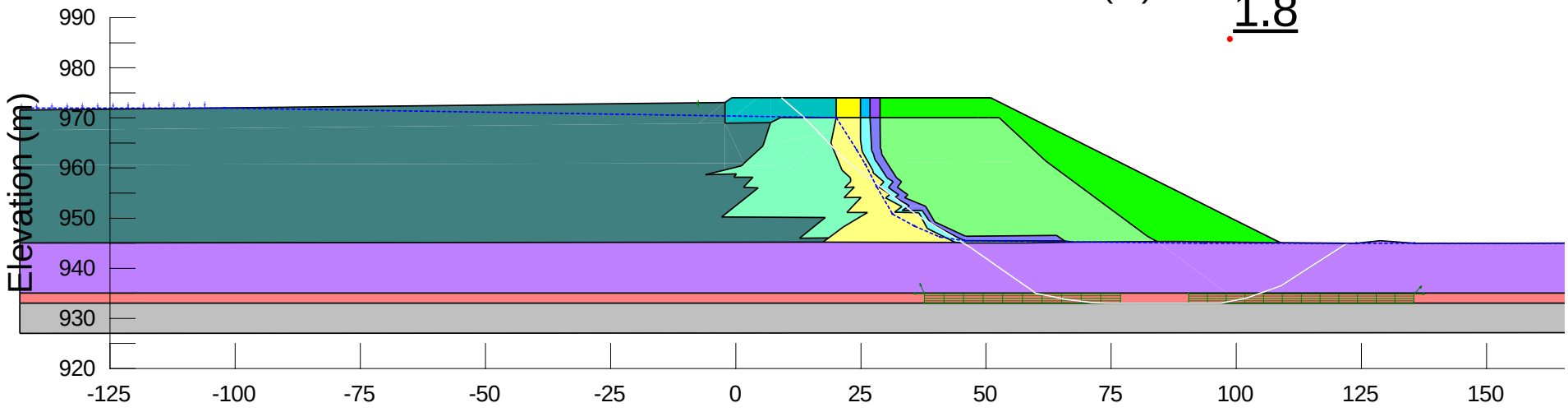
1.8





100 m beach

1.8



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pre-consolidation pressure low plasticity silty clay: 1,200 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

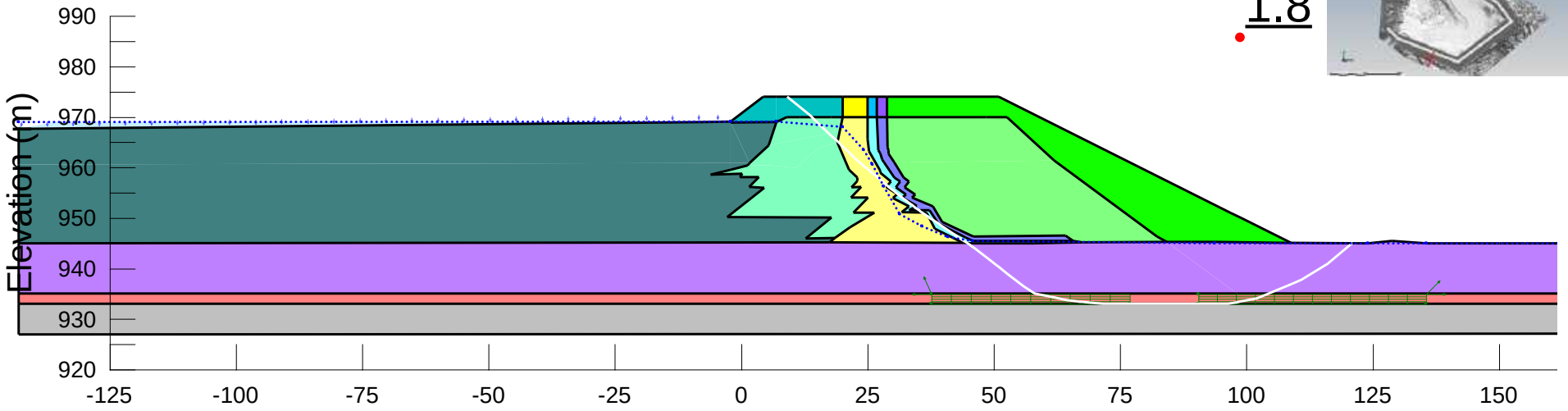
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 1+095 *(Old Stn. 1+100)*
LONG-TERM

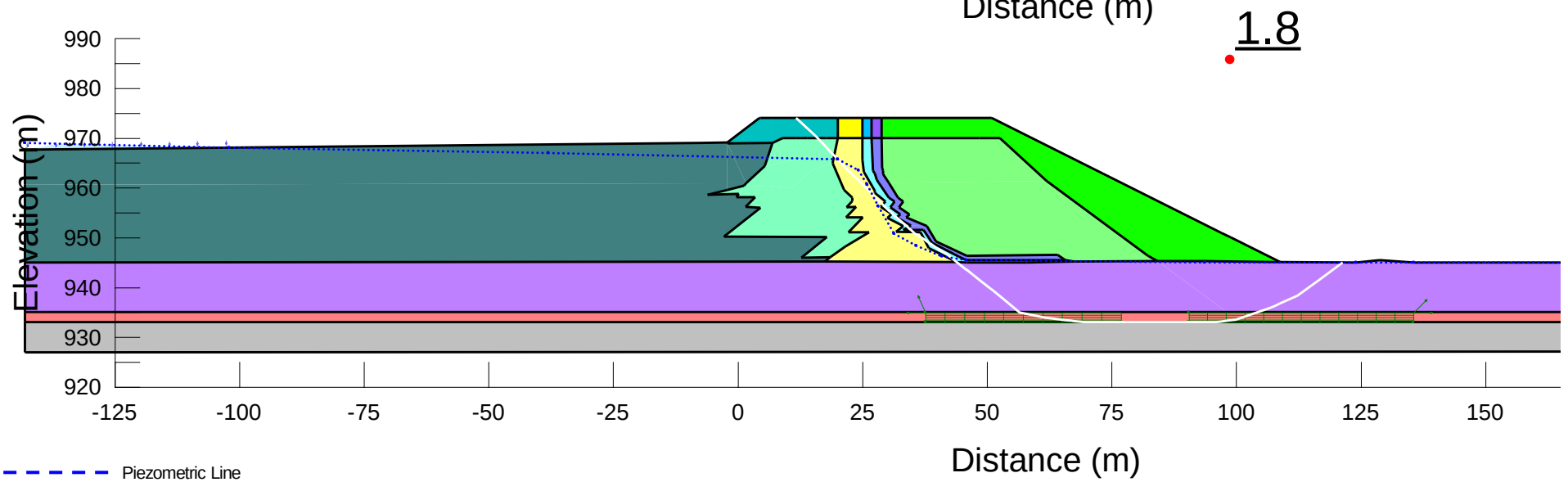
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-7

(INPUT LOCATION OF STABILITY FILES)

0 m beach



100 m beach



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.
4. Pre-consolidation pressure: Low plasticity silty clay: 1,200 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

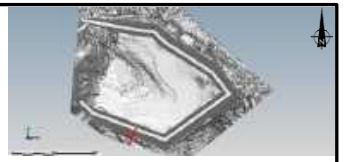
TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 1+095 *(Old Stn. 1+100)*
SHORT-TERM

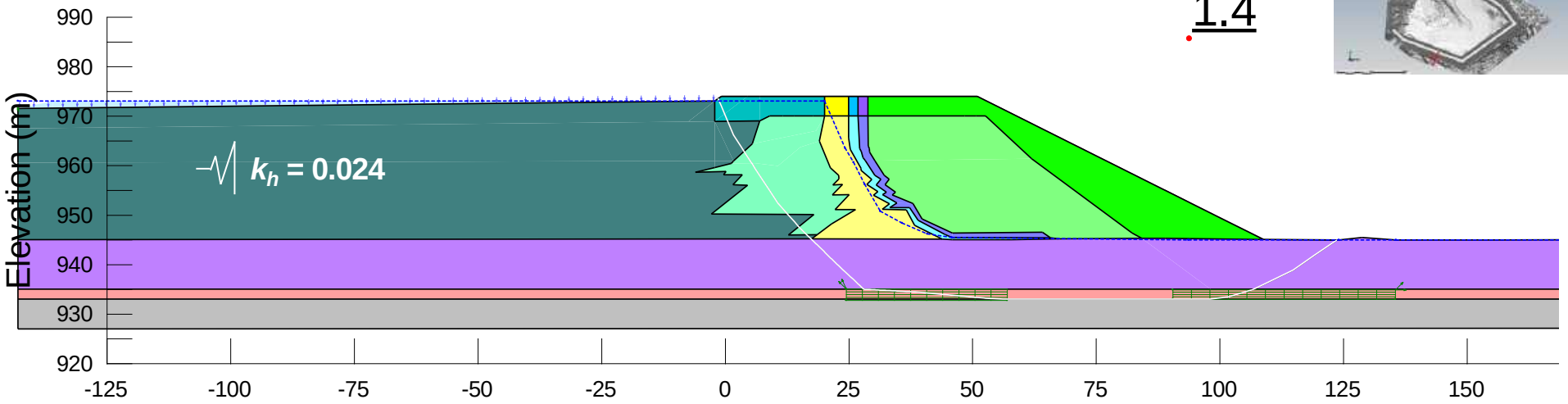
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-8

(INPUT LOCATION OF STABILITY FILES)

0 m beach

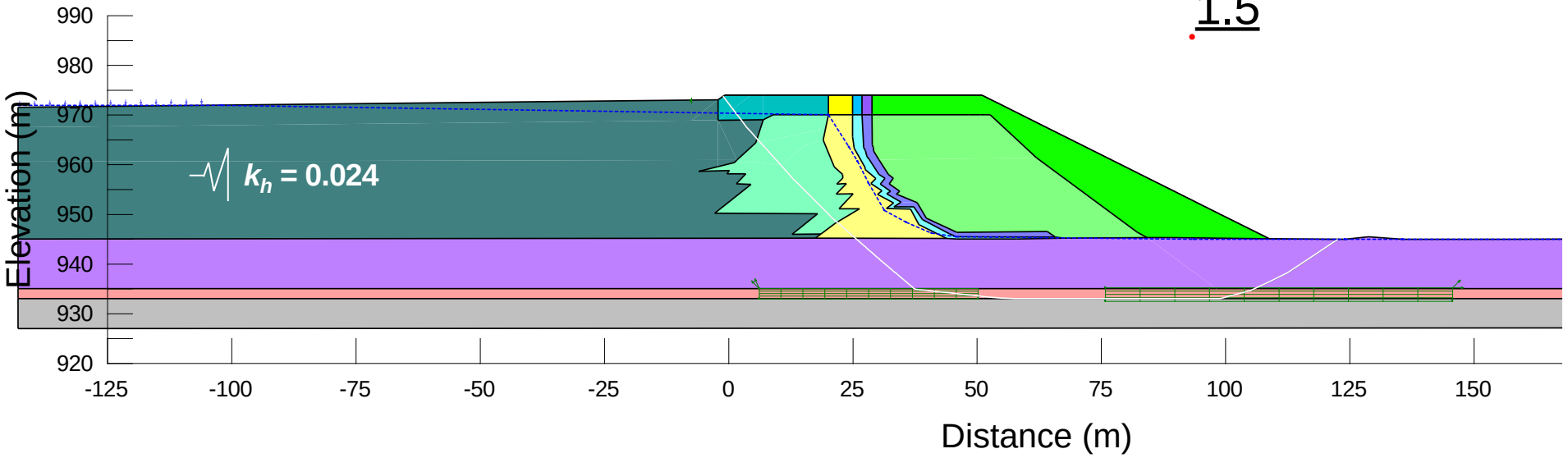
1.4





100 m beach

1.5



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. Low plasticity silty clay shear strength reduced to 80%.
6. Pre-consolidation pressure: Low plasticity silty clay: 1,200 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

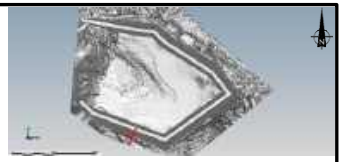
TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 1+095 *(Old Stn. 1+100)*
PSEUDO-STATIC LOADING

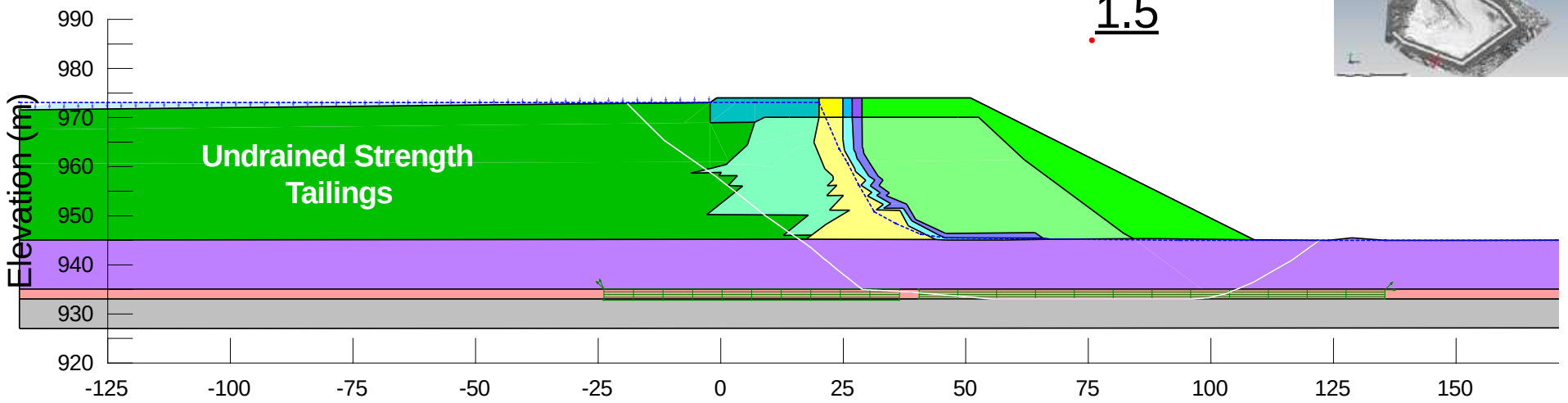
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-9

(INPUT LOCATION OF STABILITY FILES)

0 m beach

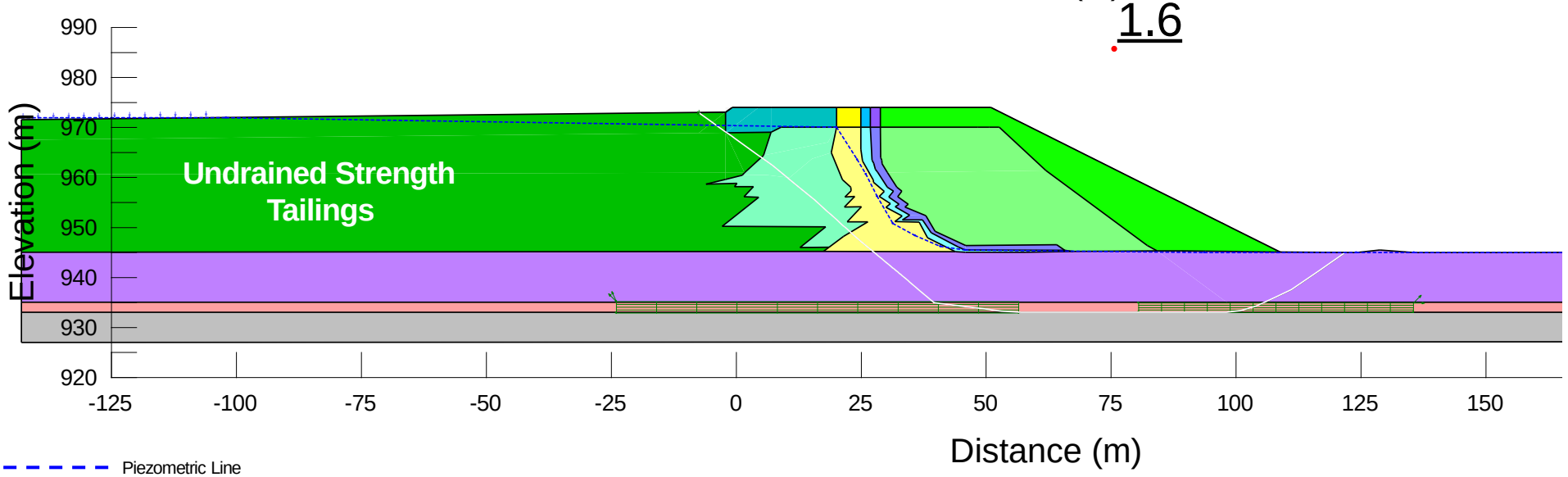
1.5





100 m beach

1.6



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Low plasticity silty clay shear strength reduced to 80%.
5. No seismic loading applied.
6. Pre-consolidation pressure: Low plasticity silty clay: 1,200 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

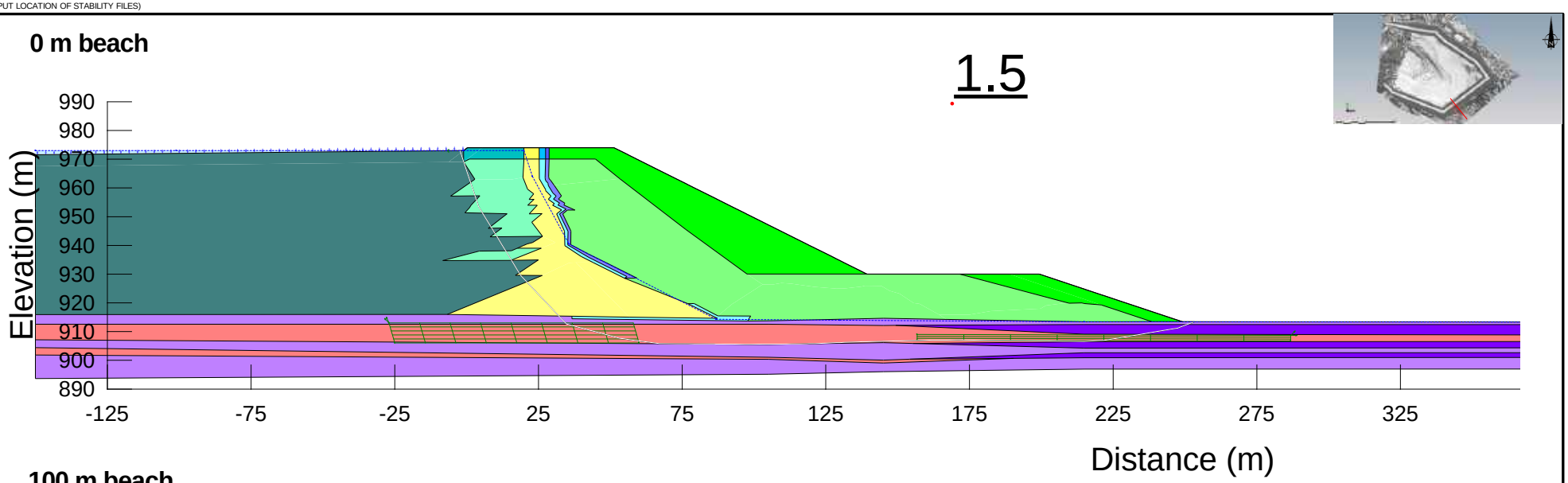
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (SOUTH EMBANKMENT)
SECTION 1+095 *(Old Stn. 1+100)*
POST-EARTHQUAKE

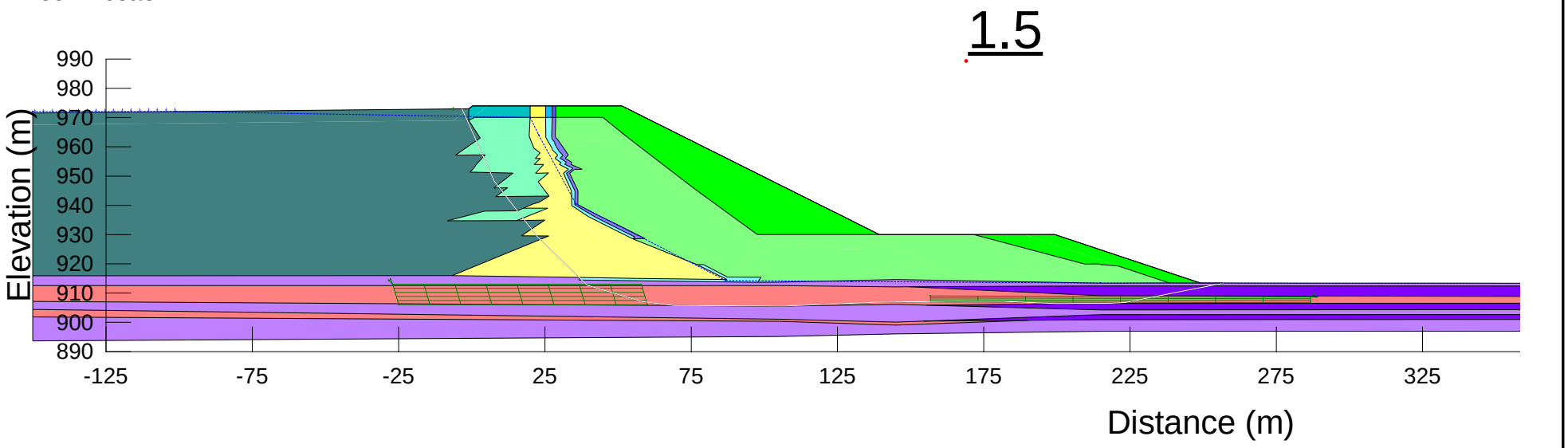
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-10

(INPUT LOCATION OF STABILITY FILES)

0 m beach



100 m beach



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 1+845 *(Old Stn. 1+850)*
LONG-TERM

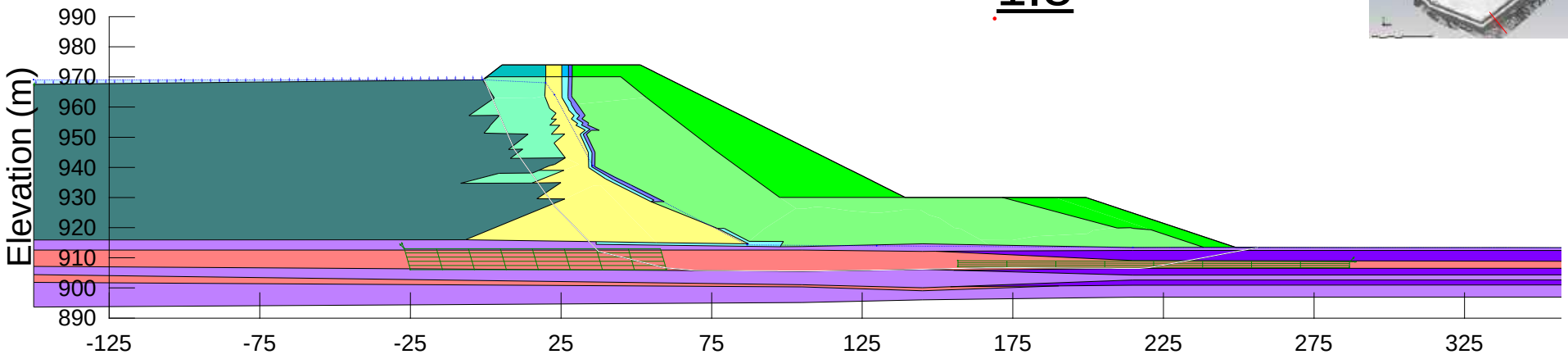
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-11

(INPUT LOCATION OF STABILITY FILES)

0 m beach

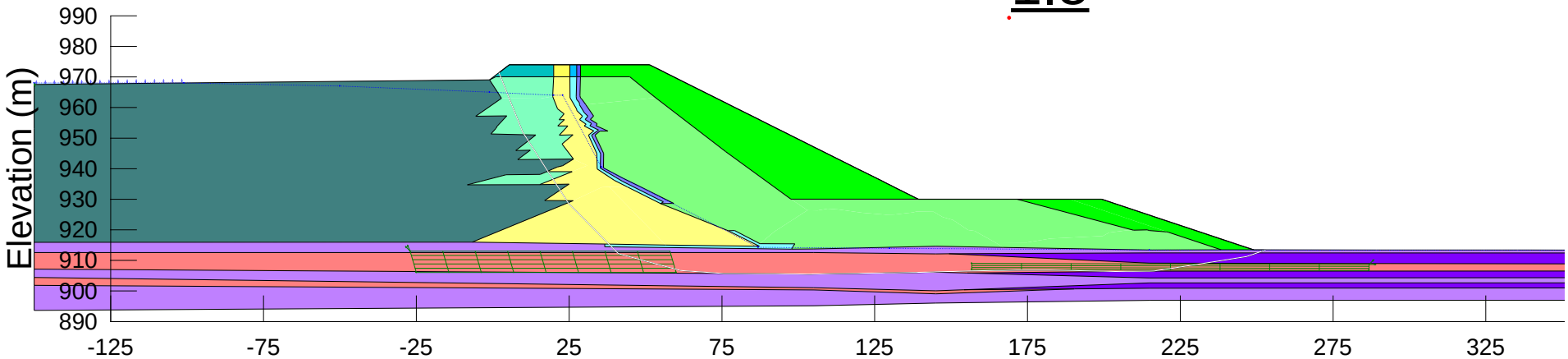
1.5





100 m beach

1.5



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 1+845 *(Old Stn. 1+850)*
SHORT-TERM

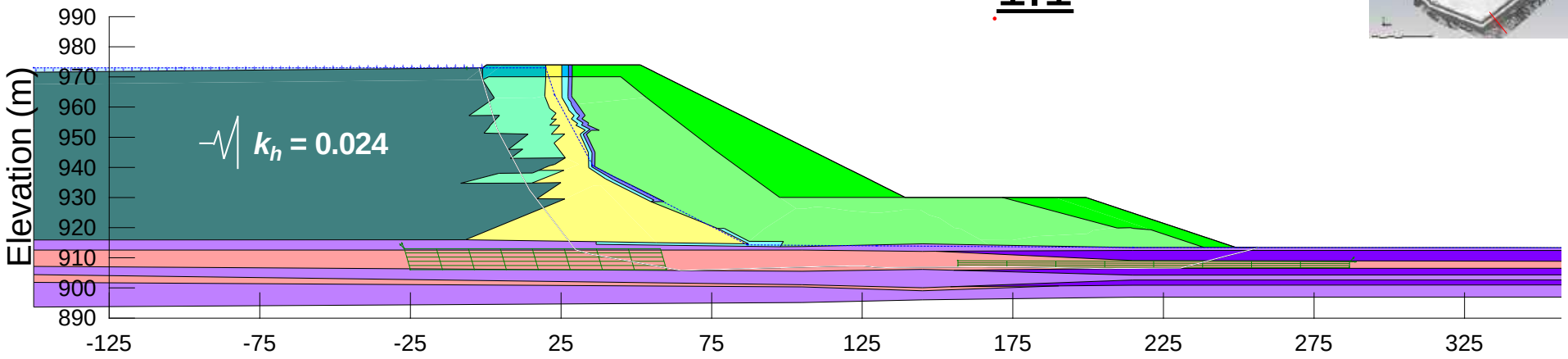
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-12

(INPUT LOCATION OF STABILITY FILES)

0 m beach

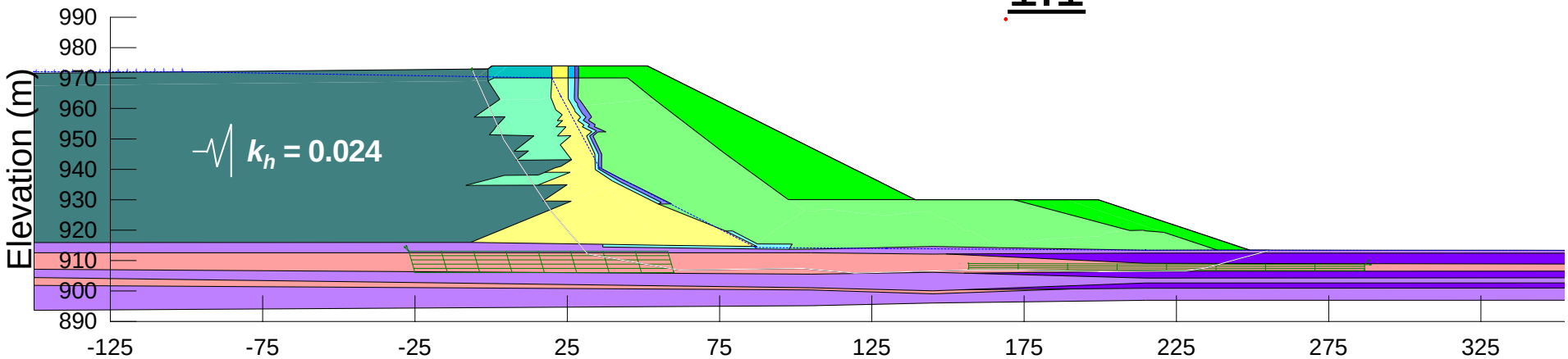


1.1



100 m beach

1.1



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 1+845 *(Old Stn. 1+850)*
PSEUDO-STATIC LOADING

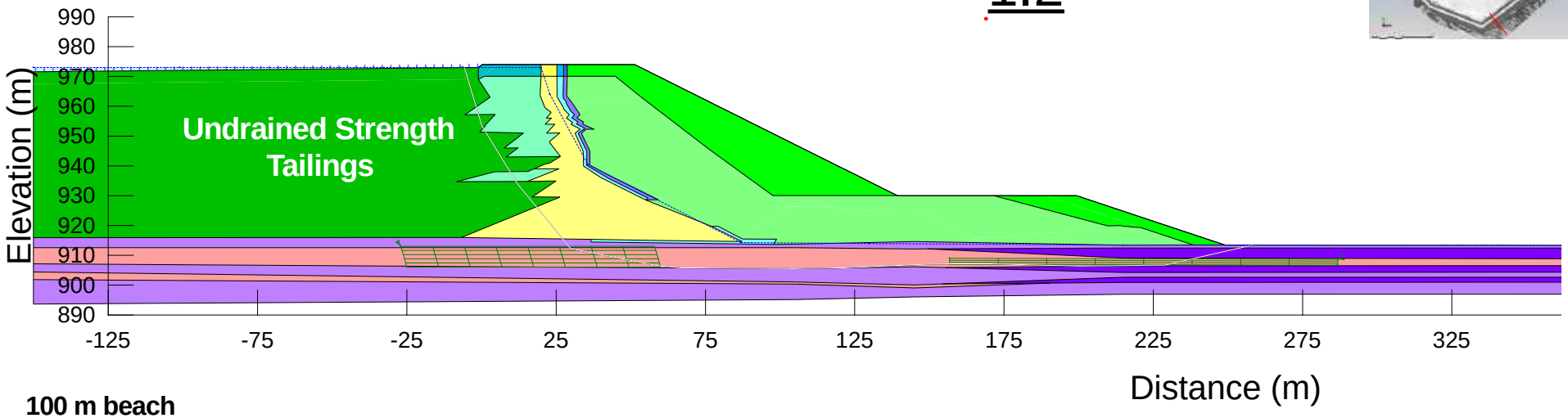
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-13

(INPUT LOCATION OF STABILITY FILES)

0 m beach

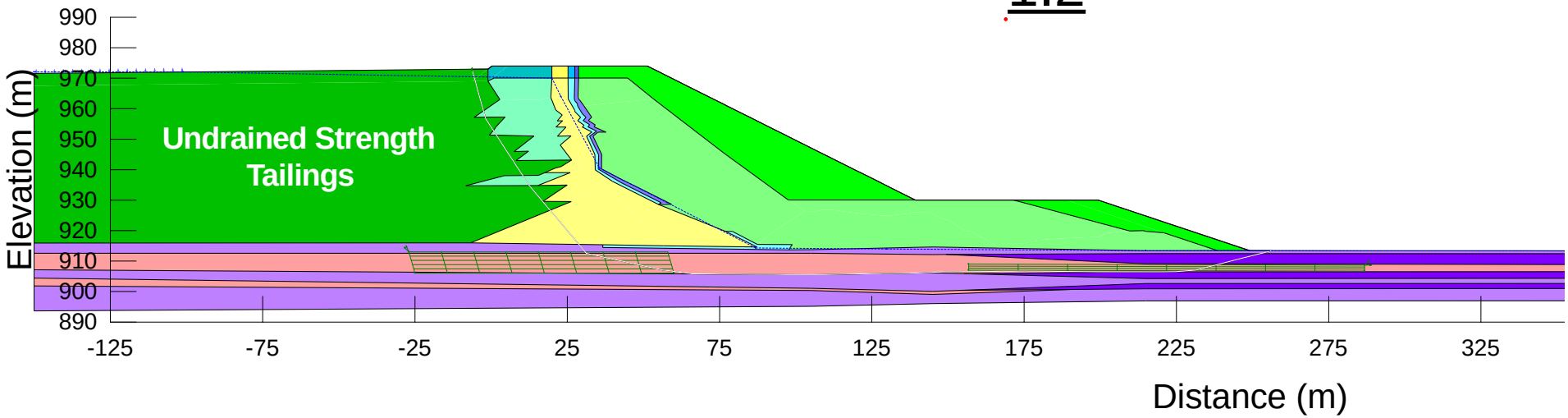
1.2





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

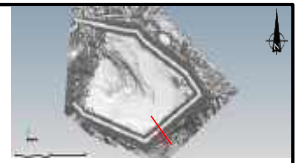
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 1+845 *(Old Stn. 1+850)*
POST-EARTHQUAKE

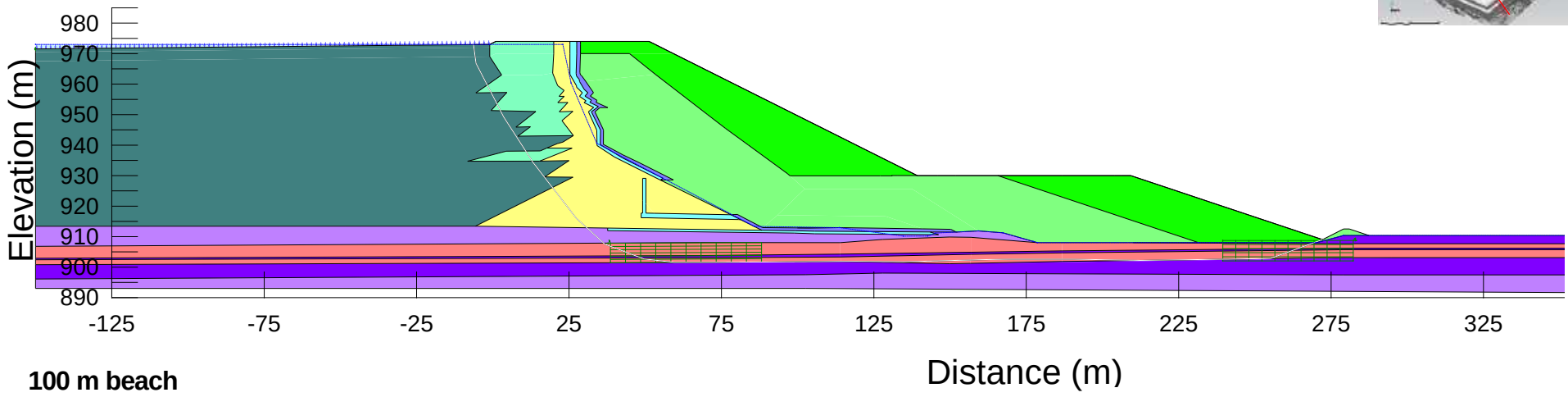
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-14

(INPUT LOCATION OF STABILITY FILES)

0 m beach

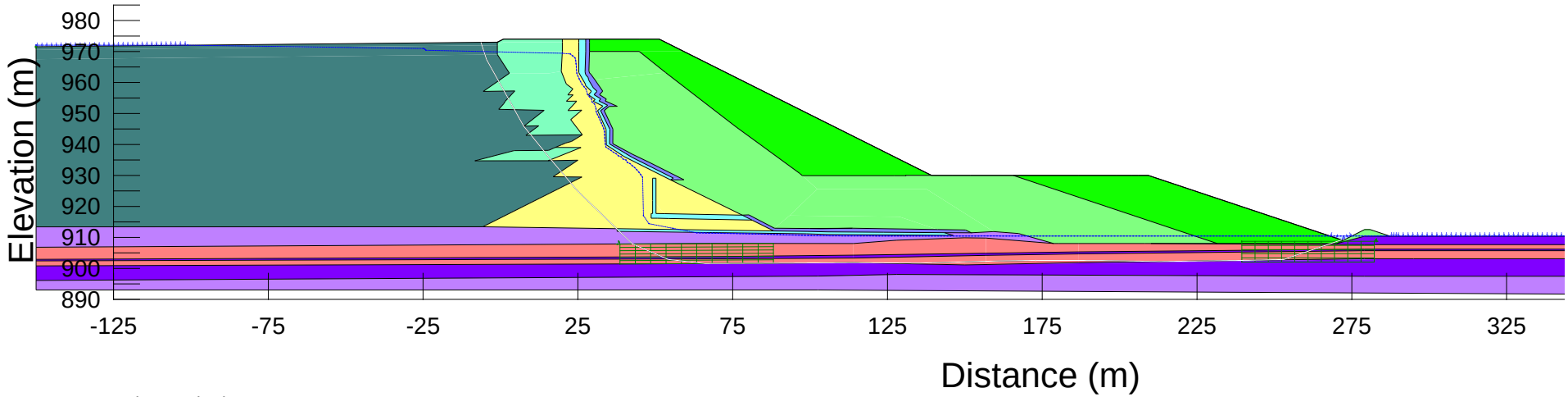
1.5





100 m beach

1.5



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
LONG-TERM

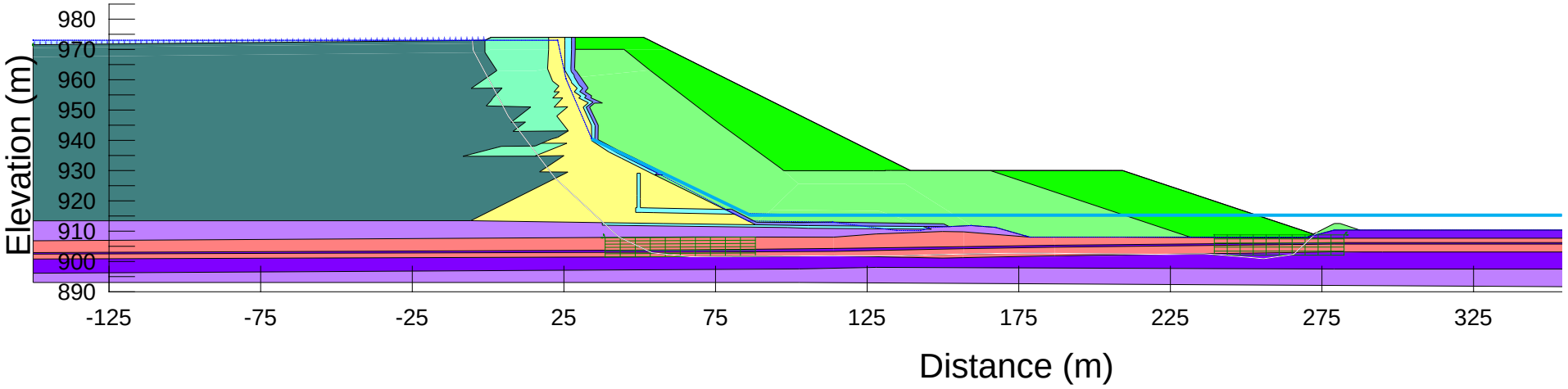
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-15

(INPUT LOCATION OF STABILITY FILES)



0 m beach

1.5



Piezometric Line #1

Piezometric Line #2

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning.
3. 0 m sub-aerial beach; pond el. 973 m.
4. Sensitivity analysis with artesian conditions (Piezometric Line #1) in the intermediate Glaciofluvial layers at an approx. 3 m pressure elevation (915 m) based on A8 and VW15-15.
5. GLU pre-consolidation pressure: 1200 kPa.
6. Piezometric Lines 1 and 2 superimposed until separation from the elevation of 941 m.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

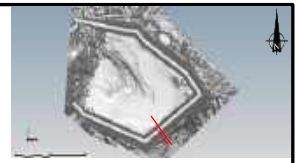
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
LONG-TERM (ARTESIAN CONDITIONS)

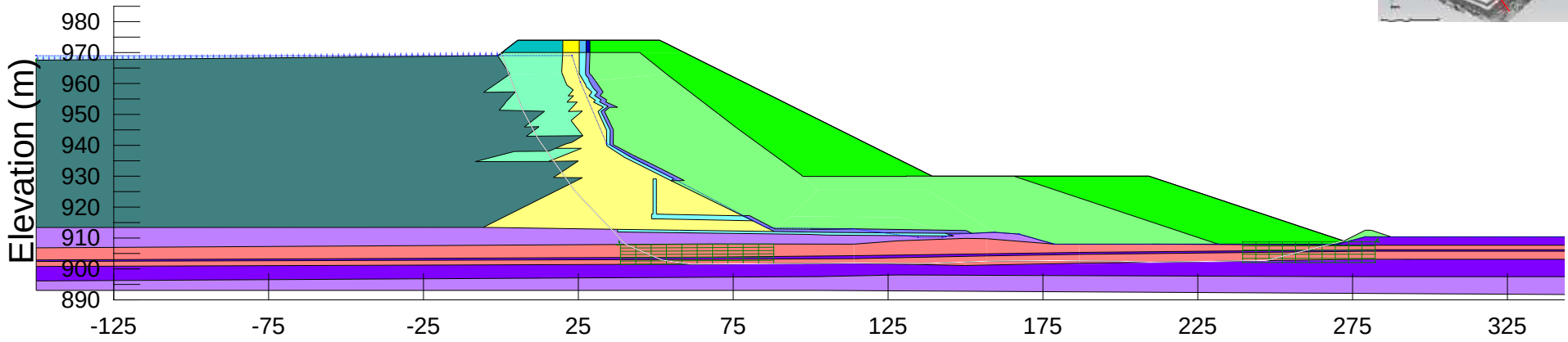
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-16

(INPUT LOCATION OF STABILITY FILES)

0 m beach

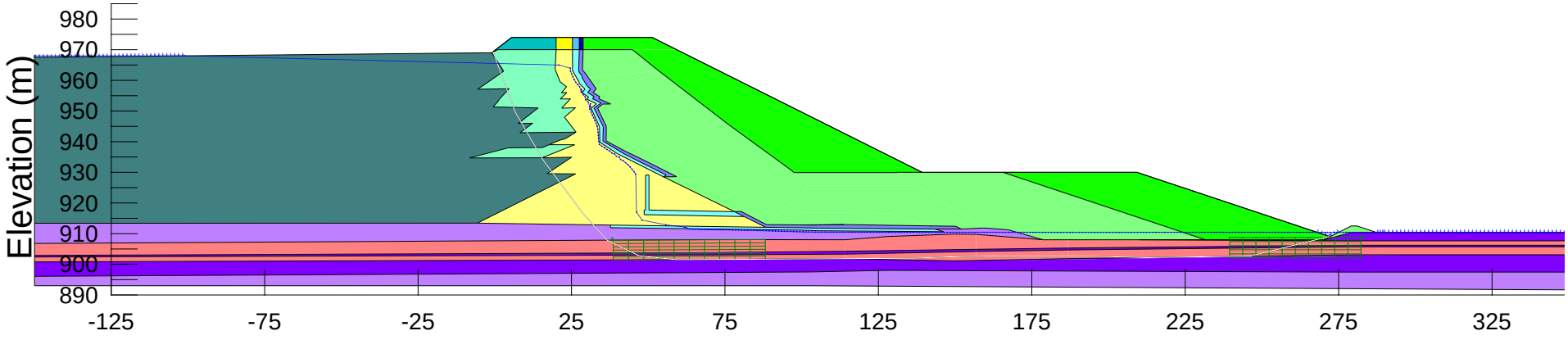
1.5





100 m beach

1.6



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

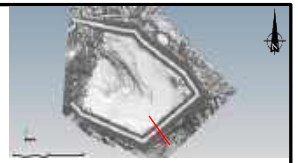
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
SHORT-TERM

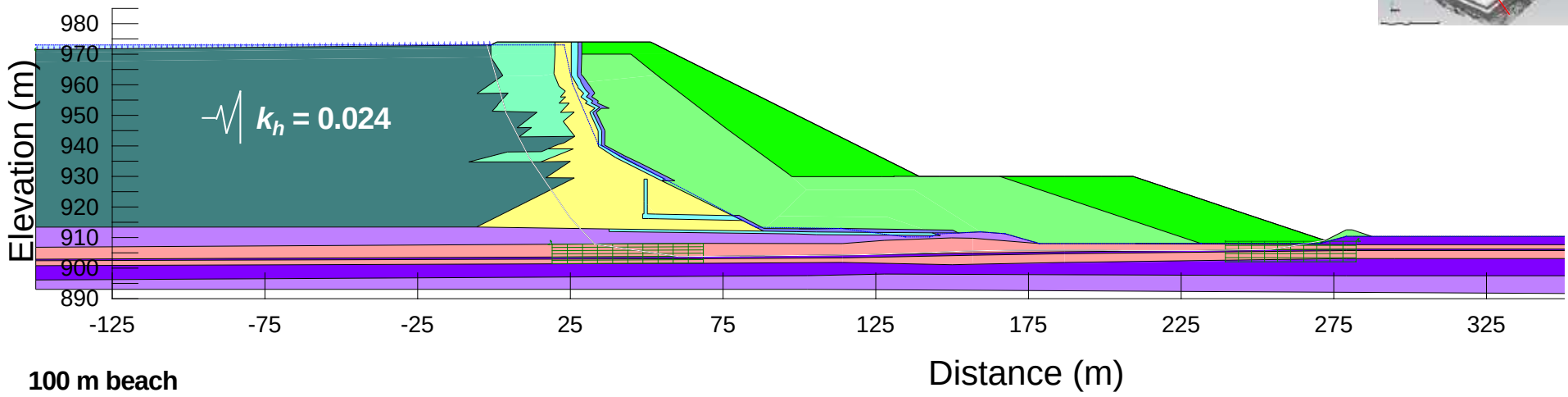
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-17

(INPUT LOCATION OF STABILITY FILES)

0 m beach

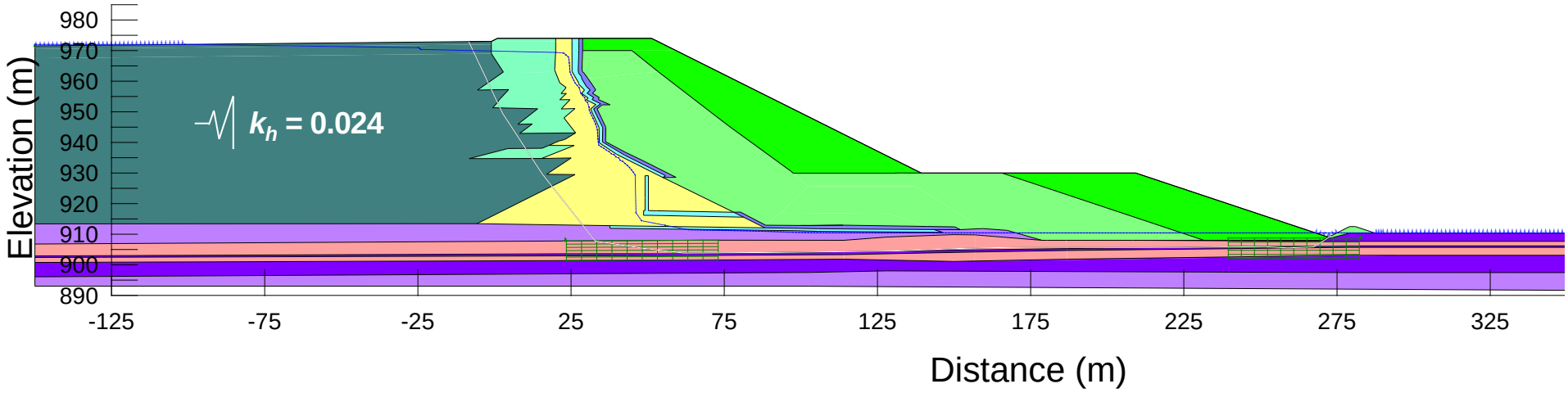
1.2





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

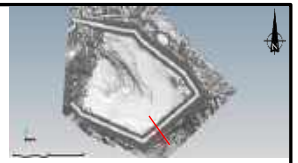
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
PSEUDO-STATIC LOADING

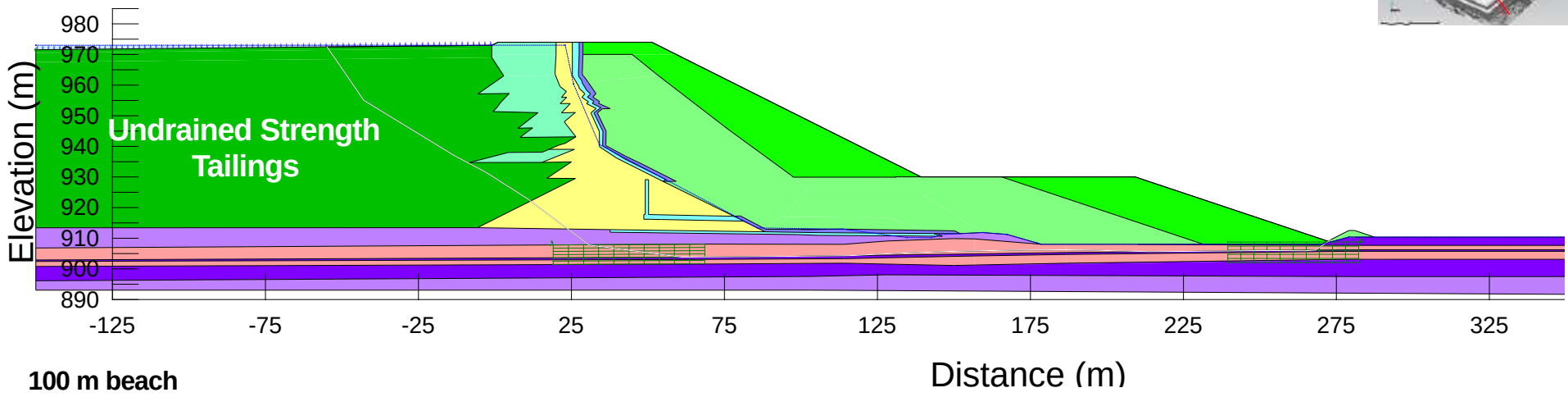
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-18

(INPUT LOCATION OF STABILITY FILES)

0 m beach

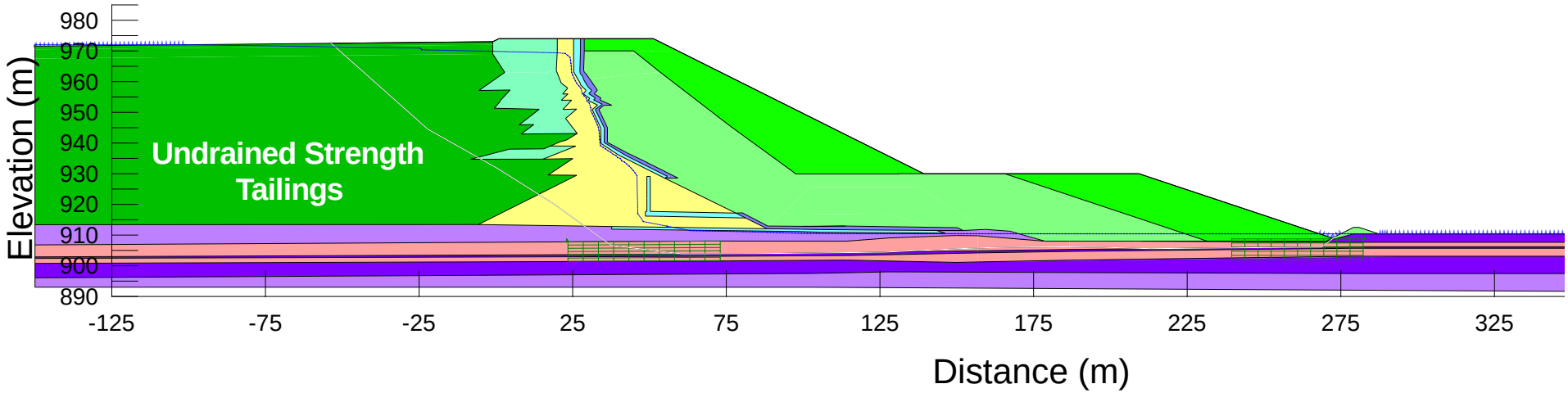
1.3





100 m beach

1.3



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+055 *(Old Stn. 2+060)*
POST-EARTHQUAKE

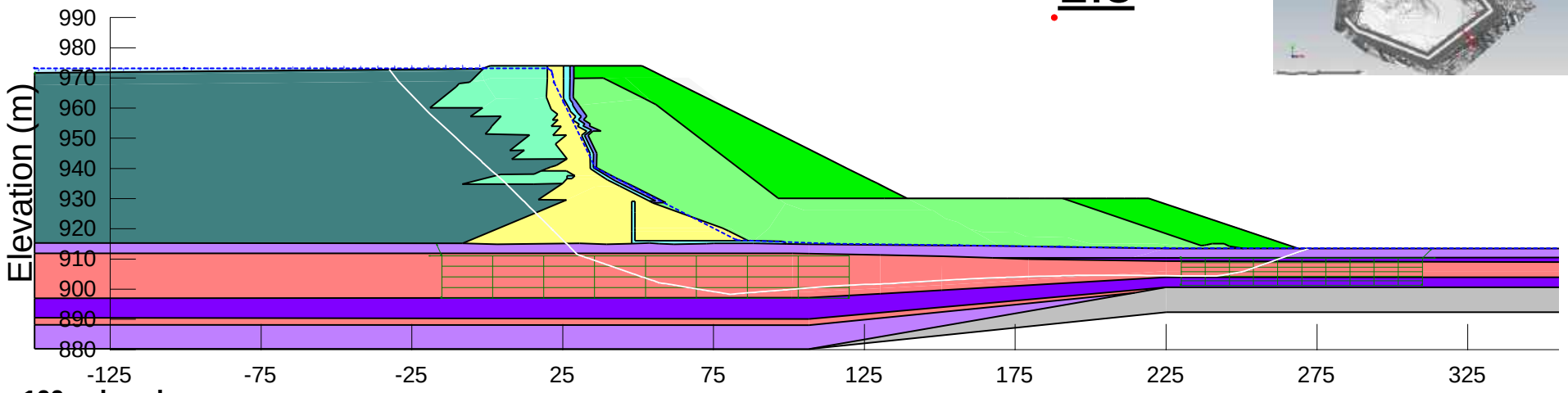
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-19

(INPUT LOCATION OF STABILITY FILES)

0 m beach

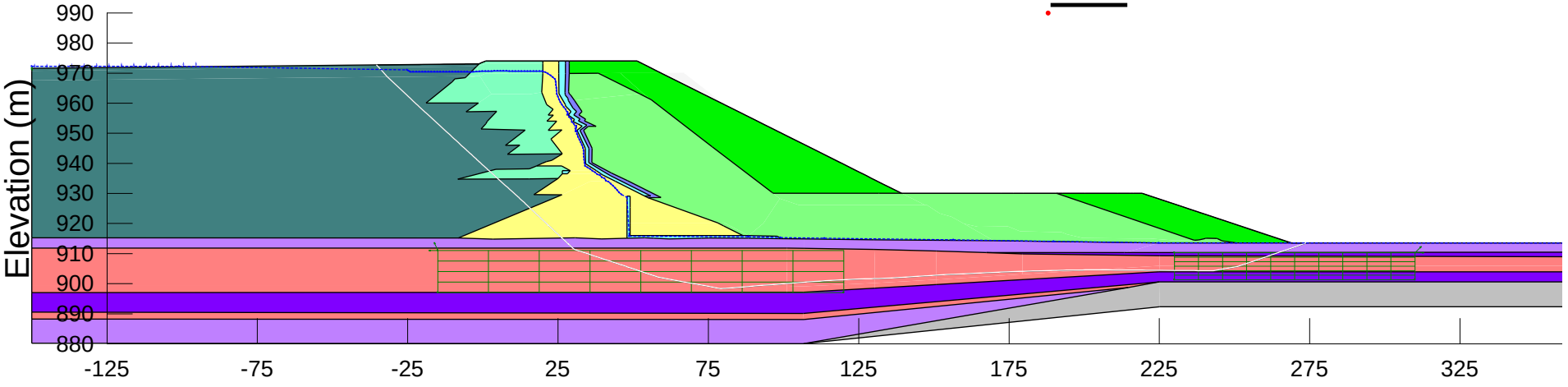
1.5





100 m beach

1.5



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

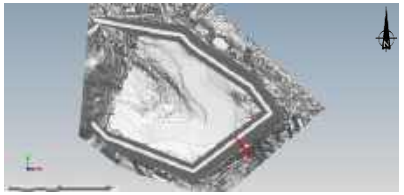
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+235 *(Old Stn. 2+240)*
LONG-TERM

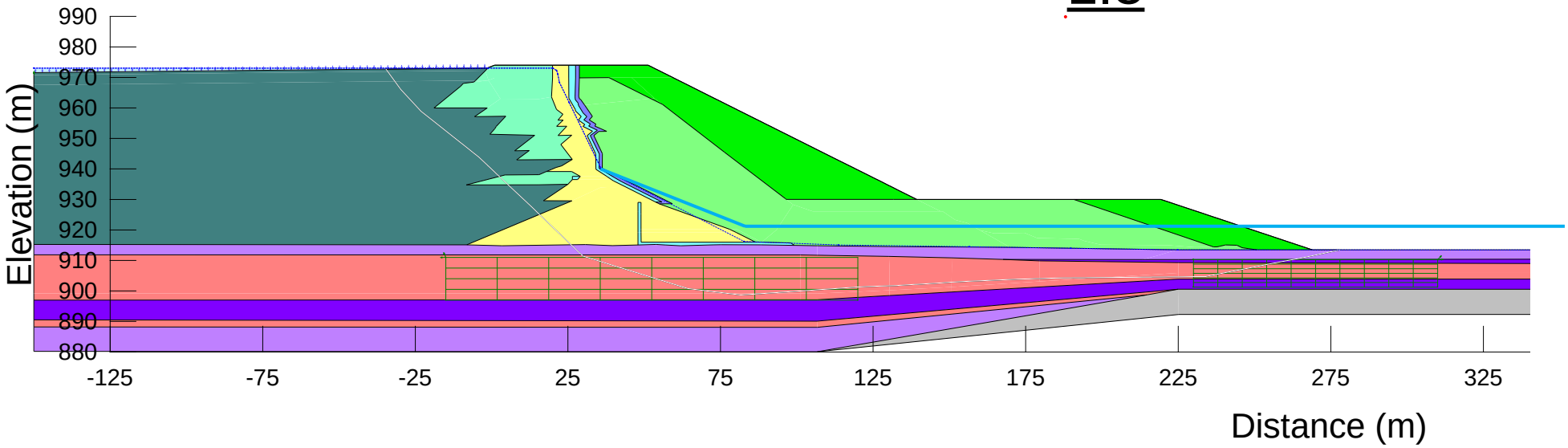
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-20

(INPUT LOCATION OF STABILITY FILES)



0 m beach

1.5



Piezometric Line #1

Piezometric Line #2

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning.
3. 0 m sub-aerial beach; pond el. 973 m.
4. Sensitivity analysis with artesian conditions (Piezometric Line #1) in the Glaciofluvial layers at an 8 m of pressure elevation (921 m) based on B4 and VW15-14.
5. GLU pre-consolidation pressure: 1200 kPa.
6. Piezometric Lines 1 and 2 superimposed until separation from the elevation of 940 m.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+235 *(Old Stn. 2+240)*
LONG-TERM (ARTESIAN CONDITIONS)

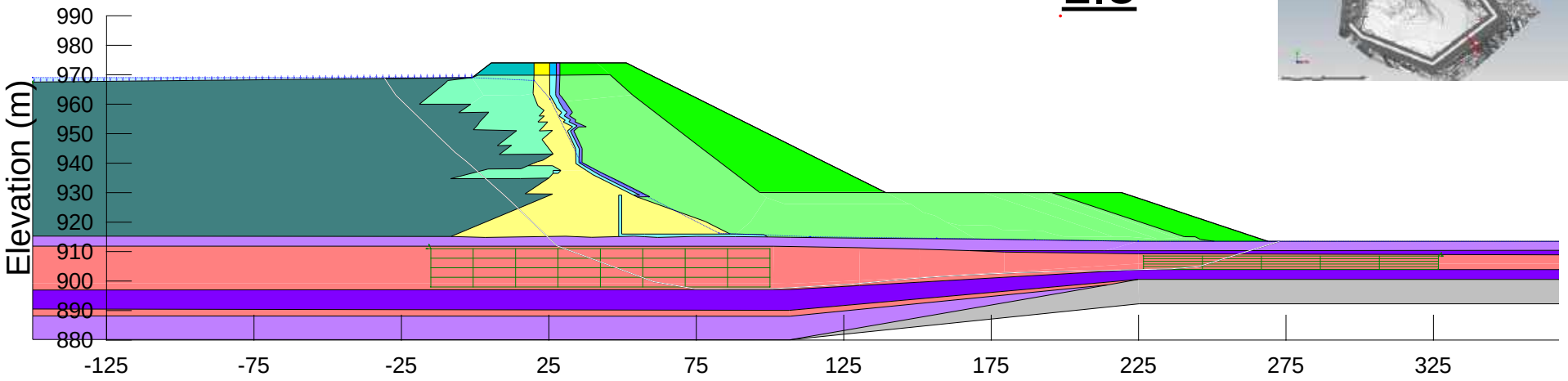
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-21

(INPUT LOCATION OF STABILITY FILES)

0 m beach

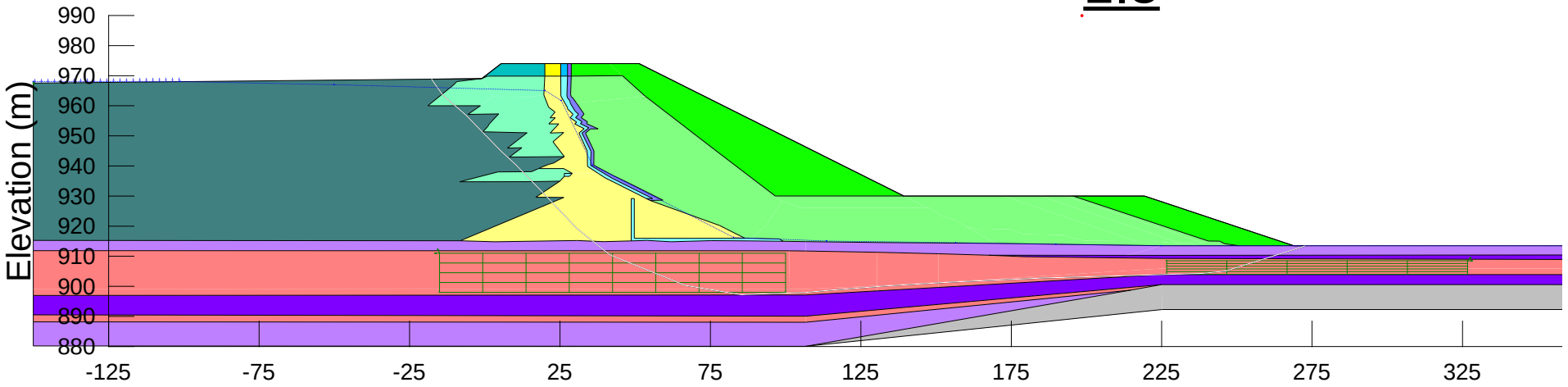
1.5





100 m beach

1.5



REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

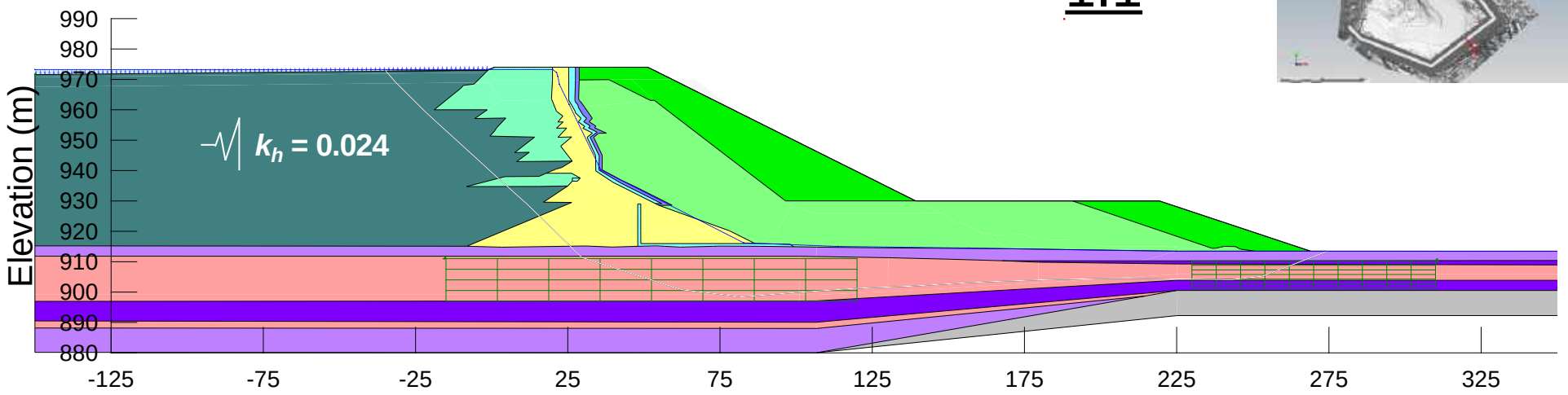
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+235 *(Old Stn. 2+240)*
SHORT-TERM

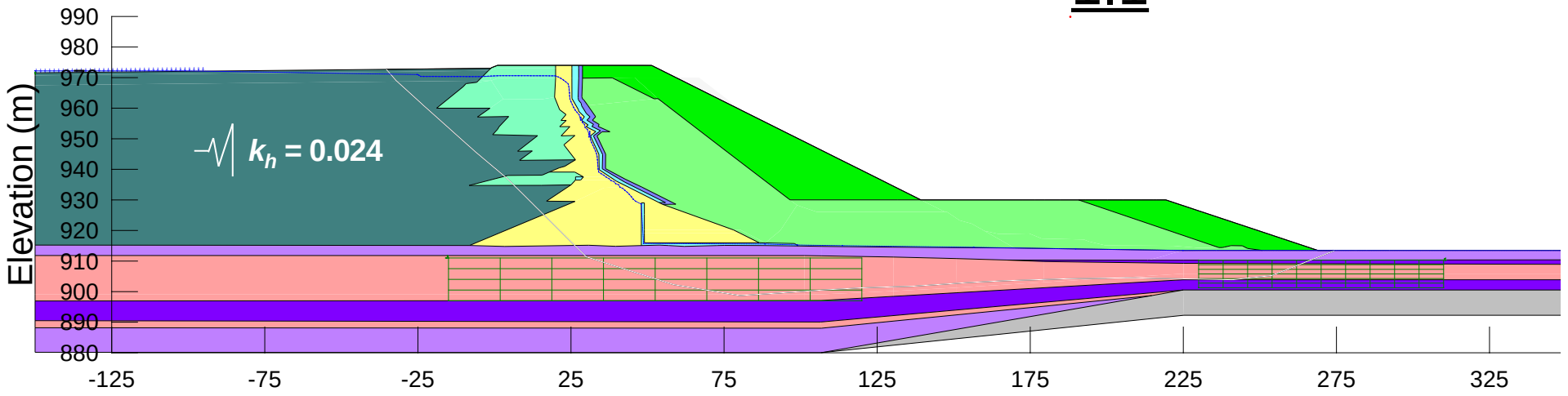
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-22

(INPUT LOCATION OF STABILITY FILES)

0 m beach



100 m beach



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

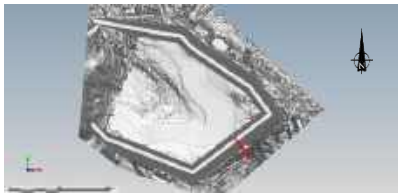
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

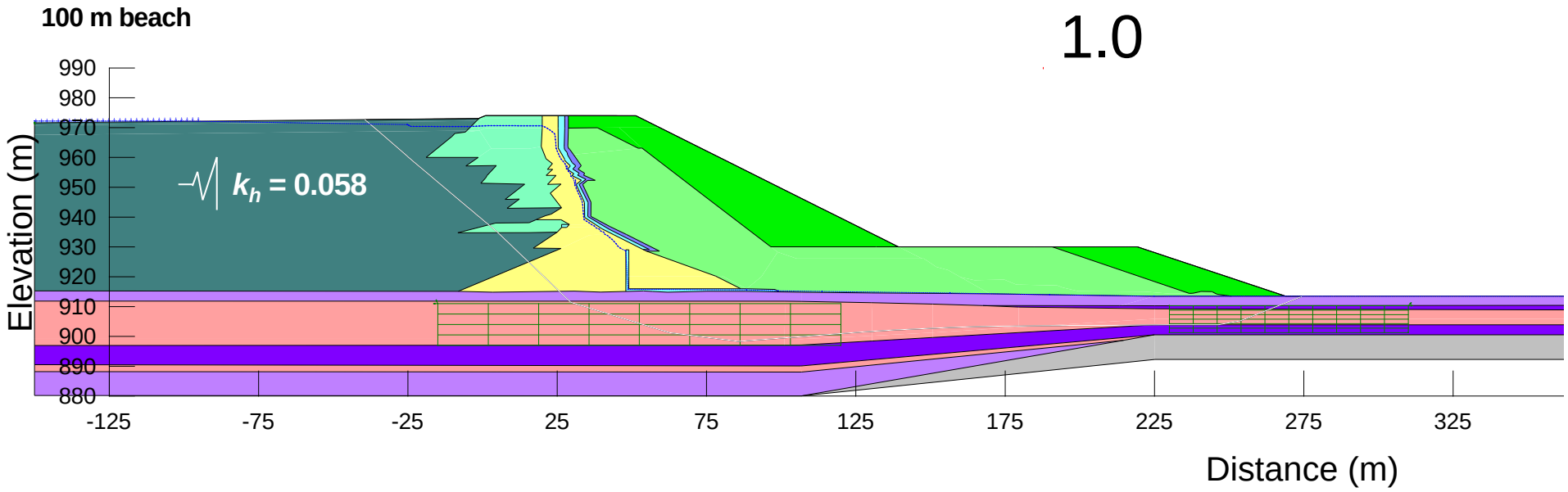
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+235 *(Old Stn. 2+240)*
PSEUDO-STATIC LOADING

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-23

(INPUT LOCATION OF STABILITY FILES)





Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain functioning.
3. 100 m sub-aerial beaches; pond el. 972 m.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 10,000-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+235 *(Old Stn. 2+240)*
PSEUDO-STATIC LOADING

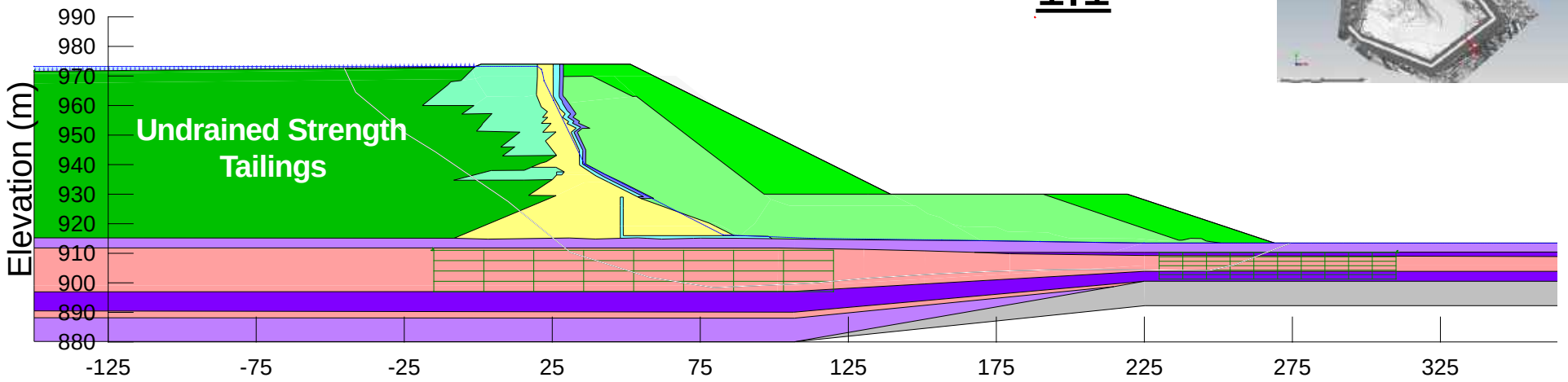
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-24

(INPUT LOCATION OF STABILITY FILES)

0 m beach

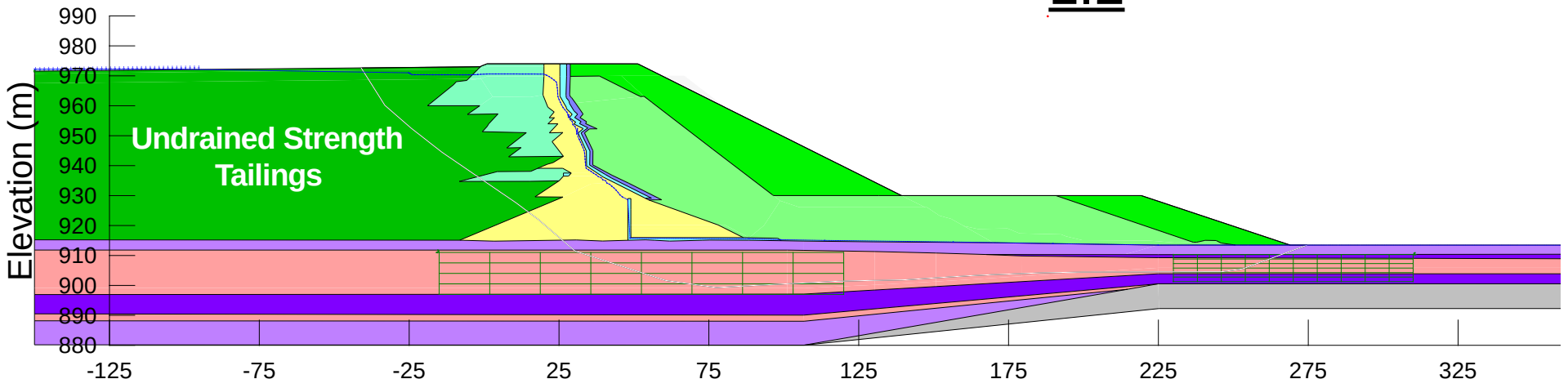
1.1





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

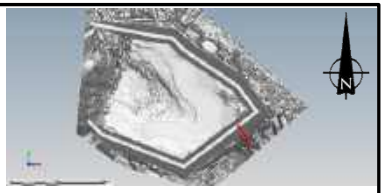
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+235 *(Old Stn. 2+240)*
POST-EARTHQUAKE

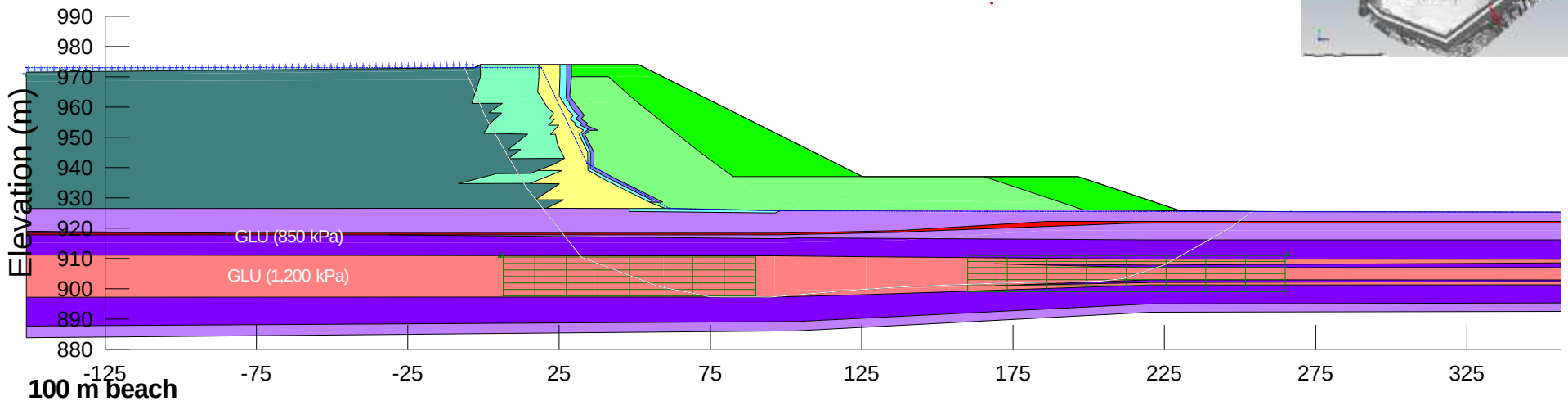
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-25

(INPUT LOCATION OF STABILITY FILES)

0 m beach

1.5

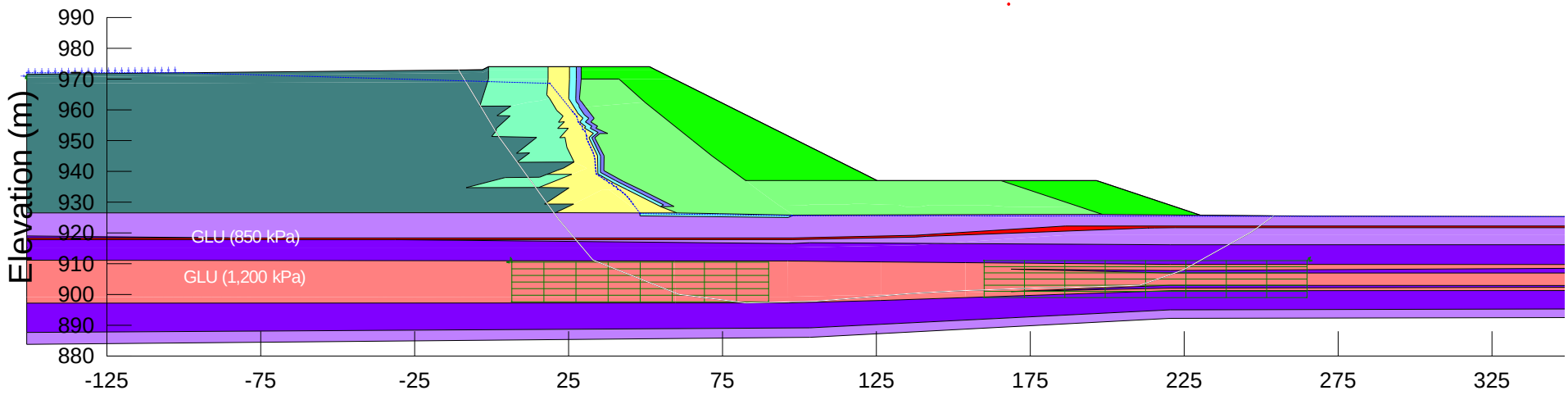




100 m beach

1.6

Distance (m)



Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

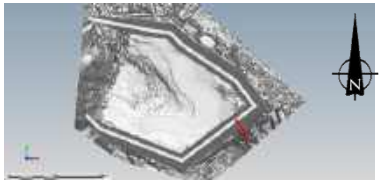
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
LONG-TERM

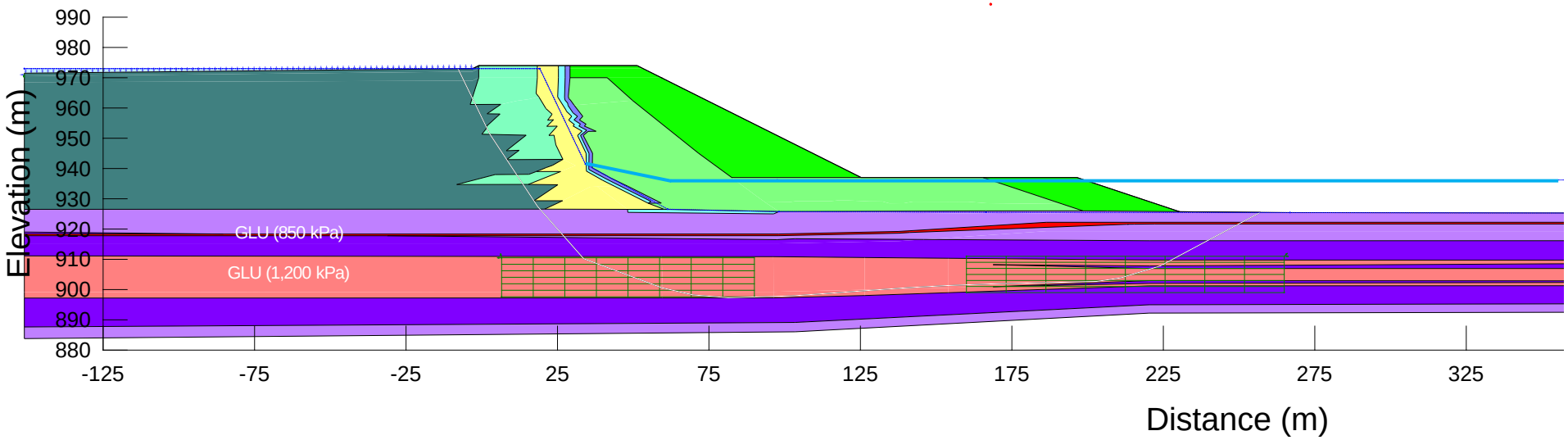
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-26

(INPUT LOCATION OF STABILITY FILES)



0 m beach

1.5



Piezometric Line #1

Piezometric Line #2

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning.
3. 0 m sub-aerial beach; pond el. 973 m.
4. Sensitivity analysis with artesian conditions (Piezometric Line #1) in the Glaciofluvial layers at an 11 m of pressure elevation (936 m) based on K1 and K2.
5. Piezometric Lines 1 and 2 superimposed until separation from the elevation of 941 m.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

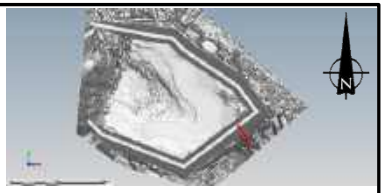
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
LONG-TERM (ARTESIAN CONDITIONS)

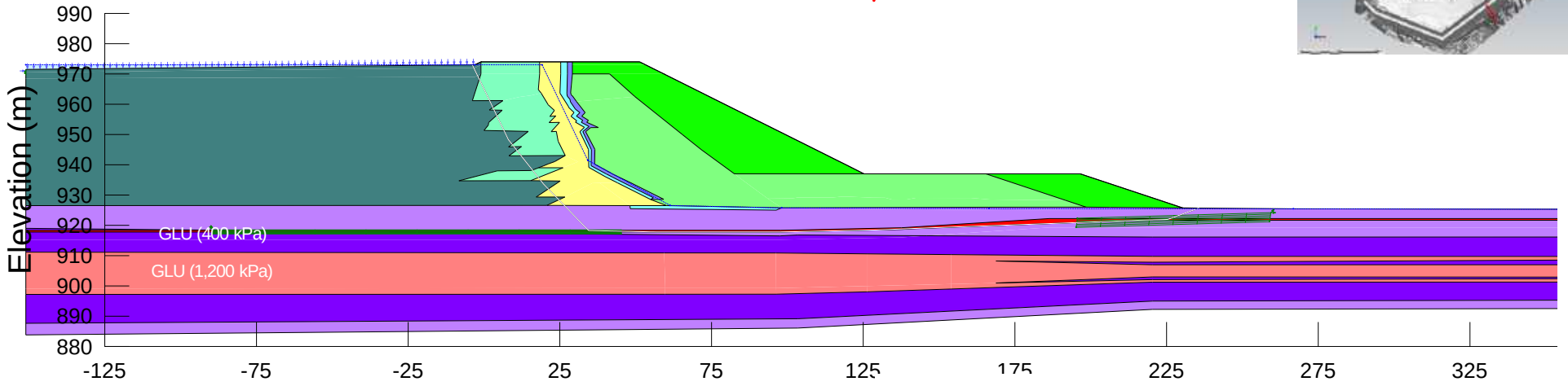
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-27

(INPUT LOCATION OF STABILITY FILES)

0 m beach

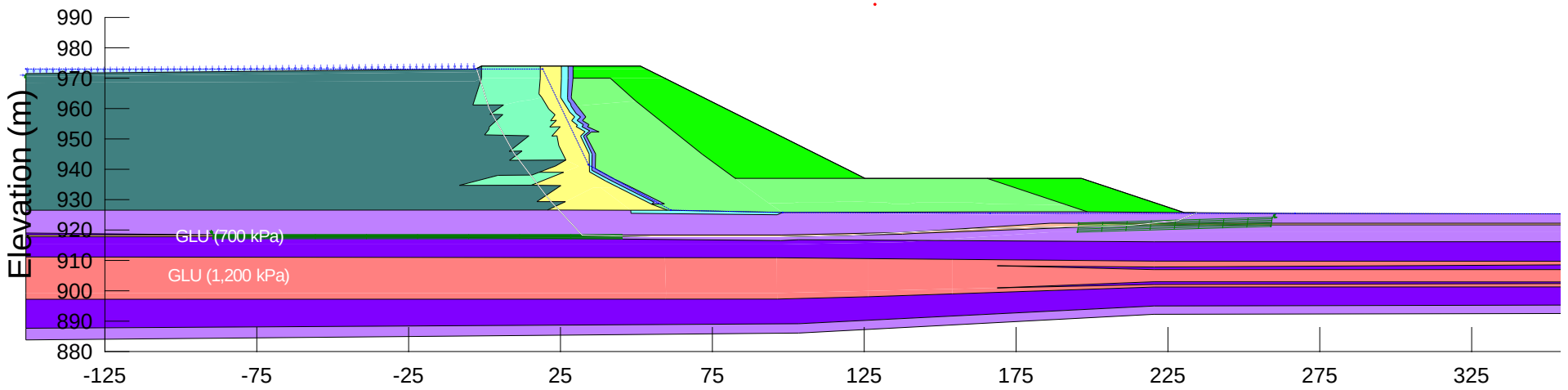
1.4





0 m beach

1.6



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning.
3. 0 m sub-aerial beach; pond el. 973 m.
4. For GLU, pre-consolidation pressure reduced to 400 kPa and 700 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

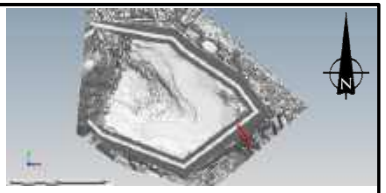
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
LONG-TERM (GLU SHEAR STRENGTH SENSITIVITY)

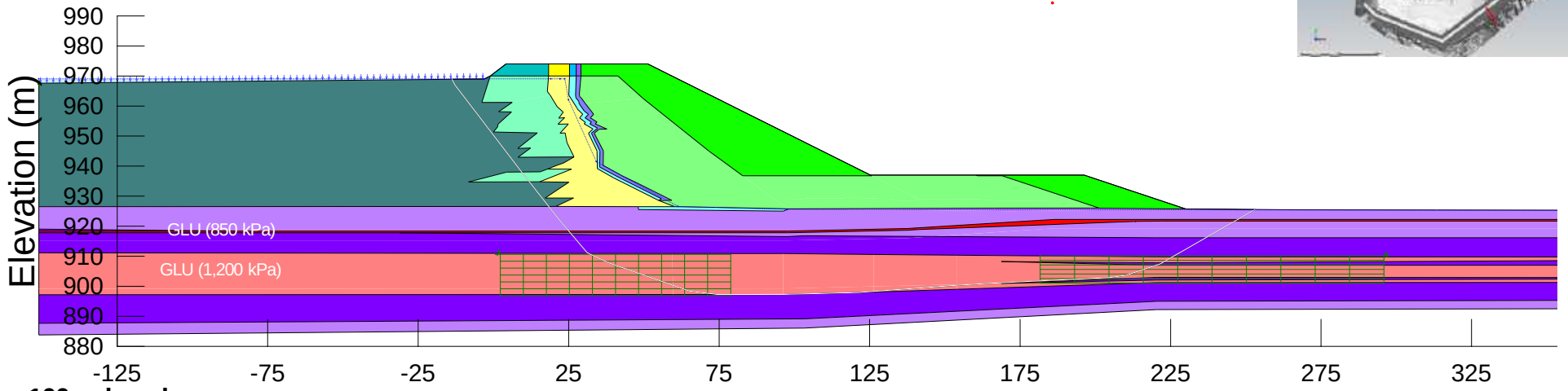
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-28

(INPUT LOCATION OF STABILITY FILES)

0 m beach

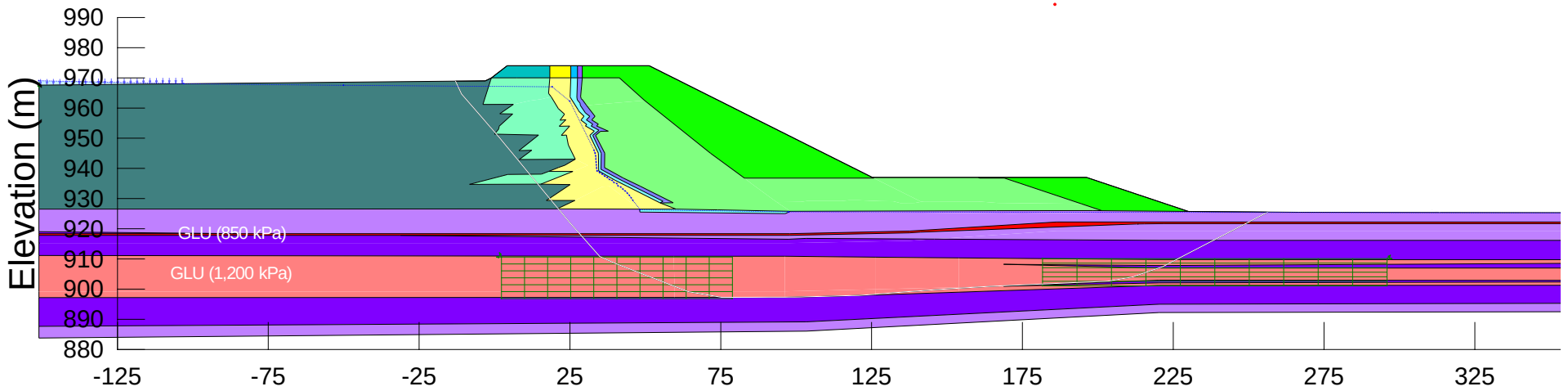
1.5





100 m beach

1.6



Distance (m)

Distance (m)

Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

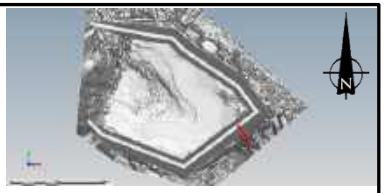
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
SHORT-TERM

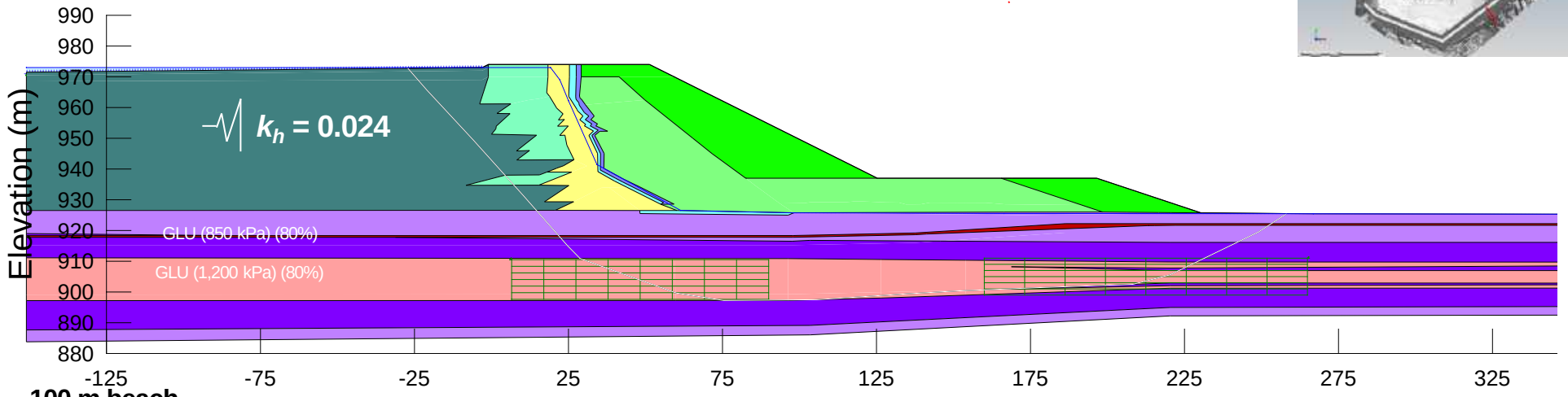
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-29

(INPUT LOCATION OF STABILITY FILES)

0 m beach

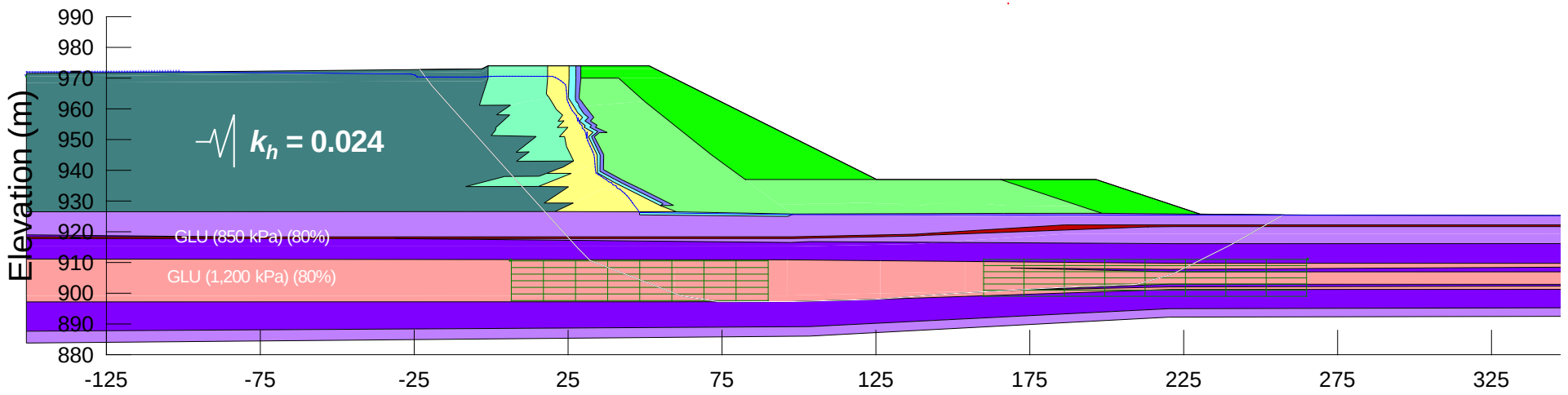
1.1





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

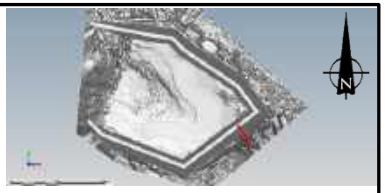
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
PSEUDO-STATIC LOADING

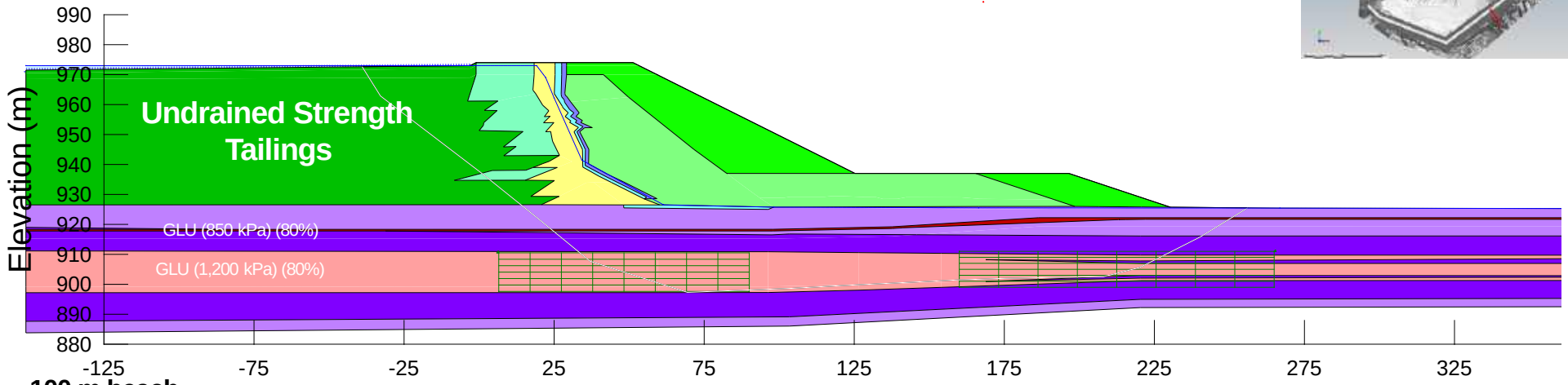
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-30

(INPUT LOCATION OF STABILITY FILES)

0 m beach

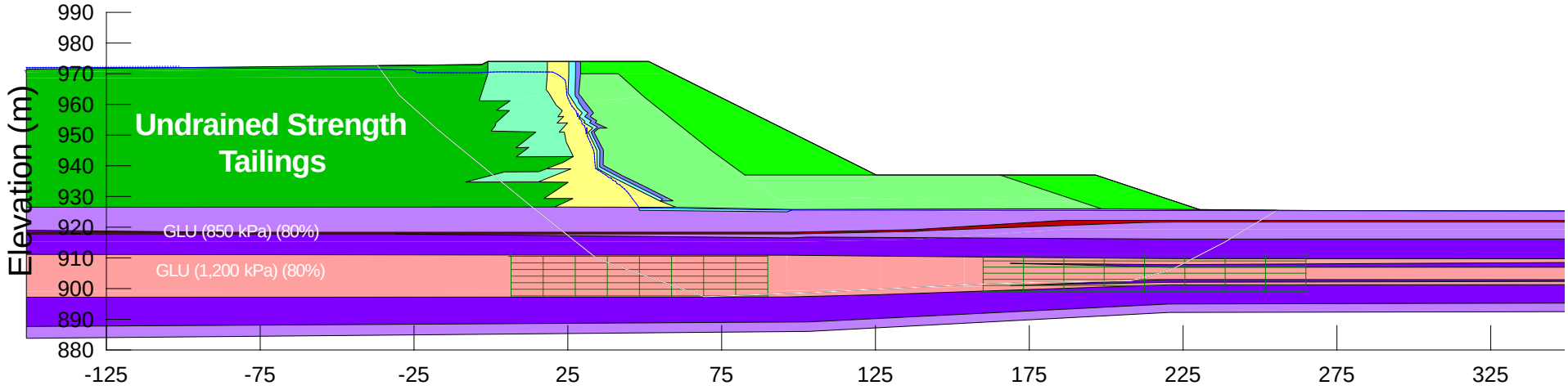
1.3





100 m beach

1.3



Distance (m)

Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

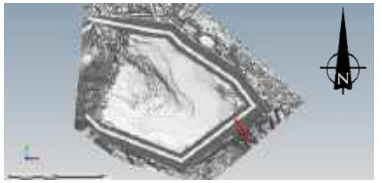
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
POST-EARTHQUAKE

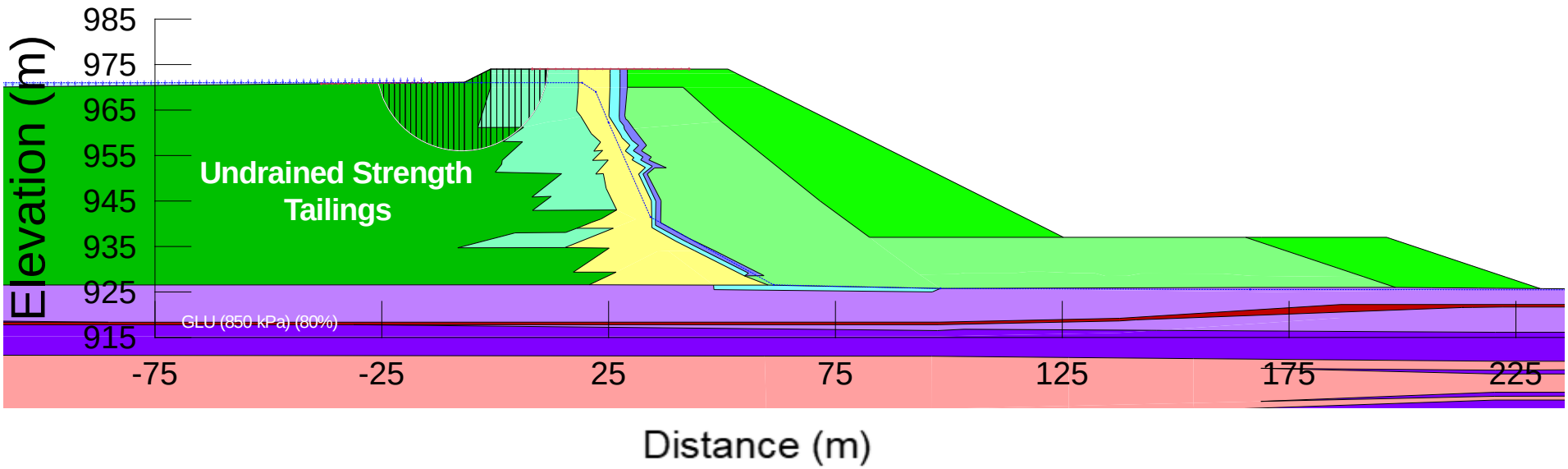
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-31

(INPUT LOCATION OF STABILITY FILES)



0 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach.
3. 0 m sub-aerial beach; pond elevation at 971 m.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

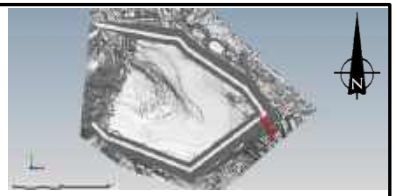
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+455 *(Old Stn. 2+460)*
POST-EARTHQUAKE (UPSTREAM)

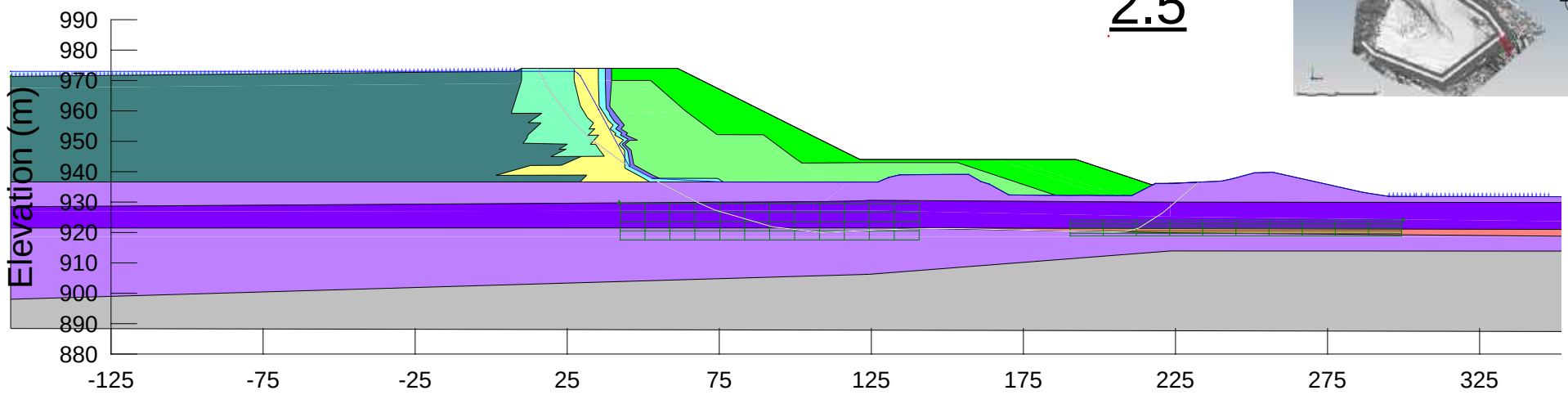
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-32

(INPUT LOCATION OF STABILITY FILES)

0 m beach

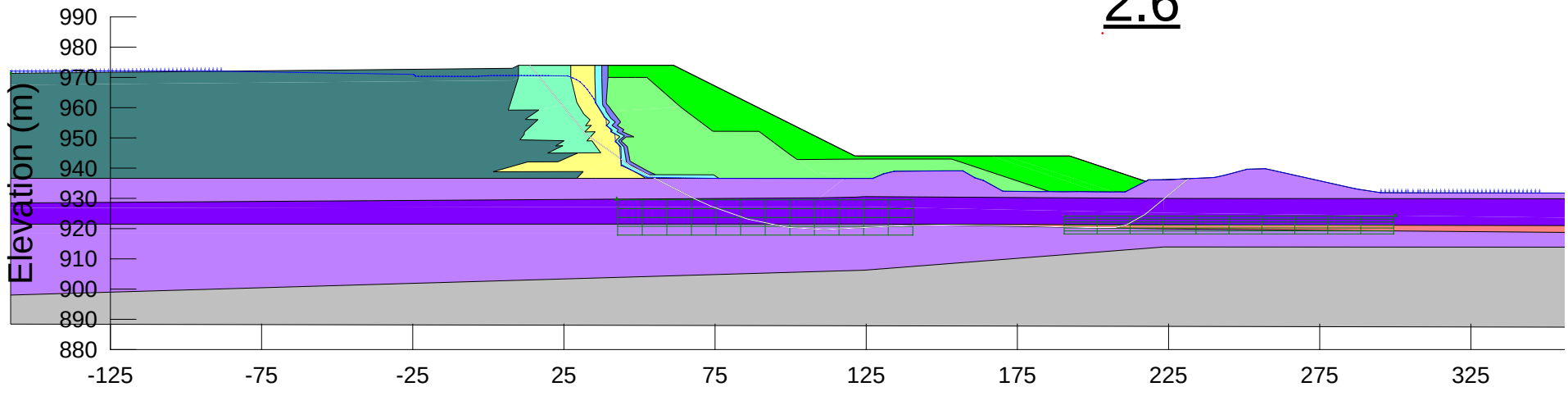
2.5





100 m beach

2.6



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

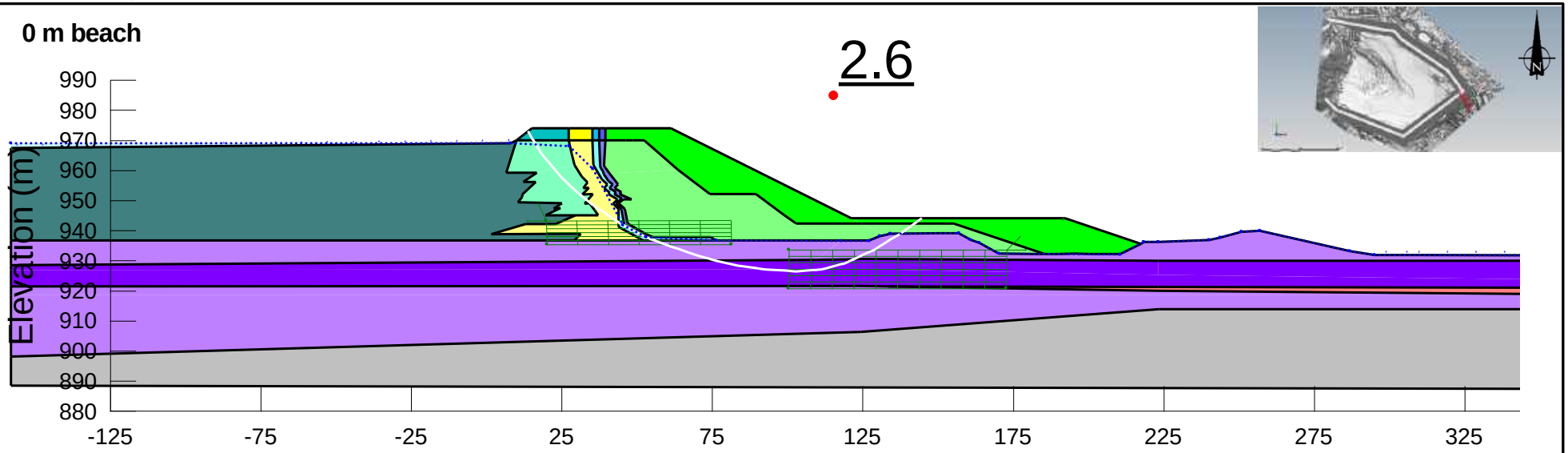
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+695 *(Old Stn. 2+700)*
LONG-TERM

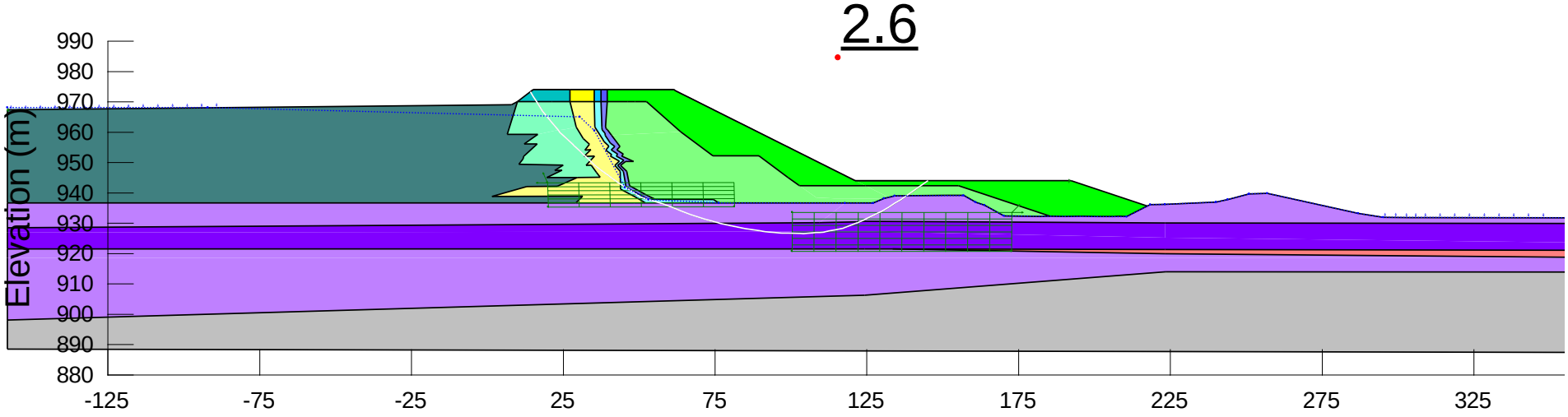
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-33

(INPUT LOCATION OF STABILITY FILES)

0 m beach



100 m beach



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

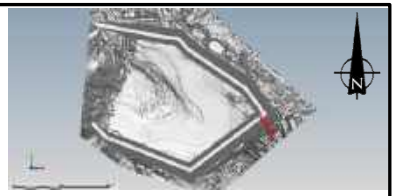
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+695 *(Old Stn. 2+700)*
SHORT-TERM

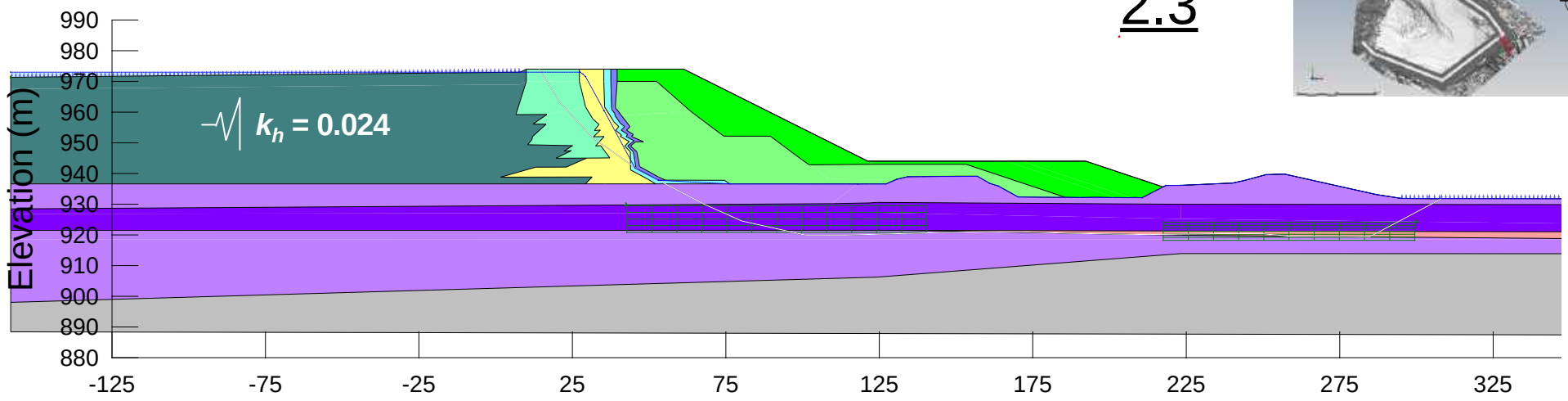
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-34

(INPUT LOCATION OF STABILITY FILES)

0 m beach

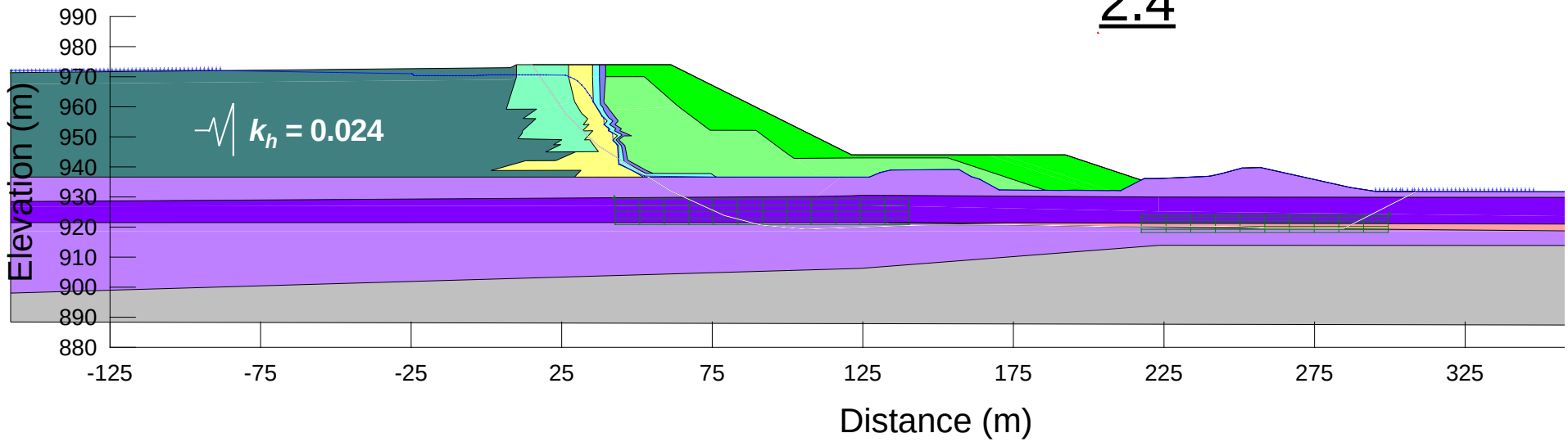
2.3





100 m beach

2.4



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

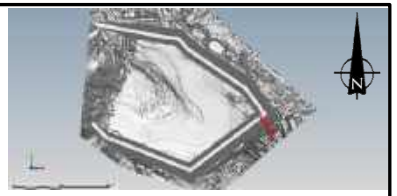
TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+695 *(Old Stn. 2+700)*
PSEUDO-STATIC LOADING

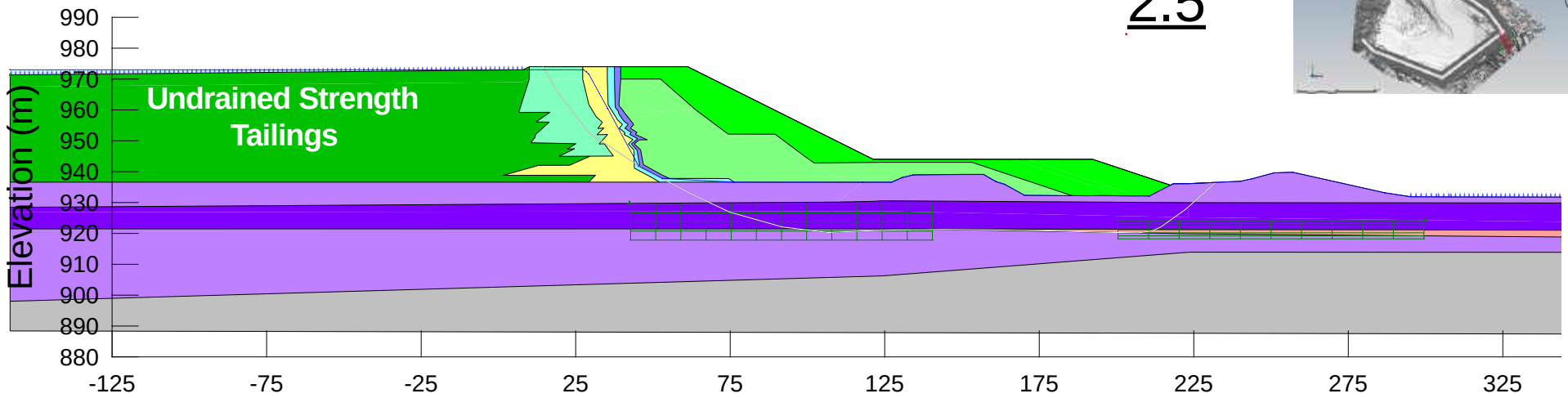
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-35

(INPUT LOCATION OF STABILITY FILES)

0 m beach

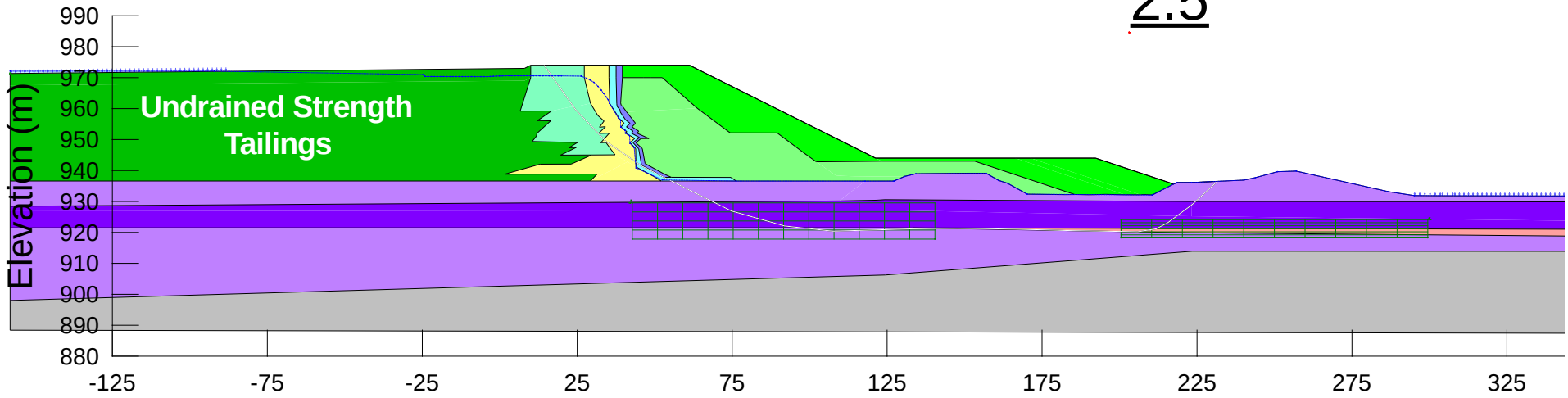
2.5





100 m beach

2.5



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

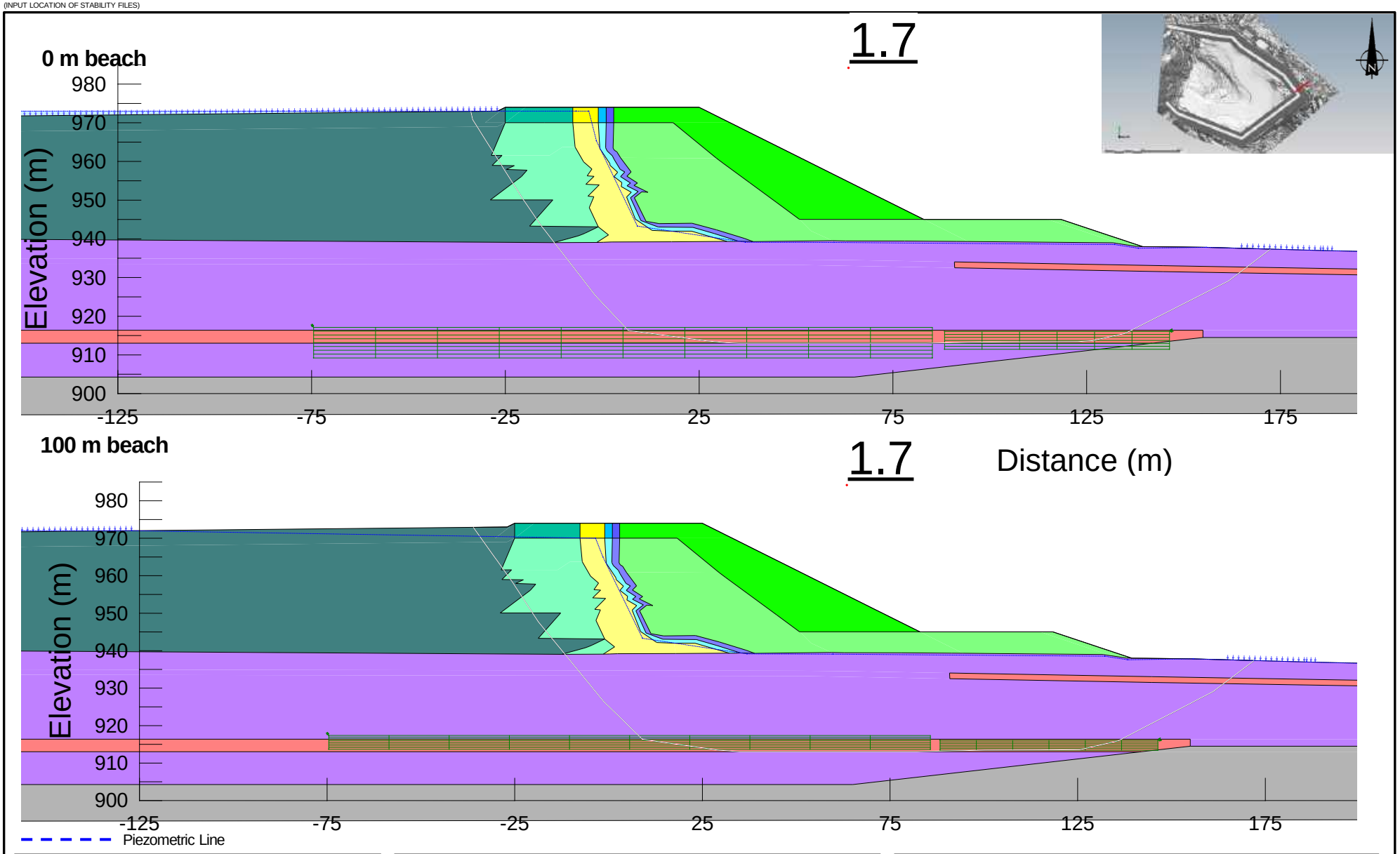
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (MAIN EMBANKMENT)
SECTION 2+695 *(Old Stn. 2+700)*
POST-EARTHQUAKE

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-36

(INPUT LOCATION OF STABILITY FILES)



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

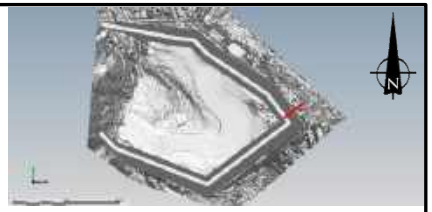
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 2+850 *(Old Stn. 2+850)*
LONG-TERM

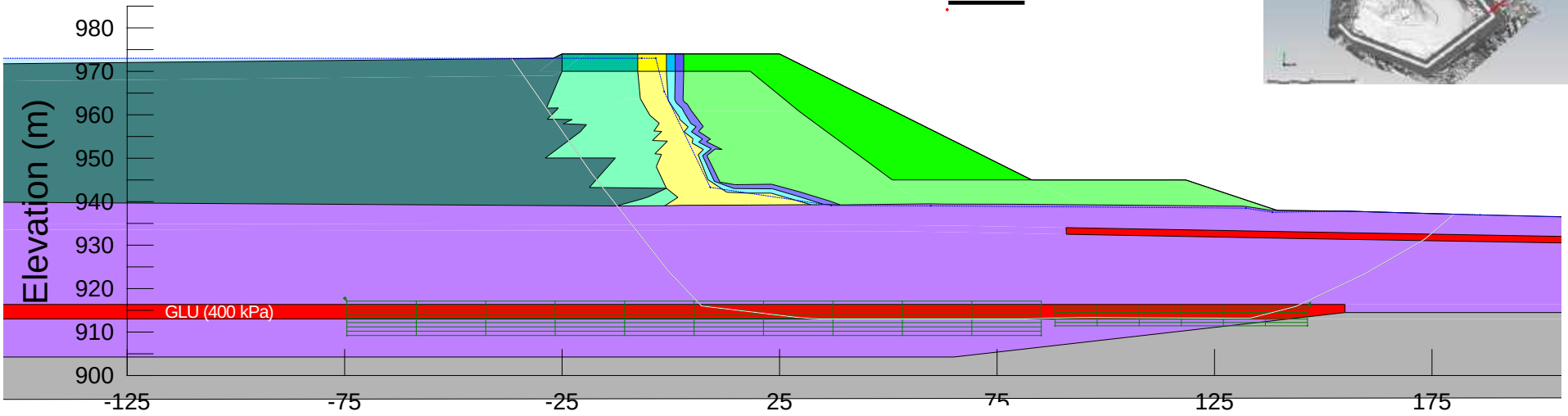
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-37

(INPUT LOCATION OF STABILITY FILES)



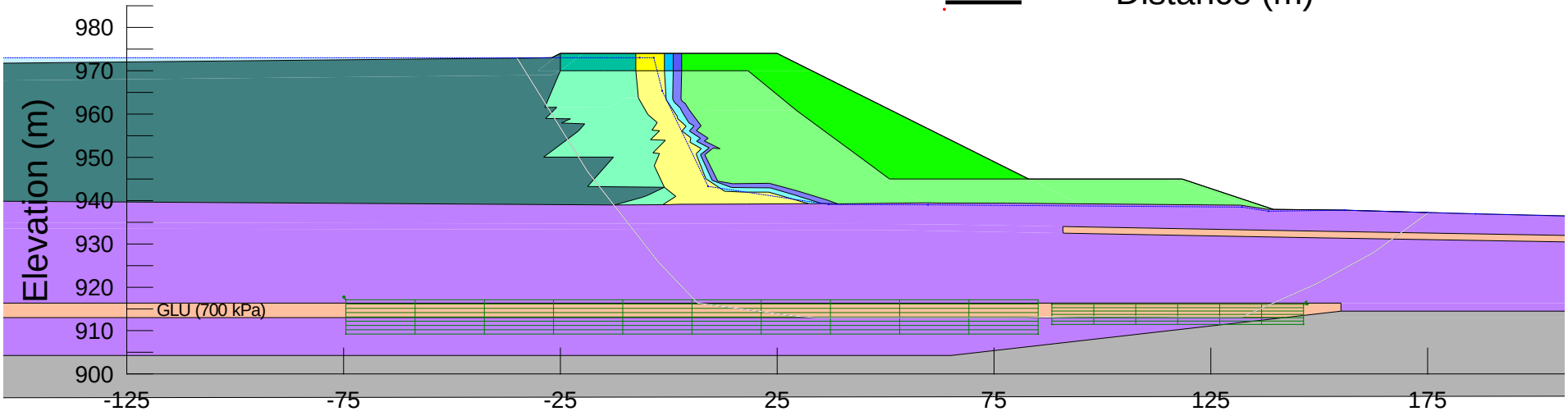
0 m beach

1.5



0 m beach

1.6



Distance (m)

Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning.
3. 0 m sub-aerial beach; pond el. 973 m.
4. Sensitivity GLU undrained shear strength with pre-consolidation pressure reduced to 400 kPa and 700 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

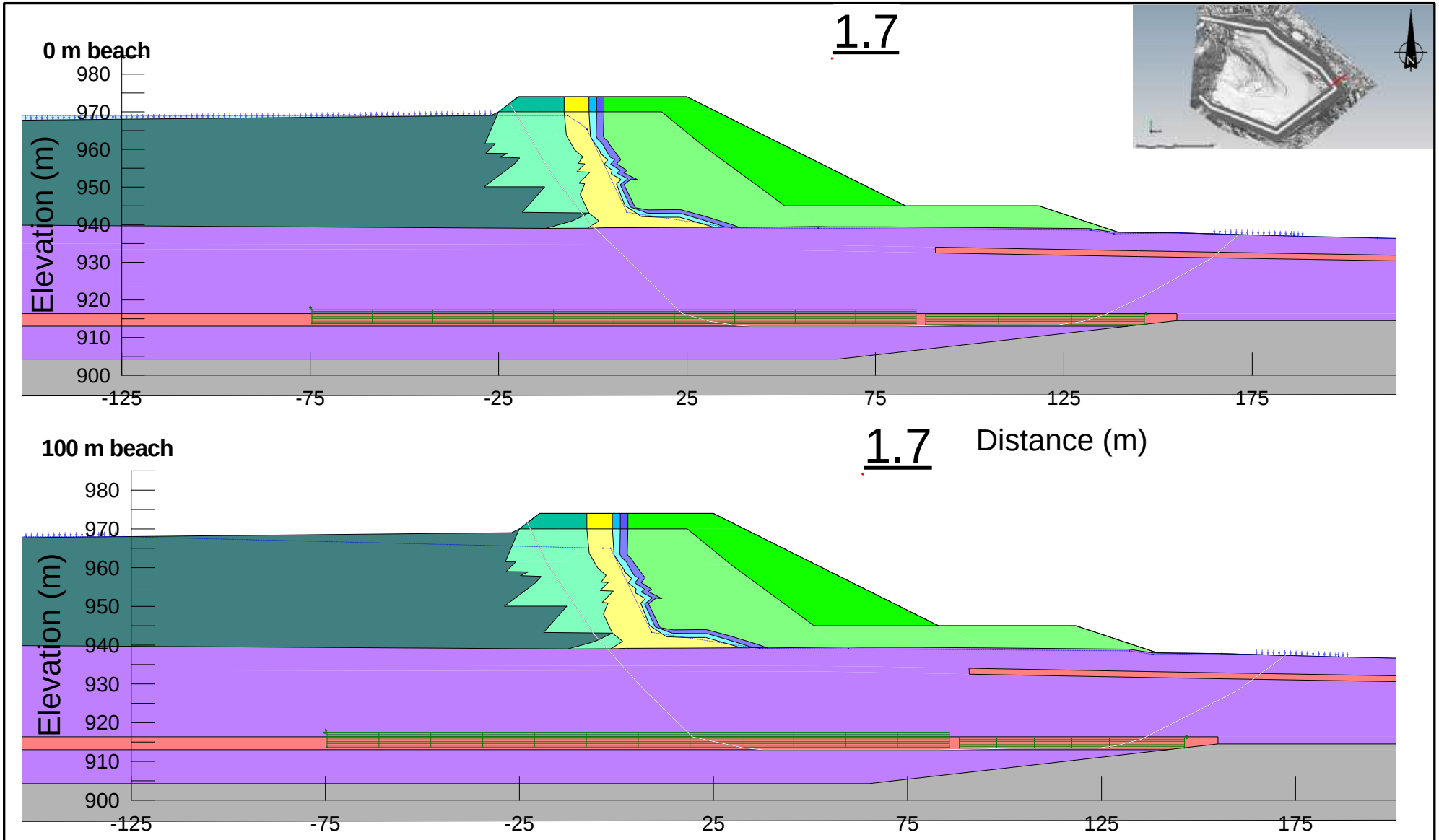
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 2+850 *(Old Stn. 2+850)*
LONG-TERM (GLU SHEAR STRENGTH SENSITIVITY)

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-38

(INPUT LOCATION OF STABILITY FILES)



REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied..
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

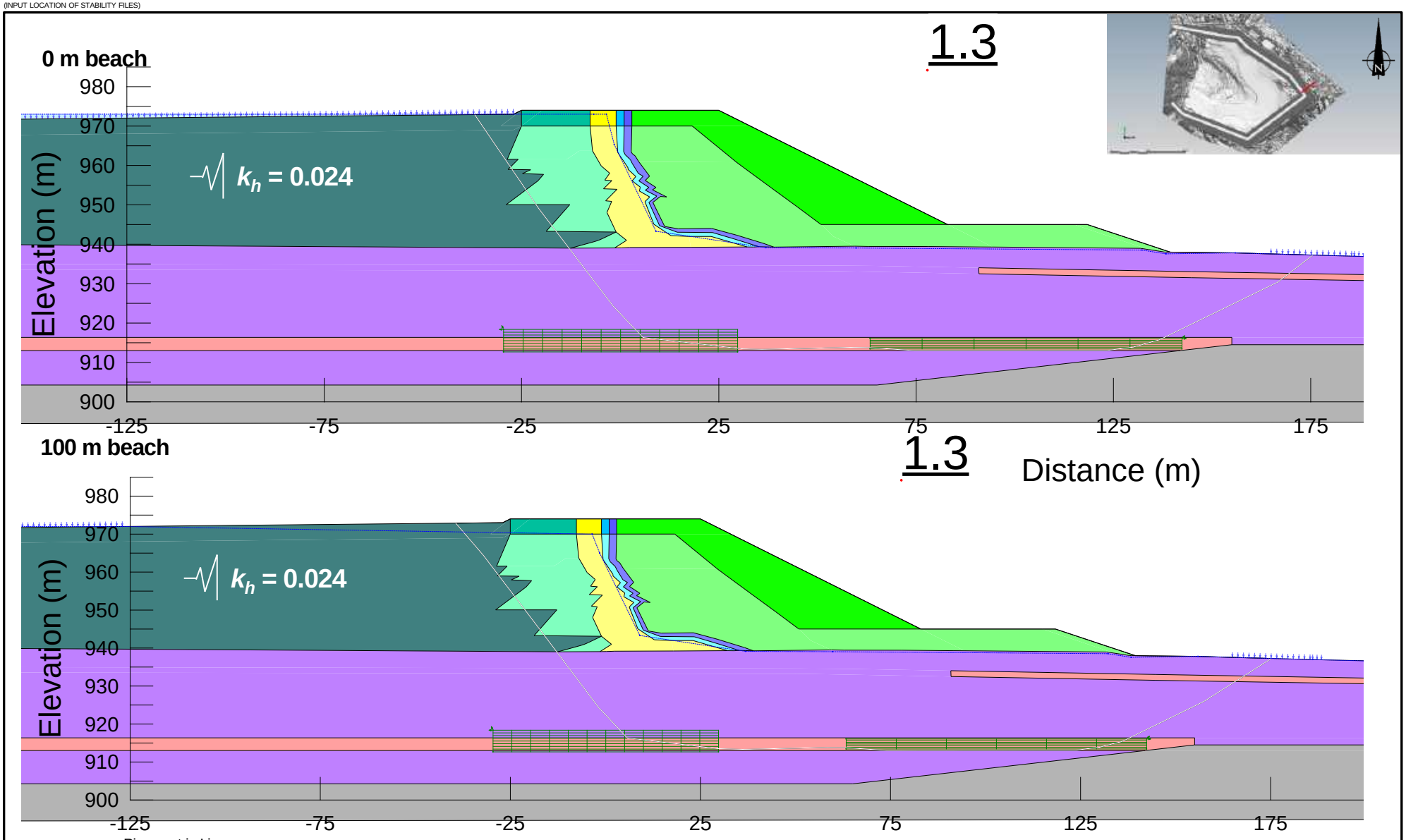
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 2+850 *(Old Stn. 2+850)*
SHORT-TERM

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-39

(INPUT LOCATION OF STABILITY FILES)



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

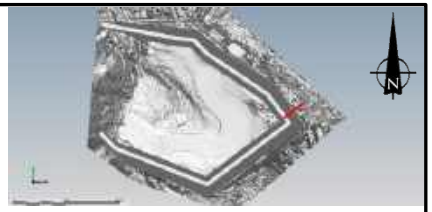
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 2+850 *(Old Stn. 2+850)*
PSEUDO-STATIC LOADING

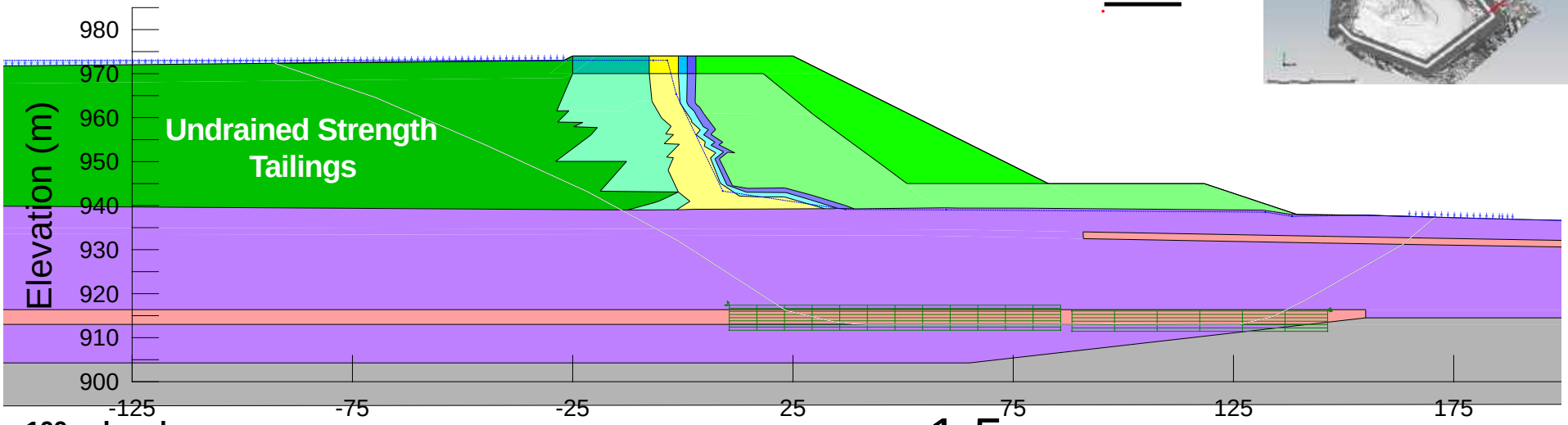
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-40

(INPUT LOCATION OF STABILITY FILES)



0 m beach

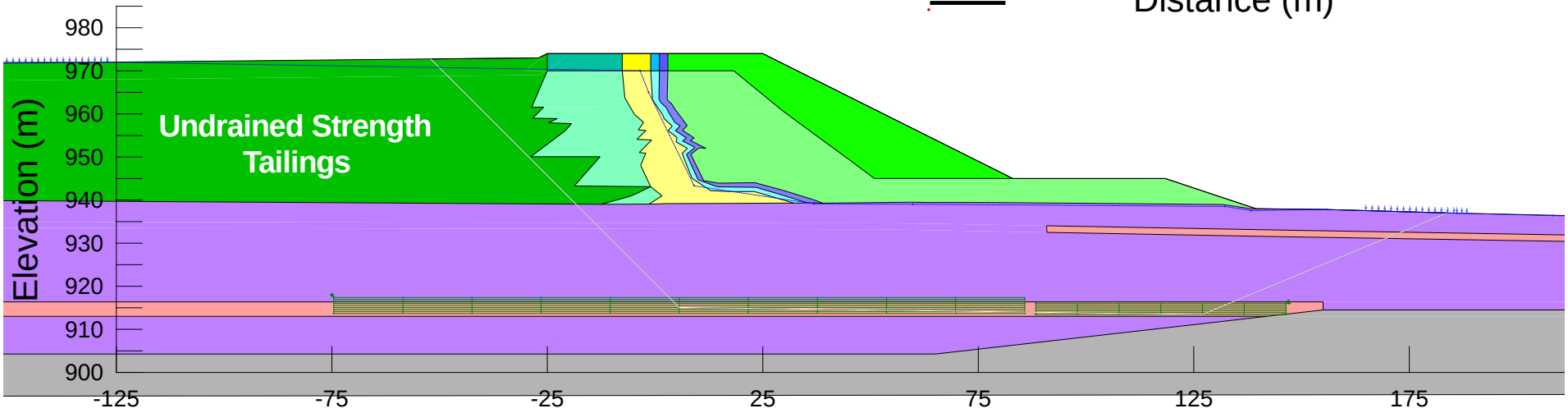
1.5



100 m beach

1.5

Distance (m)



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

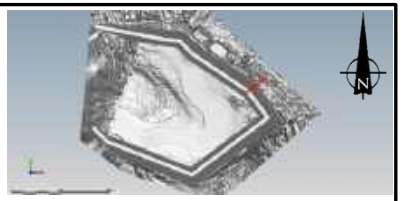
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 2+850 *(Old Stn. 2+850)*
POST-EARTHQUAKE

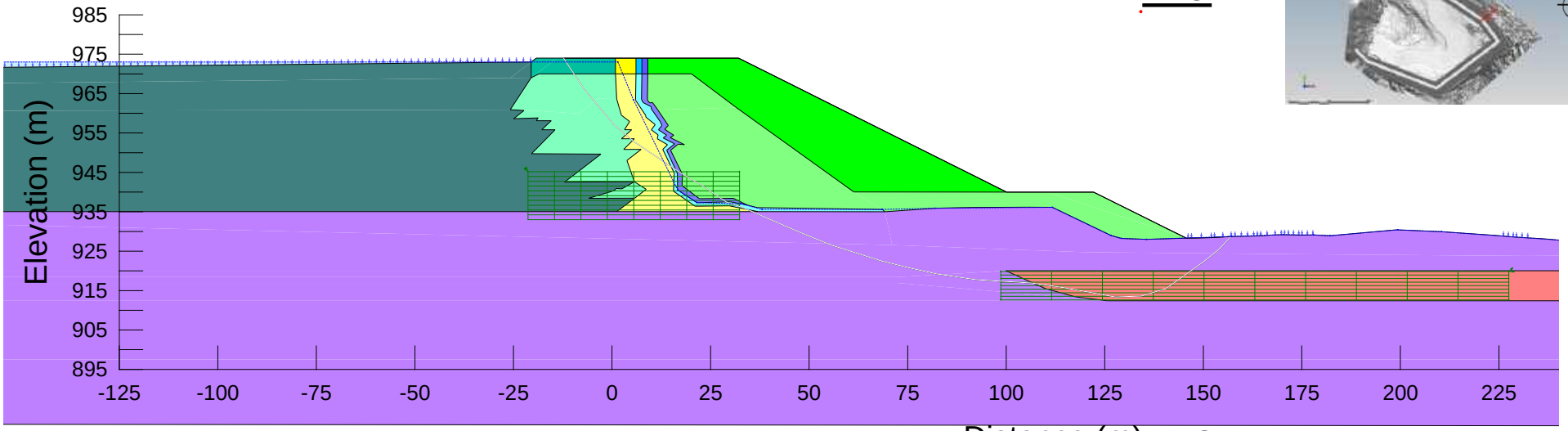
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-41

(INPUT LOCATION OF STABILITY FILES)

0 m beach

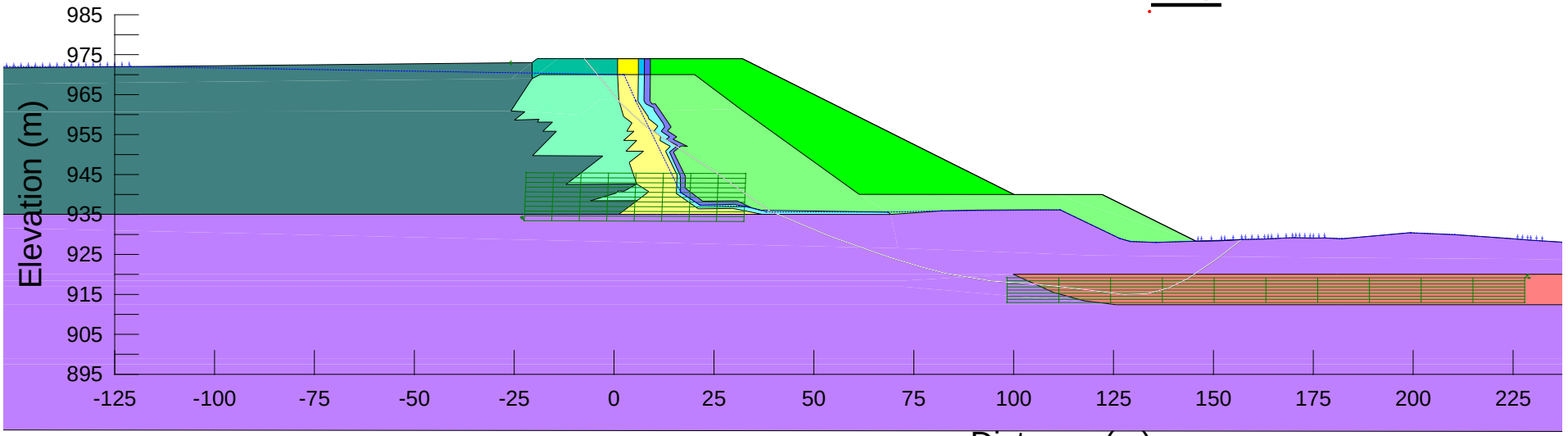
1.9





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

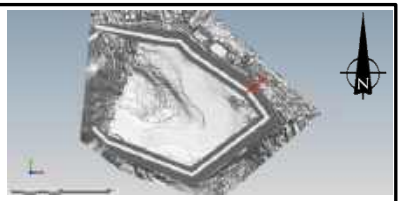
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+185 *(Old Stn. 3+190)*
LONG-TERM

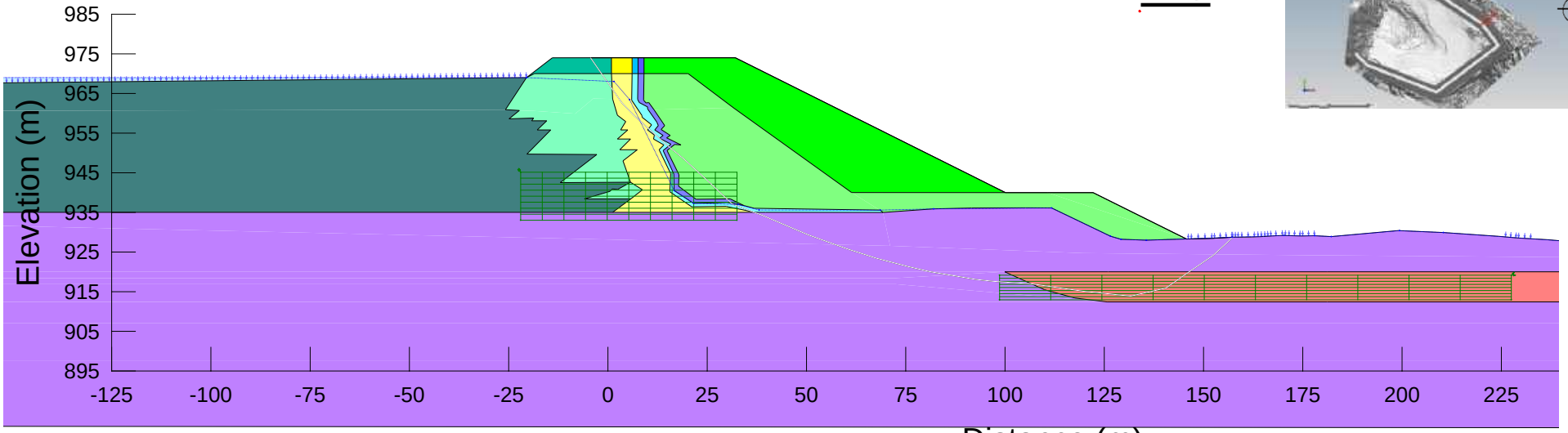
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-42

(INPUT LOCATION OF STABILITY FILES)

0 m beach

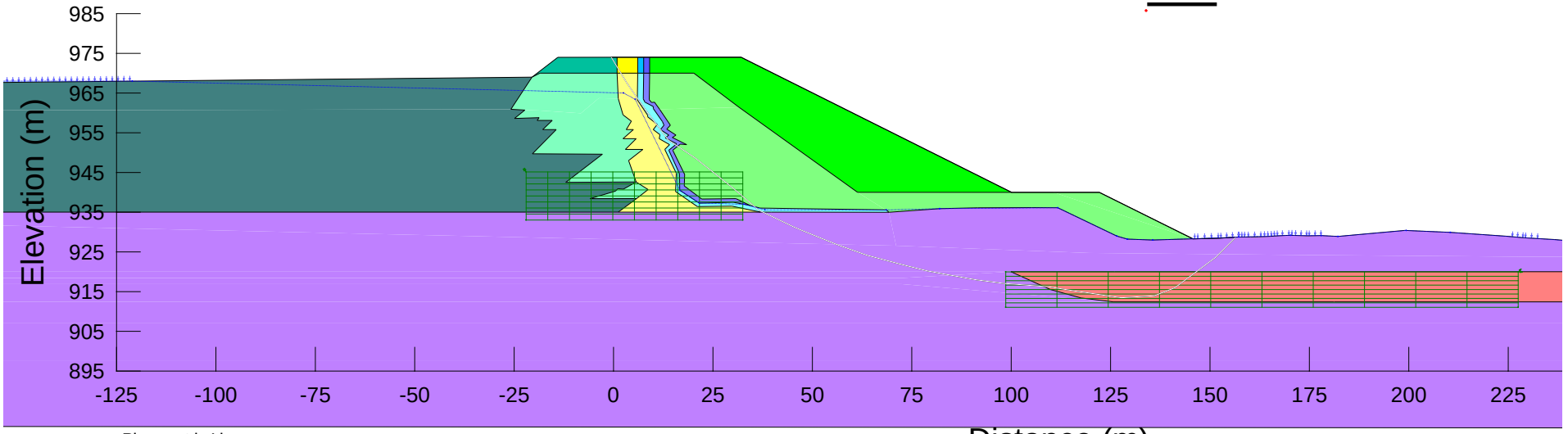
1.8





100 m beach

1.8



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

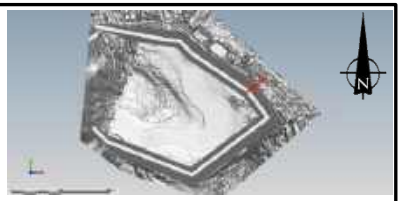
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+185 *(Old Stn. 3+190)*
SHORT-TERM

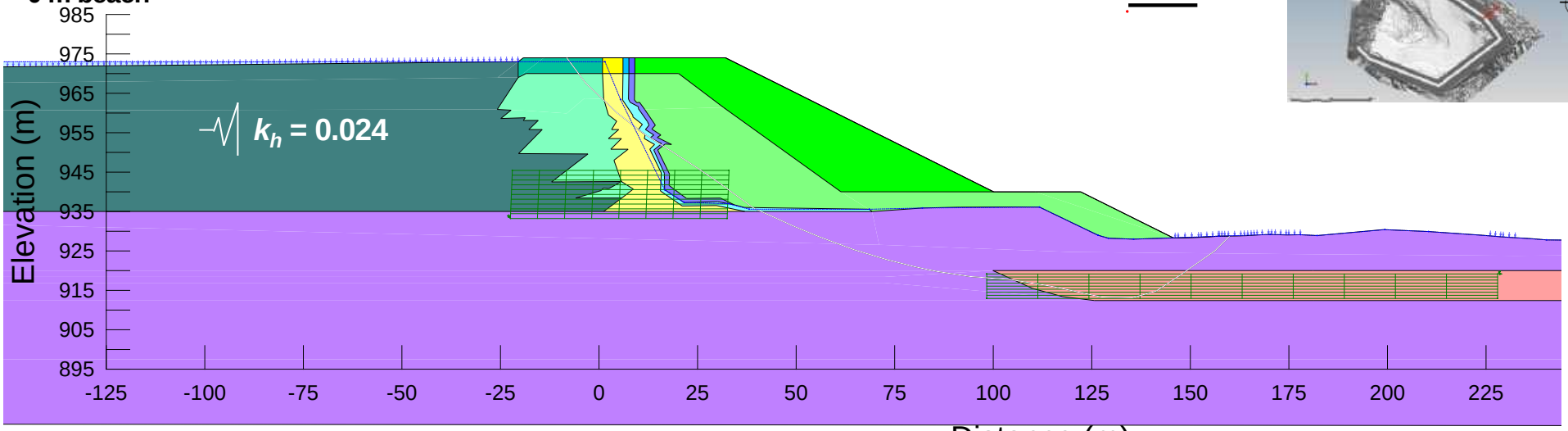
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-43

(INPUT LOCATION OF STABILITY FILES)

0 m beach

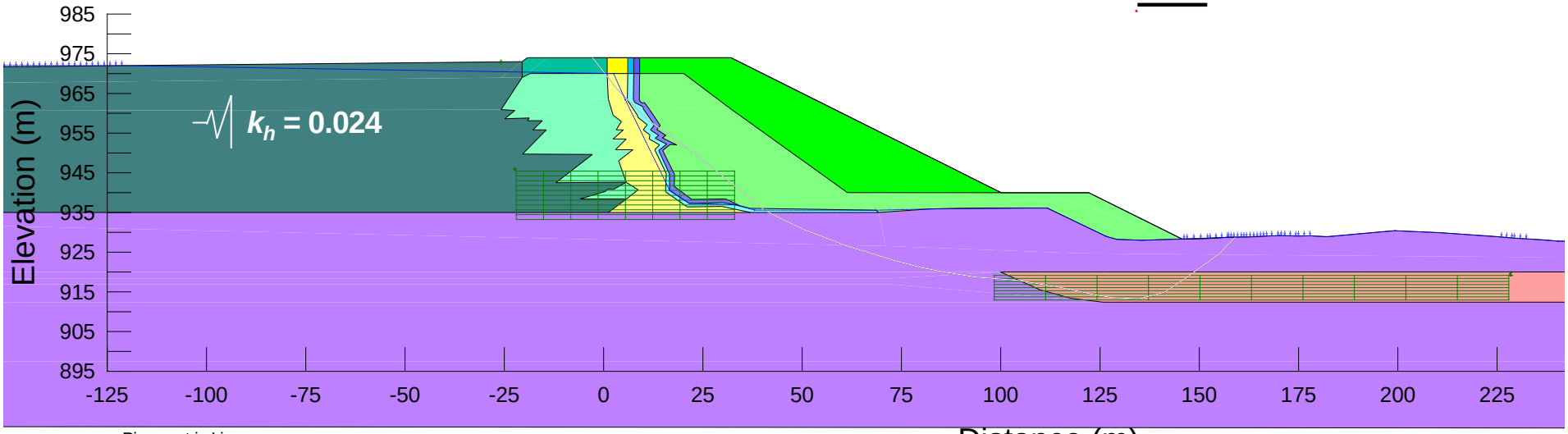
1.7





100 m beach

1.7



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

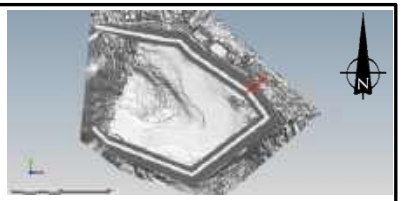
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+185 *(Old Stn. 3+190)*
PSEUDO-STATIC LOADING

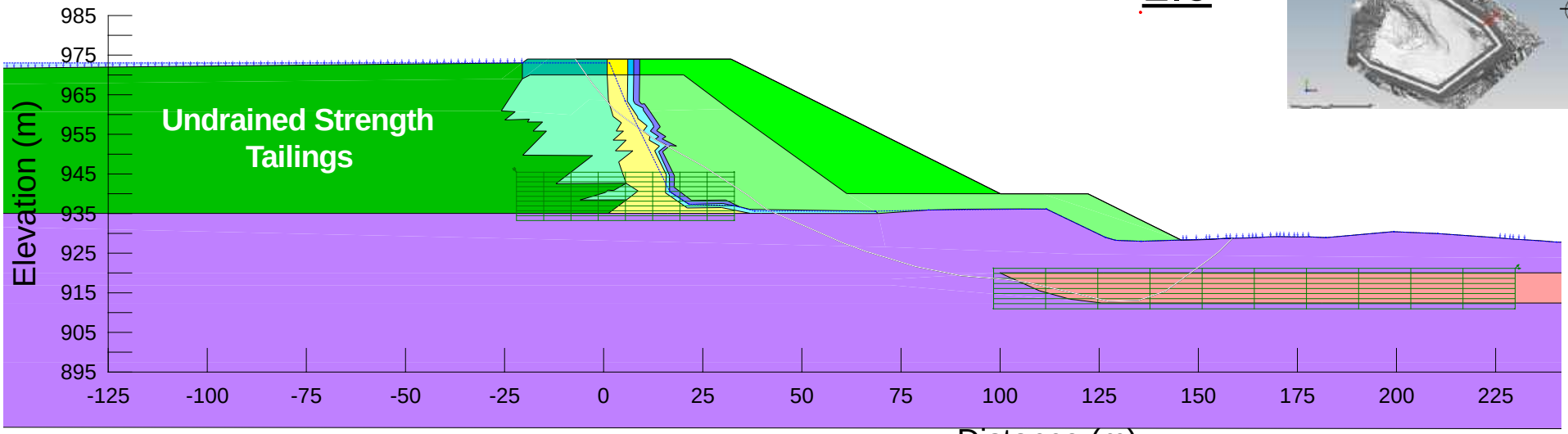
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-44

(INPUT LOCATION OF STABILITY FILES)

0 m beach

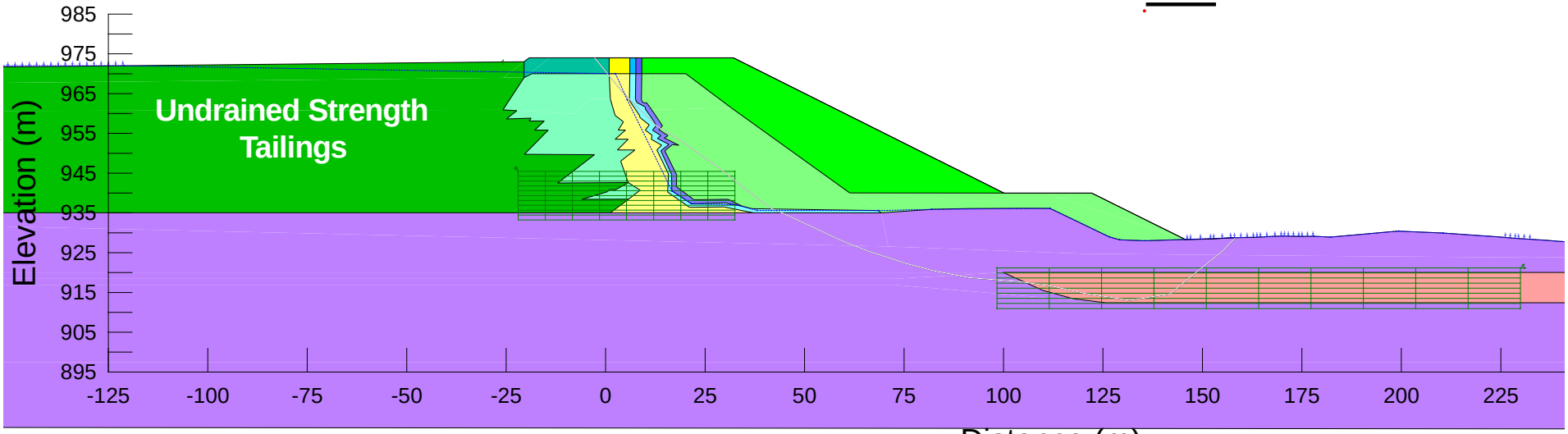
1.9





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+185 *(Old Stn. 3+190)*
POST-EARTHQUAKE

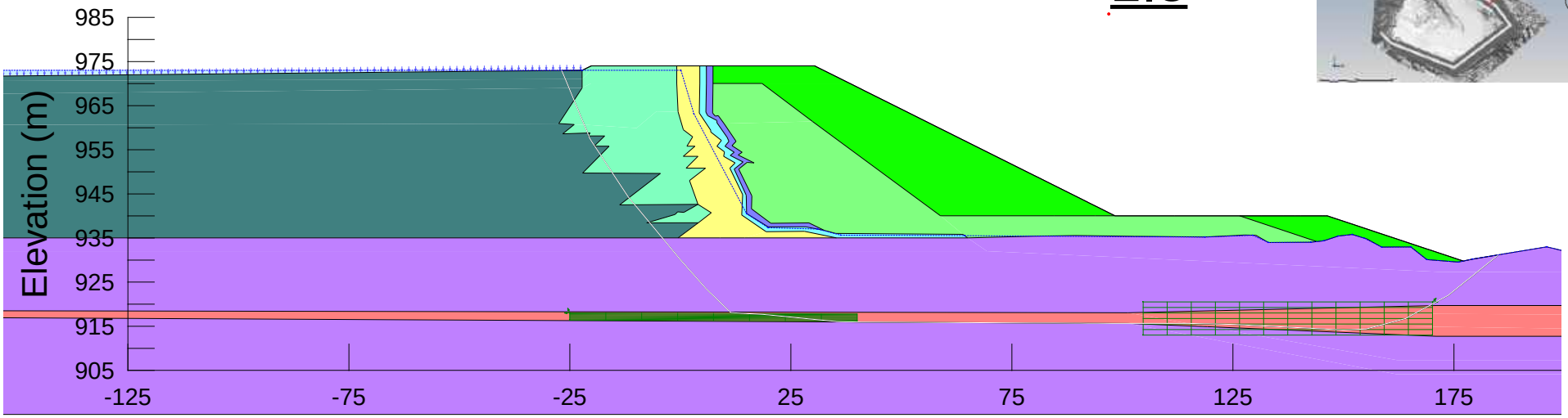
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-45

(INPUT LOCATION OF STABILITY FILES)

0 m beach

1.5

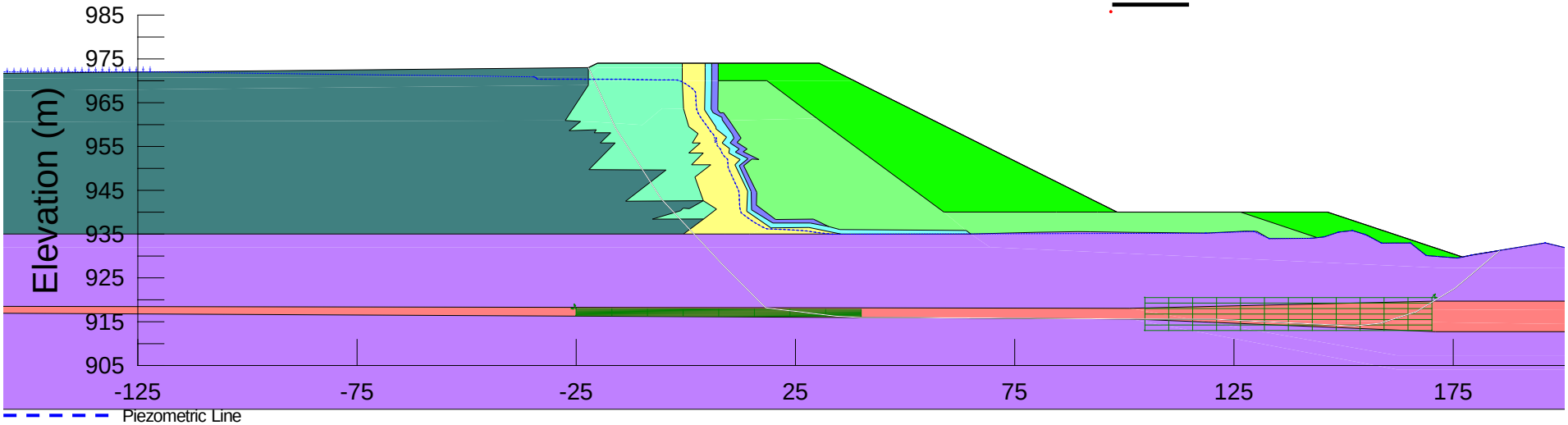




100 m beach

Distance (m)

1.6



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+270 (Old Stn. 3+275)
LONG-TERM

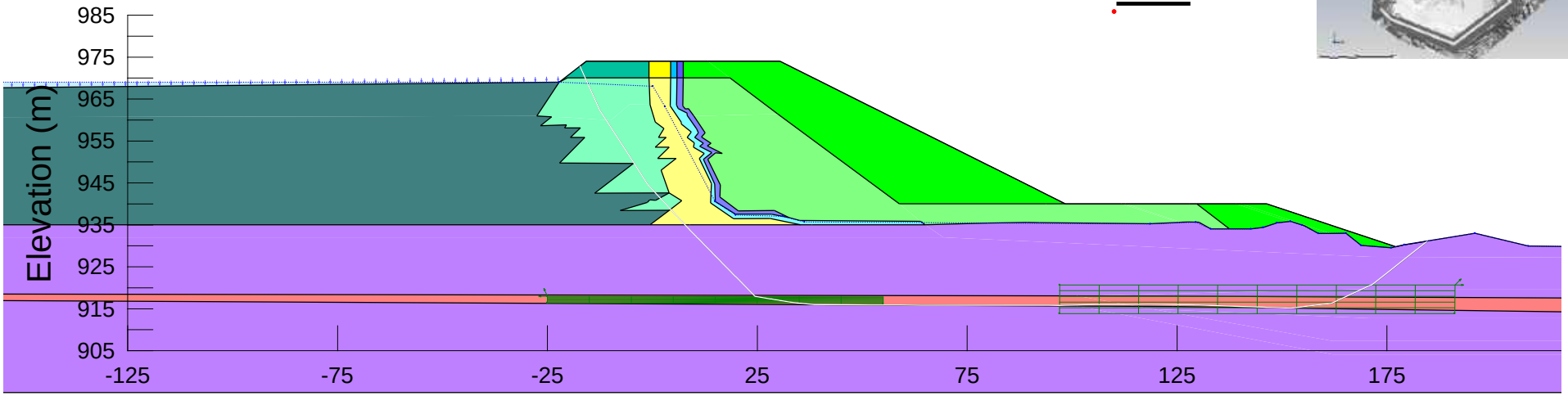
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-46

(INPUT LOCATION OF STABILITY FILES)

0 m beach

1.6

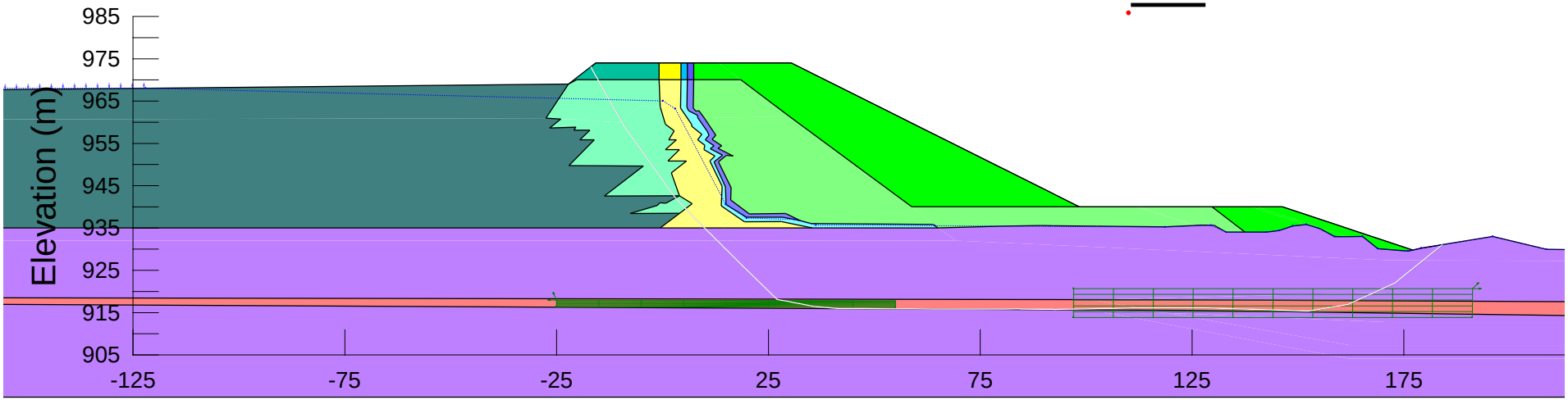




100 m beach

Distance (m)

1.6



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+270 *(Old Stn. 3+275)*
SHORT-TERM

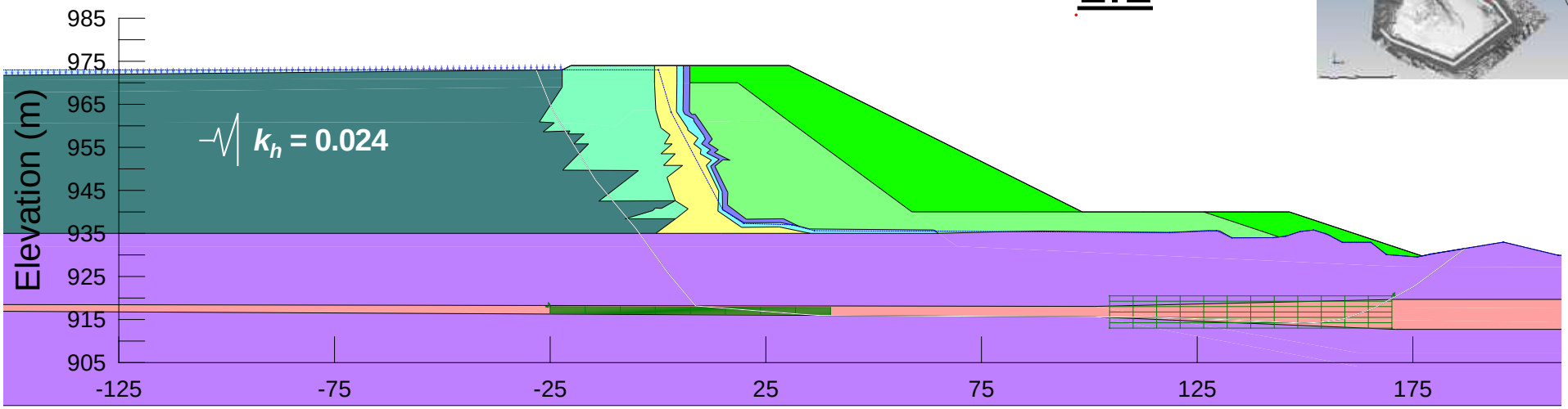
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-47

(INPUT LOCATION OF STABILITY FILES)

0 m beach

1.1

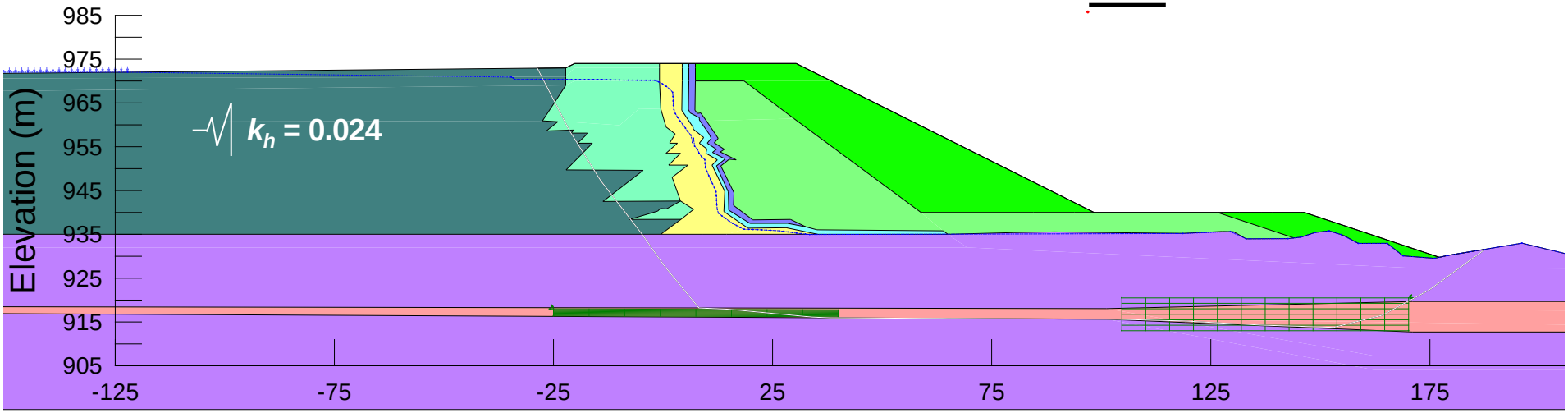




100 m beach

Distance (m)

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+270 *(Old Stn. 3+275)*
PSEUDO-STATIC LOADING

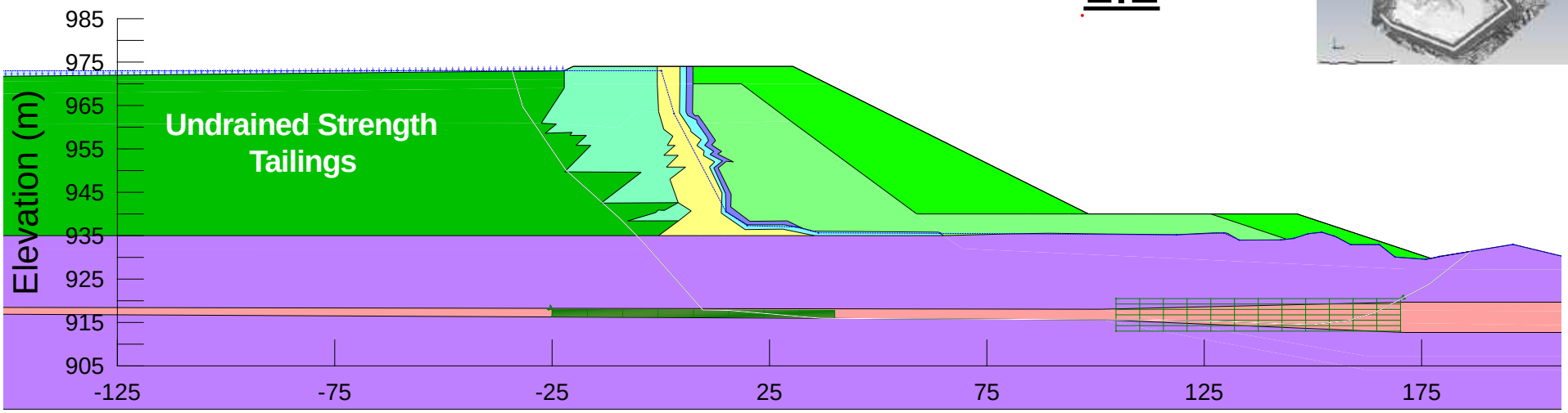
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-48

(INPUT LOCATION OF STABILITY FILES)

0 m beach

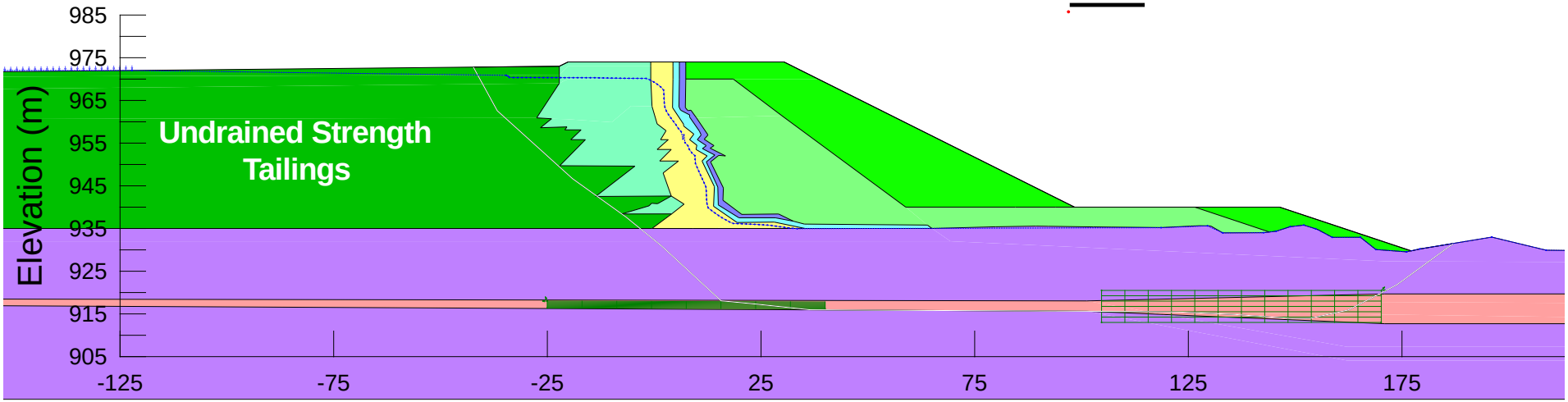
1.2





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

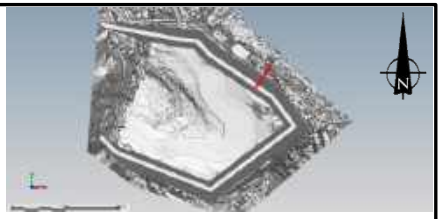
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+270 *(Old Stn. 3+275)*
POST-EARTHQUAKE

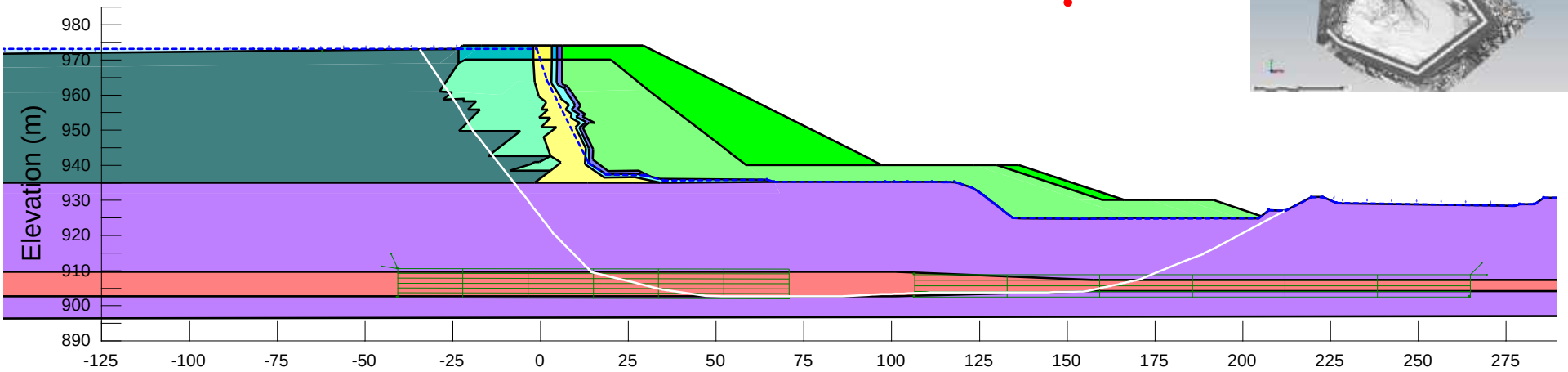
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-49

(INPUT LOCATION OF STABILITY FILES)

0 m beach

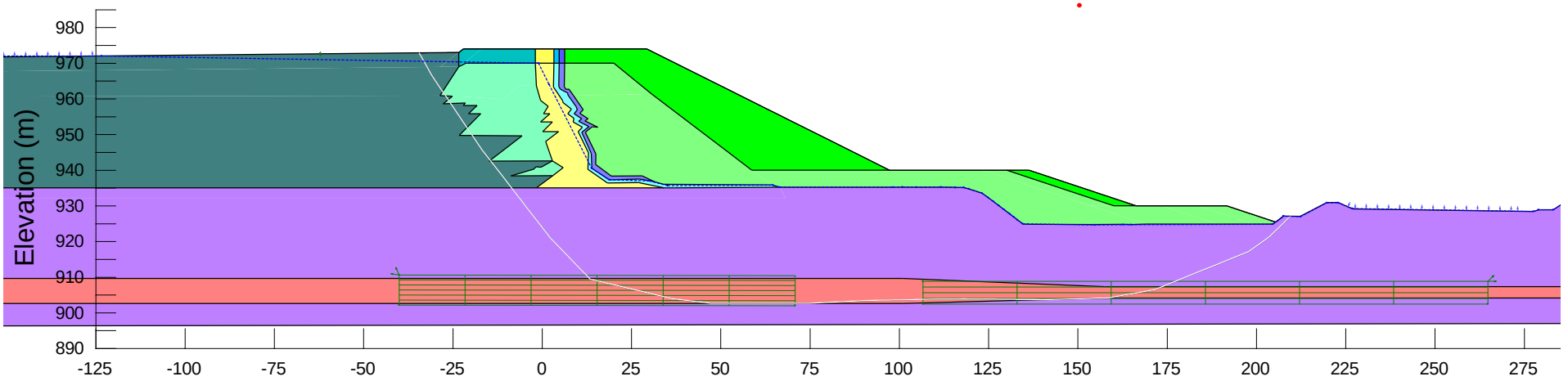
1.5





100 m beach

1.5



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

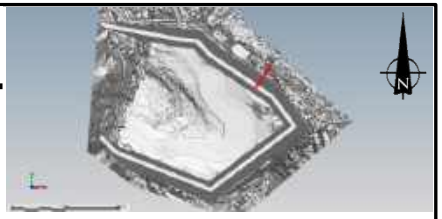
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+395 *(Old Stn. 3+400)*
LONG-TERM

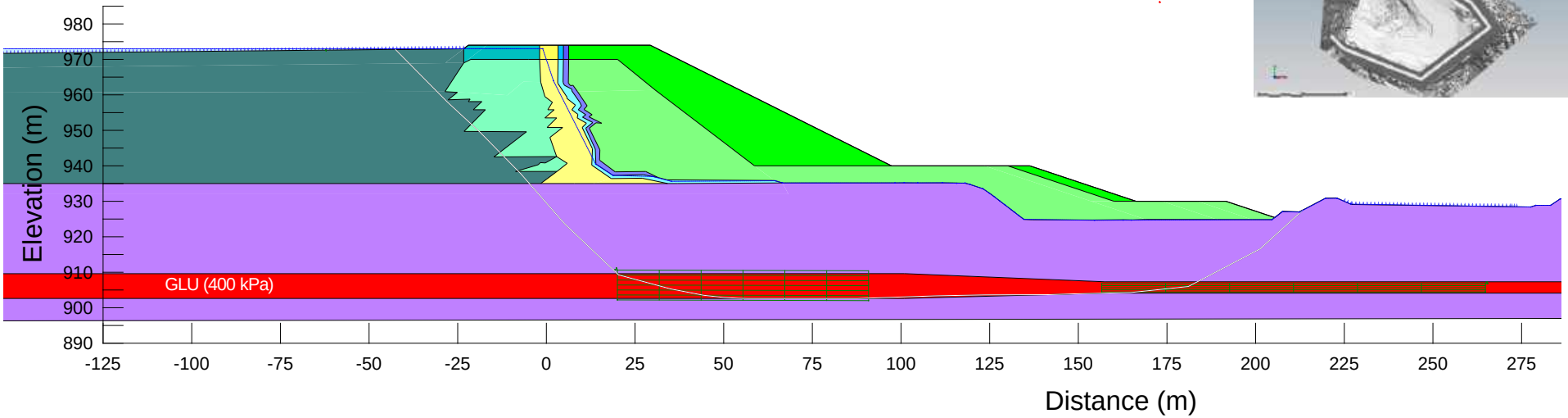
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-50

(INPUT LOCATION OF STABILITY FILES)

0 m beach

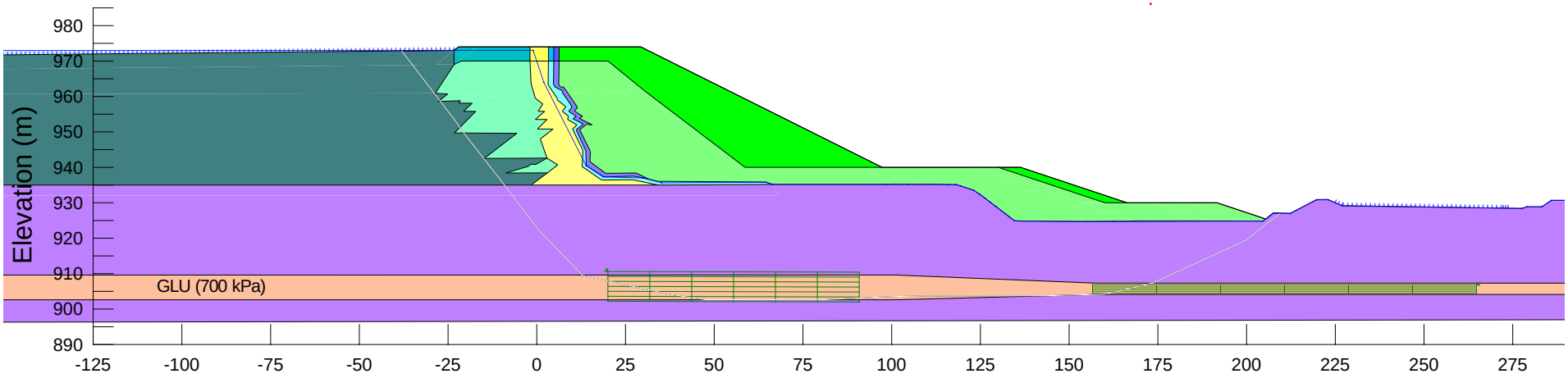
1.3





0 m beach

1.4



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning.
3. 0 m sub-aerial beach; pond el. 973 m.
4. Sensitivity GLU undrained shear strength with pre-consolidation pressure reduced to 400 kPa and 700 kPa.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

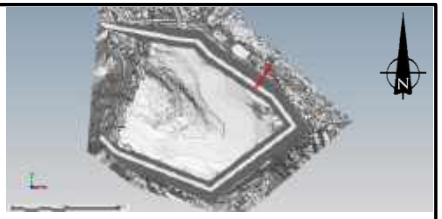
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+395 *(Old Stn. 3+400)*
LONG-TERM (GLU SHEAR STRENGTH SENSITIVITY)

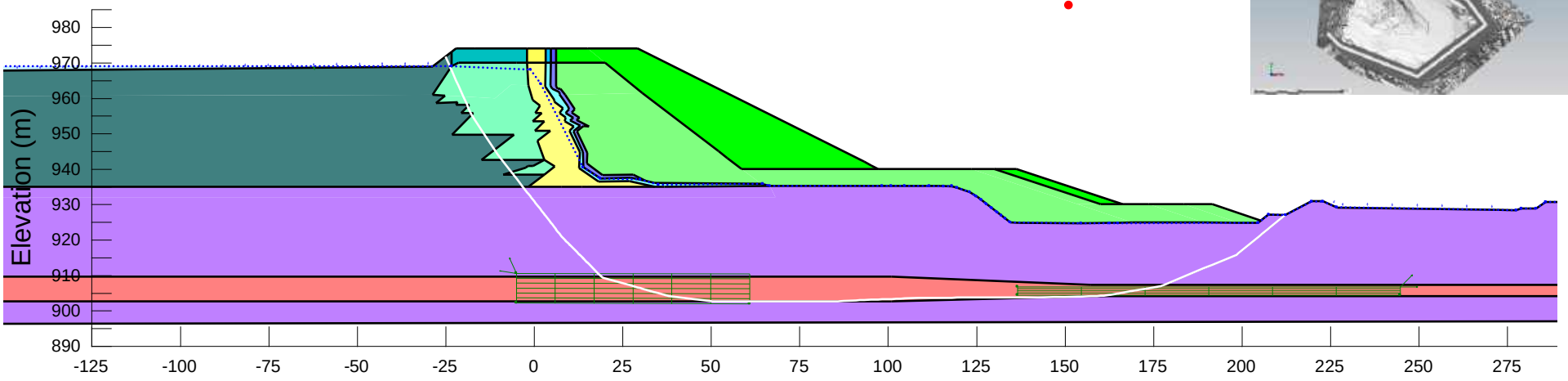
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-51

(INPUT LOCATION OF STABILITY FILES)

0 m beach

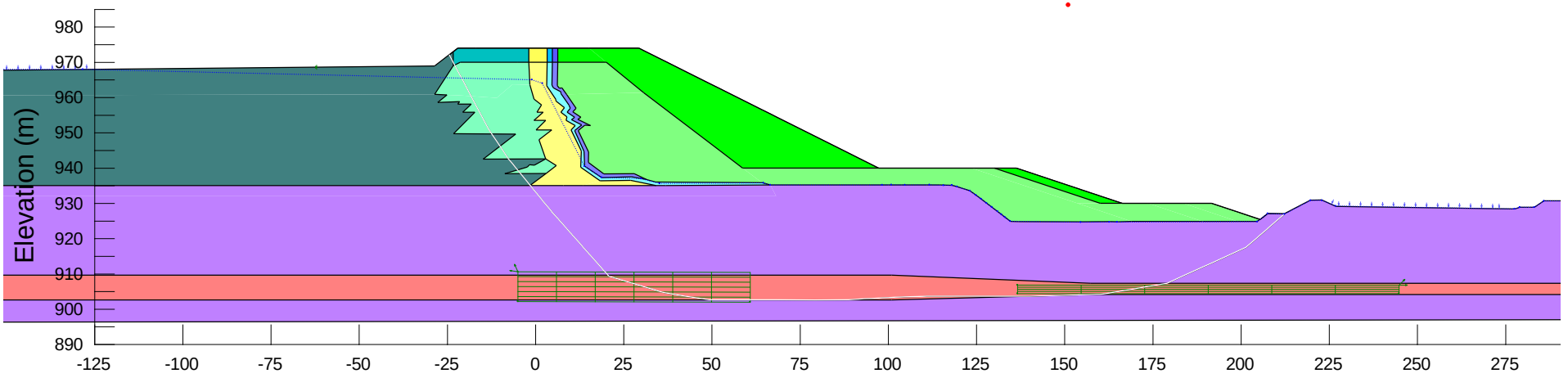
1.5





100 m beach

1.5



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

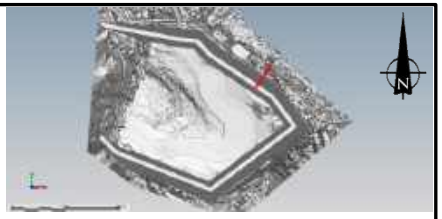
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+395 *(Old Stn. 3+400)*
SHORT-TERM

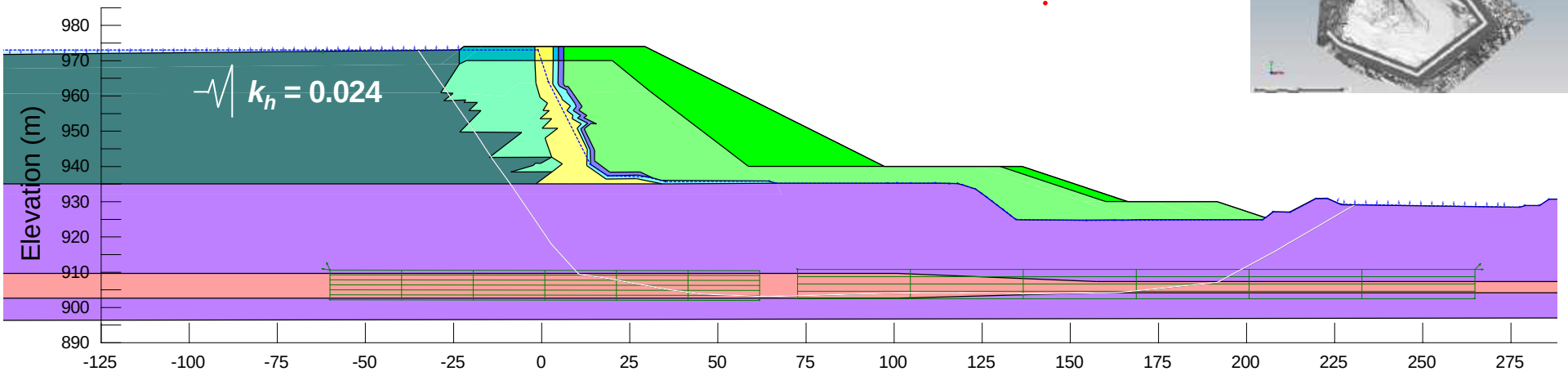
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-52

(INPUT LOCATION OF STABILITY FILES)

0 m beach

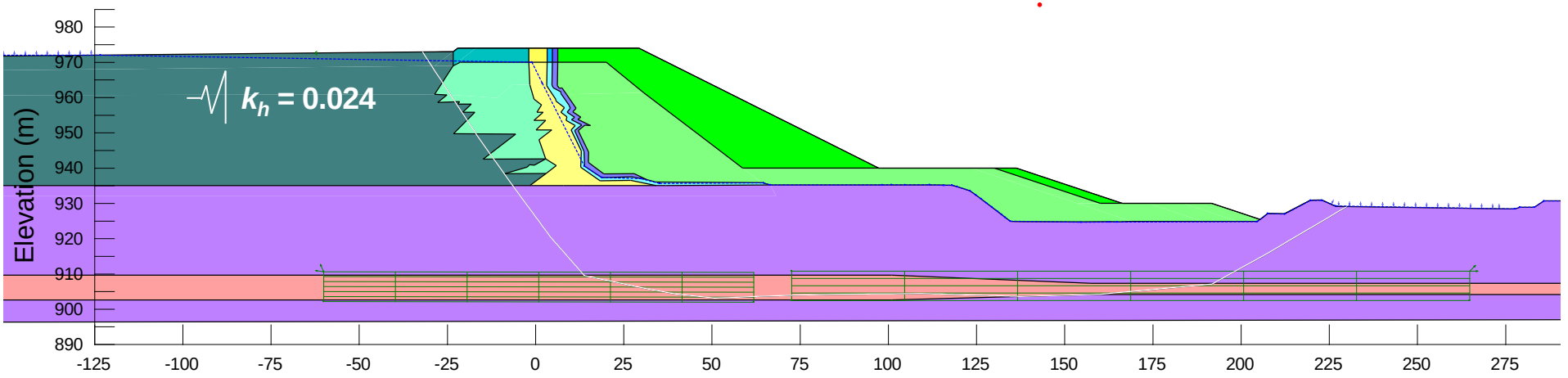
1.2





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

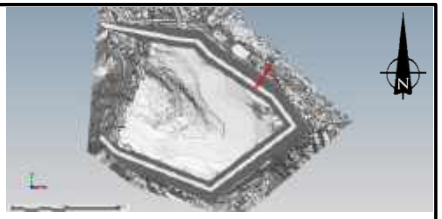
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+395 *(Old Stn. 3+400)*
PSEUDO-STATIC LOADING

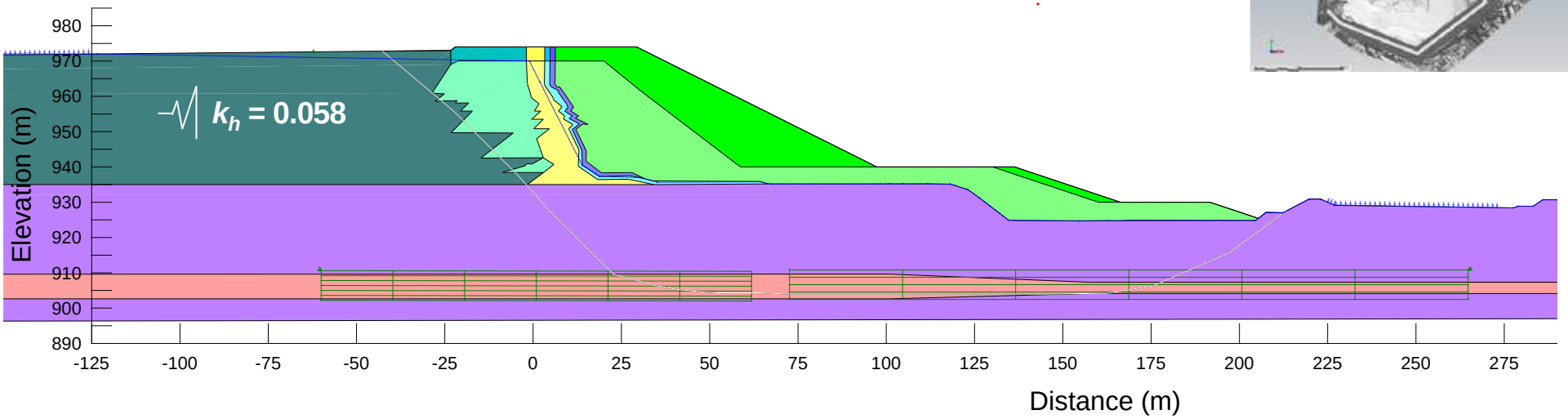
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-53

(INPUT LOCATION OF STABILITY FILES)

100 m beach

1.1





Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain functioning.
3. 100 m sub-aerial beach; pond el. 972 m.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 10,000-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

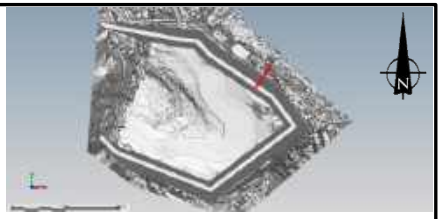
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+395 *(Old Stn. 3+400)*
PSEUDO-STATIC LOADING

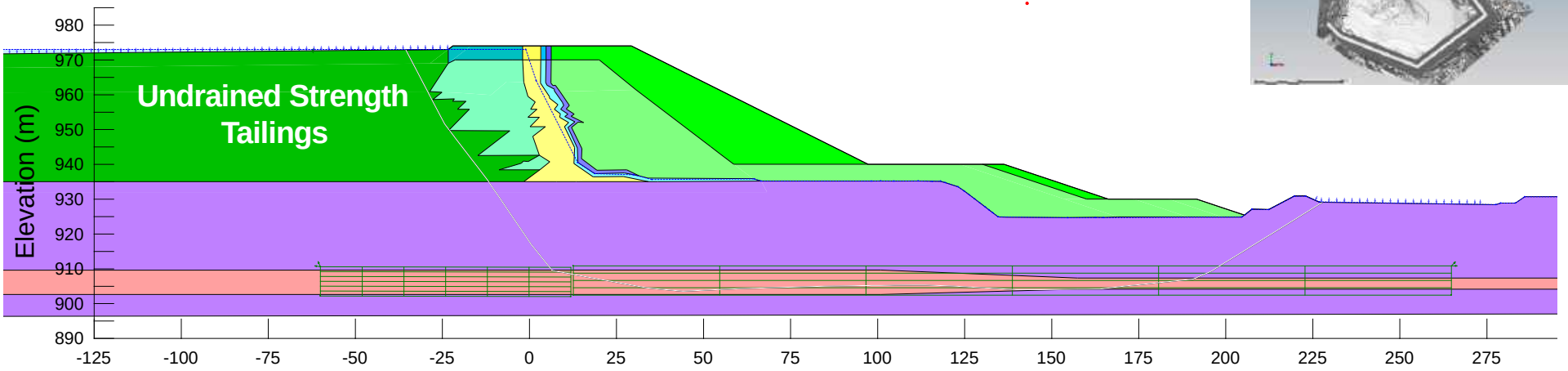
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-54

(INPUT LOCATION OF STABILITY FILES)

0 m beach

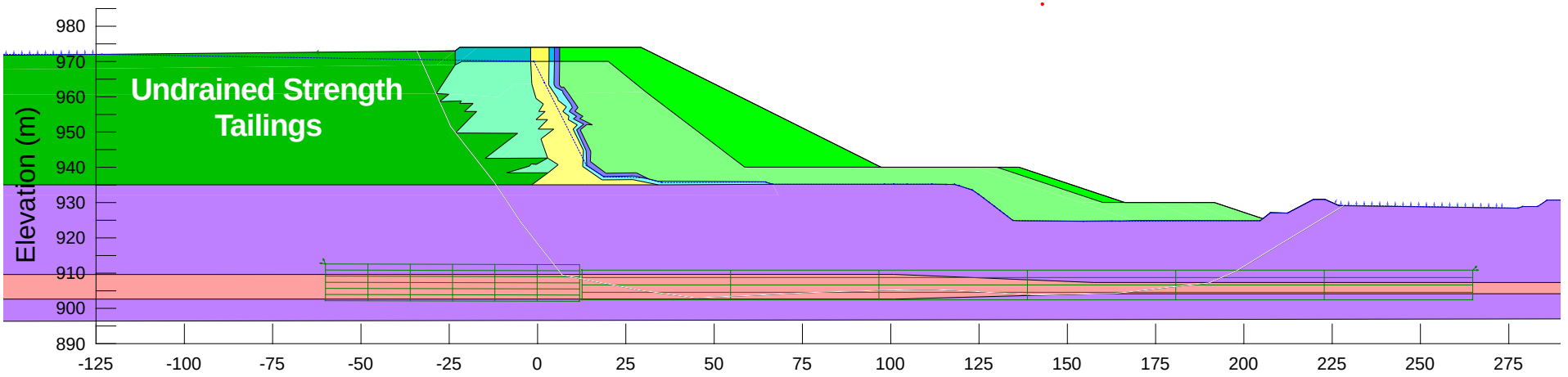
1.3





100 m beach

1.3



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

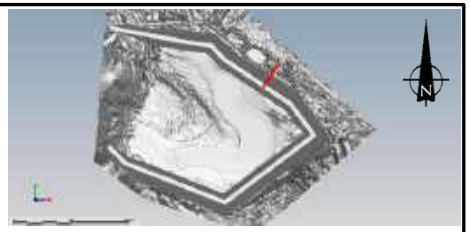
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+395 *(Old Stn. 3+400)*
POST-EARTHQUAKE

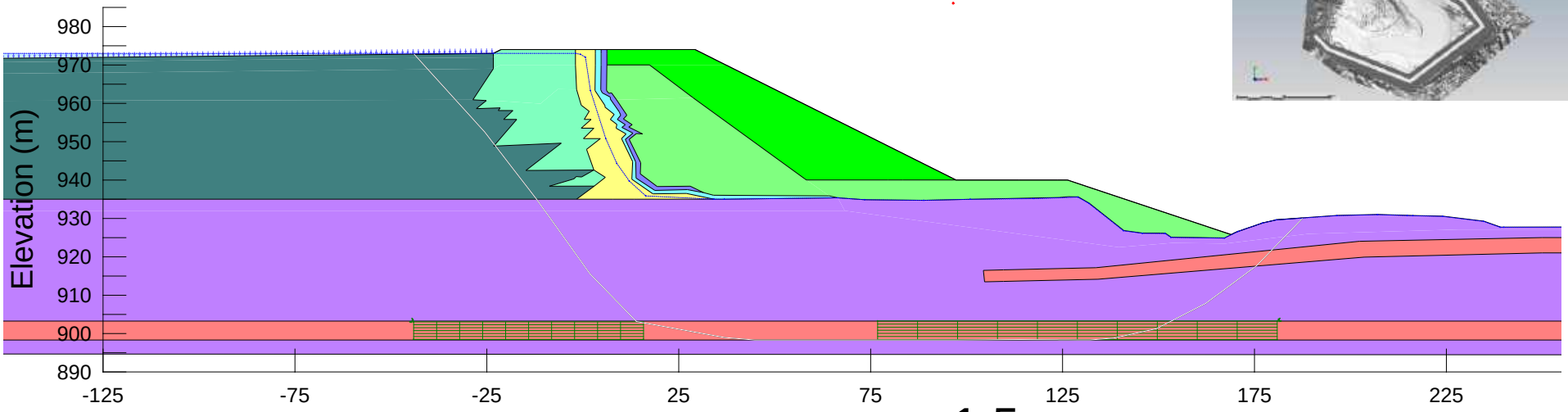
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-55

(INPUT LOCATION OF STABILITY FILES)

0 m beach

1.5

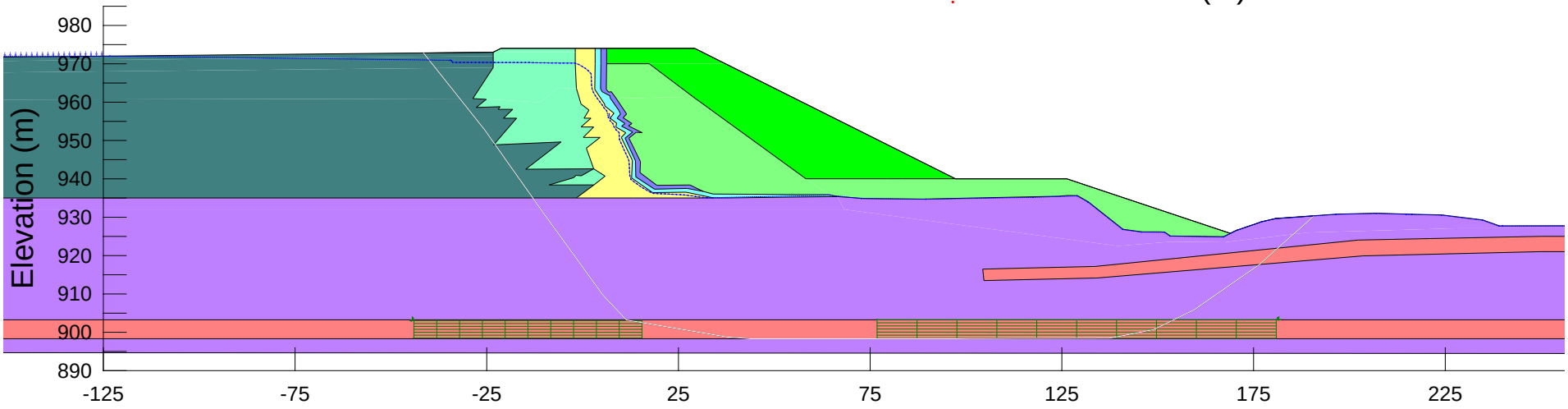




100 m beach

1.5

Distance (m)



Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

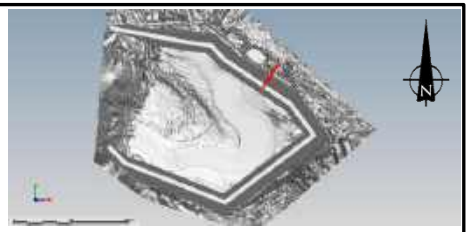
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+530 *(Old Stn. 3+535)*
LONG-TERM

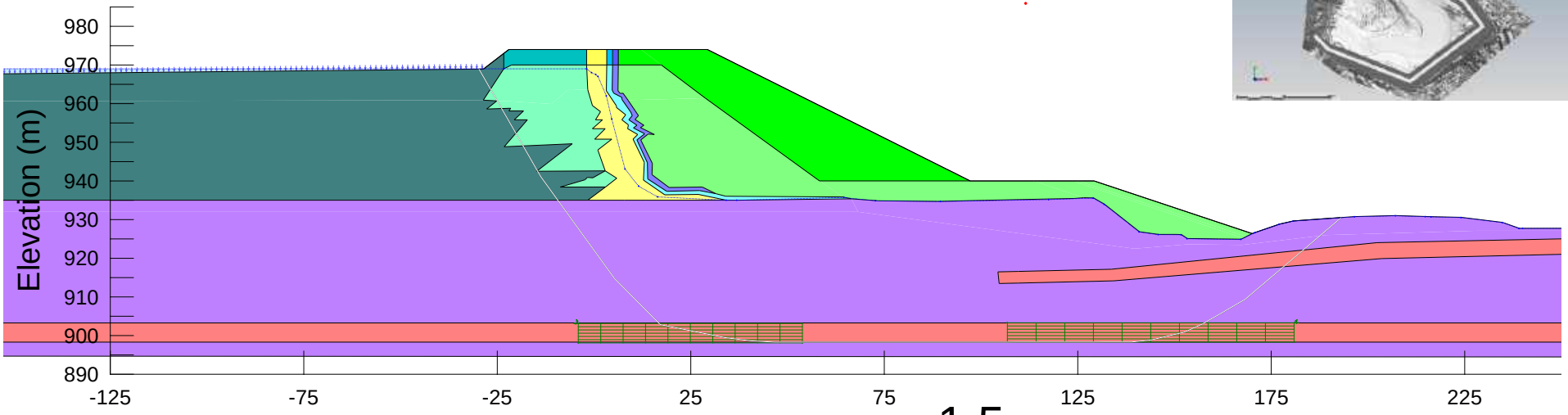
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-56

(INPUT LOCATION OF STABILITY FILES)

0 m beach

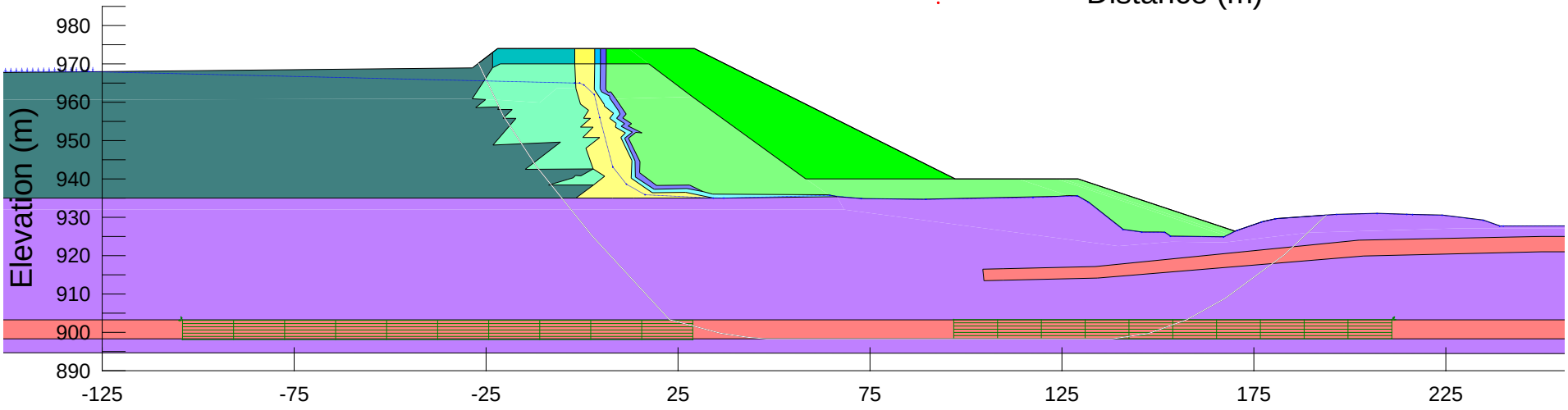
1.5





100 m beach

1.5



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

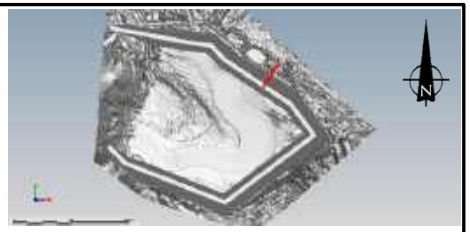
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+530 *(Old Stn. 3+535)*
SHORT-TERM

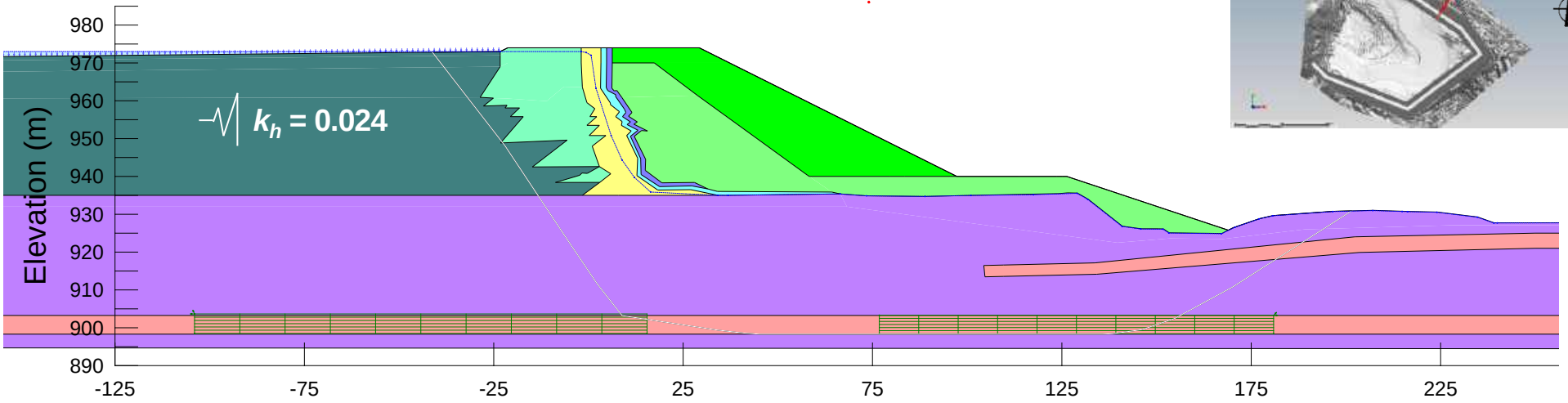
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-57

(INPUT LOCATION OF STABILITY FILES)

0 m beach

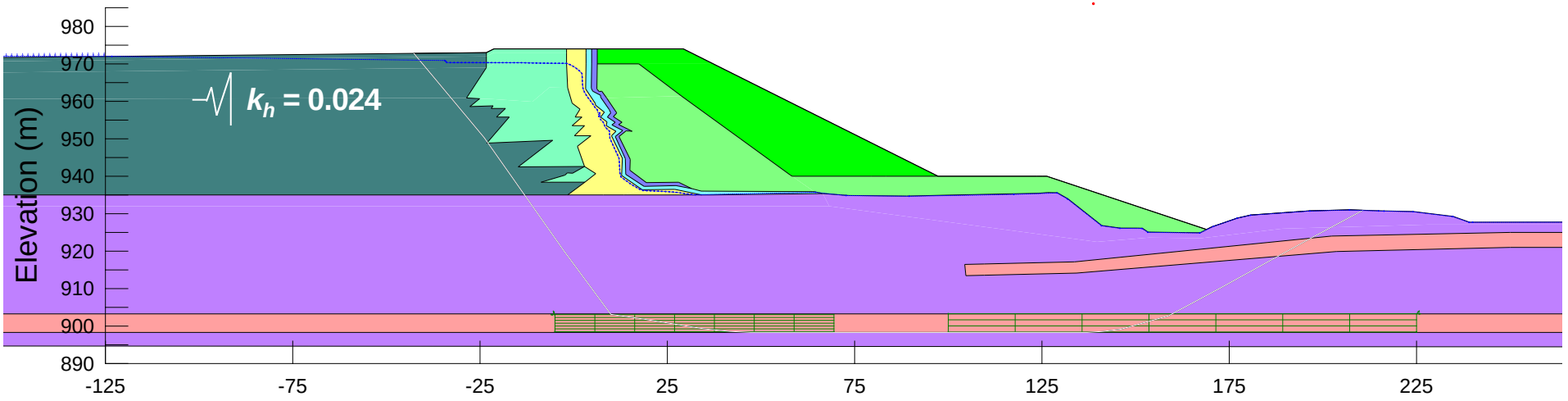
1.2





100 m beach

1.2



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

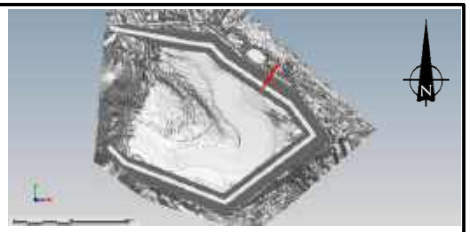
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+530 *(Old Stn. 3+535)*
PSEUDO-STATIC LOADING

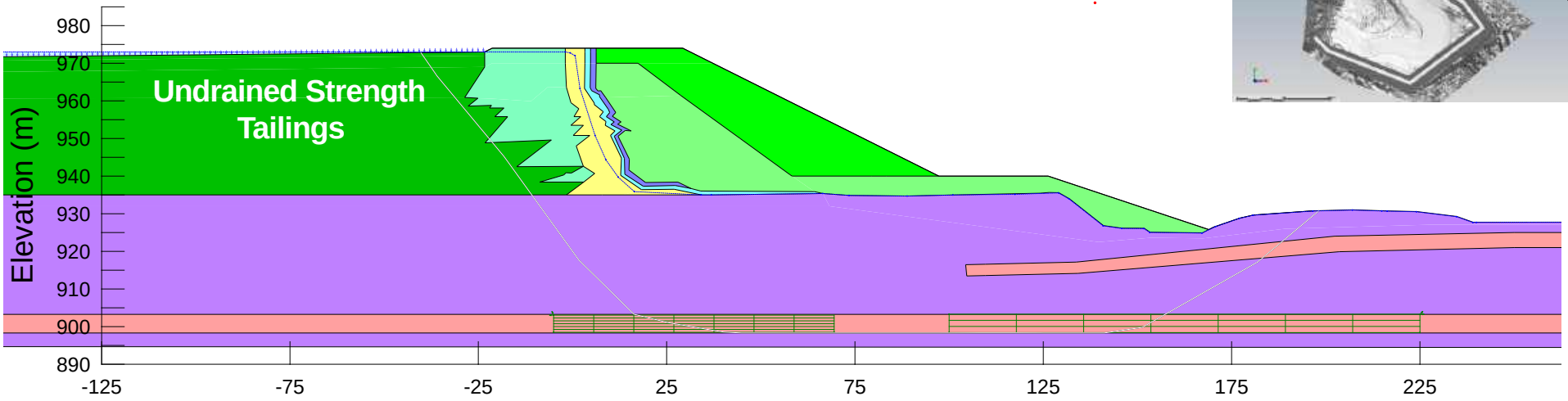
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-58

(INPUT LOCATION OF STABILITY FILES)

0 m beach

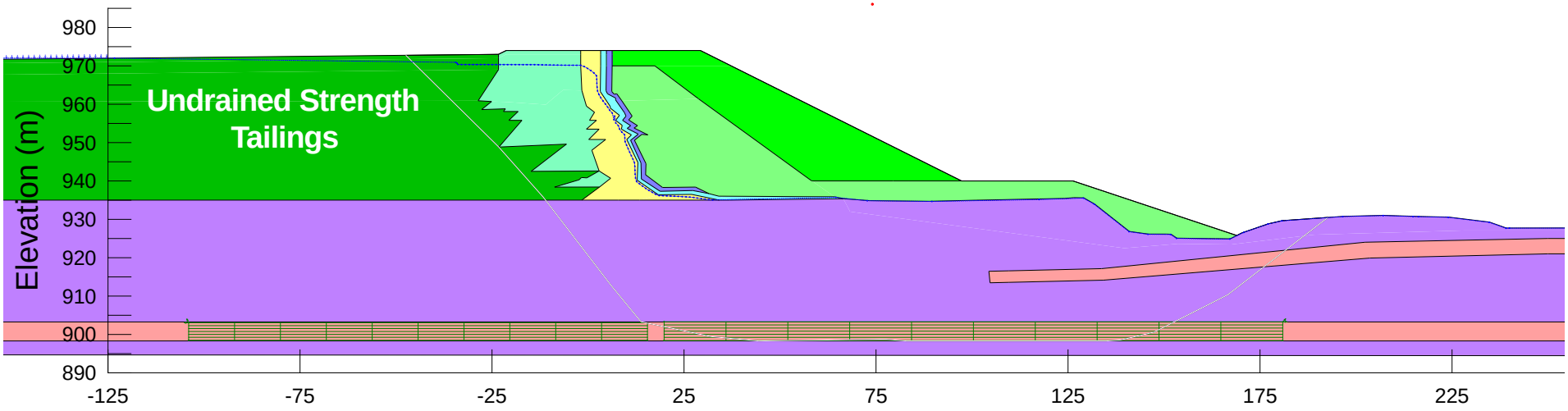
1.3





100 m beach

1.3



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

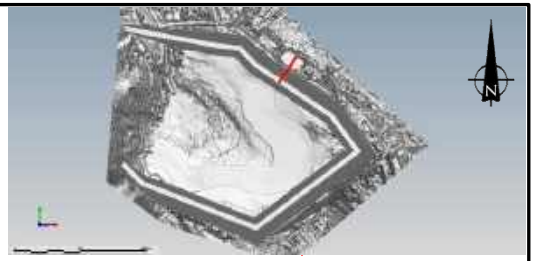
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+530 *(Old Stn. 3+535)*
POST-EARTHQUAKE

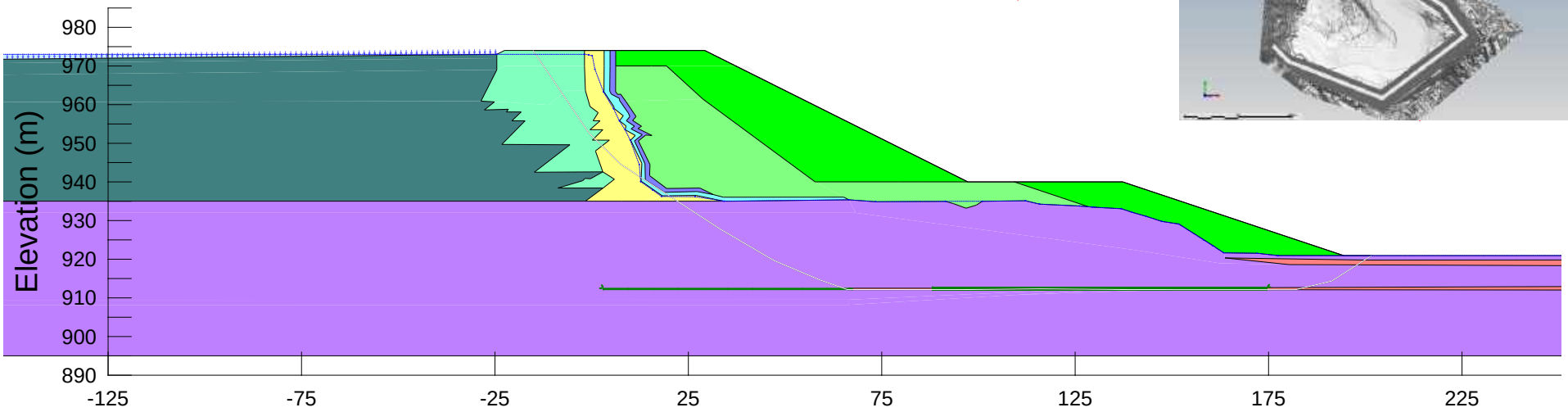
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-59

(INPUT LOCATION OF STABILITY FILES)

0 m beach

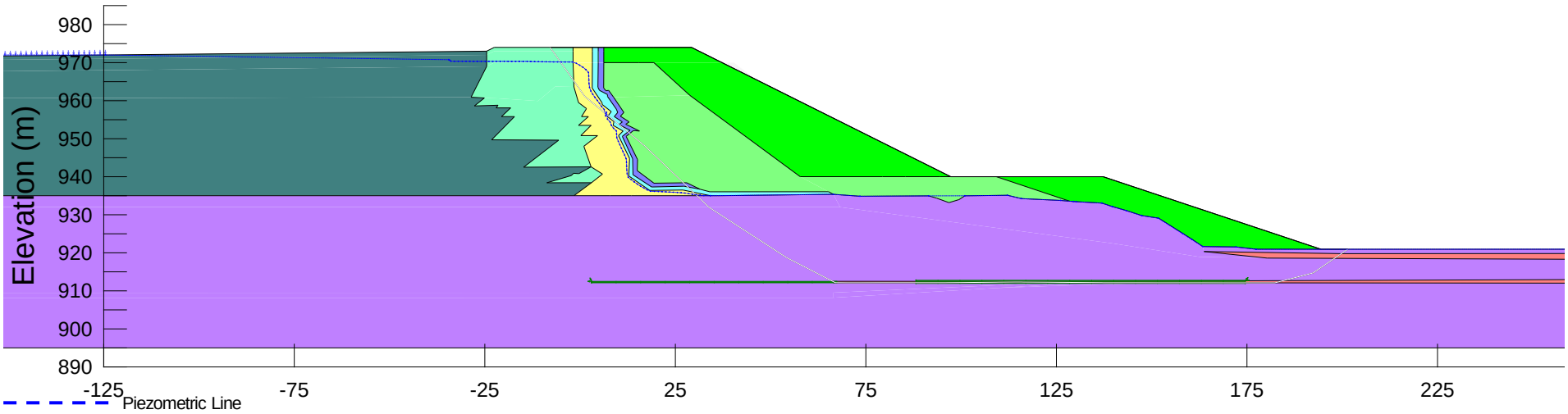
1.6





100 m beach

1.7 Distance (m)



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

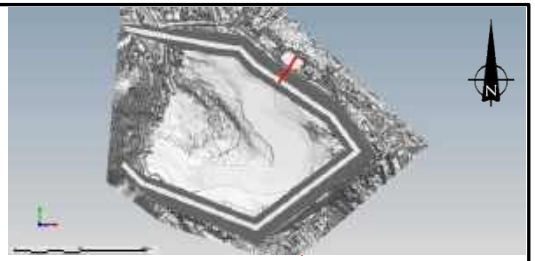
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
LONG-TERM

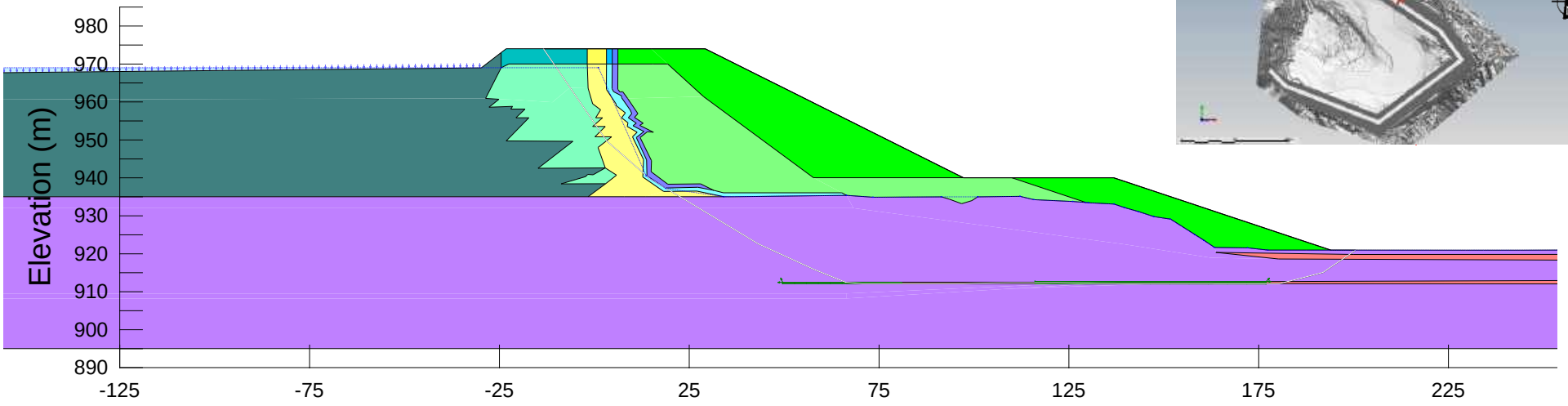
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-60

(INPUT LOCATION OF STABILITY FILES)

0 m beach

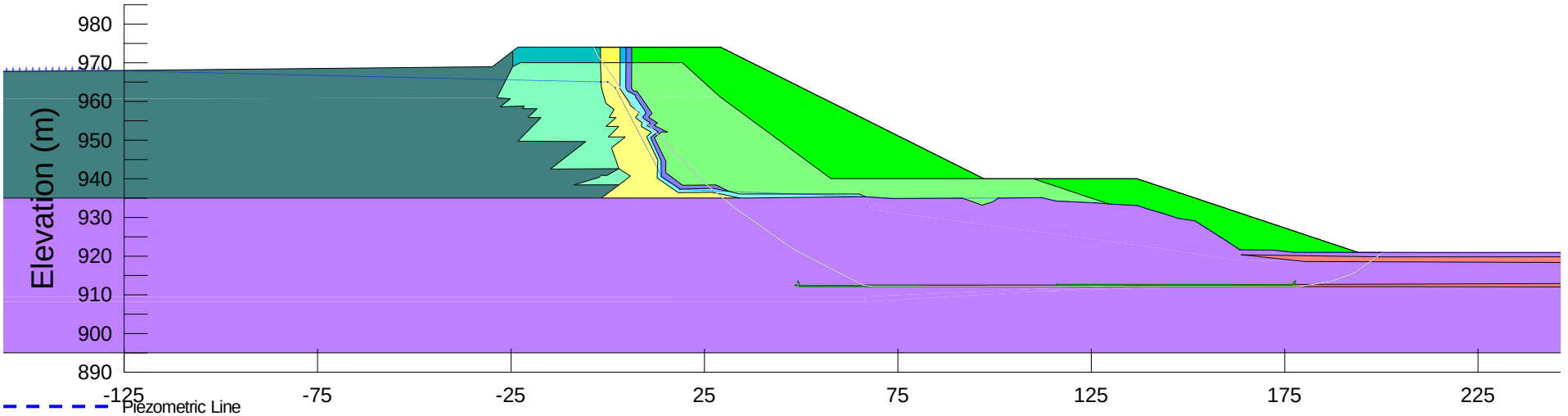
1.6





100 m beach

1.6



REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

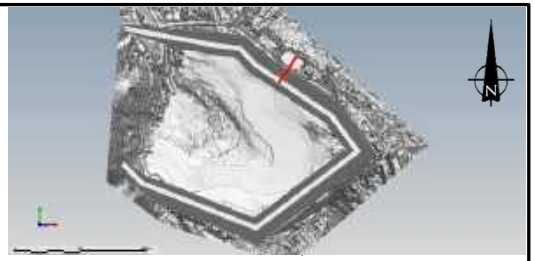
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
SHORT-TERM

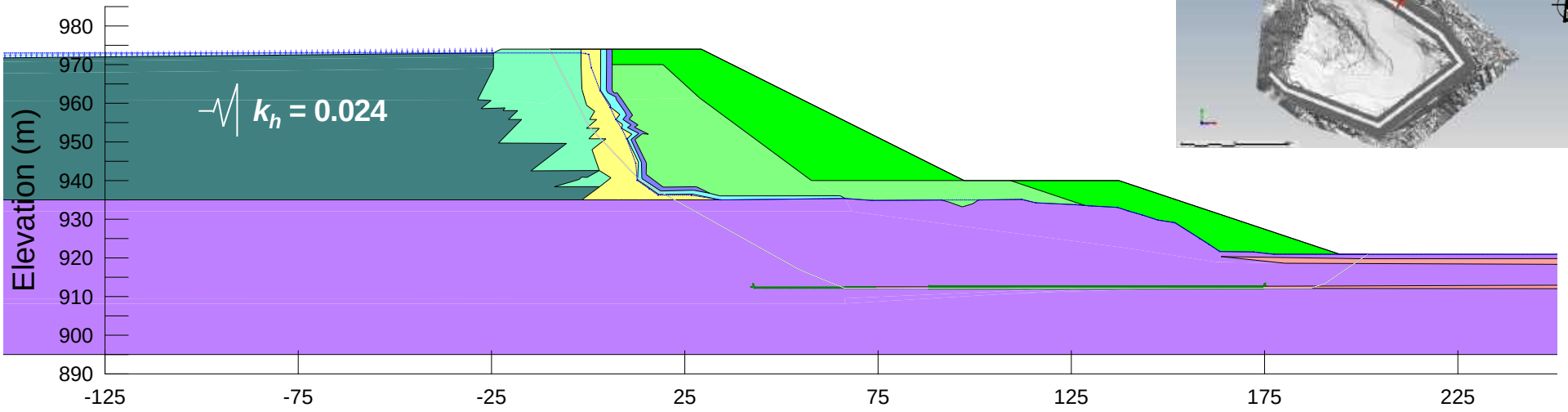
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-61

(INPUT LOCATION OF STABILITY FILES)

0 m beach

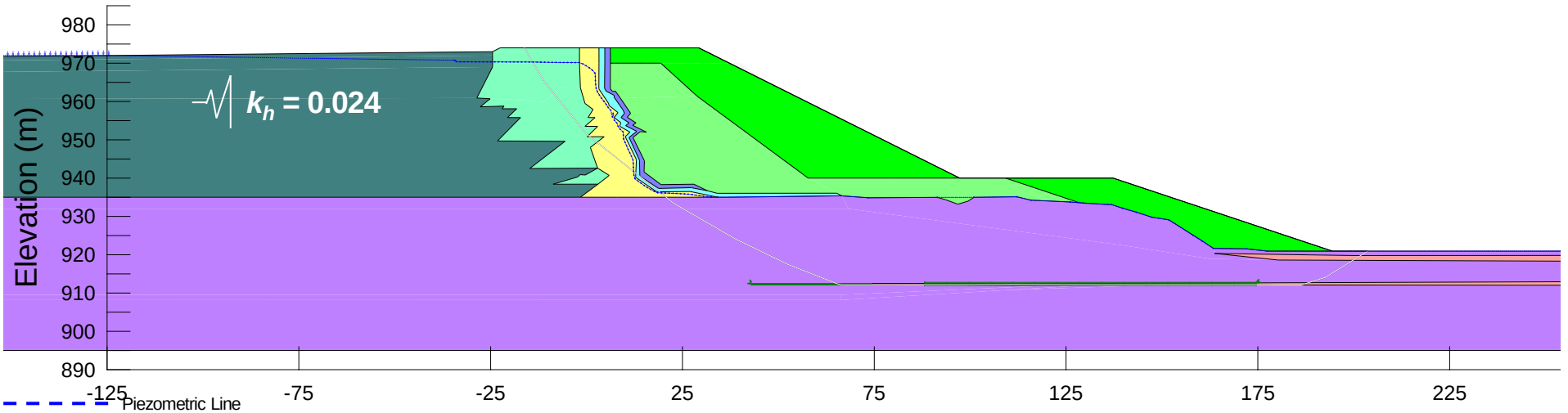
1.4





100 m beach

1.4



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

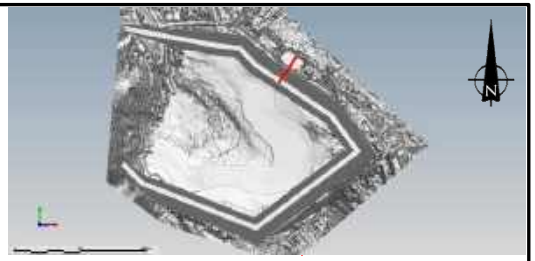
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
PSEUDO-STATIC LOADING

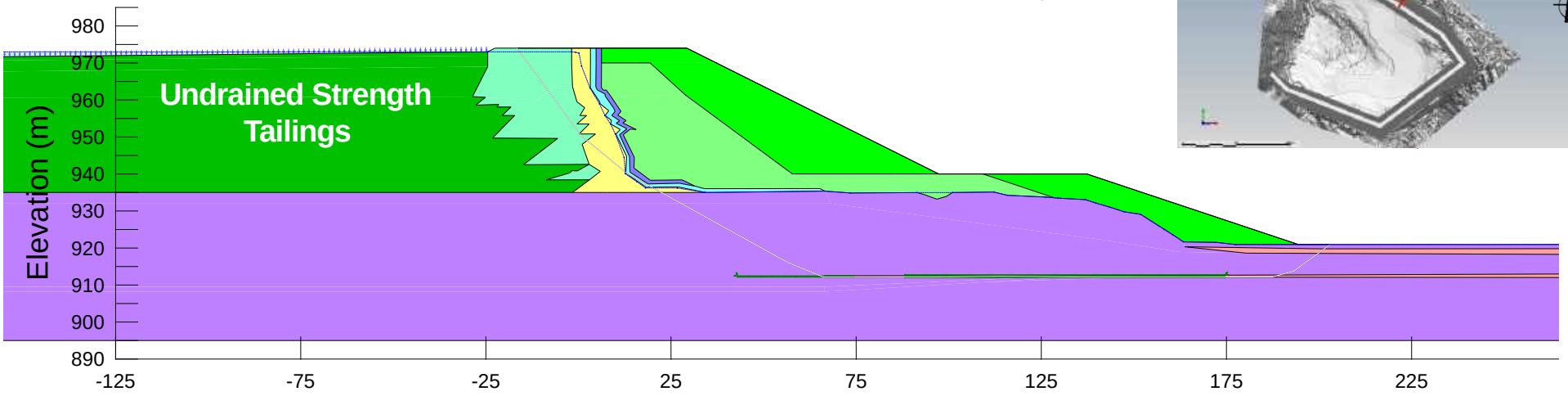
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-62

(INPUT LOCATION OF STABILITY FILES)

0 m beach

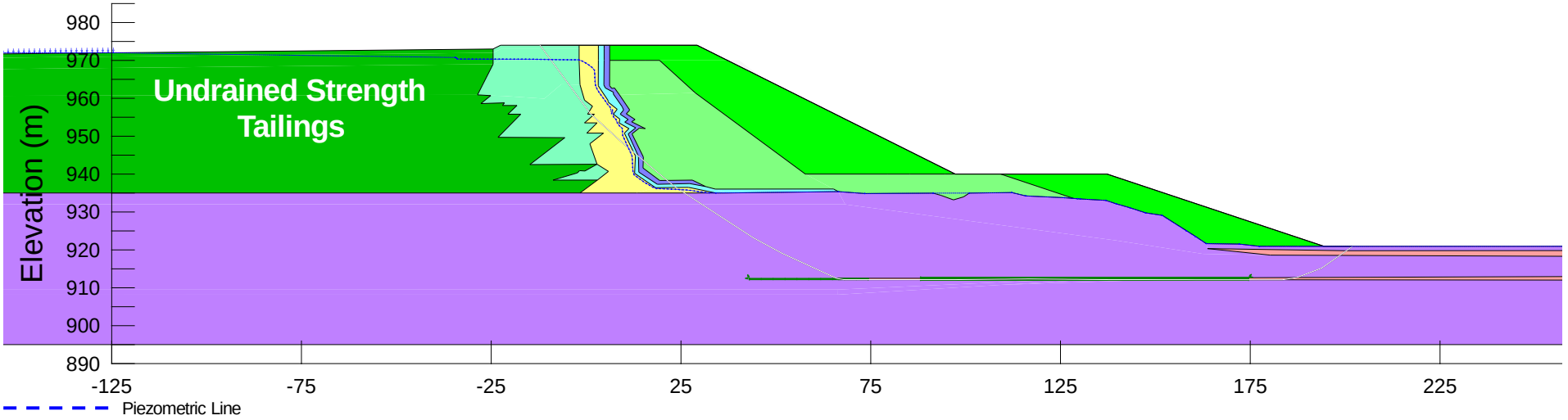
1.5





100 m beach

1.5



REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

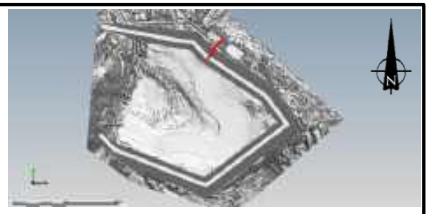
TITLE
STABILITY ANALYSIS (PERIMETER EMBANKMENT)
SECTION 3+765 *(Old Stn. 3+770)*
POST-EARTHQUAKE

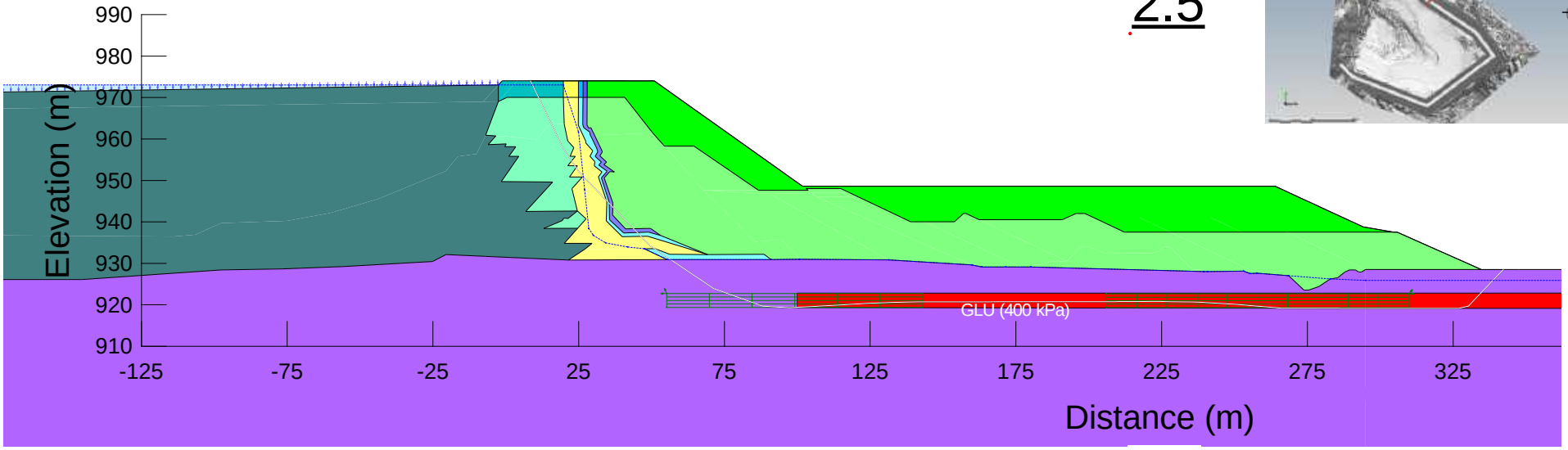
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-63

(INPUT LOCATION OF STABILITY FILES)

0 m beach

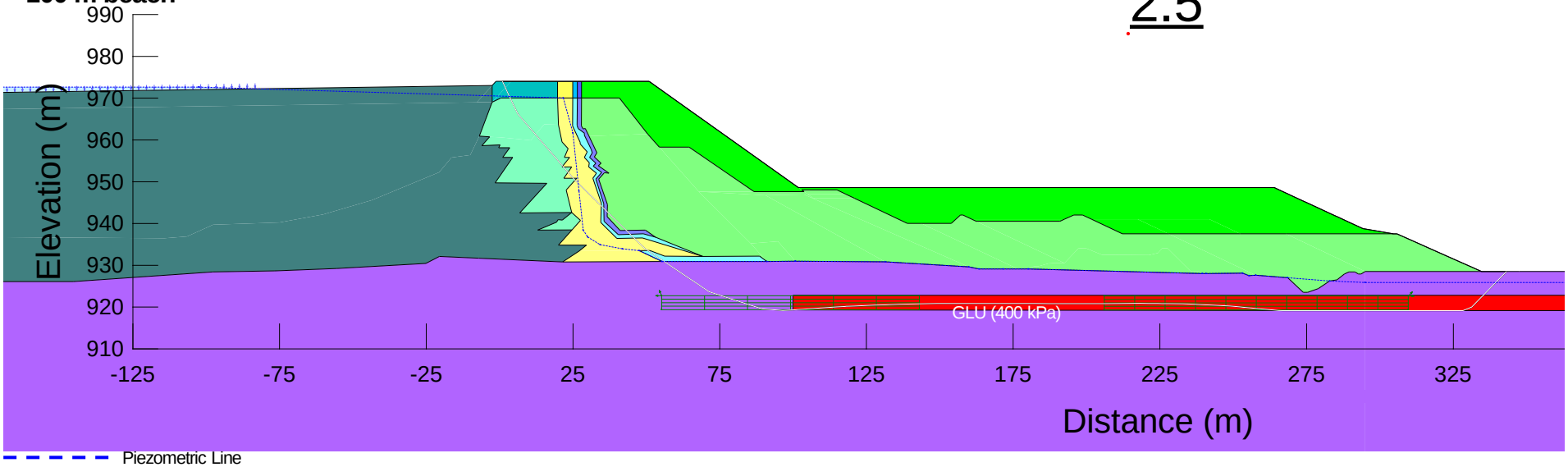
2.5





100 m beach

2.5



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

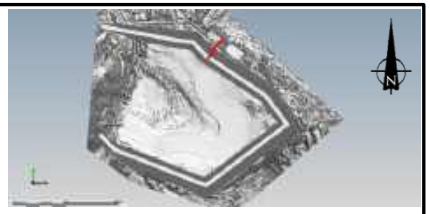
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+000 (Old Stn. 20+005)
LONG-TERM

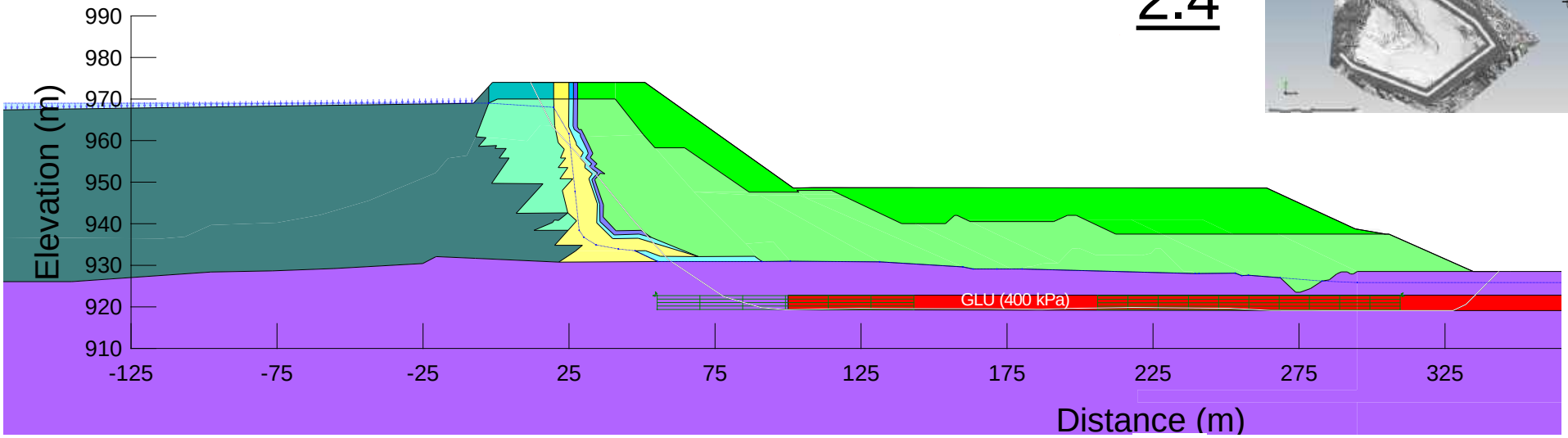
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-64

(INPUT LOCATION OF STABILITY FILES)

0 m beach

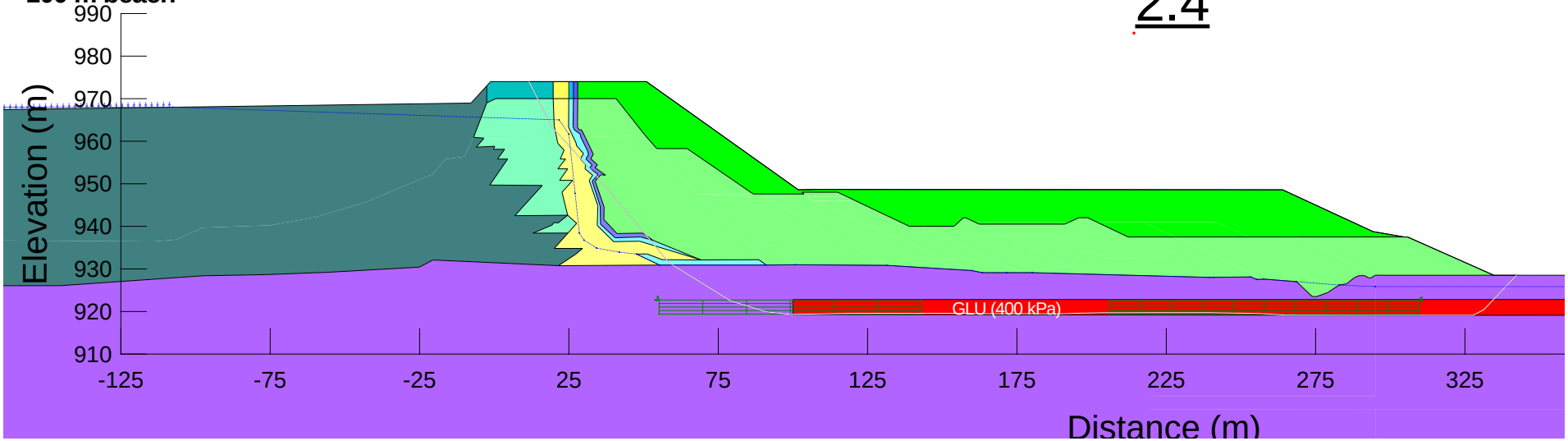
2.4





100 m beach

2.4



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

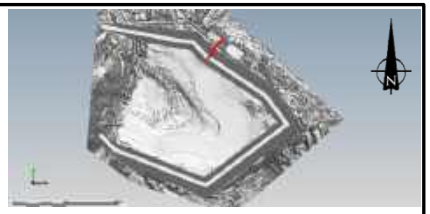
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+000 (Old Stn. 20+005)
SHORT-TERM

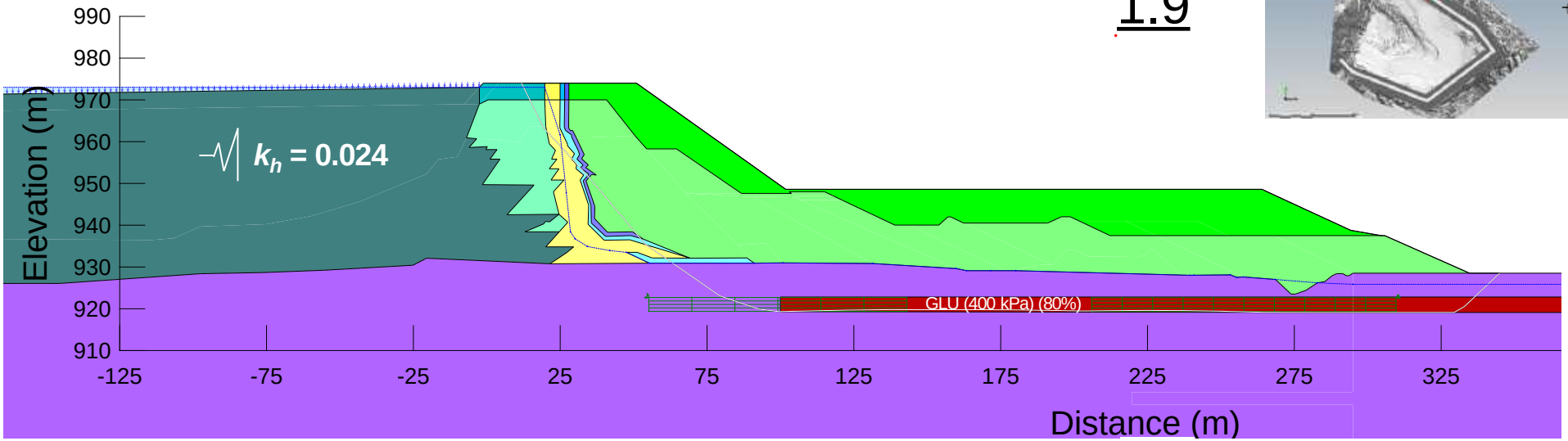
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-65

(INPUT LOCATION OF STABILITY FILES)

0 m beach

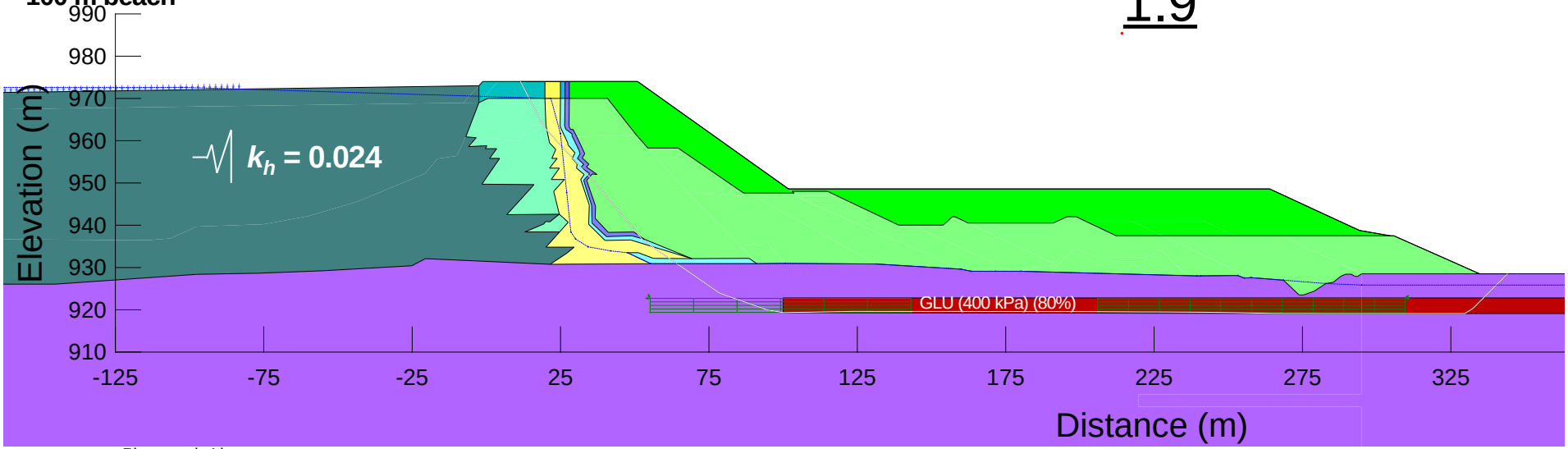
1.9





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

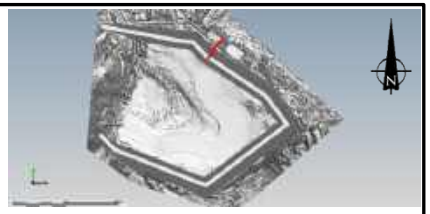
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+000 (Old Stn. 20+005)
PSEUDO-STATIC LOADING

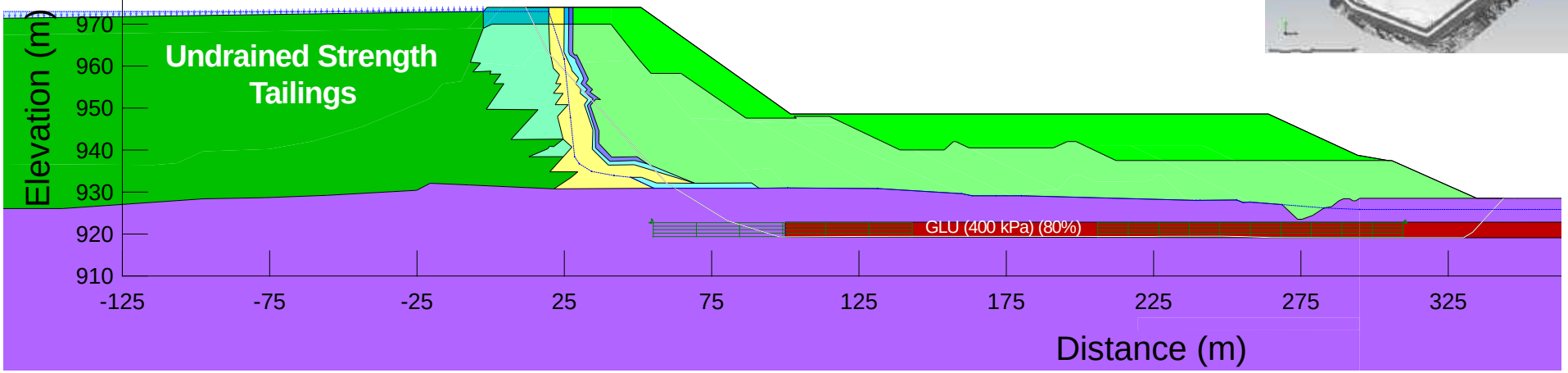
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-66

(INPUT LOCATION OF STABILITY FILES)

0 m beach

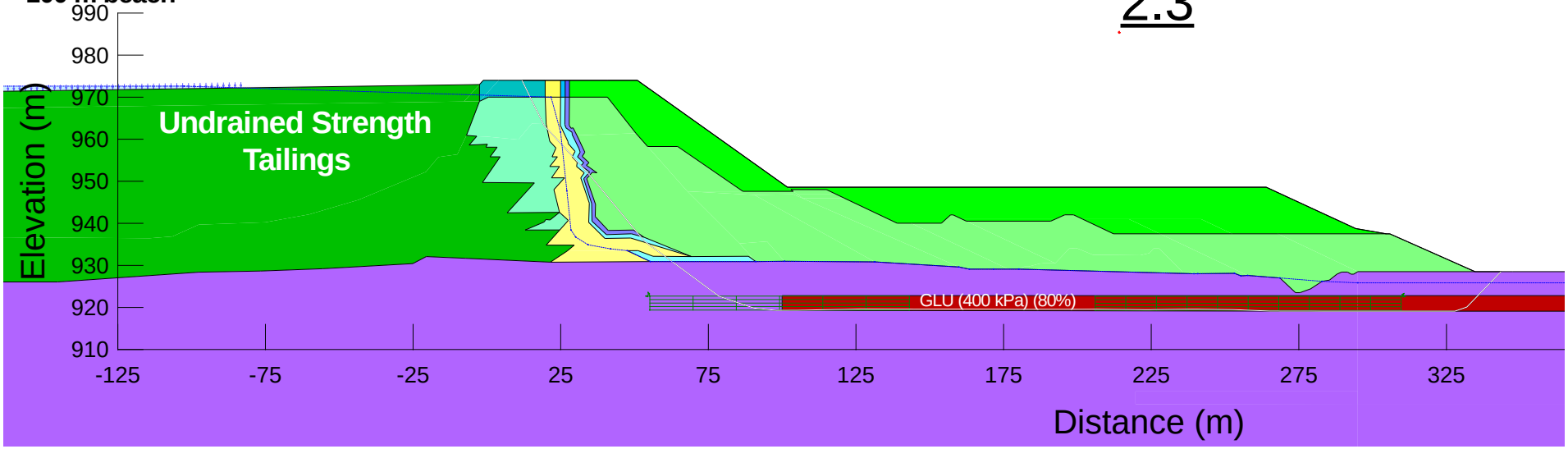
2.3





100 m beach

2.3



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

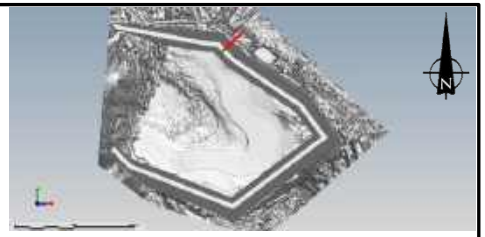
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+000 (Old Stn. 20+005)
POST-EARTHQUAKE

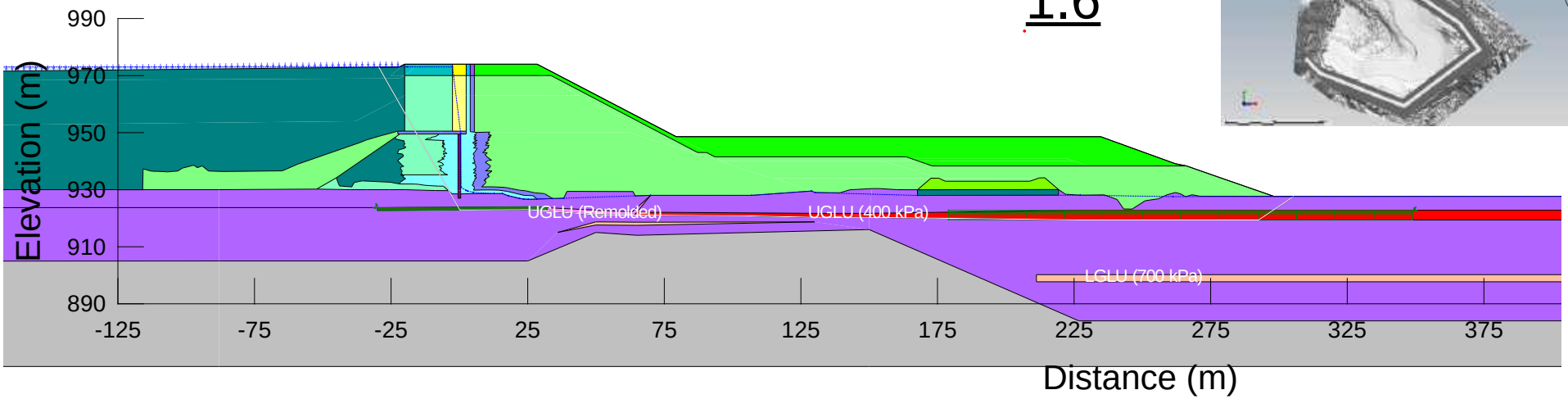
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-67

(INPUT LOCATION OF STABILITY FILES)

0 m beach

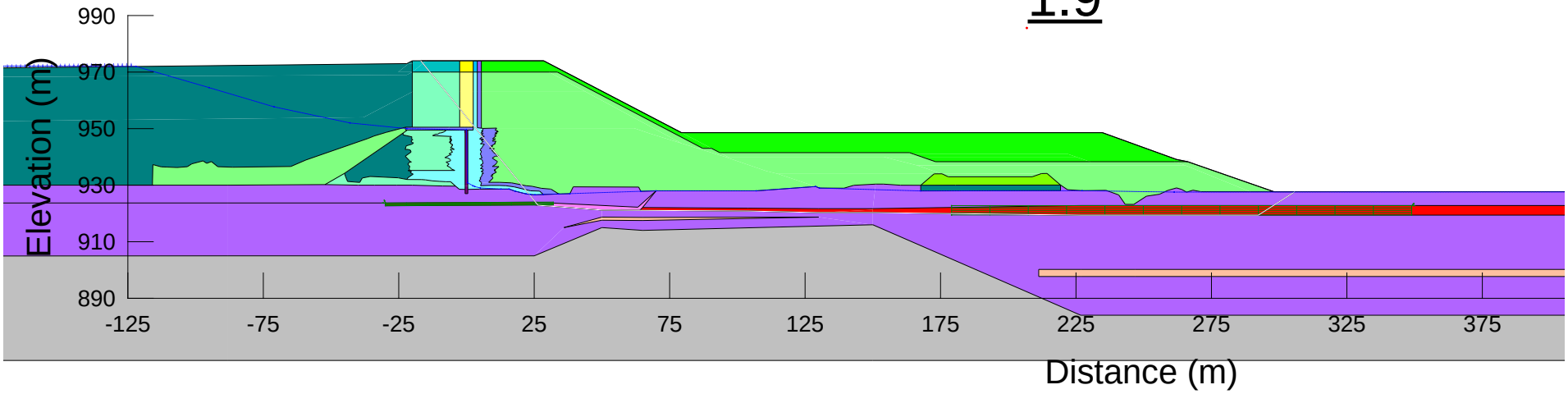
1.6





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

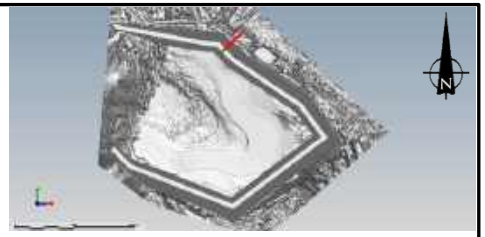
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+175 (Old Stn. 20+180)
LONG-TERM

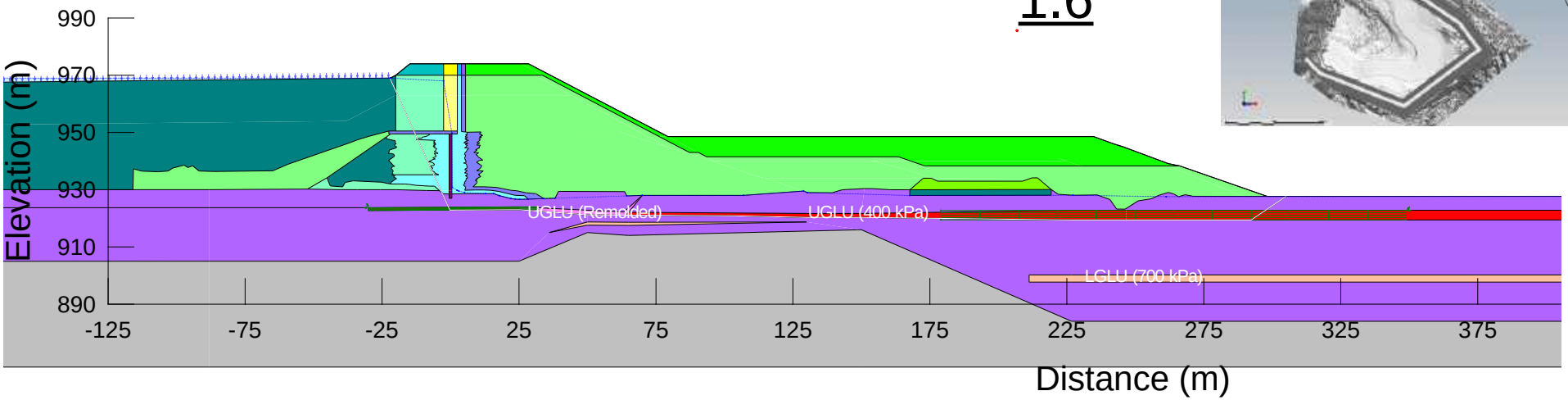
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-68

(INPUT LOCATION OF STABILITY FILES)

0 m beach

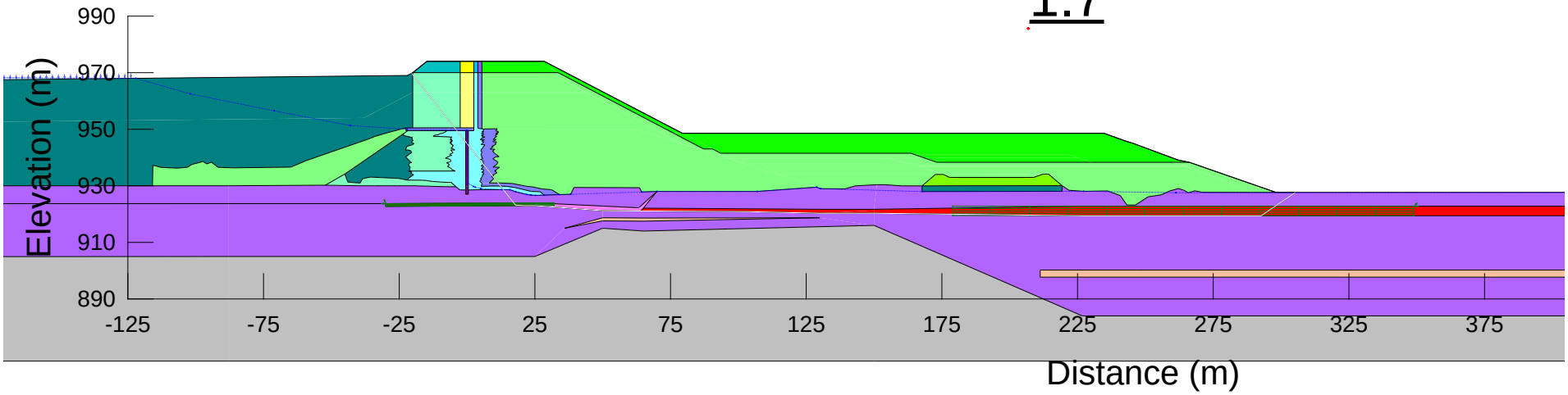
1.6





100 m beach

1.7



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

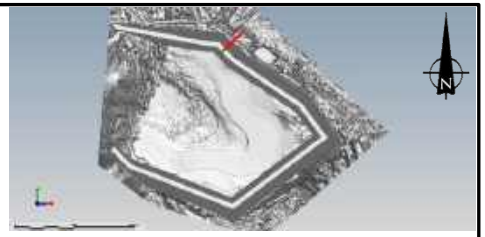
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+175 (Old Stn. 20+180)
SHORT-TERM

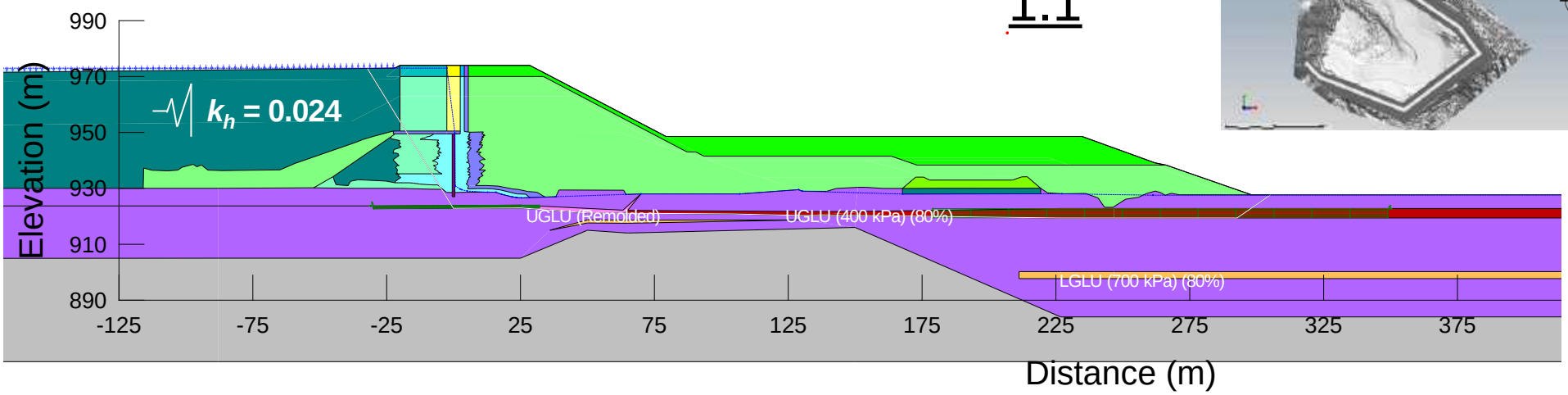
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-69

(INPUT LOCATION OF STABILITY FILES)

0 m beach

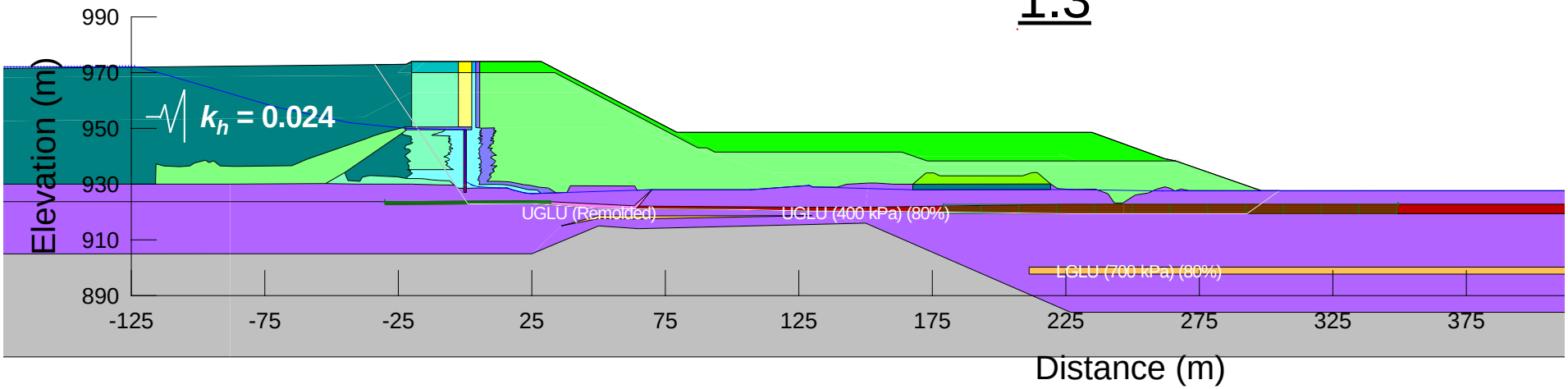
1.1





100 m beach

1.3



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

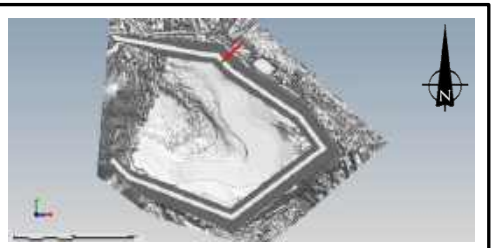
YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

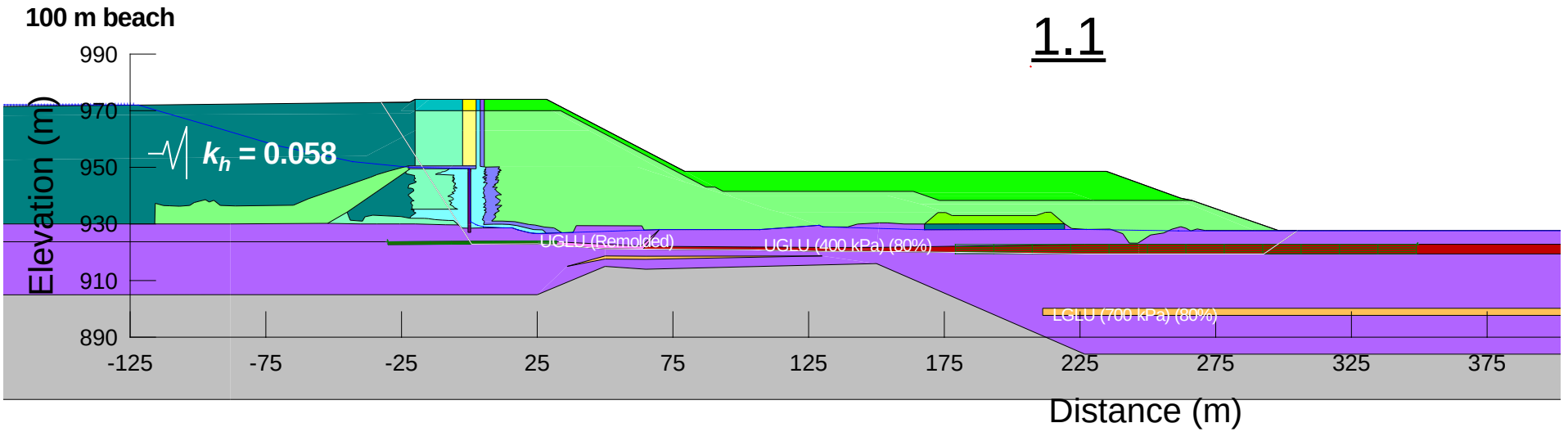
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+175 (Old Stn. 20+180)
PSEUDO-STATIC LOADING

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-70

(INPUT LOCATION OF STABILITY FILES)





Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain at the elevation of 950 m functioning.
3. 100 m sub-aerial beach; pond el. 972 m.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 10,000-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

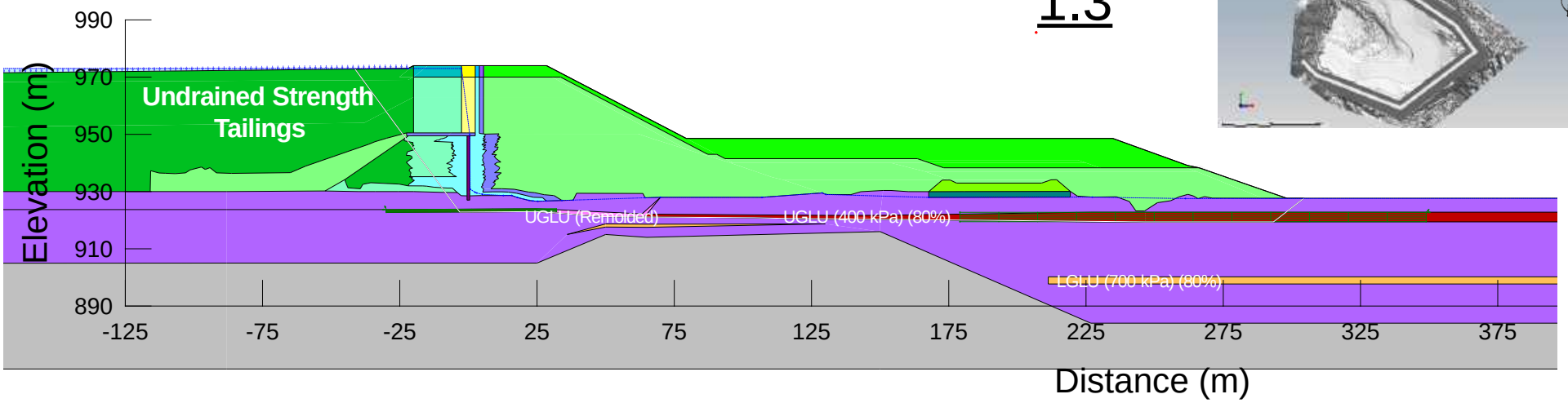
PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

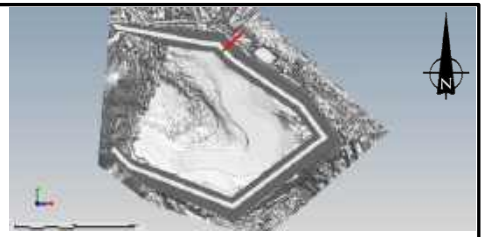
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+175 (Old Stn. 20+180)
PSEUDO-STATIC LOADING

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-71

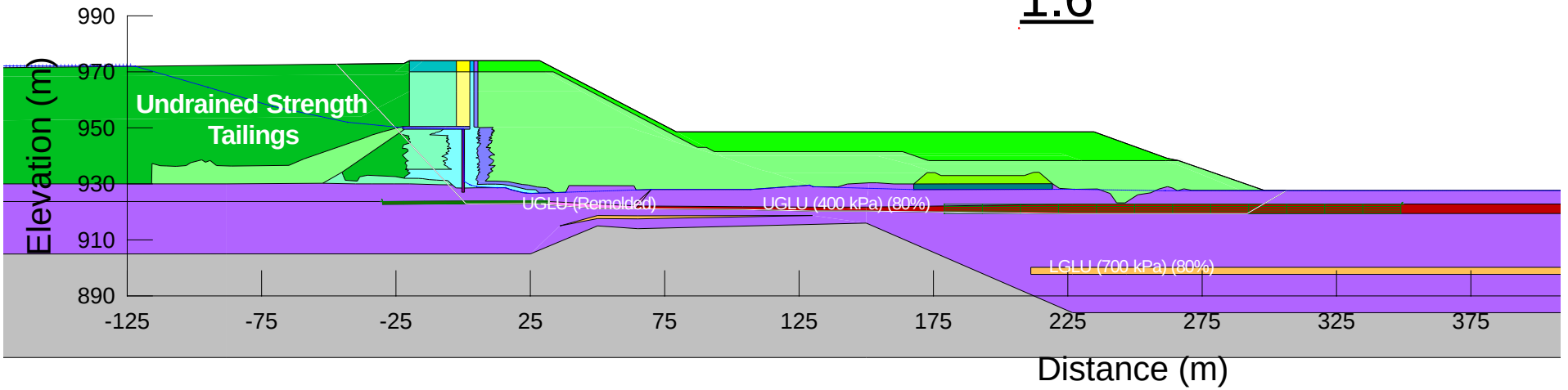
(INPUT LOCATION OF STABILITY FILES)

0 m beach





100 m beach



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

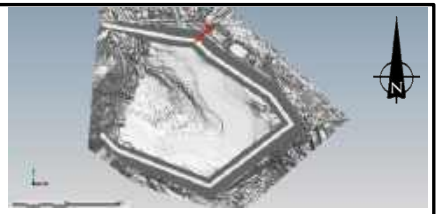
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+175 (Old Stn. 20+180)
POST-EARTHQUAKE

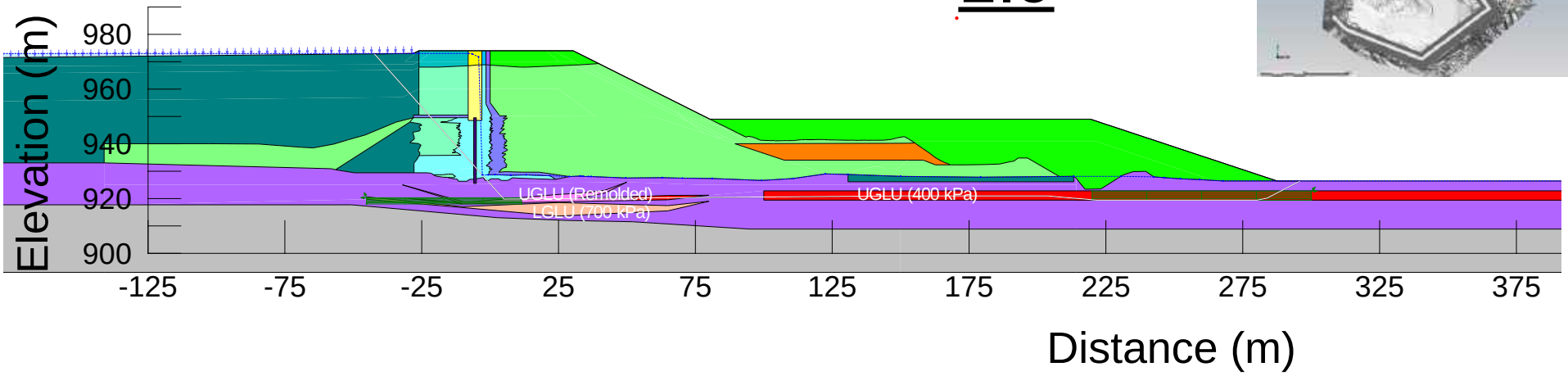
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-72

(INPUT LOCATION OF STABILITY FILES)

0 m beach

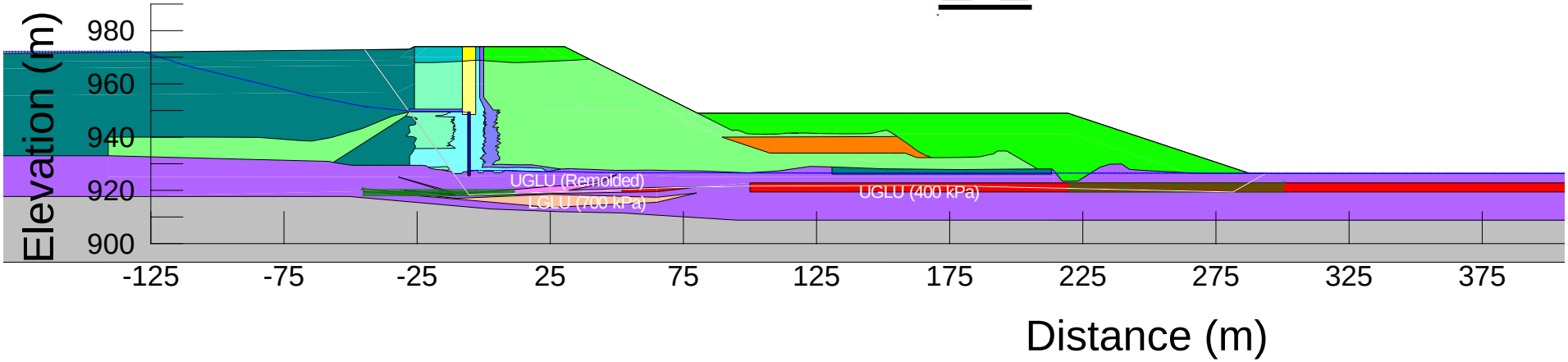
1.9





100 m beach

2.1



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

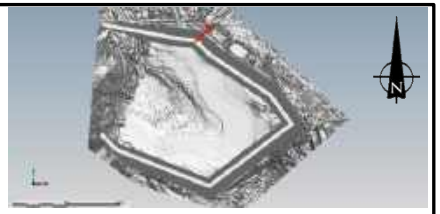
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
LONG-TERM

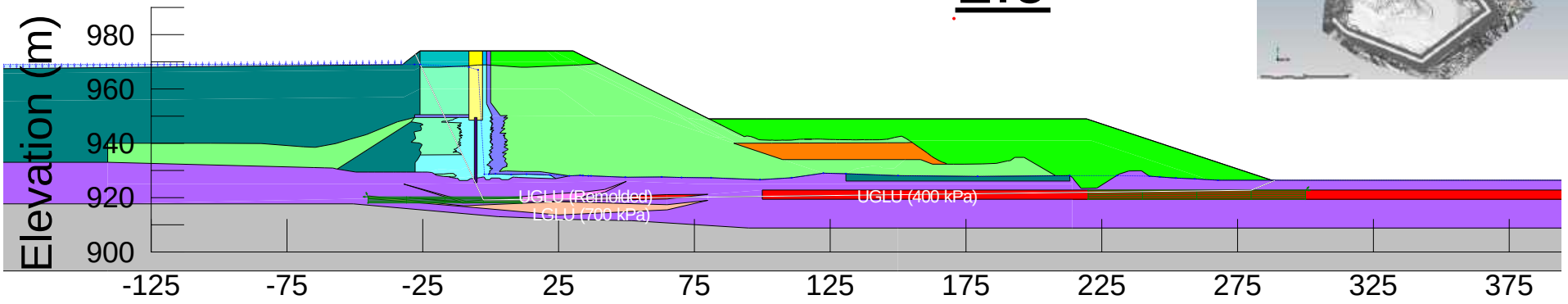
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-73

(INPUT LOCATION OF STABILITY FILES)

0 m beach

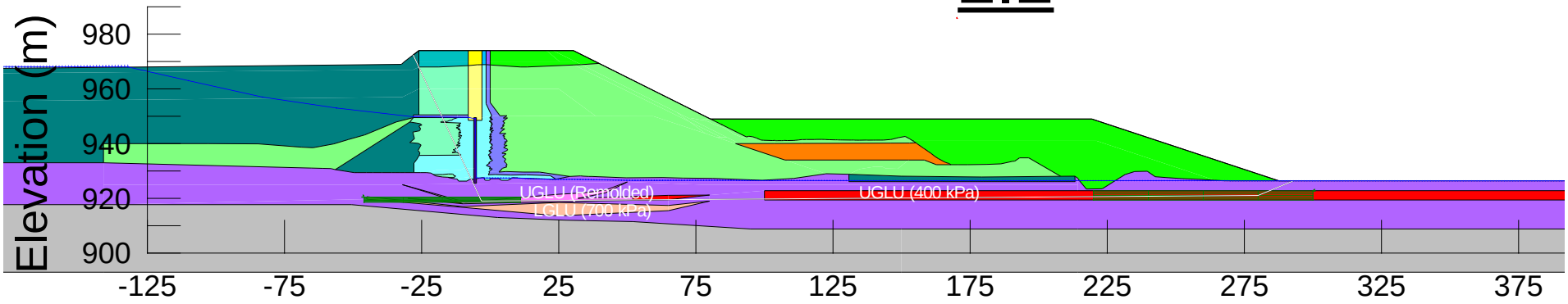
1.9





100 m beach

2.2



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

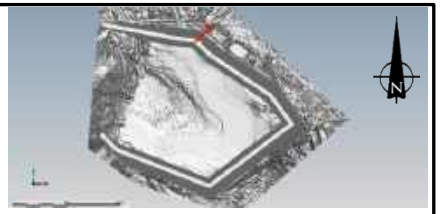
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
SHORT-TERM

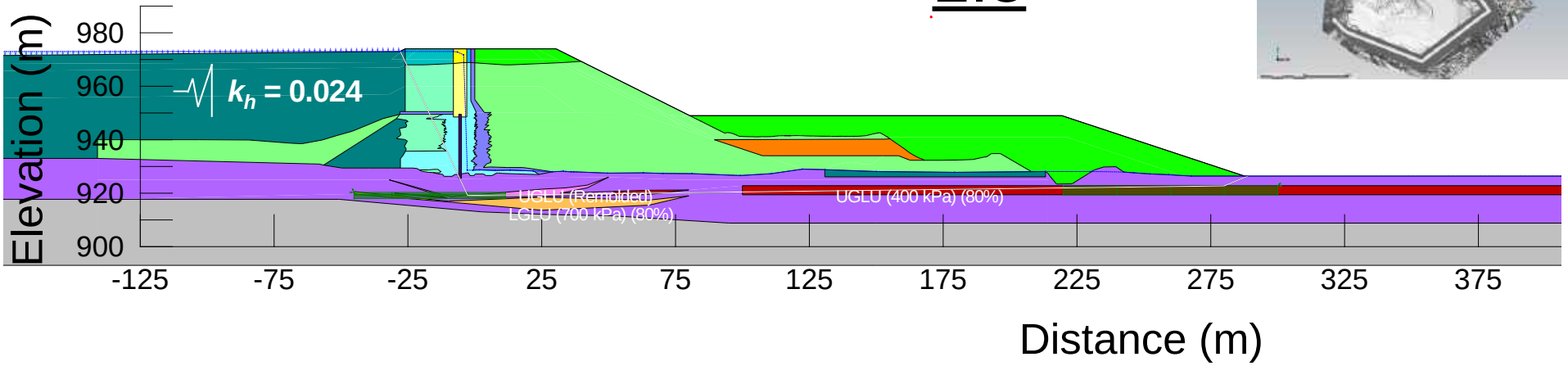
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-74

(INPUT LOCATION OF STABILITY FILES)

0 m beach

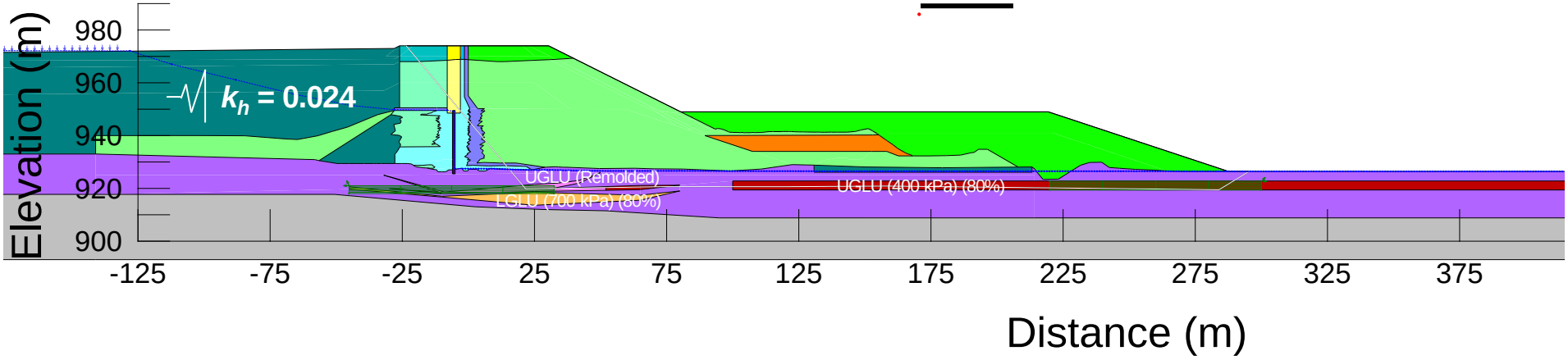
1.5





100 m beach

1.8



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

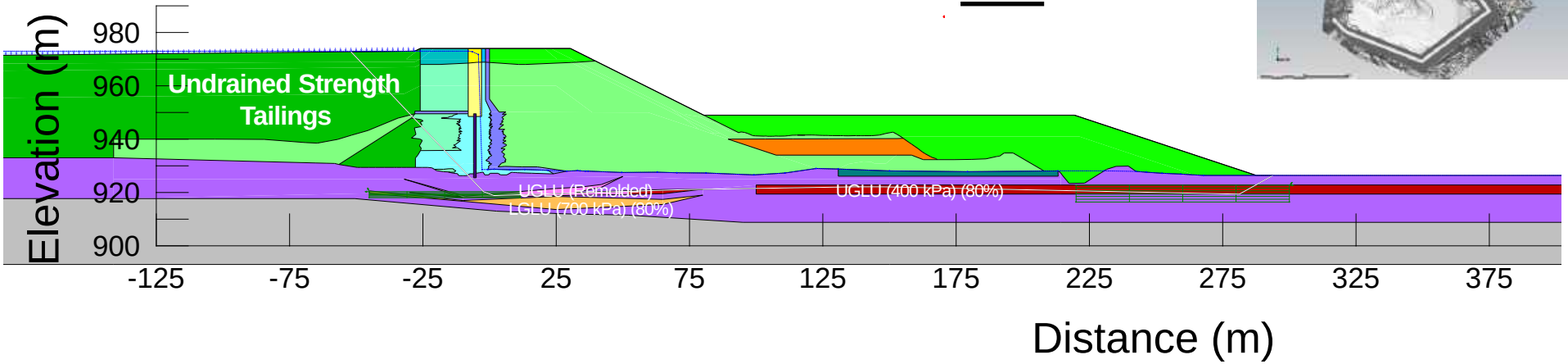
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
PSEUDO-STATIC LOADING

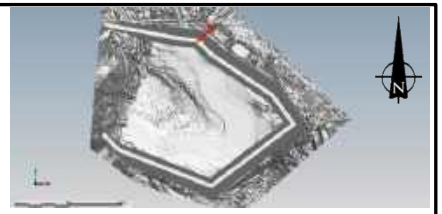
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-75

(INPUT LOCATION OF STABILITY FILES)

0 m beach

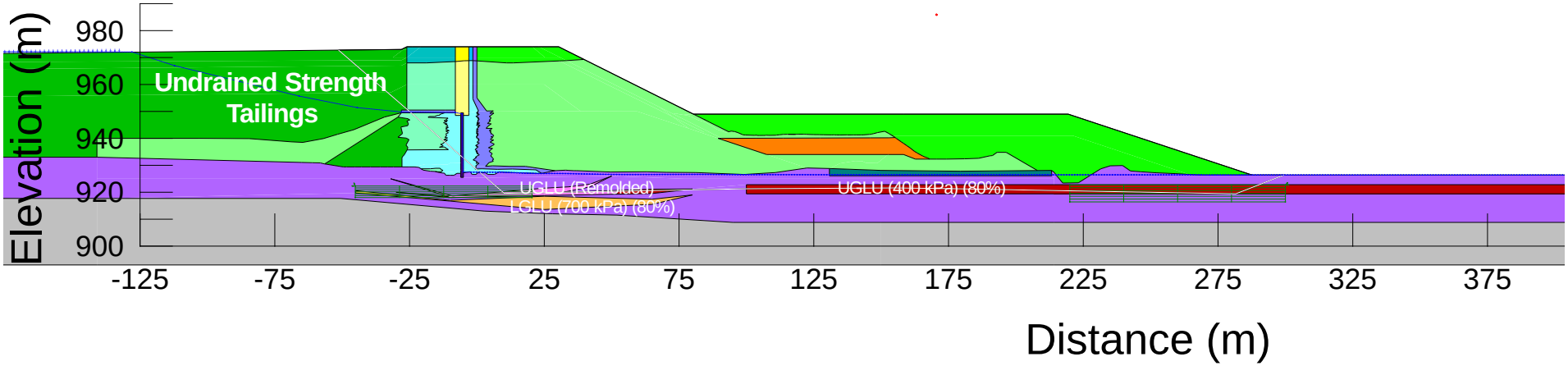
1.6





100 m beach

2.0



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

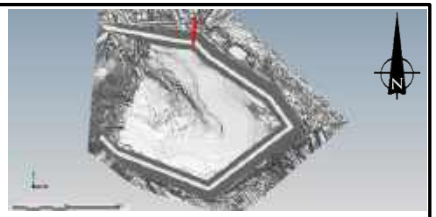
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+255 (Old Stn. 20+265)
POST-EARTHQUAKE

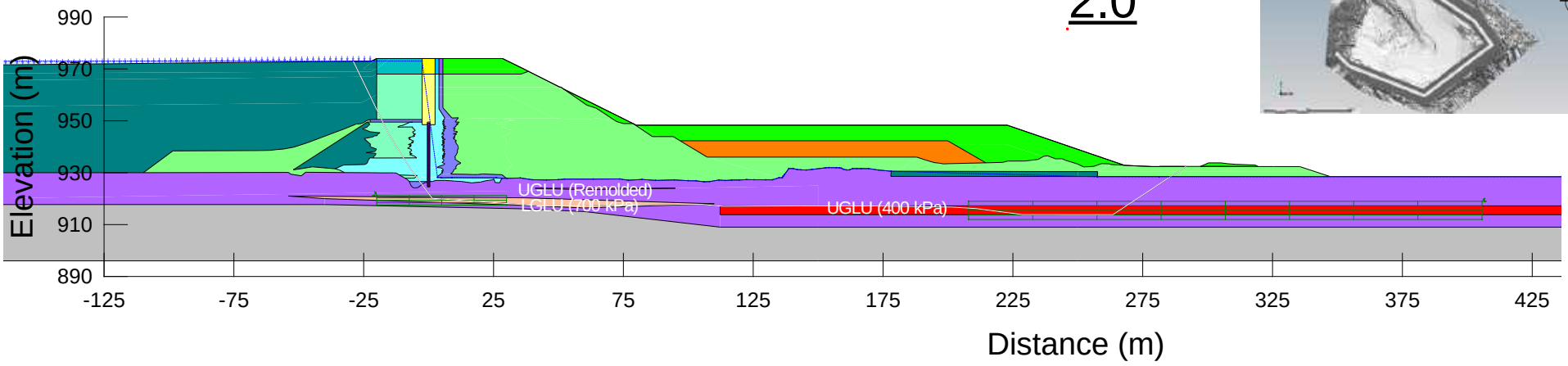
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-76

(INPUT LOCATION OF STABILITY FILES)

0 m beach

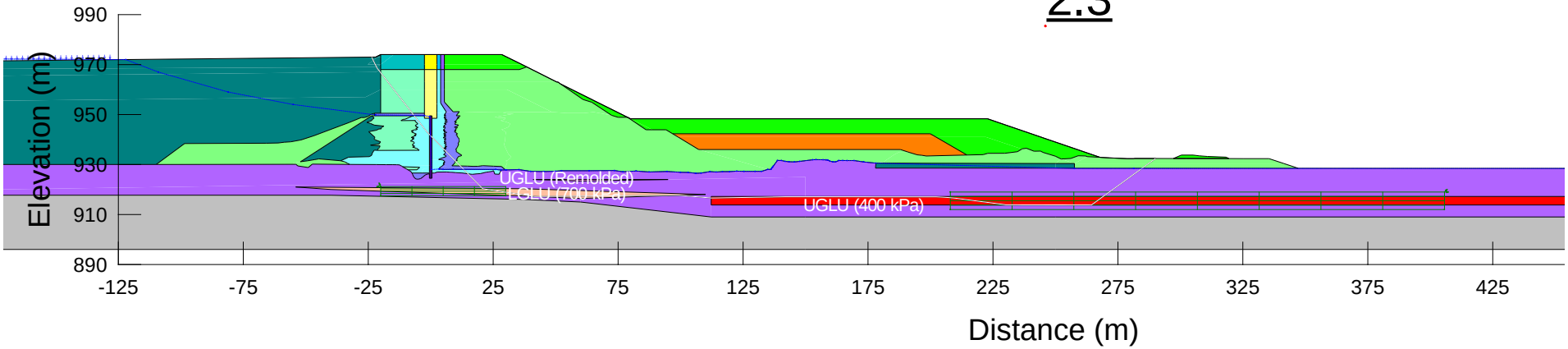
2.0





100 m beach

2.3



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

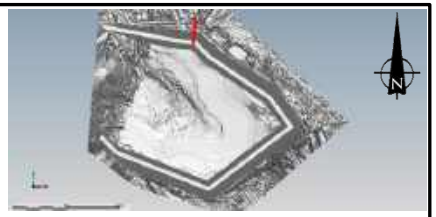
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+285 (Old Stn. 20+295)
LONG-TERM

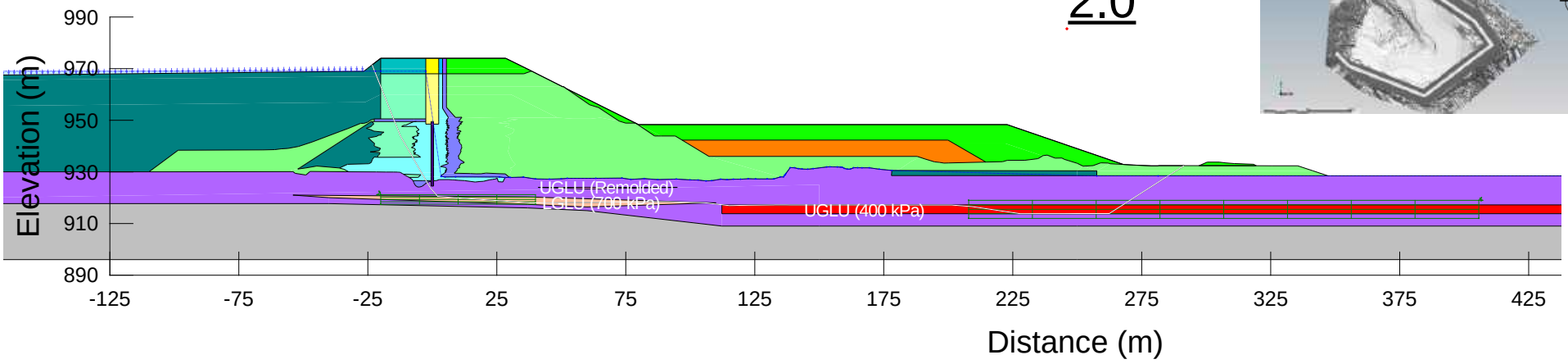
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-77

(INPUT LOCATION OF STABILITY FILES)

0 m beach

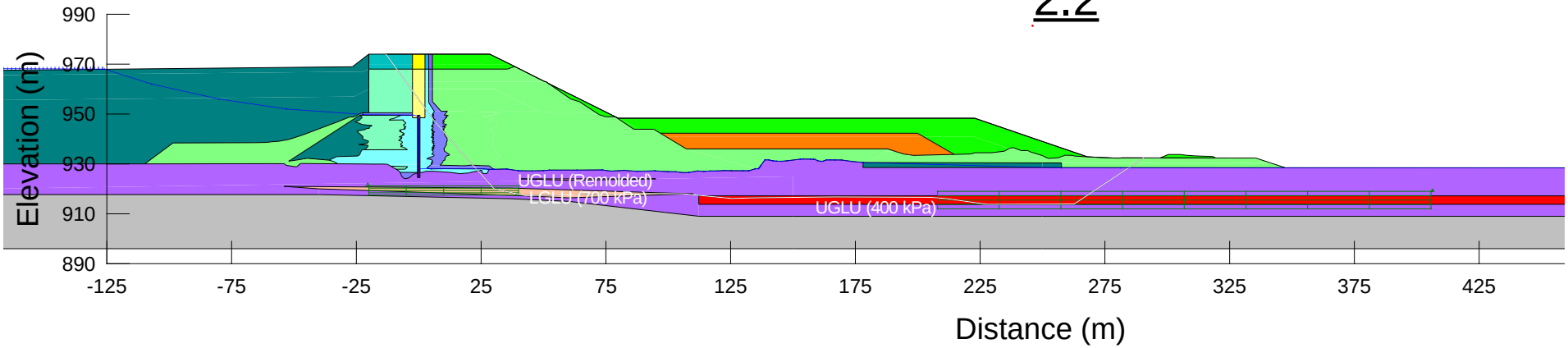
2.0





100 m beach

2.2



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

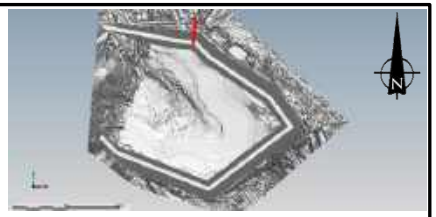
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+285 (Old Stn. 20+295)
SHORT-TERM

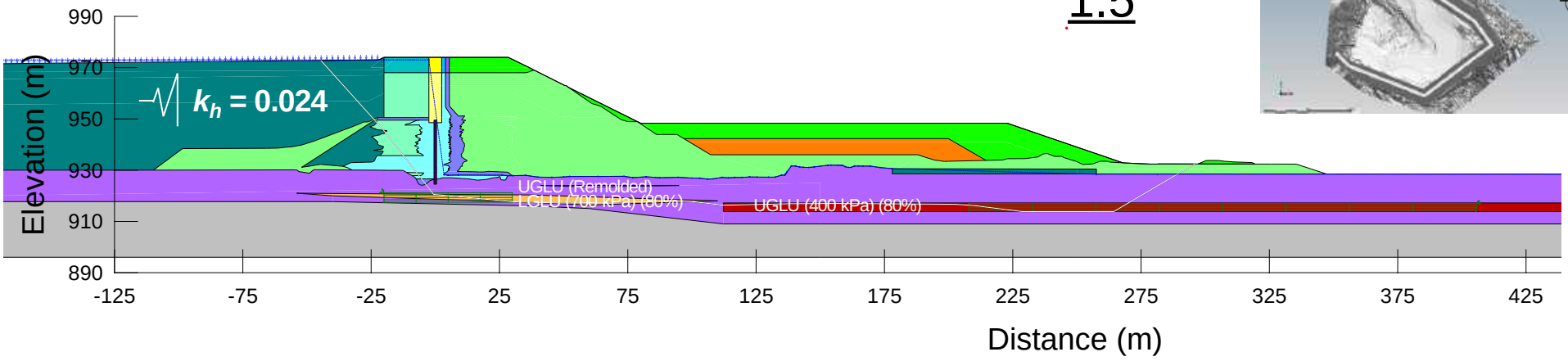
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-78

(INPUT LOCATION OF STABILITY FILES)

0 m beach

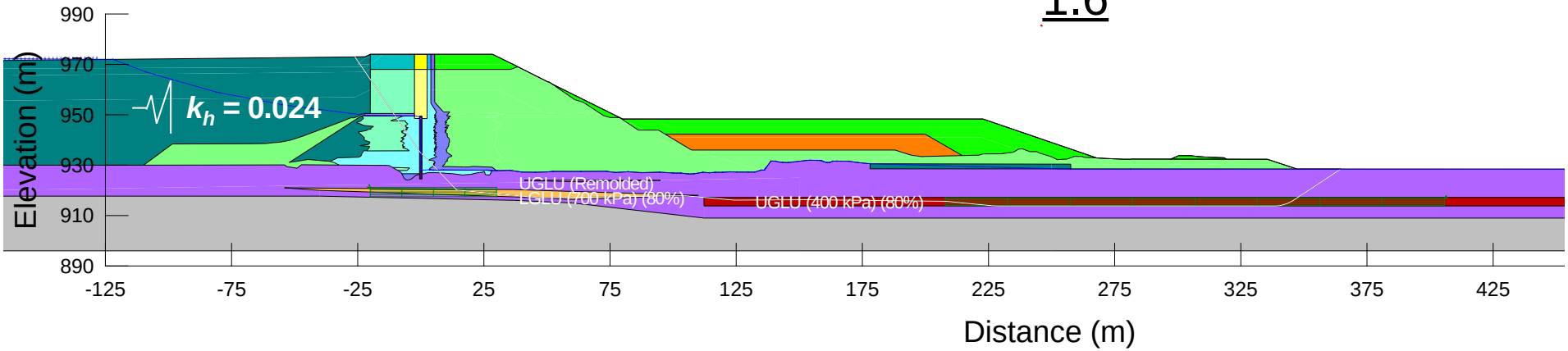
1.5





100 m beach

1.6



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

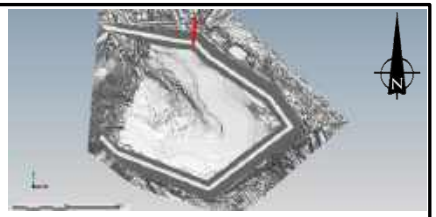
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+285 (Old Stn. 20+295)
PSEUDO-STATIC LOADING

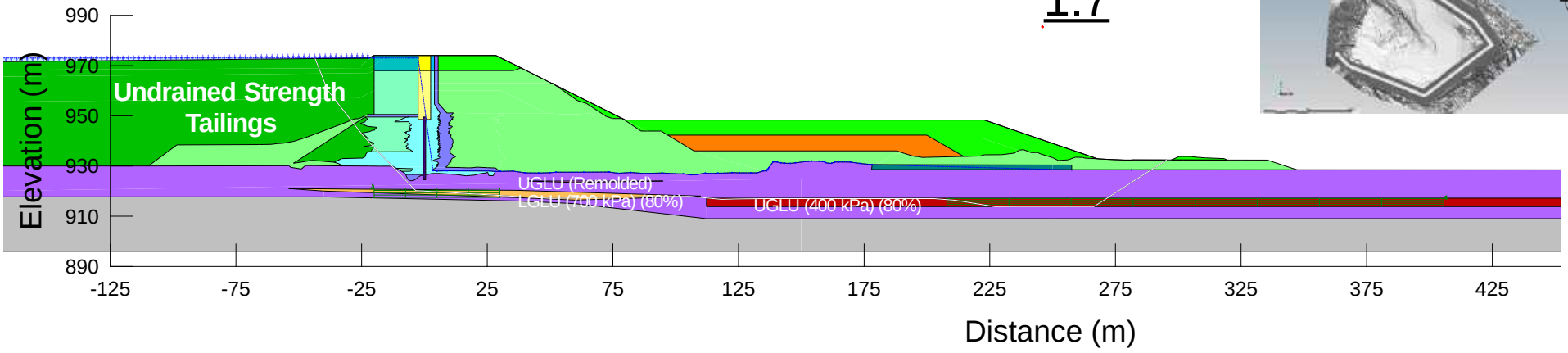
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-79

(INPUT LOCATION OF STABILITY FILES)

0 m beach

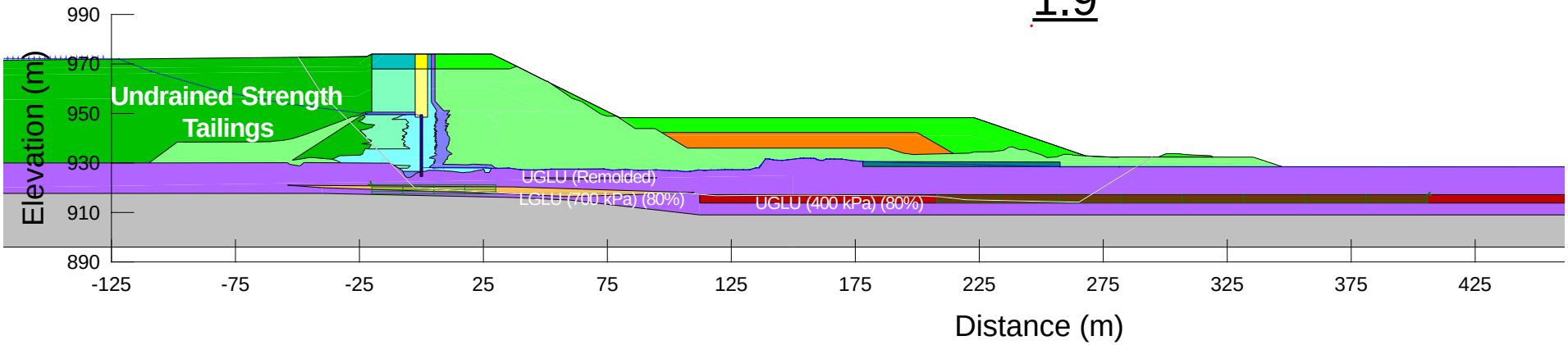
1.7





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+285 (Old Stn. 20+295)
POST-EARTHQUAKE

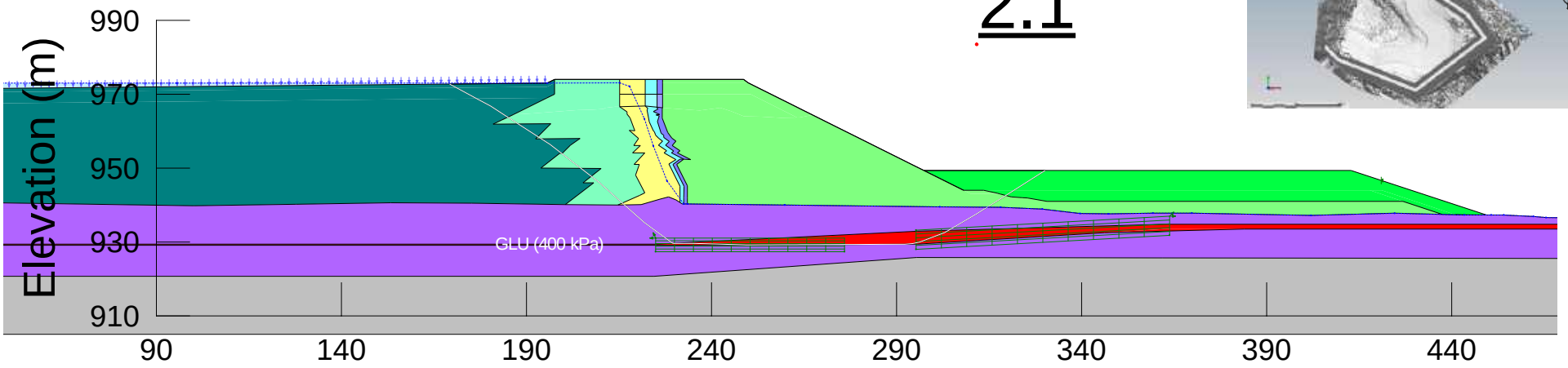
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-80

(INPUT LOCATION OF STABILITY FILES)

0 m beach

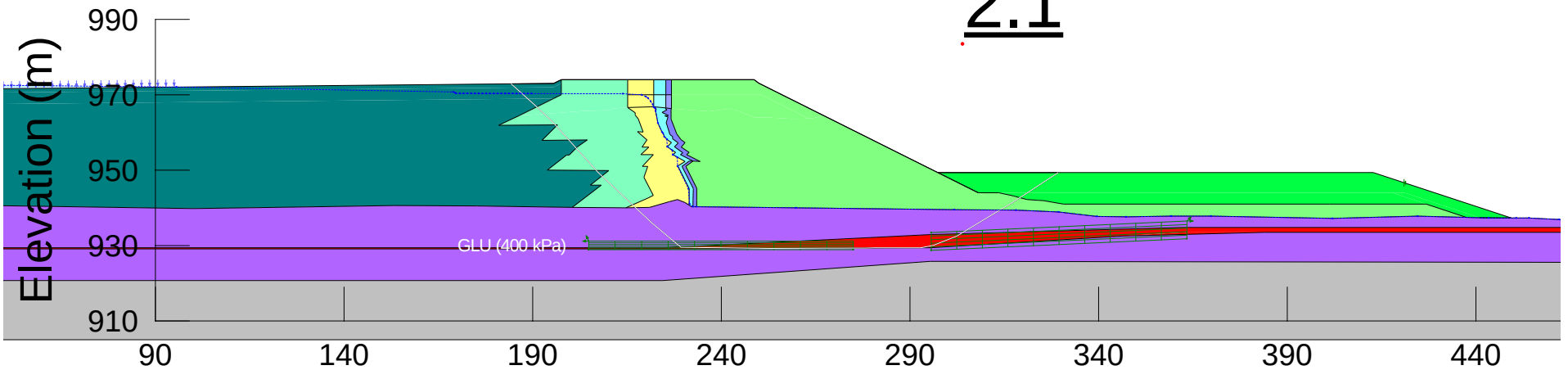
2.1





100 m beach

2.1



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+410 (Old Stn. 20+420)
LONG-TERM

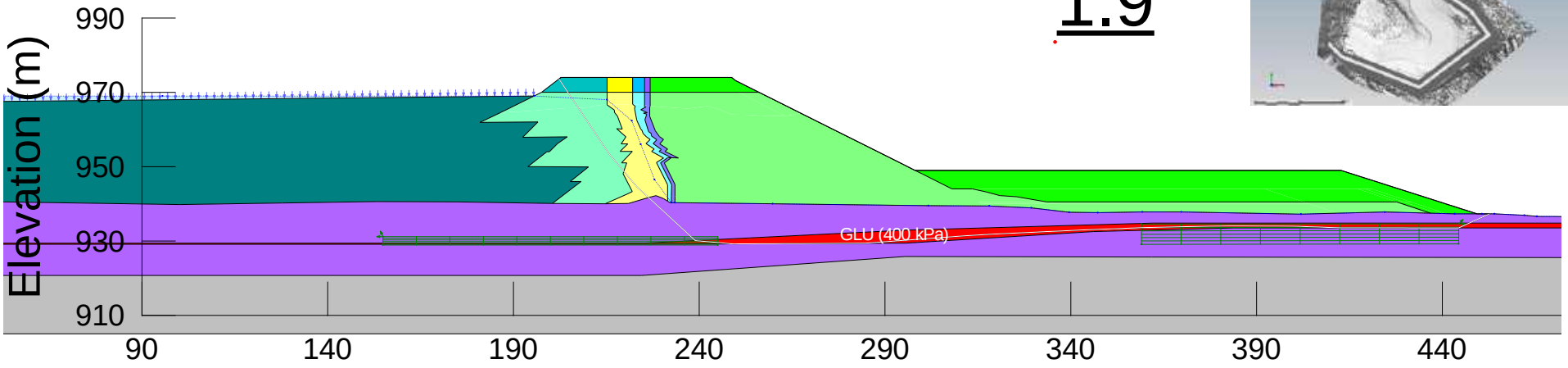
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-81

(INPUT LOCATION OF STABILITY FILES)

0 m beach

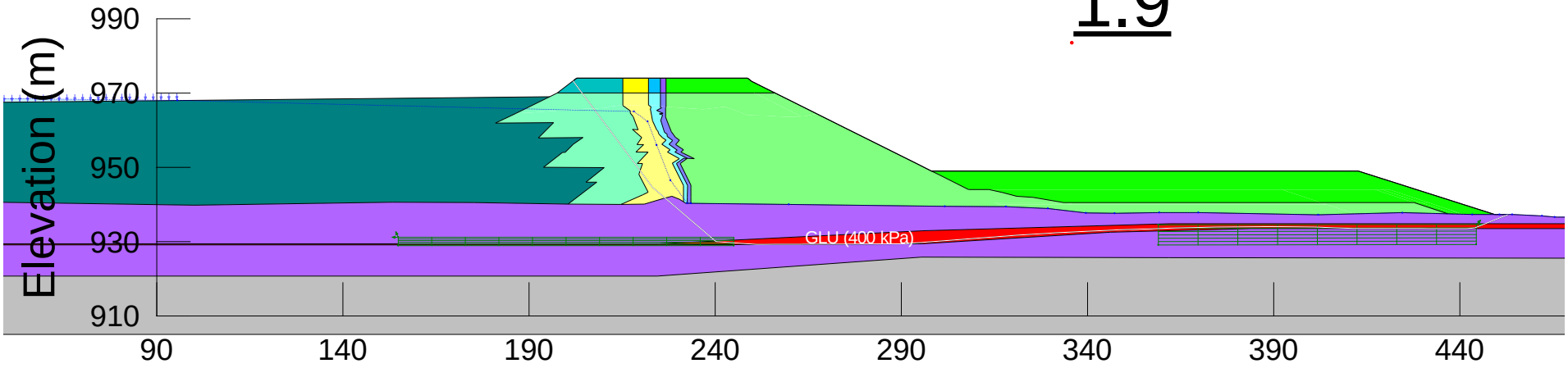
1.9





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+410 (Old Stn. 20+420)
SHORT-TERM

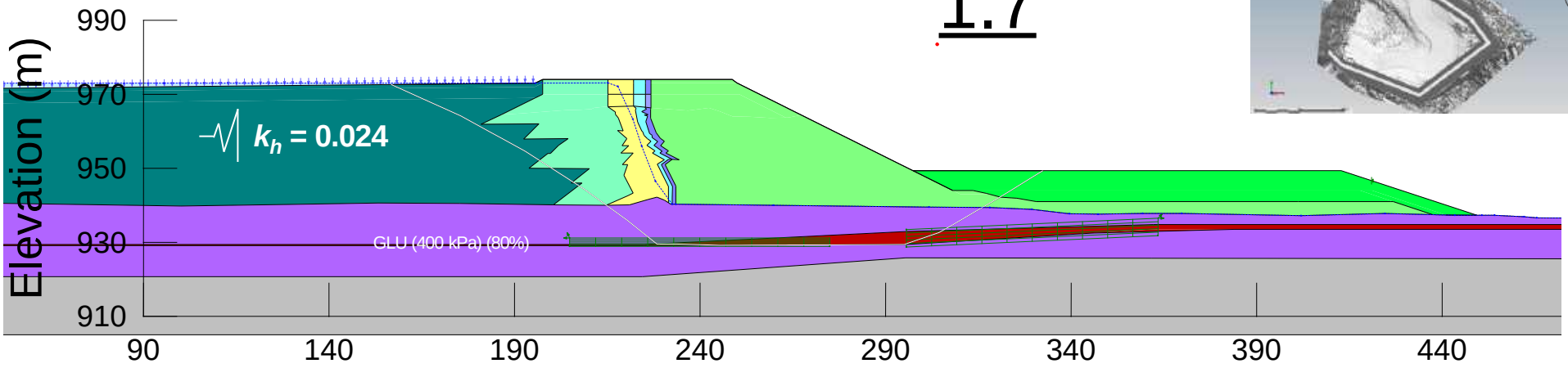
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-82

(INPUT LOCATION OF STABILITY FILES)

0 m beach

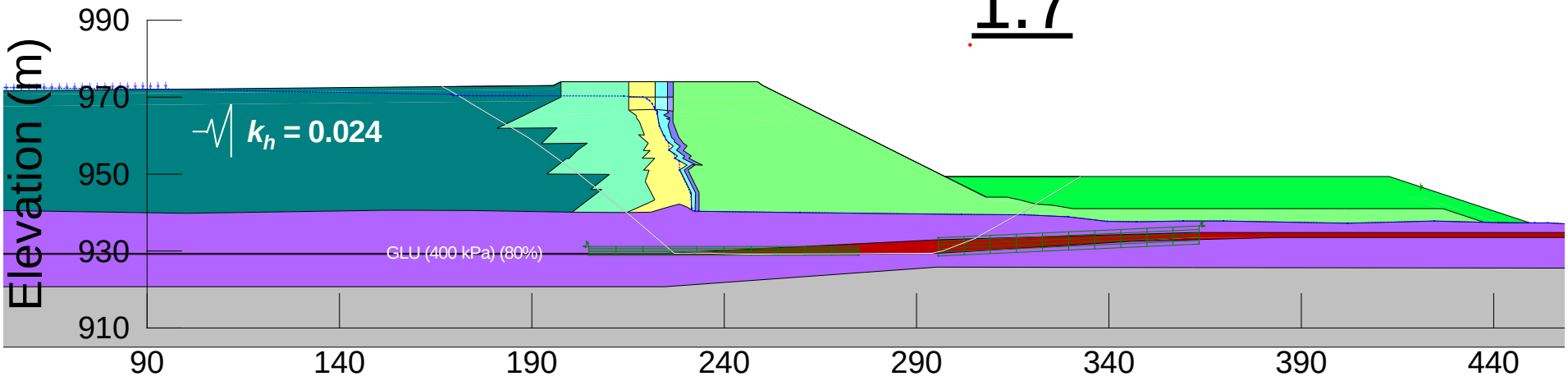
1.7





100 m beach

1.7



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+410 (Old Stn. 20+420)
PSEUDO-STATIC LOADING

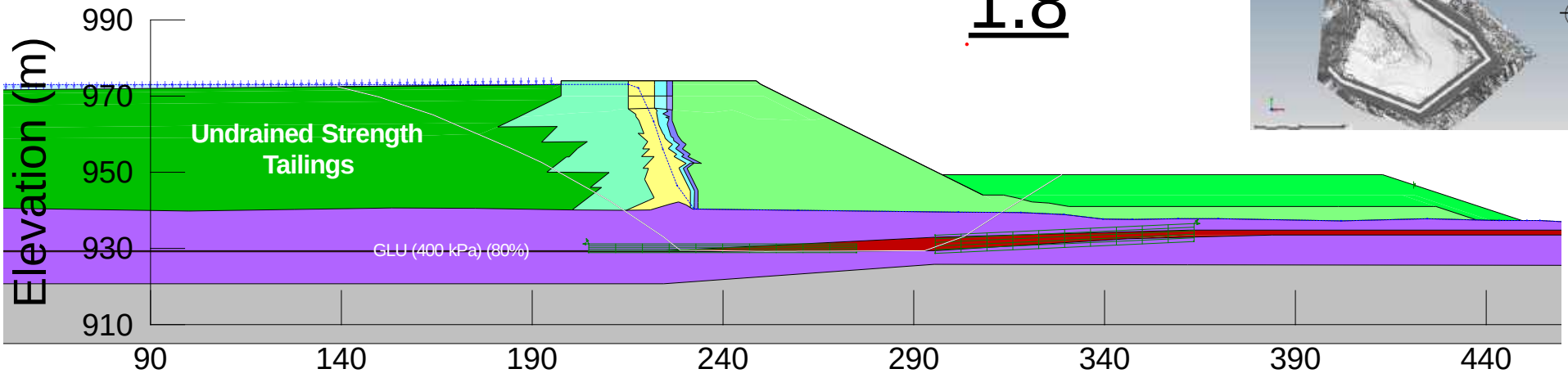
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-83

(INPUT LOCATION OF STABILITY FILES)

0 m beach

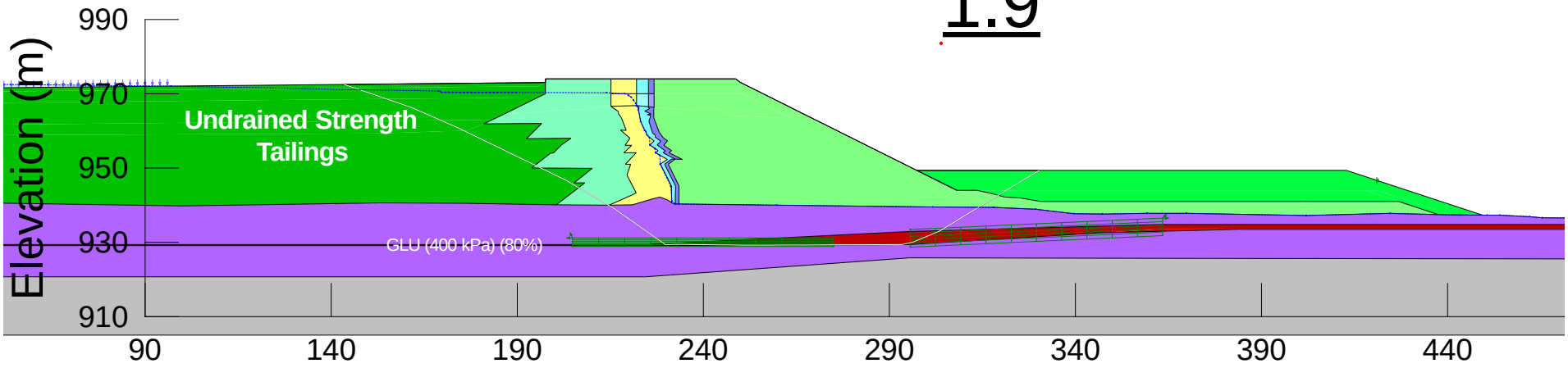
1.8





100 m beach

1.9



Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

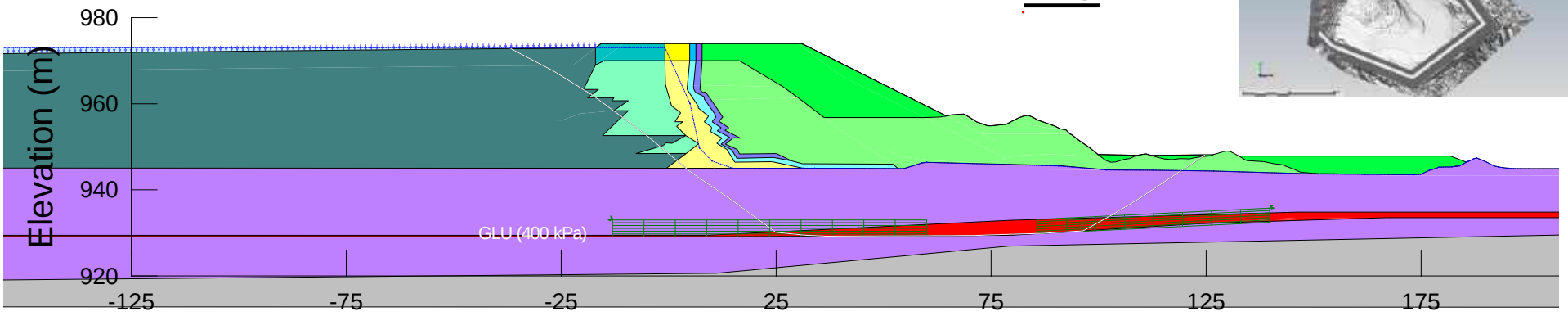
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+410 (Old Stn. 20+420)
POST-EARTHQUAKE

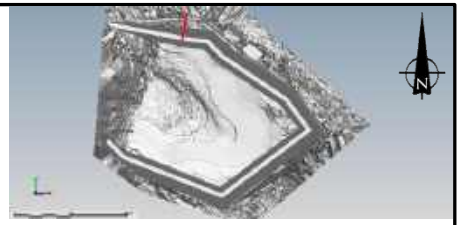
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-84

(INPUT LOCATION OF STABILITY FILES)

0 m beach

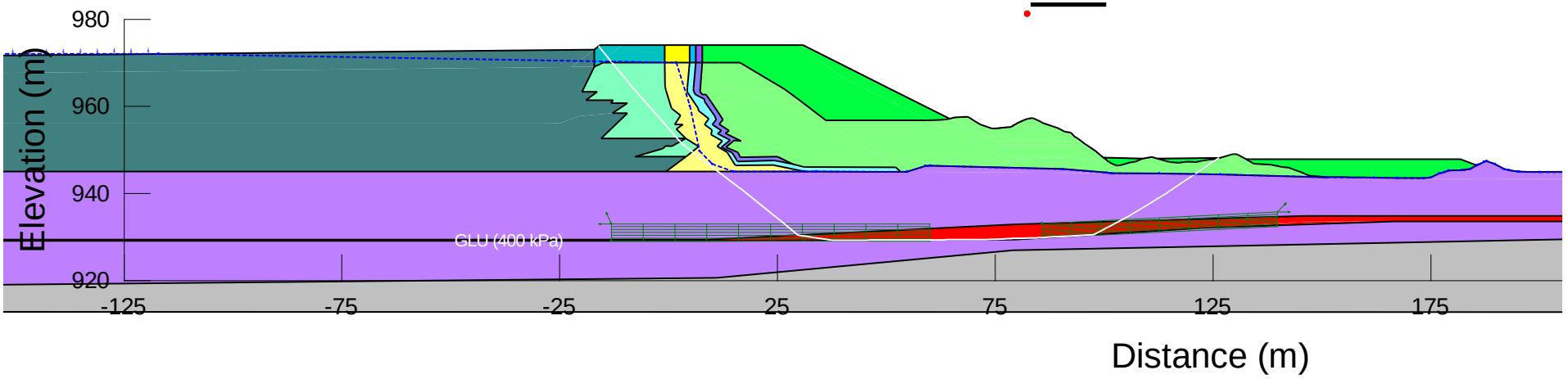
1.8





100 m beach

1.9



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

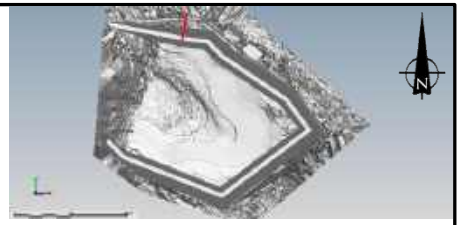
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+540 (Old Stn. 4+525)
LONG-TERM

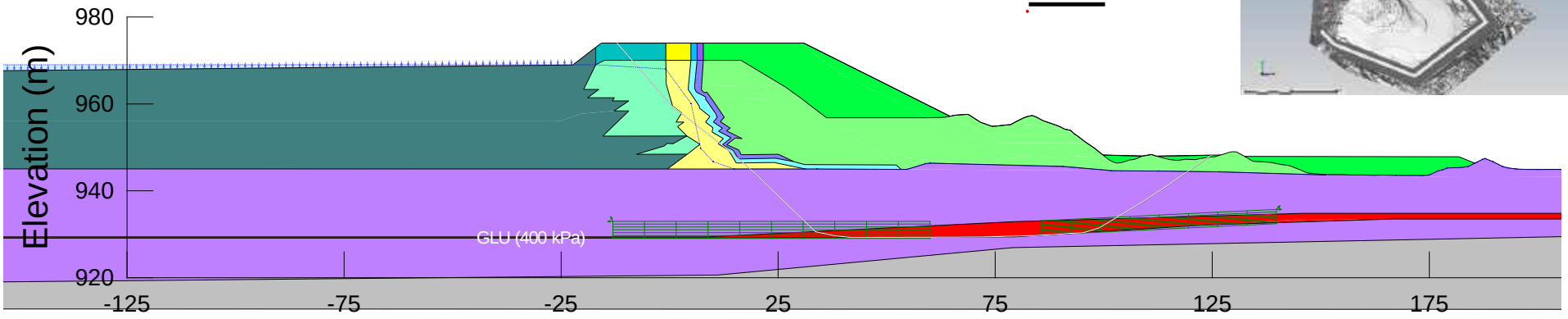
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-85

(INPUT LOCATION OF STABILITY FILES)

0 m beach

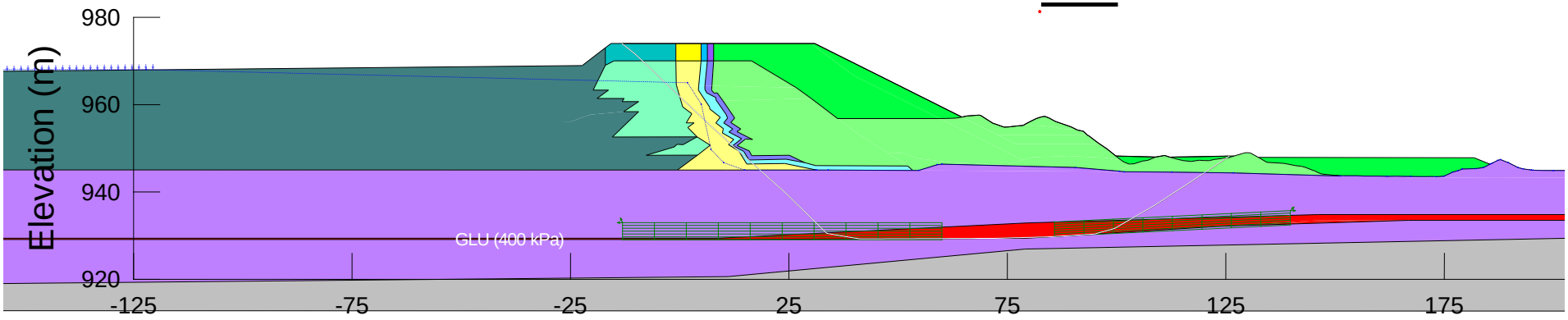
1.8





100 m beach

1.8



Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Partially consolidated foundation soils; B-Bar applied.
2. Upstream drain not installed yet in short-term scenario.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 969 m and 968 m, respectively.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

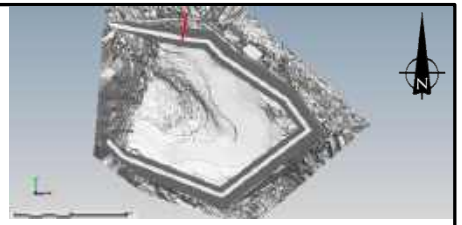
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+540 (Old Stn. 4+525)
SHORT-TERM

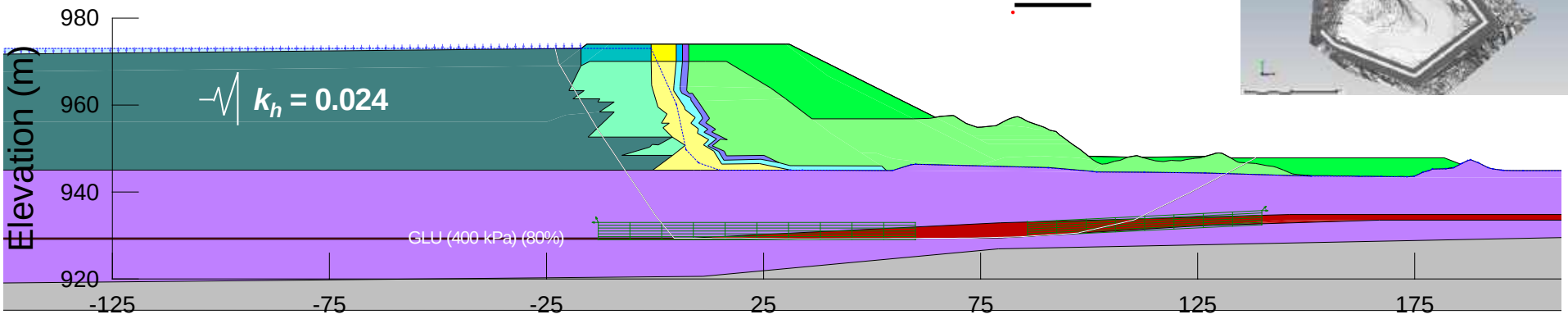
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-86

(INPUT LOCATION OF STABILITY FILES)

0 m beach

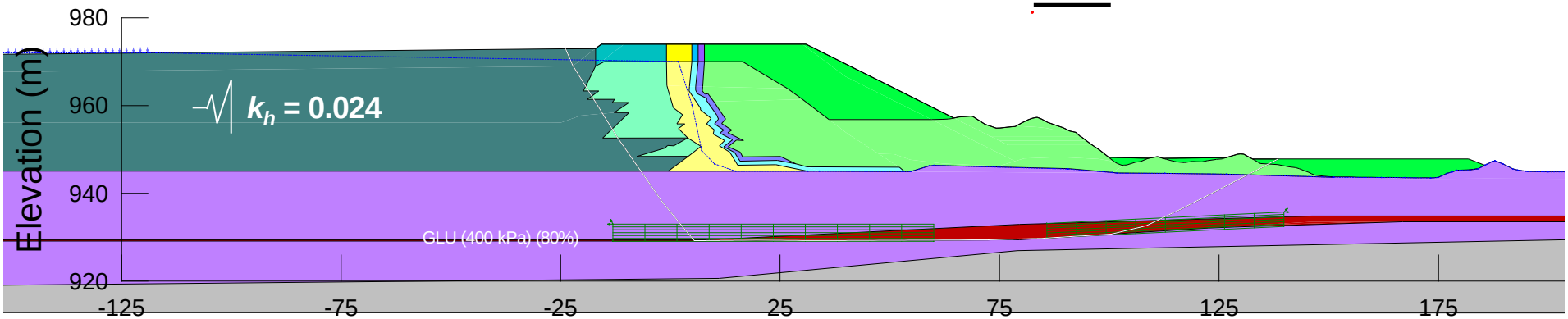
1.4





100 m beach

1.4



Piezometric Line

Distance (m)

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. Pseudo-static loading equal to 0.5 PGA of earthquake event with a 1 in 2,475-year EAP.
5. GLU shear strength reduced to 80%.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

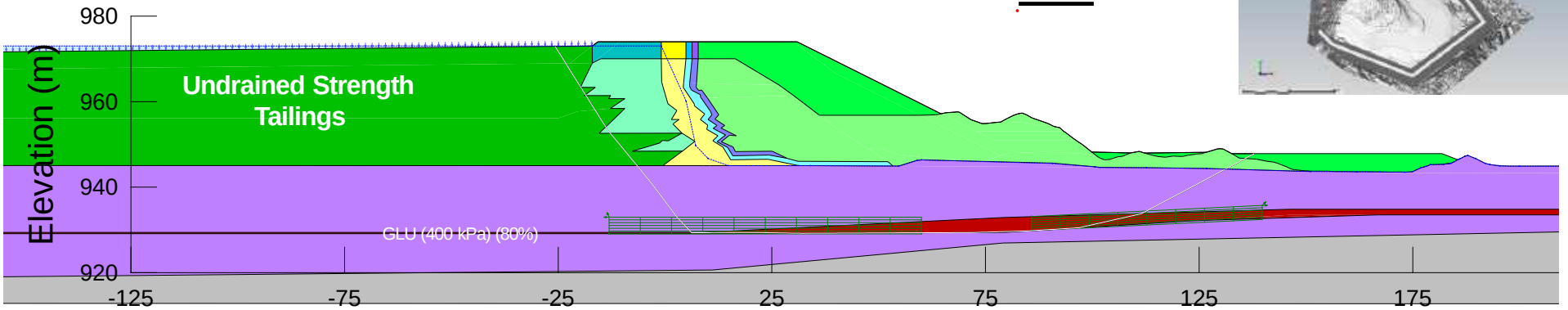
TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+540 (Old Stn. 4+525)
PSEUDO-STATIC LOADING

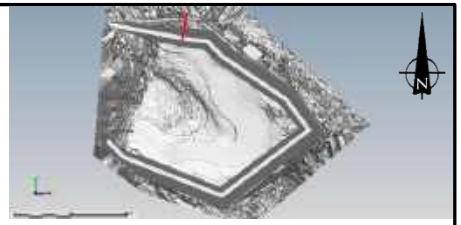
PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-87

(INPUT LOCATION OF STABILITY FILES)

0 m beach

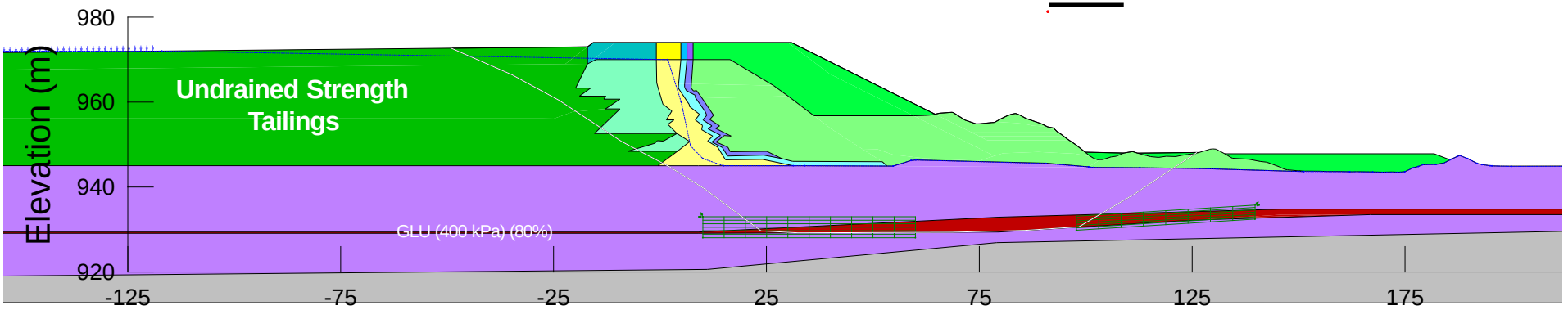
1.5





100 m beach

1.6



Piezometric Line

REFERENCES/NOTES

1. Consolidated foundation soils; no B-Bar applied.
2. Upstream drain not functioning for 0 m beach and functioning for 100 m beach.
3. 0 m and 100 m sub-aerial beaches; pond elevations at 973 m and 972 m, respectively.
4. GLU shear strength reduced to 80%.
5. No seismic loading applied.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2024-04-16
PREPARED	YJ
DESIGNED	YJ
REVIEWED	SB
APPROVED	GP

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
ELEVATION 974 m EMBANKMENT RAISE DESIGN

TITLE
STABILITY ANALYSIS (CORNER 1)
SECTION 4+540 (Old Stn. 4+525)
POST-EARTHQUAKE

PROJECT NO.	PHASE	REV.	FIGURE
CA0020527.4505	51300.51395	0	G-88

APPENDIX H

Stress Deformation Models

TECHNICAL MEMORANDUM

DATE March 21, 2024 **Reference No.** CA0020527.4505-005-TM-Rev0-51346

TO Matt O'Leary
Mount Polley Mining Corporation

FROM Andrés E. Torres Guerrero and Germán Pizarro **EMAIL andres.torres@wsp.com, german.pizarro@wsp.com**

STRESS-DEFORMATION ANALYSES OF THE ELEVATION 974 M TAILINGS STORAGE FACILITY AT MOUNT POLLEY MINE

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) has retained WSP Canada Inc. (WSP) to complete a detailed design to raise of the tailings storage facility (TSF) at the Mount Polley Mine. The design to support raising the TSF from its currently permitted elevation of 970 m to a crest elevation of 974 m is presented in WSP (2024). The design crest elevation 974 m is an interim design to enable the TSF to be raised whilst design efforts for a potential raise of the TSF to contain the life of mine tailings is advanced.

This report summarizes the results of stress-deformation analyses carried out on two (2) sections of the TSF to support the detailed design for the raise of the TSF to elevation 974 m. The analyses were based on two-dimensional finite difference models developed using the commercially available computer code FLAC Version 8.1 (Cundall 2012). The objectives of the analyses are:

- Assess the stability of the embankments at the end of construction up to elevation 974 m.
- Evaluate the seismic stability, and potential level and pattern of deformation under the 2,475-year earthquake load.

The analyses were carried out for two (2) design earthquake motions selected from eleven (11) acceleration-time histories from crustal and subduction interface earthquake events and matched to the 2,475-year ground motion spectrum. The design earthquake ground motions generated are presented in WSP (2023a).

This document includes the analysis procedure, characterization of the foundation and embankment materials, and the static and seismic deformation analyses results. This report should be read in conjunction with the detailed design report (WSP 2024) and the most recent TSF site characterization report (WSP 2023a).

2.0 BACKGROUND

The Mount Polley Mine is a copper and gold mine operated by MPMC, a subsidiary of Imperial Metals Corporation. The site is located approximately 56 km northeast of Williams Lake, British Columbia, between Polley Lake and Bootjack Lake. The TSF is located about 3 km southeast of the mill and includes one embankment that is approximately 4.8 km in length. The embankment is subdivided into three sections:

the Main Embankment, Perimeter Embankment, and South Embankment. The embankment has incorporated a staged expansion design utilizing modified centerline and centerline construction methods. The general zoning of the TSF embankment includes the following:

- upstream fill comprising select fill or tailings sand
- low-permeability till core
- filter zone
- transition zone

Rockfill forms the downstream wedge of the embankments and the downstream buttress along the Perimeter and Main embankments.

The Mount Polley Mine began production in 1997 and operated until October 2001 when operations were suspended for economic reasons. In March 2005, the mine restarted and was in operation up to the time of the TSF breach in August 2014. The embankment crest was near elevation 968 m at the time.

In 2015, the Freshet Embankment was constructed to elevation 950 m through the breach area to allow the capture and temporary storage of the 2015 and 2016 freshet flows. The construction of buttresses along the Perimeter and Main embankments was completed in October 2016 (Golder 2015a, 2017).

The 23 June 2016 amendment of the Mines Act Permit M-200 authorized the return to full operations at the mine, including construction of the TSF design to elevation 970 m (Golder 2015b) and deposition of tailings. Construction to raise the Freshet Embankment at Corner 1 to elevation 970 m started in June 2016. By September 2018, construction of the Perimeter Embankment at Corner 1 had been completed to elevation 968 m (Golder 2019). The raise of the Freshet Embankment is referred to as the Perimeter Embankment at Corner 1.

Mining operations at the Mount Polley mine were halted between May 2019 and Q4 2021 for economic reasons. In June 2022, the mill restarted operations and tailings deposition into the TSF resumed. Construction to raise the South, Main and Perimeter embankments to elevation 970 m was restarted in July 2022 and was completed in 2023. The maximum height of the Main Embankment is about 57 m; the Perimeter Embankment about 42 m and the south embankment about 32 m.

Results of limit equilibrium analyses carried out for the TSF detailed design to elevation 974 m (WSP 2024) indicated that all sections analysed had a factor of safety (FoS) above 1.5 for static conditions and a FoS above 1.0 for pseudo-static conditions and met the design criteria. In this study, stress-deformation analyses were carried out to further confirm the static and seismic stability of the embankments including the potential for strain weakening of glaciolacustrine units.

3.0 PROCEDURE

In general, the stress-deformation analyses included the following:

- Selection of the sections of the TSF to be analyzed.
- Characterization of the materials behaviour under static and seismic conditions.
- Selection of constitutive models to reproduce the characteristic behaviour of the materials.
- Development of finite difference models for the selected sections of the TSF.
- Simulation of the staged construction of the embankments up to elevation 974 m.
- Calculation of the factor of safety at the end of construction at elevation 974 m.
- Simulation of the design earthquake motion.
- Evaluation of the seismic stability of the embankments.

Each aspect of the procedure is described in the following sections of the report.

4.0 EMBANKMENT SECTIONS

Glaciolacustrine deposits have been identified along the Main and Perimeter embankments.

The overconsolidated glaciolacustrine deposits at the Perimeter Embankment at Corner 1 are identified as semi-continuous and have the lowest preconsolidation stress in the area of the TSF (WSP 2023). Along the rest of the Perimeter Embankment foundation, overconsolidated glaciolacustrine deposits are not continuous and have been characterized having a higher preconsolidation stress.

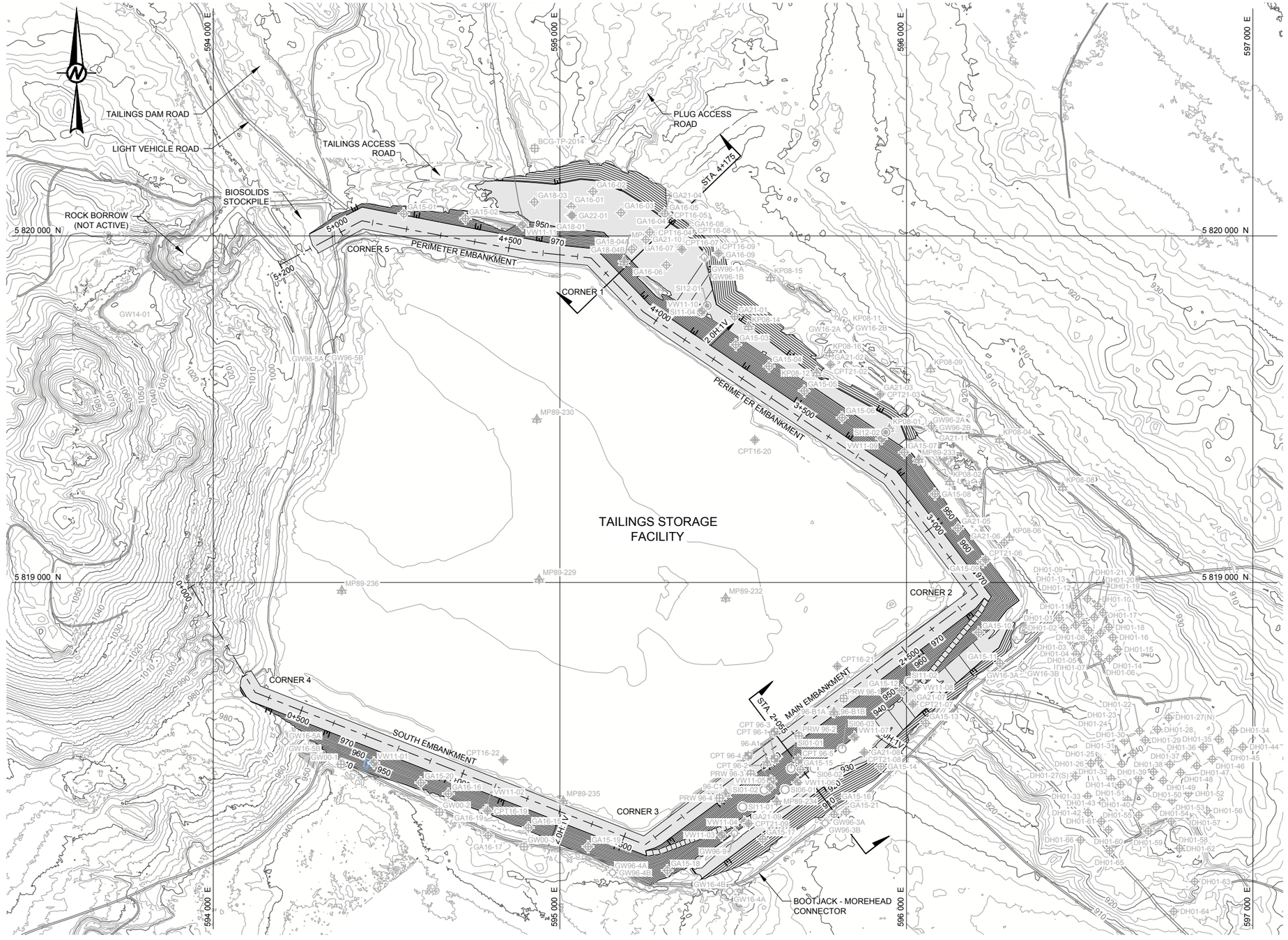
A semi-continuous layer of glaciolacustrine soil is present along the length of the Main Embankment foundation. The glaciolacustrine deposit at the Main Embankment has been characterized having the higher preconsolidation stress in the area of the TSF.

A layer of low plasticity silty clay interpreted to have deposited in a glaciolacustrine environment was identified directly above bedrock near Stn. 1+100 at the South Embankment; however, the geotechnical testing completed on the material showed that it is not representative of the intermediate or high plasticity glaciolacustrine units found at the Main and Perimeter embankments, including at Corner 1.

The stress-deformation analyses were carried out on section 2+055 at the Main Embankment and section 4+175 at the Perimeter Embankment at Corner 1. The section at the Main Embankment represents the tallest section of the facility and includes the semi-continuous layer of glaciolacustrine soil in the foundation. The section at the Perimeter Embankment includes the portion of the foundation that failed in 2014 and that has the glaciolacustrine deposit with lower preconsolidation stress. These sections also correspond to those controlling the design of the buttress at each embankment based on limit equilibrium analyses (LEA). The layout of the TSF and the location of the sections is presented in Figure 1, the geometry of the sections is shown in Figure 2; and the approximate construction sequence and groundwater conditions are presented in Table 1 and Attachment 1. The sections geometry and the construction sequence are based on construction record reports for the Main Embankment

(AMEC 2014, Golder 2017a) and the Perimeter Embankment at Corner 1 (Golder 2015a, 2017b, 2018, 2019); and the detailed design report of the TSF for elevation 974 m (WSP 2024).

The response of piezometers installed within the glaciolacustrine unit at the Perimeter Embankment at Corner 1 indicate that excess pore water pressure generated during construction of the Freshet Embankment dissipated after about one (1) year (WSP 2023a). Based on this, it was assumed in the model that if less than a year passed between construction stages then full dissipation of excess pore water pressure in the glaciolacustrine unit had not occurred (see Table 1).



LEGEND

- TAILINGS STORAGE FACILITY (TSF) EMBANKMENT CENTRELINE (4+400)
- GROUND CONTOURS (SEE NOTE 4)
- TSF EL. 974 m EMBANKMENT RAISE AND BUTTRESS DESIGN CONTOURS
- SITE ACCESS ROADS (SEE REFERENCE 5)
- GA22-01 — SONIC DRILLING, PIEZOMETER INSTALLATION - CORNER 1 EMBANKMENT (WSP GOLDER, 2022)
- GA21-10 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1, PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- CPT21-09 — CPT - PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- GA18-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 (GOLDER, 2018)
- GA16-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- CPT16-04 — CPT - TAILINGS, CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- GW16-2A — SONIC DRILLING, MONITORING WELL INSTALLATION (GOLDER, 2016)
- GA15-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION (GOLDER, 2015)
- BGC-TP-2014 — TEST PIT (BGC / GOLDER, 2014)
- SI12-01 — ODEX, SI INSTALLATION - PERIMETER EMBANKMENT (AMEC, 2012)
- VW11-01 — SONIC DRILLING, PIEZOMETER INSTALLATION (AMEC, 2011)
- SI11-01 — SONIC DRILLING, SI INSTALLATION (AMEC, 2011)
- KP08-01 — SONIC DRILLING, SPT, BORROW PROGRAM (KP, 2008)
- SI06-01 — ODEX, SPT, SI INSTALLATION - MAIN EMBANKMENT (KP, 2006)
- SI01-01 — ODEX, SPT - MAIN EMBANKMENT (KP, 2001)
- DH01-01 — DRILLING, BORROW PROGRAM (KP, 2001)
- GW00-01 — ODEX, SPT, MONITORING WELL INSTALLATION - SOUTH EMBANKMENT (KP, 2000)
- CPT 96-1 — CPT - MAIN EMBANKMENT (KP / CONETEC, 1996)
- 96-A1 — SOLID/HOLLOW STEM AUGER, SPT, PIEZOMETER INSTALLATION - MAIN EMBANKMENT (KP / R.E. GRAHAM ENG., 1996)
- PRW96-01 — SOLID STEM AUGER, PRESSURE RELIEF WELL - MAIN EMBANKMENT (KP, 1996)
- GW96-1 — AIR ROTARY, SPT, MONITORING WELL INSTALLATION (KP, 1996)
- MP89-230 — CONDEMNATION BOREHOLES, PIEZOMETER INSTALLATION (KP, 1989)
- 2+055 — CROSS-SECTION LOCATION

NOT FOR CONSTRUCTION

0 200 400
1:6,000 METRES

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP CANADA INC.

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS ARE SHOWN IN TAILINGS GRID.
3. CONTOUR INTERVAL SHOWN AT 10 m MAJOR AND 2 m MINOR.
4. GROUND CONTOURS REPRESENT COMPOSITE SURVEYS FROM 2014-2023 (SEE REFERENCES 1-4).
5. RECORD DRAWINGS FOR TSF CREST ELEVATION CONSTRUCTION TO ELEVATION 970 m ARE IN PROGRESS.

REFERENCES

1. 2014 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "MtPolley_20140805_1m_LiDAR_Contour.dwg", SURVEYED: 5 AUGUST 2014, RECEIVED: 03 SEPTEMBER 2014.
2. 2019 TOPOGRAPHY PROVIDED BY MPMC AS MULTIPLE .las FILES, SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. 2023 TSF CORNER 4 TOPOGRAPHY PROVIDED BY MPMC, FILE NAME: "1m_DEM.xml", SURVEYED: 30 JULY 2023, RECEIVED: 24 AUGUST 2023.
4. 2023 TSF TOPOGRAPHY AND BATHYMETRY PROVIDED BY MPMC AS MULTIPLE .DXF FILES, SURVEYED: 25 AUGUST 2023, RECEIVED: 21 SEPTEMBER 2023.
5. SITE FEATURES PROVIDED BY MPMC. FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 5 SEPTEMBER 2014.

CLIENT: MOUNT POLLEY MINING CORPORATION

CONSULTANT: wsp

YYYY-MM-DD	2024-03-21
DESIGNED	A. TORRES GUERRERO
PREPARED	T. KLASSEN
REVIEWED	G. PIZARRO
APPROVED	A. TORRES GUERRERO

PROJECT
MOUNT POLLEY MINE TAILINGS STORAGE FACILITY
STRESS-DEFORMATION ANALYSES OF
ELEVATION 974 m EMBANKMENT RAISE

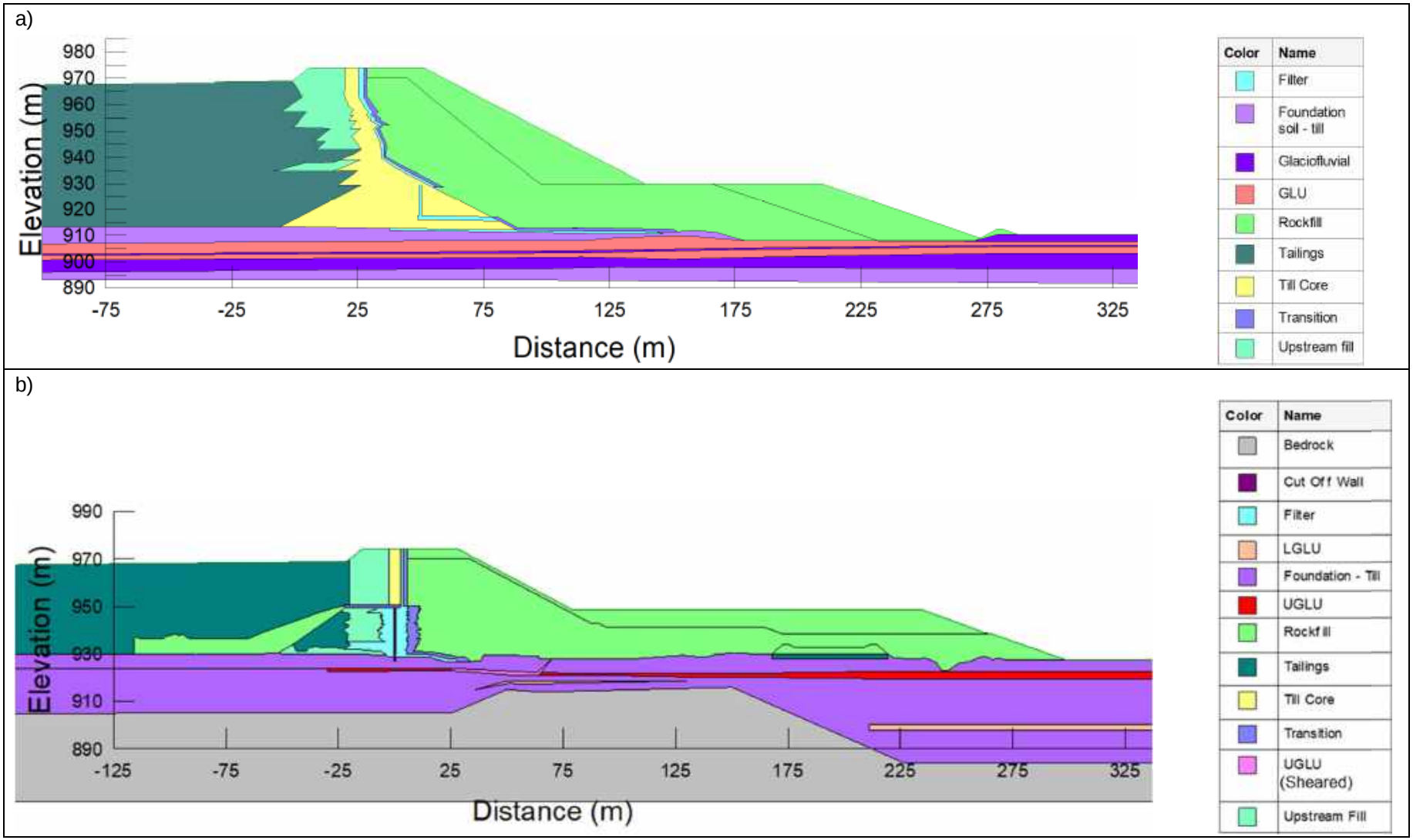
TITLE
TAILINGS STORAGE FACILITY LAYOUT AND CROSS-SECTION LOCATIONS

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
CA0020527.4505	51300/51346/005	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds.com\de\vdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\CA0020527_4505\51300\51346\Doc 005\02_PRODUCT\CN\DWG\ | File Name: CA0020527_4505-51300-51346-005-01.dwg | Last Edited By: tyklassen Date: 2024-03-01 Time:12:55:08 PM | Printed By: TYKlassen Date: 2024-03-21 Time:9:25:21 AM



Note: GLU is Glaciolacustrine Unit, UGLU is Upper Glaciolacustrine Unit and LGLU is Lower Glaciolacustrine Unit.

Figure 2: Sections Analysed in Limit Equilibrium Analyses: a) Main Embankment – Section 2+055, and b) Perimeter Embankment at Corner 1 – Section 4+175.

Table 1: Approximate Construction Sequence of the Main Embankment and Perimeter Embankment at Corner 1

Construction Stage	Main Embankment Section 2+055				Perimeter Embankment at Corner 1 Section 4+175			
	Elevation (m)							
	Embankment	Buttress[1]	Tailings	Water Table[2]	Embankment	Buttress[1]	Tailings	Water Table[2]
1	934	-	929	917	950	-	-	928
2	941	-	940	919	960 [3]	937	947	947
3	945	917	943	920	966	942	957	950
4	948	917	946	943	968	942	962	950
5	951	917	951	943	970 [3]	942	969	950
6	958	917	957	943	970	949	969	950
7	962	917	961	943	974	949	973	970
8	964	917	963	943	-	-		-
9	969	926	968	943	-	-		-
10	969	930	968	943	-	-		-
11	974	930	973	970	-	-		-

Note:

(1) Maximum elevation of the buttress.

(2) Water table elevation immediately upstream of the till core. A 100 m long tailings beach was assumed between the embankment and the TSF pond.

(3) Full dissipation of excess pore water pressure not expected before the beginning of the following construction stage.

5.0 MATERIAL CHARACTERIZATION

This section summarizes the geotechnical characterization of the materials for numerical modelling purposes. The TSF site characterization report (WSP 2023a) presents in detail the results of geotechnical testing and interpretation of geotechnical parameters.

The stratigraphic sequence identified in the area of the TSF can be generalized in order of increasing depth as follows:

- embankment materials and tailings
- till
  - glaciolacustrine sub-units
  - glaciofluvial sub-units
- bedrock

At the Perimeter Embankment at Corner 1, two distinct glaciolacustrine units have been identified and characterized separately. The location of the units is shown in Figure 2.

5.1 Foundation Characterization

5.1.1 Bedrock

Generally weathered volcaniclastic conglomerate, volcanic debris or completely weathered bedrock. Results of a downhole seismic test carried out in borehole BH15-10 indicate that the time-averaged shear-wave velocity in the upper 30 m (V_{s30}) of bedrock is about 850 m/s (WSP 2023b). The small strain shear stiffness (G_{max}) of the bedrock was estimated as:

$$G_{max} = \rho_b \cdot (V_s)^2 \qquad \textbf{Equation 1}$$

Where ρ_b is the bulk density and V_s the shear wave velocity, considered equal to the V_{s30}. The static and dynamic shear modulus were calculated as $0.95G_{max}$.

5.1.2 Foundation Till

The foundation till is generally a mixture of gravel, sand and low plasticity fines ranging from silt to silty clay, with consistency ranging from firm to hard. Collected samples showed an average fines content of 50% and an average plasticity index of 11 (WSP 2023a). Effective friction angles were estimated from triaxial tests performed on undisturbed samples at about 34 degrees (BCMEM 2015). Results from pressuremeter testing indicate that the friction angle from the upper till at Corner 1 ranges between 36 and 48 degrees, with an average of about 40 degrees.

The average shear wave velocity measured in downhole seismic tests is about 500 m/s (WSP 2022). The small strain shear stiffness (G_{max}) was calculated using Equation 1 and the static shear modulus was estimated as $0.5G_{max}$.

The shear stress-strain behaviour of the foundation till was characterized using the shear modulus reduction curves presented by Vuccetic and Dobry (1991) for a plasticity index (PI) of 15.

5.1.3 Glaciofluvial Unit

The glaciofluvial unit is generally gravelly sandy silt to silty sand with trace gravel, and an estimated compactness ranging from compact to very dense. Samples tested showed an average fines content of 63% and the fines were generally non-plastic to low plasticity. Shear strength results indicate a peak friction angle of about 35 degrees (WSP 2023a). The shear stress-strain behaviour of the glaciofluvial unit was assumed to be equal to that of the foundation till.

5.1.4 Glaciolacustrine Units

Glaciolacustrine units were identified along the Main and Perimeter embankments. Two distinct glaciolacustrine deposits have been identified at Corner 1 and are referred to as UGLU and LGLU. The UGLU was identified as the soil layer through which the 2014 undrained failure developed and was the focus of subsequent forensic investigations (IEEIRP 2015; KCB 2015a,b). The shear strength of the glaciolacustrine units, except for the UGLU that sheared during the failure in 2014, were characterized based on their preconsolidation stress.

The glaciolacustrine unit at the Main Embankment is generally low to intermediate plasticity clay, with trace to some sand, and consistency ranging from very stiff to hard. GLU samples collected from the Main Embankment showed an average plasticity index of 17.

The UGLU at Corner 1 generally consists of intermediate to high plasticity clay, with trace to some sand, and consistency ranging from firm to stiff. UGLU samples showed an average plasticity index of 27.

The LGLU at Corner 1 generally consists of low to intermediate silty clay to clay, with trace to some sand. LGLU samples showed an average plasticity index of 15.

Results from laboratory and field testing showed different degrees of overconsolidation of the glaciolacustrine units. Table 2 summarizes the vertical effective preconsolidation stress estimated for each unit (WSP 2023a).

Table 2: Vertical Effective Preconsolidation Stress of Glaciolacustrine Units from the Main Embankment and Perimeter Embankment at Corner 1

Location	Unit	Vertical Effective Preconsolidation Stress (kPa)
Main Embankment	Glaciolacustrine Unit (GLU)	1200
Perimeter Embankment at Corner 1	Upper Glaciolacustrine Unit (UGLU)	400
	Lower Glaciolacustrine Unit (LGLU)	700

The overconsolidation ratio (OCR) of the glaciolacustrine units was calculated as follows:

$$OCR = \frac{\sigma'_{vp}}{\sigma'_{vc}}$$ **Equation 2**

Where σ'_{vp} equals the vertical effective preconsolidation stress and σ'_{vc} is the current vertical effective vertical stress.

The peak undrained shear strength ($S_{u\text{-}peak}$) of the glaciolacustrine units was characterized using the SHANSEP (Stress History and Normalized Soil Engineering Properties) method proposed by Ladd and Foot (1974). Results of simple shear tests carried out on undisturbed GLU samples from the Main and Perimeter embankments yielded the following expression for estimating the peak undrained strength ratio ($S_{u\text{-}peak}/\sigma'_{vc}$) (WSP 2023a):

$$\frac{S_{u-peak}}{\sigma'_{vc}} = 0.22 \cdot OCR^{0.71} \qquad \textbf{Equation 3}$$

Undisturbed UGLU specimens from the Corner 1 exhibited a propensity for strain-weakening on shearing during simple shear tests, with an estimated sensitivity of 2 to 3 (KCB 2015a,b). A post-peak reduction in undrained shear strength was observed at shear strains in excess of 5%, and full weakening was attained at shear strains in excess of 60% (Zabolotnii 2020). Figure 3 shows the characteristic strain-weakening function considered for the glaciolacustrine units. Plastic shear strains refer to shear strains accumulated once the peak undrained shear strength is fully mobilized.

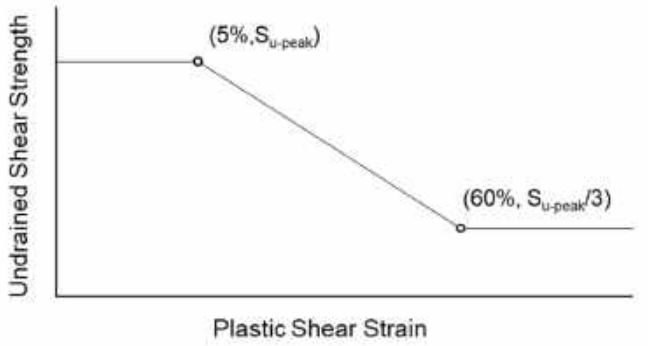


Figure 3: Glaciolacustrine Units Strain-Weakening Function

The UGLU drained peak friction angle was determined as 22 degrees (KCB 2015a,b). Drained shear strength parameters were considered for the portions of the GLU with overconsolidation ratios greater than 3.

The undrained shear strength of the UGLU that sheared during the failure in 2014was modelled constant and equal to 22 kPa, which corresponds to the average minus one standard deviation of the measured remoulded undrained shear strength values from field vane tests and CPTs as part of the forensic investigation in 2014 (WSP 2023a). Since then, the embankment was repaired and constructed to elevation 970 m (approx. 42 m high) over the area of UGLU that sheared. Potential strength gains from reconsolidation of the UGLU that sheared in 2014 have not been included in the characterization.

Shear wave velocity, V_s, of the UGLU and LGLU at Corner 1 was measured during geotechnical investigations with SCPT (BCMEM 2015). Measured V_s ranged between 120 m/s and 350 m/s. A characteristic shear wave velocity of 230 m/s was considered for the glaciolacustrine units. The small strain shear stiffness (G_{max}) was calculated using Equation 1 and the static shear modulus was assumed to be $G_{max}/8$.

Cyclic direct simple shear tests were carried out on undisturbed glaciolacustrine samples from the Main Embankment and Perimeter Embankment at Corner 1 (WSP 2023a). A preliminary assessment indicates factors of safety against cyclic softening generally greater than 1.5 under the 2,475-year earthquake load.

The shear stress-strain behaviour of the glaciolacustrine units was characterized using the shear modulus reduction curves presented by Vuccetic and Dobry (1991) for the average plasticity index (PI) of 15.

5.2 Embankment Materials and Tailings Characterization

Embankment materials were characterized based on the available data from construction monitoring (Golder 2015a; AMEC 2014) and from typical values published in literature.

Shear strength of the rockfill and transition materials was characterized by the average peak friction angle presented by Leps (1970). The peak friction angle, ϕ, of the rockfill and transition is given by:

$$\boldsymbol{\phi = 45.7 - 2.8 \cdot ln\left(\frac{\sigma'_h}{P_a}\right) < 55\ degrees} \qquad \textbf{Equation 4}$$

Where σ'_h is the horizontal effective stress and P_a is the atmospheric pressure.

The shear strength of the till core was measured on the triaxial apparatus on reconstituted specimens of till (KP 1995; BCMEM 2015). The friction angle considered for the till core was 33 degrees.

The friction angles adopted for the filter, upstream fill, and tailings were 30, 32 and 25 degrees, respectively. These values are consistent with the friction angle values used in the limit equilibrium analysis carried out for the elevation 970 and 974 m detailed TSF designs (Golder 2015b, WSP 2024).

The small strain shear stiffness (G_{max}) and static shear modulus (G_{stat}) of the embankment materials and tailings were estimated based on the compaction effort or expected density, from the Mount Polley Mine TSF construction record reports and from typical values obtained from literature (Byrne et al. 1987).

The average elastic modulus (E_0) of the cut-off wall material, estimated from the mix design (Golder 2016), was used to estimate the small strain shear stiffness of the cut-off wall at Corner 1 using:

$$\boldsymbol{G_{max} = \frac{E_0}{(2(1+\nu))}} \qquad \textbf{Equation 5}$$

Where ν is the Poisson ratio, assumed for the cut-off wall equal to 0.25.

6.0 CONSTITUTIVE MODELS

For the simulation of the staged construction of the embankments the elastic-perfectly plastic Mohr-Coulomb model was used to simulate the nonlinear behaviour of the tailings, embankment soils, and the foundation soils non-susceptible to strain-weakening (i.e., GLU with OCR greater than 3, UGLU that sheared in 2014, till and glaciofluvial soils). The strain-softening constitutive model was used to simulate the behaviour of the GLU with overconsolidation ratios less or equal to 3 (OCR≤3). The strain-softening constitutive model is based on the elastic-perfectly plastic Mohr-Coulomb model and allows the definition of the strength parameters (e.g. cohesion) as piecewise-linear functions of a softening parameter measuring the plastic shear strain. The elastic-perfectly plastic Mohr-Coulomb model was used to simulate the nonlinear behaviour of the UGLU that sheared during the failure in 2014 and GLU with overconsolidation ratios greater than 3 (OCR>3). The behaviour of the bedrock and cut-off wall was simulated with the linear elastic model. Table 3 presents the summary of the constitutive models and parameters used for the simulation of the staged construction of the embankments.

The dynamic mechanical response of both the bedrock and the cut-off wall was simulated as linear elastic (see Table 4). The dynamic behaviour of the GLU that sheared during the failure in 2014 and the GLU with overconsolidation ratio greater than 3 was modelled by complementing the linear elastic-perfectly plastic constitutive model with a hysteretic damping model. The seismic response of the GLU with overconsolidation ratios less or equal to 3 was numerically simulated by complementing the strain softening model with a hysteretic damping model. A sigmoidal fitting function was used to represent the characteristic shear stress-strain behaviour of the materials. Table 5 shows a summary of the model parameters used for these materials.

The dynamic response of the foundation till, glaciofluvial and till core was numerically modelled as non-linear, Mohr-Coulomb materials using the constitutive model UBC Hysteretic. In this model, the non-linear response is obtained by modifying the initial tangent shear moduli, that equals the small strain shear modulus ($G_{t\text{-}ini}=G_{max}$), in accordance with a hyperbolic law that depends on the shear strain level. Under cyclic loading, damping is estimated by the hysteretic loops formed by the stress-strain curves. The model input parameters are summarized in Table 6.

The dynamic response of the rockfill, filter, transition, upstream fill, and tailings was numerically modelled using the constitutive model UBCSAND developed to simulate earthquake loading and liquefaction. UBCSAND is an elasto-plastic effective stress model with the mechanical behaviour of the soil skeleton and pore water fully coupled. In UBCSAND, plastic shear induces a change in the soil skeleton volume and, if the pores are filled with water, a change in pore water pressure and effective stress occurs. Details of UBC Hysteretic and UBCSAND models can be found in Naesgaard (2011). The model input parameters are summarized in Table 7.

Table 3: Summary of the Constitutive Models and Parameters Used in the Simulation of the Staged Construction of the Embankments

Description	Constitutive Model	ρ_b (t/m^3)	Shear Strength Parameters		Elastic Parameters (1)			
			c (kPa)	ϕ (°)	$k_{G\text{-}stat}$	n	$k_{B\text{-}stat}$	m
Embankment Materials and Tailings								
Rockfill	Mohr-Coulomb	2.2	0	Equation 4	120	0.4	$8/3k_{G\text{-}stat}$	0.4
Transition		2.0						
Upstream Fill		2.0		32				
Filter		2.0		30				
Till Core		2.1		33	131	0.5		0.5
Tailings		1.7		25	94			
Cut-off Wall	Elastic	2.2	-		$G_{stat}=1.3x10^6$		$B_{stat}=5/3G_{stat}$	
Foundation Materials								
GLU (OCR≤3) (2)	Strain-softening	2.0 (3)	S_u (4)	0	$G_{stat}=1.3x10^4$		$B_{stat}=8/3G_{stat}$	
GLU (OCR>3) (2)	Mohr-Coulomb		0	22				
UGLU that sheared in 2014		1.8	22	0				
Till / Glaciofluvial		2.2	0	34	$G_{stat}=2.8x10^5$		$B_{stat}=8/3G_{stat}$	
Bedrock	Elastic	2.3	-		$G_{stat}=1.6x10^6$		$B_{stat}=8/3G_{stat}$	

Note:

(1) The static elastic shear modulus (G_{stat}) and the static elastic bulk modulus (B_{stat}) were calculated using the corresponding number (k) and exponent (n or m), mean effective stress, p'=(σ'$_1$+σ'$_2$+σ'$_3$)/3; and atmospheric pressure, P_a=100 kPa; for example: $G_{stat} = k_{G-stat} \cdot P_a \cdot \left(\frac{p'}{P_a}\right)^n$.

(2) GLU refers to GLU from the Main Embankment, and UGLU and LGLU from the Perimeter Embankment at Corner 1.

(3) Except for the UGLU from the Perimeter Embankment at Corner 1 where 1.8 t/m^3 was used. (4) S_u was calculated using Equation 2, Equation 3 and the strain-weakening function (see Figure 5).

Nomenclature: bulk density (ρ_b), cohesion (c), angle of internal friction (ϕ), static shear modulus number ($k_{G\text{-}stat}$), static shear modulus exponent (n), static bulk modulus number ($k_{B\text{-}stat}$) and static bulk modulus exponent (m).

Table 4: Parameters of the Linear Elastic Constitutive Model for the Seismic Analysis

Description	G_{dyn} (kPa)	B_{dyn} (kPa)
Bedrock	$1.6x10^6$	G_{dyn}
Cut-off Wall	$1.3x10^6$	G_{dyn}

Nomenclature: dynamic shear modulus (G_{dyn}) and dynamic bulk modulus (B_{dyn}).

Table 5: Parameters of the Mohr-Coulomb and Strain-softening Model for the Seismic Analysis

Description	Constitutive Model	G_{max} (kPa)	B_{max} (kPa)	c (kPa)	ϕ (°)	a	b	x_0
GLU (OCR≤3)	Strain-softening	$1.1x10^5$	G_{max}	S_u (1)	0	1.015	-0.52	-1.2
GLU (OCR>3)	Mohr-Coulomb		(2)	0	22			
UGLU that sheared in 2014				22	0			

Note:

(1) Su calculated using Equation 2, Equation 3 and the strain-weakening function (see Figure 5).

(2) Bmax was calculated as Bmax=2Gmax(1+ν)/(3(1- ν)), where ν is the Poisson ratio equal to 0.49.

Nomenclature: small strain shear stiffness (G_{max}), small strain bulk stiffness (B_{max}), cohesion (c), angle of internal friction (ϕ), and hysteretic parameters (a, b and x_0; Cundall 2012).

Table 6: Parameters of the UBC Hysteretic Model for the Seismic Analysis

Description	hgmax (kPa)	hbulk (kPa)	hfric (°)	hn	hrf	hdfac	hrm	hmodf1
Till / Glaciofluvial	$5.5x10^5$	hgmax	34	2	0.75	1	1.5	0.8
Till Core	(1)	hgmax	33	2	1	1	1	0.8

Note:

(1) hgmax was calculated as $\mathrm{hgmax} = k_g \cdot P_a \cdot \left(\frac{p\prime}{P_a}\right)^{n_g}$, where kg=977, ng=0.5, Pa=100 and p'=(σ'1+σ'2+σ'3)/3.

Nomenclature: maximum shear modulus (hgmax), maximum bulk modulus (hbulk), cohesion (hcoh), angle of internal friction (hfric), and hysteretic parameters (hn, hrf, hdfac, hrm, hmodf1).

Table 7: Parameters of the UBCSAND Model for the Seismic Analysis

Description	K_{ge}	K_b	n_e	m_e	K_{gp}	n_p	ϕ_{pt} (°)	ϕ (°)	R_f
Tailings	867	607	0.5	0.5	267	0.4	33	34	0.81
Filter	979	685	0.5	0.5	488	0.4	33	34	0.76
Transition									
Upstream Fill									
Rockfill	6416	4491	0.4	0	353	0.5	40	Equation 4	0.95

Nomenclature: elastic shear modulus number (K_{ge}), elastic bulk modulus number (K_b), elastic shear modulus exponent (n_e), elastic bulk modulus exponent (m_e), plastic shear modulus number (K_{gp}), plastic shear modulus exponent (n_p), peak friction angle (ϕ), friction angle at phase transformation (ϕ_{cv}) and constant that modifies the hyperbola (R_f).

7.0 STATIC ANALYSIS

The static analysis was carried out to further confirm the stability of the embankments at the end of construction to elevation 974 m. The following sections describe the finite difference models simulation of the staged construction of the embankments and the analysis results.

7.1 Finite Difference Models

Two-dimensional (2D) finite difference models were developed for the selected sections of the TSF using the commercially available computer code FLAC Version 8.1 (Cundall 2012).

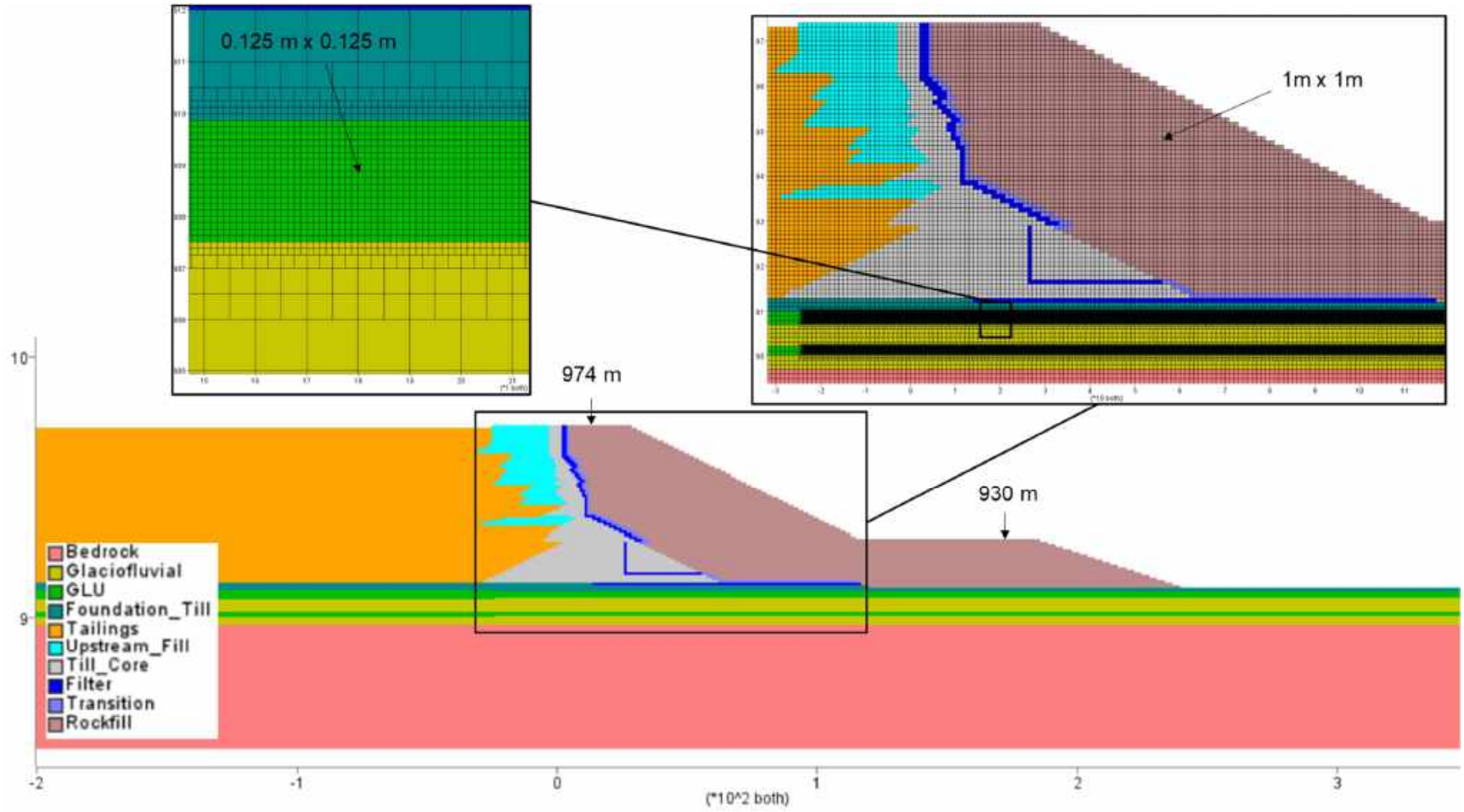
The finite difference mesh developed for section 2+055 at the Main Embankment and section 4+175 at the Perimeter Embankment at Corner 1 are shown in Figure 4 and Figure 5, respectively. The meshes extend vertically from about elevation 845 m to the embankments crest design elevation of 974 m. Horizontally, the meshes extend far enough from the embankments to avoid boundary effects. The mesh size is 1 m by 1 m at the centre of the model, increasing to about 4 m by 4 m to the far ends. Numerical models with strongly nonlinear behaviour, such as the strain-weakening behaviour exhibited by the glaciolacustrine units, are particularly sensitive to mesh sizing. Furthermore, results of three-dimensional deformation analyses of the Perimeter Embankment performed by Zabolotnii (2020) suggest that strain localization in a shear band with a thickness not exceeding 12 to 13 cm was requisite for the initiation of the breach at the Mount Polley TSF in 2014. Hence, the mesh size in the GLU at the Main Embankment and the UGLU at the Perimeter Embankment was refined to 0.125 m by 0.125 m.

7.2 Simulation of the Staged Construction of the Embankments

The staged construction of the embankments was simulated by sequentially activating horizontal layers of materials, each 1 m thick, following the construction sequence presented in Table 1. After activating each layer, the model was run to equilibrium and material properties updated according to the new stress state. If a tailings layer was activated, the pond level was raised to maintain a 100 m beach upstream of the embankment, and the pore pressures updated. Hydrostatic conditions were assumed below the water table.

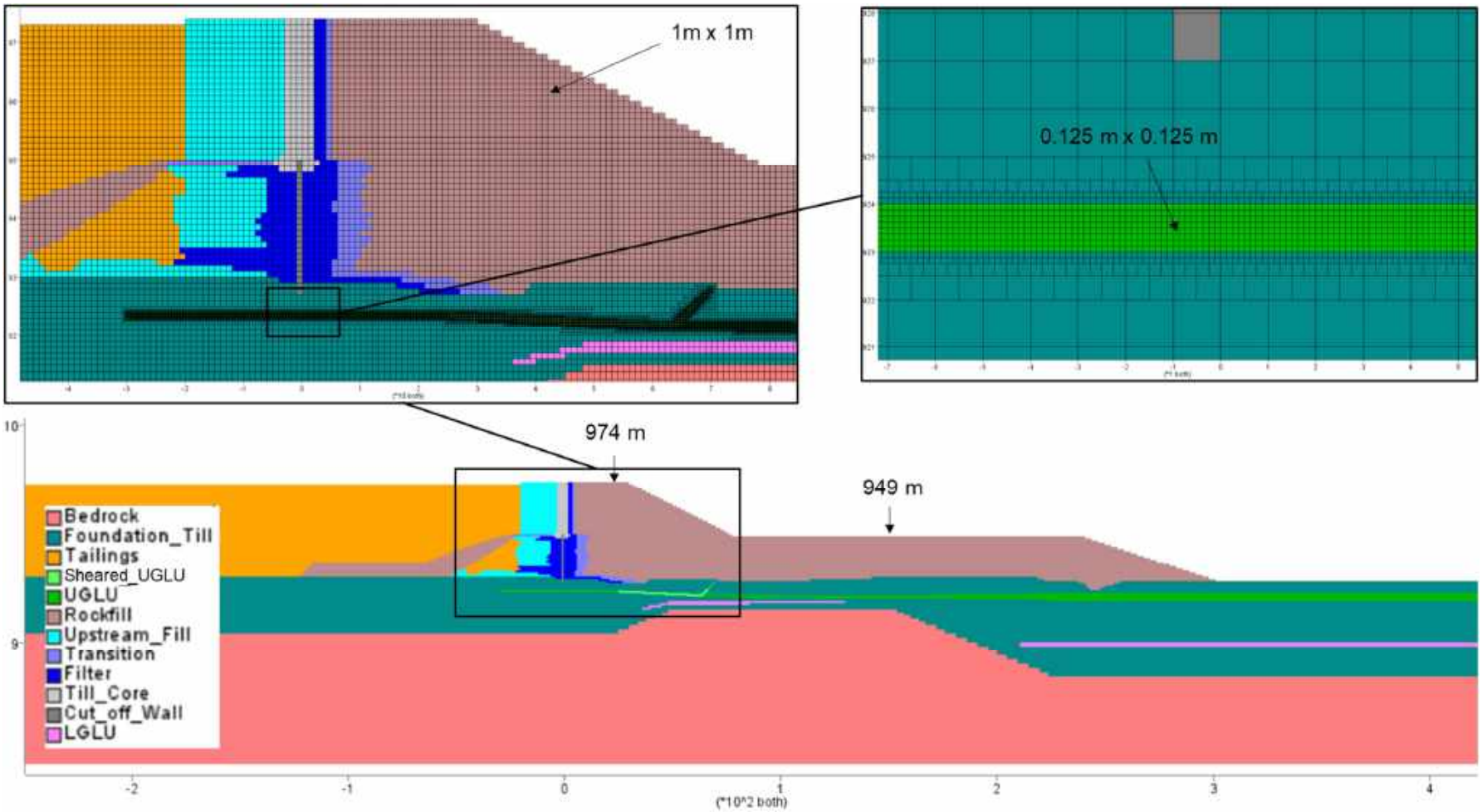
The consolidation-induced hardening of the GLU was modelled by adjusting the undrained strength of the GLU based on the existing stress state. This adjustment was only applied at the end of construction stages where complete dissipation of excess pore water pressure was expected before the beginning of the following stage (see Table 1). Plastic shear strains accumulated in previous construction stages were carried over to the following stages (i.e., GLU was assumed to not heal once the peak undrained shear strength was fully mobilized).

For the simulation of the staged construction of the embankments, the bottom boundary of the 2D numerical models was considered fixed in both vertical and horizontal directions, while the lateral boundaries were considered fixed only in the horizontal directions (i.e., on vertical rollers).



Note: Axes unit is meters.

Figure 4: Finite Difference Mesh of Main Embankment Section at Station 2+055



Note: Axes unit is meters.

Figure 5: Finite Difference Mesh of Perimeter Embankment Section at Station 4+175

7.3 Analysis Results

This section presents the results of the static analysis carried out on section 4+175 of the Main Embankment (see Figure 6) and section 2+055 of the Perimeter Embankment (see Figure 7). Contours of horizontal displacements are presented to evaluate potential deformation mechanisms. Contours of accumulated plastic shear strains at the end of construction are presented to evaluate the potential for strain-weakening in the GLU. Plastic shear strains greater than zero but less than 5% indicate that the peak undrained shear strength was fully mobilized. Plastic shear strains greater than 5% indicate post-peak conditions and initiation of weakening. Plastic shear strains greater than 60% indicate that full weakening was attained (see Figure 3). For clarity, plastic shear strains accumulated in the UGLU that sheared in 2014 are not presented in Figure 7. The UGLU that sheared in 2014 was modelled as fully weakened. The factor of safety of the embankments was computed at the end of construction using the strength reduction method.

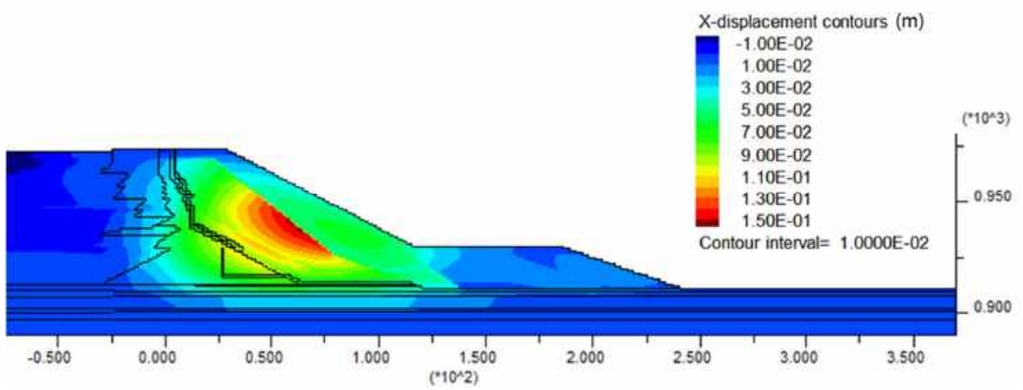
7.3.1 Main Embankment – Section 2+055

Contours of predicted horizontal displacement in the Main Embankment (see Figure 6a) show a limited, block type downstream movement of the embankment associated with shear strains accumulated in the GLU during construction. Predicted plastic shear strains accumulated in the GLU below the downstream slope of the Main Embankment are less than 1.5% (see Figure 6b), indicating that the peak undrained shear strength is fully mobilized but the weakening process is not initiated. The factor of safety (FoS) computed for section 2+055 of the Main Embankment is about 1.6 and corresponds to a block-type slip surface through the glaciolacustrine unit, as shown in Figure 6c. These results indicate that section 2+055 of the Main Embankment meets the long-term factor of safety design criteria under the analysed conditions.

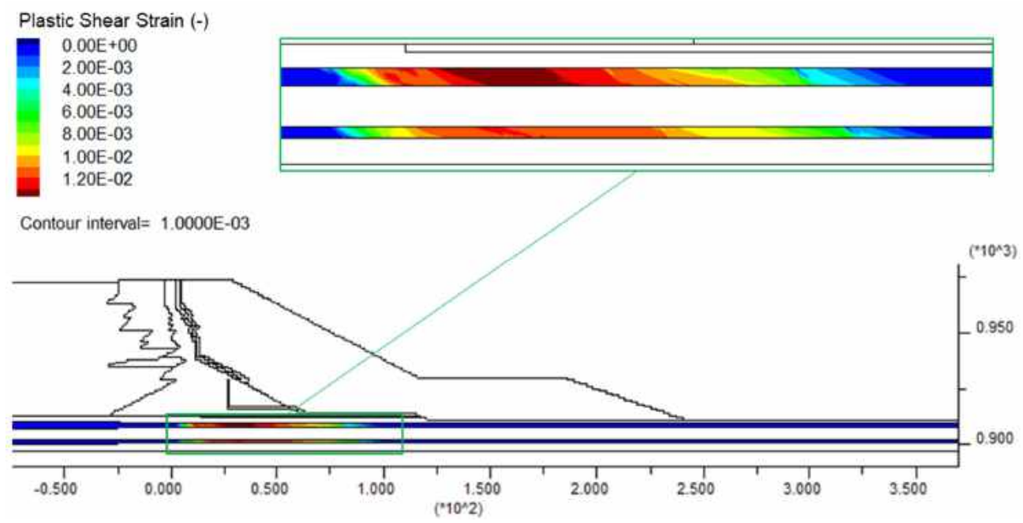
7.3.2 Perimeter Embankment at Corner 1 – Section 4+175

Contours of predicted horizontal displacement in the Perimeter Embankment at Corner 1 (see Figure 7a) show a limited, block type downstream movement of the embankment associated with shear strains accumulated in the UGLU, including the UGLU that sheared during the failure in 2014, during construction. A relatively small shear band (about 3 m long) with a maximum plastic shear strain of about 10% is predicted to develop immediately downstream of the UGLU zone that sheared in 2014. However, the predicted level of strain-weakening is relatively low (less than 6% strength reduction in a 3 m long shear band). The predicted plastic shear strains in the rest of the UGLU are generally less than 5%. The factor of safety (FoS) computed for section 4+175 is about 1.7 and corresponds to a block-type slip surface through the UGLU, as shown in Figure 7c. The static analysis results indicate that this section of the Perimeter Embankment at Corner 1 meets the long-term factor of safety design criteria under the analysed conditions.

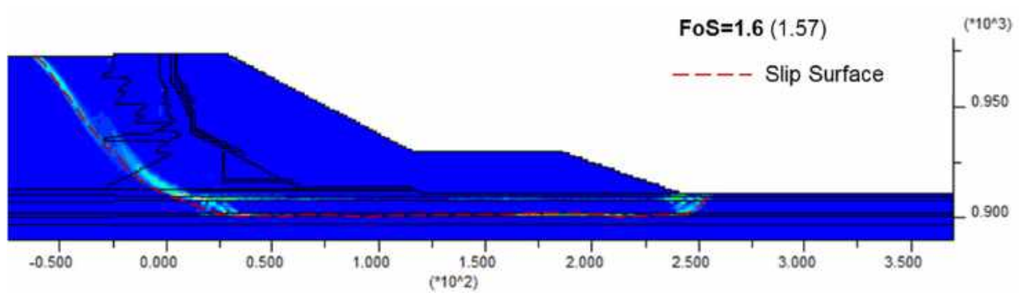
a)



b)



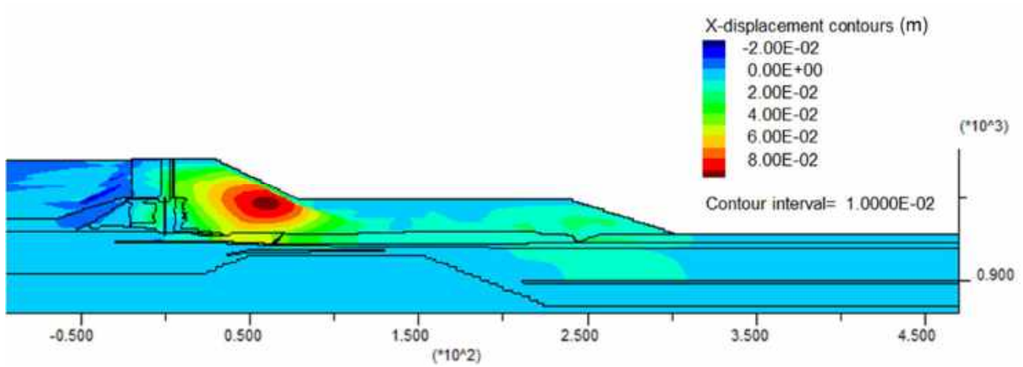
c)



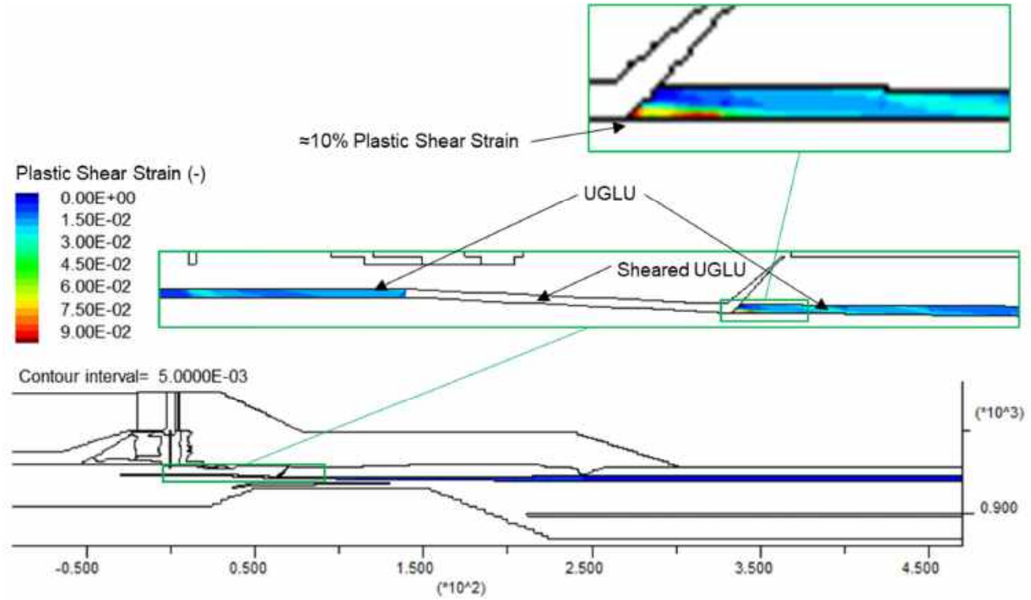
Note: Axes unit is meters.

Figure 6: Static Analysis Results for the Main Embankment – Section 2+055 at the End of the Construction to Elevation 974 m: a) Contours of Predicted Horizontal Displacement, b) Contours of Predicted Plastic Shear Strain in Glaciolacustrine Units, c) Predicted Factor of Safety.

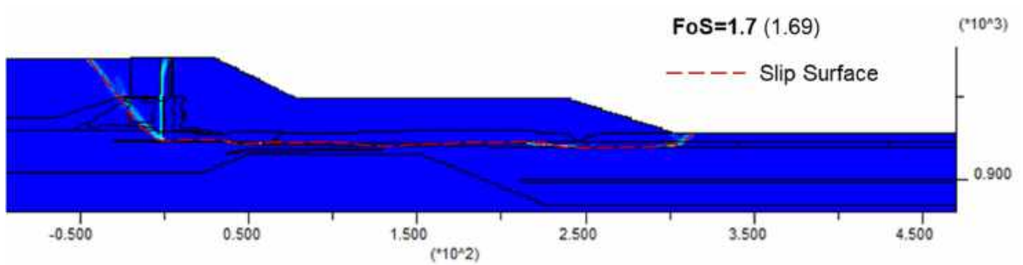
a)



b)



c)



Note: Axes unit is meters.

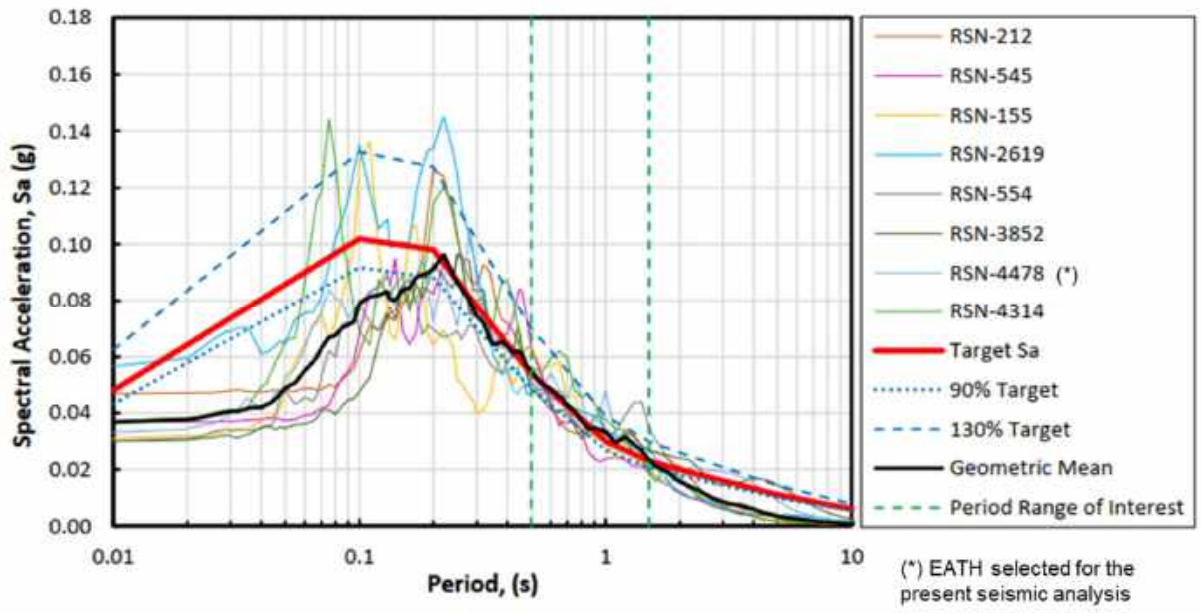
Figure 7: Static Analysis Results for the Perimeter Embankment at Corner 1 – Section 4+175 at the End of the Construction to Elevation 974 m: a) Contours of Predicted Horizontal Displacement, b) Contours of Predicted Plastic Shear Strain in the Upper Glaciolacustrine Unit, c) Predicted Factor of Safety.

8.0 EARTHQUAKE GROUND MOTIONS

WSP (2023b) carried out a site-specific probabilistic seismic hazard analysis (PSHA) for the Mount Polley TSF site. In this section, only a summary of the results is presented.

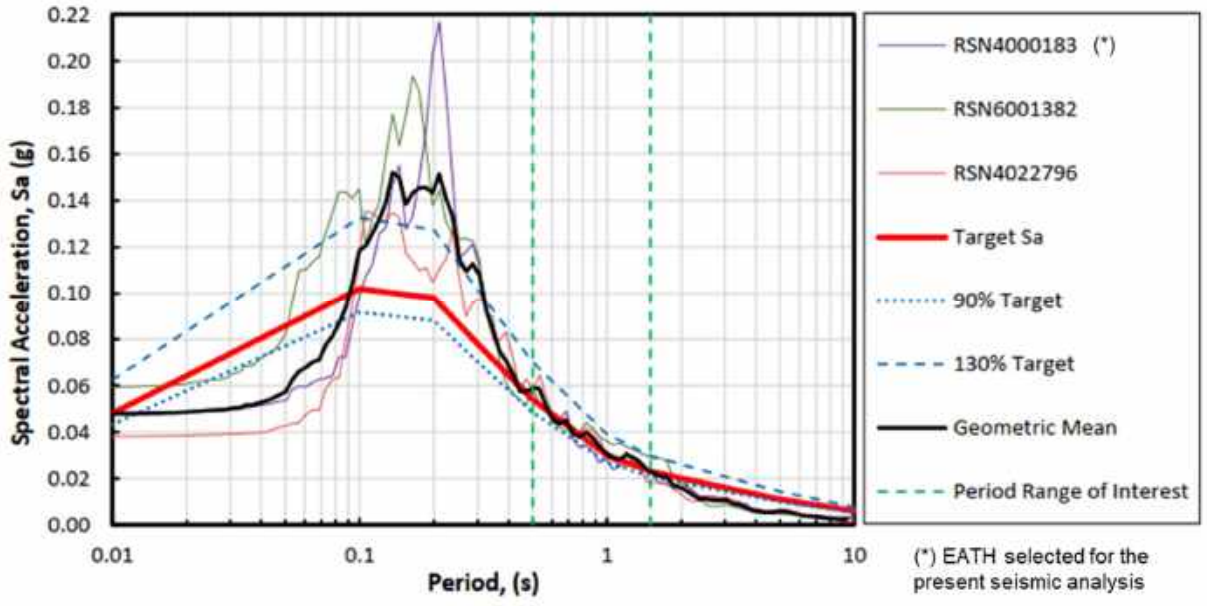
Earthquake ground motions were reported as 5%-damped, mean uniform hazard acceleration response spectra at annual exceedance probabilities (AEPs) of 1/1,000, 1/2,475, 1/5,000 and 1/10,000 for the site-specific average shear wave velocity in the 30 m below ground surface (V_{s30}) of 849 m/s. Deaggregations results show that both, near-field, moderate-magnitude earthquakes, and far-field subduction interface earthquakes contribute to the site seismic hazard. The shallow crustal earthquakes sources are dominated by moderate-magnitude earthquakes (**M**6.0 to **M**6.5) close to the site (i.e. <60 km) at all AEPs. The contribution to hazard at the site from Cascadia subduction zone sources is from large earthquakes (**M**8+) at 450 to 550 km from these at all AEPs and spectral periods of interest. Eleven two-horizontal-component earthquake acceleration time histories (EATHs; 22 records) were developed using amplitude scaling to the site-specific 1/2,475 AEP uniform hazard acceleration response spectrum within the period range of interest of 0.5 to 1.5 seconds. These 22 EATHs were developed with eight two-component (16) records from crustal earthquakes and three two-component (6) subduction interface earthquake records. Figure 8 and Figure 9 show the response spectra of one component of the individual scaled EATHs compared with the target spectrum for both crustal and subduction interface motion, respectively.

Following the design criteria (WSP 2024), earthquake ground motions with a return period of 2,475 years were selected for seismic analysis of the Mount Polley Mine TSF site. One crustal motion (RSN4478N) and one subduction interface motion (RSN4000183EW) were selected from the 22 EATHs developed, corresponding to those with the maximum Arias intensity for each seismic source.



Source: WSP 2023b.

Figure 8: Target Acceleration Response Spectrum and Response Spectra of Individual Crustal Earthquake Acceleration Time histories



Source: WSP 2023b.

Figure 9: Target Acceleration Response Spectrum and Response Spectra of Individual Subduction Interface Earthquake Acceleration Time Histories

9.0 SEISMIC ANALYSIS

The seismic analysis was carried out to further confirm the stability of the embankments under the 2,475-year earthquake loading. The following sections describe the finite difference models, simulation of the design earthquake and the analysis results.

9.1 Finite Difference Models

The size of the elements used in the finite difference model have an impact on the solution time of the seismic analysis. The smaller the elements, the greater the solution time due to the increased number of elements and the reduced timestep. The finite difference models developed for the static analysis considered 0.125 m by 0.125 m elements for the GLU at the foundation of the Main Embankment and the UGLU at Corner 1. The utilization of such element size for the seismic analysis leads to impractical solution times. Hence, the element size in the GLU was increased to 0.5 m by 0.5 m to perform the seismic analysis. The rationale behind this modification is presented in the following paragraphs.

The selection of the elements size used for the GLU in the static analysis is based on the results of the three-dimensional deformation analyses that suggest that strain localization in a shear band with a thickness not exceeding 12 to 13 cm was requisite for the initiation of the breach at the Mount Polley TSF in 2014 (Zabolotnii 2020). A level of conservatism is introduced in a two-dimensional deformation analysis when adopting the same element size for the GLU since the three-dimensional stability effects in the slope are not included.

The finite difference model developed for the Perimeter Embankment at Corner 1 in Section 7.1 was modified to evaluate the mesh size sensitivity and the degree of conservatism incorporated when using different element sizes for the UGLU. The model was adjusted to represent the geometry, groundwater conditions and construction

sequence of the embankment up to when it failed in 2014 at an approximate crest elevation of 969 m. The staged construction was simulated using different element sizes for the UGLU from 0.125 m to 1 m. Figure 10 shows a summary of the results of the analyses. An element size of 0.5 m still adds a degree of conservatism to the solution while allowing for reasonable solutions times for the seismic analysis.

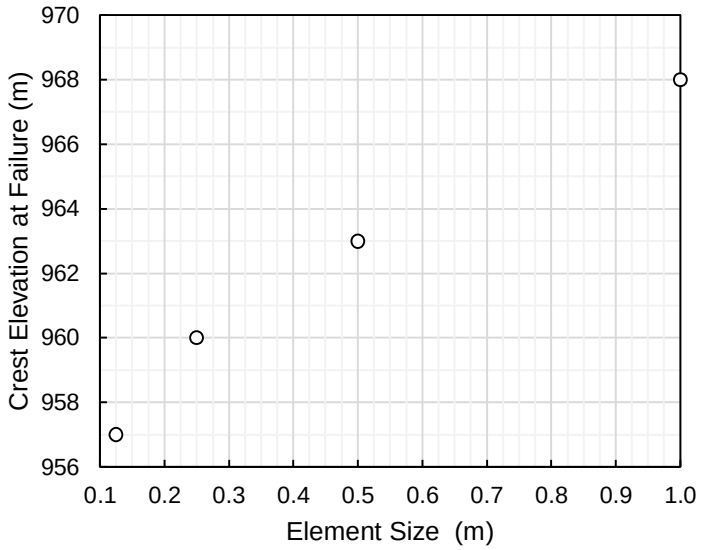


Figure 10: Mesh Sensitivity of the Modified Perimeter Embankment at Corner 1 Finite Difference Model

9.2 Conditions Prior to Application of Seismic Loading

The pre-seismic stress conditions in the embankments and foundation were estimated by simulating the staged construction of the embankments up to elevation 974 m, using 0.5 m by 0.5 m elements in the GLU. The assumed groundwater conditions include a 100 m tailings beach upstream of the embankment, as shown in Figure 11 and Figure 12. Hydrostatic conditions were assumed below the water table.

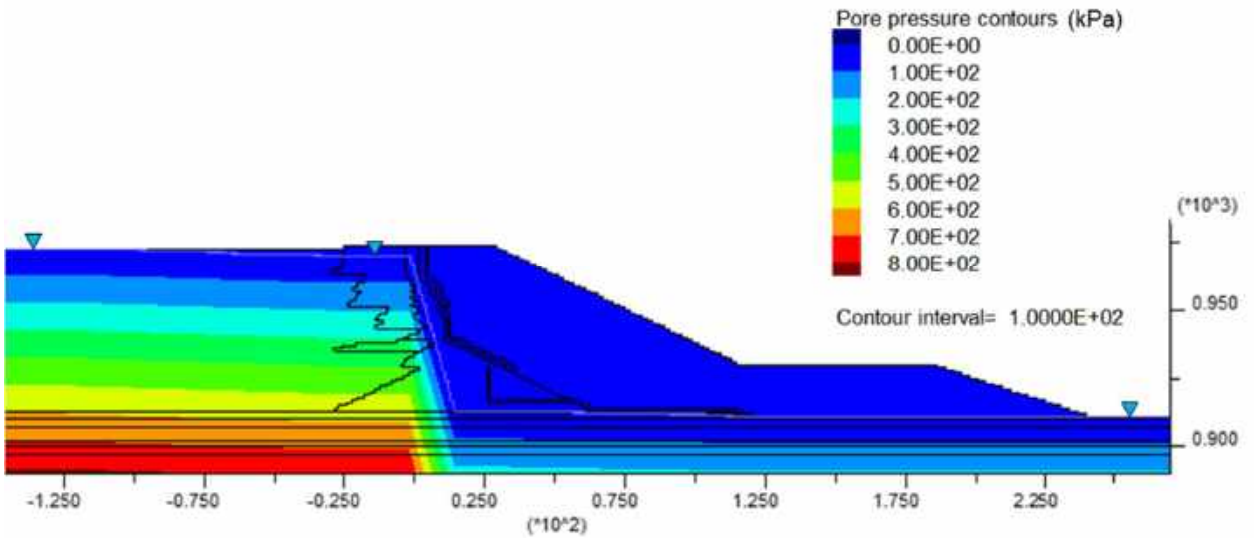


Figure 11: Assumed Pre-Seismic Groundwater Conditions, Section 2+055 – Main Embankment

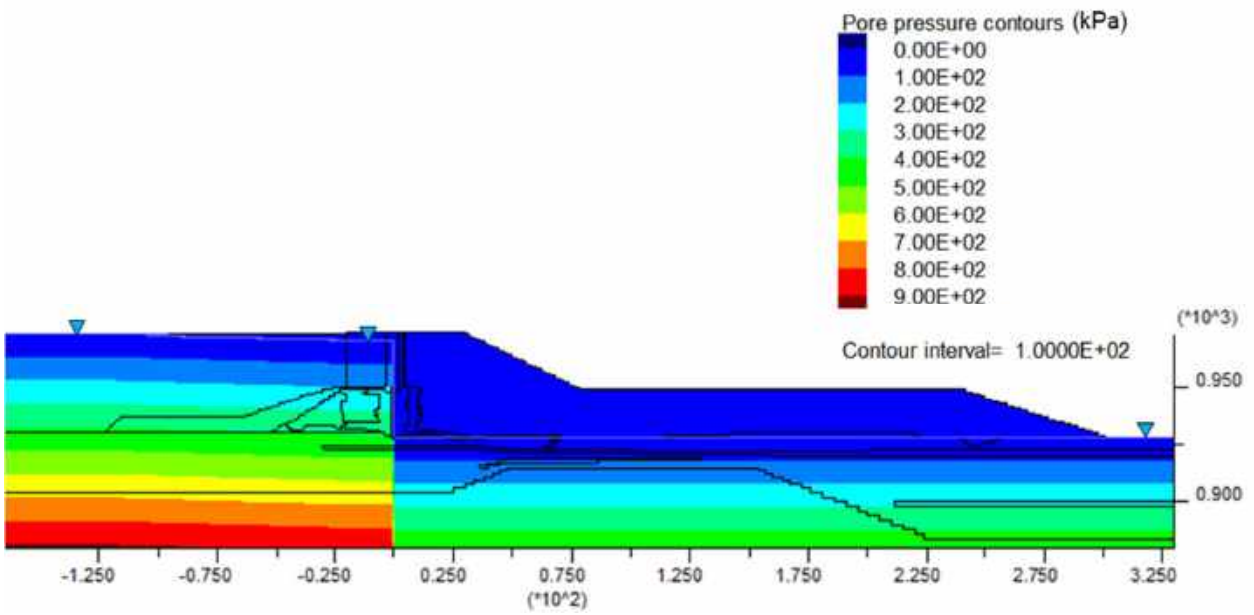


Figure 12: Assumed Pre-Seismic Groundwater Conditions, Section 4+175 – Perimeter Embankment at Corner 1

9.3 Simulation of the Design Earthquake

The response of the embankments to the design earthquake was simulated by using selected earthquake acceleration time histories (EATHs) developed in the seismic hazard assessment as input ground motions at the base of the models. One crustal motion (RSN4478N) and one subduction interface motion (RSN4000183EW) were selected from the 22 EATHs developed, corresponding to those with the maximum Arias intensity for each seismic source (see Section 8.0). The polarity (sign) of each input ground motion was inverted and the analysis repeated to assess the effect of earthquake directionality on the embankments seismic response. Direct polarity (DP) refers to the earthquake acting in one direction and reverse polarity (RP) to the opposite direction.

For the simulation of the design earthquake loading, the bottom boundaries of the model were assigned as quiet (flexible base) and the lateral boundaries as free-field.

9.4 Analysis Results

The following sections present the results of the seismic analysis carried out on section 2+055 of the Main Embankment Figure 13 to Figure 15) and section 4+175 of the Perimeter Embankment at Corner 1 (Figure 16 to Figure 18). For ease of presentation, contours plots are presented only for EATHs applied with direct polarity. Attachment 2 presents the results obtained with the selected EATHs with both polarities.

Contours of predicted horizontal and vertical seismic displacements at the end of earthquake shaking are presented to evaluate potential deformation mechanisms. Predicted displacement-time histories at selected points of the embankment are presented to assess the stability of the embankment at the end of earthquake shaking. Contours of accumulated plastic shear strains during seismic loading are presented to evaluate the potential for strain-weakening in the GLU. Contours of excess pore water pressure ratio are presented to identify where liquefaction was predicted. The excess porewater pressure ratio, $r_u=\Delta u/\sigma'_{v0}$, is defined as the ratio between the excess pore water pressure (Δu) developed during cyclic loading and the initial vertical effective stress (σ'_{v0}).

Full liquefaction occurs when the excess pore water pressure developed during cyclic loading is equal to the initial vertical effective stress (r_u=100%) However, r_u values greater than about 70% are typically high enough to induce significant soil softening and weakening. Zones where r_u exceeds 70% are referred herein as liquefied even though full liquefaction was not reached.

9.4.1 Predicted Main and Perimeter Embankment Deformations

The displacement-time histories show that the movement of both sections analysed stop at the end of earthquake shaking, indicating that the embankment in both analysed sections is stable at the end of the earthquake design ground motions (see Figure 13 and Figure 16). The maximum permanent horizontal displacement in the downstream direction predicted in the embankments and buttresses is less than 5 cm.

Results obtained using the subduction interface motion indicate that a deformation mechanism, with limited upstream movement and settlement of the upstream fill (up to 0.5 m), is initiated upstream of the embankments due to liquefaction of the tailings and upstream fill during earthquake shaking. These displacements could potentially affect the serviceability of the upstream drains at elevation 970 m. This deformation mechanism is not observed during the crustal motion because liquefaction is not triggered in the tailings and upstream fill.

The maximum permanent horizontal and vertical displacements predicted at the centreline of the embankments (i.e., at the crest of the till core) are less than 4 cm. The serviceability of the till core is not expected to be affected by this level of displacements.

9.4.2 GLU Plastic Shear Strains and Potential Strength Weakening

Main Embankment – Section 2+055

Predicted plastic shear strains accumulated during earthquake shaking are less than 0.5% in the GLU at the Main Embankment. Plastic shear strains predicted in the GLU at the end of the construction of the Main Embankment up to elevation 974 m were less than 1.5% (see Figure 6b). The predicted total plastic shear strains (static plus seismic) are still less than 2%. Hence, the weakening process is not expected to be initiated in the GLU at the Main Embankment during the earthquake design ground motions.

Perimeter Embankment at Corner 1 – Section 4+175

Predicted plastic shear strains during earthquake shaking are less than 1% in the UGLU below the downstream slope of the Perimeter Embankment at Corner 1. The static analysis predicted a limited shear band at that location with plastic shear strains of about 10% (see Figure 7b), indicating that the weakening process was initiated during construction of the embankment up to elevation 974 m. The predicted level of strain-weakening is relatively low (less than 1.5% strength reduction) and does not have a significant impact on the seismic stability of the embankment at Corner 1.

Predicted plastic shear strains during earthquake shaking is about 2% in the UGLU below the downstream slope of the buttress at the Perimeter Embankment at Corner 1. The static analysis did not predict development of plastic shear strains at that location during construction of the embankment up to elevation 974 m. Hence, initiation of the weakening process is not expected in the UGLU at that location during the earthquake design ground motions.

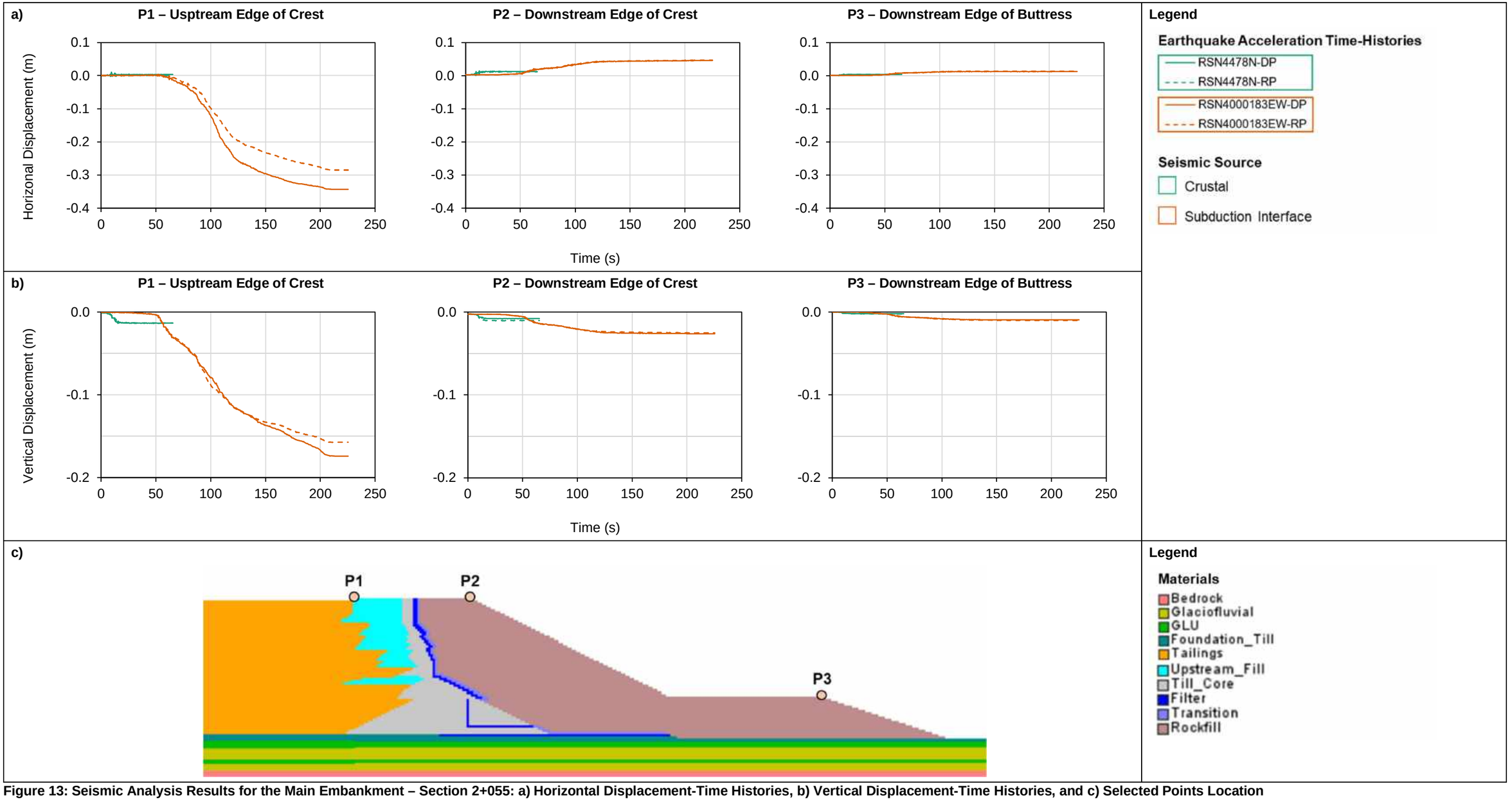
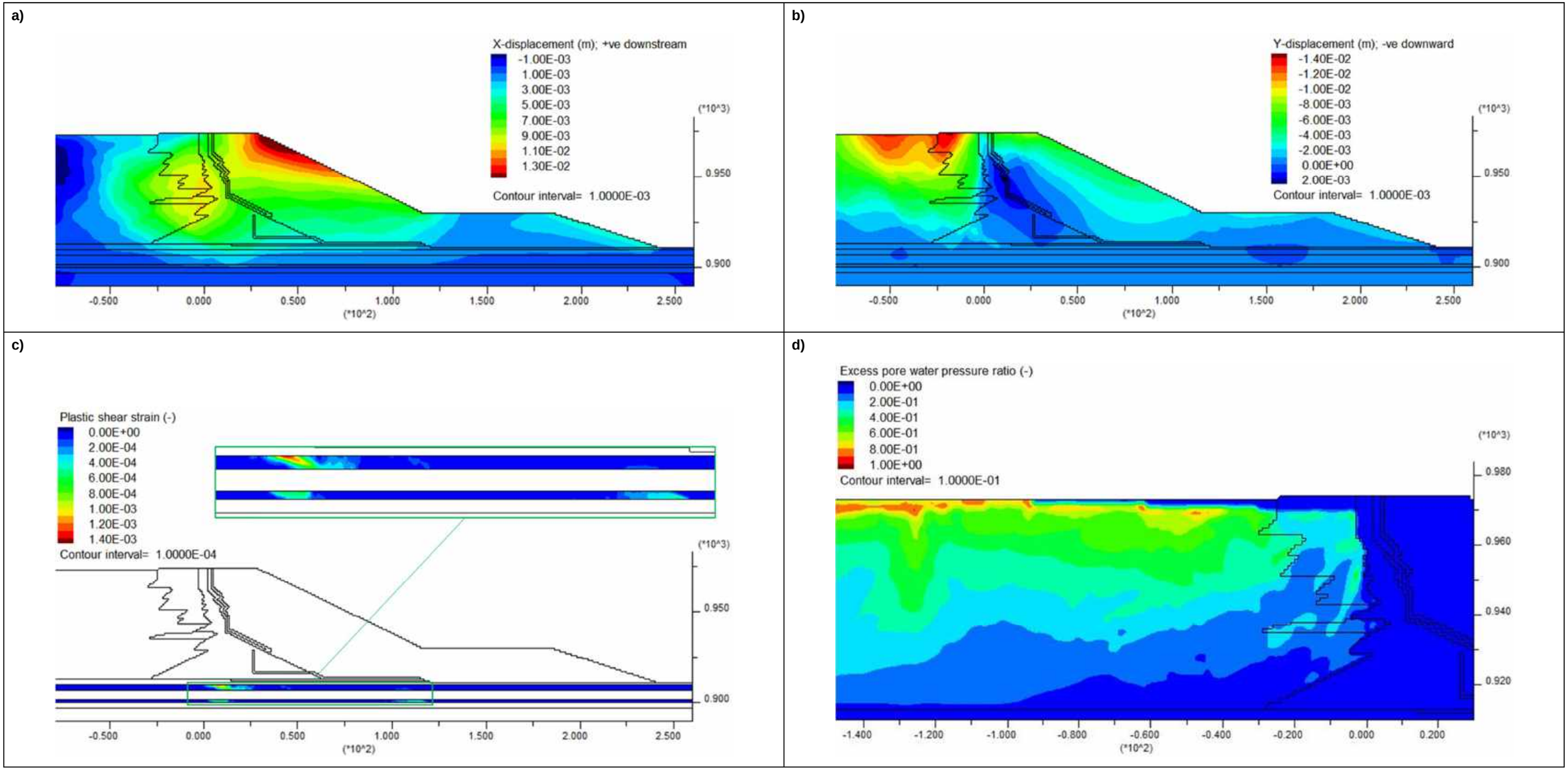
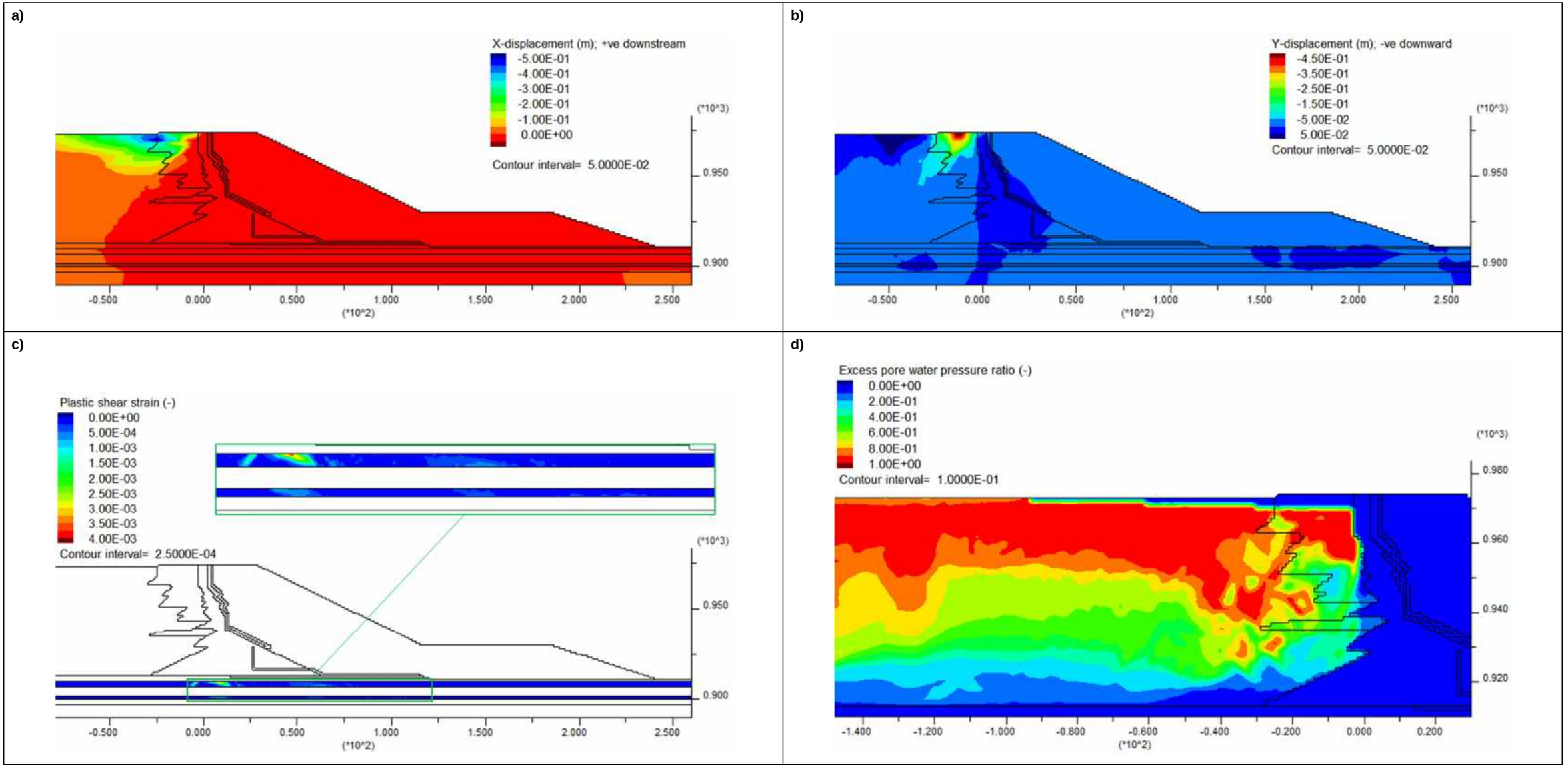


Figure 13: Seismic Analysis Results for the Main Embankment – Section 2+055: a) Horizontal Displacement-Time Histories, b) Vertical Displacement-Time Histories, and c) Selected Points Location



Note: Axes unit is meters.

Figure 14: Seismic Analysis Results for the Main Embankment – Section 2+055 at the End of the Crustal EATH RSN4478N with Direct Polarity (DP): a) Contours of Horizonal Permanent Seismic Displacement, b) Contours of Vertical Permanent Seismic Displacement, c) Contours of Permanent Seismic Plastic Shear Strains and d) Contours of Excess Pore Water Pressure Ratio (r_u).



Note: Axes unit is meters.

Figure 15: Seismic Analysis Results for the Main Embankment – Section 2+055 at the End of the Subduction Interface EATH RSN4000183EW with Direct Polarity (DP): a) Contours of Horizonal Permanent Seismic Displacement, b) Contours of Vertical Permanent Seismic Displacement, c) Contours of Permanent Seismic Plastic Shear Strains and d) Contours of Excess Pore Water Pressure Ratio (r_u).

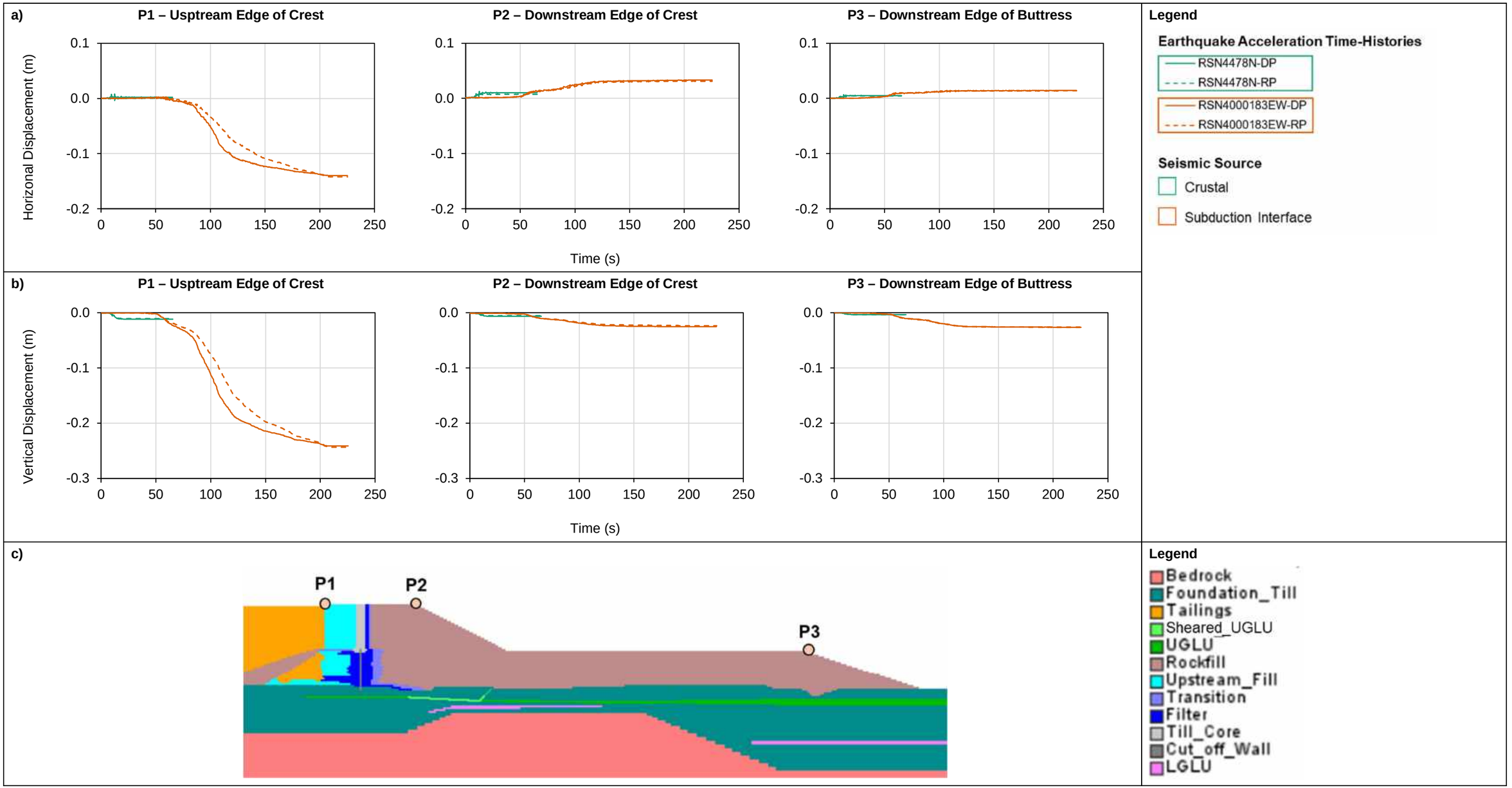
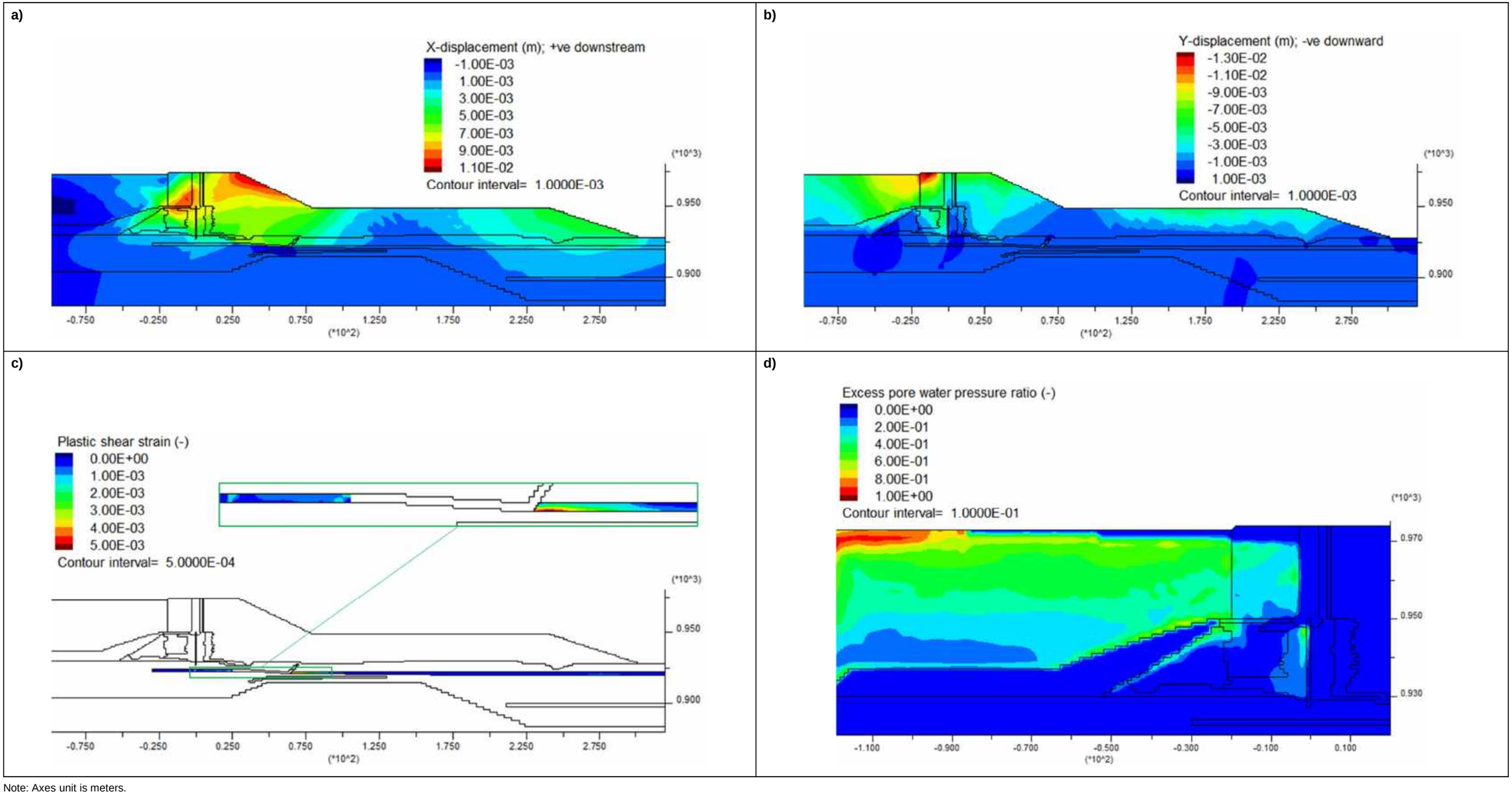
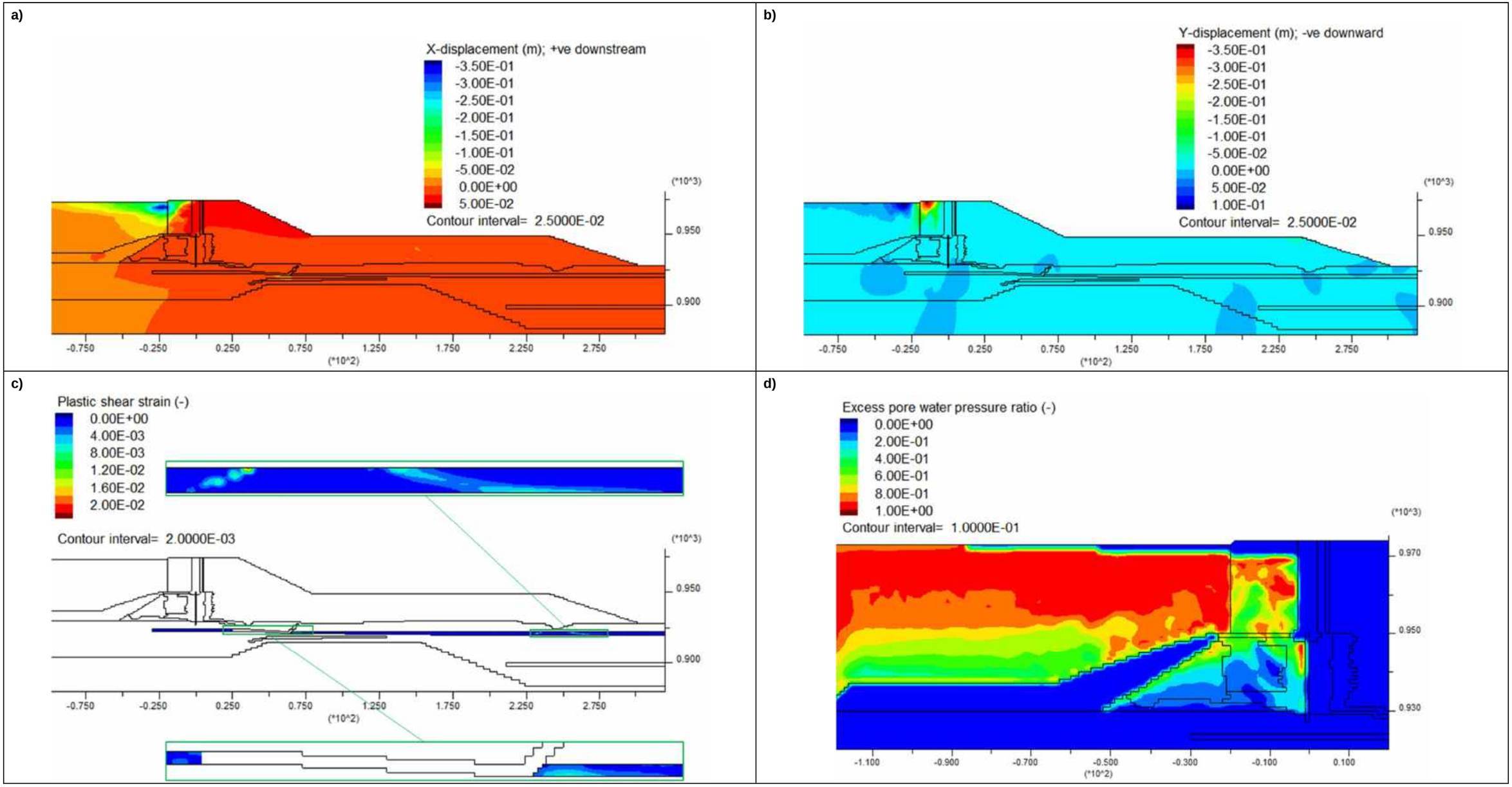


Figure 16: Seismic Analysis Results for the Perimeter Embankment at Corner 1 – Section 4+175: at Selected Points: a) Horizontal Displacement-Time Histories, b) Vertical Displacement-Time Histories, and c) Selected Points Location



Note: Axes unit is meters.

Figure 17: Seismic Analysis Results for the Perimeter Embankment at Corner 1 – Section 4+175 at the End of the Crustal EATH RSN4478N with Direct Polarity (DP): a) Contours of Horizonal Permanent Seismic Displacement, b) Contours of Vertical Permanent Seismic Displacement, c) Contours of Permanent Seismic Plastic Shear Strains and d) Contours of Excess Pore Water Pressure Ratio (r_u). (Axes Units: m)



Note: Axes unit is meters.

Figure 18: Seismic Analysis Results for the Perimeter Embankment at Corner 1 – Section 4+175 at the End of the Subduction Interface EATH RSN4000183EW with Direct Polarity (DP): a) Contours of Horizonal Permanent Seismic Displacement, b) Contours of Vertical Permanent Seismic Displacement, c) Contours of Permanent Seismic Plastic Shear Strains and d) Contours of Excess Pore Water Pressure Ratio (ru).

10.0 CONCLUSIONS

Stress-deformation analyses were carried out on section 2+055 of the Main Embankment and section 4+175 of the Perimeter Embankment at Corner 1 to support the detailed design for the raise of the TSF from elevation 970 to 974 m. The analyses were performed to further confirm the stability of the embankments at the end of construction up to elevation 974 m (static analysis) and under the 2,475-year earthquake load (seismic analysis). One crustal motion and one subduction interface motion were used as input ground motions in the seismic analysis. The conclusions of the analyses are presented in the following sections.

10.1 Static Analysis

- Section 2+055 of the Main Embankment and section 4+175 of the Perimeter Embankment at Corner 1 are predicted to be stable at the end of construction up to elevation 974 m under the analysed conditions.
- The factor of safety computed at the end of construction is about 1.6 for section 2+055 of the Main Embankment and about 1.7 for section 4+175 of the Perimeter Embankment at Corner 1.
- Strain-weakening is not predicted in the GLU at section 2+055 of the Main Embankment during construction up to elevation 974 m.
- Assuming a constant 22 kPa undrained shear strength for the UGLU that sheared during the failure in 2014 (i.e., no inclusion of potential strength gains from reconsolidation), a shear band about 3 m long with a maximum plastic shear strain of about 10% is predicted to develop below the downstream slope of the Perimeter Embankment at Corner 1 at section 4+1475. However, the predicted degree of strain-weakening is relatively low (about 6% strength reduction in a 3 m long shear band) and does not have a significant impact on the stability of the elevation 974 m embankment.

10.2 Seismic Analysis

- Section 2+055 of the Main Embankment and section 4+175 of the Perimeter Embankment at Corner 1 are predicted to be stable under the action of the 2,475-year earthquake ground motion.
- The maximum permanent horizontal displacement in the downstream direction is less than 5 cm in the embankments and buttresses of both analysed sections under the action of the 2,475-year earthquake ground motion.
- The maximum permanent horizontal and vertical displacements predicted at the centreline of the embankments in both analysed sections are less than 4 cm at the end of the 2,475-year earthquake ground motion. The serviceability of the till core is not expected to be affected by this level of displacements.
- Strain-weakening is not predicted in the GLU at section 2+055 of the Main Embankment under the action of the 2,475-year earthquake ground motion.
- Assuming a constant 22 kPa undrained shear strength for the UGLU that sheared during the failure in 2014 (i.e., no inclusion of potential strength gains from reconsolidation), a relatively low level of strain-weakening (less than 1.5% strength reduction) is predicted in the UGLU under the downstream slope of the Perimeter Embankment at section 4+175, during the 2,475-year earthquake ground motion. This degree of weakening is relatively low (less than 1.5% strength reduction) and does not have a significant impact on the seismic stability of the embankment.

- A deformation mechanism, with limited upstream movement and settlement of the upstream fill (up to 0.5 m) may develop if the phreatic surface upstream of the till core is relatively shallow and the seismic loading is enough to trigger liquefaction in the tailings and upstream fill. This deformation mechanism was predicted in both analysed sections and only under the action of the subduction interface motion. The displacements associated with this deformation mechanism could potentially affect the serviceability of the upstream drain at elevation 970 m. The seismic loading from the crustal motion was not sufficient to trigger liquefaction in the tailings and upstream fill.

11.0 CLOSING

We trust the above meets your present requirements. If you have any questions or comments, please contact the undersigned.

WSP Canada Inc.





Andrés E. Torres Guerrero, M.Sc., P.Eng.
Lead Geotechnical Engineer

Germán Pizarro, P.Eng.
Principal Geotechnical Engineer

ATG/MS/GP/hp

Engineers & Geoscientists BC Permit #1000200

Attachments: Attachment 1 – Model Construction Sequence
Attachment 2 – Seismic Analyses Results

https://golderassociates.sharepoint.com/sites/10023g/ca00205274505 deliverables/002_issued/005-tm-51346-numerical model report (tsf 974m stress-deformation analyses)/rev0/ca0020527.4505-005-tm-rev0-51346-numerical model report 21mar_24.docx

REFERENCES

AMEC. 2014. Mount Polley Mine, Tailings Storage Facility Stage 9 – 2013 As-Built and Annual Review Report. Prepared for Mount Polley Mining Corporation. Likely, BC. Submitted March 12, 2014.

BC MEM (British Columbia Ministry of Energy and Mines). 2016. Guidance Document – Health, Safety and Reclamation Code for Mines in British Columbia. Version 1.0. Updated July 2016.

British Columbia Ministry of Energy and Mines (BCMEM). 2015. Mount Polley Mine Tailings Storage Facility Breach. Investigation Report of the Chief Inspector of Mines. November 30, 2015.

Byrne, P.M, Cheung, H., and Yan, L. 1987. Soil parameters for Deformation Analyses of Sand Masses. Canadian Geotechnical Journal 1987, 24(4):366-376.

CDA. 2019. Technical Bulletin: Application of CDA Dam Safety Guidelines to Mining Dams.

Cundall P. 2012. FLAC software, Version 8.0. ITASCA Consulting Group Inc., Minneapolis, U.S.A.

Golder 2015a. Mount Polley Mine 2015 Freshet Management Embankment As-Built Construction. Prepared for Mount Polley Mining Corporation. Submitted September 4, 2015. Document No. 1413803-065-R-Rev0-2000.

Golder. 2015b. Mount Polley mine tailings storage facility detailed design to elevation 970 m. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-074-R-Rev0-3000; 3 November 2015.

Golder. 2015c. Tailings storage facility life of mine feasibility design. Document prepared for Mount Polley Mining Corporation. Golder Doc No. 1413803-072-R-Rev0-9000. 3 November 2015.

Golder 2016. Seismic Deformation Analysis of the Tailings Storage Facility at Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Submitted September 4, 2015. Document No. 1413803-065-R-Rev0-2000.

Golder. 2017a. 2016 main embankment buttress and perimeter embankment buttress extension construction record report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-071-R-Rev0-52291; 30 January 2017.

Golder. 2017b. 2016 Corner 1 Embankment Construction Record Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-120-R-Rev0-52291; 24 March 2017.

Golder. 2018. 2017 Corner 1 Embankment Construction Record Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-204-R-Rev0-52293; 7 March 2018.

Golder. 2019. 2018 Tailings Storage Facility Construction Record Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1894924-075-R-Rev0-52292; 27 March 2019.

IEEIRP (Independent Expert Engineering Investigation and Review Panel). 2015. Report on Mount Polley Tailings Storage Facility Breach. Prepared for BC Ministry of Energy and Mines. 30 January 2015.

KCB. 2015a. Mount Polley Dam Failure – Advanced Laboratory Testing Program Progress Report No. 4. Prepared for BC Ministry of Energy and Mines. Doc. No. M09954A02.730. 12 February 2015.

KCB. 2015b. Mount Polley Dam Failure – Site Investigation Progress Report No. 2. Prepared for BC Ministry of Energy and Mines. Doc. No. M09954A02.730. 21 January 2015.

Knight Piésold (Knight Piésold Ltd.). 1995. Mount Polley Project: Tailings Storage Facility Design Report. Volumes I and II. Prepared for Imperial Metals Corporation. Submitted May 26, 1995.

Ladd, C.C., and Foott, R. 1974. New Design Procedure for Stability of Soft Clays. Journal of the Geotechnical Engineering Division, 100(GT7), 736-786.

Leps, T.M. 1970. Review of Shearing Strength of Rock Fill. Proceedings of the ASCE, Journal of the Soil Mechanics and Foundations Division. Vol. 96, SM4:1159-1170, July 1970.

Naesgaard, Ernest. 2011. A Hybrid Effective Stress – Total Stress Procedure for Analyzing Soil Embankments Subjected to Potential Liquefaction and Flow. Ph.D. Thesis. Civil engineering, University of British Columbia.

Vucetic, M. and Dobry, R. (1991). Effect of Soil Plasticity on Cyclic Response. Journal of Geotechnical Engineering, Vol 117 No. 1 Paper No. 25418.

WSP Golder 2022. Bedrock Shear-Wave Velocity Measurements at Three Locations Along the Tailings Storage Facility at Mt. Polley Mine, BC. Prepared for Mount Polley Mining Corporation. WSP Doc. No. 22514095-040-TM-RevA-51344; 10 June 2022.

WSP 2023a. Tailings Storage Facility Site Characterization Report, Mount Polley Mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. 22514095-034-R-Rev0-51392. 22 September 2023.

WSP 2023b. Site-Specific Seismic Hazard Assessment, Mount Polley Mine. 31404975.000. 1 February 2023.

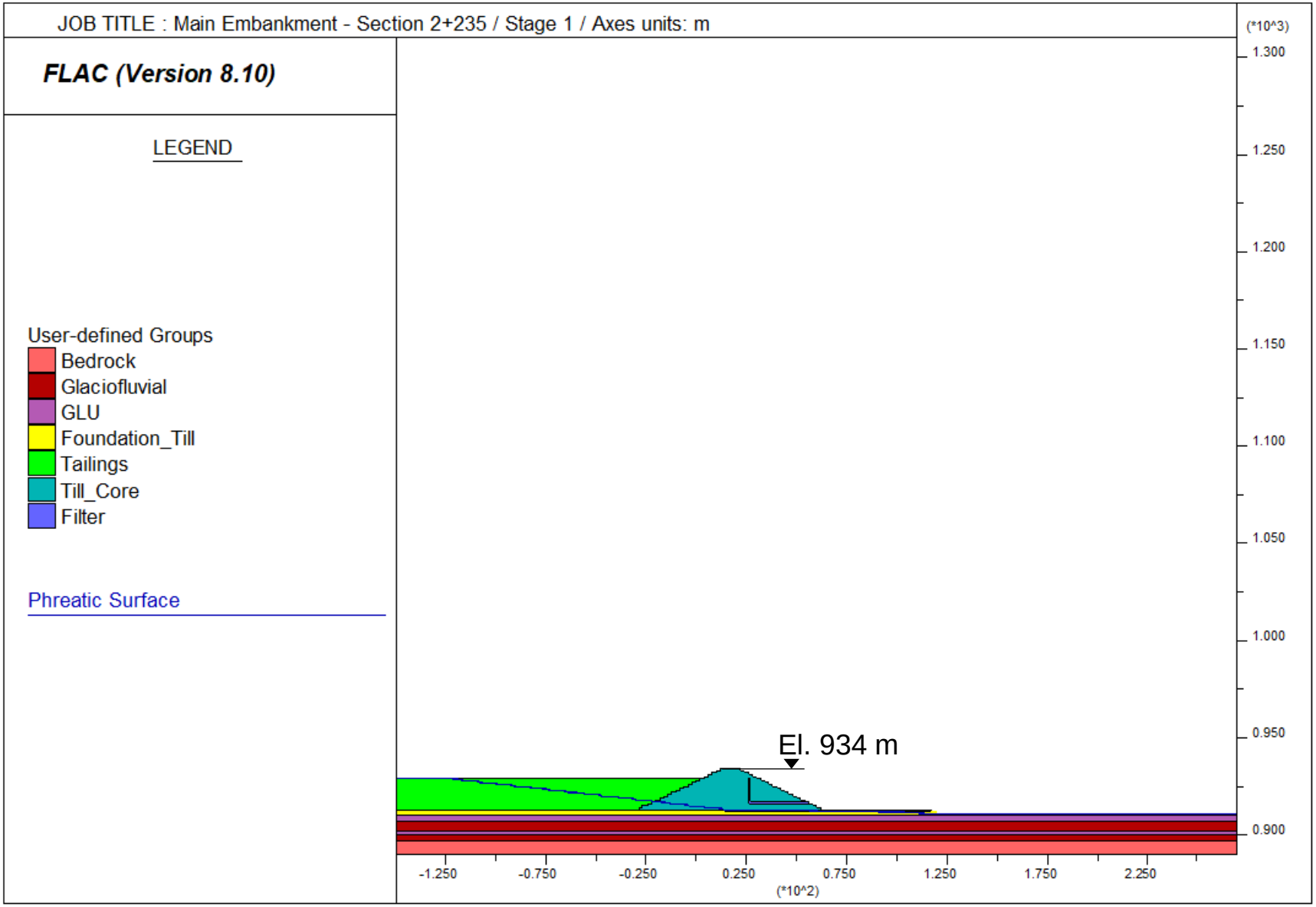
WSP 2024. Tailings Storage Facility – Detailed Design to Elevation 974 m, Mount Polley Mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. CA0020527.4505-014-R-RevA-51312; 23 February 2024.

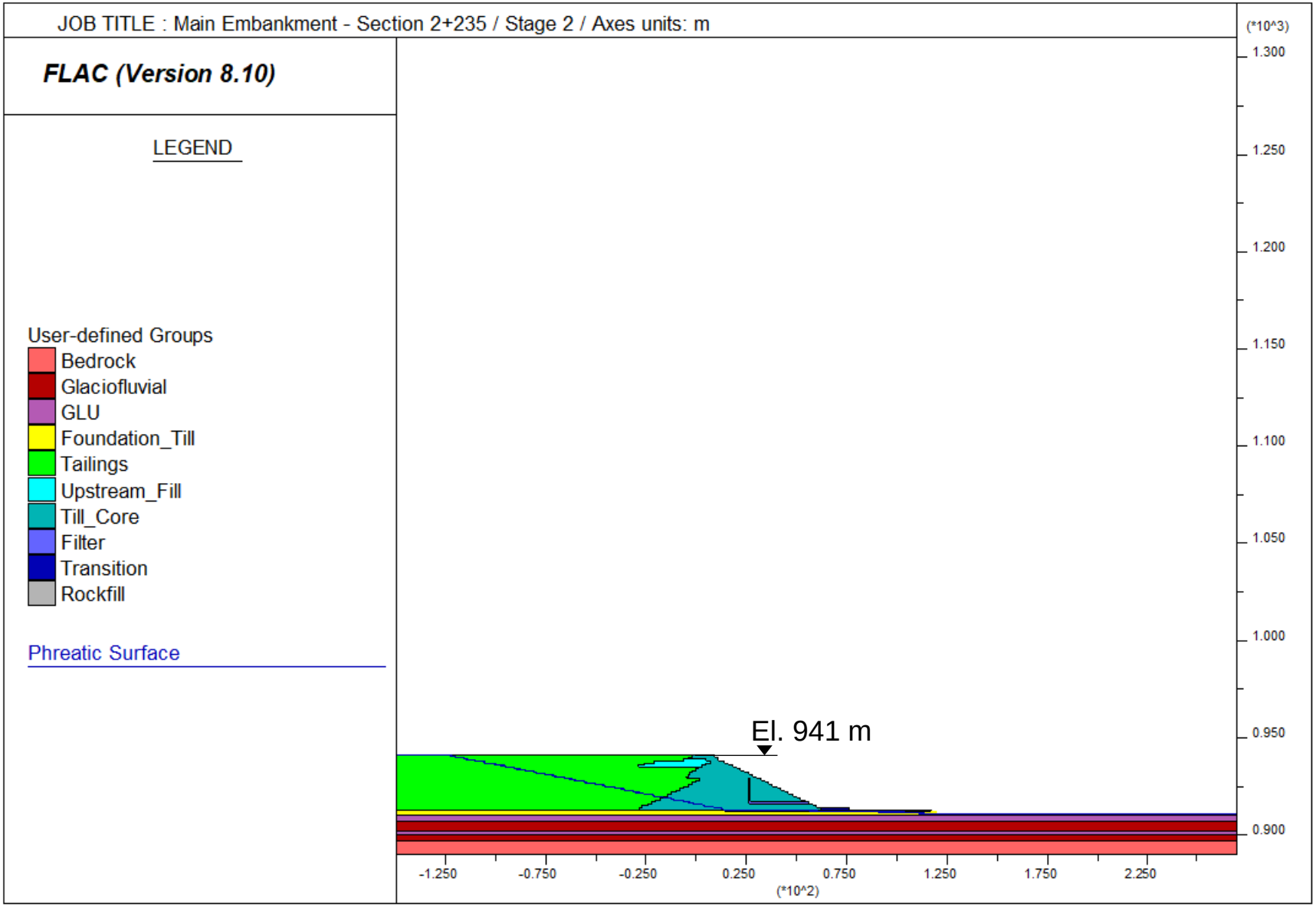
Zabolotnii, E., 2020. Three-dimensional slope stability effects in the failure at the Mount Polley Tailings Storage Facility. Doctoral Dissertation. University of Alberta, Edmonton, Canada, 2020.

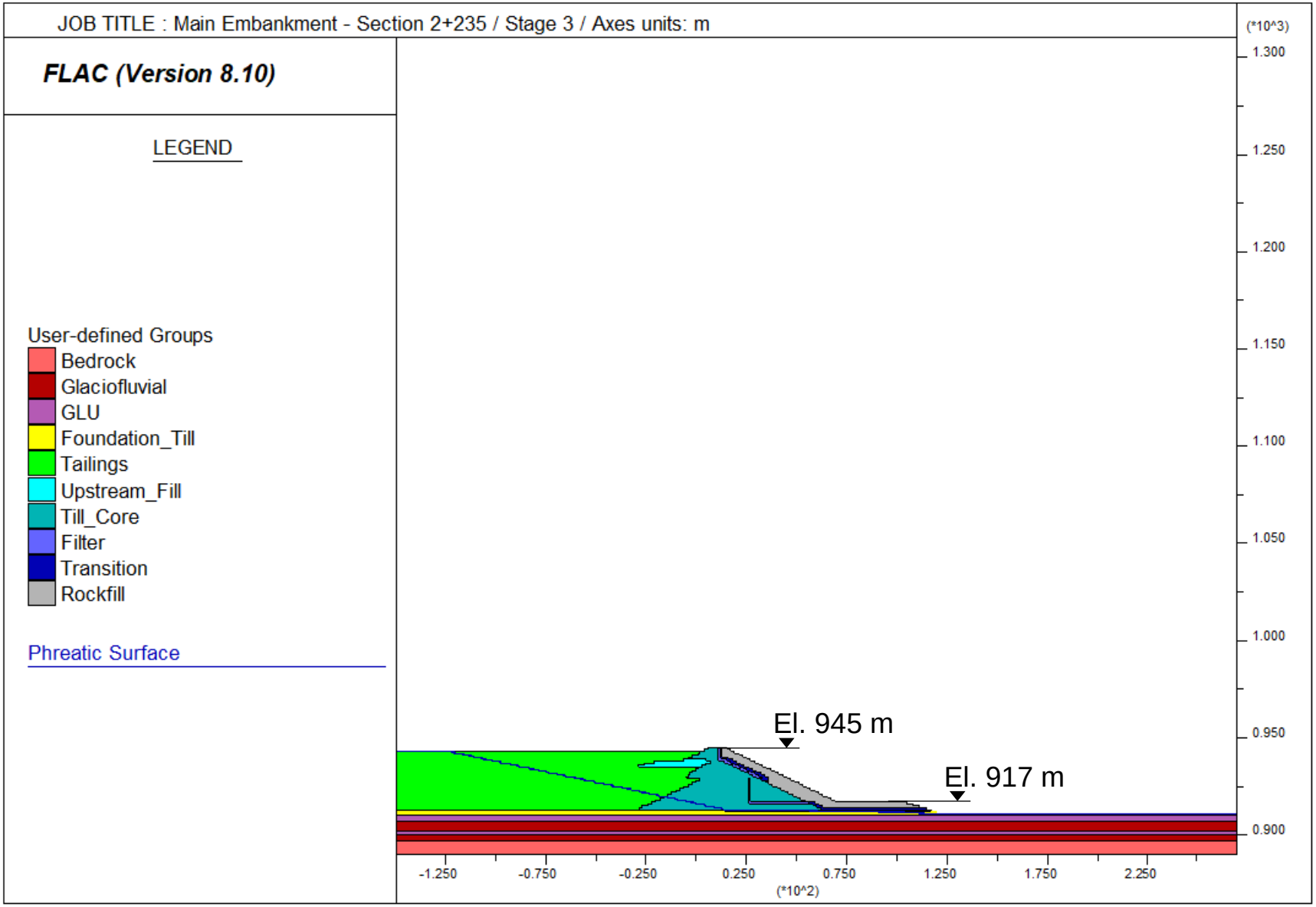
ATTACHMENT 1

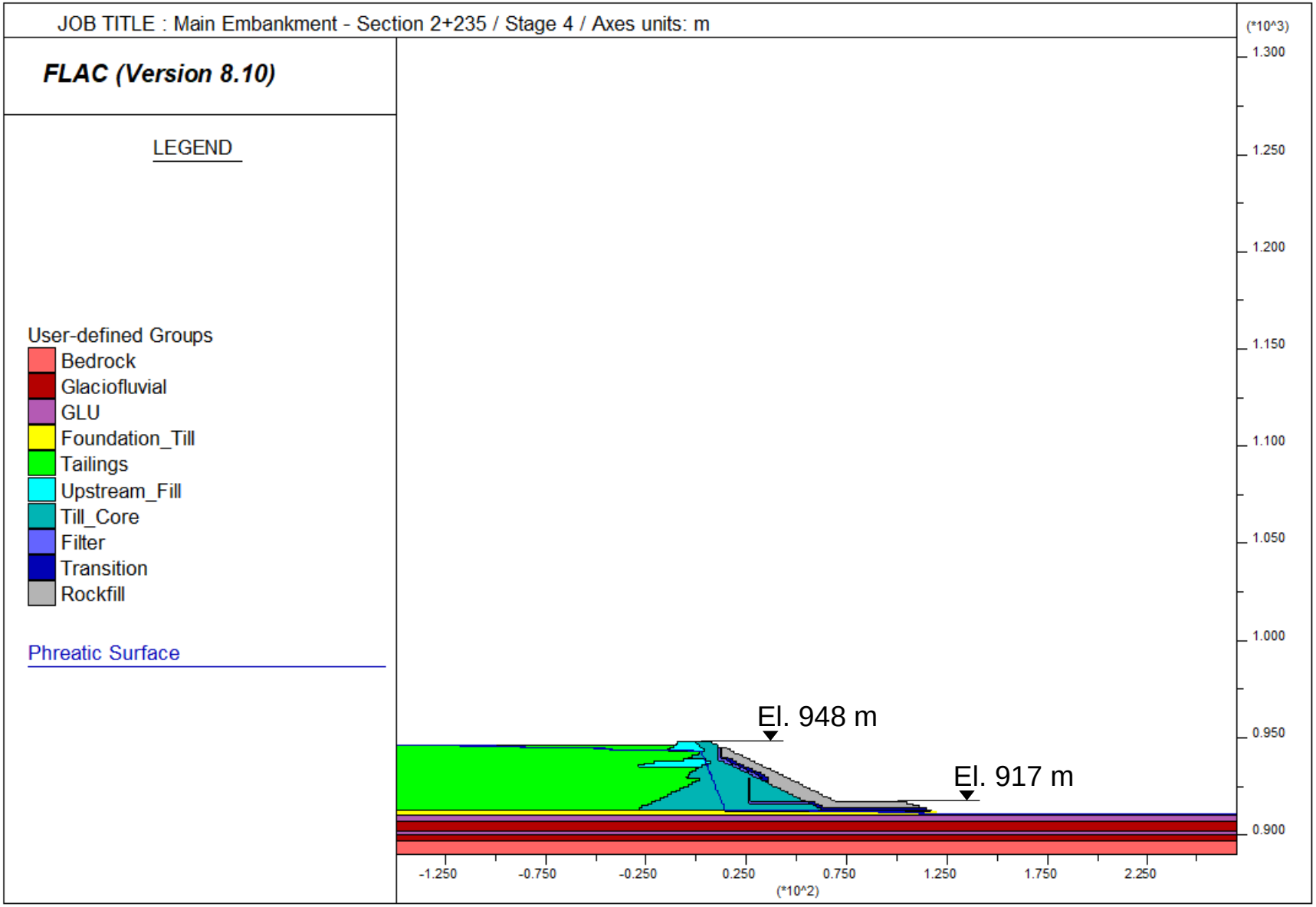
Model Construction Sequence

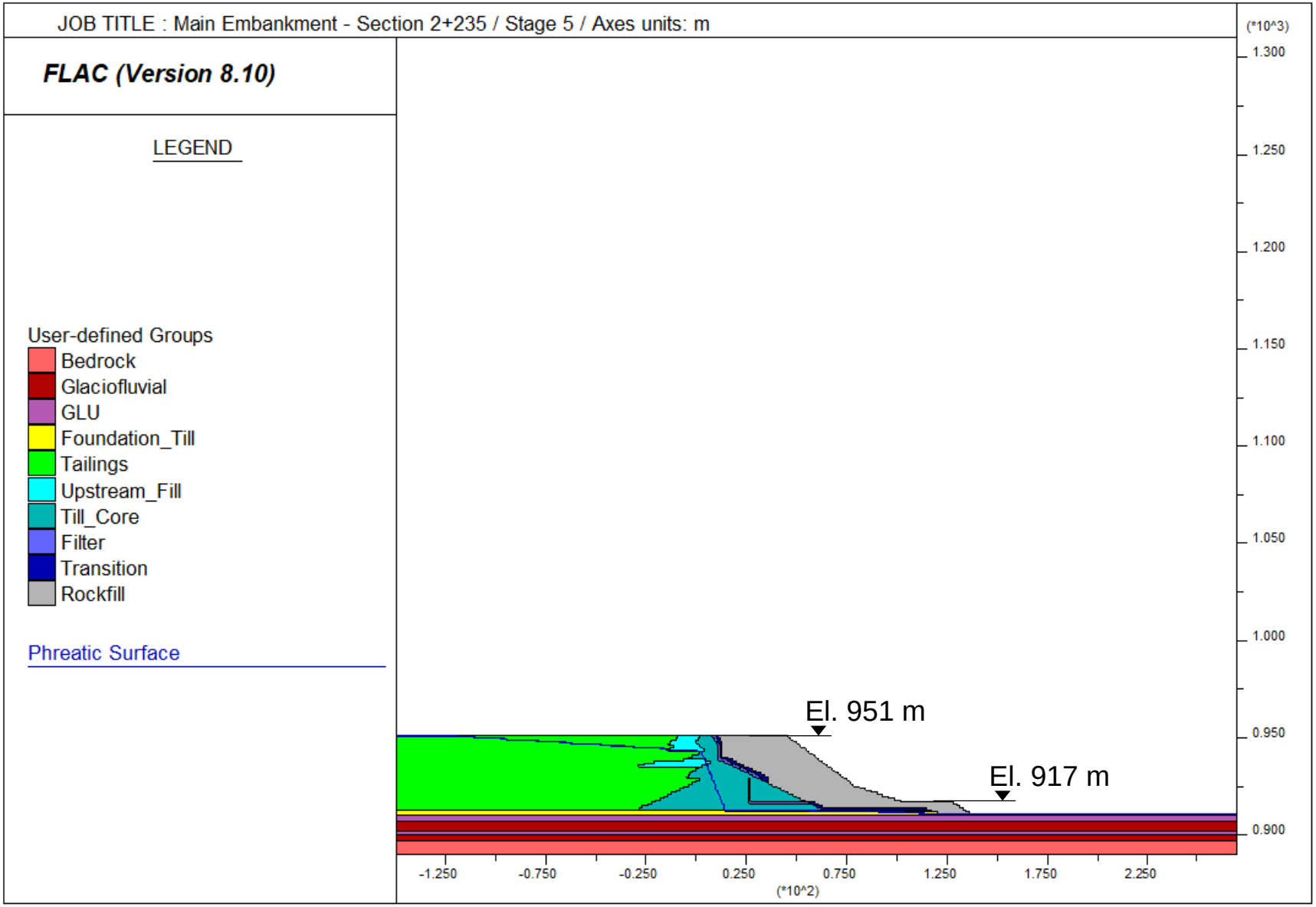
Main Embankment - Section 2+055

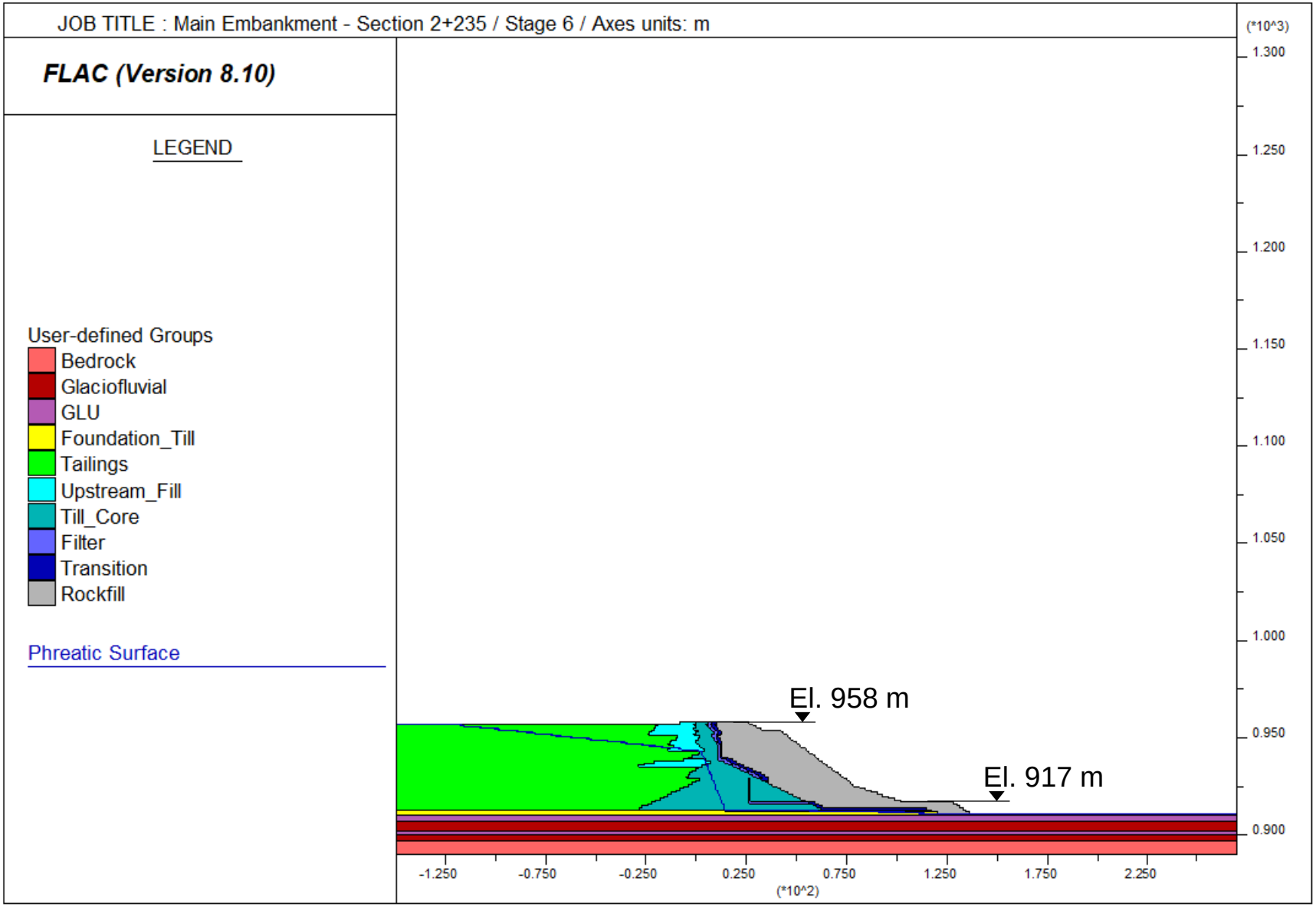

JOB TITLE : Main Embankment - Section 2+235 / Stage 1 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Till_Core
Filter
Phreatic Surface
El. 934 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

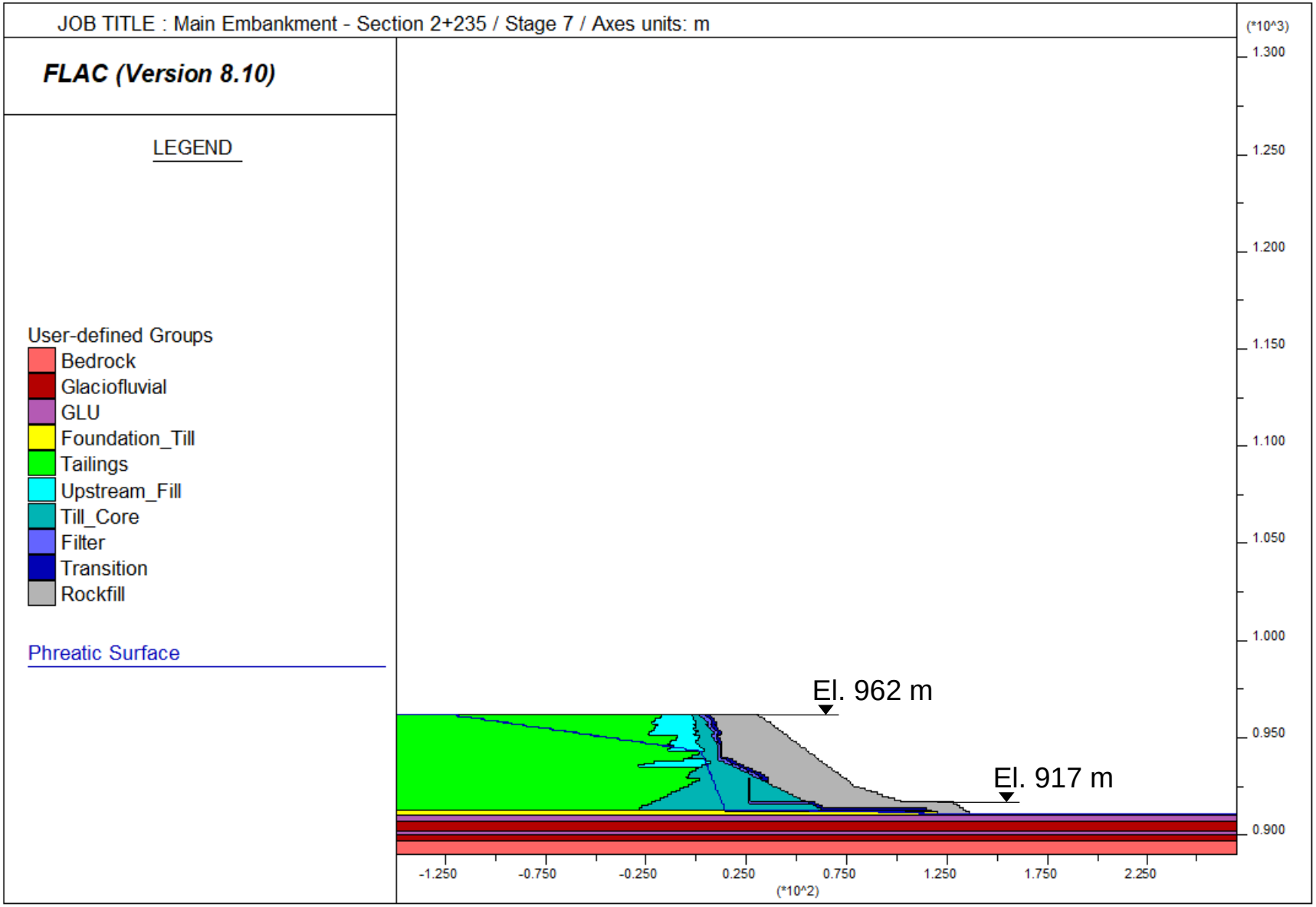

JOB TITLE : Main Embankment - Section 2+235 / Stage 2 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 941 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

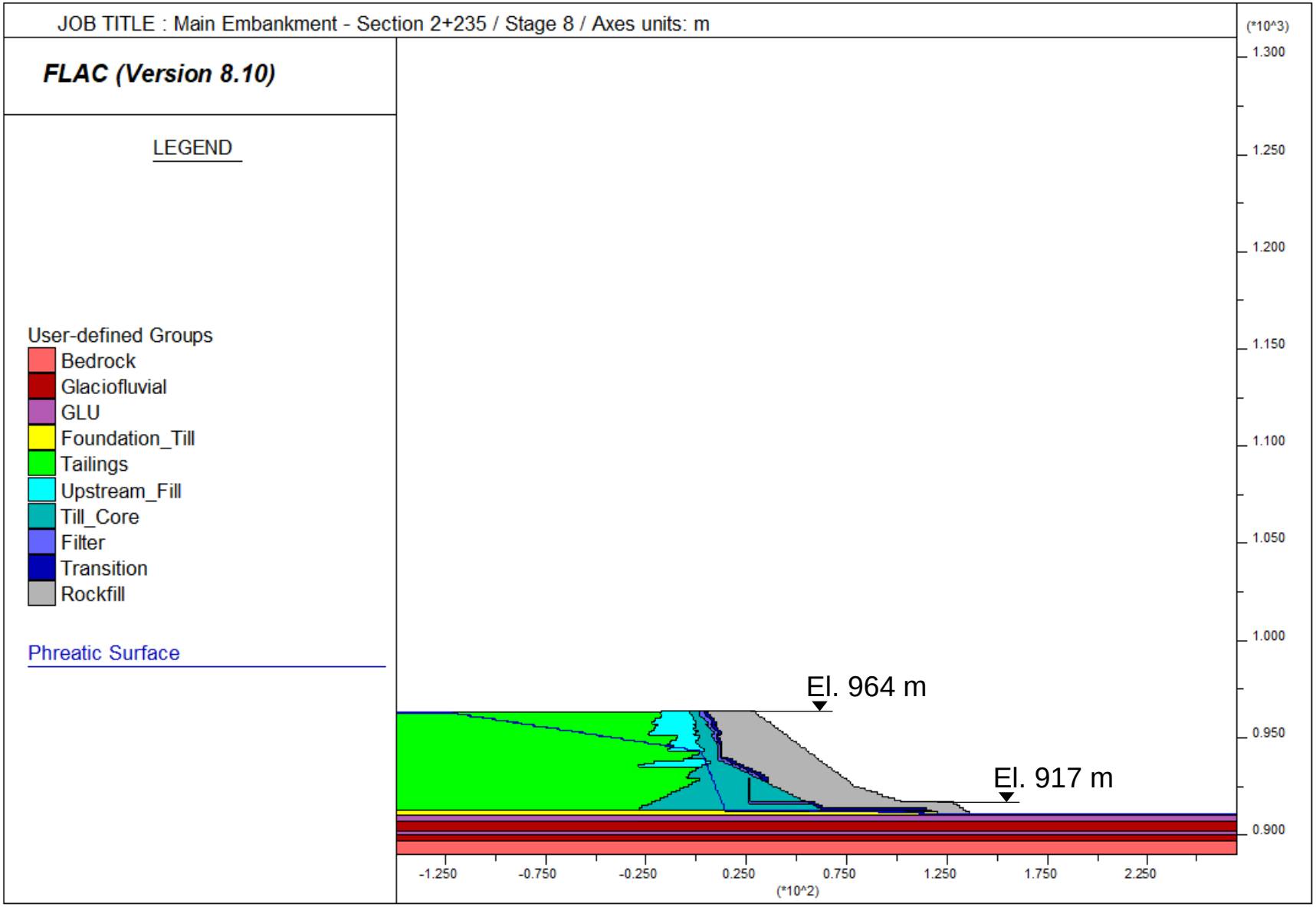

JOB TITLE : Main Embankment - Section 2+235 / Stage 3 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 945 m
El. 917 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

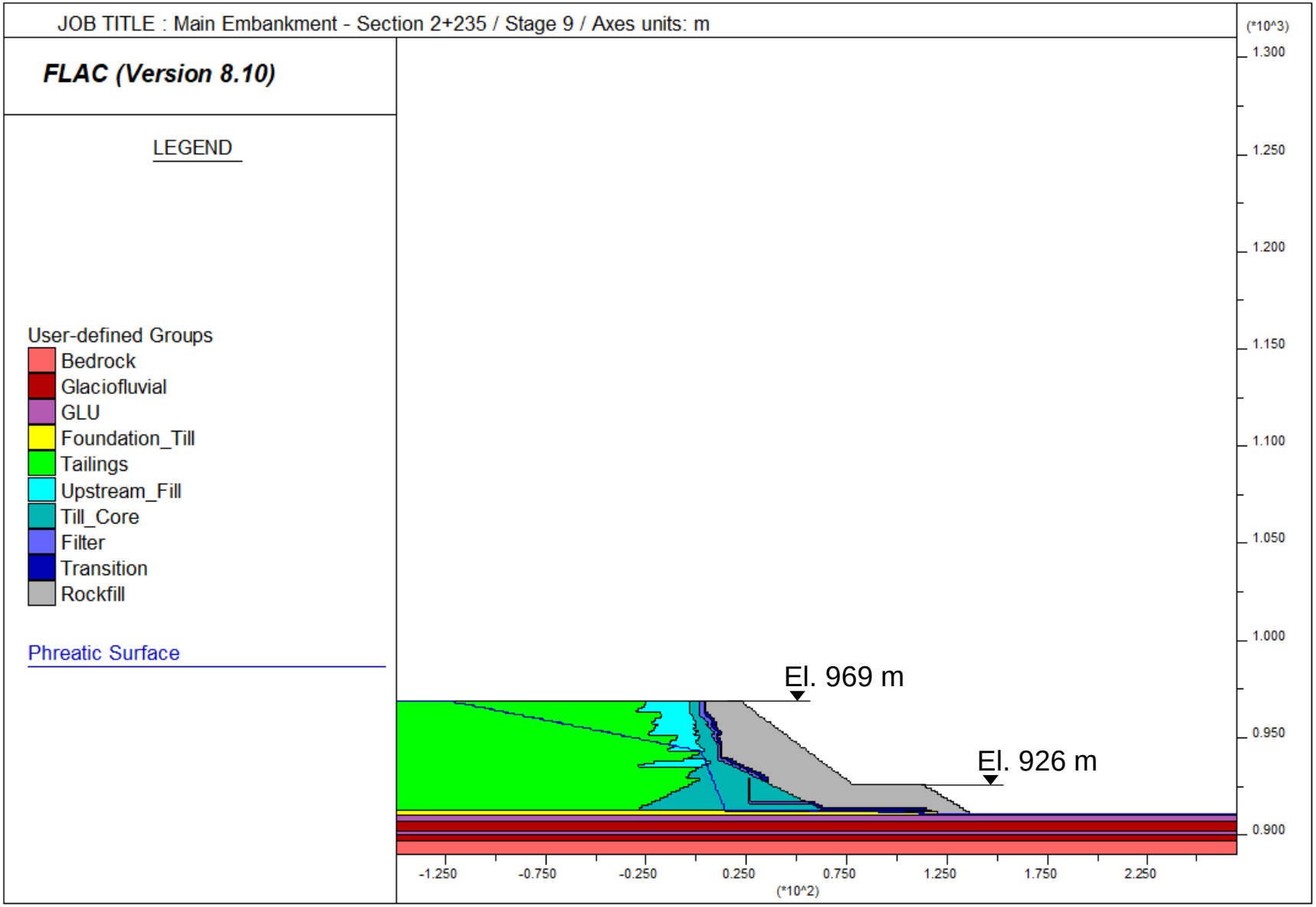

JOB TITLE : Main Embankment - Section 2+235 / Stage 4 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 948 m
El. 917 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

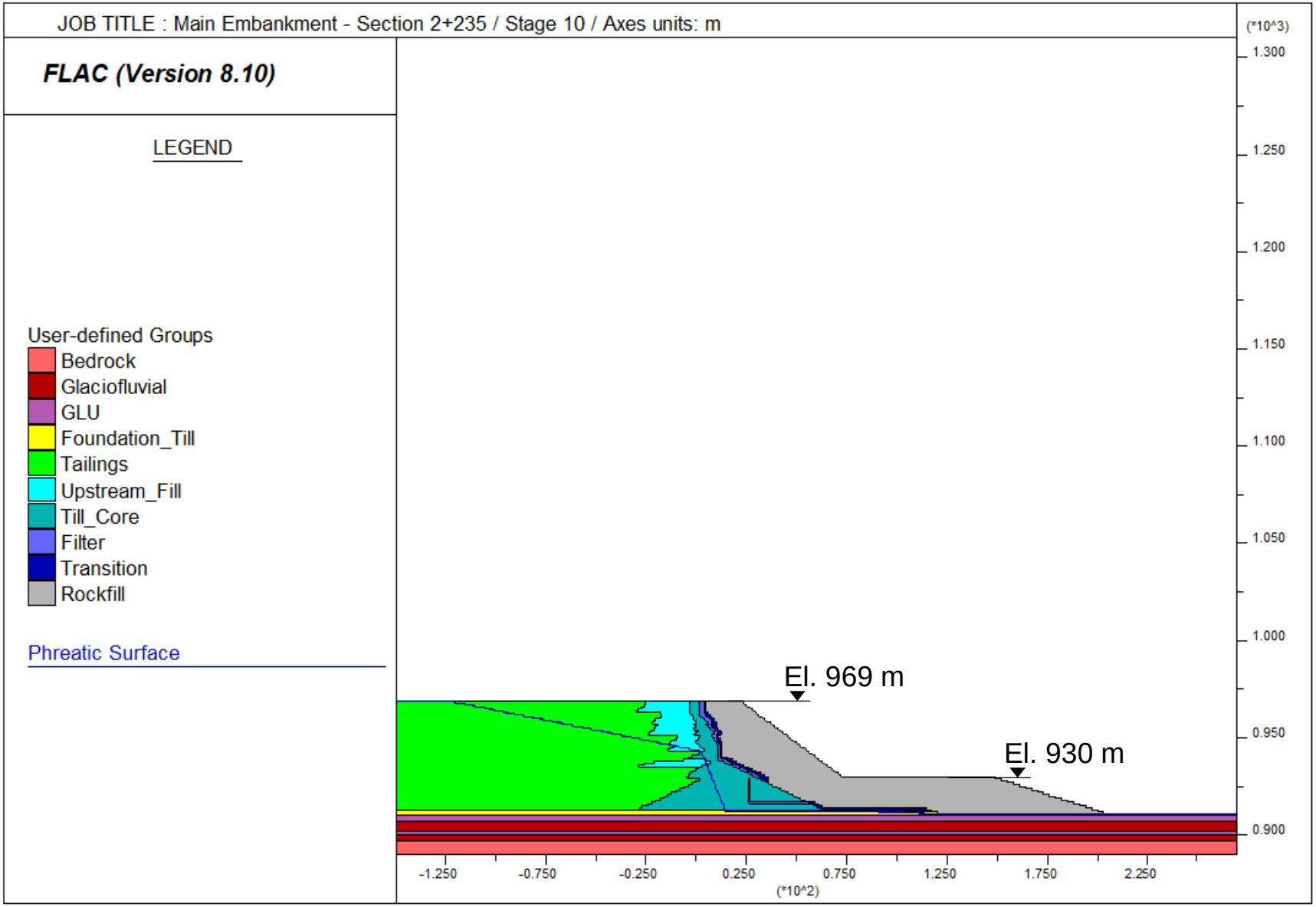

JOB TITLE : Main Embankment - Section 2+235 / Stage 5 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 951 m
El. 917 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

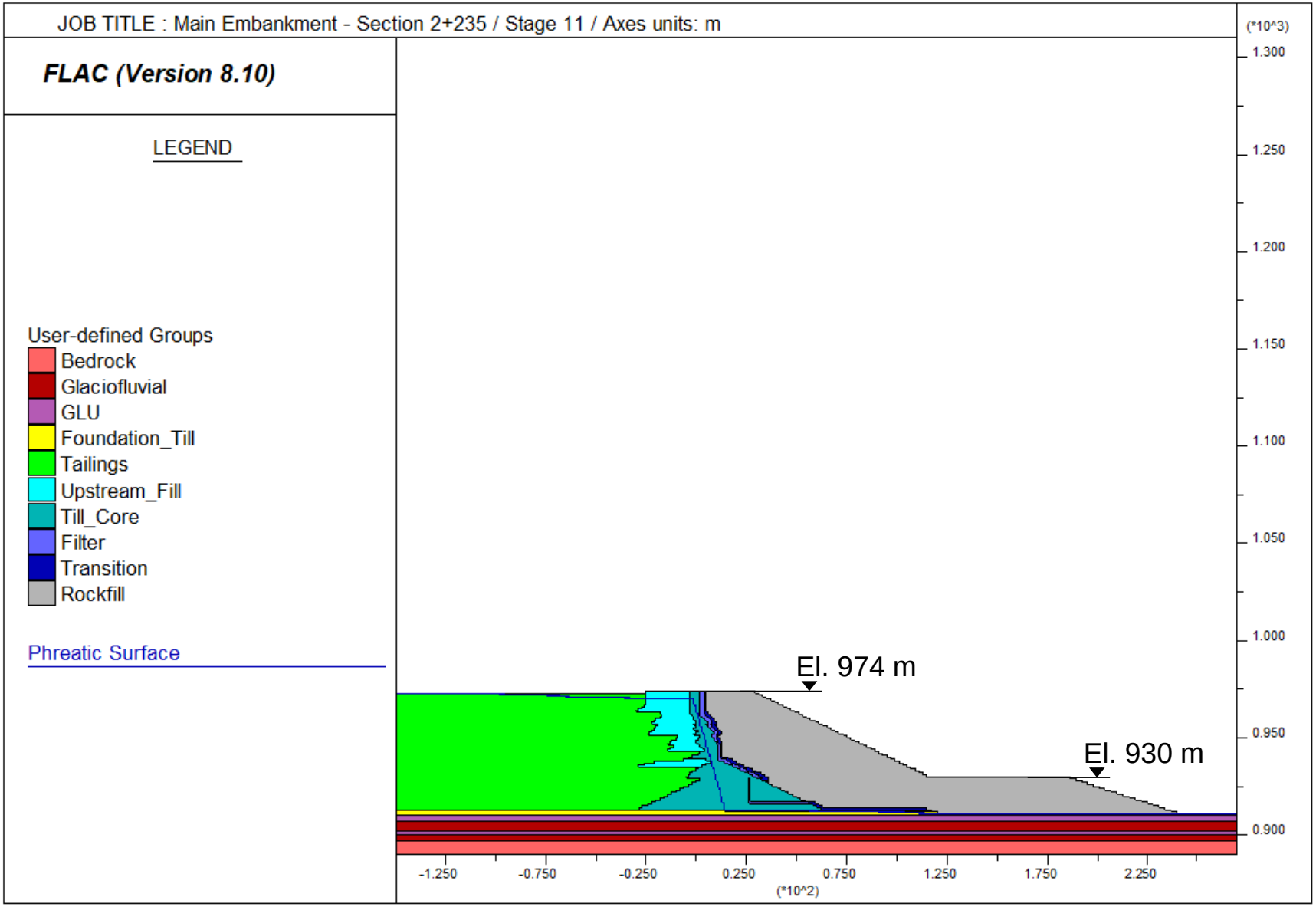

JOB TITLE : Main Embankment - Section 2+235 / Stage 6 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 958 m
El. 917 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)


JOB TITLE : Main Embankment - Section 2+235 / Stage 7 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 962 m
El. 917 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

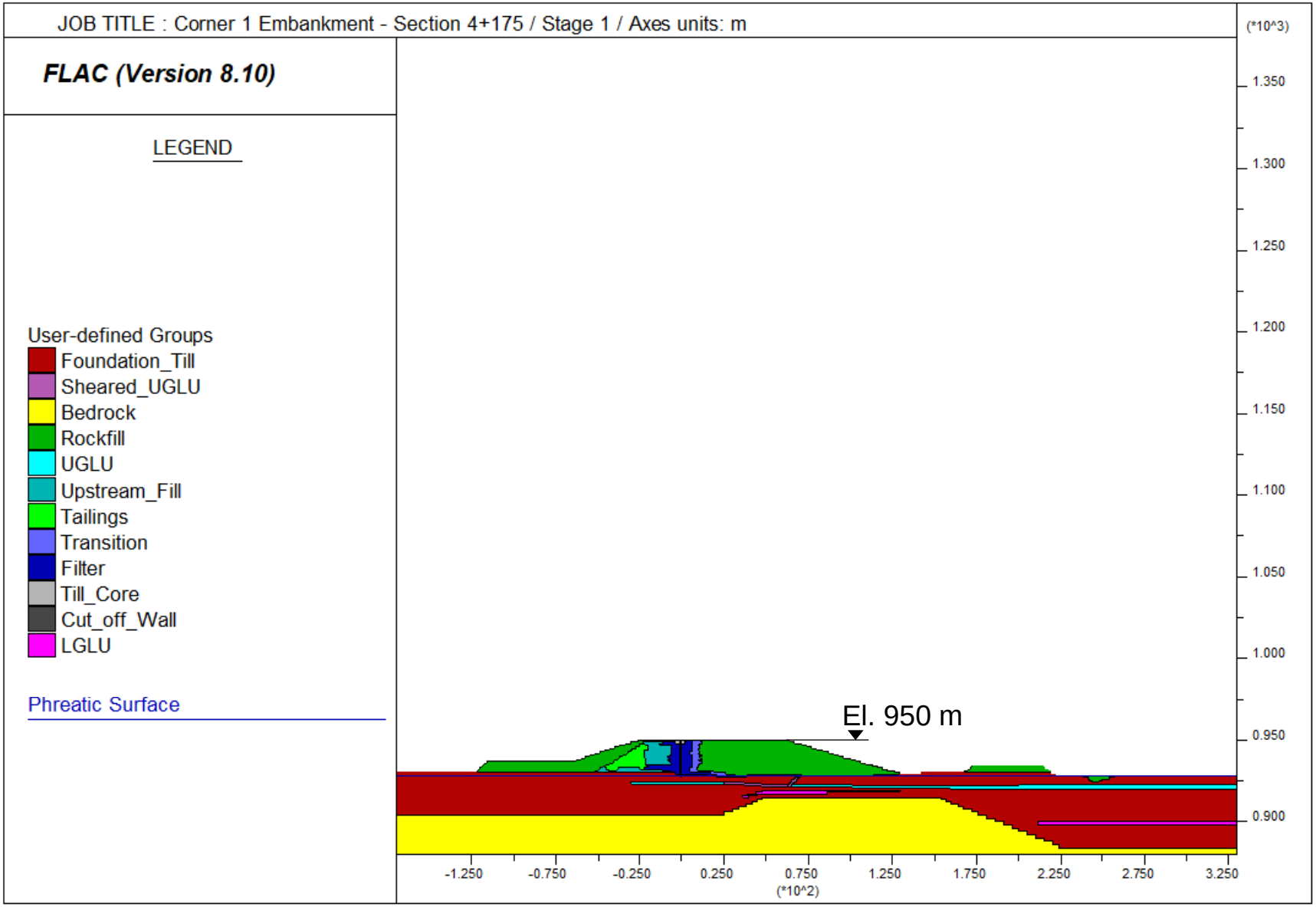

JOB TITLE : Main Embankment - Section 2+235 / Stage 8 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 964 m
El. 917 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

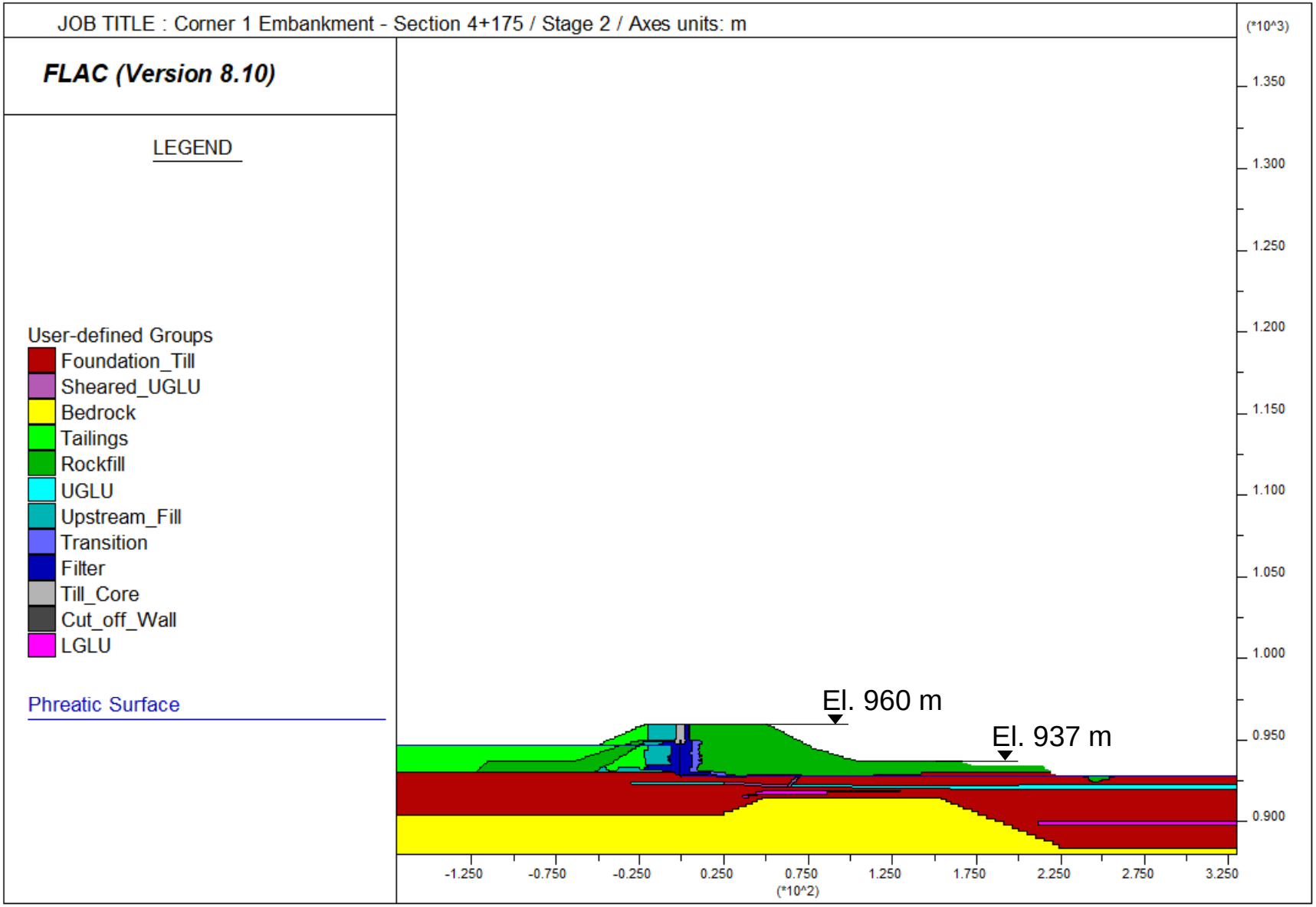

JOB TITLE : Main Embankment - Section 2+235 / Stage 9 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 969 m
El. 926 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

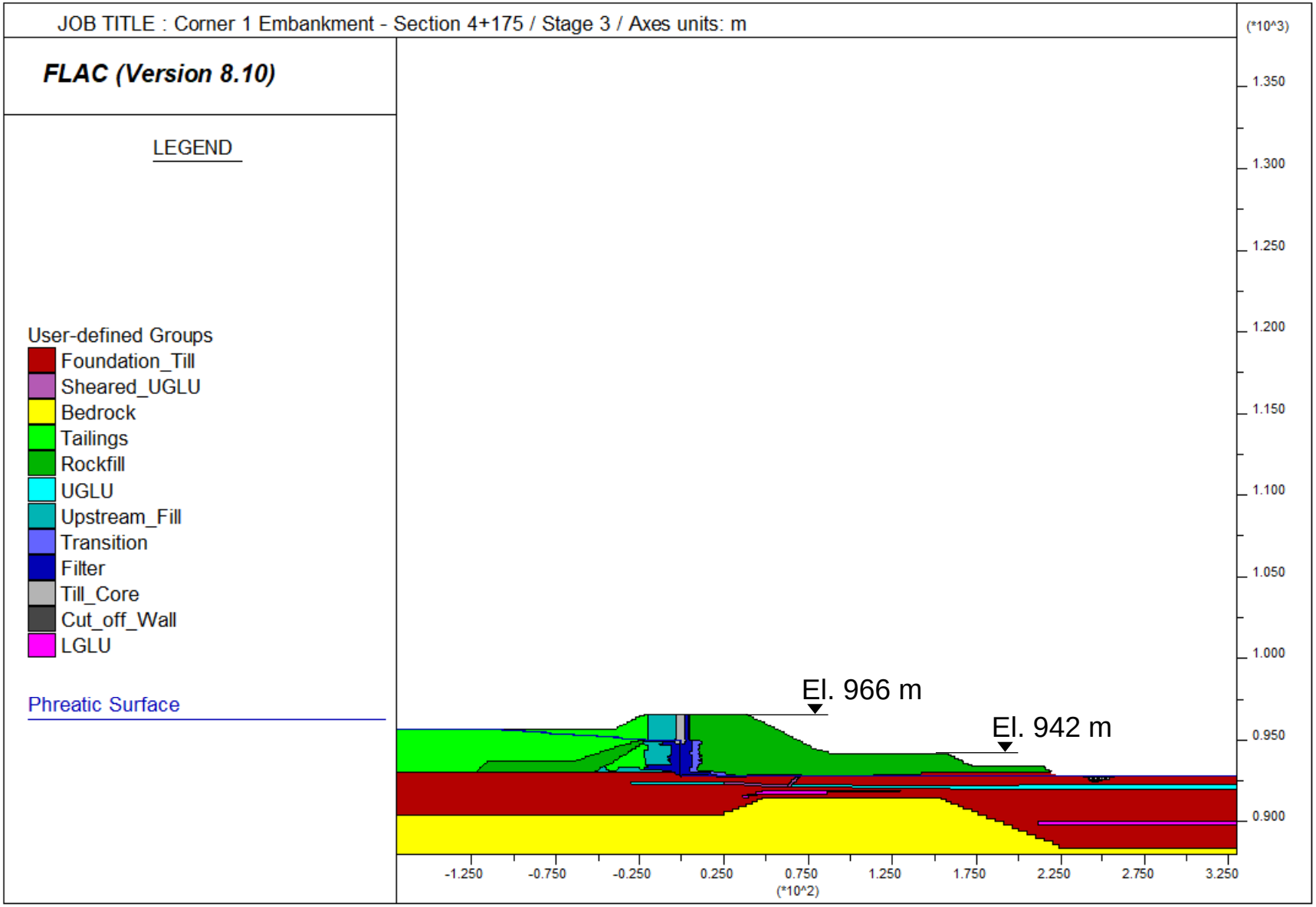

JOB TITLE : Main Embankment - Section 2+235 / Stage 10 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 969 m
El. 930 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

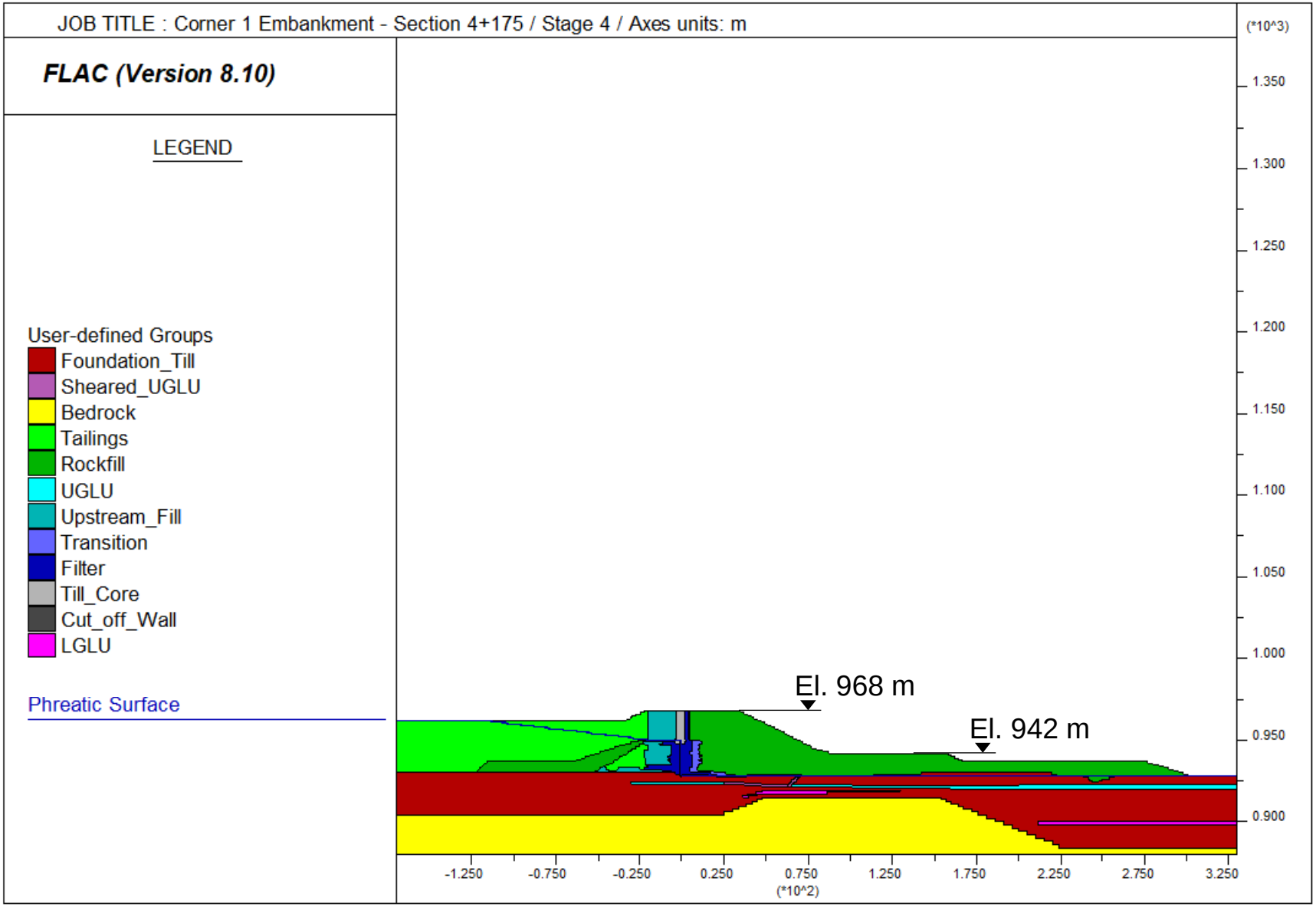

JOB TITLE : Main Embankment - Section 2+235 / Stage 11 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Bedrock
Glaciofluvial
GLU
Foundation_Till
Tailings
Upstream_Fill
Till_Core
Filter
Transition
Rockfill
Phreatic Surface
El. 974 m
El. 930 m
(*10^3)
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
(*10^2)

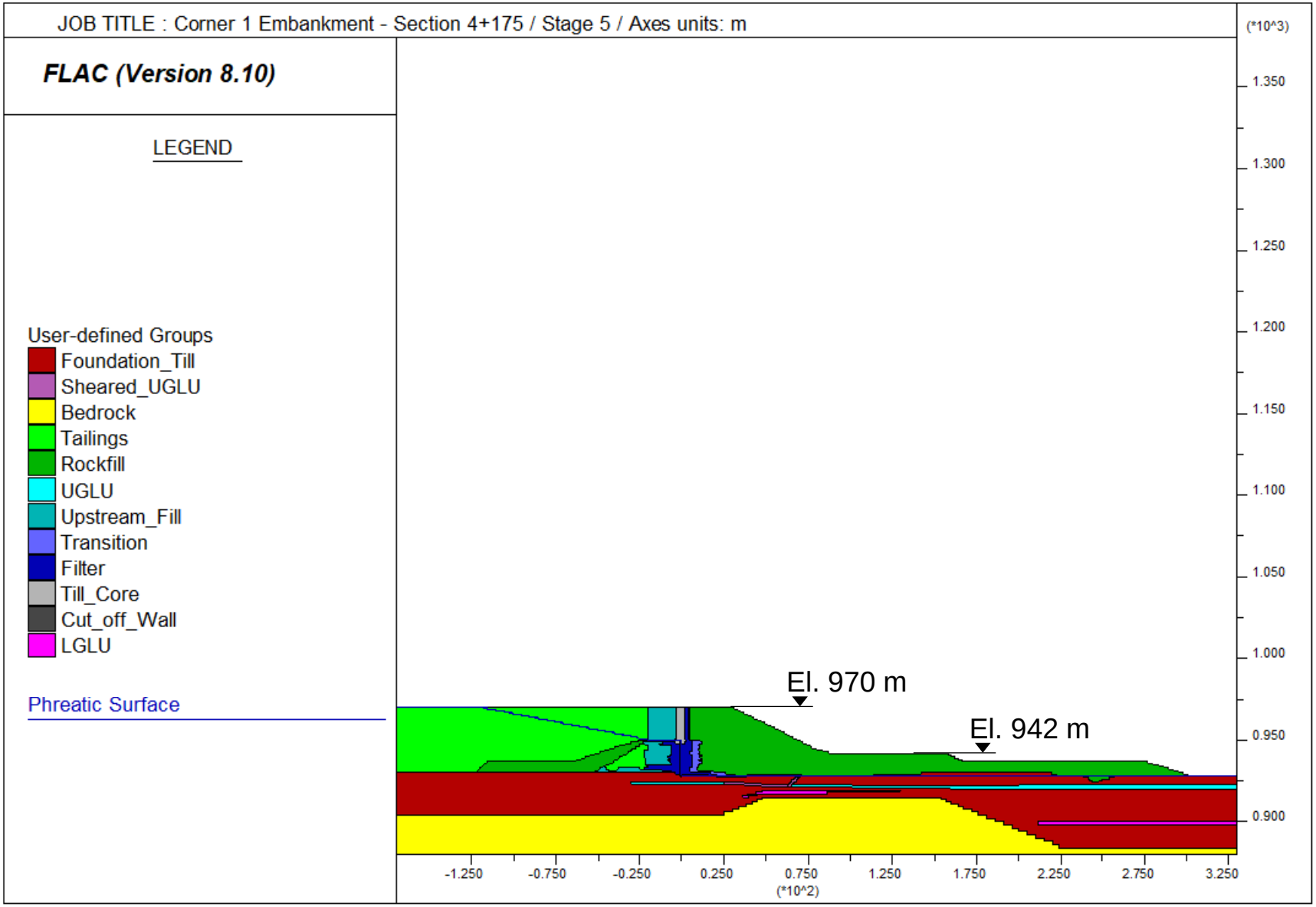
Perimeter Embankment at Corner 1 - Section 4+175

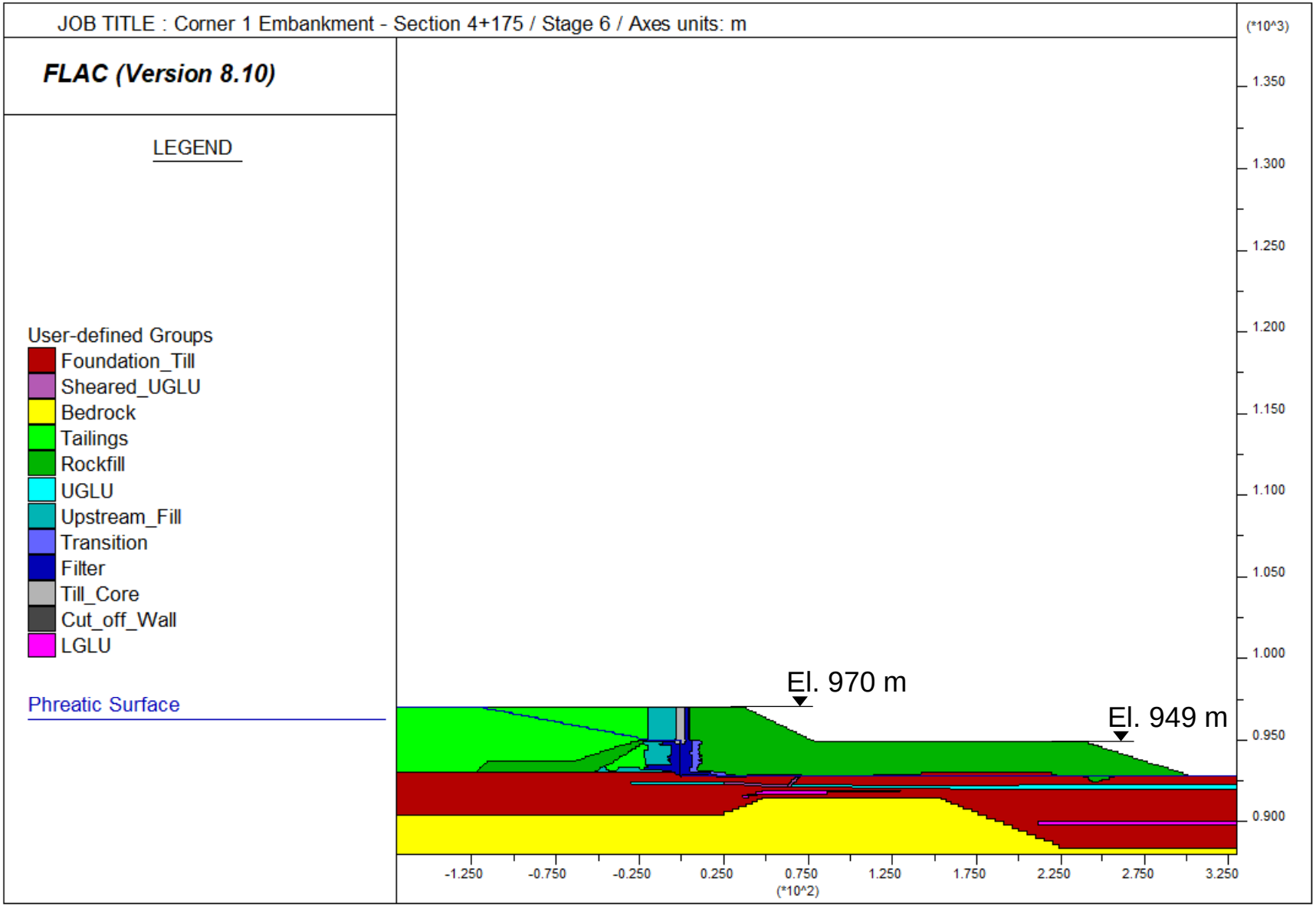

JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 1 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Rockfill
UGLU
Upstream_Fill
Tailings
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 950 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)

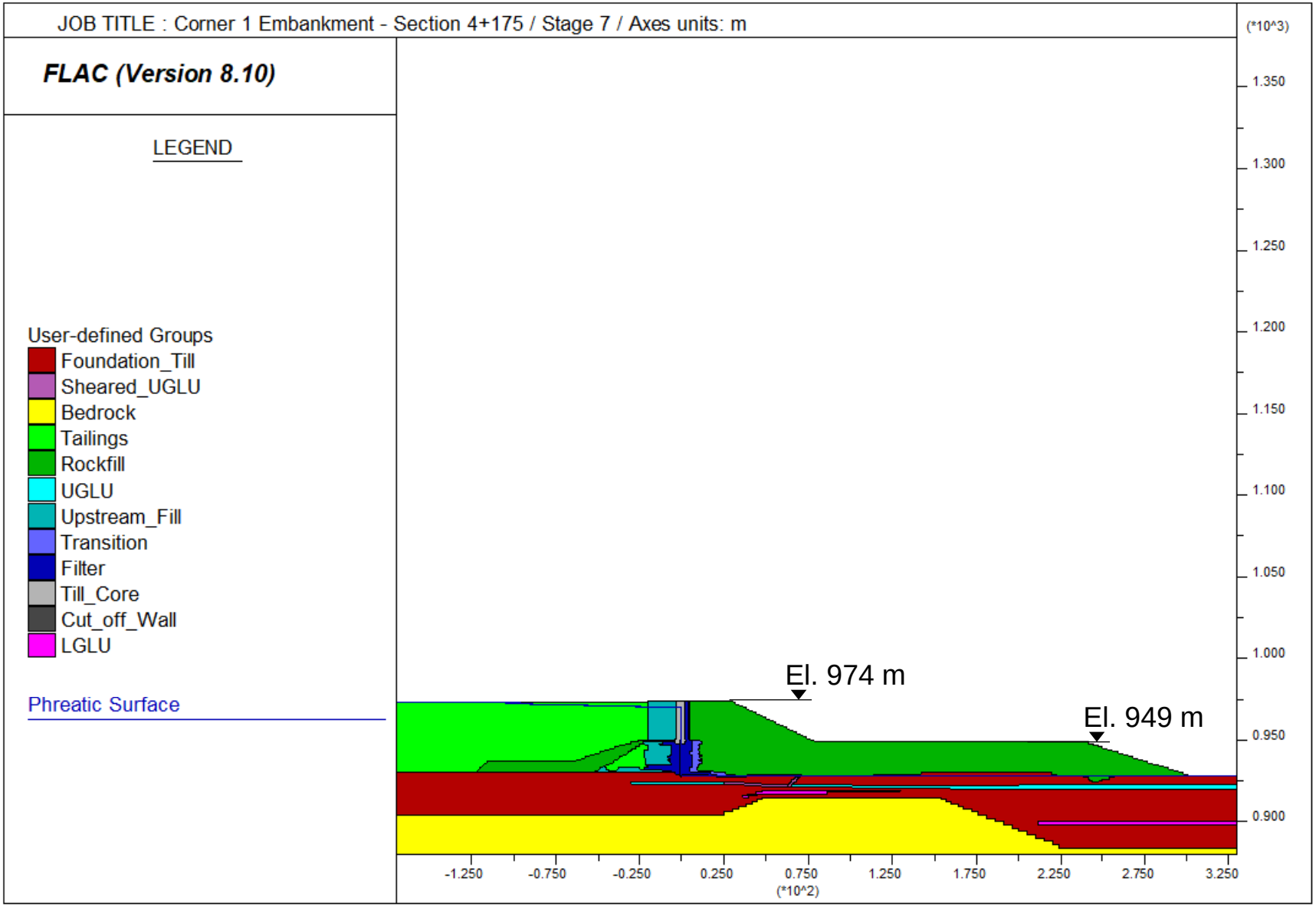

JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 2 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Tailings
Rockfill
UGLU
Upstream_Fill
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 960 m
El. 937 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 3 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Tailings
Rockfill
UGLU
Upstream_Fill
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 966 m
El. 942 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 4 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Tailings
Rockfill
UGLU
Upstream_Fill
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 968 m
El. 942 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 5 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Tailings
Rockfill
UGLU
Upstream_Fill
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 970 m
El. 942 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 6 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Tailings
Rockfill
UGLU
Upstream_Fill
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 970 m
El. 949 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / Stage 7 / Axes units: m
FLAC (Version 8.10)
LEGEND
User-defined Groups
Foundation_Till
Sheared_UGLU
Bedrock
Tailings
Rockfill
UGLU
Upstream_Fill
Transition
Filter
Till_Core
Cut_off_Wall
LGLU
Phreatic Surface
El. 974 m
El. 949 m
(*10^3)
1.350
1.300
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-1.250
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
3.250
(*10^2)

ATTACHMENT 2

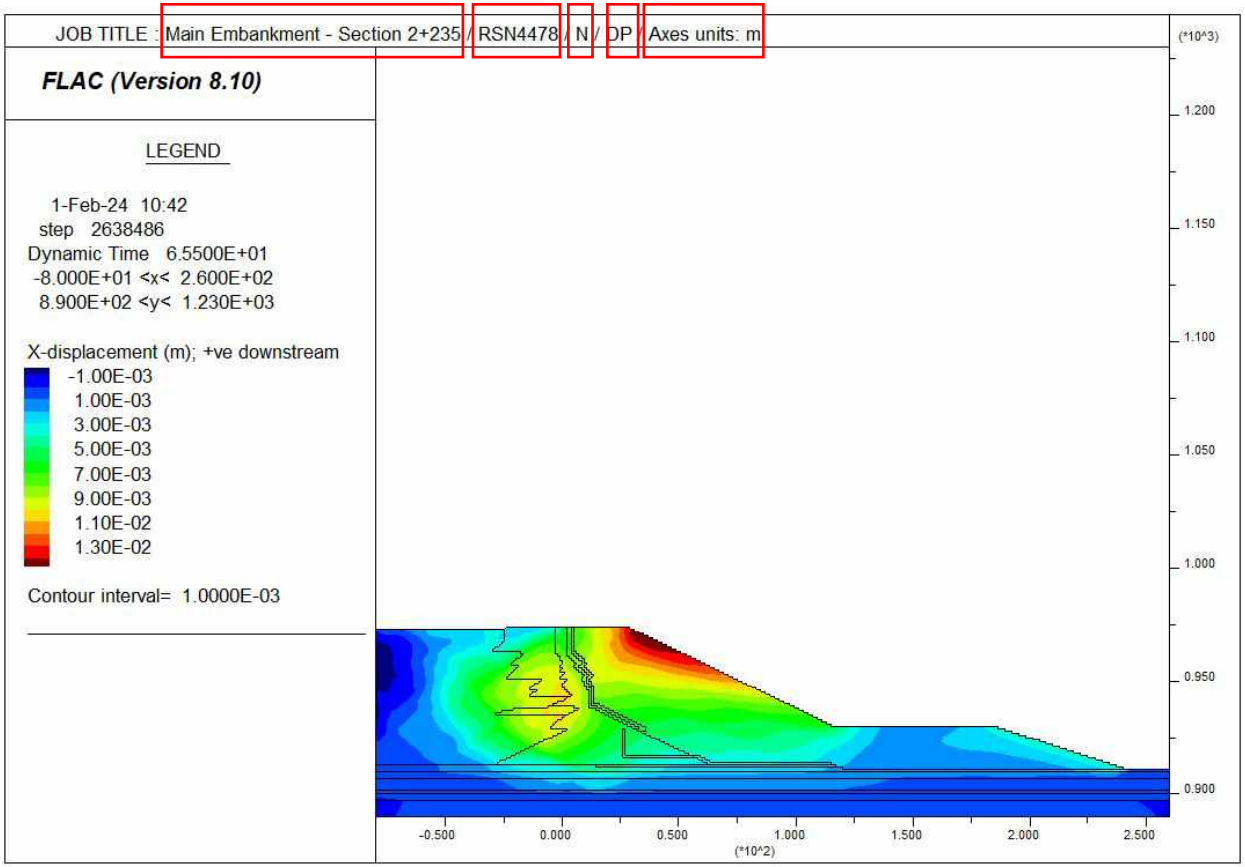
Seismic Analyses Results

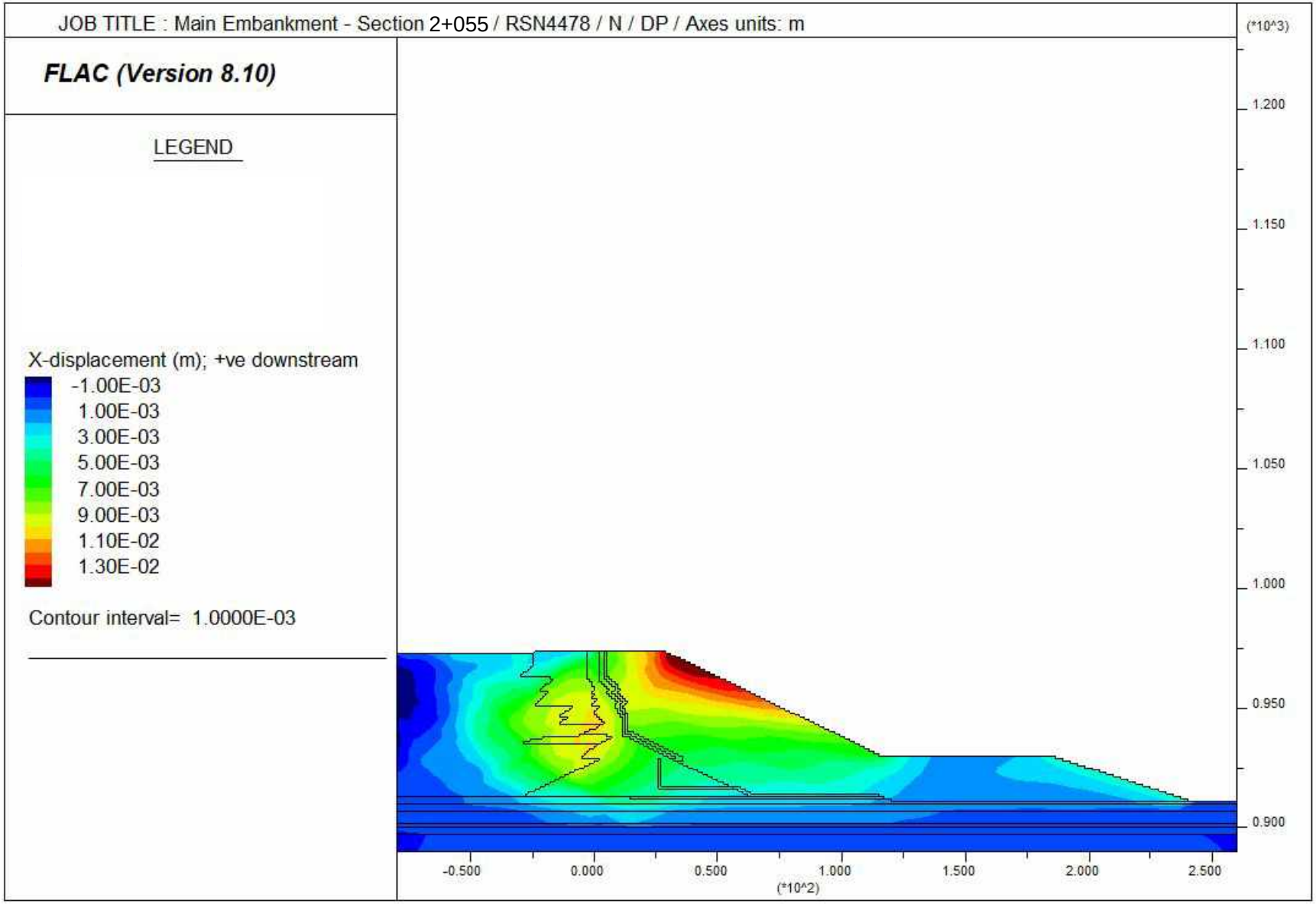
Table of Contents

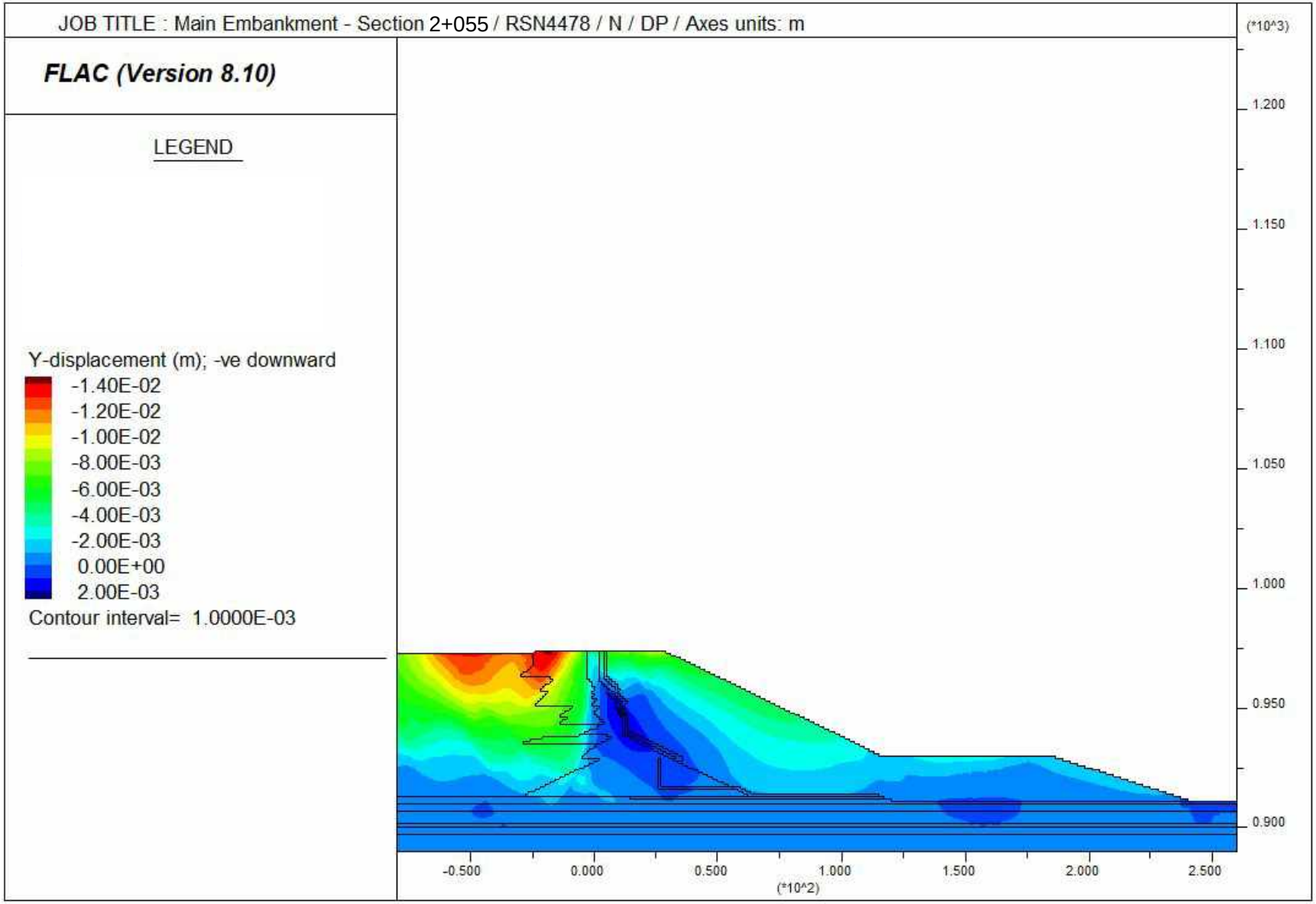
Name	Page number
Attachment Structure	**2**
Main Embankment – Section 2+055	
▪ RSN4478, Crustal Motion	
• Direct Polarity (DP)	3
• Reverse Polarity (RP)	8
▪ RSN4000183, Subduction interface motion	
• Direct Polarity (DP)	13
• Reverse Polarity (RP)	18
Perimeter Embankment at Corner 1 – Section 4+175	
▪ RSN4478, Crustal Motion	
• Direct Polarity (DP)	23
• Reverse Polarity (RP)	29
▪ RSN4000183, Subduction interface motion	
• Direct Polarity (DP)	35
• Reverse Polarity (RP)	41

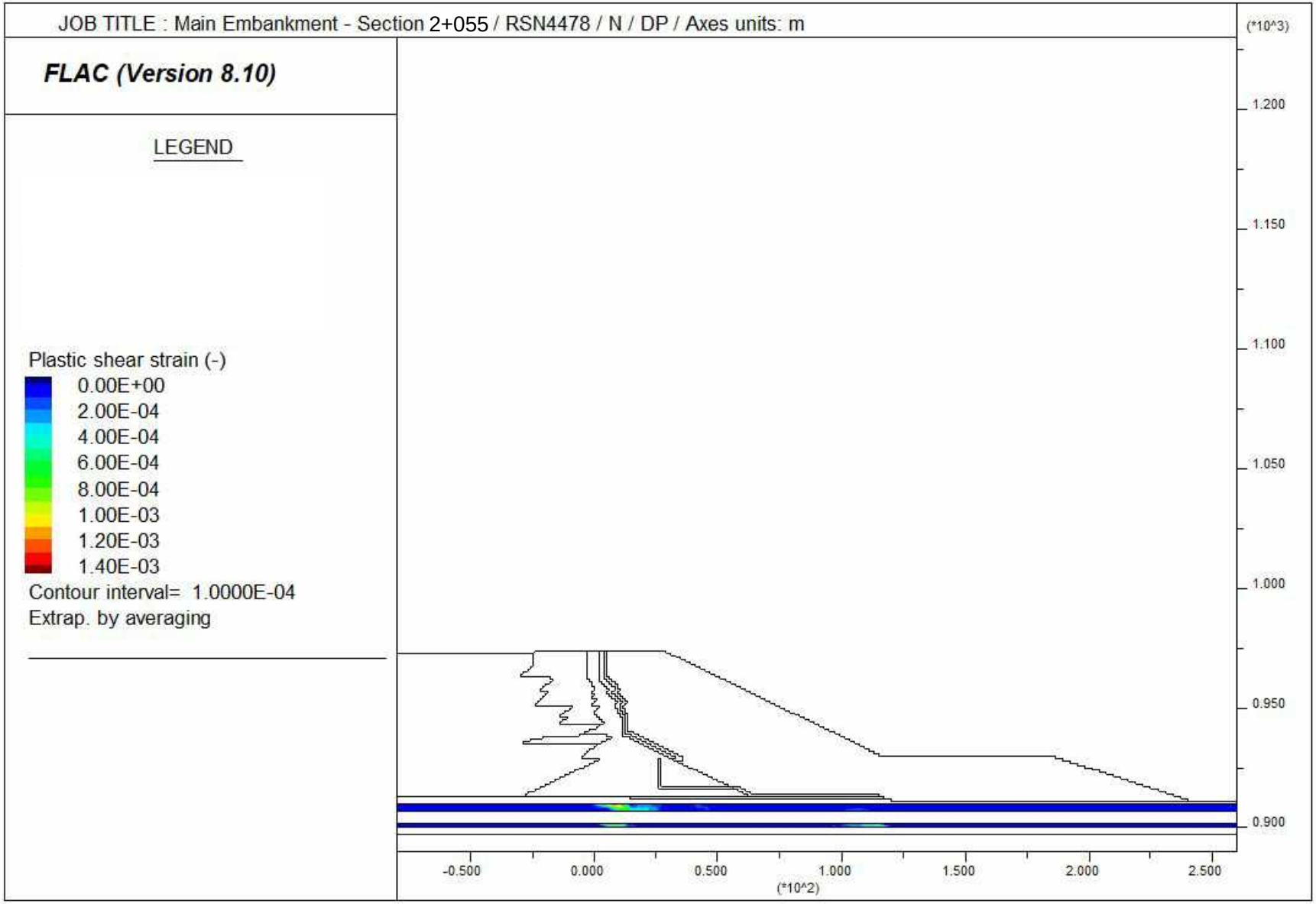
1. Embankment – Section:
   - Main Embankment
   - Perimeter Embankment at Corner 1
2. Record Sequence Number:
   - RSN4478N, Crustal Motion
   - RSN4000183EW, Subduction interface motion
3. Component earthquake motion:
   - North (N)
   - East/West (EW)
4. Polarity:
   - Direct Polarity (DP)
   - Reverse Polarity (RP)
5. Axes units: metres

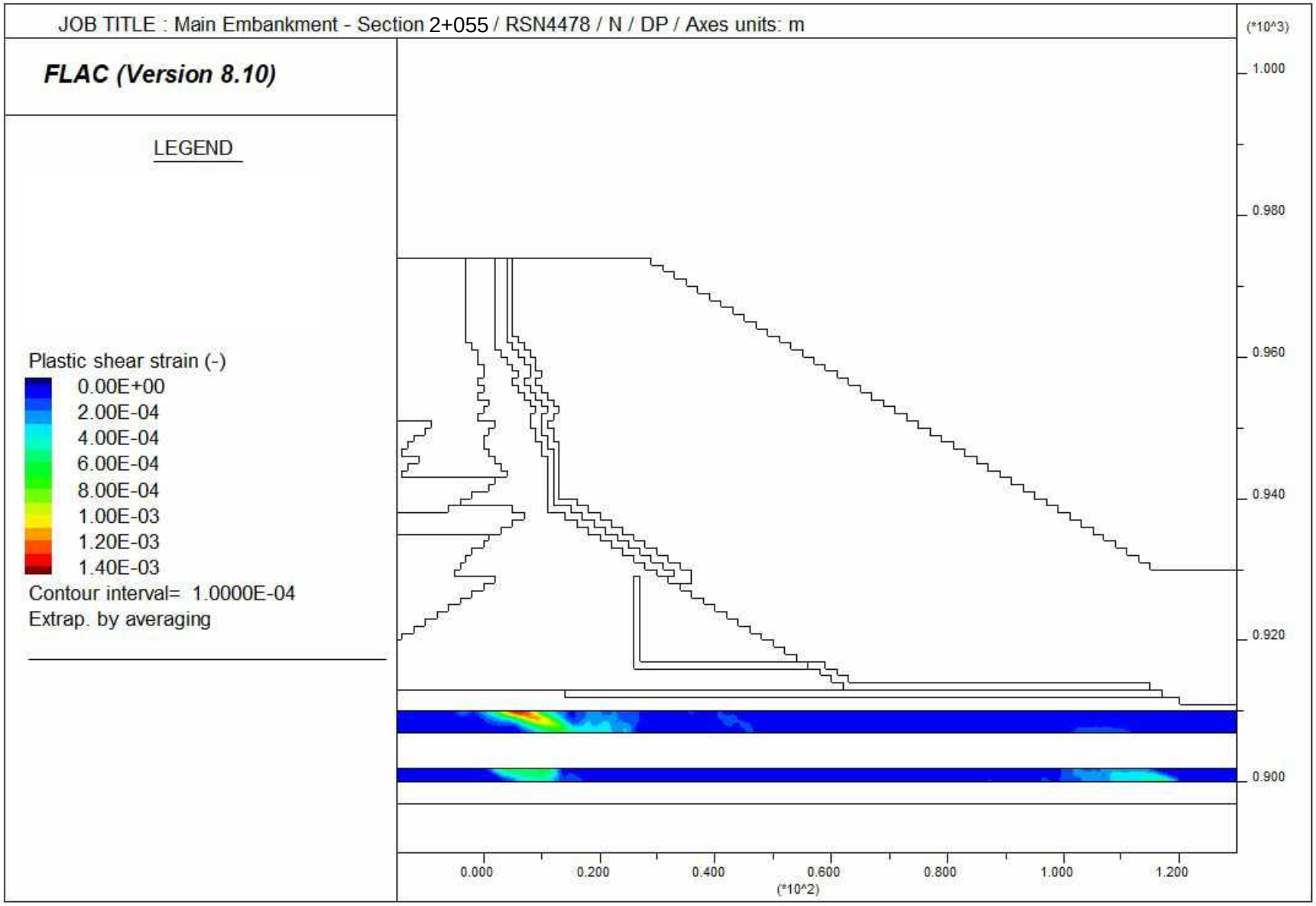
Example:

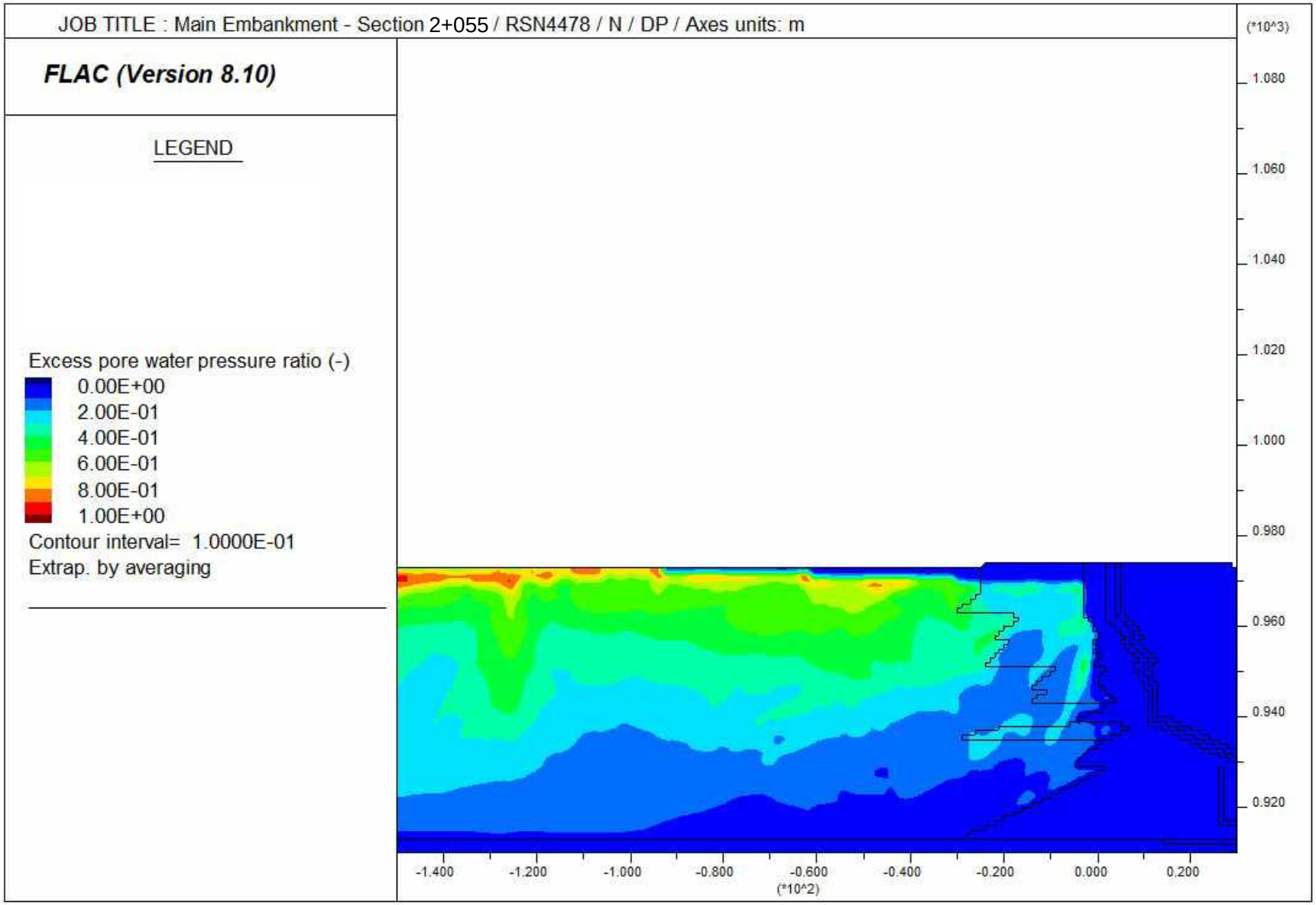


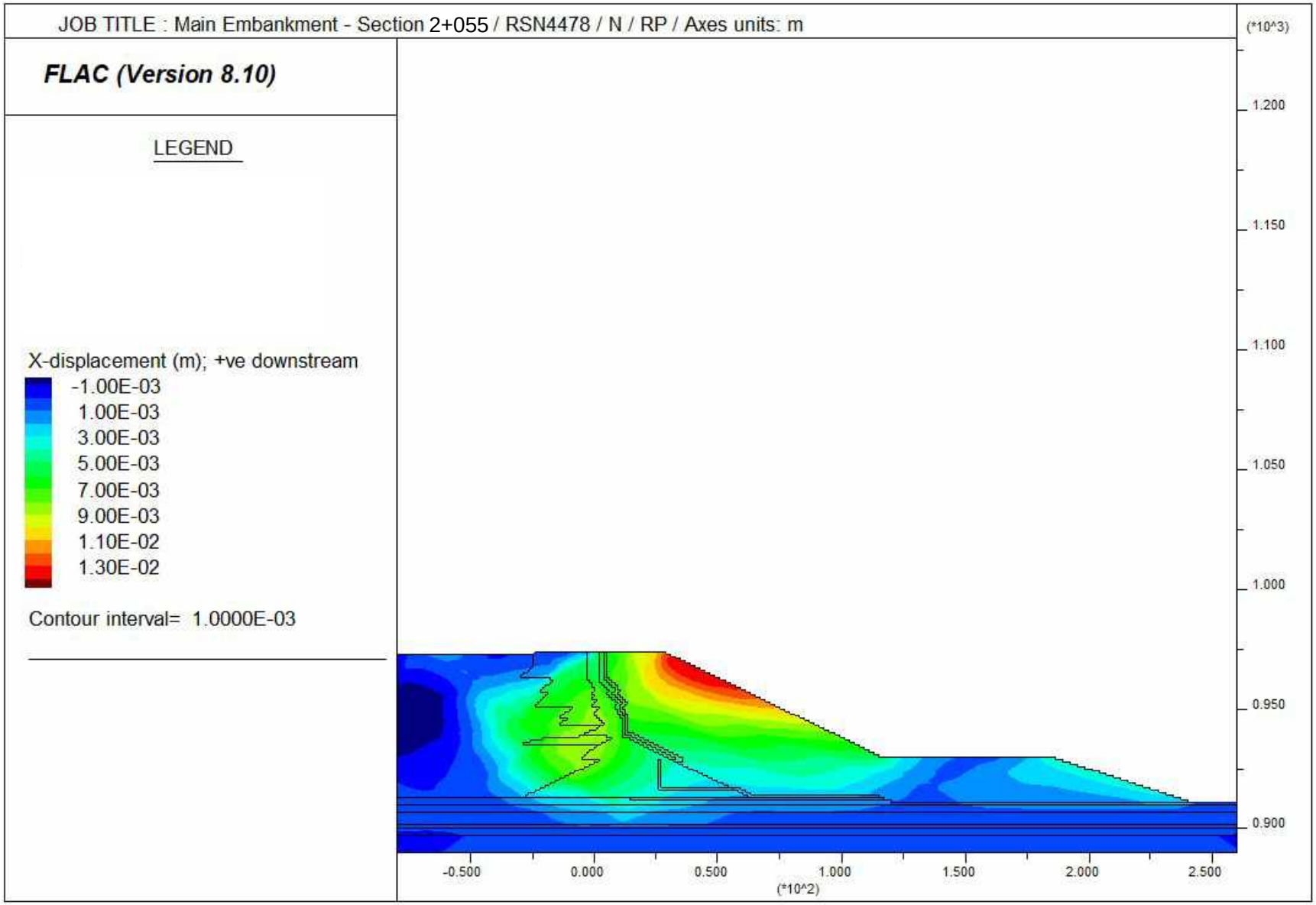

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-1.00E-03
1.00E-03
3.00E-03
5.00E-03
7.00E-03
9.00E-03
1.10E-02
1.30E-02
Contour interval= 1.0000E-03
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

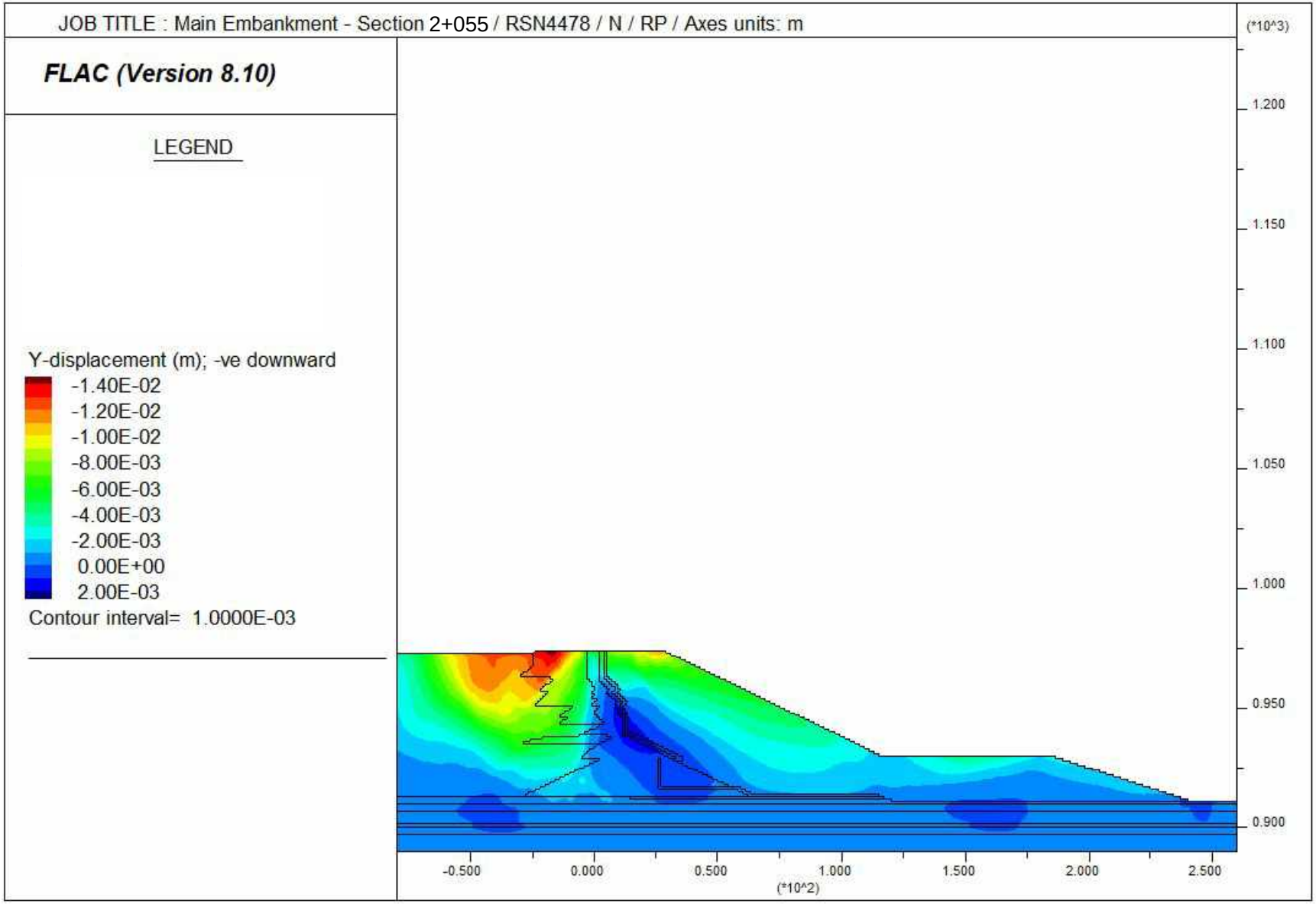

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-1.40E-02
-1.20E-02
-1.00E-02
-8.00E-03
-6.00E-03
-4.00E-03
-2.00E-03
0.00E+00
2.00E-03
Contour interval= 1.0000E-03
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

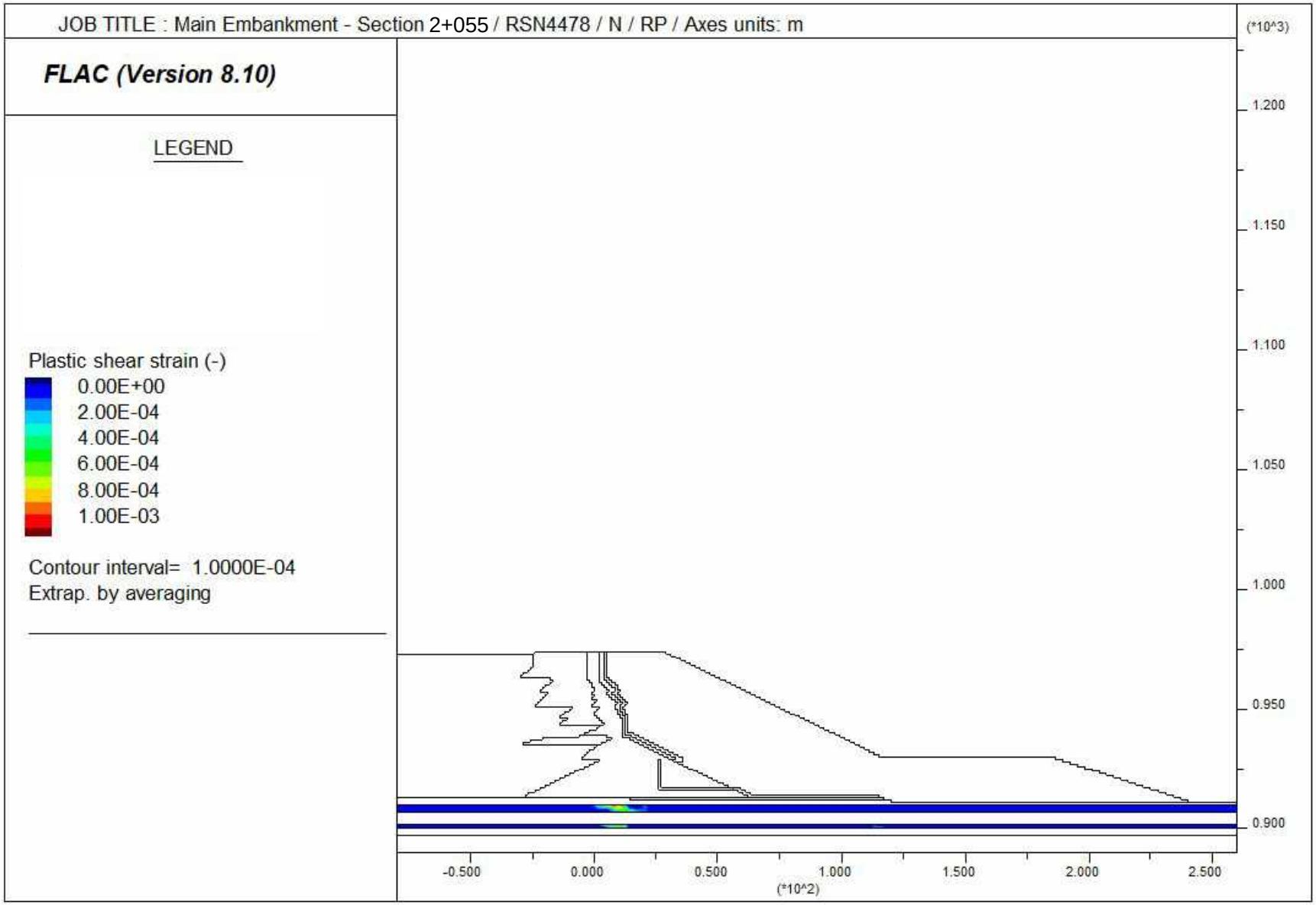

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-04
4.00E-04
6.00E-04
8.00E-04
1.00E-03
1.20E-03
1.40E-03
Contour interval= 1.0000E-04
Extrap. by averaging
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

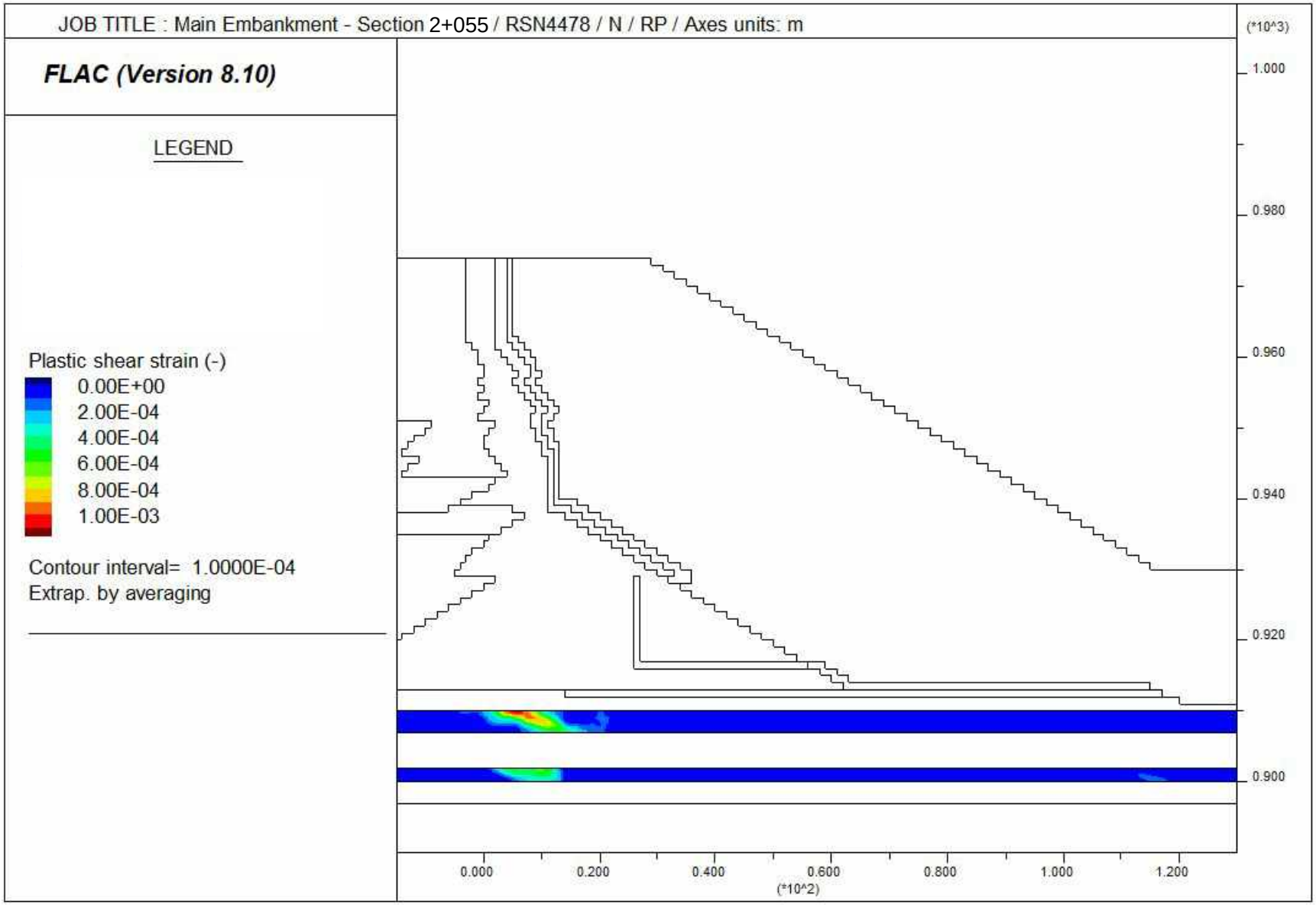

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-04
4.00E-04
6.00E-04
8.00E-04
1.00E-03
1.20E-03
1.40E-03
Contour interval= 1.0000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

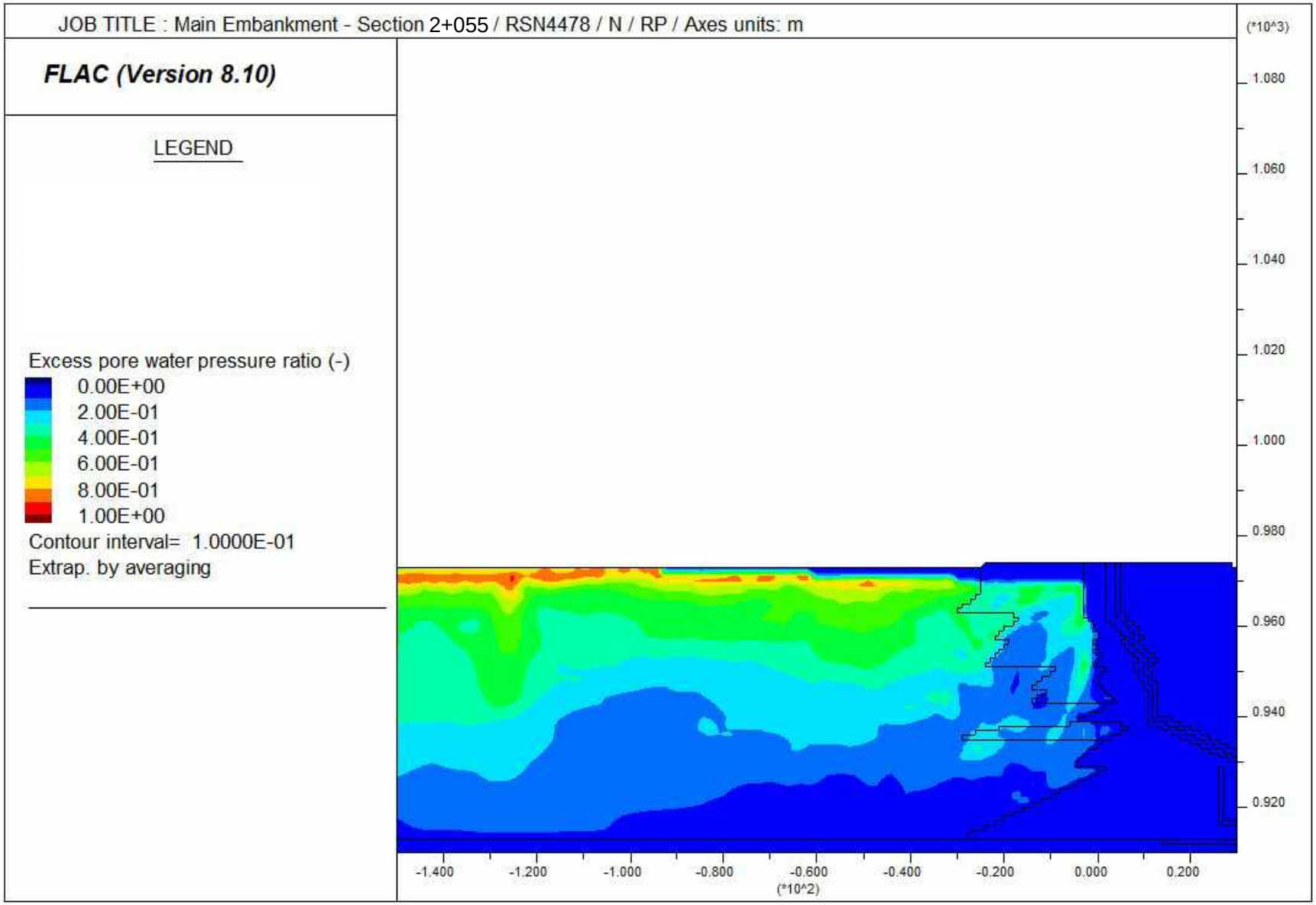

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
-1.400
-1.200
-1.000
-0.800
-0.600
-0.400
-0.200
0.000
0.200
(*10^2)

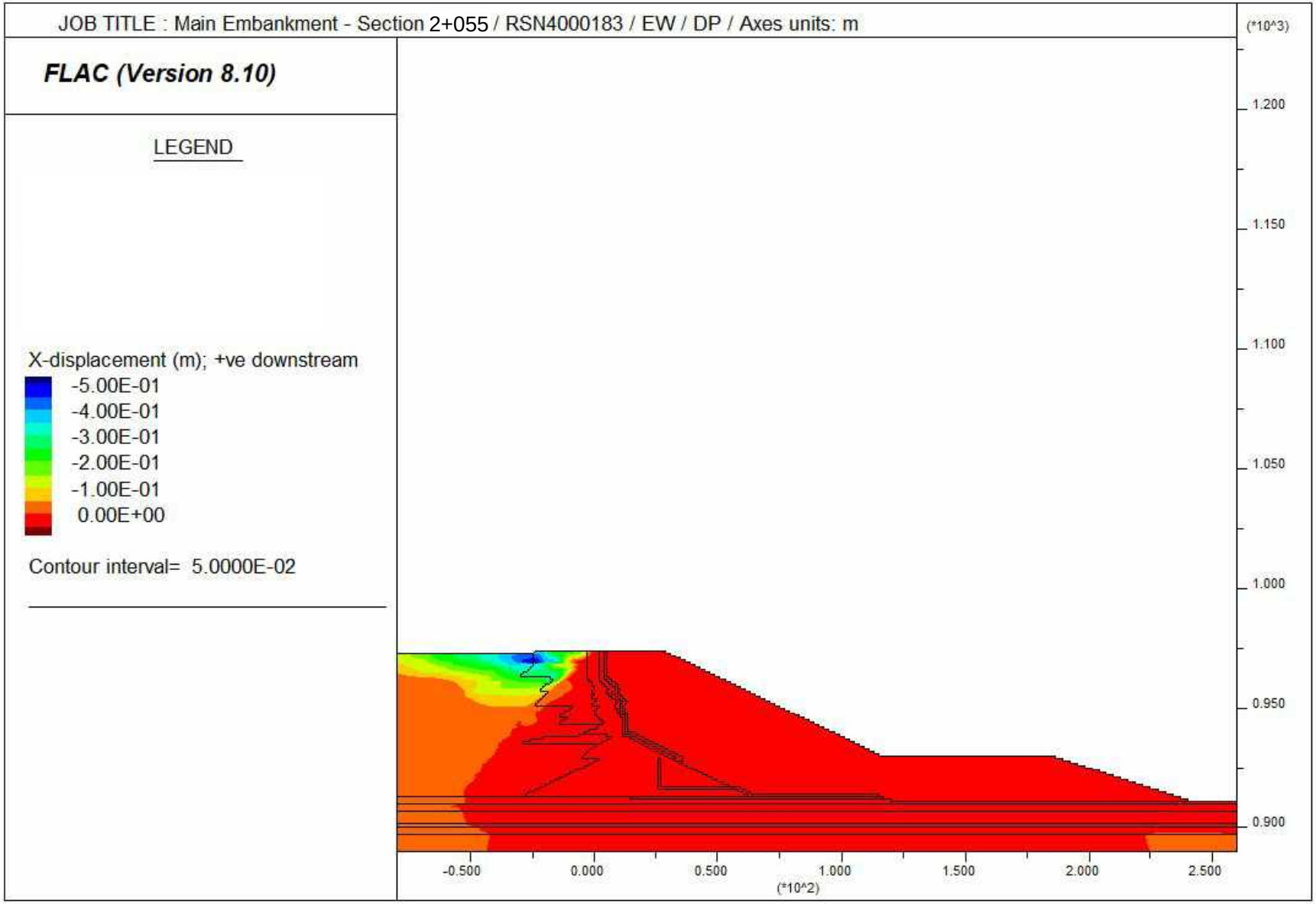

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-1.00E-03
1.00E-03
3.00E-03
5.00E-03
7.00E-03
9.00E-03
1.10E-02
1.30E-02
Contour interval= 1.0000E-03
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

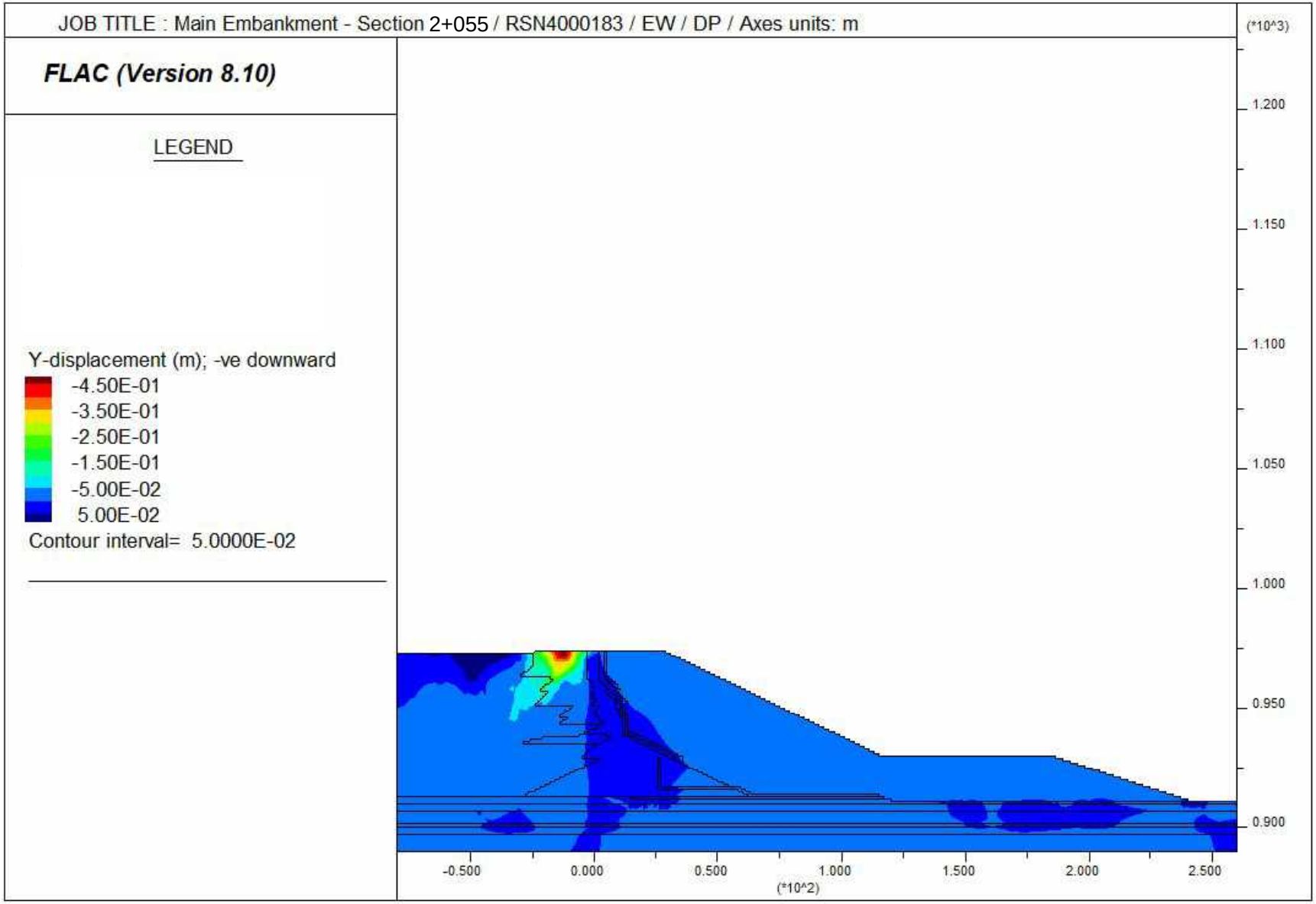

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-1.40E-02
-1.20E-02
-1.00E-02
-8.00E-03
-6.00E-03
-4.00E-03
-2.00E-03
0.00E+00
2.00E-03
Contour interval= 1.0000E-03
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

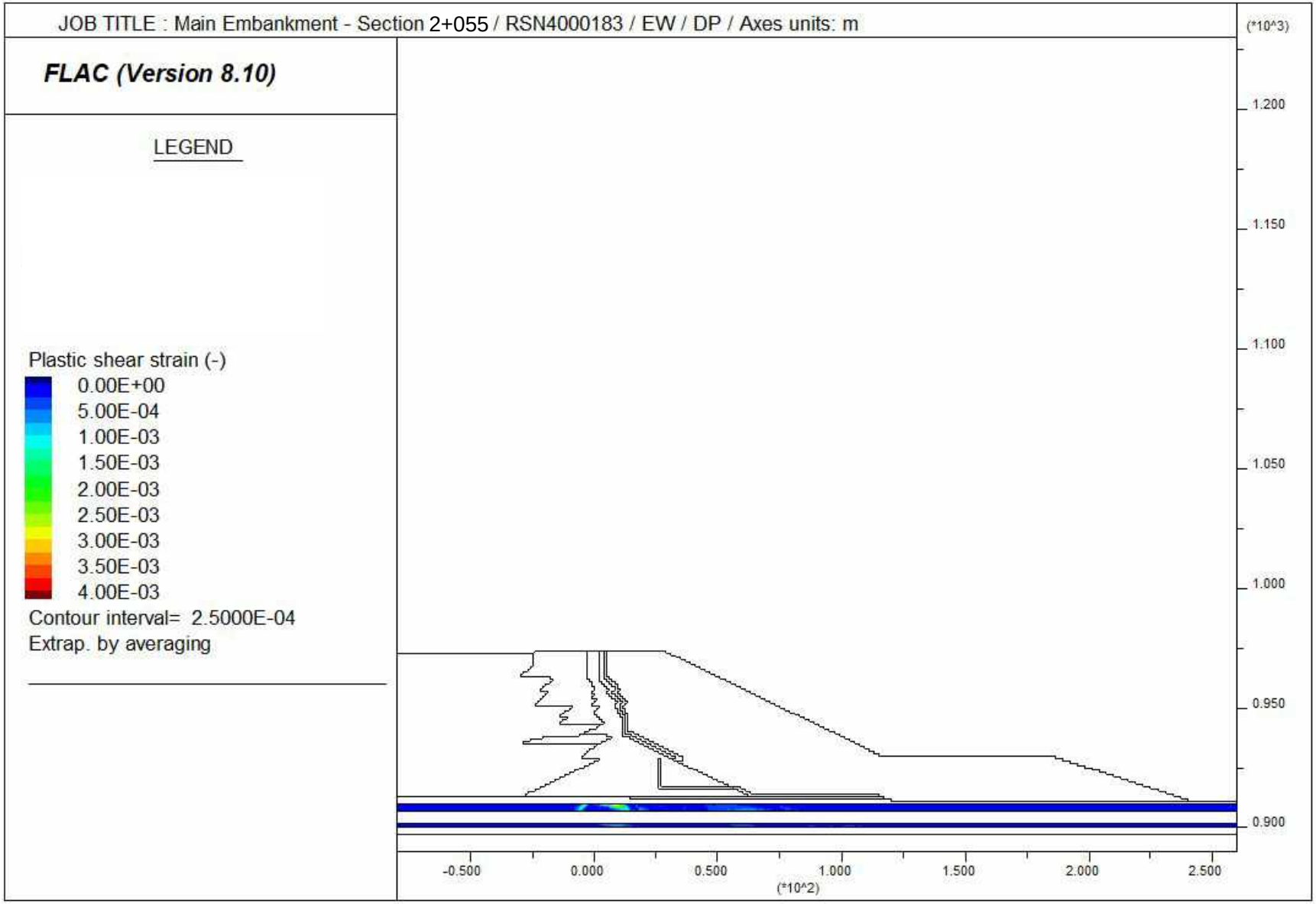

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-04
4.00E-04
6.00E-04
8.00E-04
1.00E-03
Contour interval= 1.0000E-04
Extrap. by averaging
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

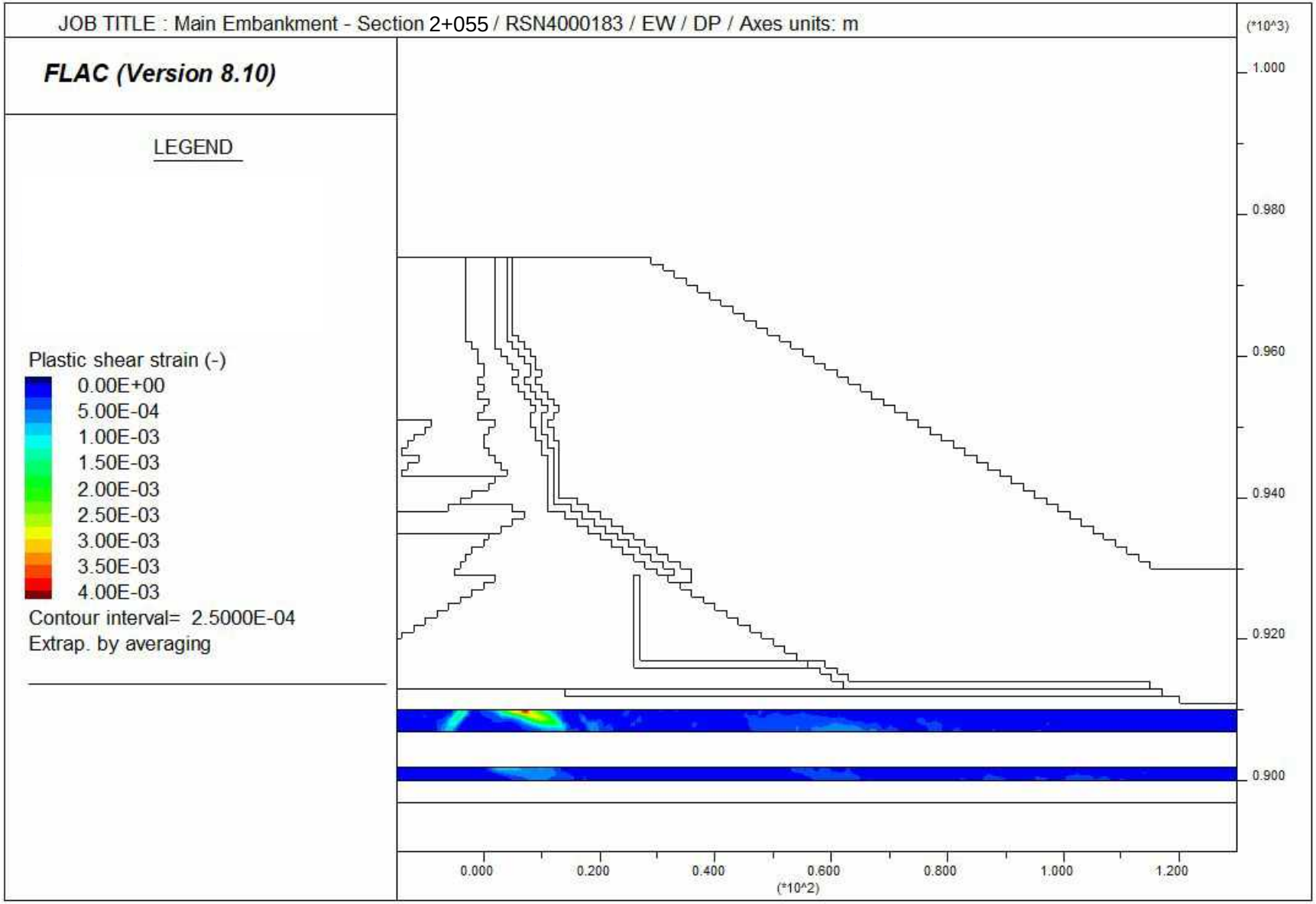

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-04
4.00E-04
6.00E-04
8.00E-04
1.00E-03
Contour interval= 1.0000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

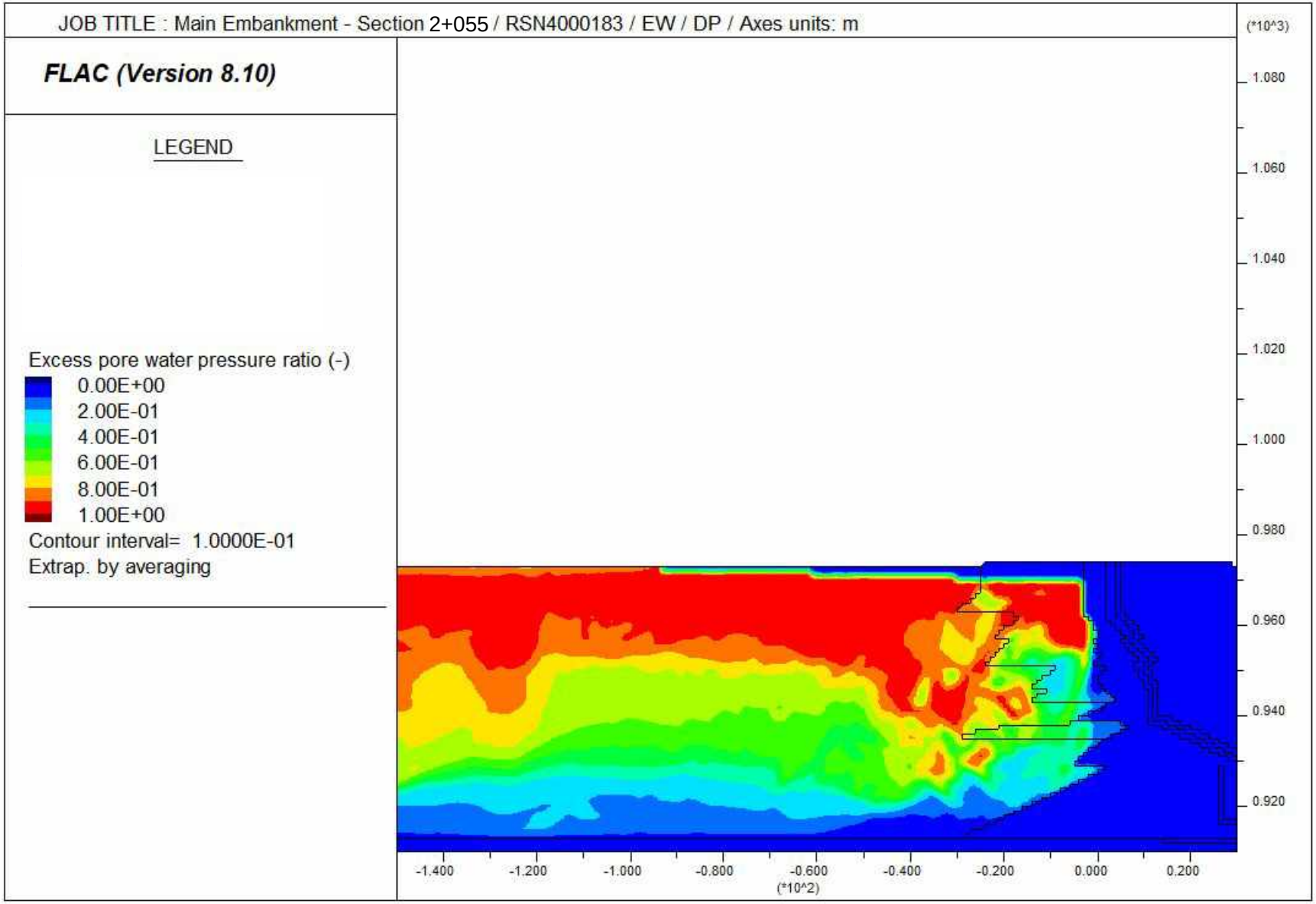

JOB TITLE : Main Embankment - Section 2+055 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
-1.400
-1.200
-1.000
-0.800
-0.600
-0.400
-0.200
0.000
0.200
(*10^2)

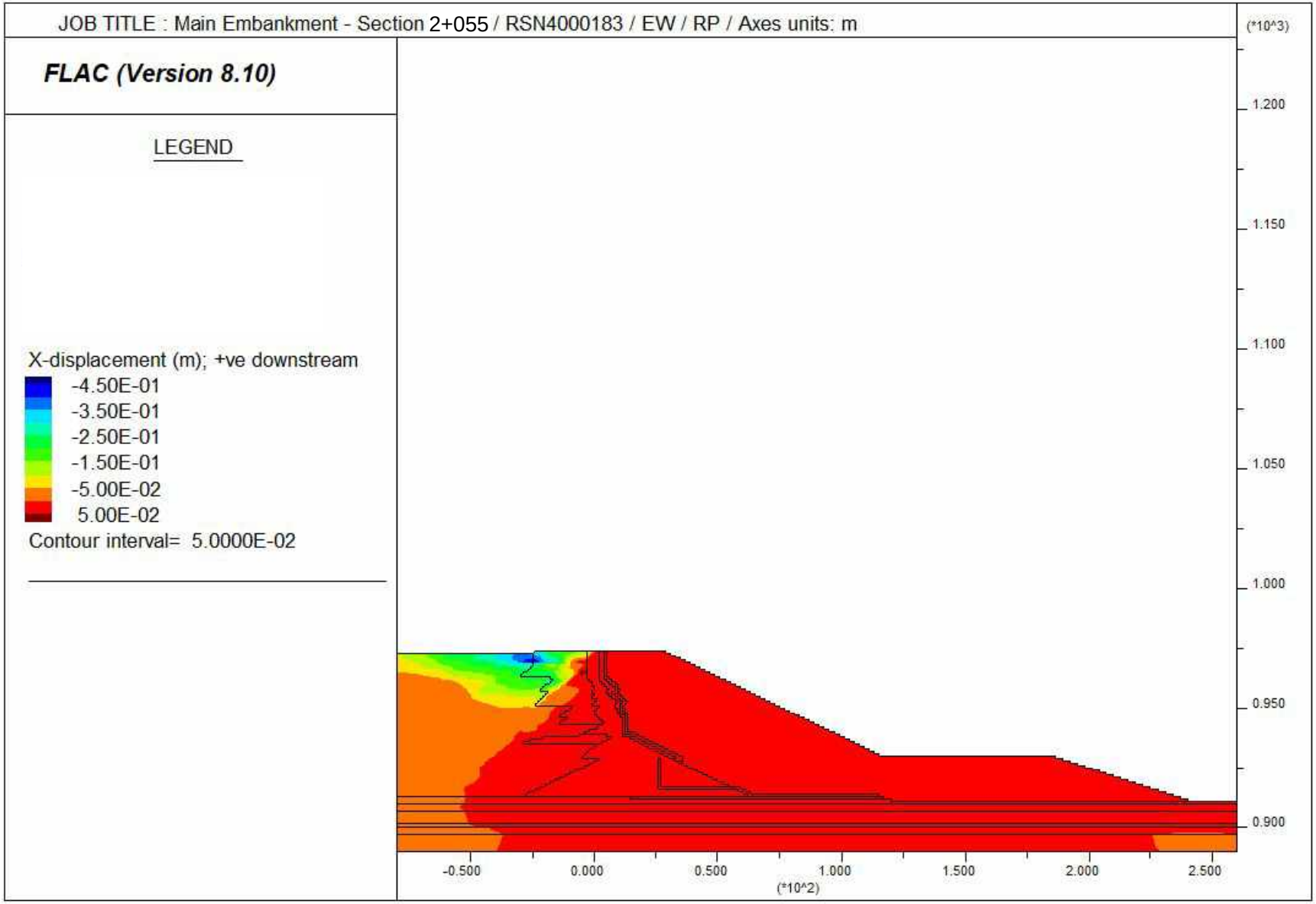

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-5.00E-01
-4.00E-01
-3.00E-01
-2.00E-01
-1.00E-01
0.00E+00
Contour interval= 5.0000E-02
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

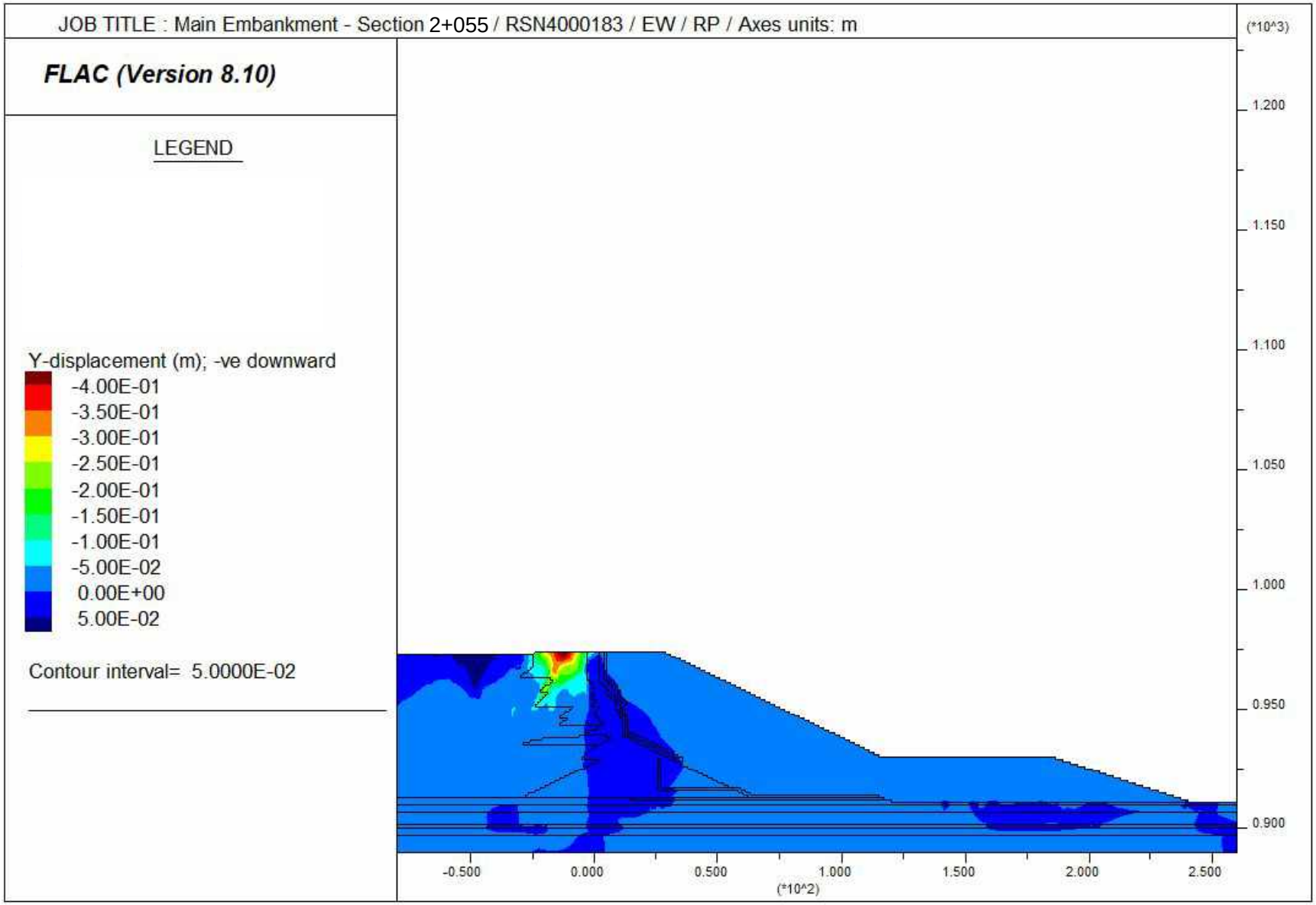

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-4.50E-01
-3.50E-01
-2.50E-01
-1.50E-01
-5.00E-02
5.00E-02
Contour interval= 5.0000E-02
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

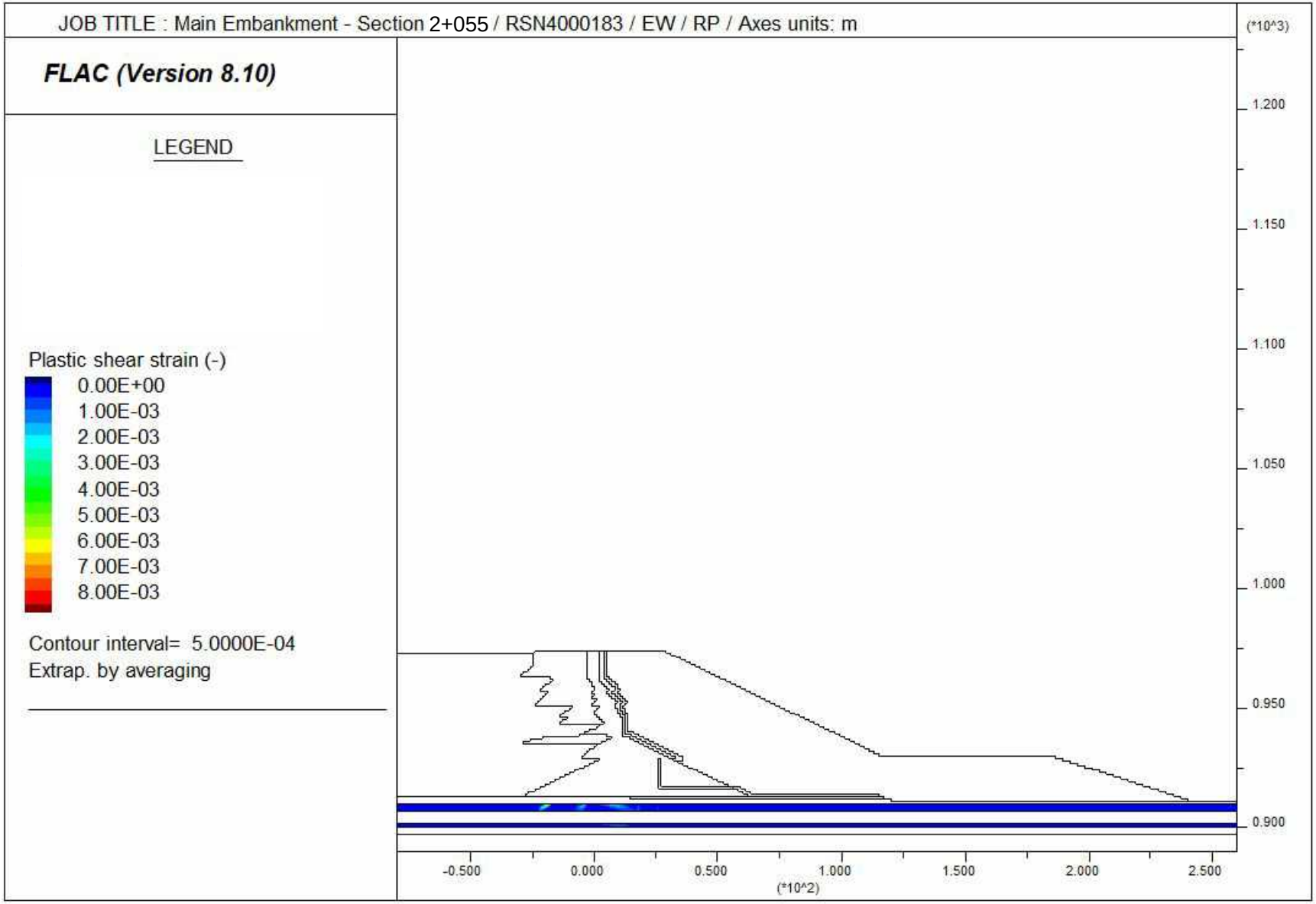

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
5.00E-04
1.00E-03
1.50E-03
2.00E-03
2.50E-03
3.00E-03
3.50E-03
4.00E-03
Contour interval= 2.5000E-04
Extrap. by averaging
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

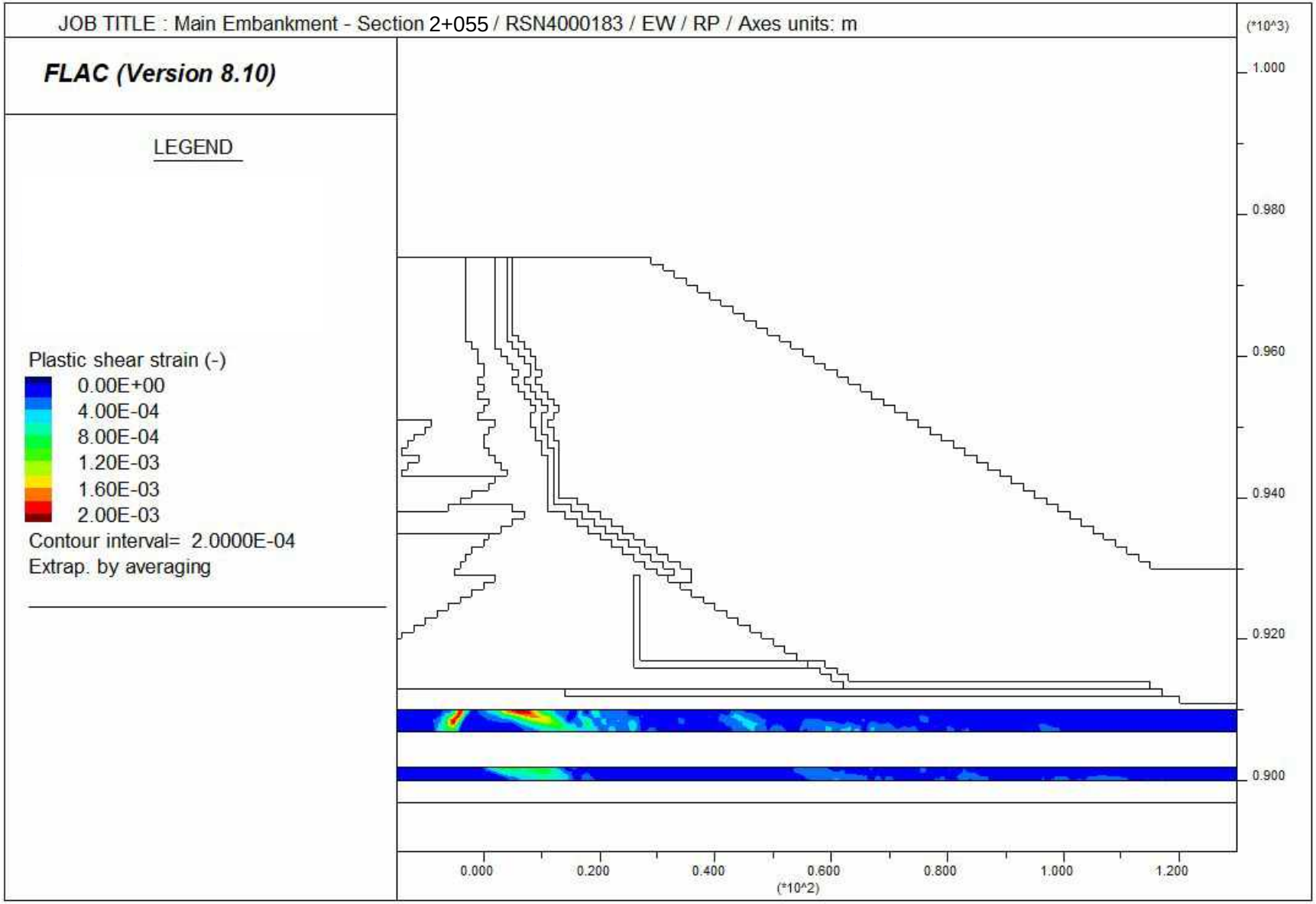

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
5.00E-04
1.00E-03
1.50E-03
2.00E-03
2.50E-03
3.00E-03
3.50E-03
4.00E-03
Contour interval= 2.5000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

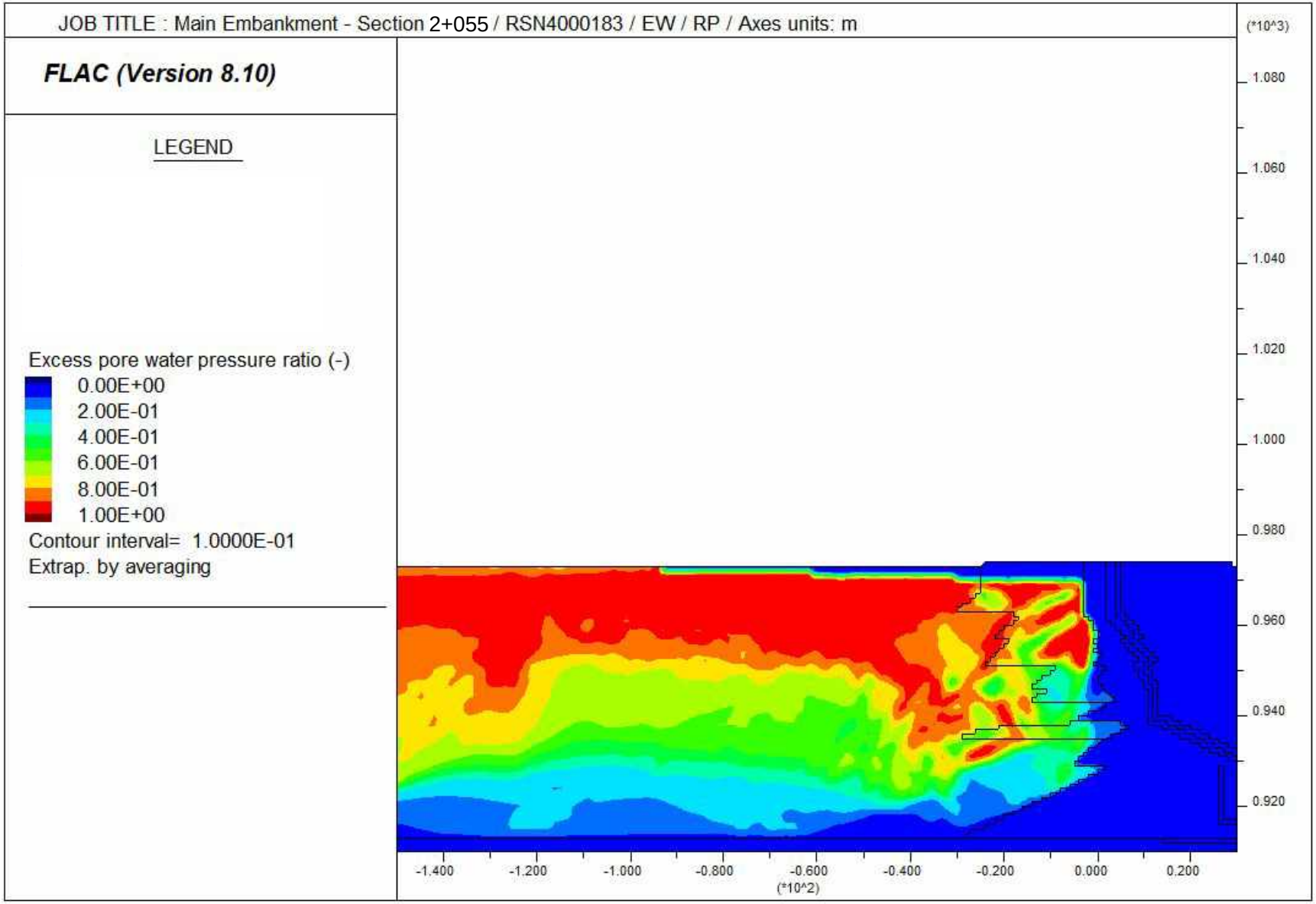

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
-1.400
-1.200
-1.000
-0.800
-0.600
-0.400
-0.200
0.000
0.200
(*10^2)

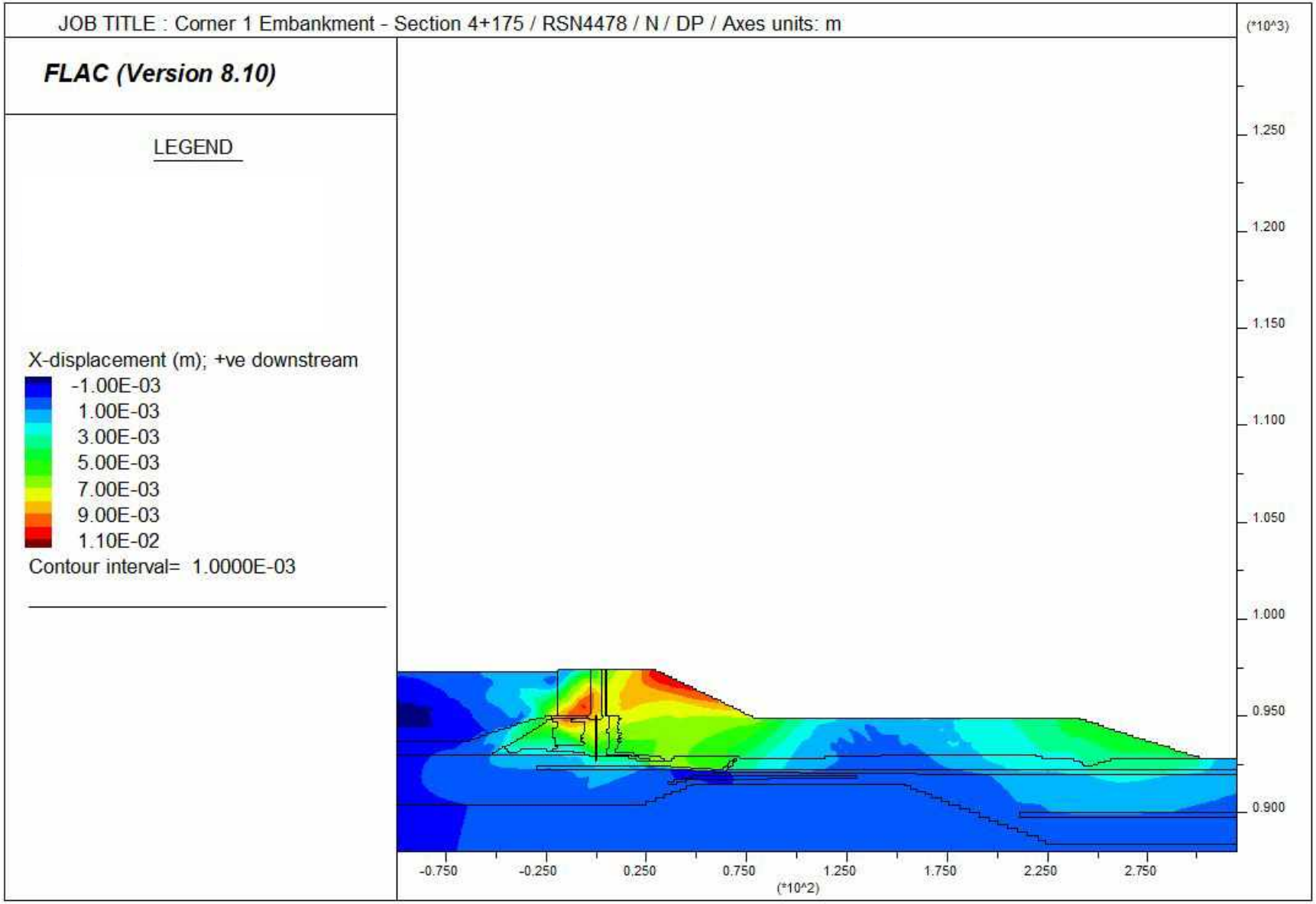

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-4.50E-01
-3.50E-01
-2.50E-01
-1.50E-01
-5.00E-02
5.00E-02
Contour interval= 5.0000E-02
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

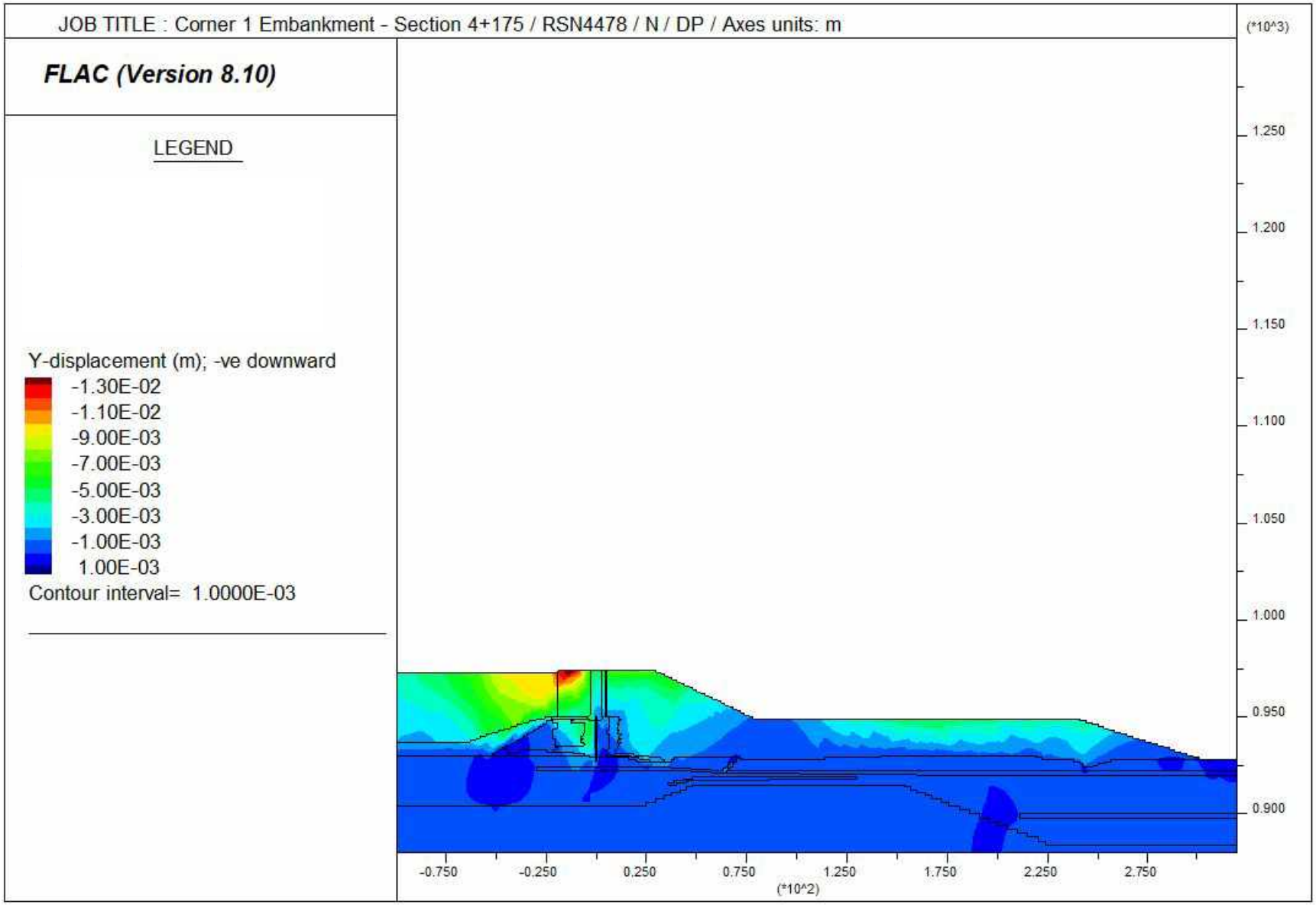

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-4.00E-01
-3.50E-01
-3.00E-01
-2.50E-01
-2.00E-01
-1.50E-01
-1.00E-01
-5.00E-02
0.00E+00
5.00E-02
Contour interval= 5.0000E-02
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

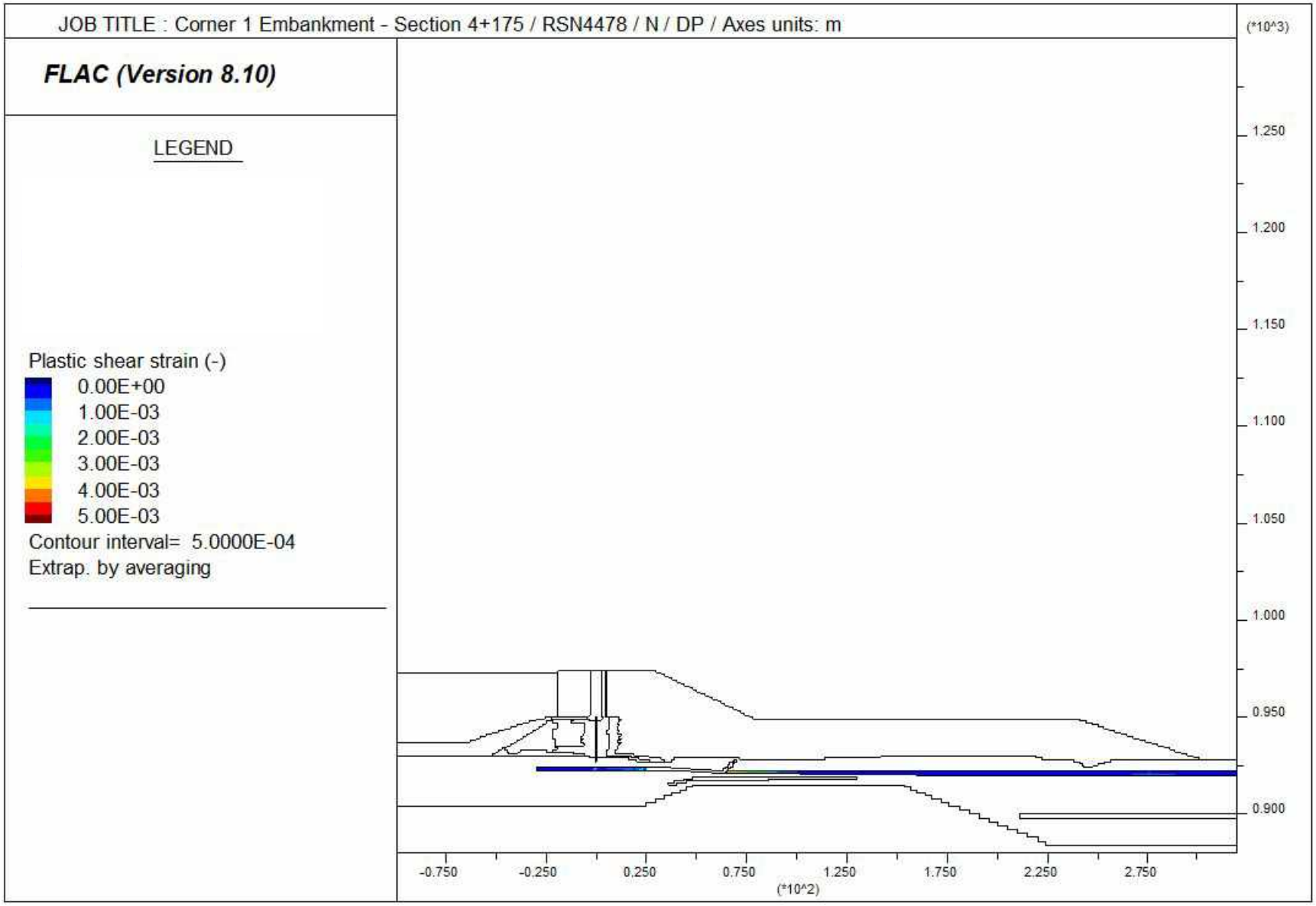

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
1.00E-03
2.00E-03
3.00E-03
4.00E-03
5.00E-03
6.00E-03
7.00E-03
8.00E-03
Contour interval= 5.0000E-04
Extrap. by averaging
(*10^3)
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.500
0.000
0.500
1.000
1.500
2.000
2.500
(*10^2)

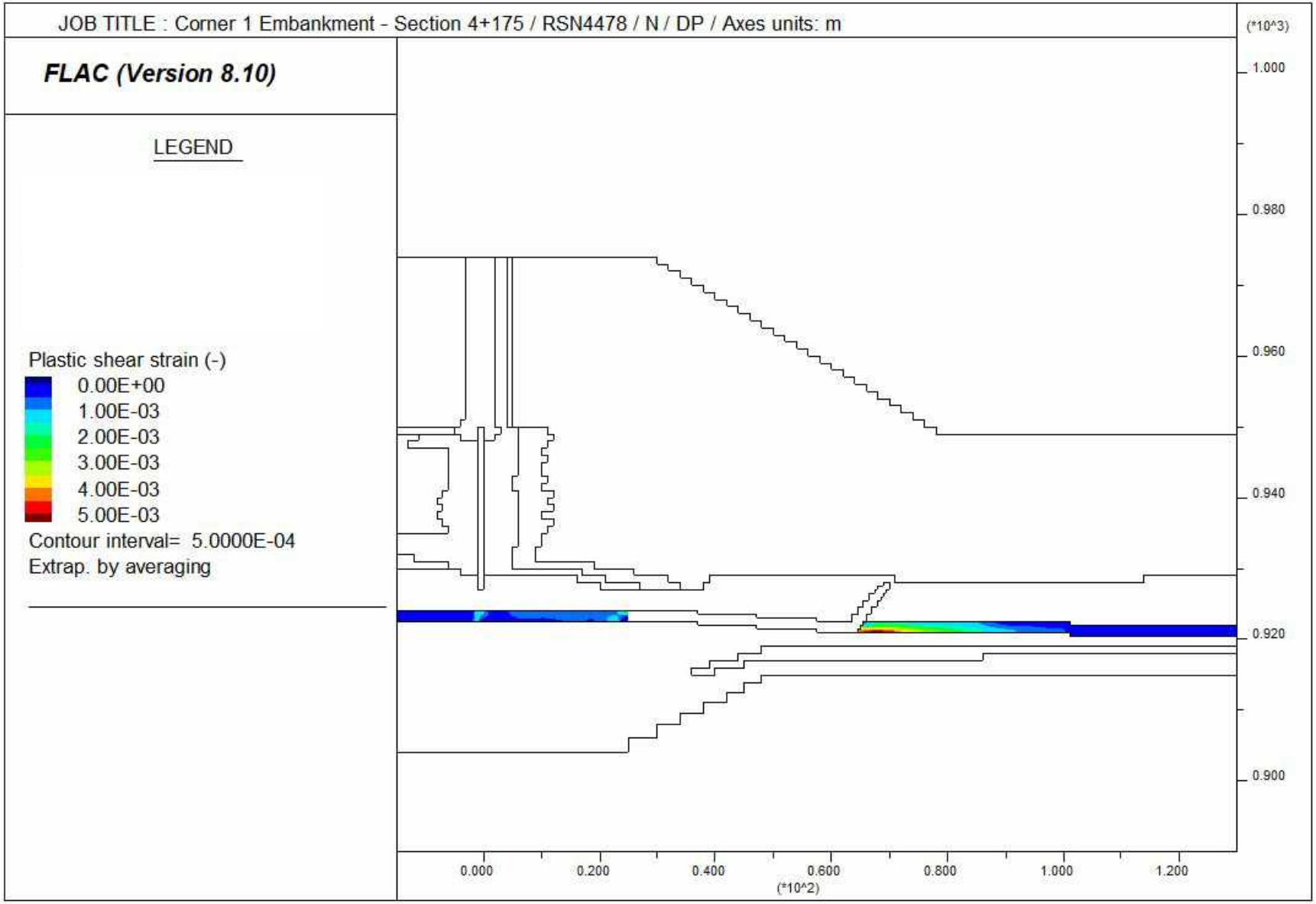

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
4.00E-04
8.00E-04
1.20E-03
1.60E-03
2.00E-03
Contour interval= 2.0000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

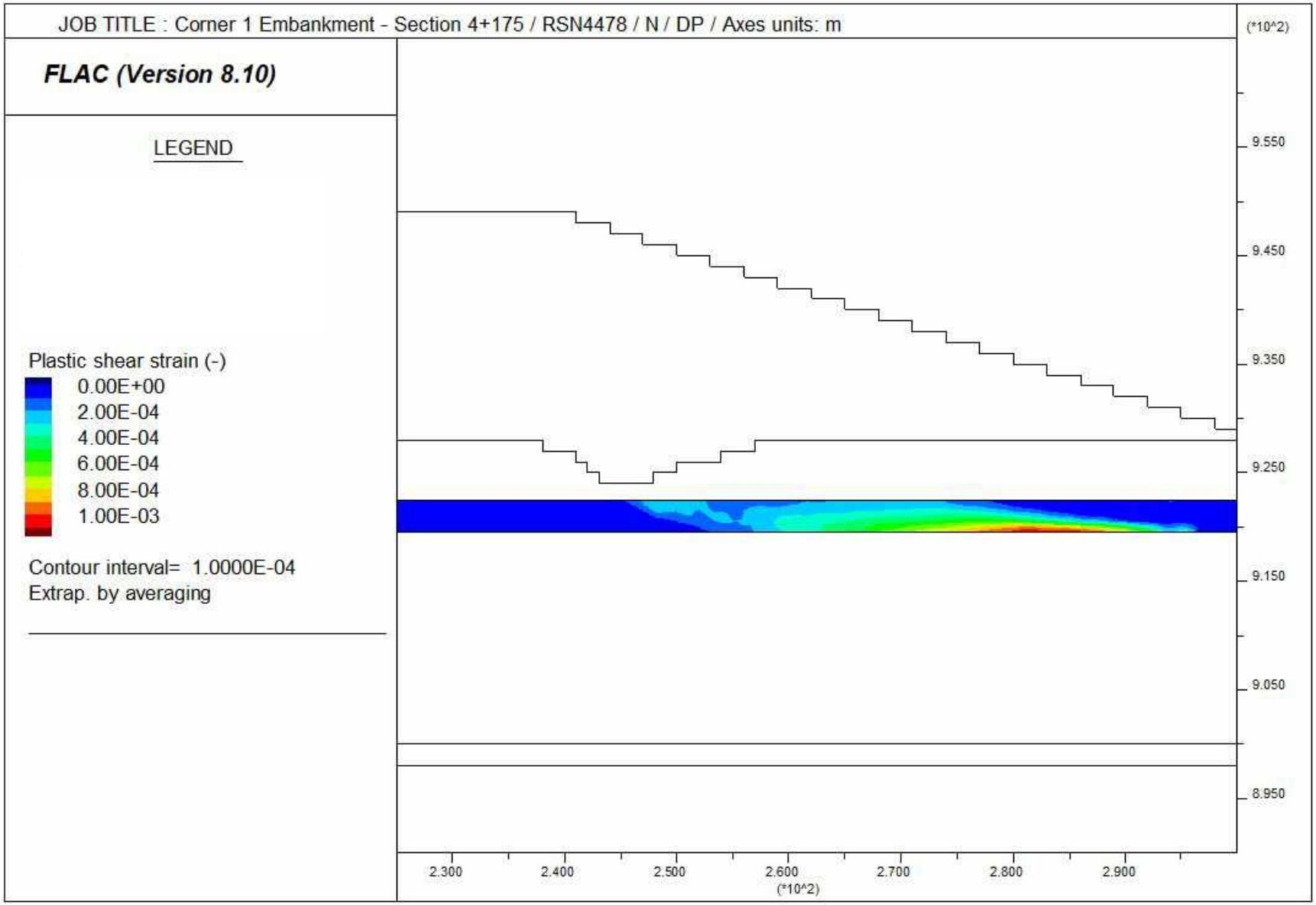

JOB TITLE : Main Embankment - Section 2+055 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.080
1.060
1.040
1.020
1.000
0.980
0.960
0.940
0.920
-1.400
-1.200
-1.000
-0.800
-0.600
-0.400
-0.200
0.000
0.200
(*10^2)

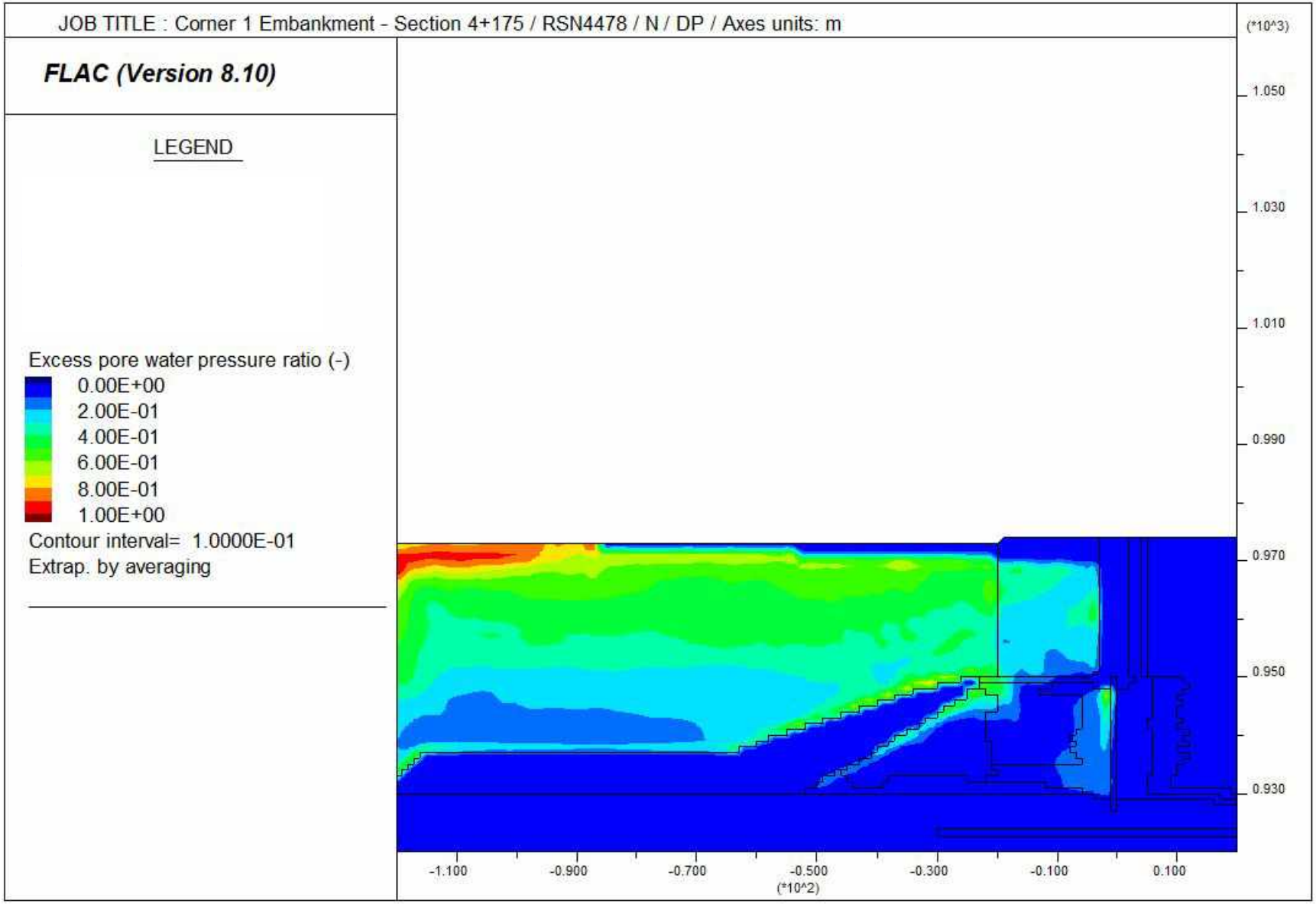

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-1.00E-03
1.00E-03
3.00E-03
5.00E-03
7.00E-03
9.00E-03
1.10E-02
Contour interval= 1.0000E-03
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

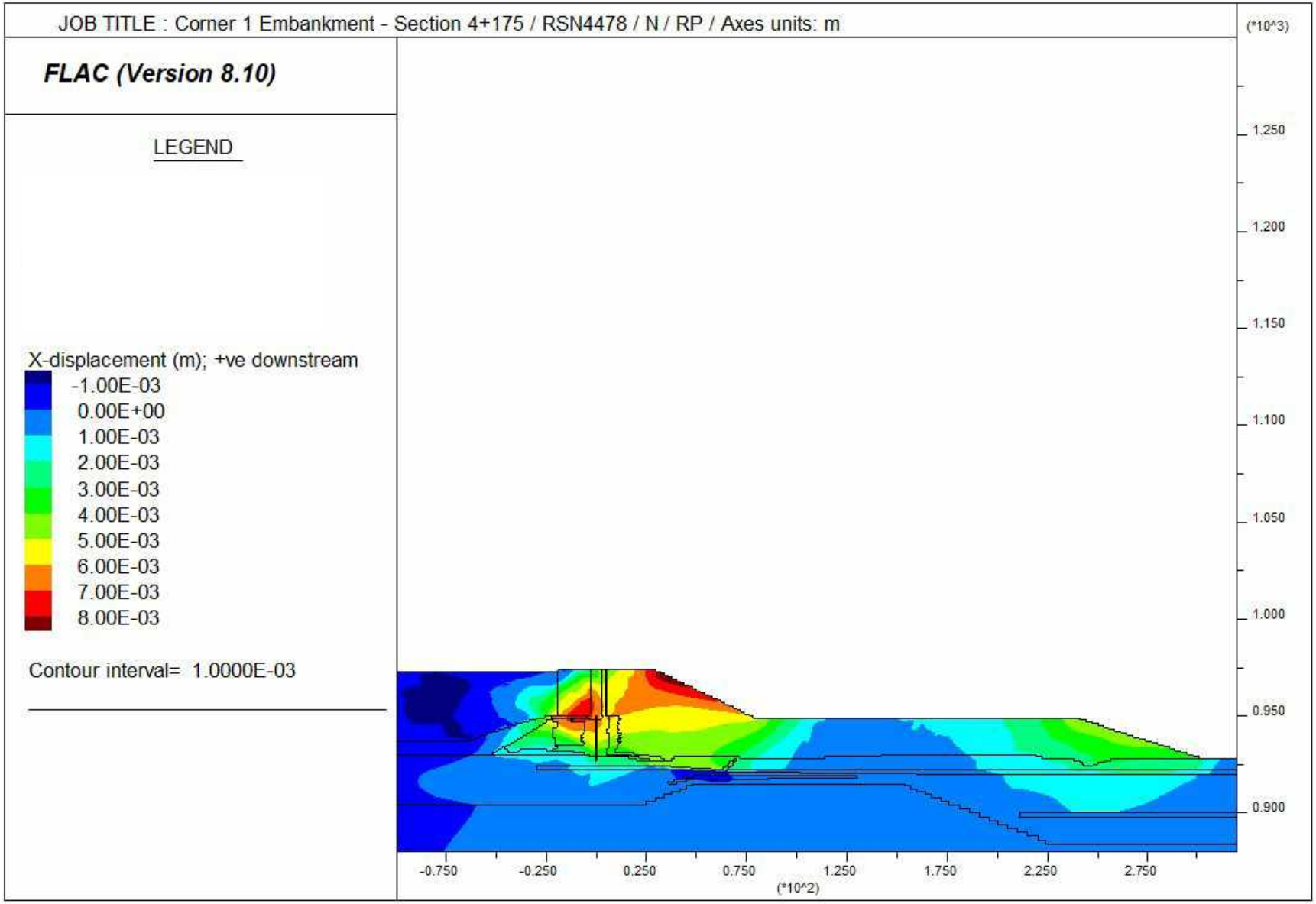

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-1.30E-02
-1.10E-02
-9.00E-03
-7.00E-03
-5.00E-03
-3.00E-03
-1.00E-03
1.00E-03
Contour interval= 1.0000E-03
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

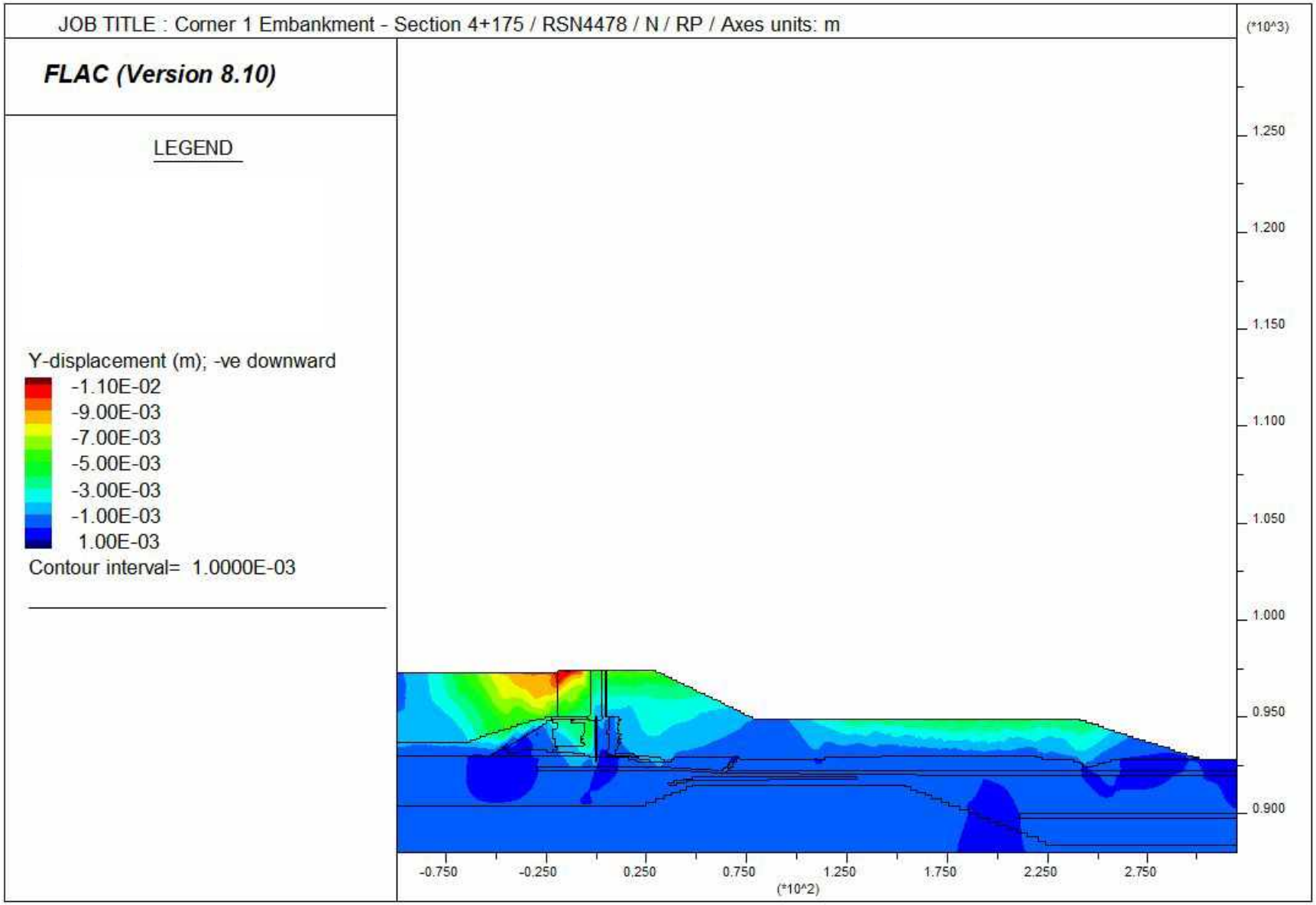

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
1.00E-03
2.00E-03
3.00E-03
4.00E-03
5.00E-03
Contour interval= 5.0000E-04
Extrap. by averaging
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

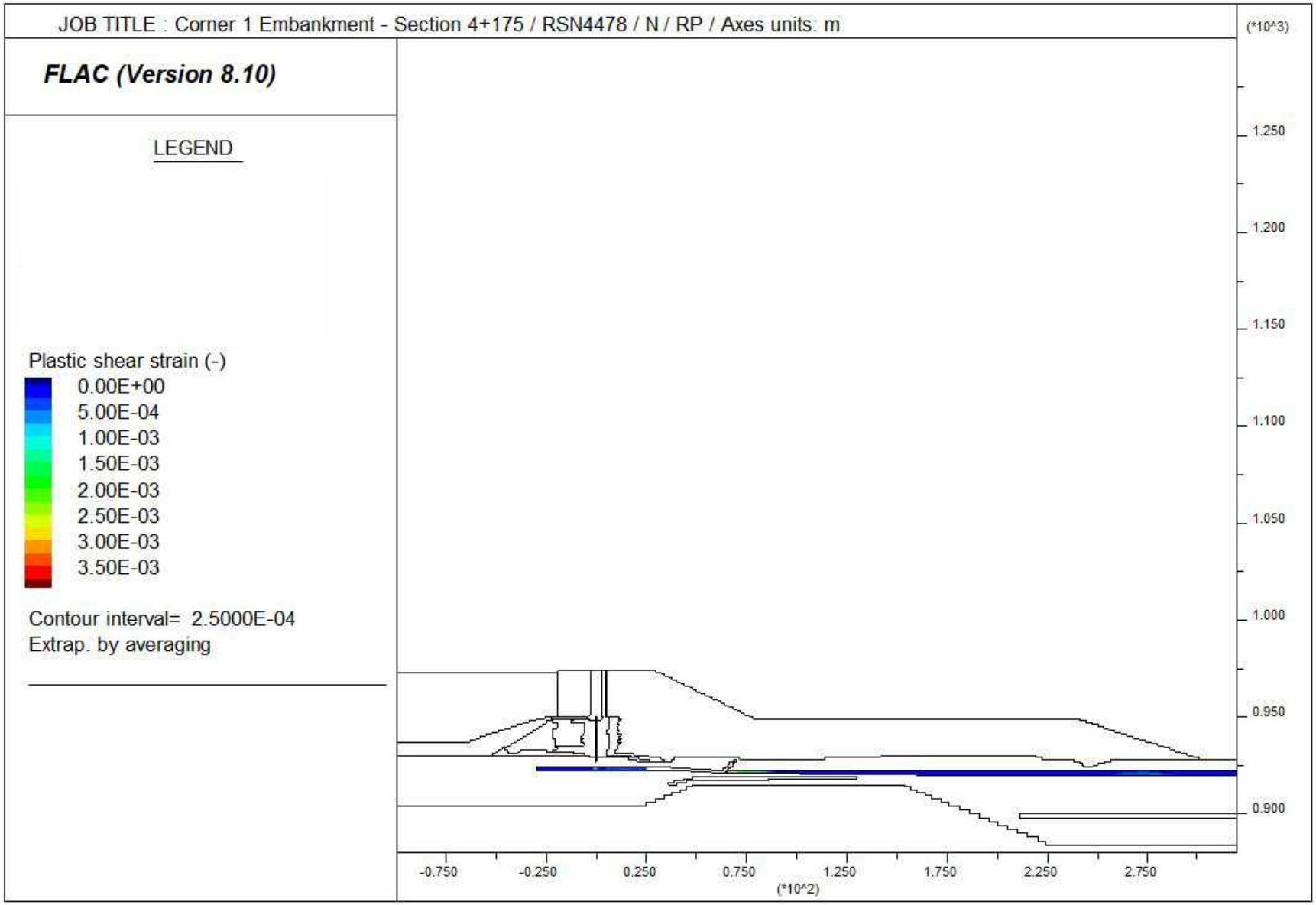

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
1.00E-03
2.00E-03
3.00E-03
4.00E-03
5.00E-03
Contour interval= 5.0000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

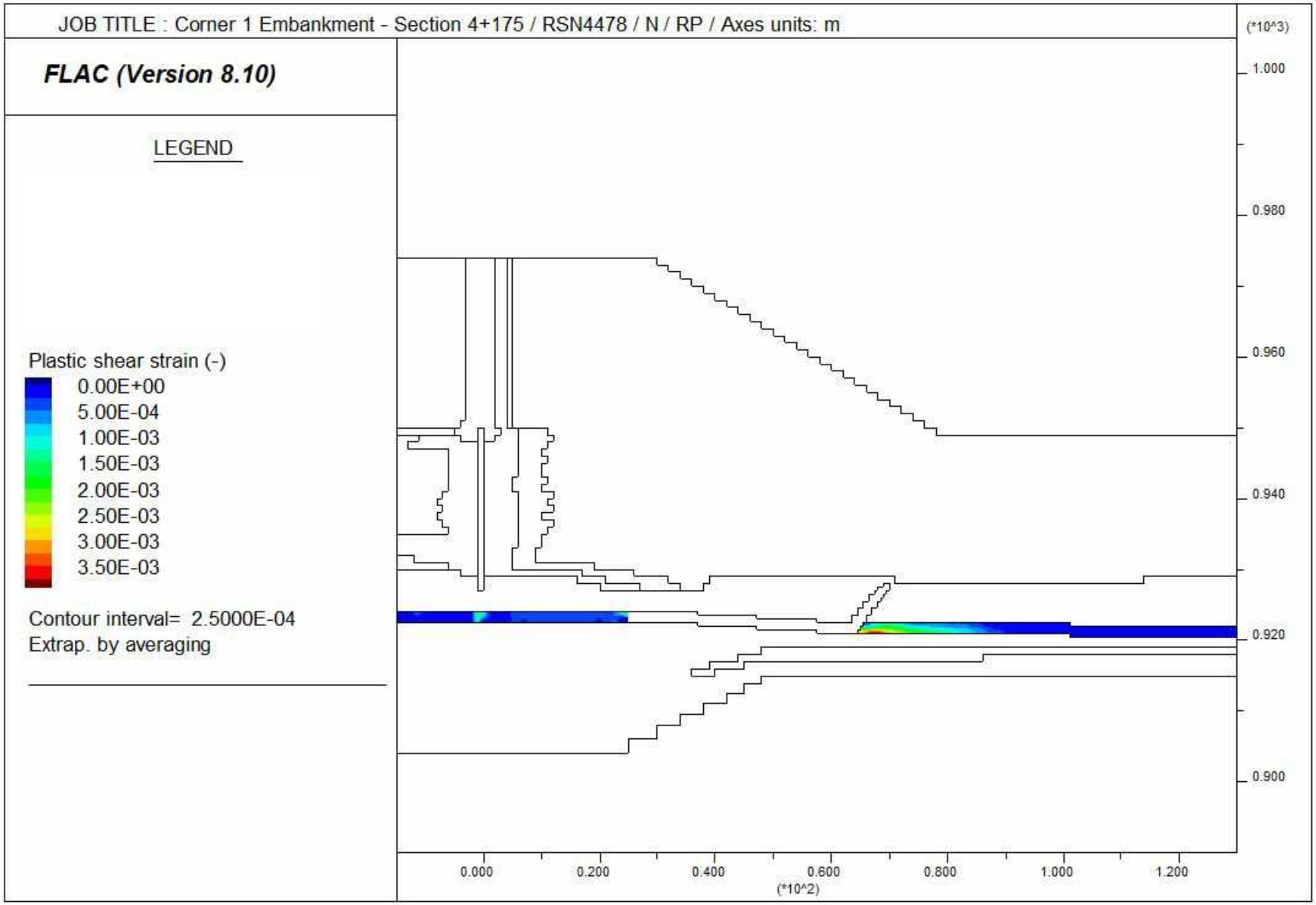

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-04
4.00E-04
6.00E-04
8.00E-04
1.00E-03
Contour interval= 1.0000E-04
Extrap. by averaging
(*10^2)
9.550
9.450
9.350
9.250
9.150
9.050
8.950
2.300
2.400
2.500
2.600
2.700
2.800
2.900
(*10^2)

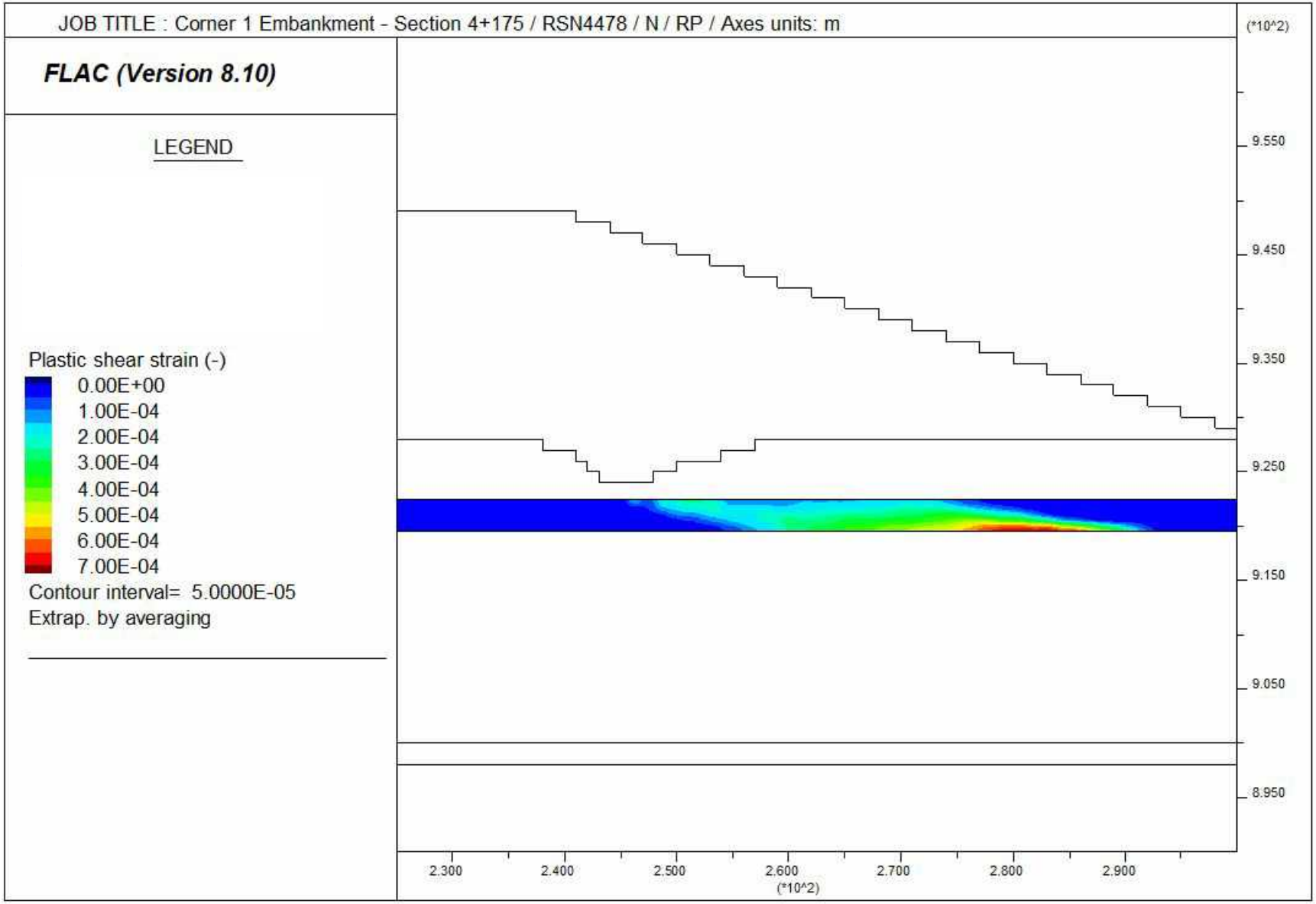

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.050
1.030
1.010
0.990
0.970
0.950
0.930
-1.100
-0.900
-0.700
-0.500
-0.300
-0.100
0.100
(*10^2)

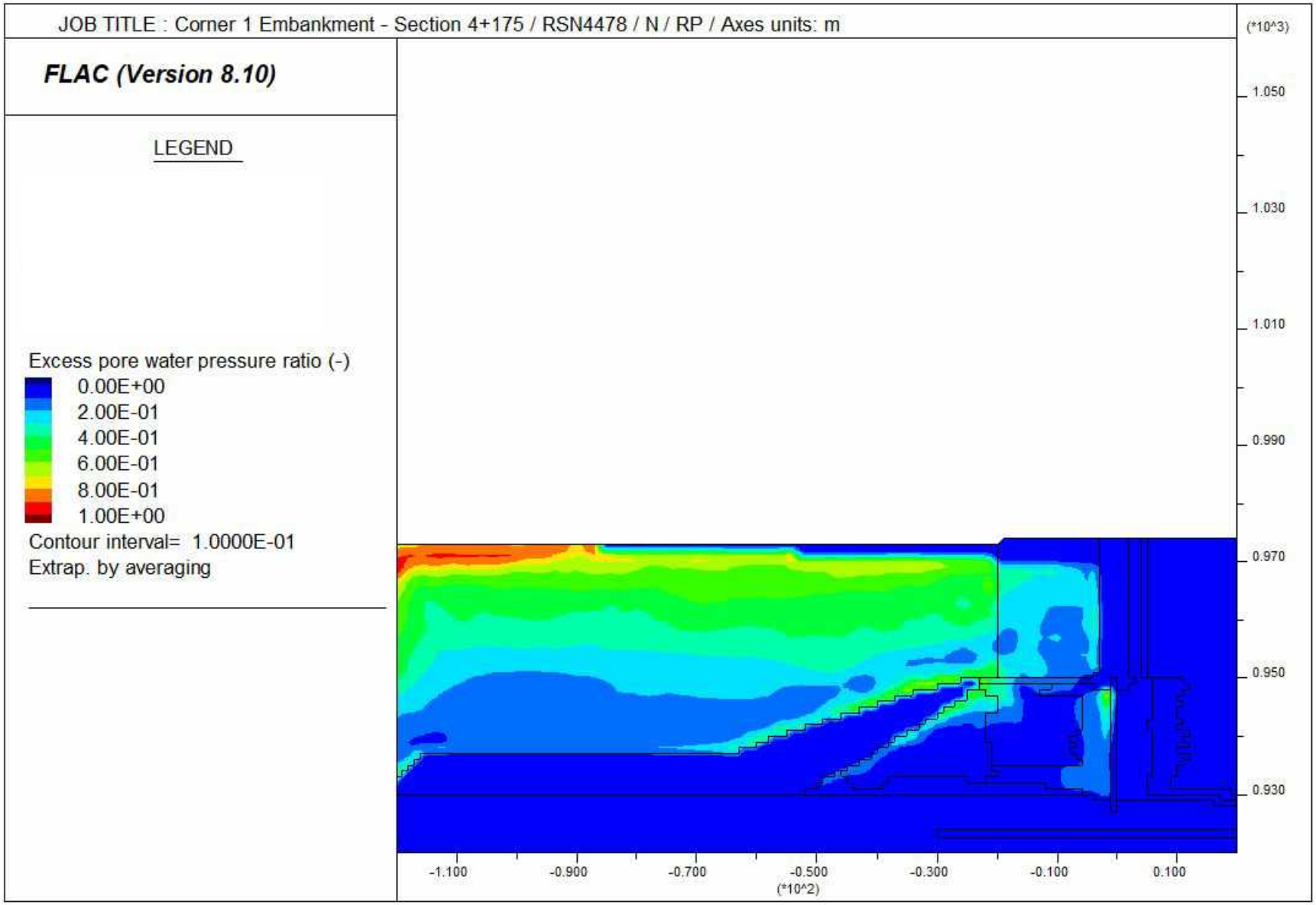

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-1.00E-03
0.00E+00
1.00E-03
2.00E-03
3.00E-03
4.00E-03
5.00E-03
6.00E-03
7.00E-03
8.00E-03
Contour interval= 1.0000E-03
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

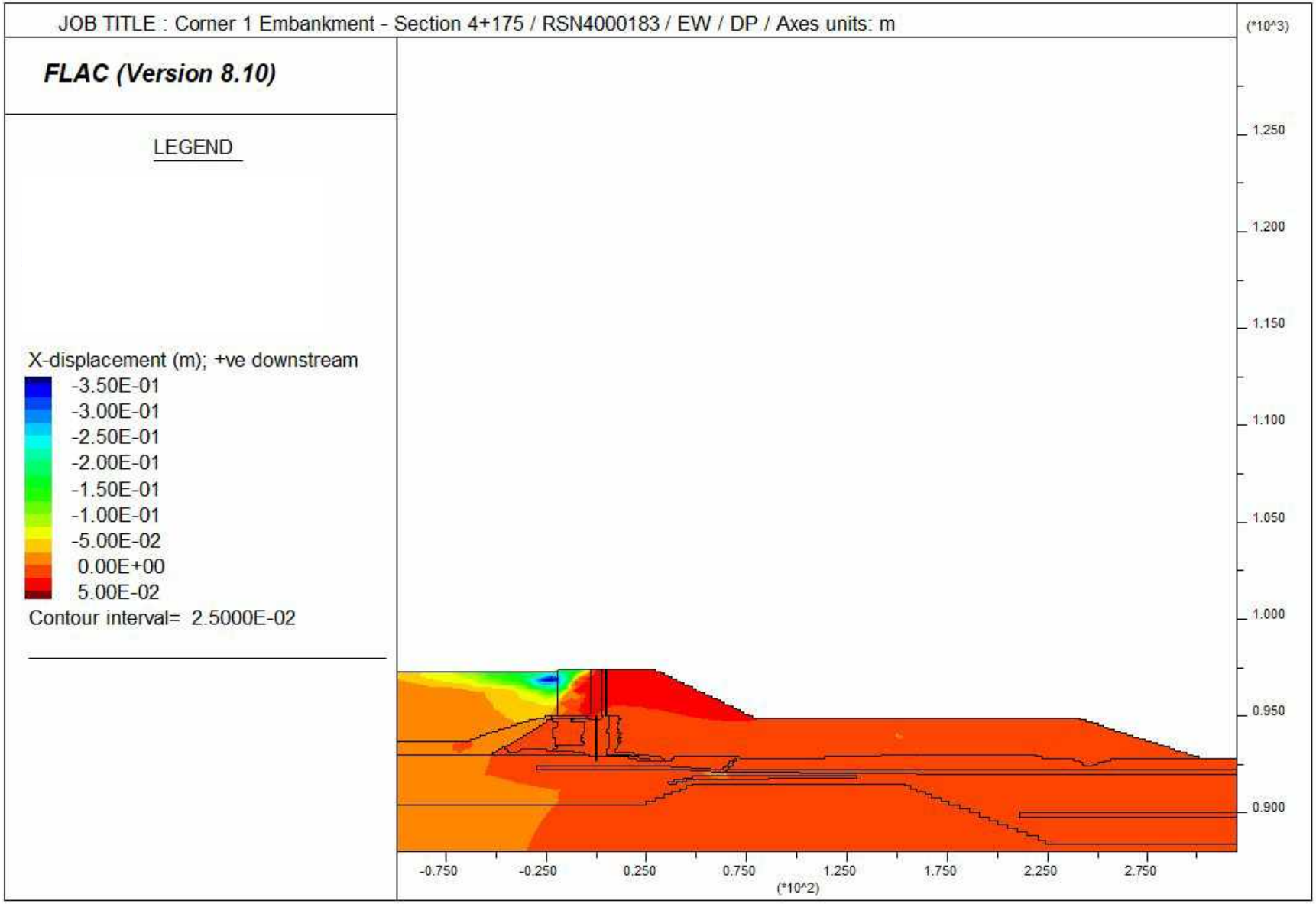

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-1.10E-02
-9.00E-03
-7.00E-03
-5.00E-03
-3.00E-03
-1.00E-03
1.00E-03
Contour interval= 1.0000E-03
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

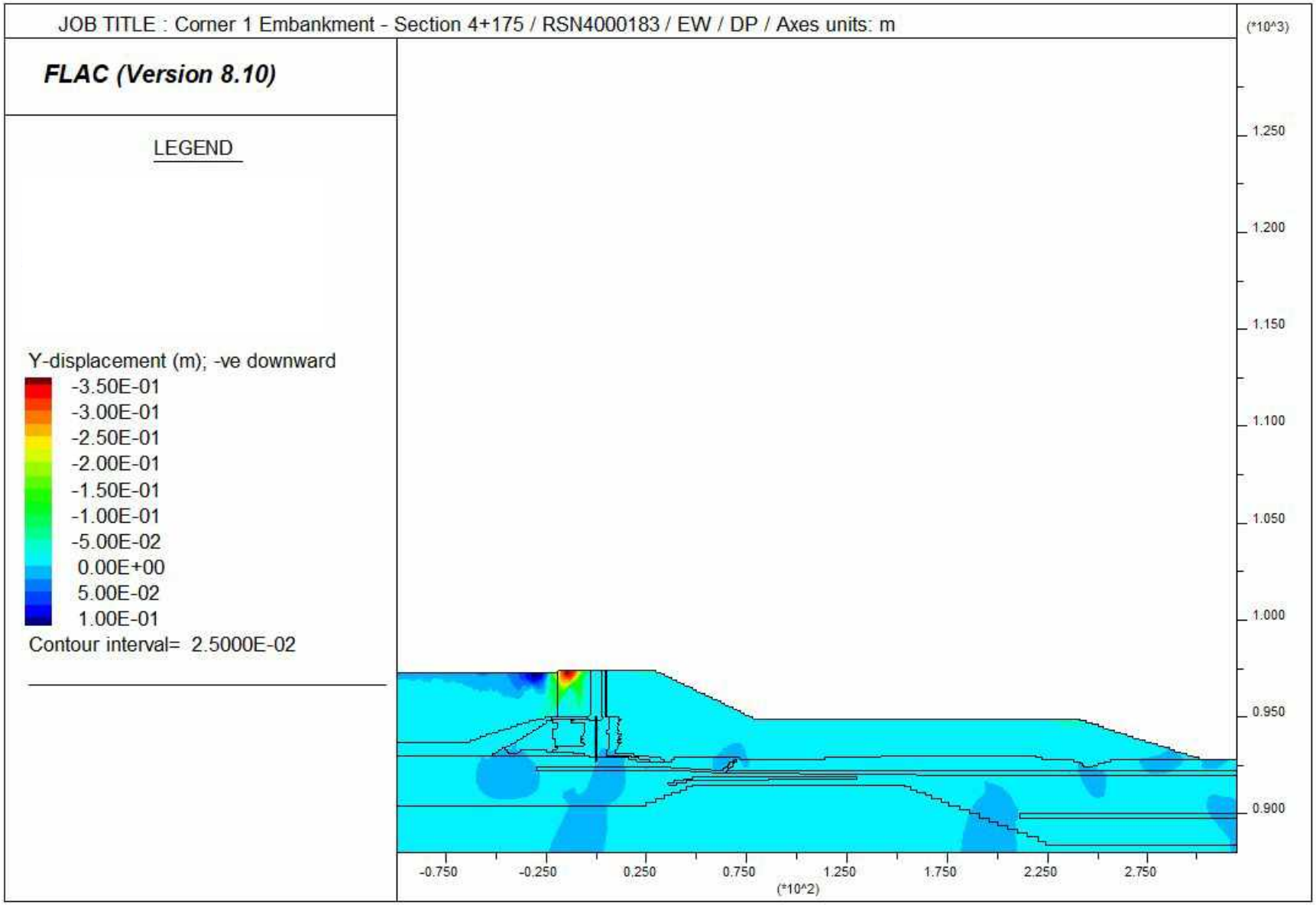

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
5.00E-04
1.00E-03
1.50E-03
2.00E-03
2.50E-03
3.00E-03
3.50E-03
Contour interval= 2.5000E-04
Extrap. by averaging
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

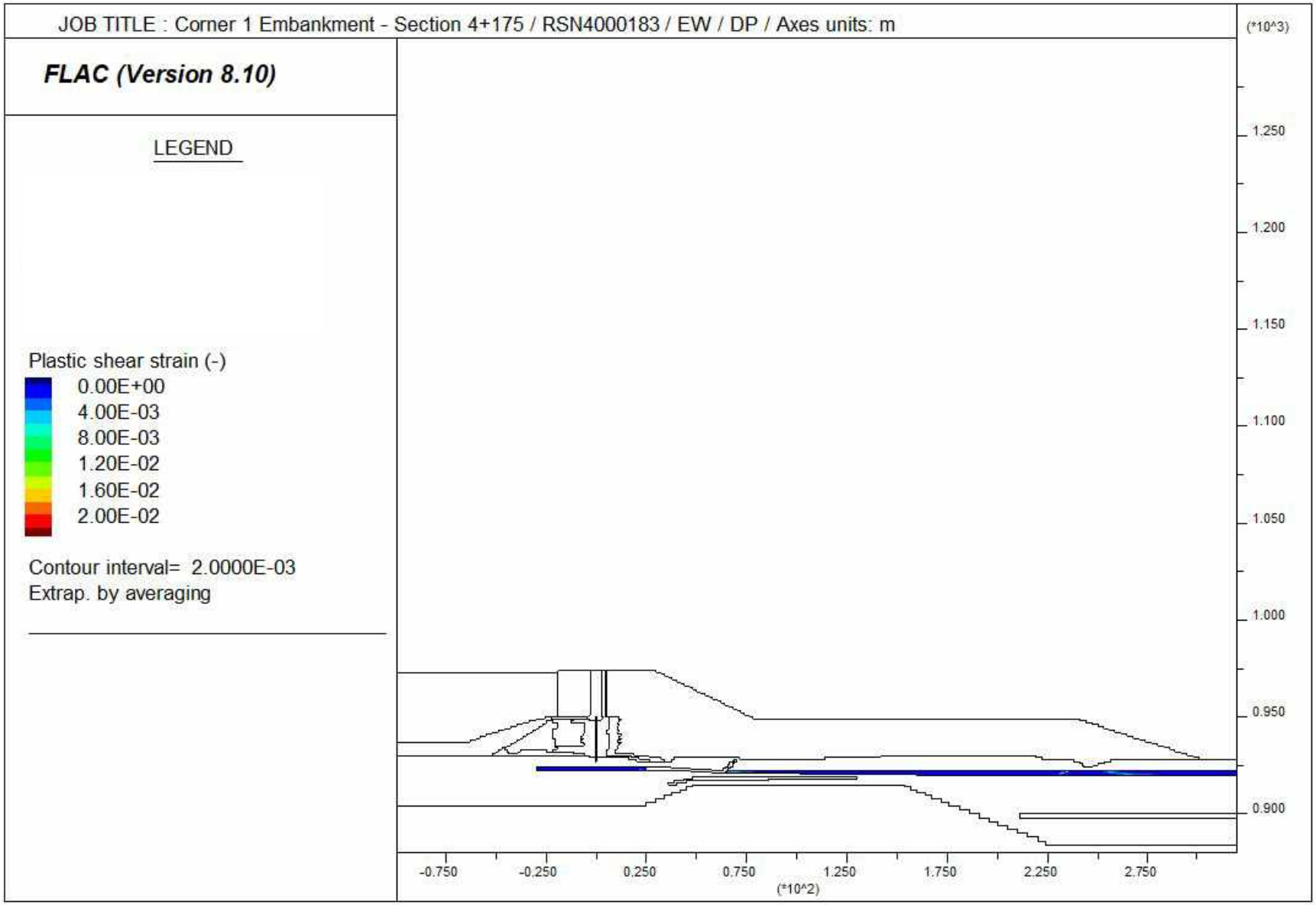

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
5.00E-04
1.00E-03
1.50E-03
2.00E-03
2.50E-03
3.00E-03
3.50E-03
Contour interval= 2.5000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

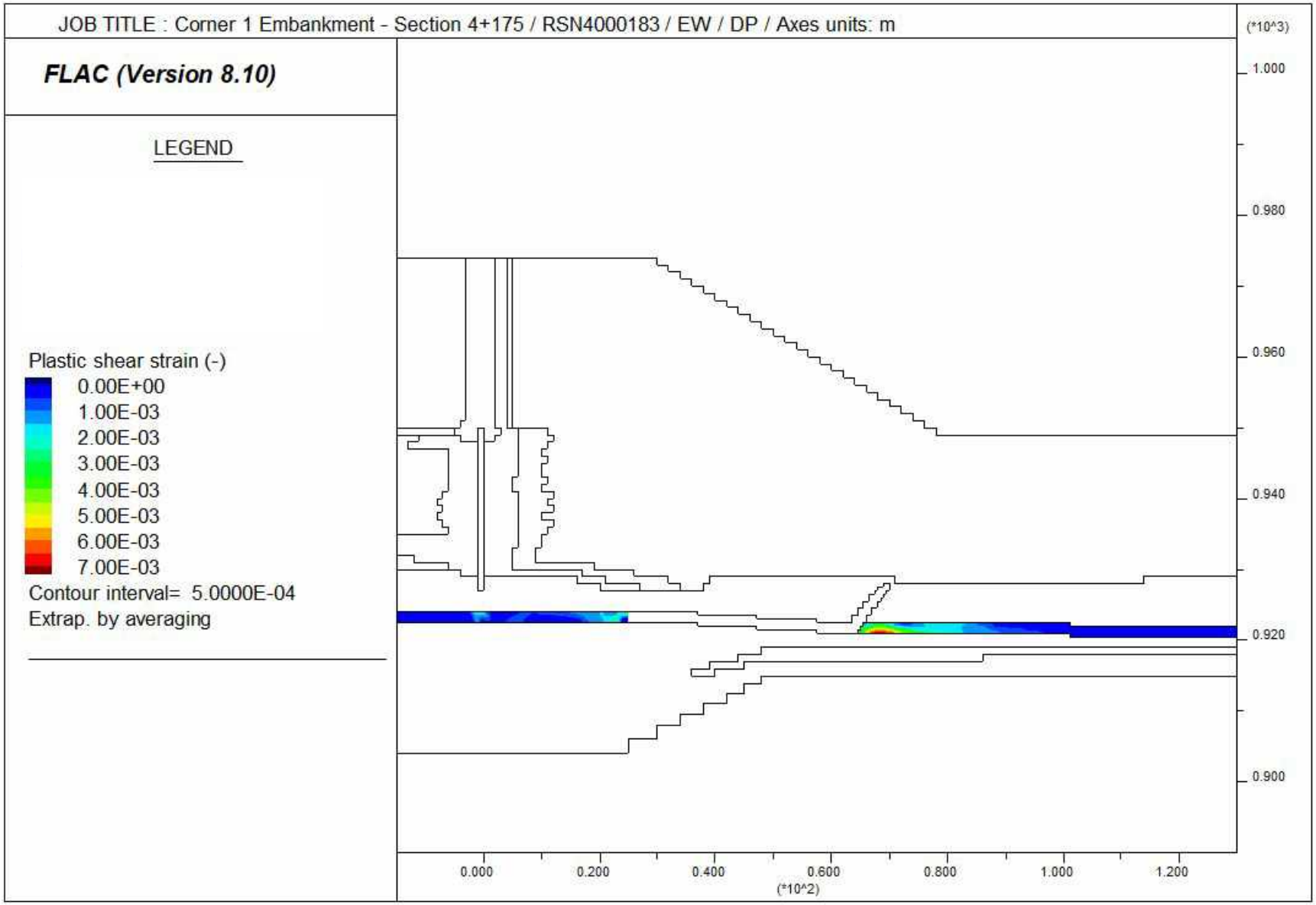

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
1.00E-04
2.00E-04
3.00E-04
4.00E-04
5.00E-04
6.00E-04
7.00E-04
Contour interval= 5.0000E-05
Extrap. by averaging
(*10^2)
9.550
9.450
9.350
9.250
9.150
9.050
8.950
2.300
2.400
2.500
2.600
2.700
2.800
2.900
(*10^2)

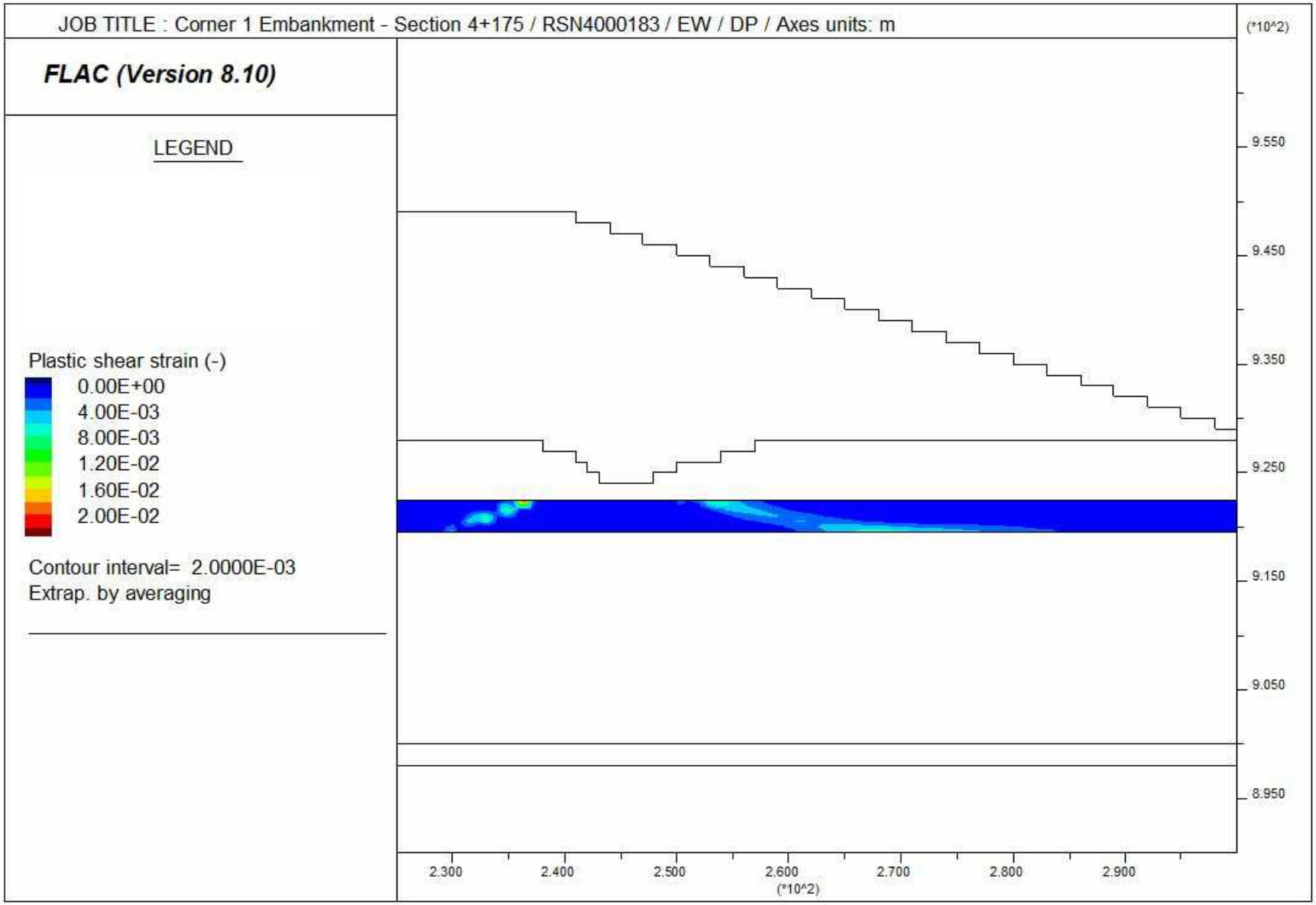

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4478 / N / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.050
1.030
1.010
0.990
0.970
0.950
0.930
-1.100
-0.900
-0.700
-0.500
-0.300
-0.100
0.100
(*10^2)

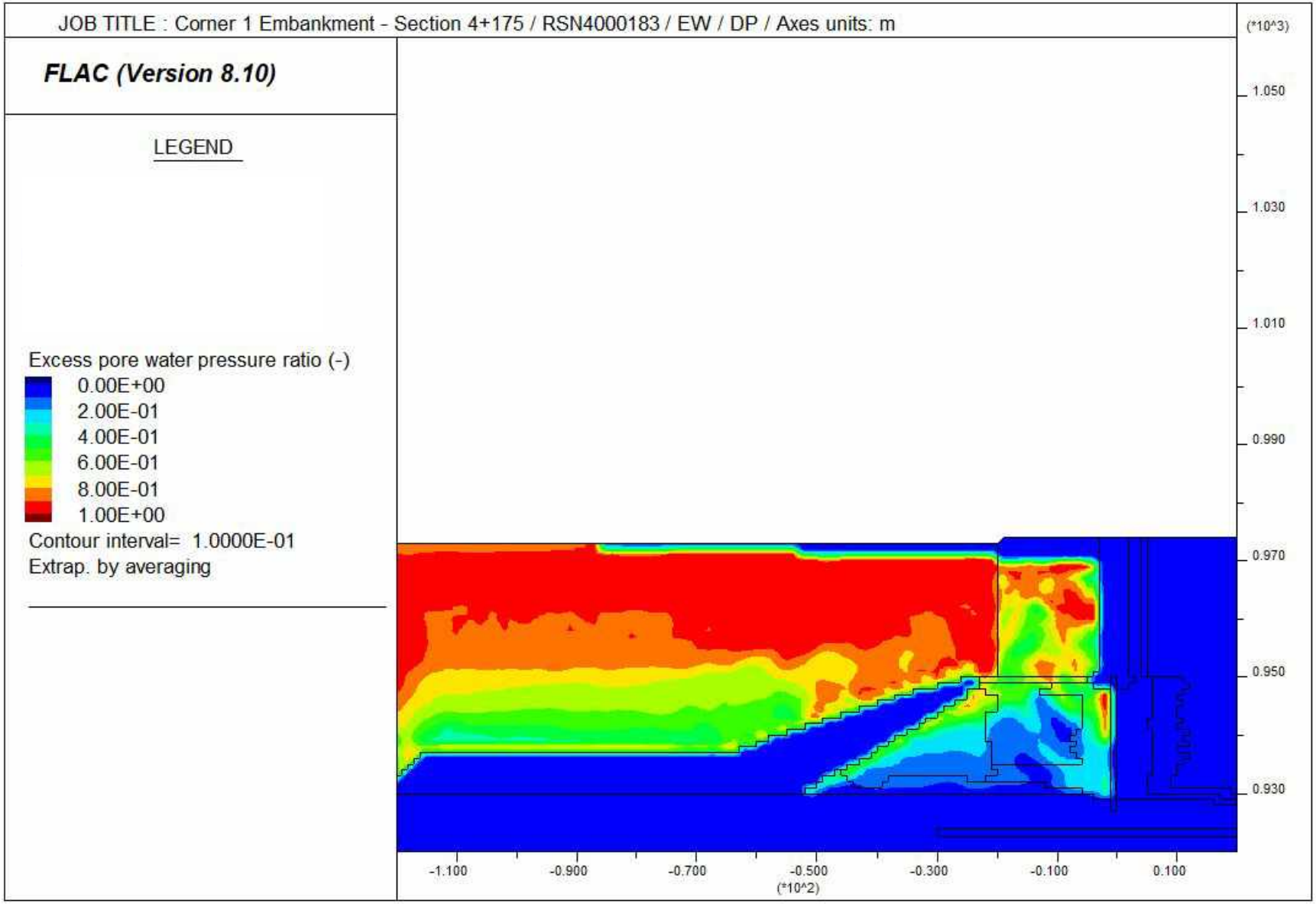

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-3.50E-01
-3.00E-01
-2.50E-01
-2.00E-01
-1.50E-01
-1.00E-01
-5.00E-02
0.00E+00
5.00E-02
Contour interval= 2.5000E-02
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

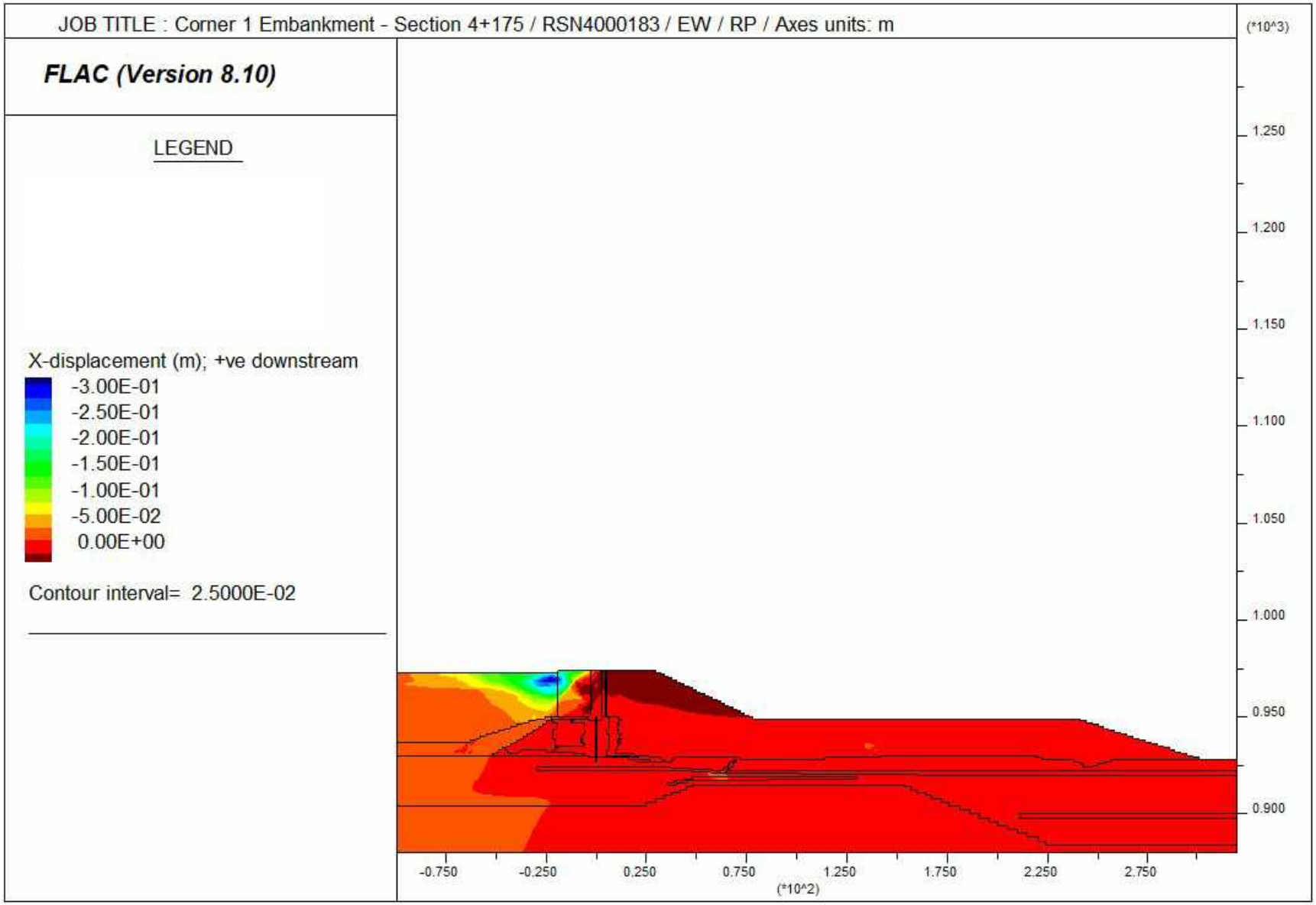

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-3.50E-01
-3.00E-01
-2.50E-01
-2.00E-01
-1.50E-01
-1.00E-01
-5.00E-02
0.00E+00
5.00E-02
1.00E-01
Contour interval= 2.5000E-02
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

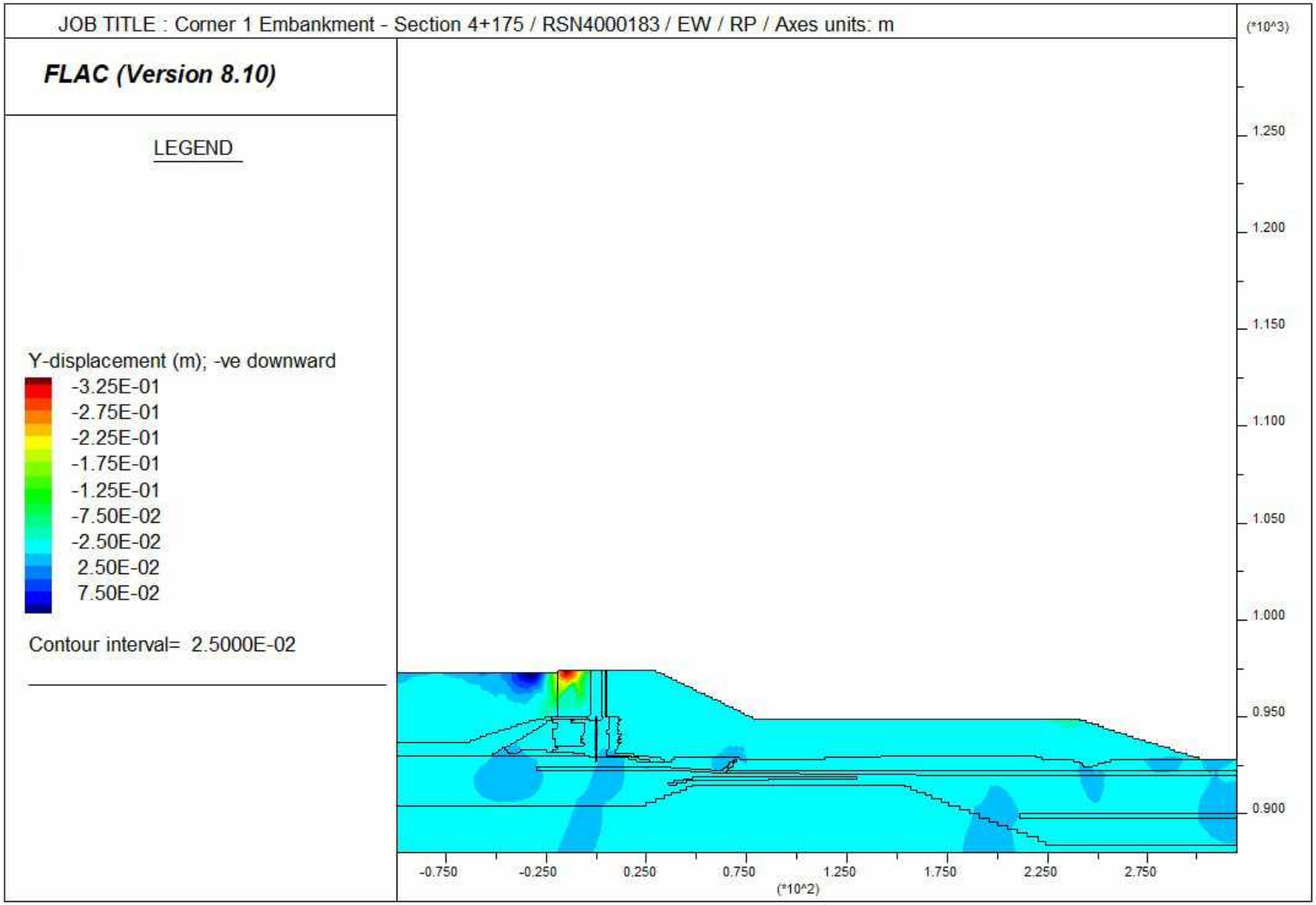

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
4.00E-03
8.00E-03
1.20E-02
1.60E-02
2.00E-02
Contour interval= 2.0000E-03
Extrap. by averaging
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)

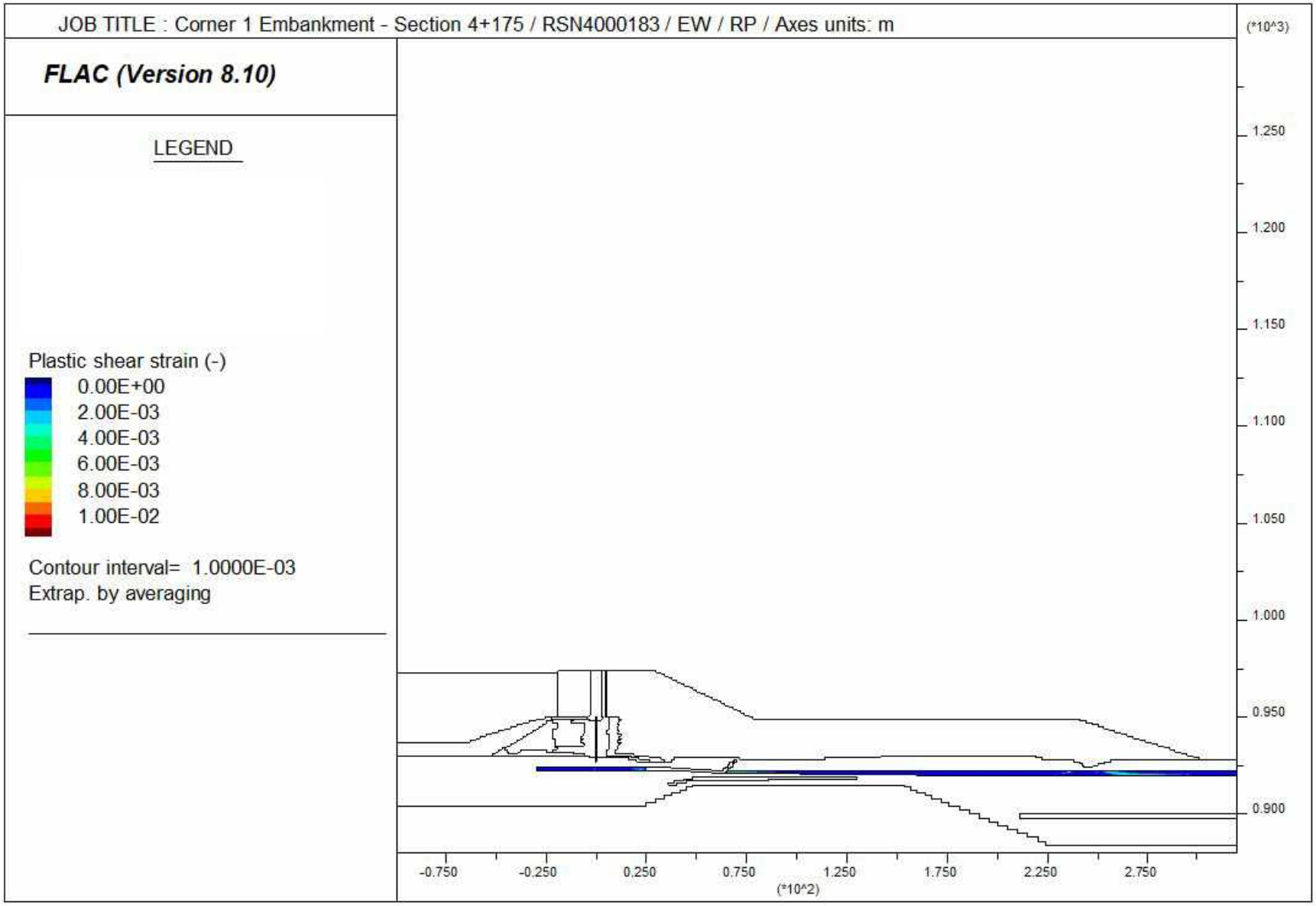

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
1.00E-03
2.00E-03
3.00E-03
4.00E-03
5.00E-03
6.00E-03
7.00E-03
Contour interval= 5.0000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)

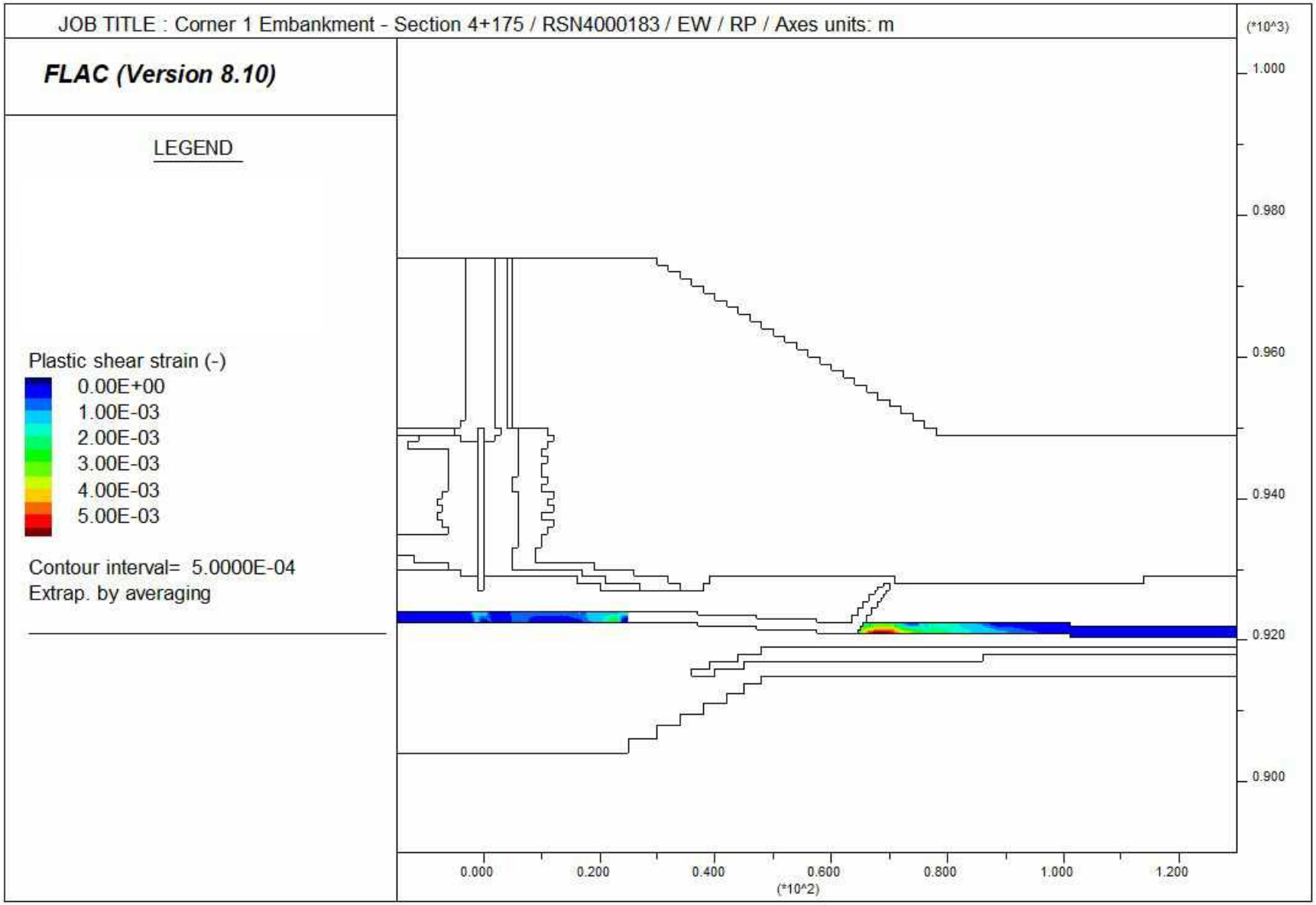

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
4.00E-03
8.00E-03
1.20E-02
1.60E-02
2.00E-02
Contour interval= 2.0000E-03
Extrap. by averaging
(*10^2)
9.550
9.450
9.350
9.250
9.150
9.050
8.950
2.300
2.400
2.500
2.600
2.700
2.800
2.900
(*10^2)

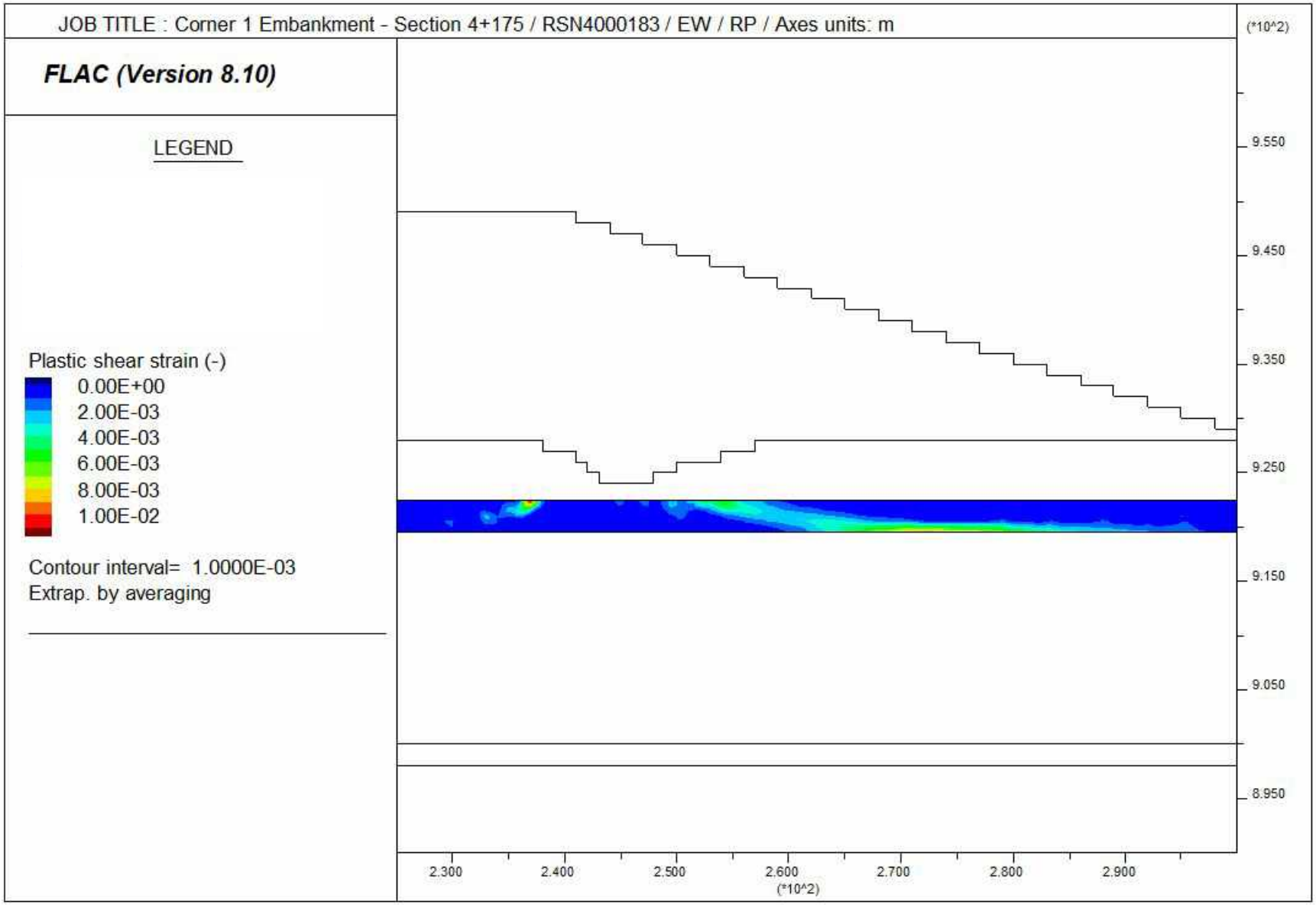

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / DP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.050
1.030
1.010
0.990
0.970
0.950
0.930
-1.100
-0.900
-0.700
-0.500
-0.300
-0.100
0.100
(*10^2)

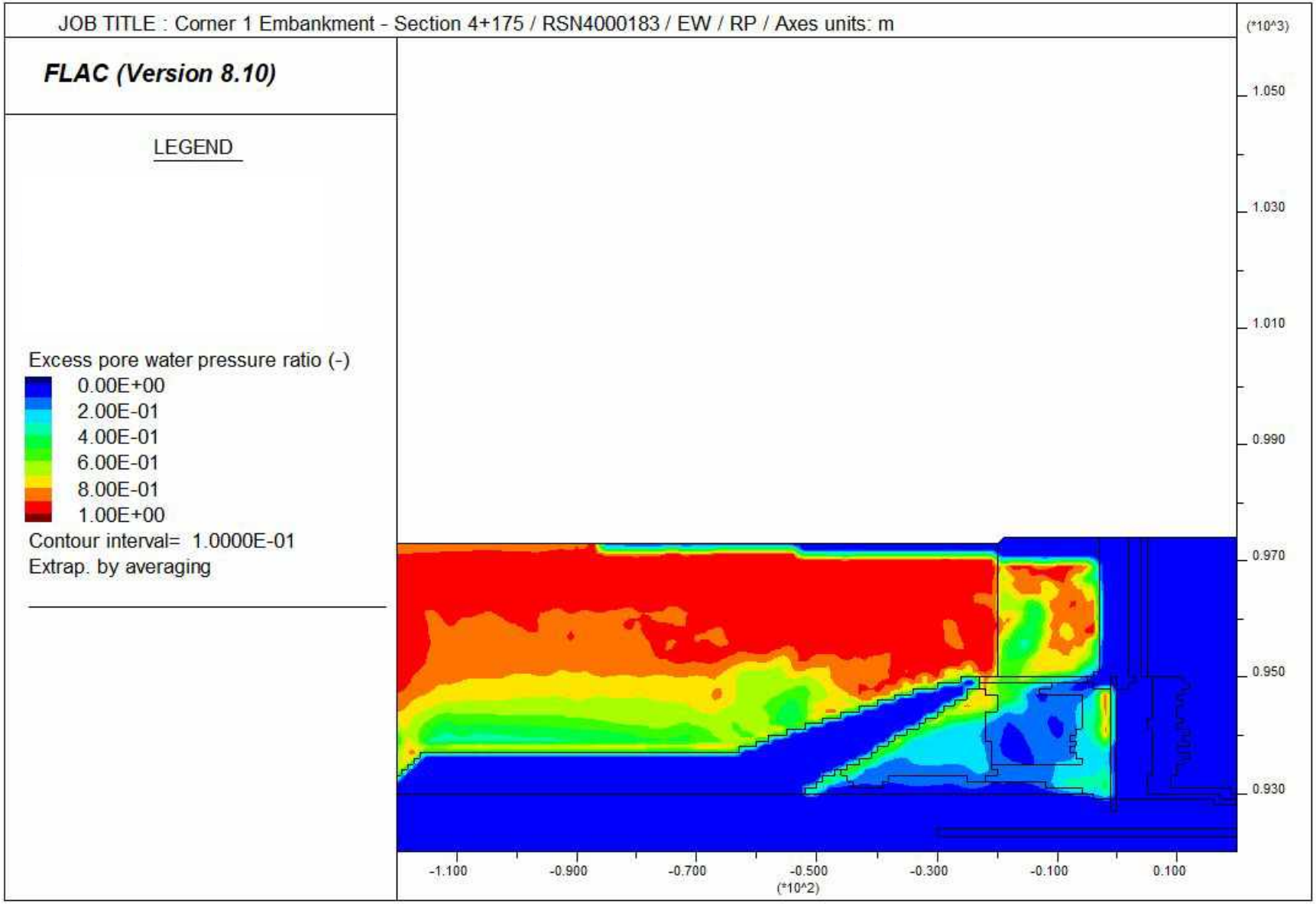

JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
X-displacement (m); +ve downstream
-3.00E-01
-2.50E-01
-2.00E-01
-1.50E-01
-1.00E-01
-5.00E-02
0.00E+00
Contour interval= 2.5000E-02
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Y-displacement (m); -ve downward
-3.25E-01
-2.75E-01
-2.25E-01
-1.75E-01
-1.25E-01
-7.50E-02
-2.50E-02
2.50E-02
7.50E-02
Contour interval= 2.5000E-02
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-03
4.00E-03
6.00E-03
8.00E-03
1.00E-02
Contour interval= 1.0000E-03
Extrap. by averaging
(*10^3)
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
-0.750
-0.250
0.250
0.750
1.250
1.750
2.250
2.750
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
1.00E-03
2.00E-03
3.00E-03
4.00E-03
5.00E-03
Contour interval= 5.0000E-04
Extrap. by averaging
(*10^3)
1.000
0.980
0.960
0.940
0.920
0.900
0.000
0.200
0.400
0.600
0.800
1.000
1.200
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Plastic shear strain (-)
0.00E+00
2.00E-03
4.00E-03
6.00E-03
8.00E-03
1.00E-02
Contour interval= 1.0000E-03
Extrap. by averaging
(*10^2)
9.550
9.450
9.350
9.250
9.150
9.050
8.950
2.300
2.400
2.500
2.600
2.700
2.800
2.900
(*10^2)


JOB TITLE : Corner 1 Embankment - Section 4+175 / RSN4000183 / EW / RP / Axes units: m
FLAC (Version 8.10)
LEGEND
Excess pore water pressure ratio (-)
0.00E+00
2.00E-01
4.00E-01
6.00E-01
8.00E-01
1.00E+00
Contour interval= 1.0000E-01
Extrap. by averaging
(*10^3)
1.050
1.030
1.010
0.990
0.970
0.950
0.930
-1.100
-0.900
-0.700
-0.500
-0.300
-0.100
0.100
(*10^2)

APPENDIX I

Water Management Design

TECHNICAL MEMORANDUM

DATE April 9, 2024 **Reference No.** CA0020527.4505-015-TM-Rev0-31151

TO Matt O'Leary
Mount Polley Mining Corporation

CC Lee Nikl, Jesse Maddaloni, Germán Pizarro and Andrew McIntosh

FROM Daniel Mullen, Nasim Hossein, and Don Kidd **EMAIL daniel.mullen@wsp.com; nasim.hosseini@wsp.com; donald.kidd@wsp.com**

TAILINGS STORAGE FACILITY RAISE TO ELEVATION 974 M DESIGN – FREEBOARD AND WATER LEVEL ANALYSIS – MOUNT POLLEY MINE

1.0 INTRODUCTION

Mount Polley Mine is a copper and gold mine operated by Mount Polley Mining Corporation (MPMC), a subsidiary of Imperial Metals Corporation. The mine is located approximately 56 km northeast of Williams Lake, British Columbia, between Polley Lake and Bootjack Lake. The total surface area of the site is 17.8 square kilometres (km^2). The tailings storage facility (TSF) is located about 3 km southeast of the mill and includes one embankment that is approximately 4.8 km in length.

This technical memorandum has been prepared by WSP Canada Inc. (WSP) to provide the hydrologic input for the design of the TSF spillway to support raising the existing TSF from its currently permitted elevation of 970 m to 974 m. The purpose of this technical memorandum is as follows:

- Assess a minimum freeboard that needs to be maintained at all times to prevent overtopping of the TSF by wave action.
- An emergency spillway (spillway) design that will maintain the required minimum freeboard during the design event.
- Estimate inflow volumes generated by the design events.
- Determine the water level at which pumping of site water to the TSF must cease.

2.0 BACKGROUND

During normal operations, the TSF will be managed by maintaining the pond volume within the operating range for reclaim water and make-up water. Deposition of tailings will be planned to maintain the pond away from the embankment and against the natural ground on the western perimeter.

The inflows that directly contribute to the TSF are from precipitation on the direct footprint of the TSF and runoff from the catchment directly above the TSF. The major contribution to TSF supernatant volume is site contact water pumped from facilities including the Central Collection Sump and Perimeter Embankment Till Borrow Pond.

Temporary detention of water in the TSF is necessary to manage large site runoff volumes that can be generated during freshet; however, a fundamental basis of the water management plan is to not accumulate water on site year over year within the TSF by treating and discharging water.

A site-wide water balance model has been developed (WSP 2023b) to support water management planning and to predict water volume/level in the TSF throughout future operations. The water balance model shows that the maximum TSF pond volume during the operational phase remains within the normal operating range during average conditions (50th percentile) and increases to approximately 3.5 million m^3, which represents the 99.5th percentile volume.

A spillway will be included in the design of the TSF Raise to Elevation 974 m as an emergency control measure to prevent potential overtopping of the facility.

3.0 DESIGN CRITERIA AND INPUTS

The design criteria for the TSF spillway during operation are described in the technical design basis memorandum document for TSF Raise to Elevation 974 m (WSP 2023a); inputs to the TSF freeboard and water level assessment are summarized in Table 1.

Table 1: Tailings Storage Facility Freeboard and Water Level Assessment Spillway Design Inputs Summary

Item No.	Item Description	Design Basis	Reference/Rationale
Background			
1	Horizontal and vertical datum	Horizontal datum is UTM Zone 10 NAD83 CSRS and vertical datum is relative to local tailings grid.	2023 LiDAR contours with 0.1 m resolution provided by MPMC (Fullerton 2024)
Climate and Hydrology			
2	24-hour 1:200-year precipitation depth	69 mm	Section 3.3
3	72-hour probable maximum precipitation (PMP)	339 mm	Section 3.3
4	24-hour snowmelt depth component of the environmental design flood (EDF)	16 mm	24-hour snowmelt using 24-hour 1:200-year precipitation and mean April temperature Section 3.4
5	72-hour snowmelt depth component of the inflow design flood (IDF)	54 mm	72-hour snowmelt using 72-hour PMP and mean April temperature Section 3.4

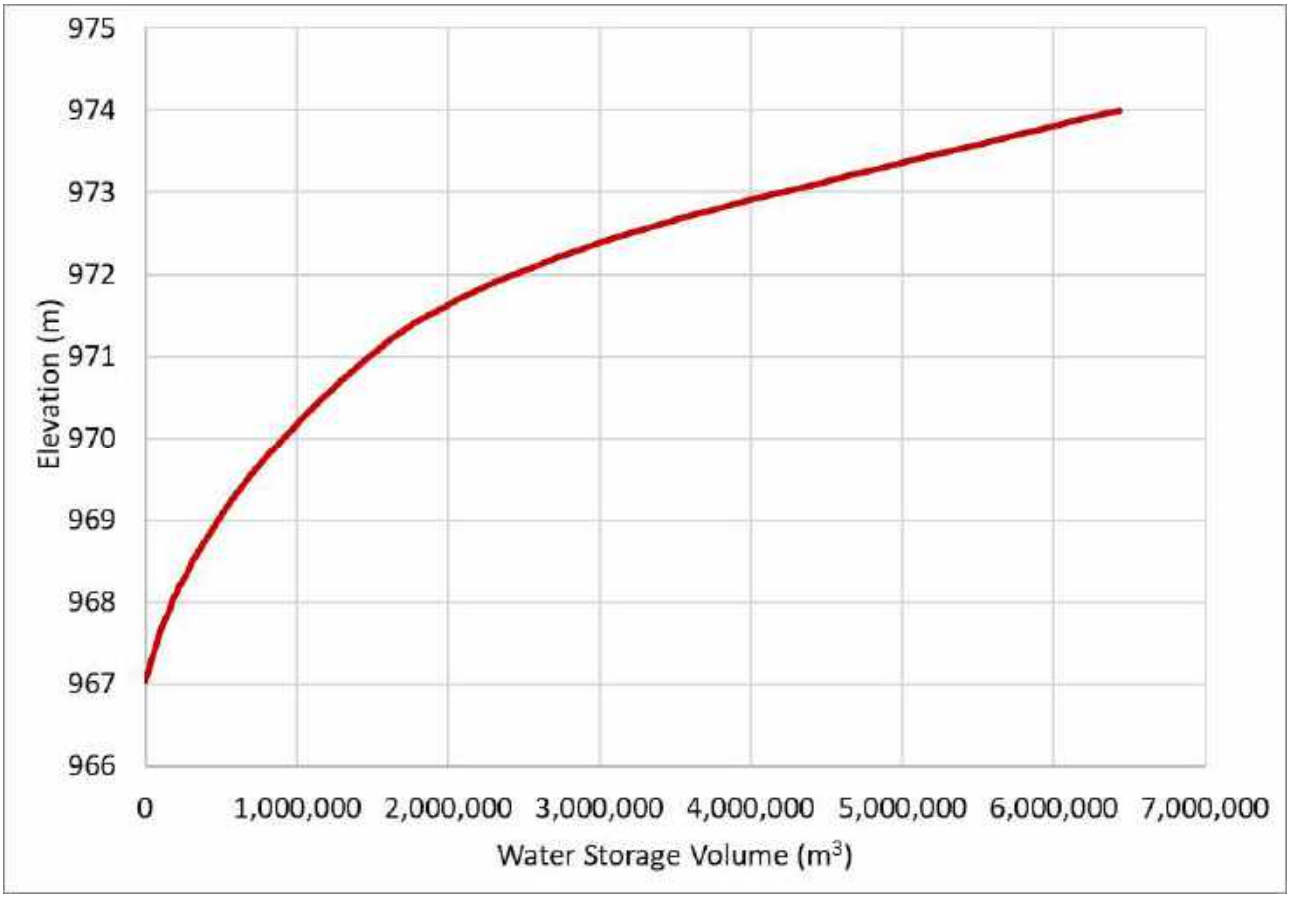
Table 1: Tailings Storage Facility Freeboard and Water Level Assessment Spillway Design Inputs Summary

Item No.	Item Description	Design Basis	Reference/Rationale
6	Snowmelt distribution	Evenly distributed over 12 hours centred on the storm peak intensity for each day	Adopted

No. = number; TSF = tailings storage facility; MPMC = Mount Polley Mining Corporation; IDF = inflow design flood; PMP = probable maximum precipitation; EDF = environmental design flood; UTM = Universal Transverse Mercator; NAD83 = North American Datum of 1983; CSRS = Canadian Spatial Reference System.

3.1 Tailings Storage Facility Storage Curve

The TSF storage curve applied in the analysis was generated from a tailings deposition model with a dam crest height of 974 m and tailings freeboard (defined as the height between the crest of the TSF and the maximum elevation of tailings) of 0.9 m and by considering a 0.5% sub-aerial and 2% sub-aqueous tailings beach slope (Figure 1) (WSP 2024).



m = metre; m^3 = cubic metre.

Figure 1: Tailings Storage Facility Stage Storage Curve

3.2 Catchment Characteristics

Catchment areas directly contributing to the TSF are provided in Table 2. This catchment delineation is the basis for the TSF spillway design. The water inflows to the TSF that are not pumped and therefore not in the direct control of the operator are as follows:

- precipitation on the direct footprint of the TSF
- runoff from the catchment directly above the TSF (TSF upstream catchment B and C)
- potential runoff from the upstream catchment (catchment A); depending on the updates to the tailings pipeline ditch

Table 2: Tailings Storage Facility Catchment Areas

Catchment	Watershed Area (km^2)
TSF upstream contact A[(a)]	0.43
TSF upstream contact B	0.24
TSF upstream contact C[(b)]	0.52
TSF	2.38

(a) The catchment area is to be refined per update to the tailings pipeline ditch.
(b) Potentially diverted via a diversion channel.
TSF = tailings storage facility; km^2 = square kilometres.

Each catchment was assigned a US Department of Agriculture (USDA) Soil Conservation Service (SCS) curve number (USDA 2009) value (Table 3) based on the land type to predict direct runoff. The wet antecedent moisture condition III was considered in the modelling.

The time of concentration was estimated using the SCS TR-55 method (USDA 2009), which divides the longest flow path into sheet flow, shallow concentrated flow, and open channel flow, and considers a minimum time of concentration of 6 minutes. The lag time was estimated as 60% of the time of concentration. Catchment areas and corresponding lag time values are provided in Table 3.

Table 3: Summary of Catchment Area Parameters

Catchment Area	Lag Time (min)	CN Value (AMC III)	Description
TSF direct	3.6[(a)]	95	TSF area
TSF upstream contact A	14.5	78	undisturbed area and disturbed area with some compacted haul road portions draining directly to TSF
TSF upstream contact B	8.6		
TSF upstream contact C	12	74	undisturbed area with some disturbed portions draining to TSF

(a) A minimum time of concentration of 6 minutes.
TSF = tailings storage facility; CN = curve number; AMC = antecedent moisture condition; min = minute.

3.3 Extreme Precipitation Events

Precipitation depths used to estimate inflows to the TSF for various return periods are presented in Table 4 and the 24-, 48-, and 72-hour probable maximum precipitation (PMP) depths are presented in Table 5.

Table 4: 24-hour Precipitation Depths for Mount Polley Mine, 1974 to 2021

Return Period (year)	24-hour Rainfall Depth (mm)[(a)]
2	33
10	47
25	54
100	64
200	69
1,000	80

(a) Log Pearson III distribution (WSP 2022).

Table 5: Probable Maximum Precipitation Depths

Duration	Depth (mm)[(b)]
24-hour	224[(a)]
48-hour	278
72-hour	339[(a)]

(a) Source: WSP 2022.
(b) Values rounded to the nearest mm.

3.4 Snowmelt

The snowmelt was determined using an energy balance method based on net longwave radiation, net shortwave radiation, and sensible and latent heat fluxes (Dunne and Leopold 1978), noting that the snowmelt is assumed to occur under cloudy skies. Consistent with runoff patterns observed on site during freshet, the snowmelt is expected to occur between March and May with a relatively greater proportion of melting happening in April.

The method is set out in Equation 1:

$$M_{R-t} = 1.42T_a + 2.5 + \frac{R_t T_a C_W}{L} + 0.0059 T_a u_2 \quad \textbf{(Equation 1)}$$

where:

$M_{R\text{-}t}$ = snowmelt in mm/day snow water equivalent for return period event duration t
R_t = rainfall depth in mm for return period event duration t, averaged over the duration of the storm
T_a = average air temperature over the return period event duration in °C
C_W = specific heat of water (equal to 1 calorie per gram per Celsius [cal/g/°C])
L = latent heat of fusion of ice equal to 80 cal/g
u_2 = wind speed in km/d

The input parameter values for Equation 1 are summarized in Table 6 and the estimated snowmelt depths are summarized in Table 7.

Table 6: Snowmelt Parameter Input Values

Parameter	Value	Rationale
R_t	See Table 4 and Table 5	Snowmelt generated by rainfall events
T_a	3.7°C	Average April air temperature (assumed snowmelt period); Climate Baseline Update (WSP 2022)
u_2	225 km/day (2.6 m/s)	Average April wind speed; tailings storage facility inflow design flood technical memorandum (Golder 2017)
C_W	1 cal/g/°C	Assumed
L	80 cal/g	Assumed

T_a = average air temperature over the return period event duration in °C; u_2 = wind speed in km/d; C_w = specific heat of water; L = latent heat of fusion of ice; cal/g/°C = calorie per gram per Celsius; cal/g = calorie per gram.

Table 7: Snowmelt Depth

Duration	Depth (mm)
24-hour 1:200-year	16
24-hour PMP	23
48-hour PMP	38
72-hour PMP	54

PMP = probable maximum precipitation; mm = millimetre.

3.5 Freeboard

The freeboard for a water-retaining structure can be defined as the minimum vertical distance between the still pool reservoir level and the crest of the retaining structure (CDA 2013, 2019). This distance needs to be maintained at all times to prevent overtopping of the containing structure by waves resulting from wind and wave set-up and run-up. The Canadian Dam Association provides the following definitions to calculate the freeboard (CDA 2013):

- *Normal freeboard* is the difference in elevation between the dam crest and the maximum operating water level of the facility. The normal freeboard is required to protect the structure from overtopping by 95% of waves caused by wind with an annual exceedance probability of 1:1,000-year event with the reservoir at maximum normal elevation.
- *Minimum freeboard* is the difference in elevation between the dam crest and the maximum water level that would result from the peak design inflow. The minimum freeboard is required to protect the structure from overtopping by 95% of waves caused by the most critical wind when the reservoir is at its maximum level during the inflow design flood (IDF). The wind for the significant consequence dam has an annual exceedance probability of a 1:10-year event.

The freeboard calculations follow the procedures and equations discussed in CDA (2013, 2019). Wind speeds, pond depth, and dam slope geometry were considered to determine the greatest wave uprush value for the normal and minimum freeboard scenarios.

Hourly wind speed and direction data for the study site are only available from 1997 to 2003, and daily wind speed data are available from 2019 to 2021. Thus, hourly data from the Environment and Climate Change Canada Williams Lake A climate station from 1961 through 2023 (ECCC 2023) were used as the basis for the frequency analysis to estimate extreme hourly wind speed for an annual exceedance probability ranging from 1:2 to 1:1,000-year. The results are provided in Table 8. No directional component was considered in this study and the wind was assumed to follow the longest fetch length of the TSF for conservatism.

Table 8: Hourly Maximum Wind Speed at the Williams Lake Station A

Annual Exceedance Probability (years)	Maximum Hourly Wind Speed (m/s)
2	23.0
10	26.3
20	27.3
50	28.6
100	29.5
200	30.3
500	31.4
1,000	32.1

m/s = metre per second.

Wave run-up was calculated using the random wave run-up height on gentle slope method by Mase (1989). A contingency of 0.3 m was selected to account for uncertainty due to settlement, crest irregularities, and construction tolerances for crest and spillway invert elevation (ANCOLD 2012). The freeboard calculation inputs and the corresponding normal and minimum freeboard are shown in Table 9. The minimum freeboard of 0.7 m is recommended when passing the IDF through the spillway.

Table 9: Tailings Storage Facility Required Freeboard Values

Description	Unit	Minimum	Normal
Design wind speed	m/s	26 (1:10-year)	32 (1:1,000-year)
Dam crest elevation	m	974	974
Maximum water elevation at IDF	m	973.3	973.3
Fetch length	km	2.0	2.0
Average water depth	m	2.3-3.8	2.3-3.8
Beach Slope	m/m	0.01[(a)]	0.01[(a)]
Wave height	m	0.76	0.97
Wind setup	m	0.08	0.11
Wave run-up[(b)]	m	0.31	0.39
Wave uprush (setup and run-up)	m	0.4	0.5
Contingency	m	0.3	0.3
Freeboard (wave uprush plus contingency)	m	0.7	0.8

(a) The beach slope is less than the minimum slope recommended by Mase (1989). The lowest recommended slope of 1/30 was used in the wave run-up estimation.

(b) Calculated using the method by Mase (1989).

IDF = inflow design flood; m = metre; m/s = metre per second; m/m = metre per metre; km = kilometre.

4.0 HYDROLOGIC AND HYDRAULIC MODELLING

4.1 Inflow Design Flood

Based on the *Health, Safety and Reclamation Code for Mines in British Columbia* (BCMEM 2022; EMLI 2022), the TSF is ranked as a significant consequence of failure facility (CDA 2013 and WSP 2023a). For a significant consequence dam, BCMEM (2022) recommends an IDF with an annual exceedance probability of one third of the way between the 1:975-year event and the probable maximum flood (PMF). For conservatism and consistency with WSP's best practice, the IDF for the TSF was selected as the PMF. The PMF for the TSF was estimated using the 72-hour PMP event plus snowmelt (snowmelt calculated using mean April temperature and the PMP rainfall). The 72-hour annual PMP of 339 mm was chosen over the spring PMP of 272 mm (WSP 2023a) to be conservative due to the inherent uncertainty in estimating the PMF. Rainfall, snowmelt depths used to estimate inflows to the TSF for the IDF event are presented in Table 10.

The rainfall depth component of the IDF was distributed using the USDA SCS Type II method for a three-day period, with a 24-hour distribution applied for each day.

The 72-hour PMP rainfall was distributed for each day of the event as follows:

a) **Day 1**—The 24-hour PMP was used.

b) **Day 2**—The rainfall depth was calculated as the difference between the 24-hour PMP and 48-hour PMP.

c) **Day 3**—The rainfall depth was calculated as the difference between the 48-hour PMP and 72-hour PMP.

The snowmelt depth component of the IDF was distributed evenly over a 12-hour period each day centred on the peak rainfall intensity of the rainfall events. Similar to the rainfall distribution for day two and day three of the events (i.e., 48-hour and 72-hour events), the snowmelt for each 12-hour period was equal to the incremental snowmelt depth from 24-hour and 48-hour snowmelt, and 48-hour and 72-hour snowmelt.

Table 10: Summary of Inflow Design Flood Parameters

Duration	Mean April Temperature (°C)	Depth[b] (mm)		
		PMP Rainfall	Total Snowmelt	Total Rainfall Plus Snowmelt
24-hour	3.7	224[a]	23	247
48-hour		278	38	316
72-hour		339[a]	54	393

(a) Source: WSP 2022.

(b) Values rounded to the nearest millimetre.

PMP = probable maximum precipitation; °C = degrees Celsius; mm = millimetre.

4.2 Environmental Design Flood

The environmental design flood (EDF) is the most severe flood that is to be managed without release of untreated water to the environment and is necessary in situations where water must be retained with no discharge to the environment or with controlled discharge through a treatment system (CDA 2019). According to CDA (2019), the selection of return period and duration of the EDF depends on factors such as the water quality that is being stored and could be released, regulatory requirements, frequency of overflow events, the rate and duration of the overflows, the environmental sensitivity of the receiving environment, downstream flow in the receiver, downstream mixing characteristics, and public perception on the matter. The following factors have been considered in the selection of EDF:

- The site-wide water balance model demonstrates that the TSF has sufficient capacity to retain the site runoff volumes during the 99.5th percentile storm event (WSP 2023b).
- Under normal conditions, the history of toxicity testing of the TSF supernatant has demonstrated that it is non-toxic.
- The water quality model predictions report (WSP 2023c) demonstrated that the measured concentrations at the TSF supernatant pond are generally below permit limits, with the exceptions for total copper and total phosphorous, total arsenic, total zinc, and dissolved aluminum. The source of the increased concentrations in the monitoring data for these parameters is thought to be due to the discharge of leachate to the TSF from the onsite test heap leach facility (Golder 2022), which has since been decommissioned. These concentrations were not observed throughout the operational phases of the mine and are considered atypical. These conditions are not expected to persist during future operational phases as the leachate will be managed exclusively through the milling process. Water quality is anticipated to undergo greater dilution during a freshet due to increased flows, which naturally dilute substances in the water. Under non-flood conditions, TSF supernatant is collected and treated.
- Snowpack is regularly monitored on site to predict water flow patterns resulting from snowmelt and to effectively manage reservoir storage.
- The immediate mixing would primarily take place within Bootjack Creek, with expected limitations on dilution. During flood events, it is common for fish to be displaced downstream, reducing their exposure to undiluted runoff.
- MPMC is required to contain and treat up to a 1-in-10-year storm flow (EMA Permit 11678).

Based on these factors, the EDF for the TSF was estimated using the 24-hour 1-in-200-year rainfall plus snowmelt. Rainfall and snowmelt depths used to estimate inflows to the TSF for the EDF event are presented in Table 11.

Table 11: Summary of Environmental Design Flood Estimation

Duration	Mean April Temperature (°C)	Depth[b] (mm)		
		1:200-year Rainfall	Total Snowmelt	Total Rainfall Plus Snowmelt
24-hour	3.7	69[a]	16	85

(a) Source: WSP 2022.

(b) Values rounded to the nearest millimetre.

°C = degrees Celsius; mm = millimetre.

4.3 Methodology

A hydrologic model was developed using United States Army Corps of Engineers Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) Model Version 4.11 (USACE 2023) to estimate inflow volumes to the TSF during the EDF and IDF events and peak flows over the proposed spillway channel during the IDF event. Inputs to the HEC-HMS model are discussed in Section 3.0 and the IDF parameters are discussed in Section 4.1.

The spillway inlet was modelled in the HEC-HMS model using the broad-crested weir equation (Brater and King 1976) to define the capacity of the weir. The spillway inlet structure will be trapezoidal with 7H:1V side slopes to allow a trafficable surface. For the trapezoidal channel composed of both triangular and rectangular sections, the discharge coefficient was determined by considering the combined effect of these two geometries on the flow characteristics of the channel. Rectangular weir coefficients of 1.4-1. and triangular weir coefficients of 1.0-1.3 were adopted depending on the hydraulic configuration of the spillway channel and crest (Smith 1995).

Design Storage Volume and Elevations

The TSF will be managed by maintaining the pond volume within the operating range for reclaim water and make-up water. The normal operating water volume of the TSF pond has been set as a range of 1.5 to 1.7 million m^3.

For operation, a trigger level to cease pumping of site water to the TSF is introduced. The trigger water level is set at 0.2 m below the spillway invert to allow time for operations to stop pumping water into the TSF in preparation for potential passage of the IDF through the spillway.

The spillway invert elevation for the TSF was determined through an iterative process using the HEC-HMS model to estimate the required minimum freeboard between the water surface passing through the spillway during the IDF and the dam crest. For modelling purposes, it was conservatively assumed that the water level within the TSF is at the invert elevation of the spillway at the beginning of the IDF event. The invert elevation of the spillway was set at elevation 972.9 m to provide the required minimum freeboard of 0.7 m (Section 3.5). The spillway was designed to convey peak discharge from the TSF during the IDF event while maintaining the required freeboard. The spillway invert was designed with a base width of 6 m with a slope of 0.3% across the dam crest.

As previously discussed, the TSF will temporarily retain site runoff volumes that can be generated during freshet and storm events. The site-wide water balance model demonstrates that the TSF has sufficient capacity to retain the site runoff volumes during the 99.5th percentile storm event (3.5 million m^3; WSP 2023b), with the EDF inflow volumes fitting comfortably within that range.

The water level and inflow volume model results for the TSF are provided in Table 12.

Table 12: Tailings Storage Facility with Spillway Water Level and Inflow Volume Results for Dam Crest Elevation 974 m

Parameters	Values
Dam crest elevation (m)	974.0
IDF inflow volume (million m^3)	1.3
Spillway invert elevation (m)	972.9
Maximum water level over spillway (during passage of IDF) (m)	973.3
Environmental design flood (million m^3)	0.2
Trigger water level to stop pumping site water to the TSF (m)	972.7

Table 12: Tailings Storage Facility with Spillway Water Level and Inflow Volume Results for Dam Crest Elevation 974 m

Parameters	Values
Normal operational pond volume range (million m^3)	1.5-1.7

IDF = inflow design flood; TSF = tailings storage facility; m = metre; m^3 = cubic metre.

The required elevation of the spillway invert will depend on the actual constructed embankment elevation. The emergency spillway design elevations relative to the dam crest elevation are provided in Table 13. The TSF storage curve applied in the analysis was deemed representative of the TSF storage curve for dam crest elevations between 970 and 974 m.

Table 13: Emergency Spillway Design Elevations

Description	Depth Below Dam Crest (m)
Trigger water level to stop pumping site water to the TSF	1.3 m
Spillway invert elevation	1.1 m
Maximum water level over spillway (during passage of IDF)	0.7 m

TSF = tailings storage facility; IDF = inflow design flood; m = metre.

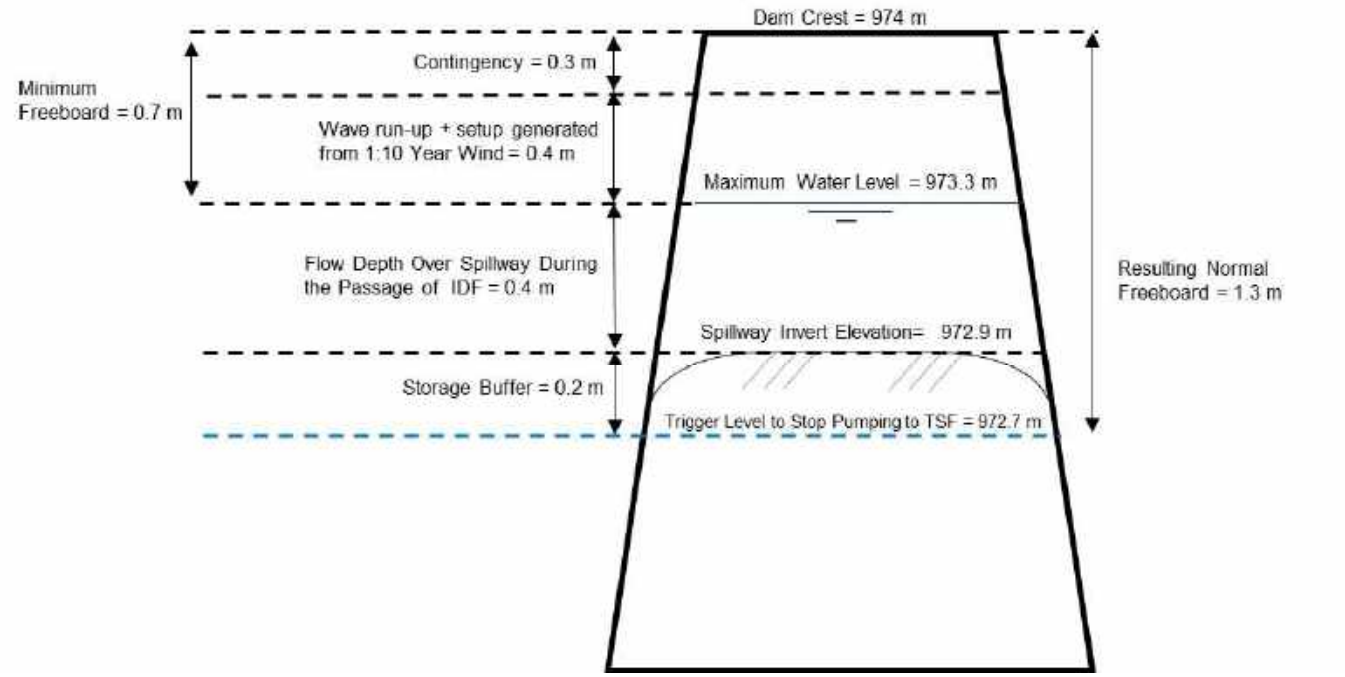
The proposed spillway dimensions and the key results from the HEC-HMS model for the spillway are provided in Table 14, and a schematic of the results is provided in Figure 2 and Figure 3.

Table 14: Summary of the Spillway Arrangement and Flood Routing Results for Inflow Design Flood

Dam Crest Elevation (m)	Spillway Invert Elevation (m)	Spillway Base Width (m)	TSF Peak Discharge During the Passage of IDF (m^3/s)	Maximum Water Level Elevation During the Passage of IDF (m)	Minimum Freeboard (m)	Resulting Normal Freeboard[(a)] (m)
974.0	972.9	6.0	2.8	973.3	0.7	>1.3

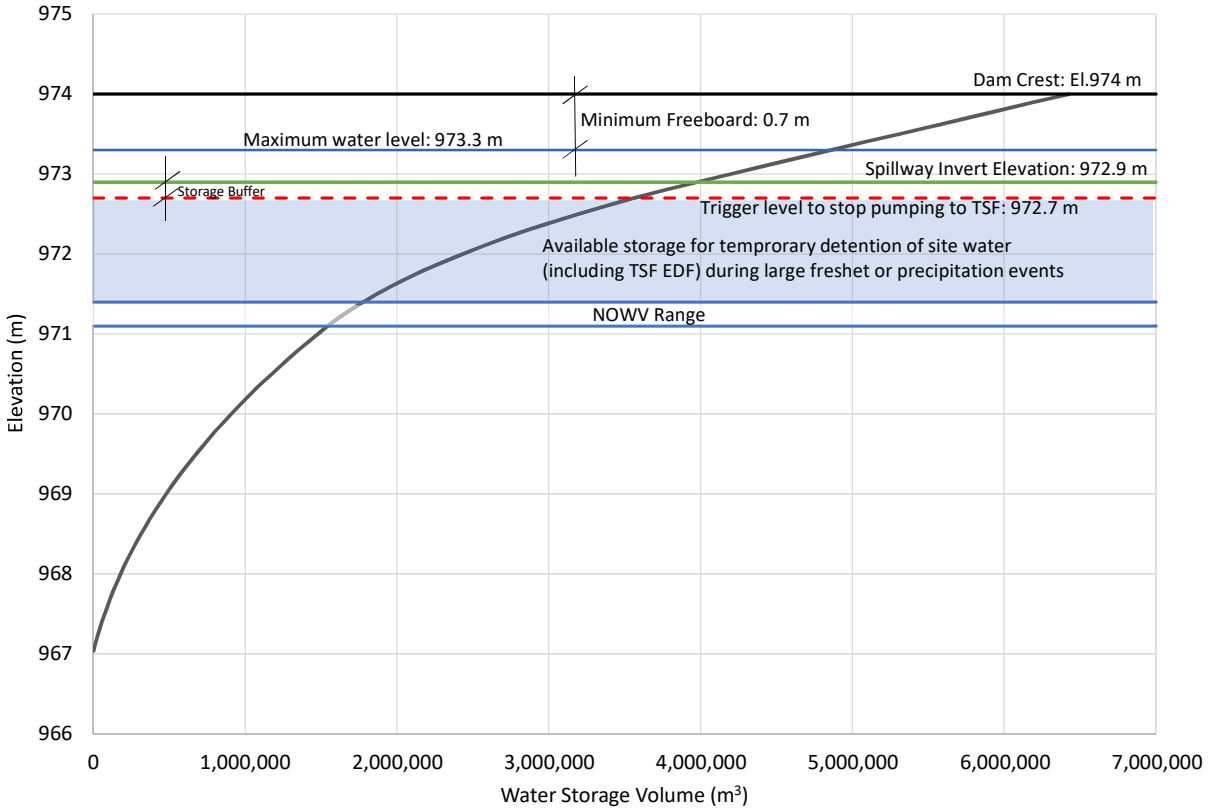
(a) The normal freeboard required is 0.8 m and presented in Section 3.5. The resulting normal freeboard is the difference in elevation between the dam crest and the maximum operating water level of the facility from the Trigger water level.

TSF = tailings storage facility; IDF = inflow design flood; m = metre; m^3/s = cubic metres per second.



IDF = inflow design flood; TSF = tailings storage facility; m = metre.

Figure 2: Design Events in Relation to Tailings Storage Facility Embankment with Spillway



TSF = tailings storage facility; EDF = environmental design flood; NOWV = normal operating water volume; m = metre; m^3 = cubic metre.

Figure 3: Design Events in Relation to the Tailings Storage Facility Storage Curve for Crest Elevation 974 m

5.0 SUMMARY

Inflow volumes to the TSF were estimated using the United States Department of Agriculture Soil Conservation Service (SCS) method. Rainfall-runoff models were developed using the SCS method implemented with HEC-HMS software (version 4.11) (USACE 2023).

The freeboard calculations follow the procedures and equations discussed in CDA (2013, 2019). A minimum freeboard of 0.7 m was recommended while passing the IDF (Section 3.5).

The IDF for the TSF was estimated using the 72-hour PMP of 339 mm plus 54 mm snowmelt. The runoff volume generated by the IDF was 1.3 million m^3.

The spillway inlet elevation was proposed at 1.1 m below the dam crest to convey the peak discharge while providing the minimum freeboard required during the design event. The spillway invert was designed to have a base width of 6 m and 7H:1V side slopes to allow a trafficable surface with a slope of 0.3% across the dam crest.

A trigger water level was set at 0.2 m below the spillway invert to allow time for operations to stop pumping site water to the TSF.

6.0 CLOSURE

We trust that the information presented herein meets the current MPMC requirements. Please do not hesitate to contact the undersigned with any questions or concerns.

WSP Canada Inc.



Nasim Hosseini, M.Sc., P.Eng.
Water Resources Engineer



Don Kidd, P.Eng.
Principal, Senior Water Resources Engineer



Daniel Mullen, B.A.Sc., EIT
Junior Water Resources Consultant

PERMIT TO PRACTICE #1000200
Engineers & Geoscientists BC

NH/DM/DK/PM/na/hp/anr

https://golderassociates.sharepoint.com/sites/10023g/ca00205274505 deliverables/002_issued/015-tm-31151-tsf 974 m raise freeboard/rev0/ca0020527.4505-015-tm-rev0-31151-tsf spillway freeboard for tsf 974 m raise 09apr_24.docx

REFERENCES

ANCOLD (Australian National Committee on Large Dams). 2012. Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure.

BCMEM (British Columbia Ministry of Energy, Mines and Low Carbon Innovation). 2022. Health, Safety and Reclamation Code for Mines in British Columbia. Revised November 2022. Victoria, BC.

Brater EF, King HW. 1976. Handbook of hydraulics for the solution of hydraulic engineering problems, 6th ed., New York NY: McGraw-Hill. 616 p.

CDA (Canadian Dam Association). 2013. Dam safety guidelines 2007 (Revised 2013).

CDA. 2019. Technical bulletin: application of CDA dam safety guidelines to mining dams.

Dunne and Leopold. 1978. Water in environmental planning. 1st ed.. New York NY: W. H. Freeman and Company. p.471–473.

EMA (*Environmental Management Act*) Permit 11678. 2022. Tracking Number: 408523. December 1, 2022.

ECCC (Environment and Climate Change Canada). 2023. Canadian climate data. [accessed May 28, 2023]. https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

EMLI (Ministry of Energy, Mines and Low Carbon Innovation). 2022. Health, safety and reclamation code for mines in British Columbia. (Revised November 2022). Victoria, BC: Ministry of Energy, Mines and Low Carbon Innovation. [accessed February 2024]. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/code-review/health_safety_and_reclamation_code_nov2022.pdf

Fullerton D. 2024. Mine Surveyor / Planner, Mount Polley Mining Corporation. 2023 LiDAR data. Email to Hosseini N, WSP Canada Inc. February 1, 2024.

Golder. 2017. Inflow Design Flood (IDF) Rainfall and snowmelt - Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Associates Ltd. Document No. 1662612-122-TM-Rev0-51171. March 9, 2017.

Golder. 2022. Comparison of Water Quality Model Predictions and 2021 Measured Concentrations – Mount Polley Mine. Document No. 22514095-023-TM-Rev0-31246. Submitted to Mount Polley Mining Corporation. March 2022.

Mase H. 1989. Random wave runup height on gentle slope. Journal of Waterway, Port, Coastal and Ocean Engineering 115(5):649–661.

Smith CD. 1995. Hydraulic Structures. Saskatoon.

USACE (US Army Corps of Engineers). 2023. Hydrologic Engineering Center Hydrologic Modeling System Version 4.11 [software]. Davis CA: Hydrologic Engineering Center. July 14, 2023.

USDA (United States Department of Agriculture). 2009. Small watershed hydrology. WinTR–55 User Guide. January 2009.

WSP (WSP Canada Inc.). 2022. Climate baseline update – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Vancouver BC: Golder Associates Ltd., a member of WSP. Document No. 22514095-066-R-Rev0-31547. August 30, 2022.

WSP. 2023a. Mount Polley Mine, British Columbia – basis of design and design criteria for life of mine tailings storage facility raise. Prepared for Mount Polley Mining Corporation. Vancouver BC: WSP Canada Inc. Document No. 22514095-067-TM-RevA-51393. February 15, 2023.

WSP. 2023b. Mount Polley Mine Water Balance Model. Springer Expansion Life-of-Mine. Reference No. 23590671-084-R-Rev0-31182. December 4, 2023.

WSP. 2023c. Comparison Of Water Quality Model Predictions And 2022 Measured Concentrations – Mount Polley Mine. Reference No. 23590671-016-TM-Rev0-31241. March 27, 2023.

WSP. 2024. Tailings storage facility – detailed design to elevation 974. Prepared for Mount Polley Mining Corporation. Vancouver BC: WSP Canada Inc. Document No. CA0020527.4505-014-R-RevA-51312. February 16, 2024.

STUDY LIMITATIONS

WSP Canada Inc. (WSP) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, has been prepared by WSP for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP's professional judgement based on the knowledge and information available at the time of completion. WSP is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations, and opinions expressed in this document pertain to the specific project, site conditions, design objective, development, and purpose described to WSP by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations, and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration, and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

APPENDIX J

Type I Independent Review Checklist and Signoff

MEMORANDUM

DATE April 17, 2024 **Reference No.** CA0020527.4505-033-M-Rev0-51397

TO Sophie Bainbridge; Germán Pizarro

FROM Patrick Sean Wells **EMAIL sean.wells@wsp.com**

INDEPENDENT REVIEW OF MOUNT POLLEY MINE TAILINGS STORAGE FACILITY DETAILED DESIGN TO ELEVATION 974 M

This memorandum is in response to your request for undertaking an independent review of the Mount Polley Mine Tailings Storage Facility Detailed Design to Elevation 974 m. The review is complete, with this memo containing list of documents reviewed, review limitations and assumptions, table of reviewer comments and responses, and the EGBC Type 1 Independent Review sheet signed and sealed.

Please contact me directly with any questions or concerns.

Document List for Review or Reference

The following documents were either reviewed or used as reference for the review:

Reviewed Documents

- WSP. 2024. Draft Tailings Storage Facility – Detailed Design to Elevation 974 m, Mount Polley Mine. Prepared for Mount Polley Mining Corporation. WSP Doc. No. CA0020527.4505-014-R-RevA-TSF Detailed Design. February 23, 2024.
- WSP 2024 Spillway CA0020527.4505-014-R-Rev0-51394-974 m TSF Detailed Design.doc – Water Management - Freeboard and Spillway Section 7.10 and Appendix I.

Reference Documents

- WSP. 2023. Draft Mount Polley Mine – Basis of Design and Design Criteria for Tailings Storage Facility Raise to Elevation 974 m. Prepared for Mount Polley Mining Corporation.
  WSP Doc. No. 23590671-067-TM-RevA-51393. November 27, 2023.
- WSP. 2023. Draft Stress-deformation analyses of the elevation 974 m Tailings Storage Facility at Mount Polley Mine. Prepared for Mount Polley Mining Corporation.
  WSP Doc. No. CA0020527.4505-005-TM-RevA-51346. March 1, 2024.
- WSP. 2023. Tailings Storage Facility Site Characterization Report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation.
  WSP Doc. No. 22514095-034-R-Rev0-51392. September 22, 2023.
- Engineers & Geoscientists British Columbia, 2023,Guide to The Standard For Documented Independent Review Of High-Risk Professional Activities Or Work, Version 2.0.

Limitations of This Review

The primary focus of this review was on Risk and Constructability. Reviews of calculations and models are not included; however, it was confirmed that these reviews were conducted by other qualified professionals.

EGBC Review Document

Checklist And Signoff for An Independent Review of High-Risk Professional Activities or Work

RE: Mount Polley Mine Tailings Storage Facility
Detailed Design to Elevation 974 m

Mount Polley Mine
British Columbia, Canada

PROFESSIONAL OF RECORD

German Pizarro-Sala, P.Eng.

WSP Canada, Inc
840 Howe Street, Vancouver, BC

Item	Reviewed Initials	Remarks
Criteria for carrying out Professional Activities or Work	PSW	Project design basis and design criteria established and documented.
Applicable codes, standards, and other requirements (laws, regulations, design requirements, etc.)	PSW	Applicable regulations and guidelines stated and used to develop criteria and guidance for design.
Geographical and/or environmental conditions and requirements	PSW	Site geotechnical and hydrotechnical conditions are documented. Site visit carried out. Foundation site investigations were carried out, documented and results used in design. Available data on tailings reviewed, an estimated tailings lower bound strength for tailings strength was used in design as stated in the report.
Assumptions for Professional Activities or Work	PSW	Integrated with the Design Criteria, Design Basis sections.
Concept for Professional Activities or Work	PSW	This work is detailed design for construction. Concept was completed as part of previous stages of work. Report includes Siting and Technology review.
Test and analysis procedures and results	PSW	Report includes details on site investigation, material property testing, stability, and seepage analysis.
Quality control and quality analysis procedures	PSW	Quality assurance and control are included as part of the Technical Specifications document. attached as an appendix.

Item	Reviewed Initials	Remarks
Calculations or analysis of representative elements	PSW	Verification of calculation and analysis reviews were completed through 3rd party verifications of the work. Evidence that reviews of the data and modelling were provided as Review Confirmations, Stability: Stability_974 (Static, PS, and post-EQ)_06DEC2023_YJ (1).xlsx; Seepage: Regular Drain Seepage Analyses (QAQC)_16FEB2024_YJ.xlsx; Filter: Gradation Envelope Comparison_29JAN2024_ED.xlsx. This satisfies that these reviews were completed by qualified personal. I did not review the specific modelling or calculation work.
Review of representative details	PSW	Detailed review of the Design Report was completed, comments/questions/recommendations made and presented to the EoR and Deputy EoR, and responses and actions taken were appropriate.
Integration of third-party components and artifacts	PSW	Work by external parties (pipe design, hydrology) are integrated with design basis criteria and final design and analysis.
Representation of output (e.g., drawings, reports, spreadsheets, models)	PSW	Drawings and cross sections were reviewed and were clear and appropriate for use.
Hazards (current and future) identified in the Risk Assessment	PSW	Risk assessment was provided as a Failure Modes and Effects Assessment, together with a Technical Memo dated March 6, 2024, providing additional details to these failure modes. This was adequate for use.
Adequacy and implementation of mitigation measures	PSW	Mitigations within the design were appropriate to the client's risk tolerance and applicable guidance.
Concerns discussed with the Professional of Record	PSW	Concerns were discussed and resolved.
For global, repetitive, or iterative design, recommendation for intervals of Independent Review	PSW	N/A

WSP Canada Inc.

I reviewed

18 Apr. 2024

INDEPENDENT REVIEWER



Patrick Sean Wells, P.Eng.

Technical Excellence and Innovation Practice Leader – Mine Waste

18 Apr. 2024

PSW/na

https://golderassociates.sharepoint.com/sites/10023g/ca00205274505 deliverables/002_issued/033-m-51397-tsf 974m design independent review/ca0020527.4505-033-m-rev0-51397-tsf 974 m design independent review_ 17apr_24.docx



wsp.com

APPENDIX 1-4: TSF Site Characterization Report

REPORT

Tailings Storage Facility Site Characterization Report

Mount Polley Mine

Submitted to:

Mount Polley Mining Corporation

PO Box 12
Likely BC V0L 1N0

Attention: Matt O'Leary

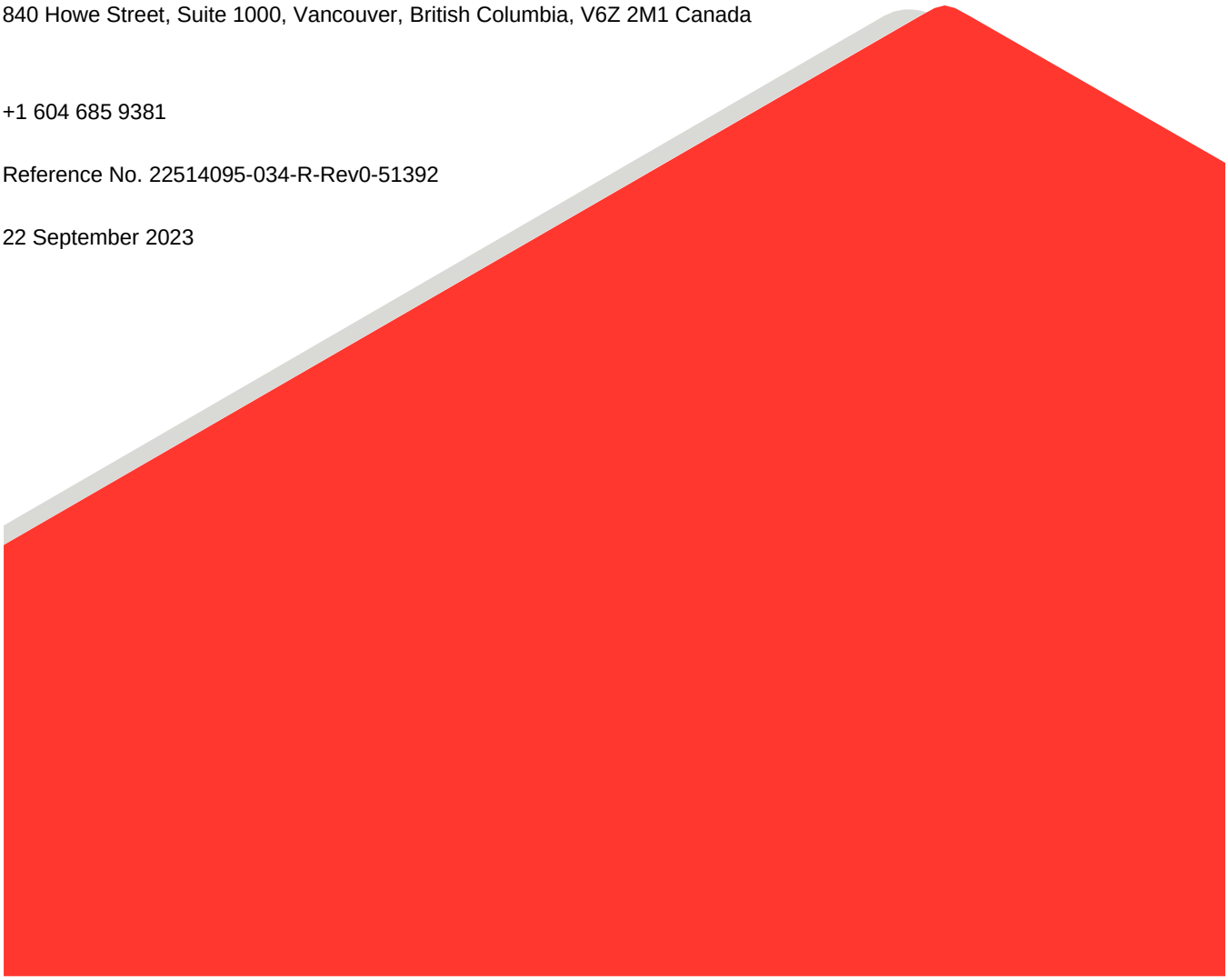
Submitted by:

WSP Canada Inc.
840 Howe Street, Suite 1000, Vancouver, British Columbia, V6Z 2M1 Canada

+1 604 685 9381

Reference No. 22514095-034-R-Rev0-51392

22 September 2023



Distribution List

Electronic Copy - Mount Polley Mining Corporation

Electronic Copy - WSP Canada Inc.

Study Limitations

WSP Canada Inc. (WSP) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by WSP for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP's professional judgement based on the knowledge and information available at the time of completion. WSP is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to WSP by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

Table of Contents

1.0 INTRODUCTION 1

2.0 TAILINGS STORAGE FACILITY DESCRIPTION 2

3.0 FOUNDATION INVESTIGATIONS AND STUDIES 3

4.0 CLIMATE 5

5.0 QUATERNARY GEOLOGY 6

5.1 Regional Geomorphological Setting 6

5.2 Regional Surficial Geology 6

5.3 Local Surficial Geology 8

5.4 Stratigraphic Interpretation 8

5.4.1 Methods 8

5.4.2 Glacial Environments and Depositional Processes 10

5.5 Depositional Environment and Quaternary History of the Tailings Storage Facility Embankment Foundation Area 10

5.5.1 Advance Stage 10

5.5.2 Recessional Stage 11

5.5.3 Geological Units of the Tailings Storage Facility Embankment Foundation Area 12

5.5.3.1 Ablation Till Unit 12

5.5.3.2 Basal Till Unit 12

5.5.3.3 Glaciolacustrine Sub-unit 12

5.5.3.4 Glaciofluvial Sub-unit 13

5.5.3.5 Bedrock 14

6.0 SEISMIC HAZARD 15

7.0 GEOTECHNICAL CONDITIONS 17

7.1 Till 17

7.2 Glaciofluvial Unit 20

7.3 Glaciolacustrine Unit 23

7.3.1 Main Embankment 23

7.3.2 Perimeter Embankment 33

7.3.3 Corner 1 Embankment 38
7.3.3.1 Upper Glaciolacustrine Unit 38
7.3.3.2 Lower Glaciolacustrine Unit 48
7.3.4 South Embankment 54
7.4 Material Parameters for Stability Analyses 56
7.4.1 Pore Pressure Response within the Foundation Soils 59
8.0 HYDROGEOLOGY 60
8.1 Hydrogeological Units and their Properties 60
8.1.1 Surficial Native Deposits 63
8.1.2 Bedrock 63
8.2 Groundwater Recharge/Discharge and Tailings Storage Facility Seepage 64
8.2.1 Recharge Areas 64
8.2.2 Tailings Storage Facility Seepage 64
8.2.3 Discharge Areas 65
8.3 Hydraulic Heads and Vertical Hydraulic Gradients 65
8.4 Groundwater Flow Direction 69
8.4.1 Pre-development Groundwater Flow Direction 69
8.4.2 Current Groundwater Flow Direction 70
8.5 Groundwater Use Downgradient of the Mine 70
9.0 GEOCHEMICAL CONDITIONS 71
9.1 Monitoring Program 71
9.2 Baseline Groundwater Quality 71
9.3 Tailings Storage Facility Tailings 71
9.4 Tailings Storage Facility Pond Water Quality 72
9.5 Current Groundwater Quality 73
10.0 DISCUSSION 74
10.1 Stability 74
10.2 Seepage 75
11.0 CLOSURE 76
REFERENCES 77

TABLES

Table 4-1: Summary of Key Climate Parameters for the Mount Polley Mine 5
Table 5-1: Stratigraphic Criteria for the Glaciolacustrine Sub-units 9
Table 6-1: Site-Specific Accelerations (5%-damped) for Selected Annual Exceedance Probabilities and Spectral Periods at the Mount Polley Tailings Storage Facility Site (V_{S30} = 849 m/s) 16
Table 7-1: Summary of Index Properties of Till 18
Table 7-2: Shear Strength Test Results of Till 19
Table 7-3: Summary of Index Properties of Glaciofluvial Unit 20
Table 7-4: Shear Strength Test Results of Glaciofluvial Unit 22
Table 7-5: Summary of Index Properties of Glaciolacustrine at the Main Embankment 24
Table 7-6: Consolidation Test Results of Glaciolacustrine Samples at the Main Embankment 26
Table 7-7: Sample Quality Assessment Criteria 27
Table 7-8: Quality Assessment of Glaciolacustrine Samples from the Main Embankment 28
Table 7-9: Simple Shear Test Results of Glaciolacustrine Samples at the Main Embankment 31
Table 7-10: Summary of Index Properties of Glaciolacustrine at the Perimeter Embankment 34
Table 7-11: Consolidation Test Results of Glaciolacustrine Samples at the Perimeter Embankment 36
Table 7-12: Quality Assessment of Glaciolacustrine Samples from the Perimeter Embankment 37
Table 7-13: Simple Shear Test Results of Glaciolacustrine Samples at the Perimeter Embankment 38
Table 7-14: Summary of Index Properties of Upper Glaciolacustrine Unit 39
Table 7-15: Consolidation Test Results of Upper Glaciolacustrine Unit Samples 42
Table 7-16: Quality Assessment of Upper Glaciolacustrine Unit Samples 44
Table 7-17: Simple Shear Test Results of Upper Glaciolacustrine Unit Samples 44
Table 7-18: Summary of Index Properties of Lower Glaciolacustrine Unit 49
Table 7-19: Consolidation Test Results of Lower Glaciolacustrine Unit Samples 51
Table 7-20: Quality Assessment of Lower Glaciolacustrine Unit Samples 52
Table 7-21: Simple Shear Test Results of Lower Glaciolacustrine Unit Samples 53
Table 7-22: Summary of Index Properties of Low Plasticity Silty Clay at the South Embankment 54
Table 7-23: Foundation Material Parameters for Stability Analyses 57
Table 8-1: Hydrogeological Units and Hydraulic Conductivity (K) Test Results 61

ILLUSTRATIONS

Illustration 5-1: Stratigraphic Column 7
Illustration 5-2: Generalized Stratigraphic Column for Quaternary Sediments of the Tailings Storage Facility Embankment Area 8
Illustration 7-1: Plasticity Chart of Till Samples 18

Illustration 7-2: Water Content against Elevation of Till Samples 19
Illustration 7-3: Plasticity Chart of Glaciofluvial Samples 21
Illustration 7-4: Water Content against Elevation of Glaciofluvial Samples 22
Illustration 7-5: Plasticity Chart of Glaciolacustrine Samples from the Main Embankment 24
Illustration 7-6: Water Content against Elevation of Glaciolacustrine Samples from the Main Embankment 25
Illustration 7-7: Water Content against Clay Content of Glaciolacustrine Samples from the Main Embankment 26
Illustration 7-8: a) Consolidation Test Results on Glaciolacustrine Samples at the Main Embankment and b) Inferred Preconsolidation Pressure from Laboratory and Cone Penetration Test Data 27
Illustration 7-9: Preconsolidation Pressure Comparison between Laboratory and Cone Penetration Test Data 29
Illustration 7-10: a) Inferred Preconsolidation pressure from Main Embankment Cone Penetration Test Data between Elev. 900 and 918 m and b) Inferred Preconsolidation pressure from Main Embankment CPT21-07 Data between Elev. 921 and 923 m. 30
Illustration 7-11: Simple Shear Test Results on Glaciolacustrine Material at the Main Embankment and Perimeter Embankment a) Undrained Shear Strength Ratio Function Estimated Following the SHANSEP Method and b) Undrained Shear Strength Ratio Function for a Preconsolidation Pressure of 1,200 kPa 32
Illustration 7-12: Cyclic Strength Ratio Required to Cause Cyclic Failure (3% Strain) Versus the Number of Uniform Loading Cycles for the Glaciolacustrine at the Main Embankment. 33
Illustration 7-13: Plasticity Chart of Glaciolacustrine Samples from the Perimeter Embankment 34
Illustration 7-14: Water Content against Elevation of Glaciolacustrine Samples from the Perimeter Embankment 35
Illustration 7-15: Water Content against Clay Content of Glaciolacustrine Samples from the Perimeter Embankment 36
Illustration 7-16: a) Consolidation Test Results on Glaciolacustrine Samples at the Perimeter Embankment and b) Inferred Preconsolidation Pressure from Laboratory and Cone Penetration Test Data 37
Illustration 7-17: Plasticity Chart of Upper Glaciolacustrine Unit Samples from the Corner 1 Embankment 40
Illustration 7-18: Water Content against Elevation of Upper Glaciolacustrine Unit Samples from the Corner 1 Embankment 41
Illustration 7-19: Water Content against Clay Content of Upper Glaciolacustrine Unit Samples from the Corner 1 Embankment 42
Illustration 7-20: Consolidation Test Results on Upper Glaciolacustrine Unit Samples 43
Illustration 7-21: Peak Undrained Shear Strength Estimated for the Upper Glaciolacustrine Unit 46
Illustration 7-22: Remoulded Undrained Shear Strength Estimated for the Upper Glaciolacustrine Unit 46
Illustration 7-23: Peak Undrained Shear Strength Ratio Estimated for the Upper Glaciolacustrine Unit 47
Illustration 7-24: Cyclic Strength Ratio Required to Cause Cyclic Failure (3% strain) versus the Number of Uniform Loading Cycles for the Upper Glaciolacustrine Unit 48
Illustration 7-25: Plasticity Chart of Lower Glaciolacustrine Unit Samples from the Corner 1 Embankment 49
Illustration 7-26: Water Content against Elevation of Lower Glaciolacustrine Unit Samples from the Corner 1 Embankment 50

Illustration 7-27: Water Content against Clay Content of Lower Glaciolacustrine Unit Samples from the Corner 1 Embankment 51
Illustration 7-28: Consolidation Test Results on Lower Glaciolacustrine Unit Samples 52
Illustration 7-29: Peak Undrained Shear Strength Ratio Estimated for the Lower Glaciolacustrine Unit 53
Illustration 7-30: Plasticity Chart of Low Plasticity Silty Clay Samples from the South Embankment 55
Illustration 7-31: Water Content against Elevation of Low Plasticity Silty Clay Samples from the South Embankment 56
Illustration 8-1: Shallow Hydraulic Head Contours for November 2020 66
Illustration 8-2: Tailings Storage Facility Pond Level and Surrounding Groundwater Levels over Time 68
Illustration 8-3: Pre-development Hydraulic Heads and Groundwater Flow Direction 69

FIGURES

Figure 1: Overview Borehole Location Plan 83
Figure 2: Corner 1 Embankment Borehole Location Plan 84
Figure 3: Surficial Geology Profile (1 of 6). Station -0+165 to 0+700 85
Figure 4: Surficial Geology Profile (2 of 6). Station 0+700 to 1+500 86
Figure 5: Surficial Geology Profile (3 of 6). Station 1+500 to 2+300 87
Figure 6: Surficial Geology Profile (4 of 6). Station 2+300 to 3+100 88
Figure 7: Surficial Geology Profile (5 of 6). Station 3+100 to 3+900 89
Figure 8: Surficial Geology Profile (6 of 6). Station 3+900 to 4+671 90
Figure 9: Zoomed-in Surficial Geology Profile. Station 3+900 to 4+050 91
Figure 10: Groundwater Quality Trends for the TSF - 1996 to 2021 (from Golder 2022b) 92

APPENDICES

APPENDIX A
Summary of Investigations

APPENDIX B
Site-Specific Seismic Hazard Assessment

APPENDIX C
Geotechnical Data

APPENDIX D
Borehole GA22-01

APPENDIX E
2021 CPT Data and Interpretation

APPENDIX F
Well Test Results and Nearest Registered Water Wells and Mapped Aquifers

APPENDIX G
Soil Grain Size Analyses for K

APPENDIX H
Assurance Statements

1.0 INTRODUCTION

The Mount Polley Mine is a copper and gold mine operated by Mount Polley Mining Corporation (MPMC), a subsidiary of Imperial Metals Corporation. The mine site is located approximately 56 km northeast of Williams Lake, British Columbia, near the town of Likely. The mine is situated between Polley Lake and Bootjack Lake, and key components include open pits; waste rock dump sites; crusher, process plant, and administrative buildings; water management systems; and the tailings storage facility (TSF). The mine began production in 1997 and tailings generated at the process plant have been deposited as a low solids content slurry in the TSF located approximately 3 km southeast of the process plant.

The 23 June 2016 amendment of the *Mines Act* Permit M-200 authorized construction and operation of the TSF to elevation 970 m (Golder 2015g); however, mining operations were suspended in May 2019 when the TSF embankment crest elevation was about 968 m.

As part of the restart of mining operations, MPMC requested WSP Canada Inc. (WSP) to advance the design of a raise of the TSF embankment above elevation 970 m. Approximately 63 million tonnes of tailings are planned to be produced and deposited in the TSF until the end of operations at the Mount Polley Mine (approximately 8.5 years of production at about 20,000 tonnes per day). Deposition of tailings generated at the process plant into the TSF resumed in June 2022 and construction to raise the TSF embankment crest to elevation 970 m restarted in July 2022.

This report presents a site characterization for the embankment foundation of the Mount Polley TSF. Site conditions are summarized with respect to climate, geology, seismicity, geotechnical conditions, hydrogeology, and geochemical conditions. Investigations of the TSF foundation site are listed for reference. A discussion of site conditions and features with the potential to impact the TSF is presented with the TSF design approach.

The Engineers and Geoscientists British Columbia (formerly The Association of Professional Engineers and Geoscientists of British Columbia, APEGBC) site characterization for dam foundation guidelines (APEGBC 2016) were followed during the preparation of this report. It is intended that this report be updated with data from future site investigations and with observations and data from construction and operation of the facility over the life of the TSF. Should the understanding and interpretation of site conditions change with time, then required changes will be documented in future revisions of this report.

This report is to be read with the Study Limitations section, which forms an integral part of this document.

MPMC defined and uses the coordinate system tailings grid for the TSF. All coordinates and elevations are presented in tailings grid.

2.0 TAILINGS STORAGE FACILITY DESCRIPTION

The TSF includes one embankment that is approximately 4.6 km in length and has a maximum height of about 55 m as of the end of 2022. The embankment is subdivided into three sections, referred to as the Main Embankment, Perimeter Embankment, and South Embankment. The general layout of the TSF embankment is shown in Figure 1 and Figure 2. The embankment has incorporated a staged expansion design utilizing modified centreline and centreline construction methods. The general zoning of the TSF embankment includes the following:

- upstream fill comprising selected fill or tailings sand
- low permeability till core
- filter zone
- transition zone
- rockfill forming the downstream zone of the embankment and the downstream buttress along the Perimeter and Main Embankments.

The TSF Clean Water Ditch is located upstream of the TSF between Corner 4 and Corner 5 and diverts runoff into a small wetland downstream of the South Embankment.

Refer to the TSF elevation 970 m detailed design and the TSF life of mine feasibility design reports for additional information (Golder 2015g,h).

3.0 FOUNDATION INVESTIGATIONS AND STUDIES

The foundation investigations and studies considered for the TSF foundation characterization are listed below. Details of report contents and scope of investigations are summarized in APPENDIX A.

A layout of the TSF with the locations of the site investigations are shown in Figure 1 and Figure 2.

Geotechnical Investigations

- *Report on Geotechnical Investigations and Design of Open Pit, Waste Dumps and Tailings Storage Facility* (KP 1990)
- *Report on 1995 Geotechnical Investigations for Mill Site and Tailings Storage Facility* (KP 1995a)
- *Stage 2A Tailings Facility Construction Selected Excerpts from Reference Information* (KP 1997d)
- *Mount Polley Mine Project: Tailings Storage Facility 2011 Geotechnical Site Investigation* (AMEC 2012)
- *Mount Polley Dam Failure – Site Investigation Progress Report No. 2* (KCB 2015c)
- *Report on Mount Polley Tailings Storage Facility Breach* (IEEIRP 2015)
- *Mount Polley Dam Failure – Advanced Laboratory Testing Program Progress Report No. 4* (KCB 2015b)
- *Laboratory Testing Results from Mount Polley Mine* (Golder 2015a)
- *2015 Geotechnical Investigation Factual Report* (Golder 2015d)
- *2016 TSF Geotechnical Investigation Factual Report* (Golder 2017)
- *2018 TSF Geotechnical Investigation Factual Report* (Golder 2018)
- *2021/2022 Tailings Storage Facility Geotechnical Investigation Factual Report* (WSP Golder 2022b)

Hydrogeology Investigations

- *1996 Groundwater Monitoring Well Installation Program* (KP 1997b)
- *Mount Polley Mine Hydrogeology Assessment and Data Review* (AMEC 2013)
- *Installation and Testing of New Monitoring Wells near the TSF, SERDS, Cariboo Pit and Wight Pit – Mount Polley Mine* (Golder 2016d)

Geological Interpretations

- *Surficial Geology and Quaternary Geological Overview of the Mt. Polley Tailings Storage Facility (TSF) Area, British Columbia* (Golder 2015c)

Documents related to TSF Designs

- *Response to Review Comments on Tailings Embankment Design* (KP 1996)
- Mount *Polley Project Tailings Storage Facility Updated Design Report* (KP 1997c)
- *Mount Polley Stage 6 TSF Design* (KP 2007b)

TSF Construction Record Reports

- *Mount Polley Mine Tailings Storage Facility Report on 1998 Construction and Annual Inspection* (KP 1999)
- *Mount Polley Mine Tailings Storage Facility Report on 1999 Construction* (KP 2000)
- *Mount Polley Mine Tailings Storage Facility Report on Stage 3 Construction* (KP 2001)
- *Mount Polley Mine Tailings Storage Facility Report on Stage 4 Construction* (KP 2007a)
- *Mount Polley Mine Tailings Storage Facility Report on Stage 6A Construction* (KP 2009)
- *2015 Freshet Management Embankment As-Built Construction* (Golder 2015f)

4.0 CLIMATE

The five-year update of the climate baseline for the site is presented in WSP Golder (2022a) and includes precipitation, air temperature, relative humidity, solar radiation, evaporation, snow depths, and wind speed and direction. Updated climate change projections for the site are also provided.

The 1974 to 1993 climate records from the nearby Environment and Climate Change Canada Likely climate station and 1995 to 2021 climate records from the local MPMC climate stations served as the basis for developing statistics for describing precipitation and temperature conditions for the site. Records from local, regional, and MPMC climate stations were reviewed to assist in characterizing climate parameters.

The site experiences high summer precipitation due to summer storms, and the lowest monthly precipitation occurs in February. Precipitation typically occurs as snowfall starting in November and accumulating until March. Average annual precipitation at the site is estimated to be 612 mm with a standard deviation of 118 mm based on precipitation records for the site from 1974 to 2021. Typically, the increase of temperatures over 0°C starts in March, leading to freshet until June.

A summary of the updated baseline climate parameters is provided in Table 4-1. An evaluation of future climate change projections indicates future climate at the site will likely be warmer and wetter, with larger variations throughout the months.

Table 4-1: Summary of Key Climate Parameters for the Mount Polley Mine

Parameter	Value
Mean annual total precipitation (mm)	612
1:2-year 24-hour rainfall (mm)	33
1:10-year 24-hour rainfall (mm)	47
1:200-year 24-hour rainfall (mm)	69
Projected annual total precipitation anomaly from baseline for 2050s (%)	+5
Projected annual total precipitation anomaly from baseline for 2080s (%)	+8
Mean annual temperature (°C)	3.9
Average winter season (sub-zero mean monthly temperatures)	November to March
Mean snow water equivalent for the month of March (mm)	185
Projected annual air temperature anomaly from baseline for 2050s (°C)	+1.8
Projected annual air temperature anomaly from baseline for 2080s (°C)	+2.7
Mean annual shallow lake evaporation (mm)	673
Mean annual potential evapotranspiration (mm)	863

Note: Statistics are based on reviewed historical records from multiple climate stations and measured and derived data (where applicable).

5.0 QUATERNARY GEOLOGY

This section provides an overview of the Quaternary geology of the TSF embankment area, including geomorphological setting, regional and local geology, stratigraphic interpretation of subsurface investigation data, and interpreted depositional environment and Quaternary history of the area.

5.1 Regional Geomorphological Setting

The region is located on the eastern edge of the Interior Plateau, at the boundary between the Quesnel Highlands and the Fraser Plateau (Holland 1976; Bichler and Bobrowsky 2003). Terrain and geomorphology of the region comprises flat and gently rolling topography with hummocky bedrock exposures, dissected by a network of streams and lakes (Holland 1976; McAndless and Taylor 2006). Surface drainage patterns are influenced by bedrock topography; most of the stream valleys in the region have a northwest orientation and drain southward toward the lowland area north of the western arm of Quesnel Lake (Bichler and Bobrowsky 2003).

During the late Pleistocene, the area of the TSF was covered by the Cordilleran Ice Sheet (Clague 1987, 1988). The gently undulating topography and surface expression of the lowland area at the head of the west arm of Quesnel Lake is the result of glacial erosion and deposition of Quaternary sediments in an environment that evolved initially as a result of glacial advance followed by glacial retreat and inundation by meltwater, creating a glacial lake (glaciolacustrine) environment (Golder 2015c). Glacial landforms within the region include streamlined landforms associated with ground moraine, such as flutings, drumlins, drumlinoid ridges, and craig and tail features (Bichler and Bobrowsky 2003). These landforms indicate a predominantly northwesterly ice flow direction for the Cordilleran Ice Sheet in the Quesnel region (Clague 1988; Bichler and Bobrowsky 2003; Hashmi et al. 2015).

5.2 Regional Surficial Geology

The regional surficial geology is predominantly the result of erosion and deposition associated with the late Pleistocene (Wisconsinan) glacial episode referred to as the Fraser Glaciation (Clague 1987, 1988).

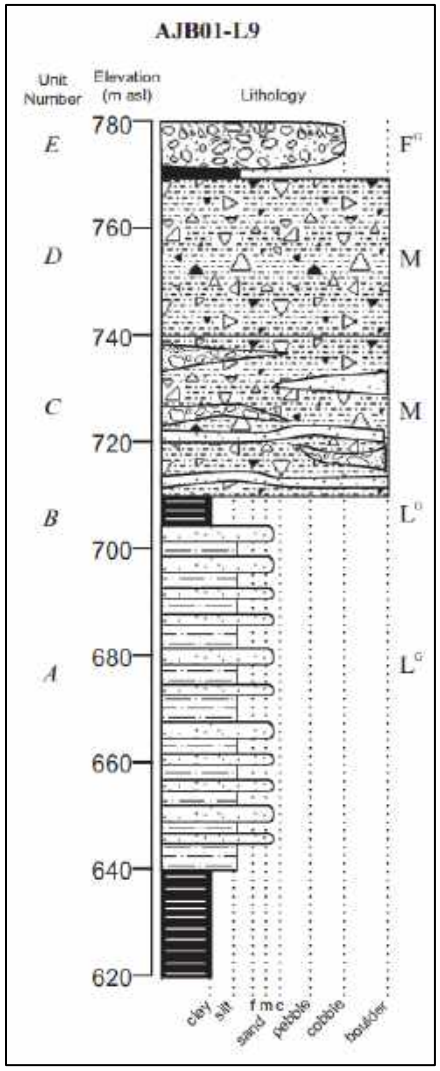
The regional surficial geology is dominated by till, glaciofluvial, and glaciolacustrine sediments of the Fraser Glaciation (Bichler and Bobrowsky 2003; McAndless and Taylor 2006). The glacial stratigraphy locally contains colluvial deposits derived from landslides initiating on valley walls during the late Pleistocene and Holocene (Clague 1988; Bichler and Bobrowsky 2003). Holocene fluvial deposits overlie the glacial deposits in areas local to watercourses and waterbodies throughout the region (Bichler and Bobrowsky 2003).

Bichler and Bobrowsky (2003) identified an “advance glaciolacustrine unit” (Illustration 5-1, Units A and B) that is overlain by a sequence consisting of basal till with intercalated glaciofluvial and glaciolacustrine sediments (Units C and D). This stratigraphic sequence is evident in available subsurface investigation data from the TSF area (Section 5.4). Basal till within the region is typically matrix-supported diamicton massive to weakly stratified, with faceted striated cobbles and boulders (Clague 1988) and is interpreted to be deposited during net glacial advance (Bichler and Bobrowsky 2003).

Glaciolacustrine sediments are present within most of the basal till in the major valleys (Illustration 5-1, Units A and B). These deposits are typically characterized by sub-horizontal, rhythmically bedded sand, silt, and clay in a coarsening upwards sequence. The unit is capped by fine-grained sediment, either rhythmically bedded or massive clay or silt, with local dropstones (Bichler and Bobrowsky 2003).

Glaciofluvial deposits are common within the major valleys, deposited in a succession of well-defined terraces (Clague 1988; Bichler and Bobrowsky 2003). Glaciofluvial sediments typically comprise moderately sorted, weakly to moderately compacted cobble or boulder gravel with a sand matrix (Illustration 5-1, Unit E). Gravel is also present locally in the form of hummocky blankets at higher elevations. Glaciofluvial fan deposits occur within valleys, with a similar composition to that of the glaciofluvial sediments, but typically with a greater sand content (Bichler and Bobrowsky 2003).

Morainal (ablation) till deposits more than 1 m thick are widespread and typically comprise poorly sorted, moderately to well-compacted silty clay diamicton. In the area of the TSF, these deposits are interpreted as ablation till (Illustration 5-1, Units C and D), deposited during net glacial recession (Clague 1988; Bichler and Bobrowsky 2003).



Source: Bichler and Bobrowsky 2003.

asl = above sea level; F^G = glaciofluvial deposits; M = basal till; L^G = glaciolacustrine deposits.

Illustration 5-1: Stratigraphic Column

5.3 Local Surficial Geology

A number of geotechnical subsurface investigations have been carried out in the TSF area (Section 3.0). The local surficial geology comprises Quaternary glacial sediments overlain by fill / anthropogenic deposits. A generalized stratigraphic sequence for the Quaternary sediments in the TSF area is presented in Illustration 5-2. The generalized stratigraphy reflects interpretations of the subsurface geology from geotechnical investigations conducted in the area of the TSF.

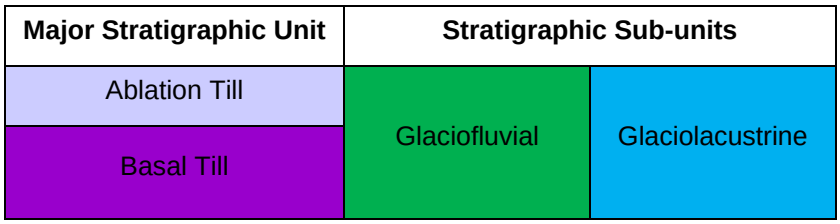


Illustration 5-2: Generalized Stratigraphic Column for Quaternary Sediments of the Tailings Storage Facility Embankment Area

This stratigraphic sequence is generally applicable to the mine area and TSF, with local variations associated with the depositional and erosional history of a particular area. The surficial geological units of the TSF embankment area are interpreted to represent two main stages of the Fraser Glaciation: the advance stage and recessional stage (Bichler and Bobrowsky 2003). Basal till is punctuated by glaciofluvial and glaciolacustrine deposits that typify the early stages of deposition (the advance stage), represented in the TSF area by basal till and associated sub-units. The ablation till and some layers of the glaciofluvial and glaciolacustrine sub-units were likely deposited during the recession stage of glaciation (Section 5.5).

Available mapping indicates the TSF area is underlain by altered, deformed, and brecciated volcanic and intrusive igneous rocks of the Late Triassic Nicola Group, with local sandstone and conglomerate of the Kamloops Group, Dragon Mountain Formation and some unnamed sediment groups (Logan et al. 2007).

5.4 Stratigraphic Interpretation

5.4.1 Methods

Stratigraphic correlations developed from the borehole data from the TSF area are presented as a series of interpretive geological cross-sections (Figure 3 to Figure 9). The stratigraphic interpretation conducted as part of this TSF foundation characterization study expands on the methods and geological interpretation and correlation completed by Golder in 2015, with updates to the previous work based on recent, detailed geological data from boreholes located close to the cross-section profile lines. General procedures used in development of the updated cross-sections and stratigraphic correlations are summarized as follows:

- **Lateral offset, priority and inferred boundaries**—Preference was given to incorporating geological data from boreholes located close to the cross-section lines and to boreholes that had the most detailed geological descriptions of the subsurface conditions encountered. Boreholes that were farther from cross-section lines were reviewed for geological correlation criteria, including information on the specific stratigraphic sequence and elevations of contacts between the different geological units. Boreholes with significant lateral offset from the lines of cross-section were generally omitted given the high degree of uncertainty in projection of the data.

- **Contact type**—Borehole logs with detailed geological descriptive information were used to determine the typical contact type between units (i.e., sharp or gradational).
- **Characteristics**—Geotechnical laboratory testing results were used to assist with distinguishing between geological units where available.

The geological criteria used to develop key stratigraphic correlations between different units are detailed in subsequent sections, with specific criteria for the glaciolacustrine deposits presented in Table 5-1. The criteria were applied to the geological descriptions in each of the boreholes used in the data compilation and review, and stratigraphic correlations identified.

Table 5-1: Stratigraphic Criteria for the Glaciolacustrine Sub-units

Geological Property	Typical Description
Unified Soil Classification System (USCS)[(a)]	CL, Cl, CH, or ML
Structure	Laminated, varved, or massive
Particle size distribution	Less than 5% gravel and 20% sand
Atterberg limits – plasticity index	10 to 25 (typically correlated to intermediate or high plasticity descriptions)
Typical stratigraphic location	Overlying or interbedded with glaciofluvial units

a) From the USCS Group Symbols: CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay, CH = high-plastic clay, ML = inorganic silt with slight or low plasticity.

Interpretation of borehole data is necessarily subjective due to the different terminology used and the consistency with which it is applied. For example, lamination, varving, and bedding were apparently used interchangeably in some of the descriptions of surficial deposits in the different borehole records both among the various consultant data sets, as well as within data obtained from individual consultants.

The scope of each previous investigation determined the level of detail included on the borehole logs in terms of stratigraphic unit descriptions, and whether geotechnical testing was completed. For example, the WSP Golder 2022 geotechnical investigation focused on identifying the glaciolacustrine unit, and therefore the borehole logs segregate units at a detailed scale accompanied by extensive geotechnical testing. In contrast, in the Knight Piésold Ltd. (KP) 1989 report, borehole records provide much less detail in terms of stratigraphic segregation of units and geotechnical testing. Not all borehole logs reviewed had plasticity ratings for stratigraphic units, nor did the associated investigation include Atterberg limits for every layer of the glaciolacustrine unit. In some factual reports, borehole records were not updated to reflect the geotechnical testing results of various surficial units. Therefore, review of both data sets was important to provide accurate stratigraphic interpretation. The Unified Soil Classification System was not used to describe surficial sediment textures in all factual reports, with some instead referring to the Wentworth Scale.

For presentation purposes on the interpretive geological cross-sections (Figure 3 to Figure 9), units of glacial sediment typically less than 0.5 m thick, as described in borehole records, were not shown on the cross-sections due to the scale of the section. This was specifically the case for thinner layers of the glaciofluvial and glaciolacustrine sub-units that were incorporated into adjacent units for cross-section presentation purposes. Similarly, small-scale interbedding, particularly among the glaciofluvial and glaciolacustrine sub-units, has not been shown on some sections.

In some areas of the TSF, the geological contact between glacial sediments and bedrock was difficult to identify accurately given the intensity of bedrock weathering. Therefore, the position of the surficial sediment-bedrock contact should be considered approximate in many parts of the TSF area.

5.4.2 Glacial Environments and Depositional Processes

Depositional environments associated with glacial sediments are inherently complex, particularly in ice-front or ablation zone settings, which are typically associated with glaciofluvial and glaciolacustrine deposits and sedimentation processes.

Glacial lakes disrupt the flow of meltwater and intercept glacial sediment being generated by processes such as ablation (ice removal) (Tweed and Carrivick 2015). Variability in the types of flow processes and meltwater velocities can complicate stratigraphic interpretation of glacial lake deposits. Sediment deposition and distribution in glaciolacustrine environments can be associated with gravity, turbidity, and density flows or currents (Carrivick and Tweed 2013). These flows can lead to structures and stratified deposits that may be interpreted as a mix of glaciofluvial and glaciolacustrine materials, particularly near the edges of a glacial lake where streams enter and exit an otherwise stagnant body of water. Sediment deposition in proximal zones of ice-marginal lakes can also be influenced by proglacial (ice front) activity.

Hillslope processes and valley tributaries entering the ablation zone following glacial retreat can also impact glaciolacustrine depositional environments (Carrivick and Tweed 2013). Ice contact deltas and the up-ice side of grounded fans can have similar characteristics to diamictic-textured till materials (Carrivick and Tweed 2013). Mass movement of valley hillslopes via processes such as slumps, debris slides, and debris flows can cause material to enter the subaqueous or water-free environment (depending on timing) and mix with existing sediments. Valley tributary systems entering the glaciofluvial and glaciolacustrine environments may also result in flow overlap and inter-fingering deposits. These mixing environments can lead to discontinuous and complex textures and structures. These processes and conditions were taken into consideration in the course of carrying out stratigraphic correlations for the TSF area.

5.5 Depositional Environment and Quaternary History of the Tailings Storage Facility Embankment Foundation Area

The stratigraphic interpretation of the TSF area generally correlates with that described by Bichler and Bobrowsky (2003), and the Golder (2015c) interpretation.

Two main stages of glacial activity can be interpreted from the surface and subsurface geological record in the TSF embankment area:

1) advance stage

2) recessional stage

5.5.1 Advance Stage

Depositional environments that developed during the late Pleistocene (Wisconsinan) Fraser Glaciation were dominated in the early stages by glacial advance of the Cordilleran ice sheet over much of central British Columbia (Clague 1987, 1988). Basal till and moraine punctuated by glaciofluvial and glaciolacustrine deposits typify the early stages of deposition, represented in the TSF area by basal till and associated sub-units.

These deposits are present across the TSF area, except in the South Embankment where bedrock is at a relatively high elevation, and the basal till unit is not interpreted to be present. The total maximum thickness of the advance glacial deposits is approximately 40 m (Figure 3 to Figure 9).

The basal till unit typically comprises a mixture of silt/clay with sand and gravel, punctuated by interbedded layers of glaciofluvial and glaciolacustrine sub-units. The relative consistency of the basal till is typically stiff to hard as a result of deposition under or in contact with glacial ice. Sediment comprising the glaciofluvial and glaciolacustrine units was transported from the area of the glacial ice sheet by meltwater streams and accumulated in lakes and stream channels in a pro-glacial (ice marginal) environment in front of the glacier. These sub-units are interpreted to represent hiatuses and/or minor localized glacial retreat, with some glaciofluvial deposits likely representing ice-frontal meltwater channel deposits. The glaciolacustrine and glaciofluvial materials were subsequently overridden and compacted by the glacial ice.

5.5.2 Recessional Stage

Ablation till and some layers of the glaciofluvial and glaciolacustrine sub-units were likely deposited during the recessional stage of glaciation, when ice stagnation, retreat and melting were the dominant processes.

The ablation till unit typically comprises firm to stiff silt and silty clay, with secondary components of gravel and sand. Fines were typically non-plastic or of low plasticity, and locally mottled. Pockets of organic material, mottled fines and iron oxide staining were encountered towards the top of the unit. These characteristics are typical of subaerially exposed sediments, allowing for weathering and development and/or deposition of organic materials.

Glaciofluvial deposits were observed locally at various levels within the ablation till unit. These discontinuous silty sand layers may represent late-stage, short-lived advance during the early-stage net glacial recession, marked by isolated glaciofluvial environments.

The glaciolacustrine sub-unit encountered near the base of the ablation till is interpreted to have formed during early-stage net glacial recession, in areas of localized ponding of glacial meltwater. These glaciolacustrine deposits likely represent the approximate upper boundary of the pro-glacial basal till and associated sub-units.

The Klohn Crippen Berger Ltd. (KCB 2015a) summary report presents an alternative interpretation for the Quaternary history of the TSF area, instead suggesting two separate glaciations: the penultimate glaciation and the Fraser Glaciation. The key difference between the KCB (2015a) interpretation of the Quaternary history of the TSF area and the interpretation presented in this report is that of the ablation till unit, which was interpreted by KCB to represent basal till deposited during advance of a second glaciation rather than ablation till deposited during retreat of the Fraser Glaciation:

- The basal till unit was interpreted by KCB (2015a) to be deposited during net advance of the penultimate glaciation.
- The ablation till unit was interpreted to be basal in origin, deposited during net advance of glaciers in the Fraser Glaciation. Interfingering of the glaciofluvial and glaciolacustrine deposits within the till unit was interpreted to represent multiple periods of glacial advance and retreat during the Fraser Glaciation.
- The diamicton within the ablation till unit was determined to be due to the presence of subglacial landforms mapped in the vicinity of the TSF area.
- Layers of the glaciolacustrine and glaciofluvial sub-units were interpreted to be deposited during glacial retreat of the penultimate glacial period, and during advance of the Fraser Glaciation.

5.5.3 Geological Units of the Tailings Storage Facility Embankment Foundation Area

5.5.3.1 Ablation Till Unit

The ablation till unit in the TSF area is interpreted as till derived from sediment entrained within the glacial ice and deposited directly by melting ice (ablation), typically in the terminus portion of the glacier. It commonly overlies basal till since it is deposited in the latest stages of glaciation. In the TSF area, these deposits are interpreted to be associated with glacial recession.

The main variables used to identify the ablation till unit were elevation, stratigraphic position, and typical unit thickness. The general elevation range of the base of the unit was estimated from borehole data to be between 925 and 940 m but may be as low as 910 m (e.g., Main Embankment).

The ablation till unit typically comprises firm to stiff silt and silty clay, with components of gravel and sand. Pockets of organic material, mottled fines, and iron oxide staining have been described towards the top of the unit. Fines are typically non-plastic or of low plasticity and are occasionally mottled.

Contacts between the ablation till unit and the overlying anthropogenic materials are sharp. The contact between the ablation till unit and underlying basal till unit is typically gradational, except where separated by the glaciolacustrine or glaciofluvial sub-units.

5.5.3.2 Basal Till Unit

Basal till is formed by the subglacial deposition of sediment carried within or below the glacier. In the TSF area, the basal till is interpreted to have been deposited during net glacial advance (Clague 1988).

The basal till unit underlies the ablation till unit and occurs at elevations between approximately 875 and 930 m, with the top contact of the unit typically between 895 and 915 m. The basal till unit is typically stiff to hard, and is composed of a mixture of silt, clay, sand, and gravel with occasional cobbles. The basal till unit differs from the ablation till unit in terms of elevation, sequence of deposition, gradation, and colour. Both the basal and ablation till units are grey to brown; however, mottling associated with oxidation and iron staining, and local pockets of organic material have been observed in the ablation till.

5.5.3.3 Glaciolacustrine Sub-unit

Glaciolacustrine deposits result from settlement of suspended sediment within lakes or sub-glacial meltwater, typically creating layers of silt and clay with laminated or varved (seasonal layering) structures (Tweed and Carrivick 2015).

Stratigraphic criteria for identifying glaciolacustrine deposits are presented in Table 5-1. The key controlling variables were structure, texture, and plasticity, where available. The glaciolacustrine sub-unit typically comprises silt, silty clay, or clay with lesser fine sand, with a varved or laminated structure. Locally, this unit may be more massive and lack a layered structure. Plasticity of this unit is typically medium to high. Trace gravel has been noted locally within the glaciolacustrine sub-unit and may represent dropstones; sand and clay lenses are recorded within some layers of this unit.

The glaciolacustrine sub-unit is interpreted to include all stratigraphic horizons with a layered structure and descriptions indicating deposition in a glacial lake or subglacial setting. This differs slightly from the geotechnical interpretation of the unit, which also applies geotechnical parameters to classify the unit (Table 5-1). As such, there are some locations where the glaciolacustrine sub-unit shown in the geological cross-section has been identified based on geological interpretation only. For example, at approximate Station 0+450 in the South

Embankment, the glaciolacustrine sub-unit has been identified at the base of the ablation till based on descriptions in borehole logs and interpreted depositional setting (Figure 3). At this location (boreholes VW11-02 and GA16-19), a layer of non-plastic to low plasticity silt with some clay and sandy to trace sand was described as bedded with occasional dropstones. This layer is interpreted to have been deposited in a glaciolacustrine environment, but it has geotechnical characteristics that differ from the intermediate and high plasticity glaciolacustrine units identified at the Main and Perimeter embankments (Section 7.3.4).

The glaciolacustrine sub-unit was typically observed near the base of the ablation till unit. It typically overlies or is interbedded with the glaciofluvial sub-unit throughout the basal till at elevations between approximately 900 and 920 m, with some layers locally occurring as low as 887 m (Perimeter Embankment). Reported thicknesses of glaciolacustrine deposits in the TSF area vary from approximately 0.3 to 15 m.

The glaciolacustrine sub-unit encountered near the base of the ablation till is interpreted to have formed during early-stage net glacial recession, in areas of localized ponding of glacial meltwater.

5.5.3.4 Glaciofluvial Sub-unit

Glaciofluvial deposits, sometimes referred to as outwash deposits, comprise sediments and landforms produced by glacial meltwater streams. The outwash sediment typically comprises cobbles, gravel and sand, with minor silt and silty clay. Glaciofluvial deposits may show a lateral decrease in grain size due to relatively rapid downstream movement of sediment. A depositional pattern known as braiding is also typical due to a lack of distinct channelling of sediment and high sediment load.

The key controlling variables for identifying glaciofluvial deposits are texture (sand and gravel dominated), grading, and sorting (where available).

A discontinuous silty and fine to coarse sand unit with trace fine gravel was identified locally within the ablation till unit between approximately 920 and 936 m elevation (Main Embankment). This may represent late-stage, short-lived advance activity during the early-stage net glacial recession, marked by isolated glaciofluvial environments.

The glaciofluvial sub-unit encountered within the basal till is typically interbedded with the glaciolacustrine sub-unit and is sub-divided into sand-dominated and gravel-dominated units. The sand-dominated glaciofluvial sub-unit typically comprises fine- to coarse-grained sand with trace silt, or silty sand with trace gravel noted locally. This sub-unit was recorded extensively throughout the basal till unit from approximately 882 to 924 m (Perimeter Embankment). Recorded thicknesses of the sand-dominated glaciofluvial layers within the TSF area range from approximately 0.15 to 12 m.

The gravel-dominated glaciofluvial sub-unit was identified locally within the Main Embankment and Perimeter Embankment only. The sub-unit typically comprises fine- to coarse-grained gravel with some sand, silt, and cobbles and was typically deposited in sequence with the sand-dominated glaciofluvial sub-unit. The gravel-dominated unit occurs between approximately 886 m (Main Embankment) and 924 m (Perimeter Embankment) elevation, with recorded thicknesses ranging from approximately 0.3 to 3 m.

Glaciofluvial sub-unit layer thicknesses were noted to vary spatially within the same layer, which is typical of stream deposition. Bifurcation (branching) and interfingering with adjacent units are also common stratigraphic characteristics of the glaciofluvial sub-unit. However, as previously noted, such detailed stratigraphic correlations were only possible where boreholes were located close to the line of the cross-section. As such, it is likely that these features are more common within the TSF area than is currently presented on the cross-sections.

Contacts between the glaciofluvial sub-unit and the glaciolacustrine sub-unit are typically sharp, and contacts with the basal till unit are commonly gradational.

The glaciofluvial sub-unit within the basal till is inferred to correlate with sand lenses described in the regional surficial stratigraphy by Bichler and Bobrowsky (2003), interpreted to represent ice-frontal meltwater channel deposits.

5.5.3.5 Bedrock

Weathered bedrock was encountered across the TSF area between approximately 873 and 968 m elevation. Bedrock described in boreholes typically comprised sand and gravel with some fines, recorded as weathered volcaniclastic conglomerate, volcanic debris or completely weathered bedrock. Locating the contact between the bedrock and overlying till was inherently difficult at many borehole locations given the highly weathered nature of the upper part of the bedrock. As such, the weathered bedrock can be difficult to distinguish from the overlying surficial deposits (Panteleyev et al. 1996; Golder 2015c).

6.0 SEISMIC HAZARD

The Mount Polley TSF site is located within the Canadian Cordillera, part of the North American Cordillera that was formed by convergent tectonic processes and the successive accretion of a number of allochthonous terranes to the ancient western margin of the North American plate, likely beginning sometime in the Late Triassic to Early Jurassic (approximately 180 to 200 million years ago) (Monger and Price 1979; Price 1994, 2000; Ricketts 2008; Monger 1989).

The present-day tectonics of western Canada are strongly influenced by the effects of relative motions of the Pacific and North America plates and remnants of the former Farallon plate that was largely subducted. The modern Explorer, Juan de Fuca, and Gorda plates are the remains of the much larger Farallon plate.

The Cascadia subduction zone (CSZ) marks the boundary where the Juan de Fuca, Explorer, and Gorda plates are being subducted beneath western North America. The 1,200 km long CSZ extends from northern California to British Columbia and is approximately 460 km west of the Mount Polley Mine at its closest approach. The present-day convergence (subduction) velocity ranges from about 43 mm/yr for the Juan de Fuca plate that decreases to the northwest to about 20 mm/yr for the Explorer plate (North America fixed). The CSZ has produced repeated great earthquakes (i.e., above moment magnitude (**M**)8) throughout the Holocene Epoch. The most recent CSZ great earthquake was an estimated **M**9.0 in January of 1700. The Cascadia subduction interface is currently locked and accumulating strain toward a future large or great earthquake (e.g., Dragert et al. 1994; Hyndman and Wang 1995; Mazzotti et al. 2003).

The southern Canadian Cordillera, where the Mount Polley Mine is located, has relatively low rates of historical seismicity relative to the CSZ. However, intermediate-to-large magnitude earthquakes have been recorded. For example, a **M**6.0 earthquake in 1918 had an epicentre approximately 220 km east of the site and a **M**5.5 earthquake occurred in 1986 with an epicentre approximately 200 km north of the site. Both earthquakes occurred in the “Rocky Mountain Trench” that marks the boundary between the western Foreland Fold and Thrust Belt and the Quesnel terrane and other terranes. The 1986 earthquake had a thrust fault mechanism, which is consistent with the general structural trends mapped in the area (e.g., Rogers et al. 1990).

WSP developed a site-specific seismic hazard model for the Mount Polley site based on source models developed for the 6th Generation Canadian National Seismic Hazard Model (Canada SHM6) and a review of geological and paleoseismological features (APPENDIX B). Both near-field, moderate-magnitude crustal earthquakes and far-field subduction interface earthquakes contribute to the site seismic hazard. The shallow crustal earthquake sources are dominated by moderate-magnitude earthquakes (**M**6.0 to **M**6.5) close to the site (i.e., less than 60 km away) at all annual exceedance probabilities. The contribution to hazard at the site from CSZ sources is from large earthquakes (**M**8+) at 450 to 550 km from the site at all annual exceedance probabilities and spectral periods of interest.

Probabilistic analysis results from the site-specific hazard model are listed in Table 6-1.

Table 6-1: Site-Specific Accelerations (5%-damped) for Selected Annual Exceedance Probabilities and Spectral Periods at the Mount Polley Tailings Storage Facility Site (V_{S30} = 849 m/s)

Performance Level – Annual Exceedance Probability	Spectral Period (s)	Acceleration[a] (g)					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
1/1,000	PGA	0.026	0.023	0.023	0.025	0.028	0.028
	0.5	0.033	0.030	0.030	0.033	0.035	0.036
	1.0	0.020	0.017	0.017	0.019	0.021	0.023
	1.5	0.015	0.012	0.012	0.015	0.017	0.018
1/2,475	PGA	0.048	0.042	0.042	0.046	0.053	0.054
	0.5	0.054	0.050	0.050	0.053	0.057	0.058
	1.0	0.030	0.026	0.027	0.030	0.033	0.035
	1.5	0.023	0.018	0.019	0.022	0.026	0.027
1/5,000	PGA	0.076	0.067	0.067	0.073	0.084	0.085
	0.5	0.079	0.073	0.073	0.079	0.083	0.084
	1.0	0.042	0.036	0.038	0.041	0.045	0.048
	1.5	0.031	0.024	0.025	0.029	0.036	0.037
1/10,000	PGA	0.116	0.102	0.102	0.111	0.128	0.128
	0.5	0.114	0.106	0.106	0.115	0.119	0.121
	1.0	0.057	0.050	0.052	0.057	0.060	0.065
	1.5	0.041	0.032	0.034	0.039	0.047	0.048

a) 5%-damped, mean, geometric-mean, peak horizontal acceleration.

PGA = peak ground acceleration.

7.0 GEOTECHNICAL CONDITIONS

This section presents a summary of results of geotechnical testing and interpreted geotechnical parameters.

A summary of available geotechnical data collected during subsurface investigations in the area of the TSF embankment is provided in APPENDIX C (Tables C1 to C5). This includes information related to boreholes, test pits, cone penetration tests (CPTs), monitoring wells and other instrumentation, and laboratory index testing results. The subsurface investigation locations are shown relative to the TSF embankment in Figure 1 and Figure 2. Surficial geological cross-sections were developed for the encountered foundation conditions which are shown in Figure 3 to Figure 9.

A borehole was drilled downstream of the Corner 1 Embankment after completion of the investigation program carried out in 2021 and 2022 (referred to as borehole GA22-01). The record of borehole and other relevant information is provided in APPENDIX D.

The following stratigraphic units were identified in the foundation of the TSF embankment.

- **Till**—The till is generally a mixture of gravel, sand, and low plastic fines ranging from silt to silty clay. The material is generally cohesive with a consistency from firm to hard. The average water content is approximately 12% (ranges from 2% to 33%). Results of geotechnical testing are presented in Section 7.1.
- **Glaciofluvial units**—The glaciofluvial units are generally gravelly sandy silt to silty sand with trace gravel. The fines content ranges from about 4% to 100% and are generally non-plastic. The material is generally non-cohesive with a compactness ranging from compact to very dense. The average water content is approximately 17% (ranges from 2% to 34%). Results of geotechnical testing are presented in Section 7.2.
- **Glaciolacustrine units**—The glaciolacustrine units are generally silty clay to clay with trace to some sand. The fines are generally intermediate to high plasticity. The material is generally cohesive with a consistency ranging from firm to very stiff. The average water contents and clay contents of the glaciolacustrine units vary based on location. Results of geotechnical testing are presented in Section 7.3.
- **Highly weathered bedrock**—Generally weathered volcaniclastic conglomerate, volcanic debris or completely weathered bedrock.

7.1 Till

Till has been encountered during many previous subsurface investigations carried out near the foundation of the TSF. Representative samples were collected throughout the investigations with selected samples chosen for subsequent laboratory testing. The laboratory testing programs generally included a range of index and/or advanced laboratory tests dependent on the specific objective at the time. A summary of the index properties for the samples of till is presented in Table 7-1.

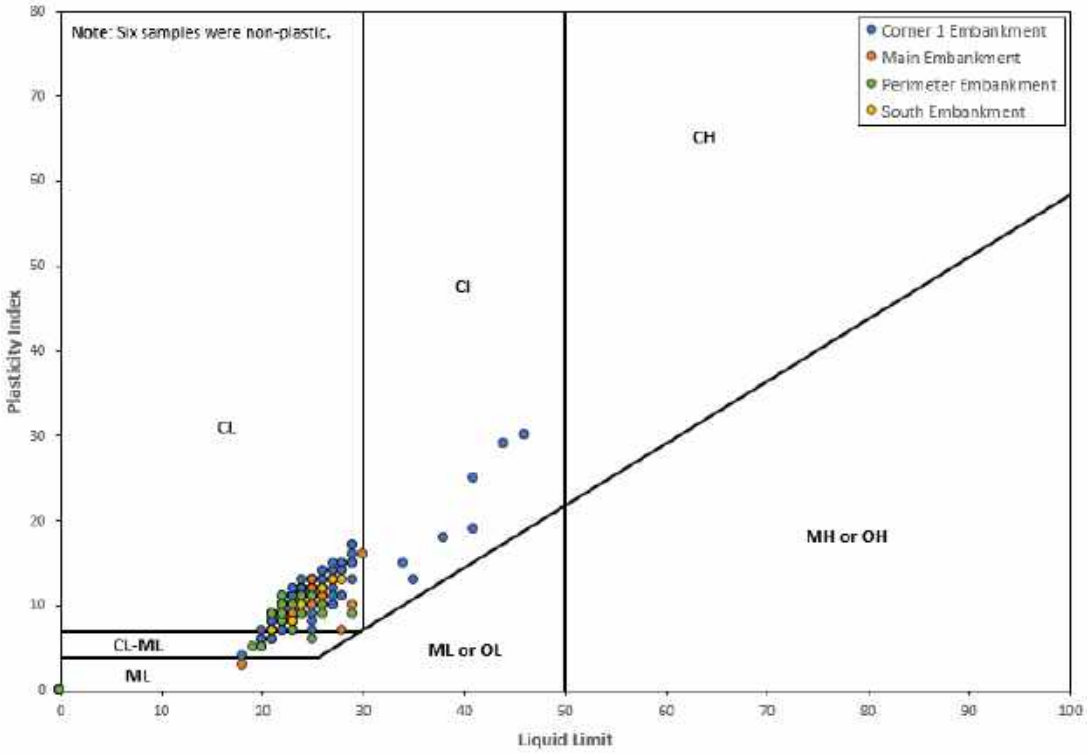
The Atterberg limit results for each embankment are shown graphically in Illustration 7-1. The fines are generally non-plastic or low plasticity and range from silt to silty clay (ML to CL, respectively). Thirteen test results were outside of this general range and had an intermediate plasticity. The samples with an intermediate plasticity were all collected from the Corner 1 Embankment.

The natural water content results were plotted against elevation, which is shown in Illustration 7-2. The average water content of the till was approximately 12% and ranged from 2% to 33%.

Table 7-1: Summary of Index Properties of Till

Index Property		Average	Minimum	Maximum	Number of Tests
Gradation	Gravel (%)	15	0	45	218
	Sand (%)	35	3	61	
	Fines (%)	50	16	97	
Liquid limit[a]		25	18	46	169
Plastic limit[a]		14	11	22	
Plasticity index[a]		11	3	30	
Water content (%)		11.8	2.0	33.1	1,645
Specific gravity of solids		2.76	2.73	2.78	6

a) Atterberg limits exclude six non-plastic results.



CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-1: Plasticity Chart of Till Samples

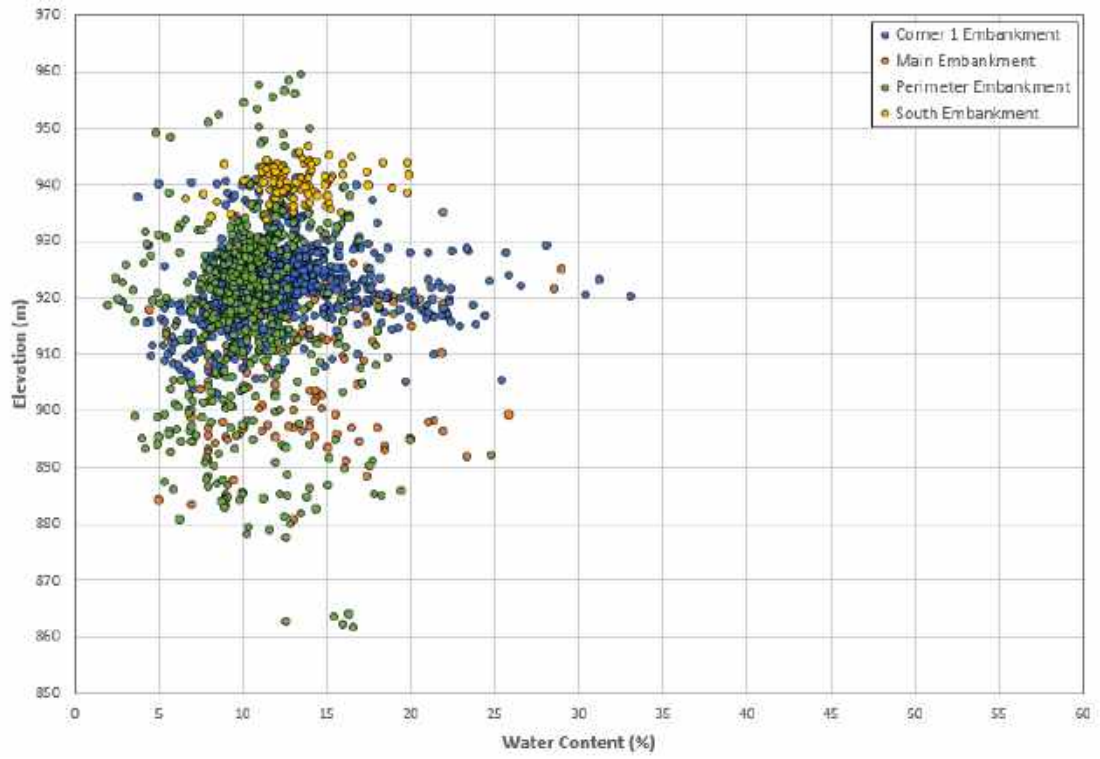


Illustration 7-2: Water Content against Elevation of Till Samples

A summary of the shear strength test results from till samples is presented in Table 7-2. The peak friction angle ranged from 30 to 41 degrees with a cohesion of 0 kPa.

Pressuremeter test results indicate the friction angle of the till at the Corner 1 Embankment ranges between 36 and 48 degrees, with an average of about 40 degrees (IEEIRP 2015).

Table 7-2: Shear Strength Test Results of Till

Borehole / Test Pit No.	Sample No.	Sample Type	Elevation (m)	Peak Shear Strength Parameter		Source
				Friction Angle (degrees)	Cohesion (kPa)	
TP95-27	n/a	Grab	926.2	35	0	KP (1995a)
TP95-37	n/a	Grab	937.0	35	0	
MR14-105	4B	Thin-walled tube	927.8	34	0	IEEIRP (2015)
MR14-106	2	Thin-walled tube	924.6	34	0	
MR14-111	5A	Thin-walled tube	922.9	35	0	
MR14-113	1C	Thin-walled tube	928.0	33	0	
SH14-10A	12	Sonic core	922.4	41	0	KCB (2015b)
	10	Sonic core	921.6	30	0	
	14	Sonic core	918.7	37	0	
TP14-01	BS-01	Block	n/a	34	0	
	BS-01	Block	n/a	33	0	

n/a = not applicable, not available

The median shear wave velocity measured in the till foundation ranged from about 320 to 400 m/s at the Corner 1 Embankment (Golder 2016a).

7.2 Glaciofluvial Unit

A summary of the index properties for the glaciofluvial samples collected from the foundation of the TSF embankment is presented in Table 7-3.

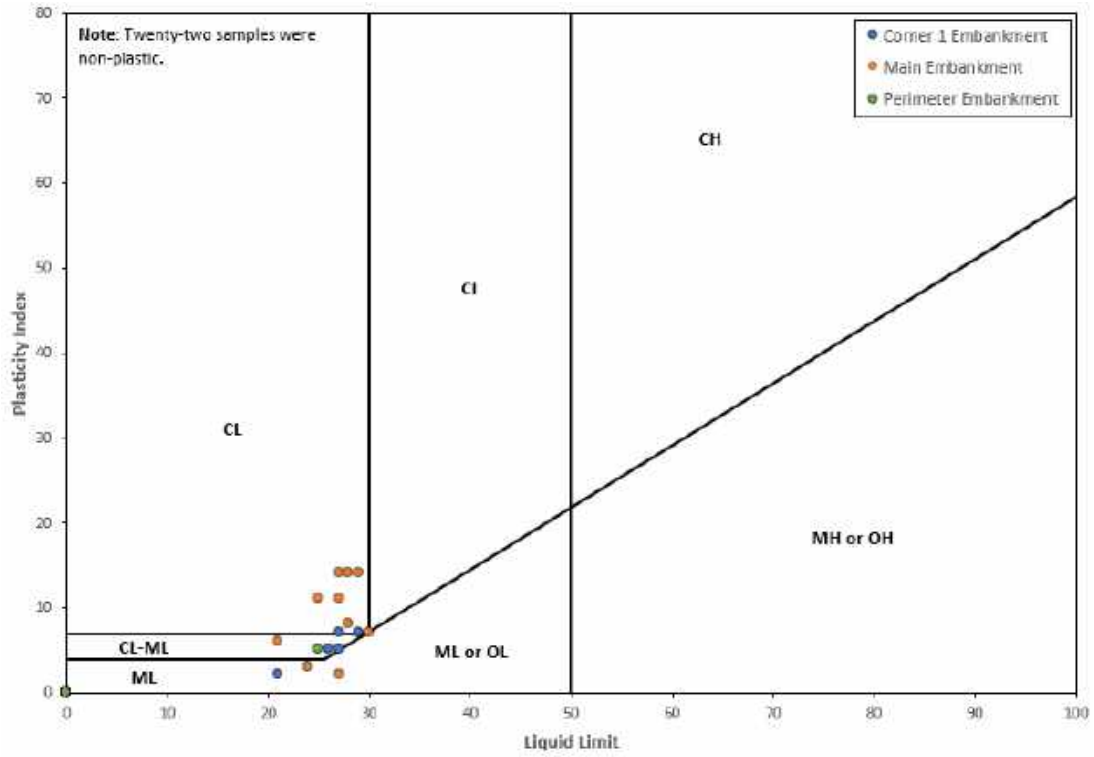
A total of 38 Atterberg limit test results were available for samples of glaciofluvial. Atterberg limit tests were generally only carried out on samples described as exhibiting some plastic behaviour. The fines are generally a non-plastic to low plastic material and range from silt to silty clay (ML to CL, respectively). Twenty-two of the 38 test results were non-plastic. The material is generally non-cohesive with a compactness ranging from compact to very dense. The Atterberg limit results for each embankment are shown graphically in Illustration 7-3.

The natural water content results were plotted against elevation, which is shown in Illustration 7-4. The average water content of the glaciofluvial was approximately 17% and ranged from 2% to 34%.

Table 7-3: Summary of Index Properties of Glaciofluvial Unit

Index Property		Average	Minimum	Maximum	Number of Tests
Gradation	Gravel (%)	6	0	47	43
	Sand (%)	32	0	85	
	Fines (%)	63	4	100	
Liquid limit[a]		26	21	30	16
Plastic limit[a]		19	13	25	
Plasticity index[a]		8	2	14	
Water content (%)		16.9	2.2	33.9	393
Specific gravity of solids		2.78	2.78	2.78	1

a) Atterberg limits exclude 22 non-plastic results.



CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-3: Plasticity Chart of Glaciofluvial Samples

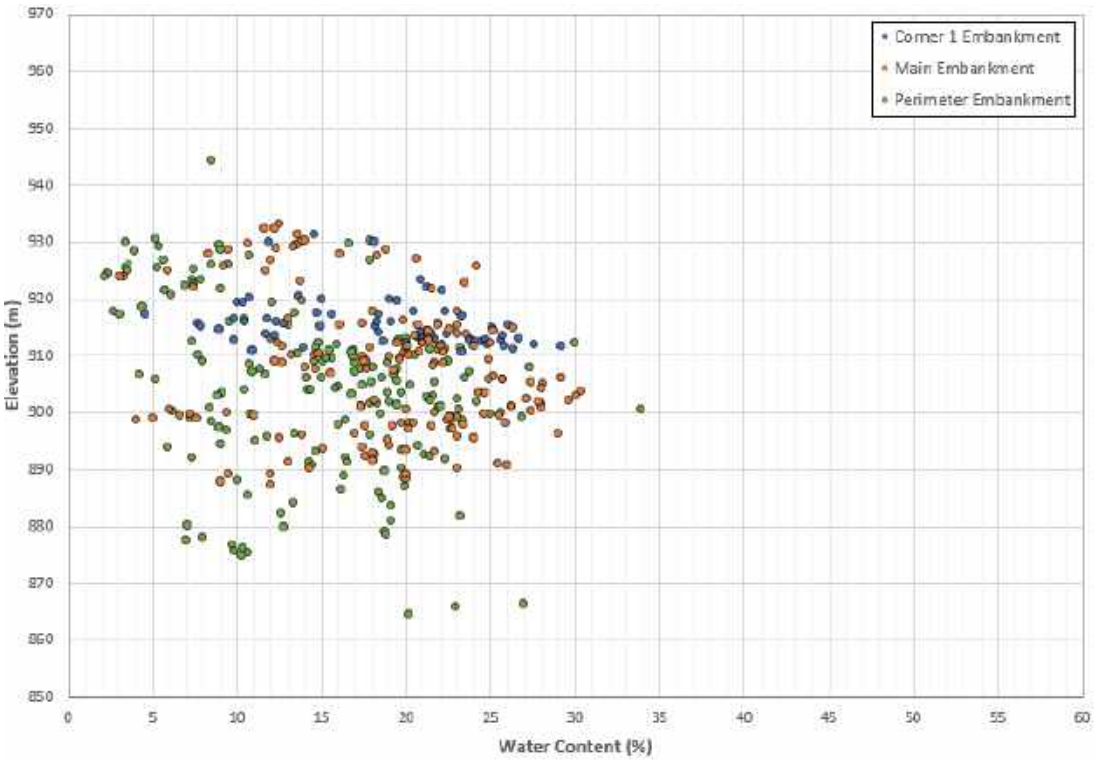


Illustration 7-4: Water Content against Elevation of Glaciofluvial Samples

A summary of the shear strength test results from glaciofluvial samples is presented in Table 7-4. The peak friction angles were 35 and 36 degrees with a cohesion of 0 kPa.

Table 7-4: Shear Strength Test Results of Glaciofluvial Unit

Borehole / Test Pit No.	Sample No.	Sample Type	Elevation (m)	Peak Shear Strength Parameter		Source
				Friction Angle (degrees)	Cohesion (kPa)	
Central Collection Sump	n/a	Thin-walled tube	n/a	36	0	Golder (2015d)
GA15-21	9 (C|U)	Thin-walled tube	902.5	35	0	

n/a = not applicable, not available

7.3 Glaciolacustrine Unit

Glaciolacustrine deposits were identified along the Main, Perimeter, and Corner 1 embankments:

- **Main Embankment**—A semi-continuous layer of glaciolacustrine soil is present at an elevation of approximately 900 to 910 m and extends along the length of the Main Embankment. A shallower layer of glaciolacustrine soil near elevation 920 m was identified near Station 2+400 and 2+750. Results of geotechnical testing completed on samples of glaciolacustrine soils from the Main Embankment are presented in Section 7.3.1.
- **Perimeter Embankment**—The glaciolacustrine soil deposits are not continuous and their elevations generally range between about 885 and 935 m. Results of geotechnical testing completed on samples of glaciolacustrine soils from the Perimeter Embankment are presented in Section 7.3.2.
- **Corner 1 Embankment**—Upper and lower glaciolacustrine soil deposits are present at this location. The upper glaciolacustrine deposit is a semi-continuous layer between approximate elevation 918 and 925 m from approximate Station 20+000 to 20+300. The lower glaciolacustrine deposit is also a semi-continuous layer between approximate elevation 900 and 918 m. Results of geotechnical testing completed on samples of glaciolacustrine soils from the Corner 1 Embankment are presented in Section 7.3.3.

A layer of low plasticity silty clay interpreted to have deposited in a glaciolacustrine environment was encountered directly above bedrock near Station 1+100 at the South Embankment; however, the geotechnical testing completed on the material showed it not to be representative of the intermediate or high plasticity glaciolacustrine units found within the footprint of the Corner 1, Main, and Perimeter embankments (Golder 2017). The results of the geotechnical testing are presented in Section 7.3.4.

7.3.1 Main Embankment

A summary of the index properties for samples of glaciolacustrine material collected from the foundation of the Main Embankment is presented in Table 7-5.

The Atterberg limit results are shown graphically in Illustration 7-5. The fines are generally a low to intermediate plastic material and range from silt to silty clay (ML to CI, respectively). Six results were outside of this general range and were either non-plastic or had a high plasticity.

The natural water content results were plotted against elevation, which is shown in Illustration 7-6. The average water content of the glaciolacustrine samples from the Main Embankment was approximately 26% and ranged from 6% to 42%.

The natural water content results were also plotted against clay content as shown in Illustration 7-7. A total of 44 hydrometer test results were available for glaciolacustrine samples from the Main Embankment foundation. The average clay content (defined as particles smaller than 0.002 mm) of the glaciolacustrine samples was approximately 30% and ranged from 7% to 49%. A general trend of increasing water content with increasing clay content can be seen in the illustration.

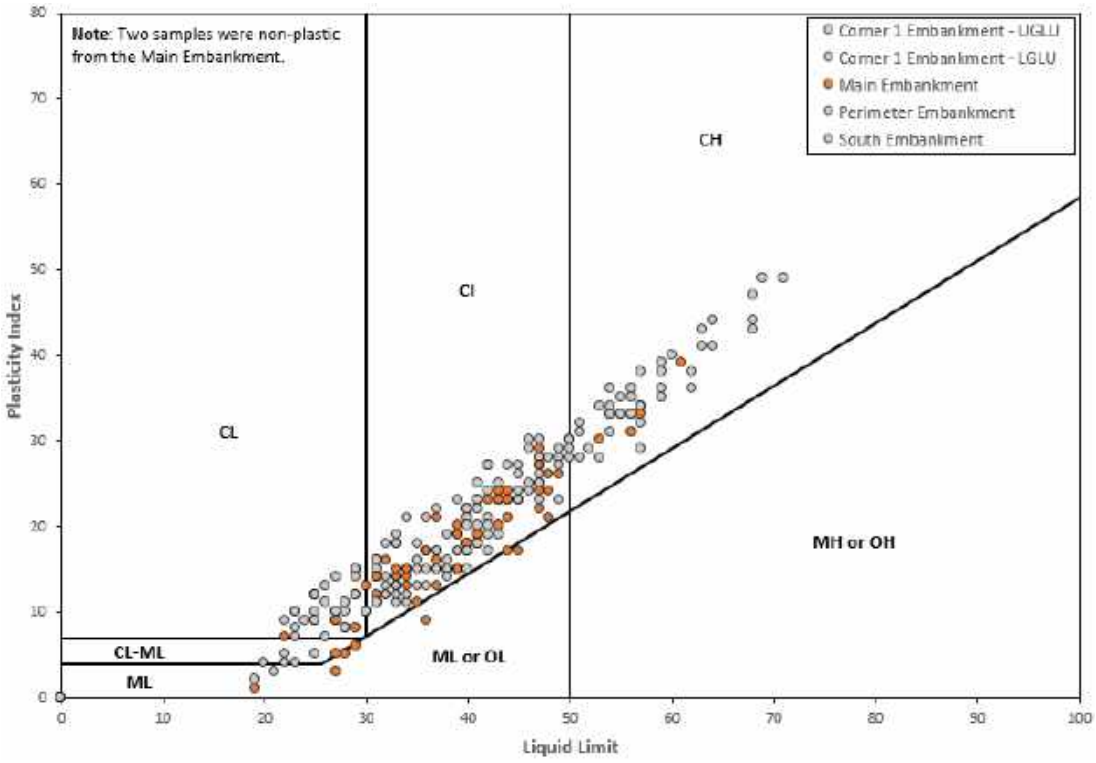
All available test results for glaciolacustrine samples collected from the foundation of the other embankments were incorporated into the illustrations for comparison.

Table 7-5: Summary of Index Properties of Glaciolacustrine at the Main Embankment

Index Property		Average	Minimum	Maximum	Number of Tests
Gradation	Gravel (%)	0	0	5	52
	Sand (%)	6	0	40	
	Fines (%)	94	60	100	
	Silt (%)	65	44	92	44
	Clay[a] (%)	30	7	49	
Liquid limit[b]		39	19	61	62
Plastic limit[b]		21	15	28	
Plasticity index[b]		17	1	39	
Water content (%)		26.1	6.3	42.1	179
Specific gravity of solids		2.75	2.65	2.80	8

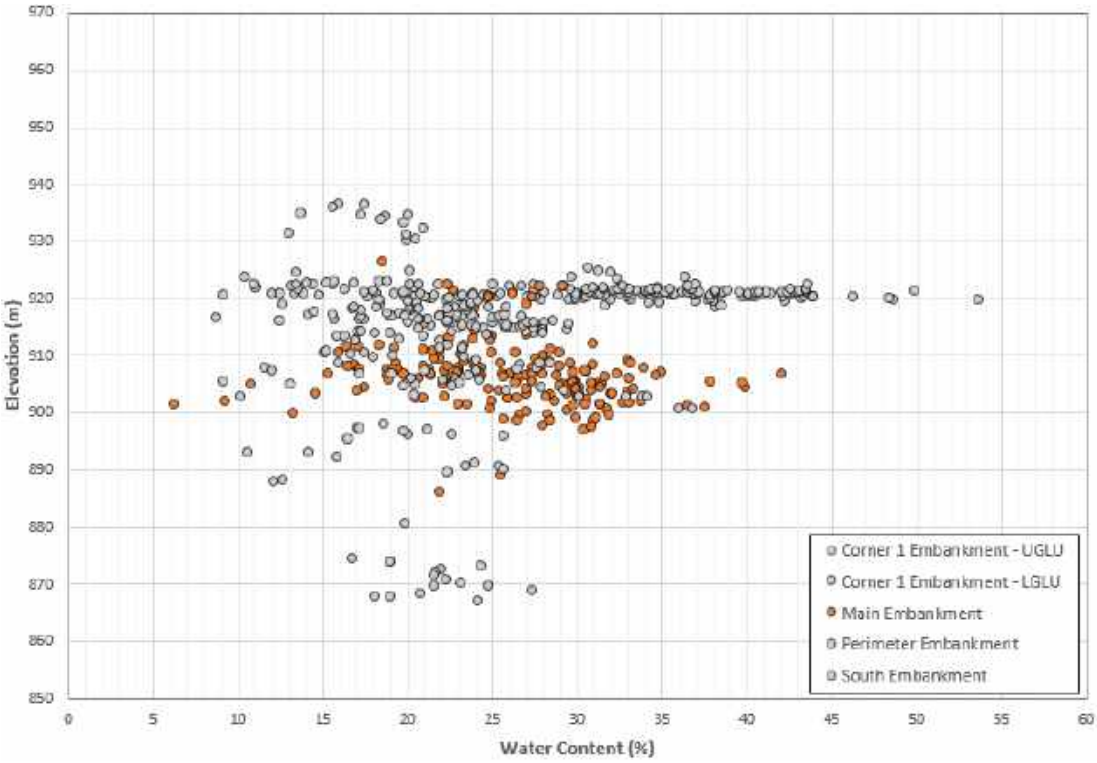
a) Clay is defined as particles smaller than 0.002 mm.

b) Atterberg limits exclude two non-plastic results from the Main Embankment.



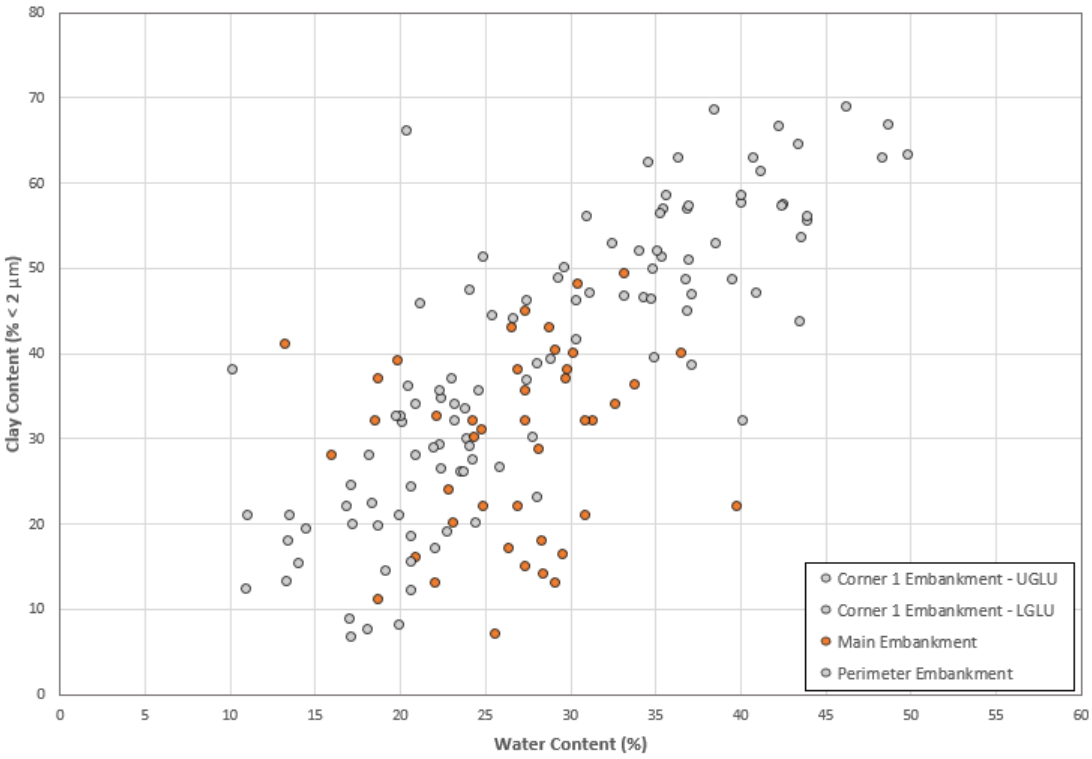
CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-5: Plasticity Chart of Glaciolacustrine Samples from the Main Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-6: Water Content against Elevation of Glaciolacustrine Samples from the Main Embankment



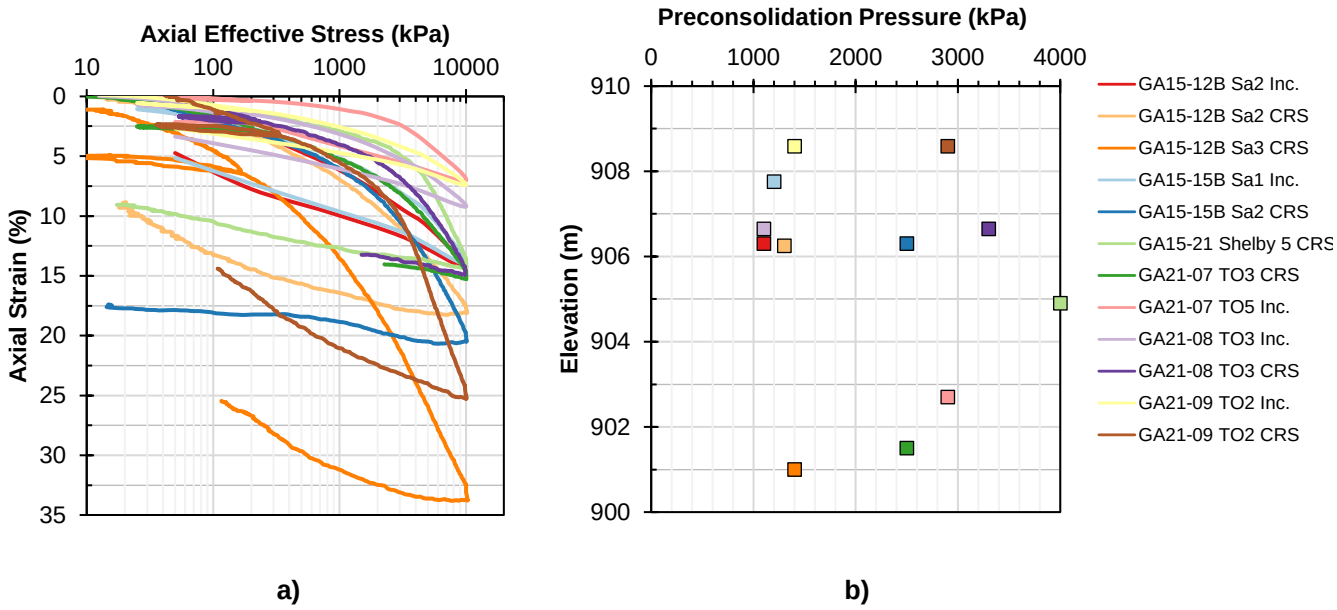
LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-7: Water Content against Clay Content of Glaciolacustrine Samples from the Main Embankment

The results of consolidation tests carried out on sonic drilling and thin-walled tube samples of glaciolacustrine material from the Main Embankment are shown in Table 7-6 and Illustration 7-8a. Illustration 7-8b presents the preconsolidation pressures estimated using the Casagrande method.

Table 7-6: Consolidation Test Results of Glaciolacustrine Samples at the Main Embankment

Borehole No.	Sample No.	Sample Type	Elevation (m)	Estimated Preconsolidation Pressure (kPa)		Source
				Casagrande	Strain Energy	
GA15-12B	2	Sonic core	906.3	1,100	1,200	Golder (2015d)
GA15-12B	2	Sonic core	906.3	1,300	1,500	
GA15-12B	3	Sonic core	901.0	1,400	1,200	
GA15-15B	1	Thin-walled tube	907.8	1,200	1,400	
GA15-15B	2	Thin-walled tube	906.3	2,500	2,700	
GA15-21	5	Thin-walled tube	904.9	4,000	4,000	
GA21-07	TO3	Thin-walled tube	902.7	2,900	3,000	WSP Golder (2022b)
GA21-07	TO5	Thin-walled tube	901.5	2,500	2,600	
GA21-08	TO3	Thin-walled tube	906.6	1,100	1,100	
GA21-08	TO3	Thin-walled tube	906.6	3,300	3,400	
GA21-09	TO2	Thin-walled tube	908.6	1,400	1,300	
GA21-09	TO2	Thin-walled tube	908.6	2,900	2,800	



CRS = constant rate of strain; Inc. = incremental load.

Illustration 7-8: a) Consolidation Test Results on Glaciolacustrine Samples at the Main Embankment and b) Inferred Preconsolidation Pressure from Laboratory and Cone Penetration Test Data

The quality of the samples was assessed using two different methods. Lunne et al. (1997) use the $\Delta e/e_0$ value to evaluate the sample quality, where Δe is the change in sample void ratio caused by reapplying the in situ effective stress (σ_{v0}'), and e_0 is the initial void ratio of the soil. Karlsrud and Hernandez-Martinez (2013) use the M_0/M_L value for sample quality evaluation, where M_0 is the maximum constrained modulus in the overconsolidated stress range and M_L is the minimum constrained modulus after the preconsolidation pressure. Table 7-7 shows the sample quality assessment based on values of $\Delta e/e_0$ and M_0/M_L and Table 7-8 presents the results of the assessment.

Table 7-7: Sample Quality Assessment Criteria

Sample Quality	Lunne et al. (1997)		Karlsrud and Hernandez-Martinez (2013)
	$\Delta e/e_0$ for OCR = 1-2	$\Delta e/e_0$ for OCR = 2-4	
1 – Very good to excellent	<0.04	<0.03	>2.0
2 – Good to fair	0.04–0.07	0.03–0.05	1.5–2.0
3 – Poor	0.07–0.14	0.05–0.10	1.0–1.5
4 – Very poor	>0.14	>0.10	<1.0

e_0 = initial void ratio; Δe = change in sample void ratio caused by reapplying σ_{v0}'; σ_{v0}' = in situ effective stress; OCR = overconsolidation ratio.

Table 7-8: Quality Assessment of Glaciolacustrine Samples from the Main Embankment

Borehole No.	Sample No.	Sample Type	Consolidation Test	Lunne et al. (1997)	Karlsrud and Hernandez-Martinez (2013)
GA15-12B	2	Sonic core	Incremental load	Poor	Very poor
GA15-12B	2	Sonic core	CRS	Very poor	Poor
GA15-12B	3	Sonic core	CRS	Very poor	Very poor
GA15-15B	1	Thin-walled tube	Incremental load	Poor	Very poor
GA15-15B	2	Thin-walled tube	CRS	Good to fair	Poor
GA15-21	5	Thin-walled tube	CRS	Very good to excellent	Good to fair
GA21-07	TO3	Thin-walled tube	CRS	Poor	Poor
GA21-07	TO5	Thin-walled tube	Incremental load	Very good to excellent	Poor
GA21-08	TO3	Thin-walled tube	Incremental load	Good to fair	Very poor
GA21-08	TO3	Thin-walled tube	CRS	Poor	Poor
GA21-09	TO2	Thin-walled tube	Incremental load	Good to fair	Very poor
GA21-09	TO2	Thin-walled tube	CRS	Poor	Good to fair

CRS = constant rate of strain.

The results of the laboratory consolidation tests were compared with the interpreted preconsolidation pressure from CPTs carried out along the Main Embankment. The preconsolidation pressure (σ'_p) from the CPT data was estimated as $\sigma'_p = 0.33 (q_t - \sigma_{vo})$ (Mayne 2001). The comparison is shown in Illustration 7-9. Tests corresponding to very poor quality samples, using either of the two methods, are excluded from the comparison. The CPT data are seen to correlate reasonably well with the laboratory consolidation tests and provide a degree of confidence in the CPT interpreted preconsolidation pressure.

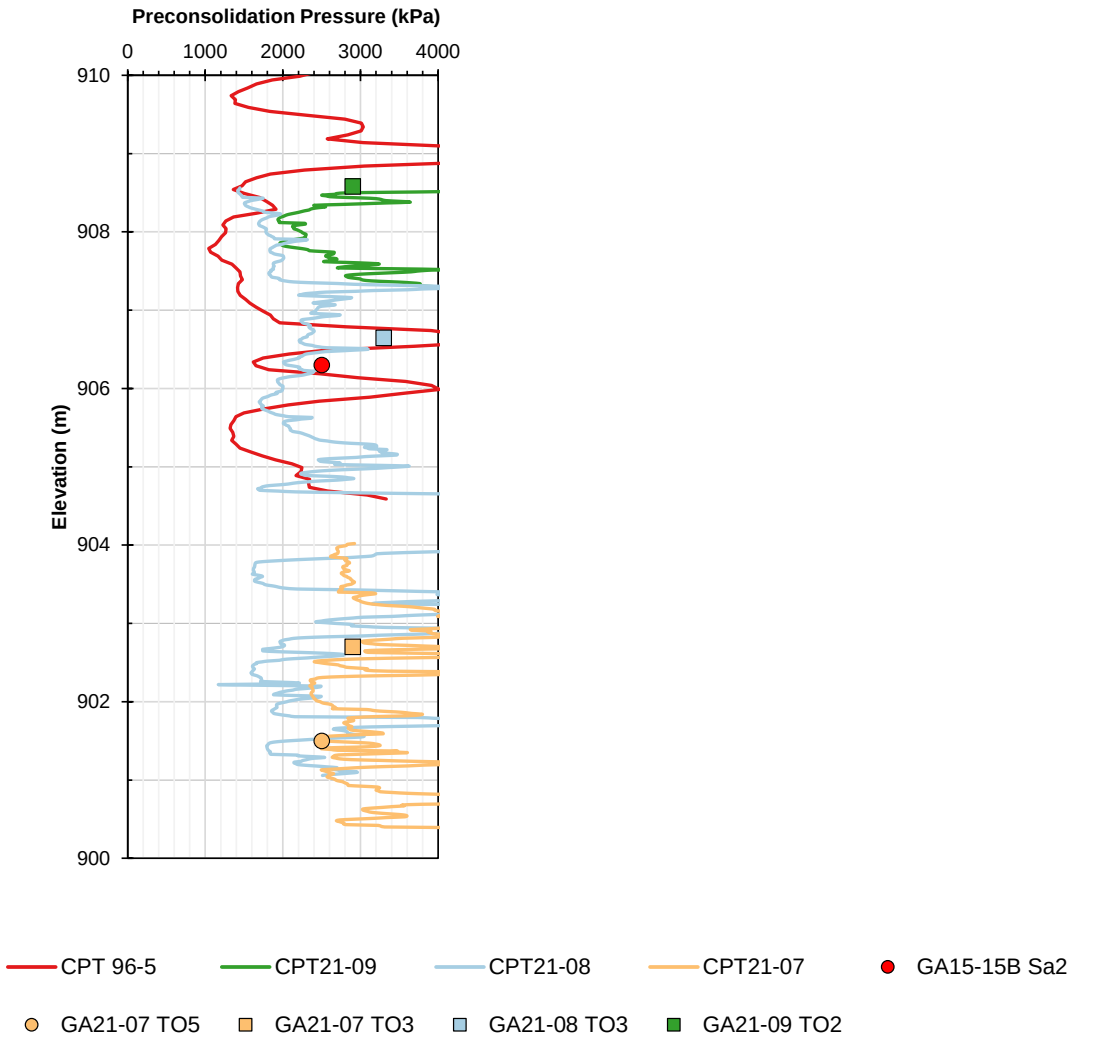


Illustration 7-9: Preconsolidation Pressure Comparison between Laboratory and Cone Penetration Test Data

The interpretations of CPTs from 1996 are presented in Golder (2015e). The interpretations of CPTs from 2021 are presented in APPENDIX E. Illustration 7-10a presents the preconsolidation pressure interpreted from all CPT data obtained at the elevation of the semi-continuous layer of glaciolacustrine soil (typically between approximate elevation 900 and 910 m). The interpreted preconsolidation pressure is generally greater than 1,200 kPa. A few points have a preconsolidation pressure between 1,000 and 1,200 kPa, as can be seen at an elevation of about 917 m for sounding PRW96-1, just below elevation 915 m for CPT96-1, and just below elevation 908 m for CPT96-5.

As shown in Illustration 7-10b, the preconsolidation pressure interpreted from CPT21-07 data near elevation 922 m (higher elevation glaciolacustrine deposit present between approximate Station 2+400 and 2+750) is greater than 850 kPa.

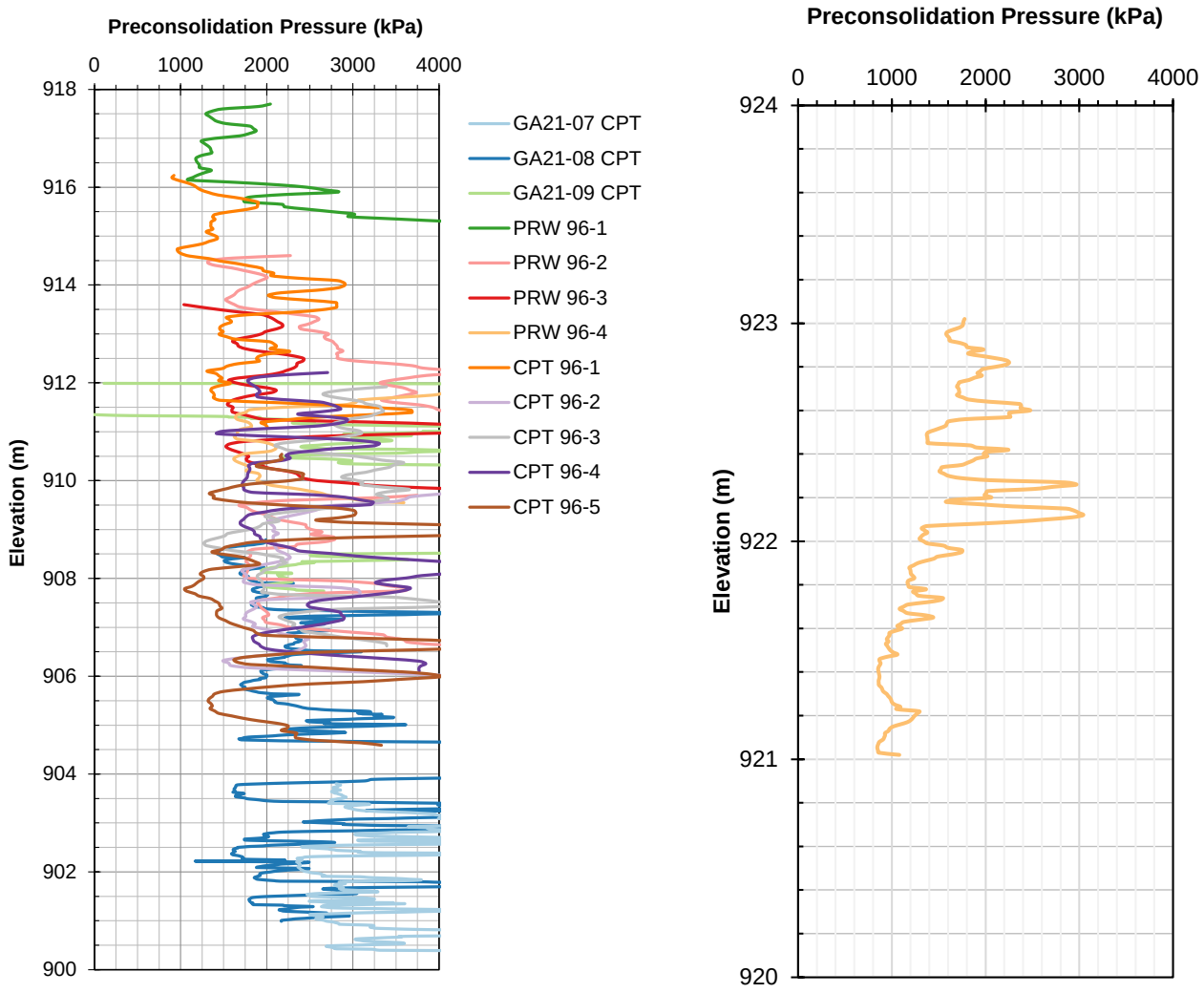


Illustration 7-10: a) Inferred Preconsolidation pressure from Main Embankment Cone Penetration Test Data between Elev. 900 and 918 m and b) Inferred Preconsolidation pressure from Main Embankment CPT21-07 Data between Elev. 921 and 923 m.

The undrained shear strength was measured in the laboratory with simple shear tests on glaciolacustrine soil samples from the Main Embankment (Golder 2015d; WSP Golder 2022b). A summary of the simple shear test results is presented in Table 7-9. The overconsolidation ratio (OCR) is presented for samples consolidated in the laboratory beyond the estimated preconsolidation pressure of the sample prior to shearing.

Table 7-9: Simple Shear Test Results of Glaciolacustrine Samples at the Main Embankment

Borehole No.	Sample No.	Sample Type	Initial Water Content (%)	Plasticity Index	Initial Vertical Effective Stress (kPa)	OCR	Maximum Undrained Shear Strength Ratio	Undrained Shear Strength Ratio at 20% Strain
GA15-12B	2	Sonic core	23.0	17	300	n/a	0.50	0.48
			22.5		900	n/a	0.32	0.30
			18.0		1,200	n/a	0.39	0.39
			18.1		1,200	n/a	0.36	n/a
GA15-12B	3	Sonic core	29.6	22	300	n/a	0.28	0.28
			38.9	n/a	900	n/a	0.26	0.23
			37.5	n/a	1,200	n/a	0.24	0.22
			27.4	n/a	300	4.0	0.71	n/a
GA15-15B	2	Thin-walled tube	30.1	27	300	n/a	0.41	0.40
			29.2	24	600	n/a	0.37	0.33
	1	Thin-walled tube	27.8	19	2,500	n/a	0.27	0.22
			24.8	17	300	8.3	0.99	0.84
GA15-21	5	Thin-walled tube	23.8	19	400	n/a	0.62	n/a
			30.9	22	800	n/a	0.32	n/a
			26.4	19	2,000	n/a	0.23	n/a
GA21-07	TO3	Thin-walled tube	22.5	19	500	4.8	0.68	0.55
			24.8	n/a	1,200	2.0	0.37	0.21
			27.9	n/a	2,400	1.0	0.23	0.17
GA21-08	TO3	Thin-walled tube	25.4	20	500	4.8	0.69	0.66
			26.7	n/a	1,200	2.0	0.40	0.37
			26.1	n/a	2,400	1.0	0.23	0.19
	TO5	Thin-walled tube	26.7	21	300	8.0	0.74	0.63

n/a = not applicable, not available

OCR = overconsolidation ratio.

Illustration 7-11a presents the undrained shear strength ratio function obtained following the SHANSEP (Stress History and Normalized Soil Engineering Properties) method (Ladd and Foot 1974). The results of the tests completed on samples collected from the Perimeter Embankment (Table 7-13 in Section 7.3.2) are also included in the illustration. The samples used to determine the SHANSEP parameters were reconsolidated to a vertical effective stress of 2,400 kPa and then the stresses were reduced to achieve the desired OCR before shearing them. Illustration 7-11b shows the undrained shear strength ratio function corresponding to a preconsolidation pressure of 1,200 kPa and compares it with results of simple shear tests carried out on specimens that were directly reconsolidated to different effective vertical stresses.

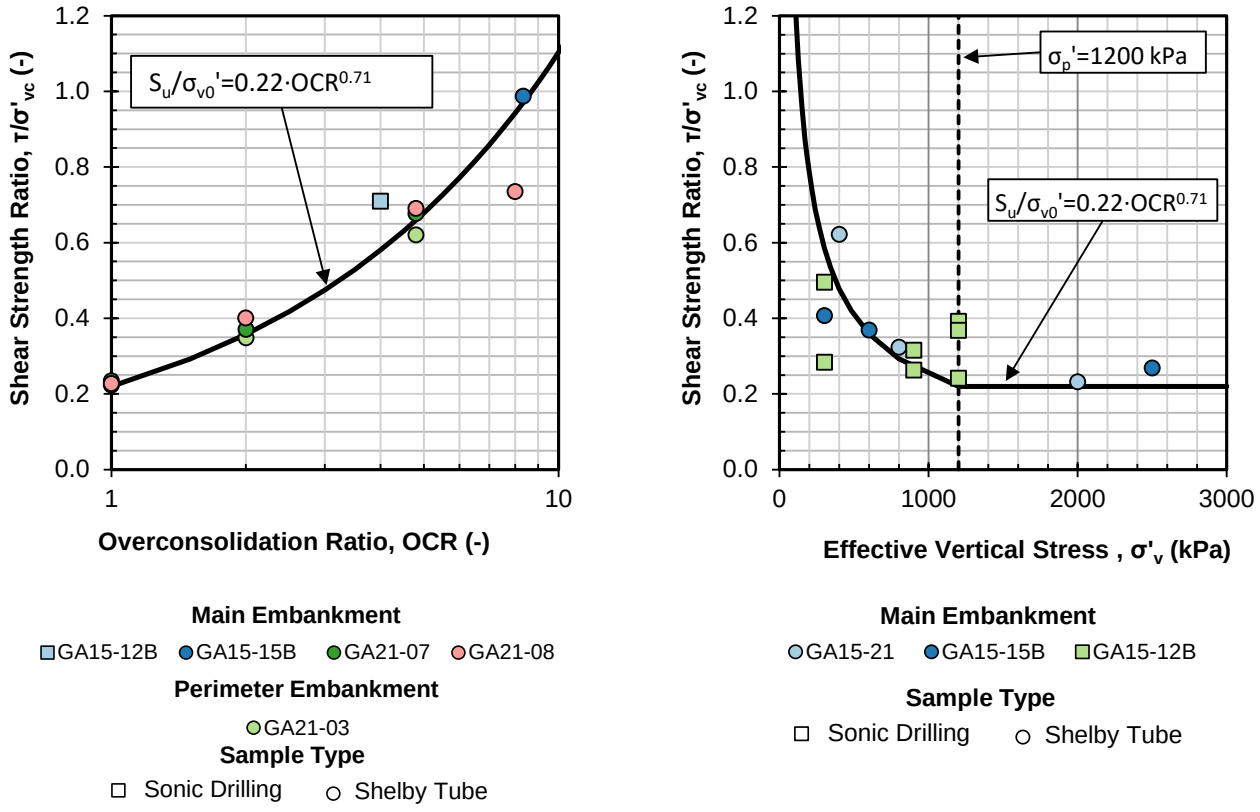


Illustration 7-11: Simple Shear Test Results on Glaciolacustrine Material at the Main Embankment and Perimeter Embankment a) Undrained Shear Strength Ratio Function Estimated Following the SHANSEP Method and b) Undrained Shear Strength Ratio Function for a Preconsolidation Pressure of 1,200 kPa

Undrained shear strength profiles were inferred using the data from CPTs carried out in 1996 and 2021 assuming an average N_{kt} factor of 15. The interpretations of CPTs from 1996 are presented in Golder (2015e). The interpretation of CPTs carried out in 2021 is presented in APPENDIX E. The undrained shear strength profiles show a strength greater than that calculated using the SHANSEP model with a preconsolidation value of 1,200 kPa. The sensitivity interpreted from the CPT data generally ranges between 2 and 3.

The effective friction angle of undisturbed glaciolacustrine samples from the Main Embankment was measured in direct shear tests and triaxial tests.

Direct shear tests were conducted on a sample collected downstream of the Main Embankment, adjacent to the Seepage Collection Pond, at a depth of 2.5 to 3.0 m (KP 2007b). No index properties were available for this sample. The peak friction angle was 26 degrees, and the residual friction angle was 23 degrees (with zero cohesion).

Triaxial tests were conducted on a reconstituted sample from the foundation of the Main Embankment (KP 1995a). The sample had a water content of 28.5% and contained 40% sand and 46% silt size particles. The peak friction angle was 33 degrees, assuming zero cohesion.

The undrained cyclic strength of undisturbed glaciolacustrine samples from the Main Embankment were measured in cyclic direct simple shear tests (WSP Golder 2022b). Illustration 7-12 shows the test results in terms of the cyclic strength ratio (CSR) required to generate single-amplitude shear strains of 3% during uniform cyclic loading.

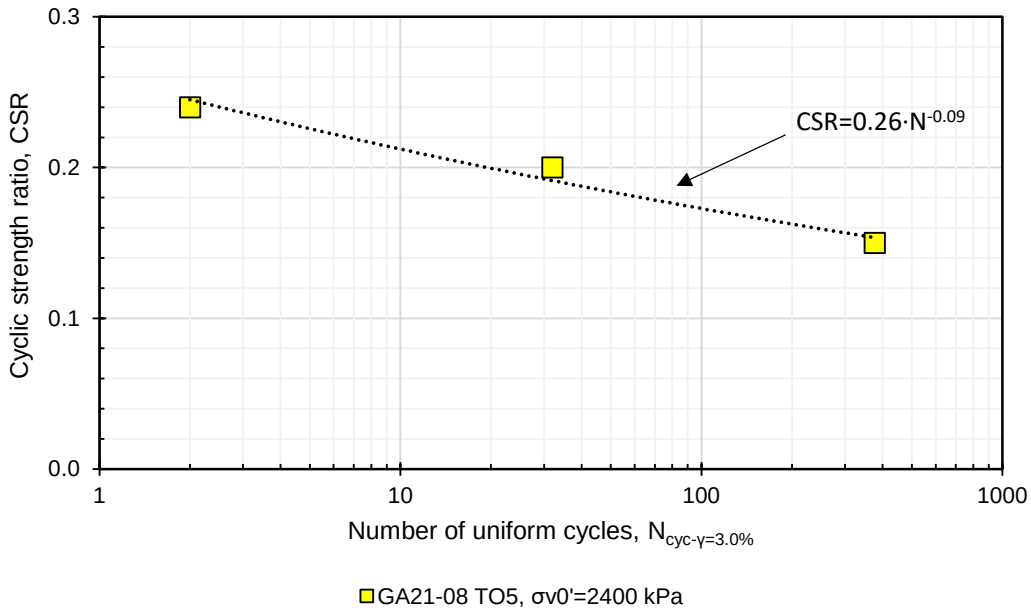


Illustration 7-12: Cyclic Strength Ratio Required to Cause Cyclic Failure (3% Strain) Versus the Number of Uniform Loading Cycles for the Glaciolacustrine at the Main Embankment.

7.3.2 Perimeter Embankment

A summary of the index properties for samples of glaciolacustrine material collected from the foundation of the Perimeter Embankment is presented in Table 7-10.

The Atterberg limit results are shown graphically in Illustration 7-13. The fines are generally a low to intermediate plastic material and range from silt to silty clay (ML to CI, respectively). Six results were outside of this general range and were either a non-plastic silt (ML) or a high plastic clay (CH).

The natural water content results were plotted against elevation, which is shown in Illustration 7-14. The average water content of the glaciolacustrine samples from the Perimeter Embankment was approximately 21% and ranged from 9% to 37%.

The natural water content results were also plotted against clay content as shown in Illustration 7-15. A total of 22 hydrometer test results were available for glaciolacustrine samples from the Perimeter Embankment foundation. The average clay content of the glaciolacustrine samples was approximately 29% and ranged from 7% to 71%. A general trend of increasing water content with increasing clay content can be seen in the illustration.

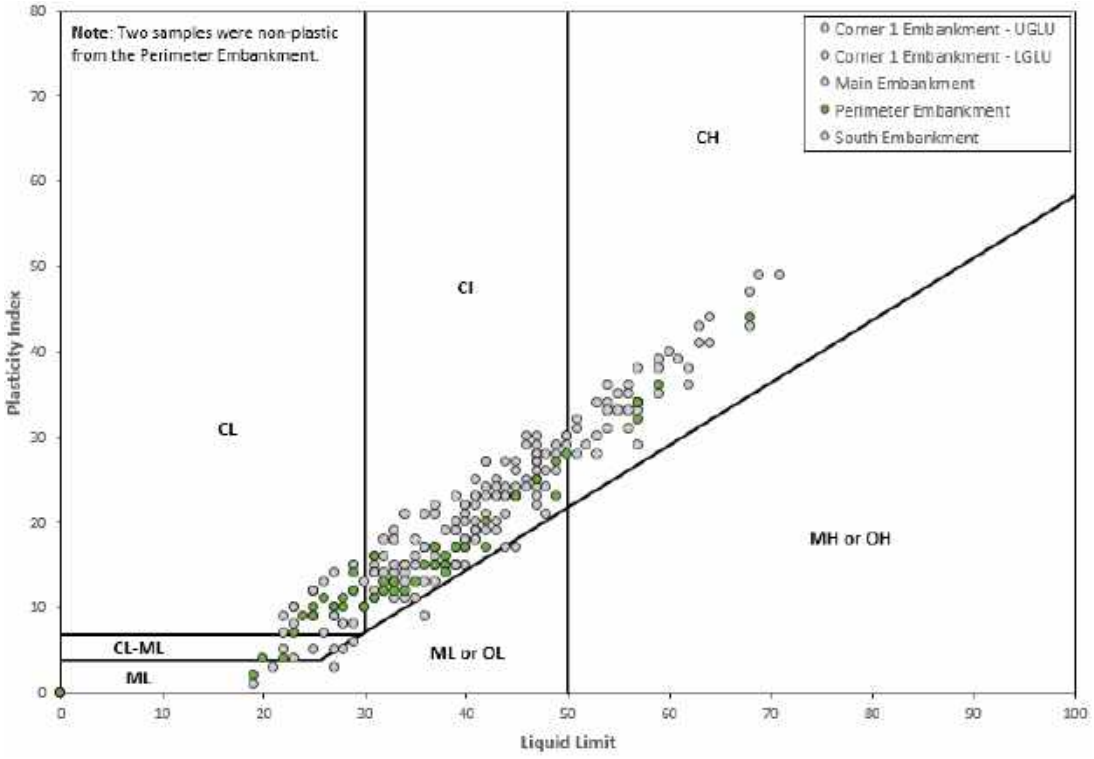
All available test results for glaciolacustrine samples collected from the foundation of the other embankments were incorporated into the illustrations for a comparison.

Table 7-10: Summary of Index Properties of Glaciolacustrine at the Perimeter Embankment

Index Property		Average	Minimum	Maximum	Number of Tests
Gradation	Gravel (%)	1	0	7	37
	Sand (%)	9	0	36	
	Fines (%)	90	60	100	
	Silt (%)	63	29	81	22
	Clay[a] (%)	29	7	71	
Liquid limit[b]		36	19	68	43
Plastic limit[b]		20	15	26	
Plasticity index[b]		16	2	44	
Water content (%)		21.4	9.2	36.8	113

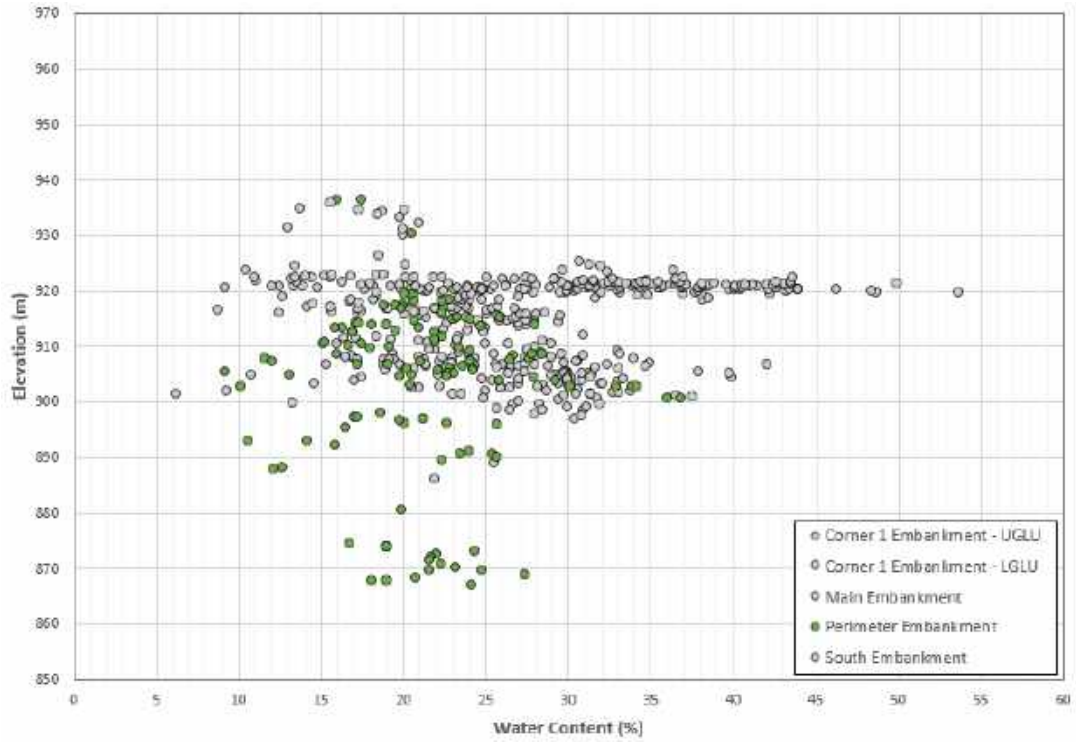
a) Clay is defined as particles smaller than 0.002 mm.

b) Atterberg limits exclude two non-plastic samples from the Perimeter Embankment.



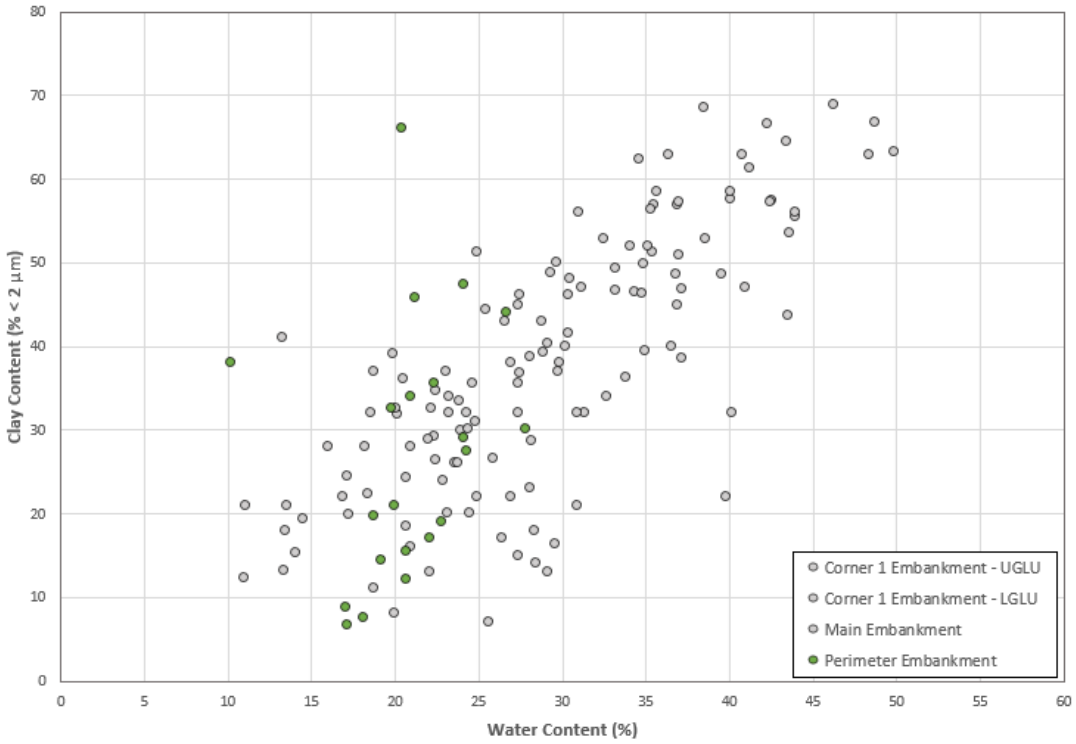
CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-13: Plasticity Chart of Glaciolacustrine Samples from the Perimeter Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-14: Water Content against Elevation of Glaciolacustrine Samples from the Perimeter Embankment



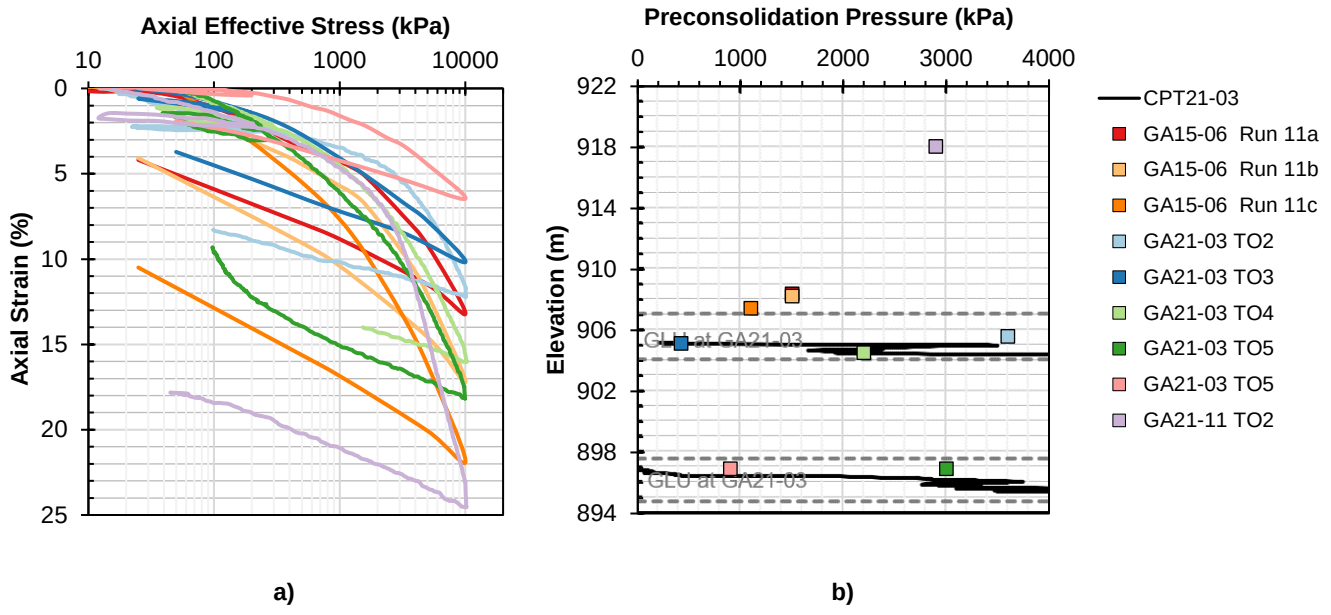
LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-15: Water Content against Clay Content of Glaciolacustrine Samples from the Perimeter Embankment

Table 7-11 and Illustration 7-16a show the results of consolidation tests carried out on sonic drilling and thin walled-tube samples of glaciolacustrine soil from the Perimeter Embankment. Illustration 7-16b presents the preconsolidation pressures estimated using the Casagrande method and compares them with the interpreted preconsolidation pressure from CPT21-03 carried out in the Perimeter Embankment. The preconsolidation pressure (σ'_p) from the CPT data was estimated as $\sigma'_p = 0.33 (q_t - \sigma_{vo})$ (Mayne 2001) and is generally greater than 1,500 kPa after the initial push of the cone. The interpretations of CPTs carried out in 2021 are presented in APPENDIX E.

Table 7-11: Consolidation Test Results of Glaciolacustrine Samples at the Perimeter Embankment

Borehole No.	Sample No.	Sample Type	Elevation (m)	Estimated Preconsolidation Pressure (kPa)		Source
				Casagrande	Strain Energy	
GA15-06	Run 11a	Sonic core	908.4	1,500	1,500	Golder (2015d)
GA15-06	Run 11b	Sonic core	908.3	1,500	1,500	
GA15-06	Run 11c	Sonic core	907.5	1,100	1,200	
GA21-03	TO2	Thin-walled tube	905.6	3,600	3,800	WSP Golder (2022b)
GA21-03	TO3	Thin-walled tube	905.2	420	480	
GA21-03	TO4	Thin-walled tube	904.6	2,200	2,500	
GA21-03	TO5	Thin-walled tube	896.9	3,000	3,100	
GA21-03	TO5	Thin-walled tube	896.9	900	900	
GA21-11	TO2	Thin-walled tube	918.1	2,900	2,700	



GLU = glaciolacustrine unit.

Illustration 7-16: a) Consolidation Test Results on Glaciolacustrine Samples at the Perimeter Embankment and b) Inferred Preconsolidation Pressure from Laboratory and Cone Penetration Test Data

The quality of the samples was assessed using the methods proposed by Lunne et al. (1997) and Karlsrud and Hernandez-Martinez (2013). A description of both methods is presented in Section 7.3.1. The results of the assessment are summarized in Table 7-12.

Table 7-12: Quality Assessment of Glaciolacustrine Samples from the Perimeter Embankment

Borehole No.	Sample No.	Sample Type	Consolidation Test	Lunne et al. (1997)	Karlsrud and Hernandez-Martinez (2013)
GA15-06	Run 11a	Sonic core	Incremental	Poor	Poor
GA15-06	Run 11b	Sonic core	Incremental	Very poor	Poor
GA15-06	Run 11c	Sonic core	Incremental	Very poor	Very poor
GA21-03	TO2	Thin-walled tube	CRS	Poor	Good to fair
GA21-03	TO3	Thin-walled tube	Incremental	Good to fair	Very poor
GA21-03	TO4	Thin-walled tube	CRS	Very poor	Poor
GA21-03	TO5	Thin-walled tube	CRS	Good to fair	Poor
GA21-03	TO5	Thin-walled tube	Incremental	Very good to excellent	Poor
GA21-11	TO2	Thin-walled tube	CRS	Very good to excellent	Very good to excellent

CRS = constant rate of strain.

The peak undrained shear strength was measured in the laboratory with simple shear tests on glaciolacustrine soil samples from the Main Embankment and Perimeter Embankment (Golder 2015d; WSP Golder 2022b). A single undrained shear strength ratio function was obtained following the SHANSEP method, as shown in Illustration 7-11. A summary of the simple shear test results from the Perimeter Embankment is presented in Table 7-13.

Table 7-13: Simple Shear Test Results of Glaciolacustrine Samples at the Perimeter Embankment

Borehole No.	Sample No.	Sample Type	Initial Water Content (%)	Plasticity Index	Initial Vertical Effective Stress (kPa)	OCR	Maximum Undrained Shear Strength Ratio	Undrained Shear Strength Ratio at 20% Strain
GA21-03	TO4	Thin-walled tube	21.3	15	500	4.8	0.62	0.56
			19.8	n/a	1,200	2.0	0.35	0.34
GA21-03	TO5	Thin-walled tube	23.3	28	2,400	1.0	0.22	0.19

OCR = overconsolidation ratio.

7.3.3 Corner 1 Embankment

Upper and lower glaciolacustrine soil deposits are present at the Corner 1 Embankment. The upper glaciolacustrine unit (UGLU) was identified as the soil layer through which the 2014 undrained failure developed and was the focus of the subsequent forensic investigations (IEEIRP 2015; KCB 2015b,c). As such, the characterization of the UGLU is presented in more detail than for the other soil units.

7.3.3.1 Upper Glaciolacustrine Unit

The UGLU generally consists of intermediate silty clay to high plasticity clay with trace to some sand and is firm to stiff. The UGLU deposit is a semi-continuous layer between about elevation 918 and 925 m from approximately Station 20+000 to 20+300. The maximum thickness of the UGLU within the breach area at Corner 1 is about 3 m as indicated from the forensic investigation carried out by the Independent Expert Engineering Investigation and Review Panel (IEEIRP 2015). The foundation investigation completed in 2016 also confirmed that the UGLU extended downstream of the breach area (Golder 2017). A summary of the index properties for samples of the UGLU collected from the Corner 1 Embankment is presented in Table 7-14.

The Atterberg limit results are shown graphically in Illustration 7-17. The fines are generally an intermediate to high plasticity material and range from silty clay to clay (CI to CH, respectively). Six results were outside of this general range and were either a low plasticity silt (ML) or a low plasticity silty clay (CL).

The natural water content results were plotted against elevation, which is shown in Illustration 7-18. The average water content of the UGLU is approximately 31% and ranges from 9% to 54%. The water content of the UGLU is generally much greater compared to the glaciolacustrine material encountered at the other embankments as shown in the illustration. The illustration also shows a relatively consistent layer of UGLU material from approximate elevation 918 to 925 m.

The natural water content results were also plotted against clay content as shown in Illustration 7-19. A total of 70 hydrometer test results were available for the UGLU sampled from the foundation of the Corner 1 Embankment. The average clay content of the UGLU is approximately 46% and ranges from 8% to 69%.

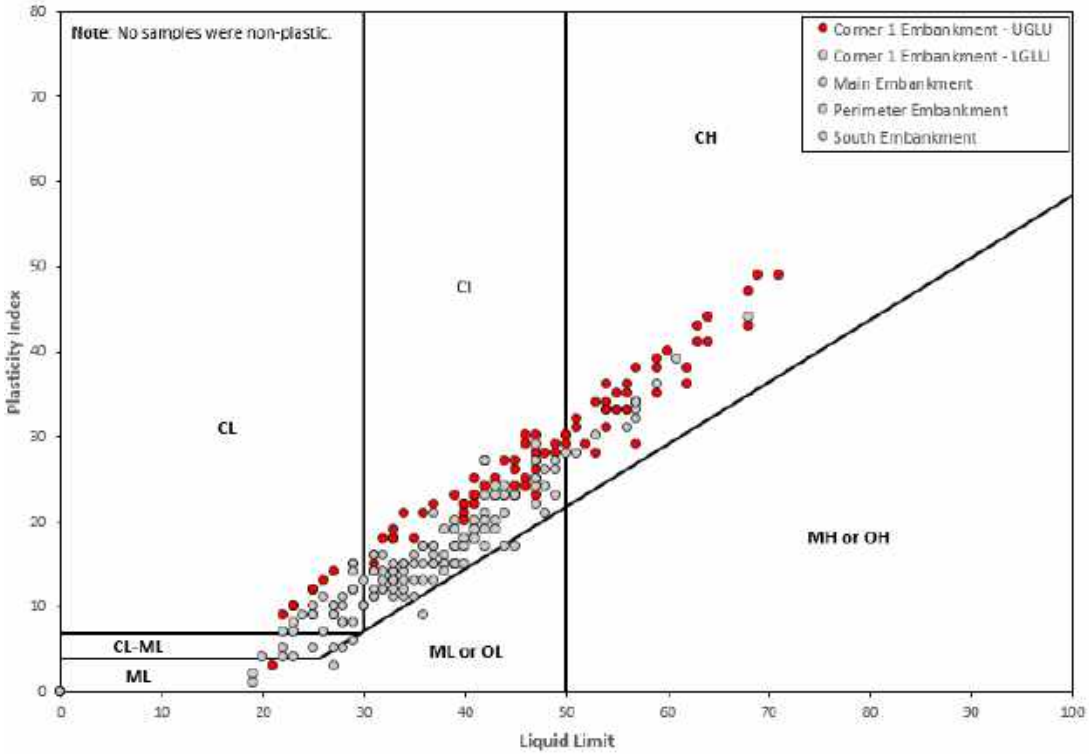
The clay content of the UGLU is generally much greater compared to the glaciolacustrine material encountered at the other embankments as shown in the illustration. A general trend of increasing water content with increasing clay content can also be seen in the illustration.

All available test results for glaciolacustrine samples collected from the foundation of the other embankments were incorporated into the illustrations for a comparison.

Table 7-14: Summary of Index Properties of Upper Glaciolacustrine Unit

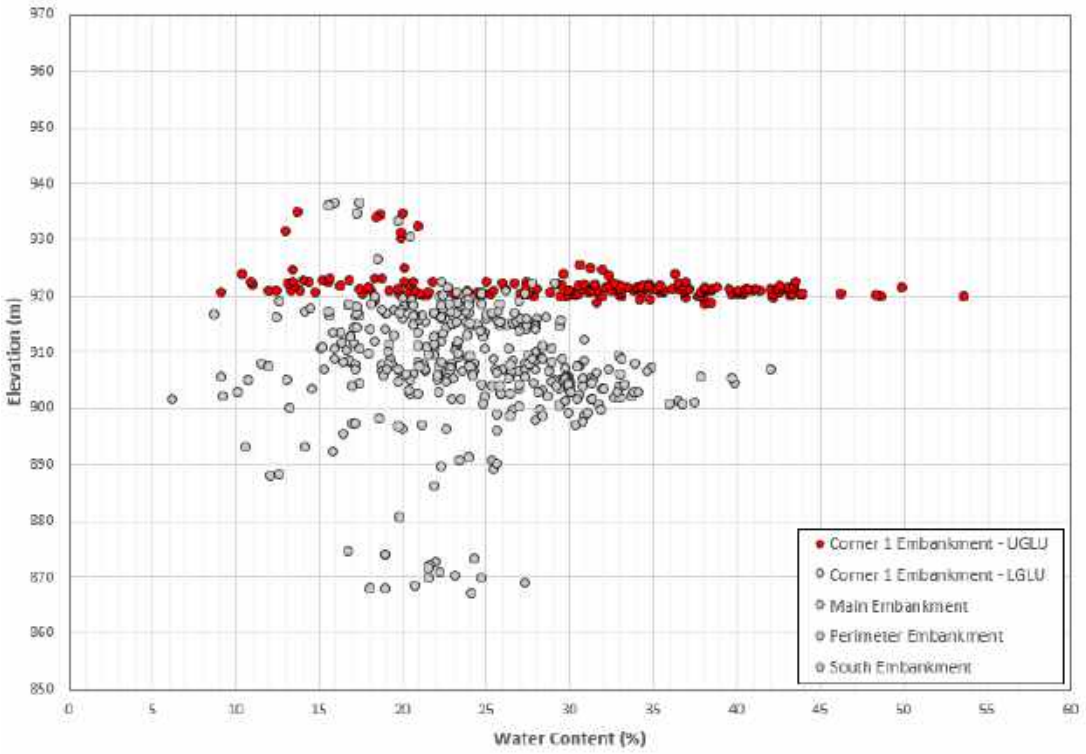
Index Property		Average	Minimum	Maximum	Number of Tests
Gradation	Gravel (%)	3	0	32	72
	Sand (%)	9	0	35	
	Fines (%)	88	43	100	
	Silt (%)	42	20	72	70
	Clay[(a)] (%)	46	8	69	
Liquid limit		46	21	71	96
Plastic limit		19	13	28	
Plasticity index		27	3	49	
Water content (%)		30.5	9.2	53.7	189
Specific gravity of solids		2.80	2.75	2.87	12

a) Clay is defined as particles smaller than 0.002 mm.



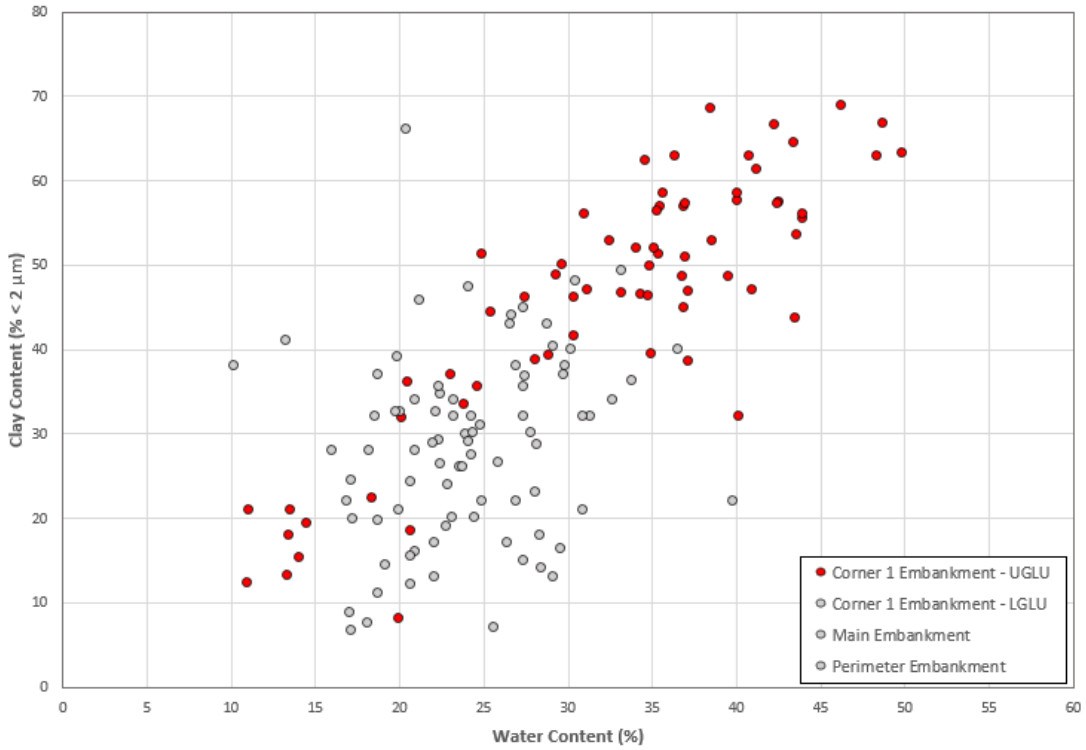
CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-17: Plasticity Chart of Upper Glaciolacustrine Unit Samples from the Corner 1 Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-18: Water Content against Elevation of Upper Glaciolacustrine Unit Samples from the Corner 1 Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-19: Water Content against Clay Content of Upper Glaciolacustrine Unit Samples from the Corner 1 Embankment

Table 7-15 and Illustration 7-20 show the results of consolidation tests carried out on the UGLU samples. The results show that the UGLU has a preconsolidation pressure, σ'_p, of about 400 kPa. Estimated hydraulic conductivity from consolidation tests was about 5×10^{-10} m/s for stresses between 100 and 800 kPa, and a coefficient of consolidation (c_v) of about 5×10^{-7} m^2/s. The coefficient of consolidation estimated from pore pressure response in the field following rockfill placement (using piezometer VST14-03) was 6×10^{-7} m^2/s.

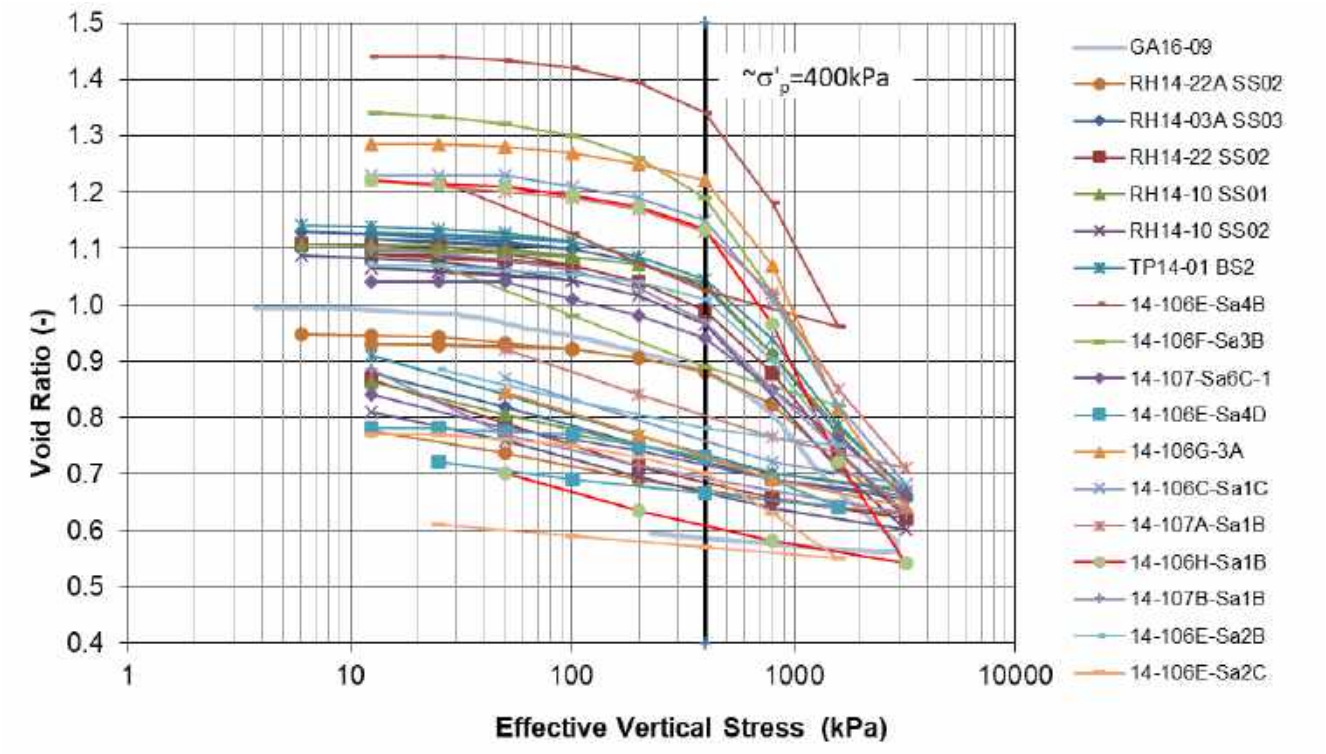
Table 7-15: Consolidation Test Results of Upper Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Sample Type	Elevation (m)	Estimated Preconsolidation Pressure (kPa)	Source
MR14-106C	1C	Thin-walled tube	920.9	454	IEEIRP (2015)
MR14-106E	2B	Thin-walled tube	921.1	474	
MR14-106E	2C	Thin-walled tube	920.8	300	
MR14-106E	4B	Thin-walled tube	920.0	535	
MR14-106E	4D	Thin-walled tube	919.8	446	
MR14-106F	3B	Thin-walled tube	920.2	443	
MR14-106G	3A	Thin-walled tube	920.4	510	
MR14-106H	1B	Thin-walled tube	921.1	449	
MR14-107	6C-1	Thin-walled tube	921.6	330	
MR14-107A	1B	Thin-walled tube	921.0	516	
MR14-107B	1B	Thin-walled tube	921.5	312	

Table 7-15: Consolidation Test Results of Upper Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Sample Type	Elevation (m)	Estimated Preconsolidation Pressure (kPa)	Source
RH14-03A	SS-03	Thin-walled tube	920.4	390	KCB (2015b)
RH14-10	SS-01	Thin-walled tube	920.8	380	
RH14-10	SS-02	Thin-walled tube	920.2	380	
RH14-22	SS-02	Thin-walled tube	920.5	400	
RH14-22A	SS-02	Thin-walled tube	920.5	420	
TP14-01	BS-02	Block	n/a	410	
GA16-09	6B	Thin-walled tube	920.2	590	Golder (2017)

n/a = not available.



σ'_p = preconsolidation pressure.

Illustration 7-20: Consolidation Test Results on Upper Glaciolacustrine Unit Samples

The quality of the samples was assessed using the methods proposed by Lunne et al. (1997) and Karlsrud and Hernandez-Martinez (2013). A description of both methods is presented in Section 7.3.1. The results of the assessment are summarized in Table 7-16.

Table 7-16: Quality Assessment of Upper Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Sample Type	Consolidation Test	Lunne et al. (1997)	Karlsrud and Hernandez-Martinez (2013)
MR14-106C	1C	Thin-walled tube	Incremental	Very good to excellent	Good to fair
MR14-106E	2B	Thin-walled tube	Incremental	Very good to excellent	Very good to excellent
MR14-106E	2C	Thin-walled tube	Incremental	Good to fair	Very poor
MR14-106E	4B	Thin-walled tube	Incremental	Very good to excellent	Very good to excellent
MR14-106E	4D	Thin-walled tube	Incremental	Good to fair	Poor
MR14-106F	3B	Thin-walled tube	Incremental	Good to fair	Poor
MR14-106G	3A	Thin-walled tube	Incremental	Very good to excellent	Very good to excellent
MR14-106H	1B	Thin-walled tube	Incremental	Very good to excellent	Very good to excellent
MR14-107	6C-1	Thin-walled tube	Incremental	Poor	Very poor
MR14-107A	1B	Thin-walled tube	Incremental	Very good to excellent	Poor
MR14-107B	1B	Thin-walled tube	Incremental	Poor	Poor
RH14-03A	SS-03	Thin-walled tube	Incremental	Good to fair	Poor
RH14-10	SS-01	Thin-walled tube	Incremental	Very good to excellent	Very good to excellent
RH14-10	SS-02	Thin-walled tube	Incremental	Good to fair	Poor
RH14-22	SS-02	Thin-walled tube	Incremental	Poor	Poor
RH14-22A	SS-02	Thin-walled tube	Incremental	Good to fair	Poor
TP14-01	BS-02	Block	Incremental	Very good to excellent	Poor
GA16-09	6B	Thin-walled tube	CRS	Poor	Very good to excellent

CRS = constant rate of strain.

The peak undrained shear strength of UGLU samples were measured in the laboratory with simple shear tests. A summary of the simple shear test results is presented in Table 7-17.

Table 7-17: Simple Shear Test Results of Upper Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Initial Water Content (%)	Plasticity Index	Initial Vertical Effective Stress (kPa)	Static Bias (kPa)	OCR	Maximum Undrained Shear Strength Ratio	Undrained Shear Strength Ratio at 20% Strain
MR14-106A	1C-T1	43.1	31	600	n/a	1.0	0.22	0.18
MR14-106A	1C-T2	36.6	31	600	60	1.0	0.23	n/a
MR14-106A	1C-T3	38.2	31	600	120	1.0	0.26	0.22
MR14-106A	1C-T4	33.1	31	300	60	1.47	0.28	0.25
MR14-106C	1B-T2	43.2	33	600	150	1.0	0.27	0.15
MR14-106C	1B-T3	38.9	33	600	60	1.0	0.21	0.17
MR14-106G	2B-T1	43.5	21	600	60	1.0	0.21	0.17
MR14-106G	B-T2	38.3	21	600	120	1.0	0.26	0.22
MR14-107	6C-T1	43.5	23	300	30	1.1	0.27	0.22

Table 7-17: Simple Shear Test Results of Upper Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Initial Water Content (%)	Plasticity Index	Initial Vertical Effective Stress (kPa)	Static Bias (kPa)	OCR	Maximum Undrained Shear Strength Ratio	Undrained Shear Strength Ratio at 20% Strain
MR14-107	6C-T2	42.6	23	300	30	1.1	0.25	0.20
MR14-107A	1A-T1	42.7	34	600	n/a	1.0	0.21	0.15
MR14-107A	1A-T2	42.1	34	600	n/a	1.0	0.20	0.18
SH14-10A	6	34.9	28	400	n/a	n/a	0.26	0.22
RH14-03A	SS-03	40.2	16	400	n/a	n/a	0.24	0.17
RH14-10	SS-01	37.2	23	400	n/a	n/a	0.23	0.16
RH14-10	SS-01	39.9	23	800	n/a	n/a	0.18	0.17
RH14-10	SS-02	36.1	35	800	n/a	n/a	0.20	0.18
RH14-10	SS-02	28.3	35	400	n/a	n/a	0.26	0.19
RH14-10	SS-02	40.3	35	100	n/a	4.0	0.66	0.53
RH14-22	SS-02	37.7	24	400	n/a	n/a	0.25	0.18
RH14-22	SS-02	40.5	24	100	n/a	4.0	0.63	0.52
RH14-22A	SS-02	36.3	30	800	n/a	n/a	0.18	0.17
RH14-22A	SS-02	39.4	30	400	n/a	n/a	0.26	0.20
RH14-22A	SS-02	35.5	30	100	n/a	4.0	0.60	0.51
TP14-01	BS-02	38.9	22	100	n/a	4.0	0.61	0.60
TP14-01	BS-02	34.5	22	400	n/a	n/a	0.26	0.17
TP14-01	BS-02	36.5	22	800	n/a	n/a	0.20	0.16

n/a = not available, not applicable.

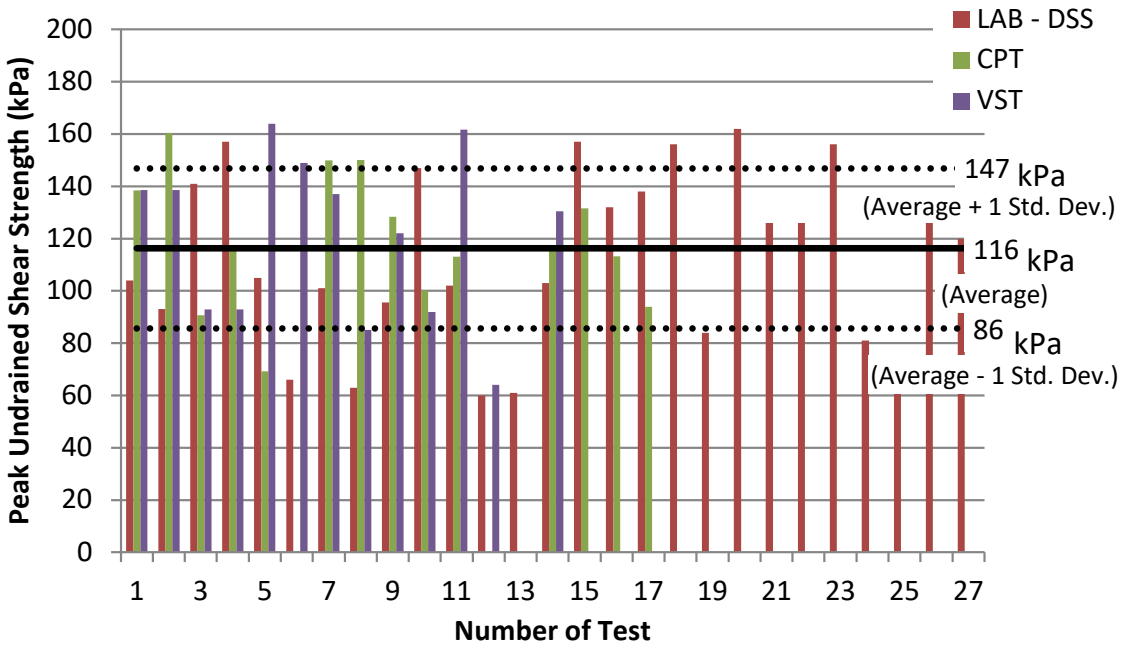
OCR = overconsolidation ratio.

The peak undrained shear strength and remoulded (residual) undrained shear strength were measured with an electronic field vane during the forensic investigations (IEEIRP 2015; KCB 2015c). The peak and remolded undrained shear strengths were also estimated from CPT data collected during the forensic investigations. The sensitivity of the UGLU was inferred to be about 2 to 3 based on average CPT tip resistance within and outside of the breach area (IEEIRP 2015). The undrained shear strength, s_u, was estimated using the cone tip resistance, q_t, total overburden stress, σ'_{v0}, and bearing factor, N_{kt}, as follows:

$$s_u = \frac{q_t - \sigma_{v0}}{N_{kt}}$$

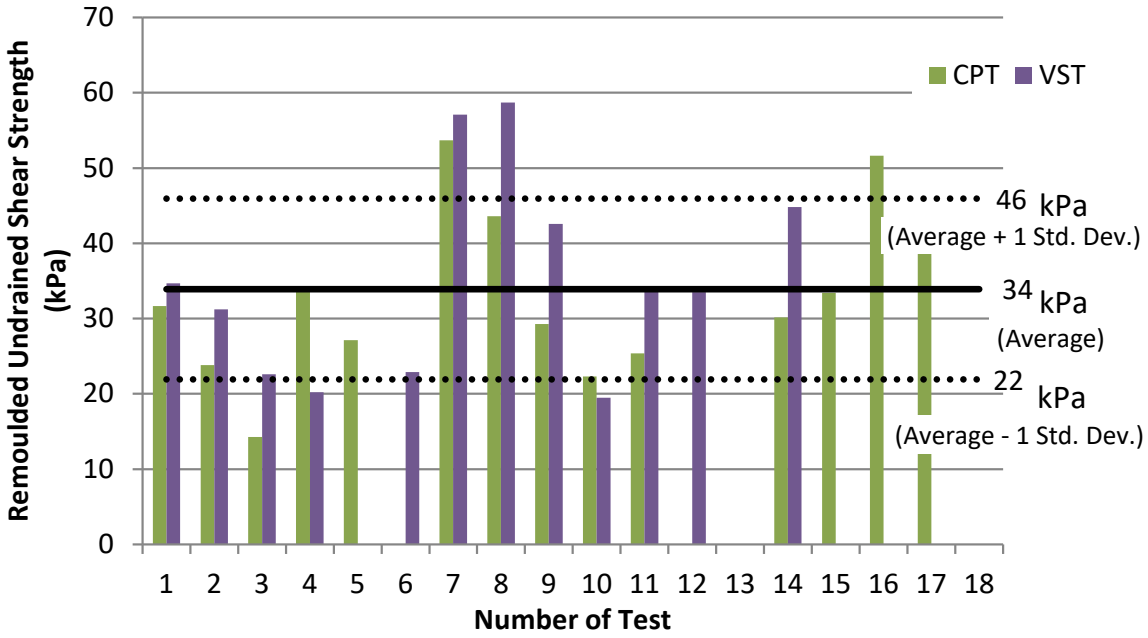
A value N_{kt} of 15 was used. The remoulded shear strength, s_{u_r}, was estimated directly from the sleeve friction resistance, f_s.

Illustration 7-21 and Illustration 7-22 show the average values and standard deviation for the peak and remoulded undrained shear strengths, respectively, estimated for the UGLU. The peak shear strength includes values estimated from the field vane test, CPTs, and simple shear tests. The remoulded undrained shear strength includes values from the field vane tests and CPTs.



LAB - DSS = direct simple shear; CPT = cone penetration test; VST = vane shear test.

Illustration 7-21: Peak Undrained Shear Strength Estimated for the Upper Glaciolacustrine Unit

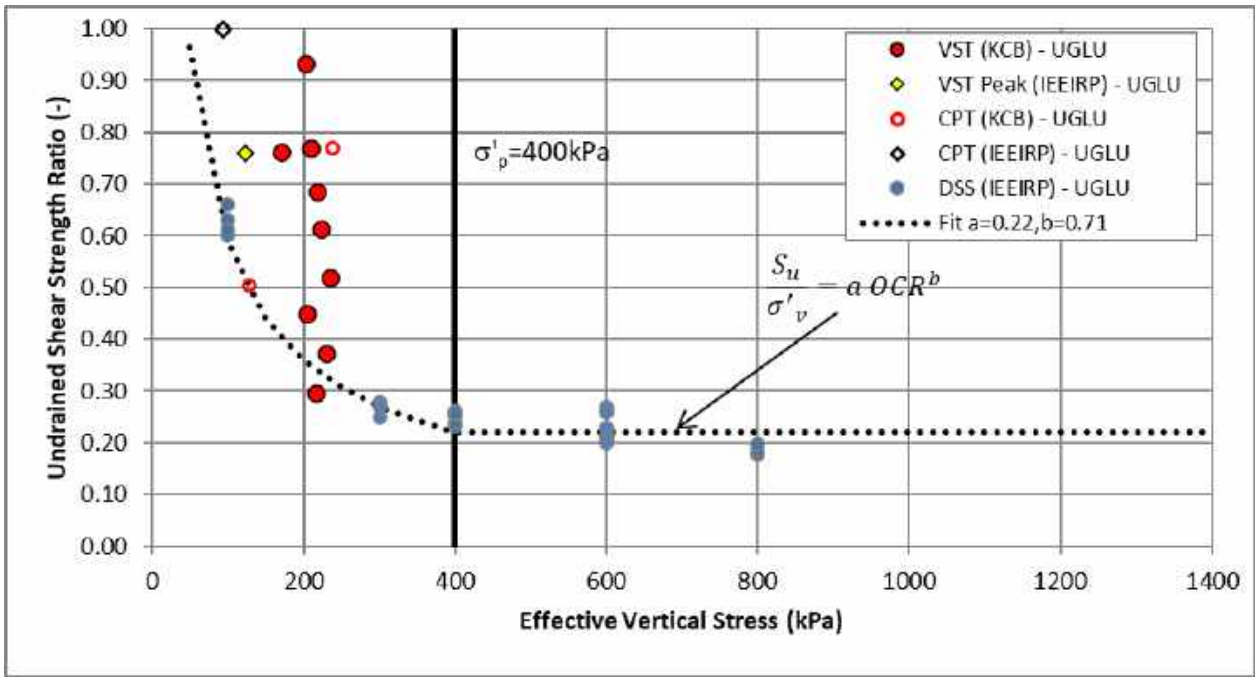


CPT = cone penetration test; VST = vane shear test.

Illustration 7-22: Remoulded Undrained Shear Strength Estimated for the Upper Glaciolacustrine Unit

The peak and remolded undrained shear strengths were also estimated using CPT data collected during the foundation investigation in 2016 downstream of the zone of the breach (Golder 2017). The estimated peak and remolded undrained shear strengths were typically greater than the averages estimated at the zone of the breach.

Illustration 7-23 shows the shear strength ratio estimated from simple shear tests at various effective vertical stress levels. Data obtained from the field vane and CPT is also included in the illustration. The undrained shear strength ratio function based on the SHANSEP method is included in Illustration 7-23. The undrained shear strength ratio (s_u/σ'_v) of the UGLU decreases with increasing effective vertical stress level. For stresses higher than the estimated preconsolidation pressure, the undrained shear strength ratio is constant at $s_u/\sigma'_v = 0.22$.



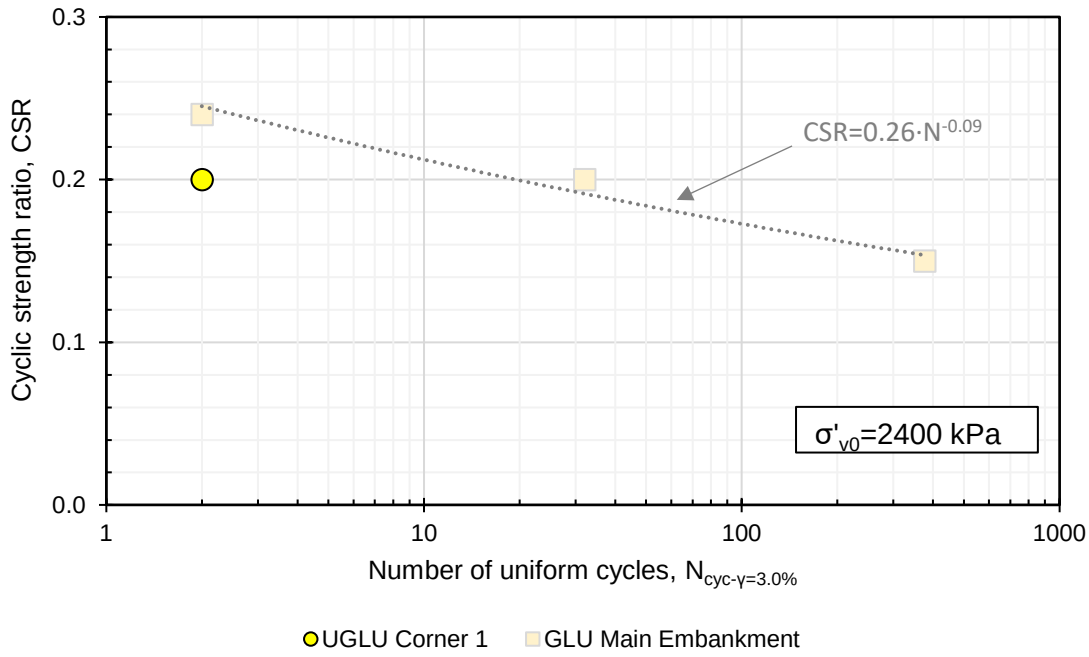
CPT = cone penetration test; OCR = overconsolidation ratio; s_u = undrained shear strength; σ'_p = preconsolidation pressure; σ'_v = effective vertical stress; SS = simple shear; UGLU = upper glaciolacustrine unit; VST = vane shear test.

Illustration 7-23: Peak Undrained Shear Strength Ratio Estimated for the Upper Glaciolacustrine Unit

The IEEIRP report presents stability analyses using a range of strength ratios from 0.22 to 0.27, with the IEEIRP "favouring a result above the average, say 0.25." The deformation analyses carried out by the IEEIRP using PLAXIS indicated collapse occurring at an undrained strength ratio of 0.29.

The peak and residual effective friction angles of the UGLU were measured on undisturbed samples in direct shear tests. The peak effective friction angle was also measured in a triaxial test, with the specimen rotated to allow failure along the GLU. The peak effective friction angle ranged from 19 to 31 degrees, and the residual effective friction angle ranged from 11 to 28 degrees, assuming zero cohesion and for normal stresses up to 800 kPa.

The undrained cyclic strength of the UGLU was measured on a single thin-walled tube sample in a cyclic direct simple shear test. Illustration 7-24 shows the test result in terms of the CSR required to generate peak (single-amplitude) shear strains of 3% during uniform cyclic loading. The test result is compared with other results obtained on glaciolacustrine samples from the Main Embankment.



σ_v'= effective vertical stress; GLU = glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-24: Cyclic Strength Ratio Required to Cause Cyclic Failure (3% strain) versus the Number of Uniform Loading Cycles for the Upper Glaciolacustrine Unit

7.3.3.2 Lower Glaciolacustrine Unit

The lower glaciolacustrine unit (LGLU) deposit is a semi-continuous layer between approximate elevation 900 and 918 m. The maximum thickness of the LGLU within the breach area at Corner 1 is approximately 5 m. The foundation investigation completed in 2016 also confirmed that the LGLU extended downstream of the breach area (Golder 2017). A summary of the index properties for samples of the LGLU collected from the Corner 1 Embankment is presented in Table 7-18.

The Atterberg limit results are shown graphically in Illustration 7-25. The fines are generally a low to intermediate plastic material and range from silty clay – clayey silt to silty clay (CL-ML to CI, respectively). One test was outside of this general range, resulting in a high plasticity clay (CH).

The natural water content results were plotted against elevation, which is shown in Illustration 7-26. The average water content of the LGLU is approximately 22% and ranges from 9% to 30%. The water content of the LGLU is generally much lower compared to the UGLU also encountered at the Corner 1 Embankment.

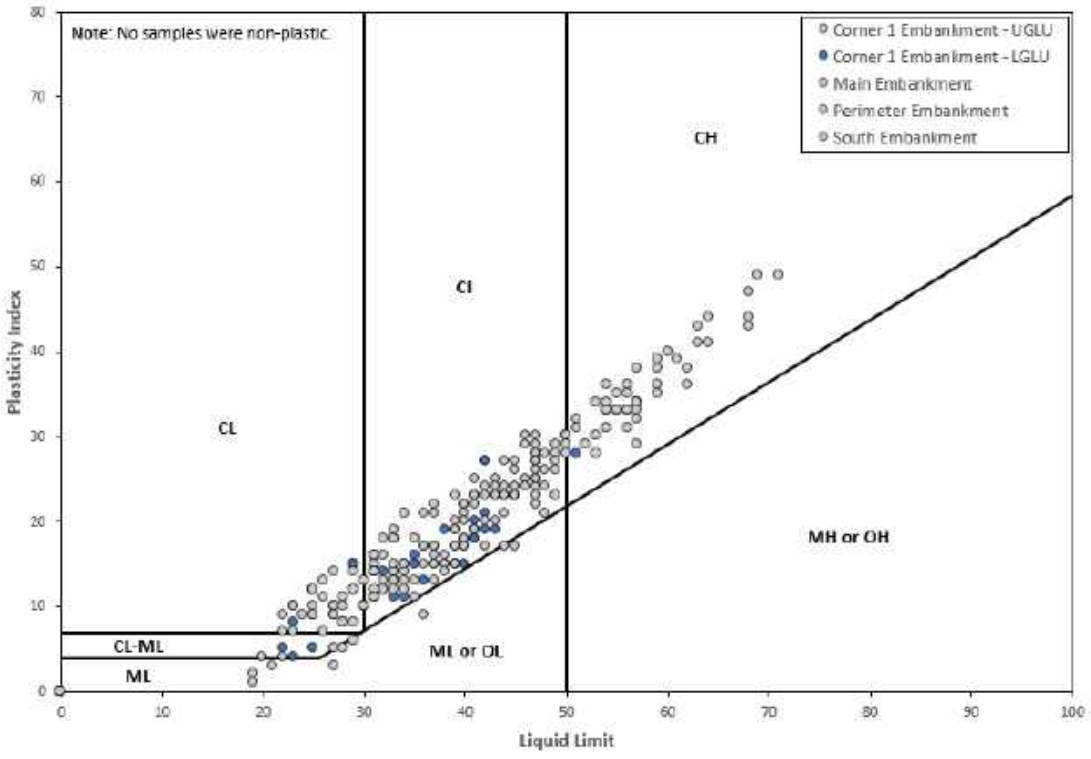
The natural water content results were also plotted against clay content as shown in Illustration 7-27. A total of 20 hydrometer test results were available for the LGLU sampled from the foundation of the Corner 1 Embankment. The average clay content of the LGLU is approximately 28% and ranges from 20% to 37%. The clay content of the LGLU is generally much lower compared to the UGLU.

All available test results for glaciolacustrine samples collected from the foundation of the other embankments were incorporated into the illustrations for comparison.

Table 7-18: Summary of Index Properties of Lower Glaciolacustrine Unit

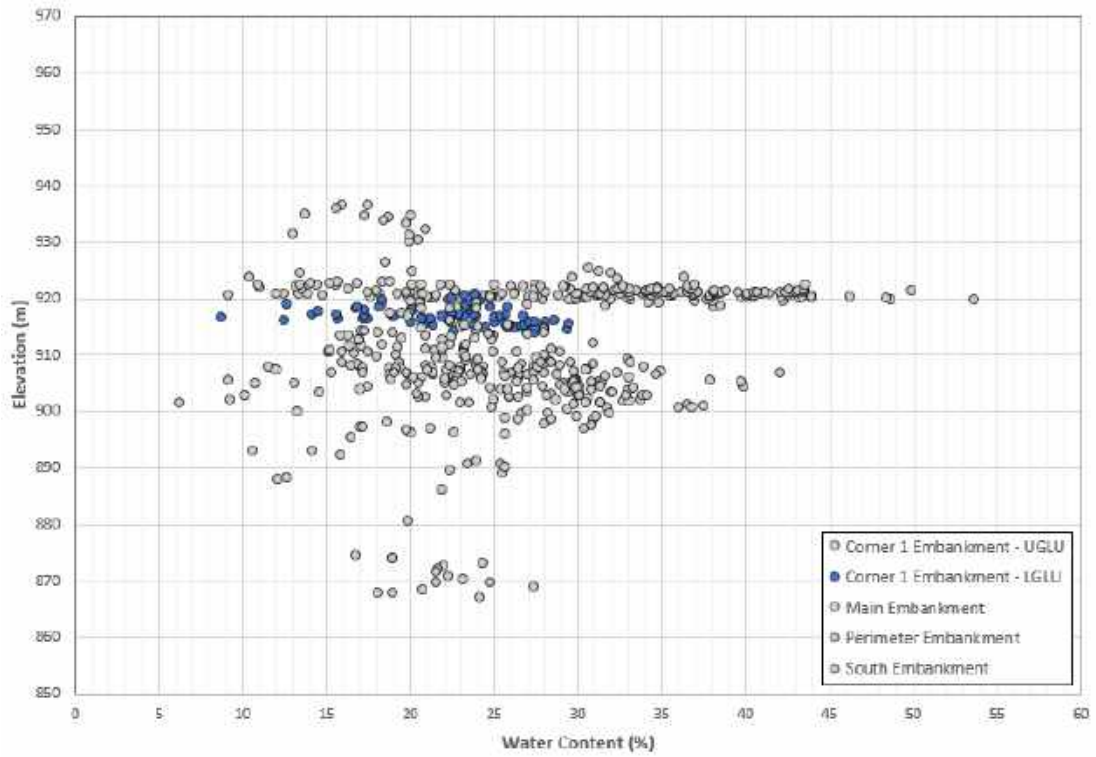
Index Property		Average	Minimum	Maximum	Number of Tests
Gradation	Gravel (%)	1	0	9	20
	Sand (%)	5	0	18	
	Fines (%)	94	80	100	
	Silt (%)	66	54	74	20
	Clay[a] (%)	28	20	37	
Liquid limit		35	22	51	29
Plastic limit		20	14	25	
Plasticity index		15	4	28	
Water content (%)		22.3	8.8	29.5	79
Specific gravity of solids		2.75	2.75	2.75	1

a) Clay is defined as particles smaller than 0.002 mm.



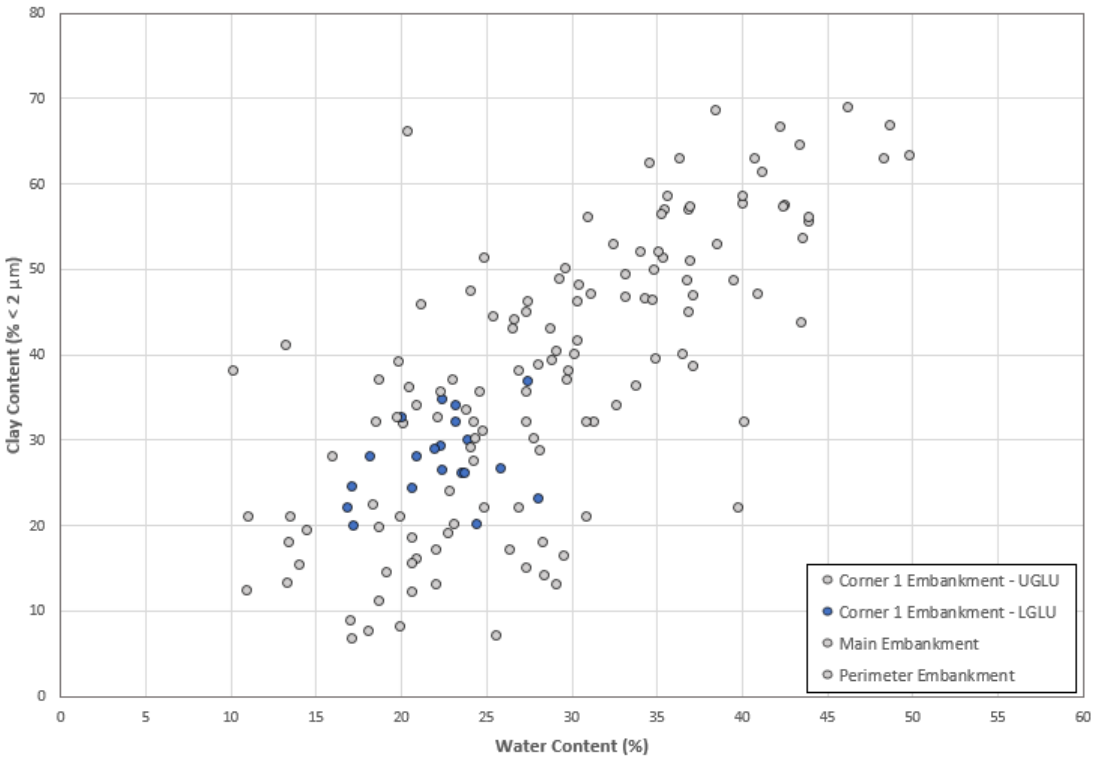
CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-25: Plasticity Chart of Lower Glaciolacustrine Unit Samples from the Corner 1 Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-26: Water Content against Elevation of Lower Glaciolacustrine Unit Samples from the Corner 1 Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-27: Water Content against Clay Content of Lower Glaciolacustrine Unit Samples from the Corner 1 Embankment

Table 7-19 and Illustration 7-28 show the results of consolidation tests carried out on the LGLU samples. The results show that the LGLU has a preconsolidation pressure, σ'_p, between about 700 and 1,200 kPa.

Table 7-19: Consolidation Test Results of Lower Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Sample Type	Elevation (m)	Estimated Preconsolidation Pressure (kPa)	Source
MR14-107A	6B	Thin-walled tube	916.7	701	IEEIRP (2015)
MR14-110	6B	Thin-walled tube	916.3	794	
SH14-10A	17	Sonic core	915.3	Preconsolidation pressure appears to exceed applied maximum load	KCB (2015b)
Central Collection Sump	4-bottom	Thin-walled tube	n/a	700–1,000	Golder (2015d)

n/a = not available.

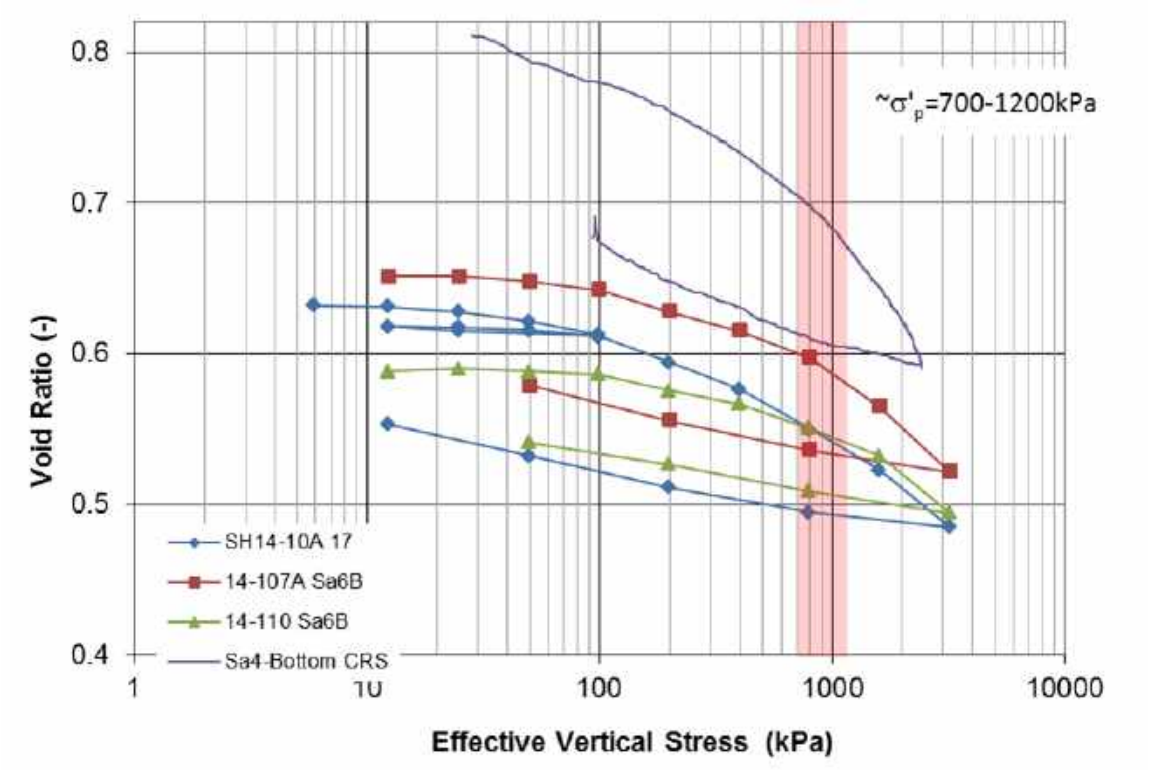


Illustration 7-28: Consolidation Test Results on Lower Glaciolacustrine Unit Samples

The quality of the samples was assessed using the methods proposed by Lunne et al. (1997) and Karlsrud and Hernandez-Martinez (2013). A description of both methods is presented in Section 7.3.1. The results of the assessment are summarized in Table 7-20.

Table 7-20: Quality Assessment of Lower Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Sample Type	Consolidation Test	Lunne et al. (1997)	Karlsrud and Hernandez-Martinez (2013)
MR14-107A	6B	Thin-walled tube	Incremental	Good to fair	Very poor
MR14-110	6B	Thin-walled tube	Incremental	Very good to excellent	Very poor
SH14-10A	17	Sonic core	Incremental	Poor	Very poor

The peak undrained shear strength of LGLU samples was measured in the laboratory with simple shear tests. A summary of the simple shear test results is presented in Table 7-21.

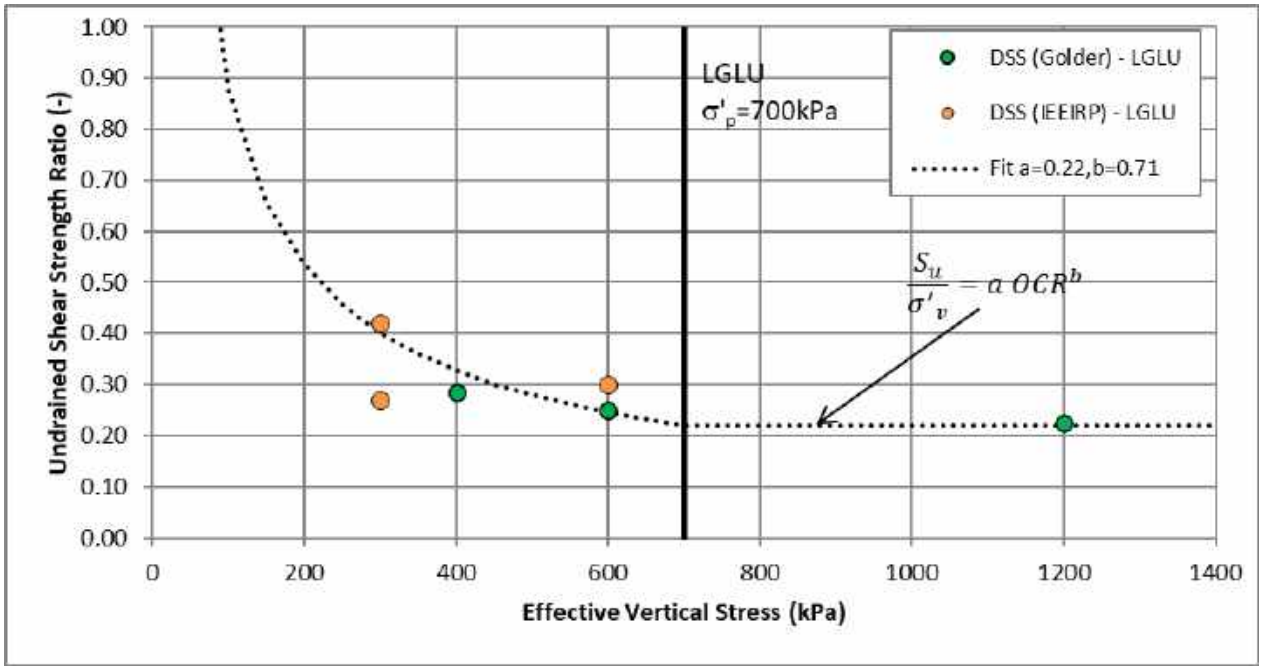
Table 7-21: Simple Shear Test Results of Lower Glaciolacustrine Unit Samples

Borehole No.	Sample No.	Initial Water Content (%)	Plasticity Index	Initial Vertical Effective Stress (kPa)	Static Bias (kPa)	OCR	Maximum Undrained Shear Strength Ratio	Undrained Shear Strength Ratio at 20% Strain
MR14-107A	7	22.2	15	600	n/a	1.2	0.30	0.25
MR14-109	6B	22.2	13	300	30	2.5	0.42	0.35
MR14-110	6C	21.2	15	300	30	2.6	0.27	0.22
Central Collection Sump	1-bottom	17.9	7	400	n/a	n/a	0.28	n/a
	2-bottom	26.0	12	600	n/a	n/a	0.25	n/a
	3-bottom	21.5	-	400	n/a	3.0	0.53	n/a
	4-bottom	25.8	17	1,200	n/a	n/a	0.23	0.17

n/a = not available, not applicable.

OCR = overconsolidation ratio.

Illustration 7-29 presents the undrained shear strength ratio function from the SHANSEP method using a preconsolidation pressure of 700 kPa. For stresses higher than the estimated preconsolidation pressure, the undrained shear strength ratio is constant at $s_u/\sigma'_v = 0.22$.



σ'_p = preconsolidation pressure; σ'_v = effective vertical stress; s_u = undrained shear strength; LGLU = lower glaciolacustrine unit; OCR = overconsolidation ratio; SS = simple shear.

Illustration 7-29: Peak Undrained Shear Strength Ratio Estimated for the Lower Glaciolacustrine Unit

A peak effective friction angle of 33 degrees and a residual effective friction angle of 25 degrees were measured on a single undisturbed sample of LGLU in a direct shear test (KCB 2015b).

7.3.4 South Embankment

One of the objectives of the 2016 foundation investigation was to confirm the characteristics of the soil previously identified as of glaciolacustrine origin in borehole VW11-02 (AMEC 2012) and to provide limits on the areal extent of this material along the South Embankment.

The material previously identified as of glaciolacustrine origin was encountered in boreholes DH98-BL-03 and VW11-02, which were drilled near a small tributary of Edney Creek (near Station 1+100). Boreholes GA16-17 and GA16-19 drilled within the area also encountered a bedded, silty soil. The area is estimated to extend about 100 m along the alignment of the South Embankment.

The description of the material intersected in borehole DH98-BL-03 is “Silt, glaciolacustrine, glaciofluvial. Rel. low permeability.” (KP 1999). The description of the material intersected in borehole VW11-02 is “SILT, some clay to clayey, trace sand, low plasticity to non-plastic, hard, […], varved”. The plastic and liquid limits were reported as 20% and 28%, respectively, and the natural water content was reported as 17% (AMEC 2012). Borehole GA16-19 was drilled within 5 m of VW11-02 and intersected material described as “sandy, clayey SILT, trace gravel.” Bedding was observed in the material intersected in GA16-19 but was not described as varved. The plastic and liquid limits were reported as 19% and 26%, respectively, and the natural water content was reported as 16% (Golder 2017). The material intersected in borehole GA16-17 (downstream of GA16-19) is described as “sandy SILT to SILTY SAND, trace gravel; brown; non-cohesive” with a measured water content of 20% (Golder 2017). The thickness of the material encountered in the four boreholes ranges from 0.5 to 1.5 m. In these four boreholes, the silty layer directly overlies bedrock.

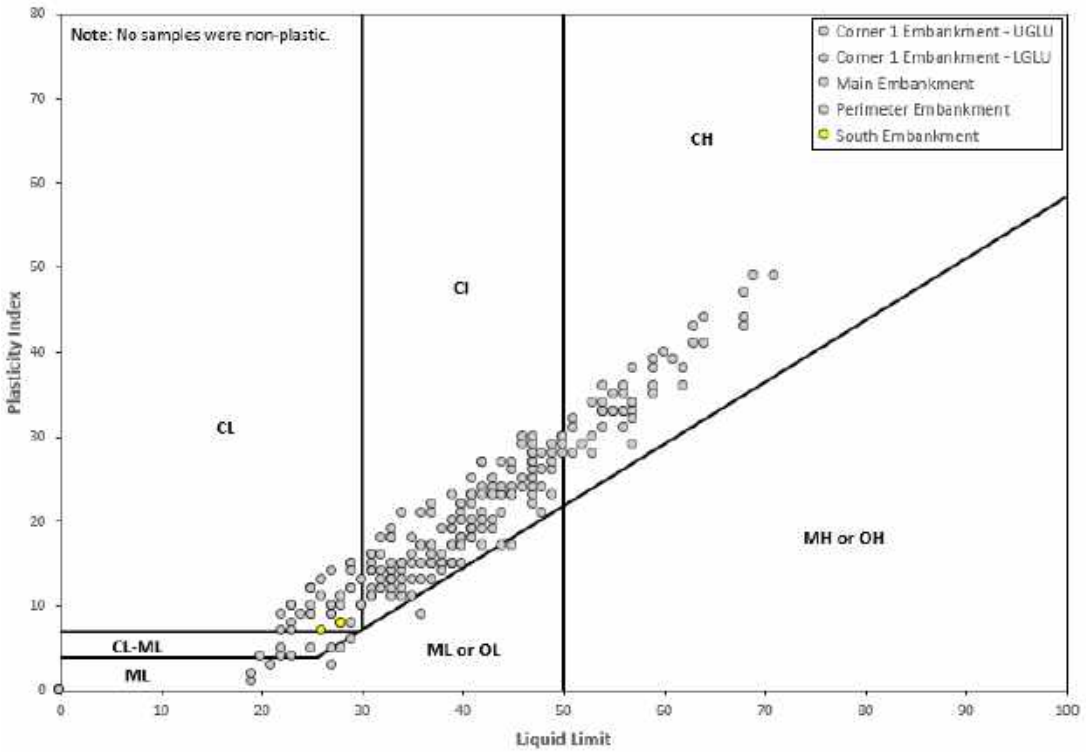
A summary of the index properties for the samples of the low plasticity silty clay collected from the foundation of the South Embankment (near Station 1+100) is presented in Table 7-22.

The Atterberg limits and natural water content results against elevation are shown graphically in Illustration 7-30 and Illustration 7-31, respectively. All available test results for glaciolacustrine samples collected from the foundation of the other embankments were incorporated into the illustrations for a comparison. The fines are a low plastic silty clay with a natural water content ranging from 15% to 20%.

The low plasticity and relatively low water content of the silty clay layer encountered at these locations are not representative of the intermediate or high plasticity glaciolacustrine units found within the footprint of the Corner 1 Embankment. Also, CPT16-19 refused at the depth of the low plasticity silty clay layer, with a tip resistance (greater than 20 MPa) and sleeve friction (greater than 500 kPa) greater than the typical values obtained in glaciolacustrine units at the Corner 1 and Main embankments.

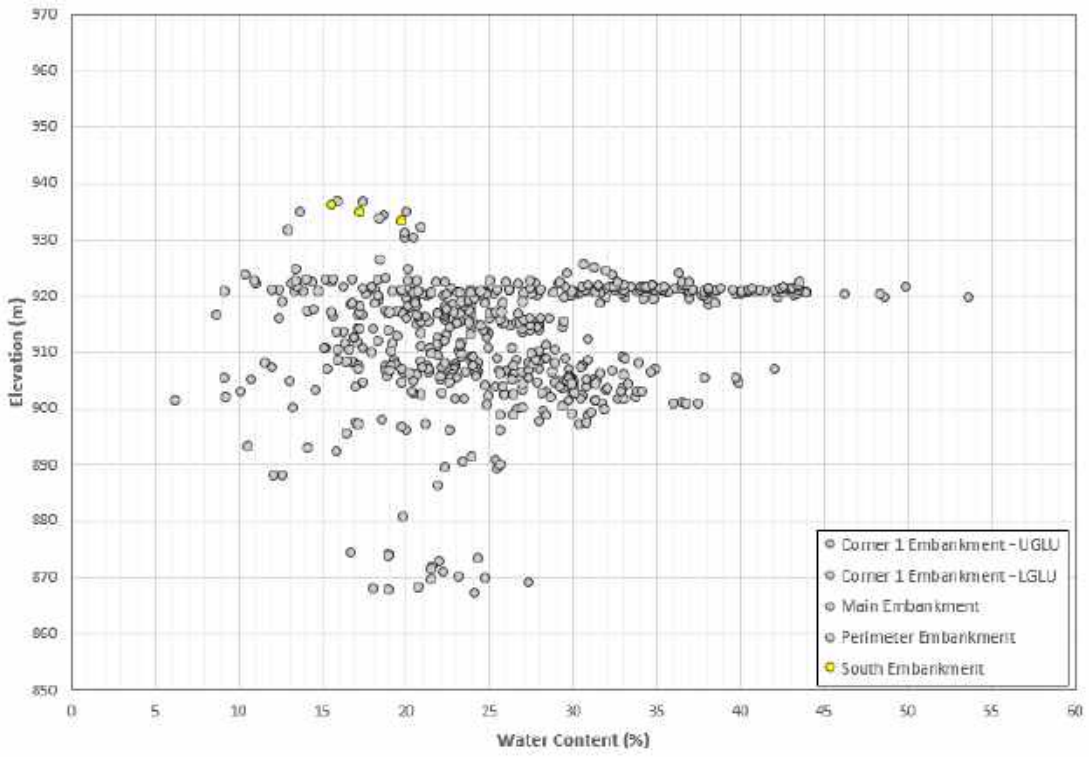
Table 7-22: Summary of Index Properties of Low Plasticity Silty Clay at the South Embankment

Index Property	Average	Minimum	Maximum	Number of Tests
Liquid limit	27	26	28	2
Plastic limit	20	19	20	
Plasticity index	8	7	8	
Water content (%)	17.6	15.6	19.8	3



CL = low-plastic clay, generally classified as silty clay; CI = intermediate-plastic clay, generally classified as silty clay; CH = high-plastic clay; CL-ML = low-plastic silty clay to clayey silt; ML = inorganic silt with slight or low plasticity; MH = high-plastic silt, generally classified as clayey silt; OL = low-plastic organic silt; OH = high-plastic organic silt.

Illustration 7-30: Plasticity Chart of Low Plasticity Silty Clay Samples from the South Embankment



LGLU = lower glaciolacustrine unit; UGLU = upper glaciolacustrine unit.

Illustration 7-31: Water Content against Elevation of Low Plasticity Silty Clay Samples from the South Embankment

7.4 Material Parameters for Stability Analyses

The material parameters for stability analyses are presented in Table 7-23.

Till and glaciofluvial materials vary in gradation depending on location, elevation, and depositional history; however, the results of the laboratory testing show a relatively consistent high strength. The shear strength parameters selected for the foundation till and glaciofluvial layers represent an average for the materials. The strength parameters are consistent with the parameters used in previous design analyses, testing results and analyses of the Corner 1 Perimeter Embankment breach carried out by the IEEIRP (2015), and the results of laboratory testing completed by KCB (2015b,c).

Glaciolacustrine soils have been analyzed using total stress (undrained) strength parameters. The total stress approach uses the SHANSEP model that accounts for preconsolidation of the soil. The preconsolidation pressure that has been selected for modelling the strength of each of the glaciolacustrine soil layers is based on the data collected for the specific layer and soils in the immediate area. The data used include the results of the laboratory strength testing, CPT profiles, the response of the soils during in situ testing and sampling (e.g., not being able to push a shear vane into the soil layer and bending of Shelby tubes during sampling) and correlation with index testing. Along the Perimeter and Main embankments, the preconsolidation pressure values selected for the analyses are at or below the lower bound of the values calculated from the laboratory consolidation tests and estimated from the CPT profiles.

Table 7-23: Foundation Material Parameters for Stability Analyses

Material	Unit Weight (kN/m^3)	Shear Strength	Pore Pressure Coefficient B-bar[(a)]	Notes
Foundation till	22	ϕ' = 34° c = 0 kPa	0.2	Triaxial testing of samples of till by IEEIRP (2015) and KCB (2015b)
Glaciofluvial	22	ϕ' = 34° c = 0 kPa	0.2	Triaxial testing of undisturbed glaciofluvial samples by Golder (2015d)
UGLU (Corner 1 Embankment)	18	Peak: $T = 0.22\ \sigma_v' \ OCR^{0.71}$ Where σ'_p = 400 kPa Remoulded: S_{ur} = 22 kPa	0.46 (peak)	Field and laboratory test programs by IEEIRP (2015) and KCB (2015b,c) including vane shear tests, CPT, and direct simple shear, direct shear, and triaxial testing Remoulded undrained shear strength selected as the average minus one standard deviation of the measured undrained shear strength values
LGLU (Corner 1 Embankment)	20	$T = 0.22\ \sigma_v' \ OCR^{0.71}$ Where σ'_p = 700 kPa	0.2	Field and laboratory test programs by IEEIRP (2015), KCB (2015b,c) and Golder (2017, 2019) including vane shear tests, CPT, and direct simple shear, direct shear, and triaxial testing
GLU (Perimeter Embankment)	20	$T = 0.22\ \sigma_v' \ OCR^{0.71}$ Where σ'_p = 900 kPa	0.2	Consolidation testing by Golder on samples from boreholes GA15-06, GA21-03, and GA21-11 at Perimeter Embankment indicate preconsolidation pressure from 900 to 3,600 kPa (excluding the samples assessed to be of very poor quality). σ'_p = 900 kPa selected as the design basis

Table 7-23: Foundation Material Parameters for Stability Analyses

Material	Unit Weight (kN/m^3)	Shear Strength	Pore Pressure Coefficient B-bar[(a)]	Notes
GLU (Main Embankment)	20	$T = 0.22\ \sigma_v'\ OCR^{0.71}$ Where $\sigma'_p = 1{,}200$ kPa	0.2	Field and laboratory test programs by KP (2007b), AMEC (2012), Golder (2015d), and WSP Golder (2022b) including vane shear tests, CPT, direct simple shear, direct shear, and triaxial testing Consolidation tests indicate a range of preconsolidation pressure from 2,500 kPa to 4,000 kPa (excluding the samples assessed to be of very poor quality) and CPT data indicate a minimum preconsolidation pressure of about 1,200 kPa. $\sigma'_p = 1{,}200$ kPa selected as the design basis
		$T = 0.22\ \sigma_v'\ OCR^{0.71}$ Where $\sigma'_p = 850$ kPa (GLU at approx. elev. 922 Station 2+400 and 2+750)		Field and laboratory test programs by AMEC (2012), Golder (2015d) and WSP Golder (2022b) CPT21-07 data indicate a minimum preconsolidation pressure of about 850 kPa. $\sigma'_p = 850$ kPa selected as the design basis
Low plasticity silty clay (Sta. 1+100 South Embankment)	20	$T = 0.22\ \sigma_v'\ OCR^{0.71}$ Where $\sigma'_p = 1{,}200$ kPa	0.2	Index laboratory testing by Golder (2017)

a) Refer to Section 7.4.1 for explanation of selected B-bar values.

T = shear strength; σ_v'= effective vertical stress; ϕ_p' = peak friction angle; c = cohesion; CPT = cone penetration test; GLU = glaciolacustrine unit; LGLU = lower glaciolacustrine unit; OCR = overconsolidation ratio; σ'_p = preconsolidation pressure; UGLU = upper glaciolacustrine unit.

7.4.1 Pore Pressure Response within the Foundation Soils

Excess pore pressures are generated within soils when a load is applied at a rate faster than water can drain from the pore spaces in the soil. The amount of excess pore pressure depends directly on the magnitude of the applied load, the permeability of the soil, and the rate of application. The pore pressure response within the soil units can be interpreted by means of the pore pressure coefficient B-bar, defined as the change in pore pressure over the change in confining stress (Skempton 1954).

Pore pressure response was measured within the glaciolacustrine, till, and glaciofluvial layers within the Corner 1 area by vibrating wire piezometers (VWPs) monitored during construction of the 2015 Freshet Management Embankment, and at a single location along the Perimeter Embankment during the buttress construction.

Pore pressure response in the UGLU (Corner 1 Embankment) was measured with VWP VST14-03, located beneath the zone of compacted rockfill for the 2015 Freshet Management Embankment construction. The maximum B-bar measured was 0.46 at an intermediate stage of construction, and at the end of fill placement (Golder 2015b). It was determined that the glaciolacustrine soils will take approximately one year to dissipate excess pore water pressures based on the rate of consolidation measured in the laboratory and the field.

Pore pressure responses in the till and glaciofluvial layers were measured with VWP SH14-07, located adjacent to the zone of upstream fill placement. The maximum B-bar measured was 0.23 at the initial piezometer readings following fill placement. The B-bar values decreased to maximums of 0.19 and 0.15 with further fill placement (Golder 2015b). The decrease in the pore pressure and hence B-bar is due to drainage from the soil occurring at a rate faster than the rate of load application.

Only the VWPs installed in borehole GA15-06 at Station 3+400 (Perimeter Embankment) showed a pore pressure response to the approximately 5 m high buttress rockfill constructed along the Perimeter Embankment in 2015. All other VWPs installed along the foundation of the Perimeter Embankment buttress did not record a response to the construction of the buttress. The maximum B-bar measured was 0.16 (Golder 2015e).

VWPs B6, B7, B11, and B12 installed in till and glaciolacustrine layers in the foundation of the Main Embankment buttress recorded excess pore water pressure when rockfill was stockpiled for embankment construction in 2022. The maximum B-bar values measured in till and glaciolacustrine soil were 0.12 and 0.13, respectively.

8.0 HYDROGEOLOGY

Much of the factual and conceptual understanding of groundwater conditions near the TSF was obtained from Golder (2016b,c), Golder (2021), and MPMC (2021).

8.1 Hydrogeological Units and their Properties

The hydrostratigraphy at the TSF includes mine waste materials (tailings), fill materials associated with engineered structures (TSF embankment), soil deposits, bedrock formations, and bedrock structures. The key native hydrogeological units which form the foundation of the TSF are depicted in the cross-sections in Figure 3 to Figure 9 and are listed in Table 8-1, along with a summary of hydraulic conductivity estimates associated with these units.

The locations of the boreholes and monitoring wells listed in Table 8-1 are shown in Figure 1 and Figure 2. Completion details related to the boreholes, test pits, cone penetration tests (CPTs), and the monitoring wells are provided in APPENDIX C (Tables C1 to C5). Single-well response test analyses that were completed in 2022 to obtain in situ hydraulic conductivity estimates are provided in APPENDIX F. Analyses regarding the hydraulic conductivity estimates based on grain size using HydrogeoSieveXL™ (an Excel-based tool to estimate hydraulic conductivity from grain-size analyses) are provided in APPENDIX G. Details on the hydraulic conductivity estimates for the glaciolacustrine unit from the analysis of CPT dissipation tests are provided in APPENDIX E. All other hydraulic conductivity estimates outlined in Table 8-1 are from historical reports referenced in the table.

Table 8-1: Hydrogeological Units and Hydraulic Conductivity (K) Test Results

Hydrostratigraphic Unit	Borehole / Monitoring Well	Source / Consultant	Method	Estimated Hydraulic Conductivity (m/s)	Material Description (as summarized from original log)
Ablation till	MP89-231	IMC (1990)	Packer test	6.4×10^{-8}	Silty till 9–12 m depth
	GA21-01 GA21-02 GA21-03 GA21-05 GA21-06 GA21-07 GA21-08	Appendix G	HydrogeoSieveXL (grain-size analysis for 10 soil samples)	Range: 2×10^{-8} to 2×10^{-6} Geomean: 2×10^{-7}	Variable
Basal till	GW00-1B	Appendix F	Solid slug and bailer	3×10^{-6}	Silt till with sand interbed
	GW00-3B	Appendix F	Solid slug	8×10^{-7}	Silt till with silt / fine sand interbed
	GW16-4B	Golder (2016d)	Solid slug	2×10^{-5}	Silty sand
	GW21-06	Appendix F	Solid slug	1×10^{-5}	Inferred sand and gravel till
	GW21-09	Appendix F	Solid slug	1×10^{-6}	Silty clay / silt and sand
	MP89-232	IMC (1990)	Packer test	7.7×10^{-8}	Clayey silt till 15–18 m depth
	MP89-233	IMC (1990)	Packer test	1.1×10^{-7}	Sandy till 12–18 m depth
	MP89-234	IMC (1990)	Packer test	1.4×10^{-7}	Clayey sand (till) 6–12 m depth
	GA21-01 GA21-02 GA21-03 GA21-05 GA21-06 GA21-08 GA21-09	Appendix F	HydrogeoSieveXL (grain-size analysis for 7 soil samples)	Range: 4×10^{-8} to 2×10^{-6} Geomean: 3×10^{-7}	Variable
Glaciolacustrine	GA21-08 GA21-11	Appendix G	HydrogeoSieveXL (grain-size analysis for 5 soil samples)	Range: 2×10^{-10} to 7×10^{-8} Geomean: 7×10^{-9}	Silty clay or sandy silty clay
	CPT21-03 CPT21-07 CPT21-08 CPT21-09	Appendix E	CPT dissipation tests (6 tests)	Range: 3×10^{-9} to 6×10^{-8} Geomean: 2×10^{-8}	CPT21-03 and CPT21-07: High plasticity clay, trace sand, varved CPT21-08: Silty clay, medium plasticity, trace sand, laminated or varved CPT21-09 (910.9 m): Sandy silty clay, medium plasticity, laminated. CPT21-09 (908.3 m): Silty clay to clay, low to high plasticity, trace sand, laminated.
Glaciofluvial	GW16-2A	Golder (2016d)	Pneumatic test	8×10^{-4}	Sandy silty gravel
	GW16-2B	Golder (2016d)	Pneumatic test	2×10^{-4}	Sand and gravel
	GW96-2B	Appendix F	Solid slug and bailer	4×10^{-4}	Sand and gravel
	GW96-4B	Appendix F	Solid slug	2×10^{-6}	Sand some gravel
	GW16-3B	Golder (2016d)	Solid slug	8×10^{-6}	Silty sand and gravel
	GA21-06	Appendix G	HydrogeoSieveXL (grain-size analysis for 1 soil sample)	3×10^{-5}	Gravelly sand

Table 8-1: Hydrogeological Units and Hydraulic Conductivity (K) Test Results

Hydrostratigraphic Unit	Borehole / Monitoring Well	Source / Consultant	Method	Estimated Hydraulic Conductivity (m/s)	Material Description (as summarized from original log)
Weathered bedrock	GW16-3A	Golder (2016d)	Recovery test	$<10^{-10}$	Weathered bedrock (silty clay)
	GW16-4A	Golder (2016d)	Recovery test	1×10^{-7}	Weathered bedrock (clayey silt and sand)
	GW96-2A	Appendix F	Solid slug	3×10^{-6}	Inferred weathered volcanic conglomerate (gravel with some coarse sand)
	MP89-231	IMC (1990)	Packer test	1.6×10^{-8}	Soft volcanics 30–37 m depth
	MP89-232	IMC (1990)	Packer test	3.2×10^{-8}	Fractured volcanics 32–37 m depth
	MP89-233	IMC (1990)	Packer test	2.2×10^{-7} 1.6×10^{-7} 1.7×10^{-7}	Soft rock 30–37 m depth Broken rock 37–46 m depth Broken rock 49–55 m depth
	MP89-235	IMC (1990)	Packer test	5.1×10^{-6}	Highly fractured bedrock in contact with overburden 6–12 m depth
Competent bedrock	GW16-5A	Golder (2016d)	Solid slug	5×10^{-6}	Inferred competent bedrock
	GW16-5B	Golder (2016d)	Recovery test	2×10^{-7}	Inferred competent bedrock
	MP89-231	IMC (1990)	Packer test	2.9×10^{-9}	Competent bedrock 37–43 m depth
	MP89-232	IMC (1990)	Packer test	1.0×10^{-7}	Competent bedrock 43–46 m depth
	MP89-234	IMC (1990)	Packer tests	3.2×10^{-9} 3.3×10^{-8}	Competent bedrock 30–37 m depth Competent bedrock 46–49 m depth
	MP89-235	IMC (1990)	Packer tests	8.6×10^{-10} 4.0×10^{-9} 1.1×10^{-7}	Very competent bedrock 12–18 m depth; Competent bedrock 18–30 m depth; Slightly fractured bedrock 30–43 m depth
	MP89-236	IMC (1990)	Packer tests	2.7×10^{-7} 2.7×10^{-8} 2.0×10^{-8} 7.7×10^{-9}	Bedrock 8–12 m depth Bedrock 14–24 m depth Bedrock 24–37 m depth Bedrock 35–46 m depth

CPT = cone penetration test.

8.1.1 Surficial Native Deposits

The surficial deposits underlying the TSF consist of glacial deposits, predominantly till (ablation till and basal till) with interbeds of glaciofluvial and glaciolacustrine sediments. The relative distribution of the till, glaciofluvial, and glaciolacustrine sediments varies by location according to the depositional and erosional history of the area as shown on the cross-sections (Figure 3 to Figure 9). The combined thickness of the glacial deposits range from approximately 5 m along a bedrock knoll near the South Embankment to approximately 60 m along portions of the Main Embankment. During foundation preparation at the North Abutment of the TSF in 2022, the thickness of the glacial deposits was observed to be on the order of 2 m. Additional test pits need to be excavated when construction resumes in 2023 to confirm the glacial deposit thickness.

The TSF till core has been keyed into the foundation till. Where the natural surficial till along and upstream of the till core alignment was observed to be less than 2 m thick, and was underlain by glaciofluvial/glaciolacustrine sediments, a low permeability till liner was constructed with a nominal thickness of at least 2 m (KP 1997a, 2011 Section 2.2; Golder 2016b, Section 3.3.1.7).

Based on the information outlined in Table 8-1 above, the hydraulic conductivity of the foundation till (ablation till and basal till) is highly variable, ranging from 1×10^{-5} m/s to 2×10^{-8} m/s. The hydraulic conductivity of the till liner was estimated by KP (2005) to be on the order of 1×10^{-8} m/s. The range in hydraulic conductivity for the glaciofluvial units, 8×10^{-4} m/s to 2×10^{-6} m/s, confirms that these units are more permeable and may act as preferential pathways for seepage from the TSF. Conversely, the range in hydraulic conductivity for the glaciolacustrine deposits, 7×10^{-8} m/s to 2×10^{-10} m/s, confirms that these units have a low permeability and may act as barriers for seepage migration and/or as confining units where they occur directly above glaciofluvial units, and could potentially cause artesian pressures in the underlying glaciofluvial units.

A previous hydrogeological assessment by Golder (2016c), which involved development of a numerical groundwater flow model for the TSF area, estimated the bulk horizontal and vertical hydraulic conductivity of the foundation soils to be on the order of 5×10^{-7} m/s and 5×10^{-8} m/s respectively (i.e., an anisotropy of 10:1), based on the results of model calibration to observed hydraulic heads and seepage flow rates at the facility. Therefore, these calibrated values are considered representative of the composite foundation overall.

8.1.2 Bedrock

The upper portion of the bedrock beneath the TSF is weathered and/or fractured and consists predominantly of volcanic conglomerate based on drilling observations in the TSF footprint prior to mining (IMC 1990).
The thickness of this weathered bedrock zone is highly variable and is inferred to range from 2 to 40 m based on borehole logs for the 1996 series monitoring wells (KP 1997b) and the 2015 series boreholes (Golder 2015d).
The underlying competent bedrock consists of Nicola Group volcanics that, according to the local geology map (Logan et al. 2007), likely consist of undivided mafic volcanic and volcanoclastic rocks and/or intrusive rocks (pseudoleucite syenite).

Based on the information outlined in Table 8-1, the hydraulic conductivity of weathered bedrock is highly variable, ranging from 5×10^{-6} m/s to 1×10^{-10} m/s in the vicinity of the TSF. Competent bedrock had a similar range in hydraulic conductivity as that of weathered bedrock (5×10^{-6} m/s to 9×10^{-10} m/s). The calculated geometric mean of the individual tests for weathered and competent bedrock is approximately 9×10^{-8} m/s and 3×10^{-8} m/s respectively. Based on the results of packer testing at two boreholes, the hydraulic conductivity of competent bedrock is expected to generally decrease with depth (as seen at MP89-236), except where bedrock fractures are encountered (as seen at MP89-235).

8.2 Groundwater Recharge/Discharge and Tailings Storage Facility Seepage

The central area of the mine site is a topographic high consisting of Polley Mountain, which reaches an elevation of approximately 1,255 m. The TSF is located about 3 km southeast of this location in a topographically low area with an original ground surface elevation of approximately 920 to 940 m. Topographic high areas are typically areas where groundwater recharge occurs, whereas topographic low areas are typically areas where groundwater discharge occurs.

8.2.1 Recharge Areas

Groundwater recharge from precipitation near the TSF is expected to occur primarily along topographic highs, such as upgradient of the western boundary of the TSF, between the TSF and Bootjack Lake. The recharge rate in this area was estimated to be approximately 20% of average annual precipitation based on the results of numerical model calibration for a groundwater flow model of the TSF area (Golder 2016c).

Prior to construction of the TSF, groundwater discharge to ground surface was reported to occur within the footprint of the TSF, as indicated by the presence of a small pond and two swampy marsh-like areas within this footprint. This is supported by the observation of a near-surface water table, artesian pressures measured below the west side of the TSF footprint, and upward groundwater flow gradients measured along the Main and Perimeter embankments, as described in Section 8.4.1). However, the construction of the TSF and the presence of the TSF Pond changed the groundwater conditions such that the TSF Pond is now a source of groundwater recharge (i.e., contributes to seepage through the foundation). The TSF Pond level rose from approximately 938 to 962 m between 2016 and 2018 (Section 8.3), and then remained relatively stable thereafter, at an elevation of approximately 962 to 963 m. The TSF Pond elevation is inferred to control the amount of seepage that reports to the TSF seepage collection systems, as described in Section 8.2.2.

8.2.2 Tailings Storage Facility Seepage

Seepage through the TSF embankment is collected at the downstream seepage collection ponds and ditches. The seepage collection ponds and ditches are unlined and are reportedly installed within till. Limited recharge is expected to occur from the seepage collection systems to the groundwater system.

The primary systems that report to the seepage collection ponds and ditches are:

- foundation drains that underlie the downstream shell of the dam
- upstream toe drains within the South, Main, and Perimeter Embankments
- four passive pressure relief wells (PRW96-1 to PRW96-4) and trenches installed below the Main Embankment

Measured flows reporting to the TSF seepage collection systems ranged between about 2,500 and 6,200 m^3/d (29 and 72 L/s) in 2021 (Golder 2022a). Most of the seepage (70% to 80%) is from the upstream drain at Corner 1 (21 to 45 L/s), with the remaining (20% to 30%) being a combination of flow from upstream drains, seepage through the embankments, flow from passive pressure relief wells and runoff (8 to 27 L/s). Golder (2015g) previously reported measured flows from the foundation drains to be on the order of 80 L/s in 2014 prior to the breach. Although not explicitly stated in the Golder (2015g) report, the foundation drains are considered to be connected to the upstream drains, and flow measurements through the embankment and from the pressure relief wells without the contribution from the upstream drains is not available.

Seepage losses through the foundation on the order of 35 to 294 m^3/d (0.4 to 3.4 L/s, about 2.2 L/s on average) were estimated to bypass the downstream seepage collection ditches and ponds based on estimates in previous design reports which considered TSF embankment elevations of 960 m (KP 1995b) and 965 m (KP 2005). More recent estimates of the seepage losses are not available.

8.2.3 Discharge Areas

The primary groundwater discharge areas downgradient of the TSF footprint include Edney Creek, Edney Creek tributaries, and Hazeltine Creek.

Within the TSF embankment foundation, there are four passive pressure relief wells and connecting trenches that were installed within native soils in 1996 (KP 1997c, Section 5.2.2). These wells act to reduce the artesian pressures along the foundation of the Main Embankment and constitute a discharge area for groundwater. The pressure relief wells are situated directly below the Main Embankment between approximately Station 1+800 and 2+300 (see Figure 1) and consist of auger holes drilled to a depth of between 10 and 22 m and backfilled with filter sand. The pressure relief trenches were excavated and backfilled with gravelly sand. Because these wells are buried below the embankment, direct flow measurement from the wells is not possible. As indicated in Section 8.2.2, flows from these wells are routed to the TSF Main Embankment Seepage Collection Pond.

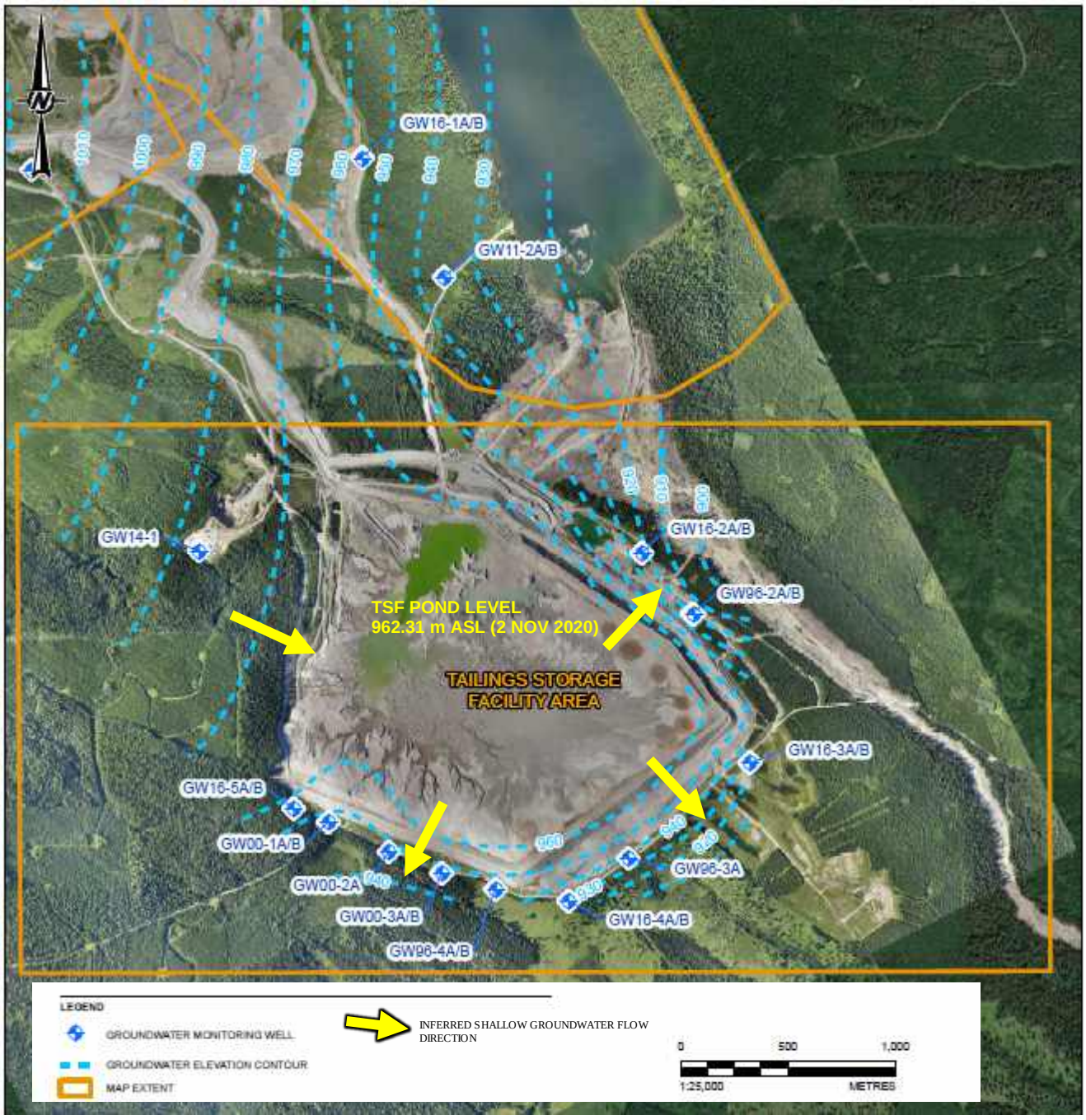
8.3 Hydraulic Heads and Vertical Hydraulic Gradients

The most recent groundwater level data is reported in the *2021 Annual Groundwater Monitoring Report* (Golder 2022b). The following information is based on that report.

Hydraulic Heads

Groundwater monitoring has been ongoing at the mine site since 1995 with the objectives to monitor direction, quantity, and quality of groundwater flow near all mine facilities. As part of this program, eight monitoring well pairs (each with one deeper well and one shallow well, and typically one bedrock and one overburden well per pair) and three single monitoring wells, all situated next to the outer perimeter of the TSF, are monitored monthly to annually, depending on location. The well locations are shown on the plan in Illustration 8-1, and also shown on the cross-sections in Figure 3 to Figure 9. Completion details for the wells are provided in APPENDIX C (Table C4). The monitoring well locations include the following, listed from west to east:

- Northwest Side: GW14-1
- South Embankment: GW16-5A/B, GW00-1A/B, GW00-2A, GW00-3A/B, GW96-4A/B
- Main Embankment: GW16-4A/B, GW96-3A, GW16-3A/B
- Perimeter Embankment: GW96-2A/B, GW16-2A/B



Source: Golder (2021) modified Figure 6.

Illustration 8-1: Shallow Hydraulic Head Contours for November 2020

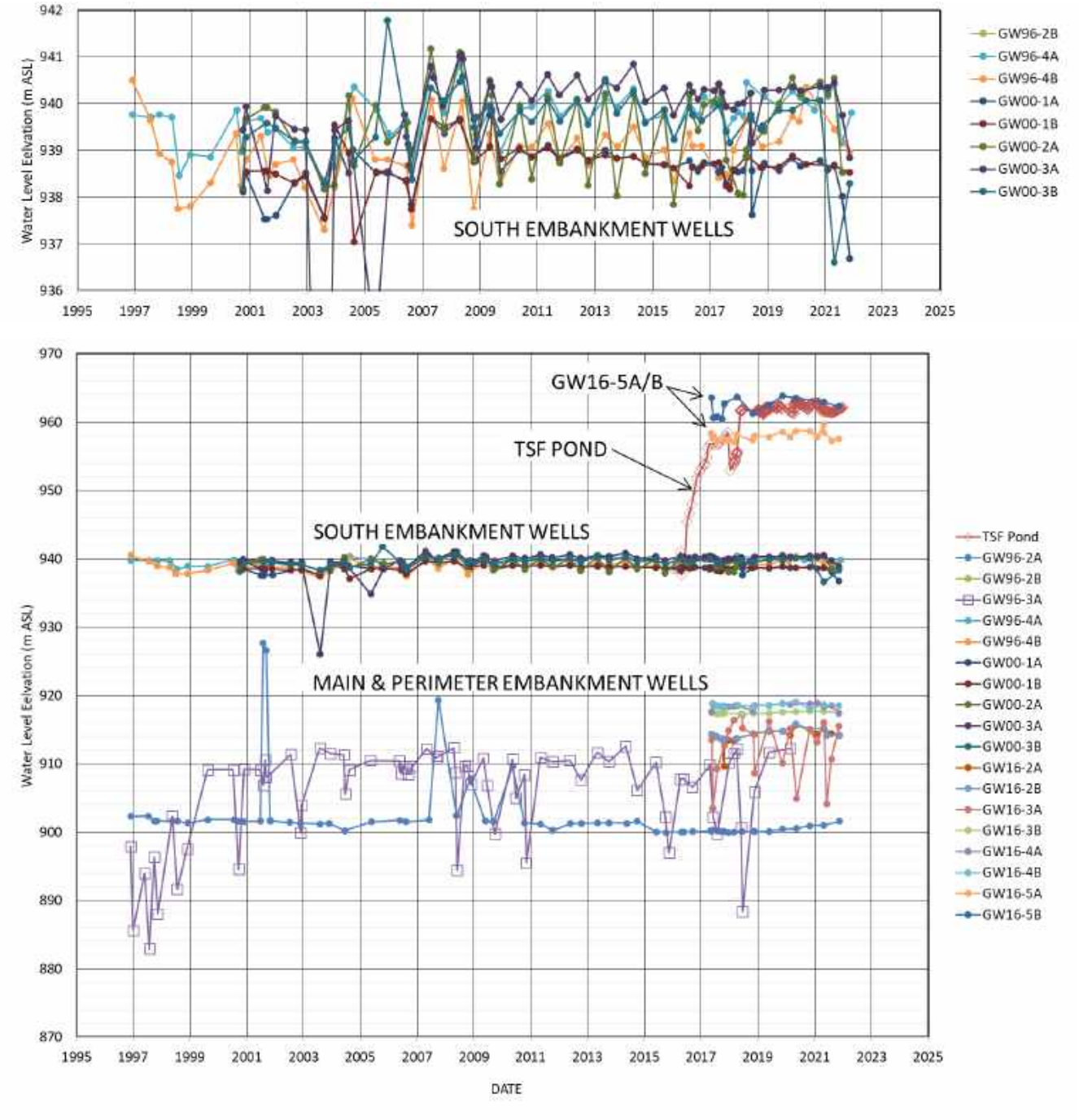
Hydraulic heads around the TSF ranged from a high of 963 m (at GW16-5B) on the northwest side of the facility to a low of 915 m (at GW96-2B) on the northeast side in 2021. As shown on the time-series water level plot in Illustration 8-2, the hydraulic heads have remained fairly constant over time since approximately 2003, excluding seasonal water level fluctuations of approximately 2 to 3 m at most locations (the small seasonal variation relative to the total head change across the facility suggests that these seasonal variations are unlikely to affect overall interpretation of groundwater flow directions near the TSF). Conversely, the TSF Pond level rose from approximately 938 m to approximately 962 m between 2016 and 2018, and then remained relatively stable thereafter at an elevation between 961 and 963 m. Currently, the monitoring well nest located at the west end of the South Embankment (GW16-5A/B) has hydraulic heads that are relatively close to the TSF Pond level, whereas hydraulic heads along the remaining perimeter of the facility are significantly lower. Although not shown in Illustration 8-1, the surface water level in Bootjack Lake, situated approximately 2 km northwest of the TSF, was approximately 987 m in 2021 (approximately 24 m higher than the current TSF Pond level), and the groundwater level within the bedrock knoll in between the TSF and Bootjack Lake was inferred to be higher relative to the lake level based on measured groundwater levels to the northwest of the TSF and closer to Polley Mountain (GW96-7; approximately 1,017 m). The distribution in hydraulic heads indicates that the groundwater flow direction is radially outward from the TSF towards the southwest, southeast, and northeast, with some groundwater inflow into the facility from the northwest. Groundwater flow direction is discussed in more detail in Section 8.4.

Next to the Perimeter Embankment, the hydraulic head observed in the deep well screen at GW96-2A completed in weathered bedrock (901.61 m on 25 November 2021) is significantly lower than would be expected based on nearby surface water elevations in Edney Creek and Hazeltine Creek, with surface water level elevations being about 10 m higher. The high hydraulic conductivity results for GW96-2A at an elevation of 878 m (3×10^{-6} m/s, see Table 8-1) indicates a possible zone of enhanced permeability at this location. According to Golder (2016c), the low water level measurement in GW96-2A suggests the well could be connected locally, through this enhanced permeability zone, to farther down-gradient and downstream areas of Hazeltine Creek. Based on the groundwater quality results for the TSF described in Section 9.5 and considering the groundwater quality trends for this well from pre-mining to present shown in Figure 10, this well does not appear to be influenced by seepage from the TSF. This suggests that the inferred enhanced permeability zone at GW96-2A is not hydraulically connected to the TSF.

Vertical Hydraulic Gradients

Data from the multi-level wells from 2019 onwards indicated mostly downward (shallow to deep) vertical hydraulic gradients around the TSF perimeter with the following exceptions:

- A consistently upward hydraulic gradient, observed from November 2019 to November 2021 next to the South Embankment close to the southwest corner of the facility (at GW96-4A/B and GW00-3A/B).
- Periodic flowing artesian conditions since approximately 2003 observed or inferred (water levels recorded at the top of the well collar on some occasions; however, the static water level height above the well collar has not been measured) at bedrock well GW96-3A situated southeast of the Main Embankment. This well location is situated downgradient of the four passive pressure relief wells described in Section 8.2.3 and next to the Main Embankment Seepage Collection Pond.



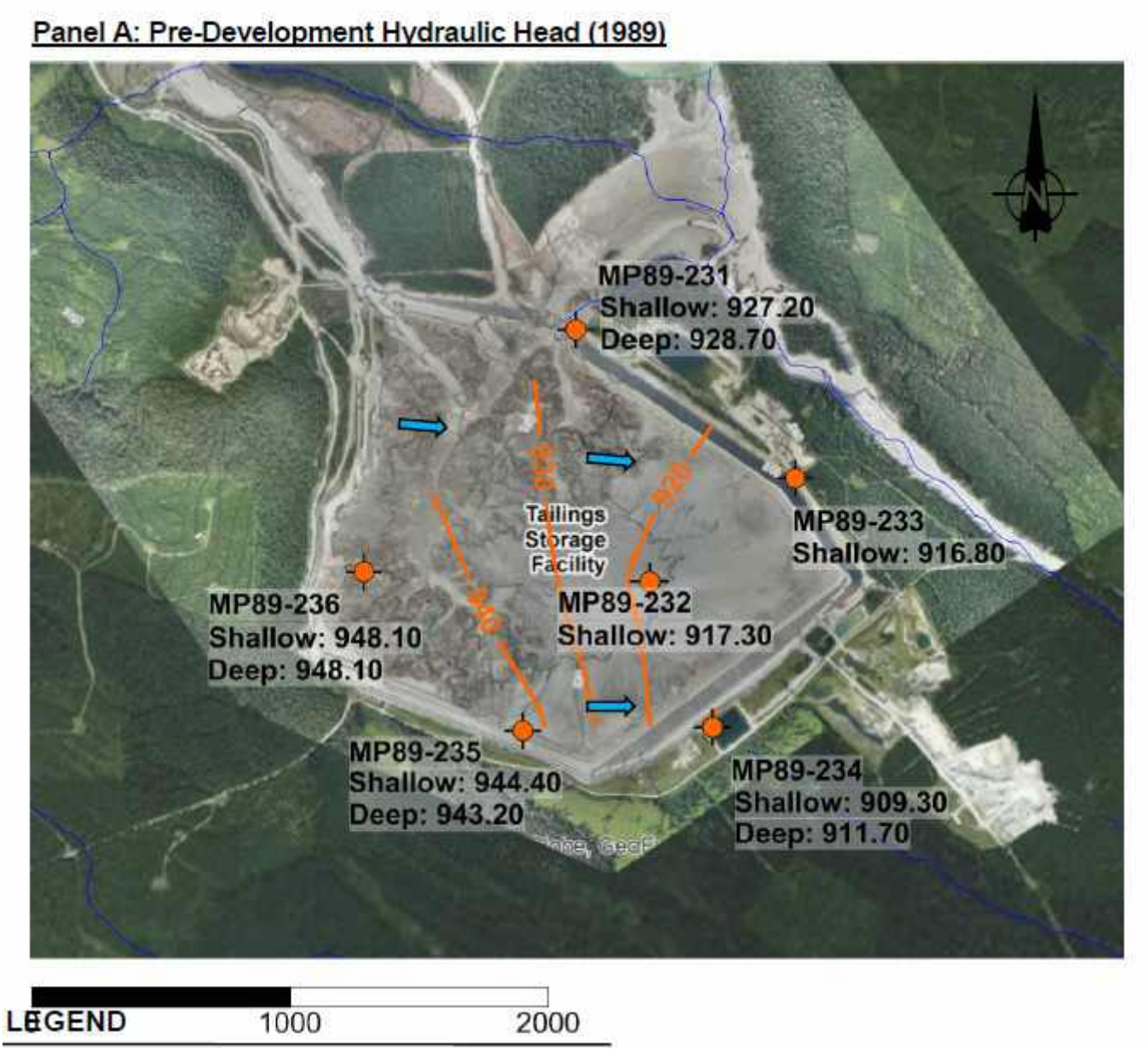
TSF = tailings storage facility.

Illustration 8-2: Tailings Storage Facility Pond Level and Surrounding Groundwater Levels over Time

8.4 Groundwater Flow Direction

8.4.1 Pre-development Groundwater Flow Direction

Prior to the TSF construction, hydraulic head measurements were collected by KP (1990) at 10 monitoring wells and piezometers. The inferred groundwater flow directions based on these data are presented in Illustration 8-3 below.



Source: KP 1990; modified from Figure 4 in Golder 2016c.

Illustration 8-3: Pre-development Hydraulic Heads and Groundwater Flow Direction

Based on the measured hydraulic heads, the groundwater flow direction prior to the development of the TSF was inferred to be from the west and northwest towards the east and southeast. The water table was observed to be near ground surface, with artesian pressures measured within the TSF basin at MP89-236 and upward groundwater flow gradients measured along the Main and Corner 1 embankments (MP89-234 and MP89-231). The observed upward gradients and artesian flow conditions are consistent with reported observations of two swampy areas and a small pond within the footprint of the TSF prior to development. A downward hydraulic gradient was observed at MP89-235, which is located near a bedrock ridge (topographic high) adjacent to and beneath the South Embankment.

8.4.2 Current Groundwater Flow Direction

The current groundwater flow direction in the area of the TSF is inferred to be partly dependent on the TSF Pond level. Provided that surface water level elevations within the TSF are above the surrounding shallow groundwater level, groundwater flow will be radial from the TSF towards the southwest, southeast, and northeast. However, when the TSF Pond level falls below the shallow groundwater levels on the west side of the TSF, then the TSF area becomes a flow-through environment, similar to pre-development conditions described above, with groundwater flow directed across the TSF from the west and northwest towards the east and southeast.

The plan in Illustration 8-1 shows the November 2020 hydraulic head contours and groundwater flow directions around the perimeter of the TSF. In 2020 and 2021, groundwater flow towards the TSF was from the upgradient, northwest side of the facility (i.e., area of GW14-1 and GW16-5A/B), originating from the area of Bootjack Lake and Polley Mountain. With the TSF Pond level at approximately 962 m, groundwater within the TSF footprint was inferred to flow radially outward towards the southwest (towards Edney Creek and its tributaries), southeast, and northeast (towards Hazeltine Creek).

8.5 Groundwater Use Downgradient of the Mine

A search in the Ministry of Environment's online database (iMapBC) in December 2022 indicated that there are no mapped aquifers within a radius of 10 km from the mine. The closest mapped aquifer, Fraser Plateau Lave Aquifer No. 124 IIIB (11), is a laterally extensive bedrock unit that was classified as having low demand and moderate vulnerability. The northern limit of this aquifer is situated more than 15 km south of the mine and is not considered to be hydraulically connected to groundwater from the mine area and the Hazeltine Channel corridor. This database search also indicated that water supply wells are not present in the immediate vicinity of the mine. The closest wells are approximately 6 km east, on the opposite (eastern) shore of Quesnel Lake. The database also contains information on water wells that are located northwest from the mine (near Little Lake) and southwest from the mine (near Gavin Lake) at a distance of at least 7 km. Considering these distances and the fact that several surface water features are between these wells and the mine, it is unlikely that seepage from the mine facilities could reach these wells or the closest mapped aquifer. A map showing the results of the water well search and the nearest mapped aquifer is included in APPENDIX F.

9.0 GEOCHEMICAL CONDITIONS

9.1 Monitoring Program

As stated previously, groundwater monitoring by MPMC has been ongoing at the mine site since 1995 with the objectives to monitor direction, quantity, and quality of groundwater flow near all mine facilities. The monitoring wells used to monitor groundwater levels around the perimeter of the TSF (listed in Section 8.3) are also used to monitor groundwater quality. The monitoring well network is shown in Illustration 8-1.

Groundwater samples from the monitoring wells are collected quarterly or semi-annually, depending on location, and are analyzed for field parameters, anions, nutrients, and dissolved metals and are reported annually. The analyses are focused on nine parameters of interest which included hardness, sulphate, nitrate, and the following dissolved metals: aluminum, arsenic, cadmium, molybdenum, and selenium.

The most recent groundwater quality data for the TSF area is reported in the *2021 Annual Groundwater Monitoring Report* (Golder 2022b). Water quality trend plots from this report are provided in Figure 10.

9.2 Baseline Groundwater Quality

The plots in Figure 10 provide information on baseline and early operations groundwater quality conditions, from 1996 to approximately 1999, at a few monitoring wells that were installed prior to or at the start of TSF operations in 1998 and continue to be monitored today. Based on these plots, baseline groundwater quality conditions are generally characterized by low concentrations of dissolved metals, sulphate, and nitrate and low to moderate hardness, with the exception of one monitoring well (GW96-3A) where concentrations of many parameters fluctuated substantially. The erratic results at GW96-3A suggest that non-natural factors (e.g., possible well contamination or well design flaws such as bentonite seal within the screened interval) were affecting the water quality results from this well. It should be noted that periodically flowing artesian conditions have been observed or inferred at this well and that it is situated next to the unlined Main Embankment Seepage Collection Pond (Section 8.3).

9.3 Tailings Storage Facility Tailings

The following information on metal leaching and acid rock drainage geochemistry is from the SRK *Derivation of Geochemical Source Terms, Mount Polley Mine* (Appendix C in Golder 2016b) and from Kennedy and Anglin (2016).

The Mount Polley copper-gold porphyry deposit is classified as an alkalic porphyry copper gold deposit. The mined mineralized zones are enriched in copper and selenium relative to global norms. Processing of the ore yields a copper sulphide concentrate. The tailings are lower in sulphide mineral content compared to the ore because most of the copper sulphides were removed through ore processing. In addition, mill process reagents, with the exception of lime, are not expected to be present within tailings. Furthermore, processing changes over time were minimal and not expected to affect the geochemical reactivity of the tailings; therefore, tailings geochemistry can be considered generally consistent over time.

Mount Polley tailings are classified as non-acid generating based on operational monitoring and testing of tailings spilled into Hazeltine Creek in August 2014. Compared to crustal normal concentrations, copper and selenium were present in the tailings sampled from Hazeltine Creek following the tailings release at order of magnitude higher concentrations, indicating tailings enriched in copper and selenium. However, average selenium concentrations in the operational tailings from within the TSF were lower than the spilled tailings in the creek and were similar to background levels (i.e., similar to average selenium concentrations in stream sediment samples from the region surrounding Mount Polley [Kennedy and Anglin 2016, Section 5.2.2]).

Humidity cell tests and column tests that ran for about 52 weeks and 35 weeks, respectively, using selected samples which had typical characteristics of tailings in the impoundment, were used to assess potential tailings leachate quality. The leachate quality from these tests is described below:

- pH typically between 8.0 and 8.2
- sulphate concentrations initially on the order of 1,000 mg/L, with decreasing concentrations over time that reached lower stabilized values
- highest copper concentration of 0.15 mg/L in one test, but with typical maximum concentrations of 0.02 mg/L in humidity cell test leachates and 0.05 mg/L in column test leachates
- highest selenium concentrations were 0.01 mg/L in humidity cell test leachates and 0.06 mg/L in column test leachates
- molybdenum concentrations initially between 2 and 3 mg/L in column leachates

9.4 Tailings Storage Facility Pond Water Quality

The quality of the TSF Pond water is monitored several times per year at monitoring location E1a as part of the Mount Polley Mine's Comprehensive Environmental Monitoring Plan under the *Environmental Management Act* Permit 11678 and *Mines Act* Permit M-200. The following water quality characteristics with respect to selected parameters of interest for this contact water (i.e., mine-affected water) from E1a were obtained from MPMC (2021, Section 4.10.1). Note that the mine was in care and maintenance in 2020 so values for the period between 2012 and 2014 are also included below.

- Annual mean hardness of 450 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 438 mg/L.
- Annual mean chloride concentration of 8.9 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 24.3 mg/L.
- Annual mean sulphate concentration of 438 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 542 mg/L.
- Annual mean nitrate concentration of 1.9 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 6.4 mg/L.
- Annual mean total iron concentration of 0.188 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 0.272 mg/L.
- Annual mean total copper concentration of 0.357 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 0.010 mg/L.
- Annual mean total selenium concentration of 0.0292 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 0.0260 mg/L.
- Annual mean total molybdenum concentration of 0.158 mg/L in 2020. For comparison, the pre-breach (2012 to 2014) mean was 0.184 mg/L.

MPMC (2021) reports that, of the parameters of interest, total molybdenum and possibly chloride have shown a general increasing trend after post-breach deposition of tailings commenced. Total copper concentrations have increased in recent years due to seepage with high copper concentration from the heap leach trial area in the waste dump.

9.5 Current Groundwater Quality

Based on the inferred groundwater flow direction described in Section 8.4, the upgradient and downgradient wells relative to the TSF are as follows:

- upgradient wells:
  - west: GW14-1 (no water quality data available for this location)
  - southwest (Corner 4): GW16-5A/B (potentially side-gradient)
- downgradient wells:
  - South Embankment: GW00-1A/B, GW00-2A, GW00-3A/B, GW96-4A/B
  - Main Embankment: GW16-4A/B, GW96-3A, GW16-3A/B
  - Perimeter Embankment: GW96-2A/B, GW16-2A/B

The following summary on groundwater quality is based on information from the *2021 Annual Groundwater Monitoring Report* (Golder 2022b). This summary provides an overview of the 2021 groundwater quality results and the groundwater quality trends for monitoring wells located around the TSF (as shown in Figure 10).

Over the last decade or so, although there were increasing parameter of interest concentration trends at some locations, significant changes to groundwater quality at the perimeter of the TSF had not been identified except with respect to sulphate. Sulphate concentrations in the shallow groundwater downgradient of the TSF approached or reached levels observed in the TSF Pond water next to the Perimeter Embankment at GW16-2B and GW96-2B and next to the South Embankment at GW96-4B. The highest sulphate concentrations were observed at GW96-2B in November 2021 (543 mg/L). These wells are known or inferred to be completed in glaciofluvial units based on soil descriptions and the relatively high hydraulic conductivity results (Table 8-1). The remaining wells indicated relatively stable or slightly decreasing sulphate concentration trends.

Groundwater quality results for the upgradient well nest location, GW16-5A/B, indicated no significant trends since the installation of the wells in 2016. Furthermore, the water quality at this location appears to be similar to baseline or pre-development water quality (described in Section 9.2).

The 2021 groundwater quality results were compared to the British Columbia (BC) Ministry of Environment and Climate Change Strategy Contaminated Sites Regulation (BC ENV 1997) standards for protection of freshwater aquatic life and the BC Approved Water Quality Guidelines for protection of aquatic life (BCWQG AW; BC ENV 2021). An analysis of the results indicated no exceedances of the Contaminated Sites Regulation standards for protection of freshwater aquatic life and no exceedances of the BCWQG AW guidelines with the following exceptions concerning the BCWQG AW criteria only:

- pH above the guideline range (6.5 to 9.0) at one downgradient well location (GW00-3A, pH = 11), with two locations only slightly above the guidelines (GW00-1A, GW16-2A)
- sulphate concentrations above the chronic guideline (128 to 429 mg/L, hardness dependent) at several downgradient well locations (GW96-2B in November 2021 [543 mg/L] but not in May 2021: GW96-4B [471 to 507 mg/L]; GW00-1A [226 mg/L]; GW16-2B [475 to 518 µg/L])
- dissolved iron above the acute guideline (350 ug/L) at one downgradient well location (GW96-4B, 785 to 877 µg/L); elevated dissolved iron concentrations were observed at the two upgradient well locations (GW14-1 in February to August 2021 [1,120 to 1,300 µg/L] but non-detectable in November 2021 [<30 µg/L], and GW16-5A [675 to 716 µg/L]).

10.0 DISCUSSION

This section presents a discussion of potential dam safety issues related to site conditions, along with the TSF design approach to mitigate each issue.

A general embankment description is included in Section 2.0. With a 970 m crest elevation, the embankment is approximately 4.8 km in length and has a maximum height of 58 m. The embankment has incorporated a staged expansion design utilizing modified centreline and centreline construction methods. The zoning of the embankment includes a low permeability till core, filter, and transition zones and rockfill zones forming the downstream shell of the embankment and the downstream buttress.

The elevation 970 m TSF design description is presented in Golder (2015g). The design to raise to facility to 987 m follows the same philosophy and is presented in WSP Golder (2022c).

10.1 Stability

Strength of Foundation Materials

Potential stability issues related to the strength of foundation materials include:

- insufficient strength in the foundation (i.e., glaciolacustrine layers) to resist the loads applied by the dam
- strain weakening of glaciolacustrine soils
- unidentified foundation conditions (e.g., unidentified glaciolacustrine deposits)

Multiple field investigations have been completed along the foundation of the embankment and buttress to delineate the extent and characterize the different foundation materials.

The weaker layers in the foundation of the embankment and buttress are the glaciolacustrine deposits. Extensive field and laboratory investigations have been completed to characterize the strength of the glaciolacustrine deposits.

The design approach is to analyze embankment stability and deformation considering the interpreted foundation conditions and includes:

- limit equilibrium analyses of downstream failure modes under static and pseudo-static conditions for the range of foundation conditions along the embankment
- limit equilibrium analyses with a range of glaciolacustrine deposits strength to assess sensitivity to potential variability
- stress-deformation analysis (2D FLAC model) to predict patterns of deformation and potential redistribution of stresses due to strain weakening of glaciolacustrine deposits

The design approach also follows the principles set out in the IEEIRP report of January 2015:

- Limit the amount of surface water to only that required for operation.
- Promote unsaturated conditions in the tailings with drainage provisions (i.e., minimum beach width and upstream drain).
- Achieve dilatant conditions throughout the tailings deposit (i.e., the existing tailings within the TSF drained and consolidated after the TSF breach in 2014 and the upstream drain promotes consolidation of new tailings).

Loading of Foundation Materials

The potential stability issue related to raising the TSF is the development of excess pore water pressure in the foundation materials during construction.

Extensive field and laboratory investigations have been completed to characterize the glaciolacustrine deposits.

The pore pressure response has been monitored within the glaciolacustrine deposits, till, and glaciofluvial layers during construction of the Corner 1 Embankment and Perimeter and Main embankment buttresses.

The design approach is to analyze embankment stability including the generation of excess pore water pressure due to loading of the foundation at key stages of construction.

Groundwater Conditions

The potential stability issue related to groundwater conditions is the failure of the Main Embankment vertical drain wells and the development of artesian pressures in the foundation.

The pore water pressure has been monitored within the glaciofluvial, till, and glaciolacustrine layers in the foundation of the Main Embankment. The readings show that the Main Embankment's vertical passive pressure relief wells continue to work and artesian pressures have not developed.

The design approach is to analyze embankment stability assuming that artesian pressures redevelop to the levels measured prior to the installation of the Main Embankment vertical drain wells.

10.2 Seepage

The potential seepage issue related to site conditions is the development of preferential flow pathways in the foundation soils (e.g., glaciofluvial layers) or bedrock, leading to increased seepage and potential groundwater quality issues.

- The design approach is to include suitable foundation preparation, placement of a filter blanket downstream of the till core and confirmation that a minimum thickness of competent till is present on surface along and upstream of the till core alignment. Where the thickness of competent till is adequate, the till core is keyed into the foundation till. Where the thickness of competent till is less than the minimum required, a till blank is constructed upstream of the till core and the till core is keyed into competent till or bedrock to cut-off through layers of higher hydraulic conductivity soils (e.g., glaciofluvial) or bedrock (e.g., fractured bedrock).
- For raises of the TSF, the thickness of competent till is confirmed during construction of the South and North abutments.

Monitoring data collected since 1996 shows that groundwater quality downgradient of the TSF is being affected by seepage from the TSF. The concentration of sulphate in groundwater downgradient of the TSF approached or reached levels observed in the TSF Pond water; however, it does not exceed the BC ENV (1997) Contaminated Sites Regulation water quality standards for protection of freshwater aquatic life. Additional groundwater monitoring downgradient of the TSF between monitoring wells showing elevated sulphate concentrations and surface water receptors should be planned.

11.0 CLOSURE

The reader is referred to the Study Limitations section, which precedes the text and forms an integral part of this report.

We trust the above meets your present requirements. If you have any questions, please contact the undersigned.

WSP Canada Inc.



Ryan Garritsen, P.Eng.
Geotechnical Engineer



2023-09-22

Germán Pizarro, P.Eng.
Principal Geotechnical Engineer



Connie Romano, M.Sc., P.Geo.
Senior Principal Hydrogeologist



Jeffrey Fillipone, Ph.D., P.Geo.
Senior Principal Geologist

RAG/GP/CR/JF/hp

https://golderassociates.sharepoint.com/sites/10023g/22514095 deliverables/002_issued/034-r-51392-foundation characterization report/rev0/22514095-034-r-rev0-51392-mt polley tsf dam site charact report_22aug_23.docx

REFERENCES

AMEC (AMEC Environment & Infrastructure, a division of AMEC Americas Limited). 2012. Mount Polley Mine Project: Tailings Storage Facility 2011 Geotechnical Site Investigation – FINAL. Prepared for Mount Polley Mining Corporation. Doc. No. VM00560.200.3. 28 March 2012.

AMEC. 2013. Mount Polley Mine Hydrogeology Assessment and Data Review. Prepared for Mount Polley Mining Corporation. 26 March 2013.

APEGBC (The Association of Professional Engineers and Geoscientists of British Columbia). 2016. The Professional Practice Guidelines – Site Characterization for Dam Foundations in BC. Version 1.2.

Bichler AJ, Bobrowsky PT. 2003. Quaternary geology of the Hydraulic map sheet, British Columbia (NTS 93A/12). British Columbia Geosciences, Research and Development Branch. Open File 2003-7. Scale 1:50,000.

BC ENV (British Columbia Ministry of Environment and Climate Change Strategy). 1997. Contaminated Sites Regulation. BC Reg. 375/96, O.C. 1480/96, under the Environmental Management Act. Includes amendments up to BC Reg. 179/2021, updated to 7 July 2021. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/375_96_00.

BC ENV. 2021. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture – Guideline Summary. Water Quality Guideline Series, WQG-20. Prov. B.C., Victoria B.C.

Carrivick JL, Tweed F. 2013. Quaternary Stratigraphy and History, Williams Lake, British Columbia. Quaternary Science Reviews, 78, pp. 34-52.

Clague JJ. 1987. Quaternary Stratigraphy and History, Williams Lake, British Columbia. Canadian Journal of Earth Science. Volume 24, pp. 147-158.

Clague JJ. 1988. Quaternary Stratigraphy and History, Quesnel, British Columbia. Géographie physique et Quaternaire. Volume 42, No. 3, pp. 279-288.

Dragert H, Hyndman RD, Rogers GC, Wang K. 1994. Current Deformation and the Width of the Seismogenic Zone of the Northern Cascadia Subduction Thrust, Journal of Geophysical Research, 99, pp. 653-668.

Golder (Golder Associates Ltd.). 2015a. Laboratory Testing Results from Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-012-TM-Rev0-2000. 26 March 2015.

Golder. 2015b. 2015 Freshet Management Embankment Design. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-008-R-Rev3-2000. 8 May 2015.

Golder. 2015c. Surficial Geology and Quaternary Geological Overview of the Mt. Polley Tailings Storage Facility (TSF) Area, British Columbia. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-058-R-Rev0-2000. 6 July 2015.

Golder. 2015d. 2015 Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-061-R-RevB-2000. 7 July 2015.

Golder. 2015e. Elevation 970 m Embankment Stability Analysis and Buttress Design. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-059-R-Rev0-3000. 10 July 2015.

Golder. 2015f. 2015 Freshet Management Embankment As-Built Construction. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-065-R-Rev0-2000. 4 September 2015.

Golder. 2015g. Tailings Storage Facility Detailed Design to Elevation 970 m. Prepared for Mount Polley Mining Corporation. Golder Doc. No.1413803-074-R-Rev0-3000. 3 November 2015.

Golder. 2015h. Tailings Storage Facility Life of Mine Feasibility Design. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-072-R-Rev0-9000. 3 November 2015.

Golder. 2016a. Seismic Deformation Analysis of the Tailings Storage Facility at Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1413803-097-R-Rev0-10000. 16 June 2016.

Golder. 2016b. Mount Polley Mine – Long Term Water Management Plan. Permit Amendment Application under the Environmental Management Act: Technical Assessment Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1411734-162-R-Rev0-16000. 17 October 2016.

Golder. 2016c Predictions of Hydrogeological Conditions near the Tailings Storage Facility during Closure – Long Term Technical Assessment Report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1411734-161-TM-Rev0-16000. 17 October 2016.

Golder. 2016d. Installation and Testing of New Monitoring Wells near the TSF, SERDS, Cariboo Pit and Wight Pit – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-058-TM-RevB-53100. 23 December 2016.

Golder. 2017. 2016 TSF Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-114-R-Rev0-51121. 10 March 2017.

Golder. 2019. 2018 TSF Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 1662612-210-R-Rev0-51121. 8 March 2019.

Golder. 2021. 2020 Annual Environmental Report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 21452039-011-R-Rev0-32131. 31 March 2021.

Golder. 2022a. 2021 Annual Dam Safety Inspection for Tailings Storage Facility Embankment. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-010-R-Rev0-52334. 29 March 2022.

Golder. 2022b. 2021 Annual Groundwater Monitoring Report – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-022-R-Rev0-32100. 31 March 2022.

Hashmi S, Plouffe A, and Ward BC. 2015. Surficial Geology, Bootjack Mountain Area, British Columbia, Parts of NTS 93-A/5, NTS 93-A/6, NTS 93-A/11, and NTS 93- A/12. Geological Survey of Canada, Canadian Geoscience Map 209 (Preliminary). British Columbia Geological Survey, Geoscience Map 2015-02. Scale 1:50,000.

Holland S. 1976. Landforms of British Columbia, A Physiographic Outline, Bulletin 48. B.C. Ministry of Energy, Mines and Petroleum Resources, pp. 138.

Hyndman RD, Wang K. 1995. The Rupture Zone of Cascadia Great Earthquakes from Current Deformation and the Thermal Regime, Journal of Geophysical Research, 100, No. 22, pp. 133-154.

IEEIRP (Independent Expert Engineering Investigation and Review Panel). 2015. Report on Mount Polley Tailings Storage Facility Breach. Prepared for BC Ministry of Energy and Mines. 30 January 2015.

IMC (Imperial Metals Corporation). 1990. Mount Polley Project. Stage 1 Environmental and Socioeconomic Impact Assessment. Volume I of II. Submitted to BC Mine Development Steering Committee. July 1990.

Karlsrud K, Hernandez-Martinez FG. 2013. Strength and Deformation Properties of Norwegian Clays from Laboratory Tests on High-Quality Block Samples. Canadian Geotechnical Journal 50:1273–1293 (2013).

KCB (Klohn Crippen Berger Ltd.). 2015a. Mount Polley Tailings Dam Failure – A Summary of Opinions in Support of CIM Investigation. Prepared for the Ministry of Energy and Mines. Doc. No. M09954A01.730. 24 August 2015.

KCB. 2015b. Mount Polley Dam Failure – Advanced Laboratory Testing Program Progress Report No. 4. Prepared for BC Ministry of Energy and Mines. Doc. No. M09954A02.730. 12 February 2015.

KCB. 2015c. Mount Polley Dam Failure – Site Investigation Progress Report No. 2. Prepared for BC Ministry of Energy and Mines. Doc. No. M09954A02.730. 21 January 2015.

Kennedy CB, Anglin CD. 2016. Geochemistry of Tailings from Mount Polley Mine, British Columbia. Proceedings Tailings and Mine Waste 2016, Keystone, Colorado, USA. 2-5 October 2016.

KP (Knight and Piésold Ltd.). 1990. Geotechnical and Tailings Disposal Studies. Feasibility Study, Volume 3 of 5, Appendix XI. Mount Polley Project, Williams Lake, BC. Wright Engineers Limited. Prepared for Imperial Metals Corporation. June 1990.

KP. 1995a. Report on 1995 Geotechnical Investigations for Mill Site and Tailings Storage Facility. Prepared for Imperial Metals Corporation. Reference No. 1623/1. 14 March 1995.

KP. 1995b. Tailings Storage Facility Design Report Volume I – Main Report. Prepared for Imperial Metals Corporation. Reference No. 1625/1. 26 May 1995.

KP. 1996. Response to Review Comments on Tailings Embankment Design. Prepared for Imperial Metals Corporation. Reference No. 1625/6. 25 January 1996.

KP. 1997a. Report on Stage Ia/Ib Construction. Prepared for Mount Polley Mining Corporation. Reference No. 10162/7-5. 14 August 1997.

KP. 1997b. 1996 Groundwater Monitoring Well Installation Program. Prepared for Mount Polley Mining Corporation. Reference No. 1628/4. 7 February 1997.

KP. 1997c. Mount Polley Project – Tailings Storage Facility Updated Design Report. Prepared for Mount Polley Mining Corporation. Reference No. 1627/2. 6 June 1997.

KP. 1997d. Stage 2A Tailings Facility Construction Selected Excerpts from Reference Information. Prepared for Mount Polley Mining Corporation. Reference No. 10162/9-2. 6 November 1997.

KP. 1999. Mount Polley Mine Tailings Storage Facility Report on 1998 Construction and Annual Inspection. Prepared for Mount Polley Mining Corporation. Reference No. 11162/10 1. 16 June 1999.

KP. 2000. Mount Polley Mine Tailings Storage Facility Report on 1999 Construction. Prepared for Mount Polley Mining Corporation. Reference No. 11162/13 5. 30 August 2000.

KP. 2001. Mount Polley Mine Tailings Storage Facility Report on Stage 3 Construction. Prepared for Mount Polley Mining Corporation. Reference No. 11162/14-3. 19 October 2001.

KP. 2005. Mount Polley Mine Design of the Tailings Storage Facility to Ultimate Elevation. Prepared for Mount Polley Mining Corporation. 14 March 2005.

KP. 2007a. Mount Polley Mine Tailings Storage Facility Report on Stage 4 Construction. Prepared for Mount Polley Mining Corporation. Reference No. VA101-1/10-1. 13 March 2007.

KP. 2007b. Mount Polley Stage 6 TSF Design. Letter to Mr. Chris Carr, Geotechnical Mines Inspector, Ministry of Energy, Mines and Petroleum Resources. Reference No. VA101 1/18 A.01. 19 December 2007.

KP. 2009. Mount Polley Mine Tailings Storage Facility Report on Stage 6A Construction. Prepared for Mount Polley Mining Corporation. Reference No. VA101-1/23-1. 10 July 2009.

KP. 2011. Tailings Storage Facility Report on Stage 6B Construction. Prepared for Mount Polley Mining Corporation. Reference No. VA101-1/29-1. 25 January 2011.

Ladd CC, Foot R. 1974. New Design Procedure for Stability of Soft Clays. J. Geotech. Engrg. Div., ASCE, 100(7), 763-786.

Logan JM, Bath A, Mihalynuk MG, Rees CJ, Ullrich TD, Friedman R. 2007. Regional Geology of the Mount Polley Area, central British Columbia. Geological Survey of Canada, Geoscience Map 2007-1. Scale 1:50,000.

Lunne T, Berre T, Strandvik S. 1997. Sample Disturbance Effects in Soft Low Plastic Norwegian Clay. In: Proceedings of the Conference on Recent Developments in Soil and Pavement Mechanics, Rio de Janeiro, June 1997, pp. 81–102.

Mayne PW. 2001. Invited Keynote: Stress-Strain-Strength-Flow Parameters from Enhanced In-Situ Tests. Proceedings, International Conference on In-Situ Measurement of Soil Properties and Case Histories (In-Situ 2001), Bali, Indonesia, 27-47.

Mazzotti S, Dragert H, Henton J, Schmidt M, Hyndman R, James T, Lu Y, and Cramer M. 2003. Current Tectonics of Northern Cascadia from a Decade of GPS Measurements, Journal of Geophysical Research, 108, 2554.

McAndless P, Taylor C. 2006. Surficial Geology of the Mount Polley Property: Summary of 2005 Exploration Work. Prepared for Mount Polley Mining Corporation. 2 April 2006.

Monger JWH. 1989. Chapter 2 – Overview of Cordilleran Geology, in Ricketts BD. ed., Western Canada Sedimentary Basin, Canadian Association of Petroleum Geology (Special Paper S30), pp. 9–32.

Monger JWH, Price RA. 1979. Geodynamic Evolution of the Canadian Cordillera - Progress and Problems: Canadian Journal of Earth Sciences Volume 16 (3), pp. 770-791.

MPMC (Mount Polley Mining Corporation). 2021. 2020 Annual Environmental Report for the Mount Polley Mine. 31 March 2021.

Panteleyev A, Bailey DG, Bloodgood MA, Hancock KD. 1996. Geology and Mineral Deposits of the Quesnel River – Horsefly Map Area, Central Quesnel Trough, British Columbia. BC Ministry of Energy and Mines. Bulletin 97. Scale 1:100,000.

Price RA. 1994. Cordilleran Tectonics and the Evolution of the Western Canada Sedimentary Basin. In: The Geological Atlas of the Western Canada Sedimentary Basin, Chapter 2, Canadian Society of Petroleum Geologists; Editors: G.D. Mossop and I. Shetsen.

Price RA. 2000. The Evolution of the Southern Cordilleran Foreland Thrust and Fold Belt and the Kinematics of Cordilleran Orogenesis. In: Conference Proceedings, GeoCanada 2000, Symposium and Field Trip, University of Calgary, Alberta.

Ricketts BD. 2008. Cordilleran Sedimentary Basins of Western Canada Record 180 Million Years of Terrane Accretion: K.J. Hsü, Series Editor: Sedimentary Basins of the World, Volume 5, The Sedimentary Basins of the United States and Canada, Andrew D. Miall (Editor). Elsevier, pp. 363-394.

Rogers GC, Cassidy JF, Ellis RM. 1990. The Prince George, British Columbia Earthquake of 21 March 1986, Bulletin of the Seismological Society of America, 80, No. 5, pp. 1144-1161.

Skempton AW. 1954. The Pore Pressure Coefficients A and B. Geotechnique Volume 4, pp. 143-147.

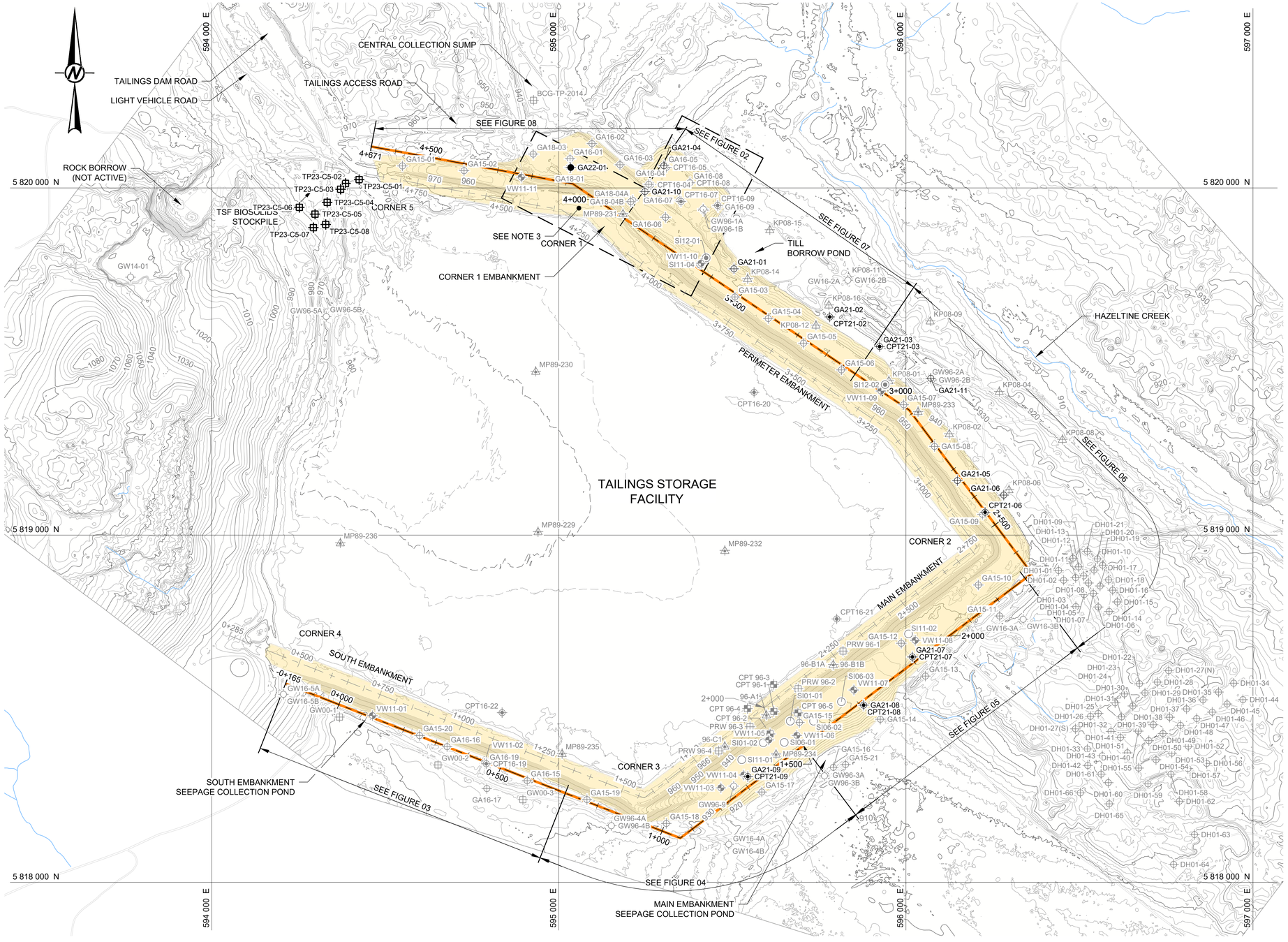
Tweed F, Carrivick JL. 2015. Deglaciation and Proglacial Lakes. Geology Today. 31. 10.1111/gto.12094.

WSP Golder (Golder Associates Ltd., a member of WSP). 2022a. Climate Baseline Update. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-066-R-Rev0-31547. 30 August 2022.

WSP Golder. 2022b. 2021/2022 Tailings Storage Facility Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-011-R-Rev0-51300. 18 October 2022.

WSP Golder. 2022c. Basis of Design and Design Criteria for Life of Mine Tailings Storage Facility Raise. Prepared for Mount Polley Mining Corporation. Golder Doc. No. 22514095-069-TM-RevA-51393. 2 September 2022.

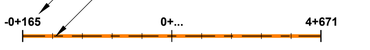
FIGURES



LEGEND

- SETOUT LINE - S.O.L. - ORIGINAL ALIGNMENT (SEE REFERENCE 1)
- GROUND CONTOURS (SEE REFERENCE 2)
- BATHYMETRY CONTOURS (SEE REFERENCE 3)
- STREAM (SEE REFERENCE 4)
- SITE ACCESS ROADS (SEE REFERENCE 4)
- GA22-01 — SONIC DRILLING, PIEZOMETER INSTALLATION - CORNER 1 EMBANKMENT (GOLDER, 2022)
- GA21-10 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1, PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- CPT21-09 — CPT - PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- GA18-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 (GOLDER, 2018)
- GA16-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- CPT16-04 — CPT - TAILINGS, CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- GW16-2A — SONIC DRILLING, MONITORING WELL INSTALLATION (GOLDER, 2016)
- GA15-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION (GOLDER, 2015)
- BGC-TP-2014 — TEST PIT (BGC / GOLDER, 2014)
- SI12-01 — ODEX, SI INSTALLATION - PERIMETER EMBANKMENT (AMEC, 2012)
- VW11-01 — SONIC DRILLING, PIEZOMETER INSTALLATION (AMEC, 2011)
- SI11-01 — SONIC DRILLING, SI INSTALLATION (AMEC, 2011)
- KP08-01 — SONIC DRILLING, SPT, BORROW PROGRAM (KP, 2008)
- SI06-01 — ODEX, SPT, SI INSTALLATION - MAIN EMBANKMENT (KP, 2006)
- SI01-01 — ODEX, SPT - MAIN EMBANKMENT (KP, 2001)
- DH01-01 — DRILLING, BORROW PROGRAM (KP, 2001)
- GW00-01 — ODEX, SPT, MONITORING WELL INSTALLATION - SOUTH EMBANKMENT (KP, 2000)
- CPT 96-1 — CPT - MAIN EMBANKMENT (KP / CONETEC, 1996)
- 96-A1 — SOLID/HOLLOW STEM AUGER, SPT, PIEZOMETER INSTALLATION - MAIN EMBANKMENT (KP / R.E. GRAHAM ENG., 1996)
- PRW96-01 — SOLID STEM AUGER, PRESSURE RELIEF WELL - MAIN EMBANKMENT (KP, 1996)
- GW96-1 — AIR ROTARY, SPT, MONITORING WELL INSTALLATION (KP, 1996)
- MP89-230 — CONDEMNATION BOREHOLES, PIEZOMETER INSTALLATION (KP, 1989)
- EMBANKMENT FOOTPRINT

GEOLOGICAL PROFILE REFERENCE LINE



0 200 400
1:6,000 METRES

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP CANADA INC.

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.
3. THE FORENSIC INVESTIGATION BOREHOLES NEAR CORNER 1 (FROM 2014) ARE NOT SHOWN ON THE FIGURE FOR CLARITY, REFER TO FIGURE 02.
4. THE FOLLOWING DRILLING INVESTIGATIONS ARE NOT SHOWN ON THE FIGURE FOR CLARITY: DH97-BA (KP 1997c), DH97-BA2 (IEERP 2015), DH98-BA2 (IEERP 2015), DH98-BA4 (IEERP 2015), DH98-BL (KP 1999), PRW98 (KP 1999), BH99 (KP 1999), AND DH99 (KP 2000).
5. TEST PIT INVESTIGATIONS ARE NOT SHOWN ON THE FIGURE FOR CLARITY.

REFERENCES

1. S.O.L - ORIGINAL ALIGNMENT PROVIDED BY BGC ENGINEERING INC., DRAWING No. 01, DRAWING TITLE, "SI PLANNING PLAN MAP", PROJECT No. P14178, FILE NAME: "ACAD-01.dwg", DATED: SEPTEMBER 2014.
2. GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.
3. BATHYMETRY CONTOURS PROVIDED BY MPMC, FILE NAME: "200617 sound.csv", SURVEYED: 17 JUNE 2020, RECEIVED: 23 JUNE 2020,
4. EXISTING SITE FEATURES PROVIDED BY MPMC, FILE NAME: "MtPolley2013-Pln.dwg", RECEIVED: 5 SEPTEMBER 2014, AND FILE NAME: "211012 SERD Site Plan.dxf", RECEIVED: 12 OCTOBER 2021.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

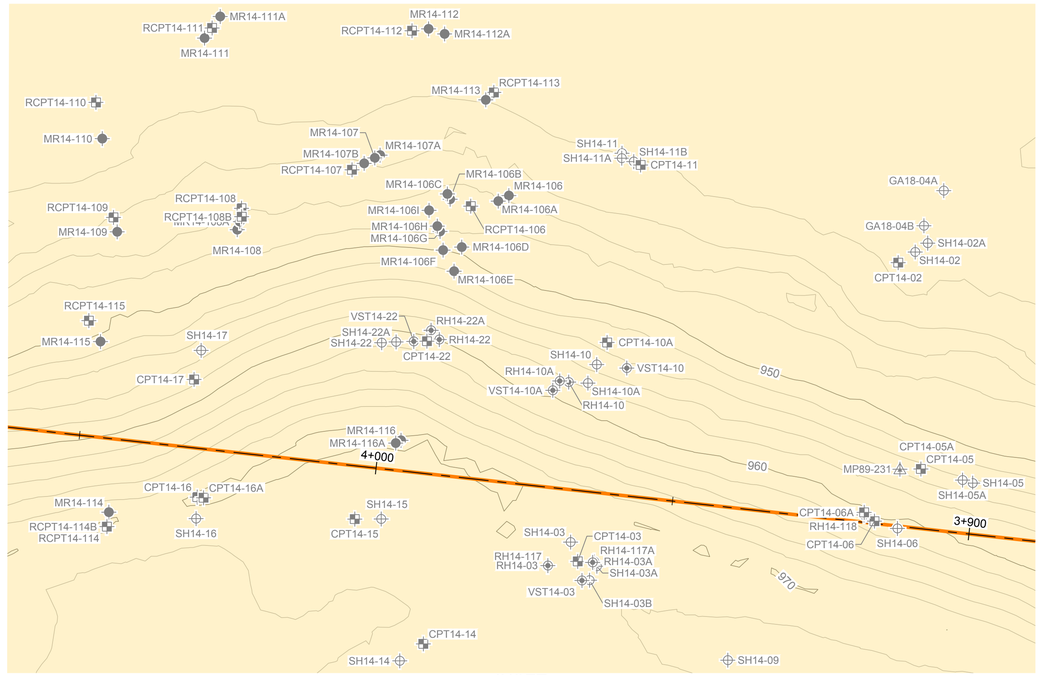
TITLE
OVERVIEW BOREHOLE LOCATION PLAN

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	01

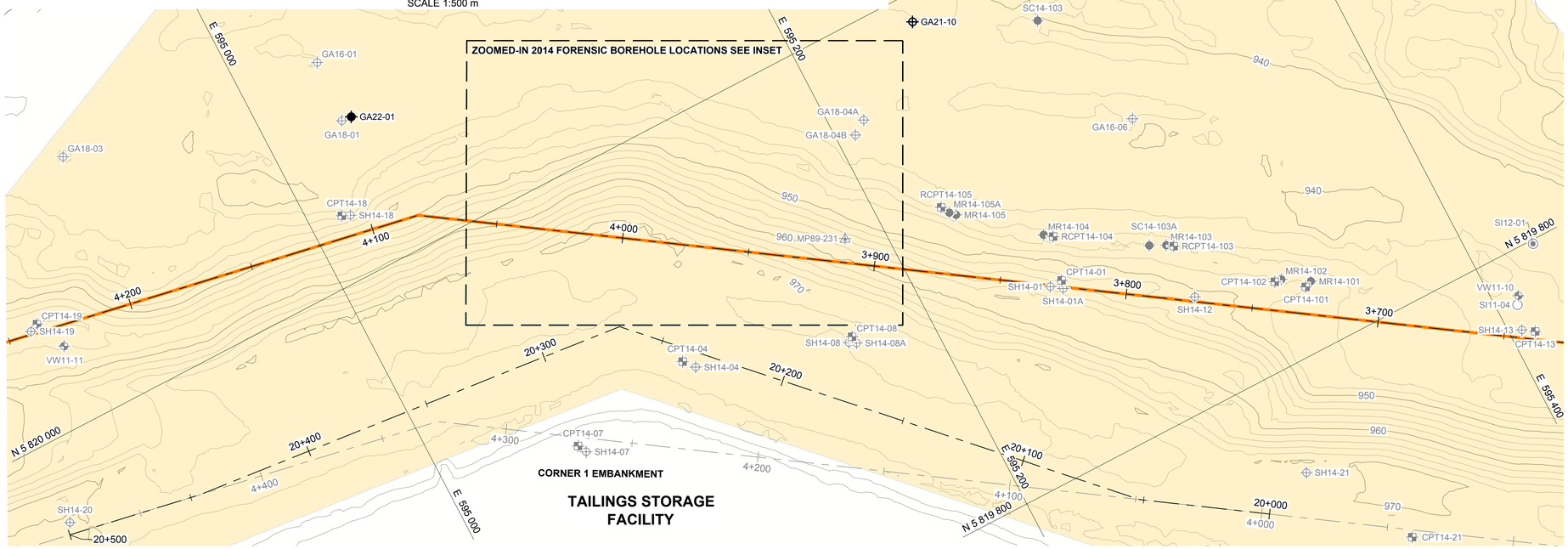
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-034-01.dwg | Last Edited By: xinwang Date: 2023-07-26 Time:12:51:50 PM | Printed By: XinWang Date: 2023-08-11 Time:12:57:46 PM



INSET
SCALE 1:500 m



CORNER 1 EMBANKMENT

TAILINGS STORAGE FACILITY

LEGEND

- 3+800 — GEOLOGICAL PROFILE REFERENCE LINE AND CHAINAGE
- 20+200 — CORNER 1 PERIMETER EMBANKMENT ALIGNMENT
- 4+400 — SETOUT LINE - S.O.L. - ORIGINAL ALIGNMENT (SEE REFERENCE 1)
- GROUND CONTOURS (SEE REFERENCE 2)
- GA22-01 — SONIC DRILLING, PIEZOMETER INSTALLATION - CORNER 1 EMBANKMENT (GOLDER, 2022)
- GA21-10 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1, PERIMETER AND MAIN EMBANKMENT (GOLDER, 2021)
- GA18-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 (GOLDER, 2018)
- GA16-01 — SONIC DRILLING, SI AND PIEZOMETER INSTALLATION - CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- CPT16-04 — CPT - TAILINGS, CORNER 1 AND SOUTH EMBANKMENT (GOLDER, 2016)
- CPT14-101 / RCPT14-103 — CPT - CORNER 1 EMBANKMENT (THE PANEL, 2014)
- CPT14-01 — CPT - CORNER 1 EMBANKMENT (KCB, 2014)
- SH14-10 — SONIC DRILLING, SI, SAA, AND PIEZOMETER INSTALLATION - CORNER 1 EMBANKMENT (KCB, 2014)
- RH14-03 / VST 14-03 — MUD ROTARY, PIEZOMTER INSTALLATION - CORNER 1 EMBANKMENT (KCB, 2014)
- MR14-104 / SC14-103 / RH14-117 — MUD ROTARY - CORNER 1 EMBANKMENMT (THE PANEL, 2014)
- SI12-01 — ODEX, SI INSTALLATION - PERIMETER EMBANKMENT (AMEC, 2012)
- SI11-01 — SONIC DRILLING, SI INSTALLATION (AMEC, 2011)
- VW11-01 — SONIC DRILLING, PIEZOMETER INSTALLATION (AMEC, 2011)
- GW96-1 — AIR ROTARY, SPT, MONITORING WELL INSTALLATION (KP, 1996)
- MP89-230 — CONDEMNATION BOREHOLES, PIEZOMETER INSTALLATION (KP, 1989)
- EMBANKMENT FOOTPRINT

0 20 40
1:500 METRES

0 50 100
1:1,000 METRES

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP CANADA INC.

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATES AND ELEVATIONS SHOWN ARE REFERENCED TO TAILINGS GRID.

REFERENCES

1. S.O.L - ORIGINAL ALIGNMENT PROVIDED BY BGC ENGINEERING INC., DRAWING No. 01, DRAWING TITLE, "SI PLANNING PLAN MAP", PROJECT No. P14178, FILE NAME: "ACAD-01.dwg", DATED: SEPTEMBER 2014.
2. GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

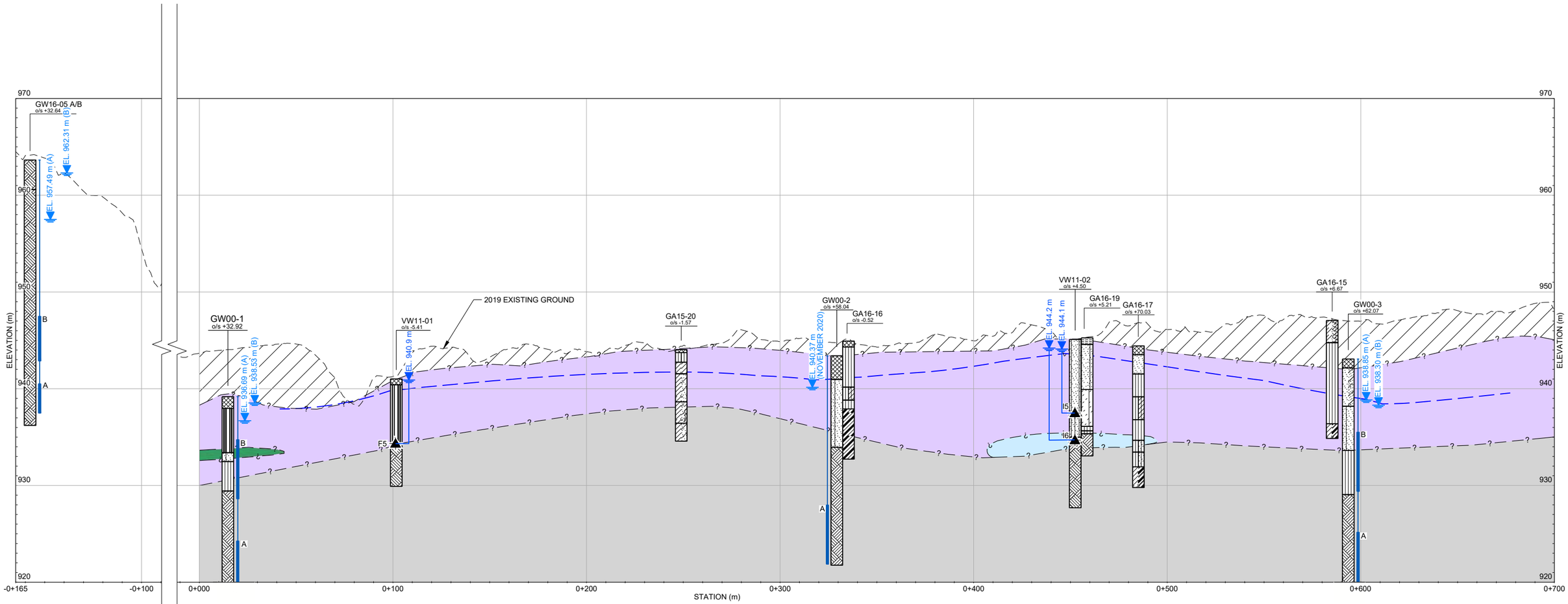
TITLE
CORNER 1 EMBANKMENT BOREHOLE LOCATION PLAN

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	02

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 25 mm

Path: \\golder.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-034-02.dwg | Last Edited By: xinwang Date: 2023-07-25 Time:12:48:52 PM | Printed By: XinWang Date: 2023-08-11 Time:3:17:33 PM



PROFILE - STA. -0+165 m TO 0+700 m

HORIZ. SCALE 1:2,000 m
VERT. SCALE 1:400 m

LEGEND

2019 EXISTING GROUND SURFACE — INFERRED STRATIGRAPHIC CONTACT
INFERRED WATER TABLE (PHREATIC SURFACE)

TEST HOLE LEGEND

BH19-02
o/s -88.59

DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER
DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES
GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021
EXISTING VIBRATING WIRE PIEZOMETER
MONITORING WELL SCREEN
TEST HOLE RECORD SHOWING SOIL CONDITIONS (FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

NOT USED FOR THE GEOLOGICAL PROFILE BOUNDARIES SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL, PT - PEAT, OL - ORGANIC SILT, OH - ORGANIC SILT, CL - SILTY CLAY, TOPSOIL, CI - SILTY CLAY, CH - CLAY, MH - CLAYEY SILT, ML - CLAYEY SILT OR SILT, ASPHALT, SC - CLAYEY SAND, SW - WELL GRADED SAND, SM - SILTY SAND, SP - POORLY GRADED SAND, GC - CLAYEY GRAVEL, GM - SILTY GRAVEL, GP - POORLY GRADED GRAVEL, GW - WELL GRADED GRAVEL, BEDROCK

SOIL STRATIGRAPHY

FILL, ABLATION TILL, GLACIOLACUSTRINE SUB-UNIT, BASAL TILL, GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED), GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

0 10 20
VERT. SCALE 1:400 METRES

0 50 100
HORIZ. SCALE 1:2,000 METRES

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

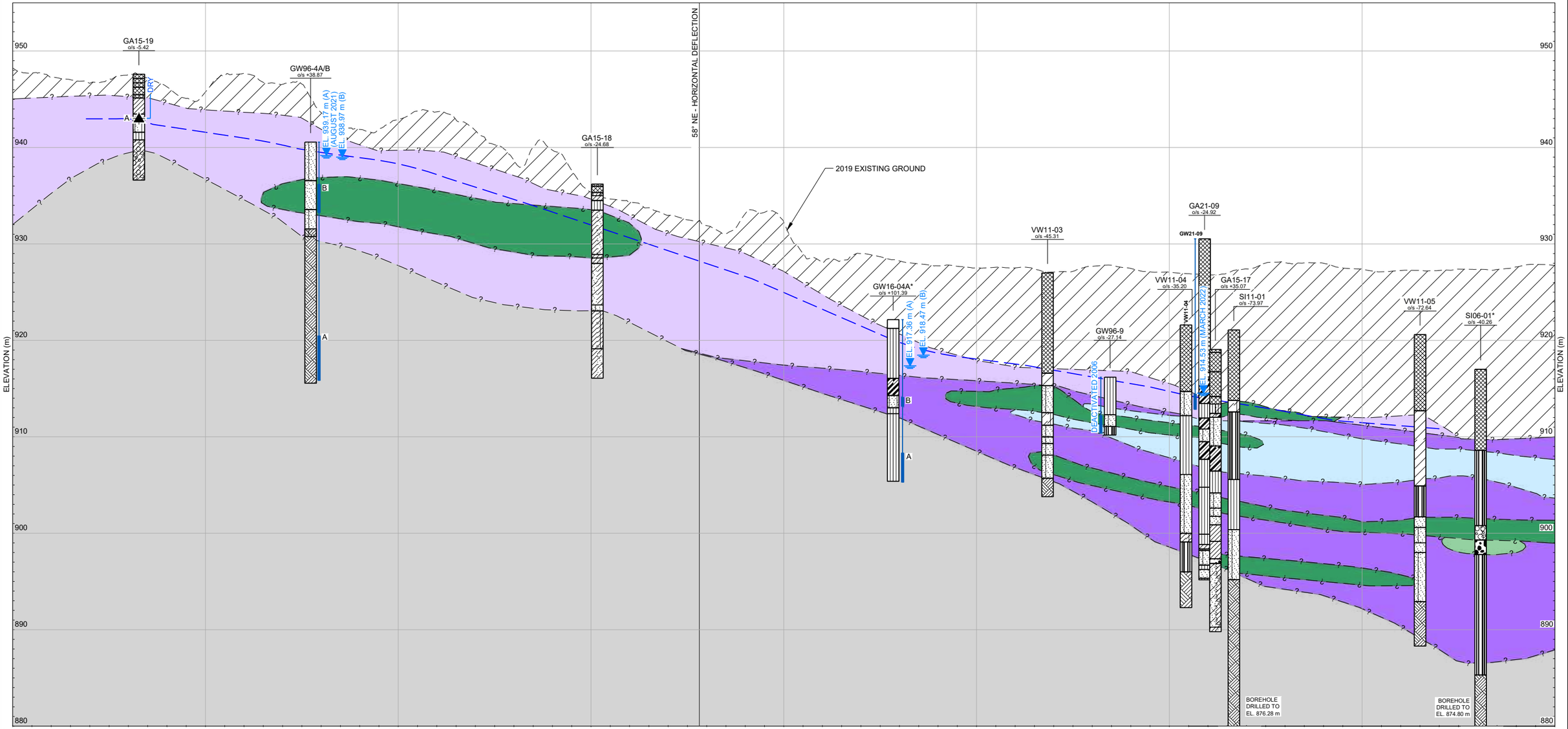
TITLE
SURFICIAL GEOLOGY PROFILE (1 OF 6)
STA. -0+165 TO 0+700

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	03

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

Path: \\golder.gds\corp\exodata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-03-03.dwg



LEGEND

2019 EXISTING GROUND SURFACE — INFERRED STRATIGRAPHIC CONTACT

INFERRED WATER TABLE (PHREATIC SURFACE)

TEST HOLE LEGEND

BH19-02 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER

o/s -88.59 — DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES

GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021

EXISTING VIBRATING WIRE PIEZOMETER

MONITORING WELL SCREEN

TEST HOLE RECORD SHOWING SOIL CONDITIONS (FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

NOT USED FOR THE GEOLOGICAL PROFILE BOUNDARIES SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL	TOPSOIL	ASPHALT	GC - CLAYEY GRAVEL
PT - PEAT	CI - SILTY CLAY	SC - CLAYEY SAND	GM - SILTY GRAVEL
OL - ORGANIC SILT	CH - CLAY	SW - WELL GRADED SAND	GP - POORLY GRADED GRAVEL
OH - ORGANIC SILT	MH - CLAYEY SILT	SM - SILTY SAND	GW - WELL GRADED GRAVEL
CL - SILTY CLAY	ML - CLAYEY SILT OR SILT	SP - POORLY GRADED SAND	BEDROCK

SOIL STRATIGRAPHY

FILL	GLACIOLACUSTRINE SUB-UNIT	GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED)
ABLATION TILL	BASAL TILL	GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

PROFILE - STA. 0+700 m TO 1+500 m

HORIZ. SCALE 1:2,000 m

VERT. SCALE 1:400 m

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENTS OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

0 10 20
VERT. SCALE 1:400 METRES

0 50 100
HORIZ. SCALE 1:2,000 METRES

CLIENT: MOUNT POLLEY MINING CORPORATION

CONSULTANT: wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

TITLE
SURFICIAL GEOLOGY PROFILE (2 OF 6)
STA. 0+700 TO 1+500

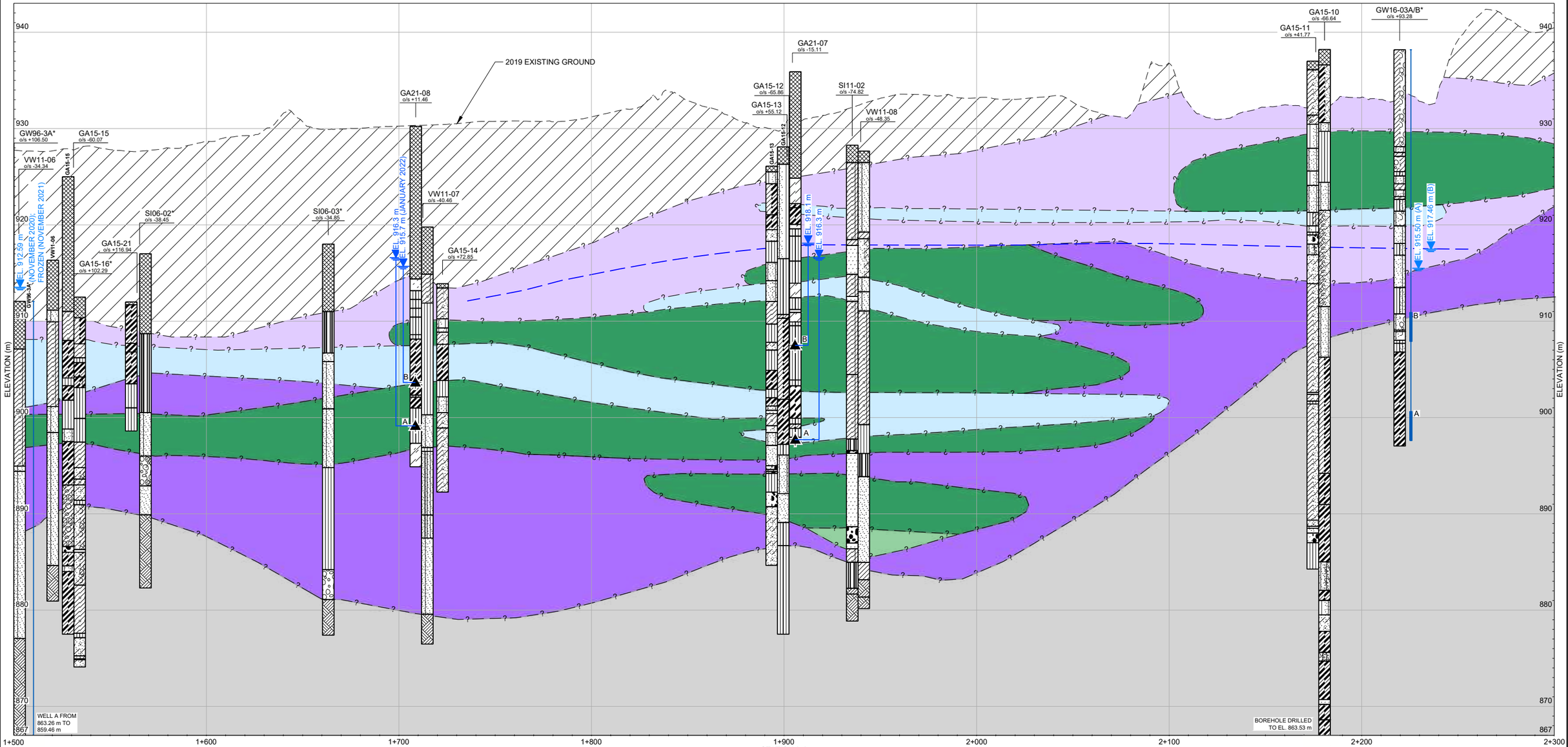
PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	04

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

0

Path: \\gp\ldfs_gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\69_PROJECTS\21452039\51300\51392\2Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-034-04.dwg | Last Edited By: gtd_xinwang Date: 2023-01-25 Time:11:59:41 AM | Printed By: XinWang Date: 2023-08-11 Time:1:01:18 PM



LEGEND

2019 EXISTING GROUND SURFACE — — ? — INFERRED STRATIGRAPHIC CONTACT

INFERRED WATER TABLE (PHREATIC SURFACE)

TEST HOLE LEGEND

BH19-02 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER

o/s -88.59 — DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES

GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021

EXISTING VIBRATING WIRE PIEZOMETER

MONITORING WELL SCREEN

TEST HOLE RECORD SHOWING SOIL CONDITIONS (FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

NOT USED FOR THE GEOLOGICAL PROFILE BOUNDARIES SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL	TOPSOIL	ASPHALT	GC - CLAYEY GRAVEL
PT - PEAT	CI - SILTY CLAY	SC - CLAYEY SAND	GM - SILTY GRAVEL
OL - ORGANIC SILT	CH - CLAY	SW - WELL GRADED SAND	GP - POORLY GRADED GRAVEL
OH - ORGANIC SILT	MH - CLAYEY SILT	SM - SILTY SAND	GW - WELL GRADED GRAVEL
CL - SILTY CLAY	ML - CLAYEY SILT OR SILT	SP - POORLY GRADED SAND	BEDROCK

SOIL STRATIGRAPHY

FILL	GLACIOLACUSTRINE SUB-UNIT	GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED)
ABLATION TILL	BASAL TILL	GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

PROFILE - STA. 1+500 m TO 2+300 m

HORIZ. SCALE 1:2,000 m
VERT. SCALE 1:400 m

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

0 10 20
VERT. SCALE 1:400 METRES

0 50 100
HORIZ. SCALE 1:2,000 METRES

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

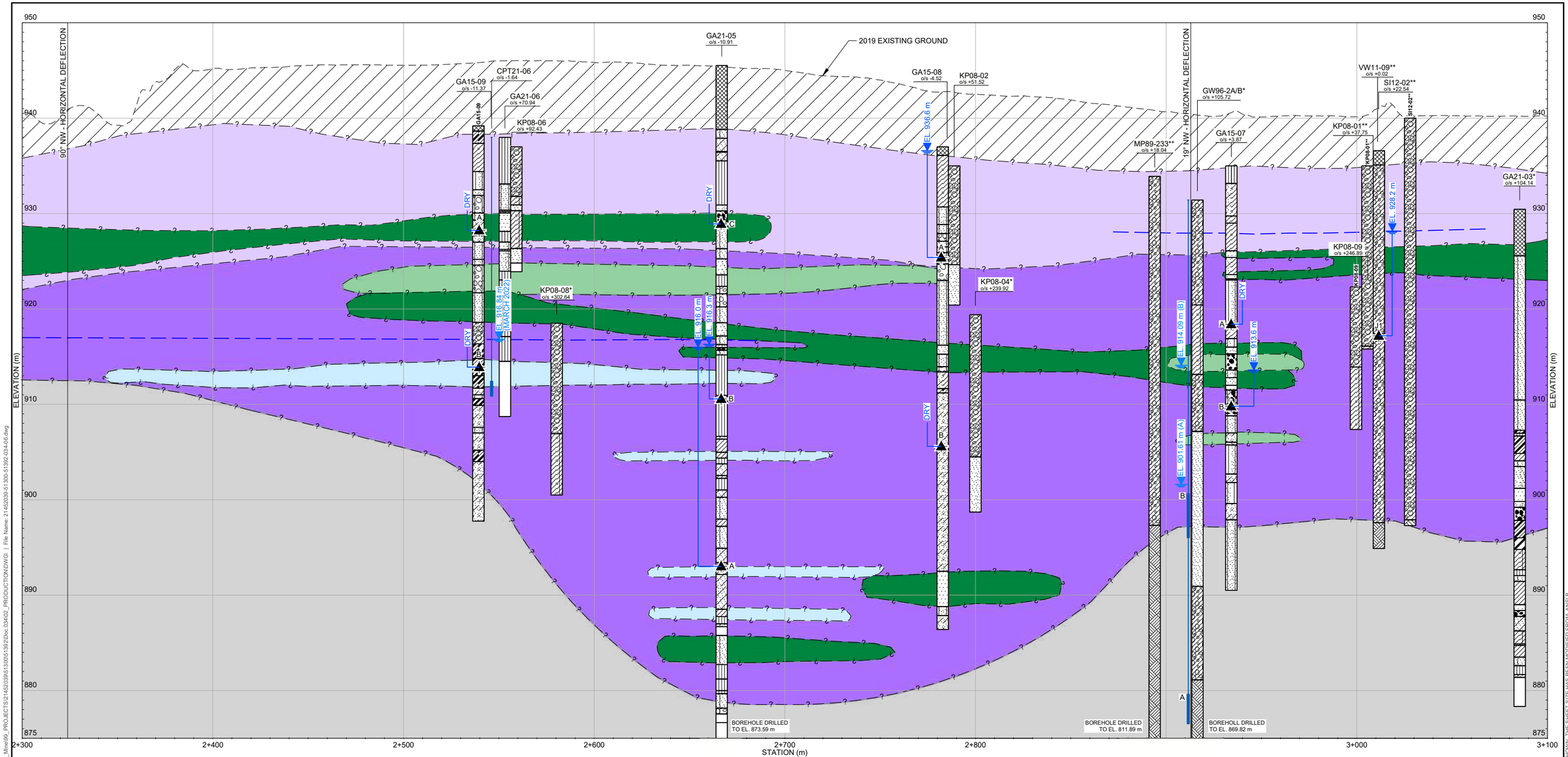
TITLE
SURFICIAL GEOLOGY PROFILE (3 OF 6)
STA. 1+500 TO 2+300

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	05

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

Path: \\pidcr.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-034-05.dwg



LEGEND

2019 EXISTING GROUND SURFACE — — ? — INFERRED STRATIGRAPHIC CONTACT

INFERRED WATER TABLE (PHREATIC SURFACE)

TEST HOLE LEGEND

BH19-02 / o/s -88.59 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER; DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES

GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021

EXISTING VIBRATING WIRE PIEZOMETER

MONITORING WELL SCREEN

TEST HOLE RECORD SHOWING SOIL CONDITIONS (FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

NOT USED FOR THE GEOLOGICAL PROFILE BOUNDARIES SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL; TOPSOIL; ASPHALT; GC - CLAYEY GRAVEL

PT - PEAT; CI - SILTY CLAY; SC - CLAYEY SAND; GM - SILTY GRAVEL

OL - ORGANIC SILT; CH - CLAY; SW - WELL GRADED SAND; GP - POORLY GRADED GRAVEL

OH - ORGANIC SILT; MH - CLAYEY SILT; SM - SILTY SAND; GW - WELL GRADED GRAVEL

CL - SILTY CLAY; ML - CLAYEY SILT OR SILT; SP - POORLY GRADED SAND; BEDROCK

SOIL STRATIGRAPHY

FILL; GLACIOLACUSTRINE SUB-UNIT; GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED)

ABLATION TILL; BASAL TILL; GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

PROFILE - STA. 2+300 m TO 3+100 m

HORIZ. SCALE 1:2,000 m

VERT. SCALE 1:400 m

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

0 10 20

VERT. SCALE 1:400 METRES

0 50 100

HORIZ. SCALE 1:2,000 METRES

CLIENT

MOUNT POLLEY MINING CORPORATION

CONSULTANT

wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT

MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

TITLE

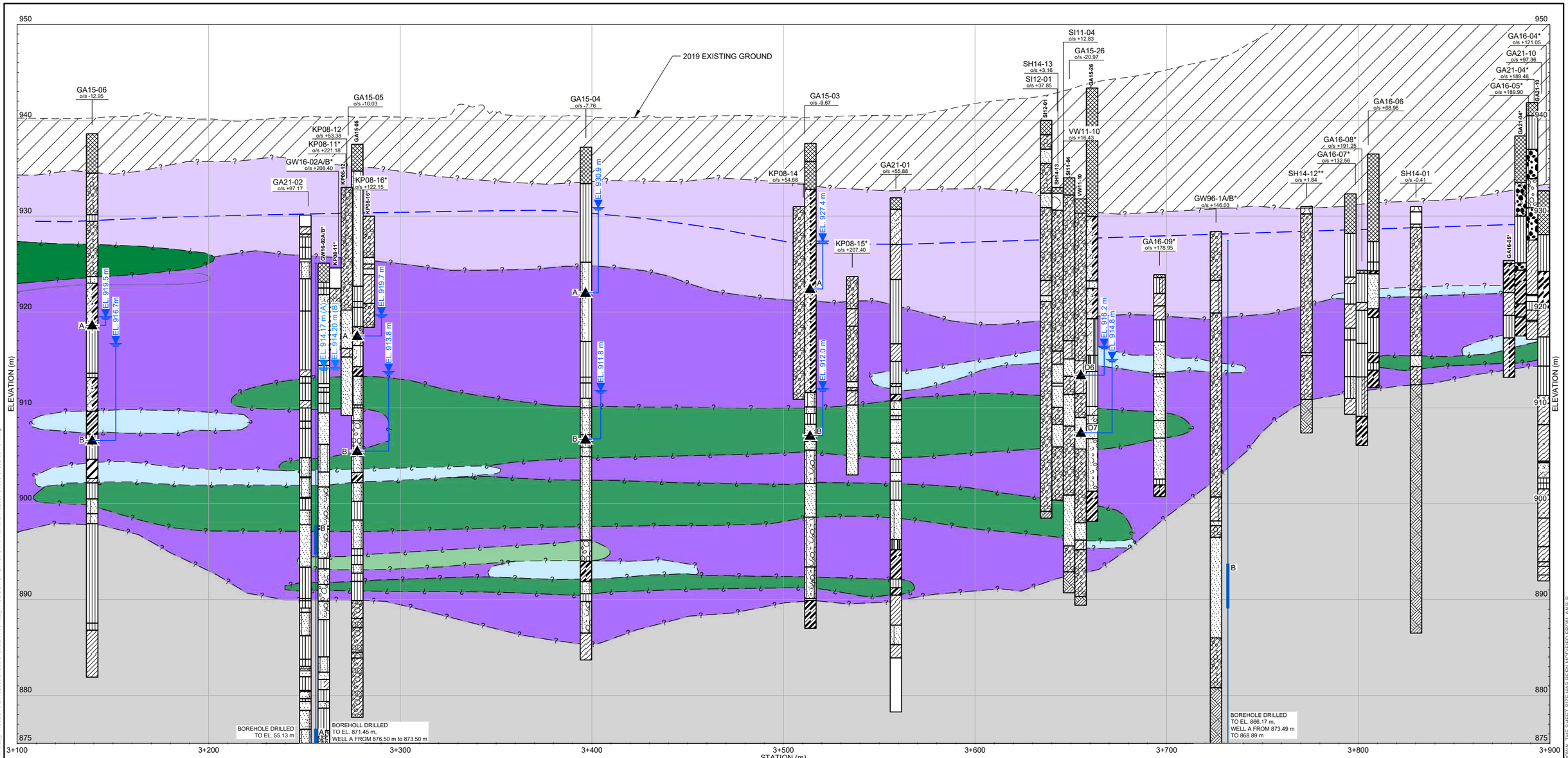
SURFICIAL GEOLOGY PROFILE (4 OF 6)
STA. 2+300 TO 3+100

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	06

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

0 25 mm

Path: \\pldir.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-03-04-06.dwg



LEGEND

2019 EXISTING GROUND SURFACE — INFERRED STRATIGRAPHIC CONTACT

INFERRED WATER TABLE (PHREATIC SURFACE)

TEST HOLE LEGEND

BH19-02 / o/s -88.59 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER; DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES

GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021

EXISTING VIBRATING WIRE PIEZOMETER

MONITORING WELL SCREEN

TEST HOLE RECORD SHOWING SOIL CONDITIONS (FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

NOT USED FOR THE GEOLOGICAL PROFILE BOUNDARIES SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL	TOPSOIL	ASPHALT	GC - CLAYEY GRAVEL
PT - PEAT	CI - SILTY CLAY	SC - CLAYEY SAND	GM - SILTY GRAVEL
OL - ORGANIC SILT	CH - CLAY	SW - WELL GRADED SAND	GP - POORLY GRADED GRAVEL
OH - ORGANIC SILT	MH - CLAYEY SILT	SM - SILTY SAND	GW - WELL GRADED GRAVEL
CL - SILTY CLAY	ML - CLAYEY SILT OR SILT	SP - POORLY GRADED SAND	BEDROCK

SOIL STRATIGRAPHY

FILL	GLACIOLACUSTRINE SUB-UNIT	GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED)
ABLATION TILL	BASAL TILL	GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

PROFILE - STA. 3+100 m TO 3+900 m

HORIZ. SCALE 1:2,000 m
VERT. SCALE 1:400 m

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

0 10 20
VERT. SCALE 1:400 METRES

0 50 100
HORIZ. SCALE 1:2,000 METRES

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

TITLE
SURFICIAL GEOLOGY PROFILE (5 OF 6)
STA. 3+100 TO 3+900

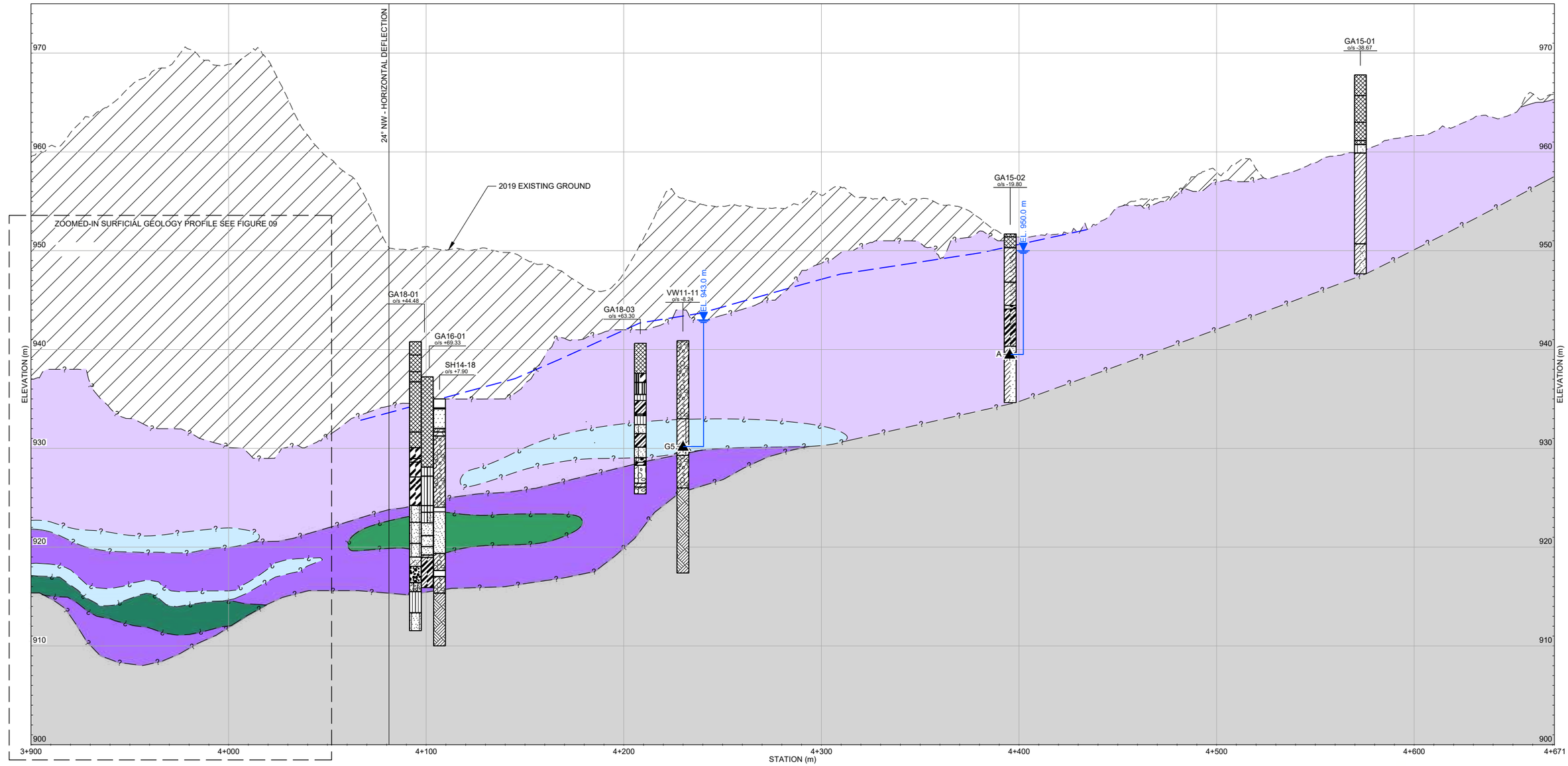
PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	07

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

0

Path: \\golder.gds\complexdata\toffice\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc.034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-034-07.dwg



LEGEND

2019 EXISTING GROUND SURFACE — — ? — INFERRED STRATIGRAPHIC CONTACT

INFERRED WATER TABLE (PHREATIC SURFACE)

TEST HOLE LEGEND

BH19-02 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER

o/s -88.59 — DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES

GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021

EXISTING VIBRATING WIRE PIEZOMETER

MONITORING WELL SCREEN

TEST HOLE RECORD SHOWING SOIL CONDITIONS (FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

NOT USED FOR THE GEOLOGICAL PROFILE BOUNDARIES SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL	TOPSOIL	ASPHALT	GC - CLAYEY GRAVEL
PT - PEAT	CI - SILTY CLAY	SC - CLAYEY SAND	GM - SILTY GRAVEL
OL - ORGANIC SILT	CH - CLAY	SW - WELL GRADED SAND	GP - POORLY GRADED GRAVEL
OH - ORGANIC SILT	MH - CLAYEY SILT	SM - SILTY SAND	GW - WELL GRADED GRAVEL
CL - SILTY CLAY	ML - CLAYEY SILT OR SILT	SP - POORLY GRADED SAND	BEDROCK

SOIL STRATIGRAPHY

FILL	GLACIOLACUSTRINE SUB-UNIT	GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED)
ABLATION TILL	BASAL TILL	GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

PROFILE - STA. 3+900 m TO 4+671 m

HORIZ. SCALE 1:2,000 m
VERT. SCALE 1:400 m

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK, EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

0 10 20
VERT. SCALE 1:400 METRES

0 50 100
HORIZ. SCALE 1:2,000 METRES

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

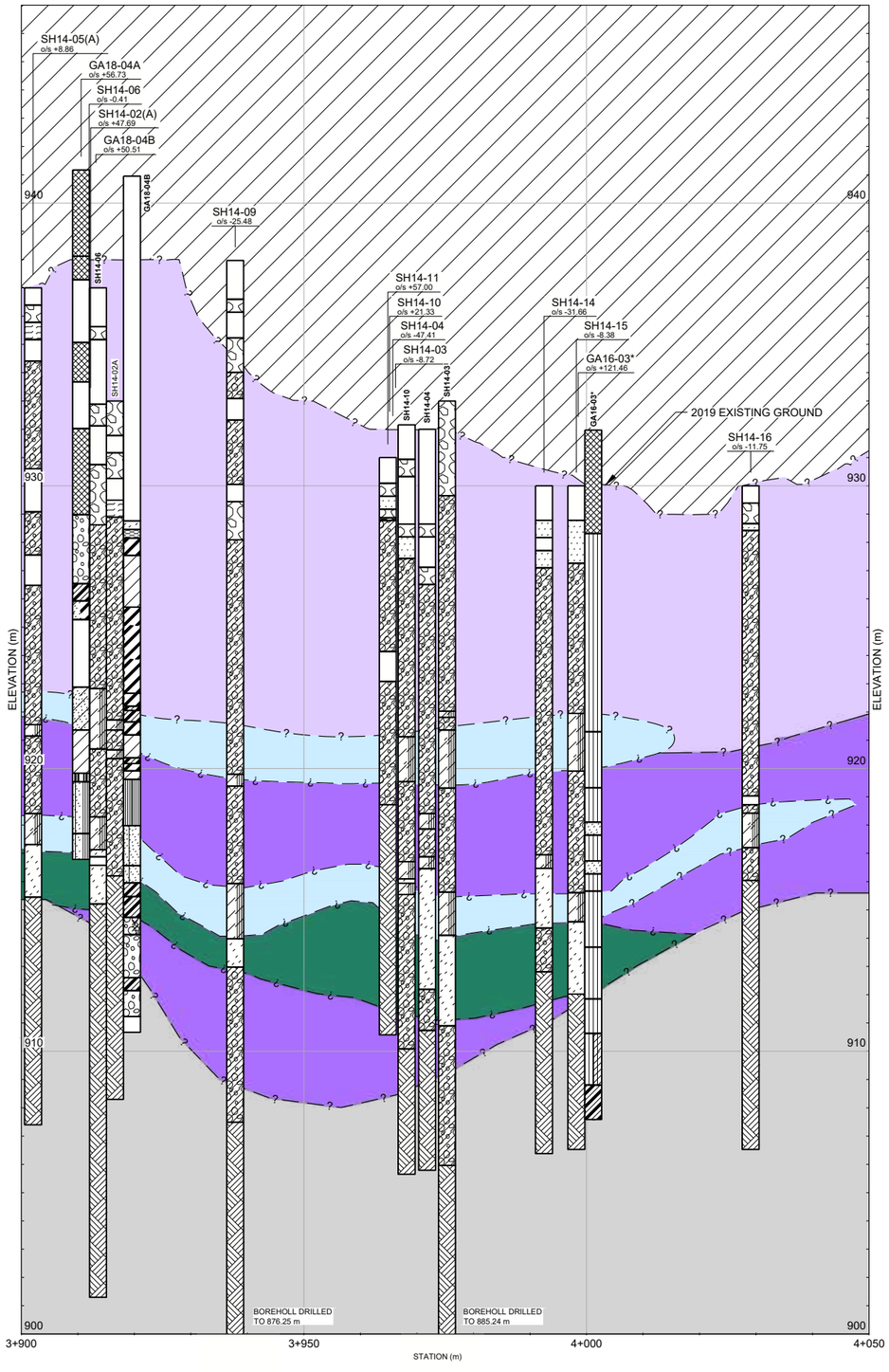
TITLE
SURFICIAL GEOLOGY PROFILE (6 OF 6)
STA. 3+900 TO 4+671

PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	08

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

Path: \\golder.gds\complexdata\office\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\09_PROJECTS\21452039\51300\51392\Doc 034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-03-08.dwg



PROFILE - STA. 3+900 m TO 4+050 m
HORIZ. SCALE 1:1,000 m
VERT. SCALE 1:200 m

LEGEND

2019 EXISTING GROUND SURFACE — INFERRED STRATIGRAPHIC CONTACT

TEST HOLE LEGEND

BH19-02 — DENOTES TEST HOLE TYPE, INVESTIGATION YEAR AND ID NUMBER
o/s -88.59 — DENOTES PERPENDICULAR DISTANCE FROM TEST HOLE TO SECTION LINE IN METRES
GROUNDWATER LEVEL / PIEZOMETRIC HEAD IN NOVEMBER / DECEMBER 2021
EXISTING VIBRATING WIRE PIEZOMETER
MONITORING WELL SCREEN
TEST HOLE RECORD SHOWING SOIL CONDITIONS
(FOR DETAILED GEOTECHNICAL INFORMATION REFER TO RECORD OF BOREHOLE)

BOREHOLE LOGS SYMBOLS SUMMARY

*	REVIEWED BOREHOLE LOG DATA ONLY. BOREHOLE LOG NOT USED FOR CREATING STRATIGRAPHIC BOUNDARIES.
**	BOREHOLE LOG DID NOT PROVIDE SUFFICIENT GEOLOGICAL DETAIL FOR INCLUSION IN STRATIGRAPHIC INTERPRETATION.

SOIL LITHOLOGY

FILL	TOPSOIL	ASPHALT	GC - CLAYEY GRAVEL
PT - PEAT	CI - SILTY CLAY	SC - CLAYEY SAND	GM - SILTY GRAVEL
OL - ORGANIC SILT	CH - CLAY	SW - WELL GRADED SAND	GP - POORLY GRADED GRAVEL
OH - ORGANIC SILT	MH - CLAYEY SILT	SM - SILTY SAND	GW - WELL GRADED GRAVEL
CL - SILTY CLAY	ML - CLAYEY SILT OR SILT	SP - POORLY GRADED SAND	BEDROCK

SOIL STRATIGRAPHY

FILL
ABLATION TILL
GLACIOLACUSTRINE SUB-UNIT
BASAL TILL
GLACIOFLUVIAL SUB-UNIT (SAND DOMINATED)
GLACIOFLUVIAL SUB-UNIT (GRAVEL DOMINATED)

BEDROCK / WEATHERED BEDROCK

BEDROCK / WEATHERED BEDROCK

NOTES

1. ALL UNITS ARE IN METRES UNLESS NOTED OTHERWISE.
2. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND MAY VARY FROM THAT SHOWN.
3. VARIOUS COMBINATIONS OF THE SYMBOLS HAVE BEEN USED TO REPRESENT TRANSITIONAL MATERIALS OR RANGES OF MATERIALS WITHIN A STRATUM.
4. PREFERENCE WAS GIVEN TO INCORPORATING GEOLOGIC DATA FROM BOREHOLES LOCATED CLOSE TO THE CROSS-SECTION LINES AND TO BOREHOLES THAT HAD THE MOST DETAILED GEOLOGIC DESCRIPTIONS OF THE SUBSURFACE CONDITIONS ENCOUNTERED. BOREHOLES THAT WERE FARTHER FROM CROSS-SECTION LINES WERE REVIEWED FOR GEOLOGICAL CORRELATION CRITERIA, INCLUDING INFORMATION ON THE SPECIFIC STRATIGRAPHIC SEQUENCE AND ELEVATIONS OF CONTACTS BETWEEN THE DIFFERENT GEOLOGIC UNITS. BOREHOLES WITH SIGNIFICANT LATERAL OFFSET FROM THE LINES OF CROSS-SECTION WERE GENERALLY OMITTED GIVEN THE HIGH DEGREE OF UNCERTAINTY IN PROJECTION OF THE DATA.

REFERENCE

1. EXISTING GROUND SURVEY PROVIDED BY MPMC, FILE NAME: "Tailings_Points_1m_18.10.2019.laz", SURVEYED: 18 OCTOBER 2019, RECEIVED: 09 FEBRUARY 2020.

0 5 10
VERT. SCALE 1:200 METRES

0 25 50
HORIZ. SCALE 1:1,000 METRES

THIS FIGURE IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INTENDED OR REPRESENTED BY WSP TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDING, BUT NOT LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSEQUENT OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WHETHER CLIENT'S OR OTHERWISE, WITHOUT WSP'S PRIOR WRITTEN PERMISSION. ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY WSP WILL BE AT CLIENT'S SOLE RISK. WSP EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYING, USING OR MAKING DECISIONS ON THIS FIGURE. THIRD PARTIES DO SO AT THEIR OWN RISK. EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS FIGURE IS THE PROPERTY OF WSP.

CLIENT: MOUNT POLLEY MINING CORPORATION

CONSULTANT: wsp

YYYY-MM-DD	2023-08-11
DESIGNED	RG/CL
PREPARED	AW
REVIEWED	JF
APPROVED	GP

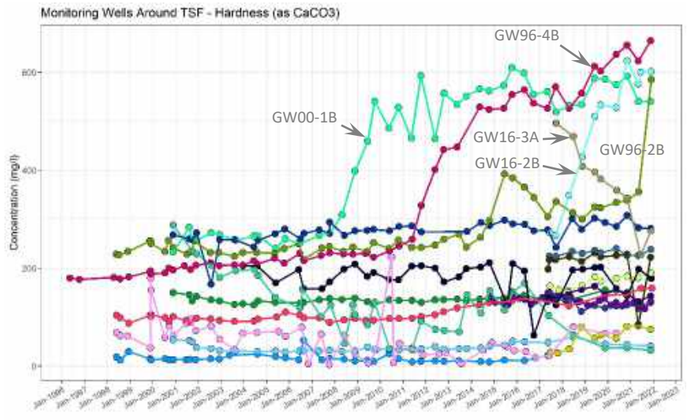
PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

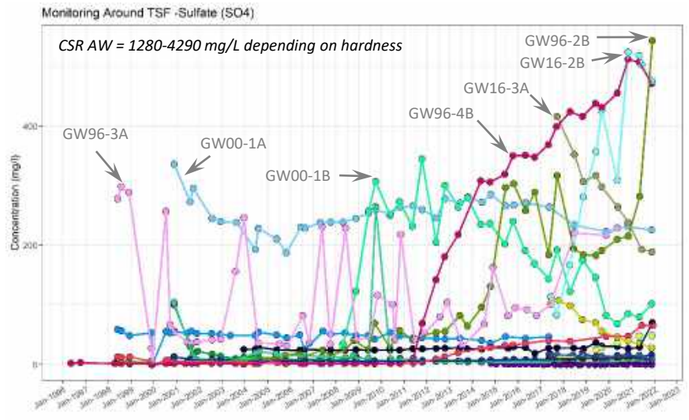
TITLE
ZOOMED-IN SURFICIAL GEOLOGY PROFILE
STA. 3+900 TO 4+050

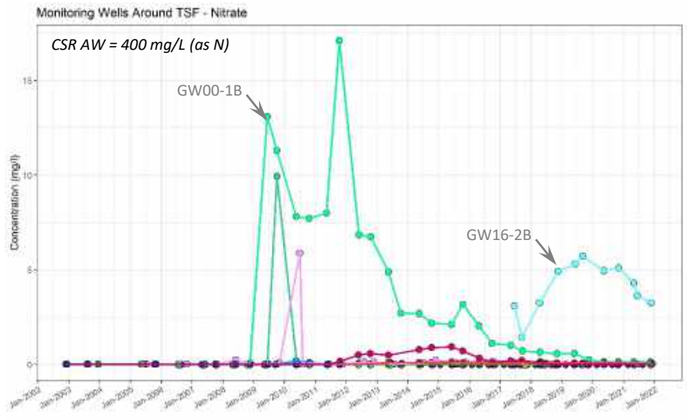
PROJECT NO.	PHASE/TASK/DOC.	REV.	FIGURE
21452039	51300/51392/034	0	09

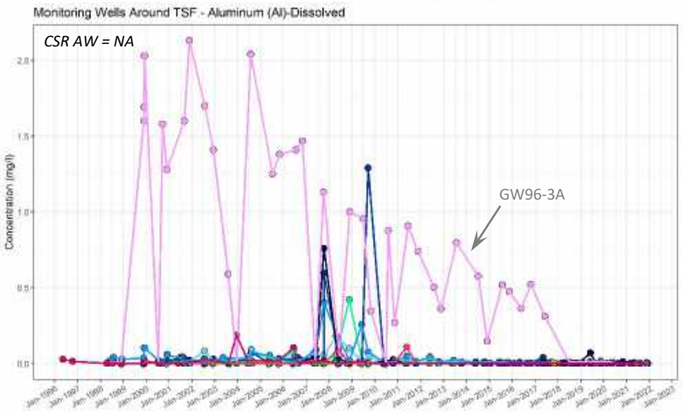
Path: \\golder.gds\complexdata\toffice\Vancouver\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\21452039\51300\51392\Doc 034\02_PRODUCTION\DWG\ | File Name: 21452039-51300-51392-03-09.dwg

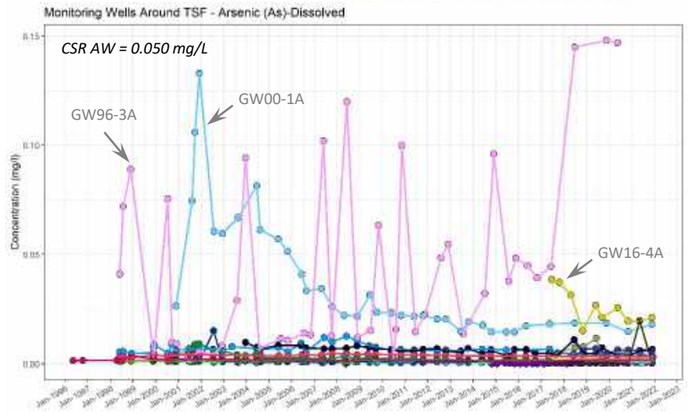
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
0 25 mm

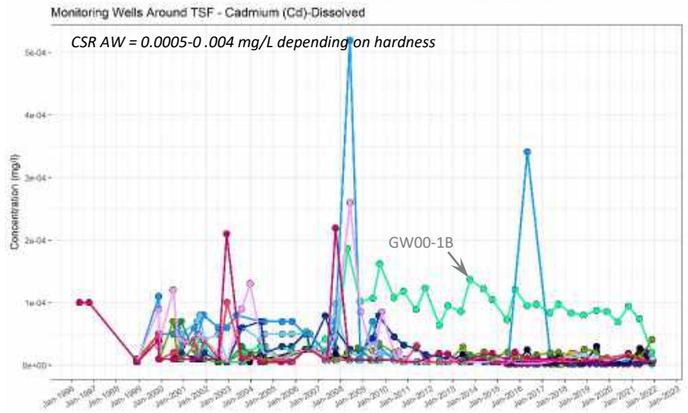


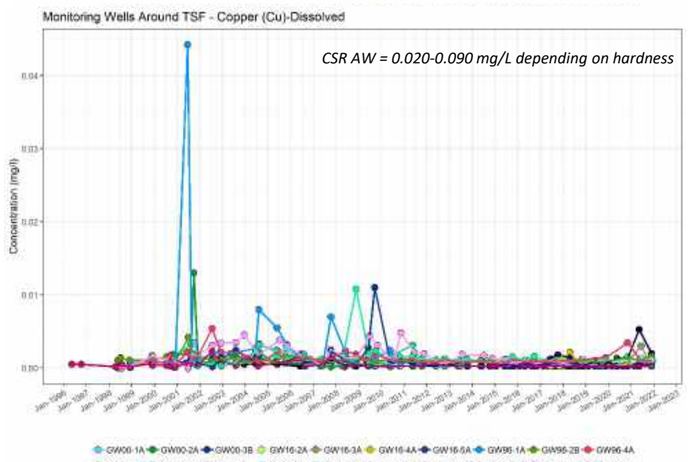


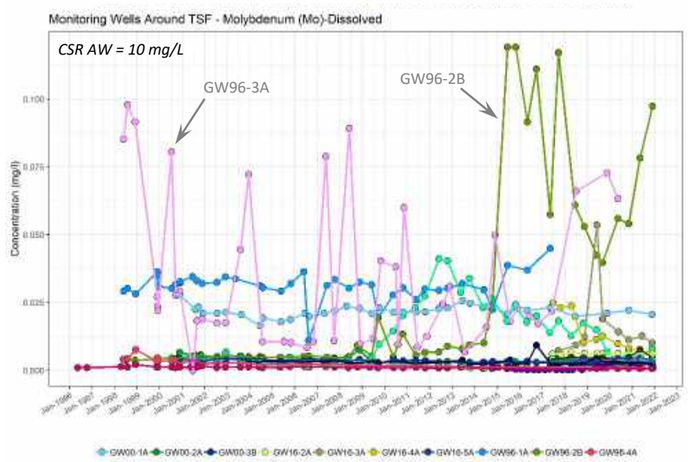


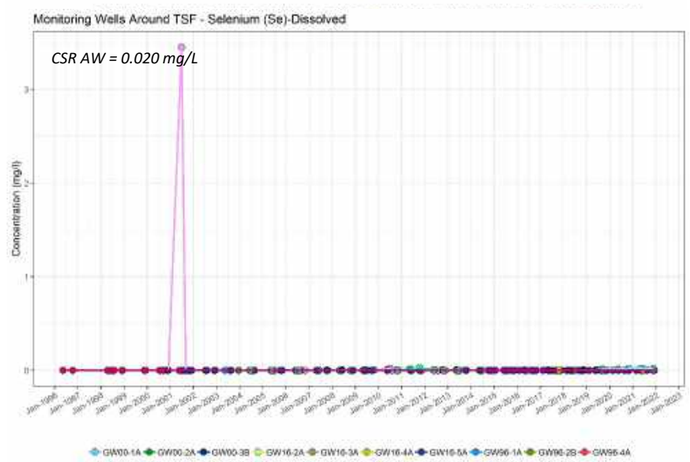












GW00-1A GW00-2A GW00-3B GW16-2A GW16-3A GW16-4A GW16-5A GW96-1A GW96-2B GW96-4A
GW00-1B GW00-3A GW14-1 GW16-2B GW16-3B GW16-4B GW16-5B GW96-2A GW96-3A GW96-4B

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-07-25
PREPARED	CR
DESIGNED	CR
REVIEWED	JF
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION

TITLE
GROUNDWATER QUALITY TRENDS FOR THE TSF – 1996 to 2021 (FROM GOLDER 2022b, FIGURE 5)

PROJECT NO.		REV.	FIGURE
22514095	51300/51392/034	0	10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

APPENDIX A

Summary of Investigations

GEOTECHNICAL INVESTIGATIONS

KP (Knight and Piésold Ltd.). 1990. Report on Geotechnical Investigations and Design of Open Pit, Waste Dumps and Tailings Storage Facility. Prepared for Imperial Metals Corporation. 12 June 1990.

Purpose

The main objectives and considerations of this study were to:

- present the design for the open pit, waste dumps, and tailings storage facility (TSF)
- provide input for the Stage 1 report and permit applications and become part of the overall Mount Polley Mine Feasibility Study

Scope

The scope related to the TSF foundation includes the following:

- site characteristics including hydrometeorology, regional geology, and seismicity
- geotechnical investigations carried out in the proposed TSF location consisting of field mapping, test pits and diamond drilling with permeability testing
  - Eighteen test pits (TPB-01 to TPB-18) were excavated within the proposed TSF footprint on 27/28 August 1989.
  - Eight condemnation boreholes (MP89-229 to MP89-236) were drilled in the proposed TSF footprint from 29 October 1989 to 12 November 1989.
    - Completion depths ranged from 73.2 to 121.9 m below ground surface.
    - Piezometers – 10 piezometers were installed in 6 boreholes (4 pneumatic and 6 standpipe piezometers).
    - Permeability testing consisted of the following:
      - packer tests – 21 tests conducted in 6 boreholes
      - falling head tests – 3 tests conducted in 3 boreholes
  - Laboratory testing of till samples collected from the test pits consisted of the following:
    - water content – 2 tests
    - Atterberg limits – 2 tests
    - sieve analysis – 2 tests
    - hydrometer – 2 tests
    - specific gravity – 1 test
    - modified Proctor – 1 test
    - permeability – 1 test
- identification of construction materials for the TSF

Data

- Appendix A – Climatological Summaries
- Appendix B – Discontinuity Data and Point Load Test Results
- Appendix C – Waste Rock Acid Generation Potential Testwork
- Appendix D – Laboratory Testwork on Tailings
- Appendix E – Geochemical Tests on Tailings
- Appendix F – Tailings Area B. Test Pit Logs, Borehole Logs and Permeability Test Results

KP (Knight Piésold Ltd.). 1995. Report on 1995 Geotechnical Investigations for Mill Site and Tailings Storage Facility. Prepared for Imperial Metals Corporation. Document No. 1623/1. 14 March 1995.

Purpose

The main objectives and considerations for the geotechnical investigation were to evaluate the type and distribution of surficial materials and the near surface foundation conditions at the mill site, along access roads and pipeline routes, potential borrow areas, within the tailings basin, and at the Polley Lake dam site.

Scope

The geotechnical investigation program was undertaken from 11 to 17 January 1995.

- Four test pits (TP95-16 to TP95-19) were excavated north of the proposed TSF and partially along the proposed tailings and reclaim pipeline route.
- Three test pits (TP95-29 to TP95-31) were excavated on the ridge east of the tailings facility to investigate potential borrow sources for future embankment construction.
- Eleven test pits (TP95-26 to TP95-28 and TP95-32 to TP95-39) were excavated within the proposed TSF footprint.
- Laboratory testing of soil samples collected from the test pits consisted of the following:
  - visual description of soils
  - water contents – 7 tests
  - Atterberg limits – 6 tests
  - sieve analysis – 7 tests
  - hydrometer – 7 tests
  - specific gravity – 4 tests
  - consolidated undrained triaxial compression – 3 tests
  - modified Proctor – 3 tests
  - falling head permeameter – 5 tests

Data

- Appendix A – Test Pit Logs
- Appendix B – Detailed Laboratory Test Results

KP (Knight Piésold Ltd.). 1997. Stage 2A Tailings Facility Construction Selected Excerpts from Reference Information. Prepared for Mount Polley Mining Corporation. Document No. 10162/9-2. 6 November 1997.

Purpose

The main objective of this report was to provide further background information on the geotechnical conditions encountered within the TSF footprint for the tender of the Stage 2A construction.

The report presents the geotechnical investigations completed for the Stage 2A construction. The main objectives and considerations for the investigation were to:

- delineate suitable borrow materials within Borrow Area No. 4
- investigate foundation conditions at the Perimeter Embankment for future downstream expansions
- complete laboratory testing of waste dump materials and mill site processed rock

Scope

The geotechnical investigation program was undertaken from 30 September 1997 to 6 October 1997.

- Twenty-one test pits (TP97-BA4-F8 to TP97-BA4-J9) were excavated at Borrow Area No. 4. Completion depths ranged from 5.0 to 6.2 m below ground surface.
- Four test pits were excavated (TP97-PETP-1 to TP97-PETP-4) within the proposed Perimeter Embankment expansion footprint. Completion depths ranged from 5.0 to 5.4 m below ground surface.
- Laboratory testing of soil samples collected from the test pits consisted of the following:
  - visual description of soils
  - water contents – 95 tests

Data

- Appendix A – Stage 2A Investigations – Test Pit Logs
- Appendix B – Borrow Area #4 – Summary of Natural Moisture Content of Test Pit Samples
- Appendix C – Particle Size Analyses of Waste Dump Material and Millsite Processed Material
- Appendix D – Stage 1A/1B Construction Quality Assurance – Record Test Data
- Appendix E – Stage 1A/1B Construction Quality Assurance – Control Test Data and Gradation Plots
- Appendix F – Borrow Area #2 Test Pit Program – Summary of Natural Moisture Content of Test Pit Samples
- Appendix G – Borrow Area #3 Test Pit Program – Summary of Natural Moisture Content of Test Pit Samples

AMEC (AMEC Environment & Infrastructure, a division of AMEC Americas Limited). 2012. Mount Polley Mine Project: Tailings Storage Facility 2011 Geotechnical Site Investigation – Final. Prepared for Mount Polley Mining Corporation. Document No. VM00560.200.3. 28 March 2012.

Purpose

The main objectives and considerations for the geotechnical investigation were to:

- further characterize the glaciolacustrine soils within the TSF foundation
- install new instrumentation and replace non-functioning instrumentation in key locations for dam performance monitoring including pore pressure response and slope movements

Scope

The geotechnical investigation program was undertaken from 29 September 2011 to 11 October 2011.

- Fourteen sonic boreholes (VW11-01 to VW11-11 and SI11-01, SI11-02, and SI11-04) were drilled downstream of the Perimeter Embankment, Main Embankment and South Embankment.
  - Completion depths ranged from 11.1 to 49.4 m below ground surface.
  - Vibrating wire piezometers (VWPs) – 23 VWPs were installed in 11 boreholes.
  - Slope inclinometers (SIs) – Three SIs were installed.
  - Shelby tubes – Three thin-walled tubes were collected.
- Four sonic boreholes were drilled at two locations outside the TSF footprint (i.e., mine site area).
  - Monitoring wells – Four monitoring wells (GW11-1A/B and GW11-2A/B) were installed at two locations.
- Laboratory testing of soil samples collected from the boreholes consisted of the following:
  - visual description of soils
  - water contents – 199 tests
  - Atterberg limits – 20 tests
  - sieve analysis – 19 tests
  - hydrometer – 16 tests

Data

- Appendix A – 2011 Laboratory Testing Data
- Appendix B – 2011 Drill Hole Site Investigation Logs
- Appendix C – Drill Core Photographs
- Appendix D – Vibrating Wire Calibration Reports
- Appendix E – Instrumentation Readings
- Appendix F – Monitoring Well Drill Hole Logs

KCB (Klohn Crippen Berger Ltd.). 2015. Mount Polley Dam Failure – Site Investigation Progress Report No. 2. Prepared for BC Ministry of Energy and Mines. Document No. M09954A02.730. 21 January 2015.

Purpose

The main objectives and considerations for the geotechnical investigation were to:

- collect field data to help determine the August 2014 embankment failure mechanism
- characterize the profile and geotechnical properties of the foundation soils both inside and outside the failed area
- investigate and characterize any construction materials within the dam that may have influenced the failure mechanism
- locate the seat of the dam failure through the foundation materials, if applicable

This report supersedes the Site Investigation Progress Report No. 1 submitted to the BC Ministry of Energy and Mines on 12 December 2014.

Scope

The geotechnical investigation program was conducted between mid-September and late-November 2014.

- Visual reconnaissance and surficial mapping were conducted at the dam breach area to establish the post-failure configuration and provide insights into the nature of the failure mechanism.
- Geophysical surveys were conducted to estimate bedrock depth and approximate material boundaries within the dam failure area (Corner 1).
  - resistivity and induced polarity – 8 survey lines
  - seismic refraction – 6 survey lines
- Phase 1 – A sonic coring program was conducted to delineate the soil profile, obtain samples for geotechnical testing, and install instrumentation.
  - Thirty-two sonic boreholes (SH14-01 to SH14-22, with additional “A” and “B” designations) were drilled at 22 locations near the dam failure area (Corner 1).
    - Completion depths ranged from 1.8 to 72.4 m below ground surface.
    - Vibrating wire piezometers – Twenty-two VWPs were installed in 8 boreholes.
    - Slope inclinometers – Five SIs were installed.
    - Preserved core samples – Thirty-three preserved core samples were collected from three boreholes (SH14-03A, SH14-03B and SH14-10A).
    - Field tests – Pocket penetrometer, pilcon and/or torvane tests were conducted approximately every 0.5 m.

- Phase 2 – Cone penetration test (CPT) soundings and in situ testing were conducted to estimate the strength, hydraulic conductivity, and consolidation characteristics of the soil units.
  - Twenty-three CPTs were conducted at 19 locations within the dam failure area (Soundings CPT14-01 to CPT14-08, CPT14-10, CPT14-11, CPT14-13 to CPT14-19, CPT14-21, and CPT14-22).
    - Continuous resistivity measurements, and several shear wave velocity and porewater pressure tests, were completed.
  - Four vane shear test (VST) locations were completed within the dam failure area.
    - A total of 10 electronic VSTs were attempted in the upper glaciolacustrine unit.
  - Two boreholes contained standard penetration test (SPT) energy measurements.
- Phase 3 – Mud rotary drilling was carried out to conduct SPTs and retrieve high quality piston samples of relevant soils for laboratory test work.
  - Six mud rotary boreholes were drilled at three locations within the dam failure area (two per location).
    - Piston tubes – Seventeen thin-walled samples of the upper glaciolacustrine unit were collected.
    - Standard penetration tests – Thirty SPTs were conducted in the upper glacial till (VST14-22, VST14-10A, RH14-03, and CPT14-05A).
- Test pits and trenches were excavated to observe the conditions in the dam and foundation soils and recover block samples for laboratory testing.
  - One test trench was excavated in the dam till core.
  - One test pit was excavated in the up-thrusted toe bulge for block sampling (TP14-01).
    - A block sample of till and a block sample of upper glaciolacustrine material was collected from the test pit.
  - Bulk samples – Two bulk samples of till core were recovered for laboratory testing.
- Laboratory testing was conducted to determine the index, hydraulic conductivity, and strength properties of the various foundation soils and dam materials.
  - visual description of soils
  - water contents – 991 tests
  - Atterberg limits – 139 tests
  - sieve analysis – 127 tests
  - hydrometer – 125 tests
  - standard Proctor – 2 tests
  - specific gravity – 17 tests
  - organic contents – 3 tests
  - X-Ray diffraction – 12 tests on samples of upper and lower glaciolacustrine units
- The following advanced geotechnical tests were ongoing at the time of report preparation:
  - consolidated drained direct shear tests on samples of upper and lower glaciolacustrine units

- direct simple shear tests on samples of upper glaciolacustrine unit
- one-dimensional consolidation tests on samples of upper and lower glaciolacustrine units
- consolidated undrained monotonic triaxial compression tests on samples of till core, upper glacial till, and upper glaciolacustrine unit
- triaxial extension tests on samples of upper glacial till
- hydraulic permeability using triaxial cell (includes monotonic shear after completion of test)

Data

- Appendix I – Sonic Core Hole Logs
- Appendix II – Core Photographs
- Appendix III – Penetrometer Test Results on Sonic Core
- Appendix IV – Instrumentation Readings
- Appendix V – Standard Penetration Test Results
- Appendix VI – Sonic Core Sample Preservation
- Appendix VII – Thin-Walled Piston Tube Samples
- Appendix VIII – Test Pits and Block Sampling
- Appendix IX – Visual Reconnaissance and Field Mapping
- Appendix X – Observations During Core Excavation
- Appendix XI – Laboratory Index Test Results
- Appendix XII – Vibrating Wire Piezometer Calibration Records
- Appendix XIII – ConeTec In-situ Testing Report
- Appendix XIV – Frontier Geosciences Geophysics Report

IEEIRP (Independent Expert Engineering Investigation and Review Panel). 2015. Report on Mount Polley Tailings Storage Facility Breach. Prepared for BC Ministry of Energy and Mines. 30 January 2015.

Purpose

The main objectives and considerations for the forensic investigation were to:

- investigate and report on the cause of the TSF failure that occurred on 4 August 2014.
  - identify any mechanism(s) of failure of the TSF
  - identify any technical, management, or other practices that may have enabled or contributed to the mechanism(s) of failure; this may include an independent review of the design, construction, operation, maintenance, surveillance, and regulation of the TSF
  - identify any changes that could be considered to reduce the potential for future such occurrences
- make recommendations to government on actions that could be taken to ensure that a similar failure does not occur at other mine sites in BC
- comment on what actions could have been taken to prevent this failure and to identify practices or successes in other jurisdictions that could be considered for implementation in BC

Scope

The forensic investigation consisted of the following:

- Surface investigations were conducted to document geological and geotechnical features exposed in the breach area prior to disturbance by investigation activities or other operations.
- Subsurface investigations were conducted to examine the soil and groundwater conditions within the breach and surrounding area.
  - The sonic boreholes drilled by KCB in 2014 (SH14-01 to SH14-22, with additional “A” and “B” designations) were observed and independently logged.
    - No additional samples were collected for laboratory testing.
  - Rotary drilling was conducted to obtain disturbed and undisturbed samples of the upper glaciolacustrine unit and other soil units for laboratory testing.
    - Thirty-two mud rotary boreholes (MR14-101 to MR14-116) were drilled at 16 locations near the dam breach area (Corner 1).
      - Completion depths ranged from 2.6 to 16.9 m below ground surface.
      - Large penetration tests (LPTs) – Continuous LPTs were completed in boreholes MR14-116 and MR14-116A.
    - Three air rotary (ODEX) boreholes (RH14-117 to RH14-118) were drilled at two locations within the dam breach area.
      - Completion depths ranged from 13.1 to 18.0 m below ground surface.
    - Two soil core boreholes (SC14-103 and SC14-103A) were drilled at one location downstream of the Perimeter Embankment.
      - Completion depths were 9.8 m below ground surface.

  - In situ sampling methods consisted of direct push of thin-walled tubes, piston tube sampling and the Pitcher Sampler.
    - Pocket penetrometer and torvane testing was conducted on the soil at the end of the tubes after retrieval of a relatively undisturbed sample.
    - All undisturbed thin-walled tube samples were CT scanned.
  - CPTs and VSTs were conducted to characterize the foundation stratigraphy and to identify sampling locations for advanced laboratory testing.
    - Two CPTs and 15 resistivity cone penetration tests (RCPTs) were advanced at 15 locations near the dam breach area (soundings CPT14-101, CPT14-102, and RCPT14-103 to RCPT14-115).
      - Completion depths ranged from 1.3 to 17.1 m below ground surface.
      - Pore pressure dissipation tests were completed at selected locations.
    - Several in situ electronic VSTs were completed at five locations within the dam breach area, referred to as VST14-105 to VST14-107B, VST14-111, and VST14-112.
  - Pressuremeter testing (PMT) was conducted in the glacial till to obtain shear strength and shear modulus values.
    - Several PMTs were completed at three locations within the dam breach area, referred to as PMT14-105 to PMT14-106, and PMT14-108.
- Laboratory testing of soil samples collected from the test pits and boreholes.
  - visual description of soils
  - water contents – 261 tests
  - Atterberg limits – 121 tests
  - sieve analysis – 126 tests
  - hydrometer – 106 tests
  - specific gravity – 6 tests
  - consolidated undrained triaxial compression – 13 tests
  - one-dimensional consolidation using incremental loading – 19 tests
  - direct simple shear – 17 tests
  - direct shear – 1 test

Data

- Appendix A – Terms of Reference
- Appendix B – Supporting Information
- Appendix C – Surface Investigation
- Appendix D – Subsurface Investigation
- Appendix E – Laboratory Testing and Results
- Appendix F – Instrumentation and Monitoring
- Appendix G – Water Balance
- Appendix H – Breach Analysis
- Appendix I – B.C. Tailings Dam Failure Frequency and Portfolio Risk
- Appendix J – Cariboo Regional District Video

KCB (Klohn Crippen Berger Ltd.). 2015. Mount Polley Dam Failure – Advanced Laboratory Testing Program Progress Report No. 4. Prepared for BC Ministry of Energy and Mines. Document No. M09954A02.730. 12 February 2015.

Purpose

The main objective of this report was to present the procedures and results of the advanced geotechnical laboratory testing program carried out on soil samples collected during the site investigation program.

This report supersedes the Advanced Laboratory Testing Program Progress Report No. 3 submitted to the BC Ministry of Energy and Mines on 21 January 2015.

Scope

The advanced geotechnical laboratory testing program began in October 2014.

- Advanced geotechnical laboratory testing was conducted on the following samples:
  - preserved (sonic) core samples of upper glacial till, and upper and lower glaciolacustrine units
  - thin-walled piston tube samples of upper glaciolacustrine unit
    - Five thin-walled tubes were selected for advanced testing.
  - block samples of upper glacial till and upper glaciolacustrine unit
    - One of each soil unit was selected for advanced testing.
  - bulk samples of the compacted till core (i.e., glacial till)
- Laboratory testing of soil samples collected from the test pit and boreholes consisted of the following:
  - one-dimensional consolidation using incremental loading – 10 tests
  - direct shear – 15 tests
  - direct simple shear (including cyclic) – 15 tests
  - permeability and consolidated undrained triaxial compression – 8 tests
  - consolidated undrained triaxial compression – 4 tests
  - consolidated undrained triaxial extension – 1 test

Data

- Appendix I – Laboratory Testing Program
- Appendix II – Specimen Preparation
- Appendix III – One-Dimensional Consolidation Results
- Appendix IV – Direct Shear Results
- Appendix V – Direct Simple Shear Results
- Appendix VI – Triaxial Test Results
- Appendix VII – Photographs
- Appendix VIII – Interpretation of Triaxial Tests on Block Samples of UGLU

Golder (Golder Associates Ltd.). 2015. Laboratory Testing Results from Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Document No. 1413803-012-TM-Rev0-2000. 26 March 2015.

Purpose

The main objective of this technical memorandum was to present the results of the laboratory testing program carried out on the soil samples obtained at the Central Collection Sump

Scope

- Laboratory testing of soil samples collected from the Central Collection Sump consisted of the following:
  - visual description of soils
  - water contents – 3 tests
  - Atterberg limits – 3 tests
  - sieve analysis – 6 tests
  - hydrometer – 3 tests
  - specific gravity – 3 tests
  - consolidated undrained triaxial compression – 3 tests
  - one-dimensional consolidation using controlled-strain loading – 1 test
  - direct simple shear – 4 tests

Data

- Attachment 1 – Lab Results
- Attachment 2 – Photographs
- Attachment 3 – Calibration Certificates

Golder (Golder Associates Ltd.). 2015. 2015 Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Document No. 1413803-061-R-RevB-2000. 7 July 2015.

Purpose

The main objectives and considerations for the geotechnical investigation were to:

- better define foundation conditions along the Perimeter, Main, and South embankments to support studies regarding the stability of the embankments
- install instrumentation to monitor the performance of the embankments

Scope

The geotechnical investigation program was conducted from January 2015 to May 2015.

- Twenty sonic boreholes (GA15-01 to GA15-20) were drilled downstream of the TSF embankments.
  - Completion depths ranged from 9.5 to 74.7 m below ground surface.
  - Vibrating wire piezometers – Thirty-three VWPs were installed in 20 boreholes.
  - Slope inclinometers – Twenty-two SIs were installed.
  - Standard penetration tests – Three SPTs were conducted in 2 boreholes.
  - Vane shear tests – Several VSTs were attempted in the initial boreholes with a Nilcon vane. However, the soil was too stiff to penetrate.
  - Grab samples and thin-walled tube samples were collected for laboratory testing.
- Three additional sonic boreholes (GA15-12B, GA15-15B, and GA15-21 [beside GA15-16]) were drilled for thin-walled tube sampling.
- One test pit was excavated downstream of the Perimeter Embankment for thin-walled tube sampling.
- Laboratory testing of soil samples collected from the boreholes consisted of the following:
  - visual description of soils
  - water contents – 795 tests
  - Atterberg limits – 113 tests
  - sieve analysis – 113 tests
  - hydrometer – 50 tests
  - specific gravity – 7 tests
  - vane shear – 73 tests conducted in the laboratory
  - consolidated undrained triaxial compression – 1 test
  - one-dimensional consolidation using incremental loading – 5 tests
  - one-dimensional consolidation using controlled-strain loading – 4 tests
  - direct simple shear – 5 tests

Data

- Appendix A – Records of Boreholes

- Appendix B – Photographs of Sonic Core
- Appendix C – Laboratory Testing Results from Mount Polley Mine Technical Memo (Golder 2014)
  - Attachment 1 – Lab Results
  - Attachment 2 – Photographs
  - Attachment 3 – Calibration Certificates
- Appendix D – Calibration Certificates
- Appendix E – Laboratory Testing Results
  - Appendix E-1 – Routine Laboratory Testing Summary Table
  - Appendix E-2 – Routine Laboratory Test Results
  - Appendix E-3 – Advanced Laboratory Tests Results

Golder (Golder Associates Ltd.). 2017. 2016 TSF Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Document No. 1662612-114-R-Rev0-51121. 10 March 2017.

Purpose

The main objectives and considerations for the geotechnical investigation were to:

- better define foundation conditions downstream of the South Embankment around borehole VW11-02
- confirm the foundation conditions downstream of the buttress for the elevation 963 m Corner 1 Embankment
- assess the condition (i.e., dilative/contractive) of the tailings upstream of the Perimeter, Main, and South embankments
- install VWPs upstream of the embankments

Scope

The geotechnical investigation program was conducted from October 2016 to January 2017.

- Thirteen sonic boreholes (GA16-01 to GA16-09, GA16-15 to GA16-17, and GA16-19) were drilled downstream of the South Embankment and the Corner 1 Embankment. Four additional sonic boreholes were drilled to install vibrating wire piezometers within the TSF.
  - Completion depths ranged from 6.6 to 40.7 m below ground surface.
  - Vibrating wire piezometers – Eleven VWPs were installed in nine boreholes.
  - Slope inclinometers – Five SIs were installed.
  - Grab samples and four thin-walled piston tube samples were collected for laboratory testing.
- Nine CPTs were conducted from 6 to 17 January 2017.
  - Three CPTs were conducted on the tailings beach upstream of the Perimeter Embankment, Main Embankment, and South Embankment.
  - One CPT was conducted downstream of the South Embankment.
  - Five CPTs were conducted downstream of the Corner 1 Embankment.
- Laboratory testing of soil samples collected from the boreholes consisted of the following:
  - visual description of soils
  - water contents – 323 tests
  - Atterberg limits – 12 tests
  - sieve analysis – 3 tests
  - hydrometer – 3 tests
  - one-dimensional consolidation using controlled-strain loading – 1 test

Data

- Appendix A – Records of Boreholes
- Appendix B – Photographs of Sonic Core
- Appendix C – CPT Report
- Appendix D – Calibration Certificates
- Appendix E – Laboratory Testing

Golder (Golder Associates Ltd.). 2019. 2018 TSF Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Document No. 1662612-210-R-Rev0-51121. 8 March 2019.

Purpose

The main objective of the geotechnical investigation was to install additional instrumentation downstream of the Corner 1 Embankment to improve monitoring of embankment performance.

Scope

The geotechnical investigation program was conducted from 16 to 20 January 2018.

- Four sonic boreholes (GA18-01, GA18-03, GA18-04A, and GA18-04B) were drilled downstream of the Corner 1 Embankment.
  - Completion depths ranged from 15.2 to 29.7 m below ground surface.
  - Vibrating wire piezometers – Nine VWPs were installed in three boreholes.
  - Slope inclinometers – Three SIs were installed.
  - Grab samples were collected for laboratory testing.
- Laboratory testing of soil samples collected from the boreholes consisted of the following:
  - visual description of soils
  - water contents – 156 tests
  - Atterberg limits – 5 tests

Data

- Appendix A – Records of Boreholes
- Appendix B – Photographs of Sonic Core
- Appendix C – VWP Calibration Certificates
- Appendix D – Laboratory Testing

WSP Golder (Golder Associates Ltd., a member of WSP). 2022. 2021/2022 Tailings Storage Facility Geotechnical Investigation Factual Report. Prepared for Mount Polley Mining Corporation. Document No. 22514095-011-R-Rev0-51300. 18 October 2022.

Purpose

The main objectives and considerations for the geotechnical investigation were to:

- confirm the foundation conditions downstream of the Perimeter Embankment buttress.
- complete additional in situ and laboratory testing to further refine the characterization of the glaciolacustrine units at the Main and Corner 1 embankments.

Scope

The geotechnical investigation program was conducted from 12 October 2021 to 4 December 2021 and 26 February 2022 to 1 March 2022.

- Eleven sonic boreholes (GA21-01 to GA21-11) were drilled downstream of the Corner 1 Embankment, Perimeter Embankment, and Main Embankment. Five additional sonic boreholes were drilled for thin-walled open tube sampling of encountered glaciolacustrine units.
  - Completion depths ranged from 20.9 to 75.0 m below ground surface.
  - Vibrating wire piezometers – Twenty VWPs were installed in eight boreholes.
  - Slope inclinometers – Five SIs were installed.
  - Monitoring wells – Two monitoring wells were installed.
  - Grab samples and thin-walled open tube samples were collected for laboratory testing. The Pitcher Sampler, Shelby tubes, and Lexan tubes were used to collect the thin-walled open tube samples.
- Six CPTs (soundings CPT21-02, CPT21-03, and CPT21-06 to CPT21-09) were conducted downstream of the Perimeter Embankment and Main Embankment.
- Laboratory testing of soil samples collected from the boreholes consisted of the following:
  - visual description of soils
  - water contents – 649 tests
  - Atterberg limits – 64 tests
  - sieve analysis – 80 tests
  - hydrometer – 45 tests
  - unit weight – 8 tests
  - one-dimensional consolidation using incremental loading – 6 tests
  - one-dimensional consolidation using controlled-strain loading – 8 tests
  - direct simple shear – 5 tests (with several points)
  - cyclic direct simple shear – 2 tests (with several points)

Data

- Appendix A – Records of Boreholes

- Appendix B – Photographs of Sonic Core
- Appendix C – Gregg Cone Penetration Test Summary Report
- Appendix D – Vibrating Wire Piezometer Calibration Certificates
- Appendix E – FP Innovations CT Scan Summary Report
- Appendix F – Laboratory Test Results
  - Appendix F1 – Particle Size Distribution
  - Appendix F2 – Atterberg Limits
  - Appendix F3 – Water Content
  - Appendix F4 – Unit Weight
  - Appendix F5 – Consolidation
  - Appendix F6 – Direct Simple Shear
  - Appendix F7 – Cyclic Direct Simple Shear

HYDROGEOLOGY INVESTIGATIONS

KP (Knight Piésold Ltd.). 1997. 1996 Groundwater Monitoring Well Installation Program. Prepared for Mount Polley Mining Corporation. Document No. 1628/4. 7 February 1997.

Purpose

The main objective was to install monitoring wells around the mine site for future groundwater quality sampling as part of the geotechnical evaluation of the open pits, waste dumps, and TSF.

Scope

The hydrogeological investigation program was conducted from 30 October 1996 to 6 December 1996.

- Eleven air rotary boreholes (GW96-1A/B to GW96-5A/B and GW96-9) were drilled at six locations around the perimeter of the TSF.
  - Completion depths ranged from 6.0 to 61.6 m below ground surface.
    - Monitoring wells – Eleven monitoring wells (GW96-1A/B to GW96-5A/B and GW96-9) were installed at six locations.
  - Standard penetration tests – SPTs were conducted in three boreholes (GW96-1A to GW96-3A).

Data

- Appendix A – Drillhole Logs
- Appendix B – Groundwater Monitoring Well Completion Details

AMEC (AMEC Environment & Infrastructure, a division of AMEC Americas Limited). 2013. Mount Polley Mine Hydrogeology Assessment and Data Review. Prepared for Mount Polley Mining Corporation. Document No. VM00560B. 26 March 2013.

Purpose

The main objectives of the hydrogeological assessment were to:

- provide a data gap analysis and attempt to resolve gaps in the available data
- characterize the local hydrogeological conditions at the mine site and develop a site-specific conceptual model
- identify surface and/or groundwater quality changes related to mining activity, specifically acid rock drainage
- determine infiltration rates into the Springer Pit and identify potential groundwater impacts related to the Springer Pit development
- identify areas of potential environmental concern and potential contaminants of concern

Scope

- A data review and compilation of relevant groundwater information collected from MPMC and the public domain was conducted.
  - Several existing monitoring wells where identified within the TSF area:
    - monitoring wells GW96-1A/B to GW96-5A/B
    - monitoring wells GW00-1A/B to GW00-3A/B
    - monitoring wells GW11-2A/B
- The hydrogeological investigation program was conducted from 14 November 2012 to 18 December 2012.
  - Two air rotary (ODEX) boreholes (SI12-01 and SI12-02) were drilled at two locations downstream of the Perimeter Embankment.
    - Completion depths were 41.5 and 42.7 m below ground surface.
    - Slope inclinometers – Two SIs (SI12-01 and SI12-02) were installed.
- A conceptual site model was developed and wells exhibiting significant changes in either baseline static water levels and/or water quality were identified.
  - Three monitoring wells installed downstream of the TSF began showing evidence of influence by mine operations:
    - GW96-2B – increased level of sulphates
    - GW96-4B – increased level of hardness, sulphates and nitrate
    - GW00-1B – increased level of hardness, sulphates, nitrates, cadmium, molybdenum, and selenium
- Hydrogeological mapping was conducted to define discharge and recharge areas.
- One monitoring well was decommissioned.

Data

- Appendix A – Borehole Logs

Golder (Golder Associates Ltd.). 2016. Installation and Testing of New Monitoring Wells near the TSF, SERDS, Cariboo Pit and Wight Pit – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. Document No. 1662612-058-TM-Rev0-53100. 23 December 2016.

Purpose

The main objective of the hydrogeological investigation was to enhance the existing monitoring well network and facilitate monitoring during ongoing operations and closure of the mine.

Scope

- Hydrogeological investigation program was conducted from 24 October 2016 to 4 December 2016.
  - Eight sonic boreholes (GW16-02A/B to GW16-05A/B) were drilled at four locations around the perimeter of the TSF.
    - Completion depths ranged from 9.1 to 53.6 m below ground surface.
    - Monitoring wells – Eight monitoring wells (GW16-02A/B to GW16-05A/B) were installed at four locations. Single-well response tests were conducted following well development at each location.

Data

- Attachment 1 – Borehole Logs
- Attachment 2 – Photographs of Well Completions
- Attachment 3 – Well Development Sheets
- Attachment 4 – Results of Hydraulic Conductivity Testing

GEOLOGICAL INTERPRETATIONS

Golder (Golder Associates Ltd.). 2015. Surficial Geology and Quaternary Geological Overview of the Mt. Polley Tailings Storage Facility (TSF) Area, British Columbia. Prepared for Mount Polley Mining Corporation. Document No. 1413803-058-R-Rev0-2000. 6 July 2015.

Purpose

The main objective of the geological overview was to provide an assessment of the surficial geology using existing geological and geotechnical data to develop an interpretation of the Quaternary deposits and geological history in the area of the TSF.

Scope

The geological overview assessment involved the following steps:

- review, compilation, and interpretation of existing subsurface and surface geological information such as:
  - subsurface geotechnical investigation data from borehole investigations
  - regional geological mapping
  - previous geotechnical reports on the TSF (both pre- and post-dam breach)
  - existing data on surficial geology and subsurface Quaternary geology
- providing local and regional Quaternary geological context for the surficial and bedrock materials present in the TSF area
- development of surficial geological cross-sections of the subsurface conditions in the TSF area

Data

- Figure 3 – Overview of Borehole and Section Locations
- Figures 4 to 9 – Surficial Geology Cross-Sections
- Figure 10 – Uppermost Native Clay Layer Elevation, Thickness
- Figure 11 – Contact Between Advance and Recessional Stage Deposits – Elevation Contour Plan
- Figures 12 to 15 – Composite Geological Cross-Sections Across TSF
- Appendix A – Records of Boreholes

DOCUMENTS RELATED TO TSF DESIGNS

KP (Knight Piésold Ltd.). 1996. Response to Review Comments on Tailings Embankment Design. Prepared for Imperial Metals Corporation. Reference No. 1625/6. 25 January 1996.

Purpose

The main objective of this study was to provide a response to the comments made by Mr. Brawner with respect to his review of the tailings embankment design. This report provides the following:

- modifications and recommendations pertaining to the embankment design
- review comments and concerns

Scope

The scope related to the TSF foundation includes the following:

- Test pit excavations near the Main Embankment to supplement the knowledge and understanding of the glacial materials within the valley.
  - Thirty-four test pits (TP95ME-01 to TP95ME-34) were excavated near the Main Embankment in early October 1995.
    - Completion depths ranged from 2.5 to 7.0 m below ground surface.
  - Six test pits were also excavated near the Seepage Collection Pond (TPS19, TPS20, TPS20.5, TPS21, TPS21.2, and TPS22).
    - Completion depths ranged from 4.0 to 6.5 m below ground surface.

Data

- Appendix A – Test Pit Logs from 1995 Supplementary Investigations

KP (Knight Piésold Ltd.). 1997. Mount Polley Project Tailings Storage Facility Updated Design Report. Prepared for Mount Polley Mining Corporation. Reference No. 1627/2. 6 June 1997.

Purpose

The main objective of this study was to provide an updated version of the original TSF design report. This report was prepared in response to:

- modifications to the embankment design
- review comments and concerns
- the additional detailed geological and geotechnical information gathered during the Stage 1A/1B construction program

Scope

The scope related to the TSF foundation includes the following:

- site characteristics including hydrometeorology, regional geology, and seismicity
  - seismic design parameters for the TSF embankments
- geotechnical investigations carried out during the Stage 1A/1B construction program in 1996 and 1997:
  - test pit excavations to identify suitable embankment fill materials in potential borrow sources including Borrow Areas No. 1, No. 2, and No. 3 (referred to as the Original Borrow Area, Future Borrow Area and Alternative Borrow Area, respectively), which are all within or near the TSF
    - Several test pits (96-43 to 96-55 and 96-84 to 96-108) were excavated in the three potential borrow sources during the 1996 construction program.
      - Completion depths ranged from 1.2 to 8.0 m below ground surface.
      - Laboratory testing of soil samples collected from the test pits consisted of the following:
        - index – water content, Atterberg limits, sieve analysis, hydrometer, and specific gravity
        - compaction – standard Proctor
        - permeability – falling head tests
        - shear strength – triaxial tests
    - Several test pits were also excavated in January 1997 (TP96-BA-E4 to TP96-BA-I9).
      - Completion depths up to 6.7 m below ground surface.
      - Laboratory tests were not specified in the report.
  - borehole investigations to define the maximum borrow depth in Borrow Areas No. 1 and No. 2
    - Twenty-eight boreholes (DH97-BA-F5 to DH97-BA-I8) were drilled with a solid and hollow stem auger in January 1997.
      - Completion depths were up to 17.0 m below ground surface.
      - SPTs were conducted in the boreholes.
    - Laboratory tests were not specified in the report.

- groundwater monitoring well drilling around the perimeter of the TSF for long-term groundwater quality monitoring
  - Eleven air rotary boreholes were drilled at six locations around the perimeter of the TSF from 30 October 1996 to 6 December 1996.
    - Monitoring wells – 11 monitoring wells (GW96-1A/B to GW96-5A/B and GW96-9) were installed at 6 locations.
    - Standard penetration tests – SPTs were conducted in three boreholes (GW96-1A to GW96-3A).
- test pit excavations to delineate the extent of the basin liners
  - Several test pits (96-1 to 96-42) were excavated to delineate the basin liner extents during the 1996 construction program.
    - Completion depths ranged from 1.1 to 7.3 m below ground surface.
    - In situ permeability testing consisted of field air entry permeameter tests of the underlying glaciolacustrine and glaciofluvial units.
  - Upper and lower basin liners were constructed near the Main Embankment.
- test pit excavations to investigate potential sand deposits for use as filter sand in the embankment drains
  - Several test pits (96-56 to 96-69 and 96-111 to 96-115) were excavated during the 1996 construction program.
    - Completion depths ranged from 4.3 to 8.2 m below ground surface.
  - Laboratory testing of soil samples collected from the test pits to evaluate suitability for filter sand consisted of the following:
    - 16 samples for index testing including water content, Atterberg limits, grain size analysis, and specific gravity
    - eight samples for effective strength parameters, compaction, and permeability testing
- borehole investigations to accompany the installation of instrumentation in the foundation soils of the Main Embankment
  - Four boreholes (96-A1, 96-B1a, 96-B1b, and 96-C1) were drilled with a solid and hollow stem auger in the Main Embankment footprint from 21 to 24 July 1996.
    - Completion depths ranged from 9.1 to 16.5 m below ground surface.
    - Vibrating wire piezometers – Six VWPs were installed in four boreholes.
    - Standard penetration tests – Sixty-four SPTs were conducted in three boreholes.
  - Laboratory tests were not specified in the report.
- CPT investigation to further investigate the foundation soils of the Main Embankment
  - Ten CPTs (soundings CPT96-1 to CPT96-5 and PRW96-1 to PRW96-4) were advanced in the Main Embankment footprint from 27 to 28 July 1996. Two soundings were advanced at PRW96-2, referred to as PRW96-2 (4) and PRW96-2 (4A).
    - Completion depths ranged from 7.65 to 15.85 m below ground surface.

    - Shear wave velocity tests were completed at 1 m intervals and several pore pressure dissipation tests.
  - Four boreholes (PRW96-1 to PRW96-4) were drilled with a solid stem auger beside their respective CPT location to serve as pressure relief wells from 27 to 28 July 1996.
    - Completion depths ranged from 9.9 to 22.1 m below ground surface.
    - Field tests – Pocket penetrometer and torvane tests were conducted at selected depths.
  - Four pressure relief trenches were also excavated downstream of the Main Embankment (test trenches PRT-01 to PRT-04).
- a detailed geological summary of the four main soil units encountered in the TSF foundation including ablation till, glaciolacustrine/glaciofluvial, basal till, and bedrock

Data

- Appendix A – Summary of Recent Geological Investigations
- Appendix B – Supplementary Investigation Reports
  - Appendix B1 – R.E. Graham Field Report
  - Appendix B2 – ConeTec Field Report

KP (Knight Piesold Ltd.). 2007. Mount Polley Stage 6 TSF Design. Letter to Mr. Chris Carr, Geotechnical Mines Inspector, Ministry of Energy, Mines and Petroleum Resources. Reference No. VA101-1/18-A.01. 19 December 2007.

Purpose

The main objective of this letter was to provide additional information on three items requested by Mr. Chris Carr:

- results of direct shear testing on lacustrine soils
- cross-sections showing stability analyses for dam raise to elevation 958 m
- slope inclinometer depth vs. cumulative displacement plots showing cumulative displacement from date of installation

Scope

The scope related to the TSF foundation includes the following:

- Two brass tube samples of a lacustrine unit were collected from a test pit (TP-07) excavated next to the Main Embankment Seepage Collection Pond on 13 May 2007.
- Testing consisted of the following:
  - direct shear – 1 test (with 3 points)

Data

- Appendix A – Direct Shear Testing Results

TSF CONSTRUCTION RECORD REPORTS

KP (Knight Piésold Ltd.). 1999. Mount Polley Mine Tailings Storage Facility Report on 1998 Construction and Annual Inspection. Prepared for Mount Polley Mining Corporation. Reference No. 11162/10-1. 16 June 1999.

Purpose

The main objectives of this report were to document the Stage 2A/2B construction program, which involved raising the Main and Perimeter embankments by 3 m to an elevation of 937 m and document the 1998 annual inspection. This report provides the following:

- discussion of the construction methods used during the program
- results of the quality assurance tests
- a review of the new instrumentation and monitoring results
- as-built drawings corresponding to the Stage 2A/2B construction program
- results of the investigations undertaken during the program
- results of the annual inspection

Scope

The scope related to the TSF foundation includes the following:

- Ten VWPs were installed in the foundation soils at the Main Embankment.
- Three pressure relief trenches (PRT98-01 to PRT98-03) and seven pressure relief wells (PRW98-01 to PRW98-07) were installed at the Main Embankment.
- Nineteen boreholes (DH98-BL-01 to DH98-BL-19) were drilled within the tailings basin to investigate the requirements for the basin liner in February 1998.
  - Completion depths ranged from 1.2 to 7.6 m below ground surface.
  - Grab samples were collected for laboratory testing.
- Forty-four boreholes (BH99-01 to BH99-44) were drilled within the tailings basin to investigate the requirements for the basin liner in 1999.
  - Completion depths ranged from 0.6 to 9.1 m below ground surface.
  - Grab samples were collected for laboratory testing.
- Laboratory testing of soil samples collected from the boreholes consisted of the following:
  - visual description of soils
  - ater contents
  - Atterberg limits
  - sieve analysis
  - hydrometer
  - consolidated undrained triaxial compression

Data

- Appendix A – Borrow Area and Basin Liner Investigations
- Appendix B – Construction Quality Assurance Record Test Summary Sheets
- Appendix C – Construction Quality Assurance Control Test Summary Sheets and Gradation Plots
- Appendix D – Consolidated Undrained Triaxial Test Results for R/ZS-12
- Appendix E – 1998 Construction Photos
- Appendix F – 1998 Annual Inspection Photos
- Appendix G – Piezometer Records
  - Appendix G1 – Tailings Piezometers
  - Appendix G2 – Embankment Foundation Piezometers
  - Appendix G3 – Embankment Fill Piezometers
  - Appendix G4 – Drain Piezometers

KP (Knight Piésold Ltd.). 2000. Mount Polley Mine Tailings Storage Facility Report on 1999 Construction. Prepared for Mount Polley Mining Corporation. Reference No. 11162/13-5. 30 August 2000.

Purpose

The main objective of this report was to document the Stage 2C construction program, which involved raising the Main and Perimeter embankments by 4 m to an elevation of 941 m. This report provides the following:

- discussion of the construction methods used during the program
- results of the quality assurance tests
- a review of the new instrumentation and monitoring results
- as-built drawings corresponding to the Stage 2C construction program
- results of the investigations undertaken during the program

Scope

The scope related to the TSF foundation includes the following:

- Ninety-one boreholes (DH99-45 to DH99-135) were drilled around the perimeter of the TSF to evaluate the potential for seepage infiltration into foundation materials during hydraulic placement of cycloned sand.
  - Completion depths ranged from 0.6 to 7.5 m below ground surface.
  - SPTs were conducted in some of the boreholes.
  - Grab samples were collected for laboratory testing.
- Twenty-four boreholes (DH99-136 to DH99-159) were drilled within Borrow Area No. 2 (downstream of the Main Embankment) to determine the availability and suitability of core zone material.
  - Completion depths ranged from 4.6 to 13.9 m below ground surface.

Data

- Appendix A – Investigations
- Appendix B – Construction Quality Assurance Control Test Summary Sheets and Gradation Plots
- Appendix C – Construction Quality Assurance Record Test Summary Sheets
- Appendix D – Stage 2C Construction Photos
- Appendix E – Stage 2C Design Modifications

KP (Knight Piésold Ltd.). 2001. Mount Polley Mine Tailings Storage Facility Report on Stage 3 Construction. Prepared for Mount Polley Mining Corporation. Reference No. 11162/14-3. 19 October 2001.

Purpose

The main objective of this report was to document the Stage 3 construction program which involved raising the TSF embankments to an elevation of 942.5 m. This report provides the following:

- discussion of the construction methods used during the program
- results of the quality assurance tests
- a review of the new instrumentation and monitoring results
- as-built drawings corresponding to the Stage 3 construction program
- results of the investigations undertaken during the program

Scope

The scope related to the TSF foundation includes the following:

- installation of four VWPs in the foundation soils
- geotechnical investigations conducted during the Stage 3 construction program
  - Three air rotary (ODEX) boreholes (GW00-01 to GW00-03) were drilled downstream of the South Embankment in August 2000.
    - Completion depths ranged from 21.0 to 24.3 m below ground surface.
    - Monitoring wells – Six monitoring wells (GW00-01A/B to GW00-03A/B) were installed at three locations.
    - SPTs were conducted in two boreholes.
  - Eighty boreholes (DH01-01 to DH01-80) were drilled to investigate the availability of glacial till within Borrow Areas No. 2, No. 3, and No. 5 in April 2001.
    - Completion depths ranged from 1.2 to 12.2 m below ground surface.
    - Grab samples were collected for laboratory testing.
  - Two air rotary (ODEX) boreholes (SI01-01 and SI01-02) were drilled downstream of the Main Embankment in July 2001.
    - Completion depths were 24.4 and 30.3 m below ground surface.
    - Slope inclinometers – Two SIs were installed.
    - SPTs were conducted in both boreholes.
  - Laboratory testing of soil samples collected from the boreholes consisted of the following:
    - visual description of soils
    - water contents
    - sieve analysis
    - hydrometer

Data

- Appendix A – Investigations
- Appendix B – Construction Quality Assurance Control Test Summary Sheets and Gradation Plots
- Appendix C – Construction Quality Assurance Record Test Summary Sheets
- Appendix D – Stage 3 Construction Photos
- Appendix E – Stage 3 Design Modifications

KP (Knight Piésold Ltd.). 2007. Mount Polley Mine Tailings Storage Facility Report on Stage 4 Construction. Prepared for Mount Polley Mining Corporation. Reference No. VA101-1/10-1. 13 March 2007.

Purpose

The main objective of this report was to document the Stage 4 construction program which involved raising the TSF embankments by 4 m to an elevation of 948 m. This report provides the following:

- discussion of the construction methods used during the program
- results of the quality assurance tests
- a review of the instrumentation monitoring results
- as-built drawings corresponding to the Stage 4 construction program
- results of the investigation undertaken during the program

Scope

The scope related to the TSF foundation includes the following:

- geotechnical investigation program conducted in May 2006
  - Three air rotary boreholes (SI06-01 to SI06-03) were drilled downstream of the Main Embankment.
    - Completion depths ranged from 34.7 to 42.2 m below ground surface.
    - Slope inclinometers – Three SIs were installed.
    - SPTs were conducted in all three boreholes.
- other relevant information:
  - Slope inclinometer SI01-01 was destroyed during Stage 4 construction.
- laboratory testing of soil samples collected from the boreholes:
  - visual description of soils
  - ater contents – 10 tests
  - Atterberg limits – 10 tests
  - sieve analysis – 10 tests
  - hydrometer – 10 tests
  - one-dimensional consolidation using incremental loading – 1 test

Data

- Appendix A – Laboratory Test Results
  - Appendix A1 – Zone S Control Results
  - Appendix A2 – Zone S Record Results
  - Appendix A3 – Zone U Results
- Appendix B – Inclinometer Installations

- Appendix B1 – Drill Logs
- Appendix B2 – Laboratory Test Results

- Appendix C – Nuclear Densometer Results
- Appendix D – Photographs

KP (Knight Piésold Ltd.). 2009. Mount Polley Mine Tailings Storage Facility Report on Stage 6A Construction. Prepared for Mount Polley Mining Corporation. Reference No. VA101-1/23-1. 10 July 2009.

Purpose

The main objective of this report was to document the Stage 6A construction program which involved raising the TSF embankments by 3 m to an elevation of 954 m. This report provides the following:

- discussion of the construction methods used during the program
- results of the quality assurance tests
- a review of the instrumentation monitoring results
- as-built drawings corresponding to the Stage 6A construction program
- results of the investigation undertaken during the program

Scope

The scope related to the TSF foundation includes the following:

- geotechnical investigation program conducted in May 2008
  - Eleven sonic boreholes (KP08-01, KP08-02, KP08-04, KP08-06, KP08-08, KP08-09, KP08-11, KP08-12, and KP08-14 to KP08-16) were drilled in a potential borrow area downstream of the Perimeter Embankment.
    - Completion depths ranged from 8.5 to 23.8 m below ground surface.
    - SPTs were conducted in most of the boreholes.
    - Grab samples were collected for laboratory testing.

Data

- Appendix A – Laboratory Test Results
  - Appendix A1 – Zone S Control
  - Appendix A2 – Zone S Record
  - Appendix A3 – Zone U Record
  - Appendix A4 – Zone F Record
  - Appendix A5 – Zone T Record
  - Appendix A6 – South Embankment Concrete Encasement – Concrete Strength Test Results
- Appendix B – Nuclear Densometer Results
  - Appendix B1 – Zone S Record
  - Appendix B2 – Zone U Record
- Appendix C – Piezometer Figures
  - Appendix C1 – Tailings Piezometers
  - Appendix C2 – Foundation Piezometers

- Appendix C3 – Fill Piezometers
- Appendix C4 – Drain Piezometers

- Appendix D – Inclinometer Data
- Appendix E – Photographs
- Appendix F – Site Investigation Drill Logs

Golder (Golder Associates Ltd.). 2015. 2015 Freshet Management Embankment As-Built Construction. Prepared for Mount Polley Mining Corporation. Document No. 1413803-065-R-Rev0-2000. 4 September 2015.

Purpose

The main objective of this report was to document the Freshet Management Embankment construction program. This report provides the following:

- summary of design and adjustments to accommodate conditions encountered during construction
- description of the major construction activities including water management
- summary of the construction quality assurance and construction quality control information
- as-built drawings
- as-built instrumentation installation
- construction documentation

Scope

The scope related to the TSF foundation includes the following:

- installation of five slope inclinometers (SI15-26 to SI15-30) during the construction program
  - Four slope inclinometers were installed in the cut-off wall, while the other was installed to replace two damaged slope inclinometers downstream of the Perimeter Embankment.
- installation of two shape accel arrays (SAAs) within existing slope inclinometers downstream of the Freshet Management Embankment
  - SAA15-01 was installed within slope inclinometer SH14-03.
  - SAA15-02 was installed within slope inclinometer SH14-16.

Data

- Appendix A – 2015 Freshet Management Embankment Issued for Construction Drawings and Construction Technical Specifications
- Appendix B – 2015 Freshet Management Embankment As-Built Construction Drawings
- Appendix C – Construction Photographs
- Appendix D – Construction Sign-Offs
- Appendix E – Cut-Off Wall As-Built Construction Report
- Appendix F – Geotechnical Instrumentation
- Appendix G – QA/QC Laboratory Test Results and Field Testing
- Appendix H – Construction Material Certificates
- Appendix I – Daily Reports
- Appendix J – Dayshift and Nightshift Reports
- Appendix K – Construction Meeting Minutes

APPENDIX B

Site-Specific Seismic Hazard Assessment

REPORT

Site-Specific Seismic Hazard Assessment

Mount Polley TSF Site, British Columbia

Submitted to:

Germán Pizarro, P.Eng

WSP Canada Inc.
Suite 200 2920 Virtual Way
Vancouver, British Columbia
Canada V5M 0C4

Submitted by:

WSP USA Inc.

18300 NE Union Hill Road, Suite 200, Redmond, Washington, USA 98052
United States of America

+1 425 883 0777

31404975.000

1 February 2023

Table of Contents

1.0 INTRODUCTION 1

1.1 Site Location 1

1.2 Background 1

1.3 Work Scope 3

1.4 Terminology 3

1.5 Report Structure 4

2.0 SITE GROUND CONDITIONS 5

3.0 SEISMIC SOURCE MODELS 5

3.1 Seismotectonic and Geological Setting 6

3.2 Canadian National Seismic Source Model 7

3.3 Earthquake Catalog 7

3.4 Shallow Crustal Sources 9

3.4.1 Uniform-area sources 9

3.4.2 Crustal Fault Sources 13

3.5 Subduction Sources 13

3.5.1 Subduction Interface 13

3.5.2 Subduction In-slab 16

3.6 Source Model Parameters 18

4.0 GROUND MOTION MODEL SELECTION AND WEIGHTING 18

4.1 Active Shallow Crustal Ground Motion Models 18

4.2 Subduction Ground Motion Models 19

5.0 PROBABILISTIC SEISMIC HAZARD ANALYSIS 21

5.1 Methodology 21

5.2 Logic Tree Analysis 21

5.3 Validation of Model Implementation 24

6.0 DETERMINISTIC ANALYSIS 26

7.0 SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ANALYSIS RESULTS 26

7.1 Hazard Curves 26

7.2 Uniform Hazard Acceleration Response Spectra 28

7.3 Magnitude-distance Deaggregation 35

8.0 SEISMIC HAZARD ANALYSIS: DISCUSSION AND RECOMMENDATIONS 45

8.1 Comparison of Seismic Hazard Assessment Results to CanadaSHM6 45

8.3 Earthquake Acceleration Time History Development 45

9.0 CLOSING 45

10.0 REFERENCES 47

TABLES

Table S-1: Site-specific accelerations (5%-damped) for selected annual exceedance probabilities and spectral periods at the Mount Polley TSF site, British Columbia, Canada (V_{S30} = 849 m/s) vi

Table 2: Terminology Used in this Report 4

Table 3: Earthquakes with M>3 Magnitude Recorded within 200 km of the Mount Polley TSF Site 7

Table 4: Uniform-area Active Shallow Crust Source Parameters 12

Table 5: Cascadia Subduction Zone Interface Seismic Source Parameters 15

Table 6: Cascadia Subduction Zone In-slab Seismic Source Parameters 17

Table 7: Selected Ground Motion Models and Weights used in this Assessment 20

Figure 4 Seismic Source Model Logic Tree used in this assessment 23

Figure 5 Logic trees for selected ground motion models and their weights for crustal, subduction interface, and subduction in-slab sources 24

Table 8: Accelerations for Validation of Models at 1/475 AEP and 1/2475 AEP 25

Table 9: Uniform Hazard Acceleration Response Spectral Ordinates for Selected AEPs 30

Table 10: Uniform Hazard Acceleration Response Spectral Ordinates for 1/1,000 AEP with Selected Fractiles 31

Table 11: Uniform Hazard Acceleration Response Spectral Ordinates for 1/2,475 AEP with Selected Fractiles 32

Table 12: Uniform Hazard Acceleration Response Spectral Ordinates for 1/5,000 AEP with Selected Fractiles 33

Table 13: Uniform Hazard Acceleration Response Spectral Ordinates for 1/10,000 AEP with selected Fractiles 34

Table 14: Average Distance, Magnitude, and Epsilon for Magnitude-distance Deaggregation for the Total Hazard 42

FIGURES

Figure 1: Historical Earthquake Epicenters in Southwestern Canada 2

Figure 2: Earthquake Epicentres and Crustal Seismic Sources for Southwestern Canada 11

Figure 3: Earthquake Epicentres and Subduction Sources for Southwest Canada....14

Figure 6: Mean hazard curves for selected spectral periods for top of engineering bedrock ground condition (V_{S30} = 849 m/s)....27

Figure 7: Mean hazard curves, showing 5th, 15th, 50th (median), 85th, and 95th fractiles for PGA (top left), 0.5 s (top right), 1.0 s (bottom left), and 1.5 s (bottom right) spectral periods....28

Figure 8: Mean Uniform Hazard Acceleration Response Spectra 30

Figure 9: 1/1,000 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles 31

Figure 10: 1/2,475 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles 32

Figure 11: 1/5,000 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles 33

Figure 12: 1/10,000 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles 34

Figure 15: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/2,475 AEP from crustal sources, color coded by epsilon in one-epsilon intervals 38

Figure 18: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/10,000 AEP from subduction sources, color coded by epsilon in one-epsilon intervals 41

APPENDICES

APPENDIX A
Earthquake Acceleration Time Histories

Appendix B
Evaluation of the Time-Average Shear-Wave Velocity

DISCLAIMERS AND LIMITATIONS

Seismic hazard analysis and geotechnical earthquake engineering are dynamic and fast-evolving fields of research and engineering practice. The standard of practice in this technical area continues to develop as new information about the sources of earthquakes becomes available. Consequently, the results presented in this report should be reviewed when new data and/or new scientific theory becomes available.

WSP USA Inc (WSP USA). has prepared this report exclusively for the use of WSP Canada Inc (WSP Canada). for the Mount Polley TSF site. If there are significant changes in the nature, design, location, or site ground conditions, then WSP should be notified so that we can review our conclusions and recommendations. A written modification or verification of the changes can be provided, if required.

EXECUTIVE SUMMARY

This report presents the results of a site-specific probabilistic seismic hazard analysis (PSHA) undertaken by WSP USA Inc. (WSP USA) for the Mount Polley Tailings Storage Facility (TSF) site approximately 380 km northeast of Vancouver, British Columbia. The PSHA has been undertaken for a site at 52.509º N latitude and 121.588º W longitude. Appendix A provides details of the development of earthquake acceleration time histories. Appendix B presents the evaluation of the time-average shear-wave velocity in the 30 m below the ground surface (V_{S30}) used in this assessment.

The site-specific PSHA is based on seismic source models developed for the 6th Generation Canadian National Seismic Hazard Model (CanadaSHM6). WSP USA's review of the tectonic setting, historical earthquake activity rates, and earthquake epicenter distribution within about 500 km of Mount Polley found that the CanadaSHM6 seismic source models are appropriate for estimating the seismic hazard of the TSF site.

Source-to-site attenuation ground motion models (GMMs) for active shallow crustal sources were applied as in CanadaSHM6. For sources associated with the Cascadia subduction zone to the southwest of the site, WSP USA applied a weighted suite of the 2020 NGA-Sub GMMs to model the source-to-site attenuation of subduction earthquake strong ground motions.

Earthquake ground motions are reported as 5%-damped, mean uniform hazard acceleration response spectra at annual exceedance probabilities (AEPs) of 1/1,000, 1/2,475, 1/5,000 and 1/10,000 for the site-specific V_{S30} of 849 m/s. Table S-1 below lists the mean uniform hazard spectral ordinates for selected AEPs at horizontal peak ground acceleration (PGA), 0.5 s, 1.0 s, and 1.5 s spectral periods developed from the site-specific PSHA at the Mount Polley TSF site. The results at an AEP of 1/2,475 are slightly lower than CanadaSHM6 at spectral periods below ~2.0 s and slightly higher at spectral periods above 2.0 s. These differences are attributed to the different ground motion model selection and weighting, and site-specific V_{S30} of 847 m/s used in this assessment.

Deaggregations were performed for the total hazard and separately for active shallow crustal and subduction sources at 1/2,475 and 1/10,000 AEPs at selected spectral periods. The results show that both near-field, moderate-magnitude crustal earthquakes and far-field subduction interface earthquakes contribute to the site seismic hazard. The shallow crustal earthquake sources are dominated by moderate-magnitude earthquakes (**M**6.0 to **M**6.5) close to the site (i.e., <60 km) at all AEPs. The contribution to hazard at the site from Cascadia subduction zone sources is from large earthquakes (**M**8+) at 450 to 550 km from these at all AEPs and spectral periods of interest.

Table S-1: Site-specific accelerations (5%-damped) for selected annual exceedance probabilities and spectral periods at the Mount Polley TSF site, British Columbia, Canada (V_{S30} = 849 m/s)

Performance Level - AEP	Spectral Period (s)	Acceleration (g)[1]					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
1/1,000	PGA	0.026	0.023	0.023	0.025	0.028	0.028
	0.5	0.033	0.030	0.030	0.033	0.035	0.036
	1.0	0.020	0.017	0.017	0.019	0.021	0.023

Performance Level - AEP	Spectral Period (s)	Acceleration (g)[1]					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
	1.5	0.015	0.012	0.012	0.015	0.017	0.018
1/2,475	PGA	0.048	0.042	0.042	0.046	0.053	0.054
	0.5	0.054	0.050	0.050	0.053	0.057	0.058
	1.0	0.030	0.026	0.027	0.030	0.033	0.035
	1.5	0.023	0.018	0.019	0.022	0.026	0.027
1/5,000	PGA	0.076	0.067	0.067	0.073	0.084	0.085
	0.5	0.079	0.073	0.073	0.079	0.083	0.084
	1.0	0.042	0.036	0.038	0.041	0.045	0.048
	1.5	0.031	0.024	0.025	0.029	0.036	0.037
1/10,000	PGA	0.116	0.102	0.102	0.111	0.128	0.128
	0.5	0.114	0.106	0.106	0.115	0.119	0.121
	1.0	0.057	0.050	0.052	0.057	0.060	0.065
	1.5	0.041	0.032	0.034	0.039	0.047	0.048

Note:

1. 5%-damped, mean, geometric-mean, peak horizontal acceleration.

Eleven two-horizontal-component EATHs (22 records) were developed using amplitude scaling to the site-specific 1/2,475 AEP uniform hazard acceleration response spectrum within the period range of interest of 0.5 to 1.5 seconds (Appendix A). These 22 EATHs were developed with eight two-component (16) records from crustal earthquakes and three two-component (6) subduction interface earthquake records. Comparison of the intensity measures of the scaled EATHs to predicted $D_{5\text{-}75}$, $D_{5\text{-}95}$, CAV, and AI intensity measures indicates that the scaled EATHs are generally within the 16th and 84th percentile range of the empirically predicted values.

1.0 INTRODUCTION

This report provides earthquake ground motions estimated from a site-specific probabilistic seismic hazard analysis (PSHA) and deterministic seismic analysis (DSA) undertaken by WSP USA Inc. (WSP USA) for the Tailings Storage Facility (TSF) at the Mount Polley mine TSF site in British Columbia, Canada. Seismic parameters presented in this report can be used to support future engineering analysis at the Mount Polley TSF site.

1.1 Site Location

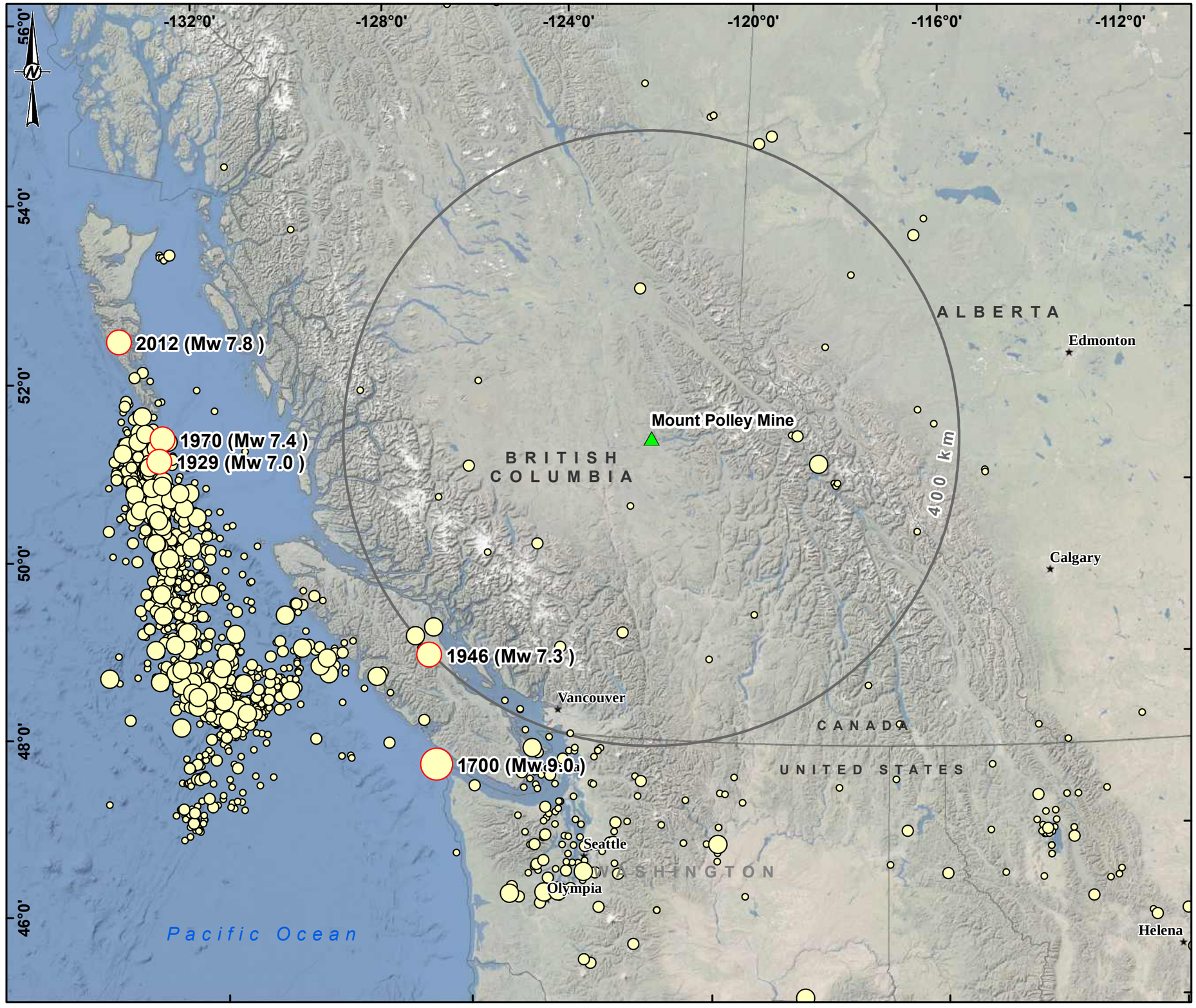
The Mount Polley TSF site is in British Columbia, about 380 km northeast of Vancouver (Figure 1). The site is at 52.509º N latitude and 121.588º W longitude, and hereinafter referred to as the 'site'.

1.2 Background

Mount Polley Mining Corporation (MPMC) requested WSP Canada Inc. (WSP Canada) to provide a series of work plans for ongoing engineering support of the Mount Polley Mine site development. One key task is to update the feasibility design for raising of the South, Main, and Perimeter embankments for the Mount Polley TSF. The design to be updated is that described in Golder (2015).

Dynamic analysis modelling requires input acceleration time histories that represent realistic earthquake ground motions for the annual exceedance probability (AEP) being considered. In turn, these acceleration time histories should reflect a state-of-practice seismic hazard analysis at the site. Because there have been several major developments in the assessment of seismic hazards in North America in recent years, and importantly the publication of the NGA-Subduction ground motion models, a revised site-specific seismic hazard analysis was included as part of Golder's work plan for stability analysis for the Mount Polley TSF.

This report presents the data, methods, and results of the site-specific PSHA undertaken to support seismic stress deformation modeling for the Mount Polley TSF. The work was undertaken by specialist staff from WSP USA Inc. and WSP New Zealand Limited (formerly Golder Associates New Zealand Ltd.) under an intercompany agreement with WSP Canada Inc. (WSP Canada). The agreed work scope of work for the PSHA and development of earthquake acceleration time histories provided in Appendix A is described in proposal 21452039-078-WP-Rev0-50000-TSF2022_28JAN_22. Further details are provided in Section 1.3 below.



LEGEND

- Project Location

Earthquake Epicenter

Moment Magnitude (Mw)

- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9
- ≥ 8

(Year and magnitude labeled)

0 100 200 400

KILOMETERS

REFERENCE(S)

1. COORDINATE SYSTEM: NAD 1983 2011 UTM ZONE 11N
2. SERVICE LAYER CREDITS: USGS,NGA,NASA,CGIAR,GEBCO,N ROBINSON,NCEAS,NLS,OS,NMA,GEODATASTYRELSEN AND THE GIS USER COMMUNITY SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

CLIENT

GOLDER ASSOCIATES LTD.

PROJECT

SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT FOR MOUNT POLLEY MINE, BRITISH COLUMBIA

TITLE

HISTORICAL EARTHQUAKE EPICENTERS IN SOUTHWESTERN CANADA

CONSULTANT

wsp

YYYY-MM-DD	2022-08-31
DESIGNED	-
PREPARED	HJ
REVIEWED	AK/ET
APPROVED	AH

PROJECT NO.	PHASE	REV.	FIGURE
6-DY039.00	-	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

PATH: G:\GOLDER\Mt_Polley\99_PROJECTS\6_DY039_00_Mt_Polley_SHA\000001_SHA_EQs\02_PRODUCTION\MXD\FIGURES\Rev\A3 140-4975_01_F01_MTPOLLEY_SHA_EQs.mxd

1.3 Work Scope

WSP USA has completed the following major tasks to develop earthquake ground motions, acceleration time histories (Appendix A), and evaluation of site time-average shear-wave velocity (Appendix B) for site-specific seismic hazard analysis at the Mount Polley TSF site:

- Reviewed existing reports and readily available published, unpublished, and on-line records of the tectonic, geologic and earthquake history of the region surrounding the site.
- Assessed available information and estimated the time-averaged shear-wave velocity of the site ground conditions beneath the Mount Polley TSF site (Appendix B).
- Developed a seismic source model based on the seismic sources in CanadaSHM6 within about 400 km of the Mount Polley TSF site.
- Evaluated and weighted appropriate site-to-source attenuation ground motion models (GMM) for southwest Canada.
- Developed probabilistic hazard curves for a ground condition with a V_{S30} of 849 m/s (i.e., time-averaged shear-wave velocity in the upper 30 m below a reference depth).
- Prepared site-specific, 5%-damped, spectral acceleration hazard curves for an AEP range from 1/10 to 1/10,000, and for discrete spectral periods at horizontal peak ground acceleration (PGA), 0.2 s, and 1.0 s.
- Developed site-specific, 5%-damped, uniform hazard response spectra (UHRS) horizontal mean values at AEPs of 1/2,475, 1/5,000, and 1/10,000 and spectral periods (T_S) up to 10 s.
- Developed spectral accelerations (S_a) mean values, and median values ± one and two standard deviations (i.e., ±1 sigma and ±2 sigma) for discrete spectral periods at PGA, 0.2 s, and 1.0 s or the selected AEPs.
- Developed probabilistic deaggregation analysis by magnitude, distance, and epsilon for mean values of PGA and S_a of 0.1 s, 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s, and 10.0 s, and at AEPs of 1/2,475, 1/5,000, and 1/10,000.
- Evaluated the PGA and S_a values for the dam performance levels (e.g., OBE and SEE) as specified by CDA (2014) and ICMM (2019) bulletins.
- Assessment and incorporation of model uncertainties used to estimate mean ground motions at the site.
- Earthquake acceleration time histories as presented in Appendix A.
- Prepared this report with the data, methods, and results of the seismic hazard analysis used to develop the recommended seismic parameters at the site.

1.4 Terminology

The terminology used in PSHA is specialised and is often used inappropriately. Use of variable and different terms can result in some confusion. Table 2 lists key terms used in this report as well as alternative, similar terms that relate terms used in this report to other commonly used terms with similar definitions.

Table 2: Terminology Used in this Report

Terms and Units	Alternative Similar Terms (units and definition may very)
Spectral period (seconds, s)	Period, natural-period, period-of-vibration, natural frequency.
Acceleration[1] (percentage of gravitational acceleration, g)	Peak geometric-mean horizontal acceleration, spectral acceleration.
Annual exceedance probability (AEP, likelihood of being exceeded in 1 year)	Return period[2] (years), frequency, annual probability of exceedance (AEP).
Uniform hazard acceleration response spectrum	Uniform hazard curve, acceleration response spectrum, response spectrum, spectral response spectrum, uniform hazard mean acceleration response spectrum.
Ground motion model (GMM)	Ground motion prediction equation (GMPE), attenuation equation.
Deaggregation	Disaggregation, de-aggregation.

Notes:

1. Where we use the term 'acceleration' it refers to the mean (geometric-mean) horizontal peak acceleration response of a 5 %-damped, single degree of freedom pendulum.
2. The inverse of the AEP is approximately equal to the return period for AEP values less than about 1/100 (0.01).

1.5 Report Structure

This report has the following structure:

- **Section 2.0: Site Ground Conditions**
  Describes the near-surface ground conditions used in this assessment
- **Section 3.0: Seismic Source Models**
  Describes the approach adopted in this assessment to model the magnitude, location, and frequency of earthquakes in the region around the site that contribute to the earthquake ground motion hazard.
- **Section 4.0: Ground Motion Model Selection and Weighting**
  Describes the ground motion models selected to undertake the PSHA, including the rationale for their selection and weighting.
- **Section 5.0: Probabilistic Seismic Hazard Analysis**
  Describes the PSHA analytical procedures of this site-specific assessment.
- **Section 6.0: Deterministic Assessment**
  Describes consideration of an MCE scenario for this assessment.
- **Section 7.0: Site-specific Probabilistic Seismic Hazard Analysis Results**
  Describes the results from the PSHA for this site-specific assessment.
- **Section 8.0: Seismic Hazard Analysis Discussion and Recommendations**
  Presents comparison of results with previous studies, and discussion of applying the results to assist in selection of engineering design.
- **Section 9.0: Closing**

- **Appendix A**

  Earthquake Acceleration Time History Development for Mount Polley TSF, British Columbia, Canada

- **Appendix B**

  Evaluation of the Time-Average Shear-Wave Velocity

2.0 SITE GROUND CONDITIONS

Near-surface site ground conditions can have a significant influence on the earthquake ground motion at a site. The effects of near surface ground conditions are spectral period dependent. Softer site ground conditions cause damping of short period waves and amplification of long period waves, and the inverse is observed at stiffer sites. Site ground conditions are incorporated into PSHA using parameters related to the shear-wave velocity profile beneath the site as used in GMMs. The shear-wave velocity related parameters are:

- V_{S30}: The time-averaged shear-wave velocity of the upper 30 m of ground or a reference surface below the site.
- $Z_{1.0}$: The depth to a shear wave velocity of 1,000 m/s.
- $Z_{2.5:}$ The depth to a shear wave velocity of 2,500 m/s.

These parameters are typically derived from the ground surface. However, they can also be developed for a reference depth such as engineering bedrock, especially in the case where the outputs of the PSHA are being used as an input for seismic ground response analysis to model the effects of non-linear behavior of near surface materials on the seismic hazard or the base of geotechnical models to assess dynamic stability. In general, there should be a negligible amount of non-linear behavior of earth materials beneath the reference depth.

Earthquake ground motions reported in this seismic hazard assessment are for V_{S30} of 849 m/s for engineering bedrock. This value was estimated through communication with the project engineering team and is based on VSP analysis at three borehole locations along the Mount Polley TSF. Appendix B provides further details for the site V_{S30} analysis used for this assessment.

The Kaklamanos et al. (2011) method based on the ground surface V_{S30} was used to estimate the $Z_{1.0}$ and $Z_{2.5}$ parameter values of 20.5 m and 590 m, respectively.

3.0 SEISMIC SOURCE MODELS

Seismic source models are an input into site-specific PSHA. They describe the spatial distribution, likelihood and magnitude of future earthquakes that may affect the site. Because the location and magnitude of future earthquakes is unknowable, a range of methods is used to predict the location, likelihood, and magnitude of future earthquakes creating a set of weighted alternative seismic source models.

The seismic source model used for this assessment adopts seismic sources and their parameters as developed for the preliminary release of the 2020 National Hazard Model of Canada (Kolaj et al. 2020b). The following sections describe the seismotectonic setting of the Mount Polley TSF site, and the source model adopted from CanadaSHM6 for this site-specific analysis.

3.1 Seismotectonic and Geological Setting

The Mount Polley TSF site is located within the Canadian Cordillera, part of the North American Cordillera that was formed by convergent tectonic processes and the successive accretion of a number of allochthonous terranes[1] to the ancient western margin of the North American plate, likely beginning sometime in the Late Triassic to Early Jurassic (~180 to 200 million years ago (Ma)) (Ricketts 2008; Price, 2000, 1994; Monger 1989; Monger and Price 1979). The accretion of allochthonous terranes was diachronous along the North American plate margin, with numerous complexities related to the amalgamation of terranes prior to accretion (e.g., Monger 1989). The Mount Polley mine site is located within the Quesnel terrane, which consists of an island arc assemblage that developed outboard of the ancient North American continental margin and was accreted to the North American plate sometime in the latest Triassic or earliest Jurassic (~200 Ma) (Beatty et al. 2006). The Quesnel terrane hosts numerous porphyry copper-gold and other important mineral deposits related to various metallogenetic processes (Nelson and Colpron 2007). East of this terrane is the Foreland Fold and Thrust Belt, comprising amalgamated volcanic, island arc and oceanic terranes that were accreted onto the western edge of the North American craton during the Late Jurassic to Paleocene about 150 to 60 Ma, together with highly deformed sedimentary sequences mostly represented by the Canadian Rocky Mountains.

The seismotectonic setting of western Canada is complex and with a diverse range of earthquake sources. The present-day tectonics of western Canada are strongly influenced by the effects of relative motions of the Pacific and North America plates and remnants of the former Farallon plate that was largely subducted. The modern Explorer, Juan de Fuca, and Gorda plates are the remain of the much larger Farallon plate.

The Cascadia subduction zone (CSZ) marks the boundary where the Juan de Fuca, Explorer, and Gorda plates are being subducted beneath western North America. The 1,200-km-long CSZ extends from northern California to British Columbia and is ~460 km west of Mount Polley at its closest approach. The present-day convergence (subduction) velocity ranges from about 43 mm/yr for the Juan de Fuca plate that decreases to the northwest to about 20 mm/yr for the Explorer plate (North America fixed). The CSZ has produced repeated great earthquakes (i.e., greater than moment magnitude (**M**)8.0 throughout the Holocene Epoch (i.e., last 11,700 years). The most recent CSZ great earthquake was an estimated **M**9.0 in January of 1700. The Cascadia subduction interface is currently locked and accumulating strain toward a future large or great earthquake (e.g., Dragert et al. 1994, Hyndman and Wang 1995, Mazzotti et al. 2003). The CSZ has a high rate of historical seismicity relative to the southern Canadian Cordillera where the Mt Polley TSF site is located.

The southern Cordillera has relatively low rates of historical seismicity relative to the northern Cordillera and CSZ to the west. However, intermediate-to-large magnitude earthquakes have been recorded. For example, an **M**6.0 earthquake in 1918 had an epicenter ~ 220 km east of the site (Halchuk et al. 2015). An **M**5.5 earthquake occurred in 1986 with an epicenter ~200 km north of the site (Table 3). Both earthquakes occurred in the “Rocky Mountain Trench” that marks the boundary between the western Foreland Fold and Thrust Belt and the Quesnel terrane and other terranes. The 1986 earthquake had a thrust fault mechanism, which is consistent with the general structural trends mapped in the area (e.g., Rogers et al. 1990).

[1] Allochthonous terranes are assemblages or packages of rocks that are stratigraphically and structurally distinct from their neighbours. Each terrane has a distinct geological history that precedes its amalgamation to other terranes. Terranes are created by crustal- and lithosphere-scale plate tectonic processes. Many allochthonous terranes have been identified throughout western North America, including Alaska.

3.2 Canadian National Seismic Source Model

The preliminary 6th Generation Seismic Hazard Model of Canada (CanadaSHM6) was released in 2020 as the basis for the 2020 National Building Code of Canada (NBCC 2020). The CanadaSHM6source modelling approach is described in more detail by Kolaj et al. (2020b). Information and digital files for the model used in this assessment were gathered from GSC Open File 8630 by Kolaj et al. (2020b; updated 29 November 2021), downloaded directly from the Natural Resources Canada website.

The Kolaj et al. (2020b) model is divided into three main components based on location — western Canada, eastern Arctic Canada, and southeast Canada. This assessment used only the western Canada component of CanadaSHM6. Between CanadaSHM5 and CanadaSHM6 significant updates were made to the western Canada model, including improved characterization of the CSZ and addition of the Leech River Valley Fault – Devil's Mountain Fault system in southern Vancouver Island. This has resulted in an increase in the estimated seismic hazard in southern British Columbia.

The Kolaj et al. (2020a) seismic source model includes sources for the CSZ interface, CSZ in-slab, active crustal, and stable crustal earthquakes. The seismic sources adopted for this assessment are described in Section 3.4 and Section 3.5 below.

3.3 Earthquake Catalog

Development of a site-specific SHA requires a comprehensive understanding of the spatial and temporal distribution of historical earthquakes for the region surrounding the site. The Seismic Hazard Earthquake Epicenter File (SHEEF2010), developed by Halchuk et al. (2015), was used to compute the earthquake occurrence rates for areal sources in CanadaSHM5 and CanadaSHM6.

The SHEEF2010 catalog includes earthquakes with an original catalog earthquake magnitude of 2.5 or higher. The estimated earthquake moment magnitude (**M**) used in the catalog can be less. The SHEEF2010 is estimated by Halchuk et al. (2015) to be complete from 1900 through 2010 for all reported magnitudes.

Although the catalog ends in 2010, updating the catalog and recalculating the activity rates has not been considered for this analysis. The update was not undertaken because there are insufficient recorded earthquakes in the region surrounding the site since 2010 to cause a change in calculated earthquake activity rates. Figure 1 presents **M**4 and larger earthquakes from SHEEF2010 within ~700 km from the site. Table 3 lists the key parameters for historical earthquakes that have occurred within 200 km from the site. Only three of the recorded earthquakes exceeded **M**4, indicating a relatively low rate of historical earthquake activity.

Table 3: Earthquakes with M>3 Magnitude Recorded within 200 km of the Mount Polley TSF Site

Date	Time (UTC)	Latitude (ºN)	Longitude (ºW)	Moment Magnitude (M)	Depth [km]	Distance to TSF site [km]
14/12/1988	04:07	53.183	122.291	3.1	5	89
28/8/1962	19:19	51.7	121.9	4.3	0	92
13/12/1968	08:50	52.4	120.2	3.7	18	95

Date	Time (UTC)	Latitude (ºN)	Longitude (ºW)	Moment Magnitude (M)	Depth [km]	Distance to TSF site [km]
13/12/1968	08:50	52.4	120.2	3.7	18	95
13/11/1968	11:59	52.32	120.12	3.2	18	102
4/6/1967	03:26	52.2	120	3.4	0	114
28/7/1965	18:33	52.3	119.8	3.5	0	124
22/10/1983	22:14	51.62	120.48	3.9	18	125
26/8/1969	01:25	51.9	120	3	18	128
16/11/1981	14:21	51.72	120.22	3.4	18	128
6/3/1988	22:54	51.486	122.604	3	10	133
22/1/1983	13:40	53.06	119.75	3.3	18	138
10/8/1968	21:10	52.88	119.63	3.2	18	139
10/3/1981	10:01	52.85	119.5	3.5	18	146
11/1/1995	23:39	51.688	119.914	3.4	5	147
23/3/1982	19:15	52.9	119.5	3.8	18	148
3/12/1957	13:47	51.6	123.3	3.3	0	155
15/4/1999	13:14	52.329	119.309	3.1	10	156
26/2/2001	21:17	52.25	119.324	3.8	11	157
2/5/2007	20:46	52.932	119.308	3	1	161
27/11/1970	22:17	52.64	119.13	3.8	10	167
10/10/2007	17:50	52.885	124.072	3.9	22.3	173
14/5/1978	22:37	52.61	118.9	4.7	7	183
29/3/1964	10:59	52	119	3.2	0	186
16/5/1996	13:13	54.182	122.036	3.5	0	189
14/5/1978	22:37	52.603	118.791	5	10	190
22/5/1985	01:29	52.42	118.79	3.3	18	190
21/3/1986	23:56	54.24	122	5.5	10	195
27/7/1968	04:52	52.3	118.7	3	18	198
26/7/1968	22:23	52.28	118.68	3.3	18	200
30/12/2003	13:22	52.354	118.661	3.3	6.1	200

3.4 Shallow Crustal Sources

3.4.1 Uniform-area sources

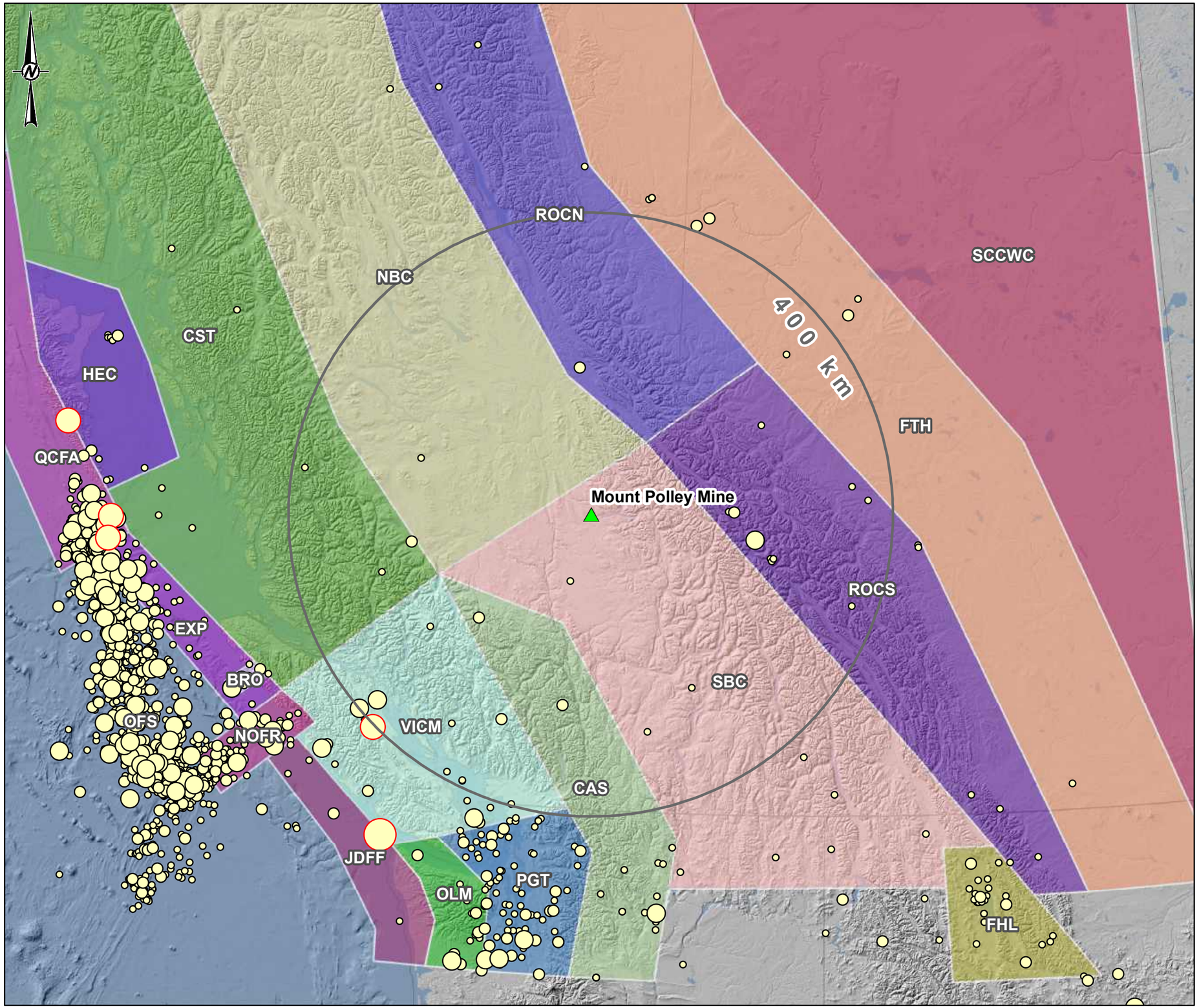
CanadaSHM6 uses uniform-area sources to model the occurrence of crustal seismicity not associated with known mapped seismogenic features such as seismically active faults or other seismogenic structures. There are eight crustal uniform-area sources within the Western CanadaSHM6 model within ~400 km of the site. These sources are described further below and shown in Figure 2.

- **Foothills (FTH):** Foreland Basin rocks located within the interior platform of western Canada immediately adjacent and east of the Canadian Cordillera. Characterized by very low rates of natural historical seismicity. In recent years oil and gas exploration has greatly increased the number of small earthquakes in the region. These “induced” earthquakes are not incorporated into this analysis because they contribute only to the short-term hazard locally and not the longer-term hazard considered here.
- **Rocky Mountain Fold/Thrust Belt North (ROCN):** Foreland fold and thrust belt of the Canadian Cordillera. This zone is characterized by slightly higher rates of historical seismicity compared to NBC and SBC. This source zone hosted an **M**5.5 earthquake in 1986.
- **Rocky Mountain Fold/Thrust Belt South (ROCS):** Foreland fold and thrust belt of the Canadian Cordillera. This zone is characterized by slightly higher rates of seismicity compared to the NBC and SBC sources zones (see below). This source zone hosted an **M**6.0 earthquake in 1918.
- **Northern British Columbia (NBC):** Interior of the Canadian Cordillera. This source zone has very low rates of historical seismicity. The eastern boundary of the NBC is the Rocky Mountain Trench. The northern boundary is marked by elevated seismicity rates interpreted to result from the transfer of strain from the Yakutat collision about 600 to 800 km to the west.
- **Southern British Columbia (SBC):** Interior of the Canadian Cordillera. This source zone has very low rates of historical seismicity. The Mount Polley TSF site is within this source zone. The eastern boundary of the SBC is the Rocky Mountain Trench. The western boundary is the Cascade Fold Belt.
- **Coastal Mountains (CST):** This source zone is underlain by the Middle Jurassic to Eocene Coastal Plutonic Complex with a relatively low rate of historical seismicity. The northern boundary is marked by elevated seismicity associated with the collision of the Yakutat Block with the North American Plate. The Yakutat Block is a composite oceanic-continental allochthonous terrane on the Pacific Plate.
- **Cascade Mountains (CAS):** The Cascade Fold Belt has historical seismicity rates higher than NBC and SBC source zones to the east.
- **Vancouver Island Coast Mountains (VICM):** This source zone is underlain by the Middle Jurassic to Eocene Coastal Plutonic Complex. This VICM has hosted numerous large crustal earthquakes in historical times including the 1949 **M**7.3 Vancouver Island earthquake. This source zone has earthquakes associated with ongoing arc volcanism.

Table 4 lists the parameters for the uniform-area sources adopted from CanadaSHM6.

The truncated Gutenberg-Richter (G-R) distribution is used to model earthquake occurrence rates within each uniform-area source zone. Three separate activity rates and three maximum earthquake magnitude (M_{max}) values are used to represent uncertainty in the estimation of the magnitude-recurrence parameters (Kolaj et al. 2020a).

For computational efficiency, these activity-rate- M_{max} pairs are collapsed down to a single weighted magnitude frequency distribution (MFD) for each area-source zone.



LEGEND

Project Location

Earthquake Epicenter

Moment Magnitude (Mw)

- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9
- ≥ 8

Seismic Source Zone

- BRO - BROOKS PENINSULA
- CAS - CASCADE MOUNTAINS
- CST - COASTAL MOUNTAINS
- EXP - EXPLORER PLATE BENDING
- FHL - FLATHEAD LAKE
- FTH - FOOTHILLS
- FWFA - FAIRWEATHER FAULT AREA
- HEC - HECATE
- JDFF - JUAN DE FUCA PLATE BENDING, OFFSHORE
- NBC - NORTHERN BRITISH COLUMBIA
- NOFR - NOOTKA
- OLM - OLYMPIC
- PGT - PUGET SOUND (shallow)
- QCFA - QUEEN CHARLOTTE FAULT AREA
- ROCN - ROCKY MOUNTAIN FOLD/THRUST BELT NORTH
- ROCS - ROCKY MOUNTAIN FOLD/THRUST BELT SOUTH
- SBC - SOUTHERN BRITISH COLUMBIA
- SCCWC - STABLE CRATONIC CORE WESTERN CANADA
- VICM - VANCOUVER ISLAND COAST MOUNTAINS

0 100 200 400

KILOMETERS

REFERENCE(S)

1. COORDINATE SYSTEM: WGS 1984 UTM ZONE 11N
2. SERVICE LAYER CREDITS: USGS,NGA,NASA,CGIAR,GEBCO,N ROBINSON,NCEAS,NLS,OS,NMA,GEODATASTYRELSEN AND THE GIS USER COMMUNITY

CLIENT

GOLDER ASSOCIATES LTD.

PROJECT

SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT FOR MOUNT POLLEY MINE, BRITISH COLUMBIA

TITLE

EARTHQUAKE EPICENTERS AND CRUSTAL SEISMIC SOURCES FOR SOUTHWESTERN CANADA

CONSULTANT

wsp

YYYY-MM-DD	2022-08-31
DESIGNED	-
PREPARED	HJ
REVIEWED	AK/ET
APPROVED	AH

PROJECT NO.	PHASE	REV.	FIGURE
6-DY039.00	-	0	**2**

PATH: G:\GOLDER\M_Polley\99_PROJECTS\6_DY039_00_Mt_Polley_SHA\00001_SHA_EQ\02_PRODUCTION\MXD\FIGURES\RevA\3 140 4975_02_F02_MTPOLLEY_SHZs.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

Table 4: Uniform-area Active Shallow Crust Source Parameters

Tectonic Region	Source Zone	Closest distance to TSF site (km)	Weighted Mmin[a]	Weighted Mmax[b]	Upper Seimogenic Depth [km]	Lower Seismogenic Depth [km]	Weighted Activity Parameters	
							N(0)[c]	b-value[d]
Active Shallow Crust	SBC	0	4.8	7.14	0	25	1955.607	1.0139
	CAS	142	4.8	7.14	0	25	111.204	0.765
	VICM	212	4.8	7.49	0	25	187.72	0.742
	CST	212	4.8	7.14	0	25	8948.44	1.0419
	NBC	30	4.8	7.14	0	25	234.184	0.869
	ROCN	113	4.8	7.19	0	25	267.36	0.834
	FTH	295	4.8	7.02	0	25	270.933	0.869
	ROCS	110	4.8	7.19	0	25	495.34	0.83

Notes:

a. Mmin is the minimum magnitude included in the source model and defines the lower magnitude truncation of the Gutenberg-Richter distribution.

b. Mmax is the maximum magnitude included in the source model and defines the upper magnitude truncation of the Gutenberg-Richter distribution. The Mmax is the weighted sum of the collapsed MFD.

c. N(0) is the annual number of earthquakes (N) at magnitude zero – this is the same as the a-value, a constant in the Gutenberg-Richter relationship. The N(0) value is the weighted sum of the collapsed MFD.

d. b-value is a constant in the Gutenberg-Richter relationship that describes the proportion of large magnitude earthquakes to small magnitude earthquakes. The b value is the weighted sum of the collapsed MFD.

3.4.2 Crustal Fault Sources

There are no known crustal seismogenic fault sources within 400 km of the Mount Polley TSF site. Accordingly, linear active crustal fault sources are not in the seismic source model. Earthquake occurrence near the site is instead modelled using shallow crustal uniform-area sources (Section 3.4.1) and CSZ sources (Section 3.5).

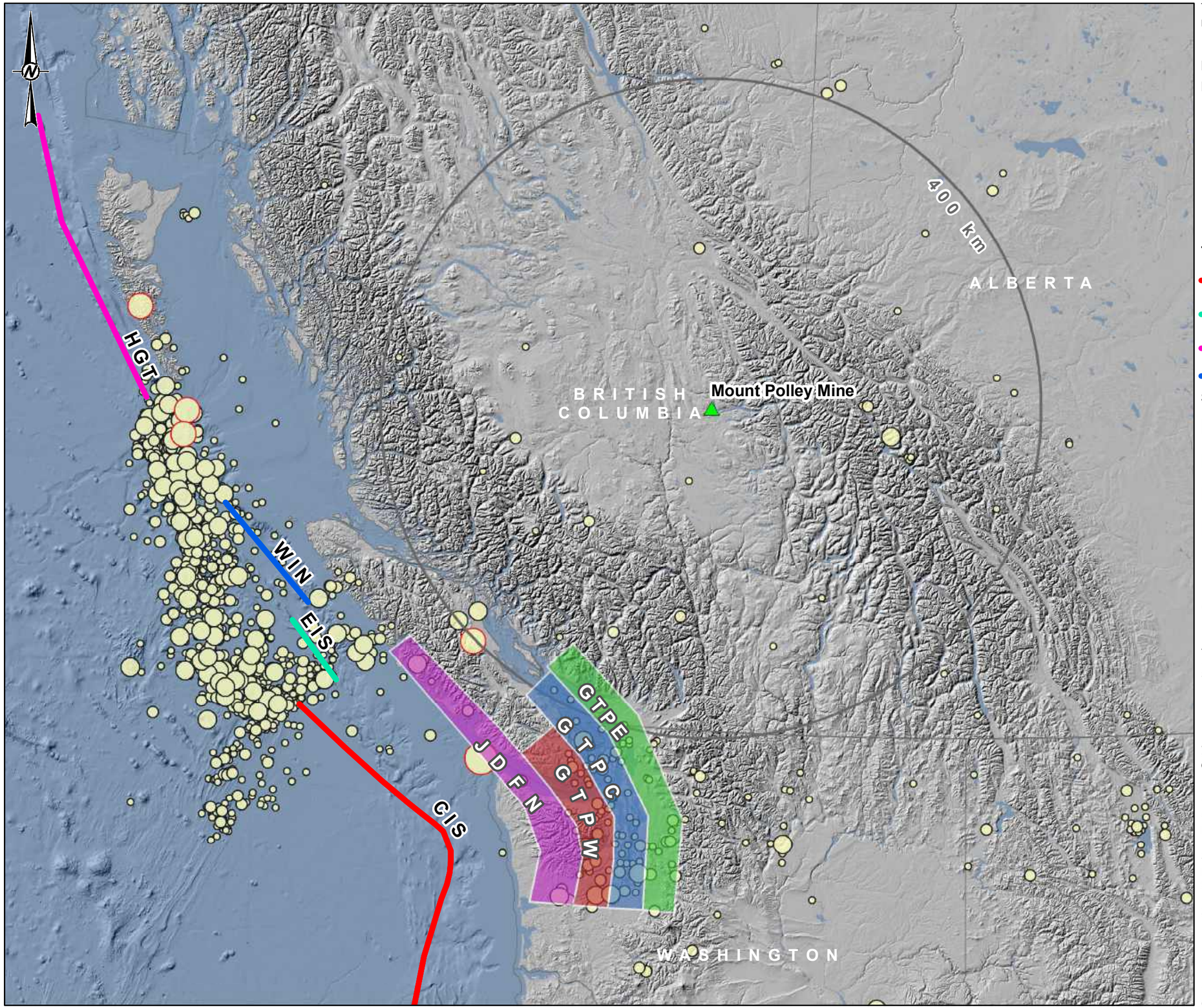
3.5 Subduction Sources

The CSZ marks the boundary where the Explorer, Juan de Fuca, and Gorda plates (i.e., remnants of the older Farallon plate) subduct beneath the North America plate. The CSZ is about 460 km from the site at its closest approach. CanadaSHM6 has separate subduction source models for the subduction interface fault and the subduction in-slab sources as shown in Figure 3. These models are used for this assessment.

3.5.1 Subduction Interface

The CSZ interface fault is the surface trace of the boundary between the subducting Juan de Fuca plate system, comprised of the Gorda, Juan de Fuca, and Explorer plates, and the overriding North American plate. The CSZ is a “mega-thrust” source known to generate great earthquakes (**M**>8.5) such as in 1700. In CanadaSHM6, the CSZ interface fault has four sections: the Cascadia Interface, the Explorer Interface, the Winona thrust fault, and the Haida Gwaii thrust fault. Compared to CanadaNSHM5, CanadaSHM6 incorporates an improved model for the Juan de Fuca segment of the Cascadia subduction zone by incorporating current understanding of the paleoseismic history rather than a simple deterministic scenario. The more refined approach has reduced the average inter-event period for great earthquakes to increase the estimated seismic hazard for many sites in the coastal regions of Western Canada.

Table 5 lists the parameters for the subduction interface sections adopted from CanadaSHM6.



LEGEND

Project Location

Earthquake Epicenter

Moment Magnitude (Mw)

- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7.0 - 7.9
- ≥ 8

Top of Subduction Interface Sources

- CIS - CASCADIA SUBDUCTION INTERFACE
- EIS - EXPLORER PLATE INTERFACE
- HGT - HAIDA GWAII THRUST FAULT
- WIN - WINONA THRUST FAULT

Subduction In-slab Sources

- GTPC - GEORGIA STRAIT PUGET SOUND CENTRAL
- GTPE - GEORGIA STRAIT PUGET SOUND EAST
- GTPW - GEORGIA STRAIT PUGET SOUND WEST
- JDFN - JUAN DE FUCA PLATE BENDING, ONSHORE (Deep)

0 100 200 400

KILOMETERS

REFERENCE(S)

1. COORDINATE SYSTEM: WGS 1984 UTM ZONE 11N
2. SERVICE LAYER CREDITS: USGS,NGA,NASA,CGIAR,GEBCO,N ROBINSON,NCEAS,NLS,OS,NMA,GEODATASTYRELSEN AND THE GIS USER COMMUNITY

CLIENT

GOLDER ASSOCIATES LTD.

PROJECT

SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT FOR MOUNT POLLEY MINE, BRITISH COLUMBIA

TITLE

EARTHQUAKE EPICENTERS AND SUBDUCTION ZONE SOURCES FOR SOUTHWESTERN CANADA

CONSULTANT

wsp

YYYY-MM-DD	2022-08-31
DESIGNED	-
PREPARED	HJ
REVIEWED	AK/ET
APPROVED	AH

PROJECT NO.	PHASE	REV.	FIGURE
6-DY039.00	-	0	3

PATH: G:\GOLDER\Mt. Polley\99_PROJECTS\6_DY039_00_Mt. Polley_SHA\Y0001_SHA_EQ\02_PRODUCTION\MXD\FIGURES\RevA\31401\4975_03_F03_MTPOLLEY_SubductionSource.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

Table 5: Cascadia Subduction Zone Interface Seismic Source Parameters

Tectonic Region	Source Zone	Model and *Weight*	Closest distance to site (km)	Mmin	Mmax[1]			Upper Seimogenic Depth [km]	Lower Seismogenic Depth [km]	Weighted Activity Parameters[1]					
					U	P	L			N(0)			b-value		
										U	P	L	U	P	L
Subduction Interface	Cascadia Interface	Landward fault depth 31.0 km *(0.25)*	463	8.4	9.3	-	9.1	5.0	31.0	Not reported			Not reported		
		Landward fault depth 27.0 km *(0.50)*	482	8.4	9.3	-	9.1	5.0	27.0	Not reported			Not reported		
		Landward fault depth 23.0 km *(0.25)*	501	8.4	9.3	-	9.1	5.0	23.0	Not reported			Not reported		
	Explorer Interface	Landward fault depth 28.0 km *(0.25)*	471	7.5	-	8.5 *(1.0)*	-	5.0	28.0	-	0.0009 *(1.0)*	-	-	-2.1715 *(1.0)*	-
		Landward fault depth 22.0 km *(0.50)*	490	7.5	-	8.0 *(1.0)*	-	5.0	22.0	-	0.003 *(1.0)*	-	-	-2.1715 *(1.0)*	-
		Landward fault depth 16.0 km *(0.25)*	509	7.5	-	7.6 *(1.0)*	-	5.0	16.0	-	0.0067 *(1.0)*	-	-	-2.1715 *(1.0)*	-
	Winona Thrust Fault		522	7.0	7.7	7.4	7.1	2.0	5.0	2313.516	4522.26	18375.9	-	0.8 *(1.0)*	-
			522	7.0	7.7	7.4	7.1	2.0	5.0	0.0373	0.102	0.5471	-	0.0001 *(1.0)*	-
	Haida Gwaii Thrust Fault		635	7.0	8.2	8.0	7.8	3.0	22.0	7894.441	10205	16062.53	-	0.8 *(1.0)*	-
			635	7.0	8.2	8.0	7.8	3.0	22.0	0.0612	0.107	0.2483	-	0.0001 *(1.0)*	-

1 Values for Mmax and Weighted Activity parameters are listed as U = Upper, P = Preferred, L = Lower

3.5.2 Subduction In-slab

The CanadaSHM6 defines four in-slab sources within about 500 km of the site. Table 6 lists the parameters from CanadaSHM6 used in this assessment. These sources represent earthquakes occurring in the subducting Juan de Fuca plate that extends beneath most of Vancouver Island, Puget Sound, and northern Washington state in the USA (Figure 3).

.

Table 6: Cascadia Subduction Zone In-slab Seismic Source Parameters

Tectonic Region	Seismic Source Zone	Closest distance to site (km)	Mmin	Mmax			Upper Seimogenic Depth [km]	Lower Seismogenic Depth [km]	Weighted Activity Parameters[1]					
				U	P	L			N(0)			b-value		
									U	P	L	U	P	L
Subduction In-slab	Georgia Strait Puget Sound Central	375	4.8	7.5	7.2	7.0	45	65	15.4	20	72.8	0.413	0.478	0.69
	Georgia Strait Puget Sound East	336	4.8	7.5	7.2	7.0	50	70	3.3	4.4	5.8	0.365	0.478	0.59
	Georgia Strait Puget Sound West	416	4.8	7.5	7.2	7.0	40	60	18.4	23.5	130.2	0.413	0.478	0.746
	Juan De Fuca Plate Bending, Onshore (Deep)	455	4.8	7.3	7.0	6.9	25	45	26.3	52.86	107.01	0.5351	0.69	0.8448

1. Values for Mmax and Weighted Activity parameters are listed as U = Upper, P = Preferred, L = Lower

3.6 Source Model Parameters

There are important parameter limits included in PSHA:

- **Source-to-site distance (R)** is the maximum distance from the site considered in the hazard calculation. The maximum r parameter (r_{max}) is selected considering the distribution of historical earthquake epicenters, limitations of the GMMs, and the AEPs and spectral periods of interest to the project. The r_{max} in CanadaSHM6 is defined depending on the tectonic region with the longest distance for the subduction sources (1000 km) and shorter distances for the crustal sources (400 to 600km).
- **Maximum earthquake magnitude (M_{max})** is the maximum earthquake magnitude expected from an earthquake source. Refer to Sections 3.4 and 3.5 for further details.
- **Minimum earthquake magnitude (M_{min})** is the minimum earthquake magnitude expected to result in some damage to the facility or site under study. Refer to Sections 3.4 and 3.5 for further details for M_{min} for the defined seismic sources.
- **Epsilon (ε)** is a standard deviation of the ground motion models above and below the median ground motion calculated from each GMM. Inclusion of excessively unlikely ground motions is computationally demanding with minimal gain in the earthquake ground motion prediction. Epsilon (ε) is truncated at five in CanadaSHM6, and was also applied in this assessment (i.e., the ground motions above and below five standard deviations of the median are not included in the hazard integral).

Epistemic uncertainty is incorporated using a logic-tree approach. GMMs are weighted and propagated through the logic tree to provide a suite of weighted results that are then summed. The CanadaSHM6 model trial version logic tree was collapsed (Kolaj et al. 2020b) to reduce the time required for calculation of the magnitude recurrence branches. The logic tree collapsing does not impact the mean hazard value obtained, only the hazard fractiles.

4.0 GROUND MOTION MODEL SELECTION AND WEIGHTING

Empirical ground motion models (GMM) are used to estimate the earthquake ground motions at a site for an earthquake with a magnitude, a rupture mechanism (e.g., normal, strike-slip, reverse or thrust), and a known source-to-site distance. The GMMs are developed for defined tectonic regions and seismic types (e.g., subduction zones or shallow crust). The GMMs used in this assessment are selected based on the similarity between the tectonic and geologic conditions in the region surrounding the site and the conditions in the regions from which earthquake recordings were selected to derive the GMMs.

4.1 Active Shallow Crustal Ground Motion Models

CanadaSHM6 uses the Pacific Earthquake Engineering Research Center (PEER) Next Generation of Ground Motion Attenuation Phase 2 Project (NGA-West2) GMMs to model source-to-site attenuation for all active shallow crustal sources. The NGA-West2 GMMs were developed for active tectonic regions based mostly on earthquake strong ground motion data recorded at seismically active, present-day tectonic plate boundaries, primarily from western United States, Japan, New Zealand, and other seismically active regions around the world.

The NGA-West2 GMMs were developed in a systematic process using improved strong ground motion recordings and considered the soil conditions at the ground motion recording stations, near-source saturation effects, and sedimentary basin and fault hanging-wall effects. These GMMs have been employed globally to model source-to-site attenuation from shallow crustal sources in PSHA. Spectral accelerations are estimated as a function of

earthquake magnitude, source-to-site distance, fault geometry, and time-averaged shear-wave velocity in the upper 30 m below the site ground reference surface (i.e., V_{S30}).

Table 7 lists the crustal GMMS used, their weights, and key distance measures.

4.2 Subduction Ground Motion Models

Subduction zone earthquake sources include both the subduction interface and subduction in-slab sources. GMMs have been developed for each of the interface and in-slab sources independently, but there is significant overlap in the development of GMMs for these sources because they are typically both used when a site is near a major subduction zone.

The selection and weighting of subduction GMMs for CanadaSHM6 is based on 15 discrete V_{S30} values. The V_{S30} value used in this assessment is not one of the pre-defined values in CanadaNSH6. Consequently, the use of GMMs in this assessment differs from that in CanadaSHM6.

This assessment uses three of the GMMs developed for the NGA-Sub project to model source-to-site attenuation for the subduction interface sources: Abrahamson and Gülerce (2020), Kuehn et al. (2020), and Parker et al. (2020). The Si (2020) GMM was developed specifically for Japanese subduction zones using only Japanese strong motion data. This GMM is not yet recommended for use outside Japan. The NGA-Sub project followed a similar methodology as the NGA-West2 project. The 2020 NGA-Sub GMMs are now considered the more advanced GMMs for subduction zone earthquakes because they have been developed using the similar robust and peer reviewed approach as used for the NGA-West2.

The Abrahamson et al. (2018) pre-NGA-Sub GMM was also used in this analysis because it was specifically developed for the CSZ as part of the BC Hydro assessment in 2012. Abrahamson et al. (2018) is an updated version of the BC Hydro GMM. The Abrahamson et al. (2018) central model was included with a relatively low weight to capture the epistemic uncertainty in CSZ ground motion predictions. The central, low, and high alternatives of Abrahamson et al. (2018) were included to capture the epistemic uncertainty for the in-slab sources.

Table 7: Selected Ground Motion Models and Weights used in this Assessment

Tectonic Region	GMMs	Weight	Primary distance metric[1]	Moment Magnitude (M) range	Source-to-site distance (km)
Active Shallow Crust	Abrahamson et al. (2014)	0.25	Rrup	3.0-8.5	0-300
	Boore et al. (2014)	0.25	Rjb	3.0-7.9	0-400
	Campbell and Bozorgnia (2014)	0.25	Rrup	3.3-8.5	0-300
	Chiou and Youngs (2014)	0.25	Rrup	3.5-8.5	0-300
Subduction Interface	Abrahamson and Gülerce (2020) *Cascadia-specific coefficients	0.35	Rrup	5.0-9.5	0-800
	Abrahamson et al. (2018)	0.15	Rrup	5.0-9.5	0-1000
	Kuehn et al. (2020)	0.35	Rrup	5.0-9.5	10-1000
	Parker et al. (2020)	0.15	Rrup	4.5-9.5	20-1000
Subduction In-slab	Abrahamson et al. (2018)	0.2	Rrup	5.0-9.5	0-1000
	Abrahamson and Gülerce (2020) *Cascadia-specific coefficients	0.4	Rrup	5.0-9.5	0-800
	Kuehn et al. (2020)	0.4	Rrup	5.0-9.5	10-1000

1. Distances metrics are Rrup for rupture plane distance, Rjb for Joyner-Boore distance as closest distance to the surface projection of the fault plane.

5.0 PROBABILISTIC SEISMIC HAZARD ANALYSIS

This section provides a general overview of the PSHA method as applied in the site-specific hazard assessment, including incorporation of uncertainties.

5.1 Methodology

PSHA is based on a method proposed by Cornell (1968) that essentially relates the recurrence of earthquakes in the seismic source models to the probability that an earthquake ground motion exceeds a certain value in a specific time period at a specific location (see following equation). This approach relies on the assumption that earthquakes occur randomly in space and time (i.e., Poisson process).

$$P(IM > s) = 1 - e^{-\varphi(s)t}$$

Where:

- *P* = probability
- *IM* = ground motion (also known as ground motion intensity measure)
- s = a specific value of ground motion
- φ(s) = annual exceedance probability (AEP)
- t = time period

For this assessment, the target annual exceedance probabilities (AEP) are 1/1,000, 1/2,475, 1/5,000 and 1/10,000. The annual probability of exceedance is calculated following equation:

$$(IM > x) = \sum_{i=1}^{n_{sources}} \lambda(M > m_{min}) \int_{m_{min}}^{m_{max}} \int_{0}^{r_{max}} P(IM > x|m,r) f_M(m,r) f_R(r) dr dm$$

Where:

- $n_{sources}$ = number of sources considered
- $\lambda(M>m_{min})$ = the rate of occurrence of earthquakes greater than m_{min} from the i_{th} source
- $P(IM>x \mid m,r)$ = the probability that *IM* exceeds x given magnitude *m* and distance *r*
- $f_M(m)f_R$® = probability density functions for magnitude *m* and distance r

The probabilistic analysis for this site was undertaken using the OpenQauke software (v.3.11.4) developed by the Global Earthquake Model Foundation (GEM, 2022).

5.2 Logic Tree Analysis

Epistemic uncertainty is the uncertainty associated with the simplified and imprecisely known scientific model of a natural process. This uncertainty is typically parameterized by considering alternative model input parameters to the PSHA (e.g., Abrahamson 2006, 2009). The input model parameters include the seismic source models, their recurrence parameters and maximum earthquake magnitudes, hypocentral depth, and ground motion model. Epistemic uncertainty is commonly accommodated through a logic-tree approach.

One of the planned changes for CanadaSHM6 was to implement the model in OpenQuake—an open-source seismic hazard and risk calculation software developed and maintained by the Global Earthquake Model Foundation (GEM 2022). Allen et al. (2020) converted CanadaSHM5 to OpenQuake to ensure the change in calculation software did not result in a change in hazard values.

As part of this implementation of the seismic source models in OpenQuake, the two magnitude-frequency distribution (MFD) branches of the logic tree, the three-alternative a- and b-value branches and three alternative M_{max} branches, were collapsed into a single MFD branch. This approach was used by Allen et al. (2020) to reduce the unreasonably long runtimes in OpenQuake v3.2 with nine weighted source model sub-branches for each earthquake source.

Variations in occurrence rates and M_{max} were collapsed into a combined, weighted average branch for computational efficiency. Allen et al. (2020) outlines in detail the implementation of CanadaSHM5 in OpenQuake and the differences in results between the two calculation software programs. While collapsing these two branches in the logic tree had a negligible impact on median hazard values, it limits the ability to perform a detailed analysis of the fractiles or model input sensitivity test. Improvements in computation runtimes in OpenQuake v.3.11 allow for a sensitivity analysis of a subset of spectral periods and return periods. The input parameters, logic tree, and weighting values used in this assessment are adopted from the Kolaj et al. (2020b) model and presented in Figure 4.

Figure 4 shows the source model logic tree used in this site-specific analysis.

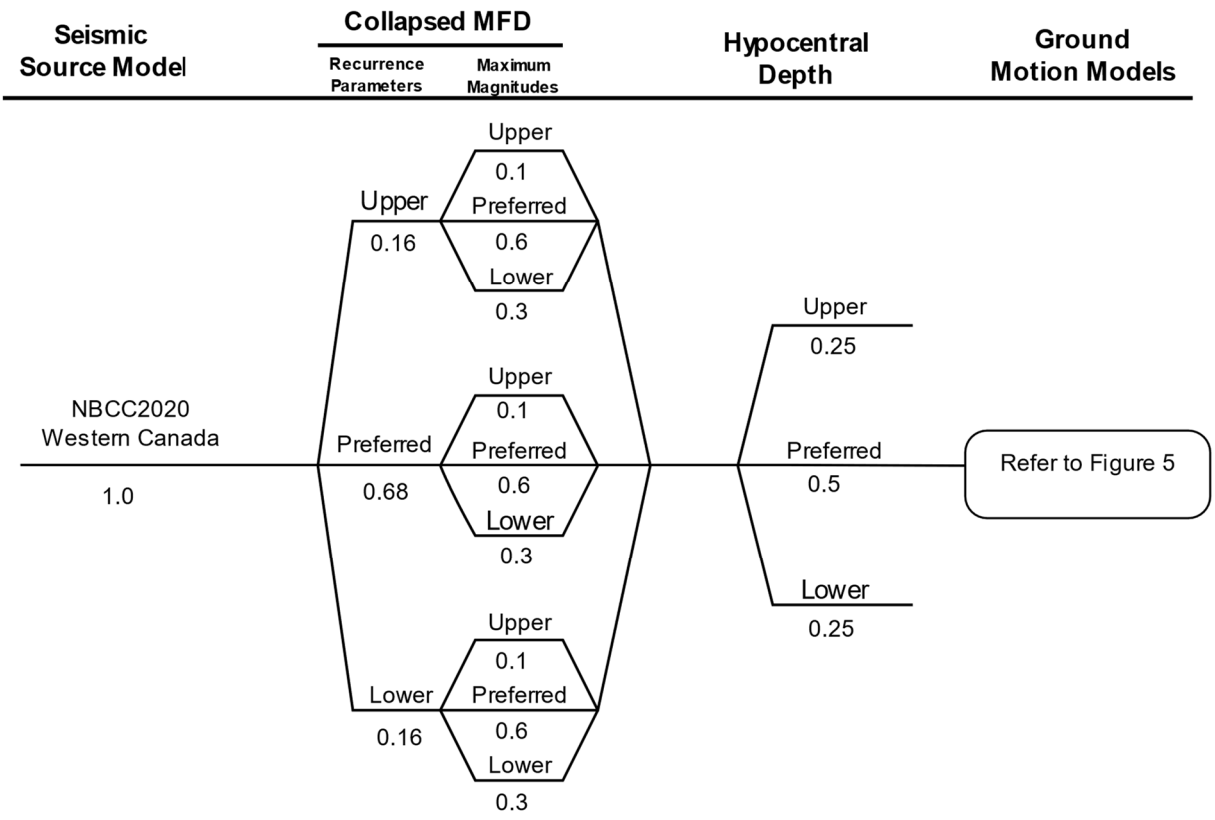


Figure 4 Seismic Source Model Logic Tree used in this assessment

Figure 5 shows the GMM logic and weighting as described in Section 4.0.

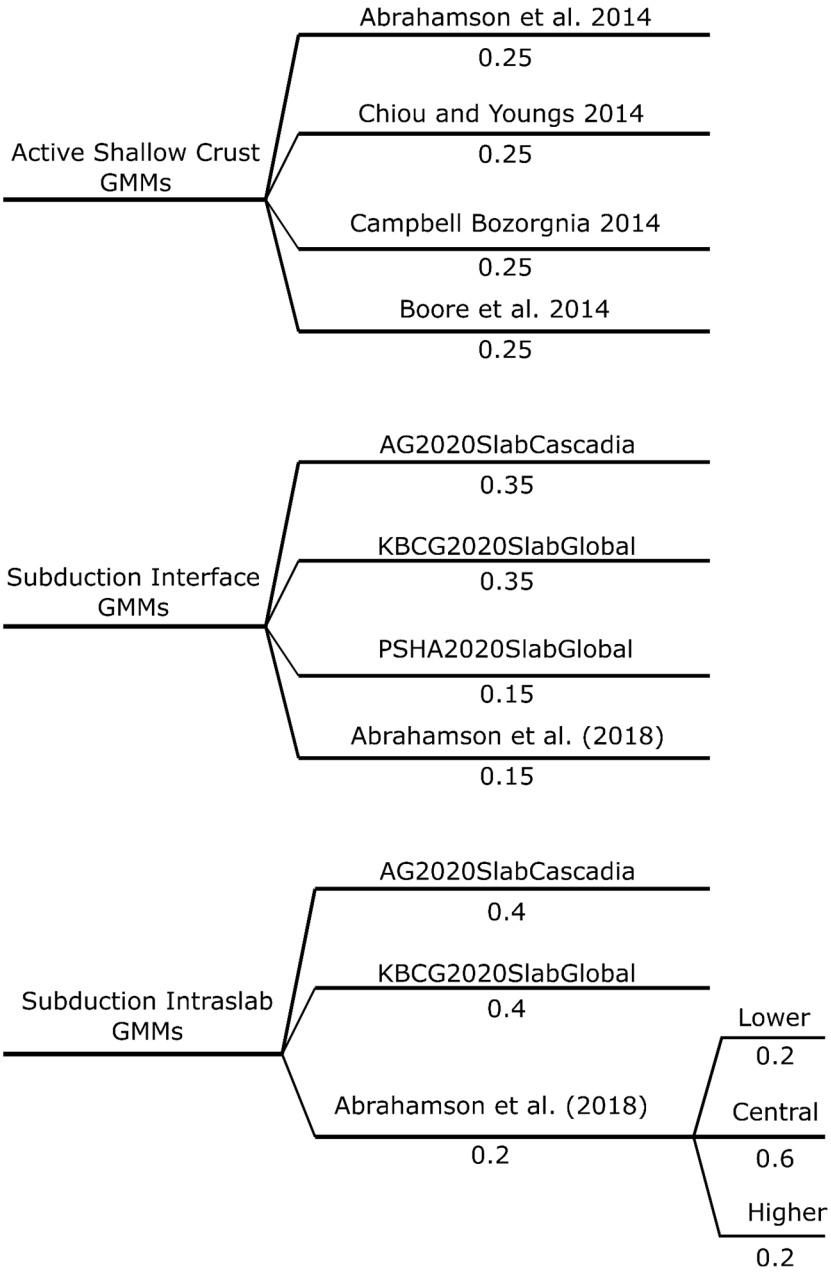


Figure 5 Logic trees for selected ground motion models and their weights for crustal, subduction interface, and subduction in-slab sources

5.3 Validation of Model Implementation

The results of a full CanadaSHM6 model (unmodified) run for the site is compared to results derived from the Seismic Hazard Tool calculator available online (Natural Resources Canada (NRCan) 2020) as the basis to validate our implementation of the CanadaSHM6 source models and GMMs in OpenQuake. Table 8 lists results for the 1/475 and 1/2475 AEPs.

The results from our implementation of CanadaSHM6 in OpenQuake and those available from the seismic hazard tool for the two AEPs are almost identical. The discrepancies in acceleration values in this validation test are negligible and can be attributed to changes in the versions of the OpenQuake software engine. From this validation test, our implementation of CanadaSHM6 is considered valid.

Table 8 also lists the 1/475 AEP and 1/2475 AEP mean hazard results using the site-specific source model developed for the site. The site-specific results are generally lower than CanadaSHM6, although the absolute value of the total hazard and differences in hazard are low. Differences in the results are primarily attributed to the different ground motion model selection and weighting, and the V_{S30} used in this assessment.

Table 8: Accelerations for Validation of Models at 1/475 AEP and 1/2475 AEP

Parameter		Mean acceleration (g)			
AEP	Spectral period (s)	CanadaSHM6 results[1] V_{S30}= 760 m/s	This assessment		
			CanadaSHM6 model[2] V_{S30}= 760 m/s	Site-specific[3] V_{S30}= 760 m/s	Site-specific [4] V_{S30} = 849 m/s
1/475	PGA	0.019	0.018	0.016	0.015
	0.2	0.037	0.036	0.031	0.029
	0.5	0.027	0.027	0.024	0.021
	1.0	0.018	0.018	0.015	0.013
	2.0	0.014	0.013	0.009	0.010
	5.0	0.006	0.006	0.004	0.008
	10.0	0.003	0.003	0.002	0.004
1/2,475	PGA	0.057	0.055	0.051	0.048
	0.2	0.115	0.111	0.107	0.098
	0.5	0.067	0.064	0.061	0.054
	1.0	0.043	0.042	0.043	0.030
	2.0	0.034	0.032	0.035	0.020
	5.0	0.018	0.017	0.011	0.011
	10.0	0.013	0.012	0.006	0.006

Notes:

1. Natural Resources Canada (2020). Obtained using NRCan Seismic Hazard Tool: https://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/nbc2020-cnb2020-en.php for V_{S30} of 760m/s at site location.
2. Variations between these results and the CanadaSHM6 results are due to minor changes between OpenQuake versions. Results presented in this assessment are from OpenQuake v3.11.4.
3. Variations between these results and the CandaSHM6 published results are due to the source models and weightings developed for this assessment.
4. As per note 3, and the difference in V_{S30}.

6.0 DETERMINISTIC ANALYSIS

The Canadian Dam Association (CDA) guidelines for tailings dams (CDA 2019, Table 3.1) permit the use of a maximum credible earthquake (MCE) for Very High and Extreme consequence facilities. The Mount Polley TSF is located within a relatively tectonically stable continental region in western North America. Major systems or segments of faults with seismogenic potential needed to estimate an MCE within about 400 km of the site are unknown based on our review of readily available information. Consequently, the magnitude-distance pair required to generate discrete, single-valued earthquakes to estimate the site-specific MCE ground motions is not possible for the Mount Polley TSF site. Probabilistically based mean accelerations developed from this assessment, therefore, are recommended for earthquake ground motion analyses at the Mount Polley TSF site.

7.0 SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ANALYSIS RESULTS

Sections below present the site-specific earthquake ground motions for the Mount Polley TSF site. Section 8.0 provides discussion of the results and recommendations. The results presented here are for a V_{s30} of 849 m/s (Appendix B).

The ground motion hazard results from the PSHA are described in three ways:

- Hazard curves that describe the acceleration at a specific spectral period at a range of AEPs. Section 7.1 describes hazard curves for the site.
- Uniform hazard acceleration response spectrum that describes the acceleration for a range of spectral periods at a specific AEP. The response spectrum is “uniform hazard” because each acceleration value has the same AEP. Section 7.2 presents uniform hazard response spectra for the site.
- Magnitude-distance deaggregations that describe the joint probability mass distribution of earthquake-magnitude and source-to-site distance that contribute to the mean hazard at a specific AEP and spectral period. Section 7.3 present magnitude-distance deaggregations for the site.

7.1 Hazard Curves

Hazard curves describe earthquake acceleration values at different AEPs at a given spectral period. Figure 6 shows mean hazard curves for selected spectral periods. The 1/1,000, 1/2,475, 1/5,000, and 1/10,000 AEPs are also shown. The mean hazard curves are the result of summing weighted hazard curves as developed from the logic tree.

Figure 7 shows PGA, 0.5 s, 1.0 s, and 1.5 s spectral period mean hazard curves with 5th, 15th, 50th (median), 85th, and 95th fractiles (median ± 1 and 2 standard deviations). The fractiles reflect the uncertainty in the hazard results as incorporated in the logic trees in this site-specific PSHA. As described in Section 5.2 the b-value and maximum earthquake magnitude uncertainties from the areal source models are not incorporated in the fractile analysis.

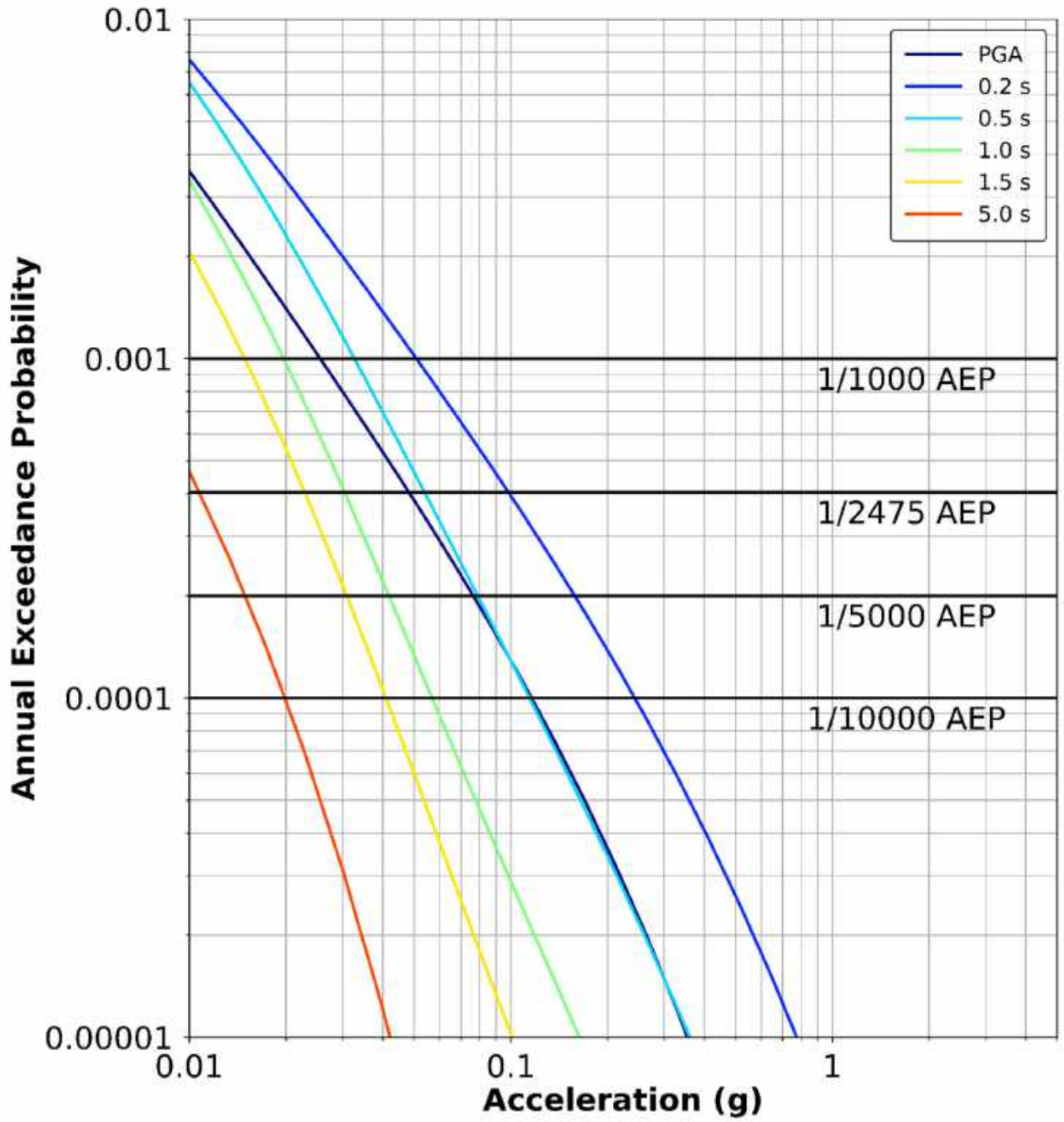


Figure 6: Mean hazard curves for selected spectral periods for top of engineering bedrock ground condition (V_{S30} = 849 m/s)

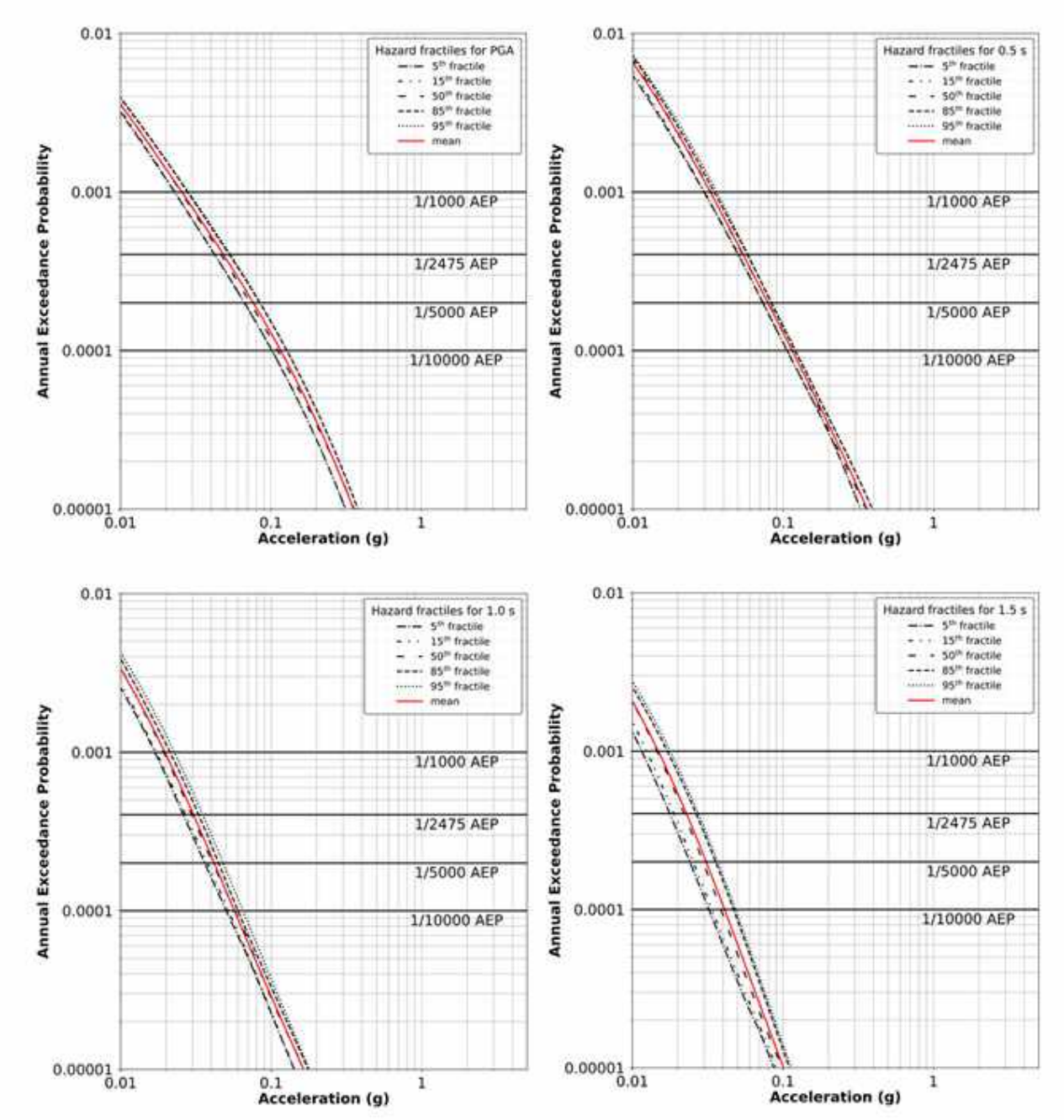


Figure 7: Mean hazard curves, showing 5th, 15th, 50th (median), 85th, and 95th fractiles for PGA (top left), 0.5 s (top right), 1.0 s (bottom left), and 1.5 s (bottom right) spectral periods

7.2 Uniform Hazard Acceleration Response Spectra

Figure 8 shows the mean uniform hazard acceleration response spectra (5%-damped) (UHRS) for the 1/1,000 AEP, 1/2,475 AEP, 1/5,000, and 1/10,000 AEP, respectively. These mean values are for the top of engineering bedrock ground condition (V_{S30} of 849 m/s). Table 9 lists the spectral ordinates for these UHRS.

Figure 9 to Figure 12 show the mean uniform hazard acceleration response spectra (5%-damped) (UHRS) along with the 5th, 15th, 50th (median), 85th, and 95th fractiles for AEPs of 1/1,000, 1/2,475, 1/5,000, and 1/10,000 AEP, respectively. Table 10 to Table 13 list the spectral ordinates for these UHRS for the 1/1,000, 1/2,475, 1/5,000, and 1/10,000 AEP, respectively. These values are for the top of engineering bedrock ground condition with a V_{S30} of 849 m/s.

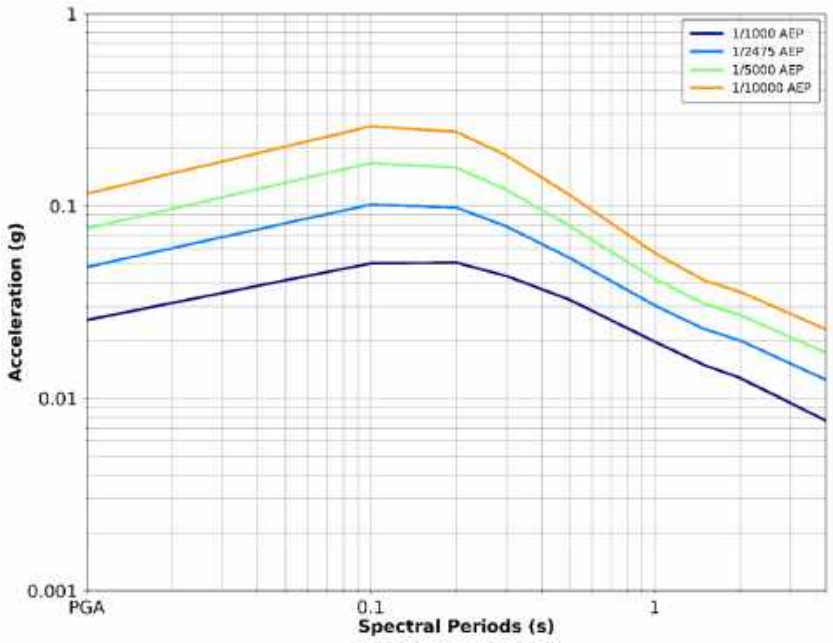


Figure 8: Mean Uniform Hazard Acceleration Response Spectra

Table 9: Uniform Hazard Acceleration Response Spectral Ordinates for Selected AEPs

Special Period (s)	Mean acceleration (g)			
	1/1,000 AEP	1/2,475 AEP	1/5,000 AEP	1/10,000 AEP
PGA	0.026	0.048	0.076	0.116
0.1	0.050	0.102	0.167	0.260
0.2	0.051	0.098	0.158	0.243
0.3	0.043	0.078	0.122	0.183
0.5	0.033	0.054	0.079	0.114
1.0	0.020	0.030	0.042	0.057
1.5	0.015	0.023	0.031	0.041
2.0	0.013	0.020	0.027	0.036
5.0	0.007	0.011	0.015	0.020
10.0	0.003	0.006	0.008	0.011

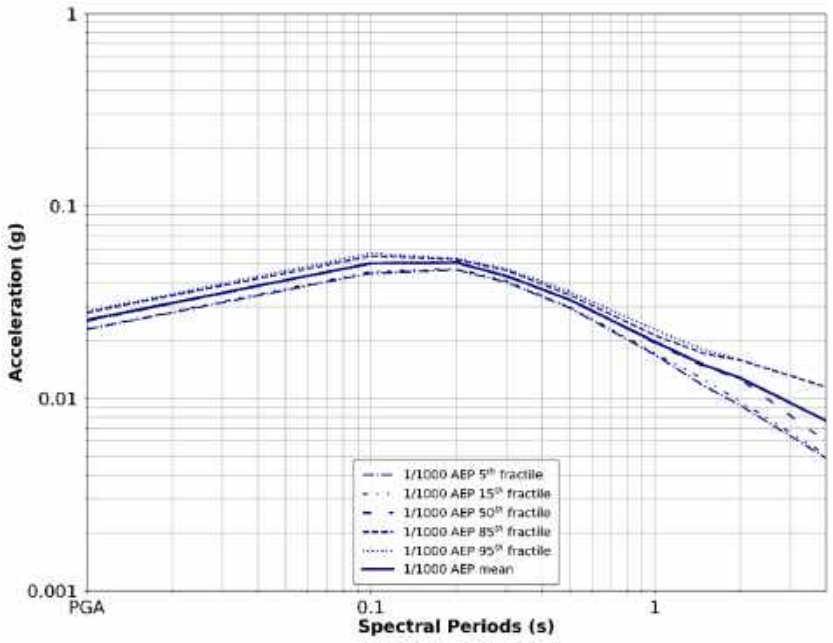


Figure 9: 1/1,000 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles

Table 10: Uniform Hazard Acceleration Response Spectral Ordinates for 1/1,000 AEP with Selected Fractiles

Spectral period (s)		Acceleration (g)					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
1/1,000AEP	PGA	0.026	0.023	0.023	0.025	0.028	0.028
	0.1	0.050	0.045	0.046	0.050	0.055	0.057
	0.2	0.051	0.047	0.047	0.052	0.053	0.053
	0.3	0.043	0.040	0.041	0.043	0.046	0.047
	0.5	0.033	0.030	0.030	0.033	0.035	0.036
	1.0	0.020	0.017	0.017	0.019	0.021	0.023
	1.5	0.015	0.012	0.012	0.015	0.017	0.018
	2.0	0.013	0.009	0.010	0.013	0.016	0.016
	5.0	0.007	0.004	0.004	0.005	0.010	0.010
	10.0	0.003	0.002	0.002	0.002	0.006	0.006

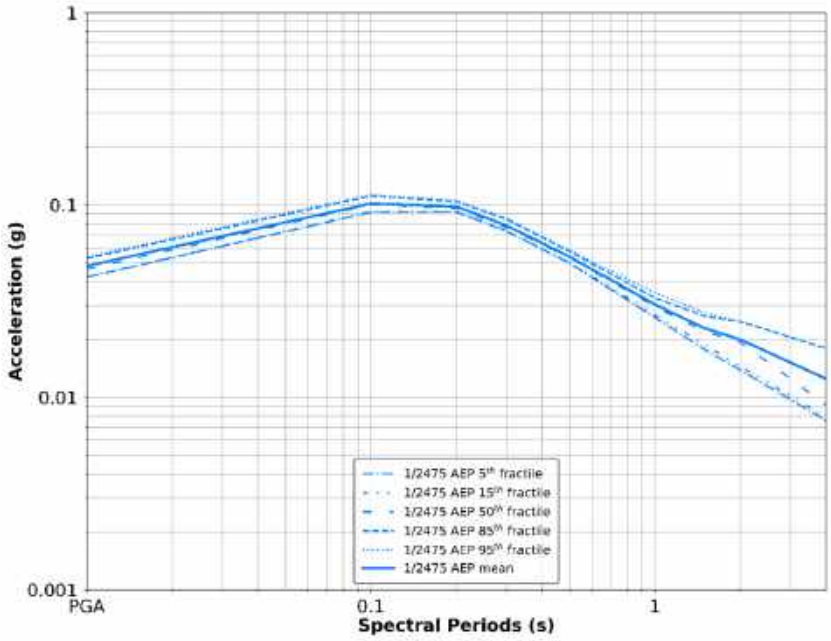


Figure 10: 1/2,475 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles

Table 11: Uniform Hazard Acceleration Response Spectral Ordinates for 1/2,475 AEP with Selected Fractiles

Spectral period (s)		Acceleration (g)					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
1/2,475 AEP	PGA	0.048	0.042	0.042	0.046	0.053	0.054
	0.1	0.102	0.092	0.092	0.101	0.112	0.113
	0.2	0.098	0.092	0.093	0.096	0.104	0.105
	0.3	0.078	0.073	0.074	0.076	0.084	0.085
	0.5	0.054	0.050	0.050	0.053	0.057	0.058
	1.0	0.030	0.026	0.027	0.030	0.033	0.035
	1.5	0.023	0.018	0.019	0.022	0.026	0.027
	2.0	0.020	0.014	0.014	0.019	0.025	0.025
	5.0	0.011	0.006	0.006	0.007	0.016	0.016
	10.0	0.006	0.003	0.003	0.004	0.009	0.009

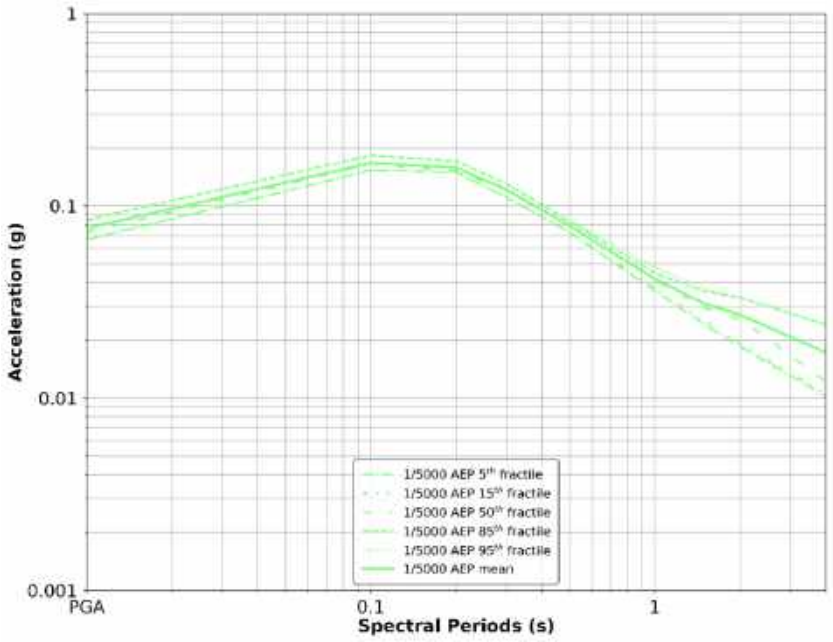


Figure 11: 1/5,000 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles

Table 12: Uniform Hazard Acceleration Response Spectral Ordinates for 1/5,000 AEP with Selected Fractiles

Spectral period (s)		Acceleration (g)					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
1/5,000 AEP	PGA	0.076	0.067	0.067	0.073	0.084	0.085
	0.1	0.167	0.153	0.153	0.165	0.183	0.184
	0.2	0.158	0.150	0.150	0.152	0.170	0.171
	0.3	0.122	0.111	0.111	0.121	0.130	0.131
	0.5	0.079	0.073	0.073	0.079	0.083	0.084
	1.0	0.042	0.036	0.038	0.041	0.045	0.048
	1.5	0.031	0.024	0.025	0.029	0.036	0.037
	2.0	0.027	0.019	0.019	0.026	0.033	0.033
	5.0	0.015	0.008	0.009	0.010	0.022	0.022
	10.0	0.008	0.004	0.004	0.005	0.012	0.012

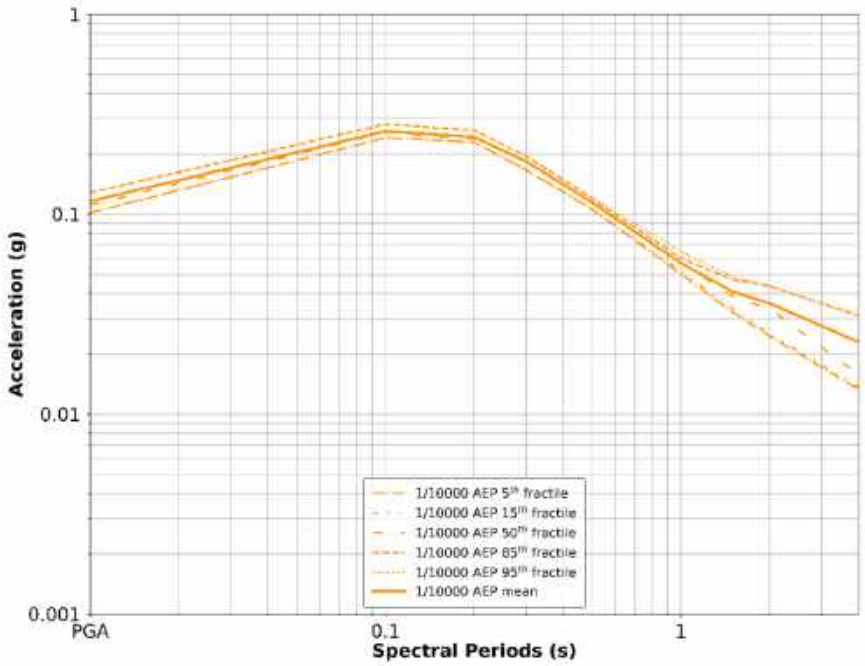


Figure 12: 1/10,000 AEP Mean Uniform Hazard Acceleration Response Spectra and Selected Fractiles

Table 13: Uniform Hazard Acceleration Response Spectral Ordinates for 1/10,000 AEP with selected Fractiles

Spectral period (s)		Acceleration (g)					
		Mean	Fractile				
			5th	15th	50th (median)	85th	95th
1/10,000 AEP	PGA	0.116	0.102	0.102	0.111	0.128	0.128
	0.1	0.260	0.240	0.240	0.256	0.282	0.282
	0.2	0.243	0.229	0.229	0.237	0.262	0.262
	0.3	0.183	0.166	0.166	0.186	0.194	0.194
	0.5	0.114	0.106	0.106	0.115	0.119	0.121
	1.0	0.057	0.050	0.052	0.057	0.060	0.065
	1.5	0.041	0.032	0.034	0.039	0.047	0.048
	2.0	0.036	0.025	0.025	0.034	0.044	0.044
	5.0	0.020	0.011	0.011	0.012	0.028	0.028
	10.0	0.011	0.005	0.005	0.006	0.015	0.015

7.3 Magnitude-distance Deaggregation

Magnitude-distance deaggregation allows identification of earthquake sources that contribute to the total mean hazard at a specified spectral acceleration and AEP. Epsilon (described in Section 3.6) is a parameter of ground-motion uncertainty that further improves the diagnostic capability of magnitude-distance hazard deaggregation. Seismic hazard assessments are concerned with probabilities of exceedance of given ground motions, so the distribution of epsilon greater than zero is important. The magnitude-distance deaggregations are color-coded by epsilon in one-epsilon bins. Selected magnitude-distance deaggregations are plotted in the following figures:

- Figure 13 shows the magnitude-distance deaggregation results of the mean spectral acceleration at PGA, 0.5 s, 1.0 s, and 1.5 s spectral periods for 1/2,475 AEP. This figure represents relative contributions to the total hazard.
- Figure 14 shows the magnitude-distance deaggregation results of the mean spectral acceleration at PGA, 0.5 s, 1.0 s, and 1.5 s spectral periods for 1/10,000 AEP. This figure represents relative contributions to the total hazard.
- Figure 15 shows the magnitude-distance deaggregation results of the mean spectral acceleration at PGA, 0.5 s, 1.0 s, and 1.5 s spectral periods for 1/2,475 AEP. This figure represents relative contribution of the crustal sources located within 400 km of the site.
- Figure 16 shows the magnitude-distance deaggregation results of the mean spectral acceleration at PGA, 0.5 s, 1.0 s, and 1.5 s spectral periods for 1/10,000 AEP. This figure represents relative contribution of the crustal sources located within 400 km of the site.
- Figure 17 shows the magnitude-distance deaggregation results of the mean spectral acceleration at PGA, 0.5 s, 1.0 s, and 1.5 s spectral periods for 1/2,475 AEP. This figure represents relative contribution of the subduction (i.e., interface and in-slab) sources located within 1000 km of the site.
- Figure 18 shows the magnitude-distance deaggregation results of the mean spectral acceleration at PGA, 0.5 s, 1.0 s, and 1.5 s spectral periods for 1/10,000 AEP. This figure represents relative contribution of the subduction (i.e., interface and in-slab) sources located within 1000 km of the site.

The mean and mode of the magnitude-distance joint probability mass distribution is often used for earthquake acceleration time history development. Table 14, Table 15 and Table 16 list the mean, median, and mode of the magnitude, distance, and epsilon values, for the 1/2,475 and 1/10,000 AEPs at PGA, and spectral periods of PGA, 0.5 s, 1.0 s, and 1.5 s, for the total hazard, crustal (within 400 km of the site), and subduction (within 1000 km of the site) sources, respectively.

These results indicate that at AEPs of 1/2,475 and 1/10,000 both crustal earthquakes and subduction interface earthquakes contribute to the total hazard at the Mount Polley TSF site. Subduction earthquakes are the dominant contributor to hazard at periods of about 1 s and longer, while the crustal earthquakes dominate the hazard contributions at the short periods, including at PGA. Appendix A describes how these results were used to develop a representative suite of acceleration time histories suitable for deformation analysis.

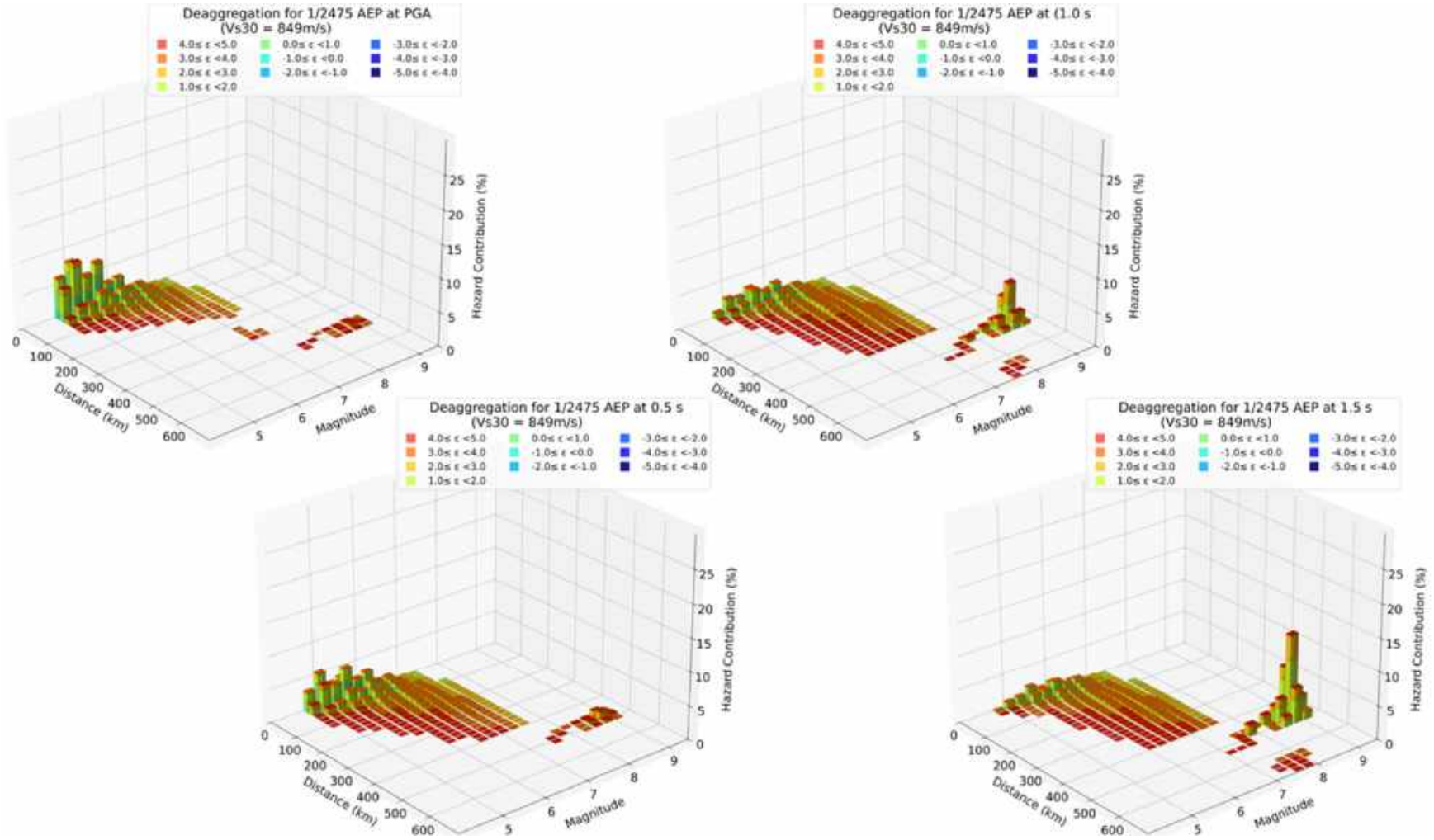


Figure 13: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/2,475 AEP from full source model, color coded by epsilon in one-epsilon intervals

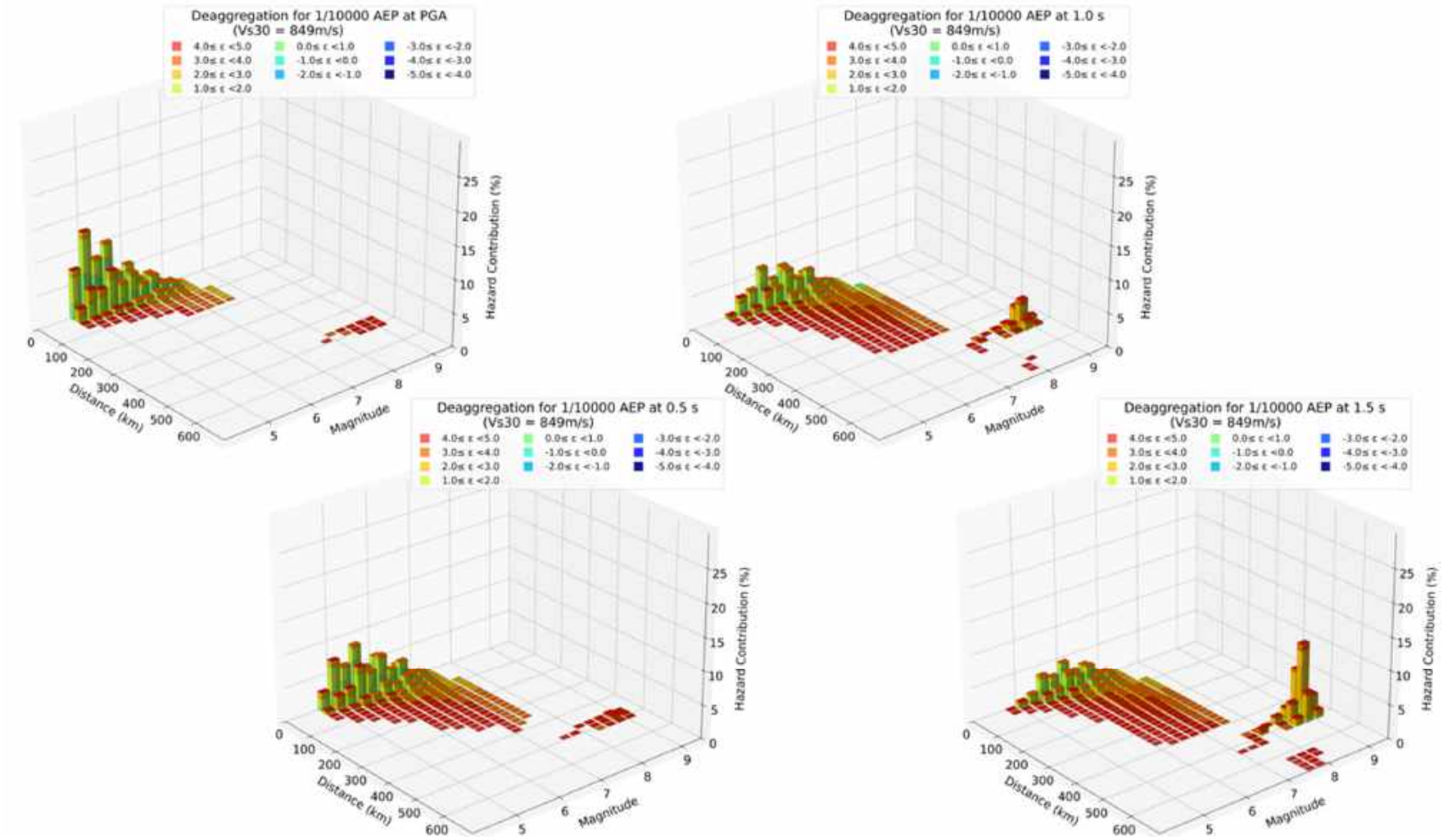


Figure 14: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/10,000 AEP from full source model, color coded by epsilon in one-epsilon intervals

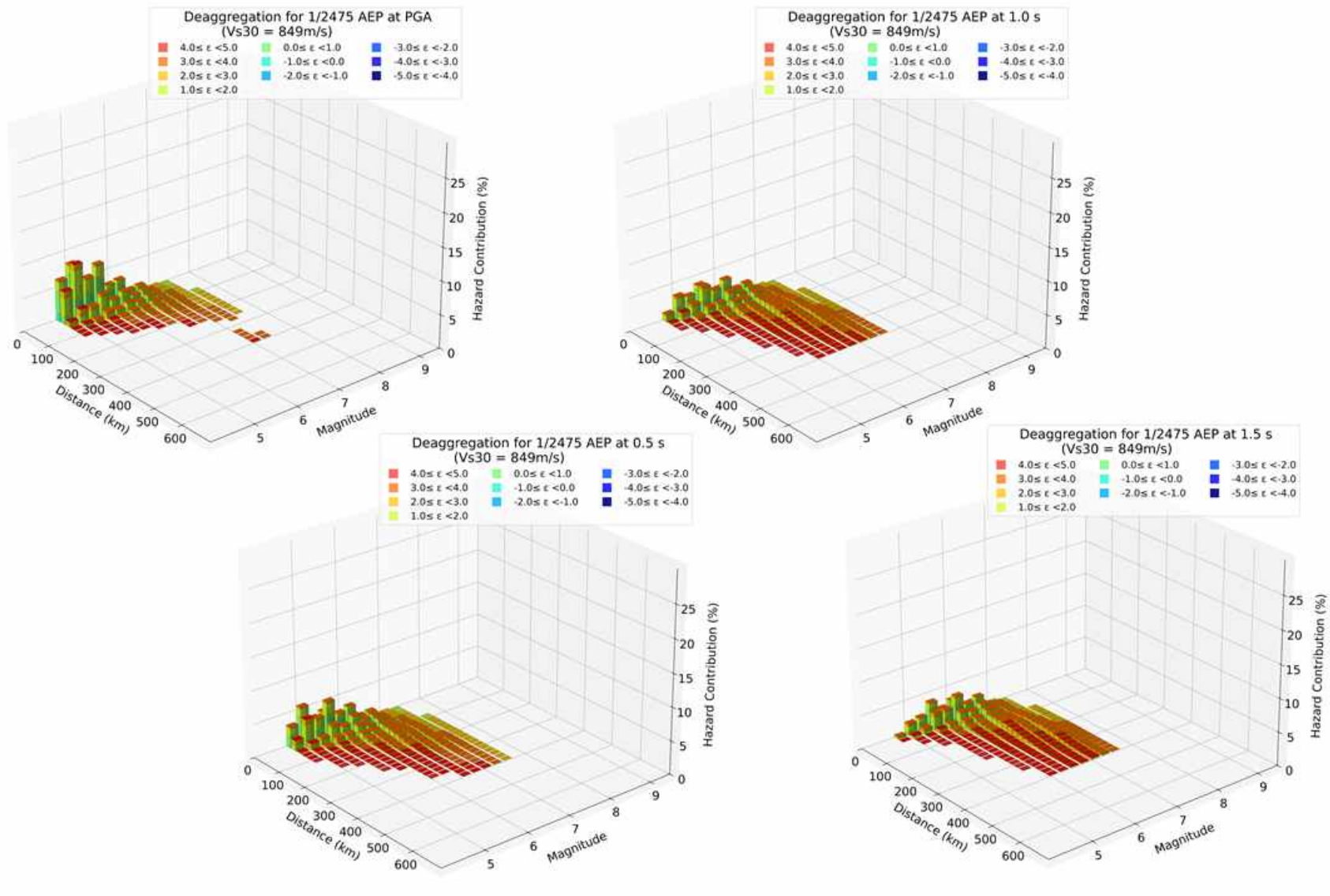


Figure 15: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/2,475 AEP from crustal sources, color coded by epsilon in one-epsilon intervals

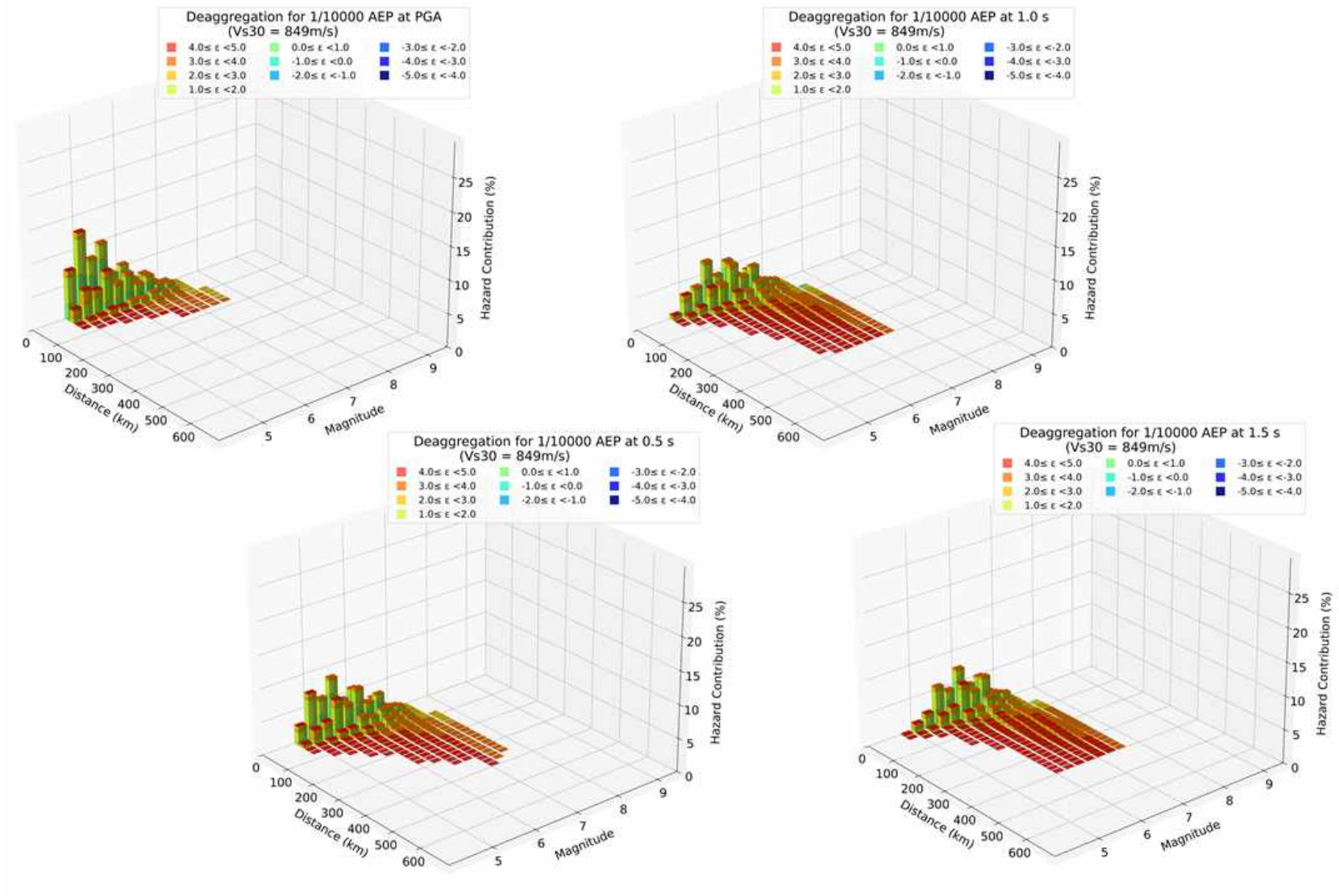


Figure 16: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/10,000 AEP from crustal sources, color coded by epsilon in one-epsilon intervals

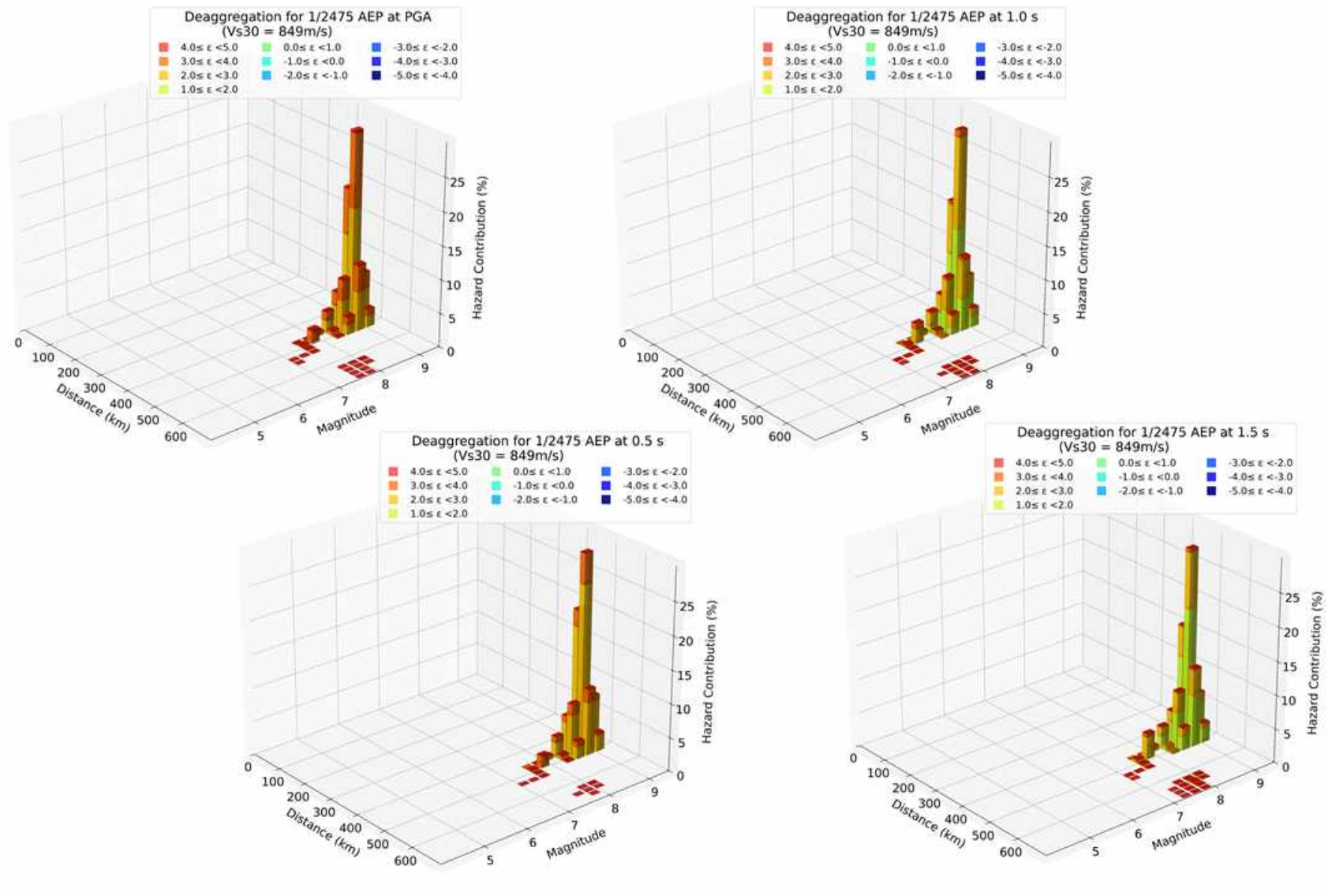


Figure 17: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/2,475 AEP from subduction sources, color coded by epsilon in one-epsilon intervals

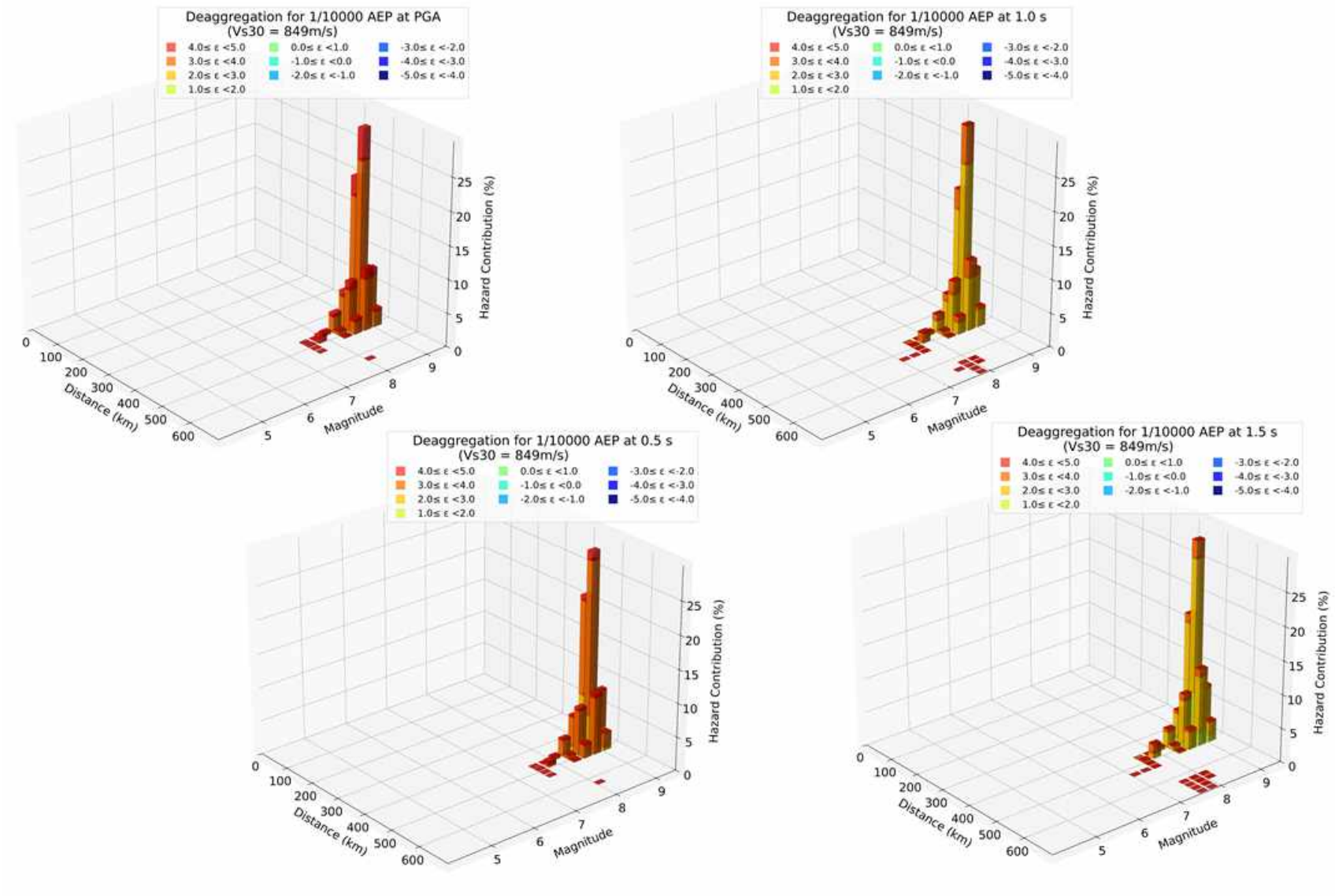


Figure 18: Magnitude-distance deaggregation of the mean PGA (upper left), 0.5 s (lower left), 1.0 s (upper right) and 1.5 s (lower right) spectral periods for the 1/10,000 AEP from subduction sources, color coded by epsilon in one-epsilon intervals

Table 14: Average Distance, Magnitude, and Epsilon for Magnitude-distance Deaggregation for the Total Hazard

AEP	Spectral period (s)	Distance (km)			Magnitude (M_w)			Epsilon[1]		
		Mean	Median	Mode	Mean	Median	Mode	Mean	Median	Mode
1/2,475	PGA	40 - 60	20 - 40	20 - 40	5.5 - 5.75	5.5 - 5.75	5.0 - 5.25	0.7	0.5	0.5
	0.5	80 - 100	40 - 60	0 - 20	6.0 - 6.25	6.0 - 6.25	5.0 - 5.25	1.0	0.5	0.5
	1.0	180 - 200	100 - 120	480 - 500	6.75 - 7.0	6.5 - 6.75	8.75 - 9.0	1.7	1.5	1.5
	1.5	280 - 300	260 - 280	480 - 500	7.5 - 7.75	7.0 - 7.25	8.75 - 9.0	2.4	2.5	2.5
1/10,000	PGA	20 - 40	0 - 20	0 - 20	5.5 - 5.75	5.5 - 5.75	5.0 - 5.25	0.6	0.5	0.5
	0.5	20 – 40	20 – 40	0 – 20	6.0 – 6.25	6.0 – 6.25	5.5 – 5.75	1.1	1.5	1.5
	1.0	100 – 120	20 – 40	480 – 500	6.5 – 6.75	6.25 – 6.5	8.75 – 9.0	1.0	0.5	0.5
	1.5	220 - 240	100 - 120	480 - 500	7.25 - 7.5	6.75 - 7.0	8.75 - 9.0	2.2	2.5	2.5

Notes:

1. Epsilon values are based on the range of values for the median-distance and median-magnitude.

Table 15: Average Distance, Magnitude, and Epsilon for Magnitude-distance Deaggregation of Crustal Seismic Sources

AEP	Spectral period (s)	Distance (km)			Magnitude (M_w)			Epsilon[1]		
		Mean	Median	Mode	Mean	Median	Mode	Mean	Median	Mode
1/2,475	PGA	20 - 40	0 - 20	0 - 20	5.5 - 5.75	5.5 - 5.75	5.0 - 5.25	0.6	0.5	0.5
	0.5	60 – 80	40 – 60	0 – 20	6.0 – 6.25	6.0 – 6.25	5.0 – 5.25	1.0	0.5	0.5
	1.0	80 – 100	60 – 80	20 – 40	6.25 – 6.5	6.25 – 6.5	6.0 – 6.25	1.3	1.5	1.5
	1.5	100 – 120	60 – 80	20 – 40	6.5 – 6.75	6.5 – 6.75	6.0 – 6.25	1.3	1.5	1.5
1/10,000	PGA	40 – 60	20 – 40	0 – 20	6.25 – 6.5	6.25 – 6.5	5.5 – 5.75	1.0	0.5	0.5
	0.5	20 – 40	20 – 40	0 – 20	6.0 – 6.25	6.0 – 6.25	5.5 – 5.75	1.1	1.5	1.5
	1.0	40 – 60	20 – 40	0 – 20	6.25 – 6.5	6.25 – 6.5	5.5 – 5.75	1.0	0.5	0.5
	1.5	60 – 80	20 - 40	0 – 20	6.25 – 6.5	6.5 – 6.75	6.0 – 6.25	1.0	0.5	0.5

Notes:

1. Epsilon values are based on the range of values for the median-distance and median-magnitude.

Table 16: Average Distance, Magnitude, and Epsilon for Magnitude-distance Deaggregation of Subduction Seismic Sources

AEP	Spectral period (s)	Distance (km)			Magnitude (M_w)			Epsilon[1]		
		Mean	Median	Mode	Mean	Median	Mode	Mean	Median	Mode
1/2,475	PGA	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	2.9	2.5	2.5
	0.5	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	2.7	2.5	2.5
	1.0	480 - 500	480 - 500	480 - 500	8.75 - 9.0	8.75 - 9.0	8.75 - 9.0	2.0	1.5	1.5
	1.5	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	1.8	1.5	1.5
1/10,000	PGA	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	3.7	3.5	3.5
	0.5	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	3.4	3.5	3.5
	1.0	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	2.7	2.5	2.5
	1.5	480 – 500	480 – 500	480 – 500	8.75 – 9.0	8.75 – 9.0	8.75 – 9.0	2.3	2.5	2.5

Notes:

1. Epsilon values are based on the range of values for the median-distance and median-magnitude.

8.0 SEISMIC HAZARD ANALYSIS: DISCUSSION AND RECOMMENDATIONS

In this section:

- The results of this site-specific seismic hazard assessment are compared to results from the CanadaSHM6
- Earthquake acceleration time history development.

8.1 Comparison of Seismic Hazard Assessment Results to CanadaSHM6

The CanadaSHM6 seismic hazard assessment is not site-specific because it was developed for a national seismic source model and for a series of fixed V_{S30} values. As part of the validation for this assessment (Section 5.3) the CanadaSHM6 results are compared to the results of this assessment at selected AEPs. The results of this site-specific assessment are slightly lower at spectral periods below 2.0 s and slightly higher at spectral periods above 2.0 s. These changes are attributed to the different ground motion model selection and weighting, and V_{S30} used in this assessment.

8.3 Earthquake Acceleration Time History Development

A principal purpose for the site-specific seismic hazard assessment reported here is to support the development of earthquake acceleration time histories. Appendix A presents the data, methods, and results from the development of a suite of 11 two-horizontal-component earthquake acceleration time histories for the Mount Polley TSF site. The 22 EATHs were developed for the site-specific, mean horizontal acceleration response spectrum with an AEP of 1/2,475 years. Electronic files with the developed EATHs were transmitted separately.

9.0 CLOSING

WSP USA appreciates the opportunity to provide WSP Canada with site-specific earthquake hazard assessment for the Mount Polley TSF site. We have applied the best-available science and our understanding of the generally accepted practice in seismic hazard assessment. If you have any questions about the content or use of this report, please contact the undersigned.

Signature Page

WSP USA Inc.



Alan Hull PhD, CEG (CA)
Senior Technical Director

https://wsponlinenam-my.sharepoint.com/personal/tonya_peeler_wsp_com/documents/31404975.000-gal-rev0- mount polley_01022023.docx

10.0 REFERENCES

Abrahamson, N. A., 2006, Seismic Hazard Assessment: Problems with Current Practice and Future Developments, 17.

Abrahamson, N. A., 2009, The state of the practice of seismic hazard analysis: From the good to the bad, EERI Chapter, The University of British Columbia, EERI 2009 Distinguished Lecture.

Abrahamson, N. et al., 2018, Update of the BC Hydro Subduction Ground-Motion Model using the NGA-Subduction Dataset, 2018/02, Pacific earthquake Engineering Research Center (PEER).

Abrahamson, N., and Z. Gülerce, 2020, Regionalized Ground-Motion Models for Subduction Earthquakes Based on the NGA-SUB Database, 237.

Abrahamson, N. A., W. J. Silva, and R. Kamai, 2014, Summary of the ASK14 Ground Motion Relation for Active Crustal Regions, Earthquake Spectra, 30, no. 3, 1025–1055, doi: 10.1193/070913EQS198M.

Allen, T. I., S. Halchuk, J. Adams, and G. A. Weatherill, 2020, Forensic PSHA: Benchmarking Canada's Fifth Generation seismic hazard model using the OpenQuake-engine, Earthquake Spectra, 36, no. 1_suppl, 91–111, doi: 10.1177/8755293019900779.

Beatty, T.W., Orchard, M.J. and Mustard, P.S., 2006, Geology and tectonic history of the Quesnel terrane in the area of Kamloops, British Columbia: In: Colpron, M. and Nelson, J.L., eds., Paleozoic Evolution and Metallogeny of Pericratonic Terranes at the Ancient Pacific Margin of North America, Canadian and Alaskan Cordillera: Geological Association of Canada, Special Paper 45, p. 483-504.

Boore, D. M., J. P. Stewart, E. Seyhan, and G. M. Atkinson, 2014, NGA-West2 Equations for Predicting PGA, PGV, and 5% Damped PSA for Shallow Crustal Earthquakes, Earthquake Spectra, 30, no. 3, 1057–1085, doi: 10.1193/070113EQS184M.

Campbell, K. W., and Y. Bozorgnia, 2014, NGA-West2 Ground Motion Model for the Average Horizontal Components of PGA, PGV, and 5% Damped Linear Acceleration Response Spectra, Earthquake Spectra, 30, no. 3, 1087–1115, doi: 10.1193/062913EQS175M.

Canadian Dam Association (CDA), 2014, Application of Dam Safety Guidelines to Mining Dams, Technical Bulletin, Toronto, Canada.

Chiou, B. S.-J., and R. R. Youngs, 2014, Update of the Chiou and Youngs NGA Model for the Average Horizontal Component of Peak Ground Motion and Response Spectra, Earthquake Spectra, 30, no. 3, 1117–1153, doi: 10.1193/072813EQS219M.

Cornell, C. A., 1968, Engineering seismic risk analysis, Bulletin of the Seismological Society of America, 58, no. 5, 1583–1606, doi: 10.1785/BSSA0580051583.

Dragert, H., R. D. Hyndman, G. C. Rogers, and K. Wang, 1994. Current deformation and the width of the seismogenic zone of the northern Cascadia subduction thrust, Journal of Geophysical Research, 99, 653-668.

GEM, 2022, OpenQuake | Global Earthquake Model Foundation: <https://www.globalquakemodel.org/openquake> (accessed July 1, 2022).

Halchuk, S., T. I. Allen, G. C. Rogers, and J. Adams, 2015, Seismic Hazard Earthquake Epicentre File (SHEEF2010) used in the fifth-generation seismic hazard maps of Canada, 7724, 7724 p.

Hyndman, R.D., and K. Wang, 1995. The rupture zone of Cascadia great earthquakes from current deformation and the thermal regime, Journal of Geophysical Research, 100, no. 22, 133-154.

ICMM, 2019, Global Tailings Standard Draft for Public Consultation: <https://globaltailingsreview.org/wp-content/uploads/2019/11/EN-Global-Tailings-Standard_CONSULTATION-DRAFT.pdf> (accessed January 10, 2022).

Kaklamanos, J., L. G. Baise, and D. M. Boore, 2011, Estimating Unknown Input Parameters when Implementing the NGA Ground-Motion Prediction Equations in Engineering Practice, Earthquake Spectra, 27, no. 4, 1219–1235, doi: 10.1193/1.3650372.

Kolaj, Michal, J. Adams, and S. Halchuk, 2020a, Seismic Hazard in Southeastern Canada: Uncertainty and Controls on Seismic Hazard in a Region of Low-to-Moderate Seismicity, 12.

Kolaj, Michal, J. Adams, and S. Halchuk, 2020b, The 6th Generation Seismic Hazard Model of Canada, 12.

Kolaj, M, S. Halchuk, J. Adams, and T. I. Allen, 2020, Sixth Generation Seismic Hazard Model of Canada: input files to produce values proposed for the 2020 National Building Code of Canada, 8630.

Kuehn, N., Y. Bozorgnia, K. W. Campbell, and N. Gregor, 2020, Partially Non-Ergodic Ground-Motion Model for Subduction Regions using the NGA-Subduction Database, 187.

Mazzotti, S., H. Dragert, J. Henton, M. Schmidt, R. Hyndman, T. James, Y. Lu, and M. Cramer, 2003. Current tectonics of northern Cascadia from a decade of GPS measurements, Journal of Geophysical Research, 108, 2554.

Monger, J.W.H., 1989. Chapter 2. Overview of Cordilleran Geology, in Ricketts, B. D. ed., Western Canada Sedimentary Basin, Canadian Association of Petroleum Geology (Special Paper S30), pp. 9–32.

Monger, J.W.H. and Price, R.A., 1979. Geodynamic evolution of the Canadian Cordillera - Progress and problems: Canadian Journal of Earth Sciences volume 16 (3), p. 770-791.

Natural Resources Canada (NRCan), G. of C., 2020, 2020 National Building Code of Canada Seismic Hazard Tool: <https://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/nbc2020-cnb2020-en.php> (accessed September 30, 2022).

Nelson, J., and Colpron, M., 2007, Tectonics and metallogeny of the British Columbia, Yukon and Alaskan Cordillera, 1.8 Ga to the present: In: Goodfellow, W.D., ed., Mineral Deposits of Canada: A Synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods: Geological Association of Canada, Mineral Deposits Division, Special Publication No. 5, p. 755-791.

Parker, G. A., J. P. Stewart, D. M. Boore, G. M. Atkinson, and B. Hassani, 2020, NGA-subduction global ground motion models with regional adjustment factors, Earthquake Spectra, 875529302110348, doi: 10.1177/87552930211034889.

Price, R.A. 1994. Cordilleran Tectonics and the Evolution of the Western Canada Sedimentary Basin: In: Geological Atlas of the Western Canada Sedimentary Basin, Chapter 2, Canadian Society of Petroleum Geologists; Editors: G.D. Mossop and I. Shetsen.

Price, R.A. 2000. The Evolution of the Southern Cordilleran Foreland Thrust and Fold Belt and the Kinematics of Cordilleran Orogenesis: In: Conference Proceedings, GeoCanada 2000, Symposium and Field Trip, University of Calgary, Alberta.

Ricketts, B.D., 2008. Cordilleran Sedimentary Basins of Western Canada Record 180 Million Years of Terrane Accretion: K.J. Hsü, Series Editor: Sedimentary Basins of the World, Volume 5, The Sedimentary Basins of the United States and Canada, Andrew D. Miall (Editor). Elsevier, pp. 363 – 394.

Rogers, G. C., J. F. Cassidy, and R. M. Ellis, 1990. The Prince George, British Columbia earthquake of 21 March 1986, Bulletin of the Seismological Society of America, 80, no. 5, 1144-1161.

Si, H., S. Midorikawa, and T. Kishida, 2020, Development of NGA-Sub Ground-Motion Model of 5%-Damped Pseudo-Spectral Acceleration Based on Database for Subduction Earthquakes in Japan, 87.

APPENDIX A

Earthquake Acceleration Time Histories

TECHNICAL MEMORANDUM

DATE February 1, 2023 **Project No.** 31404975.000

TO Andres Torres
WSP Canada Inc.

CC Alan Hull

FROM Mahir Badanagki and Feng Li **EMAIL mahir.badanagki@wsp.com**

EARTHQUAKE ACCELERATION TIME HISTORY DEVELOPMENT FOR MOUNT POLLEY MINE, BRITISH COLUMBIA, CANADA

This technical memorandum (TM) presents a suite of 11 two-horizontal-component earthquake acceleration time histories (EATHs, a.k.a. motions) developed by WSP USA Inc. (WSP USA) for the Mount Polley Mine TSF site in British Columbia, Canada. The 22 EATHs were developed for the target spectrum—the site-specific, mean horizontal acceleration response spectrum with an annual exceedance probability (AEP) of 1/2,475 years as presented in Golder (2022). Electronic files with the developed EATHs were transmitted separately.

1.0 INTRODUCTION

WSP USA developed 11, two-horizontal-component EATHs to support ongoing engineering analyses for the Mount Polley Mine site. WSP USA used the amplitude scaling method to develop the EATHs. The target spectrum is the uniform hazard response spectrum (UHRS) with a 1/2,475 AEP as presented in Golder (2022). The key steps to develop the EATHs were:

- Select seed EATHs that have similar spectral shape to the target spectrum.
- Apply the amplitude scaling method to adjust seed records to match the target spectrum.
- Compare the geometric-mean spectrum of the scaled EATHs to the target spectrum.
- Select a suite of eleven, two-component EATHs suitable for subsequent analyses at the Mount Polley Mine site.
- Prepare this TM to document the approach, procedures, and results.

Figure 1 shows the site-specific mean acceleration response spectrum (i.e., the target spectrum) for an AEP of 1/2,475 as presented in Golder (2022).

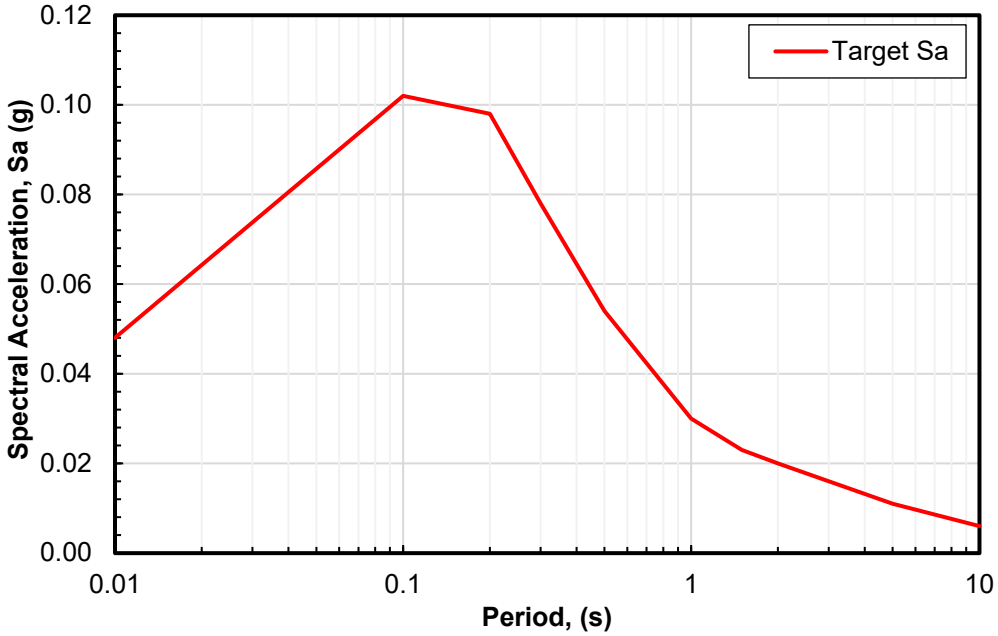


Figure 1: Site-Specific Target Acceleration Response Spectrum for an Annual Exceedance Probability (AEP) of 1/2,475 for Mt Polley TSF Site

2.0 EARTHQUAKE ACCELERATION TIME HISTORY DEVELOPMENT

The following sections describe the EATH selection criteria, process to scale the records, and the resulting EATHs.

2.1 Selection Criteria

WSP USA selected seed EATHs from the Pacific Earthquake Engineering Research Center (PEER) Next Generation Attenuation Phase 2 Project (NGA-West2) strong-motion database. Typical time history selection criteria included earthquake magnitude, source-to-site distance, style of faulting, rupture directivity, and near-surface ground condition at the recording station.

Key EATH selection criteria were:

- Earthquake records should reflect both the near-field moderate-magnitude crustal earthquakes and the far-field subduction interface earthquakes as indicated by the deaggregation analysis. WSP USA judged that eight two-component records from near-field crustal earthquakes and three two-component subduction earthquakes provided a reasonable representation of the 1/2,475 AEP hazard sources.
- Source earthquakes are of moment magnitude (**M**) 5.5 to 6.5 centered at about **M**6.0 that is the preferred modal magnitude in Golder (2022) for crustal motions. The magnitude criterion was relaxed to **M**5.5 to include more seed EATHs. For subduction interface motions, source earthquakes are of **M**8.0 to **M**9.5 centered at **M**9.0.

- Seed EATHs were recorded at stations less than 50 km for the source earthquake for crustal motions and less than 500 km for subduction interface motions.
- Seed EATHs recorded at stations with a V_{S30} (i.e., the time-averaged shear-wave velocity for the top 30 m of earth materials below the ground or reference surface) from 360 to 1500 m/s assuming the site V_{S30} of interest is 849 m/s.
- The shape of the acceleration response spectra of the seed EATHs agrees well with the shape of the target spectrum within the period range of interest of 0.5 to 1.5 seconds, which covers the estimated fundamental period of 1 second for the facility of interest.
- Scaling factors for the seed EATHs are preferred to be between 0.25 and 4.
- No more than two seed EATHs are from the same earthquake.
- No EATHs with velocity pulses were included because the site is more than 10 km away from a known seismically active fault.
- The style-of-faulting criterion was relaxed to include all fault rupture styles.

2.2 Results

The 11 EATHs were selected that meet the selection criteria described above. Figures 2 and 3 show the geometric-mean acceleration response spectrum of the selected and scaled EATHs for crustal and subduction interface motions, respectively, compared with the target response spectrum and 90% and 130% of the target (i.e., -10% and +30% of the target). Typical practice in earthquake geotechnical engineering requires the geometric-mean response spectrum to be within about 90% to 130% of the target response spectrum within the period range of interest (Figure 2).

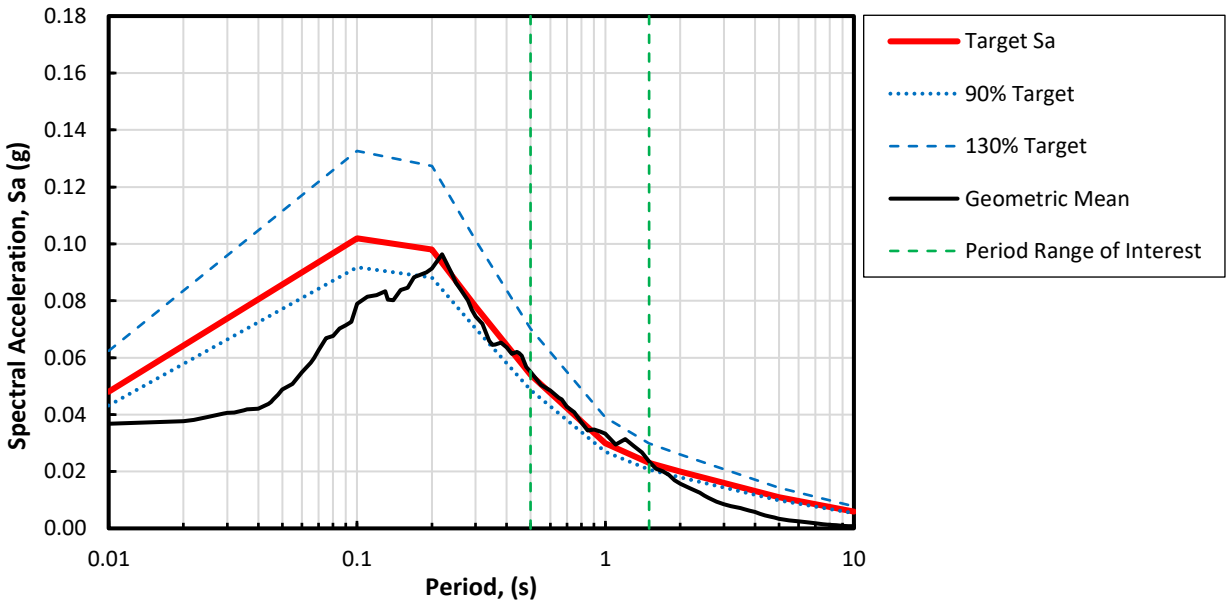


Figure 2: Target Acceleration Response Spectrum and the Geometric-Mean Response Spectrum of Selected and Scaled Crustal Earthquake Acceleration Time Histories

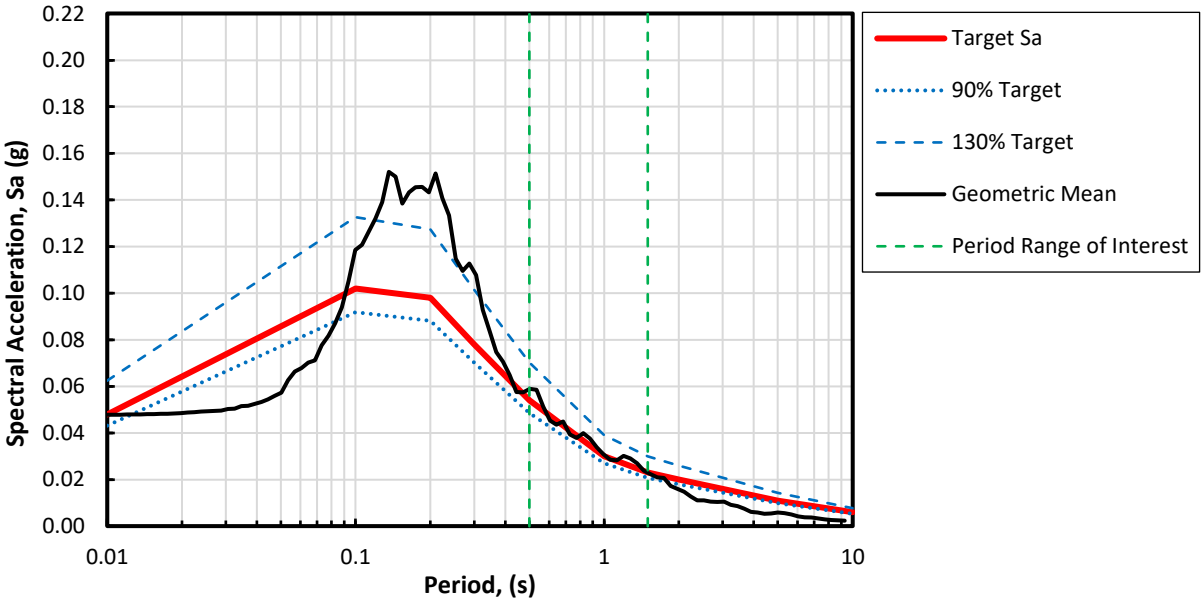


Figure 3: Target Acceleration Response Spectrum and the Geometric-Mean Response Spectrum of Selected and Scaled Interface Earthquake Acceleration Time Histories

Figures 4 and 5 show the response spectra of individual scaled EATHs compared with the target spectrum for both crustal and subduction interface motions. Figures 4 and 5 show that the individual response spectra agree reasonably well with the target. Table 1 lists key parameters of the selected and scaled EATHs.

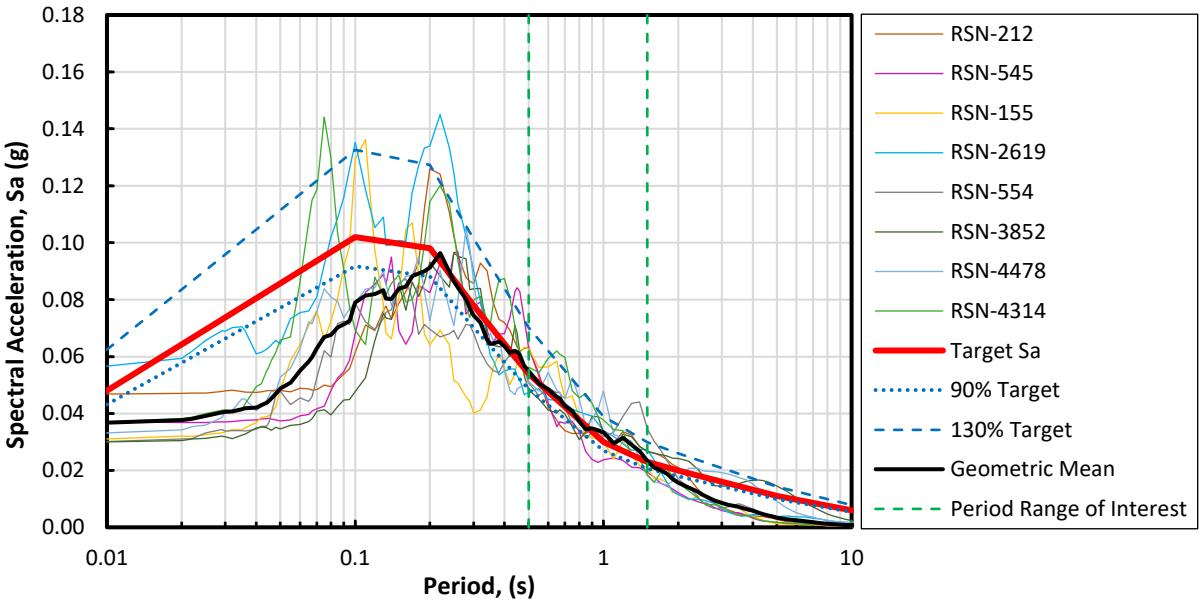


Figure 4: Target Acceleration Response Spectrum and Response Spectra of Individual Crustal Earthquake Acceleration Time Histories

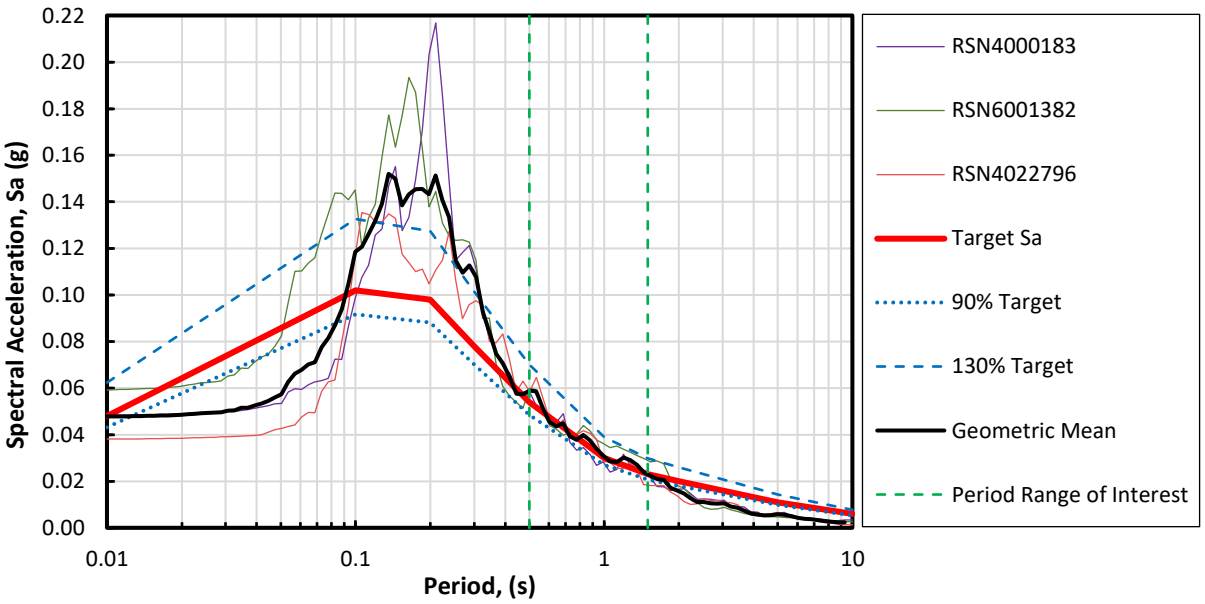


Figure 5: Target Acceleration Response Spectrum and Response Spectra of Individual Subduction Interface Earthquake Acceleration Time Histories

Table 1: Key Parameters of Selected and Scaled Earthquake Acceleration Time Histories

Record Sequence Number (RSN)[a]	Moment Magnitude (M)	Earthquake Name	Year	Station Name	Scale Factor	R_{rup}[b] (km)	R_{jb}[c] (km)	V_{S30}[d] (m/s)	Fault Type	Component	D_{5-75} (s)[e]	D_{5-95} (s)[f]	AI[g] (m/s)	CAV[h] (m/s)
155	5.90	Norcia, Italy	1979	Bevagna	1.10	31	31	401	Normal	NS	10.5	14.6	0.018	1.1
										EW	9.2	14.9	0.013	1.0
212	5.80	Livermore, USA	1980	Del Valle Dam (Toe)	0.25	25	24	403	Strike slip	156	4.8	12.1	0.006	0.6
										246	2.1	7.3	0.013	0.8
357	6.36	Coalinga, USA	1983	Parkfield-Stone Corral	0.30	34	33	565	Reverse	0	4.8	12.2	0.013	1.0
										90	5.4	11.0	0.011	1.0
554	6.19	Chalfant Valley, USA	1986	Long Valley Dam	0.40	21	18	537	Strike slip	0	5.1	11.0	0.010	0.8
										90	7.9	11.9	0.010	0.9
2619	6.20	Chi-Chi, Taiwan	1999	TCU067	0.29	28	28	434	Reverse	N	5.3	6.6	0.009	0.7
										E	5.1	7.1	0.011	0.7
3852	6.20	Chi-Chi, Taiwan	1999	CHY006	0.27	25	25	438	Strike slip	N	5.9	16.7	0.014	1.2
										E	5.7	16.4	0.012	1.1
4314	5.60	Umbria, Italy	1984	Citta Di Castello-Regnano	0.77	41	41	388	Normal	0	7.1	17.7	0.017	1.1
										90	4.9	15.5	0.017	1.1
4478	6.30	L'Aquila, Italy	2009	Lab-Gran Sasso	1.47	11	11	547	Normal	E	7.1	11.5	0.013	1.1
										N	5.6	9.3	0.020	1.2
4000183	9.12	Tohoku	2011	4000183	0.66	104	-	634	Interface	EW	47.3	82.7	0.137	8.6
										NS	47.5	87.5	0.087	6.8
6001382	8.15	Iquique	2014	6000270	0.66	105	-	415	Interface	HLE	28.0	57.4	0.064	4.3
										HLN	21.8	49.5	0.085	4.7
4022796	8.29	Tokachi-oki	2003	4000330	0.70	191	-	386	Interface	EW2	34.7	61.9	0.071	5.3
										NS2	32.9	60.6	0.079	5.4

a. The record sequence number is assigned to individual records in the PEER NGA-West2 database.
b. R_{rup} = closest distance to fault rupture.
c. R_{jb} = closest horizontal distance to the surface projection of the surface fault rupture.
d. V_{s30} = the time-averaged shear-wave velocity for the upper 30 m of earth materials below the ground surface.
e. D_{5-75} = significant duration; the time between 5% and 75% of the cumulative Arias intensity.
f. D_{5-95} = significant duration; the time between 5% and 95% of the cumulative Arias intensity.
g. AI = Arias intensity
h. CAV = cumulative absolute velocity

Earthquake magnitude and source-to-site distance are causal parameters that are indirect measures of the source and travel path characteristics of the selected EATHs. Direct intensity measures, including significant durations (e.g., D_{5-75}), CAV, and AI were compared to predictions from the empirical relations listed in Tables 2 and 3. The predicted intensity measures were calculated for a representative earthquake scenario as listed in Tables 2 and 3. The target scenarios for crustal and subduction interface earthquakes were based on the deaggregation results for the period range of interest from Golder (2022). We used the mode magnitude and mode distance from the deaggregation results.

Table 2: Predicted Intensity Measures from Empirical Relations for a Selected Representative Crustal Earthquake Scenario

Empirical Relation Source	Intensity Measure	Median	16th Percentile	84th Percentile	Closet Distance to Rupture, R_{rup} (km)	Moment Magnitude (M)
Bommer et al. (2009)	D_{5-75}[a] (s)	4	3	7	20	6.0
	D_{5-95}[b] (s)	9	6	15		
Macedo et al. (2021)	CAV[c] (m/s)	1.0	0.7	1.4		
Abrahamson et al. (2016)	AI[d] (m/s)	0.023	0.016	0.034	-	

a. D_{5-75} = significant duration; the time between 5% and 75% of the total energy
b. D_{5-95} = significant duration; the time between 5% and 95% of the total energy
c. CAV = cumulative absolute velocity
d. AI = Arias intensity

Table 3: Predicted Intensity Measures Using Empirical Relations for a Selected Representative Subduction Interface Earthquake Scenario

Empirical Relation	Intensity Measure	Median	16th Percentile	84th Percentile	Closet Distance to Rupture, R_{rup} (km)	Moment Magnitude (M)
Macedo et al. (2019)	CAV[a] (m/s)	6.5	4.9	8.5	450	9
Liu and Macedo (2022)	AI[b] (m/s)	0.12	0.09	0.18		

a. CAV = cumulative absolute velocity
b. AI = Arias intensity

Figures 6 and 7 are comparisons of the intensity measures of the scaled EATHs to the predicted intensity measures. Comparison of the intensity measures of the scaled EATHs to the predicted intensity measures indicates that the D_{5-75}, D_{5-95}, CAV, and AI of the scaled EATHs are generally within the 16th and 84th percentile range of the empirically predicted values. Figures 6 and 7 show that the CAVs of the selected and scaled motions meet the target reasonably well, whereas the AIs are relatively less than the corresponding empirically based targets for both crustal and subduction interface records. It is almost always challenging to meet all four direct measures satisfactorily. For the Mt Polley TSF site, we consider that meeting the CAV criterion is more important than meeting the AI criterion. This is because CAV was observed to correlate better to durations than AI and can potentially be a more efficient intensity measure for predicting ground deformation that depends on the number of shaking cycles above some acceleration threshold (Macedo et al. 2021).

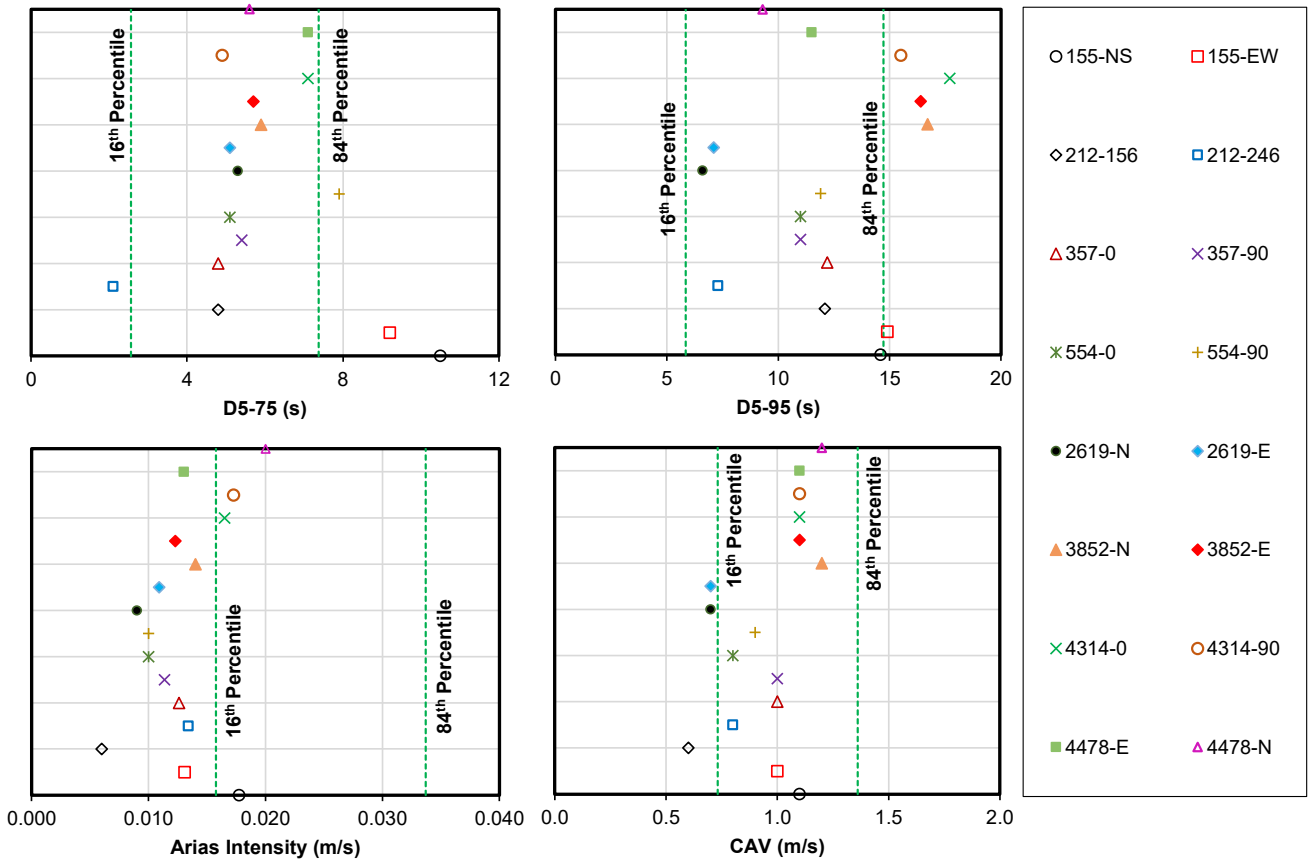


Figure 6: Comparison of Direct Intensity Measures of Selected Scaled Crustal Motions to Predictions Using Empirical Relations for the Mean 1/2,475 AEP Target Spectrum

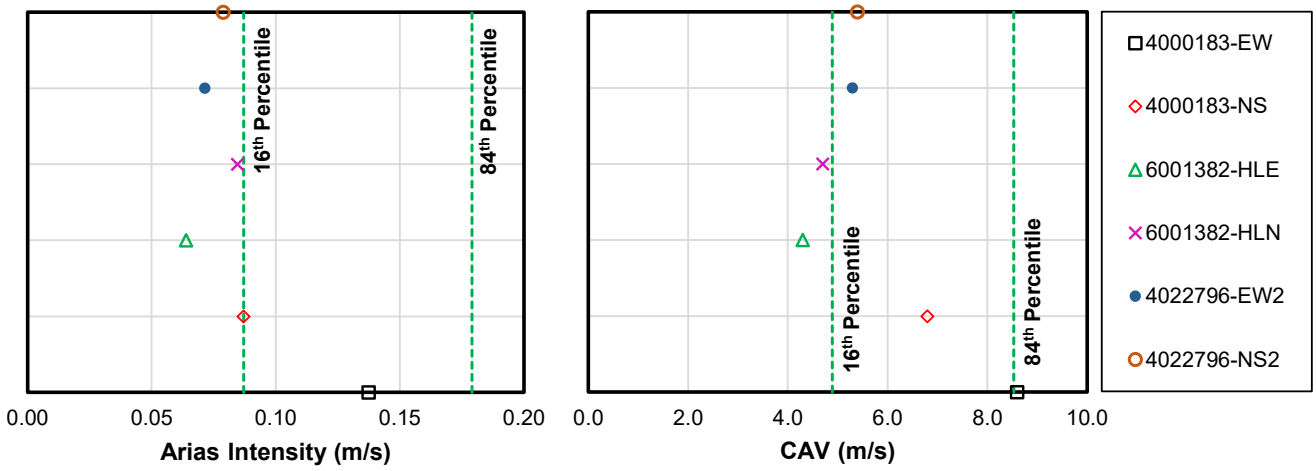


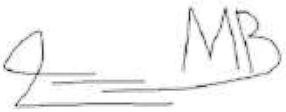
Figure 7: Comparison of Direct Intensity Measures of Selected Scaled Subduction Interface Motions to Predictions Using Empirical Relations for the Mean 1/2,475 AEP Target Spectrum

3.0 LIMITATIONS

Eleven two-horizontal-component EATHs were developed using amplitude scaling to support ongoing engineering analyses for the Mount Polley TSF site in British Columbia, Canada. These EATHs were developed specifically to address the conditions and requirements at the Mount Polley TSF site. They should not be used for other sites or projects without prior review and authorization by WSP USA.

The CAVs of the selected and scaled motions meet the target reasonably well, whereas the AIs are relatively lower than the corresponding target. For this project site, we assumed CAV is better related to the performance of the structure of interest, and hence consider the selected and scaled motions are acceptable. If subsequent analysis shows that this assumption is incorrect, then WSP USA recommends re-evaluation and reselection of the motions, if required.

WSP USA Inc.



Mahir Badanagki, PhD, EI
Associate Consultant, Geotechnical Engineer



Feng Li, PhD, PE (CA)
Lead Consultant, Geotechnical Engineer

MB/FL

Attachments: Attachment A – Amplitude Scaling Results for the 22 Individual EATHs for Target Acceleration Response Spectrum

https://wsponlinenam-my.sharepoint.com/personal/tonya_peeler_wsp_com/documents/31404975.000_tm_eaths_rev0.docx

4.0 REFERENCES

Abrahamson C, Shi HJM, and Yang B. 2016. Ground-motion prediction equations for Arias intensity consistent with the NGA-West2 ground-motion models. PEER Report 2016/05, p.57.

Bommer JJ, Stafford PJ, and Alarcón JE. 2009. Empirical equations for the prediction of the significant, bracketed, and uniform duration of earthquake ground motion. Bulletin of the Seismological Society of America, 99(6), pp.3,217–3,233.

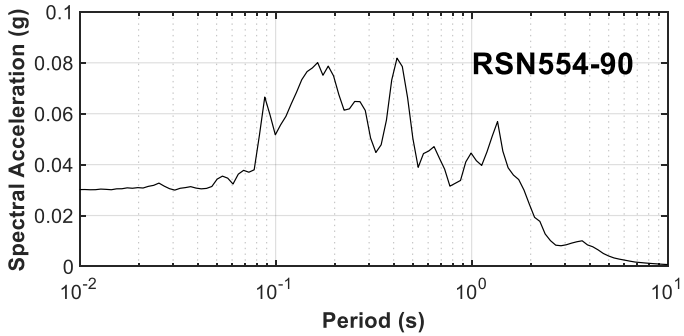
Golder Associates USA Inc. (Golder) 2022. Site-Specific Seismic Hazard Assessment, Mount Polley Mine, British Columbia.

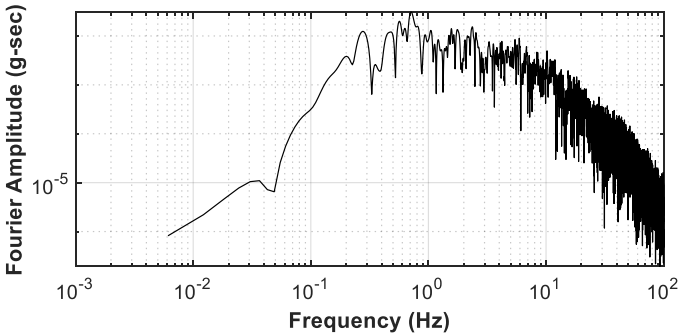
Liu C., Macedo J. 2022. New conditional, scenario-based, and non-conditional cumulative absolute velocity models for subduction tectonic settings. Earthquake Spectra. 38 (1): 615–647.

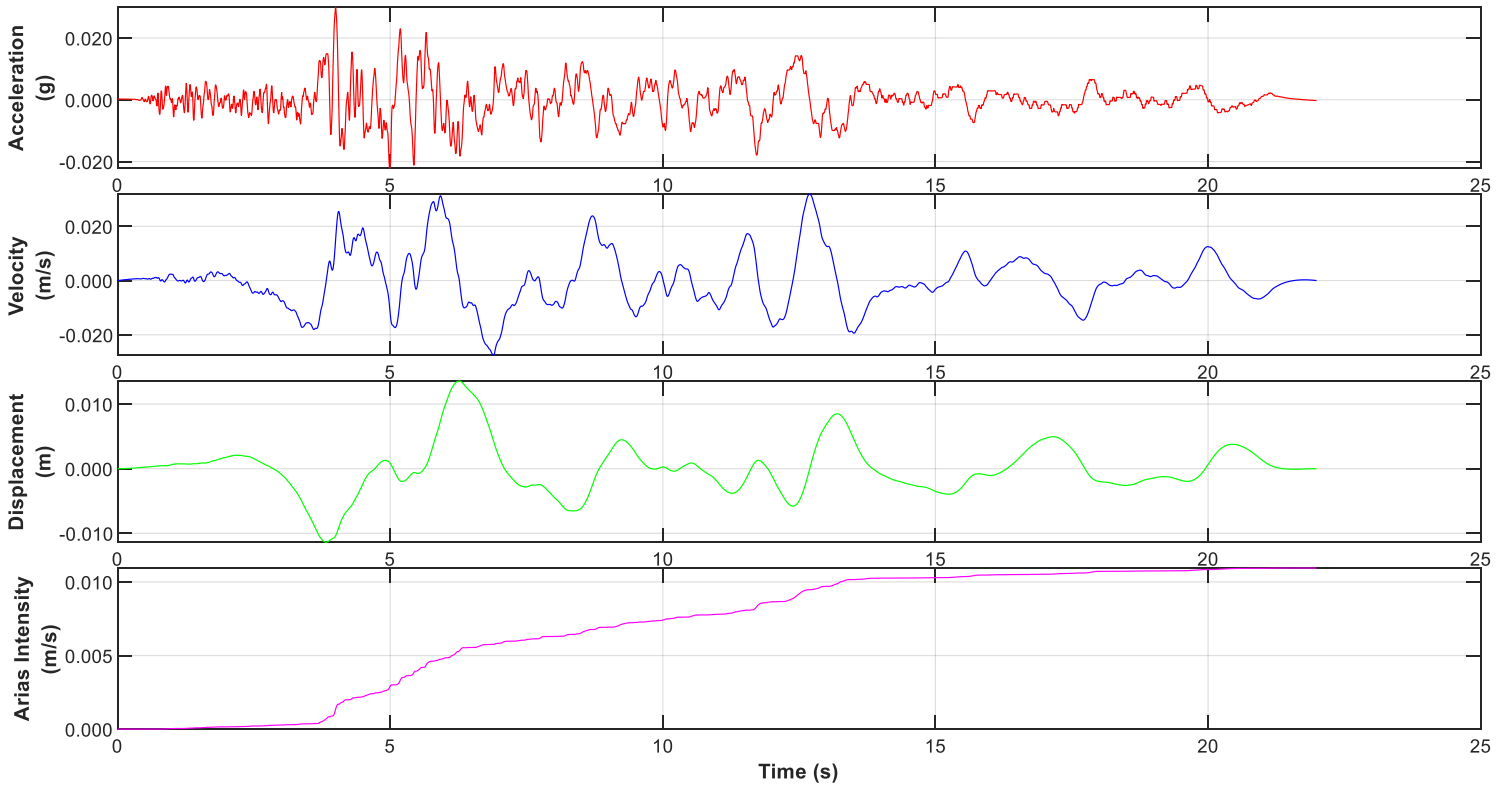
Macedo J., Abrahamson N., Bray J. D. 2019. Arias Intensity Conditional Scaling Ground-Motion Models for Subduction Zones. Bulletin of the Seismological Society of America. 109 (4): 1343–1357.

Macedo J., Abrahamson N., Liu C. 2021. New Scenario-Based Cumulative Absolute Velocity Models for Shallow Crustal Tectonic Settings. Bulletin of the Seismological Society of America; 111 (1): 157–172.

NEHRP (National Earthquake Hazards Reduction Program) Consultants Joint Venture. 2011. Selecting and Scaling Earthquake Ground Motions for Performing Response-History Analyses, National Institute of Standards and Technology (NIST) GCR 11-917-15.







CLIENT
WSP Canada Inc.

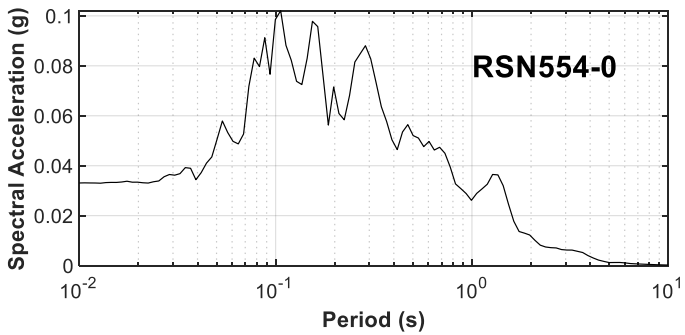
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

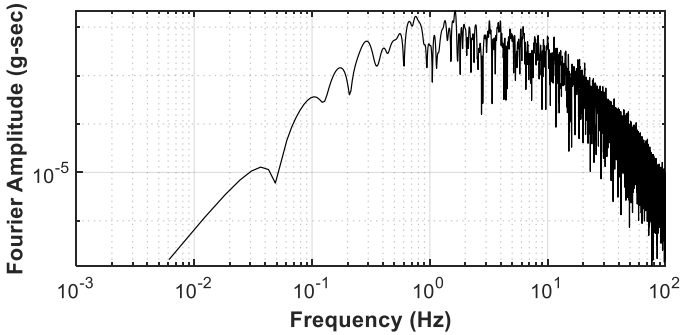
CONSULTANT

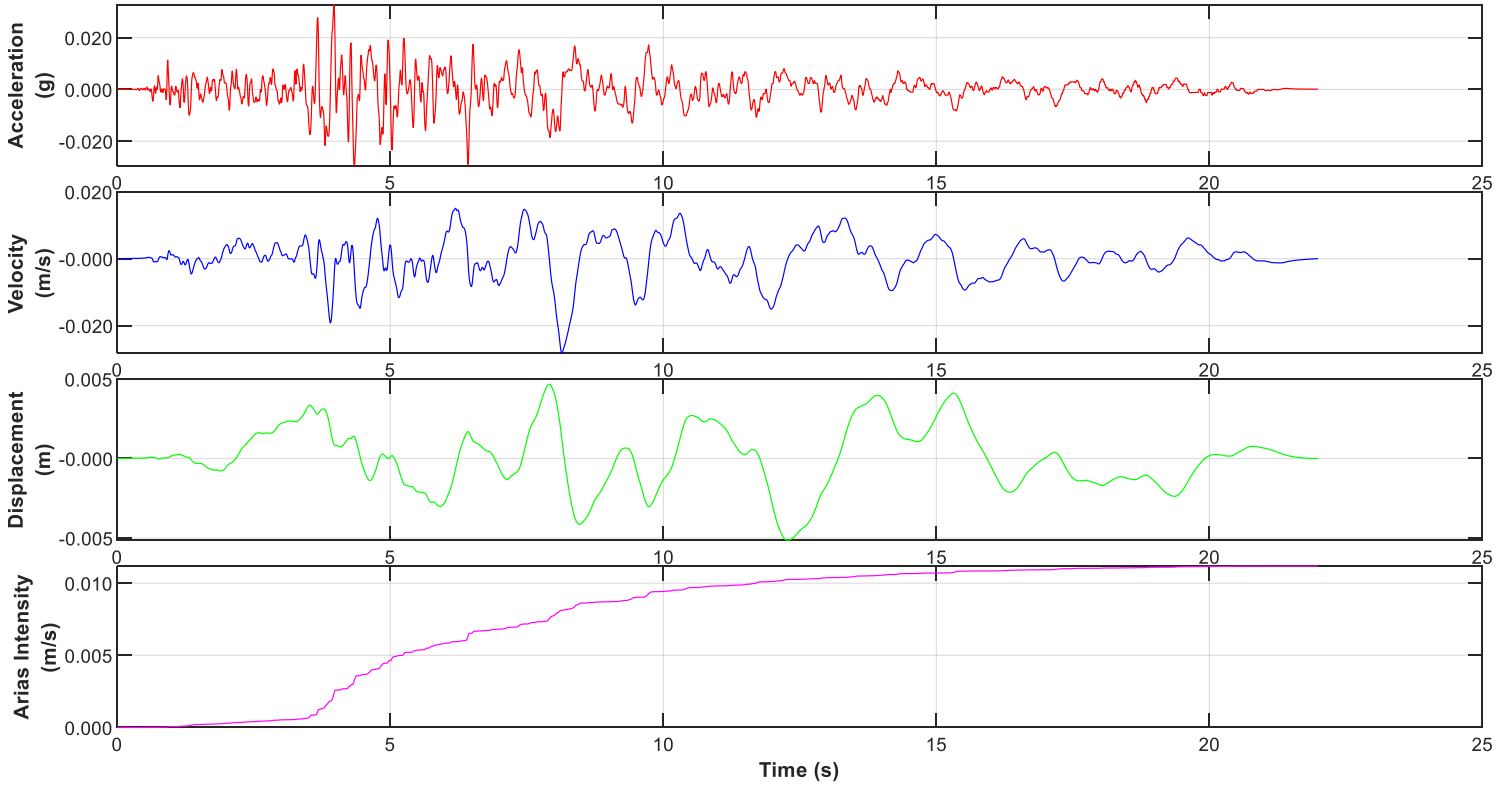
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN554-90

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**1**







CLIENT
WSP Canada Inc.

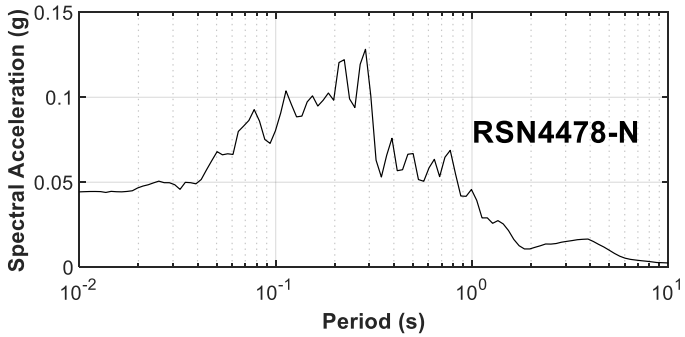
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

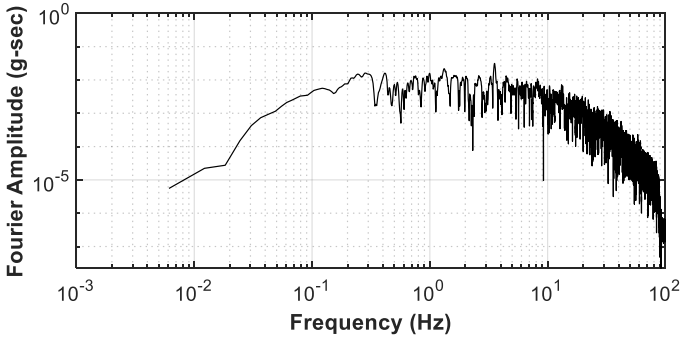
CONSULTANT

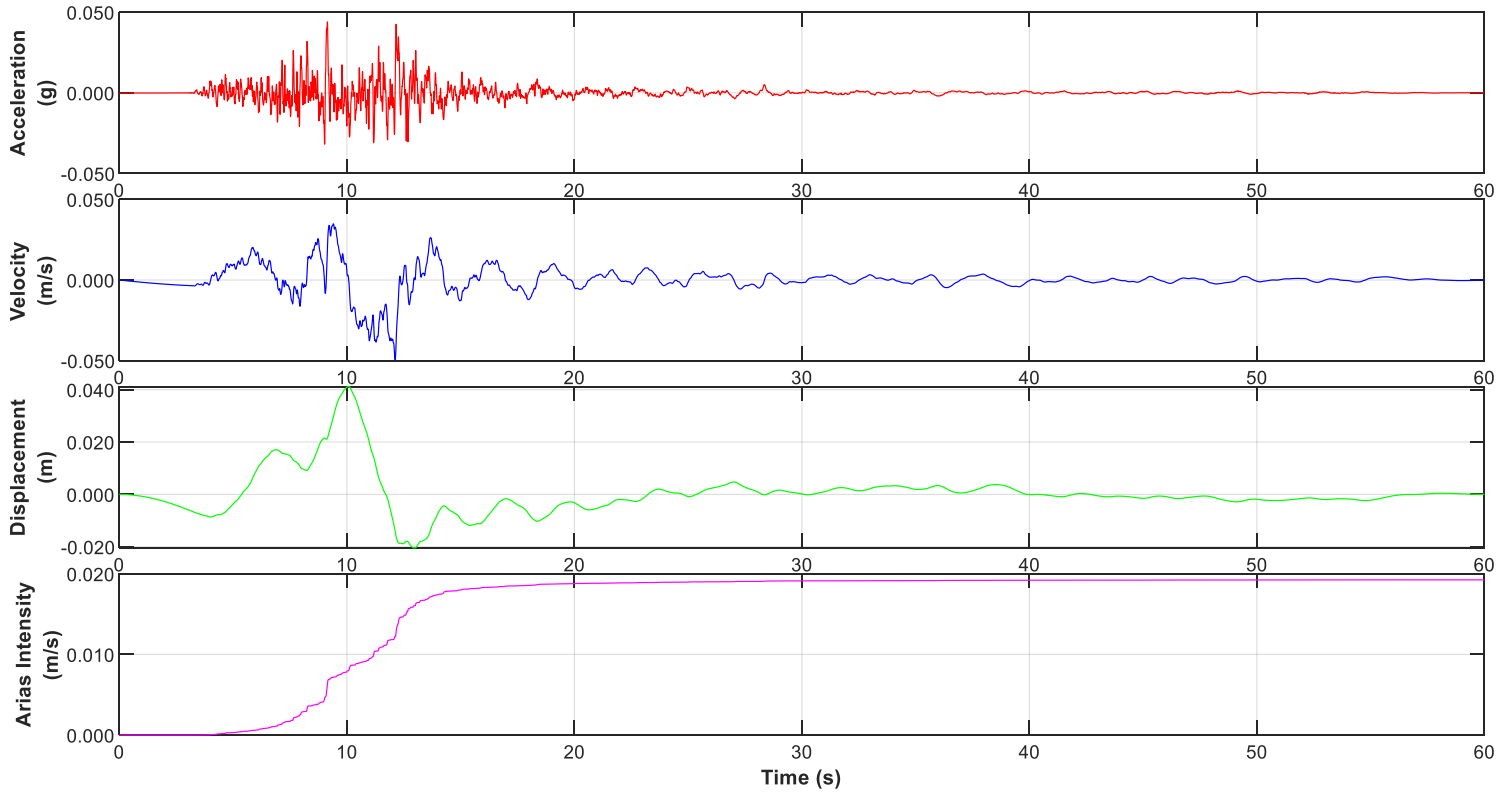
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN554-0

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**2**







CLIENT
WSP Canada Inc.

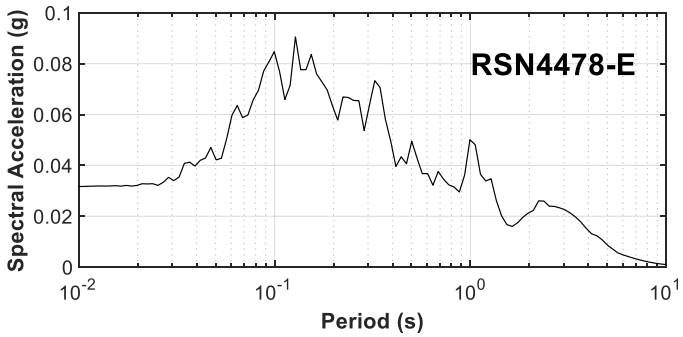
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

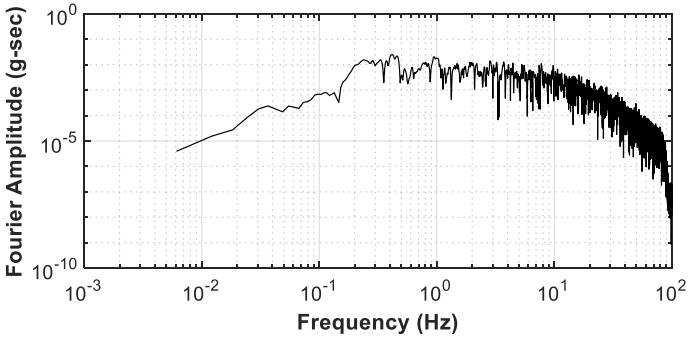
CONSULTANT

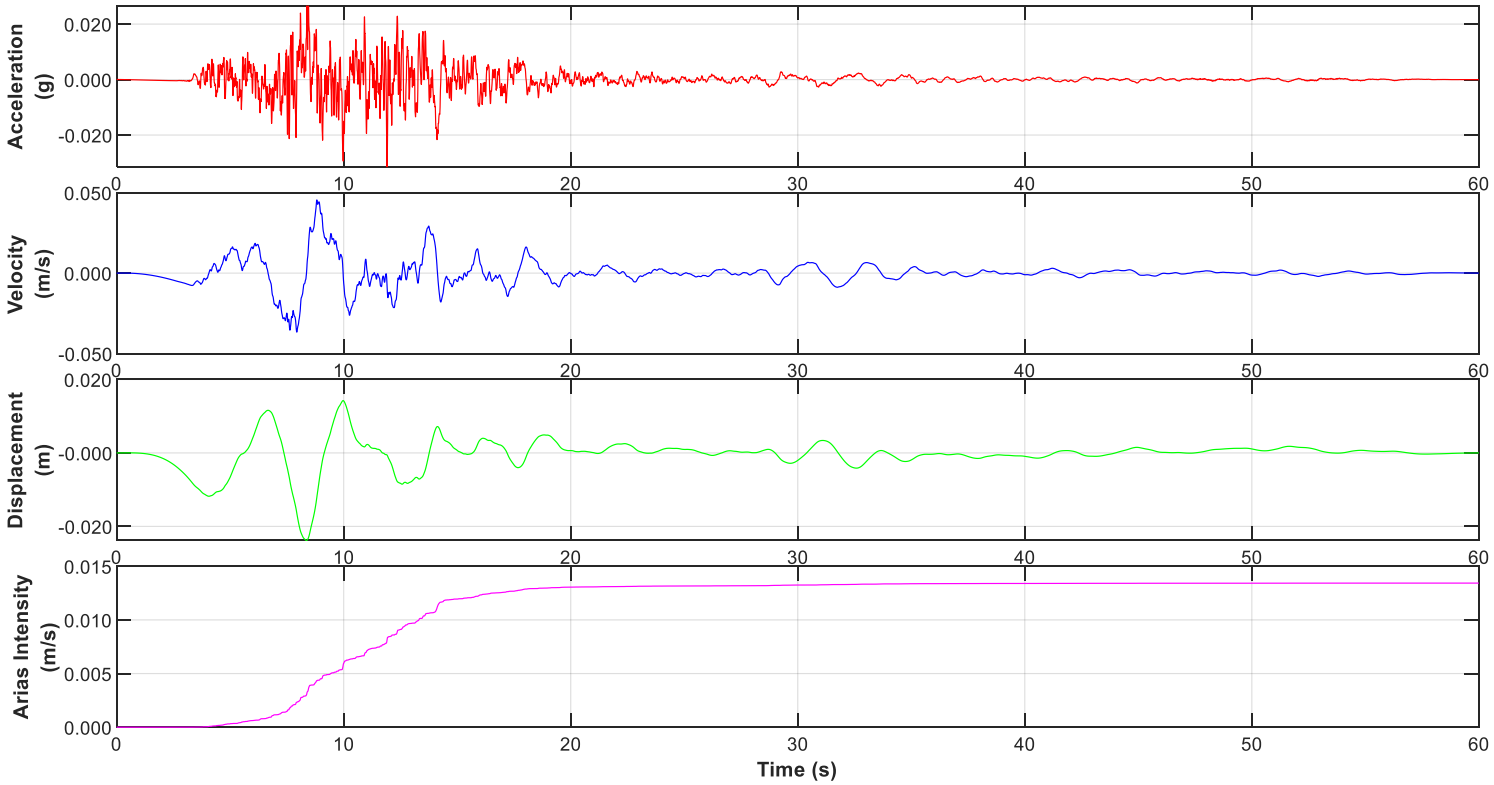
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4478-N

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**3**







CLIENT
WSP Canada Inc.

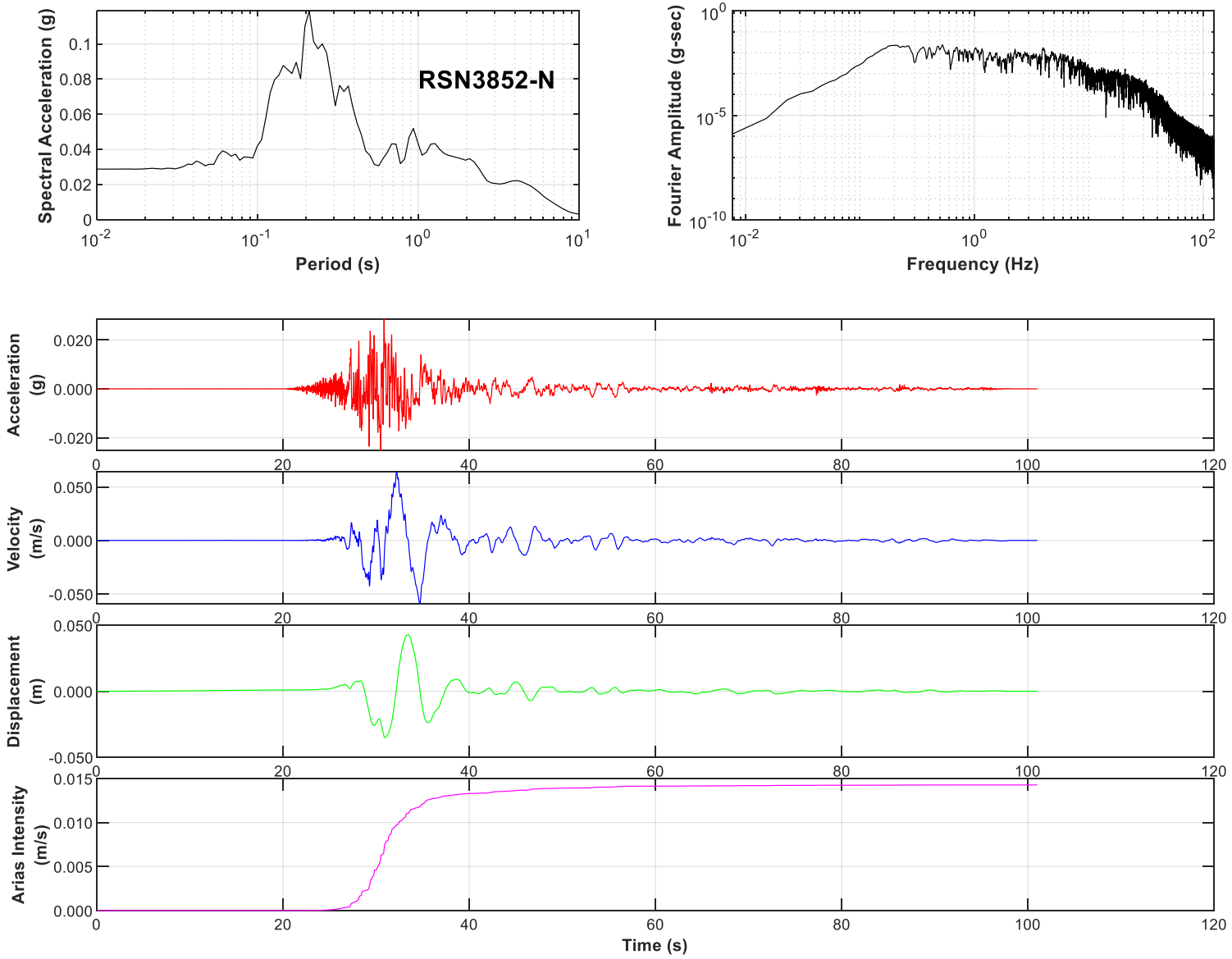
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4478-E

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**4**



CLIENT
WSP Canada Inc.

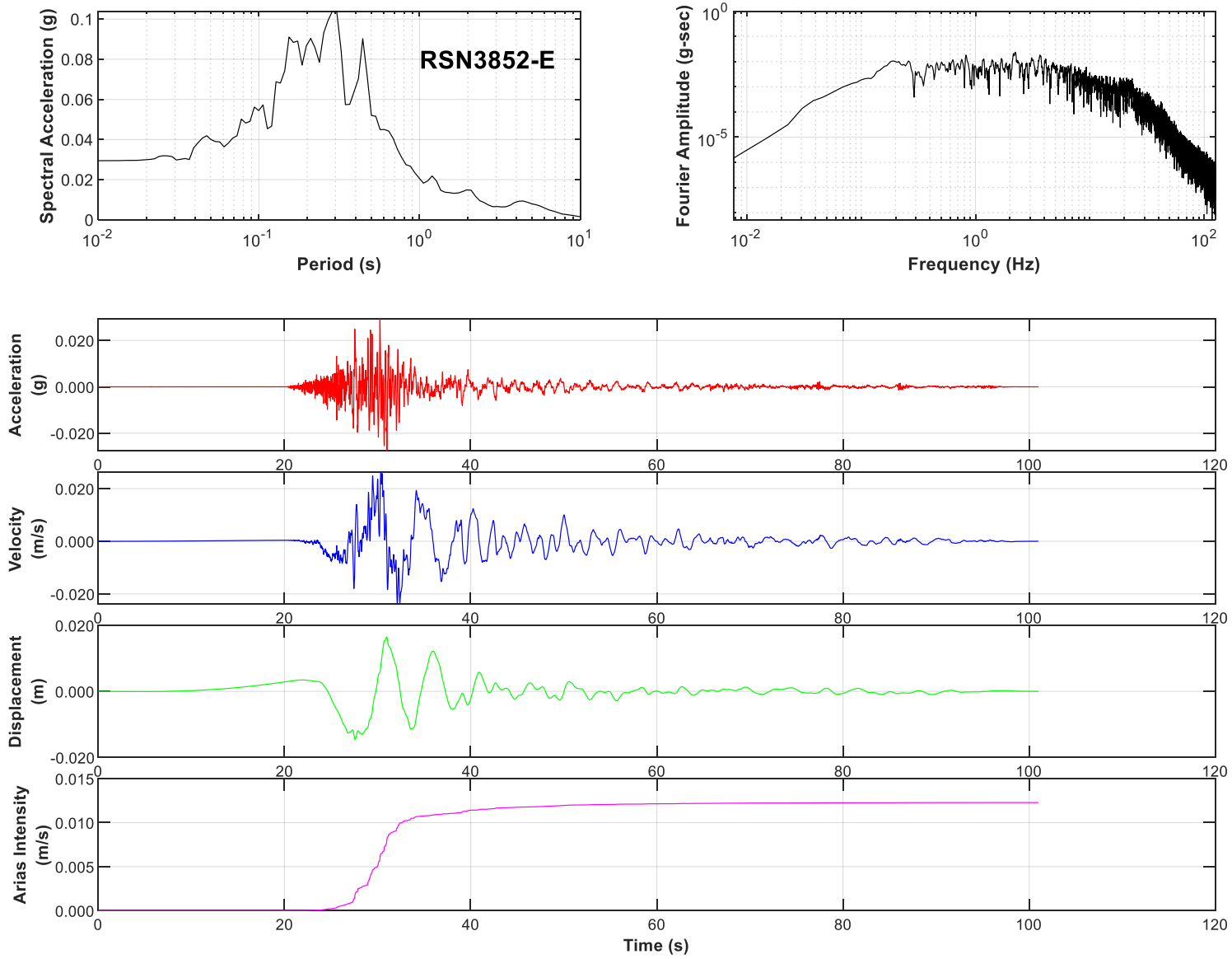
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN3852-N

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**5**



CLIENT
WSP Canada Inc.

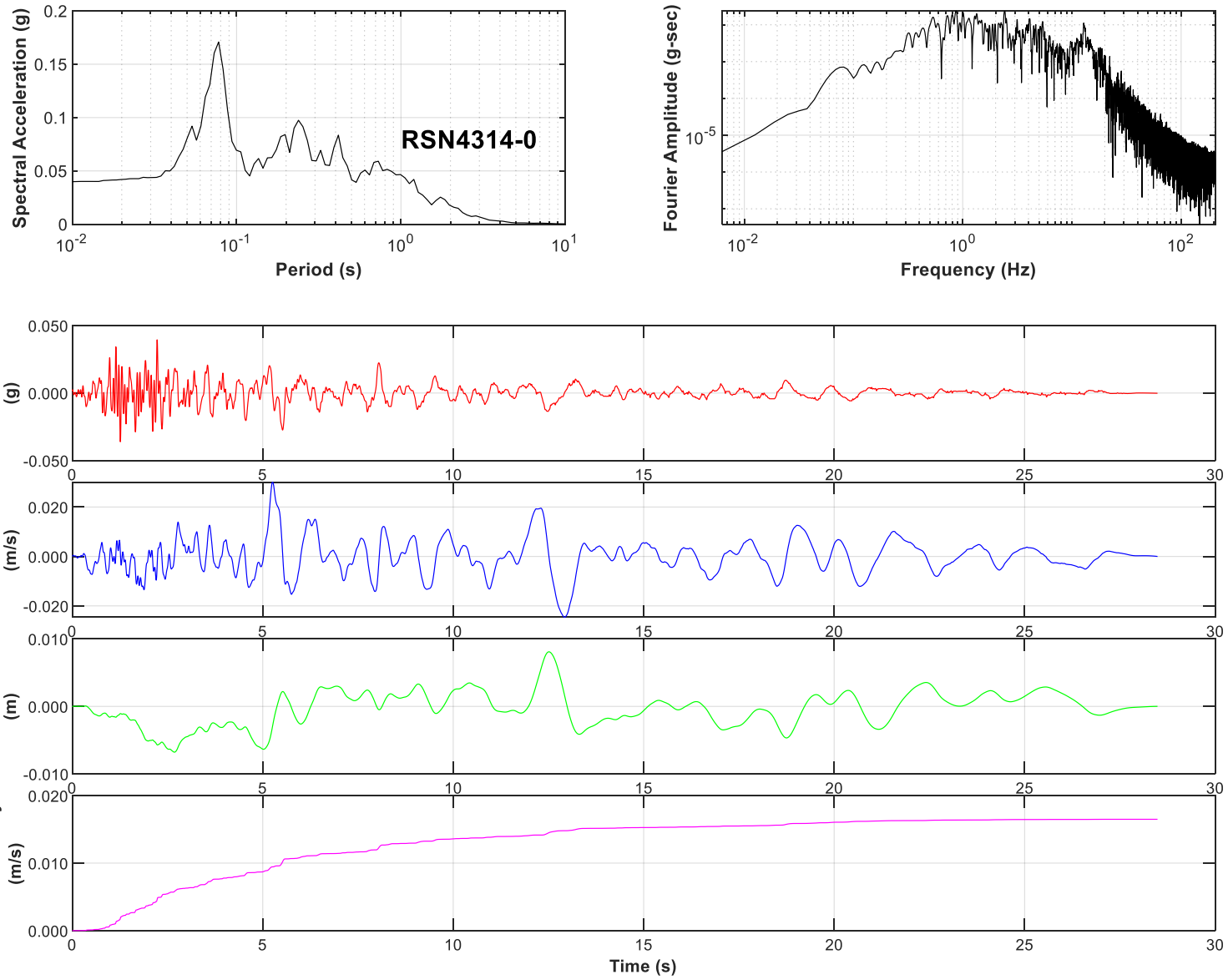
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN3852-E

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**6**



CLIENT
WSP Canada Inc.

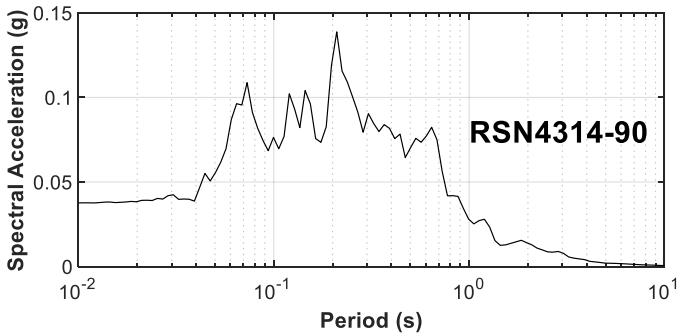
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

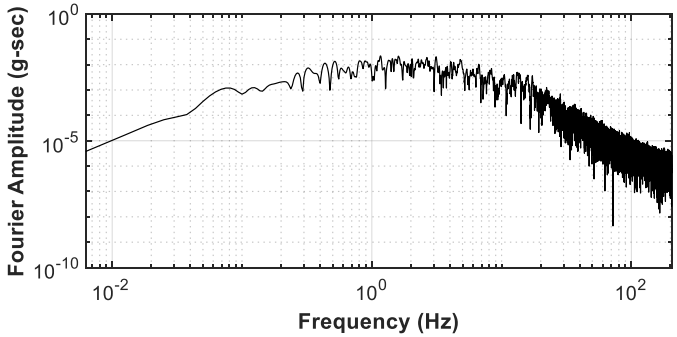
CONSULTANT

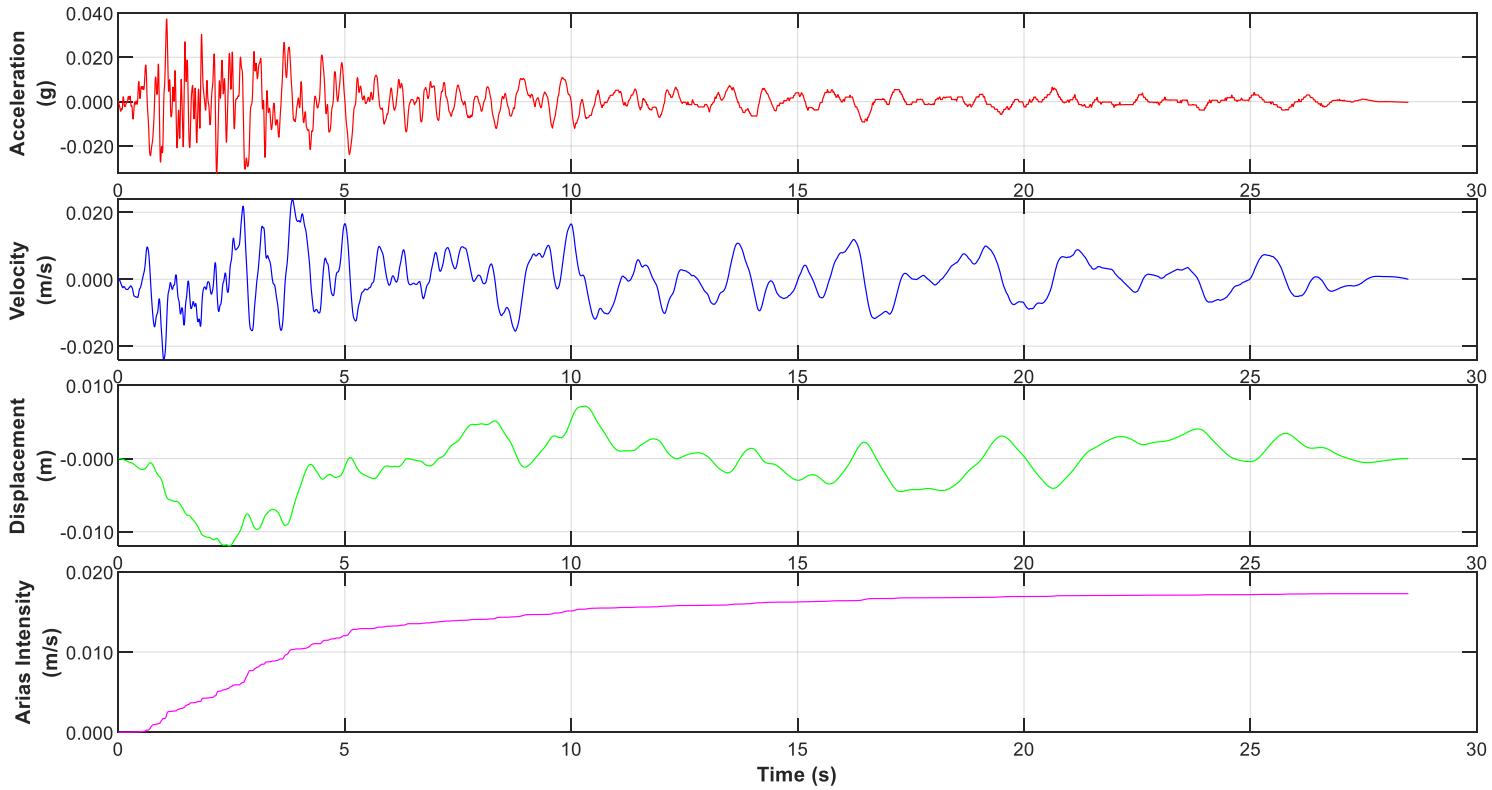
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4314-0

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**7**







CLIENT
WSP Canada Inc.

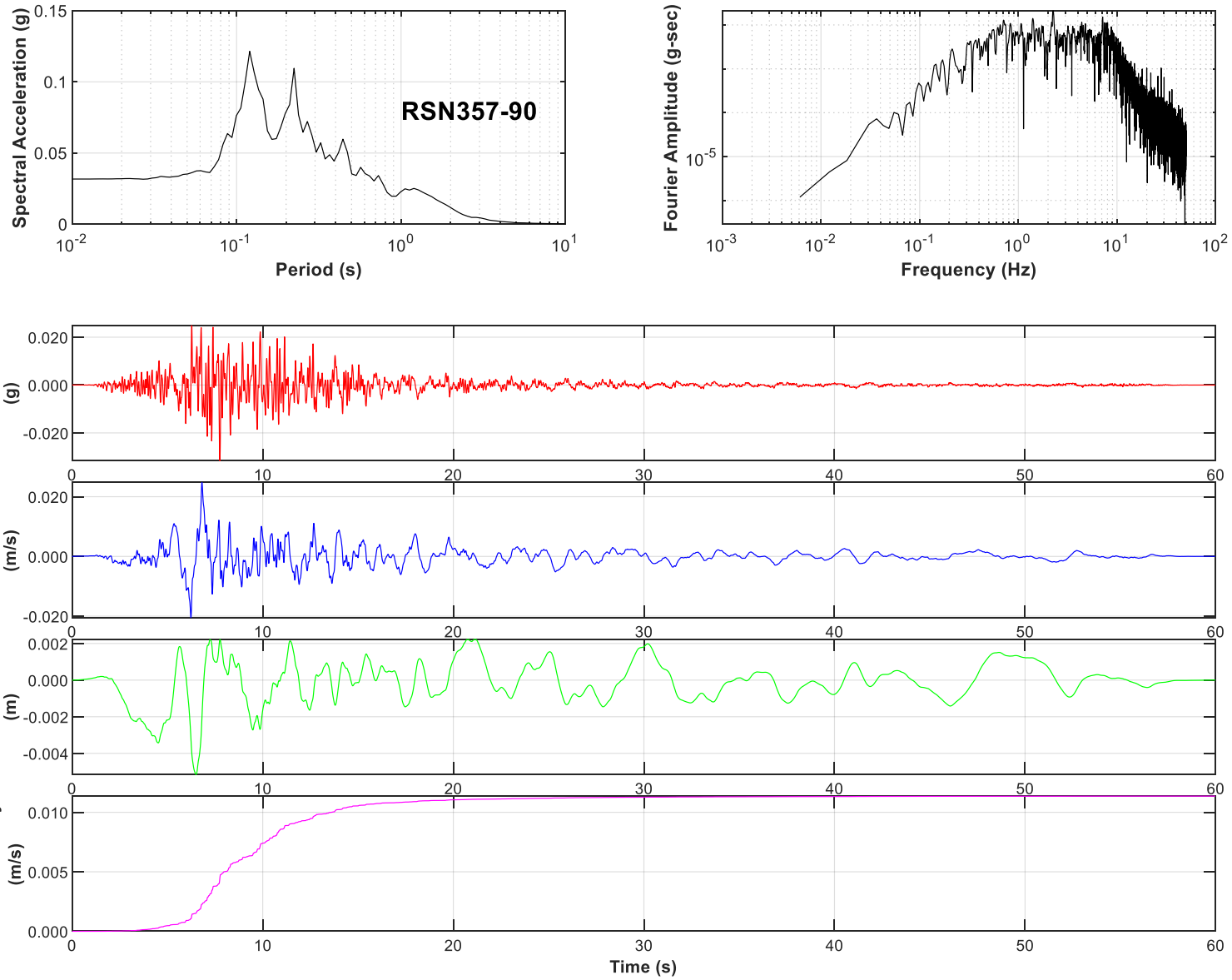
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4314-90

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**8**



CLIENT
WSP Canada Inc.

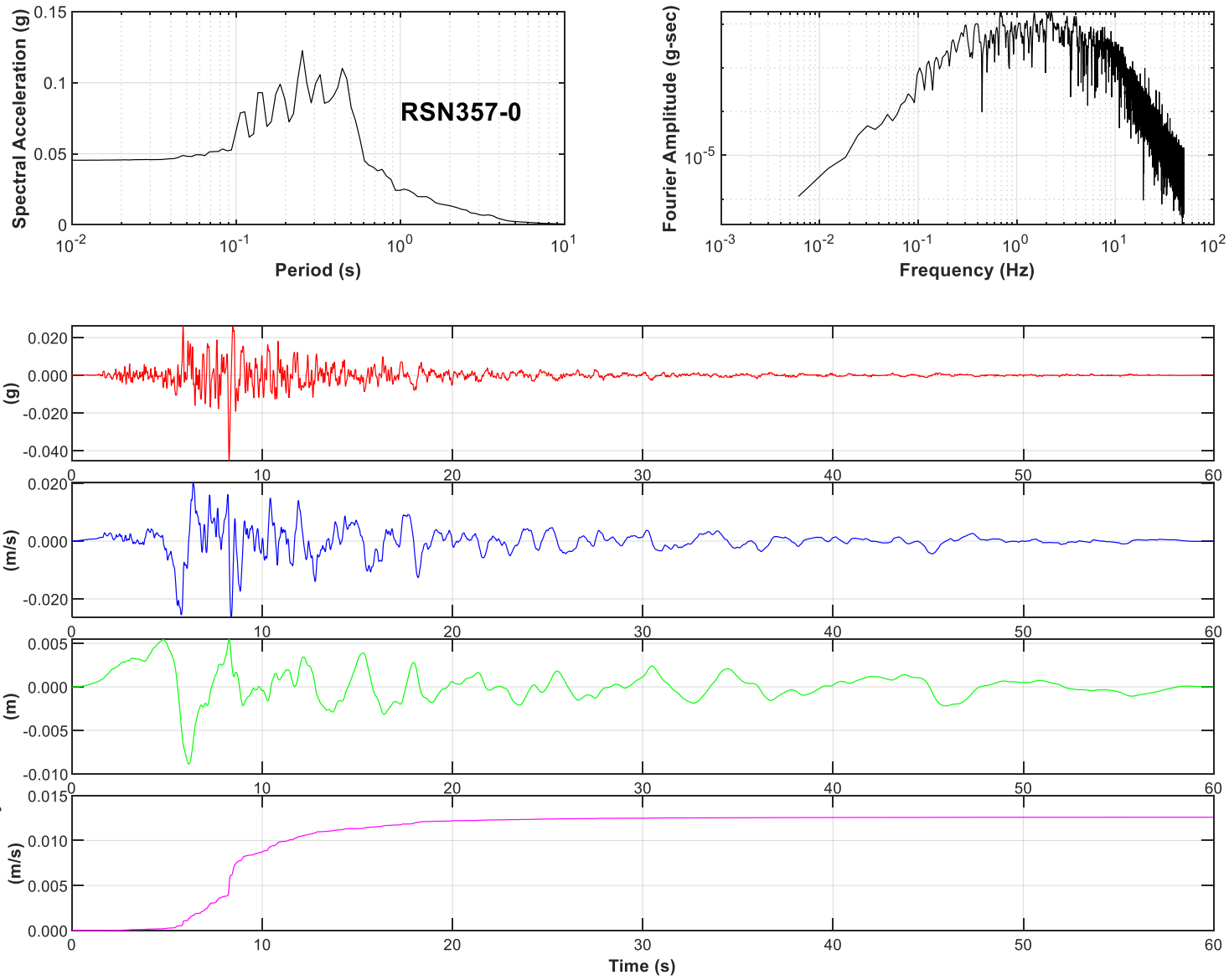
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN357-90

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**9**



CLIENT
WSP Canada Inc.

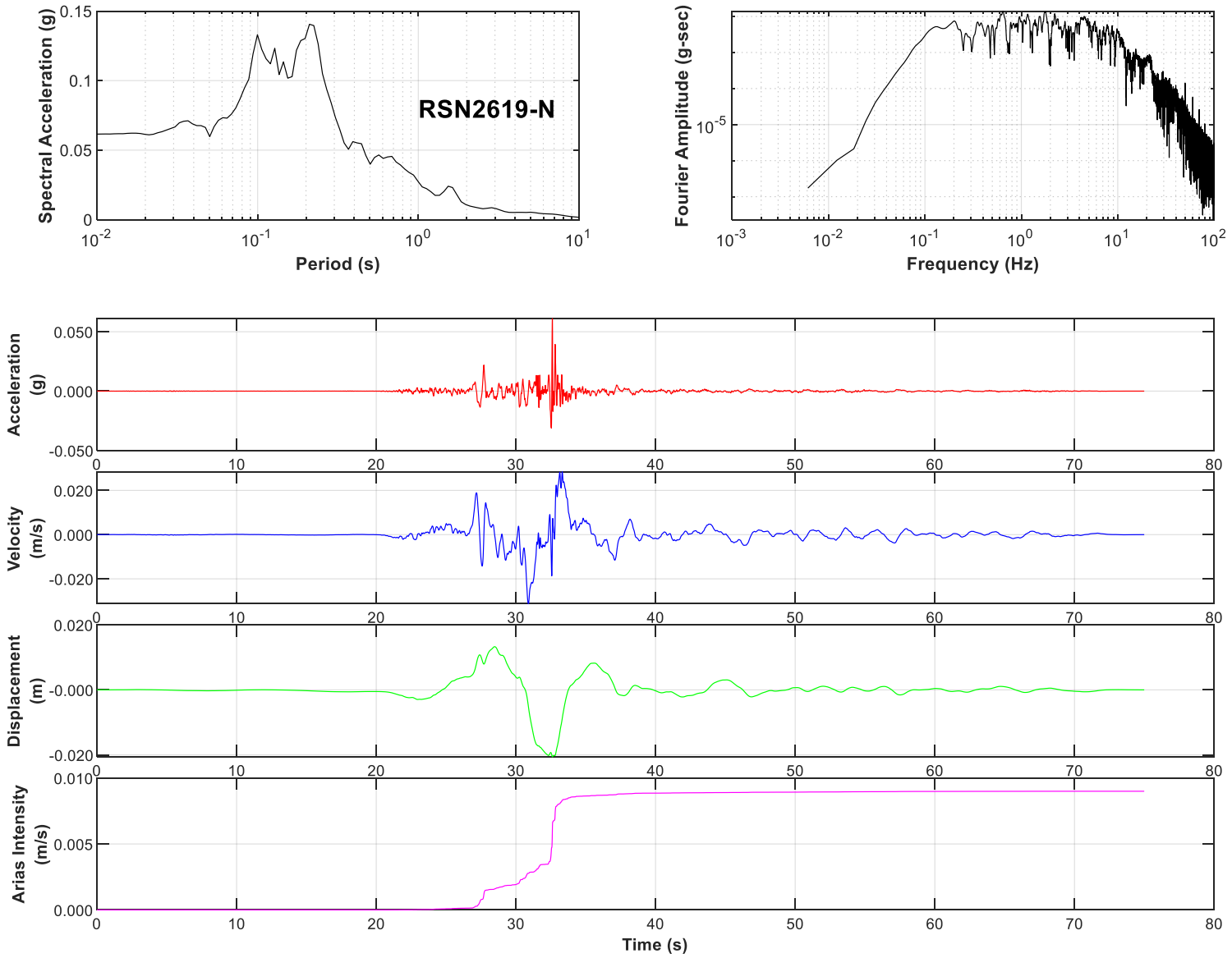
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN357-0

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**10**



CLIENT
WSP Canada Inc.

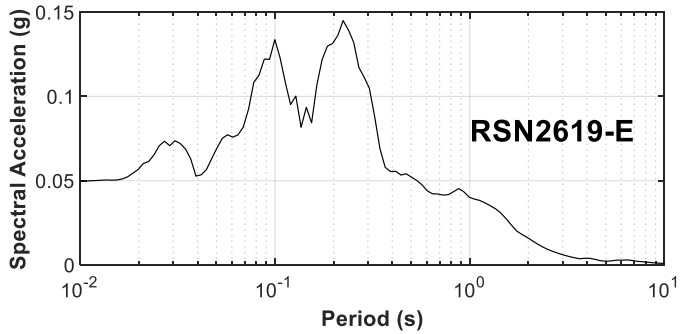
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

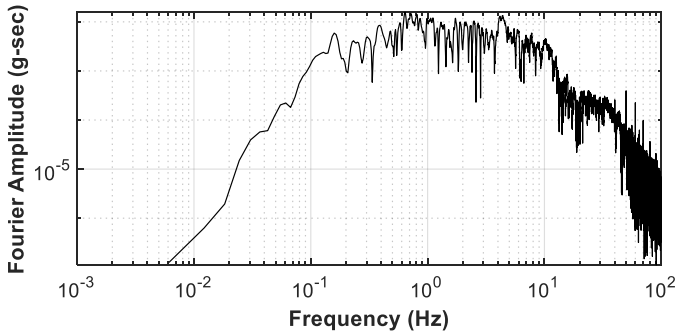
CONSULTANT

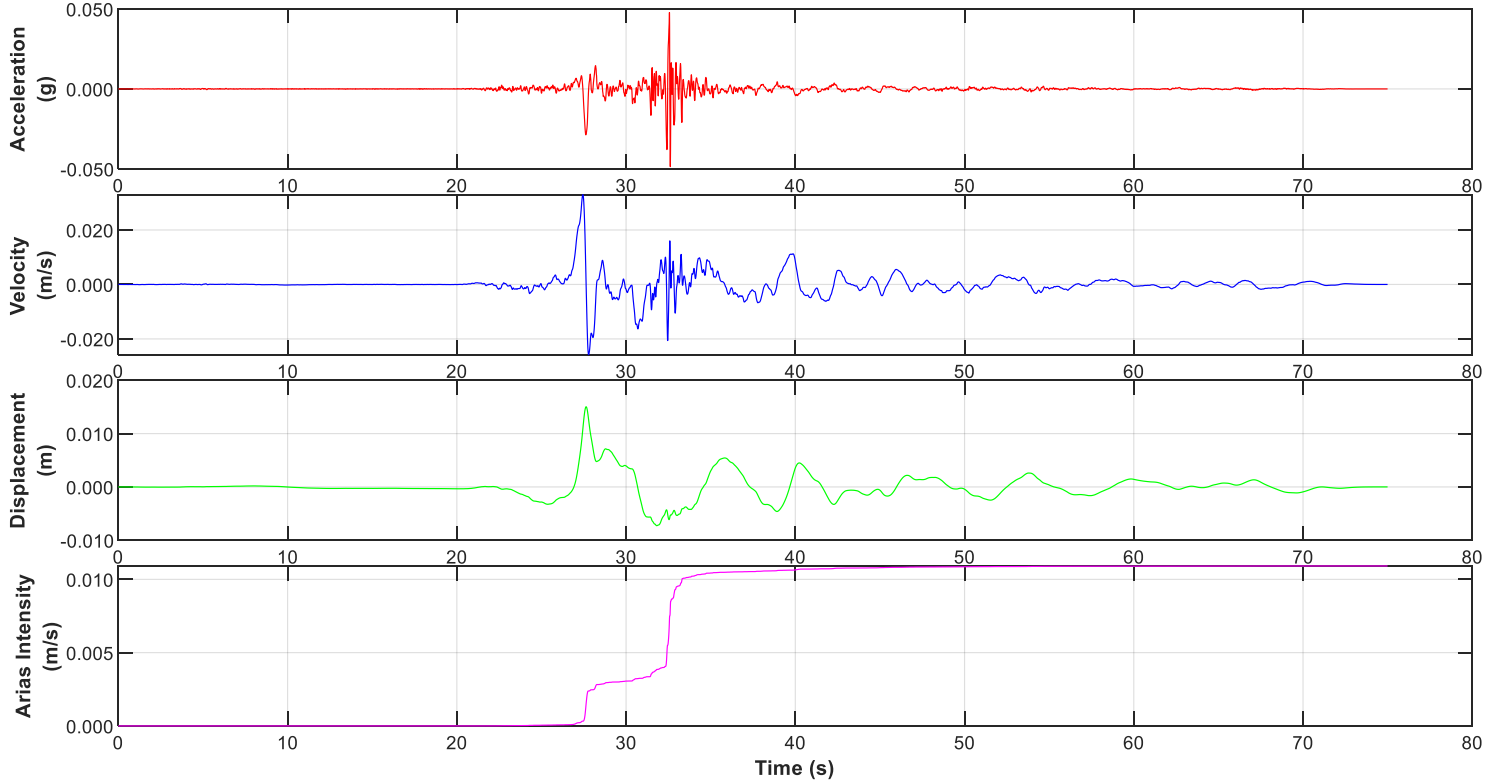
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN2619-N

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**11**







CLIENT
WSP Canada Inc.

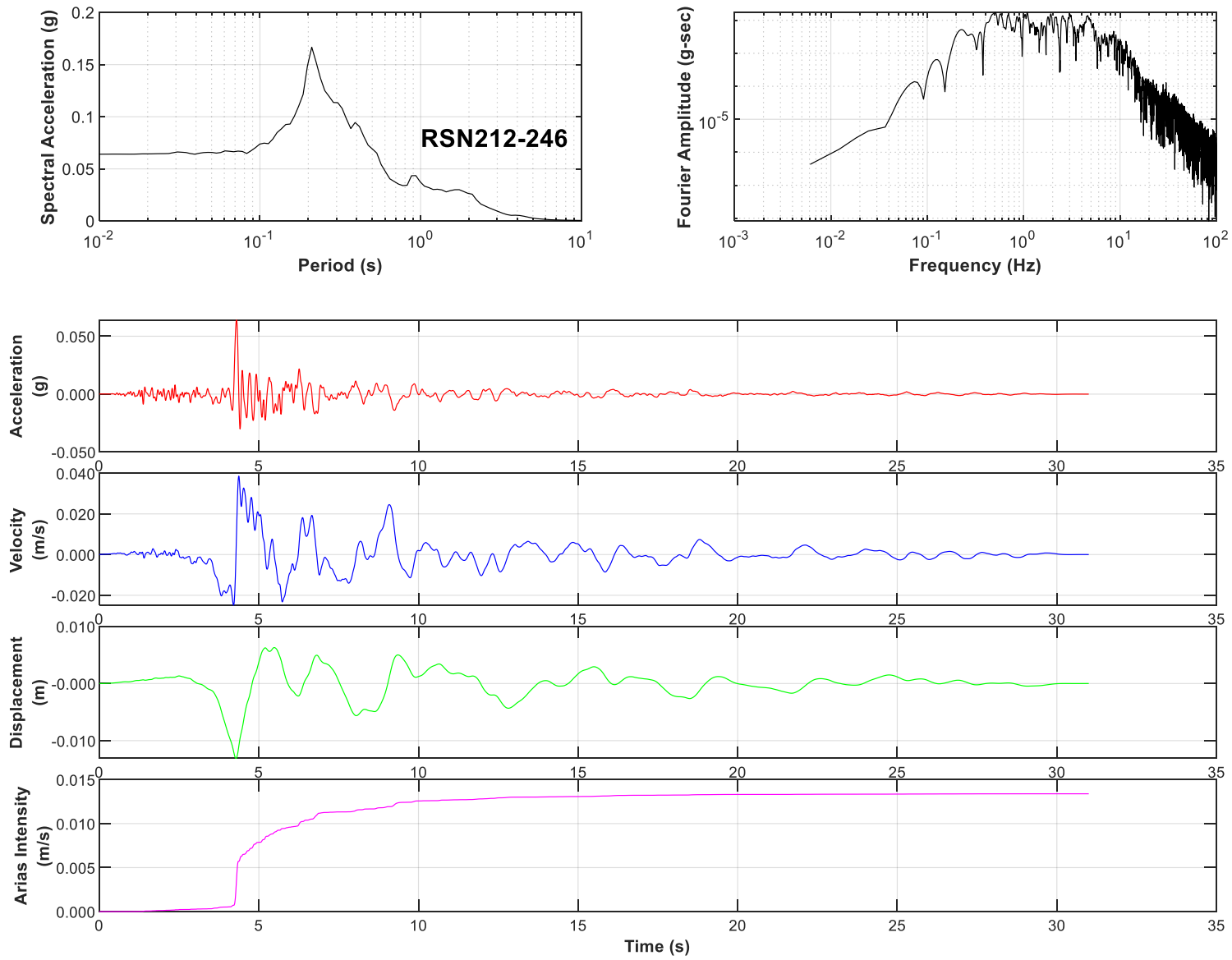
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN2619-E

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**12**



CLIENT
WSP Canada Inc.

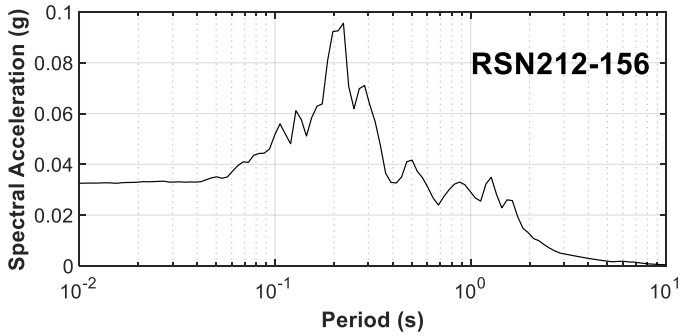
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

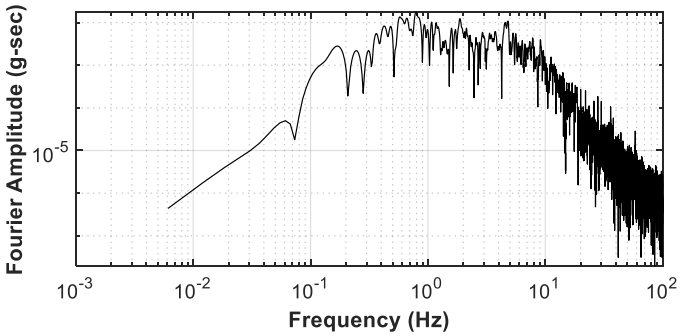
CONSULTANT

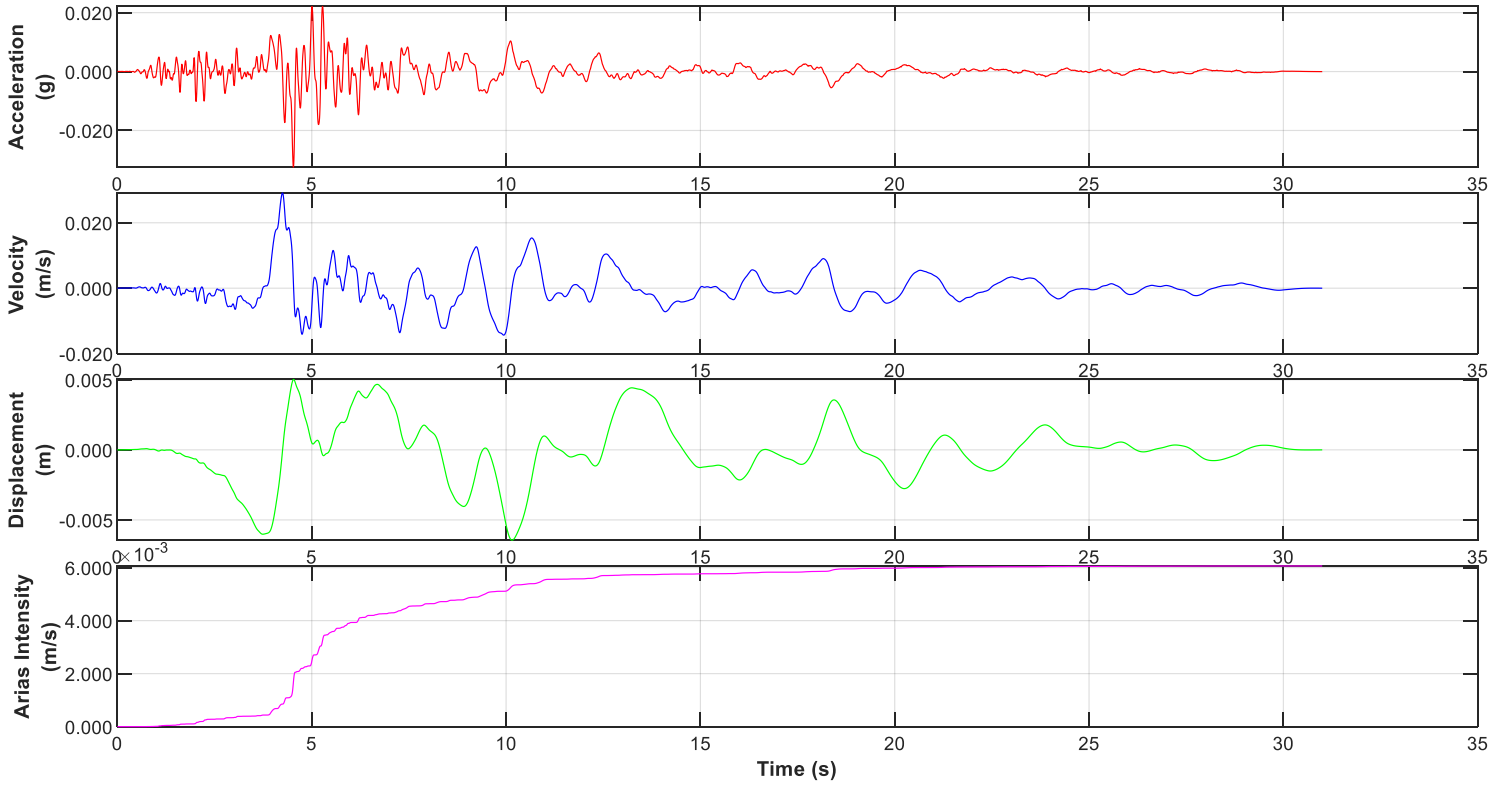
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN212-246

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**13**







CLIENT
WSP Canada Inc.

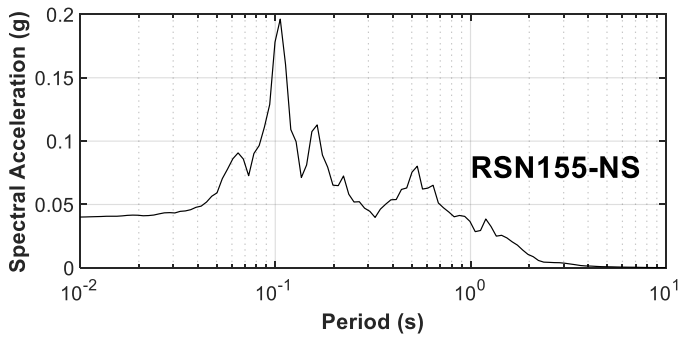
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

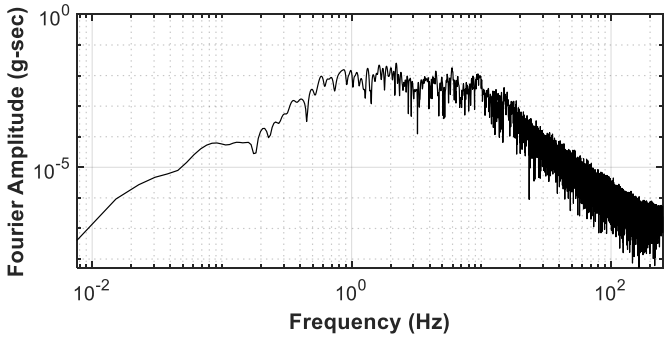
CONSULTANT

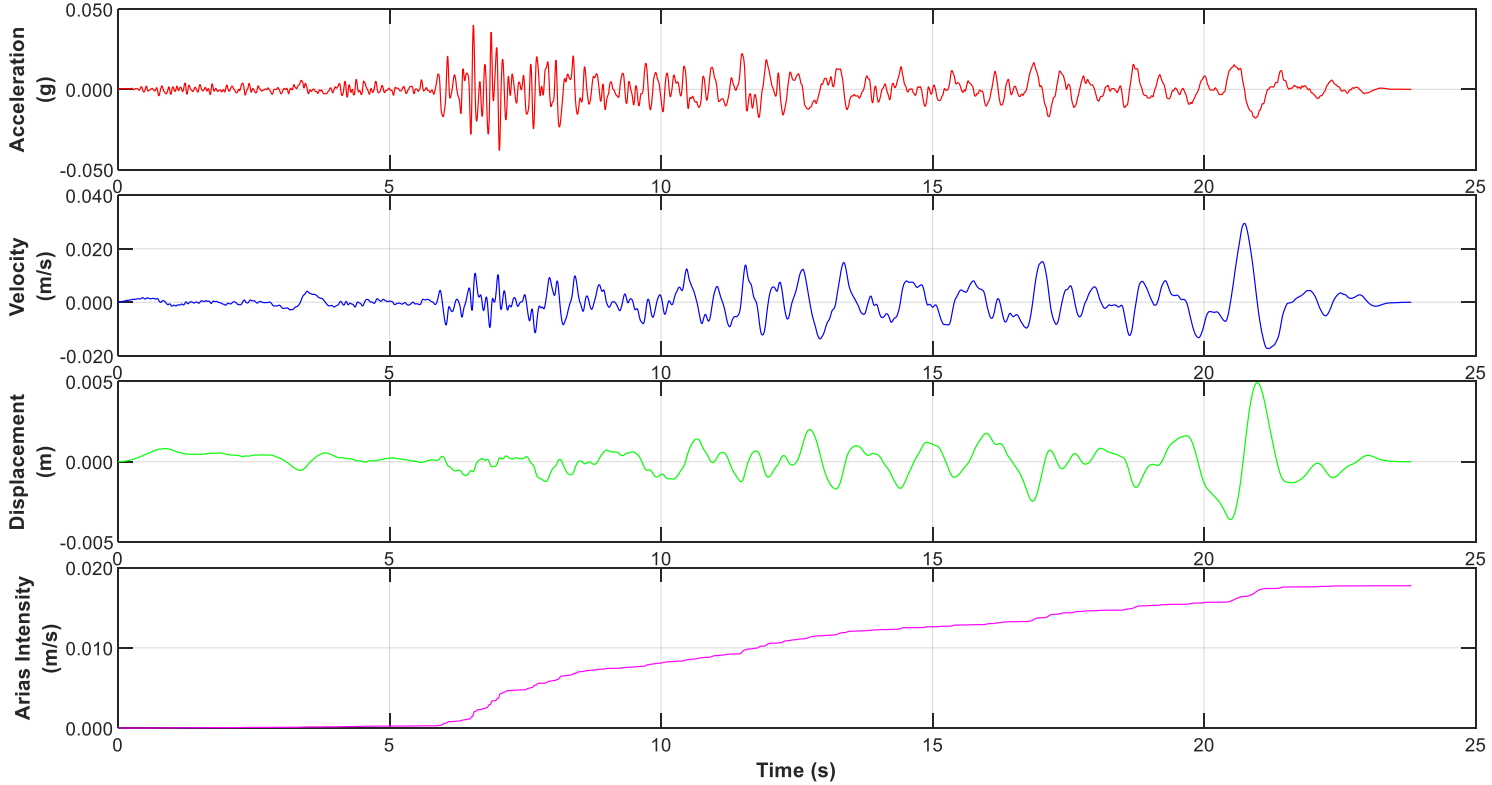
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN212-156

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**14**







CLIENT
WSP Canada Inc.

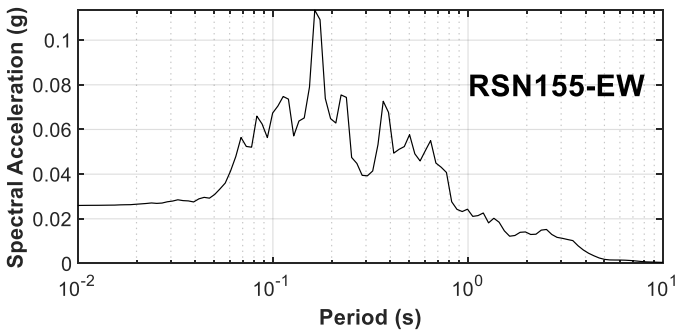
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

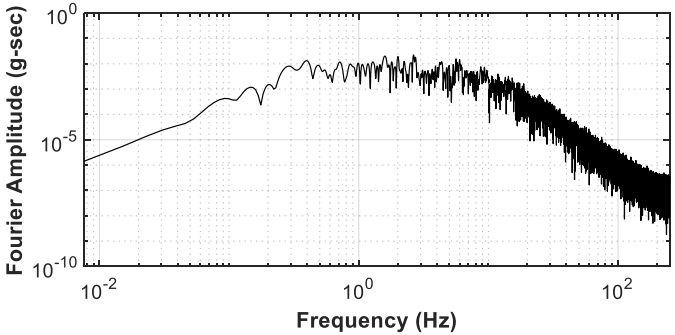
CONSULTANT

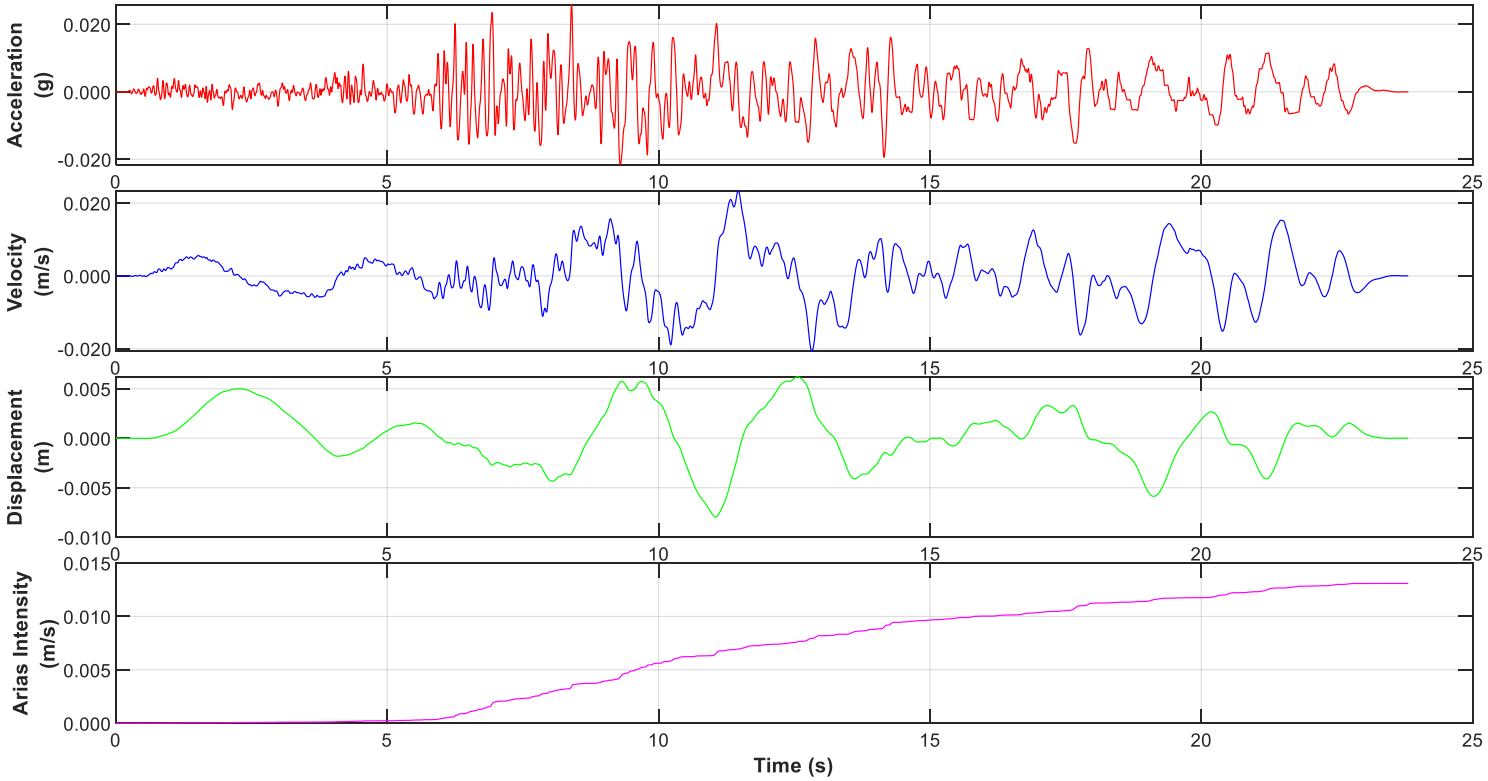
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN155-NS

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**15**







CLIENT
WSP Canada Inc.

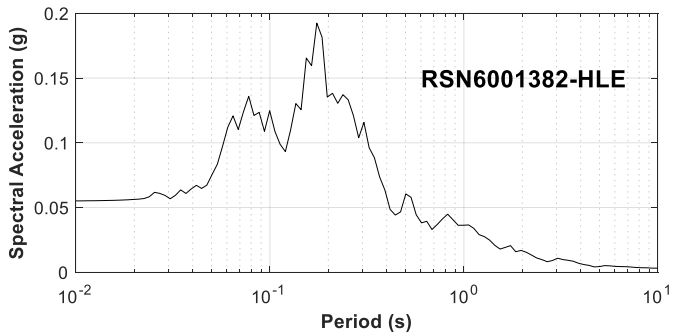
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

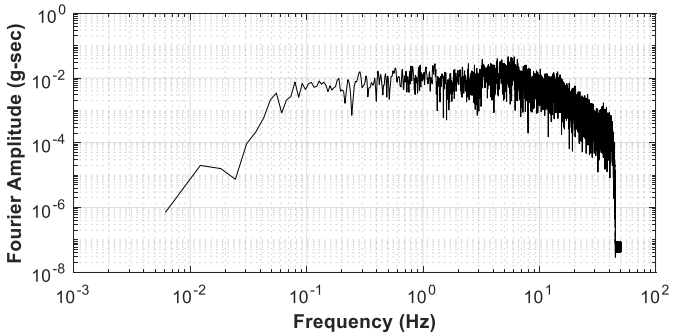
CONSULTANT

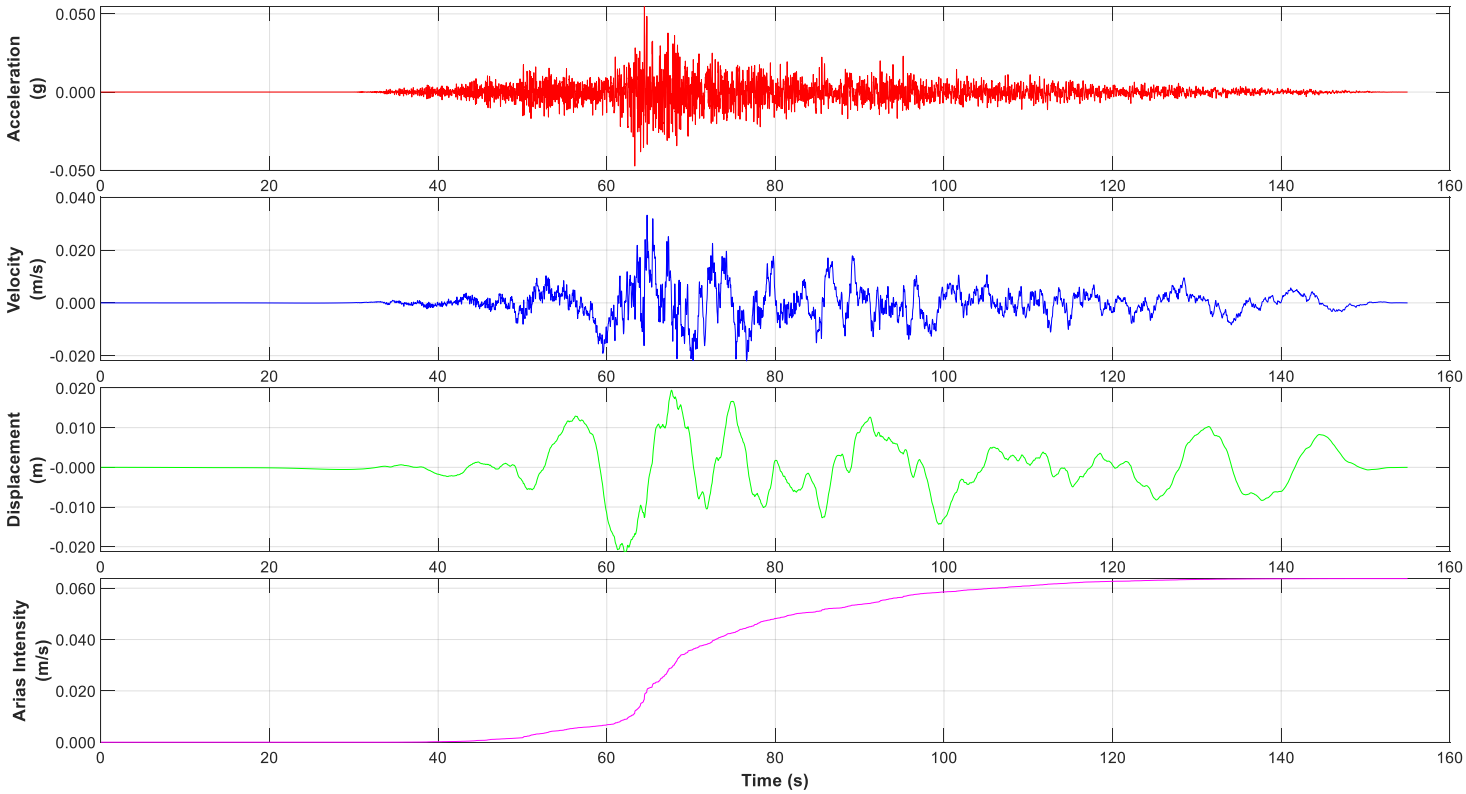
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN155-EW

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**16**







CLIENT
WSP Canada Inc.

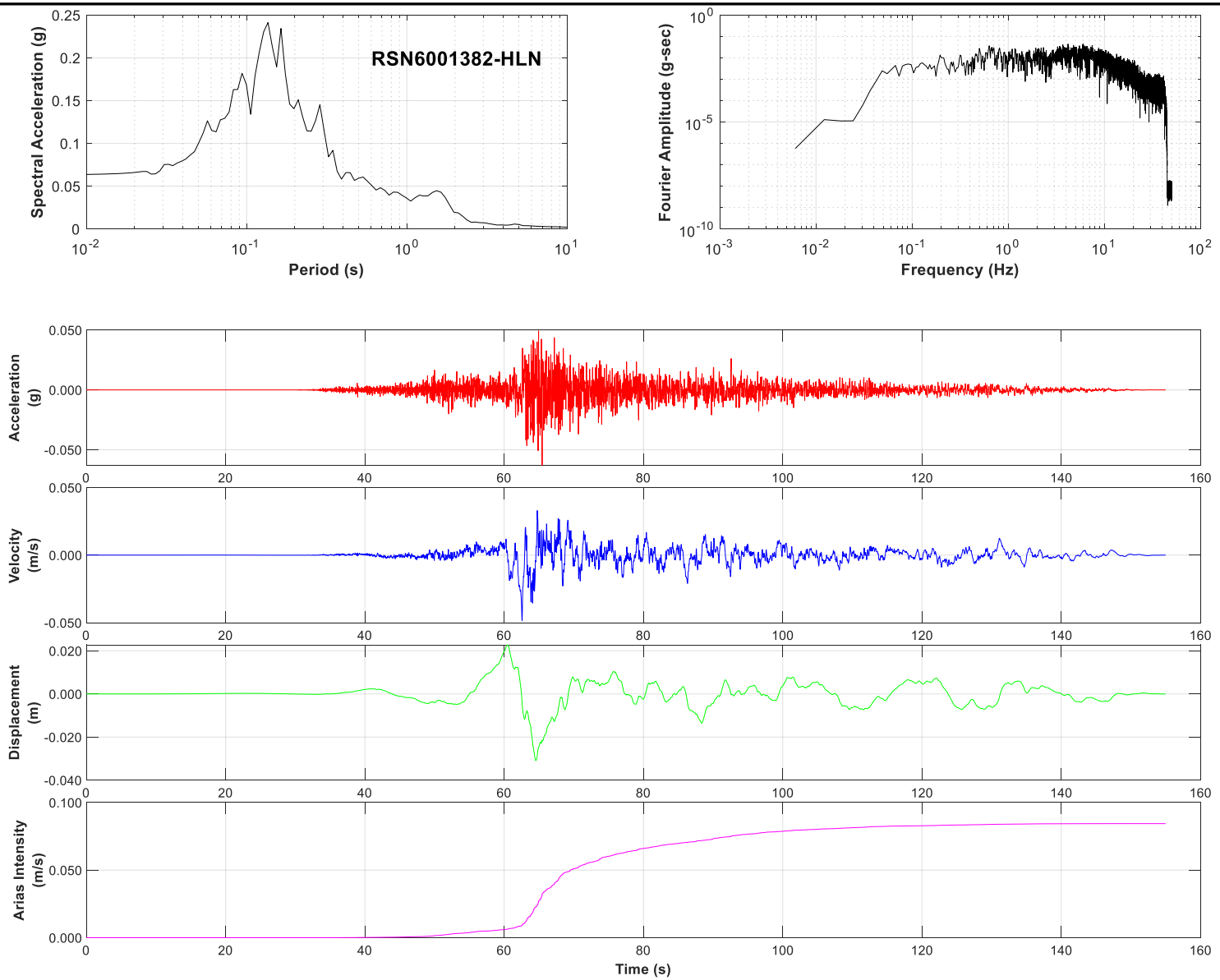
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN6001382-HLE

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**17**



CLIENT
WSP Canada Inc.

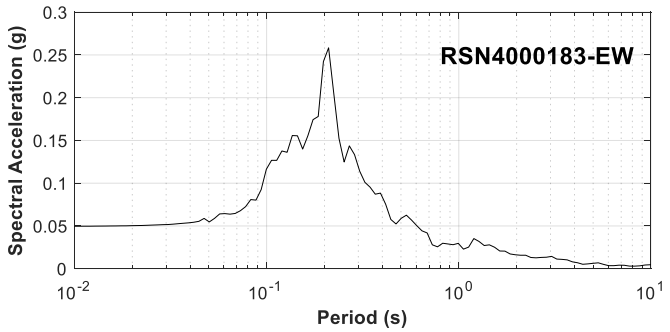
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

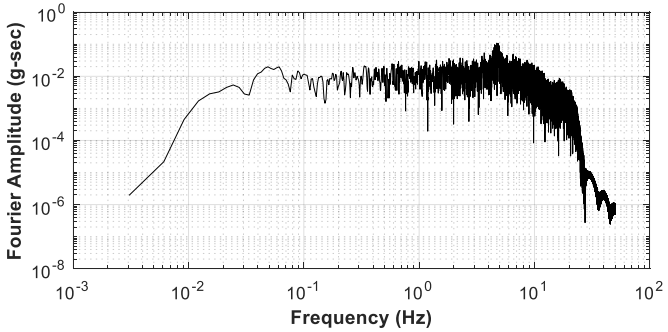
CONSULTANT

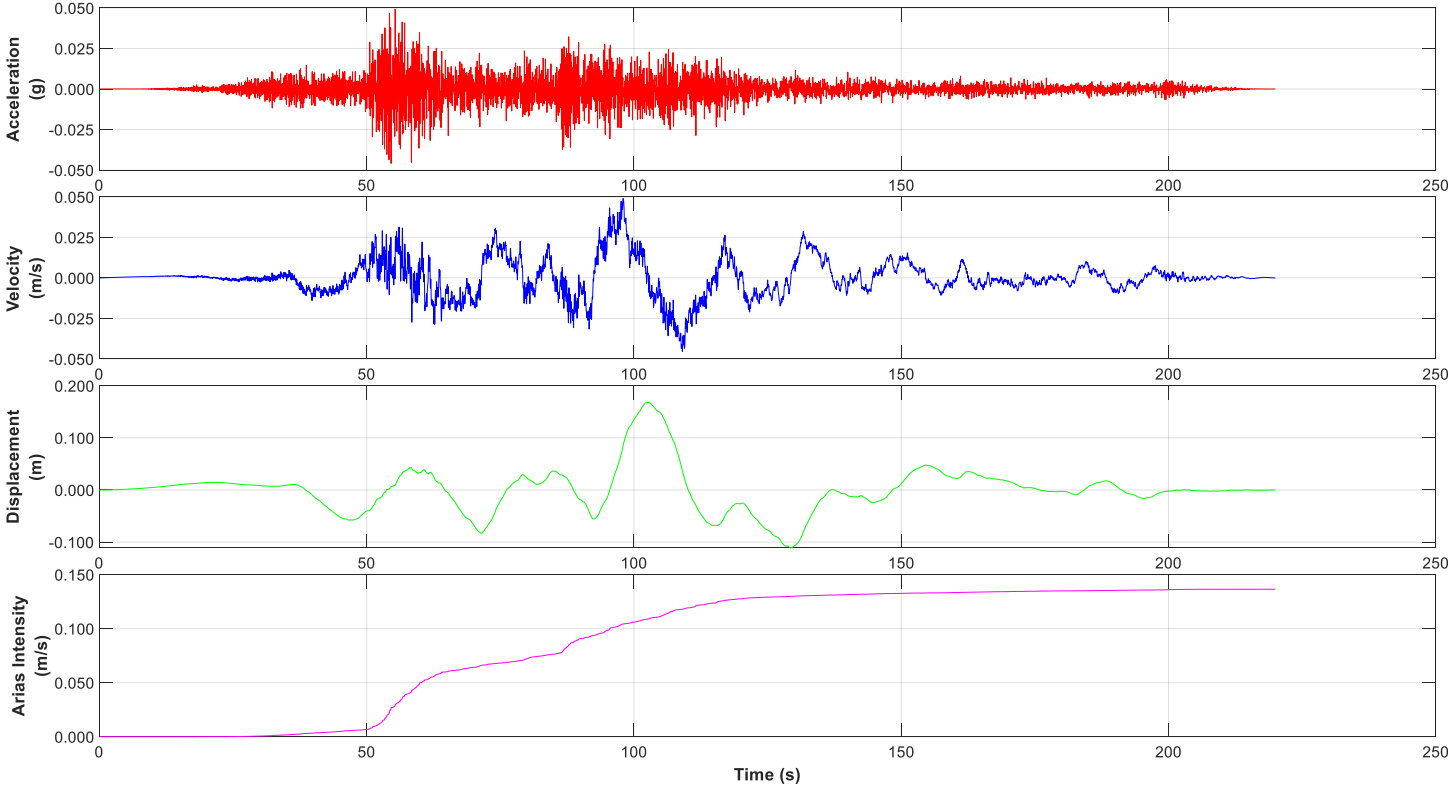
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN6001382-HLN

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**18**







CLIENT
WSP Canada Inc.

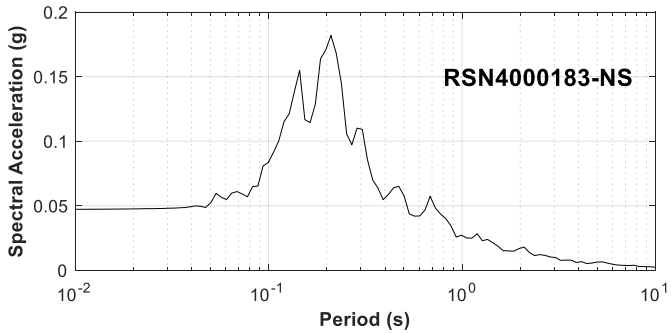
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

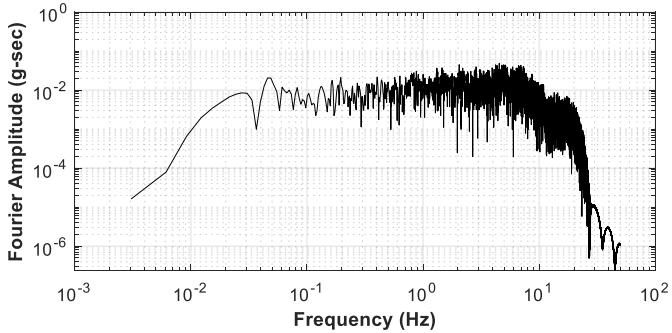
CONSULTANT

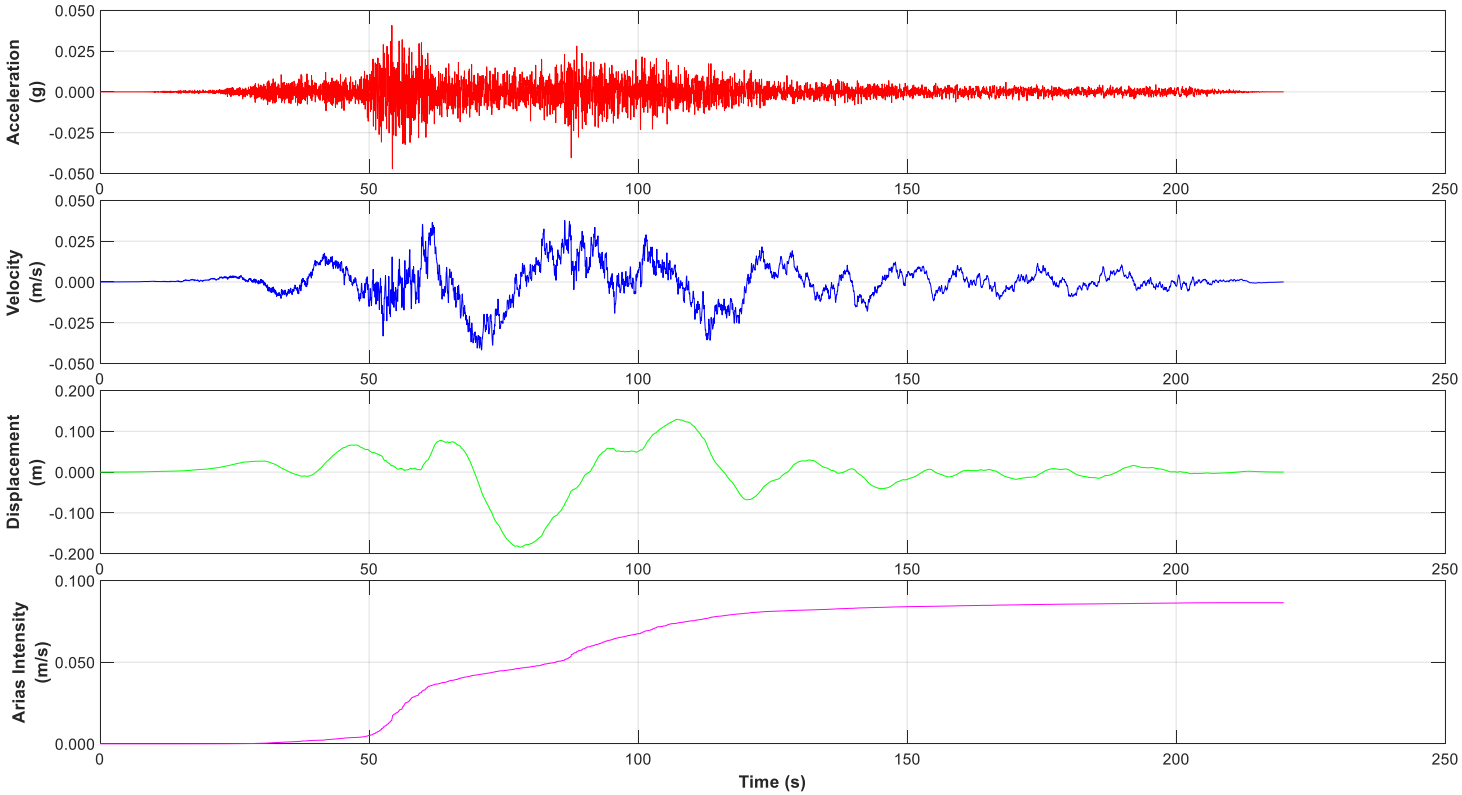
YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4000183-EW

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**19**







CLIENT
WSP Canada Inc.

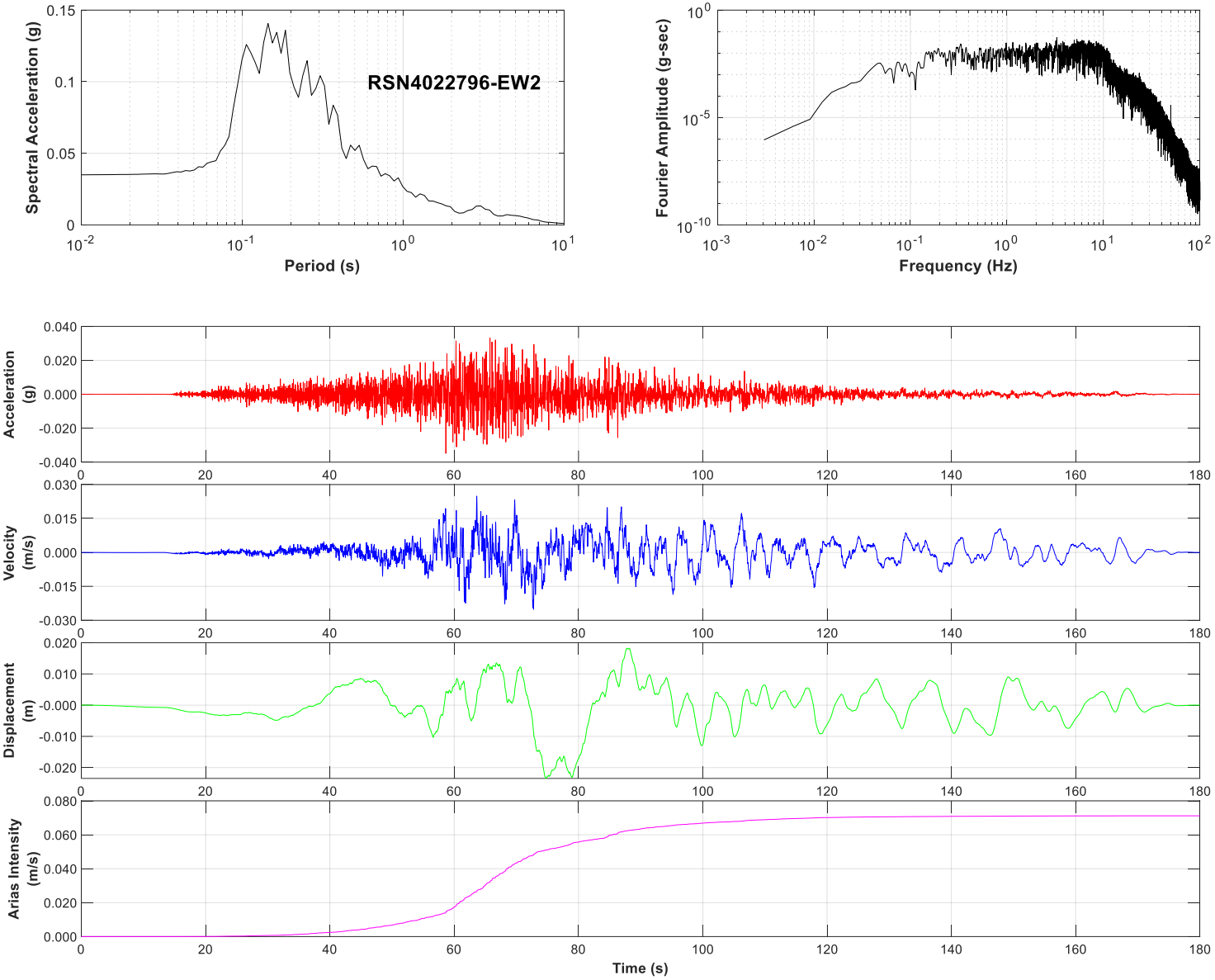
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4000183-NS

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**20**



CLIENT
WSP Canada Inc.

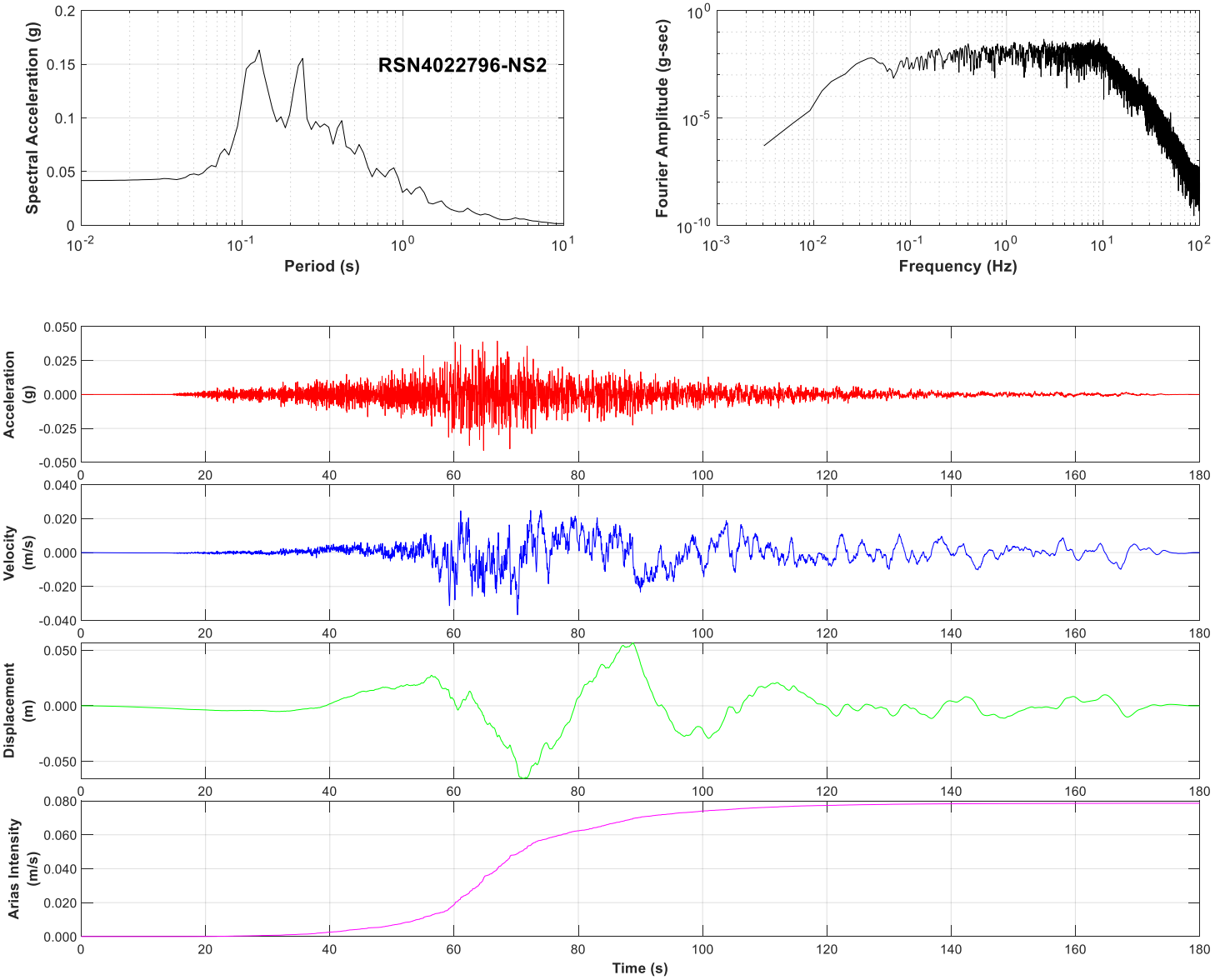
PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4022796-EW2

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**21**



CLIENT
WSP Canada Inc.

PROJECT
SITE-SPECIFIC PROBABILISTIC SEISMIC HAZARD ASSESSMENT
MT POLLEY MINE, BRITISH COLUMBIA

CONSULTANT

YYYY-MM-DD	2022-08-28
PREPARED	MAB
DESIGN	MAB
REVIEW	FL
APPROVED	FL

TITLE
AMPLITUDE SCALING RESULTS FOR RSN4022796-NS2

PROJECT No.	PHASE	Rev.	FIGURE
31404975.000	**300.00**	**01**	**22**

APPENDIX B

Evaluation of the Time-Average Shear-Wave Velocity

Memorandum

To	Alan Hull
Copy	Erin Todd
From	Matt Harris
Office	Auckland
Date	20 June 2022
File/Ref	6-DY039.00
Subject	Mt Polley VSP Reanalysis and V_{S30} Discussion

Introduction

This memo presents the results of reanalysis of VSP data from three boreholes at the tailings storage facility, Mount Polley Mine, BC Canada. The VSP measurements were originally presented in Technical Memorandum 22514095-040-TM-RevA-51344, dated 10 June 2022.

Approach to Reanalysis

Reanalysis focussed on BH15-10, as this had the deepest penetration, and is the only borehole that penetrated 30 m into material classified as bedrock. A number of approaches were taken to determination of V_{S30} for bedrock, using both the original and revised picks of shear-wave arrivals. The results are presented in Table 1 below, listed in order of reducing confidence. Based on a weighted average these velocities, the V_{S30} for bedrock at BH15-10 is considered to be 849 +/- 33 m/s.

Table 1: Summary of V_{S30} of bedrock from reanalysis of BH15-10 VSP data

Approach to Analysis	V_{S30} from Revised picks (m/s)	V_{S30} from Original picks (m/s)
Revised layer model	857	865
Initial layer model	826	877
Single layer method	852	864
1 m Interval Velocities (defined by 3-point regression)	831	850
1 m Interval Velocities (defined by 5-point regression)	864	890
1 m Interval Velocities (defined by successive arrival times)	820	873

The presented velocities were derived as follows:

WSP
Auckland
Level 3 The Westhaven
100 Beaumont St
Auckland 1010, New Zealand
+64 9 355 9500
wsp.com/nz

150 YEARS IN AOTEAROA

- Revised layer model - the velocity of each layer was calculated based on a linear regression of the vertical component of arrival times within that layer. Assignment of layer boundaries revised during reanalysis, based on slope breaks on a plot of arrival time against depth. V_{S30} calculated as the traveltime-weighted average shear wave velocity from 31.8 m to 61.8 m.
- Initial layer model – As above, without reassignment of layer boundaries.
- Single layer method - An estimate of V_{S30} obtained by assuming a single "layer" over 30 metres from top of bedrock. Based on picks at 31.8 m and 62.5 m depth.
- 1 m Interval Velocities (defined by 3-point regression) - traveltime-weighted average shear wave velocity from 31.8 m to 61.8 m, using 1 m layers with layer velocities derived from a 3-point linear regression of the slope of vertical traveltime data.
- 1 m Interval Velocities (defined by 5-point regression) - traveltime-weighted average shear wave velocity from 31.8 m to 61.8 m, using 1 m layers with layer velocities derived from a 5-point linear regression of the slope of vertical traveltime data.
- 1 m Interval Velocities (defined by successive arrival times) - traveltime-weighted average shear wave velocity from 31.8 m to 61.8 m, using 1 m layers with layer velocities derived from successive shear-wave arrival picks.

The shear-wave arrivals at 31.8 m and 62.5 m in BH15-10 are well defined. These are useful for assessing the travel time of the shear wave through the upper 30 m of material defined as bedrock, using the 'single layer' method of Hunter and Crow (2012). To assess the likely minimum and maximum V_{S30} using this method, both arrivals were picked as early and late as considered reasonable, and results compared. Based on this approach, estimated extreme minimum and maximum V_{S30} for bedrock at this borehole location are 706 m/s and 981 m/s, respectively.

Summary of Results

At borehole BH15-10, which penetrated into bedrock, V_{S30} is considered to be 849 +/- 33 m/s based on reanalysis of available VSP data. Extreme minimum and maximum V_{S30} for bedrock at BH15-10 are estimated at 706 m/s and 981 m/s, respectively.

Borehole BH15-18 only penetrated 6 m into bedrock, though showed good data quality; V_S of the upper bedrock here is considered to be 523 +/- 59 m/s. For comparison, V_S of the upper 6 m of bedrock at BH15-10 is considered to be 643 +/- 51 m/s.

At BH15-06, signal quality is poor, though estimated V_S values for the upper 10 m to 15 m of bedrock were made as roughly 350 m/s to 600 m/s.

Considerations/Data Quality

The data quality is rather variable between the three boreholes, which influences the confidence that can be attributed to each. The signal quality is best at BH15-18, though penetration into bedrock here is only around 6 m.

Signal quality at BH15-10 is considered reasonably good, and worthy of thorough analysis as this borehole penetrates over 30 m into material identified as bedrock.

At BH15-06, signal quality is poor and clear shear-wave arrivals are not able to be identified with confidence at most traces. Any velocities determined here should be treated with caution. Detailed reanalysis of this borehole has not been performed. The high V_S (up to 2820 m/s) initially reported for this borehole seems to be influenced by data quality. Single layer estimates within bedrock suggest V_S values for the upper 10 m to 15 m of bedrock here may be roughly 350 m/s to 600 m/s.

The interpretation of bedrock depths has not been changed. It should be appreciated though that the contrast between bedrock and overlying material at the site is subtle and has been noted as "pretty variable and hard to define".

During the reanalysis, discussed the data and data quality with Rob Luzitano, who performed the initial data analysis. He noted that the boreholes that were used for testing were originally installed in 2015, for use with inclinometers. This meant they were cased with PVC of a suitable diameter, though the approach taken to grouting was unknown. There may therefore be some areas where poor bonding between casing and grout has impacted data quality.

Data was not acquired at every ~1 m (3 foot) interval, as the crew on site were under time pressure during acquisition. At BH15-06 there is 3.5 m below the deepest two recorded intervals. The arrival on the lowest record is indistinct, so additional data here would have been useful.

Particularly high velocities are noted at shallow depth at BH15-06. While not repicked, note that these velocities are based on a small number of ambiguous picks and therefore considered unreliable.

Closure

I trust that this memo meets your needs. If you have any questions regarding the material contained within, please contact the undersigned.

Prepared by:



Matt Harris

Senior Geophysicist

Geophysical Services Limitation Statement

WSP geophysical services are conducted in a manner consistent with the level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions and subject to the time limits, financial and physical constraints applicable to the services.

The inherent uncertainty in geophysical results should be considered during the interpretation process. To help reduce uncertainties in the interpretation, the interpreter will typically make use of prior knowledge and any external complementary datasets, such as existing geologic information, drilling data, the location of underground services, borehole geophysical logs and other geophysical datasets.

References

Golder Associates Ltd. 2022. Bedrock Shear-Wave Velocity Measurements at Three Locations along the Tailings Storage Facility at Mt. Polley Mine, BC. Technical Memorandum (22514095-040-TM-RevA-51344, dated 10 June 2022).

Hunter, J.A. and Crow, H.L. (ed.), 2012. Shear Wave Velocity Measurement Guidelines for Canadian Seismic Site Characterization in Soil and Rock; Geological Survey of Canada, Open File 7078, 227 p. doi:10.4095/291753

APPENDIX C

Geotechnical Data

Table C1: Summary of Boreholes

Year	Consultant	Borehole ID	Drill Method	General Location Description	Coordinates		Ground Elevation (m)	Azimuth (degrees)	Inclination (degrees)	Completion Depth (m)	Bedrock Depth (m)	Geotechnical Instrumentation																Record of Borehole Log in Database?	Location on Figure 01?	Location on Figure 02?
												VWP 1				VWP 2				VWP 3				Slope Inclinometer		Shape Accel Array			
					Northing (m)	Easting (m)						Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Collar Elevation (m)	Base Elevation (m)	Sensor Top Elevation (m)	Sensor Base Elevation (m)	SAA ID	Serial No.			
1989	Knight Piesold	MP89-229	Tricone Rotary	Tailings Basin	5,818,999.58	594,945.89	929.10	0	-90	121.92	22.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1989	Knight Piesold	MP89-230	Tricone Rotary	Tailings Basin	5,819,465.36	594,932.62	929.10	0	-90	73.15	19.81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1989	Knight Piesold	MP89-231	Tricone Rotary	Corner 1 Embankment	5,819,929.90	595,178.85	927.20	0	-90	121.92	32.00	117.3	809.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
1989	Knight Piesold	MP89-232	Tricone Rotary	Tailings Basin	5,818,944.44	595,471.80	919.40	0	-90	121.9	25.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1989	Knight Piesold	MP89-233	Tricone Rotary	Perimeter Embankment	5,819,358.58	596,015.13	933.90	0	-90	121.9	36.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1989	Knight Piesold	MP89-234	Tricone Rotary	Main Embankment	5,818,369.54	595,625.93	909.30	0	-90	121.9	29.0	82.3	827.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1989	Knight Piesold	MP89-235	Tricone Rotary	South Embankment	5,818,356.15	595,016.85	946.20	0	-90	121.9	4.6	118.9	827.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1989	Knight Piesold	MP89-236	Tricone Rotary	Tailings Basin	5,818,961.71	594,395.20	949.00	0	-90	115.8	7.6	115.8	833.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	R.E. Graham Engineering	96-A1	Solid / Hollow Stem Auger	Main Embankment	5,818,482.71	595,598.14	912.67	0	-90	15.4	-	8.9	903.77	A2-PE2-01	-	2.8	909.87	A2-PE2-02	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	R.E. Graham Engineering	96-B1a	Solid Stem Auger	Main Embankment	5,818,628.27	595,787.88	916.97	0	-90	16.5	-	15.2	901.77	B2-PE2-01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	R.E. Graham Engineering	96-B1b	Solid / Hollow Stem Auger	Main Embankment	5,818,627.47	595,790.66	916.99	0	-90	9.1	-	7.4	909.59	B2-PE2-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	R.E. Graham Engineering	96-C1	Solid / Hollow Stem Auger	Main Embankment	5,818,392.41	595,478.24	915.71	0	-90	15.4	-	8.1	907.61	C2-PE2-01	-	5.1	910.61	C2-PE2-02	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-1A	Air Rotary	Corner 1 Embankment	5,819,939.06	595,415.82	927.89	0	-90	61.3	47.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
1996	Knight Piesold	GW96-1B	Air Rotary	Corner 1 Embankment	5,819,935.22	595,416.16	927.81	0	-90	42.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
1996	Knight Piesold	GW96-2A	Air Rotary	Perimeter Embankment	5,819,449.92	596,065.40	931.42	0	-90	61.6	52.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-2B	Air Rotary	Perimeter Embankment	5,819,447.08	596,074.73	931.42	0	-90	35.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-3A	Air Rotary	Main Embankment	5,818,308.97	595,768.75	912.06	0	-90	54.9	35.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-3B	Air Rotary	Main Embankment	5,818,306.52	595,765.16	912.06	0	-90	20.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-4A	Air Rotary	South Embankment	5,818,164.58	595,147.94	940.56	0	-90	25.0	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-4B	Air Rotary	South Embankment	5,818,162.87	595,151.26	940.46	0	-90	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-5A	Air Rotary	West side of TSF	5,819,626.68	594,330.34	973.55	0	-90	25.5	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-5B	Air Rotary	West side of TSF	5,819,629.64	594,329.79	973.44	0	-90	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	GW96-9	Air Rotary	Main Embankment	5,818,277.14	595,503.89	916.18	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	PRW96-1	Solid Stem Auger	Main Embankment	5,818,643.37	595,825.84	919.50	0	-90	22.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	PRW96-2	Solid Stem Auger	Main Embankment	5,818,541.21	595,686.74	913.00	0	-90	16.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	PRW96-3	Solid Stem Auger	Main Embankment	5,818,439.06	595,547.63	915.00	0	-90	9.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1996	Knight Piesold	PRW96-4	Solid Stem Auger	Main Embankment	5,818,356.46	595,443.30	918.00	0	-90	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
1997	Knight Piesold	DH97-BA-F5	-	Borrow Area No. 1	5,818,982.15	595,826.54	-	0	-90	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-F8	-	Borrow Area No. 1	5,819,095.63	595,728.43	-	0	-90	15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-F10	-	Borrow Area No. 1	5,819,173.84	595,662.79	-	0	-90	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-F13	-	Borrow Area No. 1	5,819,286.97	595,562.93	-	0	-90	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-F16	-	Borrow Area No. 1	5,819,399.40	595,465.86	-	0	-90	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-G5	-	Borrow Area No. 1	5,819,014.63	595,862.51	-	0	-90	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-G6	-	Borrow Area No. 1	5,819,052.34	595,831.08	-	0	-90	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-G7	-	Borrow Area No. 1	5,819,091.44	595,797.56	-	0	-90	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-G8	-	Borrow Area No. 1	5,819,129.85	595,765.44	-	0	-90	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H5	-	Borrow Area No. 1	5,819,048.15	595,900.92	-	0	-90	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H7	-	Borrow Area No. 1	5,819,125.66	595,834.57	-	0	-90	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H8	-	Borrow Area No. 1	5,819,164.07	595,801.75	-	0	-90	12.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H10	-	Borrow Area No. 1	5,819,240.18	595,735.41	-	0	-90	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H12	-	Borrow Area No. 1	5,819,316.30	595,669.77	-	0	-90	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H13	-	Borrow Area No. 1	5,819,354.01	595,636.95	-	0	-90	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H14	-	Borrow Area No. 1	5,819,391.02	595,605.52	-	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H15	-	Borrow Area No. 1	5,819,429.43	595,572.00	-	0	-90	14.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-H16	-	Borrow Area No. 1	5,819,467.14	595,539.18	-	0	-90	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-I5	-	Borrow Area No. 1	5,819,082.36	595,937.93	-	0	-90	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-I6	-	Borrow Area No. 1	5,819,120.77	595,905.11	-	0	-90	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-I7	-	Borrow Area No. 1	5,819,158.48	595,871.59	-	0	-90	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA-I8	-	Borrow Area No. 1	5,819,195.49	595,838.07	-	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1997	Knight Piesold	DH97-BA2-B1	-	Borrow Area No. 2	5,818,204.66	596,430.29	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-B2	-	Borrow Area No. 2	5,818,282.11	596,369.03	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-B3	-	Borrow Area No. 2	5,818,361.29	596,307.18	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-B4	-	Borrow Area No. 2	5,818,439.32	596,245.34	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-B5	-	Borrow Area No. 2	5,818,516.19	596,184.08	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-C1	-	Borrow Area No. 2	5,818,264.19	596,511.21	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-C2	-	Borrow Area No. 2	5,818,341.64	596,449.36	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-C3	-	Borrow Area No. 2	5,818,420.24	596,388.68	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-C4	-	Borrow Area No. 2	5,818,497.69	596,326.83	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-C5	-	Borrow Area No. 2	5,818,575.72	596,265.57	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-D1	-	Borrow Area No. 2	5,818,323.72	596,592.70	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-D2	-	Borrow Area No. 2	5,818,402.33	596,531.43	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-D3	-	Borrow Area No. 2	5,818,480.35	596,471.33	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-D4	-	Borrow Area No. 2	5,818,557.80	596,408.33	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1997	Knight Piesold	DH97-BA2-D5	-	Borrow Area No. 2	5,818,634.67	596,347.64	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-1	-	Borrow Area No. 4	5,819,831.28	594,714.04	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-2	-	Borrow Area No. 4	5,819,891.34	594,728.01	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-3	-	Borrow Area No. 4	5,819,851.53	594,649.10	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-4	-	Borrow Area No. 4	5,819,908.10	594,667.26	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-5 (N)	-	Borrow Area No. 4	5,819,868.99	594,596.03	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-5 (S)	-	Borrow Area No. 4	5,819,914.38	594,463.34	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-6	-	Borrow Area No. 4	5,819,771.22	594,612.09	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-7	-	Borrow Area No. 4	5,819,762.84	594,508.04	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-8	-	Borrow Area No. 4	5,819,841.06	594,477.31	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-10	-	Borrow Area No. 4	5,819,949.99	594,475.22	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-11	-	Borrow Area No. 4	5,819,932.54	594,544.35	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA4-12	-	Borrow Area No. 4	5,819,921.36	594,605.80	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-1	-	Borrow Area No. 2	5,818,539.20	596,423.03	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-2	-	Borrow Area No. 2	5,818,595.26	596,366.97	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-3	-	Borrow Area No. 2	5,818,651.32	596,281.64	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-4	-	Borrow Area No. 2	5,818,606.18	596,309.92	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-5	-	Borrow Area No. 2	5,818,546.65	596,382.85	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-6	-	Borrow Area No. 2	5,818,476.69	596,523.25	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-7	-	Borrow Area No. 2	5,818,518.86	596,497.45	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-8	-	Borrow Area No. 2	5,818,597.65	596,460.06	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-9	-	Borrow Area No. 2	5,818,646.86	596,398.72	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BA2-16	-	Main Embankment	5,818,689.52	596,103.54	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-NO-NAME	-	Main Embankment	5,818,722.76	596,173.49	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	DH98-BL-01	-	South Embankment	5,818,299.01	595,073.01	944.50	0	-90	1.5	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-02	-	Tailings Basin	5,818,490.51	594,933.26	942.00	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-03	-	South Embankment	5,818,377.20	594,800.76	943.00	0	-90	6.7	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-04	-	South Embankment	5,818,495.46	594,531.42	942.20	0	-90	7.6	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-05	-	South Embankment	5,818,478.74	594,688.69	941.80	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-06	-	South Embankment	5,818,506.61	594,727.70	939.50	0	-90	1.2	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-07	-	Tailings Basin	5,818,705.36	594,410.67	943.00	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-08	-	Tailings Basin	5,818,999.58	594,495.47	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-09	-	Tailings Basin	5,819,142.03	594,400.50	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-10	-	Tailings Basin	5,819,411.59	594,364.88	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-11	-	South Embankment	5,818,284.04	595,144.07	946.00	0	-90	2.1	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-12	-	South Embankment	5,818,375.34	595,031.71	948.00	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-13	-	South Embankment	5,818,401.97	594,895.49	945.00	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-14	-	Tailings Basin	5,818,486.39	595,029.77	941.00	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-15	-	Tailings Basin	5,818,631.68	594,861.44	933.00	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-16	-	Tailings Basin	5,818,567.29	594,894.87	936.00	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-17	-	South Embankment	5,818,456.45	594,849.06	942.00	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-18	-	South Embankment	5,818,415.59	594,759.89	942.20	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	DH98-BL-19	-	South Embankment	5,818,477.51	594,599.53	942.20	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1998	Knight Piesold	PRW98-01	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	PRW98-02	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	PRW98-03	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	PRW98-04	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	PRW98-05	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1998	Knight Piesold	PRW98-06	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N

Table C1: Summary of Boreholes

Year	Consultant	Borehole ID	Drill Method	General Location Description	Coordinates		Ground Elevation (m)	Azimuth (degrees)	Inclination (degrees)	Completion Depth (m)	Bedrock Depth (m)	Geotechnical Instrumentation																Record of Borehole Log in Database?	Location on Figure 01?	Location on Figure 02?
												VWP 1				VWP 2				VWP 3				Slope Inclinometer		Shape Accel Array						
					Northing (m)	Easting (m)						Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Collar Elevation (m)	Base Elevation (m)	Sensor Top Elevation (m)	Sensor Base Elevation (m)	SAA ID	Serial No.			
1998	Knight Piesold	PRW98-07	-	Main Embankment	-	-	-	0	-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
1999	Knight Piesold	BH99-01	-	South Embankment	5,818,482.46	594,754.94	934.00	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-02	-	South Embankment	5,818,474.41	594,729.55	936.00	0	-90	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-03	-	South Embankment	5,818,502.89	594,694.88	935.50	0	-90	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-04	-	South Embankment	5,818,510.94	594,670.73	935.50	0	-90	0.9	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-05	-	South Embankment	5,818,520.85	594,653.39	940.00	0	-90	1.2	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-06	-	South Embankment	5,818,543.76	594,609.43	935.80	0	-90	1.8	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-07	-	South Embankment	5,818,551.81	594,576.00	936.00	0	-90	2.4	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-08	-	South Embankment	5,818,567.29	594,518.41	937.50	0	-90	3.7	3.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-09	-	South Embankment	5,818,554.90	594,499.22	939.50	0	-90	5.8	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-10	-	South Embankment	5,818,553.67	594,432.97	945.00	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-11	-	South Embankment	5,818,523.94	594,462.07	943.00	0	-90	6.7	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-12	-	South Embankment	5,818,315.28	594,919.02	946.50	0	-90	5.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-13	-	South Embankment	5,818,362.34	594,899.83	948.00	0	-90	5.5	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-14	-	South Embankment	5,818,395.16	594,888.06	946.50	0	-90	5.2	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-15	-	South Embankment	5,818,470.08	594,759.89	934.50	0	-90	1.8	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-16	-	South Embankment	5,818,440.97	594,885.59	944.00	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-17	-	South Embankment	5,818,479.36	594,871.35	939.50	0	-90	5.8	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-18	-	South Embankment	5,818,505.37	594,851.53	936.50	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-19	-	South Embankment	5,818,488.65	594,822.43	935.00	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-20	-	South Embankment	5,818,464.50	594,802.00	936.00	0	-90	6.1	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-21	-	South Embankment	5,818,442.21	594,769.80	936.00	0	-90	4.3	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-22	-	Tailings Basin	5,818,855.21	594,554.32	935.00	0	-90	6.1	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-23	-	Tailings Basin	5,818,811.86	594,562.37	933.20	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-24	-	Tailings Basin	5,818,776.75	594,531.91	933.00	0	-90	4.3	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-25	-	Tailings Basin	5,818,733.23	594,506.65	933.80	0	-90	3.0	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-26	-	Tailings Basin	5,818,762.95	594,525.22	934.00	0	-90	4.6	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-27	-	Tailings Basin	5,818,794.53	594,548.13	934.00	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-28	-	Tailings Basin	5,818,746.85	594,467.64	938.00	0	-90	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-29	-	Tailings Basin	5,818,712.79	594,428.63	941.50	0	-90	5.2	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-30	-	South Embankment	5,818,652.12	594,419.34	939.50	0	-90	5.2	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-31	-	South Embankment	5,818,598.25	594,444.73	938.50	0	-90	5.8	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-32	-	Tailings Basin	5,818,681.22	594,518.41	933.10	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-33	-	South Embankment	5,818,640.35	594,511.60	933.50	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-34	-	South Embankment	5,818,591.44	594,506.03	935.50	0	-90	5.2	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-35	-	Tailings Basin	5,818,831.06	594,515.32	393.00	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-36	-	Tailings Basin	5,818,852.73	594,468.26	942.80	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-37	-	Tailings Basin	5,818,804.43	594,504.79	938.50	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-38	-	Tailings Basin	5,818,819.29	594,465.78	942.50	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-39	-	Tailings Basin	5,818,790.81	594,502.93	938.00	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-40	-	Tailings Basin	5,818,795.77	594,457.11	942.40	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-41	-	South Embankment	5,818,263.27	594,902.92	948.50	0	-90	5.8	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-42	-	South Embankment	5,818,326.43	594,963.60	947.20	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-43	-	South Embankment	5,818,357.39	594,950.60	946.80	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	BH99-44	-	South Embankment	5,818,377.82	594,941.93	946.20	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-45	-	South Embankment	5,818,531.74	594,642.13	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-46	-	South Embankment	5,818,545.24	594,659.35	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-47	-	South Embankment	5,818,539.66	594,684.49	-	0	-90	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-48	-	South Embankment	5,818,550.36	594,680.77	-	0	-90	1.2	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-49	-	South Embankment	5,818,547.57	594,697.53	-	0	-90	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-50	-	South Embankment	5,818,540.12	594,713.35	-	0	-90	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-51	-	South Embankment	5,818,514.98	594,689.61	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-52	-	South Embankment	5,818,498.69	594,706.37	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-53	-	South Embankment	5,818,517.78	594,715.22	-	0	-90	1.8	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-54	-	South Embankment	5,818,517.42	594,718.89	-	0	-90	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-55	-	South Embankment	5,818,501.04	594,738.95	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-56	-	South Embankment	5,818,468.79	594,746.65	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-57	-	South Embankment	5,818,468.22	594,733.52	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-58	-	South Embankment	5,818,459.08	594,772.91	-	0	-90	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-59	-	South Embankment	5,818,447.66	594,837.13	-	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-60	-	South Embankment	-	-	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-61	-	South Embankment	5,818,293.31	595,038.04	-	0	-90	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-62	-	South Embankment	5,818,314.37	594,988.98	-	0	-90	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-63	-	South Embankment	5,818,284.69	595,000.00	-	0	-90	1.1	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-64	-	South Embankment	5,818,259.32	595,045.95	-	0	-90	1.3	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-65	-	South Embankment	5,818,253.74	595,081.33	-	0	-90	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-66	-	South Embankment	5,818,262.06	595,125.14	-	0	-90	0.9	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-67	-	South Embankment	5,818,314.58	595,097.05	-	0	-90	2.7	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-68	-	South Embankment	5,818,354.04	595,040.07	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-69	-	South Embankment	5,818,330.92	595,013.24	-	0	-90	1.0	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-70	-	South Embankment	5,818,322.65	595,000.00	-	0	-90	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-71	-	South Embankment	5,818,347.19	594,963.58	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-72	-	South Embankment	5,818,311.23	594,972.71	-	0	-90	0.9	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-73	-	South Embankment	5,818,302.38	594,954.73	-	0	-90	3.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-74	-	Main Embankment	5,818,795.20	596,109.49	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-75	-	Main Embankment	5,818,804.62	596,093.62	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-76	-	Main Embankment	5,818,783.79	596,059.88	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-77	-	Main Embankment	5,818,758.98	596,072.29	-	0	-90	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-78	-	Main Embankment	5,818,720.78	596,040.04	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-79	-	Main Embankment	5,818,733.43	596,005.59	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-80	-	Main Embankment	5,818,710.22	595,975.87	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-81	-	Main Embankment	5,818,689.05	596,005.59	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-82	-	Main Embankment	5,818,671.54	595,946.97	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-83	-	Main Embankment	5,818,653.22	595,971.39	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-84	-	Main Embankment	5,818,643.45	595,906.66	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-85	-	Main Embankment	5,818,609.25	595,909.10	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-86	-	Main Embankment	5,818,569.55	595,880.40	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-87	-	Main Embankment	5,818,577.49	595,844.97	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-88	-	Main Embankment	5,818,511.53	595,823.60	-	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-89	-	Main Embankment	5,818,519.78	595,790.82	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-90	-	Main Embankment	5,818,481.10	595,782.68	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-91	-	Main Embankment	5,818,483.14	595,734.23	-	0	-90	2.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-92	-	Main Embankment	5,818,448.53	595,744.00	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-93	-	Main Embankment	5,818,376.06	595,655.65	-	0	-90	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-94	-	Main Embankment	5,818,394.38	595,619.82	-	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-95	-	Main Embankment	5,818,326.38	595,520.89	-	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-96	-	Main Embankment	5,818,308.06	595,540.43	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-97	-	Main Embankment	5,818,275.08	595,482.61	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-98	-	Main Embankment	5,818,349.59	595,597.84	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-99	-	Main Embankment	5,818,354.07	595,565.67	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-100	-	Main Embankment	5,818,260.43	595,437.83	-	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-101	-	Main Embankment	5,818,236.81	595,427.24	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-102	-	Main Embankment	5,818,236.81	595,405.66	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-103	-	Main Embankment	5,818,223.78	595,386.12	-	0	-90	2.9	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-104	-	Main Embankment	5,818,218.69	595,357.82	-	0	-90	2.2	2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-105	-	Main Embankment	5,818,222.36	595,321.79	-	0	-90	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-106	-	Main Embankment	5,818,215.03	595,279.04	-	0	-90	3.4	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-107	-	South Embankment	5,818,193.04	595,224.69	-	0	-90	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-108	-	Main Embankment	5,818,175.33	595,307.74	-	0	-90	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-109	-	Main Embankment	5,818,176.55	595,366.98	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-110	-	South Embankment	5,818,226.63	595,172.77	-	0	-90	1.7	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-111	-	Corner 1 Embankment	5,820,012.58	594,936.53	-	0	-90	2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N

Table C1: Summary of Boreholes

Year	Consultant	Borehole ID	Drill Method	General Location Description	Coordinates		Ground Elevation (m)	Azimuth (degrees)	Inclination (degrees)	Completion Depth (m)	Bedrock Depth (m)	Geotechnical Instrumentation																Record of Borehole Log in Database?	Location on Figure 01?	Location on Figure 02?
												VWP 1				VWP 2				VWP 3				Slope Inclinometer		Shape Accel Array						
					Northing (m)	Easting (m)						Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Collar Elevation (m)	Base Elevation (m)	Sensor Top Elevation (m)	Sensor Base Elevation (m)	SAA ID	Serial No.			
1999	Knight Piesold	DH99-112	-	Corner 1 Embankment	5,820,005.12	595,000.00	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-113	-	Corner 1 Embankment	5,820,016.31	595,026.41	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-114	-	Corner 1 Embankment	5,819,991.81	595,051.29	-	0	-90	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-115	-	Corner 1 Embankment	5,819,962.02	595,077.36	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-116	-	Corner 1 Embankment	5,819,973.66	595,111.81	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-117	-	Corner 1 Embankment	5,819,941.53	595,117.40	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-118	-	Corner 1 Embankment	5,819,947.59	595,147.66	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-119	-	Corner 1 Embankment	5,819,914.07	595,153.71	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-120	-	Corner 1 Embankment	5,819,920.59	595,197.94	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-121	-	Corner 1 Embankment	5,819,878.69	595,204.92	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-122	-	Corner 1 Embankment	5,819,887.07	595,250.08	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-123	-	Corner 1 Embankment	5,819,825.15	595,279.41	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-124	-	Perimeter Embankment	5,819,750.19	595,391.60	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-125	-	Perimeter Embankment	5,819,751.59	595,422.80	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-126	-	Perimeter Embankment	5,819,696.66	595,465.16	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-127	-	Perimeter Embankment	5,819,643.12	595,536.39	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-128	-	Perimeter Embankment	5,819,632.88	595,592.26	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-129	-	Perimeter Embankment	5,819,588.18	595,618.33	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-130	-	Perimeter Embankment	5,819,575.61	595,663.49	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-131	-	Perimeter Embankment	5,819,540.70	595,691.88	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-132	-	Corner 1 Embankment	5,820,016.10	595,044.43	-	0	-90	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-133	-	Corner 1 Embankment	5,819,972.60	594,879.16	-	0	-90	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-134	-	Borrow Area No. 2	5,818,655.79	596,347.62	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-135	-	Borrow Area No. 2	5,818,649.34	596,372.43	-	0	-90	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-136	-	Borrow Area No. 2	5,818,611.14	596,360.03	930.00	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-137	-	Borrow Area No. 2	5,818,611.14	596,398.72	937.40	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-139	-	Borrow Area No. 2	5,818,701.93	596,364.49	-	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-140	-	Borrow Area No. 2	5,818,729.21	596,468.18	938.50	0	-90	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-141	-	Borrow Area No. 2	5,818,681.59	596,551.52	938.40	0	-90	9.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-142	-	Borrow Area No. 2	5,818,663.23	596,494.47	938.60	0	-90	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-143	-	Borrow Area No. 2	5,818,661.25	596,601.14	937.80	0	-90	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-144	-	Borrow Area No. 2	5,818,634.95	596,505.88	939.00	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-145	-	Borrow Area No. 2	5,818,610.15	596,568.39	938.90	0	-90	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-146	-	Borrow Area No. 2	5,818,600.72	596,517.29	939.50	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-147	-	Borrow Area No. 2	5,818,585.84	596,584.76	939.20	0	-90	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-148	-	Borrow Area No. 2	5,818,571.95	596,529.20	939.30	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-149	-	Borrow Area No. 2	5,818,552.60	596,611.06	939.80	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-150	-	Borrow Area No. 2	5,818,530.27	596,546.07	939.20	0	-90	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-151	-	Borrow Area No. 2	5,818,751.54	596,277.67	937.00	0	-90	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-152	-	Borrow Area No. 2	5,818,772.87	596,309.42	937.20	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-153	-	Borrow Area No. 2	5,818,820.50	596,362.01	938.60	0	-90	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-154	-	Borrow Area No. 2	5,818,869.12	596,415.59	939.00	0	-90	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-155	-	Borrow Area No. 2	5,818,837.86	596,450.82	938.40	0	-90	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-156	-	Borrow Area No. 2	5,818,793.71	596,459.75	938.10	0	-90	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-157	-	Borrow Area No. 2	5,818,726.24	596,509.36	938.40	0	-90	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
1999	Knight Piesold	DH99-158	-	Borrow Area No. 2	5,818,727.23	596,434.44	938.00	0	-90	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2000	Knight Piesold	GW00-1	ODEX	South Embankment	5,818,476.00	594,368.00	939.18	0	-90	21.0	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2000	Knight Piesold	GW00-2	ODEX	South Embankment	5,818,337.50	594,651.80	943.40	0	-90	21.6	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2000	Knight Piesold	GW00-3	ODEX	South Embankment	5,818,238.10	594,896.40	943.07	0	-90	24.3	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-01	-	Borrow Area No. 2	5,818,909.31	596,436.65	-	0	-90	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-02	-	Borrow Area No. 2	5,818,880.48	596,450.41	-	0	-90	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-03	-	Borrow Area No. 2	5,818,841.85	596,468.93	-	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-04	-	Borrow Area No. 2	5,818,803.62	596,486.13	-	0	-90	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-05	-	Borrow Area No. 2	5,818,838.14	596,508.62	-	0	-90	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-06	-	Borrow Area No. 2	5,818,802.56	596,548.57	-	0	-90	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-07	-	Borrow Area No. 2	5,818,842.38	596,534.28	-	0	-90	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-08	-	Borrow Area No. 2	5,818,872.80	596,520.00	-	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-09	-	Borrow Area No. 2	5,818,895.56	596,507.03	-	0	-90	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-10	-	Borrow Area No. 2	5,818,913.55	596,536.14	-	0	-90	9.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-11	-	Borrow Area No. 2	5,818,886.83	596,482.96	-	0	-90	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-12	-	Borrow Area No. 2	5,818,920.43	596,491.16	-	0	-90	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-13	-	Borrow Area No. 2	5,818,944.50	596,475.02	-	0	-90	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-14	-	Borrow Area No. 2	5,818,788.27	596,580.58	-	0	-90	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-15	-	Borrow Area No. 2	5,818,818.04	596,603.60	-	0	-90	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-16	-	Borrow Area No. 2	5,818,850.84	596,590.37	-	0	-90	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-17	-	Borrow Area No. 2	5,818,863.81	596,554.66	-	0	-90	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-18	-	Borrow Area No. 2	5,818,883.39	596,576.88	-	0	-90	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-19	-	Borrow Area No. 2	5,818,925.72	596,559.68	-	0	-90	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-20	-	Borrow Area No. 2	5,818,943.97	596,543.81	-	0	-90	6.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-21	-	Borrow Area No. 2	5,818,964.08	596,515.76	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-22	-	Borrow Area No. 2	5,818,575.68	596,668.95	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-23	-	Borrow Area No. 2	5,818,547.90	596,628.74	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-24	-	Borrow Area No. 2	5,818,521.45	596,599.90	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-25	-	Borrow Area No. 2	5,818,489.43	596,553.07	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-26	-	Borrow Area No. 2	5,818,479.64	596,531.90	-	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-27 (N)	-	Borrow Area No. 2	5,818,615.37	596,751.50	-	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-27 (S)	-	Borrow Area No. 2	5,818,442.69	596,490.26	-	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-28	-	Borrow Area No. 2	5,818,581.50	596,720.02	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-29	-	Borrow Area No. 2	5,818,548.17	596,684.83	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-30	-	Borrow Area No. 2	5,818,511.66	596,650.96	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-31	-	Borrow Area No. 2	5,818,476.47	596,619.48	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-32	-	Borrow Area No. 2	5,818,433.61	596,588.26	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-33	-	Borrow Area No. 2	5,818,383.39	596,525.66	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-34	-	Borrow Area No. 2	5,818,577.80	596,938.03	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-35	-	Borrow Area No. 2	5,818,552.93	596,893.84	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-36	-	Borrow Area No. 2	5,818,529.65	596,848.60	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-37	-	Borrow Area No. 2	5,818,503.72	596,802.30	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-38	-	Borrow Area No. 2	5,818,477.79	596,755.47	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-39	-	Borrow Area No. 2	5,818,455.57	596,709.17	-	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-40	-	Borrow Area No. 2	5,818,436.25	596,666.57	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-41	-	Borrow Area No. 2	5,818,416.41	596,616.04	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-42	-	Borrow Area No. 2	5,818,338.08	596,526.12	-	0	-90	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-43	-	Borrow Area No. 2	5,818,364.43	596,566.80	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-44	-	Borrow Area No. 2	5,818,529.65	596,963.43	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-45	-	Borrow Area No. 2	5,818,517.74	596,918.18	-	0	-90	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-46	-	Borrow Area No. 2	5,818,495.52	596,876.12	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-47	-	Borrow Area No. 2	5,818,473.56	596,831.67	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-48	-	Borrow Area No. 2	5,818,452.39	596,785.63	-	0	-90	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-49	-	Borrow Area No. 2	5,818,428.84	596,737.74	-	0	-90	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-50	-	Borrow Area No. 2	5,818,409.00	596,696.47	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-51	-	Borrow Area No. 2	5,818,373.21	596,636.61	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-52	-	Borrow Area No. 3	5,818,392.63	596,807.67	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-53	-	Borrow Area No. 3	5,818,372.75	596,761.90	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-54	-	Borrow Area No. 3	5,818,351.49	596,717.52	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-55	-	Borrow Area No. 3	5,818,326.98	596,668.51	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-56	-	Borrow Area No. 3	5,818,341.78	596,860.38	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-57	-	Borrow Area No. 3	5,818,326.06	596,806.75	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-58	-	Borrow Area No. 3	5,818,310.80	596,759.59	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-59	-	Borrow Area No. 3	5,818,280.29	596,694.87	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-60	-	Borrow Area No. 3	5,818,283.06	596,584.37	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-61	-	Borrow Area No. 2	5,818,308.95	596,563.57	-	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-62	-	Borrow Area No. 3	5,818,231.28	596,783.17	-	0	-90	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N

Table C1: Summary of Boreholes

Year	Consultant	Borehole ID	Drill Method	General Location Description	Coordinates		Ground Elevation (m)	Azimuth (degrees)	Inclination (degrees)	Completion Depth (m)	Bedrock Depth (m)	Geotechnical Instrumentation																Record of Borehole Log in Database?	Location on Figure 01?	Location on Figure 02?
												VWP 1				VWP 2				VWP 3				Slope Inclinometer		Shape Accel Array						
					Northing (m)	Easting (m)						Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Collar Elevation (m)	Base Elevation (m)	Sensor Top Elevation (m)	Sensor Base Elevation (m)	SAA ID	Serial No.			
2001	Knight Piesold	DH01-63	-	Borrow Area No. 3	5,818,132.34	596,828.48	-	0	-90	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-64	-	Borrow Area No. 3	5,818,045.43	596,771.15	-	0	-90	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-65	-	Borrow Area No. 3	5,818,221.11	596,588.07	-	0	-90	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-66	-	Borrow Area No. 2	5,818,252.55	596,506.70	-	0	-90	4.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	DH01-67	-	-	-	-	-	0	-90	5.2	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-68	-	-	-	-	-	0	-90	2.7	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-69	-	-	-	-	-	0	-90	1.5	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-70	-	-	-	-	-	0	-90	3.0	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-71	-	-	-	-	-	0	-90	1.2	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-72	-	-	-	-	-	0	-90	1.5	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-73	-	-	-	-	-	0	-90	2.7	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-74	-	-	-	-	-	0	-90	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-75	-	-	-	-	-	0	-90	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-76	-	-	-	-	-	0	-90	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-77	-	-	-	-	-	0	-90	3.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-78	-	-	-	-	-	0	-90	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-79	-	-	-	-	-	0	-90	1.5	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	DH01-80	-	-	-	-	-	0	-90	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	N
2001	Knight Piesold	SI01-01	ODEX	Main Embankment	5,818,464.00	595,667.00	915.70	0	-90	24.4	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2001	Knight Piesold	SI01-02	ODEX	Main Embankment	5,818,401.00	595,589.00	917.30	0	-90	30.3	25.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2006	Knight Piesold	SI06-01	Air Rotary	Main Embankment	5,818,399.60	595,649.50	917.10	0	-90	42.2	31.7	-	-	-	-	-	-	-	-	-	-	-	-	917.40	875.10	-	-	Y	Y	N
2006	Knight Piesold	SI06-02	Air Rotary	Main Embankment	5,818,462.93	595,734.02	917.10	0	-90	34.7	27.2	-	-	-	-	-	-	-	-	-	-	-	-	918.10	886.10	-	-	Y	Y	N
2006	Knight Piesold	SI06-03	Air Rotary	Main Embankment	5,818,520.66	595,815.07	917.70	0	-90	40.6	36.9	-	-	-	-	-	-	-	-	-	-	-	-	918.70	882.60	-	-	Y	Y	N
2008	Knight Piesold	KP08-01	Sonic	Perimeter Embankment	5,819,445.00	595,951.00	935.00	0	-90	19.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-02	Sonic	Perimeter Embankment	5,819,292.00	596,125.00	935.00	0	-90	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-04	Sonic	Perimeter Embankment	5,819,414.00	596,269.00	920.00	0	-90	20.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-06	Sonic	Perimeter Embankment	5,819,131.00	596,297.00	937.00	0	-90	13.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-08	Sonic	Perimeter Embankment	5,819,276.00	596,451.00	918.00	0	-90	17.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-09	Sonic	Perimeter Embankment	5,819,617.00	596,070.00	921.00	0	-90	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-11	Sonic	Perimeter Embankment	5,819,744.00	595,835.00	924.00	0	-90	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-12	Sonic	Perimeter Embankment	5,819,605.00	595,741.00	933.00	0	-90	23.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-14	Sonic	Perimeter Embankment	5,819,739.00	595,544.00	931.00	0	-90	20.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-15	Sonic	Perimeter Embankment	5,819,880.00	595,608.00	925.00	0	-90	20.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2008	Knight Piesold	KP08-16	Sonic	Perimeter Embankment	5,819,663.00	595,778.00	930.00	0	-90	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-01	Sonic	South Embankment	5,818,480.00	594,463.00	941.01	0	-90	11.1	7.0	7.0	934.01	F5	1119797	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-02	Sonic	South Embankment	5,818,343.00	594,786.00	945.09	0	-90	17.4	10.7	7.6	937.49	I5	1119796	10.4	934.69	I6	1119792	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-03	Sonic	Main Embankment	5,818,272.00	595,467.00	927.00	0	-90	23.2	21.3	15.2	911.80	E6	1119794	18.9	908.10	E7	1119801	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-04	Sonic	Main Embankment	5,818,309.00	595,533.00	921.59	0	-90	29.3	25.6	12.5	909.09	C11	1119798	21.0	900.59	C12	1119795	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-05	Sonic	Main Embankment	5,818,410.00	595,605.00	920.60	0	-90	32.3	27.7	12.2	908.40	A16	1119799	16.8	903.80	A17	09-2810	24.4	896.20	A18	09-2808	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-06	Sonic	Main Embankment	5,818,423.00	595,686.00	916.34	0	-90	35.4	31.7	10.7	905.64	A19	09-2811	15.2	901.14	A20	09-2809	22.9	893.44	A21	1119786	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-07	Sonic	Main Embankment	5,818,554.00	595,850.00	919.78	0	-90	43.3	40.0	13.7	906.08	B11	1119793	25.9	893.88	B12	1119791	31.1	888.68	B13	1119785	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-08	Sonic	Main Embankment	5,818,697.00	596,027.00	927.66	0	-90	47.5	44.5	15.2	912.46	K1	1119788	33.8	893.86	K2	1119784	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-09	Sonic	Perimeter Embankment	5,819,415.00	595,928.00	936.59	0	-90	41.7	39.0	19.4	917.19	J1	1119800	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2011	AMEC	VW11-10	Sonic	Perimeter Embankment	5,819,783.00	595,410.00	931.80	0	-90	42.4	41.5	18.4	913.40	D6	1119790	24.4	907.40	D7	1119802	-	-	-	-	-	-	-	-	-	Y	Y	Y
2011	AMEC	VW11-11	Sonic	Corner 1 Embankment	5,820,031.00	594,892.00	940.89	0	-90	23.5	14.9	6.1	934.79	G4	1119789	10.7	930.19	G5	1119787	-	-	-	-	-	-	-	-	-	Y	Y	Y
2011	AMEC	SI11-01	Sonic	Main Embankment	5,818,353.00	595,527.00	921.08	0	-90	44.8	25.9	-	-	-	-	-	-	-	-	-	-	-	-	921.10	876.30	-	-	Y	Y	N
2011	AMEC	SI11-02	Sonic	Main Embankment	5,818,716.00	595,998.00	928.27	0	-90	49.4	46.0	-	-	-	-	-	-	-	-	-	-	-	-	928.30	878.90	-	-	Y	Y	N
2011	AMEC	SI11-04	Sonic	Perimeter Embankment	5,819,780.00	595,408.00	931.93	0	-90	43.3	41.1	-	-	-	-	-	-	-	-	-	-	-	-	931.90	888.60	-	-	Y	Y	Y
2012	AMEC	SI12-01	ODEX	Perimeter Embankment	5,819,786.00	595,408.00	940.00	0	-90	41.5	40.8	-	-	-	-	-	-	-	-	-	-	-	-	940.00	898.50	-	-	Y	Y	Y
2012	AMEC	SI12-02	ODEX	Perimeter Embankment	5,819,421.00	595,920.00	940.00	0	-90	42.7	42.1	-	-	-	-	-	-	-	-	-	-	-	-	940.00	897.30	-	-	Y	Y	N
2014	Thurber	MR14-101	Mud Rotary	Dam Breach Area	5,819,826.00	595,340.00	933.00	0	-90	16.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-102	Mud Rotary	Dam Breach Area	5,819,832.00	595,330.00	932.50	0	-90	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-103	Mud Rotary	Dam Breach Area	5,819,865.00	595,296.00	930.70	0	-90	9.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	SC14-103	Soil Coring	Dam Breach Area	5,819,967.00	595,292.00	930.80	0	-90	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	SC14-103A	Soil Coring	Dam Breach Area	5,819,868.00	595,290.00	930.90	0	-90	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-104	Mud Rotary	Dam Breach Area	5,819,891.00	595,255.00	931.70	0	-90	12.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-105	Mud Rotary	Dam Breach Area	5,819,914.00	595,228.00	931.70	0	-90	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-105A	Mud Rotary	Dam Breach Area	5,819,916.00	595,226.00	931.70	0	-90	2.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106	Mud Rotary	Dam Breach Area	5,819,997.00	595,148.00	929.40	0	-90	12.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106A	Mud Rotary	Dam Breach Area	5,819,997.00	595,146.00	928.70	0	-90	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106B	Mud Rotary	Dam Breach Area	5,820,001.00	595,139.00	928.50	0	-90	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106C	Mud Rotary	Dam Breach Area	5,820,002.00	595,139.00	928.50	0	-90	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106D	Mud Rotary	Dam Breach Area	5,819,993.00	595,137.00	928.70	0	-90	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106E	Mud Rotary	Dam Breach Area	5,819,990.00	595,134.00	929.00	0	-90	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106F	Mud Rotary	Dam Breach Area	5,819,994.00	595,134.00	928.70	0	-90	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106G	Mud Rotary	Dam Breach Area	5,819,997.00	595,135.00	928.70	0	-90	8.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106H	Mud Rotary	Dam Breach Area	5,819,998.00	595,135.00	928.60	0	-90	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-106I	Mud Rotary	Dam Breach Area	5,820,001.00	595,135.00	928.60	0	-90	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-107	Mud Rotary	Dam Breach Area	5,820,013.00	595,131.00	928.70	0	-90	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-107A	Mud Rotary	Dam Breach Area	5,820,013.00	595,132.00	928.30	0	-90	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-107B	Mud Rotary	Dam Breach Area	5,820,013.00	595,129.00	928.40	0	-90	7.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-108	Mud Rotary	Dam Breach Area	5,820,013.00	595,105.00	928.60	0	-90	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-108A	Mud Rotary	Dam Breach Area	5,820,014.00	595,106.00	928.60	0	-90	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-109	Mud Rotary	Dam Breach Area	5,820,022.00	595,087.00	929.00	0	-90	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-110	Mud Rotary	Dam Breach Area	5,820,037.00	595,092.00	928.70	0	-90	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-111	Mud Rotary	Dam Breach Area	5,820,044.00	595,115.00	928.60	0	-90	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-111A	Mud Rotary	Dam Breach Area	5,820,046.00	595,119.00	928.10	0	-90	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-112	Mud Rotary	Dam Breach Area	5,820,028.00	595,149.00	928.90	0	-90	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-112A	Mud Rotary	Dam Breach Area	5,820,026.00	595,151.00	928.70	0	-90	4.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-113	Mud Rotary	Dam Breach Area	5,820,013.00	595,152.00	929.40	0	-90	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-114	Mud Rotary	Dam Breach Area	5,819,981.00	595,064.00	930.60	0	-90	9.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-115	Mud Rotary	Dam Breach Area	5,820,007.00	595,076.00	929.00	0	-90	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-116	Mud Rotary	Dam Breach Area	5,819,969.00	595,113.00	930.60	0	-90	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	MR14-116A	Mud Rotary	Dam Breach Area	5,819,969.00	595,112.00	930.60	0	-90	3.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	RH14-117	ODEX / Mud Rotary	Dam Breach Area	5,819,939.00	595,125.00	932.40	0	-90	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	RH14-117A	ODEX / Mud Rotary	Dam Breach Area	5,819,936.00	595,132.00	932.60	0	-90	13.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	Thurber	RH14-118	ODEX / Mud Rotary	Dam Breach Area	5,819,922.00	595,176.00	937.70	0	-90	18.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-01	Sonic	Dam Breach Area	5,819,871.71	595,247.86	931.35	0	-90	44.5	18.6	43.3	888.05	VWP-A	VW30340	15.8	915.55	VWP-B	VW30342	8.8	922.55	VWP-C	VW30341	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-01A	Sonic	Dam Breach Area	5,819,868.67	595,252.00	931.20	0	-90	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-02	Sonic	Dam Breach Area	5,819,957.08	595,204.00	932.90	0	-90	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-02A	Sonic	Dam Breach Area	5,819,957.44	595,206.55	932.93	0	-90	24.7	16.8	15.2	917.73	VWP-A	VW30347	9.1	923.83	VWP-B	VW30343	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-03	Sonic	Dam Breach Area	5,819,940.73	595,130.30	932.52	0	-90	47.8	22.1	-	-	-	-	-	-	-	-	-	-	-	-	933.30	885.02	930.0	902.6	SAA15-01	62667	Y	N	Y
2014	KCB	SH14-03A	Sonic	Dam Breach Area	5,819,935.11	595,132.33	932.62	0	-90	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	SH14-03B	Sonic	Dam Breach Area	5,819,933.59	595,130.16	932.63	0	-90	20.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	SH14-04	Sonic	Dam Breach Area	5,819,908.34	595,109.12	932.20	0	-90	26.2	24.8	-	-	-	-	-	-	-	-	-	-	-	-	933.10	906.30	-	-	-	-	Y	N	Y
2014	KCB	SH14-05	Sonic	Dam Breach Area	5,819,918.30	595,194.61	937.11	0	-90	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-05A	Sonic	Dam Breach Area	5,819,919.53	595,193.34	937.21	0	-90	29.6	21.5	20.7	916.51	VWP-A	VW30345	15.8	921.41	VWP-B	VW30357	13.7	923.51	VWP-C	VW30356	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-06	Sonic	Dam Breach Area	5,819,917.39	595,179.92	937.46	0	-90	35.7	22.4	-	-	-	-	-	-	-	-	-	-	-	-	938.40	902.06	-	-	-	-	Y	N	Y
2014	KCB	SH14-07	Sonic	Dam Breach Area	5,819,898.72	595,055.32	931.70	0	-90	20.4	14.0	12.2	919.50	VWP-A	VW30355	9.1	922.60	VWP-B	VW30354	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-08	Sonic	Dam Breach Area	5,819,888.90	595,167.20	947.55	0	-90	60.1	42.3	34.7	912.85	VWP-A	VW30350	24.1	923.45	VWP-B	VW30353	22.9	924.65	VWP-C	VW30351	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-08A	Sonic	Dam Breach Area	5,819,887.33	595,169.80	947.61	0	-90	29.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-09	Sonic	Dam Breach Area	5,819,910.99	595,144.50	937.97	0	-90	61.7	28.0	-	-	-	-	-	-	-	-	-	-	-	-	938.90	906.57	-	-	-	-	Y	N	Y
2014	KCB	SH14-10	Sonic	Dam Breach Area	5,819,965.07	595,147.95	932.15	0	-90	26.5	22.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-10A	Sonic	Dam Breach Area	5,819,963.00	595,145.20	930.96	0	-90	17.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	SH14-11	Sonic	Dam Breach Area	5,819,994.51	595,168.10	930.97	0	-90	20.4	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-11A	Sonic	Dam Breach Area	5,819,993.79	595,167.68	930.86	0	-90	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-11B	Sonic	Dam Breach Area	5,819,992.35	595,169.20	931.17	0	-90	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-12	Sonic	Dam Breach Area	5,819,841.69	595,296.54	930.77	0	-90	23.6	20.1	15.2	915.57	VWP-A	VW30344	7.6	923.17	VWP-B	VW30348	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-13	Sonic	Perimeter Embankment	5,819,770.42	595,404.93	933.06	0	-90	32.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-14	Sonic	Dam Breach Area	5,819,936.34	595,095.71	930.12	0	-90	23.6	17.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-15	Sonic	Dam Breach Area	5,819,958.85	595,103.95	930.19	0	-90	23.5	18.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-16	Sonic	Dam Breach Area	5,819,973.26	595,076.47	930.23	0	-90	23.5	14.0	-	-	-	-	-	-	-	-	-	-	-	-	931.30	907.03	929.1	908.7	SAA15-02	62550	Y	N	Y

Table C1: Summary of Boreholes

Year	Consultant	Borehole ID	Drill Method	General Location Description	Coordinates		Ground Elevation (m)	Azimuth (degrees)	Inclination (degrees)	Completion Depth (m)	Bedrock Depth (m)	Geotechnical Instrumentation														Record of Borehole Log in Database?	Location on Figure 01?	Location on Figure 02?
												VWP 1				VWP 2				VWP 3				Slope Inclinometer		Shape Accel Array			
					Northing (m)	Easting (m)						Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Installation Depth (m)	Elevation (m)	VWP ID	Serial No.	Collar Elevation (m)	Base Elevation (m)	Sensor Top Elevation (m)	Sensor Base Elevation (m)	SAA ID	Serial No.			
2014	KCB	SH14-17	Sonic	Dam Breach Area	5,819,997.87	595,090.27	929.57	0	-90	20.4	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-18	Sonic	Dam Breach Area	5,820,024.51	595,016.05	934.76	0	-90	25.0	19.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-19	Sonic	Dam Breach Area	5,820,042.20	594,883.10	942.82	0	-90	20.4	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-20	Sonic	Dam Breach Area	5,819,968.30	594,861.83	969.92	0	-90	54.0	49.3	51.8	918.12	VWP-A	VW30368	39.9	930.02	VWP-B	VW30371	35.1	934.82	VWP-C	VW30373	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-21	Sonic	Dam Breach Area	5,819,759.86	595,303.52	968.91	0	-90	72.4	66.1	56.4	912.51	VWP-A	VW30369	43.6	925.31	VWP-B	VW30372	40.8	928.11	VWP-C	VW30370	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-22	Sonic	Dam Breach Area	5,819,985.00	595,117.70	929.89	0	-90	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	SH14-22A	Sonic	Dam Breach Area	5,819,984.00	595,119.90	929.96	0	-90	23.5	18.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y
2014	KCB	RH14-03	Mud Rotary	Dam Breach Area	5,819,939.00	595,125.10	932.40	0	-90	13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	RH14-03A	Mud Rotary	Dam Breach Area	5,819,936.00	595,132.30	932.59	0	-90	12.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	RH14-10	Mud Rotary	Dam Breach Area	5,819,964.65	595,142.43	930.91	0	-90	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	RH14-10A	Mud Rotary	Dam Breach Area	5,819,965.51	595,141.18	930.86	0	-90	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	RH14-22	Mud Rotary	Dam Breach Area	5,819,981.00	595,126.50	929.78	0	-90	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	RH14-22A	Mud Rotary	Dam Breach Area	5,819,983.00	595,126.00	929.79	0	-90	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	VST14-03	Mud Rotary	Dam Breach Area	5,819,934.14	595,129.01	932.77	0	-90	9.8	-	12.2	920.57	VWP-A	VW30346	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	VST14-10	Mud Rotary	Dam Breach Area	5,819,962.22	595,152.14	932.08	0	-90	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	VST14-10A	Mud Rotary	Dam Breach Area	5,819,964.65	595,139.43	930.91	0	-90	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2014	KCB	VST14-22	Mud Rotary	Dam Breach Area	5,819,982.71	595,122.56	929.79	0	-90	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	Y
2015	Golder	GA15-01	Sonic	Perimeter Embankment Buttress	5,820,063.30	594,549.30	967.80	0	-90	20.1	-	10.1	957.74	-	VW31559	-	-	-	-	-	-	-	-	969.30	947.67	-	-	-	-	Y	Y	N
2015	Golder	GA15-02	Sonic	Perimeter Embankment Buttress	5,820,049.70	594,727.00	951.70	0	-90	17.1	12.6	12.2	939.51	-	VW31556	-	-	-	-	-	-	-	-	952.80	934.63	-	-	-	-	Y	Y	N
2015	Golder	GA15-03	Sonic	Perimeter Embankment Buttress	5,819,685.96	595,507.54	937.60	0	-90	50.6	47.7	30.5	907.12	VWP-B	VW30361	15.2	922.36	VWP-A	VW30358	-	-	-	-	938.58	887.00	-	-	-	-	Y	Y	N
2015	Golder	GA15-04	Sonic	Perimeter Embankment Buttress	5,819,623.88	595,603.27	937.20	0	-90	53.5	32.3	30.5	906.72	VWP-B	VW30360	15.2	921.96	VWP-A	VW30359	-	-	-	-	937.97	883.70	-	-	-	-	Y	Y	N
2015	Golder	GA15-05	Sonic	Perimeter Embankment Buttress	5,819,552.77	595,704.96	937.50	0	-90	59.8	45.6	32.0	905.50	VWP-B	VW30366	20.0	917.50	VWP-A	VW30365	-	-	-	-	938.46	877.80	-	-	-	-	Y	Y	N
2015	Golder	GA15-06	Sonic	Perimeter Embankment Buttress	5,819,475.88	595,814.30	938.60	0	-90	56.7	40.7	32.0	906.60	VWP-B	VW30363	20.0	918.60	VWP-A	VW30362	-	-	-	-	939.61	881.91	-	-	-	-	Y	Y	N
2015	Golder	GA15-07	Sonic	Perimeter Embankment Buttress	5,819,375.46	595,993.82	935.00	0	-90	44.5	19.7	25.2	909.85	VWP-B	VW31562	16.6	918.39	VWP-A	VW31565	-	-	-	-	936.16	890.50	-	-	-	-	Y	Y	N
2015	Golder	GA15-08	Sonic	Perimeter Embankment Buttress	5,819,255.51	596,082.35	937.00	0	-90	50.6	25.8	31.4	905.61	VWP-B	VW31561	11.6	925.42	VWP-A	VW31560	-	-	-	-	937.70	886.40	-	-	-	-	Y	Y	N
2015	Golder	GA15-09	Sonic	Perimeter Embankment Buttress	5,819,060.02	596,220.56	939.20	0	-90	41.5	22.9	25.3	913.90	VWP-B	VW31567	11.0	928.23	VWP-A	VW31568	-	-	-	-	940.30	897.75	-	-	-	-	Y	Y	N
2015	Golder	GA15-10	Sonic	Main Embankment Buttress	5,818,856.37	596,208.51	938.21	0	-90	74.7	32.0	25.5	912.76	VWP-B	VW31569	11.9	926.32	VWP-A	VW31566	-	-	-	-	939.21	863.54	-	-	-	-	Y	Y	N
2015	Golder	GA15-11	Sonic	Main Embankment Buttress	5,818,767.00	596,270.00	937.00	0	-90	52.7	23.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2015	Golder	GA15-12	Sonic	Main Embankment Buttress	5,818,688.59	595,986.74	928.10	0	-90	50.6	41.4	29.0	899.10	VWP-B	VW30367	18.3	909.80	VWP-A	VW30349	-	-	-	-	929.11	877.50	-	-	-	-	Y	Y	N
2015	Golder	GA15-13	Sonic	Main Embankment Buttress	5,818,594.00	596,056.00	926.10	0	-90	41.5	33.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2015	Golder	GA15-14	Sonic	Main Embankment Buttress	5,818,469.60	595,926.30	913.90	0	-90	21.6	13.4	11.9	902.01	VWP-B	VW31557	6.7	907.19	VWP-A	VW31558	-	-	-	-	915.14	892.26	-	-	-	-	Y	Y	N
2015	Golder	GA15-15	Sonic	Main Embankment Buttress	5,818,460.56	595,693.19	925.00	0	-90	47.5	32.0	25.0	900.00	VWP-B	VW30364	18.0	907.02	VWP-A	VW30352	-	-	-	-	926.00	877.50	-	-	-	-	Y	Y	N
2015	Golder	GA15-16	Sonic	Main Embankment Buttress	5,818,331.00	595,791.00	912.50	0	-90	38.4	21.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2015	Golder	GA15-17	Sonic	Main Embankment Buttress	5,818,260.10	595,584.90	919.05	0	-90	29.3	22.2	20.7	898.35	VWP-B	VW31563	12.8	906.25	VWP-A	VW31564	-	-	-	-	919.93	889.79	-	-	-	-	Y	Y	N
2015	Golder	GA15-18	Sonic	Main Embankment Buttress	5,818,169.50	595,309.60	936.20	0	-90	20.1	12.5	13.4	922.80	VWP-B	1126314	6.1	930.10	VWP-A	1126315	-	-	-	-	937.06	916.08	-	-	-	-	Y	Y	N
2015	Golder	GA15-19	Sonic	South Embankment	5,818,238.20	595,081.10	947.60	0	-90	11.0	6.0	4.6	943.03	-	1126311	-	-	-	-	-	-	-	-	948.35	936.62	-	-	-	-	Y	Y	N
2015	Golder	GA15-20	Sonic	South Embankment	5,818,422.80	594,988.70	944.04	0	-90	9.5	5.4	-	-	-	-	-	-	-	-	-	-	-	-	944.61	934.58	-	-	-	-	Y	Y	N
2015	Golder	GA15-21	Sonic	Main Embankment Buttress	5,818,480.81	595,720.16	-	0	-90	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2015	Golder	VW15-22	Sonic	Corner 1 Embankment	5,819,884.00	595,118.70	950.53	0	-90	-	-	15.0	935.50	-	VW32659	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2015	Golder	VW15-23	Sonic	Corner 1 Embankment	5,819,895.00	595,131.70	951.16	0	-90	-	-	22.5	928.66	-	VW32660	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2015	Golder	VW15-24	Sonic	Corner 1 Embankment	5,819,927.00	595,058.70	950.08	0	-90	-	-	14.9	935.17	-	VW32661	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2015	Golder	VW15-25	Sonic	Corner 1 Embankment	5,819,942.00	595,060.70	951.12	0	-90	-	-	23.3	927.79	-	VW32662	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2015	Golder	SI15-26	Sonic	Perimeter Embankment Buttress	5,819,754.00	595,386.50	943.37	0	-90	45.2	42.1	-	-	-	-	-	-	-	-	-	-	-	-	943.75	898.16	-	-	-	-	Y	N	N
2015	Golder	SI15-27	Sonic	Corner 1 Embankment	5,819,858.00	595,163.30	951.09	0	-90	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-	951.49	926.61	-	-	-	-	N	N	N
2015	Golder	SI15-28	Sonic	Corner 1 Embankment	5,819,884.00	595,138.30	951.09	0	-90	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	952.01	925.55	-	-	-	-	N	N	N
2015	Golder	SI15-29	Sonic	Corner 1 Embankment	5,819,938.00	595,080.00	951.10	0	-90	28.7	-	-	-	-	-	-	-	-	-	-	-	-	-	952.12	923.41	-	-	-	-	N	N	N
2015	Golder	SI15-30	Sonic	Corner 1 Embankment	5,819,942.00	595,045.30	951.02	0	-90	24.7	-	-	-	-	-	-	-	-	-	-	-	-	-	951.28	926.92	-	-	-	-	N	N	N
2016	Golder	GA16-01	Sonic	Corner 1 Embankment Buttress	5,820,084.00	595,032.00	937.20	0	-90	21.3	18.3	15.2	922.00	VWP-B	VW39061	13.4	923.80	VWP-A	VW39064	-	-	-	-	937.80	915.10	-	-	-	-	Y	Y	Y
2016	Golder	GA16-02	Sonic	Corner 1 Embankment Buttress	5,820,128.00	595,095.00	933.00	0	-90	24.4	23.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GA16-03	Sonic	Corner 1 Embankment Buttress	5,820,067.00	595,176.00	932.00	0	-90	24.4	23.2	18.0	914.00	VWP-B	VW39067	12.2	919.80	VWP-A	VW39065	-	-	-	-	932.70	908.00	-	-	-	-	Y	Y	N
2016	Golder	GA16-04	Sonic	Corner 1 Embankment Buttress	5,820,010.00	595,259.00	932.60	0	-90	40.7	40.1	10.2	922.40	-	VW39059	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2016	Golder	GA16-05	Sonic	Corner 1 Embankment Buttress	5,820,062.00	595,305.00	925.40	0	-90	12.2	8.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2016	Golder	GA16-06	Sonic	Corner 1 Embankment Buttress	5,819,915.00	595,307.00	936.50	0	-90	24.4	22.6	16.8	919.70	-	VW39066	-	-	-	-	-	-	-	-	937.00	912.50	-	-	-	-	Y	Y	Y
2016	Golder	GA16-07	Sonic	Corner 1 Embankment Buttress	5,819,964.00	595,348.00	932.30	0	-90	23.0	21.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2016	Golder	GA16-08	Sonic	Corner 1 Embankment Buttress	5,820,015.00	595,378.00	924.30	0	-90	18.3	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2016	Golder	GA16-09	Sonic	Corner 1 Embankment Buttress	5,819,946.00	595,459.00	923.90	0	-90	23.2	22.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2016	Golder	GA16-15	Sonic	South Embankment	5,818,293.00	594,909.00	947.00	0	-90	12.2	10.7	-	-	-	-	-	-	-	-	-	-	-	-	947.80	935.30	-	-	-	-	Y	Y	N
2016	Golder	GA16-16	Sonic	South Embankment	5,818,391.00	594,678.00	944.80	0	-90	12.2	7.0	-	-	-	-	-	-	-	-	-	-	-	-	945.50	933.00	-	-	-	-	Y	Y	N
2016	Golder	GA16-17	Sonic	South Embankment	5,818,270.00	594,793.00	944.40	0	-90	14.6	12.5	10.6	933.80	-	VW39068	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GA16-18	Sonic	Corner 1 Embankment	5,819,891.00	595,118.00	961.00	0	-90	6.6	-	6.5	954.50	-	VW39063	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2016	Golder	GA16-19	Sonic	South Embankment	5,818,341.00	594,790.00	945.20	0	-90	12.2	9.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GA16-20	Sonic	Perimeter Embankment	5,819,411.00	595,562.00	961.20	0	-90	31.0	-	30.5	930.70	-	VW39060	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2016	Golder	GA16-21	Sonic	Main Embankment	5,818,759.00	595,801.00	964.00	0	-90	37.8	-	37.8	926.20	-	VW39069	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2016	Golder	GA16-22	Sonic	South Embankment	5,818,489.00	594,836.00	962.90	0	-90	24.5	-	24.4	938.50	-	VW39062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	N	N
2016	Golder	GW16-02A	Sonic	Perimeter Embankment	5,819,731.19	595,831.15	925.10	0	-90	53.6	52.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-02B	Sonic	Perimeter Embankment	5,819,734.31	595,832.84	924.95	0	-90	30.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-03A	Sonic	Main Embankment	5,818,752.04	596,335.81	938.19	0	-90	41.2	31.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-03B	Sonic	Main Embankment	5,818,757.46	596,337.84	938.35	0	-90	30.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-04A	Sonic	Main Embankment	5,818,106.62	595,491.16	922.16	0	-90	16.8	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-04B	Sonic	Main Embankment	5,818,109.50	595,489.47	922.26	0	-90	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-05A	Sonic	South Embankment	5,818,539.05	594,207.62	963.64	0	-90	27.4	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2016	Golder	GW16-05B	Sonic	South Embankment	5,818,541.45	594,206.42	963.91	0	-90	21.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2018	Golder	GA18-01	Sonic	Corner 1 Embankment Buttress	5,820,059.00	595,030.00	940.80	0	-90	29.3	24.4	25.9	914.90	VWP-C	VW48120	18.6	922.20	VWP-B	VW48122	15.8	925.00	VWP-A	VW48121	941.10	913.70	-	-	-	-	Y	Y	Y
2018	Golder	GA18-03	Sonic	Corner 1 Embankment Buttress	5,820,098.00	594,926.00	940.63	0	-90	15.2	9.1	13.1	927.50	VWP-C	VW48117	8.7	931.90	VWP-B	VW48116	7.2	933.40	VWP-A	VW48115	940.90	925.70	-	-	-	-	Y	Y	Y
2018	Golder	GA18-04A	Sonic	Corner 1 Embankment Buttress	5,819,964.00	595,213.00	941.17	0	-90	24.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2018	Golder	GA18-04B	Sonic	Corner 1 Embankment Buttress	5,819,960.00	595,207.00	940.95	0	-90	29.7	25.0	28.6	912.40	VWP-C	VW48123	19.5	921.50	VWP-B	VW48118	18.9	922.10	VWP-A	VW48119	941.30	911.00	-	-	-	-	Y	Y	Y
2021	Golder	GA21-01	Sonic	Perimeter Embankment Buttress	5,819,767.00	595,505.00	931.92	0	-90	53.6	48.0	45.5	886.44	VWP-A	VW139093	26.5	905.44	VWP-B	VW139075	19.5	912.39	VWP-C	VW139057	932.87	878.30	-	-	-	-	Y	Y	N
2021	Golder	GA21-02	Sonic	Perimeter Embankment Buttress	5,819,630.00	595,782.00	930.11	0	-90	75.0	68.9	33.9	896.19	VWP-A	VW139082	27.1	903.04	VWP-B	VW129095	16.4	913.69	VWP-C	VW139086	931.04	855.05	-	-	-	-	Y	Y	N
2021	Golder	GA21-03	Sonic	Perimeter Embankment Buttress	5,819,543.00	595,924.00	930.45	0	-90	52.1	46.9	30.1	900.36	VWP-A	VW139053	25.5	904.93	VWP-B	VW139067	15.8	914.68	VWP-C	VW139097	931.31	879.12	-	-	-	-	Y	Y	N
2021	Golder	GA21-04	Sonic	Corner 1 Embankment Buttress	5,820,064.00	595,303.00	938.38	0	-90	20.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2021	Golder	GA21-05	Sonic	Perimeter Embankment Buttress	5,819,157.00	596,148.00	945.52	0	-90	71.9	68.0	52.5	893.00	VWP-A	VW139088	34.9	910.67	VWP-B	VW139089	16.6	928.96	VWP-C	VW139096	946.52	873.42	-	-	-	-	Y	Y	N
2021	Golder	GA21-06	Sonic	Perimeter Embankment Buttress	5,819,115.00	596,282.00	937.98	0	-90	29.3	23.5	13.1	924.86	VWP-A	VW139081	8.0	929.96	VWP-B	VW139076	-	-	-	-	938.82	908.60	-	-	-	-	Y	Y	N
2021	Golder	GA21-07	Sonic	Main Embankment Buttress	5,818,649.00	596,019.00	935.90	0	-90	38.4	-	38.2	897.72	VWP-A	VW139078	28.4	907.52	VWP-B	VW139085	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2021	Golder	GA21-08	Sonic	Main Embankment Buttress	5,818,510.00	595,878.00	930.24	0	-90	35.4	-	31.1	899.16	VWP-A	VW139059	26.6	903.66	VWP-B	VW139099	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2021	Golder	GA21-09	Sonic	Main Embankment Buttress	5,818,305.00	595,544.00	930.53	0	-90	35.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2021	Golder	GA21-10	Sonic	Corner 1 Embankment Buttress	5,819,989.00	595,248.00	941.84	0	-90	24.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y
2021	Golder	GA21-11	Sonic	Perimeter Embankment Buttress	5,819,452.00	596,072.00	930.81	0	-90	27.9	-	14.3	916.53	VWP-A	VW134469	8.3	922.47	VWP-B	VW139080	-	-	-	-	-	-	-	-	-	-	Y	Y	N
2022	Golder	GA22-01	Sonic	Corner 1 Embankment Buttress	5,820,058.76	595,034.32	940.84	0	-90	26.8	22.6	15.1	925.75	-	VW136218	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	Y

Table C2: Summary of Test Pits

Year	Consultant	Test Pit ID	Method	General Location Description	Coordinates		Ground Elevation (m)	Completion Depth (m)	Bedrock Encountered? (Y/N)	Record of Test Pit Log in Database?
					Northing (m)	Easting (m)				
1989	Knight Piesold	TPB-01	CAT 225	Main Embankment	5,818,814.05	595,975.06	-	4.1	N	Y
1989	Knight Piesold	TPB-02	CAT 225	Main Embankment	5,819,012.21	596,081.47	-	4.9	N	Y
1989	Knight Piesold	TPB-03	CAT 225	Perimeter Embankment	5,819,190.28	596,214.15	-	5.5	N	Y
1989	Knight Piesold	TPB-04	CAT 225	Perimeter Embankment	5,819,396.99	596,154.10	-	5.2	N	Y
1989	Knight Piesold	TPB-05	CAT 225	Perimeter Embankment	5,819,451.74	595,919.83	-	4.0	N	Y
1989	Knight Piesold	TPB-06	CAT 225	Perimeter Embankment	5,819,675.71	595,825.50	-	5.2	N	Y
1989	Knight Piesold	TPB-07	CAT 225	Perimeter Embankment	5,819,526.73	595,699.80	-	3.4	N	Y
1989	Knight Piesold	TPB-08	CAT 225	Tailings Basin	5,819,369.37	595,609.71	-	4.9	N	Y
1989	Knight Piesold	TPB-09	CAT 225	Tailings Basin	5,818,924.19	595,540.23	-	5.2	N	Y
1989	Knight Piesold	TPB-10	CAT 225	Main Embankment	5,818,678.26	595,752.76	-	3.7	N	Y
1989	Knight Piesold	TPB-11	CAT 225	Main Embankment	5,818,380.54	595,495.64	-	5.2	N	Y
1989	Knight Piesold	TPB-12	CAT 225	Main Embankment	5,818,263.28	595,343.37	926.20	4.9	N	Y
1989	Knight Piesold	TPB-13	CAT 225	Main Embankment	5,818,465.53	595,629.39	-	4.9	N	Y
1989	Knight Piesold	TPB-14	CAT 225	Main Embankment	5,818,323.13	595,714.69	-	4.9	N	Y
1989	Knight Piesold	TPB-15	CAT 225	Tailings Basin	5,818,523.04	595,466.33	-	4.9	N	Y
1989	Knight Piesold	TPB-16	CAT 225	South Embankment	5,818,549.95	594,423.68	946.00	4.3	N	Y
1989	Knight Piesold	TPB-17	CAT 225	Tailings Basin	5,819,774.82	594,762.80	-	4.9	N	Y
1989	Knight Piesold	TPB-18	CAT 225	Corner 1 Embankment	5,819,954.10	595,051.75	-	4.9	N	Y
1995	Knight Piesold	TP95-16	Hitachi X200	TSF Access Road	5,820,580.00	594,370.00	980.00	6.4	N	Y
1995	Knight Piesold	TP95-17	Hitachi X200	TSF Access Road	5,821,110.00	594,230.00	980.00	5.8	N	Y
1995	Knight Piesold	TP95-18	Hitachi X200	Tailings / Reclaim Pipeline Route	5,821,100.00	593,285.00	992.00	3.5	N	Y
1995	Knight Piesold	TP95-19	Hitachi X200	Tailings / Reclaim Pipeline Route	5,821,600.00	592,980.00	1042.00	6.4	Y	Y
1995	Knight Piesold	TP95-26	Hitachi X200	Tailings Basin	5,819,180.00	594,645.00	938.00	6.1	N	Y
1995	Knight Piesold	TP95-27	Hitachi X200	Perimeter Embankment	5,819,740.00	595,350.00	930.00	6.2	N	Y
1995	Knight Piesold	TP95-28	Hitachi X200	Tailings Basin	5,819,360.00	595,285.00	923.40	6.2	N	Y
1995	Knight Piesold	TP95-29	Hitachi X200	Borrow Area No. 2	5,818,745.00	596,270.00	936.00	5.7	N	Y
1995	Knight Piesold	TP95-30	Hitachi X200	Borrow Area No. 2	5,818,495.00	596,560.00	938.00	5.5	N	Y
1995	Knight Piesold	TP95-31	Hitachi X200	Borrow Area No. 2	5,818,955.00	596,470.00	939.00	5.8	N	Y
1995	Knight Piesold	TP95-32	Hitachi X200	Tailings Basin	5,819,140.00	595,780.00	932.00	6.0	N	Y
1995	Knight Piesold	TP95-33	Hitachi X200	Tailings Basin	5,818,750.00	594,820.00	932.00	7.7	N	Y
1995	Knight Piesold	TP95-34	Hitachi X200	Tailings Basin	5,818,730.00	595,250.00	924.00	6.4	N	Y
1995	Knight Piesold	TP95-35	Hitachi X200	Tailings Basin	5,818,690.00	595,535.00	917.00	6.6	N	Y
1995	Knight Piesold	TP95-36	Hitachi X200	Tailings Basin	5,818,520.00	595,275.00	924.00	6.3	N	Y
1995	Knight Piesold	TP95-37	Hitachi X200	Tailings Basin	5,818,345.00	595,260.00	938.00	3.0	Y	Y
1995	Knight Piesold	TP95-38	Hitachi X200	Main Embankment	5,818,460.00	595,485.00	915.00	6.7	N	Y
1995	Knight Piesold	TP95-39	Hitachi X200	Main Embankment	5,818,405.00	595,405.00	918.00	7.5	N	Y
1995	Knight Piesold	TP95ME-01	Hitachi X200	Main Embankment	5,818,503.74	595,604.67	912.60	2.5	N	Y
1995	Knight Piesold	TP95ME-02	Hitachi X200	Main Embankment	5,818,542.46	595,636.73	913.00	3.0	N	Y
1995	Knight Piesold	TP95ME-03	Hitachi X200	Main Embankment	5,818,614.44	595,735.34	915.60	3.4	N	Y
1995	Knight Piesold	TP95ME-04	Komatsu PC 200 LC	Main Embankment	5,818,505.56	595,641.57	912.40	6.0	N	Y
1995	Knight Piesold	TP95ME-05	Komatsu PC 200 LC	Main Embankment	5,818,519.47	595,657.30	912.50	6.5	N	Y
1995	Knight Piesold	TP95ME-06	Komatsu PC 200 LC	Main Embankment	5,818,537.62	595,680.29	912.90	6.0	N	Y
1995	Knight Piesold	TP95ME-07	Komatsu PC 200 LC	Main Embankment	5,818,550.32	595,696.62	913.20	5.7	N	Y
1995	Knight Piesold	TP95ME-08	Komatsu PC 200 LC	Main Embankment	5,818,566.26	595,717.73	913.80	5.8	N	Y
1995	Knight Piesold	TP95ME-09	Komatsu PC 200 LC	Main Embankment	5,818,583.32	595,739.05	916.50	6.0	N	Y
1995	Knight Piesold	TP95ME-10	Komatsu PC 200 LC	Main Embankment	5,818,459.93	595,584.81	912.40	6.0	N	Y
1995	Knight Piesold	TP95ME-11	Komatsu PC 200 LC	Main Embankment	5,818,442.83	595,563.23	912.50	6.2	N	Y
1995	Knight Piesold	TP95ME-12	Komatsu PC 200 LC	Main Embankment	5,818,428.58	595,541.24	912.80	6.3	N	Y
1995	Knight Piesold	TP95ME-13	Komatsu PC 200 LC	Main Embankment	5,818,409.85	595,520.07	913.40	6.4	N	Y
1995	Knight Piesold	TP95ME-14	Komatsu PC 200 LC	Main Embankment	5,818,393.97	595,498.90	914.80	6.2	N	Y
1995	Knight Piesold	TP95ME-15	Komatsu PC 200 LC	Main Embankment	5,818,378.91	595,478.14	914.40	6.1	N	Y
1995	Knight Piesold	TP95ME-16	Komatsu PC 200 LC	Main Embankment	5,818,359.36	595,457.78	915.40	7.0	N	Y
1995	Knight Piesold	TP95ME-17	Komatsu PC 200 LC	Main Embankment	5,818,346.74	595,432.94	916.40	5.7	N	Y
1995	Knight Piesold	TP95ME-18	Komatsu PC 200 LC	Main Embankment	5,818,334.53	595,408.11	917.00	6.0	N	Y
1995	Knight Piesold	TP95ME-19	Komatsu PC 200 LC	Main Embankment	5,818,325.16	595,387.34	917.80	5.4	N	Y
1995	Knight Piesold	TP95ME-20	Komatsu PC 200 LC	Main Embankment	5,818,313.76	595,365.76	918.60	5.7	N	Y
1995	Knight Piesold	TP95ME-21	Komatsu PC 200 LC	Main Embankment	5,818,298.70	595,345.41	919.80	3.7	N	Y
1995	Knight Piesold	TP95ME-22	Komatsu PC 200 LC	Main Embankment	5,818,376.94	595,417.55	918.00	4.6	N	Y
1995	Knight Piesold	TP95ME-23	Komatsu PC 200 LC	Main Embankment	5,818,435.78	595,474.69	915.70	6.3	N	Y
1995	Knight Piesold	TP95ME-24	Komatsu PC 200 LC	Main Embankment	5,818,465.63	595,513.91	914.00	6.3	N	Y
1995	Knight Piesold	TP95ME-25	Komatsu PC 200 LC	Main Embankment	5,818,394.00	595,573.61	913.70	5.9	N	Y
1995	Knight Piesold	TP95ME-26	Komatsu PC 200 LC	Main Embankment	5,818,322.31	595,491.16	915.40	6.4	N	Y
1995	Knight Piesold	TP95ME-27	Komatsu PC 200 LC	Main Embankment	5,818,285.26	595,448.82	916.90	6.0	N	Y
1995	Knight Piesold	TP95ME-28	Komatsu PC 200 LC	Main Embankment	5,818,257.17	595,413.81	918.00	5.5	N	Y
1995	Knight Piesold	TP95ME-29	Komatsu PC 200 LC	Main Embankment	5,818,281.43	595,466.16	917.20	6.7	N	Y
1995	Knight Piesold	TP95ME-30	Komatsu PC 200 LC	Main Embankment	5,818,207.09	595,420.73	918.00	5.9	N	Y
1995	Knight Piesold	TP95ME-31	Komatsu PC 200 LC	Main Embankment	5,818,257.98	595,493.61	916.20	6.2	N	Y
1995	Knight Piesold	TP95ME-32	Komatsu PC 200 LC	Main Embankment	5,818,288.52	595,525.36	914.80	6.2	N	Y
1995	Knight Piesold	TP95ME-33	Komatsu PC 200 LC	Main Embankment	5,818,314.98	595,566.49	913.30	6.3	N	Y
1995	Knight Piesold	TP95ME-34	Komatsu PC 200 LC	Main Embankment	5,818,345.11	595,612.49	912.20	6.2	N	Y
1995	Knight Piesold	TPS19	JD 690D LC	Main Embankment	5,818,411.89	595,724.46	910.80	4.1	N	Y
1995	Knight Piesold	TPS20	Komatsu PC 200 LC	Main Embankment	5,818,386.15	595,679.09	911.00	6.4	N	Y
1995	Knight Piesold	TPS20.5	Komatsu PC 200 LC	Main Embankment	5,818,329.20	595,685.15	911.20	6.5	N	Y
1995	Knight Piesold	TPS21	JD 690D LC	Main Embankment	5,818,276.28	595,682.32	911.20	4.0	N	Y
1995	Knight Piesold	TPS21.2	Komatsu PC 200 LC	Main Embankment	5,818,290.02	595,717.46	910.00	6.0	N	Y
1995	Knight Piesold	TPS22	JD 690D LC	Main Embankment	5,818,408.36	595,851.97	911.00	4.9	N	Y
1996	Knight Piesold	96-1	-	Tailings Basin	5,818,487.41	595,201.48	-	3.9	N	Y
1996	Knight Piesold	96-2	-	Tailings Basin	5,818,377.48	595,290.03	-	3.0	N	Y
1996	Knight Piesold	96-3	-	Tailings Basin	5,818,422.68	595,245.45	-	2.5	N	Y
1996	Knight Piesold	96-4	-	Tailings Basin	5,818,568.10	595,148.49	-	3.9	N	Y
1996	Knight Piesold	96-5	-	Tailings Basin	5,818,532.48	595,050.02	-	3.9	N	Y

Table C2: Summary of Test Pits

Year	Consultant	Test Pit ID	Method	General Location Description	Coordinates		Ground Elevation (m)	Completion Depth (m)	Bedrock Encountered? (Y/N)	Record of Test Pit Log in Database?
					Northing (m)	Easting (m)				
1996	Knight Piesold	96-6	-	Tailings Basin	5,818,401.30	595,026.20	-	6.0	N	Y
1996	Knight Piesold	96-7	-	South Embankment	5,818,314.58	595,097.05	-	1.1	Y	Y
1996	Knight Piesold	96-8	-	Tailings Basin	5,818,402.52	595,147.12	-	2.5	Y	Y
1996	Knight Piesold	96-9	-	Tailings Basin	5,818,332.90	595,232.63	-	2.0	Y	Y
1996	Knight Piesold	96-10	-	Tailings Basin	5,818,446.90	595,355.18	-	5.3	N	Y
1996	Knight Piesold	96-11	-	Main Embankment	5,818,250.45	595,257.05	-	1.9	Y	Y
1996	Knight Piesold	96-12	-	Tailings Basin	5,818,416.77	595,331.56	-	5.6	N	Y
1996	Knight Piesold	96-13	-	Tailings Basin	5,818,488.02	595,317.72	-	2.3	N	Y
1996	Knight Piesold	96-14	-	Tailings Basin	5,818,519.37	595,350.29	-	4.0	N	Y
1996	Knight Piesold	96-15	-	Tailings Basin	5,818,472.75	595,136.13	-	5.0	N	Y
1996	Knight Piesold	96-16	-	Tailings Basin	5,818,395.19	595,061.62	-	4.8	N	Y
1996	Knight Piesold	96-17	-	Tailings Basin	5,818,506.75	595,254.61	-	6.5	N	Y
1996	Knight Piesold	96-18	-	Tailings Basin	5,818,551.94	595,267.64	-	4.5	N	Y
1996	Knight Piesold	96-19	-	Tailings Basin	5,818,392.75	595,072.01	-	4.7	Y	Y
1996	Knight Piesold	96-20	-	Main Embankment	5,818,586.55	595,307.95	-	7.3	N	Y
1996	Knight Piesold	96-21	-	Tailings Basin	5,818,512.04	595,394.67	-	5.7	N	Y
1996	Knight Piesold	96-22	-	Tailings Basin	5,818,565.79	595,371.87	-	5.2	N	Y
1996	Knight Piesold	96-23	-	Tailings Basin	5,818,586.55	595,407.29	-	2.7	N	Y
1996	Knight Piesold	96-24	-	Tailings Basin	5,818,681.23	595,353.10	-	4.3	N	Y
1996	Knight Piesold	96-25	-	Tailings Basin	5,818,737.09	595,262.31	-	5.7	N	Y
1996	Knight Piesold	96-26	-	Tailings Basin	5,818,709.16	595,307.71	-	3.0	N	Y
1996	Knight Piesold	96-27	-	Tailings Basin	5,818,770.61	595,202.26	-	2.3	N	Y
1996	Knight Piesold	96-28	-	Tailings Basin	5,818,786.67	595,274.88	-	2.4	N	Y
1996	Knight Piesold	96-29	-	Main Embankment	5,818,597.65	595,688.02	-	3.8	N	Y
1996	Knight Piesold	96-30	-	Tailings Basin	5,818,641.01	595,654.43	-	4.8	N	Y
1996	Knight Piesold	96-31	-	Tailings Basin	5,818,614.54	595,613.92	-	4.2	N	Y
1996	Knight Piesold	96-32	-	Main Embankment	5,818,569.76	595,645.27	-	3.1	N	Y
1996	Knight Piesold	96-33	-	Tailings Basin	5,818,589.71	595,571.58	-	2.5	N	Y
1996	Knight Piesold	96-34	-	Tailings Basin	5,818,561.21	595,530.05	-	2.5	N	Y
1996	Knight Piesold	96-35	-	Tailings Basin	5,818,588.08	595,500.73	-	2.5	N	Y
1996	Knight Piesold	96-36	-	Tailings Basin	5,818,617.39	595,541.04	-	2.1	N	Y
1996	Knight Piesold	96-37	-	Main Embankment	5,818,540.44	595,603.74	-	2.3	N	Y
1996	Knight Piesold	96-38	-	Main Embankment	5,818,509.91	595,563.03	-	2.3	N	Y
1996	Knight Piesold	96-39	-	Main Embankment	5,818,478.56	595,523.94	-	1.9	N	Y
1996	Knight Piesold	96-40	-	Tailings Basin	5,818,517.23	595,493.00	-	3.8	N	Y
1996	Knight Piesold	96-41	-	Main Embankment	5,818,453.41	595,487.50	-	3.7	N	Y
1996	Knight Piesold	96-42	-	Tailings Basin	5,818,490.47	595,482.21	-	4.2	N	Y
1996	Knight Piesold	96-43	-	Borrow Area No. 3	5,818,188.95	596,706.31	-	1.2	N	Y
1996	Knight Piesold	96-44	-	Borrow Area No. 3	-	-	-	2.2	N	Y
1996	Knight Piesold	96-45	-	Borrow Area No. 3	-	-	-	4.2	N	Y
1996	Knight Piesold	96-46	-	Borrow Area No. 3	-	-	-	5.3	N	Y
1996	Knight Piesold	96-47	-	Borrow Area No. 3	5,818,339.77	596,714.74	-	4.4	N	Y
1996	Knight Piesold	96-48	-	Borrow Area No. 3	-	-	-	5.0	N	Y
1996	Knight Piesold	96-49	-	Borrow Area No. 3	-	-	-	6.0	N	Y
1996	Knight Piesold	96-50	-	Borrow Area No. 3	-	-	-	5.2	N	Y
1996	Knight Piesold	96-51	-	Borrow Area No. 3	-	-	-	5.0	N	Y
1996	Knight Piesold	96-52	-	Borrow Area No. 3	5,818,268.58	596,786.68	-	4.5	N	Y
1996	Knight Piesold	96-53	-	Borrow Area No. 3	5,818,276.76	596,636.36	-	6.0	N	Y
1996	Knight Piesold	96-54	-	Borrow Area No. 2	5,818,353.16	596,608.58	-	5.8	N	Y
1996	Knight Piesold	96-55	-	Borrow Area No. 2	5,818,432.05	596,562.94	-	5.4	N	Y
1996	Knight Piesold	96-56	-	Perimeter Embankment	5,819,723.19	595,881.83	-	8.2	N	Y
1996	Knight Piesold	96-57	-	Perimeter Embankment	5,819,760.44	595,906.04	-	6.8	N	Y
1996	Knight Piesold	96-58	-	Perimeter Embankment	5,819,659.88	595,839.00	-	7.6	N	Y
1996	Knight Piesold	96-59	-	Perimeter Embankment	5,819,697.59	595,910.69	-	7.9	N	Y
1996	Knight Piesold	96-60	-	Perimeter Embankment	5,819,671.05	595,929.78	-	5.8	N	Y
1996	Knight Piesold	96-61	-	Perimeter Embankment	5,819,749.26	595,856.69	-	7.5	N	Y
1996	Knight Piesold	96-62	-	Perimeter Embankment	5,819,762.76	595,822.70	-	6.2	N	Y
1996	Knight Piesold	96-63	-	Perimeter Embankment	5,819,779.99	595,797.56	-	6.2	N	Y
1996	Knight Piesold	96-64	-	Perimeter Embankment	5,819,818.16	595,765.91	-	6.0	N	Y
1996	Knight Piesold	96-65	-	Perimeter Embankment	5,819,813.04	595,730.99	-	4.3	N	Y
1996	Knight Piesold	96-66	-	Perimeter Embankment	5,819,705.97	595,847.38	-	5.6	N	Y
1996	Knight Piesold	96-67	-	Perimeter Embankment	5,819,694.79	595,874.84	-	6.2	N	Y
1996	Knight Piesold	96-68	-	Perimeter Embankment	5,819,727.85	595,909.76	-	6.2	N	Y
1996	Knight Piesold	96-69	-	Perimeter Embankment	5,819,751.59	595,888.81	-	5.5	N	Y
1996	Knight Piesold	96-70	-	Tailings Basin	5,819,026.81	594,885.13	-	2.7	N	Y
1996	Knight Piesold	96-71	-	Tailings Basin	5,819,048.46	594,776.19	-	3.8	N	Y
1996	Knight Piesold	96-72	-	Tailings Basin	5,819,051.25	594,740.58	-	0.4	N	Y
1996	Knight Piesold	96-73	-	Tailings Basin	5,819,061.03	594,702.87	-	4.2	N	Y
1996	Knight Piesold	96-74	-	Tailings Basin	5,819,014.94	594,772.00	-	1.0	N	Y
1996	Knight Piesold	96-75	-	Tailings Basin	5,818,985.61	594,767.81	-	3.4	N	Y
1996	Knight Piesold	96-76	-	Tailings Basin	5,818,918.36	594,758.04	-	2.9	N	Y
1996	Knight Piesold	96-77	-	Tailings Basin	5,818,823.01	594,743.18	-	2.5	N	Y
1996	Knight Piesold	96-78	-	Tailings Basin	5,819,142.03	594,767.12	-	2.5	N	Y
1996	Knight Piesold	96-79	-	Tailings Basin	5,819,093.85	594,852.31	-	3.5	N	Y
1996	Knight Piesold	96-80	-	Tailings Basin	5,819,157.40	594,711.25	-	3.0	N	Y
1996	Knight Piesold	96-81	-	Tailings Basin	5,818,962.32	594,833.58	-	3.0	N	Y
1996	Knight Piesold	96-82	-	Tailings Basin	5,818,921.46	594,864.53	-	3.0	N	Y
1996	Knight Piesold	96-83	-	Tailings Basin	5,818,998.18	594,810.41	-	4.7	N	Y
1996	Knight Piesold	96-84	-	Borrow Area No. 1	5,819,082.74	596,016.53	-	5.3	N	Y
1996	Knight Piesold	96-85	-	Borrow Area No. 1	5,819,205.27	595,926.75	-	5.3	N	Y
1996	Knight Piesold	96-86	-	Borrow Area No. 1	5,819,325.38	595,827.59	-	6.4	N	Y

Table C2: Summary of Test Pits

Year	Consultant	Test Pit ID	Method	General Location Description	Coordinates		Ground Elevation (m)	Completion Depth (m)	Bedrock Encountered? (Y/N)	Record of Test Pit Log in Database?
					Northing (m)	Easting (m)				
1996	Knight Piesold	96-87	-	Borrow Area No. 1	5,819,434.32	595,725.64	-	2.5	N	Y
1996	Knight Piesold	96-88	-	Borrow Area No. 1	5,819,479.71	595,534.30	-	6.5	N	Y
1996	Knight Piesold	96-89	-	Borrow Area No. 1	5,819,314.91	595,681.64	-	2.5	N	Y
1996	Knight Piesold	96-90	-	Borrow Area No. 1	5,819,240.49	595,834.96	-	2.8	N	Y
1996	Knight Piesold	96-91	-	Borrow Area No. 1	5,819,109.60	595,919.07	-	2.5	N	Y
1996	Knight Piesold	96-92	-	Borrow Area No. 1	5,819,054.43	595,837.37	-	2.5	N	Y
1996	Knight Piesold	96-93	-	Borrow Area No. 1	5,818,710.63	595,744.21	-	5.7	N	Y
1996	Knight Piesold	96-94	-	Borrow Area No. 1	5,818,866.23	595,647.07	-	7.0	N	Y
1996	Knight Piesold	96-95	-	Borrow Area No. 1	5,818,825.45	595,808.94	-	4.0	N	Y
1996	Knight Piesold	96-96	-	Borrow Area No. 1	5,818,738.11	595,789.40	-	4.0	N	Y
1996	Knight Piesold	96-97	-	Borrow Area No. 1	5,818,784.32	595,895.26	-	3.3	N	Y
1996	Knight Piesold	96-98	-	Borrow Area No. 1	5,818,784.53	595,735.04	-	4.0	N	Y
1996	Knight Piesold	96-99	-	Borrow Area No. 1	5,818,872.09	596,030.12	-	6.0	N	Y
1996	Knight Piesold	96-100	-	Borrow Area No. 1	5,818,816.90	595,938.01	-	3.8	N	Y
1996	Knight Piesold	96-101	-	Borrow Area No. 1	5,819,013.23	595,934.43	-	7.3	N	Y
1996	Knight Piesold	96-102	-	Borrow Area No. 1	5,818,944.44	595,859.37	-	7.6	N	Y
1996	Knight Piesold	96-103	-	Borrow Area No. 1	5,819,062.81	595,755.66	-	7.5	N	Y
1996	Knight Piesold	96-104	-	Borrow Area No. 1	5,819,000.00	595,683.39	-	8.0	N	Y
1996	Knight Piesold	96-105	-	Borrow Area No. 1	5,819,129.85	595,831.08	-	6.5	N	Y
1996	Knight Piesold	96-106	-	Borrow Area No. 1	5,819,249.26	595,734.02	-	7.6	N	Y
1996	Knight Piesold	96-107	-	Borrow Area No. 1	5,819,179.43	595,659.99	-	8.0	N	Y
1996	Knight Piesold	96-108	-	Borrow Area No. 1	5,818,857.20	595,878.56	-	6.5	N	Y
1996	Knight Piesold	96-109	-	Main Embankment	5,818,273.46	595,519.66	-	3.7	N	Y
1996	Knight Piesold	96-110	-	Main Embankment	5,818,246.99	595,463.88	-	4.7	N	Y
1996	Knight Piesold	96-111	-	Perimeter Embankment	5,819,480.09	596,067.50	-	5.4	N	Y
1996	Knight Piesold	96-112	-	Perimeter Embankment	5,819,206.34	596,208.57	-	6.7	N	Y
1996	Knight Piesold	96-113	-	Perimeter Embankment	5,819,659.88	595,977.73	-	5.4	N	Y
1996	Knight Piesold	96-114	-	Perimeter Embankment	5,819,644.05	595,893.93	-	5.4	N	Y
1996	Knight Piesold	96-115	-	Perimeter Embankment	5,819,692.00	595,944.21	-	5.8	N	Y
1996	Knight Piesold	96-116	-	Tailings Basin	5,818,924.89	595,293.02	-	3.0	N	Y
1996	Knight Piesold	96-117	-	Tailings Basin	5,818,876.71	595,411.74	-	5.0	N	Y
1996	Knight Piesold	96-118	-	Tailings Basin	5,818,764.97	595,474.59	-	4.0	N	Y
1996	Knight Piesold	96-119	-	Main Embankment	5,818,482.71	595,598.14	-	5.8	N	Y
1996	Knight Piesold	TP96-BA-E4	-	Borrow Area No. 1	5,818,910.92	595,822.35	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-E5	-	Borrow Area No. 1	5,818,949.33	595,788.83	-	5.8	N	Y
1996	Knight Piesold	TP96-BA-E6	-	Borrow Area No. 1	5,818,986.34	595,757.41	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-E7	-	Borrow Area No. 1	5,819,025.10	595,724.24	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-E8	-	Borrow Area No. 1	5,819,063.51	595,690.72	-	5.5	N	Y
1996	Knight Piesold	TP96-BA-E9	-	Borrow Area No. 1	5,819,101.22	595,657.90	-	6.2	N	Y
1996	Knight Piesold	TP96-BA-F4	-	Borrow Area No. 1	5,818,948.63	595,856.57	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-F5	-	Borrow Area No. 1	5,818,982.15	595,825.85	-	6.1	N	Y
1996	Knight Piesold	TP96-BA-F6	-	Borrow Area No. 1	5,819,020.21	595,794.07	-	6.1	N	Y
1996	Knight Piesold	TP96-BA-F7	-	Borrow Area No. 1	5,819,057.92	595,761.95	-	2.3	N	Y
1996	Knight Piesold	TP96-BA-F8	-	Borrow Area No. 1	5,819,095.63	595,728.43	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-F9	-	Borrow Area No. 1	5,819,134.74	595,695.61	-	-	-	N
1996	Knight Piesold	TP96-BA-G4	-	Borrow Area No. 1	-	-	-	6.2	N	Y
1996	Knight Piesold	TP96-BA-G5	-	Borrow Area No. 1	5,819,014.63	595,862.51	-	6.2	N	Y
1996	Knight Piesold	TP96-BA-G6	-	Borrow Area No. 1	5,819,052.34	595,831.08	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-G7	-	Borrow Area No. 1	5,819,091.44	595,797.56	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-G8	-	Borrow Area No. 1	5,819,129.85	595,765.44	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-G9	-	Borrow Area No. 1	5,819,168.26	595,731.22	-	4.0	N	Y
1996	Knight Piesold	TP96-BA-H4	-	Borrow Area No. 1	5,819,007.64	595,933.04	-	6.7	N	Y
1996	Knight Piesold	TP96-BA-H5	-	Borrow Area No. 1	5,819,048.15	595,900.92	-	5.6	N	Y
1996	Knight Piesold	TP96-BA-H6	-	Borrow Area No. 1	5,819,085.68	595,868.09	-	5.5	N	Y
1996	Knight Piesold	TP96-BA-H7	-	Borrow Area No. 1	5,819,125.66	595,834.57	-	6.2	N	Y
1996	Knight Piesold	TP96-BA-H8	-	Borrow Area No. 1	5,819,164.07	595,801.75	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-H9	-	Borrow Area No. 1	5,819,201.60	595,768.23	-	6.2	N	Y
1996	Knight Piesold	TP96-BA-I4	-	Borrow Area No. 1	5,819,044.48	595,970.75	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-I5	-	Borrow Area No. 1	5,819,082.19	595,937.23	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-I6	-	Borrow Area No. 1	5,819,120.60	595,904.41	-	6.0	N	Y
1996	Knight Piesold	TP96-BA-I7	-	Borrow Area No. 1	5,819,158.31	595,870.89	-	6.1	N	Y
1996	Knight Piesold	TP96-BA-I8	-	Borrow Area No. 1	5,819,197.41	595,838.07	-	6.1	N	Y
1996	Knight Piesold	TP96-BA-I9	-	Borrow Area No. 1	5,819,235.12	595,805.24	-	6.3	N	Y
1996	Knight Piesold	PRT-01	-	Main Embankment	5,818,530.77	595,725.27	-	-	-	N
1996	Knight Piesold	PRT-02	-	Main Embankment	5,818,413.92	595,565.67	-	-	-	N
1996	Knight Piesold	PRT-03	-	Main Embankment	5,818,412.10	595,503.12	-	-	-	N
1996	Knight Piesold	PRT-04	-	Main Embankment	5,818,360.11	595,482.59	-	-	-	N
1997	Knight Piesold	TP97-BA-F11	-	Borrow Area No. 1	5,819,212.25	595,628.57	-	5.7	N	Y
1997	Knight Piesold	TP97-BA-F12	-	Borrow Area No. 1	5,819,249.96	595,596.45	-	5.8	N	Y
1997	Knight Piesold	TP97-BA-F14	-	Borrow Area No. 1	5,819,324.68	595,531.50	-	6.0	N	Y
1997	Knight Piesold	TP97-BA-F15	-	Borrow Area No. 1	5,819,363.09	595,499.38	-	6.1	N	Y
1997	Knight Piesold	TP97-BA-G4	-	Borrow Area No. 1	5,818,977.27	595,894.98	-	5.8	N	Y
1997	Knight Piesold	TP97-BA-G10	-	Borrow Area No. 1	5,819,205.27	595,693.51	-	5.9	N	Y
1997	Knight Piesold	TP97-BA-G11	-	Borrow Area No. 1	5,819,245.07	595,665.58	-	6.1	N	Y
1997	Knight Piesold	TP97-BA-G12	-	Borrow Area No. 1	5,819,283.48	595,632.06	-	5.7	N	Y
1997	Knight Piesold	TP97-BA-G13	-	Borrow Area No. 1	5,819,321.89	595,599.94	-	5.8	N	Y
1997	Knight Piesold	TP97-BA-G14	-	Borrow Area No. 1	5,819,358.20	595,567.81	-	6.1	N	Y
1997	Knight Piesold	TP97-BA-G15	-	Borrow Area No. 1	5,819,395.21	595,535.69	-	6.3	N	Y
1997	Knight Piesold	TP97-BA-G16	-	Borrow Area No. 1	5,819,433.62	595,502.17	-	5.7	N	Y
1997	Knight Piesold	TP97-BA-H3	-	Borrow Area No. 1	5,818,971.68	595,965.51	-	5.8	N	Y
1997	Knight Piesold	TP97-BA-H11	-	Borrow Area No. 1	5,819,277.72	595,703.29	-	5.7	N	Y

Table C2: Summary of Test Pits

Year	Consultant	Test Pit ID	Method	General Location Description	Coordinates		Ground Elevation (m)	Completion Depth (m)	Bedrock Encountered? (Y/N)	Record of Test Pit Log in Database?
					Northing (m)	Easting (m)				
1997	Knight Piesold	TP97-BA-H12	-	Borrow Area No. 1	-	-	-	5.9	N	Y
1997	Knight Piesold	TP97-BA-I10	-	Borrow Area No. 1	5,819,273.53	595,773.12	-	5.9	N	Y
1997	Knight Piesold	TP97-BA-I11	-	Borrow Area No. 1	5,819,311.24	595,739.60	-	5.7	N	Y
1997	Knight Piesold	TP97-BA-I12	-	Borrow Area No. 1	5,819,351.04	595,706.78	-	3.7	N	Y
1997	Knight Piesold	TP97-BA-I13	-	Borrow Area No. 1	5,819,386.66	595,673.96	-	5.5	N	Y
1997	Knight Piesold	TP97-BA-I14	-	Borrow Area No. 1	5,819,422.97	595,641.84	-	5.6	N	Y
1997	Knight Piesold	TP97-BA-I15	-	Borrow Area No. 1	5,819,462.78	595,609.71	-	5.6	N	Y
1997	Knight Piesold	TP97-BA-I16	-	Borrow Area No. 1	5,819,500.48	595,576.89	-	5.7	N	Y
1997	Knight Piesold	TP97-BA4-F8	-	Borrow Area No. 4	5,819,693.71	594,514.32	951.08	5.5	N	Y
1997	Knight Piesold	TP97-BA4-F9	-	Borrow Area No. 4	5,819,793.57	594,512.23	955.30	5.9	N	Y
1997	Knight Piesold	TP97-BA4-G4	-	Borrow Area No. 4	5,819,287.98	594,619.07	939.80	5.3	N	Y
1997	Knight Piesold	TP97-BA4-G5	-	Borrow Area No. 4	5,819,387.84	594,619.77	941.20	5.7	N	Y
1997	Knight Piesold	TP97-BA4-G6	-	Borrow Area No. 4	5,819,490.50	594,614.88	944.60	5.3	N	Y
1997	Knight Piesold	TP97-BA4-G7	-	Borrow Area No. 4	5,819,590.36	594,612.79	945.36	5.6	N	Y
1997	Knight Piesold	TP97-BA4-G8	-	Borrow Area No. 4	5,819,693.71	594,611.39	947.80	5.3	N	Y
1997	Knight Piesold	TP97-BA4-G9	-	Borrow Area No. 4	5,819,794.27	594,609.29	952.30	5.7	N	Y
1997	Knight Piesold	TP97-BA4-H4	-	Borrow Area No. 4	5,819,290.08	594,718.23	937.80	5.3	N	Y
1997	Knight Piesold	TP97-BA4-H5	-	Borrow Area No. 4	5,819,392.03	594,715.44	939.40	5.0	N	Y
1997	Knight Piesold	TP97-BA4-H6	-	Borrow Area No. 4	5,819,491.89	594,714.04	941.30	5.3	N	Y
1997	Knight Piesold	TP97-BA4-H7	-	Borrow Area No. 4	5,819,591.75	594,711.25	942.80	6.2	N	Y
1997	Knight Piesold	TP97-BA4-H8	-	Borrow Area No. 4	5,819,695.11	594,710.55	944.10	5.4	N	Y
1997	Knight Piesold	TP97-BA4-H9	-	Borrow Area No. 4	5,819,795.67	594,707.06	947.80	5.3	N	Y
1997	Knight Piesold	TP97-BA4-I4	-	Borrow Area No. 4	5,819,290.08	594,813.20	936.40	5.1	N	Y
1997	Knight Piesold	TP97-BA4-I6	-	Borrow Area No. 4	5,819,493.29	594,811.11	936.90	6.0	N	Y
1997	Knight Piesold	TP97-BA4-I7	-	Borrow Area No. 4	5,819,594.55	594,808.32	937.20	5.8	N	Y
1997	Knight Piesold	TP97-BA4-I8	-	Borrow Area No. 4	5,819,695.11	594,805.52	939.90	5.3	N	Y
1997	Knight Piesold	TP97-BA4-I9	-	Borrow Area No. 4	5,819,796.36	594,804.13	942.45	5.3	N	Y
1997	Knight Piesold	TP97-BA4-J8	Hitachi EX270	Borrow Area No. 4	5,819,695.80	594,903.99	934.41	5.1	N	Y
1997	Knight Piesold	TP97-BA4-J9	Hitachi EX270	Borrow Area No. 4	5,819,799.86	594,901.19	936.66	5.3	N	Y
1997	Knight Piesold	TP97-PETP-1	-	Perimeter Embankment	5,819,588.32	595,551.16	-	5.4	N	Y
1997	Knight Piesold	TP97-PETP-2	-	Perimeter Embankment	5,819,653.52	595,451.18	-	5.2	N	Y
1997	Knight Piesold	TP97-PETP-3	-	Corner 1 Embankment	5,819,796.98	595,281.64	-	5.1	N	Y
1997	Knight Piesold	TP97-PETP-4	-	Corner 1 Embankment	5,819,962.17	595,014.30	-	5.0	N	Y
1998	Knight Piesold	TP98-BA2-1	-	Borrow Area No. 2	5,818,449.41	596,433.45	-	-	-	N
1998	Knight Piesold	TP98-BA2-2	-	Borrow Area No. 2	5,818,548.63	596,463.71	-	-	-	N
1998	Knight Piesold	TP98-BA2-3	-	Borrow Area No. 2	5,818,541.68	596,361.52	-	-	-	N
1998	Knight Piesold	TP98-BA2-5	-	Borrow Area No. 2	5,818,640.91	596,247.41	-	-	-	N
1998	Knight Piesold	PRT98-01	-	Main Embankment	-	-	-	-	-	N
1998	Knight Piesold	PRT98-02	-	Main Embankment	-	-	-	-	-	N
1998	Knight Piesold	PRT98-03	-	Main Embankment	-	-	-	-	-	N
2014	KCB	TP14-01	Komatsu PC 400 LC	Dam Breach Area	5,819,966.80	595,121.70	931.00	-	N	N
2014	BGC	BGC-TP-2014	-	Corner 1 Embankment	5,820,252.50	594,927.20	932.14	-	-	N

Table C3: Summary of Cone Penetration Tests

Year	Consultant	CPT Sounding	Method(s)	General Location Description	Coordinates		Ground Elevation (m)	Start Depth (m)	Completion Depth (m)	Intermediate Drill Outs? (Y/N)	Record of CPT in Database?	CPT on Figure 01?	CPT on Figure 02?
					Northing (m)	Easting (m)							
1996	Knight Piesold	CPT96-1	SCPTu	Main Embankment	5,818,475.71	595,586.23	-	0.00	9.70	N	Y	Y	N
1996	Knight Piesold	CPT96-2	CPTu	Main Embankment	5,818,405.37	595,581.55	-	0.00	9.60	N	Y	Y	N
1996	Knight Piesold	CPT96-3	CPTu	Main Embankment	5,818,538.81	595,593.97	-	0.00	10.85	N	Y	Y	N
1996	Knight Piesold	CPT96-4	CPTu	Main Embankment	5,818,478.56	595,515.80	-	0.00	11.50	N	Y	Y	N
1996	Knight Piesold	CPT96-5	CPTu	Main Embankment	5,818,464.00	595,664.61	-	0.00	10.00	N	Y	Y	N
1996	Knight Piesold	PRW96-1	CPT	Main Embankment	-	-	-	0.00	7.65	N	Y	N	N
1996	Knight Piesold	PRW96-2 (4)	CPTu	Main Embankment	-	-	-	0.00	11.80	Y	Y	N	N
1996	Knight Piesold	PRW96-2 (4A)	SCPTu	Main Embankment	-	-	-	7.70	15.85	N	Y	N	N
1996	Knight Piesold	PRW96-3	CPTu	Main Embankment	-	-	-	0.00	8.25	N	Y	N	N
1996	Knight Piesold	PRW96-4	CPTu	Main Embankment	-	-	-	0.00	10.25	N	Y	N	N
2014	The Panel	CPT14-101	CPTu	Dam Breach Area	5,819,824.96	595,337.17	933.02	-	17.13	Y	Y	N	Y
2014	The Panel	CPT14-102	CPTu	Dam Breach Area	5,819,832.38	595,327.32	932.48	-	13.05	N	Y	N	Y
2014	The Panel	RCPT14-103	RCPTu	Dam Breach Area	5,819,863.30	595,298.44	930.58	-	9.43	N	Y	N	Y
2014	The Panel	RCPT14-104	RCPTu	Dam Breach Area	5,819,888.67	595,258.02	931.74	-	12.53	N	Y	N	Y
2014	The Panel	RCPT14-105	RCPTu	Dam Breach Area	5,819,919.38	595,224.14	931.61	0.00	12.28	N	Y	N	Y
2014	The Panel	RCPT14-106	RCPTu	Dam Breach Area	5,819,998.38	595,141.52	928.65	0.00	13.15	N	Y	N	Y
2014	The Panel	RCPT14-107	RCPTu	Dam Breach Area	5,820,013.00	595,126.70	928.41	0.00	14.20	N	Y	N	Y
2014	The Panel	RCPT14-108	RCPTu	Dam Breach Area	5,820,015.85	595,107.30	928.26	0.00	12.75	N	Y	N	Y
2014	The Panel	RCPT14-108B	RCPTu	Dam Breach Area	5,820,014.58	595,106.67	928.44	0.00	15.88	N	Y	N	Y
2014	The Panel	RCPT14-109	RCPTu	Dam Breach Area	5,820,024.43	595,087.57	928.63	0.00	16.15	N	Y	N	Y
2014	The Panel	RCPT14-110	RCPTu	Dam Breach Area	5,820,042.87	595,093.88	928.65	0.00	15.98	N	Y	N	Y
2014	The Panel	RCPT14-111	RCPTu	Dam Breach Area	5,820,044.92	595,116.91	928.41	0.00	14.00	N	Y	N	Y
2014	The Panel	RCPT14-112	RCPTu	Dam Breach Area	5,820,029.00	595,146.40	928.63	0.00	11.70	N	Y	N	Y
2014	The Panel	RCPT14-113	RCPTu	Dam Breach Area	5,820,013.48	595,153.78	929.17	0.00	11.93	N	Y	N	Y
2014	The Panel	RCPT14-114	RCPTu	Dam Breach Area	5,819,979.00	595,062.50	930.61	0.00	1.25	N	Y	N	Y
2014	The Panel	RCPT14-114B	RCPTu	Dam Breach Area	5,819,979.00	595,062.60	930.63	-	14.73	N	Y	N	Y
2014	The Panel	RCPT14-115	RCPTu	Dam Breach Area	5,820,011.00	595,075.90	929.11	0.00	13.00	N	Y	N	Y
2014	KCB	CPT14-01	RSCPTu	Dam Breach Area	5,819,871.83	595,252.96	931.29	2.83	14.68	Y	Y	N	Y
2014	KCB	CPT14-02	RSCPTu	Dam Breach Area	5,819,956.83	595,200.65	933.03	9.48	16.60	Y	Y	N	Y
2014	KCB	CPT14-03	RSCPTu	Dam Breach Area	5,819,937.31	595,129.86	932.47	5.38	20.53	N	Y	N	Y
2014	KCB	CPT14-04	RSCPTu	Dam Breach Area	5,819,912.66	595,105.56	932.27	5.43	17.25	N	Y	N	Y
2014	KCB	CPT14-05	RCPTu	Dam Breach Area	5,819,924.42	595,188.02	937.43	-	5.80	-	N	N	Y
2014	KCB	CPT14-05A	RSCPTu	Dam Breach Area	5,819,924.42	595,188.02	937.43	13.45	17.60	N	Y	N	Y
2014	KCB	CPT14-06	RSCPTu	Dam Breach Area	5,819,920.26	595,177.07	937.76	9.68	20.23	Y	Y	N	Y
2014	KCB	CPT14-06A	RCPTu	Dam Breach Area	5,819,922.37	595,176.22	937.71	10.70	18.10	N	Y	N	Y
2014	KCB	CPT14-07	RSCPTu	Dam Breach Area	5,819,902.21	595,053.58	931.58	6.13	14.18	N	Y	N	Y
2014	KCB	CPT14-08	RSCPTu	Dam Breach Area	5,819,890.40	595,169.41	947.50	21.23	28.88	N	Y	N	Y
2014	KCB	CPT14-10	RCPTu	Dam Breach Area	5,819,967.55	595,151.21	932.24	7.63	16.28	Y	Y	N	N
2014	KCB	CPT14-10A	RSCPTu	Dam Breach Area	5,819,967.55	595,151.21	932.24	-	11.00	-	N	N	Y
2014	KCB	CPT14-11	RSCPTu	Dam Breach Area	5,819,991.32	595,169.95	931.06	5.65	10.63	N	Y	N	Y
2014	KCB	CPT14-13	RSCPTu	Perimeter Embankment	5,819,767.45	595,409.35	933.41	6.73	22.95	Y	Y	N	Y
2014	KCB	CPT14-14	RSCPTu	Dam Breach Area	5,819,937.03	595,100.52	930.45	3.05	13.98	N	Y	N	Y
2014	KCB	CPT14-15	RSCPTu	Dam Breach Area	5,819,960.89	595,100.02	930.20	3.53	18.83	N	Y	N	Y
2014	KCB	CPT14-16	RSCPTu	Dam Breach Area	5,819,976.38	595,078.31	930.28	8.03	12.48	N	Y	N	Y
2014	KCB	CPT14-16A	RSCPTu	Dam Breach Area	5,819,975.79	595,079.20	930.44	2.33	8.98	N	Y	N	Y
2014	KCB	CPT14-17	RSCPTu	Dam Breach Area	5,819,994.09	595,086.97	929.99	3.48	13.95	Y	Y	N	Y
2014	KCB	CPT14-18	RSCPTu	Dam Breach Area	5,820,025.89	595,012.98	934.84	3.85	11.85	N	Y	N	Y
2014	KCB	CPT14-19	RSCPTu	Dam Breach Area	5,820,043.69	594,886.51	942.67	3.38	7.08	Y	Y	N	Y
2014	KCB	CPT14-21	RSCPTu	Perimeter Embankment	5,819,718.00	595,328.74	971.00	0.00	25.55	Y	Y	N	Y
2014	KCB	CPT14-22	RSCPTu	Dam Breach Area	5,819,981.72	595,124.54	929.77	3.93	18.40	N	Y	N	Y
2016	Golder	CPT16-04	CPTu	Corner 1 Embankment Buttress	5,820,009.00	595,265.00	932.80	8.50	15.80	Y	Y	Y	Y
2016	Golder	CPT16-05	CPTu	Corner 1 Embankment Buttress	5,820,060.00	595,310.00	925.50	3.10	7.60	Y	Y	Y	Y
2016	Golder	CPT16-07	CPTu	Corner 1 Embankment Buttress	5,819,961.00	595,352.00	932.40	9.00	14.80	N	Y	Y	Y
2016	Golder	CPT16-08	CPTu	Corner 1 Embankment Buttress	5,820,015.00	595,378.00	924.40	4.10	7.10	N	Y	Y	Y
2016	Golder	CPT16-09	CPTu	Corner 1 Embankment Buttress	5,819,949.00	595,458.00	923.90	2.10	6.50	N	Y	Y	Y
2016	Golder	CPT16-19	CPTu	South Embankment	5,818,341.00	594,791.00	945.20	9.10	9.50	N	Y	Y	N
2016	Golder	CPT16-20	CPTu	Perimeter Embankment (Tailings)	5,819,411.00	595,562.00	961.20	0.70	31.00	N	Y	Y	N
2016	Golder	CPT16-21	CPTu	Main Embankment (Tailings)	5,818,759.00	595,801.00	964.00	0.80	38.40	N	Y	Y	N
2016	Golder	CPT16-22	CPTu	South Embankment (Tailings)	5,818,489.00	594,836.00	962.90	0.70	24.40	N	Y	Y	N
2021	Golder	CPT21-02	SCPTu	Perimeter Embankment Buttress	5,819,628.37	595,780.62	930.07	15.24	26.20	Y	Y	Y	N
2021	Golder	CPT21-03	SCPTu	Perimeter Embankment Buttress	5,819,542.99	595,924.23	930.45	25.30	40.10	Y	Y	Y	N
2021	Golder	CPT21-06	SCPTu	Perimeter Embankment Buttress	5,819,066.04	596,228.13	946.12	30.73	30.91	N	Y	Y	N
2021	Golder	CPT21-07	SCPTu	Main Embankment Buttress	5,818,649.11	596,018.63	935.90	12.50	35.54	Y	Y	Y	N
2021	Golder	CPT21-08	SCPTu	Main Embankment Buttress	5,818,510.30	595,878.28	930.24	18.63	29.89	N	Y	Y	N
2021	Golder	CPT21-09	SCPTu	Main Embankment Buttress	5,818,304.68	595,544.37	930.53	18.53	25.42	Y	Y	Y	N

Table C4 (a): Summary of Monitoring Wells

Year	Consultant	Monitoring Well ID	Borehole	General Location Description	Coordinates		Ground Elevation (m)	Collar Elevation (m)	Screen Interval (m)		Screen Interval (mbgs)		Soil Units	Hydraulic Conductivity Tests		Record of MW in Database?	Location on Figure 01?
					Northing (m)	Easting (m)			From	To	From	To		Method	Hydraulic Conductivity (m/s)		
1989	Knight Piesold	MP89-231	MP89-231	Corner 1 Embankment	5,819,929.90	595,178.85	927.20	-	927.20	892.10	0.0	35.1	See Table B4 (b)	Packer Test	See Table C4 (b)	Y	Y
1989	Knight Piesold	MP89-232	MP89-232	Tailings Basin	5,818,944.44	595,471.80	919.40	-	919.40	904.20	0.0	15.2	See Table B4 (b)	Packer Test	See Table C4 (b)	Y	Y
1989	Knight Piesold	MP89-233	MP89-233	Perimeter Embankment	5,819,358.58	596,015.13	933.90	-	933.90	903.40	0.0	30.5	See Table B4 (b)	Packer Test	See Table C4 (b)	Y	Y
1989	Knight Piesold	MP89-234	MP89-234	Main Embankment	5,818,369.54	595,625.93	909.30	-	909.30	869.70	0.0	39.6	See Table B4 (b)	Packer Test	See Table C4 (b)	Y	Y
1989	Knight Piesold	MP89-235	MP89-235	South Embankment	5,818,356.15	595,016.85	946.20	-	946.20	914.20	0.0	32.0	See Table B4 (b)	Packer Test	See Table C4 (b)	Y	Y
1989	Knight Piesold	MP89-236	MP89-236	Tailings Basin	5,818,961.71	594,395.20	949.00	-	949.00	917.00	0.0	32.0	See Table B4 (b)	Packer Test	See Table C4 (b)	Y	Y
1996	Knight Piesold	GW96-1A	GW96-1A	Corner 1 Embankment	5,819,939.06	595,415.82	927.89	928.49	873.49	868.89	54.4	59.0	Bedrock - Volcanic Conglomerate	-	-	Y	Y
1996	Knight Piesold	GW96-1B	GW96-1B	Corner 1 Embankment	5,819,935.22	595,416.16	927.81	928.41	893.71	889.11	34.1	38.7	gravelly SAND *(Glaciofluvial)*	-	-	Y	Y
1996	Knight Piesold	GW96-2A	GW96-2A	Perimeter Embankment	5,819,449.92	596,065.40	931.42	931.92	879.62	876.52	51.8	54.9	Weathered Bedrock - Conglomerate	2022 Solid Slug	3×10^{-6}	Y	Y
1996	Knight Piesold	GW96-2B	GW96-2B	Perimeter Embankment	5,819,447.08	596,074.73	931.42	932.02	900.62	896.02	30.8	35.4	SAND and GRAVEL *(Glaciofluvial?)*	2022 Solid Slug	4×10^{-4}	Y	Y
1996	Knight Piesold	GW96-3A	GW96-3A	Main Embankment	5,818,308.97	595,768.75	912.06	912.56	863.26	859.46	48.8	52.6	Bedrock - Volcanoclastic Conglomerate	-	-	Y	Y
1996	Knight Piesold	GW96-3B	GW96-3B	Main Embankment	5,818,306.52	595,765.16	912.06	912.56	895.16	892.06	16.9	20.0	SAND *(Glaciofluvial)* overlying SAND and SILT *(Basal Till)*	-	-	Y	Y
1996	Knight Piesold	GW96-4A	GW96-4A	South Embankment	5,818,164.58	595,147.94	940.56	941.26	920.46	915.86	20.1	24.7	Bedrock - Volcanoclastic Conglomerate	-	-	Y	Y
1996	Knight Piesold	GW96-4B	GW96-4B	South Embankment	5,818,162.87	595,151.26	940.46	941.16	936.16	933.26	4.3	7.2	SAND, some gravel *(Glaciofluvial?)*	2022 Solid Slug	2×10^{-6}	Y	Y
1996	Knight Piesold	GW96-5A	GW96-5A	West side of TSF	5,819,626.68	594,330.34	973.55	974.15	958.55	954.15	15.0	19.4	Bedrock - Syenite Intrusive	-	-	Y	Y
1996	Knight Piesold	GW96-5B	GW96-5B	West side of TSF	5,819,629.64	594,329.79	973.44	974.04	969.74	966.74	3.7	6.7	sandy SILT *(Ablation Till)*	-	-	Y	Y
1996	Knight Piesold	GW96-9	GW96-9	Main Embankment	5,818,277.14	595,503.89	916.18	916.78	912.18	910.38	4.0	5.8	SAND *(Glaciofluvial)* overlying SILT *(Glaciolacustrine)*	-	-	Y	Y
2000	Knight Piesold	GW00-1A	GW00-1A	South Embankment	5,818,476.10	594,367.95	939.19	940.02	924.25	918.16	14.9	21.0	Bedrock - Volcanic, fractured	-	-	Y	Y
2000	Knight Piesold	GW00-1B	GW00-1B	South Embankment	5,818,475.85	594,371.11	939.20	940.05	934.72	928.62	4.5	10.6	SILT Till with SAND interbed *(Basal Till)*	2022 Solid Slug	3×10^{-6}	Y	Y
2000	Knight Piesold	GW00-2A	GW00-2A	South Embankment	5,818,337.64	594,651.69	943.42	944.17	927.97	921.87	15.5	21.6	Bedrock - Volcanic	-	-	Y	Y
2000	Knight Piesold	GW00-2B	GW00-2B	South Embankment	5,818,336.36	594,657.64	943.43	944.39	935.84	932.79	7.6	10.6	sandy SILT Till overlying Weathered Bedrock	-	-	Y	Y
2000	Knight Piesold	GW00-3A	GW00-3A	South Embankment	5,818,237.66	594,899.91	943.34	944.04	925.14	919.05	18.2	24.3	Weathered Bedrock	-	-	Y	Y
2000	Knight Piesold	GW00-3B	GW00-3B	South Embankment	5,818,238.09	594,896.22	943.06	943.79	935.50	929.40	7.6	13.7	SILT Till with SILT / fine SAND interbed *(Basal Till)*	2022 Solid Slug	8×10^{-7}	Y	Y
2011	AMEC	GW11-2A	GW11-2A	North of TSF	5,821,031.81	594,939.05	934.40	935.15	908.20	905.10	26.2	29.3	Weathered Bedrock	-	-	Y	N
2011	AMEC	GW11-2B	GW11-2B	North of TSF	5,821,029.90	594,937.74	934.47	935.24	923.37	920.27	11.1	14.2	sandy SILT *(Till)* overlying SILT *(Glaciofluvial)*	-	-	Y	N
2014	-	GW14-01	GW14-01	Northwest side of TSF	5,819,742.90	593,765.90	1036.30	-	-	-	-	-	Bedrock	-	-	N	Y
2016	Golder	GW16-2A	GW16-2A	Perimeter Embankment	5,819,731.19	595,831.15	925.10	925.90	876.50	873.50	48.6	51.6	sandy SILTY GRAVEL *(Glaciofluvial)*	Pneumatic	8×10^{-4}	Y	Y
2016	Golder	GW16-2B	GW16-2B	Perimeter Embankment	5,819,734.31	595,832.84	924.95	925.52	897.72	894.72	27.2	30.2	SAND and GRAVEL *(Glaciofluvial)*	Pneumatic	2×10^{-4}	Y	Y
2016	Golder	GW16-3A	GW16-3A	Main Embankment	5,818,752.04	596,335.81	938.19	938.91	900.61	897.61	37.6	40.6	Weathered Bedrock - gravelly sandy SILTY CLAY	Recovery	$<10^{-10}$	Y	Y
2016	Golder	GW16-3B	GW16-3B	Main Embankment	5,818,757.46	596,337.84	938.35	939.00	910.90	907.90	27.4	30.4	SILTY SAND and GRAVEL	Solid Slug	8×10^{-6}	Y	Y
2016	Golder	GW16-4A	GW16-4A	Main Embankment	5,818,106.62	595,491.16	922.16	922.90	908.30	905.30	13.9	16.9	Weathered Bedrock - CLAYEY SILT and SAND	Recovery	1×10^{-7}	Y	Y
2016	Golder	GW16-4B	GW16-4B	Main Embankment	5,818,109.50	595,489.47	922.26	922.97	914.07	913.17	8.2	9.1	SILTY SAND *(Ablation Till)*	Solid Slug	2×10^{-5}	Y	Y
2016	Golder	GW16-5A	GW16-5A	South Embankment	5,818,539.05	594,207.62	963.64	964.29	940.49	937.49	23.2	26.2	Inferred Competent Bedrock	Solid Slug	5×10^{-6}	Y	Y
2016	Golder	GW16-5B	GW16-5B	South Embankment	5,818,541.45	594,206.42	963.91	964.57	947.47	942.87	16.4	21.0	Inferred Competent Bedrock	Recovery	2×10^{-7}	Y	Y
2021	Golder	GW21-06	CPT21-06	Perimeter Embankment Buttress	5,819,066.00	596,228.05	946.12	947.08	912.42	910.87	33.7	35.3	Inferred SAND and GRAVEL *(Basal Till)*	2022 Solid Slug	1×10^{-5}	Y	Y
2021	Golder	GW21-09	GA21-09	Main Embankment Buttress	5,818,304.61	595,544.33	930.53	931.41	914.42	912.85	16.1	17.7	sandy SILTY CLAY / SILT and SAND *(Basal Till)*	2022 Solid Slug	1×10^{-6}	Y	Y
2022	Golder	GW22-01	GA22-01	Corner 1 Embankment Buttress	5,820,058.76	595,034.32	940.84	941.57	920.72	919.20	20.1	21.6	SILTY SAND / gravelly SAND *(Glaciofluvial)*	-	-	Y	Y

Functioning monitoring wells installed around the TSF.

Table C4 (b): Summary of Wireline Packer Test Results (IMC 1990 - Table 4-14)

TABLE 4-14
IMPERIAL METALS CORPORATION
MT. POLLEY PROJECT

TAILINGS AREA B SITE INVESTIGATION
SUMMARY OF WIRELINE PACKER PERMEABILITY TEST RESULTS

Hole No.	Depth Interval (m)	Permeability (cm/s)	Material Description
MP89-231	9 to 12	6.4×10^{-6}	Overburden
	30 to 37	1.6×10^{-6}	Soft Volcanics
	37 to 43	2.9×10^{-7}	Competent Rock
MP89-232	15 to 18	7.7×10^{-6}	Overburden
	32 to 37	3.2×10^{-6}	Fractured Volcanics
	43 to 46	1.0×10^{-5}	Competent Rock
MP89-233	12 to 18	1.1×10^{-5}	Overburden
	30 to 37	2.2×10^{-5}	Soft Rock
	37 to 46	1.6×10^{-5}	Broken Rock
	49 to 55	1.7×10^{-5}	
MP89-234	6 to 12	1.4×10^{-5}	Overburden
	30 to 37	3.2×10^{-7}	Competent Bedrock
	46 to 49	3.3×10^{-6}	Competent Bedrock
MP89-235	6 to 12	5.1×10^{-4}	Heavily Fractured Bedrock at Contact with Overburden
	12 to 18	8.6×10^{-8}	Very Competent Bedrock
	18 to 30	4.0×10^{-7}	Competent Bedrock
	30 to 43	1.1×10^{-5}	Slightly Fractured Bedrock
MP89-236	8 to 12	2.7×10^{-5}	Bedrock
	14 to 24	2.7×10^{-6}	Bedrock
	24 to 37	2.0×10^{-6}	Bedrock
	35 to 46	7.7×10^{-7}	Bedrock

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
1989	Knight Piesold	TPB-01	Main Embankment	Grab	-	-		-		-	Glacial Till	-	13.7	CL	29	19	10	-0.53	CL	-	-	-	-	-	-	-	3.0	14.0	67.0	16.0	0.002	-
1989	Knight Piesold	TPB-13,14,16	South and Main Embankment	Grab	-	-		-		-	Glacial Till	2.76	25.1	CL/CI	30	16	14	0.65	CL/CI	-	-	-	-	1935	13.3	1.60E-10	1.0	17.0	61.0	21.0	0.002	-
1995	Knight Piesold	TP95-18	Tailings / Reclaim Pipeline Route	Grab	-	1.40		990.60		990.60	Glacial Till	-	13.8	-	27	13	14	0.06	CL	-	-	-	-	2130	10.1	-	38.0	36.0	19.0	7.0	0.002	-
1995	Knight Piesold	TP95-27	Perimeter Embankment	Grab	-	3.80		926.20		926.20	Glacial Till	2.73	11.1	-	22	14	8	-0.36	CL	-	-	-	-	2200	8.0	4.00E-10	19.0	37.0	33.0	11.0	0.002	TX
1995	Knight Piesold	TP95-31	Borrow Area No. 2	Grab	-	2.20		936.80		936.80	Glacial Till	-	11.0	-	22	14	8	-0.38	CL	-	-	-	-	2200	7.6	6.00E-10	41.0	27.0	25.0	7.0	0.002	-
1995	Knight Piesold	TP95-35	Tailings Basin	Grab	-	5.40		911.60		911.60	Glaciolacustrine[1]	2.78	16.5	CL-ML	21	14	7	0.36	CL-ML	-	-	-	-	-	-	7.00E-09	2.0	22.0	65.0	11.0	0.002	-
1995	Knight Piesold	TP95-37	Tailings Basin	Grab	-	1.00		937.00		937.00	Glacial Till	-	18.8	-	27	16	11	0.25	CL	-	-	-	-	-	-	-	14.0	40.0	35.0	11.0	0.002	TX
1995	Knight Piesold	TP95-38	Main Embankment	Grab	-	6.20		908.80		908.80	Glaciolacustrine[1]	2.79	28.4	CI	33	19	14	0.67	CI	-	-	-	-	-	-	3.00E-09	3.0	6.0	73.0	18.0	0.002	-
1995	Knight Piesold	TP95-39	Main Embankment	Grab	-	7.00		911.00		911.00	Glaciolacustrine[1]	2.76	28.5	-	-	-	-	-	-	-	-	-	-	-	-	2.00E-08	0.0	40.0	46.0	14.0	0.002	TX
1996	Knight Piesold	96-45	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-1A	2.40	2.70	-	-	-	Glacial Till	2.74	8.9	-	21	15	6	-1.02	CL-ML	-	-	-	-	-	-	-	46.1	26.6	24.8	2.5	0.002	-
1996	Knight Piesold	96-45	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-1B	3.60	3.90	-	-	-	Glacial Till	2.73	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	32.7	25.4	33.9	8.0	0.002	-
1996	Knight Piesold	96-46	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-2A	0.30	0.60	-	-	-	Glacial Till	2.72	12.8	-	-	-	-	-	-	-	-	2025	10.2	-	-	-	15.7	36.2	39.1	9.0	0.002	-
1996	Knight Piesold	96-46	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-2B	2.00	3.00	-	-	-	Glacial Till	2.73	11.2	-	25	15	10	-0.38	CL	-	-	2083	10.5	-	-	-	21.5	29.0	36.5	13.0	0.002	-
1996	Knight Piesold	96-46	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-2C	2.50	3.10	-	-	-	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-46	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-2D	3.60	4.10	-	-	-	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-46	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-2E	5.00	5.30	-	-	-	Glacial Till	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-47	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-3A	1.00	2.00	-	-	-	Glacial Till	2.74	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	21.7	35.0	35.8	7.5	0.002	-
1996	Knight Piesold	96-48	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-4A	0.00	0.70	-	-	-	Glacial Till	-	17.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-48	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-4B	1.00	2.00	-	-	-	Glacial Till	-	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-48	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-4C	2.00	3.00	-	-	-	Glacial Till	2.73	10.5	-	-	-	-	-	-	-	-	2070	10.5	-	-	-	14.8	35.1	44.1	6.0	0.002	-
1996	Knight Piesold	96-48	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-4D	4.00	5.00	-	-	-	Glacial Till	-	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-49	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-5A	2.00	3.00	-	-	-	Glacial Till	2.73	11.0	-	24	15	9	-0.44	CL	-	-	2083	9.5	-	-	-	22.7	30.9	38.9	7.5	0.002	-
1996	Knight Piesold	96-49	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-5B	3.30	3.60	-	-	-	Glacial Till	-	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-50	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-6A	0.50	1.50	-	-	-	Glacial Till	2.74	11.8	-	-	-	-	-	-	-	-	2000	11.4	-	-	-	11.5	32.1	48.4	8.0	0.002	-
1996	Knight Piesold	96-50	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-6B	2.20	2.70	-	-	-	Glacial Till	-	11.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-50	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-6C	4.40	4.70	-	-	-	Glacial Till	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-51	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-7A	3.50	4.50	-	-	-	Glacial Till	2.72	9.3	-	-	-	-	-	-	-	-	2168	8.3	-	-	-	18.9	38.8	34.8	7.5	0.002	-
1996	Knight Piesold	96-51	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-7B	4.50	5.00	-	-	-	Glacial Till	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-52	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-8A	0.30	1.00	-	-	-	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-52	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-8B	1.00	2.00	-	-	-	Glacial Till	-	9.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-52	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-8C	2.50	3.00	-	-	-	Glacial Till	-	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-53	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-9A	1.00	2.00	-	-	-	Glacial Till	-	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-53	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-9B	3.00	4.00	-	-	-	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-53	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-9C	4.50	4.90	-	-	-	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-53	Borrow Area No. 3	Grab	C/ME(AB)/(ZS,ZB)-9D	6.00	6.30	-	-	-	Glacial Till	-	10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-54	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-10A	0.20	0.50	-	-	-	Glacial Till	-	14.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-54	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-10B	0.50	1.10	-	-	-	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-54	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-10C	2.00	2.40	-	-	-	Glacial Till	2.75	13.2	-	24	15	9	-0.20	CL	-	-	2025	11.3	-	-	-	15.9	34.4	43.4	6.3	0.002	-
1996	Knight Piesold	96-54	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-10D	3.40	3.60	-	-	-	Glacial Till	-	9.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11A	0.10	0.40	-	-	-	Glacial Till	-	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11B	0.40	0.85	-	-	-	Glacial Till	-	14.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11C	0.85	2.00	-	-	-	Glacial Till	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11D	2.00	3.00	-	-	-	Glacial Till	-	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11E	3.50	3.70	-	-	-	Glacial Till	-	9.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11F	4.00	4.20	-	-	-	Glacial Till	-	11.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-55	Borrow Area No. 2	Grab	C/ME(AB)/(ZS,ZB)-11G	5.00	5.40	-	-	-	Glacial Till	-	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-84	Borrow Area No. 1	Grab	C/ME/ZS-34A	0.00	0.25	-	-	-	Glacial Till	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-84	Borrow Area No. 1	Grab	C/ME/ZS-34B	0.25	0.55	-	-	-	Glacial Till	-	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-84	Borrow Area No. 1	Grab	C/ME/ZS-34C	0.55	2.00	-	-	-	Glacial Till	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-84	Borrow Area No. 1	Grab	C/ME/ZS-34E	4.80	5.10	-	-	-	Glacial Till	-	12.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-84	Borrow Area No. 1	Grab	C/ME/ZS-34F	5.50	5.70	-	-	-	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-85	Borrow Area No. 1	Grab	C/ME/ZS-35A	0.00	0.60	-	-	-	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-85	Borrow Area No. 1	Grab	C/ME/ZS-35B	0.60	2.00	-	-	-	Glacial Till	-	9.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-85	Borrow Area No. 1	Grab	C/ME/ZS-35C	3.00		-		-	Glacial Till	2.72	8.6	-	-	-	-	-	-	-	-	-	-	-	-	-	20.2	33.4	38.9	7.5	0.002	-
1996	Knight Piesold	96-85	Borrow Area No. 1	Grab	C/ME/ZS-35D	4.50		-		-	Glacial Till	-	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36A	0.00	0.25	-	-	-	Glacial Till	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36B	0.25	0.60	-	-	-	Glacial Till	-	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36C	0.60	2.00	-	-	-	Glacial Till	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36D	3.10		-		-	Glacial Till	2.75	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36E	4.50		-		-	Glacial Till	-	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36F	6.00		-		-	Glacial Till	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-86	Borrow Area No. 1	Grab	C/ME/ZS-36G	6.30		-		-	Glacial Till	-	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-87	Borrow Area No. 1	Grab	C/ME/ZS-37A	0.00	0.40	-	-	-	Glacial Till	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-87	Borrow Area No. 1	Grab	C/ME/ZS-37B	0.40	1.00	-	-	-	Glacial Till	-	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-87	Borrow Area No. 1	Grab	C/ME/ZS-37C	1.00	2.50	-	-	-	Glacial Till	2.72	11.7	-	-	-	-	-	-	-	-	-	-	-	-	-	21.6	34.7	32.7	11.0	0.002	-
1996	Knight Piesold	96-88	Borrow Area No. 1	Grab	C/ME/ZS-38A	0.30	1.10	-	-	-	Glacial Till	-	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-88	Borrow Area No. 1	Grab	C/ME/ZS-38B	1.10	2.00	-	-	-	Glacial Till	2.75	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	21.5	38.5	33.0	7.0	0.002	-
1996	Knight Piesold	96-88	Borrow Area No. 1	Grab	C/ME/ZS-38C	3.70		-		-	Glacial Till	-	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-88	Borrow Area No. 1	Grab	C/ME/ZS-38D	5.00	5.80	-	-	-	Glacial Till	-	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-88	Borrow Area No. 1	Grab	C/ME/ZS-38E	6.00		-		-	Glacial Till	-	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-89	Borrow Area No. 1	Grab	C/ME/ZS-39A	0.25	1.10	-	-	-	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-89	Borrow Area No. 1	Grab	C/ME/ZS-39B	1.10	2.50	-	-	-	Glacial Till	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-90	Borrow Area No. 1	Grab	C/ME/ZS-40A	0.50	1.20	-	-	-	Glacial Till	-	13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-90	Borrow Area No. 1	Grab	C/ME/ZS-40B	1.20	2.50	-	-	-	Glacial Till	-	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-91	Borrow Area No. 1	Grab	C/ME/ZS-41A	0.00	0.60	-	-	-	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-91	Borrow Area No. 1	Grab	C/ME/ZS-41B	0.60	2.00	-	-	-	Glacial Till	-	11.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-91	Borrow Area No. 1	Grab	C/ME/ZS-41C	2.50		-		-	Glacial Till	-	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-92	Borrow Area No. 1	Grab	C/ME/ZS-42A	0.50	1.20	-	-	-	Glacial Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-92	Borrow Area No. 1	Grab	C/ME/ZS-42B	1.20	2.50	-	-	-	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-93	Borrow Area No. 1	Grab	C/ME/ZS-20	-		-		-	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	28.6	48.2	15.0	0.002	-
1996	Knight Piesold	96-94	Borrow Area No. 1	Grab	C/ME/ZS-21	-		-		-	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-95	Borrow Area No. 1	Grab	C/ME/ZS--22A	0.50	1.50	-	-	-	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-95	Borrow Area No. 1	Grab	C/ME/ZS-22B	2.50	3.00	-	-	-	Glacial Till	-	16.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-96	Borrow Area No. 1	Grab	C/ME/ZS-23A	0.50	1.50	-	-	-	Glacial Till	2.75	13.6	CL	28	15	13	-0.11	CL	-	-	1990	12.3	-	-	-	11.4	29.1	44.5	15.0	0.002	-
1996	Knight Piesold	96-96	Borrow Area No. 1	Grab	C/ME/ZS-23B	2.50	3.50	-	-	-	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	12.8	33.5	53.7		-	-
1996	Knight Piesold	96-98	Borrow Area No. 1	Grab	C/ME/ZS-24	0.50	1.50	-	-	-	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-99	Borrow Area No. 1	Grab	C/ME/ZS-25	4.00	6.00	-	-	-	Glacial Till	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	17.6	28.9	53.5		-	-
1996	Knight Piesold	96-99	Borrow Area No. 1	Grab	C/ME/ZS-26B	5.70	7.30	-	-	-	Glacial Till	-	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	33.9	37.8	28.3		-	-
1996	Knight Piesold	96-101	Borrow Area No. 1	Grab	C/ME/ZS-26A	2.00	3.50	-	-	-	Glacial Till	-	15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8	15.2	81.0		-	-
1996	Knight Piesold	96-102	Borrow Area No. 1	Grab	C/ME/ZS-27A	0.50	2.00	-	-	-	Glacial Till	-	11.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-102	Borrow Area No. 1	Grab	C/ME/ZS-27B	2.00	3.00	-	-	-	Glacial Till	2.73	12.1	ML		Non-Plastic		-	ML	-	-	2000	11.2	-	-	-	9.8	37.8	49.4	3.0	0.002	-
1996	Knight Piesold	96-102	Borrow Area No. 1	Grab	C/ME/ZS-27C	3.00	4.00	-	-	-	Glacial Till	-	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	48.7	39.3		-	-
1996	Knight Piesold	96-102	Borrow Area No. 1	Grab	C/ME/ZS-27D	4.00	6.00	-	-	-	Glacial Till	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	13.9	47.5	38.6		-	-
1996	Knight Piesold	96-102	Borrow Area No. 1	Grab	C/ME/ZS-27E	6.00	7.00	-	-	-	Glacial Till	-	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-103	Borrow Area No. 1	Grab	C/ME/ZS-28A	1.00	3.00	-	-	-	Glacial Till	2.70	11.8	CL-ML	24	17	7	-0.74	CL-ML	-	-	2030	11.0	-	-	-	9.1	39.4	39.5	12.0	0.002	-
1996	Knight Piesold	96-103	Borrow Area No. 1	Grab	C/ME/ZS-28B	3.00	5.00	-	-	-	Glacial Till	-	9.7	-	-	-	-	-	-	-	-	-	-	-	-	-	10.6	34.2	47.2	8.0	0.002	-
1996	Knight Piesold	96-104	Borrow Area No. 1	Grab	C/ME/ZS-29	0.50	1.20	-	-	-	Glacial Till	-	14.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-105	Borrow Area No. 1	Grab	C/ME/ZS-30A	1.00	3.00	-	-	-	Glacial Till	2.73	10.2	-	22	16	6	-0.97	CL-ML	-	-	2090	9.5	-	-	-	17.3	42.7	32.0	8.0	0.002	-
1996	Knight Piesold	96-105	Borrow Area No. 1	Grab	C/ME/ZS-30B	4.00	6.00	-	-	-	Glacial Till	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-106	Borrow Area No. 1	Grab	C/ME/ZS-31A	0.50	2.00	-	-	-	Glacial Till	2.75	12.7	-	20	14	6	-0.22	CL-ML	-	-	2015	11.0	-	-	-	8.4	51.0	32.6	8.0	0.002	-
1996	Knight Piesold	96-106	Borrow Area No. 1	Grab	C/ME/ZS-31B	4.00	6.00	-	-	-	Glacial Till	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-107	Borrow Area No. 1	Grab	C/ME/ZS-32A	0.10	0.60	-	-	-	Glacial Till	-	14.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-107	Borrow Area No. 1	Grab	C/ME/ZS-32B	1.50	2.50	-	-	-	Glacial Till	2.71	13.1	CL	24	13	11	0.01	CL	-	-	2005	10.9	-	-	-	13.1	34.0	41.9	11.0	0.002	-
1996	Knight Piesold	96-107	Borrow Area No. 1	Grab	C/ME/ZS-32C	4.00	5.80	-	-	-	Glacial Till	-	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-108	Borrow Area No. 1	Grab	C/ME/ZS-33A	0.60	1.50	-	-	-	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-108	Borrow Area No. 1	Grab	C/ME/ZS-33B	1.50	2.00	-	-	-	Glacial Till	-	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-108	Borrow Area No. 1	Grab	C/ME/ZS-33D	4.50	6.00	-	-	-	Glacial Till	-	13.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-111	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-1A	0.30	0.50	-	-	-	Glacial Till	-	14.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-111	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-1B	0.80	1.00	-	-	-	Glacial Till	-	15.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-111	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-1C	2.00	4.00	-	-	-	Glacial Till	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	29.9	32.6	37.5		-	-
1996	Knight Piesold	96-111	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-1D	5.00	5.40	-	-	-	Glacial Till	-	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	23.3	34.5	37.2	5.0	0.002	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
1996	Knight Piesold	96-112	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-2A	0.70	1.00	-	-	-	Glacial Till	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-112	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-2B	3.00	3.50	-	-	-	Glacial Till	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.6	38.4	55.0	-	-
1996	Knight Piesold	96-113	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-3A	1.00	1.50	-	-	-	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-113	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-3B	2.50	3.00	-	-	-	Glacial Till	-	9.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.0	36.9	35.1	3.0	0.002	-
1996	Knight Piesold	96-114	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-4A	0.70	1.20	-	-	-	Glacial Till	-	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	Knight Piesold	96-114	Perimeter Embankment	Grab	C/ME(FB)/(ZS,ZB)-4B	2.50	3.00	-	-	-	Glacial Till	-	9.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F8	Borrow Area No. 4	Grab	-	0.70		950.38		950.38	Glacial Till	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F8	Borrow Area No. 4	Grab	-	1.40		949.68		949.68	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F8	Borrow Area No. 4	Grab	-	2.20		948.88		948.88	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F8	Borrow Area No. 4	Grab	-	3.40		947.68		947.68	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F8	Borrow Area No. 4	Grab	-	4.90		946.18		946.18	Glacial Till	-	29.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F9	Borrow Area No. 4	Grab	-	1.00		954.30		954.30	Glacial Till	-	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F9	Borrow Area No. 4	Grab	-	1.85		953.45		953.45	Glacial Till	-	13.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F9	Borrow Area No. 4	Grab	-	2.10		953.20		953.20	Glacial Till	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F9	Borrow Area No. 4	Grab	-	3.25		952.05		952.05	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F9	Borrow Area No. 4	Grab	-	4.60		950.70		950.70	Glacial Till	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-F9	Borrow Area No. 4	Grab	-	5.00		950.30		950.30	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G4	Borrow Area No. 4	Grab	-	0.70		939.10		939.10	Glacial Till	-	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G4	Borrow Area No. 4	Grab	-	2.50		937.30		937.30	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G4	Borrow Area No. 4	Grab	-	3.00		936.80		936.80	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G4	Borrow Area No. 4	Grab	-	4.00		935.80		935.80	Glacial Till	-	14.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G5	Borrow Area No. 4	Grab	-	0.50		940.70		940.70	Glacial Till	-	19.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G5	Borrow Area No. 4	Grab	-	1.60		939.60		939.60	Glacial Till	-	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G5	Borrow Area No. 4	Grab	-	3.00		938.20		938.20	Glacial Till	-	14.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G5	Borrow Area No. 4	Grab	-	5.40		935.80		935.80	Glacial Till	-	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G6	Borrow Area No. 4	Grab	-	1.60		943.00		943.00	Glacial Till	-	16.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G6	Borrow Area No. 4	Grab	-	3.00		941.60		941.60	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G6	Borrow Area No. 4	Grab	-	5.00		939.60		939.60	Glacial Till	-	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G7	Borrow Area No. 4	Grab	-	0.70		944.66		944.66	Glacial Till	-	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G7	Borrow Area No. 4	Grab	-	2.05		943.31		943.31	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G7	Borrow Area No. 4	Grab	-	3.25		942.11		942.11	Glacial Till	-	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G7	Borrow Area No. 4	Grab	-	4.00		941.36		941.36	Glacial Till	-	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G7	Borrow Area No. 4	Grab	-	5.20		940.16		940.16	Glacial Till	-	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G8	Borrow Area No. 4	Grab	-	0.70		947.10		947.10	Glacial Till	-	15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G8	Borrow Area No. 4	Grab	-	1.20		946.60		946.60	Glacial Till	-	14.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G8	Borrow Area No. 4	Grab	-	1.80		946.00		946.00	Glacial Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G8	Borrow Area No. 4	Grab	-	3.70		944.10		944.10	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G8	Borrow Area No. 4	Grab	-	5.00		942.80		942.80	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G9	Borrow Area No. 4	Grab	-	0.80		951.50		951.50	Glacial Till	-	20.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G9	Borrow Area No. 4	Grab	-	1.50		950.80		950.80	Glacial Till	-	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G9	Borrow Area No. 4	Grab	-	2.20		950.10		950.10	Glacial Till	-	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G9	Borrow Area No. 4	Grab	-	3.10		949.20		949.20	Glacial Till	-	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-G9	Borrow Area No. 4	Grab	-	4.30		948.00		948.00	Glacial Till	-	13.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H4	Borrow Area No. 4	Grab	-	0.50		937.30		937.30	Glacial Till	-	19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H4	Borrow Area No. 4	Grab	-	1.40		936.40		936.40	Glacial Till	-	15.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H4	Borrow Area No. 4	Grab	-	2.75		935.05		935.05	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H4	Borrow Area No. 4	Grab	-	5.10		932.70		932.70	Glacial Till	-	12.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H5	Borrow Area No. 4	Grab	-	0.50		938.90		938.90	Glacial Till	-	19.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H5	Borrow Area No. 4	Grab	-	1.50		937.90		937.90	Glacial Till	-	14.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H5	Borrow Area No. 4	Grab	-	2.30		937.10		937.10	Glacial Till	-	12.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H5	Borrow Area No. 4	Grab	-	4.00		935.40		935.40	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H6	Borrow Area No. 4	Grab	-	1.60		939.70		939.70	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H6	Borrow Area No. 4	Grab	-	3.40		937.90		937.90	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H6	Borrow Area No. 4	Grab	-	4.20		937.10		937.10	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H6	Borrow Area No. 4	Grab	-	5.30		936.00		936.00	Glacial Till	-	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H7	Borrow Area No. 4	Grab	-	0.90		941.90		941.90	Glacial Till	-	16.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H7	Borrow Area No. 4	Grab	-	2.05		940.75		940.75	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H7	Borrow Area No. 4	Grab	-	3.00		939.80		939.80	Glacial Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H7	Borrow Area No. 4	Grab	-	4.00		938.80		938.80	Glacial Till	-	13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H7	Borrow Area No. 4	Grab	-	5.00		937.80		937.80	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H8	Borrow Area No. 4	Grab	-	1.00		943.10		943.10	Glacial Till	-	18.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H8	Borrow Area No. 4	Grab	-	1.70		942.40		942.40	Glacial Till	-	12.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H8	Borrow Area No. 4	Grab	-	2.50		941.60		941.60	Glacial Till	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H8	Borrow Area No. 4	Grab	-	4.60		939.50		939.50	Glacial Till	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H8	Borrow Area No. 4	Grab	-	5.30		938.80		938.80	Glacial Till	-	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H9	Borrow Area No. 4	Grab	-	0.50		947.30		947.30	Glacial Till	-	18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H9	Borrow Area No. 4	Grab	-	1.60		946.20		946.20	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H9	Borrow Area No. 4	Grab	-	1.90		945.90		945.90	Glacial Till	-	12.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H9	Borrow Area No. 4	Grab	-	3.70		944.10		944.10	Glacial Till	-	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-H9	Borrow Area No. 4	Grab	-	4.40		943.40		943.40	Glacial Till	-	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I4	Borrow Area No. 4	Grab	-	1.30		935.10		935.10	Glacial Till	-	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I4	Borrow Area No. 4	Grab	-	2.30		934.10		934.10	Glacial Till	-	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I4	Borrow Area No. 4	Grab	-	3.10		933.30		933.30	Glacial Till	-	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I4	Borrow Area No. 4	Grab	-	3.70		932.70		932.70	Glacial Till	-	13.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I6	Borrow Area No. 4	Grab	-	1.00		935.90		935.90	Glacial Till	-	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I6	Borrow Area No. 4	Grab	-	2.00		934.90		934.90	Glacial Till	-	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I6	Borrow Area No. 4	Grab	-	4.40		932.50		932.50	Glacial Till	-	12.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I6	Borrow Area No. 4	Grab	-	4.40		932.50		932.50	Glaciolacustrine	-	19.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I6	Borrow Area No. 4	Grab	-	5.00		931.90		931.90	Glaciolacustrine	-	26.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I7	Borrow Area No. 4	Grab	-	0.70		936.50		936.50	Glacial Till	-	22.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I7	Borrow Area No. 4	Grab	-	1.30		935.90		935.90	Glacial Till	-	15.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I7	Borrow Area No. 4	Grab	-	2.30		934.90		934.90	Glacial Till	-	13.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I7	Borrow Area No. 4	Grab	-	3.20		934.00		934.00	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I7	Borrow Area No. 4	Grab	-	4.60		932.60		932.60	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I7	Borrow Area No. 4	Grab	-	5.20		932.00		932.00	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I8	Borrow Area No. 4	Grab	-	0.70		939.20		939.20	Glacial Till	-	17.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I8	Borrow Area No. 4	Grab	-	2.00		937.90		937.90	Glacial Till	-	10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I8	Borrow Area No. 4	Grab	-	4.50		935.40		935.40	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I9	Borrow Area No. 4	Grab	-	0.50		941.95		941.95	Glacial Till	-	22.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I9	Borrow Area No. 4	Grab	-	1.70		940.75		940.75	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I9	Borrow Area No. 4	Grab	-	3.00		939.45		939.45	Glacial Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I9	Borrow Area No. 4	Grab	-	4.30		938.15		938.15	Glacial Till	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-I9	Borrow Area No. 4	Grab	-	5.10		937.35		937.35	Glacial Till	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J8	Borrow Area No. 4	Grab	-	1.00		933.41		933.41	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J8	Borrow Area No. 4	Grab	-	1.50		932.91		932.91	Glacial Till	-	13.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J8	Borrow Area No. 4	Grab	-	3.40		931.01		931.01	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J8	Borrow Area No. 4	Grab	-	4.50		929.91		929.91	Glacial Till	-	10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J9	Borrow Area No. 4	Grab	-	0.75		935.91		935.91	Glacial Till	-	19.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J9	Borrow Area No. 4	Grab	-	2.00		934.66		934.66	Glacial Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J9	Borrow Area No. 4	Grab	-	3.40		933.26		933.26	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	Knight Piesold	TP97-BA4-J9	Borrow Area No. 4	Grab	-	4.80		931.86		931.86	Glacial Till	-	10.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	Knight Piesold	DH98-BA2-6	Borrow Area No. 2	Grab	-	2.29		-		-	Glacial Till	-	10.9	-	23	12	11	-0.10	CL	-	-	-	-	-	-	-	8.4	48.6	30.3	12.7	0.002	-
1998	Knight Piesold	DH98-BA2-9	Borrow Area No. 2	Grab	-	4.27	-	-		-	Glacial Till	-	14.5	-	23	12	11	0.23	CL	-	-	-	-	-	-	-	23.1	39.1	24.3	13.5	0.002	-
1998	Knight Piesold	DH98-BA2-11	Borrow Area No. 2	Grab	-	3.81	-	-		-	Glacial Till	-	10.6	-	20	13	7	-0.34	CL-ML	-	-	-	-	-	-	-	13.7	45.9	27.1	13.3	0.002	-
1998	Knight Piesold	DH98-BA2-16	Main Embankment	Grab	-	1.83	-	-		-	Glacial Till	-	11.8	CL	25	12	13	-0.02	CL	-	-	-	-	-	-	-	13.0	34.9	33.2	18.9	0.002	-
1998	Knight Piesold	DH98-BA4-1	Borrow Area No. 4	Grab	-	2.74	-	-		-	Glacial Till	-	11.3	CL	21	12	9	-0.08	CL	-	-	-	-	-	-	-	7.3	37.8	41.7	13.2	0.002	-
1998	Knight Piesold	DH98-BA4-6	Borrow Area No. 4	Grab	-	4.27	-	-		-	Glacial Till	-	11.0	CL	23	12	11	-0.09	CL	-	-	-	-	-	-	-	7.3	36.0	41.6	15.1	0.002	-
1998	Knight Piesold	DH98-BA4-9	Borrow Area No. 4	Grab	-	1.22	-	-		-	Glacial Till	-	12.4	CL	22	11	11	0.13	CL	-	-	-	-	-	-	-	1.0	42.0	38.6	18.4	0.002	-
1998	Knight Piesold	DH98-BL-04	South Embankment	Grab	-	1.22	940.98	940.98		940.98	Glacial Till	-	13.7	CL	24	14	10	-0.03	CL	-	-	-	-	-	-	-	8.5	39.3	33.8	18.4	0.002	-
1998	Knight Piesold	DH98-BL-08	Tailings Basin	Grab	-	3.66	-	-		-	Glaciolacustrine	-	46.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	Knight Piesold	DH98-BL-10	Tailings Basin	Grab	-	1.37	-	-		-	Glacial Till	-	14.0	CL	27	16	11	-0.18	CL	-	-	-	-	-	-	-	0.4	41.7	33.6	24.3	0.002	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution				Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
1998	Knight Piesold	DH98-BL-12	South Embankment	Grab	-	1.22		946.78		946.78	Glacial Till	-	13.9	CL	27	14	13	-0.01	CL	-	-	-	-	-	-	-	11.7	35.7	30.8	21.8	0.002	-
1999	Knight Piesold	BH99-12	South Embankment	Grab	BH99-12A	2.59	3.05	943.91	943.45	943.68	Glacial Till	-	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	32.3	61.5		-	-
1999	Knight Piesold	BH99-13	South Embankment	Grab	BH99-13A	2.59	3.05	945.41	944.95	945.18	Glacial Till	-	15.2	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	30.9	27.6	33.0	0.002	-
1999	Knight Piesold	BH99-14	South Embankment	Grab	BH99-14A	2.59	3.05	943.91	943.45	943.68	Glacial Till	-	19.8	-	-	-	-	-	-	-	-	-	-	-	-	-	11.5	30.9	57.6		-	-
1999	Knight Piesold	BH99-16	South Embankment	Grab	BH99-16A	2.59	3.05	941.41	940.95	941.18	Glacial Till	-	13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2	33.7	24.3	33.8	0.002	-
1999	Knight Piesold	BH99-16	South Embankment	Grab	BH99-16B	5.64	6.10	938.36	937.90	938.13	Glacial Till	-	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	18.1	26.2	55.7		-	-
1999	Knight Piesold	BH99-16	South Embankment	Grab	BH99-16C	8.69	9.14	935.31	934.86	935.08	Glacial Till	-	15.9	-	-	-	-	-	-	-	-	-	-	-	-	-	15.3	26.4	58.3		-	-
1999	Knight Piesold	BH99-17	South Embankment	Grab	BH99-17A	2.59	3.05	936.91	936.45	936.68	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	31.3	63.7		-	-
1999	Knight Piesold	BH99-24	Tailings Basin	Grab	BH99-24A	2.44	2.90	930.56	930.10	930.33	Glaciolacustrine	-	20.9	-	-	-	-	-	-	-	-	-	-	-	-	-	6.6	15.1	78.3		-	-
1999	Knight Piesold	BH99-27	Tailings Basin	Grab	BH99-27A	5.33	6.10	928.67	927.90	928.29	Glaciolacustrine	-	21.7	-	-	-	-	-	-	-	-	-	-	-	-	-	1.8	28.9	69.3		-	-
1999	Knight Piesold	BH99-41	South Embankment	Grab	BH99-41A	2.59	3.05	945.91	945.45	945.68	Glacial Till	-	13.4	-	-	-	-	-	-	-	-	-	-	-	-	-	11.1	34.8	54.1		-	-
1999	Knight Piesold	BH99-42	South Embankment	Grab	BH99-42A	2.59	3.05	944.61	944.15	944.38	Glacial Till	-	14.0	-	-	-	-	-	-	-	-	-	-	-	-	-	11.1	30.8	25.8	32.3	0.002	-
1999	Knight Piesold	BH99-42	South Embankment	Grab	BH99-42B	5.64	6.10	941.56	941.10	941.33	Glacial Till	-	15.4	-	-	-	-	-	-	-	-	-	-	-	-	-	8.5	30.9	60.6		-	-
1999	Knight Piesold	BH99-43	South Embankment	Grab	BH99-43A	2.59	3.05	944.21	943.75	943.98	Glacial Till	-	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	5.1	31.6	63.3		-	-
1999	Knight Piesold	BH99-43	South Embankment	Grab	BH99-43B	5.64	6.10	941.16	940.70	940.93	Glacial Till	-	15.3	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	29.8	63.8		-	-
1999	Knight Piesold	BH99-44	South Embankment	Grab	BH99-44A	2.59	3.05	943.61	943.15	943.38	Glacial Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	14.2	31.0	54.8		-	-
1999	Knight Piesold	BH99-44	South Embankment	Grab	BH99-44B	5.64	6.10	940.56	940.10	940.33	Glacial Till	-	13.2	-	-	-	-	-	-	-	-	-	-	-	-	-	22.0	26.6	21.8	29.6	0.002	-
2001	Knight Piesold	DH01-01	Borrow Area No. 2	Grab	DH01-01A	3.05		-		-	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	18.9	37.5	43.6		-	-
2001	Knight Piesold	DH01-02	Borrow Area No. 2	Grab	DH01-02A	3.05		-		-	Glacial Till	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	15.9	39.3	25.9	18.9	0.002	-
2001	Knight Piesold	DH01-02	Borrow Area No. 2	Grab	DH01-02B	6.10		-		-	Glacial Till	-	17.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-02	Borrow Area No. 2	Grab	DH01-02C	9.14		-		-	Glacial Till	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-03	Borrow Area No. 2	Grab	DH01-03A	3.05		-		-	Glacial Till	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	16.7	40.6	42.7		-	-
2001	Knight Piesold	DH01-06	Borrow Area No. 2	Grab	DH01-06A	3.05		-		-	Glacial Till	-	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	14.7	36.8	48.5		-	-
2001	Knight Piesold	DH01-07	Borrow Area No. 2	Grab	DH01-07B	6.10		-		-	Glacial Till	-	10.9	-	-	-	-	-	-	-	-	-	-	-	-	-	14.2	40.3	28.9	16.6	0.002	-
2001	Knight Piesold	DH01-08	Borrow Area No. 2	Grab	DH01-08C	9.14		-		-	Glacial Till	-	11.2	-	-	-	-	-	-	-	-	-	-	-	-	-	12.8	38.6	48.6		-	-
2001	Knight Piesold	DH01-09	Borrow Area No. 2	Grab	DH01-09A	3.05		-		-	Glacial Till	-	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-10	Borrow Area No. 2	Grab	DH01-10B	6.10		-		-	Glacial Till	-	12.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-11	Borrow Area No. 2	Grab	DH01-11C	9.14		-		-	Glacial Till	-	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-12	Borrow Area No. 2	Grab	DH01-12A	3.05		-		-	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	19.1	41.4	26.3	13.2	0.002	-
2001	Knight Piesold	DH01-12	Borrow Area No. 2	Grab	DH01-12B	6.10		-		-	Glacial Till	-	20.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-13	Borrow Area No. 2	Grab	DH01-13A	3.05		-		-	Glacial Till	-	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-14	Borrow Area No. 2	Grab	DH01-14A	3.05		-		-	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-15	Borrow Area No. 2	Grab	DH01-15A	3.05		-		-	Glacial Till	-	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-16	Borrow Area No. 2	Grab	DH01-16B	6.10		-		-	Glacial Till	-	12.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-17	Borrow Area No. 2	Grab	DH01-17A	3.05		-		-	Glacial Till	-	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	18.6	36.9	25.0	19.5	0.002	-
2001	Knight Piesold	DH01-18	Borrow Area No. 2	Grab	DH01-18A	3.05		-		-	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-19	Borrow Area No. 2	Grab	DH01-19B	6.10		-		-	Glacial Till	-	11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	48.8	39.2		-	-
2001	Knight Piesold	DH01-20	Borrow Area No. 2	Grab	DH01-20A	3.05		-		-	Glacial Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	9.7	41.2	49.1		-	-
2001	Knight Piesold	DH01-21	Borrow Area No. 2	Grab	DH01-21B	6.10		-		-	Glacial Till	-	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-23	Borrow Area No. 2	Grab	DH01-23A	3.05		-		-	Glacial Till	-	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	3.3	46.1	50.6		-	-
2001	Knight Piesold	DH01-24	Borrow Area No. 2	Grab	DH01-24A	3.05		-		-	Glacial Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-25	Borrow Area No. 2	Grab	DH01-25A	3.05		-		-	Glacial Till	-	10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-26	Borrow Area No. 2	Grab	DH01-26A	3.05		-		-	Glacial Till	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-26	Borrow Area No. 2	Grab	DH01-26B	6.10		-		-	Glacial Till	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	39.4	54.2		-	-
2001	Knight Piesold	DH01-29	Borrow Area No. 2	Grab	DH01-29A	3.05		-		-	Glacial Till	-	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	29.7	42.7	27.6		-	-
2001	Knight Piesold	DH01-30	Borrow Area No. 2	Grab	DH01-30A	3.05		-		-	Glacial Till	-	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-31	Borrow Area No. 2	Grab	DH01-31A	3.05		-		-	Glacial Till	-	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	7.2	39.9	52.9		-	-
2001	Knight Piesold	DH01-32	Borrow Area No. 2	Grab	DH01-32A	3.05		-		-	Glacial Till	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-33	Borrow Area No. 2	Grab	DH01-33B	6.10		-		-	Glacial Till	-	9.8	-	-	-	-	-	-	-	-	-	-	-	-	-	13.3	36.3	50.4		-	-
2001	Knight Piesold	DH01-39	Borrow Area No. 2	Grab	DH01-39A	3.05		-		-	Glacial Till	-	8.6	-	-	-	-	-	-	-	-	-	-	-	-	-	26.0	48.5	25.5		-	-
2001	Knight Piesold	DH01-39	Borrow Area No. 2	Grab	DH01-39B	6.10		-		-	Glacial Till	-	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	22.8	46.2	31.0		-	-
2001	Knight Piesold	DH01-40	Borrow Area No. 2	Grab	DH01-40A	3.05		-		-	Glacial Till	-	11.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-41	Borrow Area No. 2	Grab	DH01-41A	3.05		-		-	Glacial Till	-	10.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-42	Borrow Area No. 2	Grab	DH01-42A	3.05		-		-	Glacial Till	-	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	14.8	38.7	30.3	16.2	0.002	-
2001	Knight Piesold	DH01-43	Borrow Area No. 2	Grab	DH01-43A	3.05		-		-	Glacial Till	-	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-51	Borrow Area No. 2	Grab	DH01-51A	3.05		-		-	Glacial Till	-	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	9.0	39.0	52.0		-	-
2001	Knight Piesold	DH01-59	Borrow Area No. 3	Grab	DH01-59A	3.05		-		-	Glacial Till	-	12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-60	Borrow Area No. 3	Grab	DH01-60B	6.10		-		-	Glacial Till	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	11.9	34.6	53.5		-	-
2001	Knight Piesold	DH01-61	Borrow Area No. 2	Grab	DH01-61A	3.05		-		-	Glacial Till	-	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-62	Borrow Area No. 3	Grab	DH01-62A	3.05		-		-	Glacial Till	-	10.2	-	-	-	-	-	-	-	-	-	-	-	-	-	19.6	37.0	43.4		-	-
2001	Knight Piesold	DH01-64	Borrow Area No. 3	Grab	DH01-64A	3.05		-		-	Glacial Till	-	10.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-65	Borrow Area No. 3	Grab	DH01-65A	3.05		-		-	Glacial Till	-	13.1	-	-	-	-	-	-	-	-	-	-	-	-	-	8.9	35.9	35.9	19.3	0.002	-
2001	Knight Piesold	DH01-66	Borrow Area No. 2	Grab	DH01-66A	3.05		-		-	Glacial Till	-	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	Knight Piesold	DH01-67	-	Grab	DH01-67A	3.05		-		-	Glacial Till	-	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	30.5	44.1	24.9	0.002	-
2001	Knight Piesold	DH01-74	-	Grab	DH01-74A	3.05		-		-	Glacial Till	-	14.2	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	32.8	65.5		-	-
2001	Knight Piesold	DH01-75	-	Grab	DH01-75A	3.05		-		-	Glacial Till	-	14.6	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	30.8	41.4	26.9	0.002	-
2001	Knight Piesold	DH01-77	-	Grab	DH01-77A	3.05		-		-	Glacial Till	-	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	Knight Piesold	SI06-01	Main Embankment	Split Spoon	SI06-01-02	10.06		907.04		907.04	-	-	16.0	CL-ML	20	16	4	0.00	CL-ML	-	-	-	-	-	-	-	0.9	27.5	54.3	17.3	0.002	-
2006	Knight Piesold	SI06-01	Main Embankment	Thin-walled Open Tube	SI06-01-Shelby 1	13.11		903.99		903.99	-	-	30.7	ML	39	26	13	0.36	ML	-	1861	-	-	-	-	-	0.0	1.2	86.3	12.5	0.002	-
2006	Knight Piesold	SI06-02	Main Embankment	Split Spoon	SI06-02-01	8.53		908.57		908.57	-	-	24.2	CI	44	26	18	-0.10	CI	-	-	-	-	-	-	-	0.0	1.2	61.3	37.5	0.002	-
2006	Knight Piesold	SI06-02	Main Embankment	Thin-walled Open Tube	SI06-02-Shelby 1	11.73		905.37		905.37	-	-	40.3	CH/MH	53	29	24	0.47	CH/MH	-	-	-	-	-	-	-	0.0	2.2	45.3	52.5	0.002	Incremental Consolidation
2006	Knight Piesold	SI06-02	Main Embankment	Thin-walled Open Tube	SI06-02-Shelby 2	16.31	16.92	900.79	900.18	900.49	-	-	27.3	ML		Non-Plastic		-	ML	-	1583	-	-	-	-	-	0.0	1.0	96.0	3.0	0.002	-
2006	Knight Piesold	SI06-03	Main Embankment	Split Spoon	SI06-03-02A	8.53		909.17		909.17	-	-	13.6	CL-ML	24	17	7	-0.49	CL-ML	-	-	-	-	-	-	-	19.0	19.0	48.8	13.2	0.002	-
2006	Knight Piesold	SI06-03	Main Embankment	Split Spoon	SI06-03-02B	8.76		908.94		908.94	-	-	14.4	CL	28	18	10	-0.36	CL	-	-	-	-	-	-	-	4.3	6.0	66.9	22.8	0.002	-
2006	Knight Piesold	SI06-03	Main Embankment	Split Spoon	SI06-03-04	11.58		906.12		906.12	-	-	23.3	CI	37	24	13	-0.05	CI	-	-	-	-	-	-	-	1.3	5.6	66.0	27.1	0.002	-
2006	Knight Piesold	SI06-03	Main Embankment	Split Spoon	SI06-03-06	14.63		903.07		903.07	-	-	25.9	CI	42	24	18	0.11	CI	-	-	-	-	-	-	-	0.0	1.2	68.8	30.0	0.002	-
2006	Knight Piesold	SI06-03	Main Embankment	Split Spoon	SI06-03-08	17.68		900.02		900.02	-	-	23.6	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0.0	1.2	96.3	2.5	0.002	-
2011	AMEC	VW11-01	South Embankment	Grab	G1	1.40		939.61		939.61	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-01	South Embankment	Grab	G2	2.00		939.01		939.01	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	36.0	45.0	14.0	0.002	-
2011	AMEC	VW11-01	South Embankment	Grab	G3	3.50		937.51		937.51	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-01	South Embankment	Grab	G4	5.90		935.11		935.11	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-02	South Embankment	Grab	G1	1.60		943.49		943.49	Glacial Till	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-02	South Embankment	Grab	G2	3.10		941.99		941.99	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-02	South Embankment	Grab	G3	6.20		938.89		938.89	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-02	South Embankment	Grab	G4	8.90		936.19		936.19	Glacial Till	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-02	South Embankment	Grab	G5	10.50		934.59		934.59	Glaciolacustrine	-	17.3	CL	28	20	8	-0.34	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-03	Main Embankment	Grab	G1	13.20		913.80		913.80	Glaciofluvial	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-03	Main Embankment	Grab	G2	15.00		912.00		912.00	Glaciolacustrine	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-03	Main Embankment	Grab	G3	16.60		910.40		910.40	Glaciolacustrine	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-03	Main Embankment	Grab	G4	18.10		908.90		908.90	Glaciofluvial	-	22.2	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-03	Main Embankment	Grab	G5	19.30		907.70		907.70	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G1	9.20		912.39		912.39	Glacial Till	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	43.0	38.0	13.0	0.002	-
2011	AMEC	VW11-04	Main Embankment	Grab	G2	10.00		911.59		911.59	Glaciolacustrine	-	23.4	CI	44	21	23	0.10	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G3	11.70		909.89		909.89	Glaciolacustrine	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G4	13.80		907.79		907.79	Glaciolacustrine	-	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G5	15.00		906.59		906.59	Glaciolacustrine	-	32.4	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G6	16.60		904.99		904.99	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G7	18.70		902.89		902.89	-[1]	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	1.0	65.0	34.0	0.002	-
2011	AMEC	VW11-04	Main Embankment	Grab	G8	21.10		900.49		900.49	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G9	22.70		898.89		898.89	Glacial Till	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-04	Main Embankment	Grab	G10	24.80		896.79		896.79	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G1	10.10		910.50		910.50	Glaciolacustrine	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G2	12.60		908.00		908.00	Glaciolacustrine	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G3	13.70		906.90		906.90	Glaciolacustrine	-	29.8	CI	43	20	23	0.43	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G4	15.30		905.30		905.30	Glaciolacustrine	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G5	16.60		904.00		904.00	Glaciolacustrine	-	24.8	ML	27	24	3	0.27	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G6	19.30		901.30		901.30	Glaciofluvial	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G7	20.50		900.10		900.10	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G8	25.10		895.50		895.50	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-05	Main Embankment	Grab	G9	27.50		893.10		893.10	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Grab	G1	7.40		908.94		908.94	Glaciolacustrine	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2011	AMEC	VW11-06	Main Embankment	Core Return	C1	8.20		908.14		908.14	Glaciolacustrine	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C1	8.90		907.44		907.44	Glaciolacustrine	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C1	9.40		906.94		906.94	Glaciolacustrine	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C2	11.10		905.24		905.24	Glaciolacustrine	-	37.9	CI	48	24	24	0.58	CI	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C2	12.00		904.34		904.34	Glaciolacustrine	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C2	13.10		903.24		903.24	Glaciolacustrine	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C3	13.20		903.14		903.14	Glaciolacustrine	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C3	13.90		902.44		902.44	Glaciolacustrine	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C3	14.90		901.44		901.44	Glaciolacustrine	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C4	15.40		900.94		900.94	Glaciofluvial	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C4	16.90		899.44		899.44	Glaciofluvial	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C4	17.30		899.04		899.04	Glaciofluvial	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C5	17.70		898.64		898.64	Glaciofluvial	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C5	18.10		898.24		898.24	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Core Return	C5	19.60		896.74		896.74	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Grab	G2	21.10		895.24		895.24	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Grab	G3	25.10		891.24		891.24	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-06	Main Embankment	Grab	G4	31.20		885.14		885.14	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G1	5.00		914.78		914.78	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G2	8.90		910.88		910.88	Glaciolacustrine	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G3	10.50		909.28		909.28	Glaciolacustrine	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G4	11.70		908.08		908.08	Glaciolacustrine	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G5	13.20		906.58		906.58	Glaciolacustrine	-	26.1	CI	37	24	13	0.16	CI	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G6	16.30		903.48		903.48	Glaciolacustrine	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G7	17.80		901.98		901.98	Glaciolacustrine	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G8	20.20		899.58		899.58	Glaciolacustrine	-	26.7	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G9	23.00		896.78		896.78	Glacial Till	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G10	23.40		896.38		896.38	Glacial Till	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G11	25.40		894.38		894.38	Glacial Till	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G12	27.50		892.28		892.28	[1]	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G13	30.80		888.98		888.98	Glaciolacustrine	-	25.5	CL-ML	27	22	5	0.70	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G14	34.20		885.58		885.58	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G15	35.10		884.68		884.68	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G16	36.70		883.08		883.08	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-07	Main Embankment	Grab	G17	39.10		880.68		880.68	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G1	1.60		926.06		926.06	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G2	3.10		924.56		924.56	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	44.0	34.0	14.0	0.002	-
2011	AMEC	VW11-08	Main Embankment	Grab	G3	5.90		921.76		921.76	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G4	7.40		920.26		920.26	Glacial Till	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G5	7.70		919.96		919.96	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G6	8.50		919.16		919.16	Glaciolacustrine	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Core Return	C1	8.80		918.86		918.86	Glaciolacustrine	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	5.0	73.0	22.0	0.002	-
2011	AMEC	VW11-08	Main Embankment	Grab	G7	9.90		917.76		917.76	Glaciofluvial	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G8	12.30		915.36		915.36	Glaciofluvial	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	68.0	32.0		-	-
2011	AMEC	VW11-08	Main Embankment	Core Return	C2	13.60		914.06		914.06	Glaciolacustrine	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Thin-walled Open Tube	U1	14.00	14.20	913.66	913.46	913.56	Glaciolacustrine	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G9	15.40		912.26		912.26	Glaciofluvial	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	48.0	47.0	5.0	0.002	-
2011	AMEC	VW11-08	Main Embankment	Grab	G10	16.10		911.56		911.56	Glaciofluvial	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G11	16.90		910.76		910.76	Glaciolacustrine	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Thin-walled Open Tube	U2	17.00	17.40	910.66	910.26	910.46	Glaciolacustrine	-	26.4	ML	29	23	6	0.57	ML	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G12	20.00		907.66		907.66	Glaciolacustrine	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Core Return	C3	20.70		906.96		906.96	Glaciolacustrine	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G13	24.50		903.16		903.16	Glaciolacustrine	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Core Return	C4	25.30		902.36		902.36	Glaciolacustrine	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G14	27.60		900.06		900.06	Glaciolacustrine	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G15	28.80		898.86		898.86	Glaciolacustrine	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G16	30.00		897.66		897.66	Glaciolacustrine	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G17	31.90		895.76		895.76	Glaciofluvial	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G18	33.40		894.26		894.26	Glaciofluvial	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G19	34.90		892.76		892.76	Glaciofluvial	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G20	36.40		891.26		891.26	Glaciofluvial	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G21	37.30		890.36		890.36	Glaciofluvial	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G22	38.60		889.06		889.06	Glaciofluvial	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G23	39.20		888.46		888.46	Glaciofluvial	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G24	40.40		887.26		887.26	Glaciofluvial	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-08	Main Embankment	Grab	G25	43.40		884.26		884.26	Glacial Till	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G1	1.50		935.09		935.09	Glacial Till	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G2	3.20		933.39		933.39	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G3	6.60		929.99		929.99	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G4	9.40		927.19		927.19	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	9.0	41.0	41.0	9.0	0.002	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G5	12.40		924.19		924.19	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G6	15.40		921.19		921.19	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G7	18.10		918.49		918.49	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G8	19.40		917.19		917.19	Glaciolacustrine	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	11.0	67.0	21.0	0.002	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G9	20.90		915.69		915.69	Glacial Till	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G10	22.40		914.19		914.19	Glacial Till	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G11	24.20		912.39		912.39	Glacial Till	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G12	26.10		910.49		910.49	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G13	27.60		908.99		908.99	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G14	30.60		905.99		905.99	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	49.0	40.0	5.0	0.002	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G15	33.70		902.89		902.89	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G16	36.70		899.89		899.89	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G17	39.50		897.09		897.09	Weathered Bedrock	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-09	Perimeter Embankment	Grab	G18	40.70		895.89		895.89	Bedrock	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G1	1.70		930.10		930.10	Glacial Till	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G2	2.60		929.20		929.20	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G3	3.10		928.70		928.70	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G4	5.60		926.20		926.20	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G5	9.30		922.50		922.50	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G6	12.30		919.50		919.50	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	45.0	39.0	8.0	0.002	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G7	15.10		916.70		916.70	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G8	17.00		914.80		914.80	Glaciolacustrine	-	23.0	CI	39	22	17	0.06	CI	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G9	17.40		914.40		914.40	Glaciolacustrine	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.5	99.5		-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G10	18.20		913.60		913.60	Glaciolacustrine	-	24.7	CI	38	23	15	0.11	CI	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G11	19.40		912.40		912.40	Glaciolacustrine	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G12	20.00		911.80		911.80	Glaciolacustrine	-	22.4	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G13	21.20		910.60		910.60	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G14	22.40		909.40		909.40	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G15	23.00		908.80		908.80	Glaciofluvial	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G16	23.90		907.90		907.90	Glaciofluvial	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G17	25.80		906.00		906.00	Glaciofluvial	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G18	27.60		904.20		904.20	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G20	31.50		900.30		900.30	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G21	34.00		897.80		897.80	Glaciofluvial	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G22	35.80		896.00		896.00	Glaciolacustrine	-	20.1	CL	28	18	10	0.21	CL	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G23	37.00		894.80		894.80	Glacial Till	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G24	37.90		893.90		893.90	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G25	41.00		890.80		890.80	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-10	Perimeter Embankment	Grab	G26	41.80		890.00		890.00	Bedrock	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G1	0.20		940.69		940.69	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G2	0.50		940.39		940.39	Glacial Till	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G3	0.80		940.09		940.09	Glacial Till	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G4	1.10		939.79		939.79	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G5	1.70		939.19		939.19	Glacial Till	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G6	2.30		938.59		938.59	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G7	4.40		936.49		936.49	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G8	5.90		934.99		934.99	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G9	7.60		933.29		933.29	Glacial Till	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G10	8.80		932.09		932.09	Upper Glaciolacustrine[2]	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G11	9.50		931.39		931.39	Upper Glaciolacustrine[2]	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G12	9.90		930.99		930.99	Upper Glaciolacustrine[2]	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	8.0	72.0	8.0	0.002	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G13	10.80		930.09		930.09	Upper Glaciolacustrine[2]	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G14	11.40		929.49		929.49	-[1]	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G15	12.40		928.49		928.49	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G16	14.50		926.39		926.39	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G17	16.00		924.89		924.89	Weathered Bedrock	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	VW11-11	Corner 1 Embankment	Grab	G20	19.70		921.19		921.19	Bedrock	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-01	Main Embankment	Grab	G1	8.40		912.68		912.68	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-01	Main Embankment	Grab	G2	10.70		910.38		910.38	Glaciolacustrine	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	27.0	44.0	28.0	0.002	-
2011	AMEC	SI11-01	Main Embankment	Grab	G3	11.70		909.38		909.38	Glaciolacustrine	-	27.6	CI	34	21	13	0.51	CI	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-01	Main Embankment	Grab	G4	13.10		907.98		907.98	Glaciolacustrine	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-01	Main Embankment	Grab	G5	16.50		904.58		904.58	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-01	Main Embankment	Grab	G6	17.70		903.38		903.38	Glacial Till	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-01	Main Embankment	Grab	G7	19.50		901.58		901.58	Glacial Till	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	13.0	46.0	33.0	8.0	0.002	-
2011	AMEC	SI11-01	Main Embankment	Grab	G8	22.30		898.78		898.78	Glacial Till	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	39.0	35.0	26.0		-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G1	3.20		925.07		925.07	Glacial Till	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G2	5.30		922.97		922.97	Glacial Till	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G3	6.90		921.37		921.37	Glacial Till	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	15.0	38.0	36.0	11.0	0.002	-
2011	AMEC	SI11-02	Main Embankment	Grab	G4	8.40		919.87		919.87	Glacial Till	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G5	9.50		918.77		918.77	Glacial Till	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G6	10.10		918.17		918.17	Glaciolacustrine	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G7	10.60		917.67		917.67	Glaciofluvial	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G8	13.60		914.67		914.67	Glaciolacustrine	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G9	15.10		913.17		913.17	Glaciolacustrine	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G10	16.00		912.27		912.27	Glaciofluvial	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G11	16.50		911.77		911.77	Glaciolacustrine	-	18.4	ML	19	18	1	0.40	ML	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G12	20.20		908.07		908.07	Glaciolacustrine	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	14.0	70.0	16.0	0.002	-
2011	AMEC	SI11-02	Main Embankment	Grab	G13	21.50		906.77		906.77	Glaciolacustrine	-	15.4	CL	25	16	9	-0.07	CL	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G14	24.20		904.07		904.07	Glaciolacustrine	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G15	27.60		900.67		900.67	Glaciolacustrine	-	31.8	CH	57	24	33	0.24	CH	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G16	29.70		898.57		898.57	Glaciolacustrine	-	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G17	31.30		896.97		896.97	Glaciolacustrine	-	30.4	CI	37	21	16	0.59	CI	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G18	32.80		895.47		895.47	Glaciofluvial	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G19	34.90		893.37		893.37	Glaciofluvial	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G20	36.70		891.57		891.57	Glaciofluvial	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G21	37.60		890.67		890.67	Glaciofluvial	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G22	39.20		889.07		889.07	Glaciofluvial	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G23	40.40		887.87		887.87	Glaciofluvial	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G24	42.20		886.07		886.07	Glaciolacustrine	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G25	44.10		884.17		884.17	Glacial Till	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-02	Main Embankment	Grab	G26	45.00		883.27		883.27	Glacial Till	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-04	Perimeter Embankment	Core Return	C1	18.10		913.83		913.83	Glaciolacustrine	-	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-04	Perimeter Embankment	Core Return	C1	18.70		913.23		913.23	Glaciolacustrine	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	1.0	65.0	34.0	0.002	-
2011	AMEC	SI11-04	Perimeter Embankment	Core Return	C1	19.80		912.13		912.13	Glaciofluvial	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2011	AMEC	SI11-04	Perimeter Embankment	Core Return	C2	20.20		911.73		911.73	Glaciofluvial	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-101	Dam Breach Area	Thin-walled Tube	1	5.00		928.00		928.00	Possible Ablation / Moraine Till	-	11.0	SC	23	13	10	-0.20	CL	-	-	-	-	-	-	-	16.0	39.2	44.8		-	-
2014	Thurber	MR14-101	Dam Breach Area	Thin-walled Tube	2	5.70		927.30		927.30	Possible Ablation / Moraine Till	-	9.7	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-101	Dam Breach Area	Thin-walled Tube	3	6.40		926.60		926.60	Possible Ablation / Moraine Till	-	12.2	SC	22	13	9	-0.09	CL	-	-	-	-	-	-	-	16.1	36.8	31.5	15.6	0.002	-
2014	Thurber	MR14-101	Dam Breach Area	Grab	4	7.30		925.70		925.70	Possible Ablation / Moraine Till	-	9.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-101	Dam Breach Area	Thin-walled Tube	6	15.30		917.70		917.70	Basal Till	-	8.9	SC	22	14	8	-0.64	CL	-	-	-	-	-	-	-	26.0	35.3	38.7		-	-
2014	Thurber	MR14-101	Dam Breach Area	Thin-walled Tube	7	16.20		916.80		916.80	Basal Till	-	10.9	GC-GM	22	15	7	-0.59	CL-ML	-	-	-	-	-	-	-	34.0	33.4	32.6		-	-
2014	Thurber	MR14-102	Dam Breach Area	Thin-walled Tube	1	3.30		929.20		929.20	Possible Weathered Ablation / Moraine Till	-	13.0	SC	26	15	11	-0.18	CL	-	-	-	-	-	-	-	27.6	32.5	27.9	12.0	0.002	-
2014	Thurber	MR14-102	Dam Breach Area	Thin-walled Tube	2	3.90		928.60		928.60	Possible Weathered Ablation / Moraine Till	-	10.9	SC	24	13	11	-0.19	CL	-	-	-	-	-	-	-	22.6	36.4	29.0	12.0	0.002	-
2014	Thurber	MR14-102	Dam Breach Area	Thin-walled Tube	3	6.70		925.80		925.80	Possible Weathered Ablation / Moraine Till	-	11.9	SC	23	13	10	-0.11	CL	-	-	-	-	-	-	-	24.0	33.3	42.7		-	-
2014	Thurber	MR14-102	Dam Breach Area	Thin-walled Tube	5	9.40		923.10		923.10	Possible Ablation / Moraine Till	-	15.7	CL	23	13	10	0.27	CL	-	-	-	-	-	-	-	7.0	33.6	41.4	18.0	0.002	-
2014	Thurber	MR14-102	Dam Breach Area	Thin-walled Tube	6	10.00		922.50		922.50	Possible Ablation / Moraine Till	-	11.5	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-102	Dam Breach Area	Grab	7	10.60		921.90		921.90	Basal Till	-	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	1	3.50		927.20		927.20	Possible Ablation / Moraine Till	-	10.2	SC	23	13	10	-0.28	CL	-	-	-	-	-	-	-	12.0	39.7	31.4	16.9	0.002	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	2	4.90		925.80		925.80	Possible Ablation / Moraine Till	-	11.4	SC	25	14	11	-0.24	CL	-	-	-	-	-	-	-	21.6	38.4	27.3	12.7	0.002	-
2014	Thurber	MR14-103	Dam Breach Area	Grab	3	5.50		925.20		925.20	Possible Ablation / Moraine Till	-	16.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5A	7.90		922.80		922.80	Upper Glaciolacustrine[2]	-	15.7	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5B	7.90		922.80		922.80	Upper Glaciolacustrine[2]	-	18.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	3.9	26.4	47.3	22.4	0.002	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5C	8.00		922.70		922.70	Upper Glaciolacustrine[2]	-	16.9	CL	27	13	14	0.28	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5D	8.00		922.70		922.70	Upper Glaciolacustrine[2]	-	15.3	CL	33	15	18	0.02	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5E	8.10		922.60		922.60	Upper Glaciolacustrine[2]	-	14.1	CL	23	13	10	0.11	CL	-	-	-	-	-	-	-	11.0	34.7	38.9	15.3	0.002	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5F	8.30		922.40		922.40	Upper Glaciolacustrine[2]	-	25.1	CL	35	17	18	0.45	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	5G	8.30		922.40		922.40	Upper Glaciolacustrine[2]	-	27.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-103	Dam Breach Area	Thin-walled Tube	6	8.60		922.10		922.10	Basal Till	-	12.7	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	SC14-103	Dam Breach Area	Grab	1	2.70		928.10		928.10	Possible Ablation / Moraine Till	-	14.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	SC14-103	Dam Breach Area	Grab	2	3.70		927.10		927.10	Possible Ablation / Moraine Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	SC14-103	Dam Breach Area	Grab	3	5.30		925.50		925.50	Possible Ablation / Moraine Till	-	5.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	SC14-103	Dam Breach Area	Grab	4	6.80		924.00		924.00	Possible Ablation / Moraine Till	-	25.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	SC14-103	Dam Breach Area	Grab	5	8.40		922.40		922.40	Possible Ablation / Moraine Till	-	13.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-104	Dam Breach Area	Thin-walled Tube	1	3.80		927.90		927.90	Possible Ablation / Moraine Till	-	9.9	SC	22	13	9	-0.34	CL	-	-	-	-	-	-	-	16.0	36.0	32.0	16.0	0.002	-
2014	Thurber	MR14-104	Dam Breach Area	Thin-walled Tube	2	4.60		927.10		927.10	Possible Ablation / Moraine Till	-	8.9	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-104	Dam Breach Area	Grab	3	5.30		926.40		926.40	-	-	15.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-104	Dam Breach Area	Thin-walled Tube	4	6.20		925.50		925.50	Possible Ablation / Moraine Till	-	11.9	SC	23	12	11	-0.01	CL	-	-	-	-	-	-	-	26.3	35.9	24.2	13.6	0.002	-
2014	Thurber	MR14-104	Dam Breach Area	Grab	6	9.10		922.60		922.60	Possible Ablation / Moraine Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-104	Dam Breach Area	Thin-walled Tube	8	11.60		920.10		920.10	Possible Ablation / Moraine Till	-	33.1	CL	41	16	25	0.68	CL	-	-	-	-	-	-	-	8.9	31.4	24.0	35.7	0.002	-
2014	Thurber	MR14-104	Dam Breach Area	Thin-walled Tube	9	12.40		919.30		919.30	Possible Ablation / Moraine Till	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.3	35.9	37.8		-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	2	2.50		929.20		929.20	Possible Fill	-	18.7	OL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	3	3.30		928.40		928.40	Possible Fill	-	14.6	SC	28	15	13	-0.03	CL	-	-	-	-	-	-	-	15.0	43.6	26.7	14.7	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	4A	3.80		927.90		927.90	Possible Fill	-	13.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	4B	3.90		927.80		927.80	Possible Fill	-	15.5	SC	28	14	14	0.11	CL	-	-	-	-	-	-	-	10.2	41.3	31.3	17.2	0.002	TX
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	4C	4.10		927.60		927.60	Possible Fill	-	11.7	CL	25	14	11	-0.21	CL	-	-	-	-	-	-	-	6.3	38.5	37.2	18.0	0.002	OD
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	5	5.10		926.60		926.60	Possible Ablation / Moraine Till	-	13.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Grab	6	6.40		925.30		925.30	Possible Ablation / Moraine Till	-	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	7	7.10		924.60		924.60	Possible Ablation / Moraine Till	-	12.0	SC	23	12	11	0.00	CL	-	-	-	-	-	-	-	20.7	36.2	29.0	14.1	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	8	8.20		923.50		923.50	Possible Ablation / Moraine Till	-	16.2	SC	22	12	10	0.42	CL	-	-	-	-	-	-	-	16.5	37.6	30.8	15.1	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9A	9.20		922.50		922.50	Possible Ablation / Moraine Till	-	14.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9B	9.20		922.50		922.50	Possible Ablation / Moraine Till	-	21.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	19.0	11.8	45.4	23.8	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9C	9.30		922.40		922.40	Upper Glaciolacustrine[2]	-	11.0	GC	25	13	12	-0.17	CL	-	-	-	-	-	-	-	28.5	28.2	31.0	12.3	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9D	9.40		922.30		922.30	Upper Glaciolacustrine[2]	-	14.5	CL	25	13	12	0.13	CL	-	-	-	-	-	-	-	2.3	26.0	52.5	19.3	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9E	9.50		922.20		922.20	Upper Glaciolacustrine[2]	-	21.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9F	9.50		922.20		922.20	Upper Glaciolacustrine[2]	-	43.6	CH	54	20	34	0.69	CH	-	-	-	-	-	-	-	1.9	9.7	34.8	53.6	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	9G	9.70		922.00		922.00	Possible Ablation / Moraine Till	-	17.4	CL	27	13	14	0.31	CL	-	-	-	-	-	-	-	8.8	30.3	40.8	20.1	0.002	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	10	11.00		920.70		920.70	Possible Ablation / Moraine Till	-	18.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-105	Dam Breach Area	Thin-walled Tube	10	11.20		920.50		920.50	Possible Ablation / Moraine Till	-	12.9	CL	21	13	8	-0.01	CL	-	-	-	-	-	-	-	5.2	42.5	37.7	14.6	0.002	OD
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	1	3.20		926.20		926.20	Possible Ablation / Moraine Till	-	12.0	SC	25	13	12	-0.08	CL	-	-	-	-	-	-	-	21.2	34.3	29.8	14.7	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	2	4.80		924.60		924.60	Possible Ablation / Moraine Till	2.77	12.1	CL	22	12	10	0.01	CL	-	-	-	-	-	-	-	11.2	36.2	34.2	18.4	0.002	TX

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	3	5.30		924.10		924.10	Possible Ablation / Moraine Till	-	13.9	SC	25	13	12	0.08	CL	-	-	-	-	-	-	-	14.4	35.9	34.4	15.4	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	4	6.00		923.40		923.40	Possible Ablation / Moraine Till	-	12.3	GC	23	12	11	0.03	CL	-	-	-	-	-	-	-	32.8	30.7	25.0	11.5	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	5	6.80		922.60		922.60	Possible Ablation / Moraine Till	-	13.2	SC	24	12	12	0.10	CL	-	-	-	-	-	-	-	22.8	40.1	25.3	11.8	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	6A	8.00		921.40		921.40	Upper Glaciolacustrine[2]	-	-	CH	52	23	29	-	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	6B	8.00		921.40		921.40	Upper Glaciolacustrine[2]	-	35.5	CL	45	21	24	0.60	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	7A	8.70		920.70		920.70	Upper Glaciolacustrine[2]	-	13.4	SC	23	13	10	0.04	CL	-	-	-	-	-	-	-	22.0	28.3	36.5	13.2	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	7B	8.90		920.50		920.50	Upper Glaciolacustrine[2]	-	14.8	CL	29	14	15	0.05	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	7C	8.90		920.50		920.50	Basal Till	-	13.3	SC	21	13	8	0.04	CL	-	-	-	-	-	-	-	11.9	39.4	35.7	13.0	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	7D	9.00		920.40		920.40	Basal Till	-	16.4	CL	27	13	14	0.24	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	7E	9.10		920.30		920.30	Basal Till	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-	10.8	33.9	41.1	14.2	0.002	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	8A	10.40		919.00		919.00	Basal Till	-	20.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106	Dam Breach Area	Thin-walled Tube	8B	10.50		918.90		918.90	Lower Glaciolacustrine[2]	-	23.8	CL	39	24	15	-0.01	CL	-	-	-	-	-	-	-	0.0	1.7	72.2	26.1	0.002	-
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1A	7.30		921.40		921.40	Possible Ablation / Moraine Till	-	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1B	7.50		921.20		921.20	Upper Glaciolacustrine[2]	-	27.5	CL	45	19	26	0.33	CL	-	-	-	-	-	-	-	0.0	1.8	52.1	46.1	0.002	-
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1C-T1	7.60		921.10		921.10	Upper Glaciolacustrine[2]	-	43.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1C-T2	7.60		921.10		921.10	Upper Glaciolacustrine[2]	-	36.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1C-T3	7.60		921.10		921.10	Upper Glaciolacustrine[2]	-	38.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1C	7.70		921.00		921.00	Upper Glaciolacustrine[2]	-	35.3	CH	54	23	31	0.40	CH	-	-	-	-	-	-	-	0.0	0.8	42.8	56.4	0.002	-
2014	Thurber	MR14-106A	Dam Breach Area	Thin-walled Tube	1C-T4	7.70		921.00		921.00	Upper Glaciolacustrine[2]	-	33.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1B-T2	7.30		921.20		921.20	Upper Glaciolacustrine[2]	-	43.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1B-T3	7.30		921.20		921.20	Upper Glaciolacustrine[2]	-	38.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1B	7.40		921.10		921.10	Upper Glaciolacustrine[2]	-	34.6	CH	56	23	33	0.35	CH	-	-	-	-	-	-	-	0.0	1.0	36.6	62.4	0.002	-
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1B	7.50		921.00		921.00	Upper Glaciolacustrine[2]	-	38.6	CH	50	20	30	0.62	CH	-	-	-	-	-	-	-	0.0	0.2	46.9	52.9	0.002	TX
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1C	7.60		920.90		920.90	Upper Glaciolacustrine[2]	2.83	41.2	CH	62	24	38	0.45	CH	-	-	-	-	-	-	-	0.0	0.2	38.6	61.2	0.002	OD
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1C	7.60		920.90		920.90	Upper Glaciolacustrine[2]	-	40.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1D	7.70		920.80		920.80	Upper Glaciolacustrine[2]	-	23.9	CL	31	17	14	0.49	CL	-	-	-	-	-	-	-	0.0	14.3	52.3	33.4	0.002	-
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	1E	7.70		920.80		920.80	Upper Glaciolacustrine[2]	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106C	Dam Breach Area	Thin-walled Tube	2	7.80		920.70		920.70	Upper Glaciolacustrine[2]	-	13.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106D	Dam Breach Area	Thin-walled Tube	2	8.40		920.30		920.30	Upper Glaciolacustrine[2]	-	40.5	CH	54	21	33	0.59	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	2A	7.70		921.30		921.30	Upper Glaciolacustrine[2]	-	33.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	2B	7.90		921.10		921.10	Upper Glaciolacustrine[2]	-	35.2	CL	55	22	33	0.40	CL	-	-	-	-	-	-	-	-	-	-	-	-	OD
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	2C	8.00		921.00		921.00	Upper Glaciolacustrine[2]	-	35.4	CH	50	21	29	0.50	CH	-	-	-	-	-	-	-	0.0	0.5	48.2	51.3	0.002	TX
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	2C	8.20		920.80		920.80	Upper Glaciolacustrine[2]	-	25.5	CL	42	18	24	0.31	CL	-	-	-	-	-	-	-	0.0	2.9	52.7	44.4	0.002	OD
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	3A	8.30		920.70		920.70	Upper Glaciolacustrine[2]	-	30.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	3B	8.40		920.60		920.60	Upper Glaciolacustrine[2]	2.86	40.1	CH	55	20	35	0.57	CH	-	-	-	-	-	-	-	0.0	1.0	40.6	58.4	0.002	TX
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	3B	8.50		920.50		920.50	Upper Glaciolacustrine[2]	-	40.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	3C	8.80		920.20		920.20	Upper Glaciolacustrine[2]	2.87	40.1	CH	55	22	33	0.55	CH	-	-	-	-	-	-	-	0.0	0.0	42.4	57.6	0.002	TX
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	4A	8.90		920.10		920.10	Upper Glaciolacustrine[2]	-	39.8	CH	57	19	38	0.55	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	4B	9.00		920.00		920.00	Upper Glaciolacustrine[2]	-	48.4	CH	63	22	41	0.64	CH	-	-	-	-	-	-	-	0.0	10.4	26.7	62.9	0.002	OD
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	4C	9.00		920.00		920.00	Upper Glaciolacustrine[2]	-	24.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106E	Dam Breach Area	Thin-walled Tube	4D	9.20		919.80		919.80	Upper Glaciolacustrine[2]	-	24.7	CL	41	22	19	0.14	CL	-	-	-	-	-	-	-	0.0	0.0	64.5	35.5	0.002	OD
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	2B	8.00		920.70		920.70	Upper Glaciolacustrine[2]	-	30.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TX
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	2B	8.10		920.60		920.60	Upper Glaciolacustrine[2]	-	37.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.1	49.0	50.9	0.002	-
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	2B	8.10		920.60		920.60	Upper Glaciolacustrine[2]	-	41.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TX
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	2B	8.30		920.40		920.40	Upper Glaciolacustrine[2]	-	38.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TX
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	3A	8.40		920.30		920.30	Upper Glaciolacustrine[2]	-	27.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	3B	8.50		920.20		920.20	Upper Glaciolacustrine[2]	-	43.4	CH	64	23	41	0.50	CH	-	-	-	-	-	-	-	0.0	6.2	29.3	64.5	0.002	OD
2014	Thurber	MR14-106F	Dam Breach Area	Thin-walled Tube	3C	8.60		920.10		920.10	Upper Glaciolacustrine[2]	-	17.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	15.0	24.1	60.9		-	-
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	2B	7.80		920.90		920.90	Upper Glaciolacustrine[2]	-	38.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TX
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	2B-T1	7.80		920.90		920.90	Upper Glaciolacustrine[2]	-	43.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	2B	8.00		920.70		920.70	Upper Glaciolacustrine[2]	-	41.0	CL	40	19	21	1.05	CL	-	-	-	-	-	-	-	0.0	2.5	50.4	47.0	0.002	-
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	2B	8.00		920.70		920.70	Upper Glaciolacustrine[2]	-	33.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TX
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	2B	8.00		920.70		920.70	Upper Glaciolacustrine[2]	-	38.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	TX
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	2B-T2	8.10		920.60		920.60	Upper Glaciolacustrine[2]	-	38.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-106G	Dam Breach Area	Thin-walled Tube	3A	8.30		920.40		920.40	Upper Glaciolacustrine[2]	-	42.6	CH	57	23	34	0.58	CH	-	-	-	-	-	-	-	0.0	0.5	42.1	57.4	0.002	OD
2014	Thurber	MR14-106H	Dam Breach Area	Thin-walled Tube	1A	7.30		921.30		921.30	Upper Glaciolacustrine[2]	-	34.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-106H	Dam Breach Area	Thin-walled Tube	1B	7.40		921.20		921.20	Upper Glaciolacustrine[2]	-	38.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DS
2014	Thurber	MR14-106H	Dam Breach Area	Thin-walled Tube	1B	7.50		921.10		921.10	Upper Glaciolacustrine[2]	-	40.8	CH	56	20	36	0.58	CH	-	-	-	-	-	-	-	0.0	1.1	36.0	62.9	0.002	OD
2014	Thurber	MR14-106I	Dam Breach Area	Thin-walled Tube	1	7.60		921.00		921.00	Upper Glaciolacustrine[2]	-	34.1	CL	47	21	26	0.50	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	1	2.90		925.80		925.80	Possible Ablation / Moraine Till	-	13.9	SC	24	13	11	0.08	CL	-	-	-	-	-	-	-	27.5	30.3	28.7	13.5	0.002	-
2014	Thurber	MR14-107	Dam Breach Area	Grab	3	4.00		924.70		924.70	Possible Ablation / Moraine Till	-	15.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	4	4.90		923.80		923.80	Possible Ablation / Moraine Till	-	13.6	SC	24	12	12	0.13	CL	-	-	-	-	-	-	-	28.5	31.5	27.5	12.5	0.002	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	5	6.30		922.40		922.40	Possible Ablation / Moraine Till	-	12.8	SC	23	12	11	0.07	CL	-	-	-	-	-	-	-	23.3	36.4	28.4	12.0	0.002	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6	7.30		921.40		921.40	Upper Glaciolacustrine[2]	-	32.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C	7.10		921.60		921.60	Upper Glaciolacustrine[2]	-	34.8	CL	47	24	23	0.47	CL	-	-	-	-	-	-	-	0.0	0.4	53.3	46.3	0.002	OD
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C-T1	7.10		921.60		921.60	Upper Glaciolacustrine[2]	-	43.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C-T2	7.20		921.50		921.50	Upper Glaciolacustrine[2]	-	42.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C	7.30		921.40		921.40	Upper Glaciolacustrine[2]	-	32.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C	7.40		921.30		921.30	Upper Glaciolacustrine[2]	-	43.5	CL	45	22	23	0.93	CL	-	-	-	-	-	-	-	0.0	1.9	54.5	43.6	0.002	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C	7.40		921.30		921.30	Upper Glaciolacustrine[2]	-	32.2	CL/CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107	Dam Breach Area	Thin-walled Tube	6C	7.40		921.30		921.30	Upper Glaciolacustrine[2]	-	49.9	CL/CH	-	-	-	-	-	-	-	-	-	-	-	-	0.0	2.7	34.1	63.2	0.002	-
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	1A-T1	7.20		921.10		921.10	Upper Glaciolacustrine[2]	-	42.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	1A	7.20		921.10		921.10	Upper Glaciolacustrine[2]	-	42.5	CH	57	23	34	0.57	CH	-	-	-	-	-	-	-	0.0	0.3	42.6	57.2	0.002	-
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	1A-T2	7.30		921.00		921.00	Upper Glaciolacustrine[2]	-	42.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	1B	7.30		921.00		921.00	Upper Glaciolacustrine[2]	-	39.6	CL	46	21	25	0.74	CL	-	-	-	-	-	-	-	0.0	0.0	51.3	48.6	0.002	OD
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	1C	7.40		920.90		920.90	Upper Glaciolacustrine[2]	-	28.1	CL	45	18	27	0.37	CL	-	-	-	-	-	-	-	7.7	25.0	28.6	38.7	0.002	-
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	1D	7.60		920.70		920.70	Basal Till	-	13.9	CL	23	15	8	-0.14	CL	-	-	-	-	-	-	-	18.1	30.8	38.2	12.9	0.002	-
2014	Thurber	MR14-107A	Dam Breach Area	Grab	2	8.70		919.60		919.60	Basal Till	-	16.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107A	Dam Breach Area	Grab	5	11.00		917.30		917.30	Basal Till	-	18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	6A	11.50		916.80		916.80	Lower Glaciolacustrine[2]	-	17.3	CL	33	22	11	-0.43	CL	-	-	-	-	-	-	-	8.8	9.8	61.5	19.9	0.002	-
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	6B	11.60		916.70		916.70	Lower Glaciolacustrine[2]	-	22.0	CL	40	25	15	-0.20	CL	-	-	-	-	-	-	-	0.0	0.7	70.4	28.9	0.002	OD
2014	Thurber	MR14-107A	Dam Breach Area	Thin-walled Tube	7	12.00		916.30		916.30	Lower Glaciolacustrine[2]	-	22.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-107B	Dam Breach Area	Thin-walled Tube	1B	6.90		921.50		921.50	Upper Glaciolacustrine[2]	-	32.5	CL	49	20	29	0.43	CL	-	-	-	-	-	-	-	0.0	3.0	44.2	52.8	0.002	OD
2014	Thurber	MR14-107B	Dam Breach Area	Thin-walled Tube	1C	7.10		921.30		921.30	Upper Glaciolacustrine[2]	-	34.1	CH	53	25	28	0.33	CH	-	-	-	-	-	-	-	0.0	0.1	47.9	52.0	0.002	-
2014	Thurber	MR14-108	Dam Breach Area	Thin-walled Tube	1	1.80		926.80		926.80	Possible Ablation / Moraine Till	-	12.8	CL	24	14	10	-0.12	CL	-	-	-	-	-	-	-	14.7	33.7	51.6		-	-
2014	Thurber	MR14-108	Dam Breach Area	Thin-walled Tube	2	3.00		925.60		925.60	Possible Ablation / Moraine Till	-	12.6	SC	24	12	12	0.05	CL	-	-	-	-	-	-	-	25.2	30.7	30.7	13.3	0.002	-
2014	Thurber	MR14-108	Dam Breach Area	Thin-walled Tube	3	3.70		924.90		924.90	Possible Ablation / Moraine Till	-	17.6	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	14.8	46.4	38.8		-	-
2014	Thurber	MR14-108	Dam Breach Area	Thin-walled Tube	4	5.80		922.80		922.80	Possible Ablation / Moraine Till	-	17.1	SC	27	12	15	0.34	CL	-	-	-	-	-	-	-	29.1	29.5	25.6	15.7	0.002	-
2014	Thurber	MR14-108	Dam Breach Area	Thin-walled Tube	6	8.00		920.60		920.60	Possible Ablation / Moraine Till	-	17.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-108A	Dam Breach Area	Thin-walled Tube	1	8.60		920.00		920.00	Basal Till	-	19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-108A	Dam Breach Area	Thin-walled Tube	6	11.60		917.00		917.00	Lower Glaciolacustrine[2]	-	22.5	CL	43	24	19	-0.08	CL	-	-	-	-	-	-	-	0.0	1.0	72.7	26.3	0.002	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	1	1.50		927.50		927.50	Possible Ablation / Moraine Till	-	13.9	CL	26	15	11	-0.10	CL	-	-	-	-	-	-	-	10.4	35.2	54.4		-	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	2	2.70		926.30		926.30	Possible Ablation / Moraine Till	-	13.2	SC	25	14	11	-0.07	CL	-	-	-	-	-	-	-	24.6	31.7	30.2	13.5	0.002	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	3	3.50		925.50		925.50	Possible Ablation / Moraine Till	-	15.3	CL-ML	22	15	7	0.04	CL-ML	-	-	-	-	-	-	-	12.3	35.1	52.6		-	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	4	4.70		924.30		924.30	Possible Ablation / Moraine Till	-	13.0	CL-ML	23	16	7	-0.43	CL-ML	-	-	-	-	-	-	-	13.2	36.0	39.0	11.8	0.002	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	5	6.60		922.40		922.40	Basal Till	-	12.4	GC-GM	25	18	7	-0.80	CL-ML	-	-	-	-	-	-	-	31.5	30.3	30.4	7.9	0.002	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	6A	12.30		916.70		916.70	Basal Till	-	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	6B	12.30		916.70		916.70	Basal Till	-	21.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	6B	12.40		916.60		916.60	Basal Till	-	22.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	6B	12.50		916.50		916.50	Basal Till	2.74	13.1	CL/ML	-	-	-	-	-	-	-	-	-	-	-	-	17.6	20.9	48.6	12.9	0.002	-
2014	Thurber	MR14-109	Dam Breach Area	Thin-walled Tube	6B	12.50		916.50		916.50	Basal Till	-	19.9	CL	35	22	13	-0.16	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	1	2.30		926.40		926.40	Possible Ablation / Moraine Till	-	13.7	SC	25	14	11	-0.03	CL	-	-	-	-	-	-	-	22.1	33.3	44.6		-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution				Clay Threshold (< mm)	Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)			
																												Silt (%)	Clay (%)		
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	2	3.20		925.50		925.50	Possible Ablation / Moraine Till	-	13.1	SC	22	14	8	-0.11	CL	-	-	-	-	-	-	-	19.5	32.5	35.0	13.1	0.002	-
2014	Thurber	MR14-110	Dam Breach Area	Grab	3	4.10		924.60		924.60	Possible Ablation / Moraine Till	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.7	40.6	45.8		-	-
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	4	4.80		923.90		923.90	Possible Ablation / Moraine Till	-	13.0	CL	22	13	9	0.00	CL	-	-	-	-	-	-	-	12.9	32.5	40.5	14.1	0.002	-
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	5	5.70		923.00		923.00	Possible Ablation / Moraine Till	-	31.2	CL-ML	21	15	6	2.70	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	6A	12.20		916.50		916.50	Lower Glaciolacustrine[2]	-	8.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	6B	12.40		916.30		916.30	Lower Glaciolacustrine[2]	-	17.2	CL	36	23	13	-0.45	CL	-	-	-	-	-	-	-	0.0	1.1	74.4	24.5	0.002	OD
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	6C	12.50		916.20		916.20	Lower Glaciolacustrine[2]	-	21.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	6C	12.50		916.20		916.20	Lower Glaciolacustrine[2]	-	22.4	CL/ML	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.2	70.6	29.2	0.002	-
2014	Thurber	MR14-110	Dam Breach Area	Thin-walled Tube	6C	12.50		916.20		916.20	Lower Glaciolacustrine[2]	-	20.8	CL	39	24	15	-0.21	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	1	1.90		926.70		926.70	Possible Ablation / Moraine Till	-	18.2	GC	25	12	13	0.48	CL	-	-	-	-	-	-	-	35.2	29.1	23.3	12.4	0.002	-
2014	Thurber	MR14-111	Dam Breach Area	Grab	2	2.50		926.10		926.10	Possible Ablation / Moraine Till	-	14.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	3A	3.70		924.90		924.90	Possible Ablation / Moraine Till	-	12.1	SC	22	11	11	0.10	CL	-	-	-	-	-	-	-	19.3	36.9	27.8	16.0	0.002	-
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	3B	3.90		924.70		924.70	Upper Glaciolacustrine[2]	-	20.2	CL	34	13	21	0.34	CL	-	-	-	-	-	-	-	17.3	24.1	26.8	31.8	0.002	-
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	3C	4.10		924.50		924.50	Upper Glaciolacustrine[2]	-	13.5	CL	22	13	9	0.06	CL	-	-	-	-	-	-	-	12.1	33.8	36.1	18.0	0.002	-
2014	Thurber	MR14-111	Dam Breach Area	Grab	7	4.30		924.30		924.30	Possible Ablation / Moraine Till	-	13.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	5A	5.70		922.90		922.90	Possible Ablation / Moraine Till	-	12.9	CL	22	14	8	-0.14	CL	-	-	-	-	-	-	-	12.4	34.6	39.8	13.2	0.002	TX
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	5B	5.90		922.70		922.70	Possible Ablation / Moraine Till	-	10.8	CL-ML	21	15	6	-0.70	CL-ML	-	-	-	-	-	-	-	11.4	33.9	43.6	11.0	0.002	OD
2014	Thurber	MR14-111	Dam Breach Area	Thin-walled Tube	5B	5.90		922.70		922.70	Possible Ablation / Moraine Till	-	11.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-111	Dam Breach Area	Grab	6	9.90		918.70		918.70	Possible Ablation / Moraine Till	-	15.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-111A	Dam Breach Area	Grab	5	4.30		923.80		923.80	Possible Ablation / Moraine Till	-	12.6	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-112	Dam Breach Area	Thin-walled Tube	1	1.70		927.20		927.20	Possible Ablation / Moraine Till	-	11.0	SC	25	13	12	-0.17	CL	-	-	-	-	-	-	-	26.8	32.1	26.6	14.5	0.002	-
2014	Thurber	MR14-112	Dam Breach Area	Grab	3	3.80		925.10		925.10	Possible Ablation / Moraine Till	-	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-112	Dam Breach Area	Thin-walled Tube	4A	4.40		924.50		924.50	Possible Ablation / Moraine Till	-	14.4	GC	23	13	10	0.14	CL	-	-	-	-	-	-	-	37.6	27.6	23.5	11.3	0.002	-
2014	Thurber	MR14-112	Dam Breach Area	Thin-walled Tube	4B	4.60		924.30		924.30	Upper Glaciolacustrine[2]	-	32.0	CH	59	21	38	0.29	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-112	Dam Breach Area	Thin-walled Tube	4C	4.80		924.10		924.10	Possible Ablation / Moraine Till	-	16.2	CL	29	13	16	0.20	CL	-	-	-	-	-	-	-	9.1	31.7	38.1	21.1	0.002	-
2014	Thurber	MR14-112	Dam Breach Area	Grab	5	5.60		923.30		923.30	Possible Ablation / Moraine Till	-	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-112	Dam Breach Area	Grab	6	6.50		922.40		922.40	Possible Ablation / Moraine Till	-	17.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	1A	1.30		928.10		928.10	[1]	-	131.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	1B	1.30		928.10		928.10	Possible Ablation / Moraine Till	-	23.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OD
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	1C	1.40		928.00		928.00	Possible Ablation / Moraine Till	2.78	20.0	CL	27	14	13	0.46	CL	-	-	-	-	-	-	-	6.5	33.0	40.6	19.9	0.002	TX
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	1D	1.60		927.80		927.80	Possible Ablation / Moraine Till	-	17.9	CL	26	13	13	0.38	CL	-	-	-	-	-	-	-	9.8	36.9	36.7	16.6	0.002	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	2	3.90		925.50		925.50	Possible Ablation / Moraine Till	-	12.1	SC	24	13	11	-0.08	CL	-	-	-	-	-	-	-	22.3	30.5	32.7	14.5	0.002	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	3	5.20		924.20		924.20	Possible Ablation / Moraine Till	-	12.8	SC	21	12	9	0.09	CL	-	-	-	-	-	-	-	23.3	29.6	34.1	13.0	0.002	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	4A	6.30		923.10		923.10	Possible Ablation / Moraine Till	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	4A	6.30		923.10		923.10	Possible Ablation / Moraine Till	-	10.8	CL-ML	21	14	7	-0.46	CL-ML	-	-	-	-	-	-	-	3.6	35.9	48.2	12.3	0.002	OD
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	4B	6.50		922.90		922.90	Possible Ablation / Moraine Till	-	11.4	CL-ML	21	14	7	-0.37	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	4B	6.60		922.80		922.80	Possible Ablation / Moraine Till	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	3.6	35.5	48.5	12.3	0.002	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	4B	6.60		922.80		922.80	Possible Ablation / Moraine Till	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	DSS
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	5	7.40		922.00		922.00	Possible Ablation / Moraine Till	-	13.2	CL-ML	20	13	7	0.03	CL-ML	-	-	-	-	-	-	-	8.7	39.8	36.9	14.6	0.002	-
2014	Thurber	MR14-113	Dam Breach Area	Thin-walled Tube	6C	9.40		920.00		920.00	Possible Ablation / Moraine Till	-	18.7	CL	28	17	11	0.15	CL	-	-	-	-	-	-	-	4.6	27.1	50.0	18.3	0.002	OD
2014	Thurber	MR14-114	Dam Breach Area	Thin-walled Tube	2	3.80		926.80		926.80	Possible Ablation / Moraine Till	-	7.9	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-114	Dam Breach Area	Thin-walled Tube	3	4.80		925.80		925.80	Possible Ablation / Moraine Till	-	11.3	SC	23	12	11	-0.06	CL	-	-	-	-	-	-	-	25.1	32.3	28.4	14.2	0.002	-
2014	Thurber	MR14-114	Dam Breach Area	Thin-walled Tube	5	6.60		924.00		924.00	Possible Ablation / Moraine Till	-	10.8	SC	21	12	9	-0.13	CL	-	-	-	-	-	-	-	26.6	32.0	29.5	11.9	0.002	-
2014	Thurber	MR14-114	Dam Breach Area	Grab	7	9.20		921.40		921.40	Possible Ablation / Moraine Till	-	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-115	Dam Breach Area	Grab	2	2.50		926.50		926.50	Possible Ablation / Moraine Till	-	14.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-115	Dam Breach Area	Thin-walled Tube	3	3.80		925.20		925.20	Possible Ablation / Moraine Till	-	11.6	SC	23	12	11	-0.04	CL	-	-	-	-	-	-	-	25.0	31.6	28.0	15.4	0.002	-
2014	Thurber	MR14-115	Dam Breach Area	Thin-walled Tube	4	4.50		924.50		924.50	Possible Ablation / Moraine Till	-	11.3	SC	23	15	8	-0.46	CL	-	-	-	-	-	-	-	18.7	33.7	36.6	11.0	0.002	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	1	0.30		930.30		930.30	Possible Ablation / Moraine Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	2	1.50		929.10		929.10	Possible Ablation / Moraine Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	3	2.10		928.50		928.50	Possible Ablation / Moraine Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	4	2.60		928.00		928.00	Possible Ablation / Moraine Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	5	3.30		927.30		927.30	Possible Ablation / Moraine Till	-	13.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	6	4.00		926.60		926.60	Possible Ablation / Moraine Till	-	11.8	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	7	4.50		926.10		926.10	Possible Ablation / Moraine Till	-	12.5	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	8	5.10		925.50		925.50	Possible Ablation / Moraine Till	-	12.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	9	5.30		925.30		925.30	Upper Glaciolacustrine[2]	-	30.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	10	5.80		924.80		924.80	Upper Glaciolacustrine[2]	-	31.3	CL	49	21	28	0.37	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	11	6.40		924.20		924.20	Possible Ablation / Moraine Till	-	13.7	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	12	7.00		923.60		923.60	Possible Ablation / Moraine Till	-	15.4	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	13	7.50		923.10		923.10	Possible Ablation / Moraine Till	-	13.0	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	14	8.20		922.40		922.40	Possible Ablation / Moraine Till	-	13.3	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	15	8.60		922.00		922.00	Possible Ablation / Moraine Till	-	13.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	16	10.60		920.00		920.00	Upper Glaciolacustrine[2]	-	21.5	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	17	10.90		919.70		919.70	Upper Glaciolacustrine[2]	-	37.7	CH	51	20	31	0.57	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	18	11.20		919.40		919.40	Upper Glaciolacustrine[2]	-	38.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	19	11.40		919.20		919.20	Basal Till	-	16.8	CL	25	16	9	0.09	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	20	11.90		918.70		918.70	Lower Glaciolacustrine[2]	-	23.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	21	12.50		918.10		918.10	Lower Glaciolacustrine[2]	-	16.8	CL	23	15	8	0.23	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	22	13.10		917.50		917.50	Lower Glaciolacustrine[2]	-	14.6	CL-ML	22	17	5	-0.48	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	23	13.50		917.10		917.10	Lower Glaciolacustrine[2]	-	14.2	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	24	13.80		916.80		916.80	Lower Glaciolacustrine[2]	-	19.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	25	14.30		916.30		916.30	Lower Glaciolacustrine[2]	-	17.5	CL-ML	23	19	4	-0.38	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	26	14.70		915.90		915.90	Lower Glaciolacustrine[2]	-	12.5	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116	Dam Breach Area	Grab	27	15.00		915.60		915.60	Lower Glaciolacustrine[2]	-	27.1	CL	41	23	18	0.23	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116A	Dam Breach Area	Grab	1	0.30		930.30		930.30	Possible Ablation / Moraine Till	-	13.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116A	Dam Breach Area	Grab	2	0.70		929.90		929.90	Possible Ablation / Moraine Till	-	15.1	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116A	Dam Breach Area	Grab	4	2.10		928.50		928.50	Possible Ablation / Moraine Till	-	13.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	MR14-116A	Dam Breach Area	Grab	5	2.70		927.90		927.90	Possible Ablation / Moraine Till	-	11.8	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	RH14-118	Dam Breach Area	Grab	2	15.00		922.70		922.70	Possible Ablation / Moraine Till	-	13.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	RH14-118	Dam Breach Area	Grab	3	15.50		922.20		922.20	Possible Ablation / Moraine Till	-	16.6	GC	23	12	11	0.42	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	1	Slice 4		935.16		935.16	Dam Till Core	-	10.1	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	2	Slice 6		933.84		933.84	Dam Till Core	-	12.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	3	Slice 9		935.29		935.29	Dam Till Core	-	11.8	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	4	Slice 14		940.14		940.14	Dam Filter	-	7.1	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	51.4	37.6	11.0		-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	5	Slice 14		936.73		936.73	Dam Till Core	-	10.8	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	7	Slice 18		940.35		940.35	Dam Filter	-	6.8	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	58.3	32.0	9.7		-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	8	Slice 18		933.93		933.93	Fill - Sand	-	15.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	1.0	77.6	21.4		-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	9	Slice 20		937.33		937.33	Dam Till Core	-	8.1	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	50.6	37.5	12.0		-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	10	Slice 20		941.20		941.20	Dam Filter	-	9.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	12.5	32.6	38.5	16.4	0.002	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	11	Slice 24		930.13		930.13	Fill - Gravel	-	11.1	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	12	Slice 27		930.99		930.99	Dam Till Core	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	13	Slice 27		930.93		930.93	Dam Till Core	-	10.3	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	14 U/S	Slice 31		931.65		931.65	Dam Till Core	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	7.6	38.4	37.8	16.2	0.002	-
2014	Thurber	Remnant Core Excavation	Dam Breach Area	Grab	15 D/S	Slice 31		931.26		931.26	Dam Till Core	-	10.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	18.4	34.3	34.0	13.3	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	1	-	-	-		-	Dam Till Core	-	7.0	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	9.5	38.2	39.7	12.6	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	2	-	-	-		-	Glacial Till	-	8.8	SM/SC	-	-	-	-	-	-	-	-	-	-	-	-	10.2	37.2	34.6	18.0	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	3	-	-	-		-		-	38.8	ML	42	29	13	0.75	ML	-	-	-	-	-	-	-	0.0	0.5	72.6	26.9	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	4	-	-	-		-	Glacial Till	-	9.2	CL/ML	-	-	-	-	-	-	-	-	-	-	-	-	8.0	30.4	43.7	17.9	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	5	-	-	-		-	-	-	10.7	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	0.0	57.9	42.1		-	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	6	-	-	-		-	-	-	1.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	0.0	78.6	21.4		-	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	7	-	-	-		-	Dam Till Core	-	5.5	SC/SM	-	-	-	-	-	-	-	-	-	-	-	-	6.0	37.1	41.4	15.6	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	8	-	-	-		-	-	-	9.3	GP-GM	-	-	-	-	-	-	-	-	-	-	-	-	60.9	27.5	11.6		-	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	9	-	-	-		-	-	-	35.5	ML	39	29	10	0.65	ML	-	-	-	-	-	-	-	0.0	1.5	75.0	23.5	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	10	-	-	-		-		-	15.9	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	0.0	58.4	41.6		-	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	11	-	-	-		-	Glacial Till	-	6.7	SM/SC	-	-	-	-	-	-	-	-	-	-	-	-	13.6	36.0	34.5	15.9	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	12	-	-	-		-	Glacial Till	-	6.9	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	22.1	32.1	31.6	14.2	0.002	-
2014	Thurber	Site Recon	Dam Breach Area	Grab	13	-	-	-		-	Glacial Till	-	4.7	CL/ML	-	-	-	-	-	-	-	-	-	-	-	-	11.4	34.8	39.1	14.6	0.002	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G1	2.23		929.12		929.12	Upper Glacial Till	-	28.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-01	Dam Breach Area	Grab	G2	2.59		928.76		928.76	Upper Glacial Till	-	18.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G3	2.68		928.67		928.67	Upper Glacial Till	-	16.7	CL	28	13	15	0.25	CL	-	-	-	-	-	-	-	8.9	38.2	34.4	18.6	0.002	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G4	2.96		928.39		928.39	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G5	3.35		928.00		928.00	Upper Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G6	3.51		927.84		927.84	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G7	3.57		927.78		927.78	Upper Glacial Till	-	12.8	CL	26	12	14	0.06	CL	-	-	-	-	-	-	-	8.7	39.6	32.3	19.4	0.002	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G8	4.09		927.26		927.26	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G9	4.67		926.68		926.68	Upper Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G24	11.46		919.89		919.89	Middle Glacial Till	-	9.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G26	12.07		919.28		919.28	Middle Glacial Till	-	7.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G27	12.50		918.85		918.85	Middle Glacial Till	-	6.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G29	12.71		918.64		918.64	Middle Glacial Till	-	6.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G30	13.11		918.24		918.24	Middle Glacial Till	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G31	13.50		917.85		917.85	Middle Glacial Till	-	12.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G32	13.90		917.45		917.45	Middle Glacial Till	-	10.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G34	14.24		917.11		917.11	Middle Glacial Till	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G35	14.66		916.69		916.69	Middle Glacial Till	-	8.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G37	15.12		916.23		916.23	Middle Glacial Till	-	8.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G38	15.55		915.80		915.80	Middle Glacial Till	-	4.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G39	15.67		915.68		915.68	Upper Glaciofluvial	-	7.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G40	16.16		915.19		915.19	Upper Glaciofluvial	-	18.2	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G42	16.64		914.71		914.71	Lower Glaciofluvial	-	8.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G43	17.07		914.28		914.28	Lower Glacial Till	-	18.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G44	17.22		914.13		914.13	Lower Glacial Till	-	8.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G45	17.83		913.52		913.52	Lower Glacial Till	-	11.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G46	18.38		912.97		912.97	Lower Glacial Till	-	5.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G48	18.90		912.45		912.45	Weathered Bedrock (Mafic)	-	12.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G50	19.36		911.99		911.99	Weathered Bedrock (Mafic)	-	9.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G51	19.81		911.54		911.54	Weathered Bedrock (Mafic)	-	6.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G52	20.39		910.96		910.96	Weathered Bedrock (Mafic)	-	8.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G53	20.94		910.41		910.41	Weathered Bedrock (Mafic)	-	8.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G54	21.49		909.86		909.86	Weathered Bedrock (Mafic)	-	6.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G55	21.50		909.85		909.85	Weathered Bedrock (Mafic)	-	14.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G56	21.83		909.52		909.52	Weathered Bedrock (Mafic)	-	14.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G57	22.40		908.95		908.95	Weathered Bedrock (Mafic)	-	9.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G58	22.95		908.40		908.40	Weathered Bedrock (Mafic)	-	9.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G60	23.47		907.88		907.88	Weathered Bedrock (Mafic)	-	5.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G61	24.05		907.30		907.30	Weathered Bedrock (Mafic)	-	5.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G62	24.45		906.90		906.90	Weathered Bedrock (Mafic)	-	6.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G63	24.93		906.42		906.42	Weathered Bedrock (Mafic)	-	8.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G65	25.39		905.96		905.96	Weathered Bedrock (Mafic)	-	6.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G66	26.09		905.26		905.26	Weathered Bedrock (Mafic)	-	4.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G67	26.25		905.10		905.10	Weathered Bedrock (Mafic)	-	9.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G69	26.98		904.37		904.37	Weathered Bedrock (Mafic)	-	7.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G70	27.53		903.82		903.82	Weathered Bedrock (Mafic)	-	5.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G71	27.95		903.40		903.40	Weathered Bedrock (Mafic)	-	7.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G72	28.59		902.76		902.76	Weathered Bedrock (Mafic)	-	6.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G74	29.05		902.30		902.30	Weathered Bedrock (Mafic)	-	3.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G75	29.66		901.69		901.69	Weathered Bedrock (Mafic)	-	7.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G77	30.21		901.14		901.14	Weathered Bedrock (Mafic)	-	6.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G78	30.66		900.69		900.69	Weathered Bedrock (Mafic)	-	2.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G79	31.00		900.35		900.35	Weathered Bedrock (Mafic)	-	9.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G80	31.67		899.68		899.68	Weathered Bedrock (Mafic)	-	10.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G81	32.10		899.25		899.25	Weathered Bedrock (Mafic)	-	4.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G82	32.68		898.67		898.67	Weathered Bedrock (Mafic)	-	8.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G83	33.26		898.09		898.09	Weathered Bedrock (Mafic)	-	7.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G84	33.47		897.88		897.88	Weathered Bedrock (Mafic)	-	6.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G86	34.38		896.97		896.97	Weathered Bedrock (Mafic)	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G87	35.08		896.27		896.27	Weathered Bedrock (Mafic)	-	5.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G88	35.82		895.53		895.53	Weathered Bedrock (Mafic)	-	7.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G89	36.58		894.77		894.77	Weathered Bedrock (Mafic)	-	5.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G91	37.31		894.04		894.04	Weathered Bedrock (Mafic)	-	9.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01	Dam Breach Area	Grab	G92	38.07		893.28		893.28	Weathered Bedrock (Mafic)	-	12.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G1	5.12		926.08		926.08	Upper Glacial Till	-	10.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G2	5.64		925.56		925.56	Upper Glacial Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G3	5.64		925.56		925.56	Upper Glacial Till	-	12.0	SC	25	12	13	0.00	CL	-	-	-	-	-	-	-	11.9	38.8	30.7	18.6	0.002	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G4	6.02		925.18		925.18	Upper Glacial Till	-	11.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G5	6.34		924.86		924.86	Upper Glacial Till	-	11.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G6	6.61		924.59		924.59	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G8	7.04		924.16		924.16	Upper Glacial Till	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G9	7.50		923.70		923.70	Upper Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G10	7.50		923.70		923.70	Upper Glacial Till	-	12.6	CL	22	12	10	0.06	CL	-	-	-	-	-	-	-	9.2	38.4	36.6	15.8	0.002	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G11	7.77		923.43		923.43	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G12	8.02		923.18		923.18	Upper Glacial Till	-	17.2	CL	23	14	9	0.36	CL	-	-	-	-	-	-	-	3.9	28.8	48.7	18.6	0.002	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G13	8.14		923.06		923.06	Upper Glacial Till	-	15.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G14	8.38		922.82		922.82	Upper Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G15	8.84		922.36		922.36	Upper Glaciolacustrine	-	13.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G16	8.93		922.27		922.27	Upper Glaciolacustrine	-	37.0	CH	64	20	44	0.39	CH	-	-	-	-	-	-	-	0.1	7.6	35.0	57.3	0.002	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G18	9.05		922.15		922.15	Upper Glaciolacustrine	-	26.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G19	9.69		921.51		921.51	Middle Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G20	10.15		921.05		921.05	Middle Glacial Till	-	15.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G21	10.21		920.99		920.99	Middle Glacial Till	-	10.9	CL	21	13	8	-0.26	CL	-	-	-	-	-	-	-	12.5	36.9	37.0	13.6	0.002	-
2014	KCB	SH14-01A	Dam Breach Area	Grab	G22	10.67		920.53		920.53	Middle Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02	Dam Breach Area	Grab	G1	4.99		927.91		927.91	Upper Glacial Till	-	25.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02	Dam Breach Area	Grab	G2	5.48		927.42		927.42	Upper Glacial Till	-	15.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02	Dam Breach Area	Grab	G3	7.49		925.41		925.41	Upper Glacial Till	-	13.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G1	4.27		928.66		928.66	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G2	4.57		928.36		928.36	Upper Glacial Till	-	16.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G3	5.18		927.75		927.75	Upper Glacial Till	-	11.2	CL	26	12	14	-0.06	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G4	5.49		927.44		927.44	Upper Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G5	5.79		927.14		927.14	Upper Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G7	6.40		926.53		926.53	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G8	6.61		926.32		926.32	Upper Glacial Till	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G9	7.01		925.92		925.92	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G10	7.01		925.92		925.92	Upper Glacial Till	-	11.7	CL	24	12	12	-0.03	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G11	7.35		925.58		925.58	Upper Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G12	7.86		925.07		925.07	Upper Glacial Till	-	10.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G13	8.14		924.79		924.79	Upper Glacial Till	-	11.5	SC	24	11	13	0.04	CL	-	-	-	-	-	-	-	16.5	36.1	29.2	18.3	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G14	8.29		924.64		924.64	Upper Glacial Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G15	8.87		924.06		924.06	Upper Glacial Till	-	11.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G16	9.20		923.73		923.73	Upper Glacial Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G17	9.30		923.63		923.63	Upper Glacial Till	-	12.5	SC	23	11	12	0.13	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G18	9.75		923.18		923.18	Upper Glacial Till	-	11.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G19	10.21		922.72		922.72	Upper Glacial Till	-	12.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G20	10.36		922.57		922.57	Upper Glacial Till	-	10.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G22	10.82		922.11		922.11	Upper Glacial Till	-	26.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G23	11.13		921.80		921.80	Upper Glacial Till	-	21.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G24	11.31		921.62		921.62	Upper Glaciolacustrine	-	33.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G25	11.31		921.62		921.62	Upper Glaciolacustrine	-	36.8	CH	51	19	32	0.56	CH	-	-	-	-	-	-	-	0.3	4.2	46.9	48.5	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G26	11.77		921.16		921.16	Upper Glacial Till	-	12.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G27	12.25		920.68		920.68	Upper Glacial Till	-	13.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-02A	Dam Breach Area	Grab	G28	12.50		920.43		920.43	Upper Glaciolacustrine	-	31.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G29	12.56		920.37		920.37	Upper Glaciolacustrine	-	28.9	CI	41	18	23	0.47	CI	-	-	-	-	-	-	4.5	14.8	41.5	39.2	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G30	12.65		920.28		920.28	Middle Glacial Till	-	16.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G31	13.11		919.82		919.82	Middle Glacial Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G32	13.32		919.61		919.61	Middle Glacial Till	-	9.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G33	13.32		919.61		919.61	Middle Glacial Till	-	8.9	CL	20	14	6	-0.85	CL-ML	-	-	-	-	-	-	6.1	42.6	39.3	12.0	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G34	13.90		919.03		919.03	Middle Glacial Till	-	12.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G35	14.17		918.76		918.76	Middle Glacial Till	-	17.5	CL	29	16	13	0.12	CL	-	-	-	-	-	-	3.7	18.5	54.1	23.7	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G36	14.33		918.60		918.60	Middle Glacial Till	-	15.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G37	14.78		918.15		918.15	Middle Glacial Till	-	18.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G38	15.09		917.84		917.84	Lower Glaciofluvial	-	20.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G39	15.09		917.84		917.84	Lower Glaciofluvial	-	22.3	ML		Non-Plastic		-	ML	-	-	-	-	-	-	2.0	11.9	80.6	5.4	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G40	15.39		917.54		917.54	Lower Glaciofluvial	-	14.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G41	15.54		917.39		917.39	Lower Glaciofluvial	-	15.6	ML	-	-	-	-	-	-	-	-	-	-	-	0.1	52.6	47.4		-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G42	15.70		917.23		917.23	Lower Glaciofluvial	-	18.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G44	15.88		917.05		917.05	Lower Glaciofluvial	-	23.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G45	16.31		916.62		916.62	Lower Glacial Till	-	17.3	SC	24	14	10	0.33	CL	-	-	-	-	-	-	14.0	40.6	30.3	15.0	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G46	16.49		916.44		916.44	Lower Glacial Till	-	15.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G47	16.76		916.17		916.17	Lower Glacial Till	-	15.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G48	19.05		913.88		913.88	Weathered Bedrock (Mafic)	-	16.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G49	19.05		913.88		913.88	Weathered Bedrock (Mafic)	-	17.1	CI	42	23	19	-0.31	CI	-	-	-	-	-	-	0.6	38.1	42.3	19.0	0.002	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G50	19.51		913.42		913.42	Weathered Bedrock (Mafic)	-	17.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G51	19.96		912.97		912.97	Weathered Bedrock (Mafic)	-	17.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G52	20.27		912.66		912.66	Weathered Bedrock (Mafic)	-	26.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G54	23.47		909.46		909.46	Weathered Bedrock (Mafic)	-	8.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-02A	Dam Breach Area	Grab	G55	24.38		908.55		908.55	Weathered Bedrock (Mafic)	-	7.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G1	5.18		927.34		927.34	Upper Glacial Till	-	13.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G2	5.79		926.73		926.73	Upper Glacial Till	-	13.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G4	6.25		926.27		926.27	Upper Glacial Till	-	10.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G5	6.65		925.87		925.87	Upper Glacial Till	-	12.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G6	7.17		925.35		925.35	Upper Glacial Till	-	11.8	SC	24	12	12	-0.02	CL	-	-	-	-	-	-	14.7	35.5	31.8	18.0	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G7	7.32		925.20		925.20	Upper Glacial Till	-	12.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G8	7.81		924.71		924.71	Upper Glacial Till	-	10.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G9	8.23		924.29		924.29	Upper Glacial Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G11	8.84		923.68		923.68	Upper Glacial Till	-	11.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G12	9.30		923.22		923.22	Upper Glacial Till	-	12.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G13	9.45		923.07		923.07	Upper Glacial Till	-	11.8	SC	24	12	12	-0.02	CL	-	-	-	-	-	-	14.0	39.0	31.1	16.0	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G14	9.76		922.76		922.76	Upper Glacial Till	-	10.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G16	10.73		921.79		921.79	Upper Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G17	11.07		921.45		921.45	Upper Glaciolacustrine	-	31.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G18	11.10		921.42		921.42	Upper Glaciolacustrine	-	30.6	CI	41	16	25	0.58	CI	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G19	11.34		921.18		921.18	Upper Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G20	11.71		920.81		920.81	Upper Glaciolacustrine	-	32.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G21	11.89		920.63		920.63	Upper Glaciolacustrine	-	35.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G22	11.95		920.57		920.57	Upper Glaciolacustrine	-	24.5	CI	33	14	19	0.55	CI	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G23	12.19		920.33		920.33	Upper Glaciolacustrine	-	21.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G24	12.44		920.08		920.08	Upper Glaciolacustrine	-	25.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G25	12.68		919.84		919.84	Upper Glaciolacustrine	-	37.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G26	12.84		919.68		919.68	Upper Glaciolacustrine	-	33.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G27	13.20		919.32		919.32	Upper Glaciolacustrine	-	37.0	CI	44	17	27	0.74	CI	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G28	13.57		918.95		918.95	Upper Glaciolacustrine	-	18.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G29	13.72		918.80		918.80	Middle Glacial Till	-	12.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G30	14.24		918.28		918.28	Middle Glacial Till	-	10.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G31	14.63		917.89		917.89	Middle Glacial Till	-	20.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G32	15.09		917.43		917.43	Middle Glacial Till	-	22.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G33	15.30		917.22		917.22	Middle Glacial Till	-	20.9	CI	41	22	19	-0.06	CI	-	-	-	-	-	-	0.0	2.7	64.1	33.2	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G34	15.49		917.03		917.03	Middle Glacial Till	-	22.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G35	15.70		916.82		916.82	Middle Glacial Till	-	21.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G36	16.00		916.52		916.52	Middle Glacial Till	-	21.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G38	16.40		916.12		916.12	Middle Glacial Till	-	21.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G39	16.86		915.66		915.66	Middle Glacial Till	-	22.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G40	17.38		915.14		915.14	Lower Glaciolacustrine	-	26.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G41	17.44		915.08		915.08	Lower Glaciolacustrine	-	26.9	CI	42	21	21	0.28	CI	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G42	17.99		914.53		914.53	Lower Glaciolacustrine	-	26.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G43	18.29		914.23		914.23	Lower Glaciolacustrine	-	27.9	CI	31	20	11	0.72	CI	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G44	18.44		914.08		914.08	Lower Glaciolacustrine	-	27.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G45	18.75		913.77		913.77	Lower Glaciolacustrine	-	27.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G47	19.74		912.78		912.78	Upper Glaciofluvial	-	25.6	ML	27	22	5	0.72	ML	-	-	-	-	-	-	0.0	5.2	80.3	14.5	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G48	19.60		912.92		912.92	Upper Glaciofluvial	-	26.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G49	20.88		911.64		911.64	Upper Glaciofluvial	-	25.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G50	21.34		911.18		911.18	Upper Glaciofluvial	-	26.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G51	22.53		909.99		909.99	Weathered Bedrock (Sedimentary)	-	43.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G52	22.56		909.96		909.96	Weathered Bedrock (Sedimentary)	-	40.5	CH	111	34	77	0.08	CH	-	-	-	-	-	-	0.0	4.8	22.7	72.5	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G53	22.86		909.66		909.66	Weathered Bedrock (Sedimentary)	-	43.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G54	23.47		909.05		909.05	Weathered Bedrock (Sedimentary)	-	47.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G55	23.78		908.74		908.74	Weathered Bedrock (Sedimentary)	-	50.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G56	23.87		908.65		908.65	Weathered Bedrock (Sedimentary)	-	48.0	CH	88	39	49	0.18	CH	-	-	-	-	-	-	0.8	22.3	31.3	45.6	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G57	24.39		908.13		908.13	Weathered Bedrock (Sedimentary)	-	45.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G58	25.00		907.52		907.52	Weathered Bedrock (Sedimentary)	-	25.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G59	25.61		906.91		906.91	Weathered Bedrock (Sedimentary)	-	23.4	CH	71	24	47	-0.01	CH	-	-	-	-	-	-	0.9	30.2	27.5	41.4	0.002	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G60	27.43		905.09		905.09	Weathered Bedrock (Sedimentary)	-	47.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03	Dam Breach Area	Grab	G61	28.96		903.56		903.56	Weathered Bedrock (Sedimentary)	-	42.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-03B	Dam Breach Area	Grab	G4	12.14		920.49		920.49	Upper Glaciolacustrine	2.78	31.2	CI	47	20	27	0.41	CI	-	-	-	-	-	-	0.0	1.7	51.3	47.0	0.002	DS
2014	KCB	SH14-03B	Dam Breach Area	Grab	G5	12.45		920.18		920.18	Upper Glaciolacustrine	2.80	46.3	CH	68	25	43	0.50	CH	-	-	-	-	-	-	0.0	4.6	26.5	68.9	0.002	DS
2014	KCB	SH14-04	Dam Breach Area	Grab	G1	0.61		931.59		931.59	Upper Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G2	1.06		931.14		931.14	Upper Glacial Till	-	9.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G3	1.52		930.68		930.68	Upper Glacial Till	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G4	6.55		925.65		925.65	Upper Glacial Till	-	12.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G5	7.01		925.19		925.19	Upper Glacial Till	-	13.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G6	7.16		925.04		925.04	Upper Glacial Till	-	12.5	CL	23	13	10	-0.05	CL	-	-	-	-	-	-	4.4	37.4	40.1	18.1	0.002	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G7	7.46		924.74		924.74	Upper Glacial Till	-	13.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G8	7.62		924.58		924.58	Upper Glacial Till	-	14.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G9	8.04		924.16		924.16	Upper Glacial Till	-	14.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G10	8.56		923.64		923.64	Upper Glacial Till	-	8.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G12	9.29		922.91		922.91	Upper Glacial Till	-	9.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G13	9.66		922.54		922.54	Upper Glacial Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G14	10.12		922.08		922.08	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G16	10.82		921.38		921.38	Upper Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G17	11.21		920.99		920.99	Upper Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G18	11.82		920.38		920.38	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G19	12.01		920.19		920.19	Upper Glacial Till	-	12.1	CL	23	14	9	-0.21	CL	-	-	-	-	-	-	12.8	35.7	38.0	13.5	0.002	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G20	12.46		919.74		919.74	Upper Glacial Till	-	12.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G21	13.04		919.16		919.16	Upper Glacial Till	-	12.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G22	13.59		918.61		918.61	Upper Glacial Till	-	8.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G23	13.65		918.55		918.55	Upper Glaciolacustrine	-	31.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G24	13.65		918.55		918.55	Upper Glaciolacustrine	2.80	38.5	CH	71	22	49	0.34	CH	-	-	-	-	-	-	2.8	8.9	19.8	68.5	0.002	DS
2014	KCB	SH14-04	Dam Breach Area	Grab	G25	13.96		918.24		918.24	Upper Glaciolacustrine	-	38.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G26	14.14		918.06		918.06	Middle Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G27	14.23		917.97		917.97	Middle Glacial Till	-	14.9	CL	27	16	11	-0.10	CL	-	-	-	-	-	-	18.2	22.1	45.9	13.8	0.002	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G28	14.60		917.60		917.60	Middle Glacial Till	-	14.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G30	15.27		916.93		916.93	Lower Glaciolacustrine	-	25.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-04	Dam Breach Area	Grab	G31	16.30		915.90		915.90	Upper Glaciofluvial	-	18.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G32	16.46		915.74		915.74	Upper Glaciofluvial	-	21.9	ML	21	19	2	1.45	ML	-	-	-	-	-	-	-	0.0	32.6	58.1	9.3	0.002	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G33	16.91		915.29		915.29	Upper Glaciofluvial	-	26.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G34	17.37		914.83		914.83	Upper Glaciofluvial	-	25.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G35	18.13		914.07		914.07	Lower Glaciofluvial	-	20.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G36	18.13		914.07		914.07	Lower Glaciofluvial	-	18.4	SM	-	Non-Plastic	-	-	ML	-	-	-	-	-	-	-	2.4	49.4	43.2	5.1	0.002	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G37	18.74		913.46		913.46	Lower Glaciofluvial	-	12.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G38	19.20		913.00		913.00	Lower Glaciofluvial	-	21.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-04	Dam Breach Area	Grab	G39	19.66		912.54		912.54	Lower Glaciofluvial	-	24.5	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G1	3.35		933.86		933.86	Upper Glacial Till	-	16.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G2	3.81		933.40		933.40	Upper Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G3	4.12		933.09		933.09	Upper Glacial Till	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G5	5.70		931.51		931.51	Upper Glacial Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G6	6.16		931.05		931.05	Upper Glacial Till	-	11.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G7	8.48		928.73		928.73	Upper Glacial Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G8	8.78		928.43		928.43	Upper Glacial Till	-	12.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G10	11.19		926.02		926.02	Upper Glacial Till	-	14.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G11	11.68		925.53		925.53	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G13	12.35		924.86		924.86	Upper Glacial Till	-	9.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G14	12.86		924.35		924.35	Upper Glacial Till	-	7.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G16	13.57		923.64		923.64	Upper Glacial Till	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G18	14.14		923.07		923.07	Upper Glacial Till	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G20	14.85		922.36		922.36	Upper Glacial Till	-	13.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G21	15.18		922.03		922.03	Upper Glacial Till	-	14.5	CL	22	12	10	0.25	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G22	15.70		921.51		921.51	Upper Glaciolacustrine	-	29.6	CI	42	15	27	0.54	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G23	15.70		921.51		921.51	Upper Glaciolacustrine	-	34.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G24	16.16		921.05		921.05	Upper Glacial Till	-	13.1	CL	23	12	11	0.10	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G25	16.77		920.44		920.44	Middle Glacial Till	-	11.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G26	17.07		920.14		920.14	Middle Glacial Till	-	7.7	SC	21	14	7	-0.90	CL-ML	-	-	-	-	-	-	-	10.9	43.1	34.1	12.0	0.002	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G27	17.38		919.83		919.83	Middle Glacial Till	-	8.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G28	17.83		919.38		919.38	Middle Glacial Till	-	7.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G30	18.75		918.46		918.46	Lower Glaciolacustrine	-	20.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G31	18.84		918.37		918.37	Lower Glaciolacustrine	-	18.2	CL	29	17	12	0.10	CL	-	-	-	-	-	-	-	0.3	17.7	54.0	28.0	0.002	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G32	19.20		918.01		918.01	Lower Glaciolacustrine	-	20.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G34	19.51		917.70		917.70	Lower Glaciolacustrine	-	20.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G35	19.81		917.40		917.40	Lower Glaciofluvial	-	4.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G36	20.61		916.60		916.60	Lower Glaciofluvial	-	9.8	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G37	21.28		915.93		915.93	Lower Glaciofluvial	-	12.3	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-05A	Dam Breach Area	Grab	G38	21.49		915.72		915.72	Lower Glaciofluvial	-	12.8	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G1	8.48		928.98		928.98	Upper Glacial Till	-	12.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G3	8.91		928.55		928.55	Upper Glacial Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G4	10.03		927.43		927.43	Upper Glacial Till	-	10.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G5	10.25		927.21		927.21	Upper Glacial Till	-	10.4	SC	24	13	11	-0.24	CL	-	-	-	-	-	-	-	20.8	35.1	29.1	15.0	0.002	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G6	10.40		927.06		927.06	Upper Glacial Till	-	8.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G7	10.73		926.73		926.73	Upper Glacial Till	-	9.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G8	11.34		926.12		926.12	Upper Glacial Till	-	10.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G10	11.95		925.51		925.51	Upper Glacial Till	-	10.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G11	12.32		925.14		925.14	Upper Glacial Till	-	10.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G12	12.56		924.90		924.90	Upper Glacial Till	-	10.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G13	12.99		924.47		924.47	Upper Glacial Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G15	13.36		924.10		924.10	Upper Glacial Till	-	10.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G16	13.84		923.62		923.62	Upper Glacial Till	-	11.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G17	14.42		923.04		923.04	Upper Glacial Till	-	21.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G18	14.67		922.79		922.79	Upper Glacial Till	-	24.7	CL	24	13	11	1.06	CL	-	-	-	-	-	-	-	0.0	21.2	51.3	27.5	0.002	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G19	15.03		922.43		922.43	Upper Glaciolacustrine	-	20.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G20	15.09		922.37		922.37	Upper Glaciolacustrine	-	20.7	CH	21	18	3	0.90	CH	-	-	-	-	-	-	-	0.3	27.0	54.3	18.5	0.002	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G21	15.43		922.03		922.03	Upper Glaciolacustrine	-	26.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G21A	15.79		921.67		921.67	Upper Glaciolacustrine	-	31.0	CH	54	21	33	0.30	CH	-	-	-	-	-	-	-	0.4	1.7	41.9	56.0	0.002	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G22	16.19		921.27		921.27	Upper Glaciolacustrine	-	34.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G24	16.71		920.75		920.75	Middle Glacial Till	-	16.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G25	17.47		919.99		919.99	Middle Glacial Till	-	9.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G26	17.68		919.78		919.78	Middle Glacial Till	-	9.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G27	17.74		919.72		919.72	Middle Glacial Till	-	9.0	CL	22	14	8	-0.63	CL	-	-	-	-	-	-	-	19.0	35.3	33.8	12.0	0.002	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G28	18.08		919.38		919.38	Middle Glacial Till	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G29	18.35		919.11		919.11	Middle Glacial Till	-	8.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G30	18.72		918.74		918.74	Lower Glaciolacustrine	-	12.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G31	19.09		918.37		918.37	Lower Glaciolacustrine	-	16.9	CL	29	14	15	0.19	CL	-	-	-	-	-	-	-	4.8	15.4	57.7	22.0	0.002	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G32	19.60		917.86		917.86	Lower Glaciolacustrine	-	17.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G33	20.88		916.58		916.58	Lower Glaciofluvial	-	11.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-06	Dam Breach Area	Grab	G34	21.49		915.97		915.97	Lower Glaciofluvial	-	10.5	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G1	2.14		929.56		929.56	Tailings	-	20.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G2	2.44		929.26		929.26	Upper Glacial Till	-	14.2	CL	28	13	15	0.08	CL	-	-	-	-	-	-	-	8.7	35.9	36.3	19.2	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G3	2.75		928.95		928.95	Upper Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G4	3.20		928.50		928.50	Upper Glacial Till	-	10.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G5	3.66		928.04		928.04	Upper Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G7	4.42		927.28		927.28	Upper Glacial Till	-	9.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G8	5.03		926.67		926.67	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G9	5.28		926.42		926.42	Upper Glacial Till	-	11.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G10	5.43		926.27		926.27	Upper Glacial Till	-	9.5	CL	21	12	9	-0.28	CL	-	-	-	-	-	-	-	22.5	34.8	29.6	13.1	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G11	5.73		925.97		925.97	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G12	6.04		925.66		925.66	Upper Glacial Till	-	9.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G14	6.53		925.17		925.17	Upper Glacial Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G15	6.92		924.78		924.78	Upper Glacial Till	-	14.0	CL	29	12	17	0.12	CL	-	-	-	-	-	-	-	10.4	28.3	35.8	25.5	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G16	7.17		924.53		924.53	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G17	7.81		923.89		923.89	Upper Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G18	8.33		923.37		923.37	Upper Glacial Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G19A	8.54		923.16		923.16	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G19	8.65		923.05		923.05	Upper Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G21	9.15		922.55		922.55	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G21A	9.36		922.34		922.34	Upper Glacial Till	-	11.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G22	9.70		922.00		922.00	Upper Glacial Till	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G23	10.21		921.49		921.49	Upper Glacial Till	-	11.3	CL	22	12	10	-0.07	CL	-	-	-	-	-	-	-	13.7	37.5	33.7	15.1	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G24	10.46		921.24		921.24	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G25	10.85		920.85		920.85	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G26	11.22		920.48		920.48	Lower Glaciolacustrine	-	23.3	CI	38	19	19	0.23	CI	-	-	-	-	-	-	-	0.0	5.5	60.5	34.0	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G27	11.37		920.33		920.33	Lower Glaciolacustrine	-	23.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G28	11.74		919.96		919.96	Lower Glaciolacustrine	-	22.5	CI	37	20	17	0.15	CI	-	-	-	-	-	-	-	0.0	3.3	62.0	34.7	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G29	11.95		919.75		919.75	Lower Glaciolacustrine	-	22.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G30	12.26		919.44		919.44	Lower Glaciofluvial	-	10.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G31	12.90		918.80		918.80	Lower Glacial Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G32	13.14		918.56		918.56	Lower Glacial Till	-	8.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G33	13.51		918.19		918.19	Lower Glacial Till	-	8.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G33A	13.66		918.04		918.04	Lower Glacial Till	-	9.5	SC	24	13	11	-0.32	CL	-	-	-	-	-	-	-	11.9	48.0	27.6	12.5	0.002	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G34	14.48		917.22		917.22	Weathered Bedrock (Volcanic)	-	16.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-07	Dam Breach Area	Grab	G35	16.77		914.93		914.93	Weathered Bedrock (Volcanic)	-	12.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G1	20.22		927.33		927.33	Upper Glacial Till	-	13.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G2	20.37		927.18		927.18	-	-	17.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G2A	21.21		926.34		926.34	-	-	23.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G3	20.90		926.65		926.65	-	-	23.2	CI	34	18	16	0.33	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G4	21.29		926.26		926.26	Upper Glacial Till	-	10.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G5	21.90		925.65		925.65	Upper Glacial Till	-	11.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-08	Dam Breach Area	Grab	G6	22.20		925.35		925.35	Upper Glacial Till	-	10.7	SC	25	12	13	-0.10	CL	-	-	-	-	-	-	-	15.3	36.6	31.6	16.5	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G6A	22.35		925.20		925.20	Upper Glacial Till	-	11.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G7	22.81		924.74		924.74	Upper Glacial Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G8	23.42		924.13		924.13	Upper Glacial Till	-	13.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G9	23.88		923.67		923.67	Upper Glacial Till	-	14.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G10	23.88		923.67		923.67	Upper Glaciolacustrine	-	36.4	CH	63	20	43	0.38	CH	-	-	-	-	-	-	-	5.7	10.6	20.9	62.8	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G11	24.18		923.37		923.37	Upper Glacial Till	-	13.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G13	24.79		922.76		922.76	Upper Glacial Till	-	13.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G14	25.25		922.30		922.30	Upper Glacial Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G15	25.40		922.15		922.15	Upper Glacial Till	-	9.2	CL	24	15	9	-0.64	CL	-	-	-	-	-	-	-	8.2	33.4	42.6	15.8	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G16	27.99		919.56		919.56	Middle Glacial Till	-	9.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G17	28.14		919.41		919.41	Middle Glacial Till	-	9.5	CL	23	14	9	-0.50	CL	-	-	-	-	-	-	-	10.8	35.0	39.7	14.5	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G18	28.91		918.64		918.64	Middle Glacial Till	-	9.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G19	28.45		919.10		919.10	Middle Glacial Till	-	10.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G20	29.76		917.79		917.79	Middle Glacial Till	-	9.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G22	30.35		917.20		917.20	Middle Glacial Till	-	6.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G23	30.89		916.66		916.66	Middle Glacial Till	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G24	31.44		916.11		916.11	Middle Glacial Till	-	7.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G25	31.55		916.00		916.00	Middle Glacial Till	-	7.5	SM	18	14	4	-1.63	ML	-	-	-	-	-	-	-	18.6	55.8	18.6	7.0	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G26	32.16		915.39		915.39	Middle Glacial Till	-	4.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G27	32.65		914.90		914.90	Middle Glacial Till	-	11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G28	32.92		914.63		914.63	Middle Glacial Till	-	10.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G30	33.68		913.87		913.87	Upper Glaciofluvial	-	11.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G31	34.17		913.38		913.38	Upper Glaciofluvial	-	20.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G32	34.39		913.16		913.16	Upper Glaciofluvial	-	21.0	SP	27	20	7	0.14	CL-ML	-	-	-	-	-	-	-	0.0	6.7	76.3	17.0	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G33	34.81		912.74		912.74	Upper Glaciofluvial	-	24.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G34	35.15		912.40		912.40	Upper Glaciofluvial	-	18.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G35	36.73		910.82		910.82	Lower Glacial Till	-	13.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G36	37.19		910.36		910.36	Lower Glacial Till	-	7.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G37	37.65		909.90		909.90	Lower Glacial Till	-	8.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G38	38.10		909.45		909.45	Lower Glacial Till	-	6.6	SM	20	14	6	-1.23	CL-ML	-	-	-	-	-	-	-	21.7	49.6	19.7	9.0	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G39	38.41		909.14		909.14	Lower Glacial Till	-	9.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G41	39.35		908.20		908.20	Lower Glacial Till	-	8.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G42	39.69		907.86		907.86	Lower Glacial Till	-	8.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G43	40.02		907.53		907.53	Lower Glacial Till	-	10.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G44	40.36		907.19		907.19	Lower Glacial Till	-	6.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G45	40.79		906.76		906.76	Lower Glacial Till	-	8.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G46	41.00		906.55		906.55	Lower Glacial Till	-	8.8	CL	29	14	15	-0.35	CL	-	-	-	-	-	-	-	9.0	37.2	36.8	17.0	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G47	41.21		906.34		906.34	Lower Glacial Till	-	8.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G48	41.55		906.00		906.00	Lower Glacial Till	-	6.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G49	42.10		905.45		905.45	Lower Glacial Till	-	25.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G51	42.55		905.00		905.00	Weathered Bedrock (Sedimentary)	-	27.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G52	43.10		904.45		904.45	Weathered Bedrock (Sedimentary)	-	25.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G53	43.56		903.99		903.99	Weathered Bedrock (Sedimentary)	-	27.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G54	43.80		903.75		903.75	Weathered Bedrock (Sedimentary)	-	31.6	CH	77	28	49	0.07	CH	-	-	-	-	-	-	-	0.0	10.6	62.3	27.1	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G55	44.23		903.32		903.32	Weathered Bedrock (Sedimentary)	-	29.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G56	44.93		902.62		902.62	Weathered Bedrock (Sedimentary)	-	37.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G57	45.14		902.41		902.41	Weathered Bedrock (Sedimentary)	-	32.5	CH	69	34	35	-0.04	CH	-	-	-	-	-	-	-	0.0	14.6	62.4	23.0	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G58	45.60		901.95		901.95	Weathered Bedrock (Sedimentary)	-	43.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G59	46.27		901.28		901.28	Weathered Bedrock (Sedimentary)	-	41.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G60	46.73		900.82		900.82	Weathered Bedrock (Sedimentary)	-	46.8	CH	150	56	94	-0.10	CH	-	-	-	-	-	-	-	0.0	2.4	37.1	60.5	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G61	46.94		900.61		900.61	Weathered Bedrock (Sedimentary)	-	43.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G62	47.10		900.45		900.45	Weathered Bedrock (Sedimentary)	-	37.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G63	47.40		900.15		900.15	Weathered Bedrock (Sedimentary)	-	46.7	CH	137	37	100	0.10	CH	-	-	-	-	-	-	-	0.0	3.4	40.6	56.0	0.002	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G64	47.96		899.59		899.59	Weathered Bedrock (Sedimentary)	-	44.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G65	48.41		899.14		899.14	Weathered Bedrock (Sedimentary)	-	28.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G66	49.18		898.37		898.37	Weathered Bedrock (Sedimentary)	-	37.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G67	49.63		897.92		897.92	Weathered Bedrock (Sedimentary)	-	38.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G70	51.16		896.39		896.39	Weathered Bedrock (Sedimentary)	-	23.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G71	51.77		895.78		895.78	Weathered Bedrock (Sedimentary)	-	34.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G72	52.28		895.27		895.27	Weathered Bedrock (Sedimentary)	-	44.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G73	52.89		894.66		894.66	Weathered Bedrock (Sedimentary)	-	41.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G74	53.50		894.05		894.05	Weathered Bedrock (Sedimentary)	-	25.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G75	54.11		893.44		893.44	Weathered Bedrock (Sedimentary)	-	35.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08	Dam Breach Area	Grab	G76	54.72		892.83		892.83	Weathered Bedrock (Sedimentary)	-	52.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G1	25.06		922.55		922.55	Upper Glacial Till	-	15.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G2	25.40		922.21		922.21	Upper Glacial Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G3	25.77		921.84		921.84	Upper Glacial Till	-	9.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G4	26.10		921.51		921.51	Upper Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G5	26.47		921.14		921.14	Upper Glacial Till	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G5A	26.62		920.99		920.99	Upper Glacial Till	-	11.9	CL	22	12	10	-0.01	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G6	26.71		920.90		920.90	Upper Glaciolacustrine	-	26.2	CH	68	21	47	0.11	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G6A	26.80		920.81		920.81	Upper Glacial Till	-	14.4	CL	29	12	17	0.14	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G7	27.29		920.32		920.32	Upper Glacial Till	-	13.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G8	27.62		919.99		919.99	Middle Glacial Till	-	9.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G9	27.99		919.62		919.62	Middle Glacial Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G10	28.33		919.28		919.28	Middle Glacial Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G11	28.69		918.92		918.92	Middle Glacial Till	-	9.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-08A	Dam Breach Area	Grab	G12	29.03		918.58		918.58	Middle Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G2	10.21		927.76		927.76	Upper Glacial Till	-	21.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G3	10.67		927.30		927.30	Upper Glacial Till	-	15.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G4	11.37		926.60		926.60	Upper Glacial Till	-	13.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G6	11.98		925.99		925.99	Upper Glacial Till	-	11.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G7	12.37		925.60		925.60	Upper Glacial Till	-	12.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G8	12.74		925.23		925.23	Upper Glacial Till	-	8.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G9	13.14		924.83		924.83	Upper Glacial Till	-	10.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G10	13.26		924.71		924.71	Upper Glacial Till	-	10.4	SC	23	11	12	-0.05	CL	-	-	-	-	-	-	-	17.4	40.9	28.6	13.1	0.002	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G11	13.66		924.31		924.31	Upper Glacial Till	-	8.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G12	14.39		923.58		923.58	Upper Glacial Till	-	9.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G13	14.72		923.25		923.25	Upper Glacial Till	-	11.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G15	15.30		922.67		922.67	Upper Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G16	15.88		922.09		922.09	Upper Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G17	16.25		921.72		921.72	Upper Glacial Till	-	9.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G18	16.64		921.33		921.33	Upper Glacial Till	-	12.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G19	16.82		921.15		921.15	Upper Glacial Till	-	13.7	CL	21	12	9	0.19	CL	-	-	-	-	-	-	-	5.0	40.2	39.6	15.2	0.002	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G20	17.45		920.52		920.52	Upper Glacial Till	-	16.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G21	17.83		920.14		920.14	Upper Glacial Till	-	15.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G22B	18.20		919.77		919.77	Upper Glaciolacustrine	-	27.9	CI	46	17	29	0.38	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G22	18.23		919.74		919.74	Upper Glaciolacustrine	-	29.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G22A	18.35		919.62		919.62	Upper Glaciolacustrine	-	32.0	CI	53	19	34	0.38	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G23	18.84		919.13		919.13	Middle Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G24	19.23		918.74		918.74	Middle Glacial Till	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G24A	19.35		918.62		918.62	Middle Glacial Till	-	12.9	CL	25	15	10	-0.21	CL	-	-	-	-	-	-	-	5.4	33.0	45.9	15.7	0.002	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G25	19.60		918.37		918.37	Middle Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G26	20.48		917.49		917.49	Middle Glacial Till	-	9.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G27	20.82		917.15		917.15	Middle Glacial Till	-	9.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G28	21.18		916.79		916.79	Middle Glacial Till	-	8.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G29	21.52		916.45		916.45	Middle Glacial Till	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G30	21.88		916.09		916.09	Middle Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G31	22.22		915.75		915.75	Lower Glaciolacustrine	-	20.1	CI	42	23	19	-0.15	CI	-	-	-	-	-	-	-	0.7	4.9	61.9	32.6	0.002	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G32	22.71		915.26		915.26	Lower Glaciolacustrine	-	21.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-09	Dam Breach Area	Grab	G34	23.32		914.65		914.65	Lower Glaciolacustrine	-	25.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G35	23.44		914.53		914.53	Lower Glaciolacustrine	-	24.5	CI	33	20	13	0.35	CI	-	-	-	-	-	-	-	0.0	6.5	73.4	20.1	0.002	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G36	23.77		914.20		914.20	Lower Glaciolacustrine	-	22.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G37	24.96		913.01		913.01	Upper Glaciofluvial	-	23.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G38	25.24		912.73		912.73	Upper Glaciofluvial	-	23.7	ML	26	21	5	0.54	CL-ML	-	-	-	-	-	-	-	0.0	9.9	78.7	11.4	0.002	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G39	25.51		912.46		912.46	Upper Glaciofluvial	-	24.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G40	27.40		910.57		910.57	Upper Glaciofluvial	-	23.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G41	28.44		909.53		909.53	Weathered Bedrock (Sedimentary)	-	22.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G42	29.05		908.92		908.92	Weathered Bedrock (Sedimentary)	-	29.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G43	29.29		908.68		908.68	Weathered Bedrock (Sedimentary)	-	41.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G44	29.96		908.01		908.01	Weathered Bedrock (Sedimentary)	-	41.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G45	30.78		907.19		907.19	Weathered Bedrock (Sedimentary)	-	31.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G46	31.61		906.36		906.36	Weathered Bedrock (Sedimentary)	-	53.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G47	32.22		905.75		905.75	Weathered Bedrock (Sedimentary)	-	49.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G48	32.83		905.14		905.14	Weathered Bedrock (Sedimentary)	-	54.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G49	33.44		904.53		904.53	Weathered Bedrock (Sedimentary)	-	41.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G50	34.05		903.92		903.92	Weathered Bedrock (Sedimentary)	-	54.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G51	54.25		883.72		883.72	Weathered Bedrock (Sedimentary)	-	50.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G52	55.93		882.04		882.04	Weathered Bedrock (Sedimentary)	-	46.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-09	Dam Breach Area	Grab	G53	57.39		880.58		880.58	Weathered Bedrock (Sedimentary)	-	29.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G1	5.03		927.12		927.12	Upper Glacial Till	-	13.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G2	5.58		926.57		926.57	Upper Glacial Till	-	11.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G4	6.34		925.81		925.81	Upper Glacial Till	-	10.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G5	6.95		925.20		925.20	Upper Glacial Till	-	12.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G6	7.22		924.93		924.93	Upper Glacial Till	-	11.4	SC	24	12	12	-0.05	CI	-	-	-	-	-	-	-	19.6	33.6	29.8	17.0	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G7	7.59		924.56		924.56	Upper Glacial Till	-	11.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G8	8.32		923.83		923.83	Upper Glacial Till	-	12.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G10	9.08		923.07		923.07	Upper Glacial Till	-	12.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G11	9.84		922.31		922.31	Upper Glacial Till	-	10.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G12	10.21		921.94		921.94	Upper Glacial Till	-	11.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G13	10.66		921.49		921.49	Upper Glacial Till	-	10.8	SC	23	14	9	-0.36	CL	-	-	-	-	-	-	-	20.5	42.2	22.3	15.0	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G14	11.16		920.99		920.99	Upper Glaciolacustrine	-	19.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G15	11.28		920.87		920.87	Upper Glaciolacustrine	-	35.0	CH	39	16	23	0.83	CH	-	-	-	-	-	-	-	0.0	1.0	59.6	39.4	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G16	11.43		920.72		920.72	Upper Glaciolacustrine	-	31.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G17	11.73		920.42		920.42	Upper Glaciolacustrine	-	35.7	CH	60	20	40	0.39	CH	-	-	-	-	-	-	-	0.0	0.9	40.6	58.5	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G18	11.89		920.26		920.26	Upper Glaciolacustrine	-	42.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G19	12.19		919.96		919.96	Upper Glaciolacustrine	-	30.4	CH	46	16	30	0.48	CH	-	-	-	-	-	-	-	0.0	9.5	44.3	46.2	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G20	12.34		919.81		919.81	Upper Glaciolacustrine	-	43.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G21	12.50		919.65		919.65	Upper Glaciolacustrine	-	48.7	CH	69	20	49	0.59	CH	-	-	-	-	-	-	-	0.0	1.8	31.5	66.7	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G22	12.59		919.56		919.56	Upper Glaciolacustrine	-	53.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G23	13.41		918.74		918.74	Middle Glacial Till	-	11.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G24	15.09		917.06		917.06	Lower Glaciolacustrine	-	22.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G25	15.24		916.91		916.91	Lower Glaciolacustrine	-	15.6	CI	42	15	27	0.02	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G26	15.54		916.61		916.61	Lower Glaciolacustrine	-	19.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G27	15.85		916.30		916.30	Lower Glaciolacustrine	-	20.7	CI	31	17	14	0.26	CI	-	-	-	-	-	-	-	0.0	3.4	72.3	24.3	0.002	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G28	16.00		916.15		916.15	Lower Glaciolacustrine	-	15.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G29	16.76		915.39		915.39	Lower Glacial Till	-	18.3	SC	46	16	30	0.08	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G30	17.07		915.08		915.08	Lower Glacial Till	-	23.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G31	17.22		914.93		914.93	Lower Glacial Till	-	22.9	SC	44	15	29	0.27	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G32	17.53		914.62		914.62	Lower Glacial Till	-	19.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G33	18.14		914.01		914.01	Lower Glacial Till	-	15.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10	Dam Breach Area	Grab	G35	18.93		913.22		913.22	Lower Glacial Till	-	14.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-10A	Dam Breach Area	Grab	G12	9.73		921.23		921.23	Upper Glacial Till	-	11.5	CL	24	13	11	-0.14	CL	-	-	-	-	-	-	-	17.7	36.1	29.1	17.1	0.002	TXP, TXCU
2014	KCB	SH14-10A	Dam Breach Area	Grab	G10 (Clay Portion)	10.59		920.37		920.37	Upper Glaciolacustrine	-	30.4	CI	40	18	22	0.56	CI	-	-	-	-	-	-	-	2.4	7.8	48.3	41.6	0.002	-
2014	KCB	SH14-10A	Dam Breach Area	Grab	G10 (Silt Portion)	10.59		920.37		920.37	Upper Glacial Till	-	30.4	CL	28	14	14	1.17	CL	-	-	-	-	-	-	-	13.9	25.9	35.1	25.1	0.002	TXP, TXCU
2014	KCB	SH14-10A	Dam Breach Area	Grab	G6	11.74		919.22		919.22	Upper Glaciolacustrine	-	34.9	CI	48	20	28	0.53	CI	-	-	-	-	-	-	-	0.0	2.7	47.4	49.9	0.002	DS, DSS
2014	KCB	SH14-10A	Dam Breach Area	Grab	G14	13.20		917.76		917.76	Middle Glacial Till	2.76	11.3	SC	20	15	5	-0.74	CL-ML	-	-	-	-	-	-	-	10.3	47.0	31.2	11.5	0.002	TXP, TXCU
2014	KCB	SH14-10A	Dam Breach Area	Grab	G17	15.64		915.32		915.32	Lower Glaciolacustrine	2.75	21.0	CI	35	19	16	0.13	CI	-	-	-	-	-	-	-	0.0	3.5	68.5	28.0	0.002	OD, DS
2014	KCB	SH14-11	Dam Breach Area	Grab	GI	2.26		928.71		928.71	Upper Glacial Till	-	23.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G2	3.63		927.34		927.34	Upper Glacial Till	-	12.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G3	3.93		927.04		927.04	Upper Glacial Till	-	11.4	CL	26	16	10	-0.46	CL	-	-	-	-	-	-	-	8.9	37.2	38.2	15.7	0.002	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G4	4.39		926.58		926.58	Upper Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G5	5.15		925.82		925.82	Upper Glacial Till	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G6	5.76		925.21		925.21	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G7	6.43		924.54		924.54	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G9	8.66		922.31		922.31	Upper Glacial Till	-	13.8	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G10	8.81		922.16		922.16	Upper Glacial Till	-	12.9	CL-ML	21	14	7	-0.16	CL-ML	-	-	-	-	-	-	-	10.8	33.9	42.3	13.0	0.002	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G11	9.11		921.86		921.86	Upper Glacial Till	-	9.9	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G12	9.42		921.55		921.55	Upper Glacial Till	-	11.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G14	10.94		920.03		920.03	Middle Glacial Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G15	11.34		919.63		919.63	Middle Glacial Till	-	10.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G17	12.13		918.84		918.84	Lower Glacial Till	-	10.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G18	12.80		918.17		918.17	Lower Glacial Till	-	14.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11	Dam Breach Area	Grab	G19	13.59		917.38		917.38	Lower Glacial Till	-	11.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	14.1	51.5	23.8	10.5	0.002	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G1	1.68		929.49		929.49	Tailings	-	22.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G3	2.72		928.45		928.45	Upper Glacial Till	-	15.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G4	3.20		927.97		927.97	Upper Glacial Till	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G6	3.97		927.20		927.20	Upper Glacial Till	-	10.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G7	4.61		926.56		926.56	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G8	5.25		925.92		925.92	Upper Glacial Till	-	10.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G9	5.58		925.59		925.59	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G10	6.04		925.13		925.13	Upper Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G12	6.77		924.40		924.40	Upper Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G14	7.23		923.94		923.94	Upper Glacial Till	-	7.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G15	8.33		922.84		922.84	Upper Glacial Till	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G16	8.69		922.48		922.48	Upper Glacial Till	-	11.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G17	9.21		921.96		921.96	Upper Glacial Till	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G18	9.70		921.47		921.47	Middle Glacial Till	-	16.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G18A	9.76		921.41		921.41	Middle Glacial Till	-	15.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	8.6	43.7	47.7		-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G19	10.21		920.96		920.96	Middle Glacial Till	-	13.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G20	10.73		920.44		920.44	Middle Glacial Till	-	11.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G20A	11.25		919.92		919.92	Middle Glacial Till	-	12.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G21	11.40		919.77		919.77	Middle Glacial Till	-	21.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G22	11.65		919.52		919.52	Upper Glaciofluvial	-	10.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G23	12.35		918.82		918.82	Lower Glacial Till	-	11.7	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G24	12.93		918.24		918.24	Lower Glacial Till	-	12.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G25	13.48		917.69		917.69	Lower Glacial Till	-	11.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-11B	Dam Breach Area	Grab	G26	13.96		917.21		917.21	Lower Glacial Till	-	-	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G1	1.25		929.52		929.52	Upper Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G3	2.59		928.18		928.18	Upper Glacial Till	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G5	3.05		927.72		927.72	Upper Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G6	3.51		927.26		927.26	Upper Glacial Till	-	8.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G7	3.66		927.11		927.11	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G9	4.57		926.20		926.20	Upper Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G9A	5.27		925.50		925.50	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G10	5.64		925.13		925.13	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G12	6.28		924.49		924.49	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G13	6.80		923.97		923.97	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G14	7.16		923.61		923.61	Upper Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G16	8.32		922.45		922.45	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G17	8.69		922.08		922.08	Upper Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-12	Dam Breach Area	Grab	G19	9.85		920.92		920.92	Middle Glacial Till	-	8.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G21	10.73		920.04		920.04	Middle Glacial Till	-	9.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G22	11.37		919.40		919.40	Middle Glacial Till	-	9.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G24	12.13		918.64		918.64	Middle Glacial Till	-	8.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G25	12.74		918.03		918.03	Middle Glacial Till	-	7.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G27	13.50		917.27		917.27	Middle Glacial Till	-	7.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G28	14.39		916.38		916.38	Middle Glacial Till	-	8.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G30	15.18		915.59		915.59	Middle Glacial Till	-	5.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G31	15.54		915.23		915.23	Middle Glacial Till	-	16.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G32	15.91		914.86		914.86	Middle Glacial Till	-	9.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G34	16.95		913.82		913.82	Middle Glacial Till	-	9.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G35	17.71		913.06		913.06	Middle Glacial Till	-	10.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G37	18.68		912.09		912.09	Middle Glacial Till	-	10.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G38	19.23		911.54		911.54	Lower Glacial Till	-	4.7	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-12	Dam Breach Area	Grab	G40	20.09		910.68		910.68	Lower Glacial Till	-	11.3	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G1	2.80		930.26		930.26	Upper Glacial Till	-	13.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G3	3.23		929.83		929.83	Upper Glacial Till	-	13.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G4	3.78		929.28		929.28	Upper Glacial Till	-	10.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G6	4.36		928.70		928.70	Upper Glacial Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G7	4.85		928.21		928.21	Upper Glacial Till	-	12.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G8	5.27		927.79		927.79	Upper Glacial Till	-	8.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G10	6.16		926.90		926.90	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G11	7.04		926.02		926.02	Upper Glacial Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G13	7.68		925.38		925.38	Upper Glacial Till	-	9.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G14	8.32		924.74		924.74	Upper Glacial Till	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G16	9.20		923.86		923.86	Upper Glacial Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G17	9.85		923.21		923.21	Upper Glacial Till	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G19	10.85		922.21		922.21	Upper Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G20	11.31		921.75		921.75	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G22	12.34		920.72		920.72	Upper Glacial Till	-	9.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G23	12.50		920.56		920.56	Upper Glacial Till	-	9.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G25	13.87		919.19		919.19	Upper Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G26	14.45		918.61		918.61	Upper Glacial Till	-	2.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G27	14.78		918.28		918.28	Upper Glacial Till	-	18.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G29	16.03		917.03		917.03	Upper Glacial Till	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G30	16.79		916.27		916.27	Upper Glacial Till	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G31	17.07		915.99		915.99	Glaciolacustrine[1]	-	22.4	CI	42	22	20	0.02	CI	-	-	-	-	-	-	-	0.0	8.3	56.1	35.6	0.002	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G32	17.83		915.23		915.23	Glaciolacustrine[1]	-	23.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G33	18.04		915.02		915.02	Glaciolacustrine[1]	-	25.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G34	18.14		914.92		914.92	Glaciolacustrine[1]	-	24.1	CI	49	22	27	0.08	CI	-	-	-	-	-	-	-	0.0	1.1	51.6	47.3	0.002	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G35	18.59		914.47		914.47	Upper Glaciofluvial	-	21.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G37	19.96		913.10		913.10	Upper Glaciofluvial	-	20.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G40	21.18		911.88		911.88	Lower Glaciofluvial	-	22.1	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G41	21.64		911.42		911.42	Lower Glaciofluvial	-	23.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G43	22.25		910.81		910.81	Lower Glaciofluvial	-	16.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G44	23.01		910.05		910.05	Lower Glaciofluvial	-	7.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G45	23.90		909.16		909.16	Lower Glaciofluvial	-	8.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G46	25.24		907.82		907.82	Lower Glaciofluvial	-	19.5	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G48	26.88		906.18		906.18	Lower Glaciofluvial	-	14.1	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G50	27.80		905.26		905.26	Lower Glacial Till	-	6.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G51	28.29		904.77		904.77	Lower Glacial Till	-	7.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G53	29.32		903.74		903.74	Lower Glacial Till	-	5.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G54	29.90		903.16		903.16	Lower Glacial Till	-	16.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G56	30.54		902.52		902.52	Lower Glacial Till	-	10.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G57	30.97		902.09		902.09	Lower Glacial Till	-	13.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G58	31.42		901.64		901.64	Lower Glacial Till	-	8.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-13	Perimeter Embankment	Grab	G60	32.40		900.66		900.66	Lower Glacial Till	-	9.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G3	3.20		926.92		926.92	Upper Glacial Till	-	10.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G4	3.66		926.46		926.46	Upper Glacial Till	-	10.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G5	4.51		925.61		925.61	Upper Glacial Till	-	10.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G6	4.57		925.55		925.55	Upper Glacial Till	-	11.5	SC	25	17	8	-0.69	CL	-	-	-	-	-	-	-	17.6	35.5	33.9	13.0	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G7	5.30		924.82		924.82	Upper Glacial Till	-	14.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G9	6.13		923.99		923.99	Upper Glacial Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	GI0	6.83		923.29		923.29	Upper Glacial Till	-	9.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	GII	7.77		922.35		922.35	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G12	8.32		921.80		921.80	Upper Glacial Till	-	21.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G13	8.69		921.43		921.43	Upper Glacial Till	-	12.6	CL	23	14	9	-0.16	CL	-	-	-	-	-	-	-	6.7	40.5	36.7	16.1	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G14	9.02		921.10		921.10	Upper Glacial Till	-	12.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G15	9.91		920.21		920.21	Upper Glaciolacustrine	-	27.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G16	10.00		920.12		920.12	Upper Glaciolacustrine	-	24.9	CI	47	19	28	0.21	CI	-	-	-	-	-	-	-	2.3	17.8	28.7	51.2	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G18	10.27		919.85		919.85	Upper Glaciolacustrine	-	21.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G19	10.55		919.57		919.57	Middle Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G20	11.37		918.75		918.75	Middle Glacial Till	-	11.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G21	11.73		918.39		918.39	Middle Glacial Till	-	13.2	CL	27	17	10	-0.38	CL	-	-	-	-	-	-	-	8.2	31.9	43.9	16.0	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G22	12.07		918.05		918.05	Middle Glacial Till	-	12.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G23	12.89		917.23		917.23	Middle Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G24	13.32		916.80		916.80	Lower Glaciolacustrine	-	25.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G25	13.35		916.77		916.77	Lower Glaciolacustrine	-	24.0	CI	33	20	13	0.31	CI	-	-	-	-	-	-	-	0.1	6.9	63.1	29.9	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G26	14.94		915.18		915.18	Upper Glaciofluvial	-	14.9	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G27	15.09		915.03		915.03	Lower Glaciofluvial	-	7.9	GP	-	-	-	-	-	-	-	-	-	-	-	-	46.8	43.5	9.7	0.0	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G28	16.15		913.97		913.97	Lower Glacial Till	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G29	17.07		913.05		913.05	Weathered Bedrock (Sedimentary)	-	38.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G30	17.71		912.41		912.41	Weathered Bedrock (Sedimentary)	-	54.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G31	17.98		912.14		912.14	Weathered Bedrock (Sedimentary)	-	41.0	CH	103	41	62	0.00	CH	-	-	-	-	-	-	-	3.5	30.7	21.4	44.3	0.002	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G32	18.44		911.68		911.68	Weathered Bedrock (Sedimentary)	-	56.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G33	18.68		911.44		911.44	Weathered Bedrock (Sedimentary)	-	54.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G34	19.32		910.80		910.80	Weathered Bedrock (Sedimentary)	-	50.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G35	20.09		910.03		910.03	Weathered Bedrock (Sedimentary)	-	53.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G36	20.94		909.18		909.18	Weathered Bedrock (Sedimentary)	-	47.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G37	21.52		908.60		908.60	Weathered Bedrock (Sedimentary)	-	42.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G38	22.04		908.08		908.08	Weathered Bedrock (Sedimentary)	-	41.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G39	23.32		906.80		906.80	Weathered Bedrock (Sedimentary)	-	36.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-14	Dam Breach Area	Grab	G40	23.32		906.80		906.80	Weathered Bedrock (Sedimentary)	-	38.8	CH	116	36	80	0.04	CH	-	-	-	-	-	-	-	0.8	13.0	38.7	47.5	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G1	2.99		927.20		927.20	Upper Glacial Till	-	13.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G3	3.63		926.56		926.56	Upper Glacial Till	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G5	4.45		925.74		925.74	Upper Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G6	5.27		924.92		924.92	Upper Glacial Till	-	8.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G7	5.88		924.31		924.31	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G8	5.91		924.28		924.28	Upper Glacial Till	-	11.7	CL	24	12	12	-0.03	CL	-	-	-	-	-	-	-	12.0	38.1	33.7	16.2	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G9	6.92		923.27		923.27	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G10	7.56		922.63		922.63	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G12A	8.08		922.11		922.11	Upper Glaciolacustrine	-	29.3	CI	47	20	27	0.34	CI	-	-	-	-	-	-	-	0.5	2.0	48.8	48.7	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G12	8.35		921.84		921.84	Upper Glaciolacustrine	-	20.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G13	8.63		921.56		921.56	Upper Glacial Till	-	17.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G14	8.99		921.20		921.20	Upper Glacial Till	-	12.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G15	9.17		921.02		921.02	Upper Glacial Till	-	20.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G16	9.45		920.74		920.74	Upper Glaciolacustrine	-	31.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G17A	9.71		920.48		920.48	Upper Glaciolacustrine	-	33.2	CI	40	20	20	0.66	CI	-	-	-	-	-	-	-	0.2	19.0	34.2	46.6	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G17	9.75		920.44		920.44	Upper Glacial Till	-	15.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G18	10.09		920.10		920.10	Upper Glaciolacustrine	-	33.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G19	10.30		919.89		919.89	Middle Glacial Till	-	18.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-15	Dam Breach Area	Grab	G20	10.58		919.61		919.61	Middle Glacial Till	-	16.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G21	10.85		919.34		919.34	Lower Glaciolacustrine	-	24.2	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G22	11.13		919.06		919.06	Lower Glaciolacustrine	-	23.8	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G23	11.73		918.46		918.46	Lower Glaciolacustrine	-	24.8	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G24	11.80		918.39		918.39	Lower Glaciolacustrine	-	25.9	Cl	35	20	15	0.39	Cl	-	-	-	-	-	-	-	1.4	10.5	61.6	26.5	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G27	13.14		917.05		917.05	Lower Glaciolacustrine	-	23.8	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G28	13.56		916.63		916.63	Lower Glaciolacustrine	-	22.0	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G29	14.42		915.77		915.77	Lower Glaciolacustrine	-	25.1	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G30	14.48		915.71		915.71	Lower Glaciolacustrine	-	27.5	Cl	41	23	18	0.25	Cl	-	-	-	-	-	-	-	0.0	3.7	59.5	36.8	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G30A	14.78		915.41		915.41	Lower Glaciolacustrine	-	29.5	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G31	15.18		915.01		915.01	Lower Glaciolacustrine	-	26.7	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G33	16.46		913.73		913.73	Upper Glaciofluvial	-	22.4	CL	29	22	7	0.06	CL	-	-	-	-	-	-	-	2.6	9.9	75.0	12.5	0.002	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G34	16.82		913.37		913.37	Upper Glaciofluvial	-	21.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G35	18.44		911.75		911.75	Weathered Bedrock (Sedimentary)	-	25.5	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G36	19.96		910.23		910.23	Weathered Bedrock (Sedimentary)	-	27.3	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G37	21.58		908.61		908.61	Weathered Bedrock (Sedimentary)	-	15.1	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-15	Dam Breach Area	Grab	G38	23.10		907.09		907.09	Weathered Bedrock (Sedimentary)	-	14.8	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G1	1.77		928.46		928.46	Upper Glacial Till	-	14.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G2	2.23		928.00		928.00	Upper Glacial Till	-	11.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G4	2.96		927.27		927.27	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G5	3.35		926.88		926.88	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G6	3.60		926.63		926.63	Upper Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G7	4.08		926.15		926.15	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G8	4.11		926.12		926.12	Upper Glacial Till	-	11.5	CL	25	13	12	-0.13	CL	-	-	-	-	-	-	-	17.8	32.4	34.1	15.8	0.002	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G9	4.75		925.48		925.48	Upper Glacial Till	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G10	5.27		924.96		924.96	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G12	5.97		924.26		924.26	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G12A	6.40		923.83		923.83	Upper Glacial Till	-	17.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G13	6.64		923.59		923.59	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G14	7.16		923.07		923.07	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G16	7.68		922.55		922.55	Middle Glacial Till	-	15.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G17	8.32		921.91		921.91	Middle Glacial Till	-	12.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G18	8.69		921.54		921.54	Middle Glacial Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G19	8.75		921.48		921.48	Middle Glacial Till	-	14.7	CL	27	17	10	-0.23	CL	-	-	-	-	-	-	-	5.0	32.7	43.2	19.0	0.002	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G20	9.33		920.90		920.90	Middle Glacial Till	-	12.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G21	9.85		920.38		920.38	Middle Glacial Till	-	18.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G22	10.45		919.78		919.78	Lower Glaciolacustrine	-	18.4	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G25	11.77		918.46		918.46	Lower Glaciolacustrine	-	23.6	Cl	32	18	14	0.40	Cl	-	-	-	-	-	-	-	0.4	6.3	67.3	26.0	0.002	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G26	12.34		917.89		917.89	Lower Glaciolacustrine	-	23.6	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G27	13.26		916.97		916.97	Lower Glacial Till	-	14.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G28	15.00		915.23		915.23	Weathered Bedrock (Sedimentary)	-	36.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G29	16.25		913.98		913.98	Weathered Bedrock (Sedimentary)	-	26.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G30	18.14		912.09		912.09	Weathered Bedrock (Sedimentary)	-	15.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G31	21.34		908.89		908.89	Weathered Bedrock (Sedimentary)	-	25.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-16	Dam Breach Area	Grab	G32	22.56		907.67		907.67	Weathered Bedrock (Volcanic)	-	31.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G1	2.23		927.34		927.34	Tailings	-	21.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G2	2.62		926.95		926.95	Upper Glacial Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G3	2.68		926.89		926.89	Upper Glacial Till	-	10.7	SC	26	14	12	-0.28	CL	-	-	-	-	-	-	-	16.5	36.4	31.1	16.0	0.002	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G4	3.14		926.43		926.43	Upper Glacial Till	-	11.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G5	3.69		925.88		925.88	Upper Glacial Till	-	10.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G6	4.33		925.24		925.24	Upper Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G8	4.60		924.97		924.97	Upper Glacial Till	-	15.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G9	5.30		924.27		924.27	Upper Glacial Till	-	14.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G10	5.45		924.12		924.12	Upper Glacial Till	-	14.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G11	5.88		923.69		923.69	Upper Glaciolacustrine	-	29.7	CH	56	21	35	0.25	CH	-	-	-	-	-	-	-	2.9	12.8	34.3	50.0	0.002	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G12	6.19		923.38		923.38	Middle Glacial Till	-	18.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G13	6.64		922.93		922.93	Middle Glacial Till	-	14.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G14	7.16		922.41		922.41	Middle Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G15	7.59		921.98		921.98	Middle Glacial Till	-	16.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G16	7.77		921.80		921.80	Middle Glacial Till	-	16.0	Cl	34	19	15	-0.20	Cl	-	-	-	-	-	-	-	2.9	10.9	62.2	24.0	0.002	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G17	8.32		921.25		921.25	Middle Glacial Till	-	15.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G18	8.69		920.88		920.88	Middle Glacial Till	-	14.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G19	9.24		920.33		920.33	Middle Glacial Till	-	14.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G21	9.85		919.72		919.72	Middle Glacial Till	-	20.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G22	10.21		919.36		919.36	Middle Glacial Till	-	17.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G23	10.70		918.87		918.87	Middle Glacial Till	-	17.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G25	11.40		918.17		918.17	Middle Glacial Till	-	15.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G26	11.80		917.77		917.77	Middle Glacial Till	-	19.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G27	12.22		917.35		917.35	Lower Glaciolacustrine	-	22.5	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G28	12.83		916.74		916.74	Lower Glaciolacustrine	-	23.3	Cl	41	21	20	0.12	Cl	-	-	-	-	-	-	-	0.0	1.3	66.7	32.0	0.002	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G29	13.01		916.56		916.56	Lower Glaciolacustrine	-	25.1	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G31	13.75		915.82		915.82	Upper Glaciofluvial	-	19.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G32	15.70		913.87		913.87	Weathered Bedrock (Mafic)	-	10.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-17	Dam Breach Area	Grab	G33	17.07		912.50		912.50	Weathered Bedrock (Mafic)	-	11.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G1	3.16		931.60		931.60	Dam Till Core	-	11.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G2	4.27		930.49		930.49	Upper Glacial Till	-	17.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G4	5.27		929.49		929.49	Upper Glacial Till	-	14.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G5	5.64		929.12		929.12	Upper Glacial Till	-	15.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G6	5.97		928.79		928.79	Upper Glacial Till	-	13.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G8	6.80		927.96		927.96	Upper Glacial Till	-	10.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G9	7.16		927.60		927.60	Upper Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G10	7.41		927.35		927.35	Upper Glacial Till	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G12	8.32		926.44		926.44	Upper Glacial Till	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G13	8.69		926.07		926.07	Upper Glacial Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G14	9.20		925.56		925.56	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G16	9.60		925.16		925.16	Upper Glacial Till	-	15.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G18	10.45		924.31		924.31	Upper Glacial Till	-	9.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G19	10.73		924.03		924.03	Upper Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G20	11.43		923.33		923.33	Upper Glaciofluvial	-	20.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G22	12.65		922.11		922.11	Lower Glaciofluvial	-	21.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G23	13.26		921.50		921.50	Lower Glaciofluvial	-	22.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G25	14.36		920.40		920.40	Lower Glaciofluvial	-	13.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G26	14.69		920.07		920.07	Lower Glaciofluvial	-	10.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G27	15.03		919.73		919.73	Lower Glaciofluvial	-	19.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G29	15.94		918.82		918.82	Lower Glacial Till	-	9.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G30	16.28		918.48		918.48	Lower Glacial Till	-	5.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G31	16.61		918.15		918.15	Lower Glacial Till	-	7.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G33	18.14		916.62		916.62	Lower Glacial Till	-	12.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G35	19.05		915.71		915.71	Lower Glacial Till	-	6.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G36	19.81		914.95		914.95	Weathered Bedrock (Sedimentary)	-	30.9	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G38	21.12		913.64		913.64	Weathered Bedrock (Sedimentary)	-	15.1	Cl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-18	Dam Breach Area	Grab	G39	24.17		910.59		910.59	Weathered Bedrock (Volcanic)	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G1	2.93		939.89		939.89	Glacial Till	-	16.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G3	3.66		939.16		939.16	Glacial Till	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G4	4.27		938.55		938.55	Glacial Till	-	12.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G5	5.27		937.55		937.55	Glacial Till	-	9.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G6	5.64		937.18		937.18	Glacial Till	-	10.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G7	6.13		936.69		936.69	Glacial Till	-	10.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G9	6.80		936.02		936.02	Glacial Till	-	11.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G10	7.41		935.41		935.41	Glacial Till	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G12	8.32		934.50		934.50	Glacial Till	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-19	Dam Breach Area	Grab	G13	8.69		934.13		934.13	Glacial Till	-	13.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G14	8.93		933.89		933.89	Glacial Till	-	13.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G16	9.85		932.97		932.97	Glacial Till	-	13.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G17	10.45		932.37		932.37	Glacial Till	-	15.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G18	10.45		932.37		932.37	Glacial Till	-	14.0	CL	28	17	11	-0.27	CL	-	-	-	-	-	-	-	11.9	27.2	47.1	13.7	0.002	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G19	11.40		931.42		931.42	Upper Glaciofluvial	-	14.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G21	12.92		929.90		929.90	Upper Glaciofluvial	-	11.9	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G22	13.47		929.35		929.35	Glacial Till	-	11.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G26	14.36		928.46		928.46	Glacial Till	-	10.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G27	14.90		927.92		927.92	Glacial Till	-	9.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G29	15.36		927.46		927.46	Glacial Till	-	8.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G30	16.15		926.67		926.67	Weathered Bedrock (Volcanic)	-	17.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G31	16.82		926.00		926.00	Weathered Bedrock (Volcanic)	-	18.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G32	18.01		924.81		924.81	Weathered Bedrock (Volcanic)	-	18.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-19	Dam Breach Area	Grab	G33	19.78		923.04		923.04	Weathered Bedrock (Volcanic)	-	22.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G1	10.22		959.70		959.70	Dam Till Core	-	10.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G3	11.32		958.60		958.60	Dam Till Core	-	11.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G4	12.02		957.90		957.90	Dam Till Core	-	10.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G6	12.72		957.20		957.20	Dam Till Core	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G7	13.22		956.70		956.70	Dam Till Core	-	11.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G8	13.52		956.40		956.40	Dam Till Core	-	9.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G9	13.82		956.10		956.10	Dam Till Core	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G10	14.42		955.50		955.50	Dam Till Core	-	8.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G11	15.02		954.90		954.90	Dam Till Core	-	8.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G13	15.92		954.00		954.00	Dam Till Core	-	10.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G14	16.52		953.40		953.40	Dam Till Core	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G16	17.52		952.40		952.40	Dam Till Core	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G17	18.12		951.80		951.80	Dam Till Core	-	14.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G19	19.02		950.90		950.90	Dam Till Core	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G20	19.42		950.50		950.50	Dam Till Core	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G21	20.02		949.90		949.90	Dam Till Core	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G22	20.52		949.40		949.40	Dam Till Core	-	12.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G23	20.92		949.00		949.00	Dam Till Core	-	12.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G24	21.42		948.50		948.50	Dam Till Core	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G25	22.12		947.80		947.80	Dam Till Core	-	7.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G26	22.82		947.10		947.10	Dam Till Core	-	8.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G27	23.42		946.50		946.50	Dam Till Core	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G28	23.82		946.10		946.10	Dam Till Core	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G29	24.32		945.60		945.60	Dam Till Core	-	10.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G30	25.12		944.80		944.80	Dam Till Core	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G31	25.82		944.10		944.10	Dam Till Core	-	10.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G33	28.02		941.90		941.90	Dam Till Core	-	8.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G35	28.80		941.12		941.12	Glacial Till	-	13.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G37	29.41		940.51		940.51	Glacial Till	-	10.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G38	29.96		939.96		939.96	Glacial Till	-	8.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G39	30.33		939.59		939.59	Glacial Till	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G41	31.49		938.43		938.43	Glacial Till	-	9.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G42	32.10		937.82		937.82	Glacial Till	-	9.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G44	32.92		937.00		937.00	Glacial Till	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G45	33.22		936.70		936.70	Glacial Till	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G46	33.62		936.30		936.30	Glacial Till	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G48	34.44		935.48		935.48	Glacial Till	-	12.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G49	34.75		935.17		935.17	Glacial Till	-	12.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G51	35.27		934.65		934.65	Glacial Till	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G52	35.45		934.47		934.47	Glacial Till	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G53	36.00		933.92		933.92	Glacial Till	-	13.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G54	36.30		933.62		933.62	Glacial Till	-	13.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G55	36.73		933.19		933.19	Glacial Till	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G57	37.49		932.43		932.43	Glacial Till	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G58	37.80		932.12		932.12	Glacial Till	-	13.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G59	38.25		931.67		931.67	Glacial Till	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G61	39.04		930.88		930.88	Glacial Till	-	12.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G63	39.84		930.08		930.08	Upper Glaciofluvial	-	18.1	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G64	40.78		929.14		929.14	Glacial Till	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G66	41.42		928.50		928.50	Glacial Till	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G67	42.18		927.74		927.74	Glacial Till	-	11.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G68	42.64		927.28		927.28	Glacial Till	-	8.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G70	43.07		926.85		926.85	Glacial Till	-	12.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G71	43.49		926.43		926.43	Glacial Till	-	13.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G72	44.14		925.78		925.78	Glacial Till	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G73	44.17		925.75		925.75	Glacial Till	-	11.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G75	45.14		924.78		924.78	Glacial Till	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G76	45.45		924.47		924.47	Glacial Till	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G77	45.72		924.20		924.20	Glacial Till	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G79	46.54		923.38		923.38	Glacial Till	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G80	47.21		922.71		922.71	Glacial Till	-	8.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G82	48.25		921.67		921.67	Glacial Till	-	14.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G84	48.77		921.15		921.15	Glacial Till	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G85	50.02		919.90		919.90	Weathered Bedrock (Volcanic)	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G86	51.88		918.04		918.04	Weathered Bedrock (Volcanic)	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-20	Dam Breach Area	Grab	G87	53.40		916.52		916.52	Weathered Bedrock (Volcanic)	-	16.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G3	32.71		936.20		936.20	Dam Filter	-	13.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G5	33.61		935.30		935.30	Dam Till Core	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G6	34.21		934.70		934.70	Dam Till Core	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G7	34.61		934.30		934.30	Dam Till Core	-	11.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G8	35.11		933.80		933.80	Dam Till Core	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G9	35.71		933.20		933.20	Dam Till Core	-	14.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G10	36.31		932.60		932.60	Dam Till Core	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G11	37.01		931.90		931.90	Dam Till Core	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G12	38.21		930.70		930.70	Dam Till Core	-	11.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G13	38.81		930.10		930.10	Dam Till Core	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G18	39.41		929.50		929.50	Dam Till Core	-	14.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G14	39.41		929.50		929.50	Dam Till Core	-	18.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G15	40.18		928.73		928.73	Upper Glacial Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G16	40.85		928.06		928.06	Upper Glacial Till	-	12.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G17	41.18		927.73		927.73	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G19	41.76		927.15		927.15	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G20	42.07		926.84		926.84	Upper Glacial Till	-	-	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G21	42.46		926.45		926.45	Upper Glacial Till	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G22	42.92		925.99		925.99	Upper Glacial Till	-	9.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G23	43.74		925.17		925.17	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G24	44.20		924.71		924.71	Upper Glacial Till	-	14.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G25	44.69		924.22		924.22	Upper Glacial Till	-	9.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G26	45.15		923.76		923.76	Upper Glacial Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G27	45.48		923.43		923.43	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G28	46.15		922.76		922.76	Upper Glacial Till	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G29	46.73		922.18		922.18	Upper Glacial Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G30	47.07		921.84		921.84	Upper Glacial Till	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G31	47.65		921.26		921.26	Middle Glacial Till	-	12.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G32	48.25		920.66		920.66	Middle Glacial Till	-	10.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G33	48.65		920.26		920.26	Middle Glacial Till	-	8.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	SH14-21	Dam Breach Area	Grab	G34	49.47		919.44		919.44	Middle Glacial Till	-	10.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G35	49.72		919.19		919.19	Middle Glacial Till	-	2.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G36	50.14		918.77		918.77	Middle Glacial Till	-	8.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G37	50.78		918.13		918.13	Middle Glacial Till	-	5.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G38	51.33		917.58		917.58	Middle Glacial Till	-	6.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G39	51.73		917.18		917.18	Middle Glacial Till	-	10.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G40	52.58		916.33		916.33	Middle Glacial Till	-	8.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G42	53.44		915.47		915.47	Middle Glacial Till	-	8.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G43	53.80		915.11		915.11	Middle Glacial Till	-	7.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G44	54.49		914.42		914.42	Middle Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G45	54.59		914.32		914.32	Middle Glacial Till	-	9.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G46	55.36		913.55		913.55	Middle Glacial Till	-	6.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G47	55.81		913.10		913.10	Middle Glacial Till	-	9.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G48	56.12		912.79		912.79	Upper Glaciofluvial	-	9.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G49	56.79		912.12		912.12	Upper Glaciofluvial	-	20.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G50A	57.15		911.76		911.76	Upper Glaciofluvial	-	29.2	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G50	57.43		911.48		911.48	Upper Glaciofluvial	-	13.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G51	57.89		911.02		911.02	Upper Glaciofluvial	-	10.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G52	58.37		910.54		910.54	Lower Glacial Till	-	5.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G53	58.95		909.96		909.96	Lower Glacial Till	-	5.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G54	59.90		909.01		909.01	Lower Glacial Till	-	7.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G55	60.45		908.46		908.46	Lower Glacial Till	-	10.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G56	60.84		908.07		908.07	Lower Glacial Till	-	6.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G57	61.36		907.55		907.55	Lower Glacial Till	-	8.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G58	61.91		907.00		907.00	Lower Glacial Till	-	8.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G59	62.31		906.60		906.60	Lower Glacial Till	-	8.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G60	62.82		906.09		906.09	Lower Glacial Till	-	6.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G61	65.14		903.77		903.77	Lower Glacial Till	-	7.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G62	65.90		903.01		903.01	Lower Glacial Till	-	8.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G64	66.70		902.21		902.21	Weathered Bedrock (Volcanic)	-	11.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G65	67.34		901.57		901.57	Weathered Bedrock (Volcanic)	-	14.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G66	68.22		900.69		900.69	Weathered Bedrock (Volcanic)	-	13.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G67	68.77		900.14		900.14	Weathered Bedrock (Volcanic)	-	12.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G68	69.71		899.20		899.20	Weathered Bedrock (Volcanic)	-	17.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G69	70.20		898.71		898.71	Weathered Bedrock (Volcanic)	-	15.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G70	71.11		897.80		897.80	Weathered Bedrock (Volcanic)	-	13.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-21	Dam Breach Area	Grab	G71	71.72		897.19		897.19	Weathered Bedrock (Volcanic)	-	14.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G1	2.40		927.49		927.49	Tailings	-	22.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G2	2.75		927.14		927.14	Upper Glacial Till	-	13.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G4	3.36		926.53		926.53	Upper Glacial Till	-	8.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G5	4.12		925.77		925.77	Upper Glacial Till	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G7	5.25		924.64		924.64	Upper Glacial Till	-	9.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G8	5.58		924.31		924.31	Upper Glacial Till	-	12.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G10	6.77		923.12		923.12	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22	Dam Breach Area	Grab	G11	7.11		922.78		922.78	Upper Glacial Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G1	5.25		924.71		924.71	Upper Glacial Till	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G2	5.58		924.38		924.38	Upper Glacial Till	-	12.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G3	6.04		923.92		923.92	Upper Glacial Till	-	12.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G4	6.16		923.80		923.80	Upper Glacial Till	-	14.2	CL	26	13	13	0.09	CL	-	-	-	-	-	-	-	12.7	36.6	33.9	16.7	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G5	6.77		923.19		923.19	Upper Glacial Till	-	11.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G6	7.11		922.85		922.85	Upper Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G8	8.02		921.94		921.94	Upper Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G9	8.45		921.51		921.51	Upper Glacial Till	-	22.4	CL	29	14	15	0.56	CL	-	-	-	-	-	-	-	1.8	15.1	57.0	26.1	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G10	9.09		920.87		920.87	Upper Glaciolacustrine	-	30.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G11	9.45		920.51		920.51	Upper Glaciolacustrine	-	37.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G12	9.48		920.48		920.48	Upper Glaciolacustrine	-	34.4	CI	46	22	24	0.52	CI	-	-	-	-	-	-	-	0.0	1.0	52.5	46.5	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G13	10.09		919.87		919.87	Upper Glaciolacustrine	-	30.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G14	10.46		919.50		919.50	Upper Glaciolacustrine	-	42.3	CH	62	26	36	0.45	CH	-	-	-	-	-	-	-	0.4	2.4	30.7	66.5	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G15	10.86		919.10		919.10	Middle Glacial Till	-	22.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G16	11.37		918.59		918.59	Middle Glacial Till	-	21.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G17	11.40		918.56		918.56	Middle Glacial Till	-	23.7	CI	38	20	18	0.21	CI	-	-	-	-	-	-	-	0.4	2.9	66.7	30.0	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G18	11.98		917.98		917.98	Middle Glacial Till	-	22.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G19	12.75		917.21		917.21	Middle Glacial Till	-	21.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G20	13.26		916.70		916.70	Lower Glaciolacustrine	-	26.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G22	14.03		915.93		915.93	Lower Glaciolacustrine	-	28.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G23	14.45		915.51		915.51	Lower Glaciolacustrine	-	25.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G23A	14.18		915.78		915.78	Lower Glaciolacustrine	-	28.1	CI	34	23	11	0.46	CI	-	-	-	-	-	-	-	0.0	4.2	72.8	23.0	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G24	14.85		915.11		915.11	Lower Glaciolacustrine	-	23.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G25	15.40		914.56		914.56	Lower Glaciolacustrine	-	27.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G27	16.37		913.59		913.59	Upper Glaciofluvial	-	25.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G27A	16.25		913.71		913.71	Upper Glaciofluvial	-	21.5	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0.1	27.5	66.4	6.0	0.002	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G28	17.93		912.03		912.03	Upper Glaciofluvial	-	27.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	SH14-22A	Dam Breach Area	Grab	G29	17.96		912.00		912.00	Upper Glaciofluvial	-	24.8	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0.6	9.4	80.0	10.0	0.002	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-01	4.22		933.21		933.21	Upper Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-02	5.18		932.25		932.25	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-03	6.10		931.33		931.33	Upper Glacial Till	-	15.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-04	6.93		930.50		930.50	Upper Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-05	7.77		929.66		929.66	Upper Glacial Till	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-06	8.79		928.64		928.64	Upper Glacial Till	-	12.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-07	9.63		927.80		927.80	Upper Glacial Till	-	14.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-08	10.52		926.91		926.91	Upper Glacial Till	-	12.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-09	11.43		926.00		926.00	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-10	12.32		925.11		925.11	Upper Glacial Till	-	14.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	CPT14-05A	Dam Breach Area	Split Spoon	SPT-11	13.23		924.20		924.20	Upper Glacial Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-01	3.76		927.15		927.15	Upper Glacial Till	-	11.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-02	4.42		926.49		926.49	Upper Glacial Till	-	11.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-03	5.22		925.69		925.69	Upper Glacial Till	-	12.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-04	6.21		924.70		924.70	Upper Glacial Till	-	13.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-05	7.12		923.79		923.79	Upper Glacial Till	-	14.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-06	7.99		922.92		922.92	Upper Glacial Till	-	15.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-10A	Dam Breach Area	Split Spoon	SPT-07	8.90		922.01		922.01	Upper Glacial Till	-	14.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-22	Dam Breach Area	Split Spoon	SPT-01	3.10		926.69		926.69	-[1]	-	311.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-22	Dam Breach Area	Split Spoon	SPT-02	3.96		925.83		925.83	Upper Glacial Till	-	13.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-22	Dam Breach Area	Split Spoon	SPT-03	4.88		924.91		924.91	Upper Glacial Till	-	14.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-22	Dam Breach Area	Split Spoon	SPT-04	5.92		923.87		923.87	Upper Glacial Till	-	11.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-22	Dam Breach Area	Split Spoon	SPT-05	6.63		923.16		923.16	Upper Glacial Till	-	15.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	VST14-22	Dam Breach Area	Split Spoon	SPT-06	7.49		922.30		922.30	Upper Glacial Till	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	RH14-03A	Dam Breach Area	Thin-walled Piston Tube	SS-03	12.19		920.40		920.40	Upper Glaciolacustrine	-	40.2	CI	31	16	15	1.61	CI	-	-	-	-	-	-	-	0.0	16.4	51.6	32.0	0.002	OD, DSS
2014	KCB	RH14-10	Dam Breach Area	Thin-walled Piston Tube	SS-01	10.06		920.85		920.85	Upper Glaciolacustrine	2.79	37.2	CI	44	21	23	0.70	CI	-	-	-	-	-	-	-	0.0	0.7	52.5	46.8	0.002	TXCU, OD, DS, DSS
2014	KCB	RH14-10	Dam Breach Area	Thin-walled Piston Tube	SS-01	10.06		920.85		920.85	Upper Glaciolacustrine	-	37.2	CI	33	15	18	1.23	CI	-	-	-	-	-	-	-	0.0	5.5	55.9	38.6	0.002	-
2014	KCB	RH14-10	Dam Breach Area	Thin-walled Piston Tube	SS-02	10.67		920.24		920.24	Upper Glaciolacustrine	2.75	44.0	CH	59	24	35	0.57	CH	-	-	-	-	-	-	-	0.0	0.4	44.1	55.5	0.002	OD, DSS
2014	KCB	RH14-10	Dam Breach Area	Thin-walled Piston Tube	SS-02	10.67		920.24		920.24	Upper Glaciolacustrine	-	44.0	CH	59	20	39	0.62	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	RH14-10	Dam Breach Area	Thin-walled Piston Tube	SS-02	10.67		920.24		920.24	Upper Glaciolacustrine	-	44.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	RH14-22	Dam Breach Area	Thin-walled Piston Tube	SS-02	9.29		920.49		920.49	Upper Glaciolacustrine	-	36.9	CI	43	18	25	0.76	CI	-	-	-	-	-	-	-	0.0	1.6	53.5	44.9	0.002	OD, DS, DSS
2014	KCB	RH14-22	Dam Breach Area	Thin-walled Piston Tube	SS-02	9.29		920.49		920.49	Upper Glaciolacustrine	-	36.9	CH	56	23	33	0.42	CH	-	-	-	-	-	-	-	0.0	0.2	43.0	56.8	0.002	TXCU
2014	KCB	RH14-22A	Dam Breach Area	Thin-walled Piston Tube	SS-02	9.30		920.49		920.49	Upper Glaciolacustrine	2.78	35.5	CI	50	20	30	0.52	CI	-	-	-	-	-	-	-	0.0	2.3	40.9	56.8	0.002	OD, DSS
2014	KCB	TP14-01	Dam Breach Area	Block	BS-01	-	-	-		-	Upper Glacial Till	2.76	10.3	SC	26	14	12	-0.31	CL	-	-	-	-	-	-	-	21.4	34.1	30.0	14.5	0.002	TXP, TXCU, TXE
2014	KCB	TP14-01	Dam Breach Area	Block	BS-02	-	-	-		-	Upper Glaciolacustrine	2.78	-	CI	32	20	12	-	CI	-	-	-	-	-	-	-	0.0	7.1	55.4	37.5	0.002	TXCU
2014	KCB	TP14-01	Dam Breach Area	Block	BS-02	-	-	-		-	Upper Glaciolacustrine	2.79	-	CI	40	18	22	-	CI	-	-	-	-	-	-	-	0.0	2.2	52.0	45.8	0.002	OD, DS, DSS
2014	KCB	TP14-01	Dam Breach Area	Block	BS-02	-	-	-		-	Upper Glaciolacustrine	-	35.2	CH	54	18	36	0.48	CH	-	-	-	-	-	-	-	0.0	3.1	44.9	52.0	0.002	-
2014	KCB	Perimeter Embankment Core	Dam Breach Area	Bulk	TC-01	-	-	-		-	Dam Till Core	2.76	10.7	SC	23	13	10	-0.23	CL	-	-	2006	10.6	-	-	-	17.7	36.7	35.2	10.5	0.002	TXP, TXCU

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2014	KCB	Perimeter Embankment Core	Dam Breach Area	Bulk	TC-01	-		-		-	Dam Till Core	2.76	11.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	KCB	Perimeter Embankment Core	Dam Breach Area	Bulk	TC-02	-		-		-	Dam Till Core	2.76	10.8	CL	26	15	11	-0.38	CL	-	-	1977	12.5	-	-	-	11.1	34.1	37.7	17.0	0.002	TXP, TXCU
2014	KCB	Toe Bulge	Dam Breach Area	Bulk	-	-		-		-	Upper Glacial Till	-	-	CL	28	14	14	-	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	Golder	-	-	Thin-walled Tube	1-Top	4.00		-		-	Glaciofluvial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.7	80.8	16.5		-	TXCU
2014	Golder	-	-	Thin-walled Tube	1-Bottom	4.00		-		-	Glaciolacustrine	-	15.9	CL-ML	25	18	7	-0.30	CL-ML	-	-	-	-	-	-	-	3.2	16.0	62.8	18.0	0.002	DSS
2014	Golder	-	-	Thin-walled Tube	2-Top	4.00		-		-	Glaciofluvial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	82.1	16.3		-	TXCU
2014	Golder	-	-	Thin-walled Tube	2-Bottom	4.00		-		-	Glaciolacustrine	2.70	21.5	CI	32	20	12	0.13	CI	-	-	-	-	-	-	-	0.0	8.1	64.9	27.0	0.002	DSS
2014	Golder	-	-	Thin-walled Tube	3-Top	4.00		-		-	Glaciofluvial	2.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6	79.3	18.1		-	TXCU
2014	Golder	-	-	Thin-walled Tube	4-Bottom	4.00		-		-	Glaciolacustrine	2.77	25.8	CI	35	18	17	0.46	CI	-	-	-	-	-	-	-	0.3	11.5	48.2	40.0	0.002	DSS, CRS
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	1	7.20	7.50	960.60	960.30	960.45	Topsoil	-	15.1	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	2	7.80	8.00	960.00	959.80	959.90	Topsoil / Glacial Till	-	146.4	ML/SM/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	3	8.20	8.50	959.60	959.30	959.45	Glacial Till	-	13.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	4	9.20	9.50	958.60	958.30	958.45	Glacial Till	-	12.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	5	10.20	10.50	957.60	957.30	957.45	Glacial Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	6	11.20	11.50	956.60	956.30	956.45	Glacial Till	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	6B	11.70	12.00	956.10	955.80	955.95	Glacial Till	-	13.1	CL	21	12	9	0.12	CL	-	-	-	-	-	-	-	13	37	50		-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	7	12.20	12.50	955.60	955.30	955.45	Glacial Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	8	13.20	13.50	954.60	954.30	954.45	Glacial Till	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	9	14.20	14.50	953.60	953.30	953.45	Glacial Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	10	15.50	15.70	952.30	952.10	952.20	Glacial Till	-	8.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	11	16.70	17.00	951.10	950.80	950.95	Glacial Till	-	8.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	12	17.50	17.80	950.30	950.00	950.15	Glacial Till	-	11.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	13	18.50	18.80	949.30	949.00	949.15	Glacial Till	-	4.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-01	Perimeter Embankment Buttress	Grab	14	19.30	19.60	948.50	948.20	948.35	Glacial Till	-	5.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	1	1.80	2.10	949.90	949.60	949.75	Glacial Till	-	14.0	CL-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	2	2.80	3.10	948.90	948.60	948.75	Glacial Till	-	12.4	CL-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	3	3.70	4.10	948.00	947.60	947.80	Glacial Till	-	11.3	CL-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	3B	4.20	4.50	947.50	947.20	947.35	Glacial Till	-	11.1	CL-SC	25	14	11	-0.26	CL	-	-	-	-	-	-	-	18	37	45		-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	4	4.90	5.20	946.80	946.50	946.65	Glacial Till	-	12.5	CL-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	5	6.30	6.60	945.40	945.10	945.25	Glacial Till	-	13.2	CL-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	6	7.20	7.50	944.50	944.20	944.35	Glaciofluvial	-	8.5	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	7	8.60	8.90	943.10	942.80	942.95	Glacial Till	-	11.0	CI-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	8	10.60	10.90	941.10	940.80	940.95	Glacial Till	-	10.8	CI-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	9	11.60	11.90	940.10	939.80	939.95	Glacial Till	-	10.5	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	9B	12.00	12.30	939.70	939.40	939.55	Glacial Till	-	16.1	CL/SC	29	20	9	-0.43	CL	-	-	-	-	-	-	-	14	33	53		-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	10	12.60	12.90	939.10	938.80	938.95	Weathered Bedrock	-	9.0	CL/SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	11	13.60	13.90	938.10	937.80	937.95	Weathered Bedrock	-	4.8	CL/SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	12	14.60	14.90	937.10	936.80	936.95	Weathered Bedrock	-	16.0	CL/SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	13	15.60	15.90	936.10	935.80	935.95	Weathered Bedrock	-	16.0	CL/SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-02	Perimeter Embankment Buttress	Grab	14	16.60	16.90	935.10	934.80	934.95	Weathered Bedrock	-	16.5	CL/SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	1	2.10	2.40	935.50	935.20	935.35	Fill	-	6.5	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	2	3.00	3.30	934.60	934.30	934.45	Fill	-	8.7	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	3	3.90	4.20	933.70	933.40	933.55	Fill	-	12.8	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	4	4.50	4.80	933.10	932.80	932.95	Fill	-	9.1	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	5	5.40	5.70	932.20	931.90	932.05	Glacial Till	-	9.6	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	6	6.30	6.60	931.30	931.00	931.15	Glacial Till	-	10.4	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	7	7.20	7.50	930.40	930.10	930.25	Glacial Till	-	11.3	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	8	8.10	8.40	929.50	929.20	929.35	Glacial Till	-	9.9	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	9	9.30	9.60	928.30	928.00	928.15	Glacial Till	-	10.1	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	10	10.20	10.50	927.40	927.10	927.25	Glacial Till	-	8.9	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	50	11.30	11.60	926.30	926.00	926.15	Glacial Till	-	11.6	SC/CI	22	14	8	-0.30	CL	-	-	-	-	-	-	-	20	34	46		-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	11	11.60	11.80	926.00	925.80	925.90	Glacial Till	-	10.8	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	12	12.30	12.60	925.30	925.00	925.15	Glacial Till	-	9.8	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	13	13.20	13.50	924.40	924.10	924.25	Glacial Till	-	10.2	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	14	14.40	14.70	923.20	922.90	923.05	Glacial Till	-	9.1	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	15	15.60	15.90	922.00	921.70	921.85	Glacial Till	-	9.5	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	16	16.50	16.80	921.10	920.80	920.95	Glacial Till	-	10.3	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	17	17.40	17.70	920.20	919.90	920.05	Glacial Till	-	12.2	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	18	18.30	18.60	919.30	919.00	919.15	Glacial Till	-	10.7	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	19	19.50	19.80	918.10	917.80	917.95	Glacial Till	-	10.2	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	20	20.40	20.70	917.20	916.90	917.05	Glacial Till	-	9.0	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	21	21.60	21.90	916.00	915.70	915.85	Glacial Till	-	8.6	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	22	22.50	22.80	915.10	914.80	914.95	Glacial Till	-	8.2	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	23	23.70	24.00	913.90	913.60	913.75	Glacial Till	-	10.7	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	24	24.60	24.90	913.00	912.70	912.85	Glacial Till	-	10.3	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	25	25.50	25.80	912.10	911.80	911.95	Glacial Till	-	12.3	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	26	26.02	27.00	911.58	910.60	911.09	Glaciofluvial	-	21.4	ML/SM	-	Non-Plastic		-	ML	-	-	-	-	-	-	-	0	36	64		-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	26	26.02	27.00	911.58	910.60	911.09	Glaciofluvial	-	22.3	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	27	27.30	27.60	910.30	910.00	910.15	Glaciofluvial	-	20.5	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	28	28.20	29.00	909.40	908.60	909.00	Glaciofluvial	-	22.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	28	28.50	28.80	909.10	908.80	908.95	Glaciofluvial	-	15.1	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	1	3	96		-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	29	29.40	29.70	908.20	907.90	908.05	Glaciofluvial	-	27.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	30	30.30	30.60	907.30	907.00	907.15	Glaciofluvial	-	17.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	31	31.50	31.80	906.10	905.80	905.95	Glaciofluvial	-	5.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	32	32.70	33.00	904.90	904.60	904.75	Glacial Till	-	17.1	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	33	33.90	34.20	903.70	903.40	903.55	Glacial Till	-	9.9	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	34	34.80	35.10	902.80	902.50	902.65	Glacial Till	-	6.8	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	35	35.70	36.00	901.90	901.60	901.75	Glaciofluvial	-	17.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	36	36.60	36.90	901.00	900.70	900.85	Glaciofluvial	-	8.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	37	37.80	38.10	899.80	899.50	899.65	Glaciofluvial	-	18.5	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	38	38.70	39.00	898.90	898.60	898.75	Glaciofluvial	-	16.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	39	39.60	39.90	898.00	897.70	897.85	Glacial Till	-	8.1	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	40	40.80	41.20	896.80	896.40	896.60	Glacial Till	-	6.1	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	41	41.80	42.10	895.80	895.50	895.65	Glacial Till	-	9.7	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	42	43.00	43.30	894.60	894.30	894.45	Glacial Till	-	6.4	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	43	44.20	44.50	893.40	893.10	893.25	Glacial Till	-	9.6	SM-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	44	45.10	45.40	892.50	892.20	892.35	Glacial Till	-	8.6	SM-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	45	46.00	46.30	891.60	891.30	891.45	Glacial Till	-	7.9	SM-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	46	47.20	47.50	890.40	890.10	890.25	Glacial Till	-	8.3	SM-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	47	48.10	48.40	889.50	889.20	889.35	Weathered Bedrock	-	15.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	48	49.00	49.30	888.60	888.30	888.45	Weathered Bedrock	-	14.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-03	Perimeter Embankment Buttress	Grab	49	50.20	50.50	887.40	887.10	887.25	Weathered Bedrock	-	6.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	1	0.30	0.60	936.90	936.60	936.75	Fill	-	6.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	2	1.20	1.50	936.00	935.70	935.85	Fill	-	5.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	3	2.10	2.40	935.10	934.80	934.95	Fill	-	4.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	4	3.00	3.30	934.20	933.90	934.05	Fill	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	5	3.90	4.20	933.30	933.00	933.15	Glacial Till	-	15.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	6	5.40	5.70	931.80	931.50	931.65	Glacial Till	-	10.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	7	6.30	6.60	930.90	930.60	930.75	Glacial Till	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	8	7.20	7.50	930.00	929.70	929.85	Glacial Till	-	9.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	9	8.40	8.70	928.80	928.50	928.65	Glacial Till	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	10	9.30	9.60	927.90	927.60	927.75	Glacial Till	-	8.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	11	10.50	10.80	926.70	926.40	926.55	Glacial Till	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	12	11.40	11.70	925.80	925.50	925.65	Glacial Till	-	8.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	13	12.60	12.90	924.60	924.30	924.45	Glacial Till	-	12.4	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	14	13.50	13.80	923.70	923.40	923.55	Glacial Till	-	12.1	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	55B	14.00	14.40	923.20	922.80	923.00	Glacial Till	-	10.2	SM/ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	13	39	48		-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	15	14.40	14.70	922.80	922.50	922.65	Glacial Till	-	10.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	16	15.30	15.60	921.90	921.60	921.75	Glacial Till	-	11.0	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	17	16.50	16.80	920.70	920.40	920.55	Glacial Till	-	9.7	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	18	17.40	17.70	919.80	919.50	919.65	Glacial Till	-	6.9	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	19	18.30	18.60	918.90	918.60	918.75	Glacial Till	-	11.2	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	20	19.20	19.50	918.00	917.70	917.85	Glacial Till	-	9.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	21	20.40	20.70	916.80	916.50	916.65	Glacial Till	-	12.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	22	21.30	21.60	915.90	915.60	915.75	Glacial Till	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	23	22.20	22.50	915.00	914.70	914.85	Glacial Till	-	6.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	24	23.70	24.00	913.50	913.20	913.35	Glacial Till	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	25	24.60	24.90	912.60	912.30	912.45	Glacial Till	-	7.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	26	25.50	25.80	911.70	911.40	911.55	Glacial Till	-	9.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	27	26.40	26.70	910.80	910.50	910.65	Glacial Till	-	12.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	56B	26.70	27.20	910.50	910.00	910.25	Glacial Till	-	10.0	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	22	61	17		-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	28	27.30	27.60	909.90	909.60	909.75	Glaciofluvial	-	16.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	29	28.20	28.50	909.00	908.70	908.85	Glaciofluvial	-	18.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	30	29.40	29.70	907.80	907.50	907.65	Glaciofluvial	-	17.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	31	30.30	30.60	906.90	906.60	906.75	Glaciofluvial	-	4.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	32	31.50	31.80	905.70	905.40	905.55	Glaciofluvial	-	19.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	33	32.40	32.70	904.80	904.50	904.65	Bedrock	-	14.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	34	33.30	33.60	903.90	903.60	903.75	Bedrock	-	6.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	35	34.20	34.50	903.00	902.70	902.85	Bedrock	-	11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	36	35.10	35.40	902.10	901.80	901.95	Bedrock	-	6.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	37	36.00	36.30	901.20	900.90	901.05	Bedrock	-	5.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	38	36.60	36.90	900.60	900.30	900.45	Bedrock	-	5.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	39	37.50	37.80	899.70	899.40	899.55	Bedrock	-	9.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	40	38.70	39.00	898.50	898.20	898.35	Bedrock	-	5.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	41	39.90	40.20	897.30	897.00	897.15	Bedrock	-	7.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	42	40.80	41.10	896.40	896.10	896.25	Bedrock	-	5.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	57B	41.50	41.80	895.70	895.40	895.55	Bedrock	-	7.3	GM		Non-Plastic		-	ML	-	-	-	-	-	-	-	49	34	17		-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	43	42.00	42.30	895.20	894.90	895.05	Bedrock	-	8.3	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	44	42.90	43.20	894.30	894.00	894.15	Bedrock	-	6.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	45	43.80	44.10	893.40	893.10	893.25	Bedrock	-	14.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	46	44.70	45.00	892.50	892.20	892.35	Bedrock	-	11.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	47	45.90	46.20	891.30	891.00	891.15	Bedrock	-	16.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	48	46.80	47.10	890.40	890.10	890.25	Bedrock	-	21.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	49	48.00	48.30	889.20	888.90	889.05	Bedrock	-	5.7	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	50	49.20	49.50	888.00	887.70	887.85	Bedrock	-	5.5	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	51	50.10	50.40	887.10	886.80	886.95	Bedrock	-	8.9	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	52	51.00	51.30	886.20	885.90	886.05	Bedrock	-	7.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	53	51.90	52.20	885.30	885.00	885.15	Bedrock	-	6.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-04	Perimeter Embankment Buttress	Grab	54	52.80	53.10	884.40	884.10	884.25	Bedrock	-	7.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	1	0.90	1.20	936.60	936.30	936.45	Fill	-	6.9	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	2	2.70	3.00	934.80	934.50	934.65	Glacial Till	-	13.9	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	3	3.90	4.20	933.60	933.30	933.45	Glacial Till	-	13.1	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	50B	4.20	4.70	933.30	932.80	933.05	Glacial Till	-	8.0	SM/ML	22	14	8	-0.75	CL	-	-	-	-	-	-	-	9	50	41		-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	4	5.10	5.40	932.40	932.10	932.25	Glacial Till	-	10.0	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	5	6.30	6.60	931.20	930.90	931.05	Glacial Till	-	9.4	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	6	7.30	7.60	930.20	929.90	930.05	Glacial Till	-	10.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	7	8.40	8.70	929.10	928.80	928.95	Glacial Till	-	10.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	8	9.50	9.80	928.00	927.70	927.85	Glacial Till	-	9.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	9	10.20	10.50	927.30	927.00	927.15	Glacial Till	-	9.8	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	10	11.00	11.30	926.50	926.20	926.35	Glacial Till	-	9.9	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	11	12.30	12.60	925.20	924.90	925.05	Glacial Till	-	10.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	12	13.70	14.00	923.80	923.50	923.65	Glacial Till	-	10.2	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	13	14.80	15.10	922.70	922.40	922.55	Glacial Till	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	14	16.40	16.70	921.10	920.80	920.95	Glacial Till	-	9.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	15	16.70	17.00	920.80	920.50	920.65	Glacial Till	-	8.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	16	17.60	17.90	919.90	919.60	919.75	Glacial Till	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	17	18.20	18.50	919.30	919.00	919.15	Glacial Till	-	7.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	18	18.80	19.10	918.70	918.40	918.55	Glacial Till	-	7.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	19	20.30	20.60	917.20	916.90	917.05	Glacial Till	-	10.1	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	57	20.40	20.70	917.10	916.80	916.95	Glacial Till	-	19.0	CL-ML	25	19	6	0.00	CL-ML	-	-	-	-	-	-	-	4	29	67		-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	20	21.20	21.50	916.30	916.00	916.15	Glacial Till	-	8.9	SC/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	51B	22.10	22.40	915.40	915.10	915.25	Glacial Till	-	8.3	SC/ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	18	35	47		-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	21	22.40	22.70	915.10	914.80	914.95	Glacial Till	-	10.8	SC/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	58	23.20	23.50	914.30	914.00	914.15	[1]	-	19.3	CI	39	20	19	-0.04	CI	-	-	-	-	-	-	-	5	34	61		-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	22	24.20	24.50	913.30	913.00	913.15	Glaciofluvial	-	12.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	23	24.80	25.10	912.70	912.40	912.55	Glaciofluvial	-	7.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	24	25.40	25.70	912.10	911.80	911.95	Glaciofluvial	-	15.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	25	26.60	26.90	910.90	910.60	910.75	Glaciofluvial	-	16.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	52B	27.20	27.50	910.30	910.00	910.15	-	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	8	29	58	5	0.002	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	26	27.50	27.80	910.00	909.70	909.85	Glacial Till	-	8.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	27	28.40	28.70	909.10	908.80	908.95	Glacial Till	-	8.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	28	31.10	31.40	906.40	906.10	906.25	Glacial Till	-	8.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	29	32.00	32.30	905.50	905.20	905.35	Glacial Till	-	5.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	30	32.90	33.20	904.60	904.30	904.45	Glaciofluvial	-	16.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	53B	33.20	33.90	904.30	903.60	903.95	Glaciofluvial	-	14.2	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	6	55	36	3	0.002	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	31	33.90	34.20	903.60	903.30	903.45	Glaciofluvial	-	18.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	100	34.60	34.90	902.90	902.60	902.75	Glaciolacustrine	-	10.2	CI	42	25	17	-0.87	CI	-	-	-	-	-	-	-	0	4	58	38	0.002	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	32	34.70	35.00	902.80	902.50	902.65	Glaciolacustrine	-	30.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	33	35.60	35.90	901.90	901.60	901.75	Glaciofluvial	-	18.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	34	36.70	37.00	900.80	900.50	900.65	Glaciofluvial	-	23.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	35	37.70	38.00	899.80	899.50	899.65	Glaciofluvial	-	25.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	54B	38.00	38.70	899.50	898.80	899.15	Glaciofluvial	-	26.9	ML	25	20	5	1.38	CL-ML	-	-	-	-	-	-	-	0	19	81		-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	36	38.70	39.00	898.80	898.50	898.65	Glaciofluvial	-	23.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	37	40.30	40.60	897.20	896.90	897.05	Glaciofluvial	-	22.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	38	41.30	41.60	896.20	895.90	896.05	Glaciofluvial	-	17.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	39	42.50	42.80	895.00	894.70	894.85	Glacial Till	-	15.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	40	43.20	43.50	894.30	894.00	894.15	Glaciofluvial	-	20.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	41	44.00	44.30	893.50	893.20	893.35	Glaciofluvial	-	19.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	42	45.20	45.50	892.30	892.00	892.15	Glacial Till	-	24.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	43	46.30	46.60	891.20	890.90	891.05	Weathered Bedrock	-	22.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	44	47.60	47.90	889.90	889.60	889.75	Weathered Bedrock	-	7.8	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	45	48.50	48.80	889.00	888.70	888.85	Weathered Bedrock	-	4.4	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	46	49.70	50.00	887.80	887.50	887.65	Weathered Bedrock	-	5.6	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	47	50.30	50.60	887.20	886.90	887.05	Weathered Bedrock	-	6.6	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	48	50.90	51.20	886.60	886.30	886.45	Weathered Bedrock	-	11.4	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	49	51.80	52.10	885.70	885.40	885.55	Weathered Bedrock	-	12.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	50	53.00	53.30	884.50	884.20	884.35	Weathered Bedrock	-	16.2	GC/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	51	53.90	54.20	883.60	883.30	883.45	Weathered Bedrock	-	13.0	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	52	55.10	55.40	882.40	882.10	882.25	Weathered Bedrock	-	11.9	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	53	56.00	56.30	881.50	881.20	881.35	Weathered Bedrock	-	14.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	54	56.90	57.20	880.60	880.30	880.45	Weathered Bedrock	-	15.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	55	58.40	58.70	879.10	878.80	878.95	Weathered Bedrock	-	14.8	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-05	Perimeter Embankment Buttress	Grab	56	59.30	59.60	878.20	877.90	878.05	Weathered Bedrock	-	3.9	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	1	1.37	1.68	937.23	936.92	937.08	Fill	-	5.4	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	2	4.42	4.72	934.18	933.88	934.03	Glacial Till	-	9.5	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	3	5.18	5.49	933.42	933.11	933.27	Glacial Till	-	13.0	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	4	6.25	6.55	932.35	932.05	932.20	Glacial Till	-	11.9	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	50	6.40	7.30	932.20	931.30	931.75	Glacial Till	-	7.3	GC	24	13	11	-0.52	CL	-	-	-	-	-	-	-	45	28	27		-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	5	7.32	7.62	931.28	930.98	931.13	Glacial Till	-	12.4	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	6	8.23	8.53	930.37	930.07	930.22	Glacial Till	-	11.5	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	7	9.45	9.75	929.15	928.85	929.00	Glacial Till	-	9.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	8	10.52	10.82	928.08	927.78	927.93	Glacial Till	-	8.5	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution				Clay Threshold (< mm)	Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)			
																												Silt (%)	Clay (%)		
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	51	10.70	11.60	927.90	927.00	927.45	Glacial Till	-	7.8	GC	22	13	9	-0.58	CL	-	-	-	-	-	-	-	-	32		-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	9	11.58	11.89	927.02	926.71	926.87	Glacial Till	-	10.4	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	10	12.50	12.80	926.10	925.80	925.95	Glacial Till	-	8.3	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	11	13.41	13.72	925.19	924.88	925.04	Glacial Till	-	8.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	12	14.63	14.94	923.97	923.66	923.82	Glacial Till	-	8.5	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	52	14.90	15.80	923.70	922.80	923.25	Glaciofluvial	-	7.3	SM		Non-Plastic			ML	-	-	-	-	-	-	-	26	37	37		-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	13	15.85	16.15	922.75	922.45	922.60	Glacial Till	-	6.7	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	14	16.46	16.76	922.14	921.84	921.99	Glacial Till	-	7.8	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	15	17.68	17.98	920.92	920.62	920.77	Glacial Till	-	9.7	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	16	18.59	18.90	920.01	919.70	919.86	Glacial Till	-	10.4	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	53	18.60	19.50	920.00	919.10	919.55	Glacial Till	-	9.5	SC/CI	20	15	5	-1.10	CL-ML	-	-	-	-	-	-	-	21	34	45		-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	17	19.51	19.81	919.09	918.79	918.94	Glacial Till	-	9.6	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	18	20.73	21.03	917.87	917.57	917.72	Glacial Till	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	19	21.64	21.95	916.96	916.65	916.81	Glacial Till	-	7.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	20	22.56	22.86	916.04	915.74	915.89	Glacial Till	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	21	23.47	23.77	915.13	914.83	914.98	Glacial Till	-	13.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	22	24.99	25.30	913.61	913.30	913.46	Glacial Till	-	13.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	23	25.91	26.21	912.69	912.39	912.54	Glacial Till	-	13.3	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	54	26.20	26.80	912.40	911.80	912.10	Glacial Till	-	-	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	14	38	48		-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	24	26.82	27.13	911.78	911.47	911.63	Glacial Till	-	11.9	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	25	27.74	28.04	910.86	910.56	910.71	Glacial Till	-	9.7	SC/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	26	28.96	29.26	909.64	909.34	909.49	Glaciolacustrine	-	23.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	27	29.87	30.18	908.73	908.42	908.58	Glaciolacustrine	-	28.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	28	30.78	31.09	907.82	907.51	907.67	Glaciolacustrine	-	27.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	Run 11	29.60	30.80	909.00	907.80	908.40	Glaciolacustrine	-	27.8	CI	36	21	15	0.45	CI	-	-	-	-	-	-	-	0	0	70	30	0.002	Incremental Consolidation
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	Run 11	30.30	30.30	908.30	908.30	908.30	Glaciolacustrine	-	26.7	CI	47	22	25	0.19	CI	-	-	-	-	-	-	-	0	0	56	44	0.002	Incremental Consolidation
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	Run 11	31.10	31.20	907.50	907.40	907.45	Glaciolacustrine	-	26.5	CI	49	26	23	0.02	CI	-	-	-	-	-	-	-	-	-	-	-	-	Incremental Consolidation
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	Run 11	31.30	31.30	907.30	907.30	907.30	Glaciolacustrine	-	24.1	CI	38	24	14	0.01	CI	-	-	-	-	-	-	-	0	2	69	29	0.002	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	29	31.70	32.00	906.90	906.60	906.75	Glacial Till	-	8.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	30	32.61	32.92	905.99	905.68	905.84	Glacial Till	-	9.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	31	34.14	34.44	904.46	904.16	904.31	Glaciolacustrine	-	27.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	55	34.44	35.36	904.16	903.24	903.70	Glaciolacustrine	-	25.9	CH	59	23	36	0.08	CH	-	-	-	-	-	-	-	0	9	91		-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	32	34.75	35.05	903.85	903.55	903.70	Glaciolacustrine	-	29.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	100	34.90	35.20	903.70	903.40	903.55	Glaciolacustrine	-	2.4	CH	57	25	32	-0.71	CH	-	-	-	-	-	-	-	0	0	29	71	0.002	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	101	35.60	35.90	903.00	902.70	902.85	Glaciolacustrine	-	20.4	CH	57	23	34	-0.08	CH	-	-	-	-	-	-	-	0	1	33	66	0.002	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	33	35.66	35.97	902.94	902.63	902.79	Glaciolacustrine	-	32.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	34	36.58	36.88	902.02	901.72	901.87	Glaciofluvial	-	19.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	35	37.49	37.80	901.11	900.80	900.96	Glaciofluvial	-	21.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	36	38.40	38.71	900.20	899.89	900.05	Glacial Till	-	12.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	37	39.78	40.08	898.82	898.52	898.67	Glacial Till	-	7.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	38	40.84	41.15	897.76	897.45	897.61	Weathered Bedrock	-	13.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	39	41.45	41.76	897.15	896.84	897.00	Weathered Bedrock	-	14.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	40	42.37	42.67	896.23	895.93	896.08	Weathered Bedrock	-	13.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	41	43.59	43.89	895.01	894.71	894.86	Weathered Bedrock	-	13.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	42	44.81	45.11	893.79	893.49	893.64	Weathered Bedrock	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	43	46.02	46.33	892.58	892.27	892.43	Weathered Bedrock	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	44	51.21	51.51	887.39	887.09	887.24	Weathered Bedrock	-	11.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	45	52.12	52.43	886.48	886.17	886.33	Weathered Bedrock	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	46	53.04	53.34	885.56	885.26	885.41	Weathered Bedrock	-	15.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	47	54.25	54.56	884.35	884.04	884.20	Weathered Bedrock	-	13.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	48	55.32	55.63	883.28	882.97	883.13	Weathered Bedrock	-	20.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-06	Perimeter Embankment Buttress	Grab	49	56.24	56.54	882.36	882.06	882.21	Weathered Bedrock	-	18.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	1	0.30	0.60	934.70	934.40	934.55	Glacial Till	-	16.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	2	1.20	1.50	933.80	933.50	933.65	Glacial Till	-	6.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	3	2.10	2.40	932.90	932.60	932.75	Glacial Till	-	10.3	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	4	3.00	3.30	932.00	931.70	931.85	Glacial Till	-	7.6	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	12	3.30	3.90	931.70	931.10	931.40	Glacial Till	-	12.1	SC/CL	22	12	10	0.01	CL	-	-	-	-	-	-	-	26	34	40		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	5	4.20	4.50	930.80	930.50	930.65	Glacial Till	-	10.9	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	6	5.10	5.40	929.90	929.60	929.75	Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	6B	5.70	5.80	929.30	929.20	929.25	Glacial Till	-	-	CL	22	12	10	-	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	7	6.30	6.60	928.70	928.40	928.55	Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	8	7.50	7.80	927.50	927.20	927.35	Glacial Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	9	8.70	9.00	926.30	926.00	926.15	Glaciofluvial	-	8.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	10	9.60	9.90	925.40	925.10	925.25	Glacial Till	-	11.5	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	10B	9.90	10.20	925.10	924.80	924.95	Glacial Till	-	8.0	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	10C	10.20	10.50	924.80	924.50	924.65	Glacial Till	-	8.4	SC/CL	23	15	8	-0.83	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	10C	10.20	10.50	924.80	924.50	924.65	Glacial Till	-	-	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	15	36	49		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	11	10.50	10.80	924.50	924.20	924.35	Glacial Till	-	9.4	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	11B	11.60	11.90	923.40	923.10	923.25	Glaciofluvial	-	7.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	12B	12.10	12.40	922.90	922.60	922.75	Glacial Till	-	11.0	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	13	13.10	13.40	921.90	921.60	921.75	Glacial Till	-	12.0	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	16	45	39		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	13B	13.40	13.70	921.60	921.30	921.45	Glacial Till	-	8.1	ML/SM	19	14	5	-1.18	CL-ML	-	-	-	-	-	-	-	12	31	57		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	14	14.10	14.40	920.90	920.60	920.75	Glacial Till	-	14.8	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	15	15.10	15.40	919.90	919.60	919.75	Glacial Till	-	15.9	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	16	16.10	16.40	918.90	918.60	918.75	Glacial Till	-	11.9	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	17B	17.40	17.70	917.60	917.30	917.45	Glacial Till	-	16.1	CL	26	17	9	-0.10	CL	-	-	-	-	-	-	-	2	19	79		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	17	17.10	17.40	917.90	917.60	917.75	Glacial Till	-	13.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	18	18.10	18.40	916.90	916.60	916.75	Glacial Till	-	9.3	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	19	19.10	19.40	915.90	915.60	915.75	Glacial Till	-	3.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	20	19.80	20.10	915.20	914.90	915.05	Bedrock	-	4.2	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	20B	20.40	20.70	914.60	914.30	914.45	Bedrock	-	-	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	57	37	6		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	21	21.10	21.40	913.90	913.60	913.75	Bedrock	-	6.4	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	22	22.10	22.40	912.90	912.60	912.75	Bedrock	-	10.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	23	23.10	23.40	911.90	911.60	911.75	Bedrock	-	9.9	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	24	24.15	24.45	910.85	910.55	910.70	Bedrock	-	6.3	GM-GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	25	25.10	25.40	909.90	909.60	909.75	Bedrock	-	7.0	GM-GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	26	25.90	26.21	909.10	908.79	908.95	Bedrock	-	15.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	27	26.21	26.50	908.79	908.50	908.65	Bedrock	-	14.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	27B	26.50	26.80	908.50	908.20	908.35	Bedrock	-	15.2	SM		Non-Plastic			ML	-	-	-	-	-	-	-	12	60	28		-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	28	27.10	27.40	907.90	907.60	907.75	Bedrock	-	16.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	29	28.00	28.30	907.00	906.70	906.85	Bedrock	-	6.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	30	29.10	29.40	905.90	905.60	905.75	Bedrock	-	5.8	SP/GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	31	30.15	30.45	904.85	904.55	904.70	Bedrock	-	10.0	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	32	31.10	31.40	903.90	903.60	903.75	Bedrock	-	6.6	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	33	32.10	32.40	902.90	902.60	902.75	Bedrock	-	10.8	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	34	33.10	33.30	901.90	901.70	901.80	Bedrock	-	13.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	35	34.05	34.35	900.95	900.65	900.80	Bedrock	-	6.5	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	36	35.00	35.30	900.00	899.70	899.85	Bedrock	-	8.4	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	37	36.15	36.45	898.85	898.55	898.70	Bedrock	-	9.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	38	37.15	37.35	897.85	897.65	897.75	Weathered Bedrock	-	4.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	39	38.10	38.40	896.90	896.60	896.75	Weathered Bedrock	-	4.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	40	38.90	39.15	896.10	895.85	895.98	Weathered Bedrock	-	8.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	41	40.35	40.60	894.65	894.40	894.53	Weathered Bedrock	-	2.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	42	41.85	42.10	893.15	892.90	893.03	Weathered Bedrock	-	4.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-07	Perimeter Embankment Buttress	Grab	43	44.10	44.40	890.90	890.60	890.75	Weathered Bedrock	-	2.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	1	1.50	1.80	935.50	935.20	935.35	Glacial Till	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	2B	2.40	2.70	934.60	934.30	934.45	Glacial Till	-	11.3	CL	23	13	10	-0.17	CL	-	-	-	-	-	-	-	9	38	53		-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	2	2.70	3.00	934.30	934.00	934.15	Glacial Till	-	12.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	3	3.60	3.90	933.40	933.10	933.25	Glacial Till	-	14.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	4	4.50	4.80	932.50	932.20	932.35	Glacial Till	-	9.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	5	5.40	5.70	931.60	931.30	931.45	Glacial Till	-	14.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m^3)	Optimum Water Content (%)	Maximum Dry Density (kg/m^3)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	6	6.30	6.60	930.70	930.40	930.55	Glacial Till	-	5.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	6B	6.60	6.90	930.40	930.10	930.25	Glacial Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	-	28	56	16		-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	7	7.50	7.80	929.50	929.20	929.35	Glacial Till	-	4.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	8B	8.40	8.70	928.60	928.30	928.45	-	-	7.3	SM	18	14	4	-1.68	CL-ML	-	-	-	-	-	-	-	6	63	31		-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	8	8.70	9.00	928.30	928.00	928.15	-	-	8.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	9	9.90	10.20	927.10	926.80	926.95	-	-	3.8	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	10	11.10	11.40	925.90	925.60	925.75	-	-	11.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	11	12.30	12.60	924.70	924.40	924.55	-	-	6.8	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	12	13.50	13.80	923.50	923.20	923.35	-	-	2.3	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	13	14.40	14.70	922.60	922.30	922.45	Glaciofluvial	-	7.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	14	15.30	15.60	921.70	921.40	921.55	Glaciofluvial	-	5.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	15	16.20	16.50	920.80	920.50	920.65	Glaciofluvial	-	6.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	16	17.40	17.70	919.60	919.30	919.45	Glaciofluvial	-	12.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	17	18.30	18.60	918.70	918.40	918.55	Glaciofluvial	-	4.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	18	19.20	19.50	917.80	917.50	917.65	Glaciofluvial	-	13.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	19	20.40	20.70	916.60	916.30	916.45	Glaciofluvial	-	10.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	20	21.30	21.60	915.70	915.40	915.55	-	-	2.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	21	22.20	22.50	914.80	914.50	914.65	-	-	15.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	22	23.40	23.70	913.60	913.30	913.45	Glacial Till	-	5.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	23B	24.00	24.30	913.00	912.70	912.85	Glacial Till	-	7.6	SC/CL	24	15	9	-0.82	CL	-	-	-	-	-	-	-	16	41	43		-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	23	24.30	24.60	912.70	912.40	912.55	Glacial Till	-	6.4	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	24	25.20	25.50	911.80	911.50	911.65	Glacial Till	-	15.7	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	24B	25.50	25.80	911.50	911.20	911.35	-	-	-	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	12	40	48		-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	25	26.40	26.70	910.60	910.30	910.45	Bedrock	-	10.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	26	27.30	27.60	909.70	909.40	909.55	Bedrock	-	5.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	27	28.20	28.50	908.80	908.50	908.65	Bedrock	-	6.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	28	29.40	29.70	907.60	907.30	907.45	Bedrock	-	11.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	29	30.30	30.60	906.70	906.40	906.55	Bedrock	-	16.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	30	31.20	31.50	905.80	905.50	905.65	Bedrock	-	11.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	31	32.40	32.70	904.60	904.30	904.45	Bedrock	-	12.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	32	33.30	33.60	903.70	903.40	903.55	Bedrock	-	11.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	33	34.20	34.50	902.80	902.50	902.65	Bedrock	-	9.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	34	35.10	35.40	901.90	901.60	901.75	Bedrock	-	9.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	35	36.10	36.40	900.90	900.60	900.75	Bedrock	-	12.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	36	37.20	37.50	899.80	899.50	899.65	Bedrock	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	37	38.10	38.40	898.90	898.60	898.75	Bedrock	-	10.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	38	38.70	39.00	898.30	898.00	898.15	Bedrock	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	39	39.60	39.90	897.40	897.10	897.25	Bedrock	-	9.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	40	40.50	40.80	896.50	896.20	896.35	Bedrock	-	7.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	41	41.40	41.70	895.60	895.30	895.45	Bedrock	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	42	42.60	42.90	894.40	894.10	894.25	Bedrock	-	9.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	43	43.50	43.80	893.50	893.20	893.35	Bedrock	-	8.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	44	44.40	44.70	892.60	892.30	892.45	Bedrock	-	5.9	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	45	45.30	45.60	891.70	891.40	891.55	Bedrock	-	10.1	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	46	46.20	46.50	890.80	890.50	890.65	Bedrock	-	10.2	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	47	47.10	47.40	889.90	889.60	889.75	Bedrock	-	11.2	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	48	48.30	48.60	888.70	888.40	888.55	Bedrock	-	14.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	49	49.20	49.50	887.80	887.50	887.65	Bedrock	-	10.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-08	Perimeter Embankment Buttress	Grab	50	50.30	50.60	886.70	886.40	886.55	Bedrock	-	9.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	1	0.90	1.20	938.30	938.00	938.15	-	-	17.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	2	2.10	2.40	937.10	936.80	936.95	-	-	9.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	3	3.00	3.30	936.20	935.90	936.05	-	-	9.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	4B	3.90	4.20	935.30	935.00	935.15	-	-	10.2	CL	23	14	9	-0.42	CL	-	-	-	-	-	-	-	7	35	58		-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	4	4.20	4.50	935.00	934.70	934.85	-	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	5	5.40	5.70	933.80	933.50	933.65	-	-	14.8	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	5B	5.70	6.00	933.50	933.20	933.35	-	-	15.9	ML/SM	21	15	6	0.15	CL-ML	-	-	-	-	-	-	-	5	35	60		-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	6	6.30	6.60	932.90	932.60	932.75	-	-	13.0	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	7	7.20	7.50	932.00	931.70	931.85	-	-	8.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	8	8.40	8.70	930.80	930.50	930.65	-	-	9.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	9	9.30	9.60	929.90	929.60	929.75	-	-	11.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	10	10.20	10.50	929.00	928.70	928.85	-	-	5.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	11	11.10	11.40	928.10	927.80	927.95	-	-	17.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	12	12.30	12.60	926.90	926.60	926.75	-	-	5.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	13	13.20	13.50	926.00	925.70	925.85	-	-	3.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	14	14.40	14.70	924.80	924.50	924.65	-	-	10.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	15	15.30	15.60	923.90	923.60	923.75	-	-	4.6	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	16	16.20	16.50	923.00	922.70	922.85	-	-	4.1	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	17	17.40	17.70	921.80	921.50	921.65	-	-	8.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	18	18.60	18.90	920.60	920.30	920.45	-	-	7.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	19	19.50	19.80	919.70	919.40	919.55	-	-	4.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	20	20.40	20.70	918.80	918.50	918.65	-	-	4.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	21	21.30	21.60	917.90	917.60	917.75	-	-	5.8	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	22	22.50	22.80	916.70	916.40	916.55	-	-	5.2	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	23	23.40	23.70	915.80	915.50	915.65	Bedrock	-	20.2	CI/CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	100	24.00	24.30	915.20	914.90	915.05	Bedrock	-	18.0	CI/CH	38	16	22	0.09	CI	-	-	-	-	-	-	-	0	22	46	32	0.002	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	24	24.30	24.60	914.90	914.60	914.75	Bedrock	-	22.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	25	25.50	25.80	913.70	913.40	913.55	Bedrock	-	15.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	26	26.40	26.70	912.80	912.50	912.65	Bedrock	-	16.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	27	27.30	27.60	911.90	911.60	911.75	Bedrock	-	7.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	28	28.50	28.80	910.70	910.40	910.55	Bedrock	-	13.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	29	29.40	29.70	909.80	909.50	909.65	Bedrock	-	14.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	30	30.30	30.60	908.90	908.60	908.75	Bedrock	-	9.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	31	31.50	31.80	907.70	907.40	907.55	Bedrock	-	7.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	32	32.40	32.70	906.80	906.50	906.65	Bedrock	-	12.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	33	33.30	33.60	905.90	905.60	905.75	Bedrock	-	11.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	34	34.50	34.80	904.70	904.40	904.55	Bedrock	-	18.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	35	35.40	35.70	903.80	903.50	903.65	Weathered Bedrock	-	13.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	36	36.30	36.60	902.90	902.60	902.75	Weathered Bedrock	-	11.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	37	37.50	37.80	901.70	901.40	901.55	Weathered Bedrock	-	4.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	38	38.70	39.00	900.50	900.20	900.35	Weathered Bedrock	-	23.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	39	39.60	39.90	899.60	899.30	899.45	Weathered Bedrock	-	17.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-09	Perimeter Embankment Buttress	Grab	40	40.50	40.80	898.70	898.40	898.55	Weathered Bedrock	-	6.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	1	1.80	2.10	936.41	936.11	936.26	Glacial Till	-	13.8	CI/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	2	2.70	3.00	935.51	935.21	935.36	Glacial Till	-	13.0	CI/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	3	3.00	3.30	935.21	934.91	935.06	Glacial Till	-	11.9	CI/SC	26	15	11	-0.28	CL	-	-	-	-	-	-	-	14	38	48		-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	4	3.90	4.20	934.31	934.01	934.16	Glacial Till	-	9.7	CI/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	6	6.30	6.60	931.91	931.61	931.76	Glacial Till	-	9.5	CI/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	8	8.10	8.40	930.11	929.81	929.96	Glaciofluvial	-	13.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	9	9.30	9.60	928.91	928.61	928.76	Glaciofluvial	-	18.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	10	10.20	10.50	928.01	927.71	927.86	Glaciofluvial	-	16.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	10B	10.50	10.80	927.71	927.41	927.56	Glaciofluvial	-	18.3	ML			Non-Plastic		-	ML	-	-	-	-	-	-	0	11	85	4	0.002	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	11	11.10	11.40	927.11	926.81	926.96	Glaciofluvial	-	20.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	100	11.90	12.20	926.31	926.01	926.16	Glaciolacustrine[3]	-	18.6	ML	38	23	15	-0.29	CI	-	-	-	-	-	-	-	0	4	64	32	0.002	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	12	12.30	12.60	925.91	925.61	925.76	Glaciofluvial	-	24.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	13	13.20	13.50	925.01	924.71	924.86	Glaciofluvial	-	5.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	14	14.10	14.40	924.11	923.81	923.96	Glaciofluvial	-	3.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	15	15.00	15.30	923.21	922.91	923.06	Glaciofluvial	-	13.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	16	15.90	16.20	922.31	922.01	922.16	Glaciofluvial	-	7.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	17	17.10	17.40	921.11	920.81	920.96	Glacial Till	-	15.9	GC/SC	25	15	10	0.09	CL	-	-	-	-	-	-	-	39	35	26		-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	18	18.60	18.90	919.61	919.31	919.46	Glacial Till	-	10.1	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	19	19.50	19.80	918.71	918.41	918.56	Glacial Till	-	8.2	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2015	Golder	GA15-10	Main Embankment Buttress	Grab	20	20.10	20.40	918.11	917.81	917.96	Glacial Till	-	16.9	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	21	21.00	21.30	917.21	916.91	917.06	Glacial Till	-	10.2	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	22	22.20	22.50	916.01	915.71	915.86	Glacial Till	-	11.9	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	23	23.10	23.40	915.11	914.81	914.96	Glacial Till	-	20.1	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	24	24.00	24.30	914.21	913.91	914.06	Glacial Till	-	18.0	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	25	24.90	25.20	913.31	913.01	913.16	Glacial Till	-	13.5	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	26	26.10	26.40	912.11	911.81	911.96	Glacial Till	-	9.6	GC/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	27	27.30	27.60	910.91	910.61	910.76	Glacial Till	-	7.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	27B	27.60	27.90	910.61	910.31	910.46	Glacial Till	-	9.1	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	13	61	26		-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	28	28.50	28.80	909.71	909.41	909.56	Glacial Till	-	10.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	29	29.40	29.70	908.81	908.51	908.66	Glacial Till	-	17.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	30	30.60	30.90	907.61	907.31	907.46	Glacial Till	-	11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	31	31.50	31.80	906.71	906.41	906.56	Glacial Till	-	10.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	32	32.40	32.70	905.81	905.51	905.66	Weathered Bedrock	-	22.2	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	32B	33.30	33.60	904.91	904.61	904.76	Weathered Bedrock	-	14.6	CL-CI	26	15	11	-0.04	CL	-	-	-	-	-	-	-	16	34	50		-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	33	33.60	33.90	904.61	904.31	904.46	Weathered Bedrock	-	12.1	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	34	34.50	34.80	903.71	903.41	903.56	Weathered Bedrock	-	15.5	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	42B	42.60	42.90	895.61	895.31	895.46	Weathered Bedrock	-	11.3	CL-CI	31	16	15	-0.31	CI	-	-	-	-	-	-	-	19	25	56		-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	54B	54.90	55.20	883.31	883.01	883.16	Weathered Bedrock	-	10.9	SM/GM		Non-Plastic		-	ML	-	-	-	-	-	-	-	39	48	13		-	-
2015	Golder	GA15-10	Main Embankment Buttress	Grab	56B	57.30	57.60	880.91	880.61	880.76	Weathered Bedrock	-	10.1	ML/SM	23	16	7	-0.84	CL	-	-	-	-	-	-	-	28	35	37		-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	1	1.00	1.30	936.00	935.70	935.85	Glacial Till	-	12.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	2	2.00	2.30	935.00	934.70	934.85	Glacial Till	-	13.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	3	3.00	3.30	934.00	933.70	933.85	Glacial Till	-	13.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	3B	3.60	3.90	933.40	933.10	933.25	Glacial Till	-	11.6	CL/SC	25	13	12	-0.12	CL	-	-	-	-	-	-	-	25	30	45		-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	4	4.05	4.35	932.95	932.65	932.80	Glacial Till	-	11.5	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	5	5.00	5.30	932.00	931.70	931.85	Glacial Till	-	12.2	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	5B	5.70	6.00	931.30	931.00	931.15	Glacial Till	-	11.8	GC/CL	25	15	10	-0.32	CL	-	-	-	-	-	-	-	31	21	33	15	0.002	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	6	6.00	6.30	931.00	930.70	930.85	Glacial Till	-	14.8	GC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	7	7.00	7.30	930.00	929.70	929.85	Glaciofluvial	-	10.6	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	8	8.00	8.30	929.00	928.70	928.85	Glaciofluvial	-	12.3	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	9	9.00	9.30	928.00	927.70	927.85	Glaciofluvial	-	8.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	10	10.00	10.30	927.00	926.70	926.85	Glaciofluvial	-	12.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	11	11.10	11.40	925.90	925.60	925.75	Glaciofluvial	-	9.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	12	12.00	12.30	925.00	924.70	924.85	Glaciofluvial	-	11.7	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	13	13.00	13.30	924.00	923.70	923.85	Glaciofluvial	-	3.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	13B	13.30	13.60	923.70	923.40	923.55	Glaciofluvial	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	-	0	85	15		-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	14	14.10	14.40	922.90	922.60	922.75	Glaciofluvial	-	23.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	15	15.00	15.30	922.00	921.70	921.85	Glaciofluvial	-	21.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	16	15.60	15.90	921.40	921.10	921.25	Glaciolacustrine	-	22.8	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	17	16.30	16.60	920.70	920.40	920.55	Glaciolacustrine	-	24.8	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	17B	16.60	16.85	920.40	920.15	920.28	Glaciolacustrine	-	27.4	CL-ML	36	27	9	0.04	ML-OL	-	-	-	-	-	-	-	0	1	84	15	0.002	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	18	17.10	17.40	919.90	919.60	919.75	Glacial Till	-	18.1	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	19	17.80	18.10	919.20	918.90	919.05	Glacial Till	-	19.0	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	20	19.10	19.40	917.90	917.60	917.75	Glacial Till	-	4.5	SM/GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	21	20.20	20.50	916.80	916.50	916.65	Glacial Till	-	11.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	22	21.00	21.30	916.00	915.70	915.85	Glacial Till	-	7.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	23	22.10	22.40	914.90	914.60	914.75	Glacial Till	-	8.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	24	22.80	23.10	914.20	913.90	914.05	Glacial Till	-	5.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	25	23.20	23.50	913.80	913.50	913.65	Weathered Bedrock	-	12.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	26	24.20	24.50	912.80	912.50	912.65	Weathered Bedrock	-	12.1	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	27	25.20	25.50	911.80	911.50	911.65	Weathered Bedrock	-	13.5	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	27B	25.50	25.80	911.50	911.20	911.35	Weathered Bedrock	-	13.3	CL/SC	30	16	14	-0.19	CL/CI	-	-	-	-	-	-	-	14	27	59		-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	28	26.20	26.50	910.80	910.50	910.65	Weathered Bedrock	-	16.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	29	27.10	27.40	909.90	909.60	909.75	Weathered Bedrock	-	16.1	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	30	28.20	28.50	908.80	908.50	908.65	Weathered Bedrock	-	16.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	31	29.10	29.50	907.90	907.50	907.70	Weathered Bedrock	-	14.6	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	32	30.20	30.50	906.80	906.50	906.65	Weathered Bedrock	-	6.2	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	33	31.20	31.50	905.80	905.50	905.65	Weathered Bedrock	-	6.5	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	34	32.10	32.40	904.90	904.60	904.75	Weathered Bedrock	-	12.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	35	33.00	33.30	904.00	903.70	903.85	Weathered Bedrock	-	12.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	36	34.20	34.50	902.80	902.50	902.65	Weathered Bedrock	-	5.8	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	37	35.20	35.50	901.80	901.50	901.65	Weathered Bedrock	-	8.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	38	36.20	36.50	900.80	900.50	900.65	Weathered Bedrock	-	8.9	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	39	37.20	37.50	899.80	899.50	899.65	Weathered Bedrock	-	9.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	40	38.10	38.40	898.90	898.60	898.75	Weathered Bedrock	-	10.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	41	38.80	39.10	898.20	897.90	898.05	Weathered Bedrock	-	14.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	42	39.80	40.10	897.20	896.90	897.05	Weathered Bedrock	-	7.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	43	40.80	41.10	896.20	895.90	896.05	Weathered Bedrock	-	6.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	44	41.80	42.10	895.20	894.90	895.05	Weathered Bedrock	-	10.9	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	45	42.70	43.00	894.30	894.00	894.15	Weathered Bedrock	-	5.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	46	43.80	44.10	893.20	892.90	893.05	Weathered Bedrock	-	5.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	47	45.80	46.10	891.20	890.90	891.05	Weathered Bedrock	-	11.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	48	48.00	48.30	889.00	888.70	888.85	Weathered Bedrock	-	9.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	49	48.90	49.20	888.10	887.80	887.95	Weathered Bedrock	-	12.8	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	50	49.20	49.50	887.80	887.50	887.65	Weathered Bedrock	-	9.5	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	51	50.00	50.30	887.00	886.70	886.85	Weathered Bedrock	-	7.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	52	51.00	51.30	886.00	885.70	885.85	Weathered Bedrock	-	6.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-11	Main Embankment Buttress	Grab	53	52.10	52.40	884.90	884.60	884.75	Weathered Bedrock	-	7.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	1	1.80	2.10	926.30	926.00	926.15	Glacial Till	-	16.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	2	3.00	3.30	925.10	924.80	924.95	Glacial Till	-	11.5	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	3	4.20	4.50	923.90	923.60	923.75	Glacial Till	-	12.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	4	5.40	5.70	922.70	922.40	922.55	[1]	-	357.4	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	5	6.30	6.60	921.80	921.50	921.65	Glacial Till	-	15.0	SM/ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	26	27	47		-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	6	6.60	6.90	921.50	921.20	921.35	Glacial Till	-	11.9	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	7	7.20	7.50	920.90	920.60	920.75	Glacial Till	-	11.3	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	8	8.40	8.70	919.70	919.40	919.55	Glacial Till	-	14.3	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	9	9.30	9.60	918.80	918.50	918.65	Glacial Till	-	11.6	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	10	10.20	10.50	917.90	917.60	917.75	Glacial Till	-	11.2	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	11	11.40	11.70	916.70	916.40	916.55	Glaciofluvial	-	13.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	12	12.60	12.90	915.50	915.20	915.35	Glaciofluvial	-	20.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	13	13.50	13.80	914.60	914.30	914.45	Glaciofluvial	-	21.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	14	14.40	14.70	913.70	913.40	913.55	Glaciofluvial	-	20.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	15	15.30	15.60	912.80	912.50	912.65	Glaciofluvial	-	21.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	15B	15.60	15.90	912.50	912.20	912.35	Glaciofluvial	-	21.0	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	27	73		-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	16	16.20	16.50	911.90	911.60	911.75	Glaciofluvial	-	24.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	17	17.40	17.70	910.70	910.40	910.55	Glaciolacustrine	-	21.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	18	18.60	18.90	909.50	909.20	909.35	Glaciolacustrine	-	21.6	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	19	19.05	19.35	909.05	908.75	908.90	Glaciolacustrine	-	23.4	CL-CI	29	21	8	0.30	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	20	19.50	19.80	908.60	908.30	908.45	Glaciolacustrine	-	19.4	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	21	20.40	20.70	907.70	907.40	907.55	Glaciolacustrine	-	19.5	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	Run 8	20.60	20.85	907.50	907.25	907.38	Glaciolacustrine	-	18.8	CL-CI	31	17	14	0.13	CI	-	-	-	-	-	-	-	0	11	52	37	0.002	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	22	21.60	21.90	906.50	906.20	906.35	Glaciolacustrine	-	21.4	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	23	22.50	22.80	905.60	905.30	905.45	Glaciolacustrine	-	22.7	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	24	25.50	25.80	902.60	902.30	902.45	Glaciolacustrine	-	26.5	CL-CI	31	19	12	0.63	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	Run 10	26.50	26.60	901.60	901.50	901.55	Glaciolacustrine	-	32.7	CI	45	28	17	0.28	ML-OL	-	-	-	-	-	-	-	0	0	66	34	0.002	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	Run 10	26.60	28.70	901.50	899.40	900.45	Glaciolacustrine	-	24.9	CI	39	24	15	0.06	CI	-	-	-	-	-	-	-	0	2	76	22	0.002	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	25	26.70	27.00	901.40	901.10	901.25	Glaciolacustrine	-	31.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	27	28.50	28.80	899.60	899.30	899.45	Glaciolacustrine	-	28.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	28	29.40	29.70	898.70	898.40	898.55	Glaciolacustrine	-	28.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	29	30.60	30.90	897.50	897.20	897.35	Glaciolacustrine	-	30.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	100	30.90	31.10	897.20	897.00	897.10	Glaciofluvial	-	22.8	ML	30	23	7	-0.03	ML	-	-	-	-	-	-	-	0	11	71	18	0.002	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2015	Golder	GA15-12	Main Embankment Buttress	Grab	30	31.50	31.80	896.60	896.30	896.45	Glaciofluvial	-	29.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	31	32.70	33.00	895.40	895.10	895.25	Glaciofluvial	-	18.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	32	33.90	34.20	894.20	893.90	894.05	Glaciofluvial	-	17.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	32B	34.20	34.50	893.90	893.60	893.75	Glaciofluvial	-	15.1	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	33	34.80	35.10	893.30	893.00	893.15	Glaciofluvial	-	21.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	34	35.70	36.00	892.40	892.10	892.25	Glaciofluvial	-	17.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	35	36.90	37.20	891.20	890.90	891.05	Glaciofluvial	-	25.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	36	37.80	38.10	890.30	890.00	890.15	Glaciofluvial	-	14.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	37	38.70	39.00	889.40	889.10	889.25	Glaciofluvial	-	9.5	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	38	39.60	39.90	888.50	888.20	888.35	Glacial Till	-	17.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	39	40.50	40.80	887.60	887.30	887.45	Glacial Till	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	40	41.70	42.00	886.40	886.10	886.25	Weathered Bedrock	-	14.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	41	42.90	43.20	885.20	884.90	885.05	Weathered Bedrock	-	2.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	42	43.80	44.10	884.30	884.00	884.15	Weathered Bedrock	-	2.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	43	44.70	45.00	883.40	883.10	883.25	Weathered Bedrock	-	6.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	44	45.60	45.90	882.50	882.20	882.35	Weathered Bedrock	-	6.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	45	46.50	46.80	881.60	881.30	881.45	Weathered Bedrock	-	7.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	46	47.70	48.00	880.40	880.10	880.25	Weathered Bedrock	-	20.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	47	48.90	49.20	879.20	878.90	879.05	Weathered Bedrock	-	18.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12	Main Embankment Buttress	Grab	48	49.80	50.10	878.30	878.00	878.15	Weathered Bedrock	-	6.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-12B	Main Embankment Buttress	Grab	1	18.00	18.10	910.10	910.00	910.05	Glaciolacustrine	-	23.2	CL	27	18	9	0.58	CL	-	-	-	-	-	-	-	0	7	73	20	0.002	-
2015	Golder	GA15-12B	Main Embankment Buttress	Grab	2	21.50	22.10	906.60	906.00	906.30	Glaciolacustrine	2.71	19.9	CI	36	19	17	0.05	CI	-	-	-	-	-	-	-	0	7	54	39	0.002	DSS, CRS, Incremental Consolidation
2015	Golder	GA15-12B	Main Embankment Buttress	Grab	3	26.80	27.40	901.30	900.70	901.00	Glaciolacustrine	2.77	36.6	CI	47	25	22	0.53	CI	-	-	-	-	-	-	-	0	3	57	40	0.002	DSS, CRS
2015	Golder	GA15-13	Main Embankment Buttress	Grab	1	0.70	1.00	925.40	925.10	925.25	Glacial Till	-	17.4	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	2	1.70	2.00	924.40	924.10	924.25	Glacial Till	-	11.8	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	3	2.70	3.00	923.40	923.10	923.25	Glacial Till	-	14.0	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	3B	3.00	3.30	923.10	922.80	922.95	Glacial Till	-	14.3	CL-CI	30	14	16	0.02	CL/CI	-	-	-	-	-	-	-	15	31	54		-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	4	3.80	4.10	922.30	922.00	922.15	Glacial Till	-	14.0	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	5	5.20	5.50	920.90	920.60	920.75	Glaciolacustrine[1]	-	26.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	5B	5.70	6.00	920.40	920.10	920.25	Glaciolacustrine[1]	-	24.8	CI	37	16	21	0.42	CI	-	-	-	-	-	-	-	0	19	50	31	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	6	6.30	6.60	919.80	919.50	919.65	Glacial Till	-	20.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	7	7.20	7.50	918.90	918.60	918.75	Glacial Till	-	12.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	8	8.20	8.50	917.90	917.60	917.75	Glacial Till	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	9	9.20	9.50	916.90	916.60	916.75	Glacial Till	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	10	10.20	10.50	915.90	915.60	915.75	Glaciofluvial	-	17.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	10B	10.50	10.80	915.60	915.30	915.45	Glaciofluvial	-	16.1	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	60	40		-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	11	11.20	11.50	914.90	914.60	914.75	Glaciofluvial	-	22.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	12	12.20	12.50	913.90	913.60	913.75	Glaciofluvial	-	23.6	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	13	13.60	13.90	912.50	912.20	912.35	Glaciofluvial	-	19.5	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	100	14.60	14.90	911.50	911.20	911.35	Glaciofluvial	-	17.9	CL	28	20	8	-0.26	CL	-	-	-	-	-	-	-	0	5	76	19	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	14	14.80	15.10	911.30	911.00	911.15	Glaciofluvial	-	21.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	15	15.70	16.00	910.40	910.10	910.25	Glaciofluvial	-	19.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	15B	16.10	16.40	910.00	909.70	909.85	Glaciofluvial	-	17.4	CL	27	16	11	0.13	CL	-	-	-	-	-	-	-	0	6	82	12	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	16	16.80	17.10	909.30	909.00	909.15	Glaciofluvial	-	17.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	101	17.10	17.30	909.00	908.80	908.90	Glaciofluvial	-	12.7	ML	21	15	6	-0.38	CL-ML	-	-	-	-	-	-	-	0	21	60	19	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	17	18.20	18.50	907.90	907.60	907.75	Glaciofluvial	-	17.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	18	19.20	19.50	906.90	906.60	906.75	Glaciolacustrine	-	19.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	18B	19.50	19.80	906.60	906.30	906.45	Glaciolacustrine	-	18.8	ML	22	15	7	0.54	CL	-	-	-	-	-	-	-	0	19	70	11	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	19	20.20	20.50	905.90	905.60	905.75	Glaciolacustrine	-	20.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	20	21.20	21.50	904.90	904.60	904.75	Glaciolacustrine	-	29.5	CI-CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	20b	21.60	21.90	904.50	904.20	904.35	Glaciolacustrine	-	30.2	CI-CH	49	23	26	0.28	CI	-	-	-	-	-	-	-	0	0	60	40	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	21	22.30	22.60	903.80	903.50	903.65	Glaciolacustrine	-	25.4	CI-CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	22	23.30	23.60	902.80	902.50	902.65	-[1]	-	34.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	23	24.30	24.60	901.80	901.50	901.65	Glaciolacustrine	-	33.1	CI-CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	23b	24.60	24.90	901.50	901.20	901.35	Glaciolacustrine	-	31.4	CI-CH	48	22	26	0.36	CI	-	-	-	-	-	-	-	0	9	59	32	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	24	25.30	25.60	900.80	900.50	900.65	Glaciofluvial	-	20.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	102	26.20	26.40	899.90	899.70	899.80	Glaciolacustrine	-	13.3	CL	44	20	24	-0.28	CI	-	-	-	-	-	-	-	0	6	53	41	0.002	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	25	26.40	26.70	899.70	899.40	899.55	Glaciolacustrine	-	31.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	26	27.70	28.00	898.40	898.10	898.25	Glaciofluvial	-	19.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	26B	28.20	28.50	897.90	897.60	897.75	Glaciofluvial	-	19.2	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	70	30		-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	27	28.70	29.00	897.40	897.10	897.25	Glaciofluvial	-	20.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	28	29.70	30.00	896.40	896.10	896.25	Glaciofluvial	-	17.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	29	31.20	31.50	894.90	894.60	894.75	Glacial Till	-	9.1	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	30	32.20	32.50	893.90	893.60	893.75	Glacial Till	-	18.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	31	33.00	33.30	893.10	892.80	892.95	Glacial Till	-	18.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	32	34.00	34.30	892.10	891.80	891.95	Weathered Bedrock	-	6.2	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	33	35.00	35.30	891.10	890.80	890.95	Weathered Bedrock	-	6.8	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	34	35.70	36.00	890.40	890.10	890.25	Weathered Bedrock	-	12.7	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	35	36.70	37.00	889.40	889.10	889.25	Weathered Bedrock	-	12.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	36	37.70	38.00	888.40	888.10	888.25	Weathered Bedrock	-	11.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	37	38.70	39.00	887.40	887.10	887.25	Weathered Bedrock	-	16.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	38	39.70	40.00	886.40	886.10	886.25	Weathered Bedrock	-	11.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-13	Main Embankment Buttress	Grab	39	40.70	41.00	885.40	885.10	885.25	Weathered Bedrock	-	4.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	1	0.60	0.90	913.30	913.00	913.15	Glacial Till	-	14.7	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	2	1.60	1.90	912.30	912.00	912.15	Glacial Till	-	13.1	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	3	2.60	2.90	911.30	911.00	911.15	Glacial Till	-	12.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	3B	3.00	3.30	910.90	910.60	910.75	Glacial Till	-	12.0	CL/SC	23	14	9	-0.22	CL	-	-	-	-	-	-	-	-	12	37	51		-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	4	3.60	3.90	910.30	910.00	910.15	Glaciofluvial	-	13.2	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	5	4.60	4.90	909.30	909.00	909.15	Glaciofluvial	-	17.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	6	5.60	5.90	908.30	908.00	908.15	Glaciolacustrine	-	16.9	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	7	6.60	6.90	907.30	907.00	907.15	Glaciolacustrine	-	22.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	7B	6.90	7.20	907.00	906.70	906.85	Glaciolacustrine	-	22.9	CI	34	20	14	0.21	CI	-	-	-	-	-	-	-	0	1	75	24	0.002	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	8	7.90	8.20	906.00	905.70	905.85	Glaciolacustrine	-	33.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	9	8.70	9.00	905.20	904.90	905.05	Glaciolacustrine	-	31.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	9B	9.00	9.30	904.90	904.60	904.75	Glaciolacustrine	-	29.2	CI	39	20	19	0.48	CI	-	-	-	-	-	-	-	0	3	84	13	0.002	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	10	9.90	10.20	904.00	903.70	903.85	Glaciofluvial	-	30.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	10B	10.20	10.50	903.70	903.40	903.55	Glaciofluvial	-	24.6	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	0	99	1	0.002	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	11	10.90	11.20	903.00	902.70	902.85	Glaciofluvial	-	30.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	12	12.60	12.90	901.30	901.00	901.15	Glaciofluvial	-	17.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	13	14.00	14.30	899.90	899.60	899.75	Weathered Bedrock	-	8.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	14	15.00	15.30	898.90	898.60	898.75	Weathered Bedrock	-	8.4	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	15	16.10	16.40	897.80	897.50	897.65	Weathered Bedrock	-	2.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	16	17.10	17.40	896.80	896.50	896.65	Weathered Bedrock	-	14.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	17	18.10	18.40	895.80	895.50	895.65	Weathered Bedrock	-	8.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	18	19.10	19.40	894.80	894.50	894.65	Weathered Bedrock	-	8.9	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	19	20.10	20.40	893.80	893.50	893.65	Weathered Bedrock	-	11.6	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-14	Main Embankment Buttress	Grab	20	21.10	21.40	892.80	892.50	892.65	Weathered Bedrock	-	1.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	1	0.90	1.20	924.10	923.80	923.95	Fill	-	2.8	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	2	5.40	5.70	919.60	919.30	919.45	Fill	-	9.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	3	6.60	6.90	918.40	918.10	918.25	Fill	-	6.0	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	4	7.50	7.80	917.50	917.20	917.35	Fill	-	6.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	5	9.30	9.60	915.70	915.40	915.55	Fill	-	3.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	6	10.20	10.50	914.80	914.50	914.65	Fill	-	6.8	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	7	11.40	11.70	913.60	913.30	913.45	Fill	-	3.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	8	12.60	12.90	912.40	912.10	912.25	Fill	-	5.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	9	14.70	15.00	910.30	910.00	910.15	Glacial Till	-	21.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	9B	15.30	15.60	909.70	909.40	909.55	Glacial Till	-	16.0	CL	23	13	10	0.30	CL	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	10	15.90	16.20	909.10	908.80	908.95	Glacial Till	-	16.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	11	16.80	17.10	908.20	907.90	908.05	Glaciolacustrine	-	16.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	12	19.20	19.50	905.80	905.50	905.65	Glaciolacustrine	-	26.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	Run 7	19.70	19.80	905.30	905.20	905.25	Glaciolacustrine	-	29.9	CI	44	27	17	0.17	ML-OL	-	-	-	-	-	-	-	0	1	61	38	0.002	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m^3)	Optimum Water Content (%)	Maximum Dry Density (kg/m^3)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2015	Golder	GA15-15	Main Embankment Buttress	Grab	13	20.40	20.70	904.60	904.30	904.45	Glaciolacustrine	-	29.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	Run 8	21.50	21.60	903.50	903.40	903.45	Glaciofluvial	-	24.3	ML	27	25	2	-0.35	ML	-	-	-	-	-	-	-	2	0	90	8	0.002	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	14	21.60	21.90	903.40	903.10	903.25	Glaciolacustrine	-	30.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	14B	21.90	22.20	903.10	902.80	902.95	Glaciolacustrine	-	28.5	CI	42	19	23	0.41	CI	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	15	22.50	22.80	902.50	902.20	902.35	Glaciolacustrine	-	26.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	16	23.70	24.00	901.30	901.00	901.15	Glaciofluvial	-	26.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	17	24.60	24.90	900.40	900.10	900.25	Glaciofluvial	-	27.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	17B	24.90	25.20	900.10	899.80	899.95	Glaciofluvial	-	21.7	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	18	25.50	25.80	899.50	899.20	899.35	Glaciofluvial	-	23.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	19	26.70	27.00	898.30	898.00	898.15	Glaciofluvial	-	20.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	20	27.60	27.90	897.40	897.10	897.25	Glacial Till	-	10.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	21	28.50	28.80	896.50	896.20	896.35	Glacial Till	-	13.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	22	29.70	30.00	895.30	895.00	895.15	Glacial Till	-	12.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	23	30.60	30.90	894.40	894.10	894.25	Glacial Till	-	8.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	24	39.00	39.30	886.00	885.70	885.85	Weathered Bedrock	-	12.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	25	41.10	41.40	883.90	883.60	883.75	Weathered Bedrock	-	3.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	26	42.00	42.30	883.00	882.70	882.85	Weathered Bedrock	-	10.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	27	43.50	43.80	881.50	881.20	881.35	Weathered Bedrock	-	12.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	28	44.70	45.00	880.30	880.00	880.15	Weathered Bedrock	-	13.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	29	45.60	45.90	879.40	879.10	879.25	Weathered Bedrock	-	16.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15	Main Embankment Buttress	Grab	30	46.80	47.10	878.20	877.90	878.05	Weathered Bedrock	-	16.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-15B	Main Embankment Buttress	Thin-walled Piston Tube	1	17.02	17.45	907.98	907.55	907.77	Glaciolacustrine	-	24.4	CI	39	20	19	0.23	CI	-	-	-	-	-	-	-	0	1	69	30	0.002	DSS
2015	Golder	GA15-15B	Main Embankment Buttress	Thin-walled Piston Tube	1	17.02	17.45	907.98	907.55	907.77	Glaciolacustrine	-	27.4	CI	40	23	17	0.26	CI	-	-	-	-	-	-	-	1	0	67	32	0.002	Incremental Consolidation
2015	Golder	GA15-15B	Main Embankment Buttress	Thin-walled Piston Tube	2 (300 DSS)	18.54	18.92	906.46	906.08	906.27	Glaciolacustrine	-	28.8	CI	47	20	27	0.33	CI	-	-	-	-	-	-	-	0	1	56	43	0.002	DSS
2015	Golder	GA15-15B	Main Embankment Buttress	Thin-walled Piston Tube	2 (600 DSS)	18.54	18.92	906.46	906.08	906.27	Glaciolacustrine	-	26.6	CI	43	19	24	0.32	CI	-	-	-	-	-	-	-	0	1	56	43	0.002	DSS
2015	Golder	GA15-15B	Main Embankment Buttress	Thin-walled Piston Tube	2 (CRS)	18.54	18.92	906.46	906.08	906.27	Glaciolacustrine	-	27.0	CI	40	22	18	0.28	CI	-	-	-	-	-	-	-	0	2	60	38	0.002	CRS
2015	Golder	GA15-16	Main Embankment Buttress	Grab	1	0.90	1.20	911.60	911.30	911.45	Fill	-	11.5	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	2	2.30	2.60	910.20	909.90	910.05	Glaciofluvial	-	20.2	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	2B	2.70	3.00	909.80	909.50	909.65	[1]	-	17.0	CL-CI	30	17	13	0.00	CL/CI	-	-	-	-	-	-	-	7	21	72		-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	3	3.30	3.60	909.20	908.90	909.05	Glaciofluvial	-	12.2	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	4	4.30	4.60	908.20	907.90	908.05	Glaciofluvial	-	14.0	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	5	5.00	5.30	907.50	907.20	907.35	Glaciolacustrine	-	19.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	5B	5.30	5.70	907.20	906.80	907.00	Glaciolacustrine	-	24.3	CL	30	17	13	0.56	CL	-	-	-	-	-	-	-	0	10	58	32	0.002	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	6	6.00	6.30	906.50	906.20	906.35	Glaciolacustrine	-	24.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	7	6.90	7.20	905.60	905.30	905.45	Glaciolacustrine	-	29.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	7B	7.20	7.50	905.30	905.00	905.15	Glaciolacustrine	-	29.8	CI	40	22	18	0.43	CI	-	-	-	-	-	-	-	0	2	61	37	0.002	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	8	7.65	7.95	904.85	904.55	904.70	Glaciolacustrine	-	31.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	9	8.25	8.60	904.25	903.90	904.08	Glaciolacustrine	-	33.4	CI-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	9B	8.70	9.00	903.80	903.50	903.65	Glaciolacustrine	-	30.9	CI-ML	35	24	11	0.63	CI	-	-	-	-	-	-	-	0	0	79	21	0.002	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	10	9.00	9.30	903.50	903.20	903.35	Glaciolacustrine	-	29.4	CI-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	11	10.10	10.35	902.40	902.15	902.28	Glaciofluvial	-	29.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	11B	10.50	10.80	902.00	901.70	901.85	Glaciofluvial	-	27.8	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	0	95	5	0.002	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	12	11.30	11.60	901.20	900.90	901.05	Glaciofluvial	-	26.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	13	12.60	12.90	899.90	899.60	899.75	Glaciofluvial	-	24.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	14	13.60	13.90	898.90	898.60	898.75	Glaciofluvial	-	22.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	15	14.60	14.90	897.90	897.60	897.75	Glaciofluvial	-	21.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	16	15.60	15.90	896.90	896.60	896.75	Glacial Till	-	16.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	17	16.60	16.95	895.90	895.55	895.73	Glacial Till	-	15.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	18	17.30	17.60	895.20	894.90	895.05	Glacial Till	-	20.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	19	17.80	18.00	894.70	894.50	894.60	Glacial Till	-	7.1	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	20	19.10	19.30	893.40	893.20	893.30	Glacial Till	-	15.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	21	19.80	20.10	892.70	892.40	892.55	Glacial Till	-	8.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	22	20.40	20.70	892.10	891.80	891.95	Glacial Till	-	23.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	23	21.30	21.60	891.20	890.90	891.05	Glacial Till	-	16.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	24	21.90	22.20	890.60	890.30	890.45	Weathered Bedrock	-	8.9	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	25	23.15	23.45	889.35	889.05	889.20	Weathered Bedrock	-	8.3	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	26	24.20	24.50	888.30	888.00	888.15	Weathered Bedrock	-	8.6	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	27	25.25	25.60	887.25	886.90	887.08	Weathered Bedrock	-	8.6	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	28	26.20	26.50	886.30	886.00	886.15	Weathered Bedrock	-	9.3	SW/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	29	27.30	27.60	885.20	884.90	885.05	Weathered Bedrock	-	11.4	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	31	29.30	29.55	883.20	882.95	883.08	Weathered Bedrock	-	8.5	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	33	31.10	31.40	881.40	881.10	881.25	Weathered Bedrock	-	13.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	34	32.00	32.30	880.50	880.20	880.35	Weathered Bedrock	-	12.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	35	32.70	33.00	879.80	879.50	879.65	Weathered Bedrock	-	12.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	36	33.70	34.00	878.80	878.50	878.65	Weathered Bedrock	-	17.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	37	35.00	35.30	877.50	877.20	877.35	Weathered Bedrock	-	23.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	38	35.50	35.80	877.00	876.70	876.85	Weathered Bedrock	-	24.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	39	36.50	36.80	876.00	875.70	875.85	Weathered Bedrock	-	12.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-16	Main Embankment Buttress	Grab	40	38.10	38.40	874.40	874.10	874.25	Weathered Bedrock	-	16.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	1	6.30	6.60	912.75	912.45	912.60	Glacial Till	-	14.5	ML-SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	1B	6.60	6.90	912.45	912.15	912.30	Glaciofluvial	-	12.4	CL-CI	29	15	14	-0.19	CL	-	-	-	-	-	-	-	4	31	65		-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	2	7.30	7.60	911.75	911.45	911.60	Glaciofluvial	-	20.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	3	8.30	8.60	910.75	910.45	910.60	Glaciofluvial	-	20.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	3B	8.80	9.10	910.25	909.95	910.10	Glaciofluvial	-	14.6	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	71	29		-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	4	9.30	9.60	909.75	909.45	909.60	Glaciofluvial	-	19.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	5	10.60	10.90	908.45	908.15	908.30	Glaciolacustrine	-	31.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	6	11.60	11.90	907.45	907.15	907.30	Glaciolacustrine	-	30.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	100	12.40	12.60	906.65	906.45	906.55	Glaciolacustrine	-	25.6	CI	28	23	5	0.52	ML	-	-	-	-	-	-	-	0	1	92	7	0.002	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	7	12.70	13.00	906.35	906.05	906.20	Glaciofluvial	-	29.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	7B	13.00	13.30	906.05	905.75	905.90	Glaciofluvial	-	25.7	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	0	98	2	0.002	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	8	13.70	14.00	905.35	905.05	905.20	Glaciofluvial	-	28.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	9	14.70	15.00	904.35	904.05	904.20	Glaciofluvial / Till	-	28.0	ML/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	9B	15.15	15.45	903.90	903.60	903.75	Glacial Till	-	7.5	SM	18	15	3	-2.50	ML	-	-	-	-	-	-	-	27	42	31		-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	10	15.70	16.00	903.35	903.05	903.20	Glacial Till	-	8.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	11	16.70	17.00	902.35	902.05	902.20	Glaciofluvial	-	18.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	12	17.70	18.00	901.35	901.05	901.20	Glaciofluvial	-	17.3	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	13	18.70	19.00	900.35	900.05	900.20	Glacial Till	-	14.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	14	19.70	20.00	899.35	899.05	899.20	Glacial Till	-	15.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	15	20.70	21.00	898.35	898.05	898.20	Glacial Till	-	21.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	15B	21.00	21.30	898.05	897.75	897.90	Glacial Till	-	21.1	CL	28	21	7	0.01	CL	-	-	-	-	-	-	-	2	5	93		-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	16	21.70	22.00	897.35	897.05	897.20	Glacial Till	-	14.0	SW-GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	17	22.70	23.00	896.35	896.05	896.20	Weathered Bedrock	-	8.9	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	18	23.70	24.00	895.35	895.05	895.20	Weathered Bedrock	-	9.4	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	19	24.70	25.00	894.35	894.05	894.20	Weathered Bedrock	-	8.7	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	20	25.50	25.80	893.55	893.25	893.40	Weathered Bedrock	-	7.2	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-17	Main Embankment Buttress	Grab	21	26.60	26.90	892.45	892.15	892.30	Weathered Bedrock	-	16.8	SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	1	1.80	2.10	934.40	934.10	934.25	Glacial Till	-	16.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	2	2.80	3.10	933.40	933.10	933.25	Glaciofluvial	-	12.5	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	3B	3.60	3.80	932.60	932.40	932.50	Glaciofluvial	-	11.6	CL/SC	27	13	14	-0.10	CL	-	-	-	-	-	-	-	0	37	63		-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	3	3.80	4.10	932.40	932.10	932.25	Glaciofluvial	-	12.2	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	4	4.80	5.10	931.40	931.10	931.25	Glaciofluvial	-	13.6	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	5	5.80	6.10	930.40	930.10	930.25	Glaciofluvial	-	14.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	6B	6.50	6.80	929.70	929.40	929.55	Glaciofluvial	-	13.5	CL/SC	28	14	14	-0.04	CL	-	-	-	-	-	-	-	4	35	61		-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	6	6.80	7.10	929.40	929.10	929.25	Glaciofluvial	-	13.3	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	100	7.30	7.50	928.90	928.70	928.80	Glaciofluvial	-	9.5	CL	25	14	11	-0.41	CL	-	-	-	-	-	-	-	0	30	49	21	0.002	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	7	7.90	8.20	928.30	928.00	928.15	Glacial Till	-	14.2	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	8	8.80	9.10	927.40	927.10	927.25	Glacial Till	-	11.4	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	8b	9.10	9.40	927.10	926.80	926.95	Glacial Till	-	10.7	SC/CL	21	12	9	-0.14	CL	-	-	-	-	-	-	-	5	47	48		-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	9	9.80	10.10	926.40	926.10	926.25	Glacial Till	-	11.0	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	10	10.80	11.10	925.40	925.10	925.25	Glacial Till	-	10.5	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	11	11.80	12.10	924.40	924.10	924.25	Glacial Till	-	9.4	SC/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2015	Golder	GA15-18	Main Embankment Buttress	Grab	12	12.90	13.20	923.30	923.00	923.15	Weathered Bedrock	-	18.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	13	13.80	13.90	922.40	922.30	922.35	Weathered Bedrock	-	14.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	14	14.40	14.70	921.80	921.50	921.65	Weathered Bedrock	-	14.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	15	15.50	15.80	920.70	920.40	920.55	Weathered Bedrock	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	16	16.40	16.70	919.80	919.50	919.65	Weathered Bedrock	-	13.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-18	Main Embankment Buttress	Grab	17	17.40	17.70	918.80	918.50	918.65	Weathered Bedrock	-	6.2	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-19	South Embankment	Grab	1	2.50	2.80	945.10	944.80	944.95	Glacial Till	-	16.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-19	South Embankment	Grab	1B	3.00	3.30	944.60	944.30	944.45	Glacial Till	-	13.6	CL	26	14	12	-0.03	CL	-	-	-	-	-	-	-	3	35	62		-	-
2015	Golder	GA15-19	South Embankment	Grab	2	3.50	3.80	944.10	943.80	943.95	Glacial Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-19	South Embankment	Grab	3	4.50	4.80	943.10	942.80	942.95	Glacial Till	-	11.3	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-19	South Embankment	Grab	3B	5.10	5.40	942.50	942.20	942.35	Glacial Till	-	12.3	SM/ML	21	14	7	-0.24	CL-ML	-	-	-	-	-	-	-	8	43	49		-	-
2015	Golder	GA15-19	South Embankment	Grab	4	5.50	5.80	942.10	941.80	941.95	Glacial Till	-	11.2	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-19	South Embankment	Grab	5	6.80	7.10	940.80	940.50	940.65	Weathered Bedrock	-	8.0	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-19	South Embankment	Grab	6	7.80	8.10	939.80	939.50	939.65	Weathered Bedrock	-	6.6	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-20	South Embankment	Grab	1	1.50	1.80	942.54	942.24	942.39	Glacial Till	-	14.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-20	South Embankment	Grab	1B	1.80	2.10	942.24	941.94	942.09	Glacial Till	-	17.4	CL	28	15	13	0.18	CL	-	-	-	-	-	-	-	1	19	80		-	-
2015	Golder	GA15-20	South Embankment	Grab	2	2.50	2.80	941.54	941.24	941.39	Glacial Till	-	12.2	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-20	South Embankment	Grab	2b	3.00	3.30	941.04	940.74	940.89	Glacial Till	-	11.9	CL/SC	26	14	12	-0.18	CL	-	-	-	-	-	-	-	12	39	49		-	-
2015	Golder	GA15-20	South Embankment	Grab	3	3.70	4.00	940.34	940.04	940.19	Glacial Till	-	15.0	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-20	South Embankment	Grab	4	4.60	4.90	939.44	939.14	939.29	Glacial Till	-	12.8	CL/SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-20	South Embankment	Grab	4b	4.90	4.95	939.14	939.09	939.12	Glacial Till	-	13.5	CL/SC	27	14	13	-0.04	CL	-	-	-	-	-	-	-	11	44	45		-	-
2015	Golder	GA15-20	South Embankment	Grab	5	6.10	6.40	937.94	937.64	937.79	Weathered Bedrock	-	4.6	CL/SC/GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	1	5.18	5.48	907.32	907.02	907.17	Glaciolacustrine	-	30.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	2	5.48	6.10	907.02	906.40	906.71	Glaciolacustrine	-	28.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	2	5.48	6.10	907.02	906.40	906.71	Glaciolacustrine	-	42.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	3	6.10	6.70	906.40	905.80	906.10	Glaciolacustrine	-	31.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	3	6.10	6.70	906.40	905.80	906.10	Glaciolacustrine	-	25.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	5 (CRS)	7.39		905.11		905.11	Glaciolacustrine	2.76	39.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	0	1	77	22	0.002	CRS
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	5 (2000 kPa)	7.48		905.02		905.02	Glaciolacustrine	2.72	26.4	CI	34	19	15	0.49	CI	-	-	-	-	-	-	-	0	0	83	17	0.002	DSS
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	5 (800 kPa)	7.53		904.97		904.97	Glaciolacustrine	2.65	30.9	CI	47	22	25	0.36	CI	-	-	-	-	-	-	-	0	0	68	32	0.002	DSS
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	5 (400 kPa)	7.62		904.88		904.88	Glaciolacustrine	2.80	22.1	CI	39	19	20	0.16	CI	-	-	-	-	-	-	-	0	1	86	13	0.002	DSS
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	6	7.90	8.50	904.60	904.00	904.30	Glaciolacustrine	-	31.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	6	7.90	8.50	904.60	904.00	904.30	Glaciolacustrine	-	30.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	Golder	GA15-21	Main Embankment Buttress	Thin-walled Piston Tube	9 (CIU)	9.75	10.36	902.75	902.14	902.45	Glaciofluvial	2.78	27.1	ML	24	21	3	2.03	ML	-	-	-	-	-	-	-	0	27	64	9	0.002	TXCU
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	1	9.14	9.30	928.06	927.90	927.98	Till Like	-	13.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	2	9.75	9.91	927.45	927.29	927.37	Till Like	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	3	10.52	10.67	926.68	926.53	926.61	Till Like	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	4	11.20	11.35	926.00	925.85	925.93	Till Like	-	9.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	5	11.89	12.04	925.31	925.16	925.24	Till Like	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	6	12.57	12.73	924.63	924.47	924.55	Till Like	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	7	13.26	13.41	923.94	923.79	923.87	Till Like	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	8	13.94	14.10	923.26	923.10	923.18	Till Like	-	13.0	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	9	14.78	14.94	922.42	922.26	922.34	-	-	13.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	10	15.47	15.62	921.73	921.58	921.66	-	-	18.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	11	16.15	16.31	921.05	920.89	920.97	Till Like	-	12.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	12	16.84	16.99	920.36	920.21	920.29	Till Like	-	12.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	13	17.53	17.68	919.67	919.52	919.60	Till Like	-	22.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	14	18.14	18.29	919.06	918.91	918.99	Till Like	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	15	18.90	19.05	918.30	918.15	918.23	Weathered Bedrock	-	13.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	16	19.58	19.74	917.62	917.46	917.54	Weathered Bedrock	-	10.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	17	20.27	20.42	916.93	916.78	916.86	Weathered Bedrock	-	15.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-01	Corner 1 Embankment Buttress	Grab	18	20.96	21.11	916.24	916.09	916.17	Weathered Bedrock	-	7.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	1	3.05	3.20	929.95	929.80	929.88	-	-	40.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	2	3.73	3.89	929.27	929.11	929.19	-	-	19.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	3	4.27	4.42	928.73	928.58	928.66	-	-	12.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	4	4.95	5.11	928.05	927.89	927.97	Till Like	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	5	5.64	5.79	927.36	927.21	927.29	Till Like	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	6	6.32	6.48	926.68	926.52	926.60	-	-	11.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	7	7.01	7.16	925.99	925.84	925.92	Till Like	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	8	7.70	7.85	925.30	925.15	925.23	Till Like	-	13.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	9	8.46	8.61	924.54	924.39	924.47	Till Like	-	9.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	10	9.07	9.14	923.93	923.86	923.90	-	-	8.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	11	9.69	9.83	923.31	923.17	923.24	-	-	10.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	12	10.36	10.52	922.64	922.48	922.56	-	-	8.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	13	11.05	11.20	921.95	921.80	921.88	-	-	9.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	14	11.73	11.89	921.27	921.11	921.19	-	-	9.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	15	12.42	12.57	920.58	920.43	920.51	-	-	10.1	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	16	13.11	13.26	919.89	919.74	919.82	-	-	15.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	17	13.79	13.94	919.21	919.06	919.14	-	-	21.5	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	18	14.48	14.63	918.52	918.37	918.45	-	-	12.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	19	15.24	15.39	917.76	917.61	917.69	Till Like	-	15.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	20	15.93	16.08	917.07	916.92	917.00	Lower Glaciolacustrine[2]	-	22.9	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	21	16.61	16.76	916.39	916.24	916.32	Lower Glaciolacustrine[2]	-	23.1	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	22	17.30	17.45	915.70	915.55	915.63	Lower Glaciolacustrine[2]	-	22.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	23	17.98	18.14	915.02	914.86	914.94	Lower Glaciolacustrine[2]	-	23.1	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	24	18.67	18.82	914.33	914.18	914.26	Lower Glaciolacustrine[2]	-	29.4	CL-ML	25	20	5	1.88	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	25	19.35	19.51	913.65	913.49	913.57	-	-	18.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	26	20.27	20.42	912.73	912.58	912.66	-	-	21.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	27	21.11	21.26	911.89	911.74	911.82	-	-	16.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	28	21.49	21.64	911.51	911.36	911.44	-	-	24.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	29	22.17	22.33	910.83	910.67	910.75	-	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	30	22.86	23.01	910.14	909.99	910.07	-	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-02	Corner 1 Embankment Buttress	Grab	31	23.55	23.70	909.45	909.30	909.38	Weathered Bedrock	-	6.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	1	3.66	3.81	928.34	928.19	928.27	Till Like	-	22.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	2	4.27	4.42	927.73	927.58	927.66	Till Like	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	3	4.88	5.03	927.12	926.97	927.05	Till Like	-	9.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	4	5.49	5.64	926.51	926.36	926.44	Till Like	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	5	6.10	6.25	925.90	925.75	925.83	Till Like	-	13.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	6	6.71	6.86	925.29	925.14	925.22	Till Like	-	11.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	7	7.32	7.47	924.68	924.53	924.61	Till Like	-	12.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	8	7.92	8.08	924.08	923.92	924.00	Till Like	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	9	8.53	8.69	923.47	923.31	923.39	Till Like	-	9.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	10	9.14	9.30	922.86	922.70	922.78	Till Like	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	11	9.75	9.91	922.25	922.09	922.17	Till Like	-	11.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	12	10.36	10.52	921.64	921.48	921.56	Till Like	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	13	10.97	11.13	921.03	920.87	920.95	Till Like	-	8.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	14	11.58	11.73	920.42	920.27	920.35	Till Like	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	15	12.19	12.34	919.81	919.66	919.74	Till Like	-	11.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	16	12.80	12.95	919.20	919.05	919.13	Till Like	-	17.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	17	13.41	13.56	918.59	918.44	918.52	Till Like	-	12.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	18	14.02	14.17	917.98	917.83	917.91	-	-	16.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	19	14.63	14.78	917.37	917.22	917.30	Till Like	-	10.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	20	15.85	16.00	916.15	916.00	916.08	Till Like	-	11.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	21	16.46	16.61	915.54	915.39	915.47	Till Like	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	22	17.07	17.22	914.93	914.78	914.86	Till Like	-	9.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	23	17.68	17.83	914.32	914.17	914.25	Till Like	-	8.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	24	18.29	18.44	913.71	913.56	913.64	Till Like	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	25	18.90	19.05	913.10	912.95	913.03	Till Like	-	8.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	26	19.51	19.66	912.49	912.34	912.42	Till Like	-	6.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	27	20.12	20.27	911.88	911.73	911.81	Till Like	-	7.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	28	20.73	20.88	911.27	911.12	911.20	Till Like	-	10.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m^3)	Optimum Water Content (%)	Maximum Dry Density (kg/m^3)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	29	21.34	21.49	910.66	910.51	910.59	Till Like	-	10.3	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	30	21.95	22.10	910.05	909.90	909.98	Till Like	-	21.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	31	22.56	22.71	909.44	909.29	909.37	Till Like	-	8.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-03	Corner 1 Embankment Buttress	Grab	32	23.16	23.32	908.84	908.68	908.76	Weathered Bedrock	-	8.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	1	0.61	0.76	931.99	931.84	931.92	Fill	-	4.2	SP-GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	2	2.13	2.29	930.47	930.31	930.39	Fill	-	4.8	SP-GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	3	4.88	5.03	927.72	927.57	927.65	Till Like	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	4	5.64	5.79	926.96	926.81	926.89	Till Like	-	11.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	5	6.55	6.71	926.05	925.89	925.97	Till Like	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	6	7.16	7.32	925.44	925.28	925.36	Till Like	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	7	7.77	7.92	924.83	924.68	924.76	Till Like	-	12.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	8	8.38	8.53	924.22	924.07	924.15	-[1]	-	3.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	9	8.99	9.14	923.61	923.46	923.54	Upper Glaciolacustrine[2]	-	10.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	10	9.60	9.75	923.00	922.85	922.93	Upper Glaciolacustrine[2]	-	18.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	11	10.21	10.36	922.39	922.24	922.32	Upper Glaciolacustrine[2]	-	15.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Thin-walled Piston Tube	12B	10.62	10.92	921.98	921.68	921.83	Upper Glaciolacustrine[2]	-	11.1	CH	25	13	12	-0.16	CL	-	-	-	-	-	-	-	17.4	32.6	29.0	21.0	0.002	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Thin-walled Piston Tube	12	10.70	11.00	921.90	921.60	921.75	Upper Glaciolacustrine[2]	-	31.6	CH	57	28	29	0.12	CH	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	13	11.43	11.58	921.17	921.02	921.10	Upper Glaciolacustrine[2]	-	17.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	14	12.04	12.19	920.56	920.41	920.49	Upper Glaciolacustrine[2]	-	9.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	15	12.80	12.95	919.80	919.65	919.73	-	-	13.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	16	13.49	13.64	919.11	918.96	919.04	-	-	13.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	17	14.17	14.33	918.43	918.27	918.35	-	-	12.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	18	14.86	15.01	917.74	917.59	917.67	-	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	19	15.54	15.70	917.06	916.90	916.98	-	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	20	16.23	16.38	916.37	916.22	916.30	-	-	11.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	21	16.92	17.07	915.68	915.53	915.61	-	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	22	18.44	18.59	914.16	914.01	914.09	Till Like	-	9.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	23	19.13	19.28	913.47	913.32	913.40	Till Like	-	12.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	24	19.81	19.96	912.79	912.64	912.72	Till Like	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	25	20.50	20.65	912.10	911.95	912.03	Till Like	-	9.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	26	21.34	21.49	911.26	911.11	911.19	Lower Glaciolacustrine[2]	-	23.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	26B	21.49	22.02	911.11	910.58	910.85	Lower Glaciolacustrine[2]	-	23.3	CL	51	23	28	0.01	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	27	22.02	22.17	910.58	910.43	910.51	Lower Glaciolacustrine[2]	-	15.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	28	22.71	22.86	909.89	909.74	909.82	Till Like	-	16.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	29	23.39	23.55	909.21	909.05	909.13	Till Like	-	15.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	30	24.08	24.23	908.52	908.37	908.45	Till Like	-	12.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	31	24.77	24.92	907.83	907.68	907.76	Till Like	-	14.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	32	25.45	25.60	907.15	907.00	907.08	Till Like	-	12.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	33	26.14	26.29	906.46	906.31	906.39	Till Like	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	34	26.82	26.97	905.78	905.63	905.71	Till Like	-	10.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	35	27.51	27.66	905.09	904.94	905.02	Till Like	-	19.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	36	28.19	28.35	904.41	904.25	904.33	-	-	8.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	37	28.88	29.03	903.72	903.57	903.65	-	-	10.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	38	29.57	29.72	903.03	902.88	902.96	-	-	11.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	39	30.25	30.40	902.35	902.20	902.28	-	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	40	31.09	31.24	901.51	901.36	901.44	-	-	14.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	41	31.78	31.93	900.82	900.67	900.75	-	-	6.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	42	32.46	32.61	900.14	899.99	900.07	-	-	6.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	43	33.15	33.30	899.45	899.30	899.38	-	-	9.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	44	33.83	33.99	898.77	898.61	898.69	-	-	16.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	45	34.52	34.67	898.08	897.93	898.01	-	-	5.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	46	35.20	35.36	897.40	897.24	897.32	-	-	12.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	47	35.89	36.04	896.71	896.56	896.64	-	-	5.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	48	36.58	36.73	896.02	895.87	895.95	-	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	49	37.26	37.41	895.34	895.19	895.27	-	-	9.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	50	37.95	38.10	894.65	894.50	894.58	-	-	11.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	51	38.63	38.79	893.97	893.81	893.89	-	-	5.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	52	39.32	39.47	893.28	893.13	893.21	-	-	7.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	53	40.01	40.16	892.59	892.44	892.52	Weathered Bedrock	-	15.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-04	Corner 1 Embankment Buttress	Grab	54	40.54	40.69	892.06	891.91	891.99	Weathered Bedrock	-	2.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	1	0.30	0.46	925.10	924.94	925.02	Till Like	-	11.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	2	0.91	1.07	924.49	924.33	924.41	Till Like	-	9.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	3	1.52	1.68	923.88	923.72	923.80	Till Like	-	10.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	4	2.13	2.29	923.27	923.11	923.19	Till Like	-	10.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	5	2.74	2.90	922.66	922.50	922.58	Till Like	-	11.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	6	3.35	3.51	922.05	921.89	921.97	Upper Glaciolacustrine[2]	-	13.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Thin-walled Piston Tube	7	3.80	4.10	921.60	921.30	921.45	Upper Glaciolacustrine[2]	-	16.3	CL	37	15	22	0.06	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Thin-walled Piston Tube	7B	3.80	4.10	921.60	921.30	921.45	Upper Glaciolacustrine[2]	-	13.6	CL	26	13	13	0.05	CL	-	-	-	-	-	-	-	23.0	28.9	27.1	21.0	0.002	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	8	4.57	4.72	920.83	920.68	920.76	Upper Glaciolacustrine[2]	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	9	5.18	5.33	920.22	920.07	920.15	Upper Glaciolacustrine[2]	-	21.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	10	5.79	5.94	919.61	919.46	919.54	Till Like	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	11	6.40	6.55	919.00	918.85	918.93	Till Like	-	5.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	12	7.01	7.16	918.39	918.24	918.32	Till Like	-	10.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	13	7.62	7.77	917.78	917.63	917.71	Till Like	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-05	Corner 1 Embankment Buttress	Grab	14	8.23	8.38	917.17	917.02	917.10	Weathered Bedrock	-	8.5	CL-CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	1	9.14	9.30	927.36	927.20	927.28	-	-	8.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	2	9.75	9.91	926.75	926.59	926.67	-	-	10.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	3	10.36	10.52	926.14	925.98	926.06	-	-	13.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	4	10.97	11.13	925.53	925.37	925.45	-	-	11.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	5	11.58	11.73	924.92	924.77	924.85	-	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	6	12.19	12.34	924.31	924.16	924.24	-	-	10.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	7	12.80	12.95	923.70	923.55	923.63	Till Like	-	9.1	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	8	13.41	13.56	923.09	922.94	923.02	Till Like	-	9.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	9	14.02	14.17	922.48	922.33	922.41	Till Like	-	12.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	10	14.63	14.78	921.87	921.72	921.80	Till Like	-	12.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	11	15.24	15.39	921.26	921.11	921.19	Till Like	-	13.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	12	15.85	16.00	920.65	920.50	920.58	Till Like	-	9.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	13	16.46	16.61	920.04	919.89	919.97	-	-	16.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	14	17.07	17.22	919.43	919.28	919.36	Till Like	-	20.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	15	17.68	17.83	918.82	918.67	918.75	Till Like	-	11.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	16	18.29	18.44	918.21	918.06	918.14	Till Like	-	8.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	17	18.90	19.05	917.60	917.45	917.53	Till Like	-	10.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	18	19.51	19.66	916.99	916.84	916.92	Till Like	-	9.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	19	20.12	20.27	916.38	916.23	916.31	Till Like	-	10.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	20	20.73	20.88	915.77	915.62	915.70	-	-	19.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	21	21.34	21.49	915.16	915.01	915.09	-	-	11.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	22	21.95	22.10	914.55	914.40	914.48	Till Like	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-06	Corner 1 Embankment Buttress	Grab	23	22.56	22.71	913.94	913.79	913.87	Weathered Bedrock	-	8.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	1	4.11	4.27	928.19	928.03	928.11	Till Like	-	14.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	2	4.80	4.95	927.50	927.35	927.43	Till Like	-	13.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	3	5.49	5.64	926.81	926.66	926.74	Till Like	-	14.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	4	6.17	6.32	926.13	925.98	926.06	Till Like	-	13.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	5	6.86	7.01	925.44	925.29	925.37	Till Like	-	14.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	6	7.54	7.70	924.76	924.60	924.68	Till Like	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Thin-walled Piston Tube	8	8.70	9.00	923.60	923.30	923.45	Upper Glaciolacustrine[2]	-	32.4	CL	39	22	17	0.61	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	9	9.60	9.75	922.70	922.55	922.63	-	-	13.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	10	10.29	10.44	922.01	921.86	921.94	-	-	17.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	11	10.97	11.13	921.33	921.17	921.25	-	-	13.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	12	11.66	11.81	920.64	920.49	920.57	-	-	13.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m^3)	Optimum Water Content (%)	Maximum Dry Density (kg/m^3)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	13	12.34	12.50	919.96	919.80	919.88	-	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	14	13.03	13.18	919.27	919.12	919.20	-	-	12.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	15	13.72	13.87	918.58	918.43	918.51	-	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	16	14.40	14.55	917.90	917.75	917.83	-	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	17	15.09	15.24	917.21	917.06	917.14	-	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	18	15.77	15.93	916.53	916.37	916.45	-	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	19	16.46	16.61	915.84	915.69	915.77	-	-	10.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	20	17.15	17.30	915.15	915.00	915.08	-	-	9.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	21	17.83	17.98	914.47	914.32	914.40	-	-	13.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	22	18.52	18.67	913.78	913.63	913.71	-	-	15.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	23	19.20	19.35	913.10	912.95	913.03	-	-	8.2	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	24	19.89	20.04	912.41	912.26	912.34	-	-	8.0	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	25	20.57	20.73	911.73	911.57	911.65	-	-	8.6	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	26	21.26	21.34	911.04	910.96	911.00	-	-	7.3	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-07	Corner 1 Embankment Buttress	Grab	27	21.49	21.64	910.81	910.66	910.74	Weathered Bedrock	-	18.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	1	0.30	0.46	924.00	923.84	923.92	Till Like	-	15.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	2	0.91	1.07	923.39	923.23	923.31	Till Like	-	12.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	3	1.52	1.68	922.78	922.62	922.70	Till Like	-	13.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	4	2.13	2.29	922.17	922.01	922.09	Till Like	-	10.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	5	2.74	2.90	921.56	921.40	921.48	Till Like	-	11.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	6	3.35	3.96	920.95	920.34	920.65	Upper Glaciolacustrine[2]	-	19.3	CL	41	18	23	0.06	CI	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	7	3.96	4.11	920.34	920.19	920.27	Upper Glaciolacustrine[2]	-	23.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	8	4.57	4.72	919.73	919.58	919.66	Till Like	-	12.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	9	5.18	5.33	919.12	918.97	919.05	Till Like	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	10	5.79	5.94	918.51	918.36	918.44	Till Like	-	11.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	11	6.40	6.55	917.90	917.75	917.83	Till Like	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	12	7.01	7.16	917.29	917.14	917.22	Till Like	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	13	7.62	7.77	916.68	916.53	916.61	Till Like	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	14	8.23	8.38	916.07	915.92	916.00	Till Like	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	15	8.84	8.99	915.46	915.31	915.39	Till Like	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	16	9.45	9.60	914.85	914.70	914.78	Till Like	-	9.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	17	10.06	10.21	914.24	914.09	914.17	Till Like	-	9.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	18	10.67	10.82	913.63	913.48	913.56	Till Like	-	7.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	19	11.28	11.43	913.02	912.87	912.95	Till Like	-	8.2	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	20	11.89	12.04	912.41	912.26	912.34	Till Like	-	9.7	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	21	12.50	12.65	911.80	911.65	911.73	Till Like	-	11.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	22	13.11	13.26	911.19	911.04	911.12	Till Like	-	9.3	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	23	13.72	13.87	910.58	910.43	910.51	Till Like	-	9.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	24	14.33	14.48	909.97	909.82	909.90	Till Like	-	6.9	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	25	14.94	15.09	909.36	909.21	909.29	Till Like	-	9.1	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	26	15.54	15.70	908.76	908.60	908.68	Weathered Bedrock	-	6.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	27	16.15	16.31	908.15	907.99	908.07	Weathered Bedrock	-	6.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	28	16.76	16.92	907.54	907.38	907.46	Weathered Bedrock	-	6.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	29	17.37	17.53	906.93	906.77	906.85	Weathered Bedrock	-	8.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-08	Corner 1 Embankment Buttress	Grab	30	17.98	18.14	906.32	906.16	906.24	Weathered Bedrock	-	6.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	1	0.30	0.46	923.60	923.44	923.52	Till Like	-	14.8	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	2	0.91	1.07	922.99	922.83	922.91	Till Like	-	11.3	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	3	1.52	1.68	922.38	922.22	922.30	Till Like	-	12.8	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	4	2.13	2.29	921.77	921.61	921.69	Till Like	-	13.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	5	2.74	2.90	921.16	921.00	921.08	-[1]	-	25.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Thin-walled Piston Tube	6	3.35	4.00	920.55	919.90	920.23	Upper Glaciolacustrine[2]	-	30.6	CL	33	19	14	0.83	CI	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Thin-walled Piston Tube	6B	3.35	4.00	920.55	919.90	920.23	Upper Glaciolacustrine[2]	2.75	23.1	CL	36	15	21	0.39	CI	-	-	-	-	-	-	-	5.0	22.5	35.5	37.0	0.002	CRS
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	7	4.10	4.40	919.80	919.50	919.65	Upper Glaciolacustrine[2]	-	29.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	8	4.57	4.72	919.33	919.18	919.26	Upper Glaciolacustrine[2]	-	34.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	9	5.18	5.33	918.72	918.57	918.65	Till Like	-	12.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	10	5.79	5.94	918.11	917.96	918.04	Till Like	-	9.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	11	6.40	6.55	917.50	917.35	917.43	Till Like	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	12	7.01	7.16	916.89	916.74	916.82	Till Like	-	8.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	13	7.62	7.77	916.28	916.13	916.21	Till Like	-	5.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	14	8.23	8.38	915.67	915.52	915.60	Till Like	-	8.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	15	8.84	8.99	915.06	914.91	914.99	Till Like	-	7.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	16	9.45	9.60	914.45	914.30	914.38	Till Like	-	12.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	17	10.06	10.21	913.84	913.69	913.77	Till Like	-	11.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	18	10.67	10.82	913.23	913.08	913.16	Till Like	-	9.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	19	11.28	11.43	912.62	912.47	912.55	Till Like	-	6.7	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	20	11.89	12.04	912.01	911.86	911.94	Till Like	-	6.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	21	12.50	12.65	911.40	911.25	911.33	Till Like	-	5.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	22	13.11	13.26	910.79	910.64	910.72	Till Like	-	7.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	23	13.72	13.87	910.18	910.03	910.11	Till Like	-	9.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	24	14.33	14.48	909.57	909.42	909.50	Till Like	-	4.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	25	14.94	15.09	908.96	908.81	908.89	Till Like	-	5.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	26	15.54	15.70	908.36	908.20	908.28	Till Like	-	5.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	27	16.15	16.31	907.75	907.59	907.67	Till Like	-	6.2	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	28	16.76	16.92	907.14	906.98	907.06	Till Like	-	6.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	29	17.37	17.53	906.53	906.37	906.45	-	-	9.3	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	30	17.98	18.14	905.92	905.76	905.84	-	-	8.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	31	18.59	18.75	905.31	905.15	905.23	-	-	10.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	32	19.20	19.35	904.70	904.55	904.63	-	-	9.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	33	19.81	19.96	904.09	903.94	904.02	-	-	6.1	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	34	20.42	20.57	903.48	903.33	903.41	-	-	6.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	35	21.03	21.18	902.87	902.72	902.80	-	-	7.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-09	Corner 1 Embankment Buttress	Grab	36	21.64	21.79	902.26	902.11	902.19	-	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	1	3.05	3.20	943.95	943.80	943.88	Till Like	-	18.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	2	3.66	3.81	943.34	943.19	943.27	Till Like	-	12.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	3	4.27	4.42	942.73	942.58	942.66	Till Like	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	4	4.88	5.03	942.12	941.97	942.05	Till Like	-	11.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	5	5.49	5.64	941.51	941.36	941.44	Till Like	-	14.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	6	6.10	6.25	940.90	940.75	940.83	Till Like	-	10.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	7	6.71	6.86	940.29	940.14	940.22	Till Like	-	11.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	8	7.32	7.47	939.68	939.53	939.61	Till Like	-	13.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	9	7.92	8.08	939.08	938.92	939.00	Till Like	-	11.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-15	South Embankment	Grab	10	8.53	8.69	938.47	938.31	938.39	Till Like	-	19.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	1	0.61	0.76	944.19	944.04	944.12	Till Like	-	14.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	2	1.22	1.37	943.58	943.43	943.51	Till Like	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	3	1.83	1.98	942.97	942.82	942.90	Till Like	-	11.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	4	2.44	2.59	942.36	942.21	942.29	Till Like	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	5	3.05	3.20	941.75	941.60	941.68	Till Like	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	6	3.66	3.81	941.14	940.99	941.07	Till Like	-	13.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	7	4.27	4.42	940.53	940.38	940.46	Till Like	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	8	4.88	5.03	939.92	939.77	939.85	Till Like	-	17.5	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	9	5.49	5.64	939.31	939.16	939.24	Till Like	-	18.9	CL-ML	23	15	8	0.49	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	10	6.10	6.25	938.70	938.55	938.63	Till Like	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-16	South Embankment	Grab	11	6.71	6.86	938.09	937.94	938.02	Till Like	-	15.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	1	0.91	1.07	943.49	943.33	943.41	Till Like	-	8.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	2	1.52	1.68	942.88	942.72	942.80	Till Like	-	11.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	3	2.13	2.29	942.27	942.11	942.19	Till Like	-	12.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	4	2.74	2.90	941.66	941.50	941.58	Till Like	-	16.0	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	5	3.35	3.51	941.05	940.89	940.97	Till Like	-	12.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	6	3.96	4.11	940.44	940.29	940.37	Till Like	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	7	4.57	4.72	939.83	939.68	939.76	Till Like	-	14.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m^3)	Optimum Water Content (%)	Maximum Dry Density (kg/m^3)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2016	Golder	GA16-17	South Embankment	Grab	8	5.18	5.33	939.22	939.07	939.15	Till Like	-	12.7	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	9	5.79	5.94	938.61	938.46	938.54	Till Like	-	12.1	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	10	6.40	6.55	938.00	937.85	937.93	Till Like	-	14.5	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	11	7.01	7.16	937.39	937.24	937.32	Till Like	-	13.0	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	12	7.62	7.77	936.78	936.63	936.71	Till Like	-	15.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	13	8.23	8.38	936.17	936.02	936.10	Till Like	-	13.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	14	8.84	8.99	935.56	935.41	935.49	Till Like	-	15.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	15	9.45	9.60	934.95	934.80	934.88	Till Like	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	16	10.06	10.21	934.34	934.19	934.27	Till Like	-	8.1	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	17	10.67	10.82	933.73	933.58	933.66	Till Like	-	11.4	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-17	South Embankment	Grab	18	11.28	11.43	933.12	932.97	933.05	Glaciolacustrine[2]	-	19.8	ML-SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	1	0.30	0.46	944.90	944.74	944.82	-	-	21.0	OH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	2	0.91	1.07	944.29	944.13	944.21	Till Like	-	11.4	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	3	1.52	1.68	943.68	943.52	943.60	Till Like	-	14.1	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	4	2.13	2.29	943.07	942.91	942.99	Till Like	-	12.3	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	5	2.74	2.90	942.46	942.30	942.38	Till Like	-	12.6	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	6	3.35	3.51	941.85	941.69	941.77	Till Like	-	19.9	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	7	3.96	4.11	941.24	941.09	941.17	Till Like	-	13.5	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	8	4.57	4.72	940.63	940.48	940.56	Till Like	-	10.1	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	9	5.18	5.33	940.02	939.87	939.95	Till Like	-	12.2	SP-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	10	5.79	5.94	939.41	939.26	939.34	Till Like	-	12.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	11	6.40	6.55	938.80	938.65	938.73	Till Like	-	12.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	12	7.01	7.16	938.19	938.04	938.12	Till Like	-	7.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	13	7.62	7.77	937.58	937.43	937.51	Till Like	-	6.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	14	8.23	8.38	936.97	936.82	936.90	Till Like	-	8.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	15	8.84	8.99	936.36	936.21	936.29	Till Like	-	11.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Golder	GA16-19	South Embankment	Grab	16	9.14	9.45	936.06	935.75	935.91	Glaciolacustrine[2]	-	15.6	ML	26	19	7	-0.49	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	1	0.39		940.41		940.41	Fill	-	12.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	2	0.82		939.98		939.98	Fill	-	16.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	3	1.26		939.54		939.54	Fill	-	10.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	4	1.69		939.11		939.11	Fill	-	13.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	5	2.13		938.67		938.67	Fill	-	9.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	6	2.56		938.24		938.24	Fill	-	15.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	7	3.00		937.80		937.80	Fill	-	15.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	8	3.44		937.36		937.36	Fill	-	18.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	9	3.87		936.93		936.93	Fill	-	9.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	10	4.31		936.49		936.49	Fill	-	6.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	11	4.74		936.06		936.06	Fill	-	9.7	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	12	5.18		935.62		935.62	Fill	-	8.7	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	13	5.61		935.19		935.19	Fill	-	10.7	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	14	6.05		934.75		934.75	Fill	-	7.7	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	15	6.56		934.24		934.24	Fill	-	9.2	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	16	7.07		933.73		933.73	Fill	-	7.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	17	7.58		933.23		933.23	Fill	-	4.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	18	8.08		932.72		932.72	Fill	-	7.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	19	8.59		932.21		932.21	Fill	-	6.7	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	20	9.10		931.70		931.70	Fill	-	7.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	21	9.61		931.19		931.19	Fill	-	7.2	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	22	10.12		930.68		930.68	Fill	-	9.1	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	23	10.63		930.18		930.18	Fill	-	11.1	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	24	11.13		929.67		929.67	-	-	16.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	25	11.64		929.16		929.16	-	-	15.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	26	12.15		928.65		928.65	-	-	14.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	27	12.91		927.89		927.89	-	-	11.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	28	13.68		927.13		927.13	-	-	9.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	29	14.44		926.36		926.36	-	-	11.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	30	15.00		925.80		925.80	-	-	11.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	31	15.50		925.30		925.30	-	-	13.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	32	16.00		924.80		924.80	-	-	12.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	33	16.50		924.30		924.30	-	-	10.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	34	17.00		923.80		923.80	-	-	20.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	35	17.50		923.30		923.30	-	-	22.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	36	18.00		922.80		922.80	-	-	19.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	37	18.50		922.30		922.30	-	-	14.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	38	19.00		921.80		921.80	-	-	16.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	39	19.50		921.30		921.30	-	-	16.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	40	20.00		920.80		920.80	-	-	11.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	41	20.50		920.30		920.30	-	-	11.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	42	21.00		919.80		919.80	-	-	10.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	43	21.50		919.30		919.30	-	-	12.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	44	22.00		918.80		918.80	-	-	-	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	45	22.50		918.30		918.30	-	-	17.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	46	23.00		917.80		917.80	Weathered Bedrock	-	12.3	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	47	23.50		917.30		917.30	Weathered Bedrock	-	15.4	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	48	24.00		916.80		916.80	Weathered Bedrock	-	11.9	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	49	24.50		916.30		916.30	Weathered Bedrock	-	13.6	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	50	25.00		915.80		915.80	Weathered Bedrock	-	16.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	51	25.50		915.30		915.30	Inferred Bedrock	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	52	26.00		914.80		914.80	Inferred Bedrock	-	15.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	53	26.50		914.30		914.30	Inferred Bedrock	-	13.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	54	27.00		913.80		913.80	Inferred Bedrock	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	55	27.50		913.30		913.30	Inferred Bedrock	-	12.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	56	28.00		912.80		912.80	Inferred Bedrock	-	8.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-01	Corner 1 Embankment Buttress	Grab	57	28.50		912.30		912.30	Inferred Bedrock	-	16.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	1	0.50		940.13		940.13	Fill	-	9.6	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	2	1.00		939.63		939.63	Fill	-	10.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	3	1.50		939.13		939.13	Fill	-	8.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	4	2.00		938.63		938.63	Fill	-	9.1	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	5	2.50		938.13		938.13	Fill	-	5.1	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	6	3.00		937.63		937.63	Till Like	-	3.8	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	7	3.50		937.13		937.13	Till Like	-	17.7	MH/CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	8	4.00		936.63		936.63	Till Like	-	12.3	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	9	4.50		936.13		936.13	-	-	11.6	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	10	5.00		935.63		935.63	-	-	11.8	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	11	5.50		935.13		935.13	-	-	13.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	12	5.90		934.73		934.73	Upper Glaciolacustrine[1]	-	13.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	31	6.10		934.53		934.53	Upper Glaciolacustrine[1]	-	20.1	CI	34	19	15	0.07	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	13	6.50		934.13		934.13	Upper Glaciolacustrine[1]	-	18.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	14	7.00		933.63		933.63	Upper Glaciolacustrine[1]	-	18.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	15	7.50		933.13		933.13	-	-	17.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	16	8.00		932.63		932.63	-	-	24.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	17	8.50		932.13		932.13	-	-	15.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	18	9.00		931.63		931.63	-	-	11.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	19	9.50		931.13		931.13	Till Like	-	13.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	20	10.00		930.63		930.63	Till Like	-	11.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	21	10.50		930.13		930.13	Till Like	-	8.8	CI/SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	22	11.00		929.63		929.63	Till Like	-	9.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	23	11.50		929.13		929.13	Till Like	-	4.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	24	11.94		928.69		928.69	Weathered Bedrock	-	5.7	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	25	12.19		928.44		928.44	-	-	10.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	26	13.00		927.63		927.63	Weathered Bedrock	-	2.2	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	27	13.50		927.13		927.13	Weathered Bedrock	-	2.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	28	14.27		926.36		926.36	-	-	17.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	29	14.65		925.98		925.98	Weathered Bedrock	-	3.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-03	Corner 1 Embankment Buttress	Grab	30	15.00		925.63		925.63	Weathered Bedrock	-	3.2	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	1	0.49		940.68		940.68	Fill	-	19.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	2	1.01		940.16		940.16	Fill	-	20.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	3	1.49		939.68		939.68	Fill	-	17.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	4	1.98		939.19		939.19	Fill	-	9.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	5	2.50		938.67		938.67	Fill	-	7.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	6	2.99		938.18		938.18	Fill	-	15.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	7	3.51		937.66		937.66	Fill	-	14.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	8	3.99		937.18		937.18	Fill	-	8.8	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	9	6.49		934.68		934.68	Fill	-	6.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	10	7.01		934.16		934.16	Fill	-	6.2	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	11	7.50		933.67		933.67	Fill	-	3.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	12	9.69		931.48		931.48	Fill	-	7.8	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	13	10.00		931.17		931.17	Fill	-	5.1	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	14	10.49		930.68		930.68	Fill	-	5.4	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	15	11.00		930.17		930.17	Fill	-	6.8	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	16	11.49		929.68		929.68	Fill	-	6.2	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	17	12.01		929.16		929.16	Fill	-	6.7	GM/GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	18	12.50		928.67		928.67	-	-	6.9	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	19	14.63		926.54		926.54	-	-	14.4	GP/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	20	15.00		926.17		926.17	-	-	-	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	21	15.37		925.80		925.80	-	-	16.6	SC/CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	22	18.50		922.67		922.67	-	-	11.2	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	23	18.99		922.18		922.18	-	-	11.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	24	20.48		920.69		920.69	-	-	15.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	25	21.00		920.17		920.17	-	-	20.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	26	21.01		920.16		920.16	-	-	19.3	CL	24	14	10	0.53	CL	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	27	21.49		919.68		919.68	-	-	17.1	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	28	22.01		919.16		919.16	-	-	13.4	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	29	22.49		918.68		918.68	Till Like	-	20.2	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	30	22.98		918.19		918.19	Till Like	-	9.5	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	31	23.50		917.67		917.67	-	-	23.5	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04A	Corner 1 Embankment Buttress	Grab	32	23.99		917.18		917.18	-	-	26.5	SM/ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	1	12.68		928.27		928.27	Topsoil	-	207.1	OL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	2	13.20		927.75		927.75	-	-	44.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	3	13.69		927.26		927.26	Till Like	-	11.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	4	14.20		926.75		926.75	Till Like	-	10.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	5	14.69		926.26		926.26	Till Like	-	9.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	6	15.18		925.77		925.77	Till Like	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	7	15.70		925.25		925.25	-	-	10.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	8	16.18		924.77		924.77	-	-	10.0	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	9	16.70		924.25		924.25	-	-	11.3	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	10	17.19		923.76		923.76	-	-	10.8	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	11	17.68		923.27		923.27	-	-	11.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	12	18.20		922.75		922.75	-	-	11.9	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	13	18.79		922.16		922.16	Upper Glaciolacustrine[2]	-	32.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	20	18.87		922.09		922.09	Upper Glaciolacustrine[2]	-	36.6	CI	47	17	30	0.65	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	14	19.25		921.70		921.70	Upper Glaciolacustrine[1]	-	34.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	19	19.40		921.55		921.55	Upper Glaciolacustrine[2]	-	36.7	CH	41	19	22	0.80	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	15	19.66		921.29		921.29	Upper Glaciolacustrine[2]	-	18.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	16	19.91		921.04		921.04	Upper Glaciolacustrine[1]	-	36.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	17	20.47		920.48		920.48	-	-	14.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	21	20.68		920.28		920.28	Upper Glaciolacustrine[2]	-	19.9	CI	31	15	16	0.31	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	18	20.87		920.08		920.08	-	-	20.2	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	22	21.82		919.13		919.13	Till Like	-	10.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	23	22.34		918.61		918.61	Till Like	-	8.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	24	22.83		918.12		918.12	Till Like	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	25	23.35		917.60		917.60	-	-	11.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	26	23.84		917.11		917.11	-	-	20.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	27	24.32		916.63		916.63	Till Like	-	24.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	28	24.84		916.11		916.11	Till Like	-	13.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	29	25.33		915.62		915.62	Till Like	-	16.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	30	25.85		915.10		915.10	Weathered Bedrock	-	14.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	31	26.33		914.62		914.62	Weathered Bedrock	-	10.0	GP-GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	32	26.82		914.13		914.13	Weathered Bedrock	-	13.4	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	33	27.34		913.61		913.61	Weathered Bedrock	-	7.0	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	34	27.83		913.12		913.12	Weathered Bedrock	-	4.9	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	35	28.32		912.63		912.63	Weathered Bedrock	-	5.7	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	36	28.83		912.12		912.12	Weathered Bedrock	-	9.7	CI/GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	37	29.32		911.63		911.63	Weathered Bedrock	-	8.0	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	Golder	GA18-04B	Corner 1 Embankment Buttress	Grab	38	29.72		911.23		911.23	Weathered Bedrock	-	4.5	GP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	1	1.22		930.70		930.70	Basal Till	-	12.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	1	1.52	1.83	930.40	930.09	930.25	Basal Till	-	-	SC	-	-	-	-	-	-	-	-	-	-	-	-	14.1	40.3	31.8	13.8	0.002	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	2	1.83		930.09		930.09	Basal Till	-	11.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	3	2.13		929.79		929.79	Basal Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	4	2.74		929.18		929.18	Basal Till	-	9.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	5	3.35		928.57		928.57	Basal Till	-	10.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	6	3.96		927.96		927.96	Basal Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	2	3.96	4.27	927.96	927.65	927.81	Basal Till	-	-	SC	-	-	-	-	-	-	-	-	-	-	-	-	15.1	40.2	31.0	13.7	0.002	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	7	4.57		927.35		927.35	Basal Till	-	12.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	8	5.18		926.74		926.74	Basal Till	-	10.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	9	5.79		926.13		926.13	Basal Till	-	9.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	10	6.40		925.52		925.52	Basal Till	-	7.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	11	7.01		924.91		924.91	Basal Till	-	8.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	12	7.62		924.30		924.30	Basal Till	-	8.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	13	8.23		923.69		923.69	Basal Till	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	14	8.84		923.08		923.08	Basal Till	-	8.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	15	9.45		922.47		922.47	Basal Till	-	8.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	16	10.06		921.86		921.86	Basal Till	-	7.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	17	10.67		921.25		921.25	Basal Till	-	8.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	18	11.28		920.64		920.64	Basal Till	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	19	11.89		920.03		920.03	Basal Till	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	20	12.50		919.42		919.42	Basal Till	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	21	13.11		918.81		918.81	Basal Till	-	7.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	22	13.72		918.20		918.20	Basal Till	-	7.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	23	14.33		917.59		917.59	Basal Till	-	7.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	24	14.94		916.98		916.98	Basal Till	-	8.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	25	15.54		916.38		916.38	Basal Till	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	6	15.85	16.15	916.07	915.77	915.92	Basal Till	-	8.9	CL	22	11	11	-0.19	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	26	16.15		915.77		915.77	Basal Till	-	8.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	27	16.76		915.16		915.16	Basal Till	-	8.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	28	17.37		914.55		914.55	Basal Till	-	8.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	29	17.98		913.94		913.94	Basal Till	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	30	18.59		913.33		913.33	Basal Till	-	7.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	31	19.20		912.72		912.72	Basal Till	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	8	19.39	19.69	912.53	912.23	912.38	Glaciolacustrine	-	17.0	CL	27	17	10	0.00	CL	-	-	-	-	-	-	-	-	-	-	0.3	8.1	91.6	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	32	19.51		912.41		912.41	Glaciolacustrine	-	17.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	33	19.81		912.11		912.11	Basal Till	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	34	20.42		911.50		911.50	Basal Till	-	17.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	10	20.51	21.18	911.41	910.74	911.08	Glaciolacustrine[2]	-	22.0	CI	33	21	12	0.08	CI	-	-	-	-	-	-	-	0	2.8	97.2		-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	35	21.03		910.89		910.89	-	-	21.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	36	21.64		910.28		910.28	Glaciofluvial	-	13.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	37	22.25		909.67		909.67	Glaciofluvial	-	15.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	38	22.86		909.06		909.06	Basal Till	-	10.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	39	23.47		908.45		908.45	Glaciofluvial	-	10.8	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	13	23.77	24.08	908.15	907.84	908.00	Glaciofluvial	-	-	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	40.0	49.0	11.0		-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	40	24.08		907.84		907.84	Glaciofluvial	-	11.3	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	41	24.69		907.23		907.23	Glaciofluvial	-	10.9	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	42	25.30		906.62		906.62	Glaciofluvial	-	11.7	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	43	25.91		906.01		906.01	Glaciofluvial	-	18.6	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	44	26.52		905.40		905.40	Glaciofluvial	-	17.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	45	27.13		904.79		904.79	Glaciofluvial	-	17.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	46	27.74		904.18		904.18	Basal Till	-	10.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	47	28.35		903.57		903.57	Basal Till	-	9.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	48	28.96		902.96		902.96	-	-	17.2	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	49	29.57		902.35		902.35	-	-	12.5	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	50	30.18		901.74		901.74	Basal Till	-	7.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	51	30.78		901.14		901.14	Basal Till	-	6.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	52	31.39		900.53		900.53	Basal Till	-	6.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	53	32.00		899.92		899.92	Basal Till	-	6.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	54	32.61		899.31		899.31	Basal Till	-	5.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	55	33.22		898.70		898.70	Basal Till	-	4.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	56	33.83		898.09		898.09	Basal Till	-	10.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	57	34.44		897.48		897.48	Basal Till	-	10.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	18	34.75	35.36	897.17	896.56	896.87	Basal Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	-	8.6	50.9	32.8	7.7	0.002	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	58	35.05		896.87		896.87	Basal Till	-	9.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	59	35.66		896.26		896.26	Basal Till	-	6.9	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	60	36.27		895.65		895.65	Basal Till	-	7.2	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	61	36.88		895.04		895.04	Basal Till	-	4.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	62	37.49		894.43		894.43	Basal Till	-	7.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	63	38.10		893.82		893.82	Basal Till	-	4.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	64	38.71		893.21		893.21	Basal Till	-	4.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	65	39.32		892.60		892.60	Basal Till	-	5.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	66	39.93		891.99		891.99	Glaciofluvial	-	7.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	67	40.54		891.38		891.38	Glaciofluvial	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	68	41.15		890.77		890.77	Basal Till	-	7.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	69	41.76		890.16		890.16	-	-	13.4	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	70	42.37		889.55		889.55	-	-	16.7	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	22	42.37	42.67	889.55	889.25	889.40	-	-	16.9	CL/CI	30	17	13	-0.01	CL/CI	-	-	-	-	-	-	-	1.2	7.7	91.1		-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	71	42.98		888.94		888.94	-	-	10.9	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	72	43.59		888.33		888.33	-	-	15.3	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	73	44.20		887.72		887.72	-	-	16.4	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	74	44.81		887.11		887.11	Glaciofluvial	-	19.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	75	45.42		886.50		886.50	Glaciofluvial	-	16.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	76	46.02		885.90		885.90	Glaciofluvial	-	18.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	77	46.63		885.29		885.29	Basal Till	-	12.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Grab	25	46.94	47.24	884.98	884.68	884.83	Basal Till	-	12.7	CL	26	16	10	-0.33	CL	-	-	-	-	-	-	-	0.6	14.1	85.3		-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	78	47.24		884.68		884.68	Basal Till	-	13.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	79	47.85		884.07		884.07	Basal Till	-	9.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	80	48.46		883.46		883.46	Bedrock	-	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	81	49.07		882.85		882.85	Bedrock	-	4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	82	49.68		882.24		882.24	Bedrock	-	3.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-01	Perimeter Embankment Buttress	Chunk	83	50.29		881.63		881.63	Bedrock	-	3.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	1	1.22		928.89		928.89	Basal Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	2	1.83		928.28		928.28	Basal Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	1	1.98	2.29	928.13	927.82	927.98	-	-	16.4	CL	26	14	12	0.20	CL	-	-	-	-	-	-	-	6.0	30.1	63.9		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	3	2.13		927.98		927.98	-	-	15.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Thin-walled Open Tube	TO5	2.13	3.66	927.98	926.45	927.22	Basal Till	-	-	SC	-	-	-	-	-	2151	2365	-	-	-	-	-	11.6	39.3	35.7	13.4	0.002	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	4	2.74		927.37		927.37	Basal Till	-	11.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	5	3.35		926.76		926.76	Basal Till	-	10.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	6	3.96		926.15		926.15	Glaciofluvial	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	7	4.57		925.54		925.54	Glaciofluvial	-	5.3	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	8	5.18		924.93		924.93	-	-	3.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	3	5.49	5.79	924.62	924.32	924.47	-	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	-	22.7	43.2	27.7	6.4	0.002	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	9	5.79		924.32		924.32	-	-	3.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	10	6.40		923.71		923.71	-	-	5.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	11	7.01		923.10		923.10	-	-	5.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	4	7.32	7.62	922.79	922.49	922.64	-	-	5.5	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	30.6	69.4		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	12	7.62		922.49		922.49	-	-	5.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	13	8.23		921.88		921.88	-	-	25.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	14	8.84		921.27		921.27	-	-	5.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	15	9.45		920.66		920.66	-	-	5.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	16	10.06		920.05		920.05	-	-	4.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	17	10.67		919.44		919.44	-	-	9.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	18	11.28		918.83		918.83	-	-	21.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	19	11.89		918.22		918.22	-	-	6.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	20	12.50		917.61		917.61	-	-	4.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	21	13.11		917.00		917.00	-	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	22	13.72		916.39		916.39	-	-	15.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	23	14.33		915.78		915.78	-	-	19.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	24	14.94		915.17		915.17	-	-	22.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	25	15.54		914.57		914.57	-	-	17.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	26	16.15		913.96		913.96	-	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	9	16.15	16.46	913.96	913.65	913.81	Glaciolacustrine	-	19.0	CL	27	17	10	0.20	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	27	16.76		913.35		913.35	Glaciolacustrine	-	16.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	28	17.37		912.74		912.74	Glaciofluvial	-	19.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	29	17.98		912.13		912.13	Glaciofluvial	-	14.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	30	18.59		911.52		911.52	Glaciofluvial	-	14.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	31	19.20		910.91		910.91	Glaciofluvial	-	15.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	11	19.51	19.81	910.60	910.30	910.45	-	-	17.7	CL	27	18	9	-0.03	CL	-	-	-	-	-	-	-	0	5.6	94.4		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	32	19.81		910.30		910.30	-	-	18.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	33	20.42		909.69		909.69	Glaciofluvial	-	15.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	34	21.03		909.08		909.08	Glaciofluvial	-	14.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	35	21.64		908.47		908.47	-	-	16.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	36	22.25		907.86		907.86	-	-	13.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	37	22.86		907.25		907.25	Glaciofluvial	-	23.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	38	23.47		906.64		906.64	Glaciofluvial	-	19.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	39	24.08		906.03		906.03	Glaciofluvial	-	23.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	40	24.69		905.42		905.42	Glaciofluvial	-	21.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	41	25.30		904.81		904.81	Glaciofluvial	-	20.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	42	25.91		904.20		904.20	Glaciofluvial	-	15.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Thin-walled Open Tube	TO3	26.21	27.13	903.90	902.98	903.44	Glaciofluvial	-	-	ML	-	-	-	-	-	1826	2262	-	-	-	-	-	0.2	35.3	58.4	6.1	0.002	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	43	26.52		903.59		903.59	Glaciofluvial	-	19.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	44	27.13		902.98		902.98	Glaciofluvial	-	21.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	15	27.31	27.40	902.80	902.71	902.76	Glaciolacustrine	-	33.9	CI	40	23	17	0.64	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	45	27.37		902.74		902.74	Glaciolacustrine	-	34.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	46	27.74		902.37		902.37	Glaciofluvial	-	23.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	47	28.35		901.76		901.76	Glaciofluvial	-	24.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	48	28.96		901.15		901.15	Glaciofluvial	-	22.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	17	29.44	29.54	900.67	900.57	900.62	Glaciolacustrine	-	36.8	CI	34	22	12	1.23	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	49	29.50		900.61		900.61	Glaciolacustrine	-	36.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	50	29.57		900.54		900.54	Glaciofluvial	-	33.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	51	30.18		899.93		899.93	Glaciofluvial	-	25.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	52	30.78		899.33		899.33	Glaciofluvial	-	22.6	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	53	31.39		898.72		898.72	Glaciofluvial	-	22.7	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	54	32.00		898.11		898.11	Glaciofluvial	-	20.2	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	55	32.61		897.50		897.50	Glaciofluvial	-	8.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	56	33.22		896.89		896.89	Glaciofluvial	-	9.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	19	33.22	33.53	896.89	896.58	896.74	Glaciofluvial	-	-	SP	-	-	-	-	-	-	-	-	-	-	-	34.3	61.6	4.1		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	57	33.83		896.28		896.28	Glaciofluvial	-	13.4	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	58	34.44		895.67		895.67	Glaciofluvial	-	11.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	59	35.05		895.06		895.06	Glaciofluvial	-	11.1	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	60	35.66		894.45		894.45	Glaciofluvial	-	9.1	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	61	36.27		893.84		893.84	Glaciofluvial	-	5.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	62	36.88		893.23		893.23	Glaciofluvial	-	14.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	63	37.49		892.62		892.62	Glaciofluvial	-	18.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	64	38.10		892.01		892.01	Glaciofluvial	-	16.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	65	38.71		891.40		891.40	Glaciofluvial	-	16.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	66	39.32		890.79		890.79	Glaciofluvial	-	14.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	67	39.93		890.18		890.18	Glaciofluvial	-	19.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	68	40.54		889.57		889.57	Glaciofluvial	-	18.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	69	41.15		888.96		888.96	Glaciofluvial	-	16.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	70	41.76		888.35		888.35	Basal Till	-	8.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	71	42.37		887.74		887.74	Basal Till	-	7.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	72	42.98		887.13		887.13	Basal Till	-	8.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	73	43.59		886.52		886.52	Basal Till	-	8.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	74	44.20		885.91		885.91	Basal Till	-	5.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	75	44.81		885.30		885.30	Basal Till	-	10.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	76	45.42		884.69		884.69	Basal Till	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	77	46.02		884.09		884.09	Basal Till	-	8.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	78	46.63		883.48		883.48	Glaciofluvial	-	19.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	24	47.09	47.34	883.02	882.77	882.90	Basal Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	23.3	35.5	25.3	15.9	0.002	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	79	47.24		882.87		882.87	Basal Till	-	8.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	80	47.85		882.26		882.26	Glaciofluvial	-	12.6	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	81	48.46		881.65		881.65	Glaciofluvial	-	23.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	82	49.07		881.04		881.04	Glaciofluvial	-	19.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	83	49.65		880.46		880.46	Glaciolacustrine	-	19.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	84	49.83		880.28		880.28	Glaciofluvial	-	7.1	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	85	50.29		879.82		879.82	Glaciofluvial	-	12.8	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	86	50.90		879.21		879.21	Glaciofluvial	-	18.8	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	87	51.51		878.60		878.60	Glaciofluvial	-	18.8	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	88	52.12		877.99		877.99	Glaciofluvial	-	8.0	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	89	52.73		877.38		877.38	Glaciofluvial	-	7.0	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	90	53.34		876.77		876.77	Glaciofluvial	-	9.8	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	91	53.95		876.16		876.16	Glaciofluvial	-	10.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	92	54.56		875.55		875.55	Glaciofluvial	-	9.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	27	54.56	54.86	875.55	875.25	875.40	Glaciofluvial	-	10.6	SM		Non-Plastic		-	ML	-	-	-	-	-	-	-	36.6	46.2	17.2		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	93	55.17		874.94		874.94	Glaciofluvial	-	10.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	94	55.78		874.33		874.33	Glaciolacustrine	-	16.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	29	56.08	56.39	874.03	873.72	873.88	Glaciolacustrine	-	19.0	CI	35	22	13	-0.23	CI	-	-	-	-	-	-	-	0	1.7	98.3		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	95	56.39		873.72		873.72	Glaciolacustrine	-	19.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	96	57.00		873.11		873.11	Glaciolacustrine	-	24.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	97	57.61		872.50		872.50	Glaciolacustrine	-	22.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	98	58.22		871.89		871.89	Glaciolacustrine	-	21.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	99	58.83		871.28		871.28	Glaciolacustrine	-	21.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	100	59.44		870.67		870.67	Glaciolacustrine	-	22.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	101	60.05		870.06		870.06	Glaciolacustrine	-	23.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	32	60.35	60.66	869.76	869.45	869.61	Glaciolacustrine	-	24.8	CI	38	22	16	0.18	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	102	60.66		869.45		869.45	Glaciolacustrine	-	21.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	103	61.26		868.85		868.85	Glaciolacustrine	-	27.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	104	61.87		868.24		868.24	Glaciolacustrine	-	20.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Grab	33	62.18	62.48	867.93	867.63	867.78	Glaciolacustrine	-	18.1	CI	31	20	11	-0.17	CI	-	-	-	-	-	-	-	0	2.2	97.8		-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	105	62.48		867.63		867.63	Glaciolacustrine	-	19.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	106	63.09		867.02		867.02	Glaciolacustrine	-	24.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	107	63.70		866.41		866.41	Glaciofluvial	-	27.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	108	64.31		865.80		865.80	Glaciofluvial	-	22.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	109	64.92		865.19		865.19	-	-	15.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	110	65.53		864.58		864.58	Glaciofluvial	-	20.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	111	66.14		863.97		863.97	Basal Till	-	16.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	112	66.75		863.36		863.36	Basal Till	-	15.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	113	67.36		862.75		862.75	Basal Till	-	12.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	114	67.97		862.14		862.14	Basal Till	-	15.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	115	68.58		861.53		861.53	Basal Till	-	16.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	116	69.19		860.92		860.92	-	-	15.5	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	117	69.80		860.31		860.31	-	-	15.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	118	70.41		859.70		859.70	Bedrock	-	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	119	71.02		859.09		859.09	Bedrock	-	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-02	Perimeter Embankment Buttress	Chunk	120	71.63		858.48		858.48	Bedrock	-	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	1	5.18		925.27		925.27	Ablation Till	-	12.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	2	5.79		924.66		924.66	Ablation Till	-	10.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	3	6.40		924.05		924.05	Ablation Till	-	10.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	4	7.01		923.44		923.44	Ablation Till	-	9.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	2	7.01	7.32	923.44	923.13	923.29	Ablation Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	16.7	43.6	31.5	8.2	0.002	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	5	7.62		922.83		922.83	Ablation Till	-	9.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	6	8.23		922.22		922.22	Ablation Till	-	10.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	7	8.84		921.61		921.61	Ablation Till	-	12.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	8	9.45		921.00		921.00	Ablation Till	-	8.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	9	10.06		920.39		920.39	Ablation Till	-	11.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	4	10.36	10.67	920.09	919.78	919.94	Ablation Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	25.0	34.8	30.3	9.9	0.002	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	10	10.67		919.78		919.78	Ablation Till	-	10.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	11	11.28		919.17		919.17	Ablation Till	-	12.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	12	11.89		918.56		918.56	Ablation Till	-	11.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	13	12.50		917.95		917.95	Ablation Till	-	10.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	14	13.11		917.34		917.34	Ablation Till	-	10.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	15	13.72		916.73		916.73	Ablation Till	-	11.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	16	14.33		916.12		916.12	Ablation Till	-	11.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	17	14.94		915.51		915.51	Ablation Till	-	12.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	18	15.54		914.91		914.91	Ablation Till	-	12.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	19	16.15		914.30		914.30	Ablation Till	-	12.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	20	16.76		913.69		913.69	Ablation Till	-	12.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	21	17.37		913.08		913.08	Ablation Till	-	11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	22	17.98		912.47		912.47	Ablation Till	-	11.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	23	18.59		911.86		911.86	Ablation Till	-	12.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	24	19.20		911.25		911.25	Ablation Till	-	11.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	25	19.81		910.64		910.64	Ablation Till	-	11.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	26	20.42		910.03		910.03	Ablation Till	-	12.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	27	21.03		909.42		909.42	Ablation Till	-	11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	28	21.64		908.81		908.81	Ablation Till	-	11.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	29	22.25		908.20		908.20	Ablation Till	-	10.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	30	22.86		907.59		907.59	Ablation Till	-	12.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	12	23.17	23.47	907.28	906.98	907.13	Glaciolacustrine	-	21.1	CI	45	22	23	-0.04	CI	-	-	-	-	-	-	-	5.6	7.9	86.5		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	31	23.47		906.98		906.98	Basal Till	-	9.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	32	24.08		906.37		906.37	Glaciolacustrine	-	23.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	13	24.38	24.69	906.07	905.76	905.92	Glaciolacustrine	-	24.3	CI	37	22	15	0.15	CI	-	-	-	-	-	-	-	0	2.3	97.7		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	33	24.69		905.76		905.76	Glaciolacustrine	-	22.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Thin-walled Open Tube	TO2	24.69	24.99	905.76	905.46	905.61	Glaciolacustrine	-	22.1	CI		Non-Plastic		-	ML	-	-	-	-	-	-	-	0	17.4	65.6	17.0	0.002	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Thin-walled Open Tube	TO2-CRS	24.69	24.99	905.76	905.46	905.61	Glaciolacustrine	-	24.3	CI	33	20	13	0.33	CI	-	-	-	-	-	-	-	0	1.3	71.3	27.4	0.002	CRS
2021	Golder	GA21-03	Perimeter Embankment Buttress	Thin-walled Open Tube	TO3	24.99	25.60	905.46	904.85	905.16	Glaciolacustrine	-	22.8	CI	32	19	13	0.29	CI	-	-	-	-	-	-	-	0	3.7	77.3	19.0	0.002	Incremental Consolidation
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	34	25.30		905.15		905.15	Glaciolacustrine	-	23.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	14	25.60	25.91	904.85	904.54	904.70	Glaciolacustrine	-	20.5	CL/CI	30	20	10	0.05	CL/CI	-	-	-	-	-	-	-	0	10.5	89.5		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Thin-walled Open Tube	TO4-CRS	25.60	26.21	904.85	904.24	904.55	Glaciolacustrine	-	19.8	CL/CI	37	22	15	-0.15	CI	1682	2014	-	-	-	-	-	0	1.8	65.6	32.6	0.002	DSS, CRS
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	35	25.91		904.54		904.54	Glaciolacustrine	-	22.7	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	36	26.52		903.93		903.93	Glaciofluvial	-	10.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	37	27.13		903.32		903.32	Glaciofluvial	-	16.8	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	38	27.74		902.71		902.71	Glaciofluvial	-	21.3	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	39	28.35		902.10		902.10	Glaciofluvial	-	21.4	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	40	28.96		901.49		901.49	Glaciofluvial	-	19.5	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	41	30.18		900.27		900.27	Glaciofluvial	-	6.1	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	42	30.78		899.67		899.67	Glaciofluvial	-	10.8	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	43	31.39		899.06		899.06	Glaciofluvial	-	7.2	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	44	32.00		898.45		898.45	Glaciofluvial	-	8.5	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	45	32.61		897.84		897.84	Glaciolacustrine	-	18.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	46	33.22		897.23		897.23	Glaciolacustrine	-	17.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	19	33.22	33.53	897.23	896.92	897.08	Glaciolacustrine	-	17.2	CI	37	20	17	-0.16	CI	-	-	-	-	-	-	-	0	2.0	98.0		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Thin-walled Open Tube	TO5-DSS	33.22	33.83	897.23	896.62	896.93	Glaciolacustrine	-	21.2	CI	50	22	28	-0.03	CI/CH	-	-	-	-	-	-	-	2.5	8.0	43.7	45.8	0.002	DSS, CRS, Incremental Consolidation
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	47	33.83		896.62		896.62	Glaciolacustrine	-	19.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	48	34.44		896.01		896.01	Glaciolacustrine	-	22.7	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	20	34.44	34.75	896.01	895.70	895.86	Glaciolacustrine	-	25.7	CH	68	24	44	0.04	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	49	35.05		895.40		895.40	Glaciolacustrine	-	16.5	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	50	35.66		894.79		894.79	-	-	10.8	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	51	36.27		894.18		894.18	-	-	10.5	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	21	36.58	36.88	893.87	893.57	893.72	-	-	16.8	CL-ML	20	15	5	0.36	CL-ML	-	-	-	-	-	-	-	1.7	25.6	72.7		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	52	36.88		893.57		893.57	-	-	17.7	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	53	37.49		892.96		892.96	-	-	25.4	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	22	37.80	38.10	892.65	892.35	892.50	Glaciofluvial	-	21.1	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	54	38.10		892.35		892.35	Glaciofluvial	-	21.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	55	38.71		891.74		891.74	Glaciofluvial	-	22.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	56	39.32		891.13		891.13	Glaciolacustrine	-	24.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	57	39.93		890.52		890.52	Glaciolacustrine	-	25.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	23	39.93	40.23	890.52	890.22	890.37	Glaciolacustrine	-	23.5	CL	29	15	14	0.61	CL	-	-	-	-	-	-	-	0	3.8	96.2		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	58	40.54		889.91		889.91	Glaciolacustrine	-	25.7	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	59	41.15		889.30		889.30	Glaciolacustrine	-	22.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	60	41.76		888.69		888.69	Glaciofluvial	-	19.9	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	61	42.37		888.08		888.08	Glaciofluvial	-	10.0	GW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	62	42.98		887.47		887.47	Basal Till	-	8.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	63	43.59		886.86		886.86	Basal Till	-	9.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	25	43.59	43.89	886.86	886.56	886.71	Basal Till	-	-	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	20.6	35.4	34.6	9.4	0.002	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	64	44.20		886.25		886.25	Basal Till	-	14.0	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	65	44.81		885.64		885.64	Basal Till	-	19.5	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Grab	26	45.11	45.42	885.34	885.03	885.19	Basal Till	-	17.9	CL-ML	23	16	7	0.27	CL-ML	-	-	-	-	-	-	-	1.4	26.7	71.9		-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	66	45.42		885.03		885.03	Basal Till	-	18.3	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	67	46.02		884.43		884.43	Basal Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	68	46.63		883.82		883.82	Basal Till	-	8.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-03	Perimeter Embankment Buttress	Chunk	69	47.24		883.21		883.21	Weathered Bedrock	-	18.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	1	14.33		924.05		924.05	Ablation Till	-	13.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	2	14.94		923.44		923.44	Ablation Till	-	12.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	3	15.54		922.84		922.84	Ablation Till	-	12.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	4	16.15		922.23		922.23	Ablation Till	-	12.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	5	16.76		921.62		921.62	Ablation Till	-	10.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	6	17.37		921.01		921.01	Ablation Till	-	14.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Grab	4	17.53	17.68	920.85	920.70	920.78	Upper Glaciolacustrine[2]	-	18.2	CI	32	14	18	0.23	CI	-	-	-	-	-	-	-	2.0	20.1	77.9		-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	7	17.68		920.70		920.70	Upper Glaciolacustrine[2]	-	20.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Thin-walled Open Tube	TO1	17.68	18.29	920.70	920.09	920.40	Upper Glaciolacustrine[2]	-	20.5	CI	47	19	28	0.05	CI	-	-	-	-	-	-	-	32.3	9.5	22.1	36.1	0.002	Cyclic DSS
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Chunk	8	19.05		919.33		919.33	Basal Till	-	17.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Thin-walled Open Tube	TO3	19.20	20.12	919.18	918.26	918.72	Basal Till	-	-	SC	-	-	-	-	-	-	-	-	-	-	-	-	14.8	39.7	33.2	12.3	0.002	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Thin-walled Open Tube	TO4	20.12	20.73	918.26	917.65	917.96	Basal Till	-	-	SC	-	-	-	-	-	2063	2320	-	-	-	-	-	21.1	34.5	31.0	13.4	0.002	-
2021	Golder	GA21-04	Corner 1 Embankment Buttress	Thin-walled Open Tube	TO5	20.73	20.88	917.65	917.50	917.58	Basal Till	-	-	SC	-	-	-	-	-	1982	2250	-	-	-	-	-	14.9	39.2	32.7	13.2	0.002	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	1	7.01		938.51		938.51	Ablation Till	-	5.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	2	7.62		937.90		937.90	Ablation Till	-	16.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	3	8.23		937.29		937.29	Ablation Till	-	11.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	1	8.23	8.53	937.29	936.99	937.14	Ablation Till	-	-	SC	-	-	-	-	-	-	-	-	-	-	-	-	17.4	41.7	28.7	12.2	0.002	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	4	8.84		936.68		936.68	Ablation Till	-	10.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	2	9.02	9.08	936.50	936.44	936.47	Glaciolacustrine	-	17.5	CI	31	15	16	0.16	CI	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	5	9.05		936.47		936.47	Glaciolacustrine	-	16.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	6	9.45		936.07		936.07	Ablation Till	-	11.9	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	7	10.06		935.46		935.46	Ablation Till	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	8	10.67		934.85		934.85	Ablation Till	-	11.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	9	11.28		934.24		934.24	Ablation Till	-	16.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	10	11.58		933.94		933.94	Ablation Till	-	16.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	11	12.50		933.02		933.02	Ablation Till	-	15.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	12	13.11		932.41		932.41	Ablation Till	-	15.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	13	13.72		931.80		931.80	Ablation Till	-	14.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	14	14.33		931.19		931.19	Ablation Till	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	15	14.94		930.58		930.58	Glaciofluvial	-	5.2	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	16	15.54		929.98		929.98	Glaciofluvial	-	3.4	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	17	16.15		929.37		929.37	Glaciofluvial	-	9.0	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	18	16.76		928.76		928.76	Glaciofluvial	-	9.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	19	17.98		927.54		927.54	Glaciofluvial	-	10.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	20	18.59		926.93		926.93	Glaciofluvial	-	5.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	21	19.20		926.32		926.32	Glaciofluvial	-	3.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	22	19.81		925.71		925.71	Basal Till	-	3.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	23	20.42		925.10		925.10	Glaciofluvial	-	7.4	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	24	21.03		924.49		924.49	Glaciofluvial	-	2.4	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	25	21.64		923.88		923.88	Glaciofluvial	-	2.2	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	26	22.25		923.27		923.27	Basal Till	-	2.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	27	22.86		922.66		922.66	Basal Till	-	2.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	28	23.47		922.05		922.05	-	-	6.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	29	24.08		921.44		921.44	-	-	3.3	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	30	24.69		920.83		920.83	-	-	3.0	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	31	25.30		920.22		920.22	-	-	3.1	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	32	25.91		919.61		919.61	Basal Till	-	2.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	33	26.82		918.70		918.70	Basal Till	-	11.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	34	27.74		917.78		917.78	Glaciofluvial	-	2.7	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	35	28.35		917.17		917.17	Glaciofluvial	-	3.1	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	11	28.65	28.96	916.87	916.56	916.72	Basal Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	-	7.5	44.7	41.8	6.0	0.002	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	36	28.96		916.56		916.56	Basal Till	-	12.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	37	29.57		915.95		915.95	Glaciofluvial	-	9.6	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	38	30.18		915.34		915.34	Glaciofluvial	-	13.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	39	30.78		914.74		914.74	Basal Till	-	10.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	40	31.39		914.13		914.13	Basal Till	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	41	32.00		913.52		913.52	Basal Till	-	12.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	42	32.61		912.91		912.91	Basal Till	-	15.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	43	33.22		912.30		912.30	Basal Till	-	14.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	44	33.83		911.69		911.69	Basal Till	-	14.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	45	34.44		911.08		911.08	Basal Till	-	16.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	16	34.75	35.05	910.77	910.47	910.62	Glaciolacustrine	-	15.3	CL	29	17	12	-0.14	CL	-	-	-	-	-	-	-	1.2	24.8	74.0		-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	46	35.05		910.47		910.47	Glaciolacustrine	-	17.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	47	35.66		909.86		909.86	Basal Till	-	14.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	48	36.27		909.25		909.25	Basal Till	-	18.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	49	36.88		908.64		908.64	Basal Till	-	14.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	50	37.49		908.03		908.03	Basal Till	-	18.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	51	38.10		907.42		907.42	Basal Till	-	17.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	52	38.71		906.81		906.81	Basal Till	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	53	39.32		906.20		906.20	Basal Till	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	54	39.93		905.59		905.59	Basal Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	55	40.54		904.98		904.98	Basal Till	-	13.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	19	40.54	40.84	904.98	904.68	904.83	-	-	15.0	CL	29	15	14	0.00	CL	-	-	-	-	-	-	-	2.0	16.5	81.5		-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	56	41.15		904.37		904.37	-	-	14.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	57	41.76		903.76		903.76	Basal Till	-	10.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	58	42.37		903.15		903.15	Basal Till	-	8.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	59	42.98		902.54		902.54	Basal Till	-	12.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	20	42.98	43.28	902.54	902.24	902.39	Basal Till	-	9.3	CL	27	14	13	-0.36	CL	-	-	-	-	-	-	-	0	39.0	61.0		-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	60	43.59		901.93		901.93	Basal Till	-	8.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	61	44.20		901.32		901.32	Basal Till	-	7.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	62	44.81		900.71		900.71	Basal Till	-	9.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	63	45.42		900.10		900.10	Basal Till	-	7.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	64	46.02		899.50		899.50	Basal Till	-	6.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	65	46.63		898.89		898.89	Basal Till	-	3.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	66	47.24		898.28		898.28	Basal Till	-	10.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	67	47.85		897.67		897.67	Basal Till	-	13.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	68	48.46		897.06		897.06	Basal Till	-	7.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	69	49.07		896.45		896.45	Basal Till	-	5.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	70	49.68		895.84		895.84	Basal Till	-	5.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	71	50.29		895.23		895.23	Basal Till	-	5.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	72	50.90		894.62		894.62	Basal Till	-	10.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	73	51.51		894.01		894.01	Basal Till	-	12.3	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	74	52.12		893.40		893.40	Basal Till	-	12.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	27	52.43	52.73	893.09	892.79	892.94	Glaciolacustrine	-	10.6	CL	26	15	11	-0.40	CL	-	-	-	-	-	-	-	4.4	35.6	60.0		-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	75	52.73		892.79		892.79	Glaciolacustrine	-	14.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	76	53.34		892.18		892.18	Glaciolacustrine	-	15.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	77	53.95		891.57		891.57	Basal Till	-	15.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	78	54.56		890.96		890.96	Basal Till	-	17.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	79	55.17		890.35		890.35	Basal Till	-	17.6	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	80	55.78		889.74		889.74	Basal Till	-	16.0	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	81	57.00		888.52		888.52	Basal Till	-	12.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Grab	30	57.30	57.61	888.22	887.91	888.07	Glaciolacustrine	-	12.7	CL	25	15	10	-0.23	CL	-	-	-	-	-	-	-	7.2	27.1	65.7		-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	82	57.61		887.91		887.91	Glaciolacustrine	-	12.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	83	58.22		887.30		887.30	Basal Till	-	5.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	84	58.83		886.69		886.69	Basal Till	-	15.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	85	60.05		885.47		885.47	Glaciofluvial	-	10.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	86	60.66		884.86		884.86	Glaciofluvial	-	18.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	87	61.26		884.26		884.26	Glaciofluvial	-	13.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	88	63.09		882.43		882.43	Basal Till	-	14.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	89	63.70		881.82		881.82	Basal Till	-	13.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	90	64.31		881.21		881.21	Basal Till	-	12.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	91	64.92		880.60		880.60	Basal Till	-	6.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	92	65.68		879.84		879.84	Basal Till	-	12.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	93	66.14		879.38		879.38	Basal Till	-	10.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	94	66.75		878.77		878.77	Basal Till	-	11.7	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	95	67.36		878.16		878.16	Basal Till	-	10.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	96	67.97		877.55		877.55	Basal Till	-	12.6	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-05	Perimeter Embankment Buttress	Chunk	97	68.58		876.94		876.94	Bedrock	-	9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	1	0.30		937.68		937.68	Basal Till	-	12.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	2	0.91		937.07		937.07	Basal Till	-	12.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	3	1.52		936.46		936.46	Basal Till	-	10.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	4	2.13		935.85		935.85	Basal Till	-	10.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Grab	1	2.44	2.74	935.54	935.24	935.39	Basal Till	-	-	ML	-	-	-	-	-	-	-	-	-	-	-	5.3	36.4	42.8	15.5	0.002	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	5	2.74		935.24		935.24	Basal Till	-	12.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	6	3.35		934.63		934.63	Basal Till	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	7	3.96		934.02		934.02	Basal Till	-	10.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	8	4.57		933.41		933.41	Basal Till	-	9.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	9	5.18		932.80		932.80	Basal Till	-	6.4	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	10	5.79		932.19		932.19	Basal Till	-	6.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	11	6.40		931.58		931.58	Basal Till	-	4.3	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Grab	2	6.40	6.71	931.58	931.27	931.43	Basal Till	-	-	SM	-	-	-	-	-	-	-	-	-	-	-	32.4	43.9	18.4	5.3	0.002	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	12	7.01		930.97		930.97	Basal Till	-	5.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	13	7.62		930.36		930.36	Glaciofluvial	-	17.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Grab	3	7.77	7.93	930.21	930.05	930.13	Glaciolacustrine	-	20.5	CI	32	20	12	0.04	CI	-	-	-	-	-	-	-	0.8	14.7	84.5		-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	14	8.23		929.75		929.75	Glaciofluvial	-	16.6	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	15	8.84		929.14		929.14	Glaciofluvial	-	5.4	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	16	9.45		928.53		928.53	Glaciofluvial	-	4.0	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	17	10.06		927.92		927.92	Basal Till	-	6.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	18	10.67		927.31		927.31	Basal Till	-	4.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	19	11.28		926.70		926.70	Glaciofluvial	-	17.8	SW-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	20	11.89		926.09		926.09	Basal Till	-	4.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	21	12.50		925.48		925.48	Glaciofluvial	-	3.4	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Grab	6	12.80	13.11	925.18	924.87	925.03	Glaciofluvial	-	-	SP-SM	-	-	-	-	-	-	-	-	-	-	-	44.3	44.8	8.6	2.3	0.002	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	22	13.11		924.87		924.87	Glaciofluvial	-	3.5	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	23	14.33		923.65		923.65	Basal Till	-	9.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	24	14.94		923.04		923.04	Basal Till	-	7.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	25	15.54		922.44		922.44	Basal Till	-	7.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	26	16.15		921.83		921.83	Glaciofluvial	-	9.0	SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	27	16.76		921.22		921.22	Basal Till	-	3.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Grab	8	16.76	17.07	921.22	920.91	921.07	Basal Till	-	-	GM	-	-	-	-	-	-	-	-	-	-	-	38.1	35.5	20.4	6.0	0.002	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	28	17.37		920.61		920.61	Basal Till	-	5.0	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	29	17.98		920.00		920.00	Basal Till	-	5.5	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	30	18.59		919.39		919.39	Basal Till	-	4.6	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	31	19.20		918.78		918.78	Basal Till	-	5.1	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	32	19.81		918.17		918.17	Basal Till	-	3.2	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	33	20.42		917.56		917.56	Basal Till	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	34	21.03		916.95		916.95	Basal Till	-	7.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	35	21.64		916.34		916.34	Basal Till	-	8.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	36	22.25		915.73		915.73	Basal Till	-	9.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-06	Perimeter Embankment Buttress	Chunk	37	22.86		915.12		915.12	Basal Till	-	11.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	1	11.28		924.62		924.62	Basal Till	-	14.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	2	11.89		924.01		924.01	Basal Till	-	12.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Grab	1	11.89	12.19	924.01	923.71	923.86	Basal Till	-	-	CL	-	-	-	-	-	-	-	-	-	-	-	12.1	33.8	36.8	17.3	0.002	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	3	12.50		923.40		923.40	Basal Till	-	13.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	4	13.11		922.79		922.79	Basal Till	-	15.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	5	13.72		922.18		922.18	Glaciolacustrine	-	22.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Grab	2	13.72	14.02	922.18	921.88	922.03	Glaciolacustrine	-	27.8	CI	47	18	29	0.34	CI	-	-	-	-	-	-	-	4.9	16.6	78.5		-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2021	Golder	GA21-07	Main Embankment Buttress	Thin-walled Open Tube	TO1	13.72	14.17	922.18	921.73	921.96	Glaciolacustrine	-	29.2	CI	45	22	23	0.31	CI	-	-	-	-	-	-	-	1.5	12.1	46.1	40.3	0.002	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	6	14.33		921.57		921.57	Basal Till	-	28.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	7	14.94		920.96		920.96	Basal Till	-	11.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	8	15.54		920.36		920.36	Basal Till	-	13.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	9	16.15		919.75		919.75	Glaciofluvial	-	13.8	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	10	16.76		919.14		919.14	Basal Till	-	11.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	11	17.37		918.53		918.53	Basal Till	-	12.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	12	17.98		917.92		917.92	Basal Till	-	12.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	13	18.59		917.31		917.31	Basal Till	-	12.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	14	19.20		916.70		916.70	Basal Till	-	9.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	15	19.81		916.09		916.09	Glaciofluvial	-	19.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	16	20.42		915.48		915.48	Glaciofluvial	-	21.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	17	21.03		914.87		914.87	Glaciofluvial	-	26.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	18	21.64		914.26		914.26	Glaciofluvial	-	25.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	19	22.25		913.65		913.65	Glaciolacustrine	-	24.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	20	22.86		913.04		913.04	Glaciolacustrine	-	22.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Grab	9	22.86	23.17	913.04	912.73	912.89	Glaciolacustrine	-	23.9	CL	27	18	9	0.66	CL	-	-	-	-	-	-	-	0	15.6	84.4		-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	21	23.47		912.43		912.43	Glaciolacustrine	-	24.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	22	24.08		911.82		911.82	Glaciofluvial	-	22.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	23	24.69		911.21		911.21	Glaciolacustrine	-	19.3	MH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	24	25.30		910.60		910.60	-	-	19.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Grab	11	25.30	25.60	910.60	910.30	910.45	-	-	19.3	CL	28	18	10	0.13	CL	-	-	-	-	-	-	-	0	5.2	94.8		-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	25	25.91		909.99		909.99	-	-	22.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	26	26.52		909.38		909.38	Glaciofluvial	-	19.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	27	27.13		908.77		908.77	Glaciofluvial	-	21.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	28	27.74		908.16		908.16	Glaciofluvial	-	21.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	29	28.35		907.55		907.55	Glaciofluvial	-	19.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	30	28.96		906.94		906.94	-	-	18.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	31	29.57		906.33		906.33	-	-	21.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	32	30.18		905.72		905.72	-	-	28.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	33	30.78		905.12		905.12	-	-	30.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	34	31.39		904.51		904.51	-	-	33.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	35	32.00		903.90		903.90	-	-	34.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	36	32.61		903.29		903.29	Glaciolacustrine	-	32.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Thin-walled Open Tube	TO3	32.92	33.53	902.98	902.37	902.68	Glaciolacustrine	-	22.2	CH	41	22	19	0.01	CI	1353	1587	-	-	-	-	-	0	0.6	66.8	32.6	0.002	-
2021	Golder	GA21-07	Main Embankment Buttress	Thin-walled Open Tube	TO3-DSS	32.92	33.53	902.98	902.37	902.68	Glaciolacustrine	-	28.2	CH	33	18	15	0.68	CI	-	-	-	-	-	-	-	0	1.1	70.3	28.6	0.002	DSS, CRS
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	37	33.22		902.68		902.68	Glaciolacustrine	-	30.1	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	38	33.83		902.07		902.07	Glaciolacustrine	-	30.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Grab	15	33.83	34.14	902.07	901.76	901.92	Glaciolacustrine	-	28.7	CH	61	22	39	0.17	CH	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Thin-walled Open Tube	TO4	33.83	34.14	902.07	901.76	901.92	Glaciolacustrine	-	33.8	CH	43	20	23	0.60	CI	-	-	-	-	-	-	-	0	2.0	61.7	36.3	0.002	CRS, Incremental Consolidation
2021	Golder	GA21-07	Main Embankment Buttress	Thin-walled Open Tube	TO5	34.14	34.75	901.76	901.15	901.46	Glaciolacustrine	-	30.5	CH	53	23	30	0.25	CH	1559	2014	-	-	-	-	-	0	1.7	50.3	48.0	0.002	Incremental Consolidation
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	39	34.44		901.46		901.46	Glaciolacustrine	-	23.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	40	35.05		900.85		900.85	Glaciolacustrine	-	37.6	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	41	35.66		900.24		900.24	Glaciolacustrine	-	29.4	CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	42	36.27		899.63		899.63	Glaciofluvial	-	25.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	43	36.88		899.02		899.02	Glaciolacustrine	-	31.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	44	37.49		898.41		898.41	-	-	29.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-07	Main Embankment Buttress	Chunk	45	38.10		897.80		897.80	Glaciofluvial	-	23.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	1	17.37		912.87		912.87	Ablation Till	-	15.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Grab	1	17.37	17.68	912.87	912.56	912.72	Ablation Till	-	-	ML	-	-	-	-	-	-	-	-	-	-	-	-	13.4	35.4	38.9	12.3	0.002	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	2	17.98		912.26		912.26	Ablation Till	-	17.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	3	18.59		911.65		911.65	Glaciofluvial	-	12.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	4	19.20		911.04		911.04	-	-	8.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	5	19.81		910.43		910.43	-	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	6	20.42		909.82		909.82	Glaciofluvial	-	19.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	7	21.03		909.21		909.21	Glaciofluvial	-	24.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	8	21.64		908.60		908.60	Glaciolacustrine	-	25.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	9	22.25		907.99		907.99	Glaciolacustrine	-	22.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Grab	4	22.71	22.86	907.53	907.38	907.46	Glaciolacustrine	-	21.3	CI	36	19	17	0.14	CI	-	-	-	-	-	-	-	0	5.5	94.5		-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	10	22.86		907.38		907.38	Glaciolacustrine	-	17.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	11	23.47		906.77		906.77	Glaciolacustrine	-	21.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Thin-walled Open Tube	TO3	23.53	23.68	906.71	906.56	906.64	Glaciolacustrine	-	27.4	CI	43	23	20	0.22	CI	-	-	-	-	-	-	-	0	5.0	59.4	35.6	0.002	DSS, CRS, Incremental Consolidation
2021	Golder	GA21-08	Main Embankment Buttress	Grab	5	23.77	23.93	906.47	906.31	906.39	Glaciolacustrine	-	34.7	CI	48	27	21	0.37	CI	-	-	-	-	-	-	-	0	0.5	99.5		-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	12	24.08		906.16		906.16	Glaciolacustrine	-	22.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	13	24.69		905.55		905.55	Glaciolacustrine	-	18.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Thin-walled Open Tube	TO5-DSS	24.69	25.30	905.55	904.94	905.25	Glaciolacustrine	-	27.4	CI	44	23	21	0.21	CI	1599	2027	-	-	-	-	-	0	0.3	54.8	44.9	0.002	DSS, Cyclic DSS
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	14	25.30		904.94		904.94	Glaciolacustrine	-	10.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	15	25.91		904.33		904.33	Glaciolacustrine	-	17.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Grab	6	26.06	26.21	904.18	904.03	904.11	Glaciolacustrine	-	30.0	CI	47	23	24	0.29	CI	-	-	-	-	-	-	-	0	3.1	96.9		-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	16	26.52		903.72		903.72	Glaciolacustrine	-	17.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	17	27.13		903.11		903.11	Glaciolacustrine	-	14.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Grab	7	27.43	27.74	902.81	902.50	902.66	Glaciolacustrine	-	-	CI	-	-	-	-	-	-	-	-	-	-	-	-	0	0.2	55.6	44.2	0.002	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	18	27.74		902.50		902.50	Glaciolacustrine	-	20.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	19	28.35		901.89		901.89	Glaciolacustrine	-	9.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	20	28.96		901.28		901.28	Glaciolacustrine	-	6.3	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Grab	8	28.96	29.26	901.28	900.98	901.13	Glaciolacustrine	-	29.8	CI	41	22	19	0.41	CI	-	-	-	-	-	-	-	0	0.2	99.8		-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	21	29.57		900.67		900.67	Glaciofluvial	-	6.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	22	30.18		900.06		900.06	Glaciofluvial	-	9.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	23	30.78		899.46		899.46	Glaciofluvial	-	6.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	24	31.39		898.85		898.85	Glaciofluvial	-	7.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	25	32.00		898.24		898.24	Glaciofluvial	-	25.9	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	26	32.61		897.63		897.63	Glaciofluvial	-	17.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	27	33.22		897.02		897.02	Basal Till	-	12.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	28	33.83		896.41		896.41	Basal Till	-	11.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	29	34.44		895.80		895.80	Basal Till	-	9.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-08	Main Embankment Buttress	Grab	10	34.75	35.05	895.49	895.19	895.34	Basal Till	-	-	CL	-	-	-	-	-	-	-	-	-	-	-	-	6.0	41.9	33.2	18.9	0.002	-
2021	Golder	GA21-08	Main Embankment Buttress	Chunk	30	35.05		895.19		895.19	Basal Till	-	14.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	1	14.33		916.20		916.20	Basal Till	-	12.8	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	2	14.94		915.59		915.59	Basal Till	-	17.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	3	15.54		914.99		914.99	Basal Till	-	9.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	4	16.15		914.38		914.38	Basal Till	-	14.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	5	16.76		913.77		913.77	Basal Till	-	13.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	6	17.37		913.16		913.16	Basal Till	-	5.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	7	17.98		912.55		912.55	Basal Till	-	6.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Grab	3	18.90	19.05	911.63	911.48	911.56	Glaciolacustrine	-	17.1	CI	32	16	16	0.07	CI	-	-	-	-	-	-	-	0	25.4	74.6		-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	8	18.59		911.94		911.94	Basal Till	-	5.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	9	19.20		911.33		911.33	Glaciolacustrine	-	16.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	10	19.81		910.72		910.72	Glaciofluvial	-	22.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	11	20.12		910.41		910.41	Glaciofluvial	-	14.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	12	21.64		908.89		908.89	Glaciolacustrine	-	24.0	CL/CH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Thin-walled Open Tube	TO2	21.64	22.25	908.89	908.28	908.59	Glaciolacustrine	-	29.6	CL/CH	28	20	8	1.20	CL	-	-	-	-	-	-	-	0	0.8	82.8	16.4	0.002	-
2021	Golder	GA21-09	Main Embankment Buttress	Thin-walled Open Tube	TO2-CRS	21.64	22.25	908.89	908.28	908.59	Glaciolacustrine	-	33.2	CL/CH	56	25	31	0.26	CH	-	-	-	-	-	-	-	0	0.2	50.5	49.3	0.002	CRS, Incremental Consolidation
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	13	22.86		907.67		907.67	Glaciofluvial	-	14.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	14	23.47		907.06		907.06	Glaciofluvial	-	15.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	15	24.08		906.45		906.45	Glaciofluvial	-	25.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Grab	7	24.38	24.69	906.15	905.84	906.00	Glaciofluvial	-	24.9	ML		Non-Plastic		-	ML	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	16	24.69		905.84		905.84	Glaciofluvial	-	25.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	17	25.30		905.23		905.23	Glaciofluvial	-	27.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	18	25.91		904.62		904.62	Basal Till	-	16.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	19	26.52		904.01		904.01	Basal Till	-	10.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	20	27.13		903.40		903.40	Basal Till	-	14.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m³)	Wet Density (kg/m³)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m³)	Optimum Water Content (%)	Maximum Dry Density (kg/m³)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2021	Golder	GA21-09	Main Embankment Buttress	Grab	8	27.43	27.74	903.10	902.79	902.95	Basal Till	-	-	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	11.3	25.9	54.0	8.8	0.002	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	21	27.74		902.79		902.79	Basal Till	-	14.7	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	22	28.35		902.18		902.18	Basal Till	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	23	28.96		901.57		901.57	Basal Till	-	14.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	24	29.57		900.96		900.96	Basal Till	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	25	30.18		900.35		900.35	Basal Till	-	11.0	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	26	30.78		899.75		899.75	Glaciofluvial	-	7.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	27	31.39		899.14		899.14	Glaciofluvial	-	22.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Grab	9	31.70	32.00	898.83	898.53	898.68	Glaciolacustrine	-	25.7	CL/CI	30	20	10	0.57	CL/CI	-	-	-	-	-	-	-	-	0	5.1	94.9		-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	28	32.00		898.53		898.53	Glaciolacustrine	-	26.5	CL/CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	29	32.61		897.92		897.92	Basal Till	-	8.8	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	30	33.22		897.31		897.31	Basal Till	-	11.5	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	31	33.83		896.70		896.70	Basal Till	-	10.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	32	34.44		896.09		896.09	Glaciofluvial	-	13.8	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-09	Main Embankment Buttress	Chunk	33	35.05		895.48		895.48	Glaciofluvial	-	12.5	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	1	3.35		938.49		938.49	Fill	-	18.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	2	3.96		937.88		937.88	Fill	-	15.5	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	3	4.57		937.27		937.27	Fill	-	15.6	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	4	14.33		927.51		927.51	Ablation Till	-	10.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	5	14.94		926.90		926.90	Ablation Till	-	9.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	6	15.54		926.30		926.30	Ablation Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	7	16.15		925.69		925.69	Ablation Till	-	10.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	8	16.76		925.08		925.08	Ablation Till	-	11.0	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	9	17.37		924.47		924.47	Ablation Till	-	13.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	10	17.98		923.86		923.86	Ablation Till	-	11.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	11	18.59		923.25		923.25	Ablation Till	-	11.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	12	19.20		922.64		922.64	Ablation Till	-	12.6	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	13	19.81		922.03		922.03	Ablation Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	14	21.03		920.81		920.81	Ablation Till	-	13.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	15	21.64		920.20		920.20	Ablation Till	-	12.3	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	16	22.25		919.59		919.59	Ablation Till	-	12.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	17	23.01		918.83		918.83	Ablation Till	-	12.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	18	23.47		918.37		918.37	Ablation Till	-	13.9	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	19	24.08		917.76		917.76	Ablation Till	-	11.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-10	Corner 1 Embankment Buttress	Chunk	20	24.69		917.15		917.15	Ablation Till	-	10.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	1	0.61		930.20		930.20	Ablation Till	-	15.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	2	1.22		929.59		929.59	Ablation Till	-	12.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	3	1.83		928.98		928.98	Ablation Till	-	13.1	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	4	2.44		928.37		928.37	Ablation Till	-	11.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	5	3.05		927.76		927.76	Ablation Till	-	10.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	6	3.66		927.15		927.15	Ablation Till	-	10.2	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	7	4.27		926.54		926.54	Ablation Till	-	10.9	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	8	4.72		926.09		926.09	Ablation Till	-	11.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	9	5.49		925.32		925.32	Ablation Till	-	10.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	10	6.10		924.71		924.71	Ablation Till	-	11.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	11	6.71		924.10		924.10	Ablation Till	-	9.6	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	12	7.32		923.49		923.49	Ablation Till	-	10.7	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	13	7.92		922.89		922.89	Ablation Till	-	11.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	14	8.38		922.43		922.43	Glaciofluvial	-	6.9	SP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	15	9.14		921.67		921.67	Ablation Till	-	10.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	16	9.75		921.06		921.06	Ablation Till	-	19.8	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	17	10.21		920.60		920.60	Ablation Till	-	15.1	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	18	10.97		919.84		919.84	Ablation Till	-	11.4	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	19	11.43		919.38		919.38	Glaciolacustrine	-	20.1	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	20	11.73		919.08		919.08	Glaciolacustrine	-	20.6	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	21	12.50		918.31		918.31	Glaciolacustrine	-	22.9	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Thin-walled Open Tube	TO2-CRS	12.65	12.83	918.16	917.98	918.07	Glaciolacustrine	-	20.7	ML/CL	25	16	9	0.52	CL	-	-	-	-	-	-	-	-	0	10.8	73.7	15.5	0.002	CRS
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	22	12.83		917.98		917.98	Glaciolacustrine	-	22.4	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Grab	15	13.41	13.65	917.40	917.16	917.28	Glaciolacustrine	-	18.8	ML/CL	28	17	11	0.16	CL	-	-	-	-	-	-	-	-	3.1	11.6	65.6	19.7	0.002	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	23	13.56		917.25		917.25	Glaciolacustrine	-	19.5	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	24	14.17		916.64		916.64	Glaciolacustrine	-	19.9	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Thin-walled Open Tube	TO9-CRS	16.00	16.23	914.81	914.58	914.70	Glaciolacustrine	-	20.7	ML/CL	20	16	4	1.18	CL-ML	-	-	-	-	-	-	-	-	0.8	16.4	70.6	12.2	0.002	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Grab	16	16.64	16.76	914.17	914.05	914.11	Glaciolacustrine	-	17.1	ML/CL	22	18	4	-0.23	CL-ML	-	-	-	-	-	-	-	-	0.9	12.9	77.5	8.7	0.002	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	25	16.73		914.08		914.08	Glaciolacustrine	-	17.3	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Thin-walled Open Tube	TO11-CRS	16.76	17.14	914.05	913.67	913.86	Glaciolacustrine	-	18.1	ML/CL	23	16	7	0.30	CL-ML	-	-	-	-	-	-	-	-	0.5	11.5	80.5	7.5	0.002	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	26	17.47		913.34		913.34	Glaciolacustrine	-	15.9	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	27	18.07		912.74		912.74	Glaciolacustrine	-	19.5	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	28	18.75		912.06		912.06	Ablation Till	-	11.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	29	19.35		911.46		911.46	Ablation Till	-	9.0	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	30	19.96		910.85		910.85	Ablation Till	-	9.5	CI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	31	20.57		910.24		910.24	Glaciolacustrine	-	16.7	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Grab	20	20.73	21.03	910.08	909.78	909.93	Glaciolacustrine	-	19.2	ML/CL	24	15	9	0.47	CL	-	-	-	-	-	-	-	-	4.3	18.4	62.9	14.4	0.002	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	32	21.18		909.63		909.63	Glaciolacustrine	-	18.1	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	33	21.79		909.02		909.02	Glaciolacustrine	-	24.1	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	34	22.40		908.41		908.41	Glaciolacustrine	-	16.0	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	35	23.01		907.80		907.80	Glaciolacustrine	-	11.6	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	36	23.62		907.19		907.19	Glaciolacustrine	-	12.1	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Grab	24	23.93	24.23	906.88	906.58	906.73	Glaciolacustrine	-	17.2	ML/CL	19	17	2	0.10	ML	-	-	-	-	-	-	-	-	4.0	20.7	68.7	6.6	0.002	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	37	24.23		906.58		906.58	Glaciolacustrine	-	19.1	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	38	24.84		905.97		905.97	Glaciolacustrine	-	20.2	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	39	25.45		905.36		905.36	Glaciolacustrine	-	9.2	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	40	26.06		904.75		904.75	Glaciolacustrine	-	13.2	ML/CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	41	26.67		904.14		904.14	Glaciofluvial	-	14.4	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	42	27.28		903.53		903.53	Glaciofluvial	-	9.2	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2021	Golder	GA21-11	Perimeter Embankment Buttress	Chunk	43	27.89		902.92		902.92	Glaciofluvial	-	8.9	GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	1	0.46		940.38		940.38	Tailings	-	7.8	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	2	2.29		938.55		938.55	Tailings	-	18.1	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	3	3.51		937.33		937.33	Tailings	-	18.6	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	4	5.03		935.81		935.81	Rockfill	-	8.6	GW-GM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Grab	6	11.28	11.58	929.56	929.26	929.41	Glacial Till	-	16.8	CL	27	15	12	0.15	CL	-	-	-	-	-	-	-	-	8.6	37.1	34.3	20.0	0.002	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	5	11.43		929.41		929.41	Glacial Till	-	17.5	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	6	12.04		928.80		928.80	Glacial Till	-	17.1	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	7	12.65		928.19		928.19	Glacial Till	-	13.2	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	8	13.11		927.73		-927.73	Glacial Till	-	9.8	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	9	13.87		926.97		926.97	Glacial Till	-	9.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	10	14.33		926.51		926.51	Glacial Till	-	9.7	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Grab	10	14.93	15.24	925.91	925.60	925.76	Glacial Till	-	9.3	SC	22	13	9	-0.41	CL	-	-	-	-	-	-	-	-	14.0	37.2	29.7	19.1	0.002	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	11	15.09		925.75		925.75	Glacial Till	-	9.1	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	12	15.54		925.30		925.30	Glacial Till	-	10.4	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	13	16.31		924.53		924.53	Glacial Till	-	10.8	SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Grab	12	17.07	17.37	923.77	923.47	923.62	-	-	17.9	CL-ML	20	16	4	0.48	CL-ML	-	-	-	-	-	-	-	-	0.1	12.7	16.2	71.0	0.002	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	14	17.22		923.62		923.62	-	-	18.3	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Grab	13	17.98	18.29	922.86	922.55	922.71	-	-	24.3	CL-ML	26	20	6	0.72	CL-ML	-	-	-	-	-	-	-	-	0.2	3.0	89.2	7.6	0.002	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	15	18.14		922.70		922.70	-	-	24.9	CL-ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	16	18.59		922.25		922.25	-	-	24.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	17	19.32		921.52		921.52	-	-	18.3	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	18	19.66		921.18		921.18	-	-	13.9	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	19	20.27		920.57		920.57	-	-	16.2	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Grab	17	20.73	21.03	920.11	919.81	919.96	Glaciofluvial	-	15.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	1.8	71.4	24.3	2.5	0.002	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	20	20.88		919.96		919.96	Glaciofluvial	-	19.0	SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	21	21.22		919.62		919.62	-	-	11.0	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C5: Summary of Index Test Results

Year	Consultant	Borehole / Test Pit ID	General Location Description	Sample Type	Sample No.	Depth (m)		Elevation (m)			Soil Unit	Specific Gravity	Water Content (%)	Unified Soil Classification System (USCS)	Atterberg Limits				Atterberg Classification	Dry Density (kg/m^3)	Wet Density (kg/m^3)	Standard Proctor		Modified Proctor		Hydraulic Conductivity (m/s)	Particle Size Distribution					Advanced Testing Completed
						From	To	From	To	Mid-Point					Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)				Maximum Dry Density (kg/m^3)	Optimum Water Content (%)	Maximum Dry Density (kg/m^3)	Optimum Water Content (%)		Gravel (%)	Sand (%)	Fines (%)		Clay Threshold (< mm)	
																												Silt (%)	Clay (%)		
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	22	22.10		918.74		918.74	-	-	13.7	SP-SM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	23	22.40		918.44		918.44	Glacial Till	-	16.4	CL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	24	23.32		917.52		917.52	Weathered Bedrock	-	11.2	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2022	Golder	GA22-01	Corner 1 Embankment Buttress	Chunk	25	23.93		916.91		916.91	Weathered Bedrock	-	6.4	ML	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1. Soil unit was redefined from original description based on further assessment.
2. Soil unit was redefined from glaciolacustrine to either upper glaciolacustrine or lower glaciolacustrine.

APPENDIX D

Borehole GA22-01

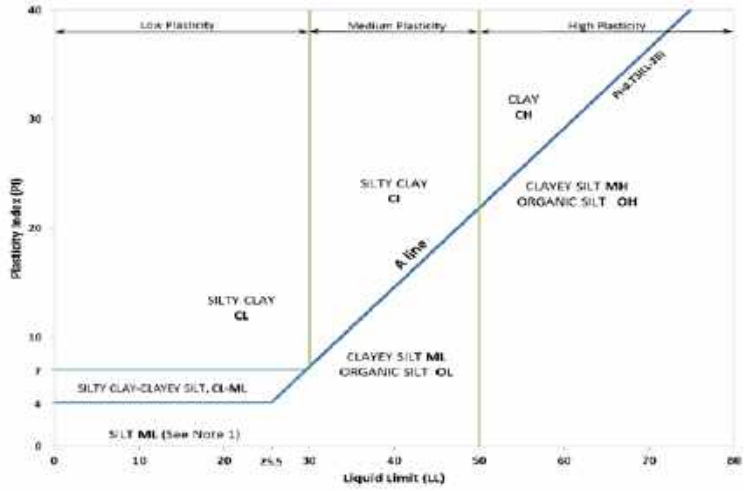
Appendix D1
Record of Borehole

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

RECORD OF BOREHOLE: GA22-01

CLIENT:	Mount Polley Mining Corporation	START DATE:	July 19, 2022	ELEVATION:	940.84 m (Ground)
PROJECT:	2021 TSF Site Investigation	END DATE:	July 20, 2022	COORDINATES:	N: 5820058.8 m E: 595034.3 m
PROJECT NO:	21452039 / 51300 / 51331	INCLINATION:	90.0°	COORD SYS:	CA Tailings Grid - Mount Polley
LOCATION:	Mount Polley Mine, Likely, B.C.	CONTRACTOR:	Geotech Drilling Services Ltd.	HORZ DATUM:	NAD83
				HOLE LOC:	Corner 1 Embankment Buttress

DRILL RIG: TSI 150CC Sonic Rig

DRILL METHOD: Sonic Drilling - 178-mm Hole Dia.

DEPTH (m)	MATERIAL PROFILE: DESCRIPTION	USCS	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	REC %	N-VALUE	SOIL CORE: RUN NO.	REC % (20 40 60 80)	WATER CONTENT: Plastic & Liquid Limits (%), Water Content (%), NP Nonplastic (0 20 40 60 80 100)	GRADATION %: GRAVEL	SAND	FINES	GROUNDWATER OBSERVATIONS	CONSTRUCTION AND INSTALLATION DETAILS
				0.00 / 940.08	1	GS			1							0.00 - 0.30 m bgs: Concrete
1	TAILINGS - (SP-SM) SAND, fine, poorly graded, some gravel, some fines; brown; non-cohesive, moist, compact.	SP-SM														
2	TAILINGS - (SM) SILTY SAND, fine, trace gravel; grey; non-cohesive, wet, compact.	SM		0.76 / 936.88	2	GS										
3					3	GS										0.30 - 6.10 m bgs: Bentonite Chips
4	ROCK FILL - (GW-GM) sandy GRAVEL, fine to coarse, well graded, subangular to angular, some fines; brown; 15% by volume cobbles/boulders; non-cohesive, moist, compact.	GW-GM		3.96	4	GS			2							
5																
6	- 6.10 m: becomes increased gravel and cobbles/ boulders content.															
7					5	GS			3							
8															21 Jul 22 13:00 ▼	6.10 - 10.77 m bgs: Cement-Bentonite Grout and Slough
9																
10																

Continued on Next Page

GW22-01
Stickup = 0.69 m

DEPTH SCALE: 1:50

HAMMER TYPE: N/A

REV: 0

LOGGED: Jonathan Simonson DATE: Jul 19, 2022

CHECKED: Germán Pizarro DATE: Jan 19, 2023

Draft

RECORD OF BOREHOLE: GA22-01

CLIENT:	Mount Polley Mining Corporation	START DATE:	July 19, 2022	ELEVATION:	940.84 m (Ground)
PROJECT:	2021 TSF Site Investigation	END DATE:	July 20, 2022	COORDINATES:	N: 5820058.8 m E: 595034.3 m
PROJECT NO:	21452039 / 51300 / 51331	INCLINATION:	90.0°	COORD SYS:	CA Tailings Grid - Mount Polley
LOCATION:	Mount Polley Mine, Likely, B.C.	CONTRACTOR:	Geotech Drilling Services Ltd.	HORZ DATUM:	NAD83
				HOLE LOC:	Corner 1 Embankment Buttress

DRILL RIG: TSI 150CC Sonic Rig

DRILL METHOD: Sonic Drilling - 178-mm Hole Dia.

DEPTH (m)	DESCRIPTION	USCS	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	REC %	N-VALUE	SOIL CORE RUN NO.	WATER CONTENT (Plastic & Liquid Limits (%), Water Content (%), NP Nonplastic)	GRADATION % GRAVEL	SAND	FINES	GROUNDWATER OBSERVATIONS	CONSTRUCTION AND INSTALLATION DETAILS
	ROCK FILL - (GW-GM) sandy GRAVEL, fine to coarse, well graded, subangular to angular, some fines; brown; 15% by volume cobbles/boulders; non-cohesive, moist, compact.	GW-GM	930.07					4						
11	(CL) SILTY CLAY and SAND, low plasticity, fine to coarse sand, some fine gravel; brown mottled, iron oxide staining, (TILL), grey veins with small rootlets; cohesive, w > PL, firm.		10.77	6	GS					9	37	54		
12	- 12.04 m: small inclusion of organics.	CL	928.65	7	GS									
	(CL) sandy SILTY CLAY, low plasticity, some gravel; brown, (TILL); cohesive, w < PL, very stiff.		12.19	8	GS									
13	- 12.95 to 13.41 m: becomes gravelly.		927.43											
	(SC) gravelly CLAYEY SAND, fine to coarse sand, low plasticity fines, fine to coarse gravel, grey, (TILL), presence of cobbles/boulders; cohesive, w < PL, hard.		13.41	9	GS			5						10.77 - 16.61 m bgs: Cement-Bentonite Grout
14														
15	- 15.24 m: becomes very stiff.	SC		10	GS					14	37	49		VW136218 (15.09 m)
16	- 16.15 m: becomes stiff.			11	GS									
			924.08											
17	(CL-ML) sandy SILTY CLAY to CLAYEY SILT, low plasticity, fine sand, trace gravel; dark grey, slight laminations; non-cohesive, moist to wet, compact to dense.		16.76	12	GS			6		0	13	87		
18	- 17.68 m: becomes trace sand, brown, wet, loose to compact	CL-ML		13	GS					0	3	97		16.61 - 18.44 m bgs: Bentonite Chips
			922.40											
19	(ML) sandy SILT, non plastic, trace gravel; brown; non-cohesive, wet, compact.	ML	18.44	14	GS									18.44 - 19.76 m bgs: Bentonite Pellets
			921.41											
20	(SM) gravelly SILTY SAND; brown, iron oxide staining; non-cohesive, wet, compact.	SM	19.43	15	GS			7						

Continued on Next Page

DEPTH SCALE: 1:50

HAMMER TYPE: N/A

REV: 0

LOGGED: Jonathan Simonson DATE: Jul 19, 2022

CHECKED: Germán Pizarro DATE: Jan 19, 2023

Document / Soil-Sonic 1 Gradation / Golder - 1 Metric Global / Golder CA Auto (common in Canada) / 2022-11-10

RECORD OF BOREHOLE: GA22-01

CLIENT:	Mount Polley Mining Corporation	START DATE:	July 19, 2022	ELEVATION:	940.84 m (Ground)
PROJECT:	2021 TSF Site Investigation	END DATE:	July 20, 2022	COORDINATES:	N: 5820058.8 m E: 595034.3 m
PROJECT NO:	21452039 / 51300 / 51331	INCLINATION:	90.0°	COORD SYS:	CA Tailings Grid - Mount Polley
LOCATION:	Mount Polley Mine, Likely, B.C.	CONTRACTOR:	Geotech Drilling Services Ltd.	HORZ DATUM:	NAD83
				HOLE LOC:	Corner 1 Embankment Buttress

DRILL RIG: TSI 150CC Sonic Rig

DRILL METHOD: Sonic Drilling - 178-mm Hole Dia.

DEPTH (m)	DESCRIPTION	USCS	ELEV. (m) / DEPTH (m)
21	(SM) gravelly SILTY SAND; brown, iron oxide staining; non-cohesive, wet, compact.	SM	920.42 / 20.42
	(SM) SILTY SAND, fine to coarse, non-plastic fines, trace gravel; brown, (GLACIOFLUVIAL); non-cohesive, wet, compact.		919.73
	- 21.11 to 21.16 m: silt lens		21.11
22	(SP-SM) gravelly SAND, medium to coarse, poorly graded, some fines; brown; non-cohesive, wet, compact. - 21.56 m: becomes fine to coarse sand, some gravel	SP-SM	918.59
	(CL) sandy SILTY CLAY, low plasticity, some gravel; brown, iron oxide staining, (TILL); cohesive, w < PL, stiff.	CL	22.25 / 918.28
23	BEDROCK, slightly weathered, grey, fine to coarse grained, strong to very strong.		22.56
24			
25			
26			914.02
27	End of hole at 26.82 m.		
28	Notes: - Chunk samples were collected approximately every 0.6 m and tested on-site for water content. - The compactness of non-cohesive soils was inferred based on resistance to drilling penetration.		
29			
30			

SAMPLES (Hammer: N/A; ASTM D1586, Blows per 0.15 m 623-N hammer, 0.76-m drop)

NUMBER	TYPE	REC %	N-VALUE
16	GS		
17	GS		
18	GS		
19	GS		
20	GS		
21	GS		
22	GS		
23	GS		

SOIL CORE: RUN NO. 8, 9, 10; REC % (20 40 60 80)

WATER CONTENT: Plastic & Liquid Limits (%); Water Content (%); NP Nonplastic; 0 20 40 60 80 100

GRADATION %

GRAVEL	SAND	FINES
2	71	27

GROUNDWATER OBSERVATIONS

CONSTRUCTION AND INSTALLATION DETAILS

- 19.76 - 21.79 m bgs: Silica Sand 10/20
- 21.79 - 26.82 m bgs: Bentonite Chips

DEPTH SCALE: 1:50

HAMMER TYPE: N/A

REV: 0

LOGGED: Jonathan Simonson DATE: Jul 19, 2022

CHECKED: Germán Pizarro DATE: Jan 19, 2023

Document / Soil-Sonic 1 Gradation / Golder - 1 Metric Global / Golder CA Auto (common in Canada) / 2022-11-10

MONITORING WELL COMPLETION AND BOREHOLE ABANDONMENT DETAILS

1) Well ID: GW22-01

2) Date: 20 July 2022

3) Borehole Diameter: 177.8 mm above 21.34 mbgs and 152.4 mm below 21.34 mbgs ☐ in ☐ m

4) Standpipe Diameter: 50.8 mm ☐ in ☐ m

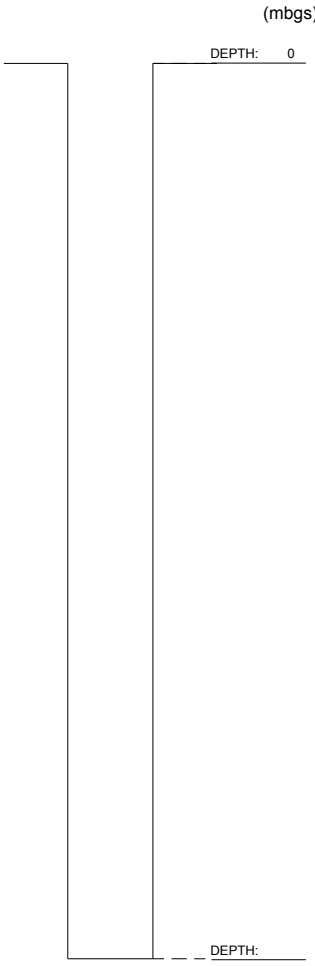
5) Screen Length: 1.52 m

6) Approx. Water Level: 8.67 ☒ mbgs ☐ mbtop

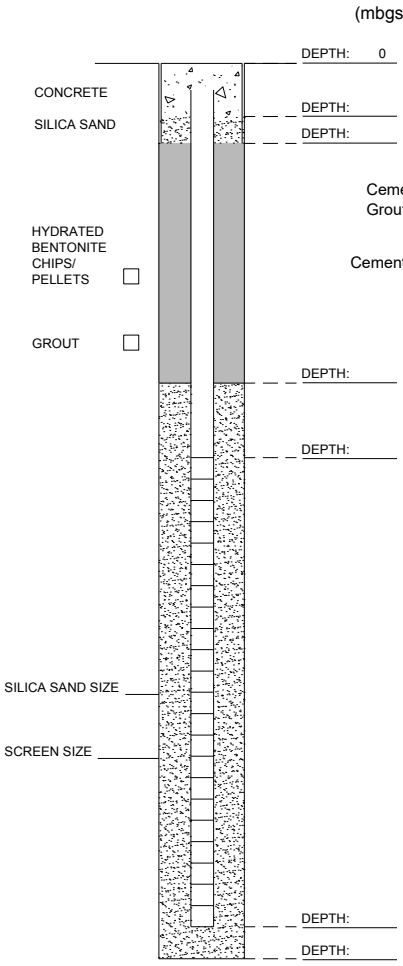
7) Approx. Well Depth: 21.64 ☒ mbgs ☐ mbtop

8) Stick-up Height: 0.69 ☒ mags
(Top of pipe)

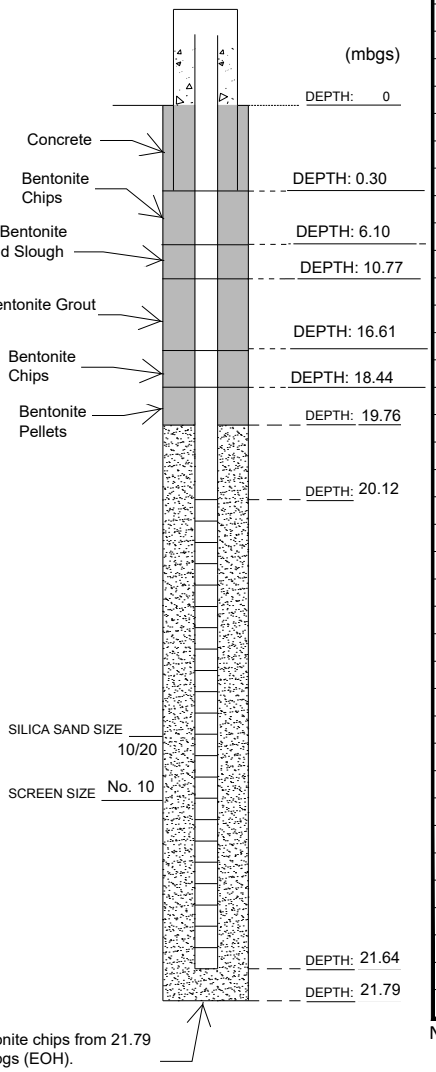
BOREHOLE ABANDONMENT



FLUSHMOUNT WELL INSTALLATION



STICK-UP WELL INSTALLATION



ft	m	ft	m
1	0.3	41	12.5
2	0.6	42	12.8
3	0.9	43	13.1
4	1.2	44	13.4
5	1.5	45	13.7
6	1.8	46	14.0
7	2.1	47	14.3
8	2.4	48	14.6
9	2.7	49	14.9
10	3.0	50	15.2
11	3.4	51	15.5
12	3.7	52	15.8
13	4.0	53	16.2
14	4.3	54	16.5
15	4.6	55	16.8
16	4.9	56	17.1
17	5.2	57	17.4
18	5.5	58	17.7
19	5.8	59	18.0
20	6.1	60	18.3
21	6.4	61	18.6
22	6.7	62	18.9
23	7.0	63	19.2
24	7.3	64	19.5
25	7.6	65	19.8
26	7.9	66	20.1
27	8.2	67	20.4
28	8.5	68	20.7
29	8.8	69	21.0
30	9.1	70	21.3
31	9.4	71	21.6
32	9.8	72	21.9
33	10.1	73	22.3
34	10.4	74	22.6
35	10.7	75	22.9
36	11.0	76	23.2
37	11.3	77	23.5
38	11.6	78	23.8
39	11.9	79	24.1
40	12.2	80	24.4

Note: 0.15 meters=6 inches

MONITORING WELL INSTALLATION GUIDELINES

BENTONITE SILICA SAND CONCRETE SLOUGH

mbgs = meters below ground surface; mags = meters above ground surface; mbtop = meters below top of pipe

Appendix D2
Photographs of Sonic Core



CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2022-11-04
PREPARED	RG
DESIGN	RG
REVIEW	GP
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
2022 TAILINGS STORAGE FACILITY GEOTECHNICAL INVESTIGATION

TITLE
BOREHOLE: GA22-01
DATE DRILLED: 19 JULY 2022
DEPTH RANGE: 0.0 to 20.0 ft / 0.0 to 6.1 m

PROJECT No.	Phase/Task	Rev.	Figure No.
22514095	**51100 / 51115**	**0**	**D-1**



CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2022-11-04
PREPARED	RG
DESIGN	RG
REVIEW	GP
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
2022 TAILINGS STORAGE FACILITY GEOTECHNICAL INVESTIGATION

TITLE
BOREHOLE: GA22-01
DATE DRILLED: 19 JULY 2022
DEPTH RANGE: 20.0 to 40.0 ft / 6.1 to 12.2 m

PROJECT No.	Phase/Task	Rev.	Figure No.
22514095	**51100 / 51115**	**0**	**D-2**





CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2022-11-04
PREPARED	RG
DESIGN	RG
REVIEW	GP
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
2022 TAILINGS STORAGE FACILITY GEOTECHNICAL INVESTIGATION

TITLE
BOREHOLE: GA22-01
DATE DRILLED: 19 JULY 2022
DEPTH RANGE: 40.0 to 58.7 ft / 12.2 to 17.9 m

PROJECT No.	Phase/Task	Rev.	Figure No.
22514095	**51100 / 51115**	**0**	**D-3**



CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2022-11-04
PREPARED	RG
DESIGN	RG
REVIEW	GP
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
2022 TAILINGS STORAGE FACILITY GEOTECHNICAL INVESTIGATION

TITLE
BOREHOLE: GA22-01
DATE DRILLED: 19 JULY 2022
DEPTH RANGE: 58.7 to 70.0 ft / 17.9 to 21.3 m

PROJECT No.	Phase/Task	Rev.	Figure No.
22514095	**51100 / 51115**	**0**	**D-4**





CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2022-11-04
PREPARED	RG
DESIGN	RG
REVIEW	GP
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
2022 TAILINGS STORAGE FACILITY GEOTECHNICAL INVESTIGATION

TITLE
BOREHOLE: GA22-01
DATE DRILLED: 19 / 20 JULY 2022
DEPTH RANGE: 70.0 to 80.0 ft / 21.3 to 24.4 m

PROJECT No.	Phase/Task	Rev.	Figure No.
22514095	**51100 / 51115**	**0**	**D-5**



CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2022-11-04
PREPARED	RG
DESIGN	RG
REVIEW	GP
APPROVED	GP

PROJECT
MOUNT POLLEY MINE
2022 TAILINGS STORAGE FACILITY GEOTECHNICAL INVESTIGATION

TITLE
BOREHOLE: GA22-01
DATE DRILLED: 20 JULY 2022
DEPTH RANGE: 80.0 to 88.0 ft / 24.4 to 26.8 m

PROJECT No.	Phase/Task	Rev.	Figure No.
22514095	**51100 / 51115**	**0**	**D-6**

Appendix D3
VWP Calibration Certificate

Calibration Record

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	HUCKLEBERRY MINES LTD.
Sales Order:	228638
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW136218
Mfg Number:	P136218
Range:	350 kPa
Cable Length:	20 meters
Cable Marking:	551052 m to 551073 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	9010	9010	9010	0.1	0.02	0.1	0.03
70.0	8328	8329	8329	69.8	-0.04	69.8	-0.05
140.0	7644	7644	7644	140.0	0.01	140.0	0.00
210.0	6960	6960	6960	210.1	0.02	210.1	0.01
280.0	6277	6277	6277	280.1	0.02	280.1	0.02
350.0	5596	5595	5595	349.9	-0.03	349.9	-0.02
Max Error (%)					0.04		0.05

Linear Calibration Factor: **CF = 1.0246e-01 kPa/B unit**
Temperature Correction Factor: **Tk = -7.3641e-02 kPa/°C rise**

Polynomial Gauge Factor:
A = 2.2220e-08 kPa/(B unit)² **B = -1.0278e-01 kPa/B unit** **C = calculate (see below) kPa**

Users must establish site zero readings for calculation purposes
Polynomial C = -[A(L_0^2) + B(L_0)]

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = $Hz^2/1000$ ie: 1700 Hz = 2890 B units

	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
Shipped Zero Readings:	15 Jul 2021	8986	21.6	1016.0

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 15/07/2021

Approved: Samantha Shaw **Date:** 15/07/2021

Appendix D4
Laboratory Test Results

Water Content Summary
ASTM D2216

Test Request #	B23-001	Project Number:	22514095-51100-51115
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation		

Sample Location	Sample				Soil Description	Water Content %	Method	Remarks
	Ref	Top (m)	Base (m)	Type				
GA22-01	CS1	0.46		CS		7.8	B	
GA22-01	CS2	2.29		CS		18.1	B	
GA22-01	CS3	3.51		CS		18.6	B	
GA22-01	CS4	5.03		CS		8.6	B	
GA22-01	CS5	11.43		CS		17.5	B	
GA22-01	CS6	12.04		CS		17.1	B	
GA22-01	CS7	12.65		CS		13.2	B	
GA22-01	CS8	13.11		CS		9.8	B	
GA22-01	CS9	13.87		CS		9.8	B	
GA22-01	CS10	14.33		CS		9.7	B	
GA22-01	CS11	15.09		CS		9.1	B	
GA22-01	CS12	15.54		CS		10.4	B	
GA22-01	CS13	16.31		CS		10.8	B	
GA22-01	CS14	17.22		CS		18.3	B	
GA22-01	CS15	18.14		CS		24.9	B	
GA22-01	CS16	18.59		CS		24.3	B	
GA22-01	CS17	19.32		CS		18.3	B	
GA22-01	CS18	19.66		CS		13.9	B	
GA22-01	CS19	20.27		CS		16.2	B	
GA22-01	CS20	20.88		CS		19.0	B	
GA22-01	CS21	21.22		CS		11.0	B	
GA22-01	CS22	22.10		CS		13.7	B	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with WSP's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of WSP's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: TBach **Date:** 25 Jul 2022

Checked by: SJohn **Date:** 10 Jan 2023

Reviewed by: RGarritsen **Date:** 10 Jan 2023

WSP Canada Inc.
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2,
Canada
[+1] 604 412 6899

Water Content Summary
ASTM D2216

Test Request #	B23-001	Project Number:	22514095-51100-51115
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation		

Sample Location	Sample				Soil Description	Water Content %	Method	Remarks
	Ref	Top (m)	Base (m)	Type				
GA22-01	CS23	22.40		CS		16.4	B	
GA22-01	CS24	23.32		CS		11.2	B	
GA22-01	CS25	23.93		CS		6.4	B	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with WSP's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of WSP's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: TBach **Date:** 25 Jul 2022

Checked by: SJohn **Date:** 10 Jan 2023

Reviewed by: RGarritsen **Date:** 10 Jan 2023

WSP Canada Inc.
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2,
Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

Water Content Summary
ASTM D2216

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation		

Sample Location	Sample				Soil Description	Water Content %	Method	Remarks
	Ref	Top (m)	Base (m)	Type				
GA22-01	6	11.28	11.58	GS		16.8	B	
GA22-01	10	14.94	15.24	GS		9.3	B	
GA22-01	12	17.07	17.37	GS		17.9	B	
GA22-01	13	17.98	18.29	GS		24.3	B	
GA22-01	17	20.73	21.03	GS		15.0	B	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JPandez **Date:** 30 Aug 2022

Checked by: VNogra **Date:** 01 Sep 2022

Reviewed by: SJohn **Date:** 07 Sep 2022

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

PARTICLE SIZE DISTRIBUTION

ASTM D6913 and ASTM D422

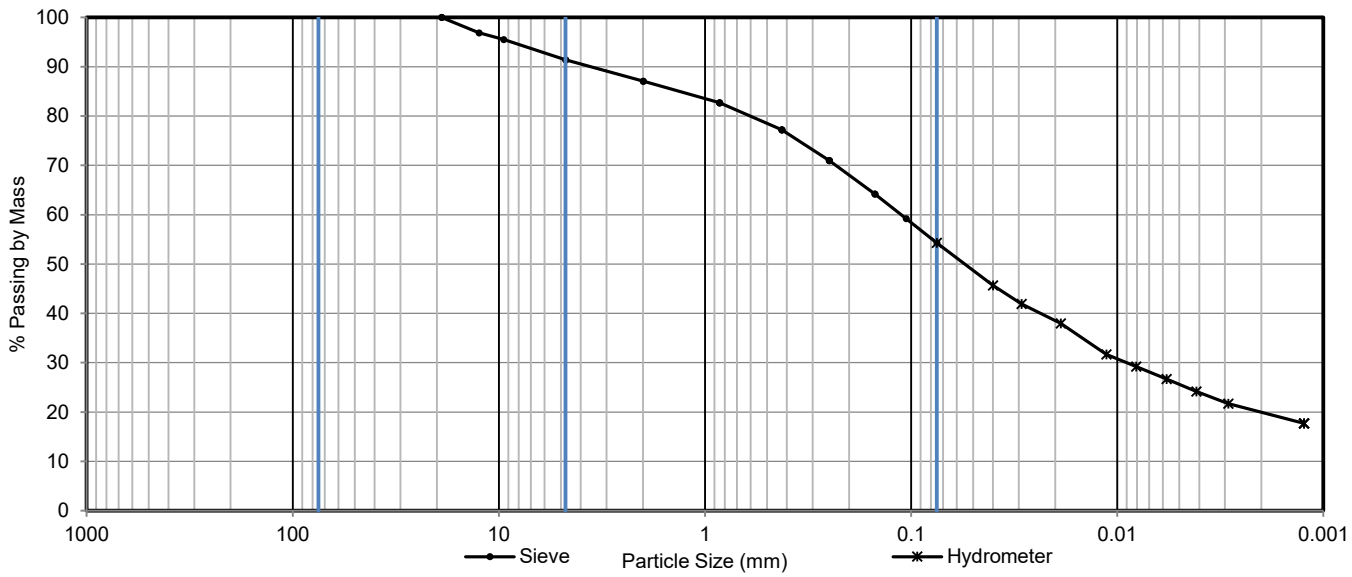
Method B

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	6
Soil Description:		Type:	GS
		Depth (m):	11.28 - 11.58

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	8/31/2022
Specimen Description	NA				

Grain Size Distribution (%) 8.6 37.1 54.3

BOULDER | COBBLE | GRAVEL (Coarse, Fine) | SAND (Coarse, Medium, Fine) | FINES (Silt, Clay)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
3/4"	19	100.0	0.0401	45.7
1/2"	12.5	96.9	0.0291	41.9
3/8"	9.5	95.5	0.0188	38.0
#4	4.75	91.4	0.0113	31.7
#10	2	87.1	0.0081	29.2
#20	0.85	82.7	0.0058	26.7
#40	0.425	77.2	0.0041	24.2
#60	0.25	71.0	0.0029	21.7
#100	0.15	64.2	0.0012	17.7
#140	0.106	59.2		
#200	0.075	54.3		
			0.005 mm	25.60
			0.002 mm	20.00
			D60	0.11
			D30	0.01
			D10	
			Cu	
			Cc	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: VNogra **Date:** 31-Aug-22 **Checked by:** VNogra **Date:** 1-Sep-22 **Reviewed by:** SJohn **Date:** 7-Sep-22

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

PARTICLE SIZE DISTRIBUTION

ASTM D6913 and ASTM D422

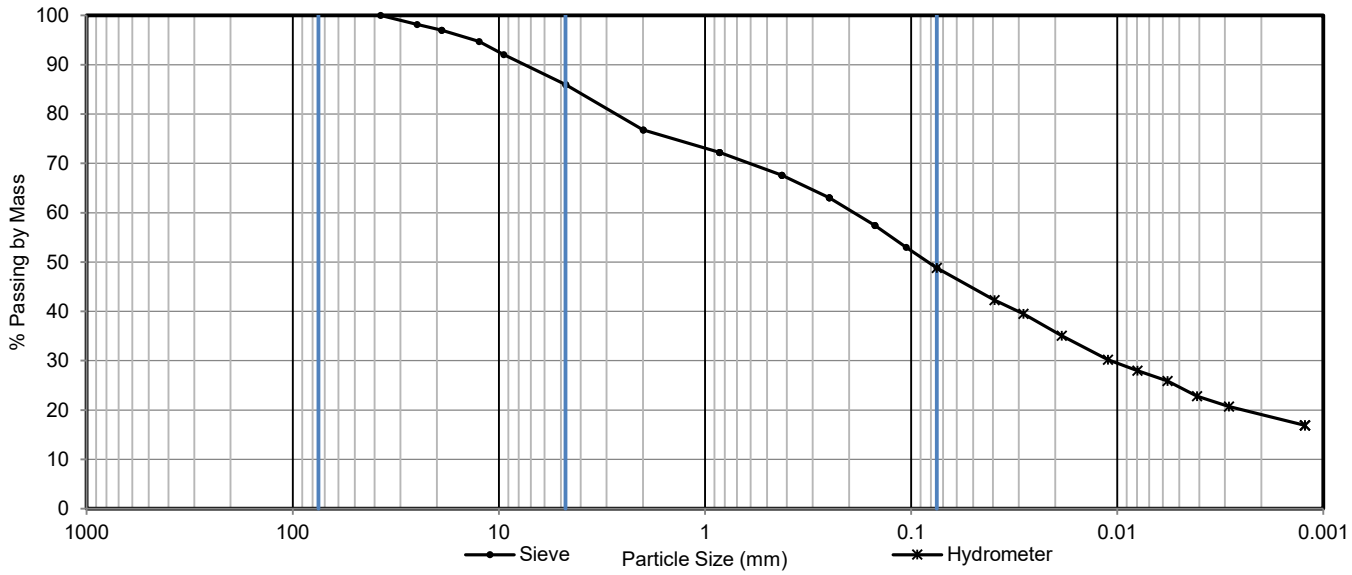
Method B

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	10
Soil Description:		Type:	GS
		Depth (m):	14.94 - 15.24

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	8/31/2022
Specimen Description	NA				

Grain Size Distribution (%) 14.0 37.2 48.8

BOULDER | COBBLE | GRAVEL (Coarse, Fine) | SAND (Coarse, Medium, Fine) | FINES (Silt, Clay)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1 1/2"	37.5	100.0	0.0394	42.3
1"	25	98.2	0.0285	39.5
3/4"	19	97.0	0.0186	35.1
1/2"	12.5	94.7	0.0111	30.2
3/8"	9.5	92.1	0.0080	28.0
#4	4.75	86.0	0.0057	25.9
#10	2	76.8	0.0041	22.8
#20	0.85	72.2	0.0029	20.7
#40	0.425	67.6	0.0012	16.9
#60	0.25	63.1		
#100	0.15	57.5		
#140	0.106	53.0		
#200	0.075	48.8		
			0.005 mm	24.60
			0.002 mm	19.10
			D60	0.19
			D30	0.01
			D10	
			Cu	
			Cc	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: VNogra **Date:** 31-Aug-22 **Checked by:** VNogra **Date:** 1-Sep-22 **Reviewed by:** SJohn **Date:** 7-Sep-22

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

PARTICLE SIZE DISTRIBUTION

ASTM D6913 and ASTM D422

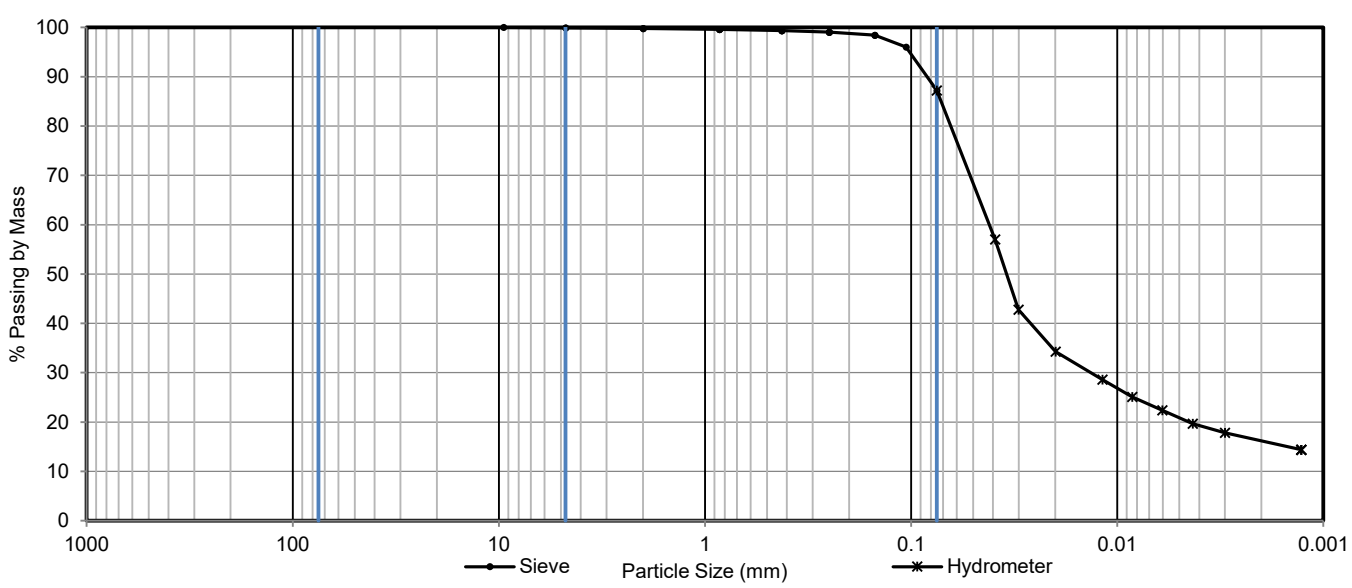
Method B

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	12
Soil Description:		Type:	GS
		Depth (m):	17.07 - 17.37

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	8/31/2022
Specimen Description	NA				

Grain Size Distribution (%) 0.1 12.7 87.2

BOULDER | COBBLE | GRAVEL (Coarse, Fine) | SAND (Coarse, Medium, Fine) | FINES (Silt, Clay)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
3/8"	9.5	100.0	0.0391	57.0
#4	4.75	99.9	0.0301	42.8
#10	2	99.8	0.0199	34.3
#20	0.85	99.6	0.0118	28.6
#40	0.425	99.3	0.0085	25.1
#60	0.25	99.0	0.0060	22.4
#100	0.15	98.4	0.0043	19.7
#140	0.106	96.1	0.0030	17.8
#200	0.075	87.2	0.0013	14.4
			0.005 mm	20.90
			0.002 mm	16.20
			D60	0.04
			D30	0.01
			D10	
			Cu	
			Cc	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: VNogra **Date:** 31-Aug-22 **Checked by:** VNogra **Date:** 1-Sep-22 **Reviewed by:** SJohn **Date:** 7-Sep-22

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

PARTICLE SIZE DISTRIBUTION

ASTM D6913 and ASTM D422

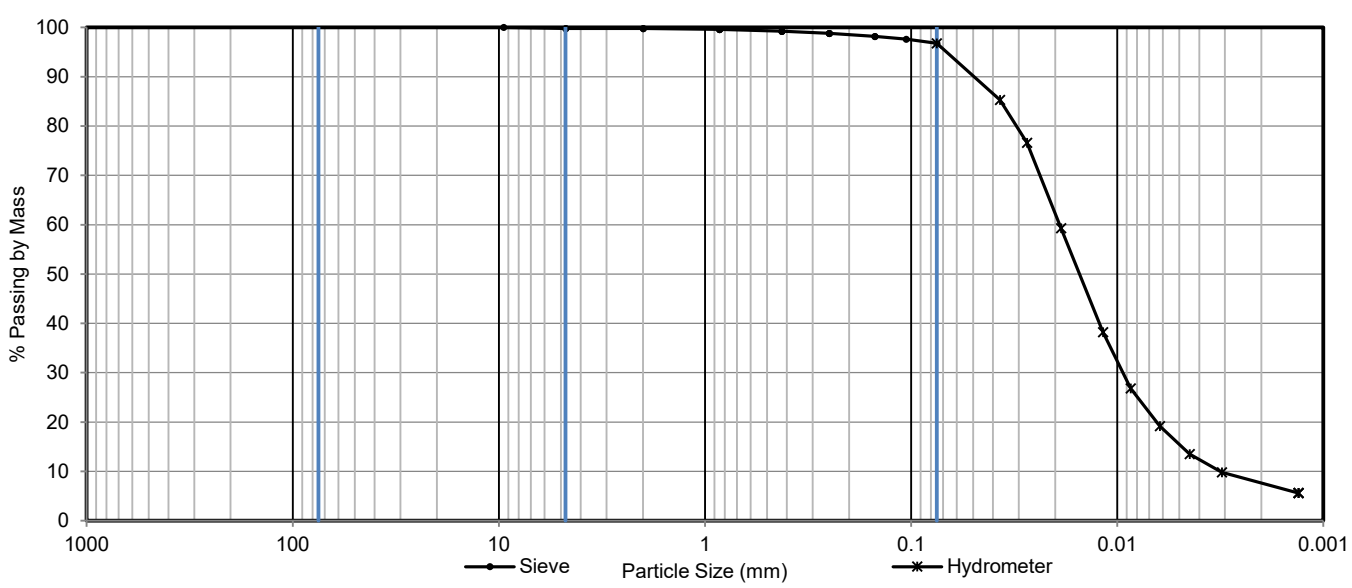
Method B

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	13
Soil Description:		Type:	GS
		Depth (m):	17.98 - 18.29

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	8/31/2022
Specimen Description	NA				

Grain Size Distribution (%) 0.2 3.0 96.8

BOULDER | COBBLE | GRAVEL (Coarse, Fine) | SAND (Coarse, Medium, Fine) | FINES (Silt, Clay)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
3/8"	9.5	100.0	0.0371	85.3
#4	4.75	99.8	0.0274	76.6
#10	2	99.8	0.0187	59.3
#20	0.85	99.6	0.0117	38.2
#40	0.425	99.2	0.0086	26.8
#60	0.25	98.8	0.0062	19.2
#100	0.15	98.2	0.0045	13.5
#140	0.106	97.6	0.0031	9.8
#200	0.075	96.8	0.0013	5.6
			0.005 mm	15.50
			0.002 mm	7.60
			D60	0.02
			D30	0.01
			D10	0.00
			Cu	6.00
			Cc	1.50

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: VNogra **Date:** 31-Aug-22 **Checked by:** VNogra **Date:** 1-Sep-22 **Reviewed by:** SJohn **Date:** 7-Sep-22

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

PARTICLE SIZE DISTRIBUTION

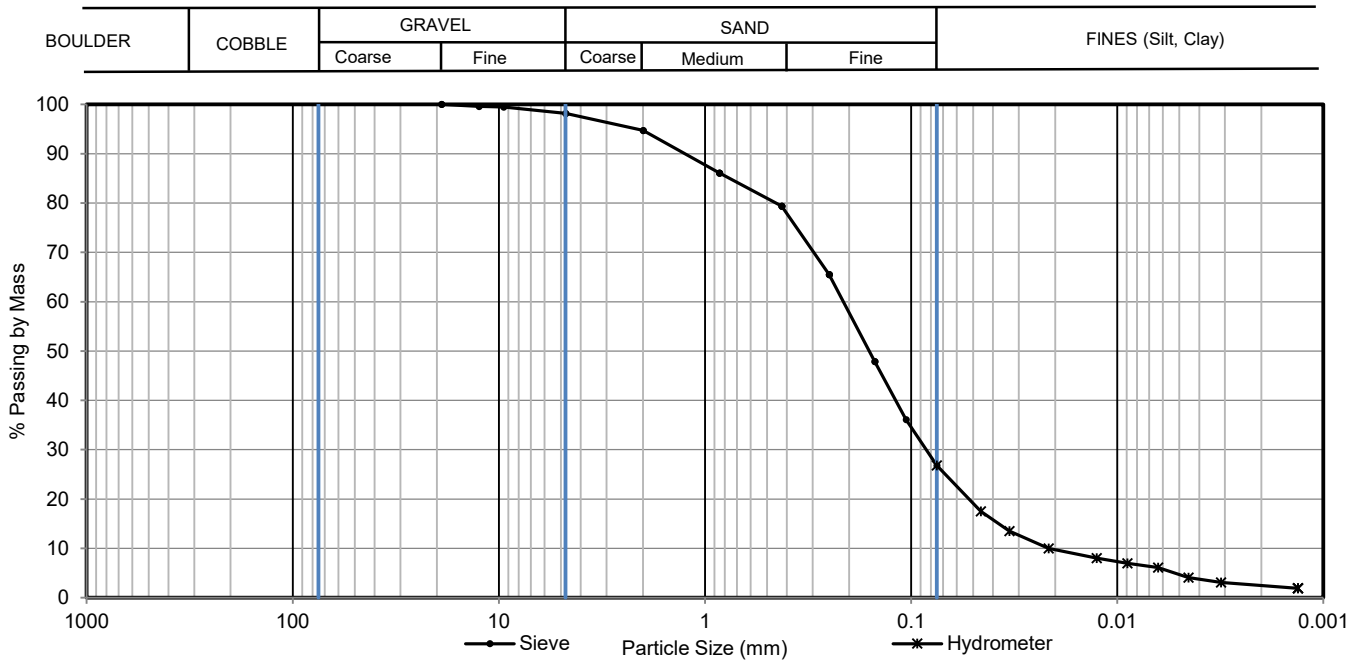
ASTM D6913 and ASTM D422

Method B

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	17
Soil Description:		Type:	GS
		Depth (m):	20.73 - 21.03

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	8/31/2022
Specimen Description	NA				

Grain Size Distribution (%) 1.8 71.4 26.8



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
3/4"	19	100.0	0.0459	17.5
1/2"	12.5	99.6	0.0333	13.5
3/8"	9.5	99.5	0.0215	10.0
#4	4.75	98.2	0.0126	8.0
#10	2	94.7	0.0089	7.0
#20	0.85	86.1	0.0063	6.1
#40	0.425	79.4	0.0045	4.1
#60	0.25	65.5	0.0031	3.1
#100	0.15	47.9	0.0013	1.9
#140	0.106	36.1		
#200	0.075	26.8		
			0.005 mm	4.70
			0.002 mm	2.50
			D60	0.21
			D30	0.08
			D10	0.02
			Cu	9.90
			Cc	1.60

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: VNogra **Date:** 31-Aug-22 **Checked by:** VNogra **Date:** 1-Sep-22 **Reviewed by:** SJohn **Date:** 7-Sep-22

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

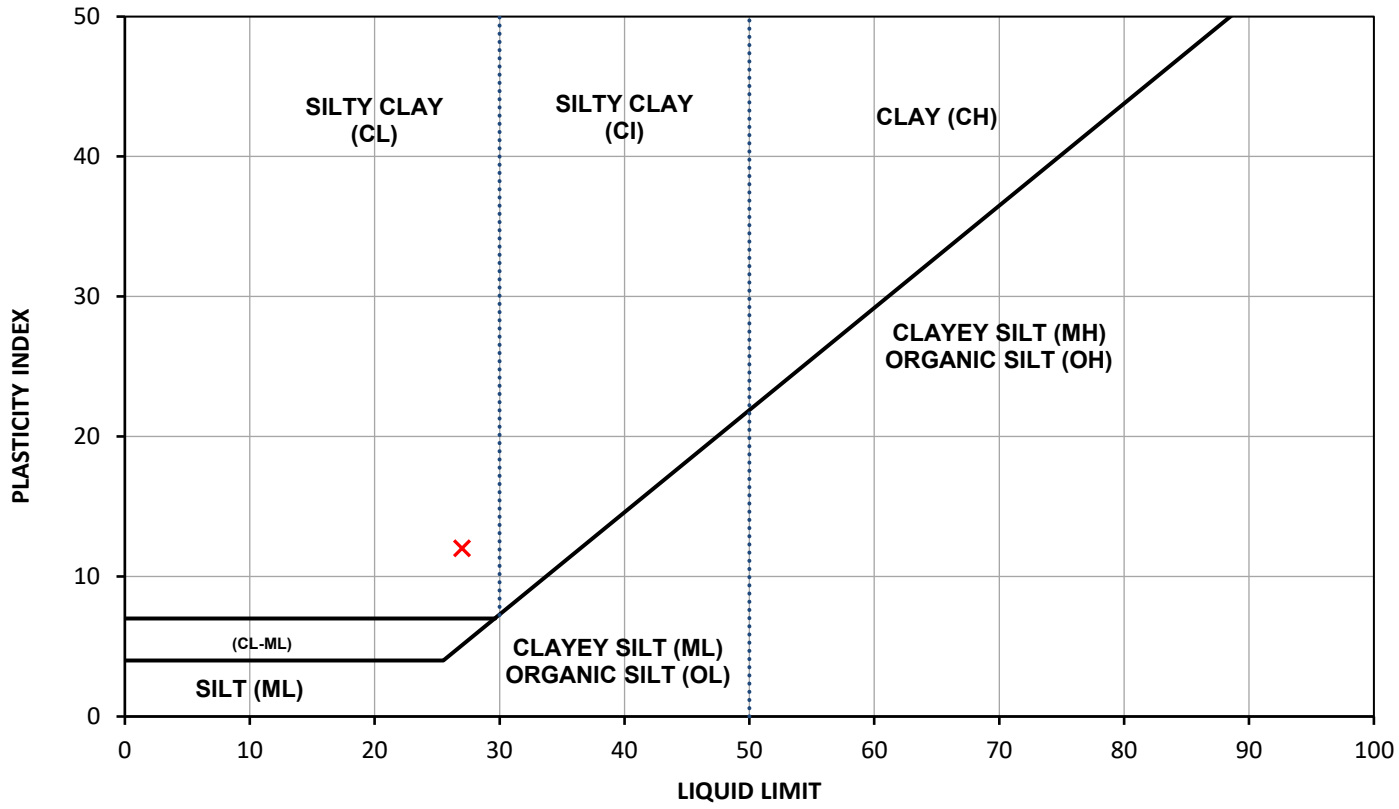
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

ASTM D4318

Method A - Multipoint Test

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	6
Soil Description:		Type:	GS
		Depth (m):	11.28 - 11.58

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	01 Sep 2022
Specimen Description	NA				



Legend
A-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
GA22-01	6	11.28	11.58	77	16.8	27	15	12	0.15

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested after >425um removed

Notes:

Disclaimer:
The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JPandez **Date:** 01 Sep 2022
Checked by: VNogra **Date:** 06 Sep 2022
Reviewed by: SJohn **Date:** 07 Sep 2022

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

GOLDER
MEMBER OF WSP

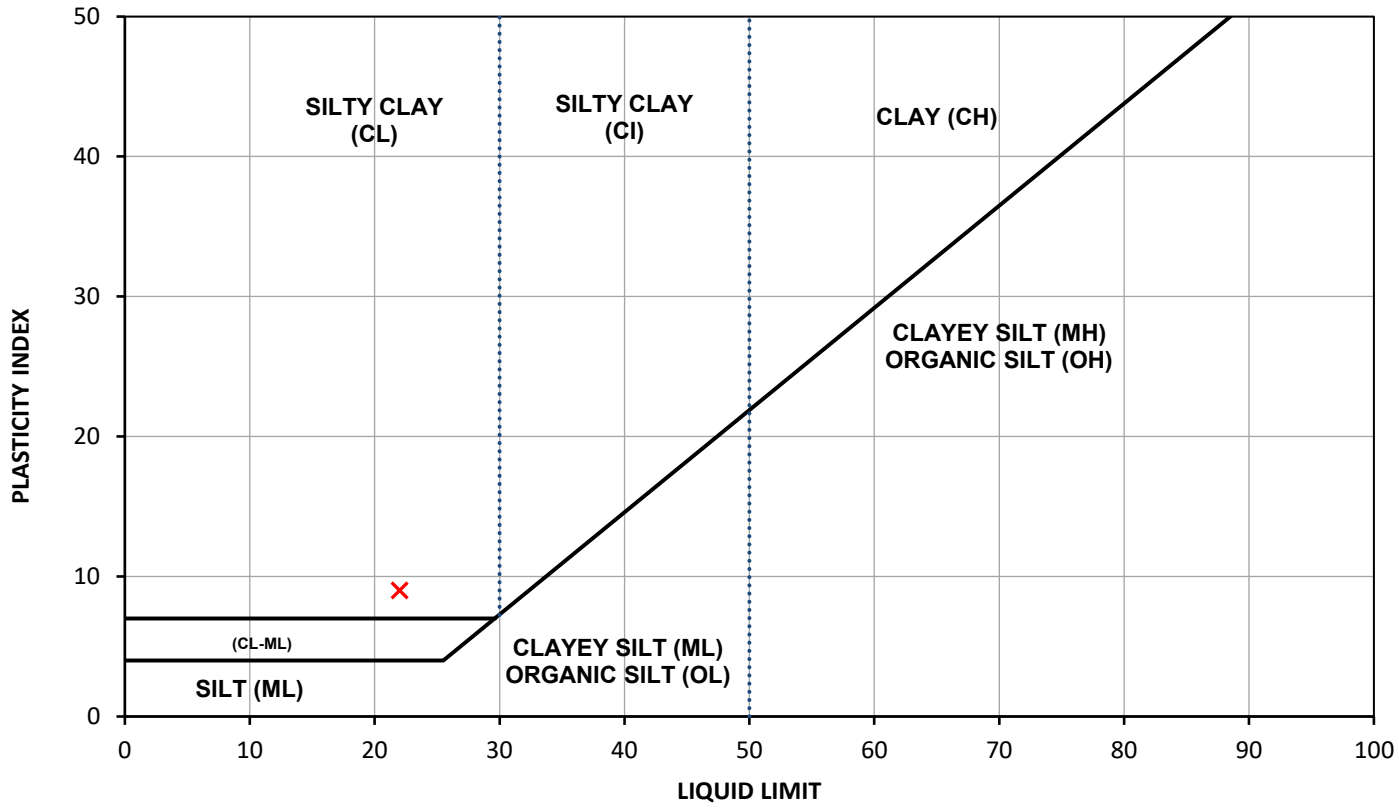
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

ASTM D4318

Method A - Multipoint Test

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	10
Soil Description:		Type:	GS
		Depth (m):	14.94 - 15.24

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	01 Sep 2022
Specimen Description	NA				



Legend
A-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
GA22-01	10	14.94	15.24	68	9.3	22	13	9	-0.41

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested after >425um removed

Notes:

Disclaimer:
The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JPandez **Date:** 01 Sep 2022
Checked by: VNogra **Date:** 06 Sep 2022
Reviewed by: SJohn **Date:** 07 Sep 2022

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

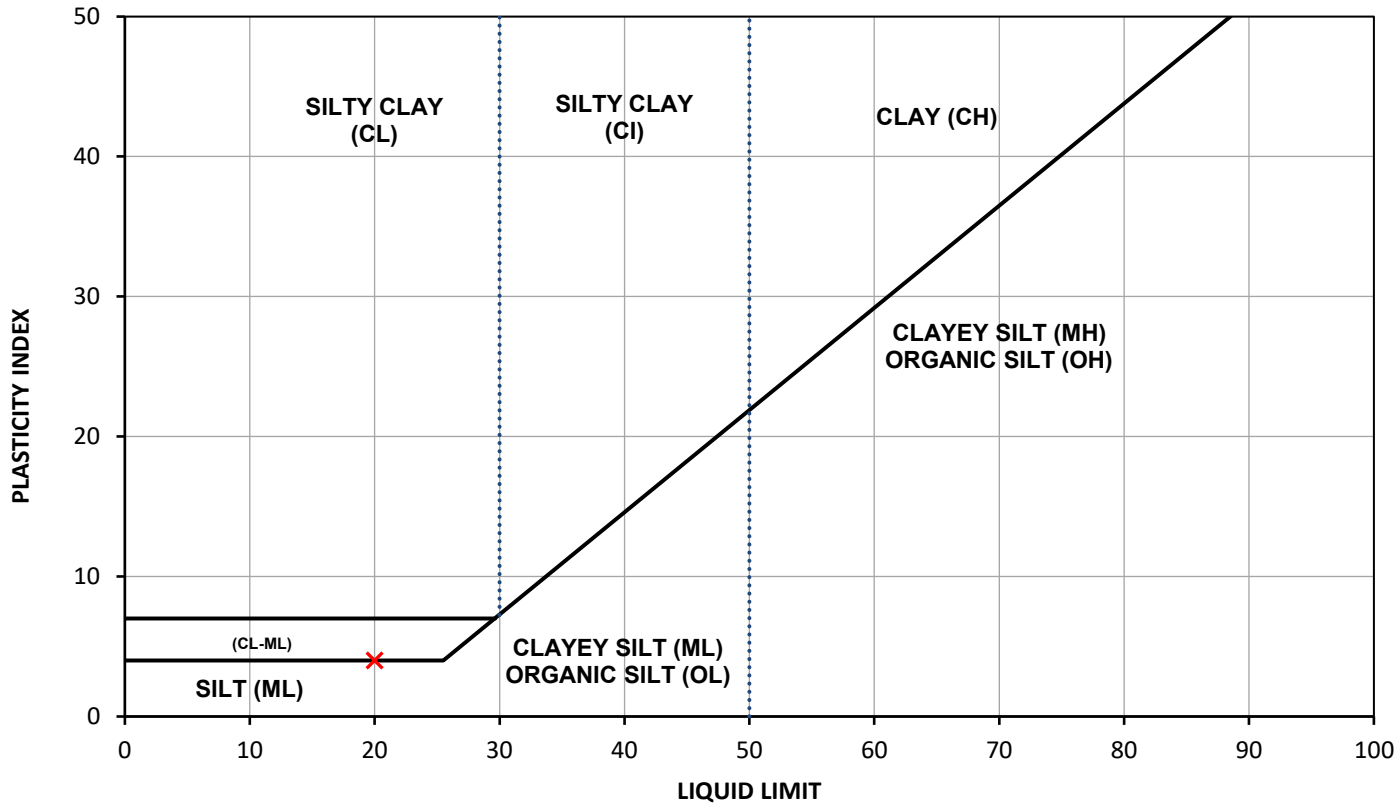
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

ASTM D4318

Method A - Multipoint Test

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	12
Soil Description:		Type:	GS
		Depth (m):	17.07 - 17.37

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	06 Sep 2022
Specimen Description	NA				



Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
GA22-01	12	17.07	17.37	99	17.9	20	16	4	0.48

NP = Non-Plastic
ND = Not Determined

Test Preparation
Wet Preparation Tested in natural condition

Notes:

Disclaimer:
The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JPandez **Date:** 06 Sep 2022
Checked by: VNogra **Date:** 07 Sep 2022
Reviewed by: SJohn **Date:** 07 Sep 2022

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

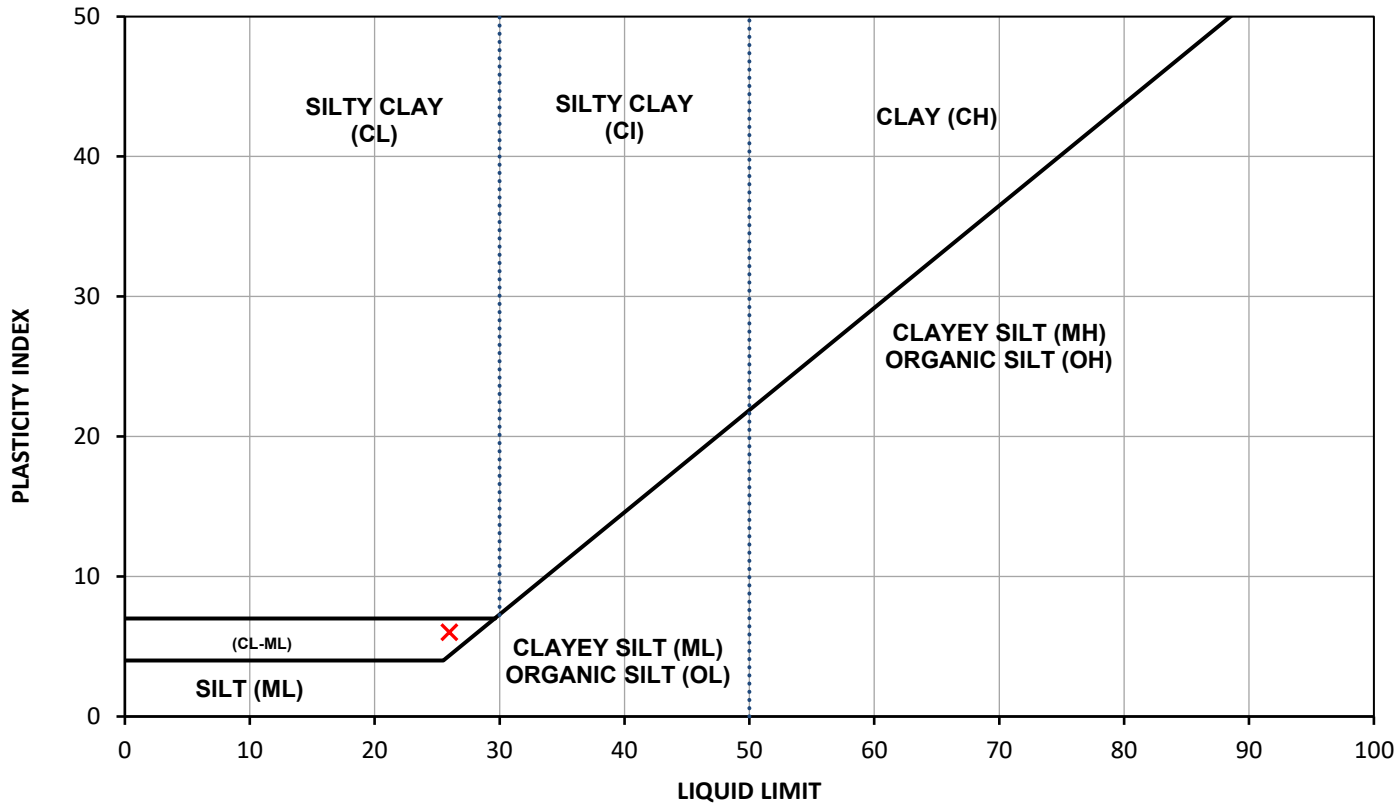
LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

ASTM D4318

Method A - Multipoint Test

Test Request #	B22-274	Project Number:	22514095-51300-51331
Client:	Mount Polley Mining Corporation	Project Location:	Mount Polley Mine, Likely, BC
Project Name:	2022 TSF Geotechnical Investigation	Sample Location:	GA22-01
Source:		Sample No.:	13
Soil Description:		Type:	GS
		Depth (m):	17.98 - 18.29

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	06 Sep 2022
Specimen Description	NA				



Legend

A-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
GA22-01	13	17.98	18.29	99	24.3	26	20	6	0.72

NP = Non-Plastic
ND = Not Determined

Test Preparation
Wet Preparation Tested in natural condition

Notes:

Disclaimer:
The laboratory testing services reported herein have been performed in accordance with the terms of a contract with Golder's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of Golder's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

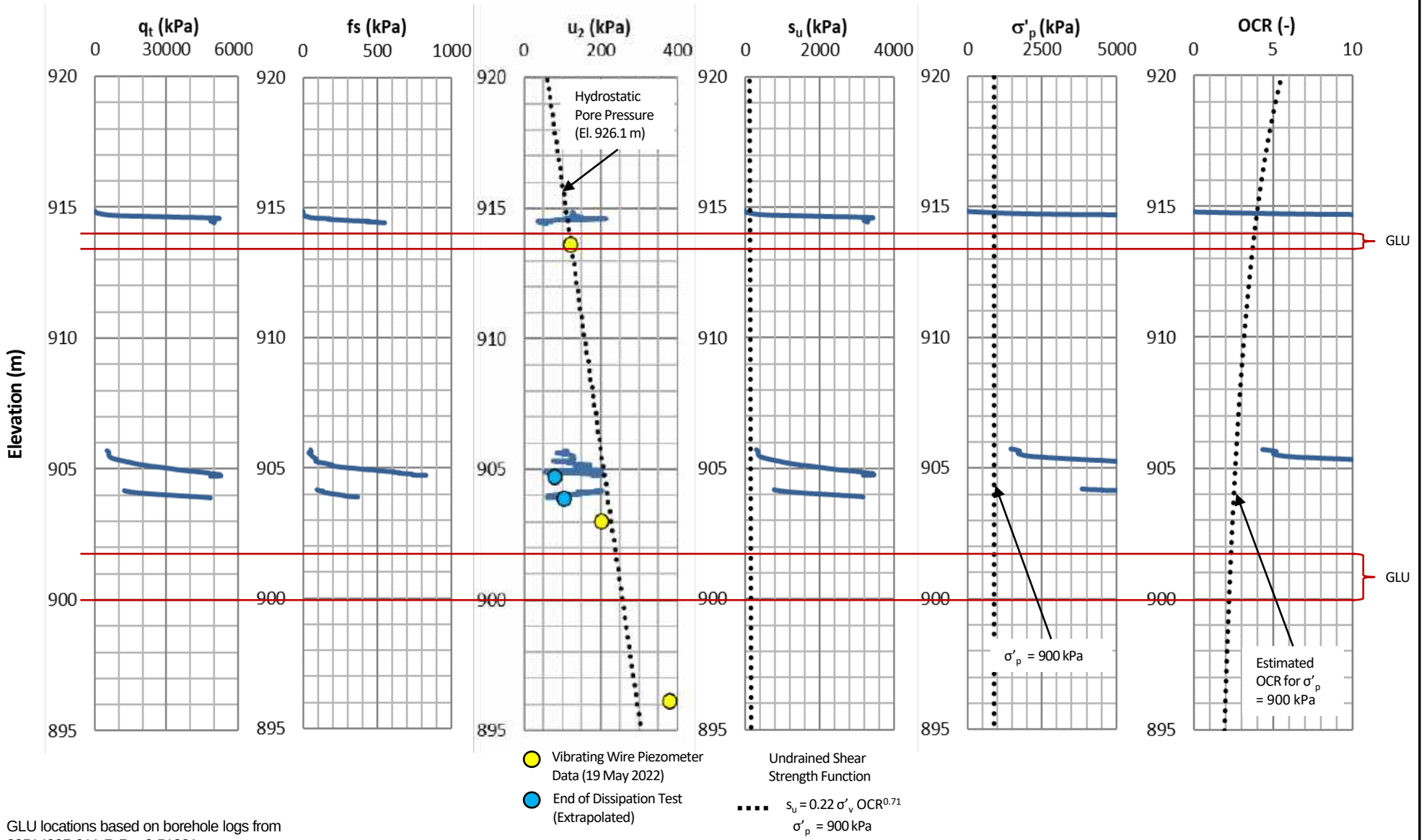
Tested by: JPandez **Date:** 06 Sep 2022
Checked by: VNogra **Date:** 07 Sep 2022
Reviewed by: SJohn **Date:** 07 Sep 2022

Golder Associates
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada
[+1] 604 412 6899

APPENDIX E

2021 CPT Data and Interpretation

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIlkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946



GLU locations based on borehole logs from 22514095-011-R-Rev0-51391.

REFERENCES/NOTES

1. q_t = Tip Resistance
2. fs = Sleeve Friction
3. u_2 = Pore Pressure
4. s_u = Undrained Shear Strength
5. σ'_p = Preconsolidation Stress
6. OCR = Overconsolidation Ratio
7. σ'_v = Vertical Effective Stress
8. σ_v = Total Vertical Stress
9. GLU = Glaciolacustrine Unit
10. $s_u = (q_t-\sigma_v)/15$
11. $\sigma'_p = 0.33(q_t-\sigma_v)$
12. $OCR = \sigma'_p/\sigma'_v$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

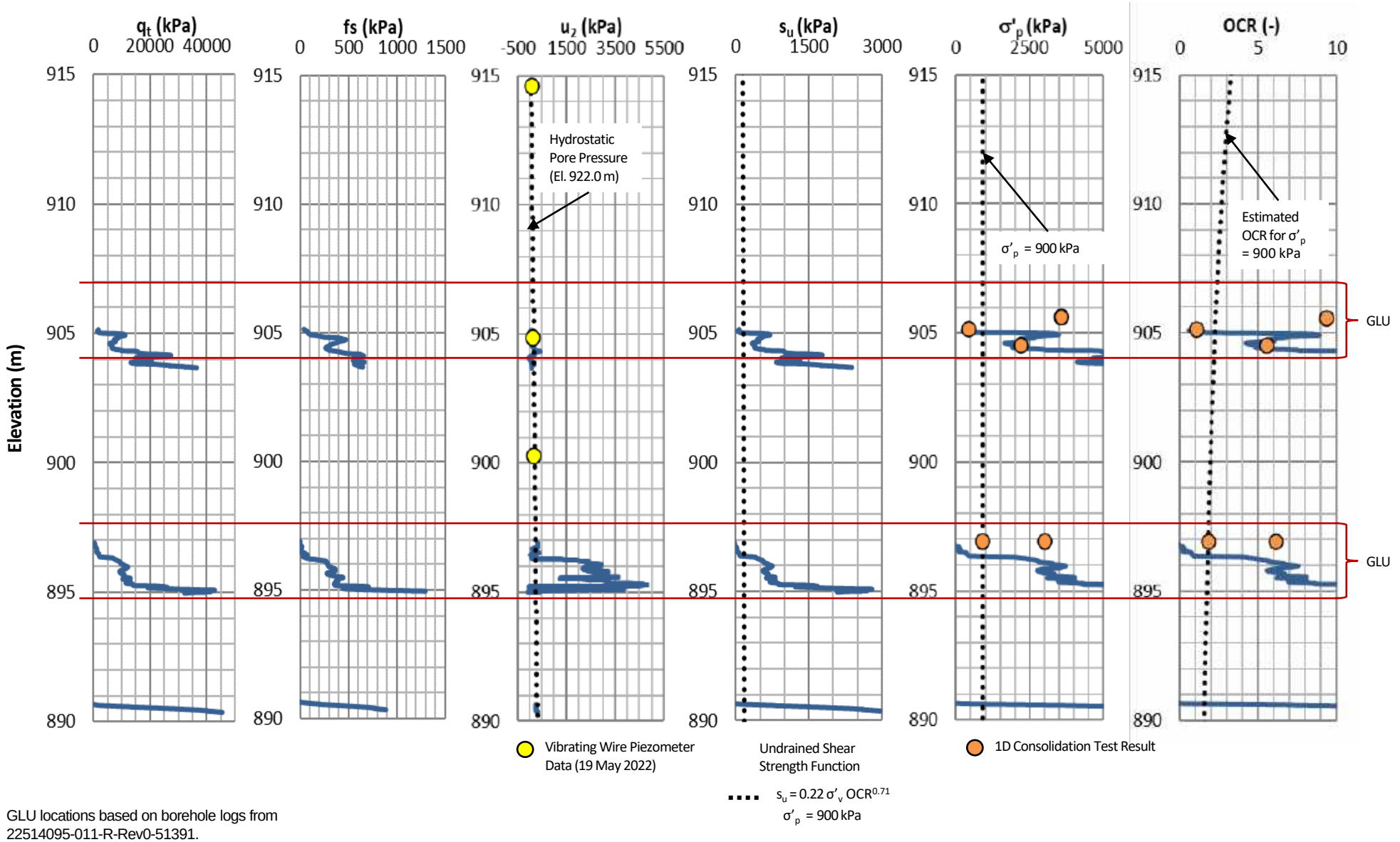
YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
CPT21-02

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-1

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946



GLU locations based on borehole logs from 22514095-011-R-Rev0-51391.

REFERENCES/NOTES

1. q_t = Tip Resistance
2. fs = Sleeve Friction
3. u_2 = Pore Pressure
4. s_u = Undrained Shear Strength
5. σ'_p = Preconsolidation Stress
6. OCR = Overconsolidation Ratio
7. σ'_v = Vertical Effective Stress
8. σ_v = Total Vertical Stress
9. GLU = Glaciolacustrine Unit
10. $s_u = (q_t - \sigma_v)/15$
11. $\sigma'_p = 0.33(q_t - \sigma_v)$
12. $OCR = \sigma'_p / \sigma'_v$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

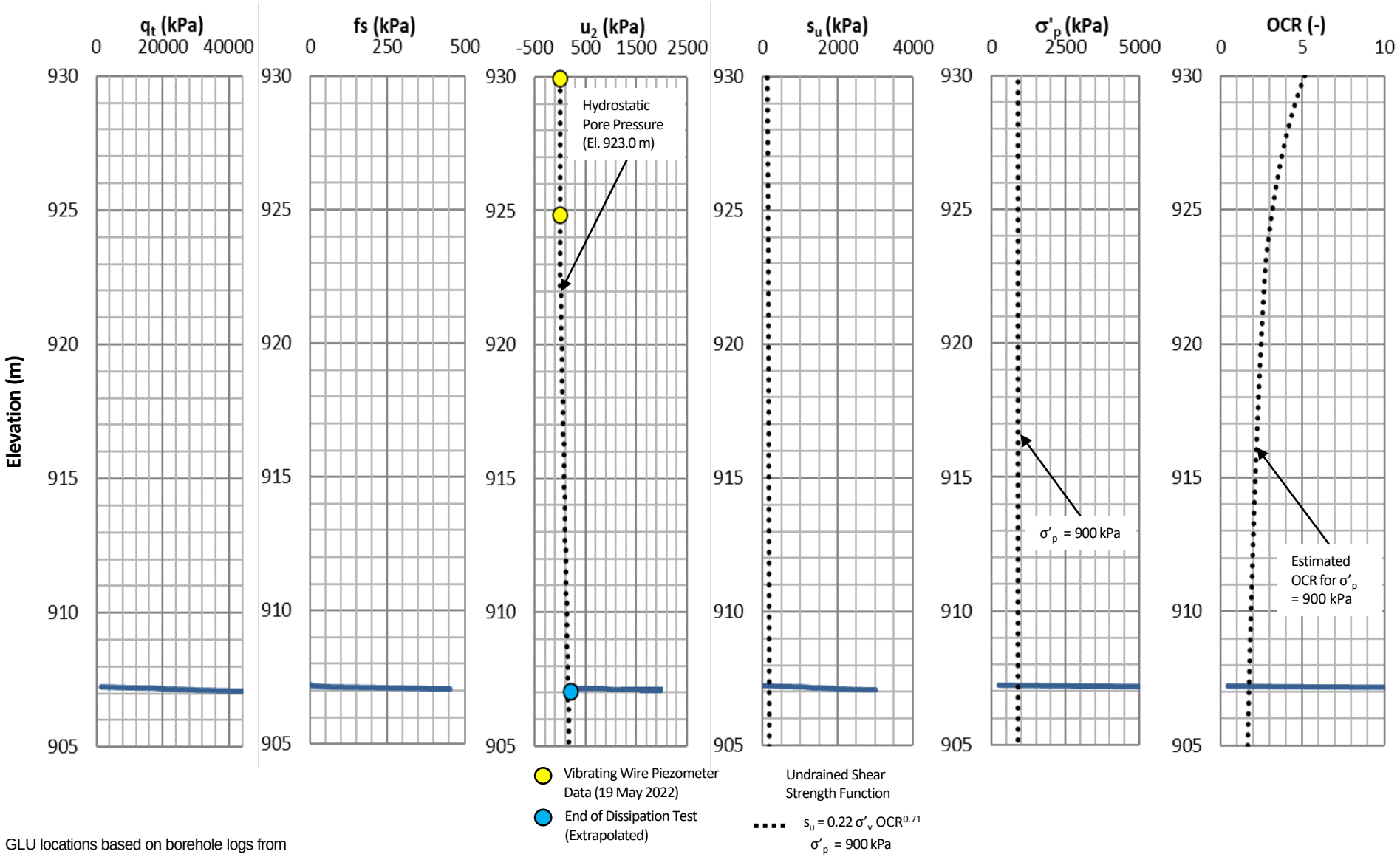
YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
CPT21-03

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-2

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946



GLU locations based on borehole logs from 22514095-011-R-Rev0-51391.

REFERENCES/NOTES

1. q_t = Tip Resistance
2. fs = Sleeve Friction
3. u_2 = Pore Pressure
4. s_u = Undrained Shear Strength
5. σ'$_p$ = Preconsolidation Stress
6. OCR = Overconsolidation Ratio
7. σ'$_v$ = Vertical Effective Stress
8. σ_v = Total Vertical Stress
9. GLU = Glaciolacustrine Unit
10. $s_u = (q_t-\sigma_v)/15$
11. $\sigma'_p = 0.33(q_t-\sigma_v)$
12. $OCR = \sigma'_p/\sigma'_v$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

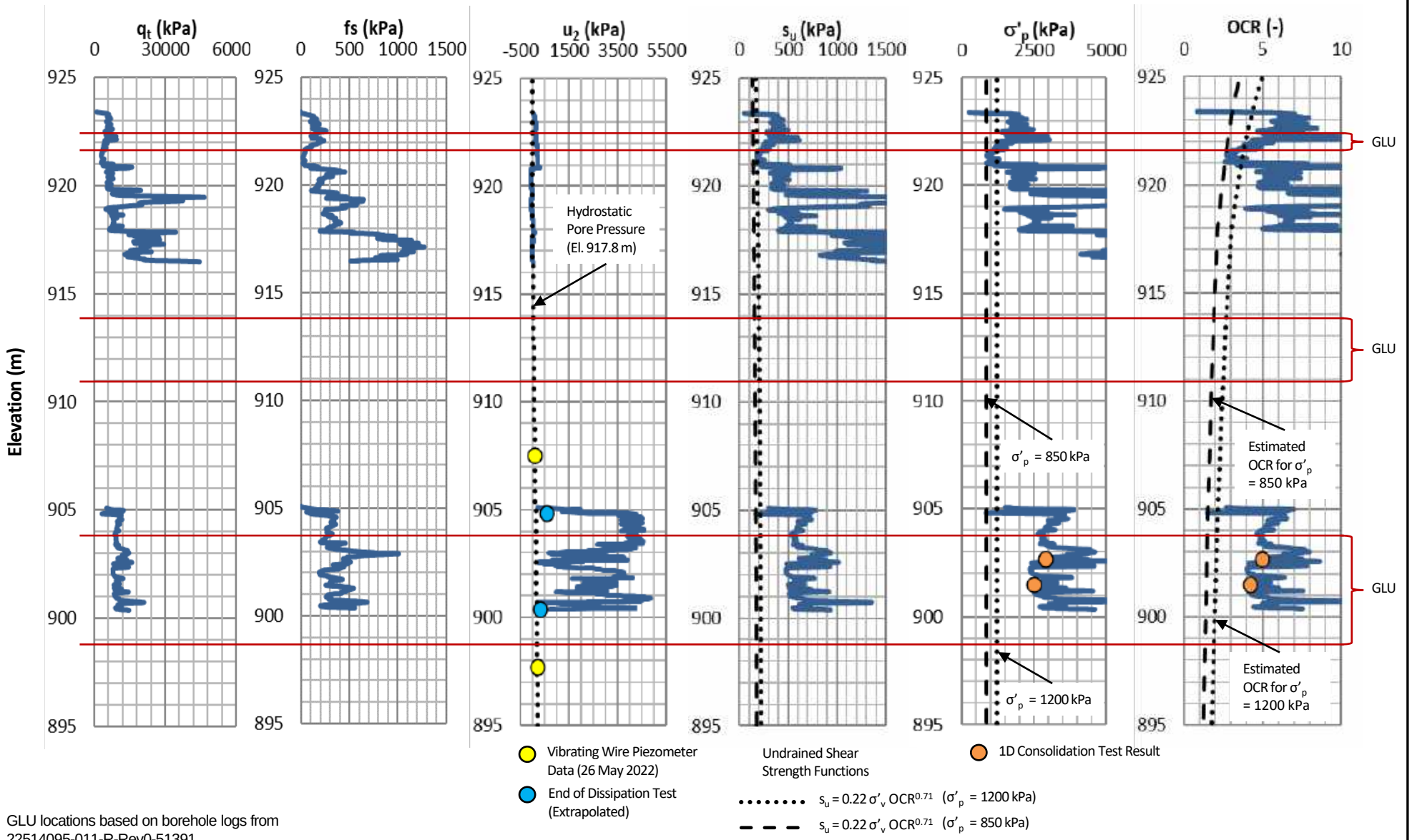
YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
CPT21-06

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-3

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIlkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946



GLU locations based on borehole logs from 22514095-011-R-Rev0-51391.

REFERENCES/NOTES

1. q_t = Tip Resistance
2. fs = Sleeve Friction
3. u_2 = Pore Pressure
4. s_u = Undrained Shear Strength
5. σ'$_p$ = Preconsolidation Stress
6. OCR = Overconsolidation Ratio
7. σ'$_v$ = Vertical Effective Stress
8. σ_v = Total Vertical Stress
9. GLU = Glaciolacustrine Unit
10. $s_u = (q_t-\sigma_v)/15$
11. $\sigma'_p = 0.33(q_t-\sigma_v)$
12. $OCR = \sigma'_p/\sigma'_v$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

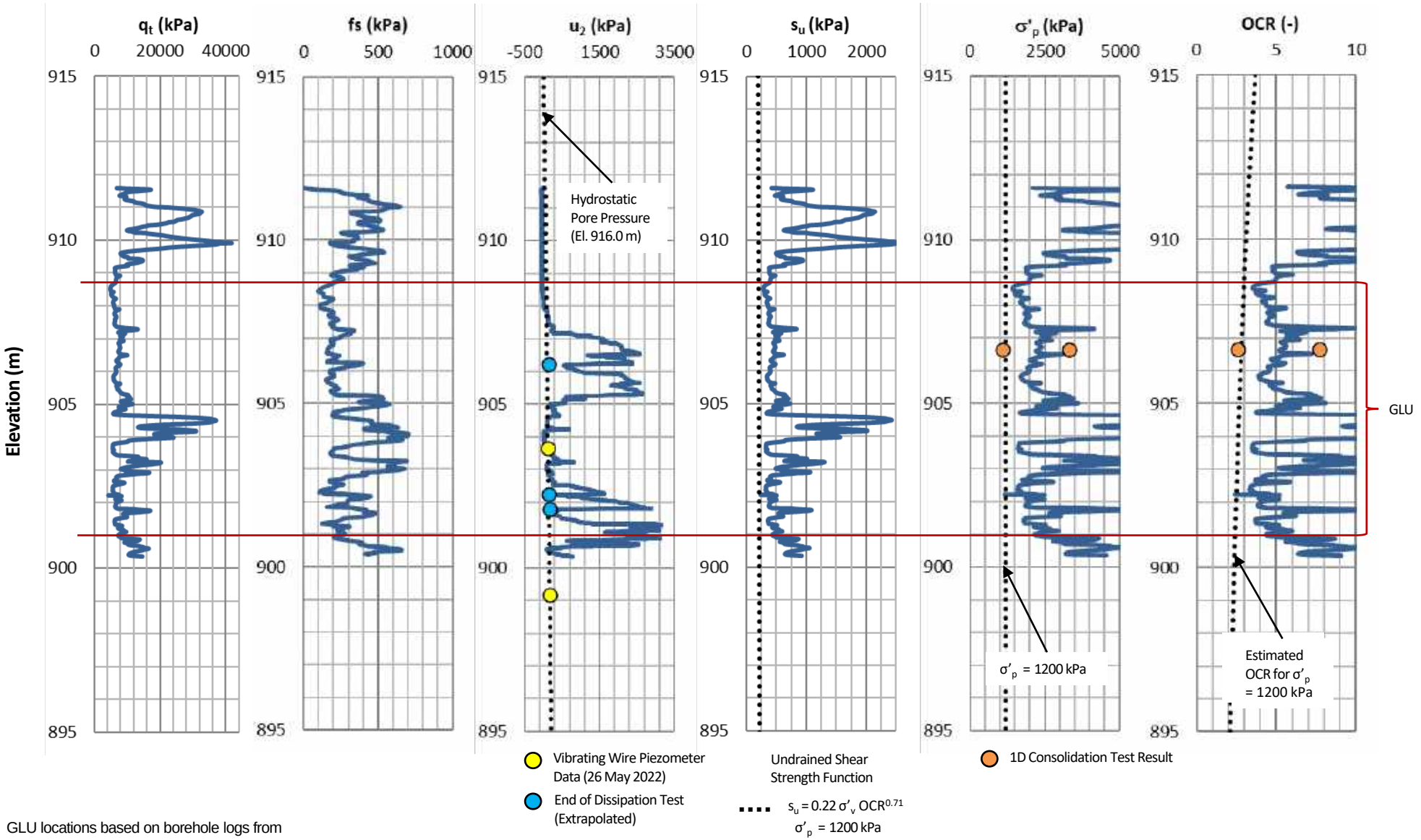
YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
CPT21-07

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-4

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIlkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946



GLU locations based on borehole logs from 22514095-011-R-Rev0-51391.

REFERENCES/NOTES

1. q_t = Tip Resistance
2. fs = Sleeve Friction
3. u_2 = Pore Pressure
4. s_u = Undrained Shear Strength
5. σ'_p = Preconsolidation Stress
6. OCR = Overconsolidation Ratio
7. σ'_v = Vertical Effective Stress
8. σ_v = Total Vertical Stress
9. GLU = Glaciolacustrine Unit
10. $s_u = (q_t-\sigma_v)/15$
11. $\sigma'_p = 0.33(q_t-\sigma_v)$
12. $OCR = \sigma'_p/\sigma'_v$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

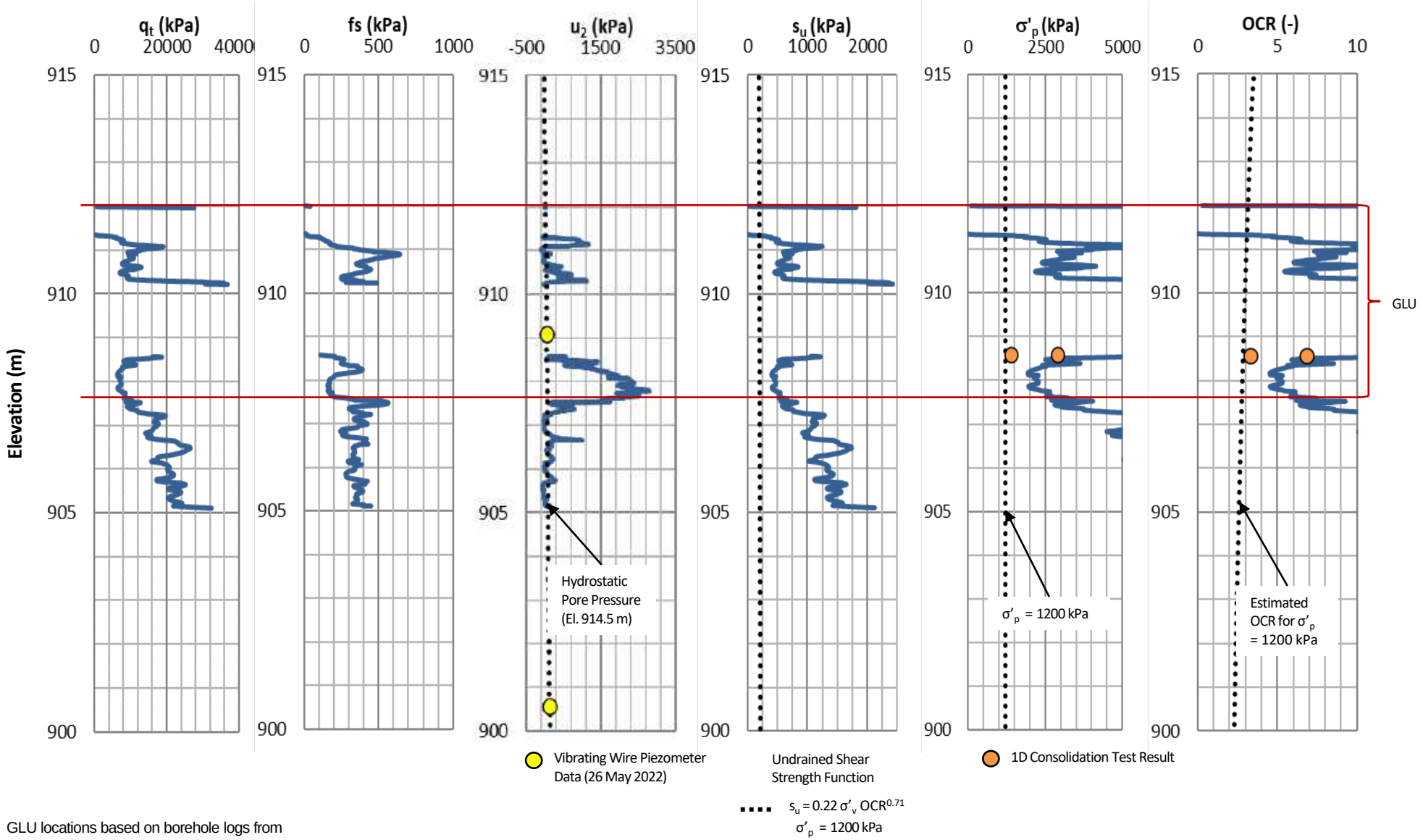
YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
CPT21-08

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-5

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946



GLU locations based on borehole logs from 22514095-011-R-Rev0-51391.

REFERENCES/NOTES

1. q_t = Tip Resistance
2. fs = Sleeve Friction
3. u_2 = Pore Pressure
4. s_u = Undrained Shear Strength
5. σ'_p = Preconsolidation Stress
6. OCR = Overconsolidation Ratio
7. σ'_v = Vertical Effective Stress
8. σ_v = Total Vertical Stress
9. GLU = Glaciolacustrine Unit
10. $s_u = (q_t - \sigma_v)/15$
11. $\sigma'_p = 0.33(q_t - \sigma_v)$
12. $OCR = \sigma'_p / \sigma'_v$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
CPT21-09

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-6

https://golderassociates.sharepoint.com/sites/10023g/50000_TSF_ENGINEERING/Forms/AllItems.aspx?csf=1&web=1&e=nYBCs9&ovuser=3d234255%2De20f%2D4205%2D88a5%2D9658a402999b%2Cscott%2Ecoombs%40wsp%2Ecom&OR=Teams%2DHL&CT=1661378880663&clickparams=eyJBcHBOYW1lIjoiVGVhbXMtRGVza3RvcCIsIlkFwcFZlcnNpb24iOiIyNy8yMjA3MzEwMTAwNSIsIkhhc0ZlZGVyYXRlZFVzZXIiOnRydWV9&cid=9dc739fa%2De3f1%2D4631%2Dabbf%2Dce95a81677b4&RootFolder=%2Fsites%2F10023g%2F50000%5FTSF%5FENGINEERING%2F51300%5FUltimate%5FDesign%2F51331%5F2021%20Site%20Investigation%2FCPT%2FCPTu%20Interpretation&FolderCTID=0x012000ECCF7810C0D4C94D91E590ED93C22946

CPT	Elevation (m)	t_{50} (s)	Estimated Hydraulic Conductivity (m/s)	Lithology
CPT21-02	904.7	27	1.6×10^{-7}	Silt and sand, non plastic fines (glaciofluvial)
CPT21-02	903.9	18	2.7×10^{-7}	Silt and sand, non plastic fines (glaciofluvial)
CPT21-03	895.1	655	3.0×10^{-9}	High plasticity clay, trace sand, varved (glaciolacustrine)
CPT21-07	920.9	726	2.7×10^{-9}	Gravelly sandy silty clay, medium plasticity (basal till)
CPT21-07	904.8	81	4.1×10^{-8}	Clayey silt, medium plasticity
CPT21-07	900.4	73	4.7×10^{-8}	High plasticity clay, trace sand, varved (glaciolacustrine)
CPT21-08	906.2	127	2.3×10^{-8}	Silty clay, medium plasticity, trace sand, laminated (glaciolacustrine)
CPT21-08	902.3	301	8.0×10^{-9}	Silt, non-plastic, laminated (glaciofluvial)
CPT21-08	901.8	62	5.8×10^{-8}	Silty clay, medium plasticity, varved (glaciolacustrine)
CPT21-09	910.9	158	1.8×10^{-8}	Sandy silty clay, medium plasticity, laminated (glaciolacustrine)
CPT21-09	908.3	198	1.3×10^{-8}	Silty clay to clay, low to high plasticity, trace sand, laminated (glaciolacustrine)

REFERENCES/NOTES

1. Hydraulic conductivity estimates based on Parez & Fauriel (1988).

$$k_h\,(cm/s) \approx \left(\frac{1}{251 * t_{50}(sec)}\right)^{1.25}$$

CLIENT
MOUNT POLLEY MINING CORPORATION

CONSULTANT
wsp

YYYY-MM-DD	2023-03-13
PREPARED	S. Coombs
DESIGNED	A., Torres
REVIEWED	A. Torres
APPROVED	G. Pizarro

PROJECT
MOUNT POLLEY MINE
TAILINGS STORAGE FACILITY
FOUNDATION CHARACTERIZATION REPORT

TITLE
CPT DATA AND INTERPRETATION
ESTIMATED HYDRAULIC CONDUCTIVITY FROM DISSIPATION TESTS

PROJECT NO.	PHASE	TASK	REV.	FIGURE
22514095	51300	51392	0	E-7

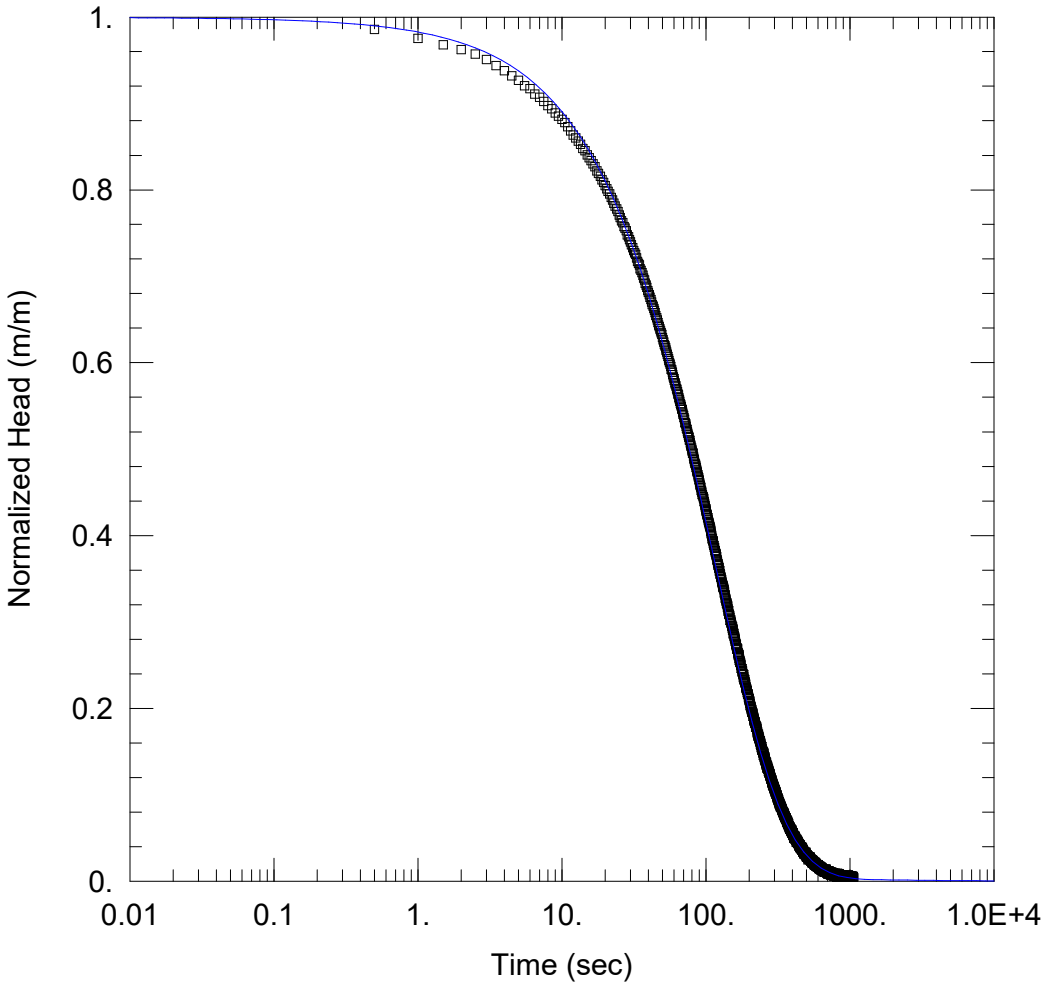
APPENDIX F

Well Test Results and Nearest Registered Water Wells and Mapped Aquifers

Well Location Data					GW Levels			Screened Interval					Single Well Response Test Results		
Easting	Northing	Well No.	Ground Surface Elevation (m)	TOC Elevation (m)	Date	Water Level (mbtoc)	Water Level (m)	Top (mbgs)	Bottom (mbgs)	Top (m)	Bottom (m)	HS unit	Method	Number of Tests Analyzed	K (m/s)
594371.11	5818475.85	GW00-1B	939.20	940.05	02-Jun-22	1.34	938.71	4.5	10.6	934.7	928.6	SILT Till with SAND interbed (Basal Till)	Solid Slug and Bailer	5	3E-06
594896.22	5818238.09	GW00-3B	943.06	943.79	02-Jun-22	3.80	939.98	7.6	13.7	935.5	929.4	SILT Till with SILT/f.SAND interbed (Basal Till)	Solid Slug	2	8E-07
596065.40	5819449.92	GW96-2A	931.42	931.92	01-Jun-22	30.80	901.13	51.8	54.9	879.6	876.5	Weathered Bedrock - conglomerate	Solid Slug	2	3E-06
596074.73	5819447.08	GW96-2B	931.42	932.02	01-Jun-22	17.21	914.81	30.8	35.4	900.6	896.0	SAND and GRAVEL *(Glaciofluvial?)*	Solid Slug and Bailer	8	4E-04
595151.26	5818162.87	GW96-4B	940.46	941.16	01-Jun-22	1.91	939.25	4.3	7.2	936.2	933.3	SAND and GRAVEL *(Glaciofluvial?)*	Solid Slug	6	2E-06
596228.05	5819066.00	GW21-06	946.12	947.08	31-Mar-22	30.24	916.84	33.7	35.3	912.4	910.9	Unknown Overburden	Solid Slug	2	1E-05
595544.37	5818304.68	GW21-09	930.53	931.44	31-Mar-22	16.91	914.53	16.1	17.7	914.4	912.9	Silty CLAY / SILT and SAND (Basal Till)	Solid Slug	2	1E-06

* indicates this elevation was calculated from stickup, not directly surveyed

[1] this is the reccommended method to start with, but ideally tests should be conducted with both the small and large slu



WELL TEST ANALYSIS

Data Set: C:\...\GW96-2A_1b_GH.aqt
Date: 06/16/22 Time: 15:41:04

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

Saturated Thickness: 24.96 m

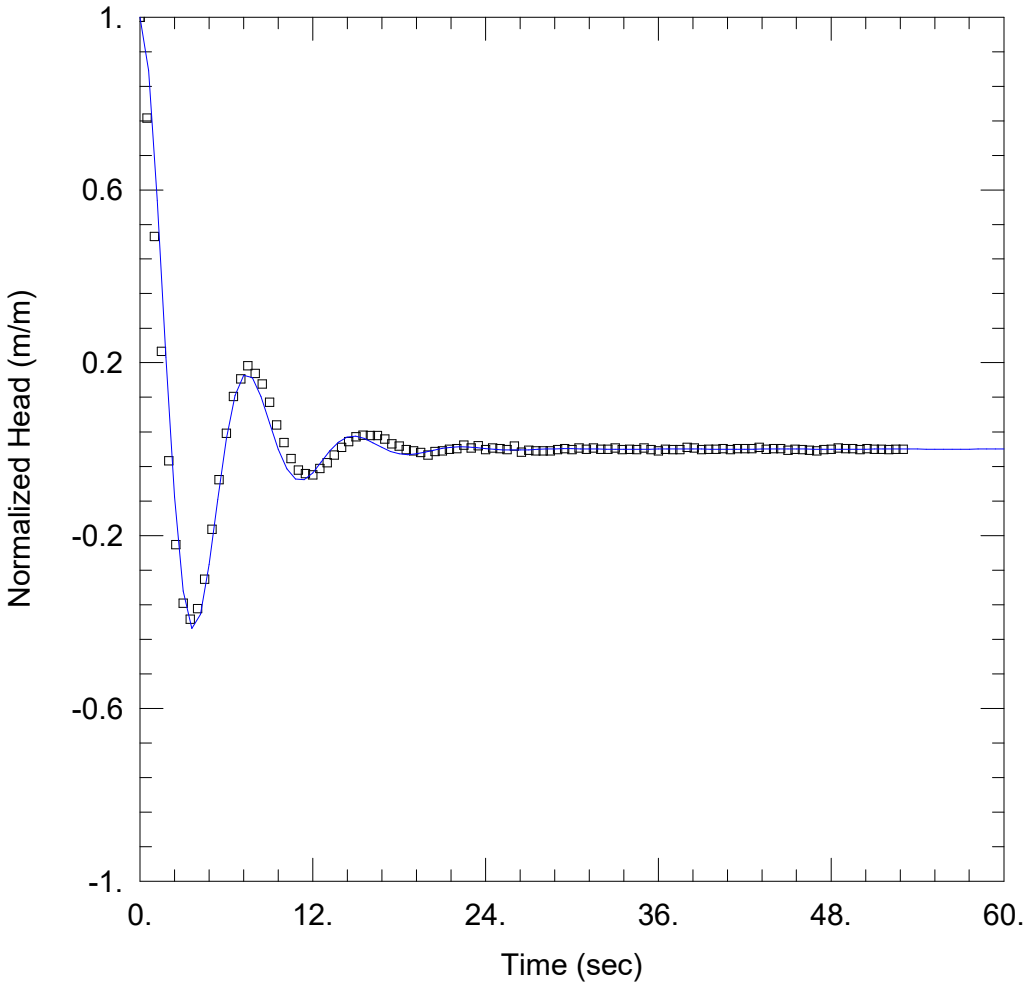
WELL DATA (GW96-2A)

Initial Displacement: 0.4507 m
Total Well Penetration Depth: 24.96 m
Casing Radius: 0.026 m
Static Water Column Height: 24.96 m
Screen Length: 4.3 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 2.7E-6 m/sec
Kz/Kr = 1.
Ss = 9.6E-6 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\GW96-2B_1b_GH.aqt
Date: 06/16/22 Time: 15:50:31

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

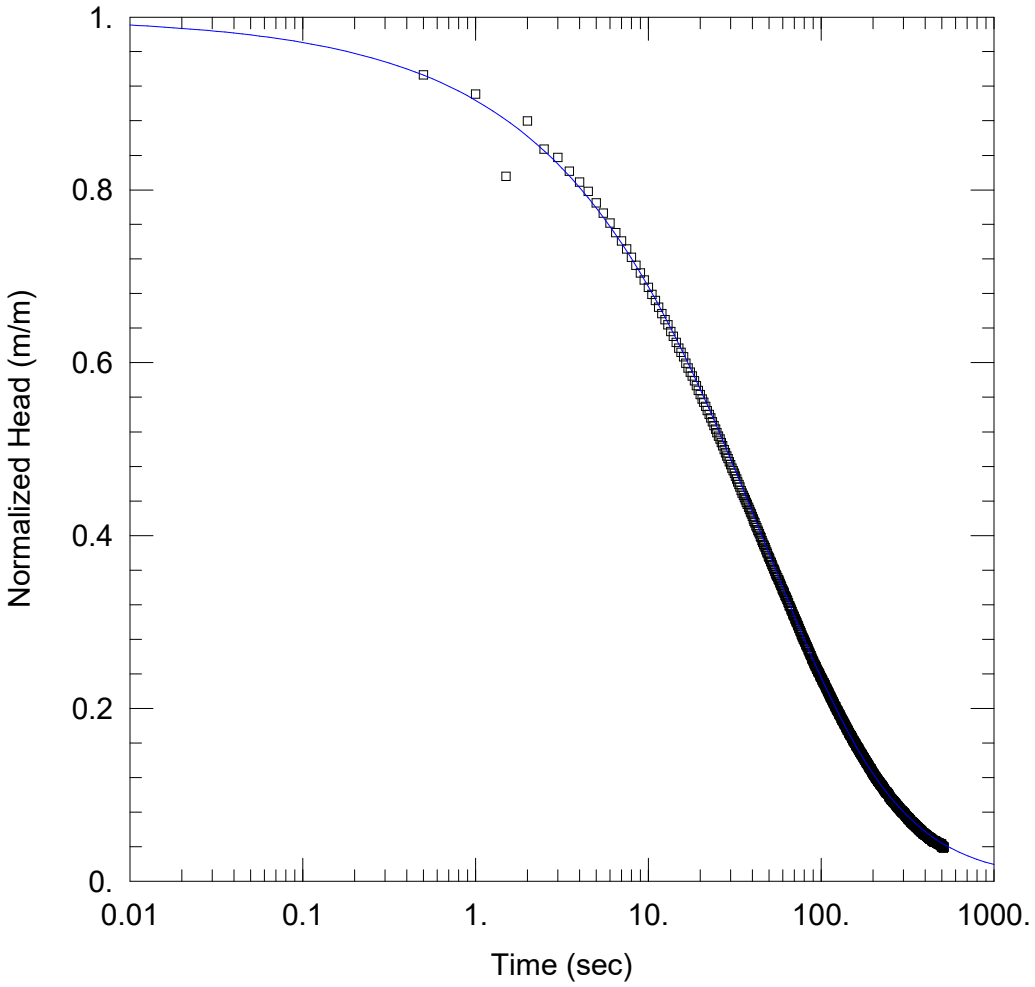
Saturated Thickness: 19.15 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW96-2B)

Initial Displacement: 0.0737 m
Total Well Penetration Depth: 19.15 m
Casing Radius: 0.026 m
Static Water Column Height: 19.15 m
Screen Length: 6. m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar
K = 0.00039 m/sec
Le = 12.71 m



WELL TEST ANALYSIS

Data Set: C:\...\GW96-4B_2a_GH.aqt
Date: 06/16/22 Time: 16:36:10

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

Saturated Thickness: 6.27 m

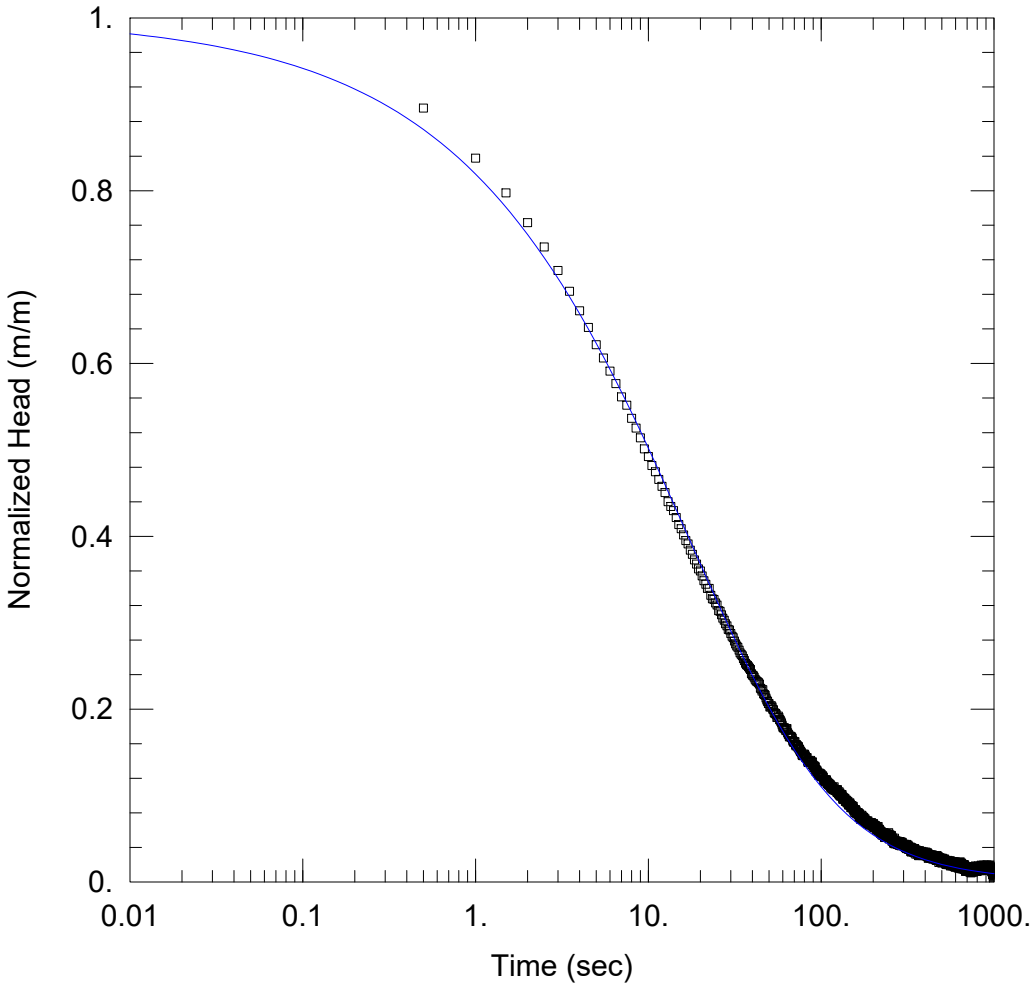
WELL DATA (GW96-4B)

Initial Displacement: 0.4043 m
Total Well Penetration Depth: 6.27 m
Casing Radius: 0.026 m
Static Water Column Height: 6.27 m
Screen Length: 4.6 m
Well Radius: 0.075 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.0E-6 m/sec
Kz/Kr = 1.
Ss = 0.0031 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\GW00-1B_1b_GH.aqt
Date: 06/15/22 Time: 11:00:00

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

Saturated Thickness: 9.39 m

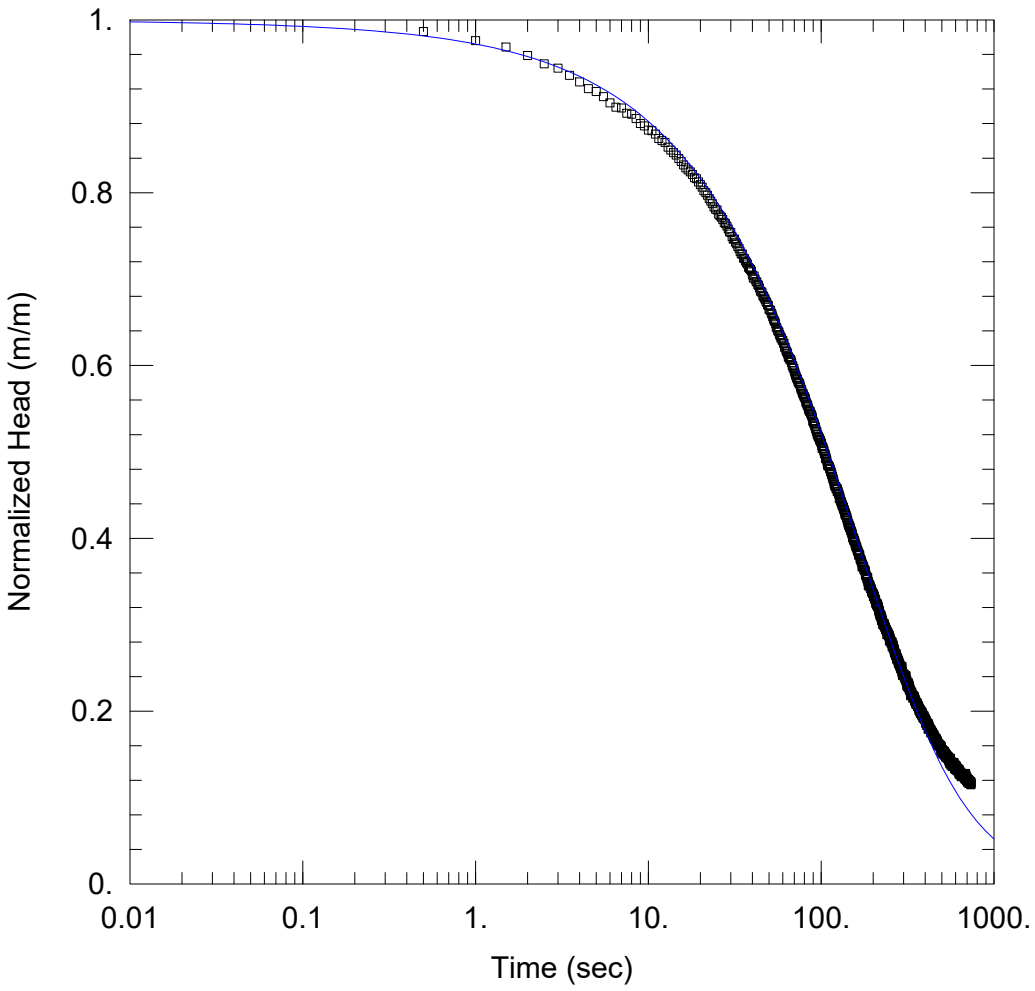
WELL DATA (GW00-1b)

Initial Displacement: 0.1245 m
Total Well Penetration Depth: 9.39 m
Casing Radius: 0.025 m
Static Water Column Height: 9.39 m
Screen Length: 6.1 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.7E-6 m/sec
Kz/Kr = 1.
Ss = 0.01 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\GW00-3B_1b_GH.aqt
Date: 06/15/22 Time: 11:33:34

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

Saturated Thickness: 9.92 m

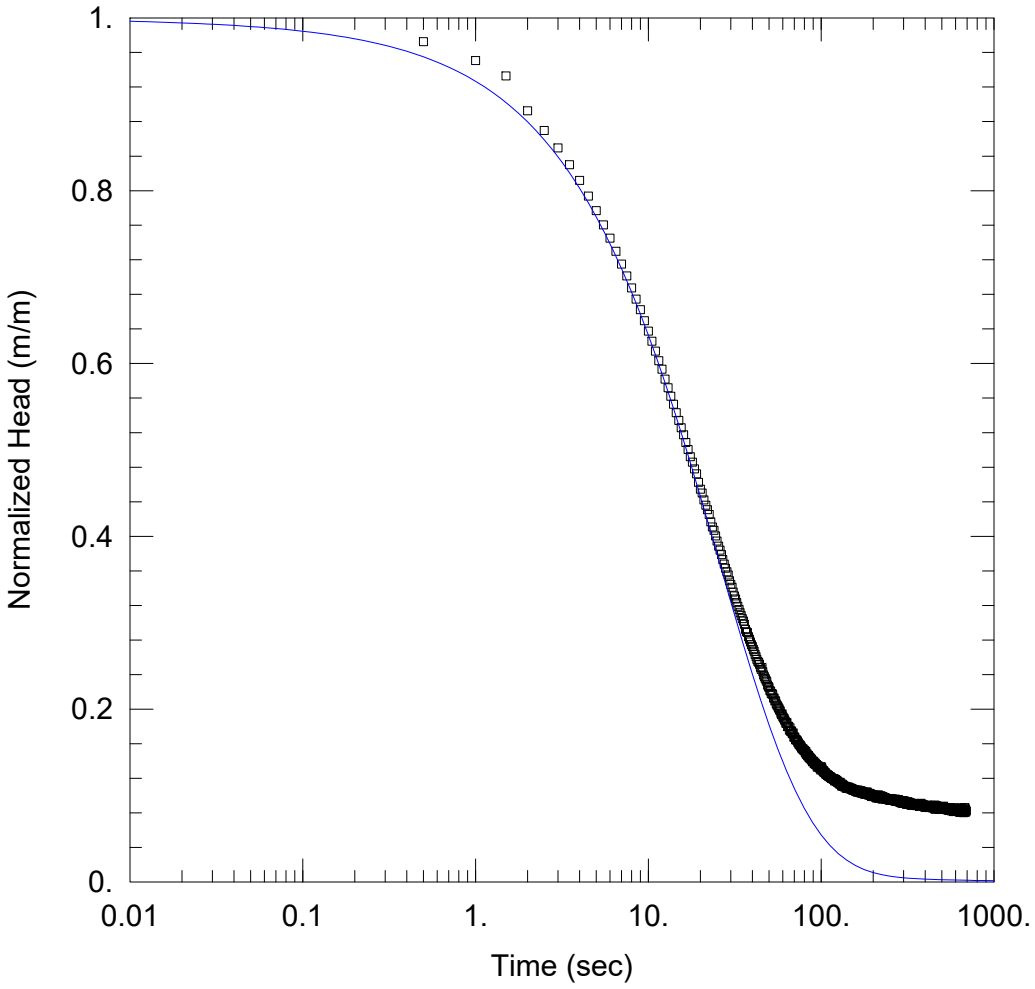
WELL DATA (GW00-3b)

Initial Displacement: 0.4201 m
Total Well Penetration Depth: 9.92 m
Casing Radius: 0.025 m
Static Water Column Height: 9.92 m
Screen Length: 6.1 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 7.5E-7 m/sec
Kz/Kr = 1.
Ss = 0.0005 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW21-06_1b_GH.aqt
Date: 06/16/22 Time: 14:59:29

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

Saturated Thickness: 6. m

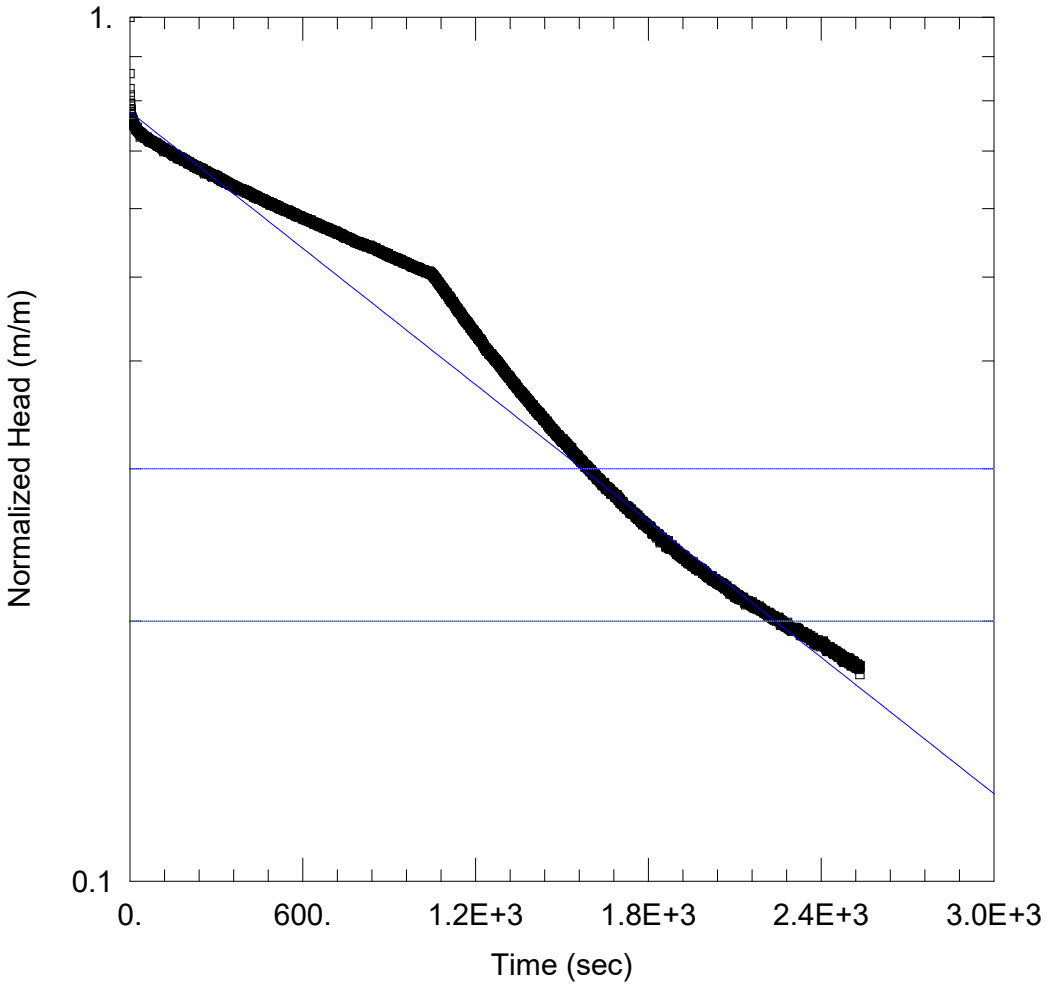
WELL DATA (MW21-06)

Initial Displacement: 0.4292 m
Total Well Penetration Depth: 6.05 m
Casing Radius: 0.025 m
Static Water Column Height: 6. m
Screen Length: 1.6 m
Well Radius: 0.076 m

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 2.2E-5 m/sec
Kz/Kr = 1.
Ss = 0.0003 m^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW21-09_1_GH.aqt
Date: 07/06/22 Time: 09:55:25

PROJECT INFORMATION

Company: Golder
Client: Mount Polley Mine
Project: 22514095
Test Well: GW00-1B
Test Date: June 4, 2022

AQUIFER DATA

Saturated Thickness: 1.7 m Anisotropy Ratio (Kz/Kr): 1.

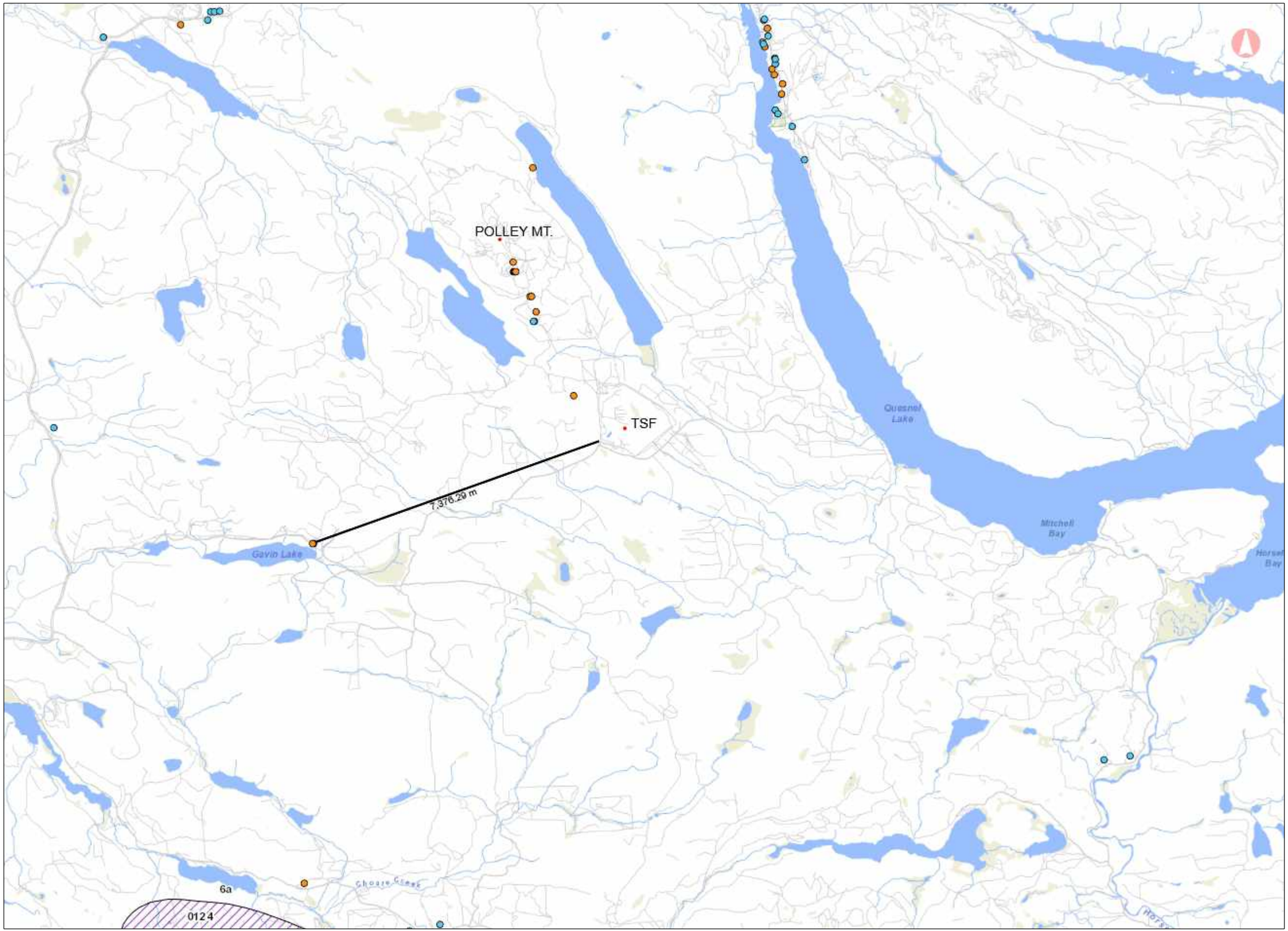
WELL DATA (MW21-09)

Initial Displacement: 0.353 m
Total Well Penetration Depth: 1.73 m
Casing Radius: 0.025 m
Static Water Column Height: 1.7 m
Screen Length: 1.6 m
Well Radius: 0.076 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 9.5E-7 m/sec y0 = 0.2742 m



BRITISH COLUMBIA

iMapBC Mapping

Legend

Water Wells - Private Domes

Water Wells - Licensed/Unli

WELL_LICENCE_GENERAL_S

- Licensed
- Unlicensed

Aquifers - Subtype - BC - Cc

AQUIFER_SUBTYPE_CODE

- 1a
- 1b
- 1c
- 2
- 3
- 4a
- 4b
- 4c
- 5a
- 5b
- 6a
- 6b
- UNK

Aquifers - Vulnerability - BC

VULNERABILITY_CODE

- Bedrock High Vulnerability
- Bedrock Moderate Vulnerability
- Bedrock Low Vulnerability
- Unconsolidated High Vulnerabili
- Unconsolidated Moderate Vulne

0 1.83 3.7 km

1: 90,000

Copyright/Disclaimer

The material contained in this web site is owned by the Government of British Columbia and protected by copyright law. It may not be reproduced or redistributed without the prior written permission of the Province of British Columbia. To request permission to reproduce all or part of the material on this web site please complete the Copyright Permission Request Form which can be accessed through the Copyright Information Page.

CAUTION: Maps obtained using this site are not designed to assist in navigation. These maps may be generalized and may not reflect current conditions. Uncharted hazards may exist. DO NOT USE THESE MAPS FOR NAVIGATIONAL PURPOSES.

Datum:	NAD83
Projection:	NAD_1983_BC_Environment_Albers

Key Map of British Columbia



APPENDIX G

Soil Grain Size Analyses for K

Sample Location	Sample No.	Depth (m)	Lithology	Soil Descripton	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Other (%)	Bulk Density	K (m/s) Estimate from HydrogeoSieve	
											K (m/s)	K Estimation Method Details
GA21-01	GS1	1.52 - 1.83	Ablation Till	gravelly CLAYEY SAND and SILTY CLAY	13.8	31.8	40.3	14.1	0.0	NA	1E-07	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-01	GS2	3.96 - 4.27	Ablation Till	gravelly CLAYEY SAND and SILTY CLAY	13.7	31.0	40.2	15.1	0.0	NA	1E-07	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-01	GS18	34.75 - 35.36	Basal Till	gravelly sandy SILT	7.7	32.8	50.9	8.6	0.0	NA	2E-06	Estimation from Krumbein and Monk. The geometric mean seems too low
GA21-02	GS3	5.49 - 5.79	Ablation Till	gravelly sandy SILT	6.4	27.7	43.2	22.7	0.0	NA	1E-06	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-02	GS24	47.09 - 47.34	Basal Till	sandy CLAYEY SILT	15.9	25.3	35.5	23.3	0.0	NA	1E-07	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-03	GS2	7.01 - 7.32	Ablation Till	sandy gravelly SILT	8.2	31.5	43.6	16.7	0.0	NA	4E-07	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-03	GS4	10.36 - 10.67	Ablation Till	sandy gravelly SILT	9.9	30.3	34.8	25.0	0.0	NA	2E-06	Estimation from Krumbein and Monk. The geometric mean seems too low
GA21-03	GS25	43.59 - 43.89	Basal Till	sandy gravelly SILTY CLAY	9.4	34.6	35.4	20.6	0.0	NA	1E-06	Estimation from Krumbein and Monk. The geometric mean seems too low
GA21-05	GS1	8.23 - 8.53	Ablation Till	sandy SILTY CLAY	12.2	28.7	41.7	17.4	0.0	NA	2E-07	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-05	GS11	28.65 - 28.96	Basal Till	SILT	6.0	41.8	44.7	7.5	0.0	NA	3E-07	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-06	GS1	2.44 - 2.74	Ablation Till	gravelly sandy SILT	15.5	42.8	36.4	5.3	0.0	NA	2E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-06	GS2	6.40 - 6.71	Ablation Till	gravelly SILTY SAND	5.3	18.4	43.9	32.4	0.0	NA	1E-06	Geometric mean of applicable methods (Terzaghi, Sauerbrei, Kozeny-Carmen, Zamarin, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-06	GS6	12.80 - 13.11	Glaciofluvial	gravelly SAND	2.3	8.6	44.8	44.3	0.0	NA	3E-05	Geometric mean of applicable methods (Terzaghi, Sauerbrei, Zamarin, Barr, Alyamani and Sen) too low, use 10 times higher (i.e., use 3E-4 m/s)
GA21-06	GS8	16.76 - 17.07	Basal Till	gravelly sandy SILT	6.0	20.4	35.5	38.1	0.0	NA	1E-06	Geometric mean of applicable methods (Terzaghi, Sauerbrei, Kozeny-Carmen, Zamarin, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-07	GS1	11.89 - 12.19	Ablation Till	sandy SILTY CLAY	17.3	36.8	33.8	12.1	0.0	NA	2E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-08	GS1	17.37 - 17.68	Ablation Till	sandy SILT	12.3	38.9	35.4	13.4	0.0	NA	9E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-08	GS7	27.43 - 27.74	Glaciolacustrine	SILTY CLAY	44.2	55.6	0.2	0.0	0.0	NA	3E-10	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-08	GS10	34.75 - 35.05	Basal Till	sandy SILTY CLAY	18.9	33.2	41.9	6.0	0.0	NA	4E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen, Krumbein and Monk)
GA21-09	GS8	27.43 - 27.74	Basal Till	sandy SILT	8.8	54.0	25.9	11.3	0.0	NA	6E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-11	GS15	13.41 - 13.65	Glaciolacustrine	SILTY CLAY	19.7	65.6	11.6	3.1	0.0	NA	4E-09	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-11	GS16	16.64 - 16.76	Glaciolacustrine	SILTY CLAY	8.7	77.5	12.9	0.9	0.0	NA	2E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-11	GS20	20.73 - 21.03	Glaciolacustrine	sandy SILTY CLAY	14.4	62.9	18.4	4.3	0.0	NA	9E-09	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)
GA21-11	GS24	23.93 - 24.23	Glaciolacustrine	sandy SILTY CLAY	6.6	68.7	20.7	4.0	0.0	NA	7E-08	Geometric mean of applicable methods (Sauerbrei, Barr, Alyamani and Sen)

APPENDIX H

Assurance Statements

APPENDIX A-1: DESIGN ENGINEER'S SITE CHARACTERIZATION ASSURANCE STATEMENT

To: The Owner(s) Date: 18 September 2023

Name: Mount Polley Mining Corporation

Address: PO Box 12, Likely, BC, V0L 1N0

For the dam:

UTM (Location): Zone IOU; Easting 595,768; Northing 5,818,548

Located at (Description): near Likely, BC

Name of dam or description: Mount Polley Tailings Storage Facility

Provincial dam number: Permit M-200

Dam function: Tailings Storage

Current *project stage* is:

Check one

☐ Feasibility design
☐ Detailed design
▪ Construction/operations

The undersigned hereby gives assurance that he/she is a qualified APEGBC-registered professional and is a professional engineer and is the **Design Engineer** for the dam project identified above.

I have signed, sealed, and dated the attached dam site characterization report in accordance with the *APEGBC Professional Practice Guidelines – Site Characterization for Dam Foundations in BC*. The report must be read in conjunction with this Assurance Statement.

In preparing the dam site characterization report, I have completed the following activities:

(Check the applicable items)

Completed by the Design Engineer	Activity
X	Collected and reviewed available and relevant background information, documentation, and data
X	Visited the site and reviewed the conditions in the field that may be relevant for site characterization
X	Developed and executed a site characterization program that provides information to support the design of the dam, subject to the qualifications noted
X	Reviewed previous site characterization studies and data and updated the dam site characterization assessment report to include all data and, where appropriate, revised interpretations of data
X	Assessed potential areas of risk identified during site characterization programs to date and, as far as is practical, addressed the risks
X	Evaluated the level of complexity of the site and documented how it was assessed and supported by the site characterization program(s)
X	Reviewed and accepted all assurance statements submitted by the supporting registered professionals (SRPs)
X	Prepared a data record report
X	Prepared the dam site characterization report, which interprets the site conditions

In preparing the dam site characterization report, I have completed the following activities or reviewed and accepted such activities completed by a supporting registered professional (SRP):

(Check the applicable items)

Completed by the Design Engineer	Completed by the SRP, and reviewed and accepted by the Design Engineer	Activity
	X	Assessed the surficial and bedrock geological models to confirm that they adequately support the understanding of the spatial variability of the geotechnical properties of the foundation materials
X		Carried out sufficient in situ and laboratory testing to quantify the geotechnical properties of the foundation materials
X		Assessed the strength properties of the foundation materials with consideration of stress state and response to loadings
	X	Assessed the hydrogeological properties of the foundation materials with consideration of potential hydraulic gradients, artesian pressures, and seepage flow paths
	X	Assessed the seismotectonic conditions to provide a basis for the seismic hazard analysis of the dam
X	X	Evaluated the level of complexity of the site and documented how it was assessed and supported by the site characterization program(s)
X		Reviewed and accepted all assurance statements submitted by the supporting registered professionals (SRPs)
X	X	Prepared a data record report
X	X	Prepared the dam site characterization report, which interprets the site conditions

I hereby give my assurance that based on the attached dam site characterization report, at this point in time:

Check one

- [x] The dam site characterization report is reasonably comprehensive and supports the design of the dam.
- [ ] The dam site characterization report is not sufficiently comprehensive to support the design of the dam, in that the dam site characterization report identifies areas of potential concern that require additional investigation as set out in section(s) _____ of the attached dam site characterization report

Name: (print) Germán Pizarro

Signature: _____ Date: 18 September 2023

Address: 840 Howe Street, #1000, Vancouver, BC, V6Z 2M1

(Affix professional seal here)

Telephone: 604 787 2166

Email: german.pizarro@wsp.com

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
G. E. PIZARRO SALA
40077

2023-09-22

(If the APEGBC professional is a member of a firm, complete the following)

I am a member of the firm WSP Canada Inc.

(Print name of firm)

and I sign this letter on behalf of the firm.

APPENDIX A-2: SUPPORTING REGISTERED PROFESSIONAL'S ASSURANCE STATEMENT OF PROFESSIONAL SERVICES

To: The Design Engineer Date: 5 September 2023

Name: Germán Pizarro-Sala

Address: WSP Canada Inc

840 Howe Street, #1000, Vancouver BC, V6Z 2M1, Canada

For the dam:

UTM (Location): Zone: IOU; Easting 595768.72 m; Northing 5818548.36 m

Located at (Description): near Likely, British Columbia

Name of dam or description: TSF Embankment

Dam function: tailings storage

Owned by: Mount Polley Mining Corporation (MPMC)

Current project stage is:

Check one

☐ Feasibility design
☐ Detailed design
☒ Construction/operations

This is to advise that the undersigned is a **supporting registered professional** (SRP) retained by MPMC to carry out supporting professional services for the dam.

I undertook supporting professional services in the following:

(Check applicable sections)

☐ Bedrock/structural geology
☐ Surficial geology
☐ Geotechnical investigations
☒ Hydrogeology
☐ Seismotectonic investigations
☐ Other

The undersigned hereby gives assurance that the

hydrogeological and geochemical assessment

and the documents prepared by this supporting registered professional for the project have been carried out in a manner that meets the intent of the applicable APEGBC guidelines and good professional practice.

These professional services are described, and the results of them reported on in the documents prepared by me, or under my direct supervision, which bear my professional seal.

(With respect to field reviews, initial the following statements, as applicable. Leave blank those that are not applicable.)

_____ Field review(s) are not applicable

CR Field review(s) are applicable:

CR I have performed field review(s) for the services identified above. (field review: 30 May 2022 to 1 June 2022)

_____ Field review(s) have been performed by _____.

I confirm that I have communicated and liaised as required with the appropriate APEGBC professionals for the purposes of my services.

I hereby give my assurance that I am an APEGBC-registered professional.

Name: (print) Connie Romano

Signature: CRomano Date: 5 September 2023

Address: WSP Canada Inc.

840 Howe St. #1000, Vancouver BC, V6Z 2M1

Telephone:

Email: connie.romano@wsp.com



2023-09-05

(If the APEGBC professional is a member of a firm, complete the following)

I am a member of the firm WSP Canada Inc.

(Print name of firm)

and I sign this letter on behalf of the firm.

APPENDIX A-2: SUPPORTING REGISTERED PROFESSIONAL'S ASSURANCE STATEMENT OF PROFESSIONAL SERVICES

To: The Design Engineer Date: 9 September 2023

Name: (print) Germán Pizarro, PEng

Address: (print) WSP Global Inc. 840 Howe Street, Suite 1000

Vancouver, British Columbia V6Z 2M1 Canada

For the dam:

UTM (Location): Zone: 10U; Easting 595768.72 m; Northing 5818548.36 m

Located at (Description): near Likely, British Columbia

Name of dam or description: TSF embankment

Dam function: tailings storage

Owned by: Mount Polley Mining Corporation (MPMC)

Current project stage is:

Check one

- ☐ Feasibility design
- ☐ Detailed design
- ☑ Construction/operations

This is to advise that the undersigned is a **supporting registered professional** (SRP) retained by MPMC to carry out supporting professional services for the dam.

I undertook supporting professional services in the following:

(Check applicable sections)

- ☑ Bedrock/structural geology
- ☑ Surficial geology
- ☐ Geotechnical investigations
- ☐ Hydrogeology
- ☑ Seismotectonic investigations
- ☐ Other

The undersigned hereby gives assurance that the surficial geology, bedrock geology, seismotectonics (Insert here the specific professional services carried out) and the documents prepared by this supporting registered professional for the project have been carried out in a manner that meets the intent of the applicable APEGBC guidelines and good professional practice.

These professional services are described, and the results of them reported on in the documents prepared by me, or under my direct supervision, which bear my professional seal.

(With respect to field reviews, initial the following statements, as applicable. Leave blank those that are not applicable.)

_____ Field review(s) are not applicable

X Field review(s) are applicable:

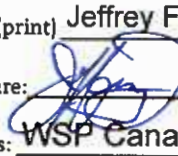
X I have performed field review(s) for the services identified above.

_____ Field review(s) have been performed by _____.

I confirm that I have communicated and liaised as required with the appropriate APEGBC professionals for the purposes of my services.

I hereby give my assurance that I am an APEGBC-registered professional.

Name: (print) Jeffrey Fillipone

Signature:  Date: 9 September 2023

Address: WSP Canada Inc.

301-3600 Uptown Blvd.

Victoria, BC V8Z 0B9

Telephone: 250-360-3572

Email: jeff.fillipone@wsp.com

(Affix professional seal here)



(If the APEGBC professional is a member of a firm, complete the following)

I am a member of the firm WSP Canada Inc
(Print name of firm)

and I sign this letter on behalf of the firm.



wsp.com

APPENDIX 1-5: Author Statements

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Chris Dodd

   Title Registered Professional Consulting Archaeologist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: BC Association of Professional Archaeologists Registration # n/a

3. Brief description of professional services:

   Archaeological input for Section 2.12-Archaeology and Section 9.11-Archaeological Management and Impact Mitigation for the Springer Pit Expansion Joint Application

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X

Print Name: Chris Dodd

Witnessed by:

X

Print Name: Konain Sajid

Date signed: Nov 28, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Scanned with CamScanner

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act*, the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Chris Dodd (Print Name), as a member of BC Association of Professional Archaeologists declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Springer Pit Expansion Joint Application (Name of Application/Project/Work).
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Luc LaChance (Name of Contact), erring on the side of caution.

Scanned with CamScanner

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X _____

Print name: Chris Dodd

Date: Nov 28, 2023

Witnessed by:

X _____

Print name: Konain Sajid

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.

Scanned with CamScanner

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Jacqueline Foley

   Title Senior Principal Hydrogeologist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: Engineers and Geoscientists BC Registration # 130626

3. Brief description of professional services:

   Provided hydrogeological support and technical oversite in support of the permit application.

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: Witnessed by:

X Jacqueline Foley **X**

Print Name: Jacqueline Foley Print Name: Konain Sajid

Date signed: 23 November 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Jacqueline Foley (Print First and Last Name), as a member of Engineers and Geoscientists of BC (Print Name of Professional Association) declare

Select one of the following:

☑ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this application/assessment (application/project/work/etc.).
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Ministry of Environment and Climate Change Strategy (Ministry/Crown Agency), erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X Jacqueline Foley

Witnessed by:

X Konain

Print name: Jacqueline Foley

Print name: Konain Sajid

Date: 23 November 2023

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Hannah Gray Hubbard

   Title Lead Senior Geological Engineer

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: EGBC Registration # 48028

3. Brief description of professional services:

   Geotechnical assessment of open pits and waste rock dumps

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X

Print Name: Hannah Gray Hubbard

Witnessed by:

X

Print Name: Bryan Chiu

Date signed: Nov 28, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act*, the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Alannah Gray Hubbard (Professional Engineer and Licensee Name), as a member of EGBC (Professional Association) declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this permit application (project, application, etc.).
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Morgan Dyes (Ministry Contact Name), erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X _____

Print name: Hannah Gray Hubbard

Date: Nov 28, 2023

Witnessed by:

X _____

Print name: Bryan China

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional DREW KAISER

   Title Biologist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: College of Applied Biologists Registration # 2332

3. Brief description of professional services:

   PEER REVIEW OF SECTIONS 2.10, 6.2, 9.10 IN THE JOINT APPLICATION FOR MINE PERMIT (M-200) FOR MOUNT Polley MINE

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X

Print Name: DREW KAISER

Witnessed by:

X

Print Name: Kristine Novakowski

Date signed: 24 November 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of
Environment and
Climate Change Strategy

BRITISH COLUMBIA

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I DREW KAISER, as a member of COLLEGE OF ARLIED BIOLOGISTS
(Print First and Last Name) (Full Name of Professional Association)
declare

Select one of the following:

☐ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this PROJECT - MOUNT POLLEY MINE - SPRINGER PIT EXPANSION.
(Name of Project)
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to LUC LACHANCE, erring on the side of caution.
(Ministry Contact Name)

BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

N/A

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

N/A

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X

Print name: DREW KAISER

Witnessed by:

X

Print name: Kristine Novakowski

Date: 24 NOVEMBER 2023

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Jorden Laskosky

Title Senior, Mine Closure and Reclamation Specialist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

Name of Association: BC Institute of Agrologists Registration # 4447

3. Brief description of professional services:

Acted as a qualified professional for Section 2.3.5., Section 4.0 and Section 7.5. of the MPMC Springer Pit Expansion Application

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X Jorden Laskosky

Print Name: Jorden Laskosky

Witnessed by:

X

Print Name: Konain Sajid

Date signed: 23 November 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I **Jorden Laskosky**, as a member of **British Columbia Institute of Agrologists** declare

Select one of the following:

☐ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Springer Pit Expansion Permit Application

I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Insert Ministry Contact Name, erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X Jorden Laskosky

Print name: Jorden Laskosky

Date: 23 November 2023

Witnessed by:

X

Print name: Konain Sajid

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional: Shauna Litke

   Title: Senior Consultant (Geochemistry)

2. Are you a registered member of a professional association in B.C.? ☑ Yes ☐ No

   Name of Association: Engineers and Geoscientists BC Registration #: 49392

3. Brief description of professional services:

   Assessment of ML/ARD potential, development of geochemical source terms, and review of ML/ARD Procedure Manual

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X _____

Print Name: Shauna Litke

Witnessed by:

This signature has been scanned. The author has given permission for its use in this particular document. The original signature is held on file.

X _____

Print Name: Lara Sirotic

Date signed: November 28, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Shauna Litke, as a member of EGBC declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this **application**.

I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to **Luc LaChance**, erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X _____

Print name: Shauna Litke

Witnessed by:

This signature has been scanned. The author has given permission for its use in this particular document. The original signature is held on file.

X _____

Print name: Lara Sirotic

Date: November 28, 2023

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional: Jesse Maddaloni

   Title: Senior Mechanical Engineer

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: EGBC Registration # P.Eng #36620

3. Brief description of professional services:

   Mine site water management planning

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X 

Print Name: Jesse Maddaloni

Witnessed by:

X 

Print Name: Konain Sajid

Date signed: November 27, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Jesse Maddaloni, as a member of EGBC declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this application.
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Luc LaChance, erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X _____

Print name: Jesse Maddaloni

Date: November 27, 2023

Witnessed by:

X _____

Print name: Konain Sajid

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Andrew McIntosh

Title Certified Erosion and Sediment Control Lead

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

Name of Association: ESCA-BC Registration # 210306

3. Brief description of professional services:

Review and update of site Erosion and Sediment Control Management Plan

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: Witnessed by:

X Andrew McIntosh **X** L. Nikl

Print Name: Andrew McIntosh Print Name: Lee Nikl

Date signed: November 22, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Andrew McIntosh (Insert First and Last Name), as a member of ESCA-BC (Insert Professional Association) declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Application (application/project/work/etc.).
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to EMLI (Insert Ministry Contact Name), erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X Andrew McIntosh

Print name: Andrew McIntosh

Date: November 22, 2023

Witnessed by:

X L. Nikl

Print name: Lee Nikl

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Lee Nikl

   Title Senior Environmental Scientist, Fellow.

2. Are you a registered member of a professional association in B.C.? ☑ Yes ☐ No

   Name of Association: College of Applied Biologists Registration # 601

3. Brief description of professional services:
   Project Director for Joint Application for a Permit Amendment at Mount Polley Mine

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

x L. Nikl

Print Name: Lee Nikl

Witnessed by:

x Ryan Johnson

Print Name: Ryan Johnson

Date signed: Nov. 23, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Lee Nikl, as a member of College of Applied Biologists declare

Select one of the following:

☑ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Joint Application for a Permit Amendment. I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Luc LaChance, erring on the side of caution.

Ministry of Environment and Climate Change Strategy

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

N/A.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X L. Nikl

Print name: Lee Nikl.

Date: Nov. 23, 2023.

Witnessed by:

X Ryan Johnson

Print name: Ryan Johnson

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional: Tanya Seebacher

   Title: Terrestrial Biologist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: College of Applied Biologists Registration # 2191

3. Brief description of professional services:

   Peer review of sections 2.10, 6.2, 9.10 in Springer Pit Expansion Application (Mt. Polley Mine)

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

x [signature]

Print Name: Tanya Seebacher

Witnessed by:

x [signature]

Print Name: DAVID FEGHALI

Date signed: 23 Nov 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act*, the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Tanya Seebacher (Print First and Last Name), as a member of the College of Applied Biologists. (Print Name of Professional Association) declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Project - Mount Polley Springer Pit Expansion (applications and/or work). I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Luc LaChance (Ministry Contact Name), erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):
N/A

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:
N/A

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X [signature]

Print name: Tanya Seebacher

Date: 23 November 2023

Witnessed by:

X [signature]

Print name: DAVID FEGHALI

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Rachelle Smith

Title Intermediate Biologist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

Name of Association: College of Applied Biology Registration # 3960

3. Brief description of professional services:

Provided support for the wildlife biology components of Sections 2.10, 6.2 and 9.10 of the MPMC Springer Pit Expansion permit application.

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: Witnessed by:

X **X**

Print Name: Rachelle Smith Print Name: Konain Sajid

Date signed: 23 November 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Rachelle Smith, as a member of College of Applied Biology declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this application/assessment.
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Ministry of Environment and Climate Change Strategy, erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature:

X R.Smith _____

Print name: Rachelle Smith

Date: 23 November 2023

Witnessed by:

X Konain _____

Print name: Konain Sajid

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Barbara Wernick

   Title Senior Principal Environmental Scientist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: College of Applied Biologists Registration # 1171

3. Brief description of professional services:

   Senior oversight for Sections 2.7 - Water Quality, 2.8 - Sediment Quality, 2.9 - Fisheries and Aquatic Resources, and 6.1 - Aquatic Resources of the Springer Pit Expansion Permit Application Technical Assessment Report.

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: 

X _____

Print Name: Barbara Wernick

Witnessed by: 

X _____

Print Name: Konain Sajid

Date signed: November 24, 2023

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Barbara Wernick, as a member of College of Applied Biologists declare

Select one of the following:

☒ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this application.

I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Ministry of Environment, erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):
n/a

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature: 

X _____

Print name: Barbara Wernick

Date: November 24, 2023

Witnessed by: 

X _____

Print name: Konain Sajid

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional: Peter Morgan

   Title: Fellow, Engineering Manager-Mine Water

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: Engineers and Geoscientists BC Registration # 15896

3. Brief description of professional services:

   Reviewing and updating the Sediment and Erosion Control Management Plan for the Mount Polley Mine site.

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: **X** Peter Morgan

Witnessed by: **X** Andrew McIntosh

Print Name: Peter Morgan

Print Name: Andrew McIntosh

Date signed: February 16, 2024

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Peter Morgan (Print First and Last Name), as a member of EGBC (Name of Professional Association) declare

Select one of the following:

☑ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this Sediment and Erosion Control Management Plan (Identify Type of Work).
I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Ministry of Environment and Climate Change Strategy (Name of Ministry), erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

_____

_____

_____

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

_____

_____

_____

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signature: Peter Morgan

X _____

Witnessed by: Andrew McIntosh

X _____

Print name: Peter Morgan

Print name: Andrew McIntosh

Date: February 16, 2024

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

APPENDIX 2-1: Climate Baseline

REPORT

Climate Baseline Update

Mount Polley Mine

Submitted to:

Mount Polley Mining Corporation

PO Box 12
Likely, BC V0L 1N0

Submitted by:

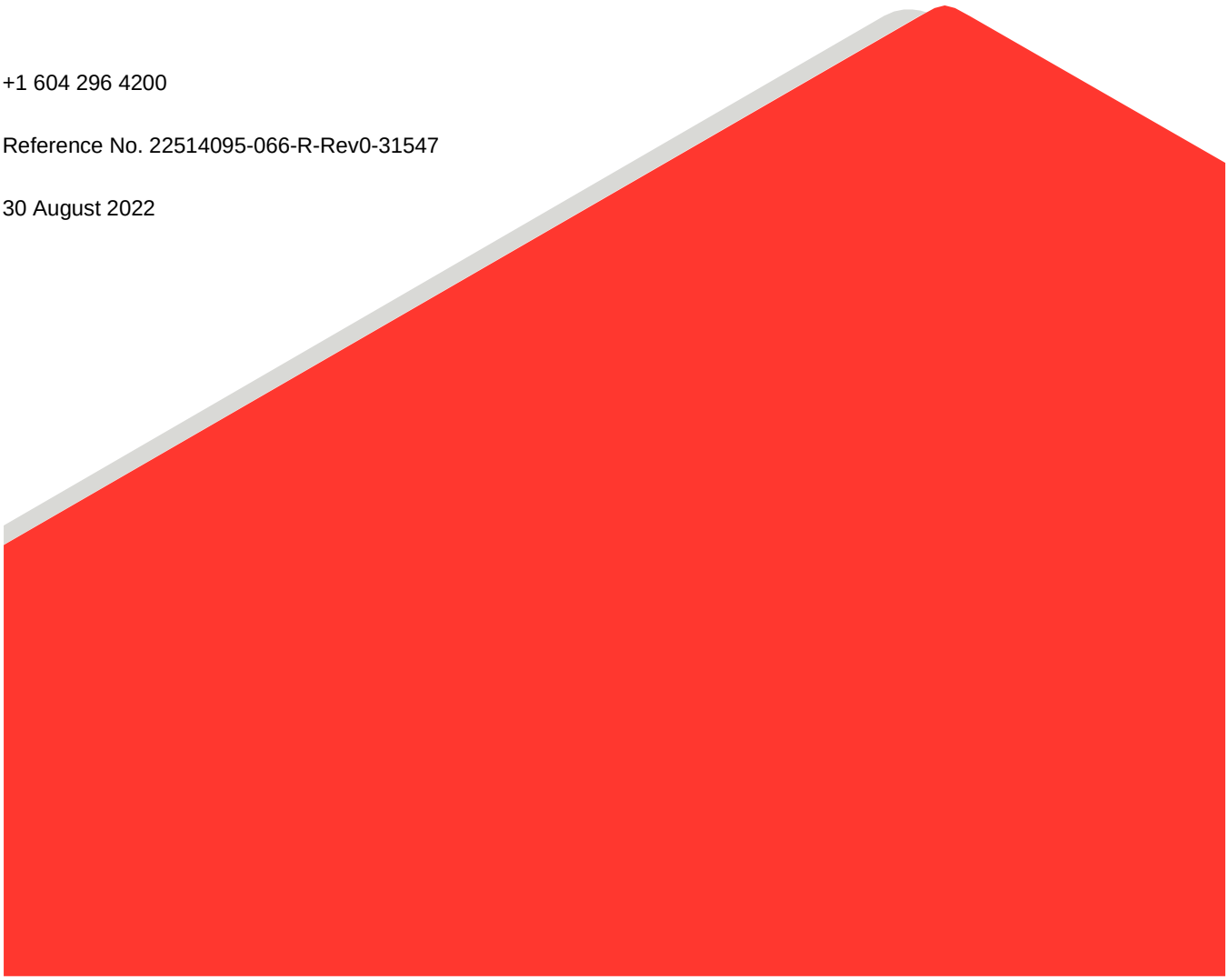
Golder Associates Ltd.

Suite 200 - 2920 Virtual Way, Vancouver, British Columbia, V5M 0C4, Canada

+1 604 296 4200

Reference No. 22514095-066-R-Rev0-31547

30 August 2022



Distribution List

Electronic Copy - Mount Polley Mining Corporation

Electronic Copy - Golder Associates Ltd.

Executive Summary

This report provides a five-year update of climate baseline at Mount Polley Mine site (the Site) owned and operated by Mount Polley Mining Corporation (MPMC), a subsidiary of Imperial Metals Corporation. Updated baseline statistics are presented for precipitation (total precipitation, rainfall), air temperature, relative humidity, solar radiation, evaporation, snow depths, wind speed and directions. Updated climate change projections for the Site are also provided.

The 1974 to 1993 climate records from the nearby Environment and Climate Change Canada (ECCC) Likely climate station and 1995 to 2021 climate records from the local MPMC climate stations served as the basis for developing statistics for describing precipitation and temperature conditions for the Site. Records from regional and MPMC climate stations were reviewed to assist in characterizing climate parameters, such as relative humidity and solar radiation, and to support the identification of spatial trends. Local and regional climate station data were interrogated for inconsistencies or gaps, and then infilled using regional data and translation factors.

A summary of the updated baseline climate parameters developed in this study is provided in Table 1. The trends in climate parameters at the Site are similar to those at the ECCC regional stations considered in the study. An evaluation of future climate change projections indicates future climate at the Site will likely be warmer and wetter, with larger variations throughout the months.

Table 1: Summary of Key Mount Polley Climate Parameters

Parameter	Value
Mean annual total precipitation (mm)	612
1:2-year 24-hour rainfall (mm)	33
1:200-year 24-hour rainfall (mm)	69
Projected annual total precipitation anomaly from baseline for 2050's (%)	+5
Projected annual total precipitation anomaly from baseline for 2080's (%)	+8
Mean annual temperature (°C)	3.9
Average winter season (sub-zero mean monthly temperatures)	November to March
Projected annual air temperature anomaly from baseline for 2050's (°C)	+1.8
Projected annual air temperature anomaly from baseline for 2080's (°C)	+2.7
Mean annual relative humidity (%)	68.1
Mean annual solar radiation (W/m^2)	135
Mean annual shallow lake evaporation (mm)	673
Mean annual potential evapotranspiration (mm)	863
Mean snow water equivalent for the month of March (mm)	185

Note: Statistics are based on reviewed historical records from multiple climate stations and measured and derived data (where applicable).
mm = millimetre; ˚C = degrees Celsius; W/m^2 = watts per square metre.

Study Limitations

Golder Associates Ltd., a member of WSP (WSP Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, has been prepared by WSP Golder for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP Golder's professional judgement based on the knowledge and information available at the time of completion. WSP Golder is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations, and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to WSP Golder by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations, and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings, and other documents contained herein, as well as all electronic media prepared by WSP Golder are considered its professional work product and shall remain the copyright property of WSP Golder. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration, and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

Table of Contents

STUDY LIMITATIONS ..... **iii**

1.0 INTRODUCTON **1**

1.1 Overview 1

1.2 Purpose 1

1.3 Scope 1

2.0 STUDY AREAS **2**

2.1 Local Study Area 2

2.2 Regional Study Area 6

3.0 METHODS **8**

3.1 Study Design 8

3.2 Review of Existing Information 8

3.2.1 Local Climate Stations 8

3.2.2 Regional Climate Stations 9

3.3 Data Processing 10

3.4 Data Analysis 10

3.4.1 Precipitation 10

3.4.2 Temperature 13

3.4.3 Relative Humidity 17

3.4.4 Solar Radiation 20

3.4.5 Evaporation and Evapotranspiration 21

3.4.6 Wind Speed and Direction 22

3.4.7 Snow Cover Properties 22

4.0 RESULTS **23**

4.1 Annual Precipitation 23

4.2 Rainfall 25

4.3 Air Temperature 26

4.4 Relative Humidity 28
4.5 Solar Radiation 29
4.6 Evaporation and Evapotranspiration 30
4.6.1 Shallow Lake Evaporation 30
4.6.2 Potential Evapotranspiration 31
4.6.3 Actual Evapotranspiration 32
4.7 Wind Speed and Direction 33
4.8 Snow Cover Properties 37
5.0 CLIMATE CHANGE PROJECTIONS 38
5.1 Data Sources for Future Climate 38
5.2 Global Climate Change Projections 38
5.3 Regional Climate Change Projections 38
5.4 Climate Change Projections Results 40
5.4.1 Future Temperature and Precipitation Projections 40
5.4.2 Future Relative Humidity Projections 46
5.4.3 Future Solar Radiation Projections 50
5.4.4 Future Evaporation Projections 54
5.4.5 Snow Cover Properties Projections 54
6.0 CONCLUSION AND RECOMMENDATIONS 56
REFERENCES 58

TABLES

Table 1: Summary of Key Mount Polley Climate Parameters ii
Table 2: Local Climate Stations for the Mount Polley Mine 9
Table 3: Local Snow Course Sites at the Mount Polley Mine 9
Table 4: Regional Climate Stations for the Mount Polley Mine 10
Table 5: Regional Climate Stations Priority Sequence for Precipitation Data Gap Infilling in Extended Record for MPMC 12
Table 6: Monthly and Annual Air Temperature Climate Normals for Regional ECCC Climate Stations 14

Table 7: Monthly Air Temperature Lapse Rate Variation Among Five Regional ECCC Climate Stations (1971 to 2000 period of record for ECCC Likely; 1981 to 2010 period of record for remaining stations) 16

Table 8: Regional Climate Stations Priority Sequence for Temperature Data Gap Infilling in Extended Record for MPMC 16

Table 9: Annual Precipitation Depths for the Site (1974-2021) 23

Table 10: Monthly Precipitation Depths for the Site (1974-2021) 25

Table 11: 24-hour Precipitation Depths for the Site (1974-2021) 25

Table 12: Annual, Spring, and Summer PMP Depths for the Site (1974-2021) 26

Table 13: Derived Air Temperature (°C) Statistics for Mount Polley Mine, 1974 to 2021 27

Table 14: Derived Monthly and Annual Relative Humidity Statistics for the Site (1974-2021) 28

Table 15: Estimated Solar Radiation Statistics for the Site (1974-2001) 29

Table 16 : Estimated Monthly and Annual Shallow Lake Evaporation Statistics for the Site (1974-2001) 30

Table 17 : Estimated Monthly and Annual Potential Evapotranspiration Statistics for the Site (1974-2001) 31

Table 18 : Estimated Monthly and Annual Actual Evapotranspiration Statistics for the Site (1974-2001) 32

Table 19: Comparison of Relative Frequency of Wind Speed from Mill Weather Station and Weather Station 1 for the Site 35

Table 20: Comparison of Relative Frequency of Wind Speed Seasonal Distributions from Mill Weather Station and Weather Station 1 for the Site 36

Table 21: Snow Water Equivalent for the Site (1997-2021) 37

Table 22: Inventory of Global Climate Models Referenced in this Study 39

Table 23: Projected Anomalies in Monthly and Annual Temperature in the 2050s from Baseline 43

Table 24: Projected Anomalies in Monthly and Annual Temperature in the 2080s from Baseline 44

Table 25: Projected Anomalies in Monthly and Annual Precipitation in the 2050s from Baseline 44

Table 26: Projected Anomalies in Monthly and Annual Precipitation in the 2080s from Baseline 45

Table 27: Projected Mean Annual Relative Humidity for all GCMs (2050s) 46

Table 28: Projected Mean Annual Relative Humidity for all GCMs (2080s) 47

Table 29: Projected Anomalies in Monthly and Annual Relative Humidity in the 2050s from Baseline 49

Table 30: Projected Anomalies in Monthly and Annual Relative Humidity in the 2080s from Baseline 49

Table 31: Projected Mean Annual Solar Radiation for all GCMs (2050s) 50

Table 32: Projected Mean Annual Solar Radiation for all GCMs (2080s) 51

Table 33: Projected Anomalies in Monthly and Annual Solar Radiation in the 2050s from Baseline 53

Table 34: Projected Anomalies in Monthly and Annual Solar Radiation in the 2080s from Baseline 54

Table 35: Projected Annual Precipitation-As-Snow Anomaly for the Mount Polley Mine Area 55

Table 36: Snow Depth Change Relative to 1986 to 2005 Predictions for British Columbia (ECCC 2019) 55

FIGURES

Figure 1: Mount Polley Mine Site and Surrounding Water Bodies and Topography Pre-Mining Activities 3

Figure 2: Mount Polley Site Study Area Climate and Snow Course Stations 5

Figure 3: Regional and Mount Polley Climate Stations 7

Figure 4: April-to-November Rainfall Distributions at Mount Polley Mine and ECCC Likely Climate Stations 12

Figure 5: Mean Monthly Air Temperature Distributions for the Site and Likely ECCC Climate Station 13

Figure 6: Mean Monthly Air Temperature for Regional ECCC Climate Stations (1971 to 2000 period of record for ECCC Likely; 1981 to 2010 period of record for remaining stations) 15

Figure 7 : Annual, April-to-October, and November-to-March Air Temperature Lapse Rates for Regional ECCC Climate Stations (1971 to 2000 period of record for ECCC Likely; 1981 to 2010 period of record for remaining stations) 15

Figure 8: Concurrent Daily Relative Humidity Values at the MPMC and ECCC Quesnel Climate Stations (2019-2021) 17

Figure 9 : Correlation Relationship of Daily Relative Humidity Values at MPMC and ECCC Quesnel Climate Stations (2019-2021) 18

Figure 10 : Concurrent Daily Relative Humidity Values at MPMC and ECCC Williams Lake Climate Stations (2019-2021) 19

Figure 11 : Correlation Relationship of Daily Relative Humidity Values at MPMC and ECCC Williams Lake Climate Stations (2019-2021) 19

Figure 12 : Mean Monthly Solar Radiation for MPMC and ECCC Regional Climate Stations 20

Figure 13 : Daily Solar Radiation Correlation Between ECCC Williams Lake and Prince George Climate Stations (1973-1995) 21

Figure 14 : Annual Precipitation Frequency Analysis – Wet Results 24

Figure 15 : Annual Precipitation Frequency Analysis - Dry Results 24

Figure 16 : Derived Monthly Air Temperature Statistics for Mount Polley Mine (1974-2021) 27

Figure 17 : Derived Monthly Relative Humidity for the Site (1974-2021) 28

Figure 18 : Estimated Monthly Solar Radiation for the Site (1974-2001) 29

Figure 19 : Estimated Shallow Lake Evaporation Statistics for the Site (1974-2001) 31

Figure 20 : Estimated Potential Evapotranspiration Statistics for the Site (1974-2001) 32

Figure 21 : Estimated Actual Evapotranspiration Statistics for the Site (1974-2001) 33

Figure 22: MPMC Station Monitoring Period and Seasonal Wind Roses - 29 August 1997 to 27 November 2003 34

Figure 23: Comparison of Relative Frequency of Wind Speed from Mill Weather Station and Weather Station 1 for the Site 35

Figure 24: Comparison of Relative Frequency of Wind Speed Seasonal Distribution from Mill Weather Station and Weather Station 1 for the Site 36
Figure 25: Scatter Plots Presenting Annual Temperature and Precipitation Projections for the 2050s and the 2080s for the Mount Polley Mine Area 40
Figure 26: Monthly Projected Temperature Anomalies for the Mount Polley Mine Area (2050s) 41
Figure 27: Monthly Projected Temperature Anomalies for the Mount Polley Mine Area (2080s) 42
Figure 28: Monthly Projected Precipitation Anomalies for the Mount Polley Mine Area (2050s) 42
Figure 29: Monthly Projected Precipitation Anomalies for the Mount Polley Mine Area (2080s) 43
Figure 30: Projected Mean Annual Relative Humidity for all GCMs (2050s) 46
Figure 31: Projected Mean Annual Relative Humidity for all GCMs (2080s) 47
Figure 32: Monthly Projected Relative Humidity Anomalies for Mount Polley Mine Area (2050s) 48
Figure 33: Monthly Projected Relative Humidity Anomalies for Mount Polley Mine Area (2080s) 48
Figure 34: Projected Mean Annual Solar Radiation Anomaly for all GCMs (2050s) 50
Figure 35: Projected Mean Annual Solar Radiation Anomaly for all GCMs (2080s) 51
Figure 36: Projected Monthly Solar Radiation Anomalies for Mount Polley Mine Area (2050s) 52
Figure 37: Projected Monthly Solar Radiation Anomalies for Mount Polley Mine Area (2080s) 53

1.0 INTRODUCTION

1.1 Overview

Mount Polley Mining Corporation (MPMC), a subsidiary of Imperial Metals Corporation, owns and operates the Mount Polley Mine (the Mine). The Mine is a copper-gold mine located 56 km northeast of Williams Lake, British Columbia (BC).

1.2 Purpose

Guidance from the Global Industry Standard on Tailings Management (GISTM) published by the International Council on Mining & Metals (ICMM) (2020) stipulates under Requirement 2.1 that the environmental knowledge base including climate parameters should be updated every five years to capture uncertainties due to climate change.

The last climate baseline for the Mine site (the Site) was carried out by Golder Associates Ltd., a member of WSP (WSP Golder) in 2016, and MPMC has retained WSP Golder to prepare an update. The purpose of the update is to extend the existing long-term climate dataset for the Site using local and regional data collected in the last 5 years in support of design activities.

This report provides a climate baseline update for precipitation, air temperature, relative humidity, solar radiation, evaporation, wind speed and direction, and snow depths, and includes updated climate change projections for the Site.

1.3 Scope

The scope of work for this climate study included:

- Literature review of previous descriptions of climate conditions near the Site study area.
- Statistical analysis of historical climate records at different locations near the Site study area to develop statistics for climate variables, including precipitation (total precipitation, rainfall), air temperature, relative humidity, solar radiation, wind speed and direction, and snow cover properties.
- Mathematical modelling to calculate evaporation and potential evapotranspiration statistics for the Site study area.
- Statistical analysis of point climate data from downscaled circulation models using Shared Socioeconomic Pathways scenarios (ECCC 2022c) for future climate projections for the Site study area.

2.0 STUDY AREAS

The Site is located 56 km northwest of Williams Lake, British Columbia (BC) near the eastern edge of the Fraser Plateau physiographic subdivision, approximately 10 km west of its boundary with the Quesnel Highland subdivision, as defined by Holland (1976).

2.1 Local Study Area

Within the area of the Mine, the plateau has somewhat higher relief, with the Mine rising approximately 300 metres (m) above the surrounding terrain. Topographically, the Site area consists of north–south trending ridges of moderate elevation and relief. Local elevations range from 922 metres above sea level (masl) at Polley Lake to 1,266 masl at the top of Polley Mountain with an average elevation of 1,038 masl. The total surface area of the Site is 17.8 square kilometers (km^2).

The Site is located on the divide of two sub-watersheds within the Quesnel Lake watershed. The western watershed, which includes drainage from Bootjack Lake, discharges to the Quesnel River via Morehead Creek and drained approximately 60% of the Mount Polley area prior to Mine construction. The eastern watershed includes Polley Lake, which discharges to the east via Hazeltine Creek, Edney Creek, and the West Arm of Quesnel Lake. The Hazeltine Creek and Edney Creek watershed areas at Quesnel Lake are approximately 30.2 km^2 and 87.4 km^2, respectively. Approximately 10.5 km^2 that historically reported to this watershed is now within the Site contact water runoff collection system catchment.

Bootjack Creek is a small tributary of Hazeltine Creek downstream of Polley Lake. Historically, Bootjack Lake discharged into Hazeltine Creek via Bootjack Creek, but in 1913 a dam was constructed at the south end of Bootjack Lake and the flow direction was reversed in order to direct water into Morehead Lake for hydropower production. This resulted in 14 km^2 being diverted from the Hazeltine Creek catchment. The old Bootjack Lake Dam was upgraded by MPMC in 1997 as fulfillment of a Fish Habitat Compensation Agreement signed between MPMC and the regulating federal and provincial agencies. The Bootjack Lake watershed area is 11.2 km^2; approximately 2.3 km^2 that historically reported to this watershed is now within the Site contact water runoff collection system catchment. Currently, Bootjack Creek reports to Polley Lake.

The regional topography, water bodies, and pre-mining watersheds are shown in Figure 1. Mine Site water collection systems and catchment areas are not included in the scope of this report.

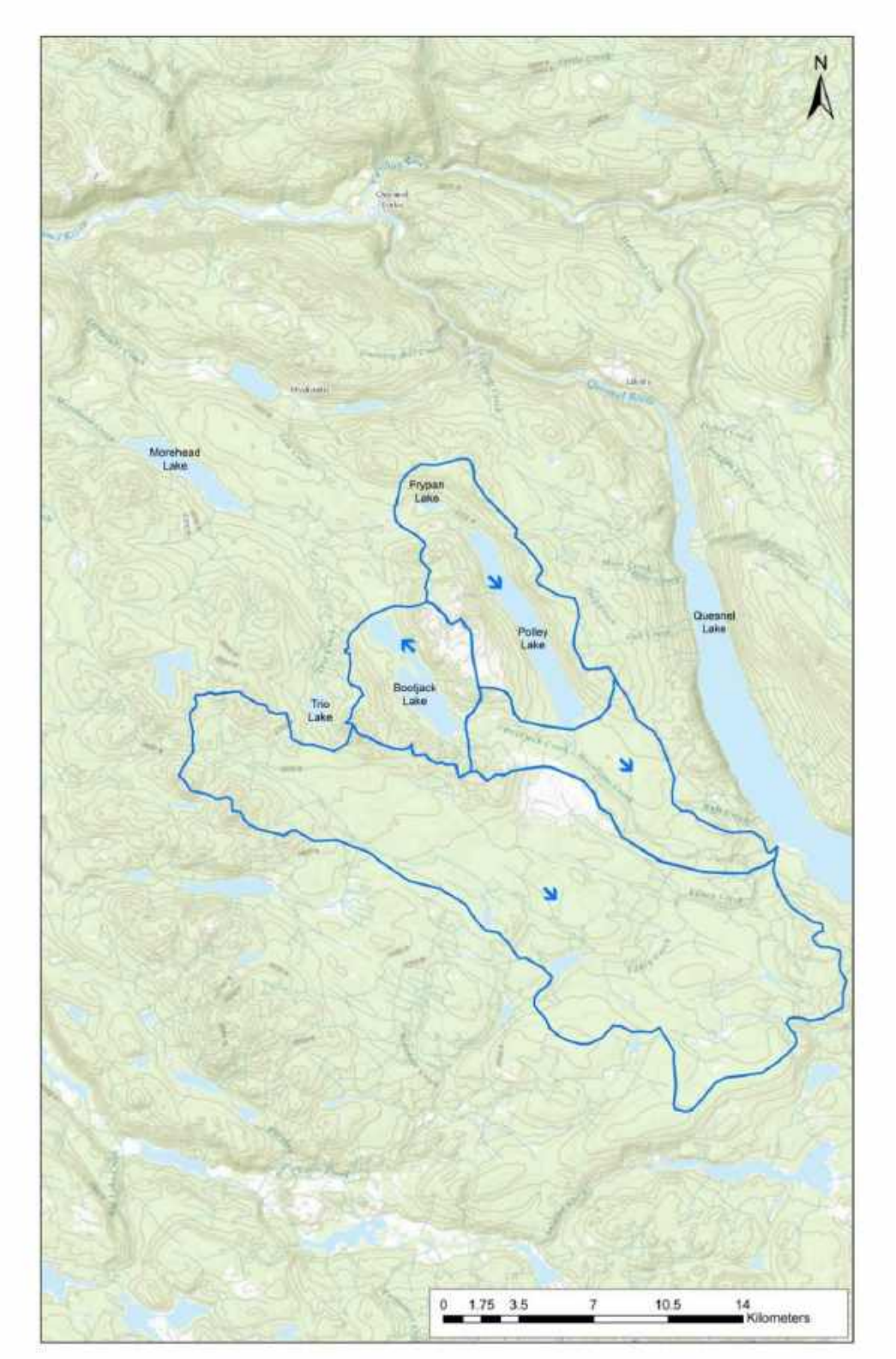
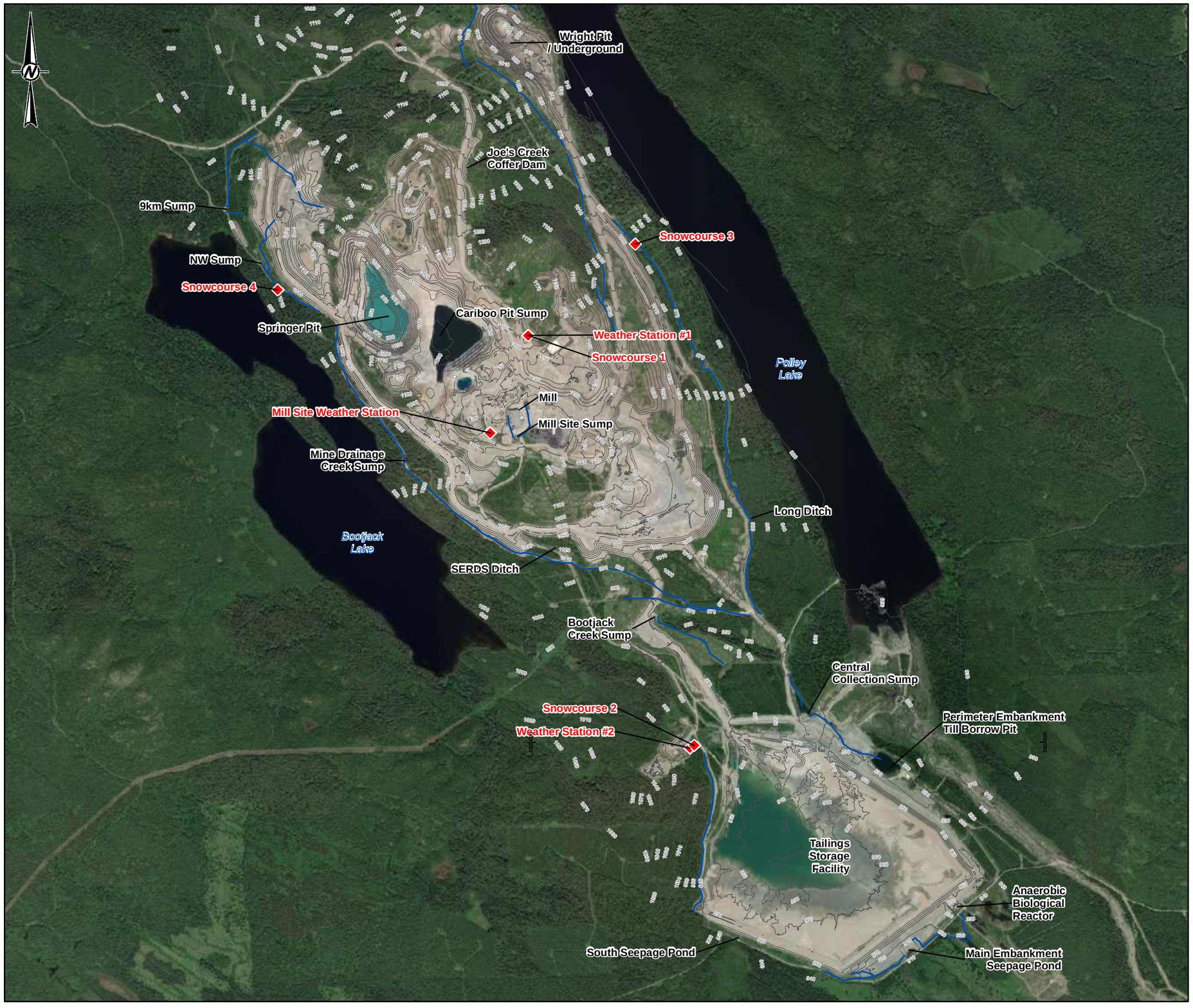


Figure 1: Mount Polley Mine Site and Surrounding Area Water Bodies and Topography Pre-Mining Activities

The Site study area is presented in Figure 2 The Site study area comprises the footprint of the physical infrastructure of the Mine and the tailings storage facility (TSF).



LEGEND

- CLIMATE STATION
- WATER COLLECTION DITCH
- CONTOUR (10m)

0 600 1,200

1:30,000 METRES

REFERENCE(S)

1. CONTOURS AND PROJECT IMAGERY OBTAINED FROM SNC LAVALIN (2014)
2. WATER CATCHMENT AREAS INTERPOLATED BY GOLDER ASSOCIATES LTD.
3. BASE IMAGERY SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. DATUM: NAD 1983 UTM ZONE 10N

CLIENT

MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS

PROJECT

WATER MANAGMENT PLAN - BASELINE CLIMATE UPDATE

TITLE

MOUNT POLLEY SITE STUDY AREA CLIMATE STATIONS

CONSULTANT

WSP GOLDER

YYYY-MM-DD	2022-08-29
DESIGNED	DM
PREPARED	CDB
REVIEWED	DRW
APPROVED	JD

PROJECT NO.	CONTROL	REV.	FIGURE
22514095	31500/31547	0	2

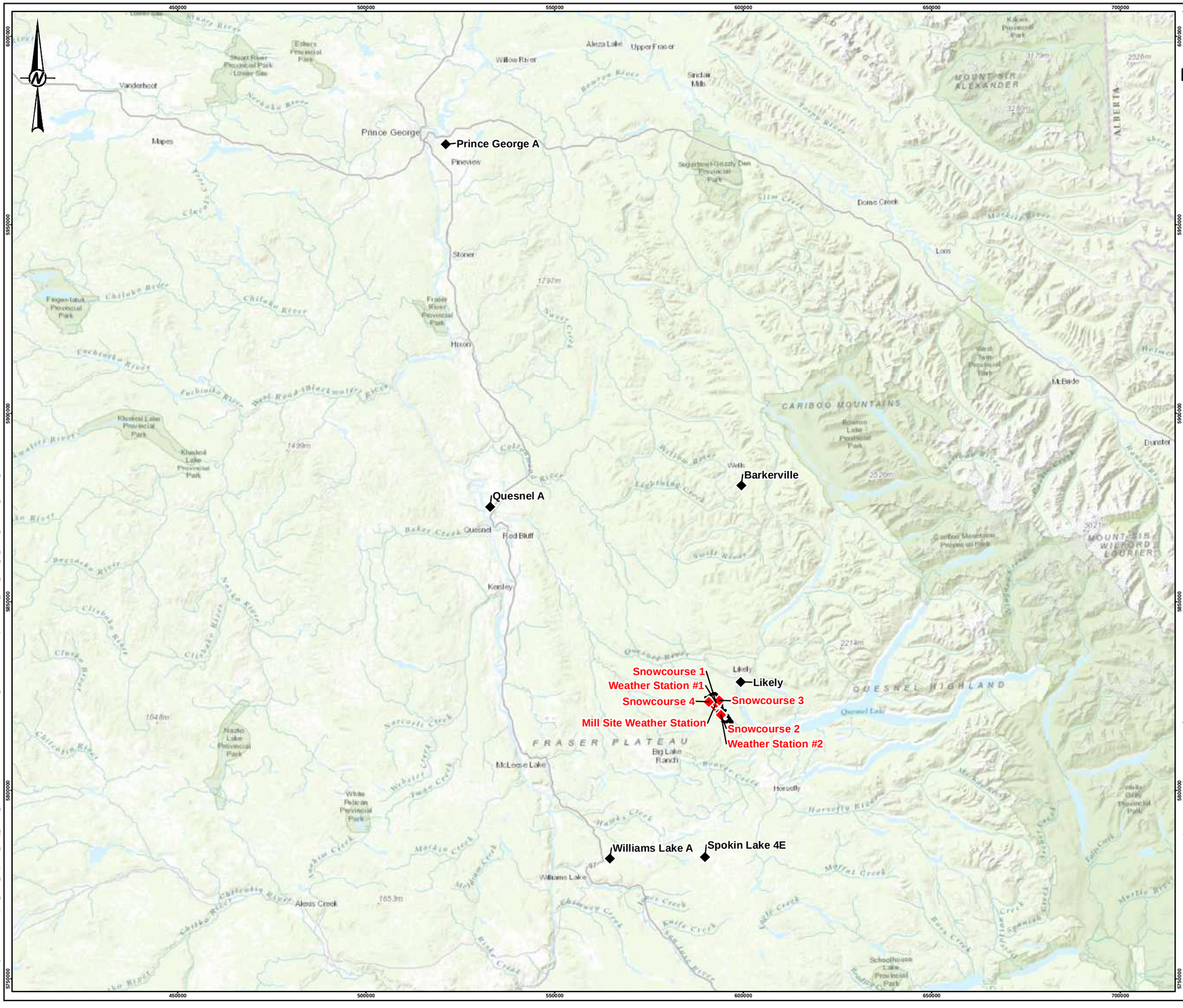
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25mm

PATH: Y:\burnaby\CAD-GIS\Client\Imperial_Metals_Corp\Mount_Polley_Mine\99_PROJECTS\22514095\31500\31547\Doc zzz\02_PRODUCTION\MXD\Report\22514095_31500_31547_02_SITE_STUDY_AREA_CLIMATE_STATIONS.mxd PRINTED ON: 2022-08-29 AT: 3:46:36 PM

2.2 Regional Study Area

The regional study area (RSA) is comprised of the nearest Environment and Climate Change Canada (ECCC) climate stations (Figure 3). The RSA ECCC climate stations have elevations ranging from 1,283 m to 545 m with a mean elevation of 908 m, 130 m below the mean elevation of the Site study area.


Prince George A
Barkerville
Quesnel A
Likely
Snowcourse 1
Weather Station #1
Snowcourse 4
Snowcourse 3
Mill Site Weather Station
Snowcourse 2
Weather Station #2
Williams Lake A
Spokin Lake 4E
Vanderhoof
Prince George
Mapes
Pineview
Stoner
Hixon
Quesnel
Red Bluff
Kersley
Likely
Williams Lake
Alexis Creek
Dome Creek
Loos
McBride
Dunster
Willow River
Aleza Lake
Upper Fraser
Sinclair Mills
Valemount
Tete Jaune Cache
Blue River
Clearwater
Barriere
Kamloops
Little Fort
Horsefly
Wells
Barkerville
Bowron Lake Provincial Park
Cariboo Mountains Provincial Park
Mount Sir Alexander
Mount Sir Wilfrid Laurier
Quesnel Lake
Big Lake Ranch
McLeese Lake
Naziko Lake Provincial Park
White Pelican Provincial Park
Kluskoil Lake Provincial Park
Fraser River Provincial Park
Fraser Lake Provincial Park
Esters Provincial Park
Stuart River Provincial Park - Lower Sia
Segaterbow/Grizzly Den Provincial Park
West Twin Provincial Park
Schoolhouse Lake Provincial Park
Valley View Provincial Park
Kakwa Provincial Park
Cariboo Mountains
Quesnel Highland
Fraser Plateau
Alberta
1797m
1499m
1648m
2214m
2526m
3021m
3179m
3240m
1653m
Stuart River
Nechako River
Cluculz Lake
Chilako River
Euchiniko River
Fraser River
Baker Creek
Swift River
Cottonwood River
Willow River
Bowron River
Torpy River
Slim Creek
Morkill River
Narcosli Creek
Webster Creek
Twan Creek
Beaver Creek
Horsefly River
Hawks Creek
Martin Creek
Moffat Creek
Spanish Creek
Euchiniko River
Chilcotin River
Taseko River
Clisbako River
Clusko River
Chilko River
Big Creek
Lightning Creek
Deception Creek
Keithley Creek
Mosquito Creek
Sheep Creek
Ellis Creek
Boss Creek
Fall Creek
Myrtle Creek
Skoonka Creek
Nazko River
Blackwater River
Euchiniko River
Chilanko River
Chilako River
Nazko River
Baker Creek
Quesnel

3.0 METHODS

3.1 Study Design

Climate parameters (e.g., precipitation, temperature, and evaporation) vary both spatially and temporally. They vary spatially in response to changes in elevation and/or overall circulation patterns, and temporally, across the seasons, and from year to year. Describing the climate conditions for a certain area means presenting the climate statistics that capture the variation, including both the average expected values and the extent of the variation around the average.

The summary statistics for precipitation, temperature, evaporation, relative humidity, solar radiation, wind speed and directions, and snow depths presented herein were prepared from historical measurements recorded at local climate stations, supported by data collected from nearby regional climate stations. Raw station data were interrogated for inconsistencies or gaps then infilled using regional data and translation factors to generate short duration (daily and sub-daily) and long-duration (Annual) estimates for a range of return periods (precipitation only) or percentiles (temperature, evaporation, relative humidity, and solar radiation only). Except for wind and snow cover, the datasets were extended using historical regional data and translation factors to include a range of possible weather events and climatic trends.

Future climate projections come from publicly available statistical downscaled future climate projections on a daily scale. Recognizing the inherent uncertainty with projections, multiple projections from multiple models and scenarios were included in the analysis. Therefore, the future projections are provided in terms of percentiles or exceedance probabilities. The following sections provide a summary of the climate stations used in this report.

3.2 Review of Existing Information

Climate conditions for the Site were estimated based on data from several meteorological stations in the region and at the Site (Figure 3). The meteorological stations are listed in Table 2 and Table 4.

3.2.1 Local Climate Stations

MPMC has operated climate stations on site since 1995, although the station data records are not continuous. From 1995 through 2012, MPMC maintained one climate station at the Mill Site that measured and recorded rainfall (1997 to 2012), temperature (1995 to 2012) and wind velocity and directions (1997 to 2003). In 2012, this station was replaced with two stations: one near the mill site (WS1) and one adjacent to the TSF (WS2). These new stations measure and record wind speed, relative humidity, solar radiation, temperature, and rainfall.

Rainfall was measured using a manual rain gauge from 1997 to present at each climate station, and in 2019 automated tipping rain gauges were added at WS1 and WS2. For this study, rainfall for the Site was averaged across all instruments that recorded rainfall on a given day. Relative humidity and solar radiation were recorded at WS1 and WS2 from 2019 to 2021, although records are not continuous. In addition, solar radiation was recorded at the Mill Site station from 2001 to 2003.

Details of these stations are provided in Table 2 and their locations are shown in Figure 2.

Table 2: Local Climate Stations for the Mount Polley Mine

Station Name	Northing (m N)[1]	Easting (m E)[1]	Elevation (masl)[2]	Data Type	Period of Record
Mill Site Weather Station	5822420	592495	1,118	R, T, WS, WD	1995-2012
Weather Station #1 (WS1) [near mill]	5822420	592792	1,171	R, T, RH, SR, E, WS	2012-2021[3]
Weather Station #2 (WS2) [TSF]	5819955	594059	964	R, T, RH, SR, E, WS	2012-2021[3]

1) UTM Coordinate system – Zone 10U.

2) Elevation for on-site climate stations measured with handheld GPS device.

3) Station still in operation.

TSF = tailings storage facility; masl = metres above sea level.

R = Rainfall; S = Snowfall; T = Temperature; RH = Relative Humidity; SR = Solar Radiation; E = Evaporation; WS = Wind Speed; WD = Wind Direction.

During the winter, snowpack is measured at four snow course sites at a minimum frequency of once per month, with more frequent measurements typically taken during the melt phase. The details of these snow course stations are provided in Table 3 and their locations are shown in Figure 2.

Table 3: Local Snow Course Sites at the Mount Polley Mine

Station Name	ID	Northing (m N)[1]	Easting (m E)[1]	Approximate Elevation (masl)[2]	Period of Record
Snow Course # 1 (near mill)	N/A	5823182	592792	1,171	1997–2010, 2015–current
Snow Course # 2 (near TSF)	N/A	5819976	594092	964	1997–current
Snow Course # 3	N/A	5823895	593632	976	2012–current
Snow Course # 4	N/A	5823537	590835	1,112	2015–current

1) UTM Coordinate system - Zone 10U.

2) Elevation for on-site climate stations measured with handheld GPS device.

masl = metres above sea level; N/A = not applicable; TSF = Tailings Storage Facility.

3.2.2 Regional Climate Stations

Five Environment and Climate Change Canada (ECCC) climate stations: Likely, Spokin Lake, Williams Lake, Barkerville, and Quesnel, were selected for the update due to their proximity to the Site, length of record, elevation range, and concurrent period of record with the local climate stations at the Site. In addition, the ECCC Prince George climate station was added to include an additional station with solar radiation data. Historical records were retrieved from ECCC's Historical Climate Data web server (ECCC 2022a). More recent records were compiled through e-mail correspondence with ECCC staff (ECCC 2022b). The regional climate station details are provided in Table 4, and their respective locations are shown in Figure 3.

Table 4: Regional Climate Stations for the Mount Polley Mine

Station Name (ID)	Northing (m N)[1]	Easting (m E)[1]	Elevation (masl)	Approximate Distance to Site (km)	Data Type	Period of Record[2]
Likely (1094616)	5828785	599332	724	9	P, R, S, T	1974-1993
Williams Lake A (1098940)	5781820	564666	940	50	P, R, S, T, RH, SR	1961-2021[4]
Spokin Lake 4E (1097646)	5782274	589827	1,033	40	P, R, S, T	1983-2021[4]
Barkerville (1090660)	5880996	599515	1,283	59	P, R, S, T	1888-2021[3, 4]
Quesnel A[5] (1096630)	5873987	546720	545	80	P, R, S, T, RH	1946-2021[4]
Prince George A (1096450)	5971423	521103	691	163	P, R, S, T, RH, SR	1973-1995

1) UTM Coordinate system – Zone 10U.
2) Length of record from start year to end year may not reflect the number of complete years of data.
3) Provisional data for the period January 2016 to December 2021 were provided by ECCC.
4) Station still in operation.
5) Combined record from Quesnel A and Quesnel Airport Auto stations. Stations are located at the same location.

ID = Identification; masl = metres above sea level; km = kilometre.
P = Precipitation; R = Rainfall; S = Snowfall; T = Temperature; RH = Relative Humidity; SR = Solar Radiation.

3.3 Data Processing

Climate parameter statistics for the Site were prepared using data from the three on-site climate stations operated by MPMC, and the five regional climate stations operated by ECCC (Sections 3.2.1 and 3.2.2). Data were interrogated for gaps and errors, and where appropriate, extended and filled with data from regional stations using translation factors derived from the available periods of record as described in Section 3.4. Local data were screened for outliers in the time series that may be indicative of errors or equipment malfunction. Potential high outliers were identified in the Mount Polley rainfall record in April 2009 but were not removed from the time series as there was insufficient evidence to support removal. In addition, climate parameter records were checked using the World Meteorological Organization (WMO) guidelines (WMO 2018) as reference. Monthly records were removed if there were more than five days missing, or more than 3 consecutive days missing. Annual records were only calculated using years with a complete dataset (twelve months).

3.4 Data Analysis

3.4.1 Precipitation

The MPMC precipitation dataset was extended and infilled using the available data record from the five regional stations as described below to derive a daily and 24-hour long-term synthetic precipitation dataset for the Site.

Extended MPMC Precipitation Data Record

The Likely ECCC Station data were considered to extend the precipitation record for the Site given the station's length of record and proximity to the Site. As the Likely ECCC station and MPMC climate stations do not have concurrent data sets, the mean monthly April-to-November rainfall distribution for the available data records were compared to evaluate the suitability of using the Likely station data to represent precipitation conditions at the Site. As shown in Figure 4, the Likely and Site station monthly precipitation distributions show a similar trend overall, with MPMC recording notably greater rainfall in April, and notably less rainfall in June and August relative to Likely. The notable differences in monthly rainfall between the MPMC and Likely datasets for the months of April, June, and August were investigated with the following observations:

- April: the length of record for MPMC is relatively short and is not continuous, and outliers have potential to bias mean monthly rainfall. As previously mentioned, potential high outliers were identified in the Mount Polley rainfall record in April 2009 but were not removed from the time series as there was insufficient evidence to support removal. However, if the potential high outlier data were to be removed, the mean monthly April values would be more aligned between the data sets (48.8 mm for MPMC versus of 33.1 mm for Likely).
- June: review of the MPMC and concurrent regional June monthly rainfall records for Barkerville, Spokin Lake, and Williams Lake indicate that relatively low June rainfall totals (compared to average values for the complete available data set from the regional stations) were recorded in several years during the 1997 to 2021 period of record (2002, 2003, 2006, 2009, 2014, 2019, and 2021). These years represent approximately 40% of the available June records for MPMC, suggesting the MPMC mean June rainfall may be biased low (i.e., due to shorter period of record used in computing the mean) compared to Likely.
- August: review of regional rainfall records for Barkerville, Spokin Lake, and Williams Lake from 1997 to 2021 (i.e., concurrent with the MPMC precipitation data set), indicate that regional mean August monthly rainfall records were 84%, 87%, and 85% of the mean of the full period of record, respectively, indicating that there has been reduction (compared to the longer-term mean) in August rainfall regionally in more recent years. In other words, the differences between MPMC and Likely mean August rainfall values may be attributed to differing precipitation trends in the respective reporting periods.

Based on above, the historical Likely ECCC Station record was considered acceptable for extending the historical precipitation record for the Site. Owing to the elevation difference between the Site and Likely ECCC Station, a precipitation-elevation orographic factor was applied to adjust the raw precipitation data from the Likely ECCC climate station to the Site. The adjustment was based on the April-to-November rainfall ranking factor of the raw Likely ECCC climate station and Site rainfall records.

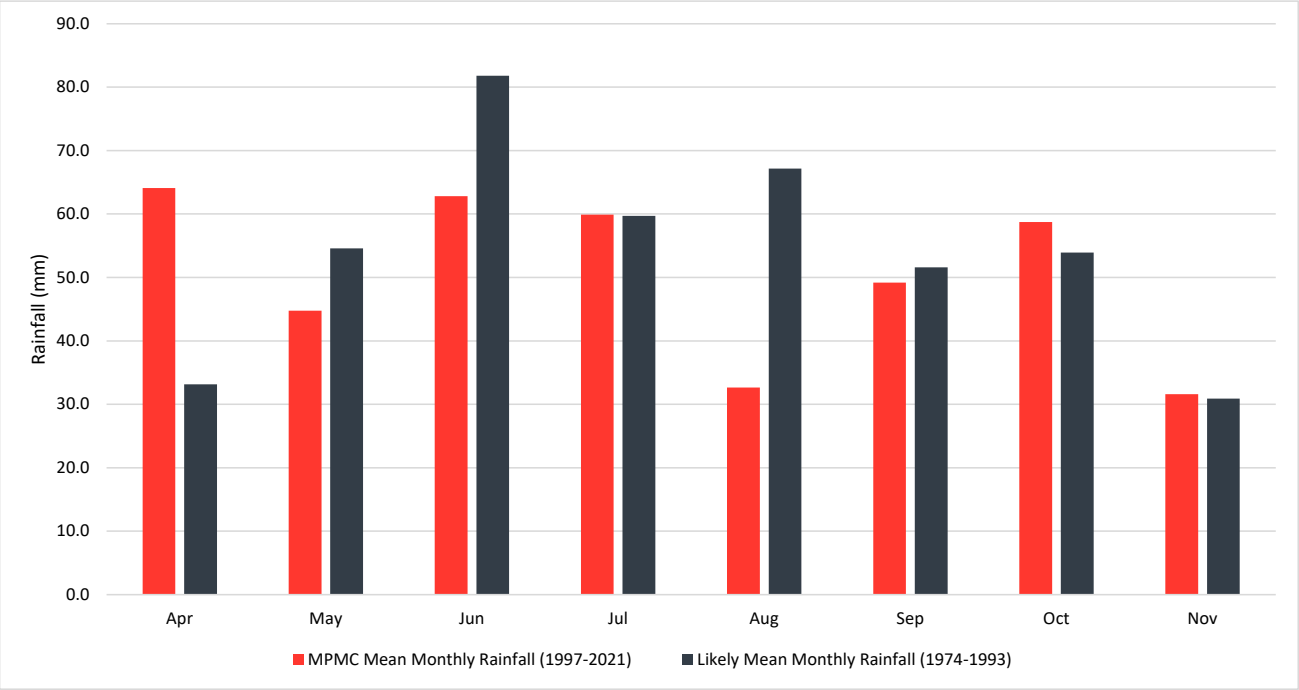


Figure 4: April-to-November Rainfall Distributions at Mount Polley Mine and ECCC Likely Climate Stations

MPMC Precipitation Data Gap Infilling

The priority sequence of concurrent regional climate station data used to infill gaps in the extended Site precipitation record was determined by analyzing measured daily rainfall from April to November for all climate stations; it was assumed that precipitation occurring between December and March occurred as snowfall. The regional climate station priority sequence considered the best-fit measured concurrent daily rainfall correlation (Rainfall Correlation), rainfall ranking correlation (Rainfall Rank), and percentage of time rain was recorded on the same day (Concurrent Daily Rain) between the raw data collected at the MPMC climate stations and each ECCC climate station (Table 5). Regional climate station precipitation data replaced missing rainfall data in the extended Site data record following the priority sequence, and all precipitation data from December to March as it was assumed precipitation during this period occurs as snowfall and daily snowfall is not recorded at the Site.

Table 5: Regional Climate Stations Priority Sequence for Precipitation Data Gap Infilling in Extended Record for MPMC

Priority	Station	Rainfall Correlation (R^2)	Rainfall Rank (R^2)	Concurrent Daily Rain (%)	Period of Record	Currently Active	Distance from site (km)
1	Williams Lake A	0.1950	0.9872	61.8	1960-2021	Yes	50
2	Spokin Lake 4E	0.1829	0.9747	65.8	1983-2021	Yes	40
3	Barkerville	0.1579	0.9216	66.4	1888-2021	Yes	59
4	Quesnel A	0.0502	0.9556	23.3	1946-2021	Yes	80

A precipitation-elevation orographic factor was applied to adjust the raw precipitation data from the ECCC climate stations used to infill gaps. The adjustment was based on the April-to-November rainfall ranking factor of the raw ECCC climate station and Site rainfall records.

Daily to 24-Hour, 3-day, and 10-day Precipitation

The daily long-term synthetic precipitation dataset was converted to 24-hour, 3-day, and 10-day precipitation by applying a factor of 1.13 (WMO 2009), 1.03, and 1.01 (Miller 1964), respectively.

3.4.2 Temperature

Similar to precipitation analysis above, the MPMC temperature dataset was extended and infilled using the available data record from the five regional stations to derive a long-term synthetic temperature dataset for the Site.

Extended MPMC Temperature Data Record

The Likely ECCC Station data were considered to extend the temperature record for the Site given the station's length of record and proximity to the Site. As the Likely ECCC station and MPMC climate stations do not have concurrent data sets, the mean monthly air temperature distributions for the Site and Likely climate stations were compared to evaluate the suitability of using the Likely station data to represent temperature conditions at the Site. As shown in Figure 5, the monthly distributions show similar trend with MPMC and the historical Likely ECCC Station record was considered acceptable for extending the historical temperature record for the Site. Owing to the elevation difference between the Site and Likely ECCC Station, a temperature-elevation orographic factor was applied to adjust the raw precipitation data from the Likely ECCC climate station used to extend the historical record. The adjustment was based on monthly regional lapse-rates as discussed below.

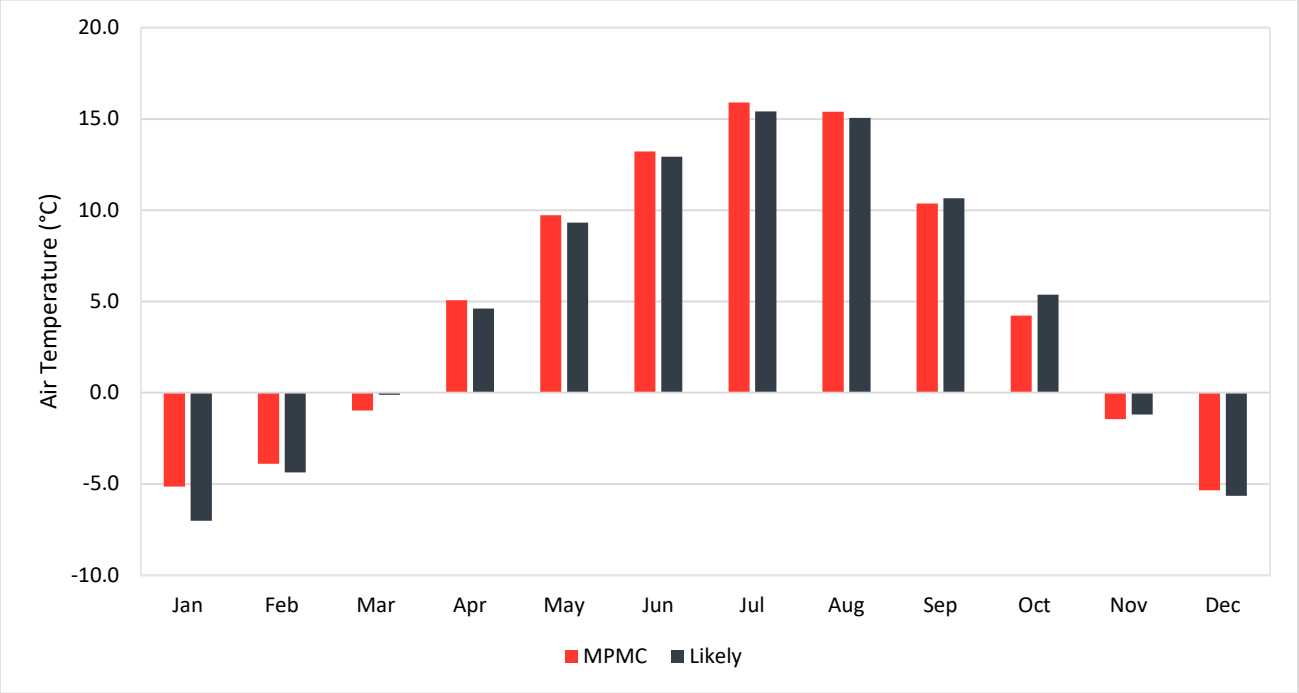


Figure 5: Mean Monthly Air Temperature Distributions for the Site and Likely ECCC Climate Station

ECCC Climate Normals for the regional climate stations were reviewed and are summarized in Table 6 and mean monthly air temperatures are presented in Figure 6. Comparing the Normals for the five regional ECCC Climate stations, there is an evident trend (the temperature lapse rate) of decreasing mean annual temperature with increasing elevation. The annual temperature lapse rate for the region is -0.47 °C / 100 m elevation increase. The lapse rate is larger for warmer months (April to October -0.55 °C / 100 m) and smaller for colder months (November to March -0.33 °C / 100 m). When analysed at a monthly level, the lapse rate is lowest for January (-0.09°C / 100 m) and highest for April, May, June, and July (-0.61°C / 100 m, -0.61°C / 100 m, -0.60°C / 100 m, and -0.59°C / 100 m, respectively). The R^2 of the linear trend is markedly lower for January (0.43) than for all the other months of the year (0.79 to 0.92), which suggests that temperature inversion may occur in the region in January. Lapse rates are presented in Table 7 and Figure 7.

Table 6: Monthly and Annual Air Temperature Climate Normals for Regional ECCC Climate Stations

Station Name	Quesnel A (545 masl)	Williams Lake A (940 masl)	Spokin Lake 4E (1,033 masl)	Barkerville (1,283 masl)	Likely (740 masl)
Time period for EC Climate Normals	1981-2010	1981-2010	1981-2010	1981-2010	1971-2000
Month	**Temperature (°C)**				
January	-6.9	-6.7	-7.6	-7.5	-7.0
February	-3.6	-4.1	-5.4	-5.9	-4.4
March	1.3	0.3	-1.2	-2.8	-0.1
April	6.4	4.9	3.7	1.4	4.6
May	11.1	9.6	8.0	6.2	9.3
June	14.7	13.3	11.4	10.0	12.9
July	16.8	16.0	13.4	12.3	15.4
August	16.4	15.3	12.8	12.8	15.1
September	11.5	10.6	8.5	8.0	10.7
October	5.5	4.6	3.4	2.4	5.4
November	-1.4	-2.3	-3.2	-4.3	-1.2
December	-5.9	-7.3	-7.7	-7.8	-5.7
Annual	**5.5**	**4.5**	**3.0**	**2.0**	**4.6**

masl = metres above sea level.

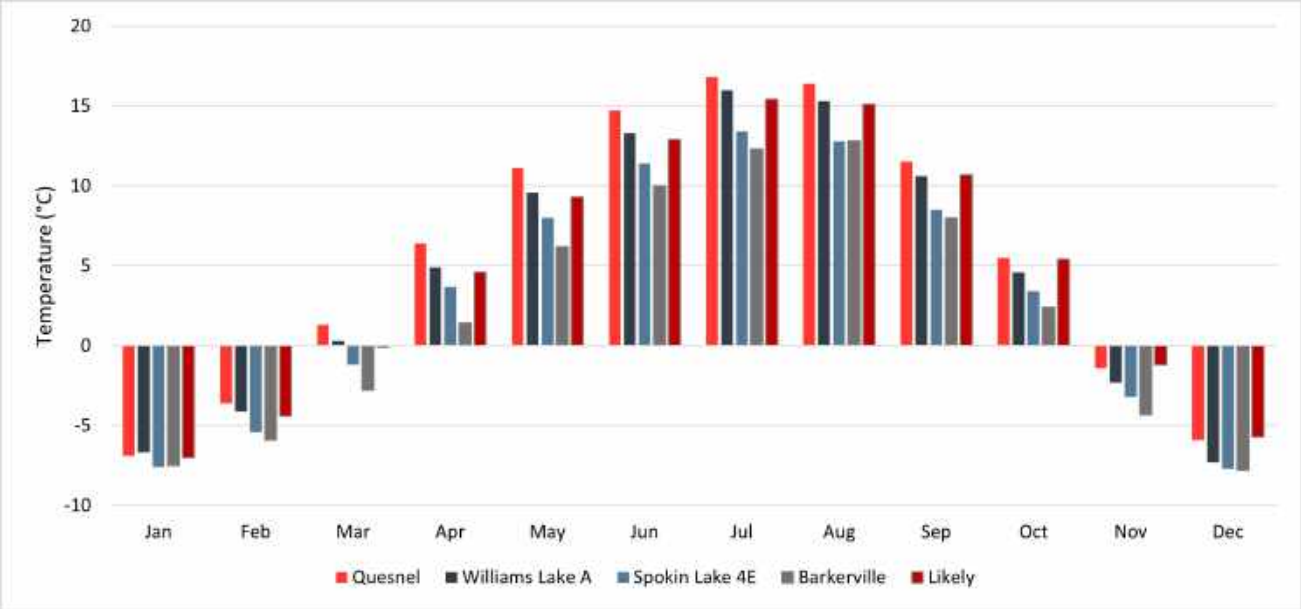


Figure 6: Mean Monthly Air Temperature for Regional ECCC Climate Stations (1971 to 2000 period of record for ECCC Likely; 1981 to 2010 period of record for remaining stations)

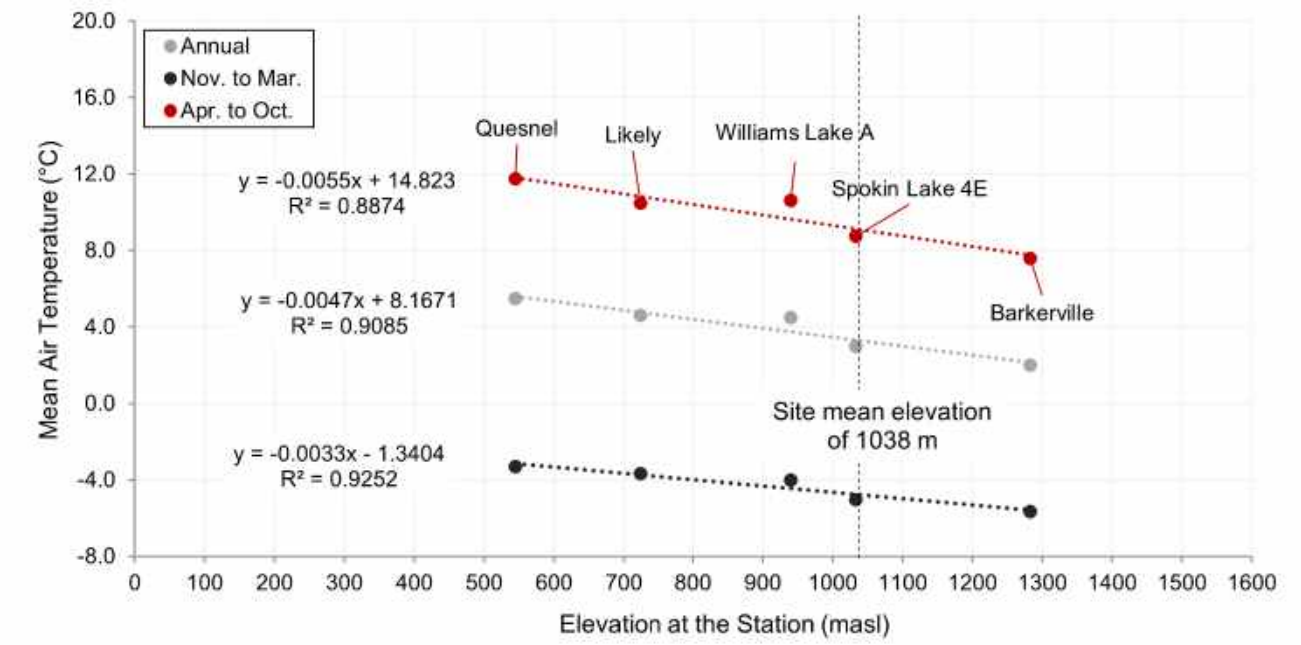


Figure 7 : Annual, April-to-October, and November-to-March Air Temperature Lapse Rates for Regional ECCC Climate Stations (1971 to 2000 period of record for ECCC Likely; 1981 to 2010 period of record for remaining stations)

Table 7: Monthly Air Temperature Lapse Rate Variation Among Five Regional ECCC Climate Stations (1971 to 2000 period of record for ECCC Likely; 1981 to 2010 period of record for remaining stations)

Month	Lapse Rate = °C Difference / 100 m Elevation Increase	R^2 of the Linear Trend
January	-0.09	0.43
February	-0.30	0.82
March	-0.51	0.86
April	-0.61	0.88
May	-0.61	0.89
June	-0.60	0.87
July	-0.59	0.81
August	-0.50	0.79
September	-0.49	0.85
October	-0.45	0.92
November	-0.43	0.90
December	-0.32	0.82
Annual	-0.47	0.91

MPMC Temperature Data Gap Infilling

The priority sequence of regional climate station data used to infill gaps in the extended Site air temperature record was based on the best-fit daily air temperature correlation (Temperature Correlation), air temperature ranking (Temperature Ranking), and concurrent daily temperature recordings between the MPMC climate stations and each ECCC climate station (Table 8).

Table 8: Regional Climate Stations Priority Sequence for Temperature Data Gap Infilling in Extended Record for MPMC

Priority	Station	Temperature Correlation (R^2)	Temperature Rank (R^2)	Concurrent Daily Temperature (%)	Period of Record	Currently Active	Distance from site (km)
1	Williams Lake A	0.8917	0.9942	93.5	1960-2021	Yes	50
2	Barkerville	0.8834	0.9951	99.0	1888-2021	Yes	59
3	Quesnel A	0.8628	0.9861	97.5	1946-2021	Yes	80
4	Spokin Lake 4E	0.8525	0.9810	99.5	1983-2021	Yes	40

Regional ECCC climate station daily air temperature data were adjusted using the monthly air temperature lapse-rate presented in Table 7 to derive representative air temperature at the Site.

3.4.3 Relative Humidity

Relative humidity data are available for the Site from 2019 to 2021 and for ECCC climate stations Quesnel (1953 to 2021) and Williams Lake (1961 to 2021). The MPMC WS1 relative humidity record is more complete than WS2's record; therefore, WS1 data were used for the analysis and infilled with WS2 data where necessary and if available. However, relative humidity data for the Site are insufficient for characterizing long-term climatic conditions of the Site due to the short period of record. Therefore, data from Quesnel and Williams Lake stations were reviewed and analyzed to define a representative relative humidity estimate for the Site. Comparisons between the Site data and each ECCC climate station data were made to determine which station best represents the potential relative humidity at the Site.

Figure 8 and Figure 9 present the comparison between concurrent daily relative humidity values at the ECCC Quesnel and MPMC climate stations (January 2019 to December 2021). The 15-day moving average indicates that the relative humidity is generally higher at the Site than at the ECCC Quesnel climate station. The two datasets are well correlated (R^2=0.96).

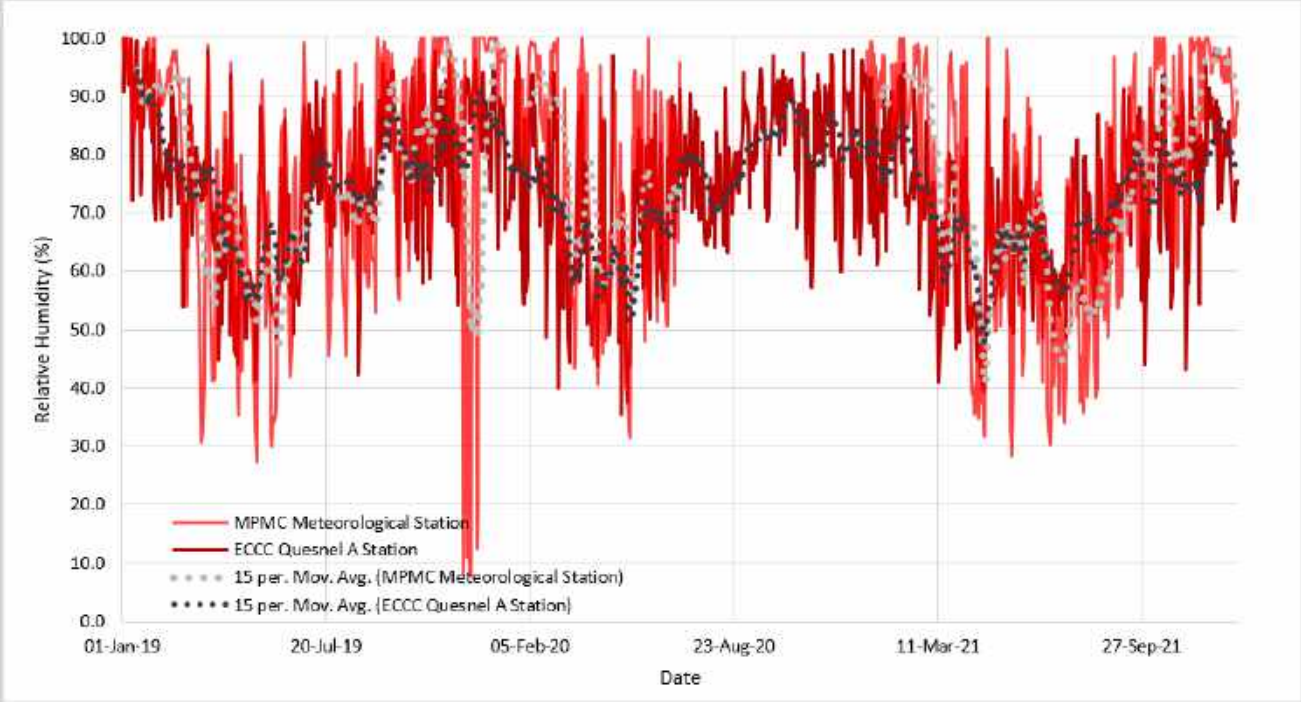


Figure 8: Concurrent Daily Relative Humidity Values at the MPMC and ECCC Quesnel Climate Stations (2019-2021)

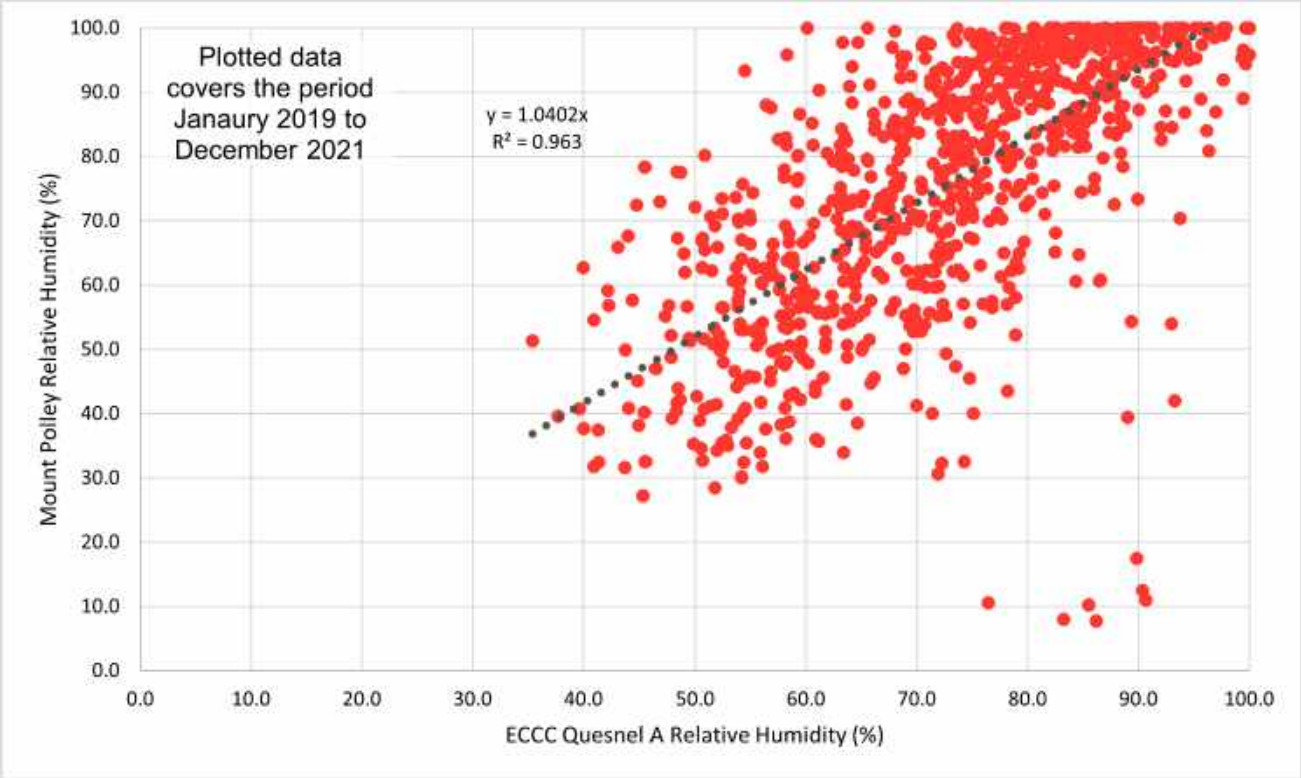


Figure 9: Correlation Relationship of Daily Relative Humidity Values at MPMC and ECCC Quesnel Climate Stations (2019-2021)

Figure 10 and Figure 11 present the comparison between concurrent daily relative humidity values at the ECCC Williams Lake and MPMC climate stations (January 2019 to December 2021). The 15-day moving average indicates that the relative humidity is generally higher at the Site than at ECCC Williams Lake climate station. The two datasets are very well correlated (R^2=0.98).

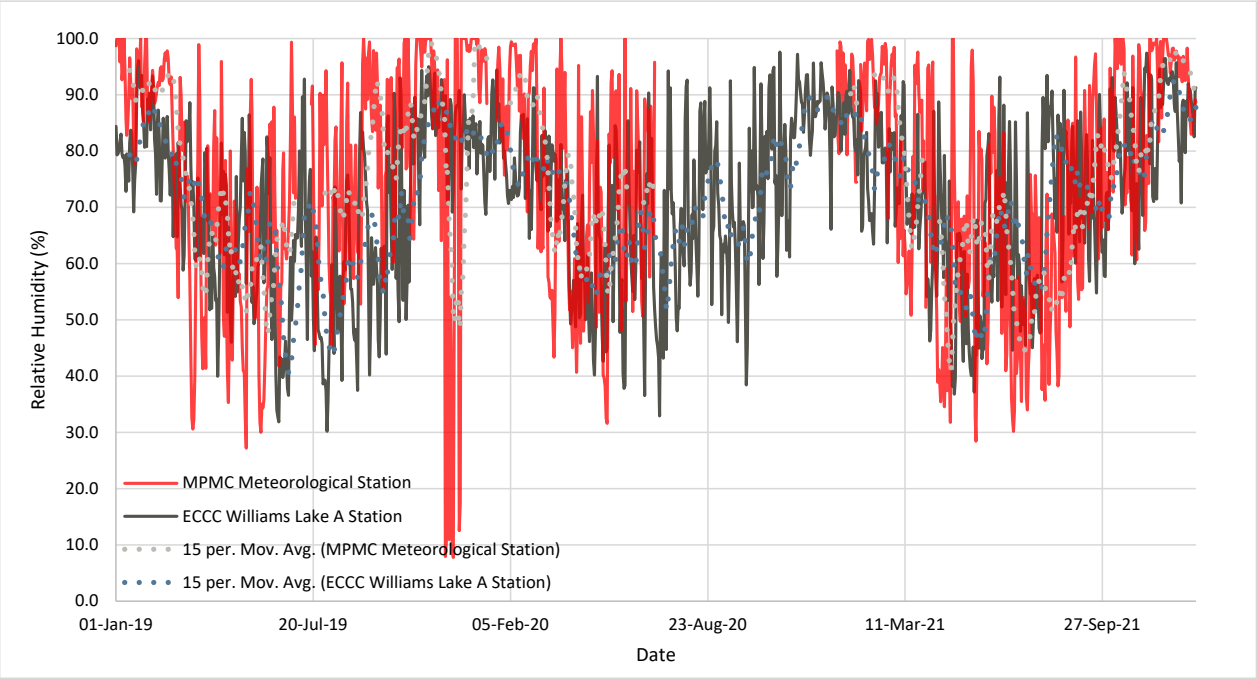


Figure 10 : Concurrent Daily Relative Humidity Values at MPMC and ECCC Williams Lake Climate Stations (2019-2021)

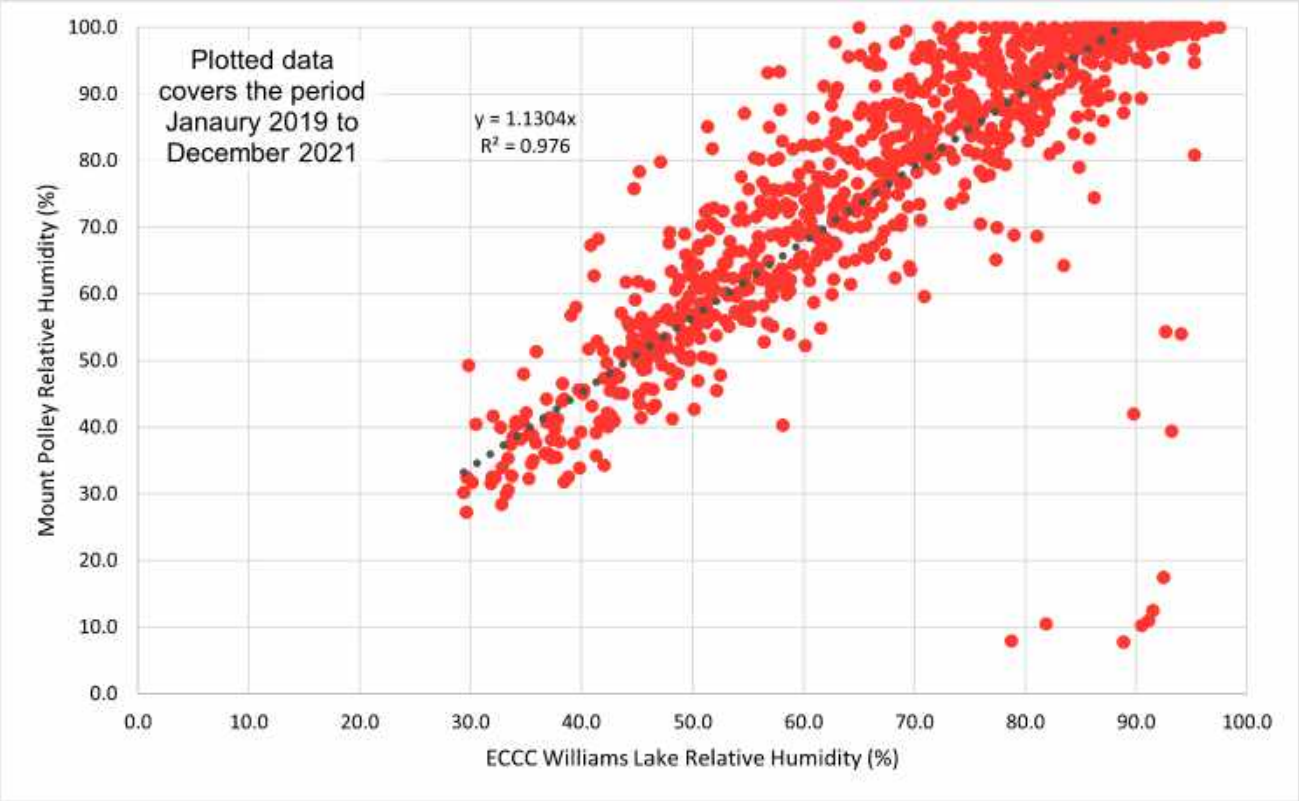


Figure 11 : Correlation Relationship of Daily Relative Humidity Values at MPMC and ECCC Williams Lake Climate Stations (2019-2021)

A long-term relative humidity time series for the Site was developed using ECCC Williams Lake A data infilled with ECCC Quesnel A data with an adjustment factor of 1.13 and 1.04 based on the relationships presented in Figure 11 and Figure 9, respectively.

3.4.4 Solar Radiation

Solar radiation data are available for the Site from 2001 to 2003 and 2019 to 2021, and for ECCC climate stations Williams Lake (1961 to 2001) and Prince George (1973 to 1995). Solar radiation data for the Site are insufficient for characterizing climatic conditions of the Site due to the short period of record, and as the data recorded in 2001 is incomplete and not concurrent with either ECCC climate station. However, as presented in Figure 12, a discernible trend in mean monthly solar radiation is apparent for MPMC solar radiation (2019 to 2021) and in data from the ECCC Williams Lake and Prince George climate stations. Figure 13 presents ECCC Williams Lake and Prince George mean monthly solar radiation correlation (R^2 = 0.98) from 1973 to 1995.

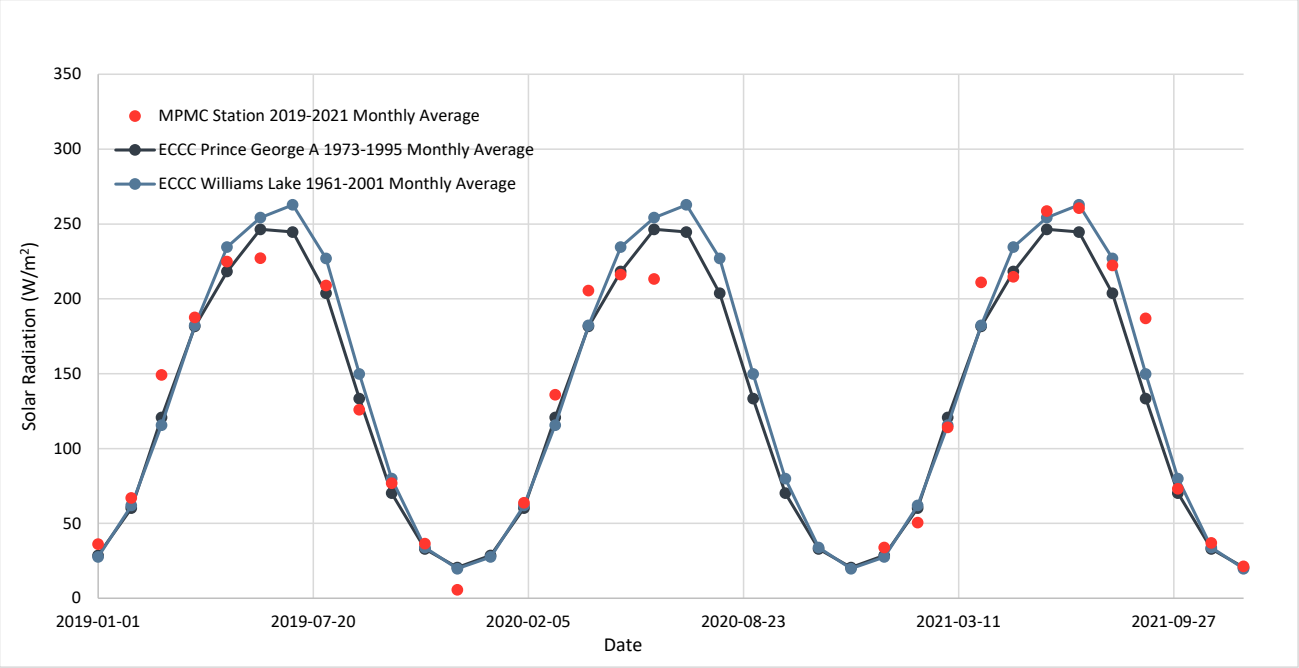


Figure 12 : Mean Monthly Solar Radiation for MPMC and ECCC Regional Climate Stations

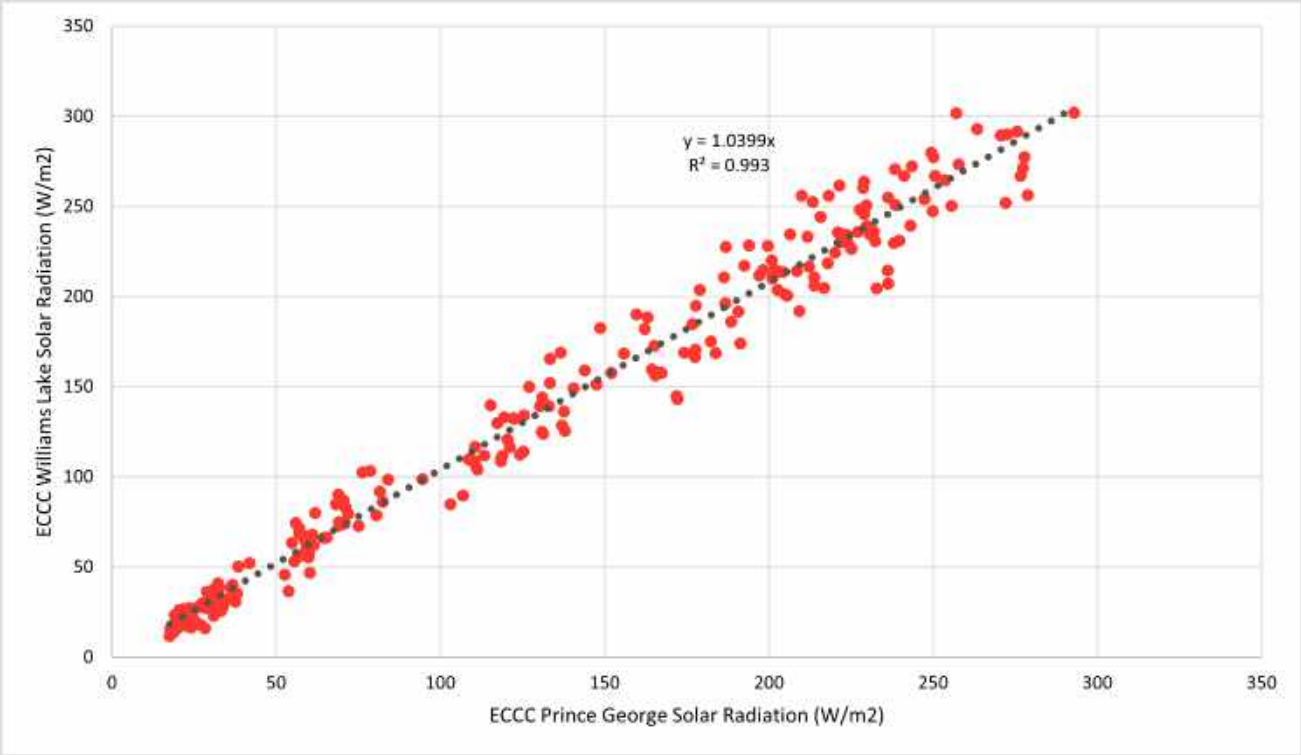


Figure 13 : Daily Solar Radiation Correlation Between ECCC Williams Lake and Prince George Climate Stations (1973-1995)

The strong correlation between ECCC Williams Lake and Prince George climate stations suggest there is little variation in solar radiation across the region. Based on the comparison of mean monthly solar radiation records and the proximity in distance to the Site, solar radiation statistics for the Site were determined from the ECCC Williams Lake data. Missing values were infilled by adjusting the Prince George records by a factor of 1.04 based on the relationship presented in Figure 13.

3.4.5 Evaporation and Evapotranspiration

Evaporation monitoring data are available for the Site from 2019 to 2021; however, the data are not continuous, and the length of record is not sufficient for characterizing the evaporation conditions at the Site. Therefore, a mathematical model (Morton 1983) was used to calculate evaporation and evapotranspiration (actual and potential) for the Site based on the long-term synthetic records for air temperature, relative humidity, and solar radiation. Evaporation in this study is defined as free water evaporation, or the amount of evaporation from open/free water surfaces (i.e., the water is returned to the atmosphere from lakes, ponds, and watercourses). Potential evapotranspiration is the water loss that occurs from a vegetated natural surface if there is no deficiency of water in the soil for use by vegetation (Thornthwaite 1948).

3.4.6 Wind Speed and Direction

Hourly wind speed and direction data are available for the Site from 1997 to 2003, and daily wind speed data are available from 2019 to 2021; however, the data are not continuous. The hourly wind speed and direction data available from 1997 to 2003 were used to develop wind rose plots. A wind rose depicts the relative frequency of wind from a given direction on a 16-point compass. Each ring on the wind rose represents a frequency of 2% of the data period. The length of the shaded bars on each wind rose petal represents the frequency of wind recorded from a given direction within a defined wind speed range. A wind rose is provided for the period of August 1997 to November 2003, and seasonal wind roses are presented to display seasonal variability in wind patterns, where the seasons have been defined as follows:

- Winter – December to February
- Spring – March to May
- Summer – June to August
- Autumn – September to November

Daily wind data recorded from 2019 to 2021 from WS1 and WS2 were wind speed only, no direction. The period of record for WS2 and 2020 are incomplete and are not included in the analysis. The relative frequency (%) of the magnitude of the daily wind speed data recorded at WS1 for 2019 and 2021 were compared in this study to the relative frequency (%) of wind speed magnitude of the data from 1997 to 2003.

3.4.7 Snow Cover Properties

Snow cover is an important climatic variable as it influences the spring freshet flow volume and distribution. Snow cover data at the Site are available monthly from manual measurements from 1997 to 2022, recorded as snow-water-equivalent (SWE). Measurements, although not continuous, are typically recorded at the beginning and end of a month, with the latter being representative of the monthly SWE.

4.0 RESULTS

The following section summarizes the precipitation, air temperature, relative humidity, solar radiation, evaporation and evapotranspiration, wind speed and direction, and snow cover baseline conditions at the Site.

4.1 Annual Precipitation

The Site experiences high summer precipitation due to summer storms, with the lowest monthly precipitation occurring in February. Precipitation typically occurs as snowfall starting in November and accumulates until March. Average annual precipitation at the Site is estimated to be 612 mm with a standard deviation of 118 mm. Frequency analyses of the derived long-term precipitation time series for the Site were undertaken to generate the variability in monthly and annual precipitation of the Site. Estimated annual wet and dry precipitation depths for a range of return periods are shown in Table 9, Figure 14, and Figure 15.

Table 9: Annual Precipitation Depths for the Site (1974-2021)

Return Period (yr)	Wet (mm)[1]	Dry (mm)[1]
5	714	508
10	768	459
25	825	412
50	861	386
100	893	366
200	922	349
Average	612	

1) Weibull distribution was selected based on the statistical distribution goodness-of-fit-test.

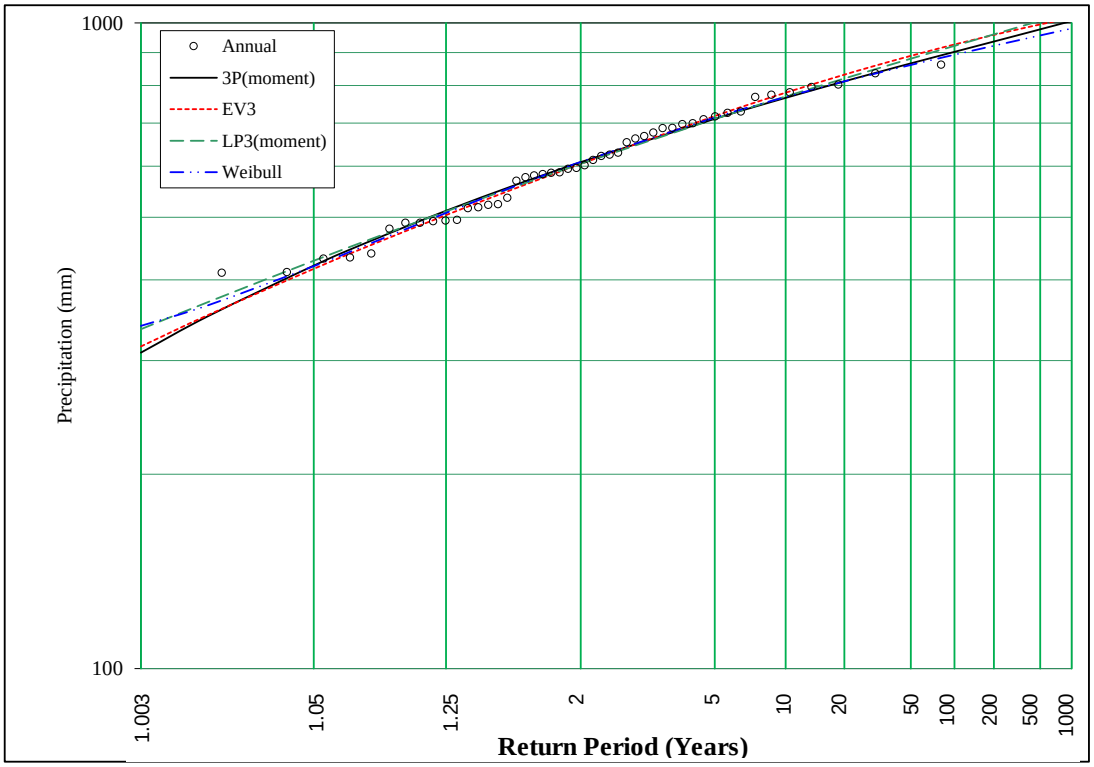


Figure 14 : Annual Precipitation Frequency Analysis – Wet Results

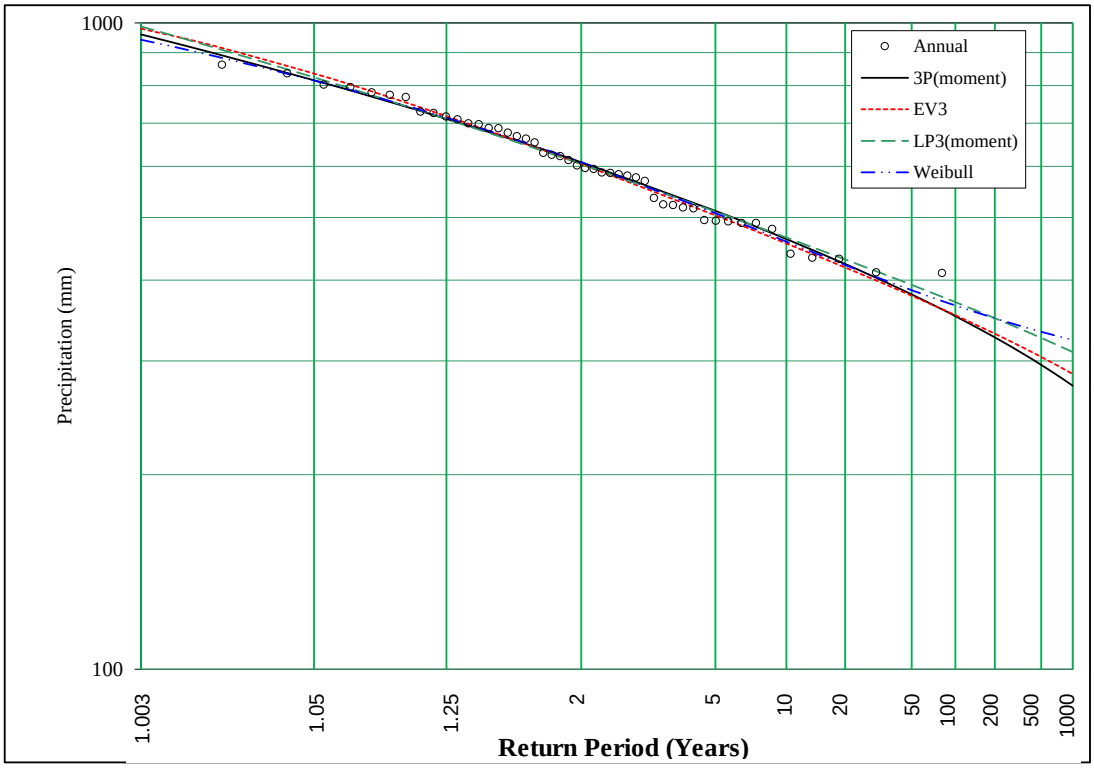


Figure 15 : Annual Precipitation Frequency Analysis - Dry Results

Monthly values for the 25- and 200-year return periods for wet and dry precipitation depths are presented in Table 10. Monthly values for the 1:25 year dry and wet precipitation for the 1:200 year dry and wet precipitation were assumed to follow the same monthly distribution as the average precipitation.

Table 10: Monthly Precipitation Depths for the Site (1974-2021)

Month[1]	Precipitation (mm)				
	Average	1:200 Year Wet	1:25 Year Wet	1:25 Year Dry	1:200 Year Dry
January	49.4	74.3	66.5	33.2	28.2
February	35.8	54.0	48.3	24.1	20.5
March	29.7	44.7	40.0	20.0	16.9
April	44.7	67.3	60.2	30.1	25.5
May	49.9	75.2	67.2	33.6	28.5
June	70.8	107	95.4	47.7	40.4
July	63.6	95.8	85.7	42.9	36.3
August	50.6	76.2	68.1	34.1	28.8
September	52.3	78.8	70.5	35.2	29.9
October	58.1	87.5	78.2	39.1	33.1
November	49.8	75.0	67.1	33.5	28.4
December	57.6	86.8	77.7	38.8	32.9
Annual Total[2]	**612**	**922**	**825**	**412**	**349**

1) Wet and Dry Monthly values assumed to follow the same monthly distribution as the Average.

2) Annual total precipitation depths were rounded to the nearest mm for presentation purposes; therefore, it may appear the sum of the monthly values do not equal the annual total.

4.2 Rainfall

Annual maximum series for 24-hour precipitation from the derived historical data set was used to undertake a frequency analysis to provide rainfall design values. Results are shown in Table 10. The 24-hour, 3-day, and 10-day annual, spring, and summer probable maximum precipitation (PMP) depths were estimated using the Hershfield method (WMO 2009).

Table 11: 24-hour Precipitation Depths for the Site (1974-2021)

Return Period (yr)	Depth (mm) [1, 2]
2	**33**
10	**47**
25	**54**
100	**64**
200	**69**
1000	**80**

1) Log Pearson III distribution was selected based on the statistical distribution goodness-of-fit test.

2) Values rounded up to the nearest mm.

Table 12: Annual, Spring, and Summer PMP Depths for the Site (1974-2021)

Period	Annual PMP[1] (mm)	Spring PMP[1, 2] (mm)	Summer PMP[1, 3] (mm)
24-Hour	224	192	191
3-Day[4]	339	272	294
10-Day[5]	562	295	486

1) The PMP does not have a return period.
2) Spring = March, April, May.
3) Summer = June, July, August.
4) Adjusted from fixed-time interval by a factor of 1.03 (Miller 1964).
5) Adjusted from fixed time interval by a factor of 1.01 (Miller 1964).

4.3 Air Temperature

Air temperature statistics for the Site were developed using historical data from the nearby ECCC climate station in Likely approximately 9 km northeast of the Site. The historical Likely data set was adjusted to the average elevation of the Mount Polley mine by applying the regional monthly lapse rate presented in Table 7. Data gaps were infilled using data from the four regional ECCC climate stations in a prioritized sequence and applying the monthly temperature lapse rate to adjust for elevation.

Monthly and annual air temperature statistics for the Site (1974-2021) are presented in Table 13 and Figure 16. The estimated mean annual temperature varies between 1.7°C and 6.3°C, with a long-term mean of 3.9°C. Mean monthly temperatures vary between –6.7°C in January and 15.1°C in July. The historical daily maximum and minimum air temperature from the derived long-term data set was 38.1°C in June 2021 (measured at the Site) and -39.8°C in December 1996, respectively. Mean monthly air temperatures generally turn positive in April and negative in November. The percentiles presented in Table 13 indicate the probability of the air temperature to be less than the calculated value for each period, i.e. the 25th percentile for the month of March indicates the monthly air temperature for March is 25% probable to be less than -2.2°C, or 75% probable to exceed -2.2°C. Larger variation between the 25th and 75th percentiles indicate greater variation in air temperature from the median during the month with the largest variations occurring in the winter months (December, January, and February).

Table 13: Derived Air Temperature (°C) Statistics for Mount Polley Mine, 1974 to 2021

Month	Temperature (°C)							
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile	Daily Maximum	Daily Minimum
January	-16.0	-6.7	-0.3	-8.7	-6.3	-4.0	11.2	-39.4
February	-13.0	-4.8	0.7	-7.7	-4.3	-2.1	13.6	-35.4
March	-6.7	-1.0	3.2	-2.2	-0.8	0.5	18.4	-32.7
April	-0.7	3.7	12.0	2.8	3.7	4.3	27.5	-16.7
May	5.2	8.5	13.1	7.5	8.3	9.6	33.1	-7.9
June	8.6	12.2	15.5	11.1	12.2	13.2	38.1	-4.9
July	11.8	15.1	21.2	13.3	14.8	16.4	36.0	0.6
August	11.0	14.6	17.1	13.6	14.8	15.7	33.0	-4.1
September	6.8	10.0	14.2	8.7	9.6	11.2	36.3	-7.1
October	0.8	4.1	8.7	3.4	4.1	4.7	31.1	-26.4
November	-13.7	-2.4	2.6	-3.8	-2.1	-0.4	17.3	-36.9
December	-13.7	-6.6	-1.2	-9.5	-5.5	-3.9	11.3	-39.8
Annual	**1.7**	**3.9**	**6.3**	**3.2**	**3.9**	**4.5**	**38.1**	**-39.8**

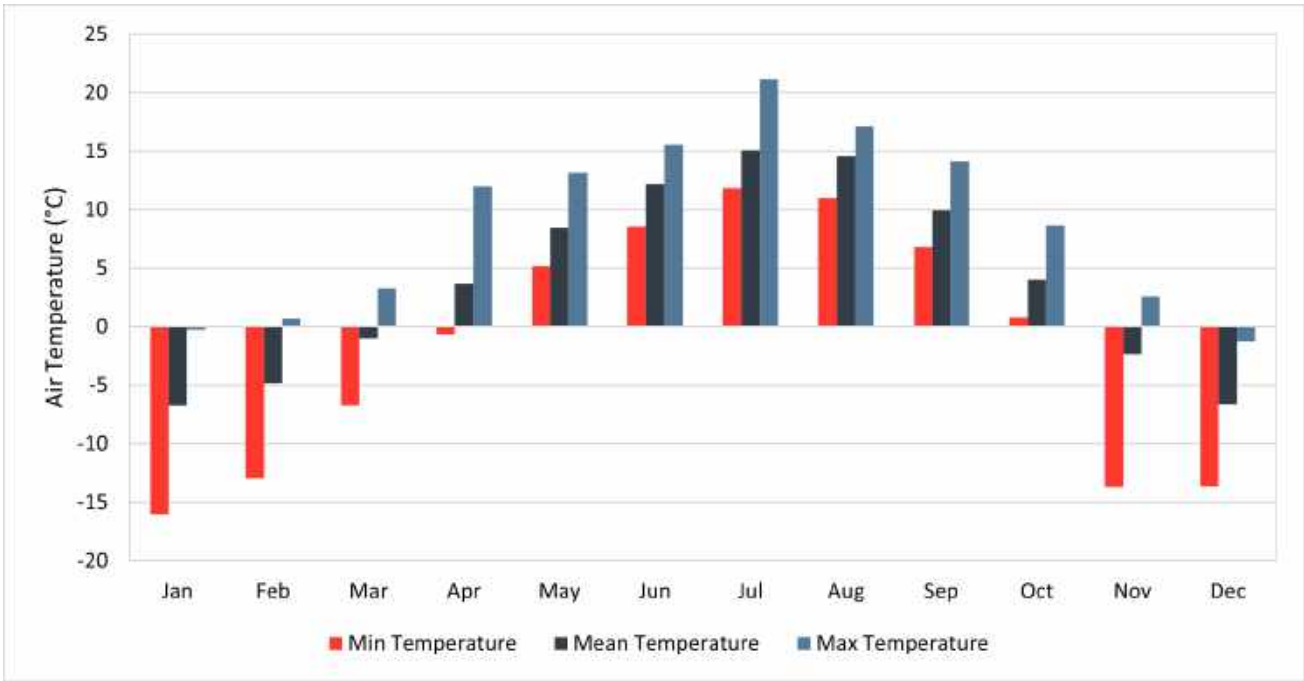


Figure 16 : Derived Monthly Air Temperature Statistics for Mount Polley Mine (1974-2021)

4.4 Relative Humidity

Statistics for relative humidity are presented in Table 14 and Figure 17. Mean annual relative humidity is 68.1%. Monthly mean values vary between 57.7% in April to 82.2% in December. The 25th and 75th percentiles for monthly relative humidity show little variation from the median indicating the Site experiences relatively constant relative humidity on a monthly basis from year to year.

Table 14: Derived Monthly and Annual Relative Humidity Statistics for the Site (1974-2021)

Month	Relative Humidity (%)					
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile
January	69.2	81.3	90.1	78.9	81.7	84.0
February	65.5	75.0	84.8	72.0	75.6	77.8
March	55.4	64.9	76.2	61.0	64.0	68.3
April	47.9	57.7	69.4	54.9	57.4	60.5
May	45.6	58.1	70.3	54.1	57.8	61.5
June	44.2	60.4	72.4	54.4	60.2	67.7
July	42.2	59.0	72.9	52.6	58.6	65.9
August	48.4	60.2	81.2	55.0	58.8	63.6
September	47.5	66.4	79.1	61.3	66.1	71.3
October	54.3	72.3	86.7	69.7	72.0	76.1
November	61.4	80.1	87.8	77.6	80.4	83.5
December	70.8	82.2	89.3	78.9	82.6	85.0
Annual	**54.4**	**68.1**	**80.0**	**64.2**	**67.9**	**72.1**

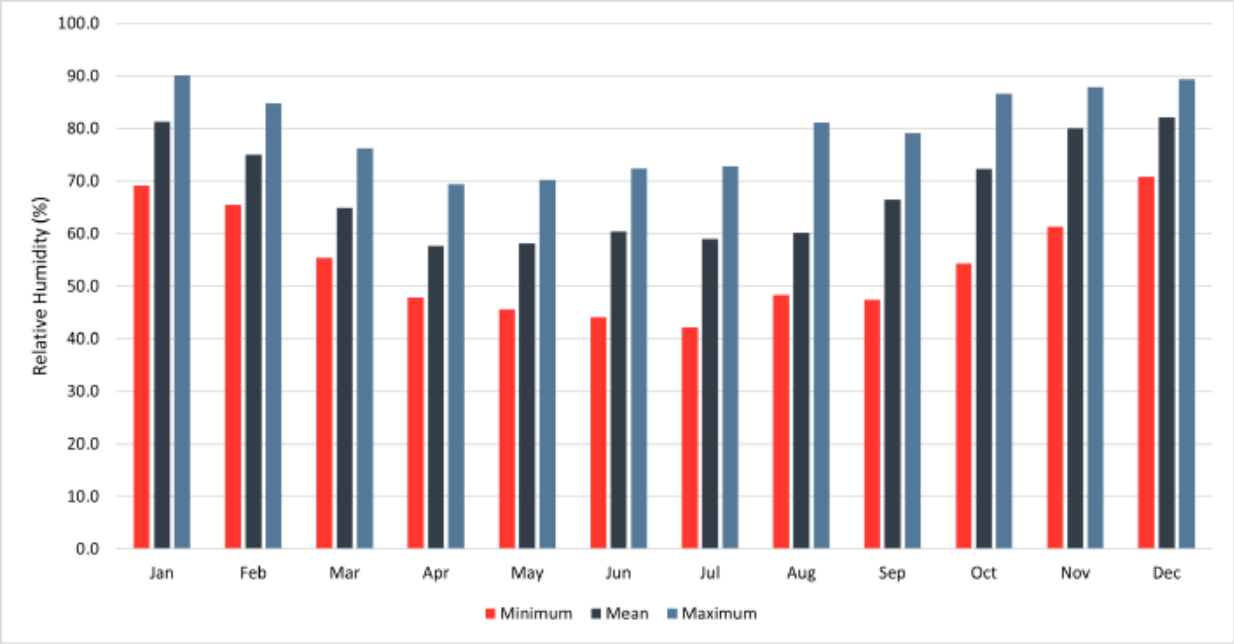


Figure 17 : Derived Monthly Relative Humidity for the Site (1974-2021)

4.5 Solar Radiation

Table 15 and Figure 16 present solar radiation statistics for the Site. Mean annual solar radiation is 135 W/m^2, with a minimum of 127 W/m^2 and maximum of 148 W/m^2. Mean monthly solar radiation varies between 20 W/m^2 in December to 257 W/m^2 in July following the same seasonal pattern for monthly air temperature. The 25th and 75th percentiles show greatest variation in solar radiation occurs in the summer months when solar radiation is greatest during the year, and less variation in winter months when solar radiation is lowest.

Table 15: Estimated Solar Radiation Statistics for the Site (1974-2001)

Month	Solar Radiation (W/m^2)					
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile
January	16	27	40	23	27	32
February	37	60	86	54	61	67
March	85	114	152	108	113	123
April	143	180	215	161	179	201
May	196	230	275	214	227	250
June	192	246	302	228	244	267
July	211	257	318	234	258	276
August	158	225	261	211	228	248
September	99	152	188	139	149	168
October	55	79	103	71	79	86
November	23	33	50	28	32	37
December	12	20	27	18	20	23
Annual	**127**	**135**	**148**	**132**	**135**	**140**

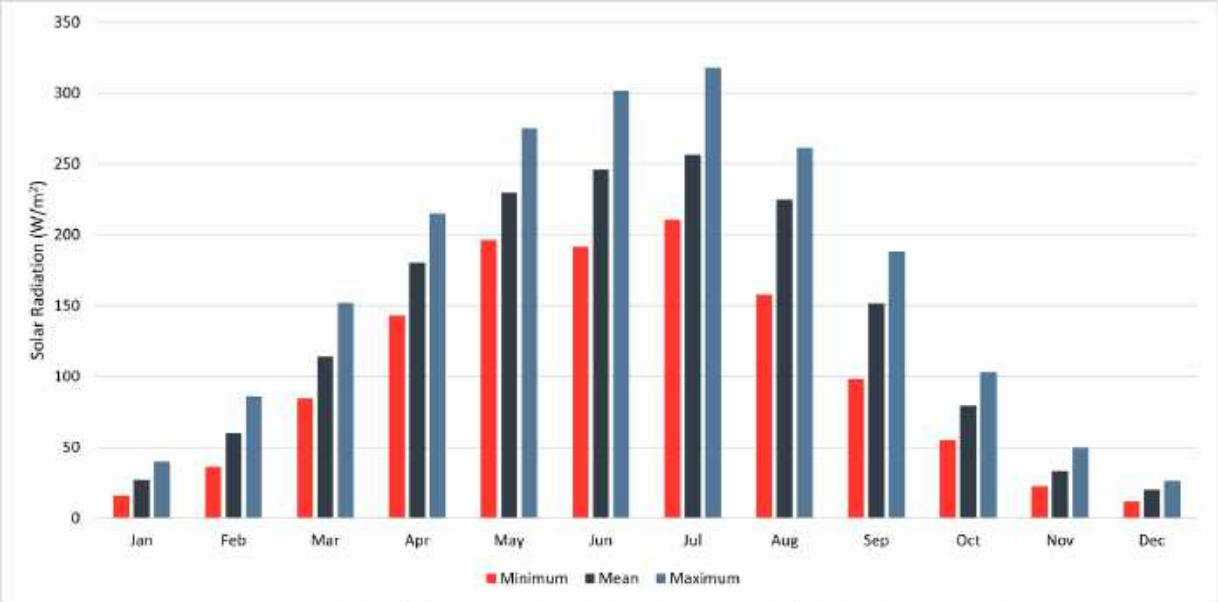


Figure 18 : Estimated Monthly Solar Radiation for the Site (1974-2001)

4.6 Evaporation and Evapotranspiration

The Morton model (Morton 1983) was applied to calculate monthly evaporation, potential evapotranspiration (PET), and actual evapotranspiration (AET) for the Site based on the air temperature, relative humidity, and solar radiation data presented in Sections 4.3, 4.4, and 4.5, respectively. The calculated evaporation rates are considered reflective of potential shallow lake evaporation rates; that is, there is no thermal impact of deeper water levels.

4.6.1 Shallow Lake Evaporation

Table 16 and Figure 19 present monthly statistics for shallow lake evaporation using the Morton Model. The mean annual evaporation rate is estimated to be 673 mm, varying between 606 mm and 762 mm. Mean monthly evaporation rates vary between 0 mm in December to 138 mm in July. The 25th and 75th percentiles indicate that greatest variation in monthly evaporation occurs in July when evaporation is greatest, and lowest variation occurs in January and December when evaporation is lowest.

Table 16 : Estimated Monthly and Annual Shallow Lake Evaporation Statistics for the Site (1974-2001)

Month	Shallow Lake Evaporation (mm)					
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile
January	0	1	4	0	0	1
February	1	7	12	4	7	10
March	24	32	43	29	32	34
April	52	66	79	59	67	72
May	86	105	140	96	102	115
June	95	122	155	110	121	132
July	110	138	173	123	136	153
August	80	115	137	107	113	130
September	37	61	80	54	60	70
October	18	22	28	20	21	23
November	0	4	8	1	4	6
December	0	0	3	0	0	1
Annual	**606**	**673**	**762**	**648**	**670**	**699**

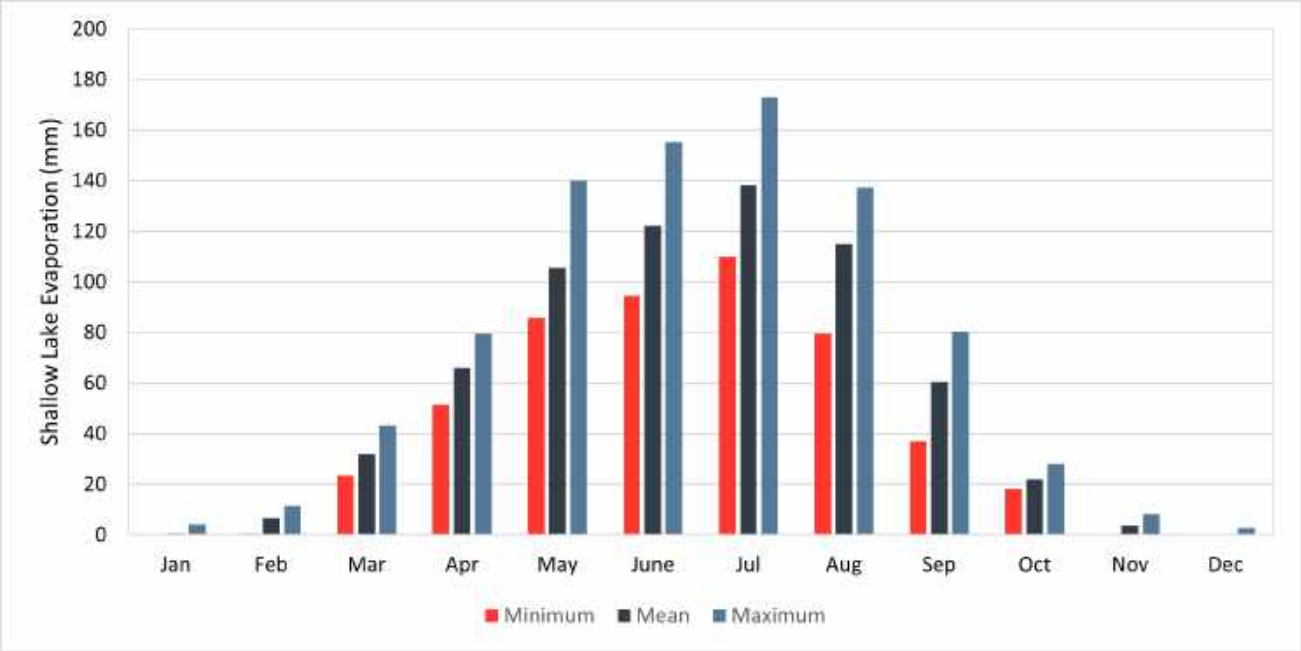


Figure 19 : Estimated Shallow Lake Evaporation Statistics for the Site (1974-2001)

4.6.2 Potential Evapotranspiration

Table 17 and Figure 20 present monthly statistics for PET using the Morton Model. The mean annual PET rate is estimated to be 863 mm, varying between 744 mm and 1022 mm. Mean monthly PET rates vary between 1 mm in December and January to 171 mm in July. The 25th and 75th percentiles indicate that greatest variation in monthly PET occurs in July when PET is greatest, and lowest variation occurs in January and December when PET is lowest. On an annual basis, PET rates are greater than shallow lake evaporation and AET since PET is not limited by the availability of water.

Table 17 : Estimated Monthly and Annual Potential Evapotranspiration Statistics for the Site (1974-2001)

Month	Potential Evapotranspiration (mm)					
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile
January	0	1	5	0	0	2
February	1	7	11	4	7	10
March	24	41	59	34	42	45
April	68	92	112	83	93	102
May	103	134	178	120	131	149
June	113	150	195	125	155	174
July	124	171	240	151	166	191
August	84	151	199	135	152	174
September	54	89	117	71	89	108
October	17	24	40	20	23	26
November	0	4	9	1	4	6
December	0	1	4	0	0	1
Annual	**744**	**863**	**1022**	**815**	**856**	**925**

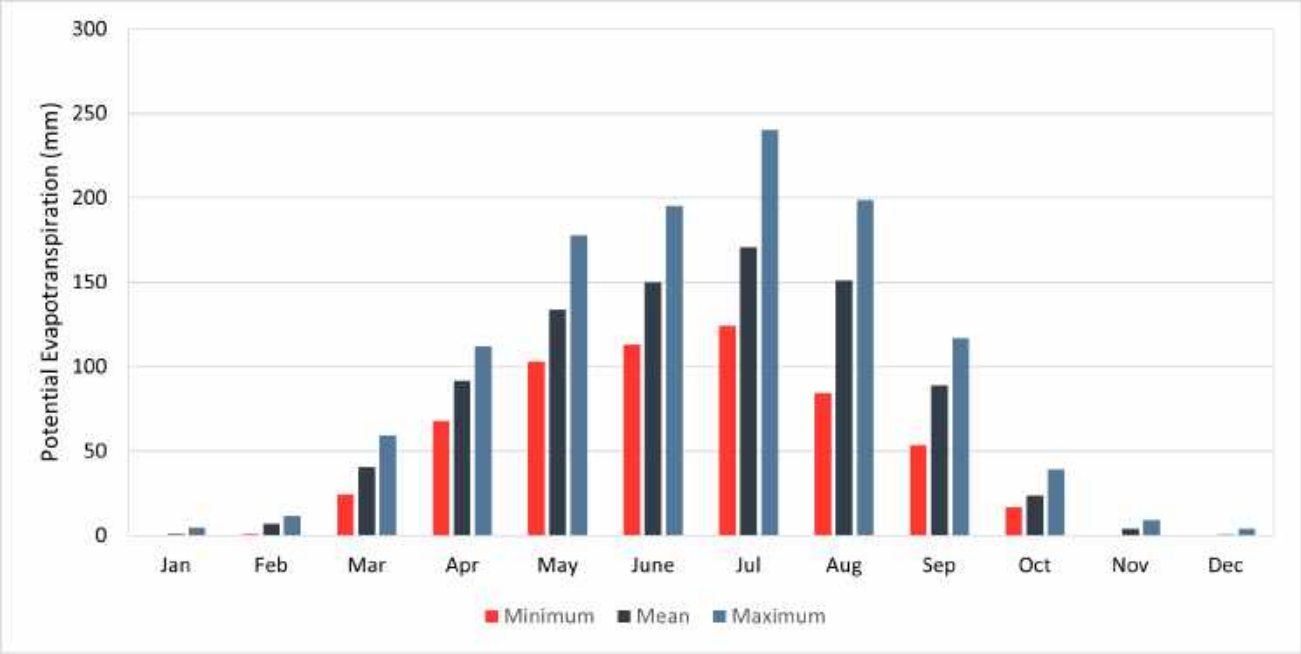


Figure 20 : Estimated Potential Evapotranspiration Statistics for the Site (1974-2001)

4.6.3 Actual Evapotranspiration

Table 18 and Figure 21 present monthly statistics for AET as calculated using the Morton Model. The mean annual AET rate is estimated to be 399 mm, varying between 319 mm and 449 mm. Mean monthly AET rates vary between 1 mm in December and January to 89 mm in July. The 25th and 75th percentiles indicate that greatest variation in monthly AET occurs in July when AET is greatest, and lowest variation occurs in January and December when AET is lowest. On an annual basis, AET at the Site is less than shallow lake evaporation and PET rates because AET is limited by the availability of water, particularly during the summer months when the air temperature is highest.

Table 18 : Estimated Monthly and Annual Actual Evapotranspiration Statistics for the Site (1974-2001)

Month	Actual Evapotranspiration (mm)					
	Minimum	Mean	Maximum	25th Percentile	50th Percentile	75th Percentile
January	0	1	5	0	0	2
February	1	7	11	4	7	9
March	15	18	25	17	18	19
April	16	31	47	26	30	35
May	42	64	84	60	63	68
June	48	80	98	75	80	86
July	61	89	105	83	89	99
August	51	63	78	57	63	69
September	10	23	35	18	22	29
October	11	17	22	16	17	18
November	0	4	9	1	4	6
December	0	1	4	0	0	1
Annual	**319**	**399**	**449**	**370**	**409**	**419**

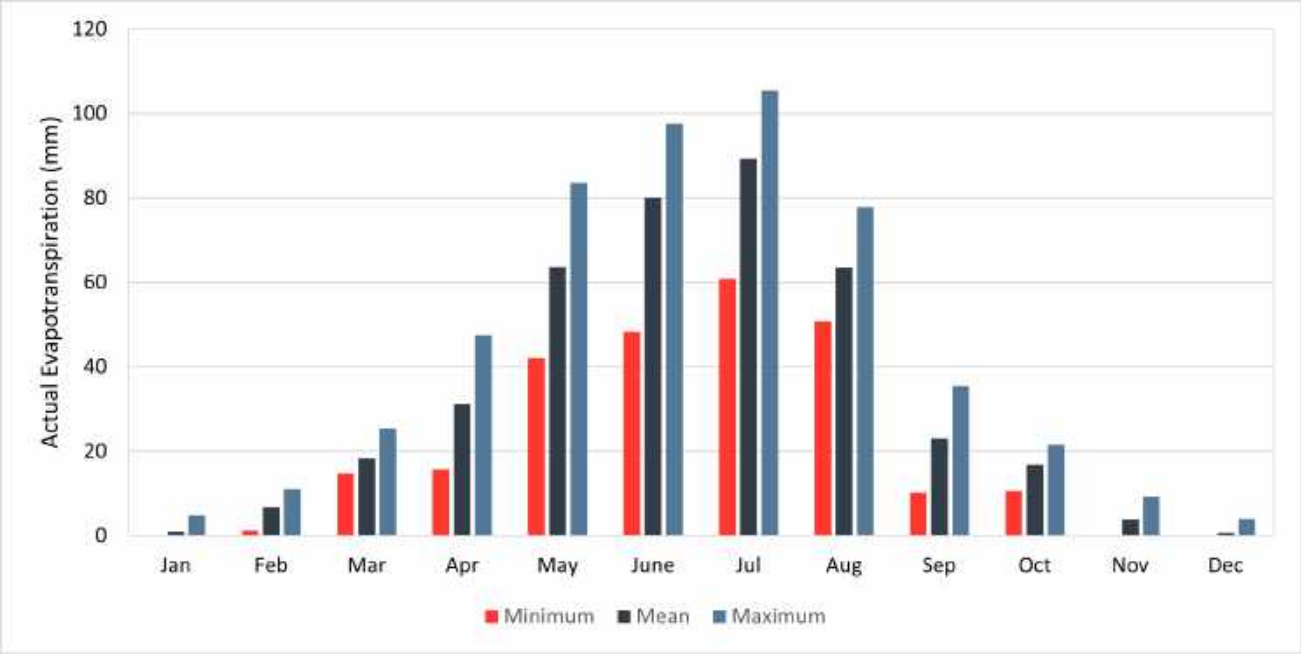


Figure 21 : Estimated Actual Evapotranspiration Statistics for the Site (1974-2001)

4.7 Wind Speed and Direction

A wind rose plot for the Site depicting the relative frequency of mean hourly wind speed and direction, and the seasonal distribution, between 29 August 1997 and 27 November 2003 is shown in Figure 22.

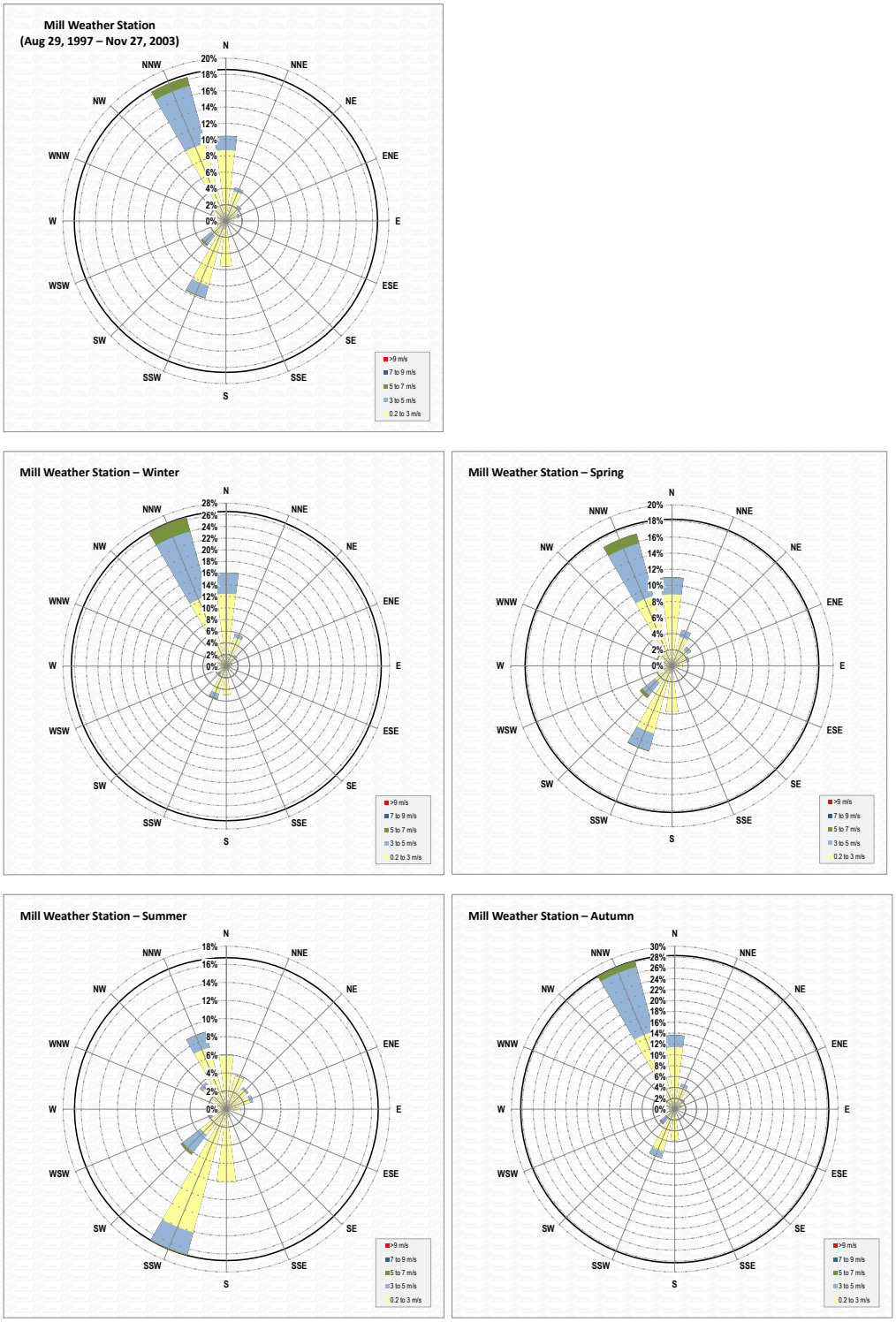


Figure 22: MPMC Station Monitoring Period and Seasonal Wind Roses - 29 August 1997 to 27 November 2003

Spring = March, April, May; Summer = June, July, August; Autumn = September, October, November; Winter = December, January, February.

Winds measured at the Site typically blew from the north-northwest, north, and south-southwest directions, with minimal winds from the east and the west. The spring, autumn, and winter seasonal wind roses were consistent with the wind rose pattern for the entire monitoring period; however, during the summer months, the majority of winds were from the south-southwest. Similarly, wind speeds in spring, autumn, and winter were generally consistent with the wind rose for the entire monitoring period, while wind speeds in summer were generally lower.

Wind speed measured and seasonal distributions at the Site from 2019 to 2021 were consistent with the relative frequency of wind speed magnitudes and the seasonal distributions recorded between 29 August 1997 and 27 November 2003 (Table 19 and Figure 23). A similar seasonal pattern in wind speed is identifiable with lower wind speeds in the summer months and higher wind speeds in the spring, autumn, and winter months (Table 20 and Figure 24). It is noted that the data from 2019 and 2021 are daily wind speed rather than hourly wind speed and only the relative frequency (%) of wind speed magnitude was compared.

Table 19: Comparison of Relative Frequency of Wind Speed from Mill Weather Station and Weather Station 1 for the Site

Wind Speed (m/s)	Mill Weather Station 29 August 1997 to 27 November 2003[1]	Weather Station 1 1 January 2019 to 31 December 2021[2]
calm	35%	28%
0.2 to 3 m/s	50%	56%
3 to 5 m/s	14%	13%
5 to 7 m/s	2%	3%
7 to 9 m/s	0%	0%
>9 m/s	0%	0%

1) Recorded as hourly wind speed.

2) Recorded as daily wind speed.

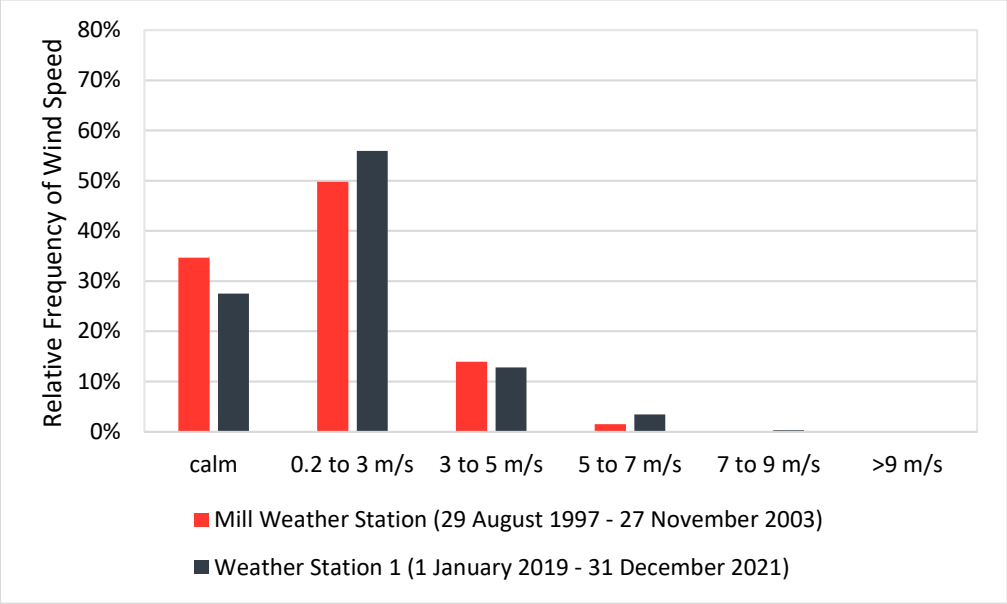


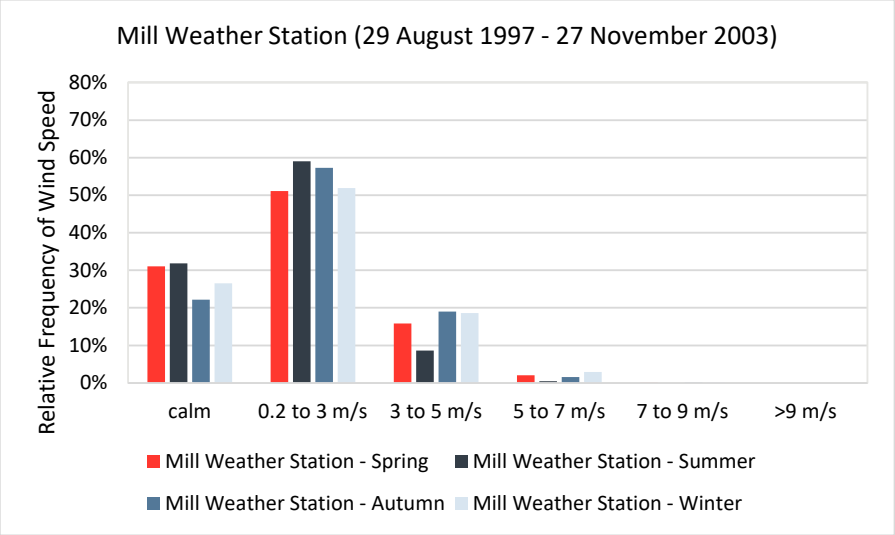
Figure 23: Comparison of Relative Frequency of Wind Speed from Mill Weather Station and Weather Station 1 for the Site

Table 20: Comparison of Relative Frequency of Wind Speed Seasonal Distributions from Mill Weather Station and Weather Station 1 for the Site

Wind Speed (m/s)	Mill Weather Station 29 August 1997 to 27 November 2003[1]				Weather Station 1 1 January 2019 to 31 December 2021[2]			
	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
calm	31%	32%	22%	27%	23%	18%	31%	37%
0.2 to 3 m/s	51%	59%	57%	52%	58%	75%	46%	44%
3 to 5 m/s	16%	9%	19%	19%	13%	7%	17%	15%
5 to 7 m/s	2%	0%	2%	3%	5%	0%	6%	3%
7 to 9 m/s	0%	0%	0%	0%	1%	0%	0%	1%

1) Recorded as hourly wind speed.

2) Recorded as daily wind speed.



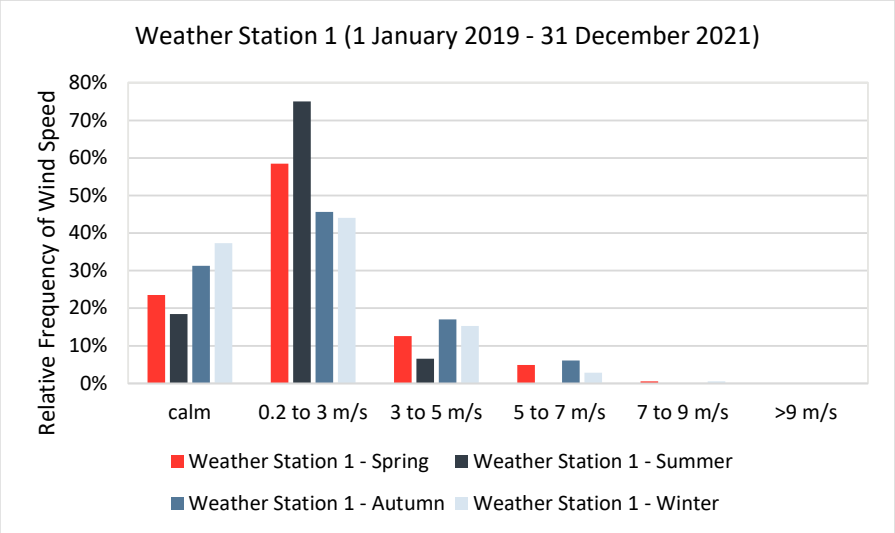


Figure 24: Comparison of Relative Frequency of Wind Speed Seasonal Distribution from Mill Weather Station and Weather Station 1 for the Site

4.8 Snow Cover Properties

Snow cover monthly statistics, reported as SWE, are presented in Table 21. At 50% exceedance, snow begins accumulating in November and achieves its maximum in March, reducing to 0 mm in April. The 5th and 95th percentiles and standard deviation values demonstrate the variability in the amount of SWE at the Site, with March having the greatest variability from year to year.

Table 21: Snow Water Equivalent for the Site (1997-2021)

Month	Number of Measurements	Mean (mm)	Minimum (mm)	Percentile					Maximum (mm)	Standard Deviation (mm)
				5%	25%	50%	75%	95%		
January	22	147	76	88	120	139	164	327	339	56
February	22	182	99	104	131	193	222	338	344	61
March	22	185	0	6	97	198	257	403	411	108
April	21	33	0	0	0	0	81	177	177	58
November	22	17	0	0	0	9	37	72	72	25
December	22	102	32	50	77	101	122	193	196	44

5.0 CLIMATE CHANGE PROJECTIONS

Future climate projections are important for understanding how climate is projected to change at the Site from the climate baseline. Future climate projections come from publicly available statistical downscaled future climate projections on a daily scale. Recognizing the inherent uncertainty with projections, multiple projections from multiple models and scenarios were included in the analysis presented herein, and the future projections are presented in terms of percentiles or exceedance probabilities. Changes to climate may influence how representative the statistics estimated based on historical data are for future time periods.

5.1 Data Sources for Future Climate

The Intergovernmental Panel on Climate Change (IPCC) is generally considered to be the definitive source of information related to past and future climate change as well as climate science. As an international body, the IPCC provides a common source of information relating to emission scenarios, provides third party reviews of models, and recommends approaches to document future climate projections. Periodically, the IPCC issues assessment reports summarizing the current state of climate science. The Sixth Assessment Report (AR6) (IPCC 2021) represents the most currently available complete synthesis of information regarding climate change.

5.2 Global Climate Change Projections

Future climate is typically projected using global circulation models (GCMs) that involve the mathematical representation of global land, sea, and atmosphere interactions over a long period of time. These GCMs have been developed by various government agencies, but they share a number of common elements as described by the IPCC (2021). The IPCC does not run the models but acts as a clearinghouse for the distribution and sharing of the model forecasts.

Global climate models require extensive inputs to characterize the physical processes and social development paths that could alter climate in the future. To represent the wide range of the possible inputs to global climate models, the IPCC has established a series of Shared Socioeconomic Pathways (SSPs) that help define the future levels of radiative forcing terms. Future climate projection data are available from approximately 30 GCMs and four main SSPs (SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5) in AR6 (ECCC 2022c).

The primary differentiating aspect of each model are the SSPs developed by the IPCC and presented in AR6 to quantify potential emission output scenarios (ECCC 2022c). The SSPs were created with varying assumptions about human developments and are designed to work in combination with an updated version of the Representative Concentration Pathways (RCPs) from the previous IPCC Fifth Assessment Report (AR5) (ECCC 2022c). The SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 scenarios are the four common greenhouse gas concentration profiles that are widely used; SSP5-8.5 represents the most extreme scenario with the highest volume of greenhouse gases emitted (ECCC 2022c).

5.3 Regional Climate Change Projections

The climate change projection data available from ClimateData.ca portal provided by ECCC uses GCMs with RCP pathways from IPCC AR5 rather than the latest SSPs from AR6. Therefore, the data used in this study will be obtained from ClimateBC.ca provided by the University of British Columbia (UBC). This tool downscales PRISM (Daly et al. 2008) 1971-2000 gridded monthly climate normal data (800 x 800 m) to scale-free point locations and uses the scale-free data as a baseline to downscale more than 200 future climate variables for individual years and periods between 1901 and 2100 (Wang et al. 2016).

The ClimateBC (UBC 2022) tool that is currently managed by UBC uses the same data management framework as Coupled Model Intercomparison Project Number 6 (CMIP6) where the SSP emission profiles are coupled with GCMs. ClimateBC selected a subset of eight GCMs from the models contributing to the CMIP6 ScenarioMIP project based on the following criteria (UBC 2022):

- Minimum of three historical runs available.
- Minimum temperature and maximum temperature available for all runs.
- At least one run for each of the four main SSP marker scenarios.
- One model per institution.
- No closely related models based on Figure 5 in *Reduced global warming from CMIP6 projections when weighting models by performance and independence* (Brunner et al. 2020).
- No large biases over BC.
- Are within IPCCs transient climate response "likely[1]" range and Earth's equilibrium climate sensitivity "very likely[2]" range.

The eight GCMs presented in this report are ACCESS-ESM1-5, BC-CSM2-MR, CNRM-ESM2-1, GFDL-ESM4, GISS-E2-1-G, MIROC6, MPI-ESM1-2-HR, and MRI-ESM2-0.

Table 22: Inventory of Global Climate Models Referenced in this Study

Model	Source / Institution
ACCESS-ESM1-5	Commonwealth Scientific and Industrial Research Organisation
BC-CSM2-MR	Beijing Climate Center
CNRM-ESM2-1	CNRM (Centre National de Recherches Meteorologiques) and CERFACS (Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique)
GFDL-ESM4	National Oceanic and Atmospheric Administration, Geophysical Fluid Dynamics Laboratory
GISS-E2-1-G	Goddard Institute for Space Studies
MIROC6	JAMSTEC (Japan Agency for Marine-Earth Science and Technology), AORI (Atmosphere and Ocean Research Institute), NIES (National Institute for Environmental Studies), and R-CCS (RIKEN Center for Computational Science)
MPI-ESM1-2-HR	Max Planck Institute for Meteorology
MRI-ESM2-0	Meteorological Research Institute

The Site coordinates and elevation were entered into ClimateBC to extract site-specific model outputs (i.e., projections) for precipitation, air temperature, solar radiation, relative humidity, and precipitation as snowfall.

[1] Transient climate response metric in the range 1.4 to 2.2°C (66% likelihood) deemed as "likely" in AR6 (Hausfather et al. 2022).

[2] Equilibrium climate sensitivity metric in the range 2 to 5°C deemed as "very likely" in AR6 (Hausfather et al. 2022).

5.4 Climate Change Projections Results

The following sections build on the current climate baseline by providing the projected changes under future climate conditions for two future time horizons (2041-2070; 2050s, and 2071-2100; 2080s). Time horizons used for the available projections are by periods. Section 5.4.1 provides a description of future projected conditions for temperature and precipitation. Sections 5.4.2 through 5.4.5 provide the projected changes in relative humidity, solar radiation, evaporation, and snow cover. In all sections, projections are provided in terms of exceedance probability measured over the 32-member multi-model ensemble (i.e., 8 models and 4 SSPs). The focus of the results discussion is on the 50th percentile (median), while additional exceedance probabilities are available in the tables presented, including the maximum and minimum. Using the median, or 50th percentile, provides an indication of the middle of the projected changes from the multi-model ensemble.

5.4.1 Future Temperature and Precipitation Projections

This section provides the projected future mean temperature and total precipitation for the Site. The future climate projections are benchmarked against a modelled baseline (e.g., ClimateBC output of the baseline information available for the 32-member multi-model ensemble for the normal period of 1991-2020) and are described in terms of “anomaly” or change from the baseline.

Annual Temperature and Precipitation Projections

Comparisons of the future climate projections of temperature and precipitation for the Site for the 2050s (2041-2070) and 2080s (2071-2100) projection periods are shown as a scatter plot in Figure 25. The plots illustrate the projected change in temperature (vertical axis) and precipitation (horizontal axis) from the current climate baseline (1991 through 2020 normal period) for each of the models and the four SSPs considered in the IPCC’s AR6 (IPCC 2021). For reference, the current climate is shown as a solid circle where the axes intersect. The model projections are generally in the upper right quadrant of the plots, suggesting a future climate that will likely be warmer and wetter. There is a larger spread of future projected precipitation, with a majority of model runs projecting a wetter future climate. Precipitation projections typically have larger uncertainty than temperature projections due to the challenge of capturing precipitation in the climate models (temperature is better understood) (Araya-Osses et al. 2020).

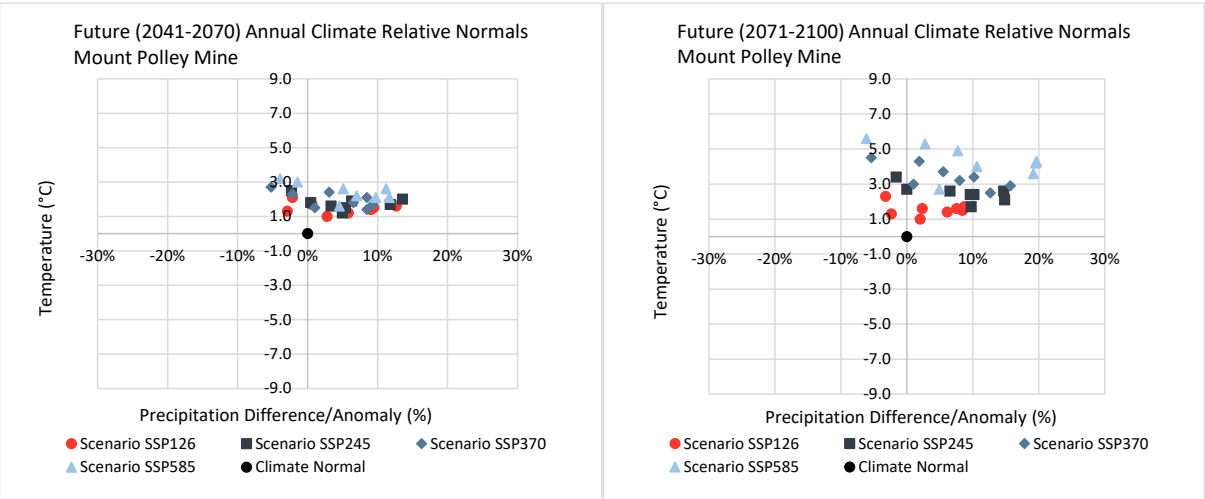


Figure 25: Scatter Plots Presenting Annual Temperature and Precipitation Projections for the 2050s and the 2080s for the Mount Polley Mine Area

Monthly Temperature and Precipitation Projections

Figure 26 and Figure 27 depict the projected anomalies in monthly temperatures for the Site for the 2050s and 2080s, respectively. The figures also show a dashed line which represents the median of all the modelled projections. The dotted lines in the figures represents the spread between the 5th percentile and the 95th percentile of the ensemble. The figures show projected increases in temperature for all months for the 2050s and the 2080s. For the 2050s (Figure 26) the projected increase in the median temperature (dashed line) is less in winter months and greater in the summer months, with an annual average increase of 1.8ºC. The 5th and 95th percentiles of the 2050s ensembles range from an increase of 1.2ºC to around 2.9ºC. The 95th percentile shows a larger variation throughout the months of the year compared to the 5th percentile, and a seasonal pattern arises for the summer months, with larger projected increases of 4.3°C.

The projected increase in the median temperature for the 2080s (Figure 27) is less in winter months and greater in the summer months, with an annual average increase of 2.7ºC. The 5th and 95th percentiles of the 2080s ensemble range from an increase of approximately 1.4ºC to 5.1ºC on average. The 95th percentile shows a larger variation throughout the months of the year and greatest variation in the summer months, with projected increases of 7ºC.

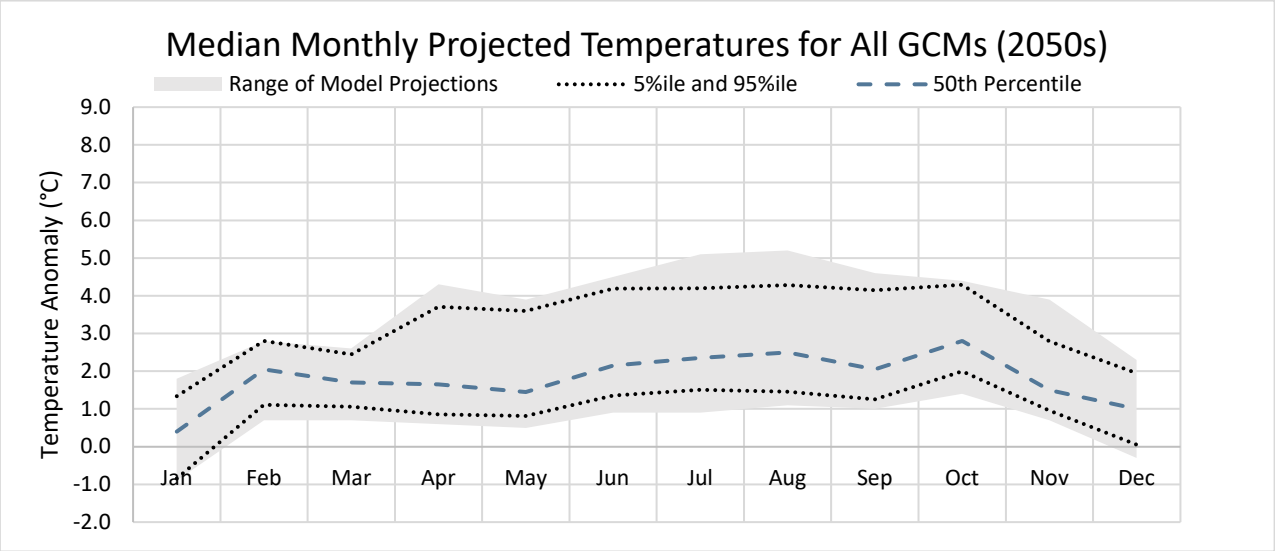


Figure 26: Monthly Projected Temperature Anomalies for the Mount Polley Mine Area (2050s)

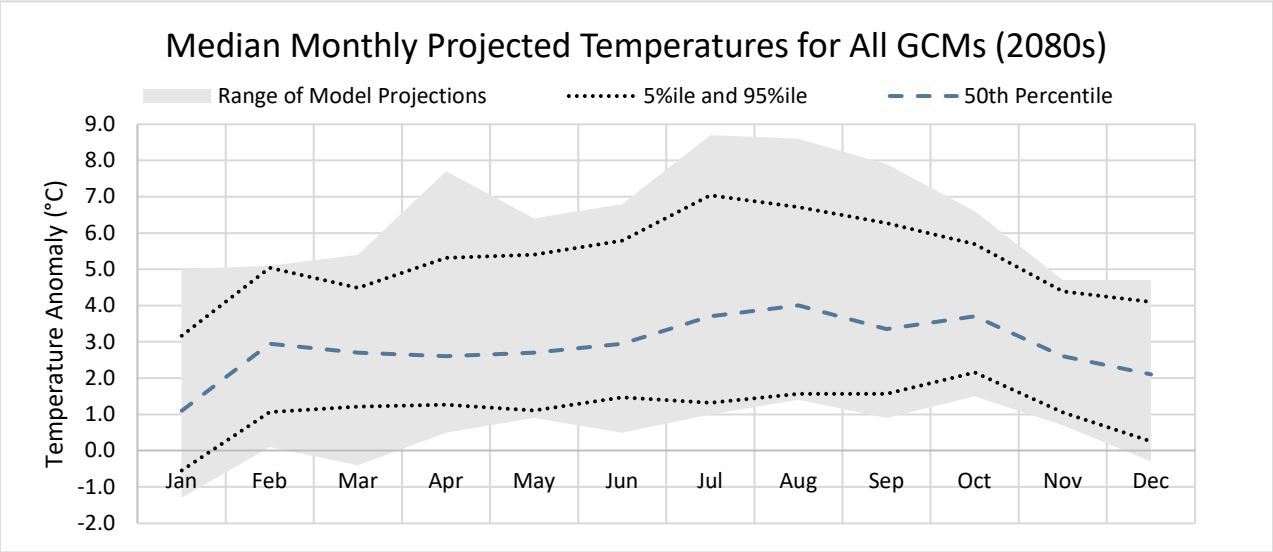


Figure 27: Monthly Projected Temperature Anomalies for the Mount Polley Mine Area (2080s)

Figure 28 and Figure 29 present the monthly projected precipitation anomalies for the Site for the 2050s and 2080s, respectively. For the 2050s (Figure 28) the projected median anomaly (dashed line) indicates changes in the seasonal distribution throughout the year, with an annual average increase of 5%, except for the summer where a slight decrease is projected for the months of June and July. The summer and fall months also present a larger spread in projections from the ensemble (shaded area on the graph), indicating less agreement between the projections. The 2080s (Figure 29) present similar behaviour to the 2050s except for an overall higher projected increase (around 8%), except for the months of June and July, where a decrease in precipitation is projected.

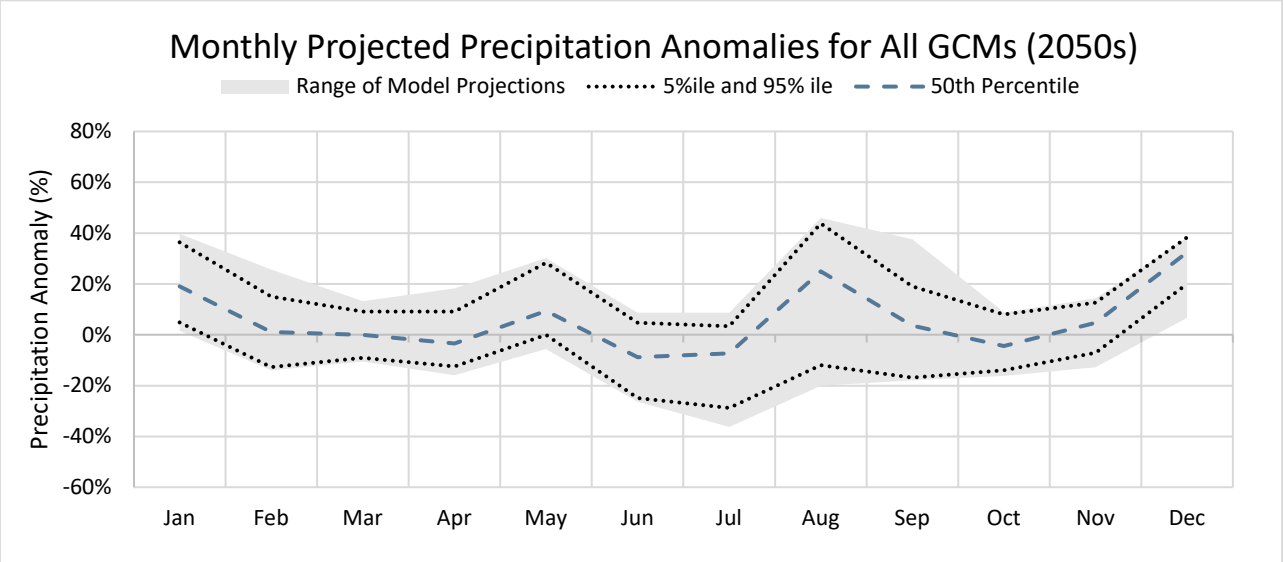


Figure 28: Monthly Projected Precipitation Anomalies for the Mount Polley Mine Area (2050s)

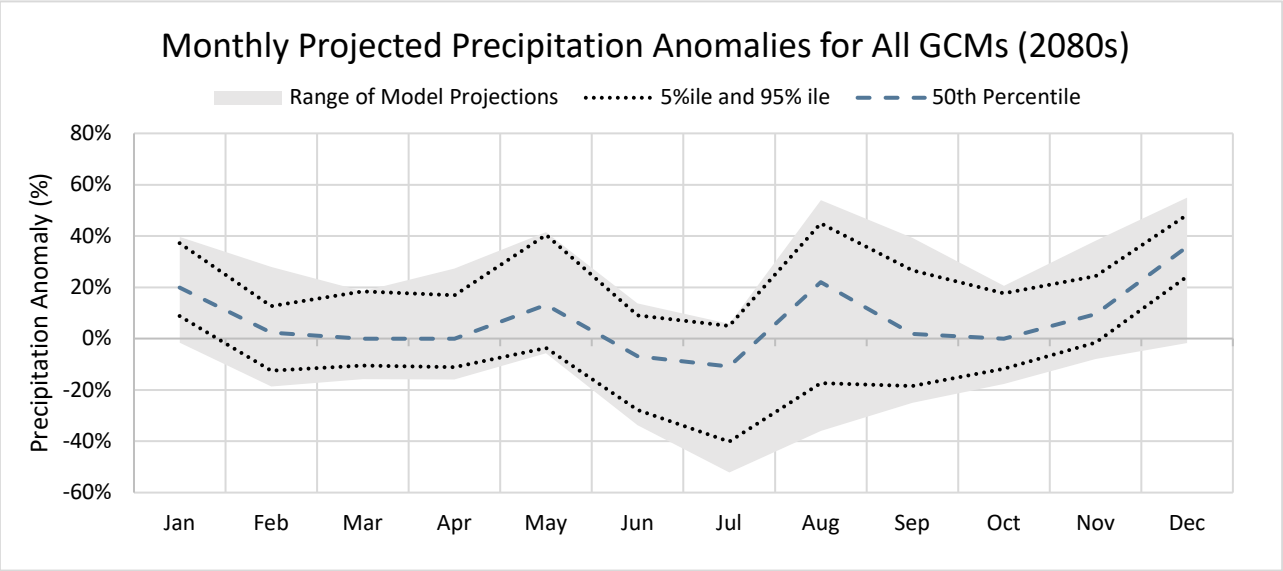


Figure 29: Monthly Projected Precipitation Anomalies for the Mount Polley Mine Area (2080s)

Overall, there is less variability and uncertainty (measured as the agreement within the ensemble or range of projected anomalies) during the 2050s. However, variability increases for both the precipitation and temperature anomalies during the 2080s.

Annual and Monthly Temperature and Precipitation Projections Summary

The projected future changes in the 2050s and 2080s from the baseline period (1991 through 2020) in monthly and annual temperatures are summarized in Table 23 and Table 24. In the 2050s, at 50% exceedance probability, the annual temperature is projected to increase by 1.8°C, with the biggest monthly increase of 2.8°C in October, and smallest monthly increase of 0.4°C in January. In the 2080s, at 50% exceedance probability, the annual temperature is projected to increase by 2.7°C, with the biggest monthly increase of 4.0°C in August, and smallest monthly increase of 1.1°C in January.

Table 23: Projected Anomalies in Monthly and Annual Temperature in the 2050s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	-0.9	-0.8	-0.4	0.1	0.4	0.6	1.1	1.3	1.7	1.8	0.3	0.6
February	0.7	1.1	1.2	1.6	2.1	2.4	2.8	2.8	2.8	2.8	2.0	0.6
March	0.7	1.1	1.1	1.4	1.7	2.1	2.2	2.4	2.6	2.6	1.7	0.5
April	0.6	0.9	0.9	1.3	1.7	2.1	3.1	3.7	4.3	4.3	1.9	0.9
May	0.5	0.8	0.9	1.2	1.5	2.7	3.5	3.6	3.8	3.9	1.9	1.0
June	0.9	1.4	1.4	1.7	2.2	2.5	3.2	4.2	4.4	4.5	2.2	0.9
July	0.9	1.5	1.6	1.8	2.4	3.1	4.1	4.2	4.8	5.1	2.6	1.0
August	1.1	1.5	1.7	2.2	2.5	3.2	3.9	4.3	5.0	5.2	2.7	0.9
September	1.0	1.3	1.5	1.7	2.1	2.8	4.0	4.1	4.5	4.6	2.4	0.9
October	1.4	2.0	2.2	2.4	2.8	3.6	4.0	4.3	4.4	4.4	2.9	0.8
November	0.7	1.0	1.1	1.2	1.5	2.1	2.6	2.8	3.6	3.9	1.7	0.7
December	-0.3	0.1	0.2	0.7	1.0	1.3	1.8	1.9	2.2	2.3	1.0	0.6
Annual	1.0	1.2	1.3	1.5	1.8	2.3	2.6	2.9	3.2	3.2	1.9	0.8

Table 24: Projected Anomalies in Monthly and Annual Temperature in the 2080s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	-1.3	-0.5	-0.2	0.4	1.1	1.8	2.7	3.2	4.5	5.0	1.2	1.3
February	0.1	1.1	1.4	2.1	3.0	3.6	5.0	5.0	5.1	5.1	3.0	1.3
March	-0.4	1.2	1.3	1.8	2.7	3.3	4.2	4.5	5.2	5.4	2.6	1.2
April	0.5	1.3	1.5	1.9	2.6	3.7	4.5	5.3	7.1	7.7	2.9	1.5
May	0.9	1.1	1.3	1.8	2.7	3.7	4.8	5.4	6.1	6.4	2.9	1.4
June	0.5	1.5	1.7	2.3	3.0	3.9	4.9	5.8	6.5	6.8	3.2	1.4
July	1.0	1.3	1.9	2.6	3.7	4.8	6.1	7.0	8.2	8.7	3.9	1.8
August	1.4	1.6	2.1	2.9	4.0	5.1	6.4	6.7	8.1	8.6	4.1	1.7
September	0.9	1.6	1.8	2.3	3.4	4.2	5.6	6.3	7.5	7.9	3.5	1.6
October	1.5	2.2	2.3	2.9	3.7	4.7	5.1	5.7	6.4	6.6	3.8	1.2
November	0.7	1.1	1.1	1.6	2.6	3.4	4.2	4.4	4.6	4.7	2.6	1.1
December	-0.3	0.3	0.6	1.2	2.1	2.9	3.5	4.1	4.5	4.7	2.1	1.2
Annual	1.0	1.4	1.5	2.0	2.7	3.8	4.5	5.1	5.5	5.6	3.0	1.4

The projected future changes in the 2050s and 2080s from the baseline period (1991 through 2020) in monthly and annual precipitation are summarized in Table 25 and Table 26. The annual precipitation in the 2050s is projected to increase by 5% from the baseline at the 50% exceedance probability. The projected highest monthly increases in the 2050s occur in the winter and August while small and negative changes are expected in June and July. The 2080s annual precipitation is projected to increase by 8% from the baseline, with the largest increases occurring in winter and August, and a small decrease in the summer months of June and July.

Table 25: Projected Anomalies in Monthly and Annual Precipitation in the 2050s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	2%	5%	8%	13%	19%	23%	35%	36%	39%	40%	19%	9%
February	-14%	-13%	-9%	-7%	1%	7%	14%	15%	23%	26%	1%	10%
March	-11%	-9%	-8%	-5%	0%	5%	8%	9%	12%	13%	0%	6%
April	-16%	-12%	-11%	-7%	-3%	2%	7%	9%	15%	18%	-2%	7%
May	-6%	0%	4%	8%	9%	15%	21%	28%	30%	30%	11%	8%
June	-26%	-25%	-21%	-18%	-9%	-3%	1%	5%	8%	9%	-9%	9%
July	-36%	-29%	-23%	-13%	-7%	-3%	0%	3%	8%	9%	-9%	10%
August	-20%	-12%	-2%	8%	25%	32%	34%	44%	46%	46%	20%	17%
September	-18%	-17%	-16%	-11%	4%	8%	14%	19%	34%	38%	1%	13%
October	-16%	-14%	-10%	-8%	-4%	-1%	4%	8%	9%	9%	-4%	6%
November	-13%	-7%	-5%	0%	5%	8%	11%	13%	14%	14%	4%	6%
December	7%	20%	22%	28%	33%	35%	38%	38%	38%	38%	31%	7%
Annual	-5%	-3%	-2%	1%	5%	9%	12%	12%	13%	14%	5%	5%

Table 26: Projected Anomalies in Monthly and Annual Precipitation in the 2080s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	-2%	9%	11%	14%	20%	27%	30%	37%	39%	40%	21%	9%
February	-19%	-12%	-7%	-2%	2%	7%	12%	13%	24%	28%	2%	9%
March	-16%	-11%	-8%	-5%	0%	8%	13%	18%	18%	18%	1%	9%
April	-16%	-11%	-9%	-7%	0%	12%	16%	17%	24%	27%	2%	11%
May	-6%	-4%	2%	8%	13%	19%	35%	40%	42%	42%	15%	12%
June	-34%	-28%	-24%	-18%	-7%	0%	5%	9%	13%	14%	-9%	12%
July	-52%	-40%	-30%	-19%	-11%	-3%	4%	5%	6%	6%	-13%	15%
August	-36%	-17%	-8%	8%	22%	29%	41%	45%	52%	54%	18%	20%
September	-25%	-18%	-15%	-4%	2%	15%	21%	27%	36%	39%	4%	15%
October	-18%	-12%	-10%	-6%	0%	9%	15%	18%	20%	21%	1%	10%
November	-8%	-2%	0%	4%	10%	16%	22%	24%	35%	38%	11%	9%
December	-2%	24%	25%	33%	36%	42%	47%	48%	53%	55%	36%	10%
Annual	-6%	-4%	-2%	2%	8%	10%	16%	19%	20%	20%	7%	7%

Comparison to Regional Projections

Within Canada there are two major sources of regional projections available: the ClimateData.ca portal (ClimateData 2022) and Canada's Changing Climate Report (Bush and Lemmen 2019). The ClimataData.ca portal provides summarized information about selected locations within Canada using a multi-model ensemble across multiple emission scenarios following IPCC AR5 RCPs (IPCC 2013). Canada's Changing Climate Report (Bush and Lemmen 2019) looks at changing climate trends across Canada and how regional changes fit within the national and global context of climate change. Both resources are used to provide context for the analysis of projections presented in Section 5.4.1 above.

Under a high emissions scenario (RCP 8.5), the ClimateData.ca portal projects a mean annual average temperature increase of 1.6ºC for the 2021 to 2050 period at the Site, 3.6ºC for the 2051 to 2080 period, and 5.1ºC for the end of the century relative to the climate normal period from 1981 to 2010 (ClimateData.ca 2022). This is consistent with the ensemble projections presented above that show increases of 1.8ºC for the 2050s (2041-2070) and 2.7ºC for the 2080s (2071-2100) relative to the modelled climate normal period from 1991 to 2020. Similarly, average annual precipitation is projected by ClimateData.ca to increase by 5% for the 2021 to 2050 period, 12% for the 2051 to 2080 period, and by 15% for the end of the century relative to climate normal period from 1951 to 1980 (ClimateData.ca 2022). These projected changes are consistent with the projections presented above considering the difference in the projection and normal periods (i.e., projection of 5% increase for the 2041 to 2070 period above compared to the 7% increase for the 2051 to 2080 period relative to normal period from 1991 to 2020).

Bush and Lemmen (2019) (Canada's Change Climate Report) does not include trends specifically for the Mine area; however, projections indicate an increase in both mean annual temperature and precipitation, with northern Canada expected to experience larger increases. Under a low emissions scenario (RCP 2.6) temperature is projected to increase by 1.8°C and by more than 6°C under a high emissions scenario (RCP 8.5) by the end of the century. Annual mean precipitation is projected to increase by 7% under a low emissions scenario (RCP 2.6) and by 24% under a high emissions scenario (RCP 8.5) by the end of the century (Bush and Lemmen 2019).

5.4.2 Future Relative Humidity Projections

Annual Projections

Comparison of the future mean annual relative humidity projections from all GCMs for the Mine area and 2050s and 2080s projection periods are shown in Table 27 and Figure 30, and Table 28 and Figure 31, respectively. Projections for the 2050s period shows little variation compared to the baseline period (1991 to 2020) for all climate models and all SSPs with an anomaly range of -2% to 2%. Projections for the 2080s period shows similar pattern to the 2050s period (-1% to 2% anomaly range) for SSP1-2.6 and SSP2-4.5, and greater variation for higher emissions scenarios SSP3-7.0 and SSP5-8.5 (-2% to 5% anomaly range).

Table 27: Projected Mean Annual Relative Humidity for all GCMs (2050s)

Climate Model	Relative Humidity Anomaly (%)			
	Scenario SSP1-2.6	Scenario SSP2-4.5	Scenario SSP3-7.0	Scenario SSP5-8.5
ACCESS-ESM1-5	1.0	2.0	2.0	2.0
BCC-CSM2-MR	0.0	0.0	0.0	1.0
CNRM-ESM2-1	0.0	0.0	0.0	0.0
GFDL-ESM4	0.0	-1.0	-2.0	-1.0
GISS-E2-1-G	1.0	0.0	1.0	1.0
MIROC6	1.0	1.0	1.0	1.0
MPI-ESM1-2-HR	-1.0	-1.0	-1.0	1.0
MRI-ESM2-0	0.0	0.0	-1.0	-1.0
Baseline	0.0	0.0	0.0	0.0
Anomaly Range	-1 to 1	-1 to 2	-2 to 2	-1 to 2

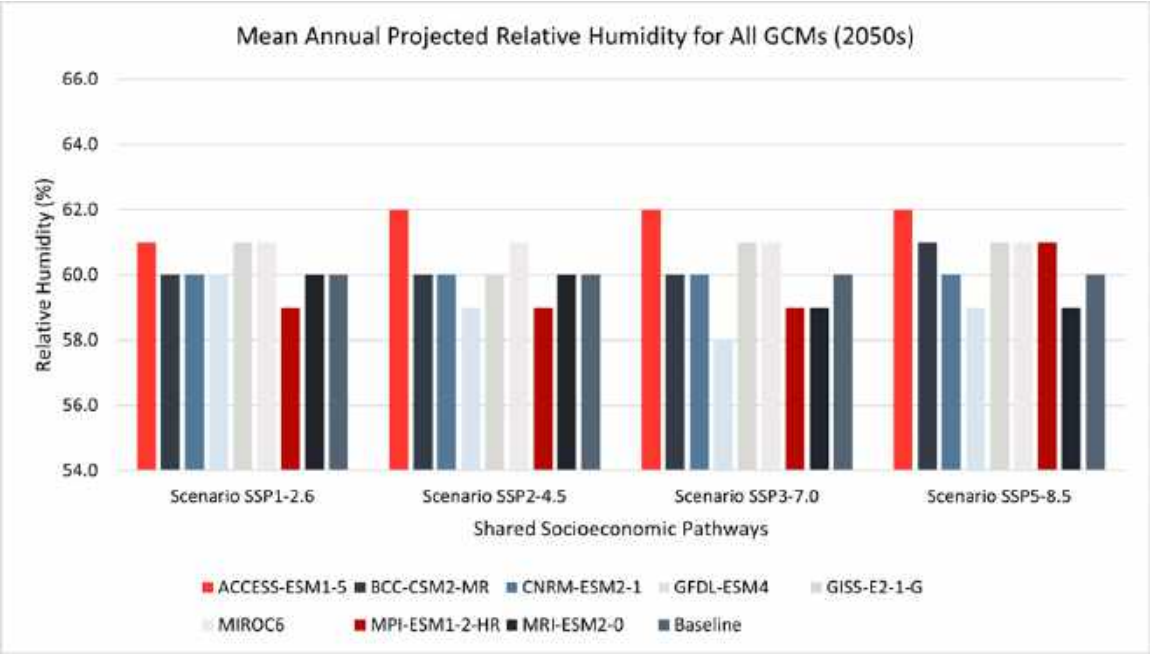


Figure 30: Projected Mean Annual Relative Humidity for all GCMs (2050s)

Table 28: Projected Mean Annual Relative Humidity for all GCMs (2080s)

Climate Model	Relative Humidity Anomaly (%)			
	Scenario SSP1-2.6	Scenario SSP2-4.5	Scenario SSP3-7.0	Scenario SSP5-8.5
ACCESS-ESM1-5	2.0	2.0	4.0	4.0
BCC-CSM2-MR	1.0	1.0	0.0	2.0
CNRM-ESM2-1	0.0	1.0	1.0	1.0
GFDL-ESM4	0.0	-1.0	-2.0	-1.0
GISS-E2-1-G	1.0	1.0	2.0	1.0
MIROC6	1.0	1.0	1.0	2.0
MPI-ESM1-2-HR	-1.0	-1.0	-1.0	5.0
MRI-ESM2-0	0.0	-1.0	-1.0	-1.0
Baseline	0.0	0.0	0.0	0.0
Anomaly Range	-1 to 2	-1 to 2	-2 to 4	-1 to 5

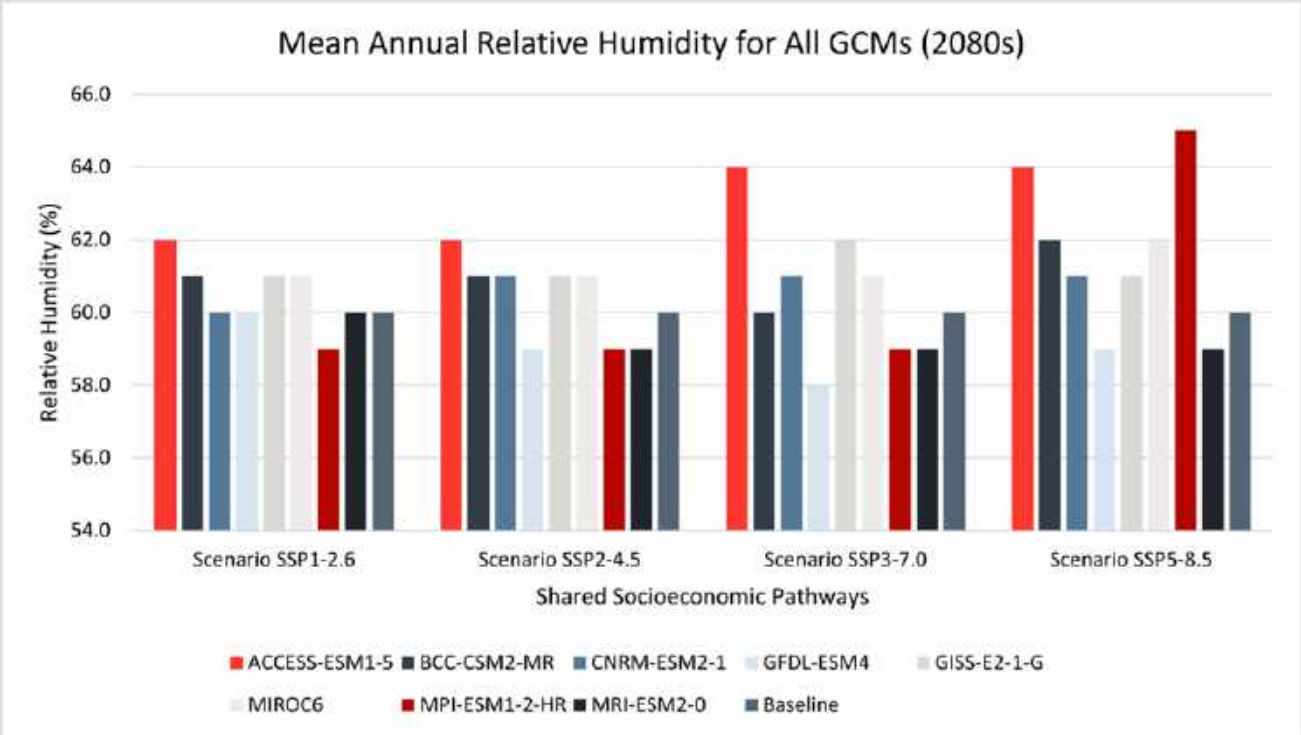


Figure 31: Projected Mean Annual Relative Humidity for all GCMs (2080s)

Monthly Projections

Figure 32 and Figure 33 depict the projected anomalies in monthly median relative humidity at the Site for the 2050s and 2080s, respectively. The figures also show a dashed line which represents the median of all the modelled projections. The dotted lines in the figures represent the spread between the 5th percentile and the 95th percentile of the ensemble. The figures show the projected seasonal pattern with increases in relative humidity for spring and summer months and decreases in relative humidity for winter months, with no change to the annual average. The 5th and 95th percentiles of the 2050s ensembles range from a decrease of -1.0% to an increase of 2.2% on average. The 5th and 95th percentile variations follow the projected median throughout the months of the year, with no discernible seasonal pattern. The 5th and 95th percentiles of the 2080s ensemble, range from a decrease of -1.0% to an increase of 4.0% on average. The 5th and 95th percentile variations are similar throughout the winter months of the year with larger projected uncertainty in the spring and summer months.

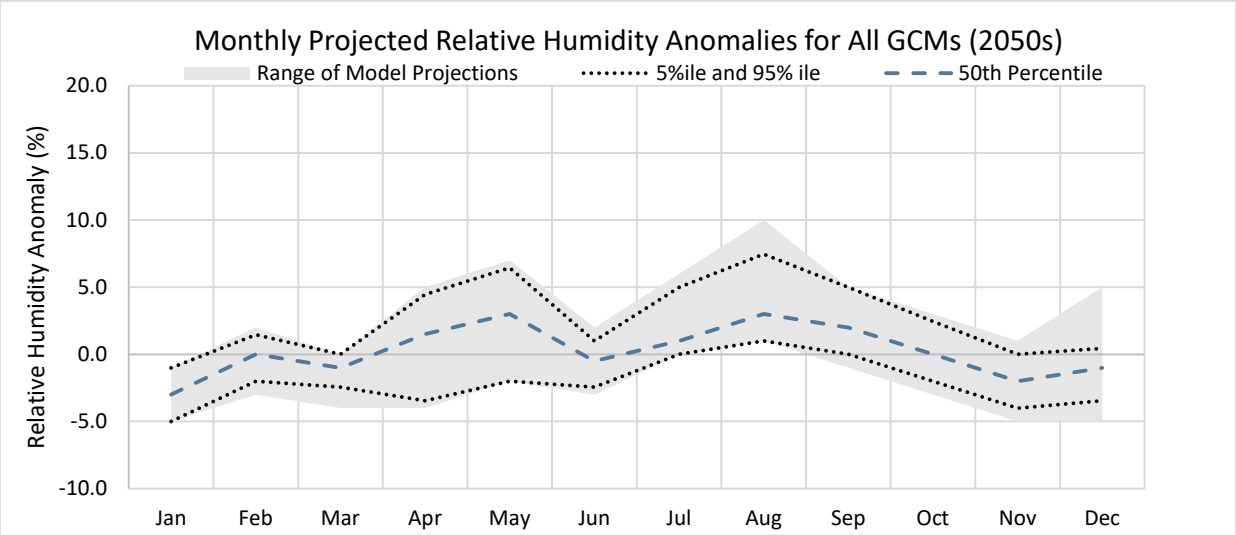


Figure 32: Monthly Projected Relative Humidity Anomalies for Mount Polley Mine Area (2050s)

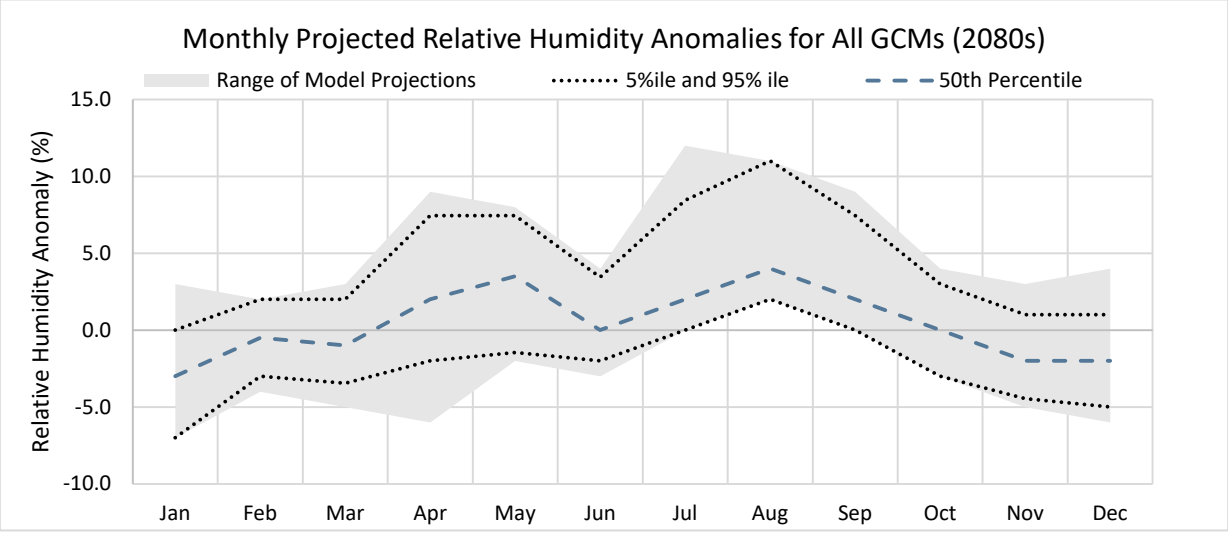


Figure 33: Monthly Projected Relative Humidity Anomalies for Mount Polley Mine Area (2080s)

Summary of Annual and Monthly Projections

The projected future changes in the 2050s and 2080s from the baseline period (1991 through 2020) in monthly and annual relative humidity are summarized in Table 29 and Table 30. In the 2050s, at 50% exceedance probability, the annual relative humidity is projected to remain the same as baseline conditions with monthly relative humidity increasing in spring and summer months (up to 3% absolute increase in May and August) and decreasing in fall and winter months (up to -3% absolute decrease in January). In the 2080s, at 50% exceedance probability, the annual relative humidity is projected to remain the same as baseline conditions with monthly relative humidity increasing in spring and summer months (up to 4% absolute increase in August) and decreasing in fall and winter months (up to -3% in January). There is greater variability in the range of relative humidity in the summer months (Figure 33).

Table 29: Projected Anomalies in Monthly and Annual Relative Humidity in the 2050s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	-5%	-5%	-5%	-4%	-3%	-1%	-1%	-1%	-1%	-1%	-3%	1%
February	-3%	-2%	-2%	-1%	0%	1%	1%	1%	2%	2%	0%	1%
March	-4%	-2%	-2%	-2%	-1%	0%	0%	0%	0%	0%	-1%	1%
April	-4%	-3%	-2%	0%	2%	3%	4%	4%	5%	5%	1%	2%
May	-2%	-2%	-1%	2%	3%	4%	6%	6%	7%	7%	3%	2%
June	-3%	-2%	-2%	-1%	-1%	1%	1%	1%	2%	2%	0%	1%
July	0%	0%	0%	1%	1%	2%	4%	5%	6%	6%	2%	2%
August	1%	1%	1%	2%	3%	5%	7%	7%	9%	10%	4%	2%
September	-1%	0%	1%	1%	2%	3%	4%	5%	5%	5%	2%	2%
October	-3%	-2%	-2%	-1%	0%	1%	2%	2%	3%	3%	0%	1%
November	-5%	-4%	-4%	-3%	-2%	-1%	0%	0%	1%	1%	-2%	2%
December	-5%	-3%	-3%	-3%	-1%	0%	0%	0%	4%	5%	-1%	2%
Annual	-2%	-1%	-1%	0%	0%	1%	1%	2%	2%	2%	0%	1%

Table 30: Projected Anomalies in Monthly and Annual Relative Humidity in the 2080s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	-7%	-7%	-6%	-5%	-3%	-1%	0%	0%	2%	3%	-3%	2%
February	-4%	-3%	-3%	-1%	-1%	1%	1%	2%	2%	2%	0%	2%
March	-5%	-3%	-2%	-2%	-1%	0%	1%	2%	3%	3%	-1%	2%
April	-6%	-2%	-2%	1%	2%	3%	5%	7%	9%	9%	2%	3%
May	-2%	-1%	0%	2%	4%	5%	7%	7%	8%	8%	3%	3%
June	-3%	-2%	-2%	-1%	0%	2%	3%	3%	4%	4%	0%	2%
July	0%	0%	0%	1%	2%	4%	7%	8%	11%	12%	3%	3%
August	2%	2%	2%	2%	4%	6%	9%	11%	11%	11%	5%	3%
September	0%	0%	1%	1%	2%	3%	7%	7%	9%	9%	3%	2%
October	-3%	-3%	-2%	-1%	0%	1%	3%	3%	4%	4%	0%	2%
November	-5%	-4%	-4%	-3%	-2%	0%	0%	1%	2%	3%	-2%	2%
December	-6%	-5%	-5%	-4%	-2%	0%	1%	1%	3%	4%	-2%	2%
Annual	-2%	-1%	-1%	-1%	1%	1%	2%	4%	5%	5%	1%	2%

5.4.3 Future Solar Radiation Projections

Annual Projections

Comparison of the future mean annual solar radiation projections for the Mine area for the 2050s and 2080s projection periods are shown in Table 31 and Figure 34, and Table 32 and Figure 35, respectively. Baseline solar radiation for the Site is from ECCC Williams Lake climate station for the period from 1961 through 2001 as modelled baseline solar radiation for the Site is not available. Projections for the 2050s period shows a mean annual solar radiation increase of 4.3% from baseline, with a range of 2.1% to 11.3% increase from baseline across all climate models and SSPs. Projections for the 2080s period shows a mean annual solar radiation increase of 5% from baseline, with a range of 1.2% to 12.2% increase from baseline across all climate models and SSPs.

Table 31: Projected Mean Annual Solar Radiation for all GCMs (2050s)

Climate Model	Solar Radiation Anomaly			
	Scenario SSP1-2.6	Scenario SSP2-4.5	Scenario SSP3-7.0	Scenario SSP5-8.5
ACCESS-ESM1-5	7.1%	6.3%	7.1%	7.1%
BCC-CSM2-MR	7.1%	7.1%	9.7%	11.3%
CNRM-ESM2-1	3.7%	3.7%	2.9%	2.9%
GFDL-ESM4	4.6%	4.6%	2.9%	2.9%
GISS-E2-1-G	4.6%	2.1%	2.1%	2.1%
MIROC6	4.6%	2.1%	2.1%	2.1%
MPI-ESM1-2-HR	2.1%	2.1%	2.9%	2.1%
MRI-ESM2-0	4.6%	4.6%	2.9%	4.6%
Baseline[(a)]	0%	0%	0%	0%
Anomaly Range	2.1% to 7.1%	2.1% to 7.1%	2.1% to 9.7%	2.1% to 11.3%

a) Baseline solar radiation for the Site is from ECCC Williams Lake climate station for a period from 1961 through 2001.

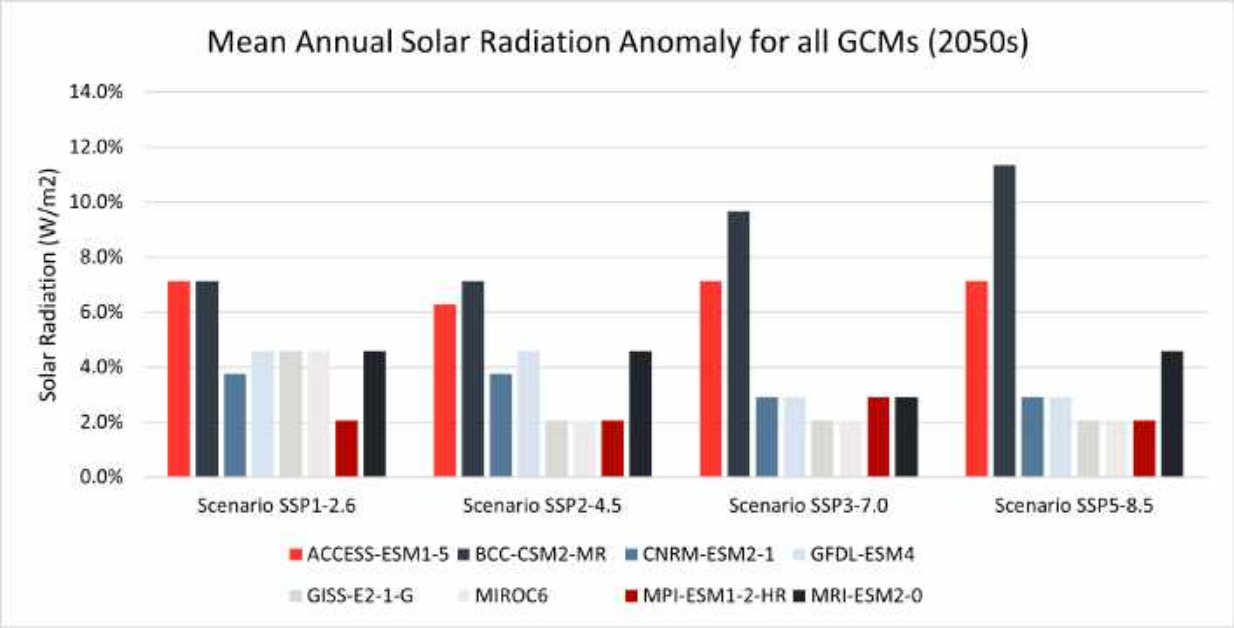


Figure 34: Projected Mean Annual Solar Radiation Anomaly for all GCMs (2050s)

Table 32: Projected Mean Annual Solar Radiation for all GCMs (2080s)

Climate Model	Solar Radiation Anomaly			
	Scenario SSP1-2.6	Scenario SSP2-4.5	Scenario SSP3-7.0	Scenario SSP5-8.5
ACCESS-ESM1-5	7.1%	7.1%	8.0%	8.0%
BCC-CSM2-MR	9.7%	10.5%	13.9%	12.2%
CNRM-ESM2-1	3.7%	2.1%	2.9%	0.4%
GFDL-ESM4	5.4%	4.6%	6.3%	2.1%
GISS-E2-1-G	5.4%	2.9%	2.9%	0.4%
MIROC6	4.6%	2.9%	2.1%	1.2%
MPI-ESM1-2-HR	2.9%	1.2%	2.9%	1.2%
MRI-ESM2-0	7.1%	4.6%	3.7%	2.9%
Baseline[a]	0%	0%	0%	0%
Anomaly Range	2.9% to 9.7	1.2% to 10.5%	2.1% to 13.9%	0.4% to 12.2%

a) Baseline solar radiation for the Site is from ECCC Williams Lake climate station for a period from 1961 through 2001.

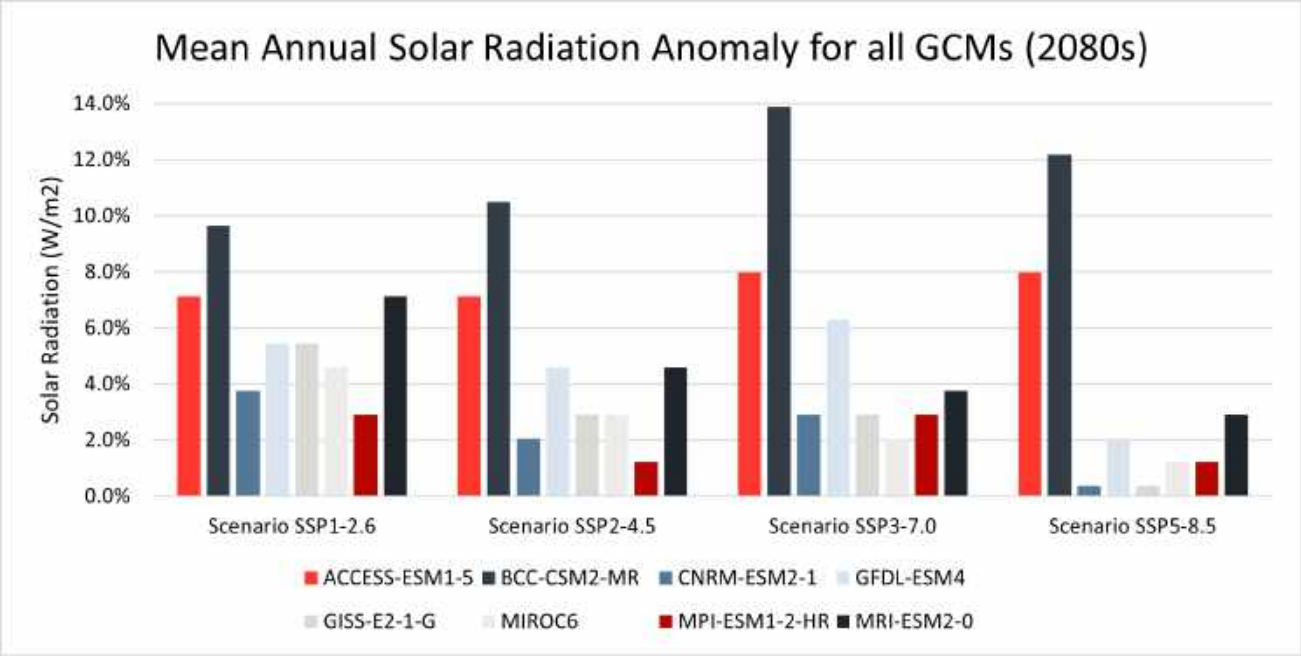


Figure 35: Projected Mean Annual Solar Radiation Anomaly for all GCMs (2080s)

Monthly Projections

Figure 36 and Figure 37 depict the projected anomalies in monthly solar radiation at the Site for the 2050s and 2080s, respectively. The figures also show a dashed line which represents the median of all the modelled projections. The dotted lines in the figures represents the spread between the 5th percentile and 95th percentile of the ensemble. The figures show projected increases in solar radiation for all months for the 2050s and the 2080s except for April, May, and October. For the 2050s (Figure 36) the projected increase in the solar radiation (dashed line) is greater in winter months and less in the summer months, with an annual average increase of 5.1 W/m^2. The 5th and 95th percentiles of the 2050s ensembles range from 2.8 W/m^2 to 11.3 W/m^2 on average with the largest variation occurring in the summer months. The 95th percentile shows a larger variation during the summer months, with projected increases of nearly 21.7 W/m^2.

The projected increase in the mean solar radiation for the 2080s (Figure 37) show a similar pattern to the 2050s period. The projected increase (dotted line) is greater in winter months and less in summer months, with an average annual increase of 5.1 W/m^2. The 5th and 95th percentiles of the 2080s ensemble range from 1.2 W/m^2 to 15.4 W/m2 on average. The 95th percentile shows a larger variation throughout the summer months, with projected increases of nearly 41.2 W/m^2. There is greater uncertainty in the projected solar radiation in July and August.

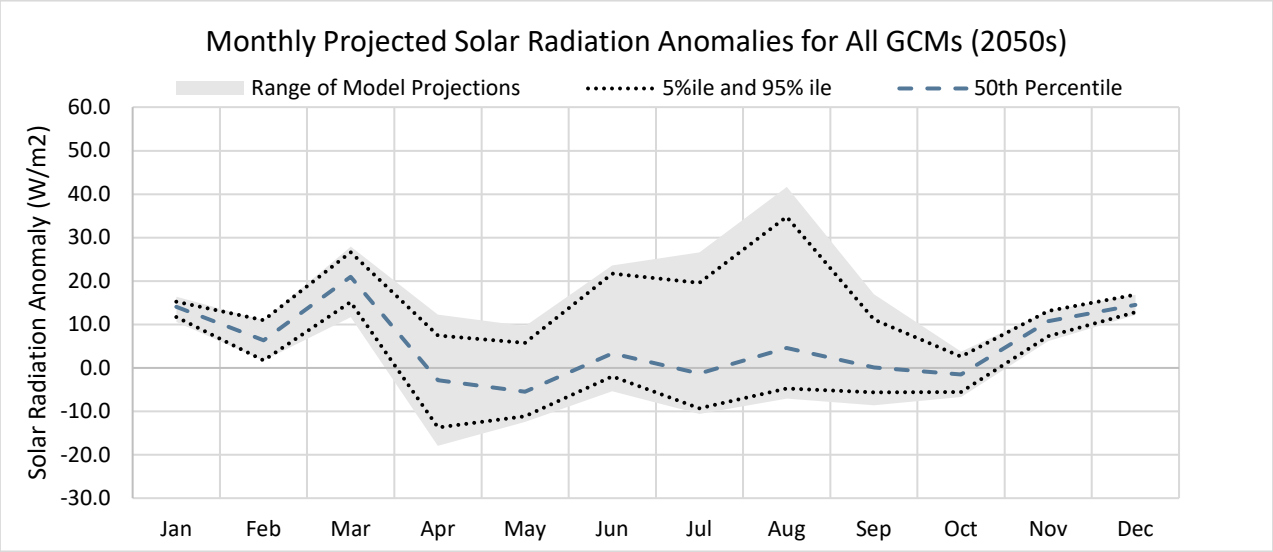


Figure 36: Projected Monthly Solar Radiation Anomalies for Mount Polley Mine Area (2050s)

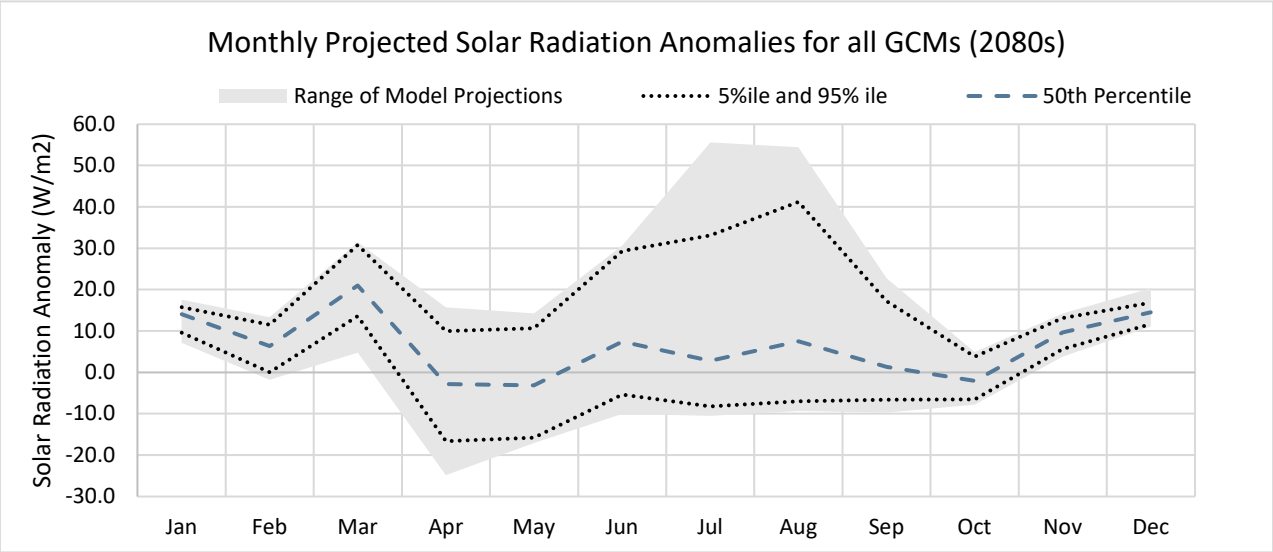


Figure 37: Projected Monthly Solar Radiation Anomalies for Mount Polley Mine Area (2080s)

Summary of Annual and Monthly Projections

The projected future changes in the 2050s and 2080s from the baseline period (Williams Lake 1961 through 2001) in monthly and annual solar radiation are summarized in Table 33 and Table 34. In the 2050s and 2080s, at 50% exceedance probability, the median annual solar radiation is projected to increase by 5.1 W/m^2. Monthly solar radiation is projected to increase for all months except April, May, and October.

Table 33: Projected Anomalies in Monthly and Annual Solar Radiation in the 2050s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	10.6	11.8	12.9	13.8	14.1	15.2	15.2	15.2	16.0	16.4	14.0	1.2
February	1.7	1.7	2.9	5.2	6.3	8.7	10.9	11.0	11.0	11.0	6.7	2.8
March	11.7	15.2	16.5	18.4	21.0	23.3	25.5	26.7	27.9	27.9	21.0	3.7
April	-17.9	-13.7	-8.6	-4.0	-2.8	1.2	4.0	7.5	11.2	12.2	-2.0	6.3
May	-12.4	-11.2	-10.1	-7.8	-5.5	-0.8	1.3	5.8	9.6	9.6	-4.4	5.3
June	-5.4	-1.9	-1.9	0.4	3.3	9.7	17.8	21.7	23.6	23.6	6.1	7.6
July	-10.5	-9.3	-8.2	-4.2	-1.3	4.2	11.3	19.6	26.6	26.6	1.2	9.1
August	-7.0	-4.7	-4.7	-0.1	4.6	10.4	27.3	34.8	41.3	41.7	7.7	12.1
September	-8.6	-5.6	-3.9	-2.8	0.1	4.5	8.7	11.1	15.1	16.9	1.1	5.8
October	-6.7	-5.5	-4.4	-2.0	-1.5	0.6	2.5	2.6	3.4	3.8	-1.0	2.6
November	6.2	7.3	7.4	9.6	10.8	10.8	12.0	13.1	13.1	13.1	10.2	1.7
December	12.2	12.8	13.4	14.5	14.5	15.7	16.7	16.8	16.8	16.8	14.8	1.2
Annual	2.8	2.8	2.8	2.8	5.1	6.9	9.8	11.3	14.8	15.6	5.9	3.3

Table 34: Projected Anomalies in Monthly and Annual Solar Radiation in the 2080s from Baseline

Month	Min	Percentiles								Max	Mean	Std. Dev.
		5%	10%	25%	50%	75%	90%	95%	99%			
January	7.1	9.5	10.6	12.6	14.1	14.4	15.2	15.8	17.2	17.6	13.3	2.2
February	-1.8	0.0	1.7	2.9	6.3	8.7	11.0	11.5	12.9	13.3	6.1	3.7
March	4.7	13.6	15.2	17.5	21.0	24.5	27.7	30.8	31.4	31.4	20.5	5.7
April	-24.9	-16.6	-15.4	-6.9	-2.8	3.3	8.7	9.9	13.9	15.7	-2.8	9.1
May	-17.1	-15.8	-14.5	-10.7	-3.1	-0.8	4.9	10.7	13.5	14.3	-4.0	8.0
June	-10.0	-5.4	-1.9	0.4	7.4	15.5	23.5	29.3	30.6	30.6	8.2	10.6
July	-10.5	-8.2	-5.9	-3.6	2.8	11.5	18.3	33.1	52.0	55.6	6.2	14.3
August	-9.4	-7.0	-0.1	2.2	7.5	12.7	32.8	41.2	51.9	54.4	10.3	14.2
September	-9.7	-6.7	-5.1	-3.9	1.3	5.6	9.8	17.2	22.0	22.7	2.0	7.5
October	-7.8	-6.6	-5.5	-4.4	-2.0	0.6	2.6	3.8	4.6	4.9	-1.6	3.3
November	3.8	5.6	7.3	8.5	9.6	10.8	12.0	13.1	13.9	14.3	9.4	2.3
December	11.0	11.7	12.2	13.4	14.5	15.7	15.7	16.8	19.3	20.3	14.3	1.9
Annual	0.5	1.2	1.7	3.7	5.1	9.8	13.0	15.4	18.3	19.0	6.6	4.7

5.4.4 Future Evaporation Projections

Evaporation and evapotranspiration projections are not available from ClimateBC or ClimateData.ca. However, evaporation and evapotranspiration are likely to change as dependent variables change, in particular air temperature. The extent of the change will depend on the climate change scenario.

5.4.5 Snow Cover Properties Projections

Potential changes in winter air temperature will likely lead to changes in snow cover properties and the annual SWE available for freshet. ClimateBC does not project snow cover and instead projects precipitation-as-snow (PAS) for future climate periods. PAS projections are indicative of the trends in total snow cover and SWE available to contribute to freshet flows, with less PAS resulting in less SWE. Table 35 summarizes ClimateBC projected PAS for future normal periods relative to the modelled baseline period (1991 through 2020) and indicates an overall decrease in PAS in the future. At 50% exceedance probability, the annual PAS is projected to decrease by 30 mm and 59 mm on average for the 2050s and 2080s, respectively.

Climate change model data published for the province of BC by ECCC (2019) project snow depth reduction relative to the 1986 to 2005 reference normal period using CMIP5 RCP (Table 36). At 50% exceedance, the snow cover depth is projected to decrease by 83 mm and 117 mm on average for the 2046-2065 and 2081-2100 normal periods, respectively.

Table 35: Projected Annual Precipitation-As-Snow Anomaly for the Mount Polley Mine Area

Shared Socioeconomic Pathway	Normal Period	Precipitation-as-Snow Anomaly Percentiles (mm)		
		25%	50%	75%
SSP1-2.6	2011-2040	-7	-4	2
	2041-2070	-23	-17	-13
	2071-2100	-25	-21	-18
SSP2-4.5	2011-2040	-11	-5	2
	2041-2070	-32	-27	-18
	2071-2100	-50	-47	-38
SSP3-7.0	2011-2040	-5	-2	2
	2041-2070	-41	-33	-16
	2071-2100	-78	-72	-55
SSP5-8.5	2011-2040	-6	-1	3
	2041-2070	-50	-43	-29
	2071-2100	-110	-95	-80
Average	2011-2040	-7	-3	2
	2041-2070	-36	-30	-19
	2071-2100	-66	-59	-48

Table 36: Snow Depth Change Relative to 1986 to 2005 Predictions for British Columbia (ECCC 2019)

Representative concentration Pathway	Normal Period	Snow Depth Change (mm)		
		25%	50%	75%
RCP2.6	2016-2035	-46.5	-41.4	-12.7
	2046-2065	-67.5	-61.3	-17.4
	2081-2100	-72.6	-68.4	-21.3
RCP4.5	2016-2035	-43.8	-39	-10
	2046-2065	-80.4	-80.5	-33.4
	2081-2100	-109.1	-105.4	-37
RCP8.5	2016-2035	-52.8	-50.1	-14.1
	2046-2065	-101	-105.7	-35.4
	2081-2100	-159.4	-176.4	-58.9

6.0 CONCLUSION AND RECOMMENDATIONS

This report provides the five-year update of climate baseline at Mount Polley Mine Site as per Requirement 2.1 of the Global Industry Standards on Tailings Management (GISTM). The purpose of the update is to extend the existing long-term climate data for the Site using local and regional data collected in the last five years. The last climate baseline update was carried out by WSP Golder in 2016.

This report provides an updated climate baseline for precipitation, air temperature, relative humidity, solar radiation, evaporation, wind speed and direction, and snow depths, and includes updated climate change projections for the Site. Overall, trends in these climate parameters at Mount Polley are similar to those at Environment and Climate Change Canada (ECCC) regional stations. Future climate projections for Mount Polley show that the future climate at the Site would likely be warmer and wetter, with larger variations throughout the months. The greatest variation would likely be in summer months with a projected summer temperature increase of 7°C and less summer precipitation by the year 2100. Annual temperature is projected to increase by 2.7^{o}C and annual precipitation is projected to increase by 8% from the baseline by 2100.

The updated climate parameters and extended long-term climate dataset are deemed to be representative of the climate at the Site and are suitable for support of design and modelling activities. It is recommended that MPMC continue to monitor and record climate data, and that the climate parameters be updated a minimum of every five years to encompass local and regional data collected, and to reflect uncertainties due to climate change.

Signature Page

Golder Associates Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
Dr. J. Y. DIIWU
53838

August 30, 2022

Daniel Mullen, BASc, E.I.T.
Water Resources Specialist

John Diiwu, PhD, P.Eng., EP
Senior Water Resources Engineer

Reviewed by:

Dan R. Walker, PhD, P.Eng.
Senior Water Resources/Hydrotechnical Engineer, Fellow

PERMIT TO PRACTICE #1003064
Engineers & Geoscientists BC

DM/JD/ss/ca

https://golderassociates.sharepoint.com/sites/10023g/22514095 deliverables/002_issued/066-r-31547-climate baseline update/22514095-066-r-rev0-31547-climate baseline update 30aug_22.docx

REFERENCES

Araya-Osses, D., Casanueva, A., Román-Figueroa, C. et al. 2020. Climate change projections of temperature and precipitation in Chile based on statistical downscaling. Clim Dyn 54, 4309–4330 (2020). https://doi.org/10.1007/s00382-020-05231-4

Brunner L., A. G. Pendergrass, F. Lehner, A. L. Merrifield, R. Lorenz, and R. Knutti. 2020. Reduced Global Warming from CIMP6 Projections when Weighting Models by Performance and Independence. Earth Syst. Dynam., 11, 995-1012. https://doi.org/10.5194/esd-11-995-2020.

Bush, E. and Lemmen, D. S., editors. 2019. Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p.

ClimateData.ca. 2022. Download Station Data and Climate Models. Available at https://climatedata.ca. Accessed on 26 April 2022.

Daly, C; Halbleib, M; Smith, J. I; Gibson, W. P; Doggett, M. K; Taylor, G. H; Curtis, J, 2008. Physiographically sensitive mapping of temperature and precipitation across the conterminous United States. Int. J. Climatol., 28, 2031–2064.

ECCC (Environment and Climate Change Canada). 2022a. Historical Climate Data. http://climate.weather.gc.ca. Accessed 2 February 2022.

ECCC. 2022b. "RE: Barkerville Data- Station 1090660" by Electronic Mail from ec.climatouest-climatewest.ec@canada.ca on 9 February 2022.

ECCC. 2018. Received by Electronic Mail on 23 April 2018.

ECCC. 2022c. CMIP6 and Shared Socio-economic Pathways Overview. Available at https://climate-scenarios.canada.ca/?page=cmip6-overview-notes. Accessed on 22 April 2022.

ECCC. 2019. Canadian Climate Data and Scenarios – CMIP5. Modified 24 July 2019. http://climate-scenarios.canada.ca/files/cmip5/cmip5-plots/cmip5_ensembles_canada_summary.pdf. Accessed 3 May 2022.

ICMM (International Council on Mining and Metals). 2020. Global Industry Standard on Tailings Management. August 2020.

IPCC (Intergovernmental Panel on Climate Change). 2021. Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate. Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Hausfather, Z., K. Marvel, G. A. Schmidt, J. W. Nielsen-Gammon, and M. Zelinka. 2022. Climate simulations: recognize the “hot model” problem. Nature 605:26–29.

Holland, D. D. (1976). Landforms of British Columbia – a physiographic outline. Bulletin No. 48, B.C. Department of Mines and Petroleum Resources. Queen’s Printer. Victoria, B.C. 138 p. + map insert.

Morton F. I. 1983. Operational Estimates of Areal Evapotranspiration and their Significance to the Science and Practice of Hydrology. Journal of Hydrology 66: 1-76.

Golder. 2016. Mount Polley Mining Corporation. Mount Polley Mine Long Term Water Management Plan. Permit Amendment Application under the Environmental Management Act: Technical Assessment Report. Report submitted to Luke Moger, Mount Polley Mining Corporation, Golder Doc. No. 1411734-162-R-Rev0-16000. 17 October 2016Miller, J. F. 1964. Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. Engineering Division, Soil Conservation Service, United States Department of Agriculture.

Thornthwaite C. W. 1948. An Approach toward a Rational Classification of Climate. Geographical Review 38: 55-94.

UBC (University of British Columbia). 2022. ClimateBC Software version 7.30. https://climatebc.ca/. Accessed on 9 May 2022.

Wang T, Hamann A, Spittlehouse D, Carroll C. 2016. Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. PLoS ONE 11(6): e0156720. doi:10.1371/journal.pone.0156720

WMO (World Meteorological Organization). 2018. Guide to Climatological Practices (WMO-No. 100). 2018 edition. Geneva.

WMO. 2009. Manual Estimation of Probable Maximum Precipitation (PMP) (WMO-No. 1045). Geneva.



golder.com

APPENDIX 2-2: Geochemical Source Terms

FINAL

Mount Polley Mine Geochemical Source Terms – 2023 Update

Mount Polley Mine, BC, Canada

Mount Polley Mining Corporation



SRK Consulting (Canada) Inc. ▪ CAPR002434 ▪ October 2023

srk consulting

FINAL

Mount Polley Mine Geochemical Source Terms – 2023 Update

Mount Polley Mine, BC, Canada

Prepared for:
Mount Polley Mining Corporation
Box 12
Likely, BC, V0L 1N0
Canada

+1 250 790 2215
www.imperialmetals.com

Prepared by:
SRK Consulting (Canada) Inc.
320 Granville Street, Suite 2600
Vancouver, BC V6C 1S9
Canada

+1 604 681 4196
www.srk.com

Lead Author: Shauna Litke, PEng **Initials:** SJL
Reviewer: Stephen Day, PGeo **Initials:** SJD

File Name:
MPSourceTerms_Report_CAPR002434_FINAL_20231025.docx

Suggested Citation:
SRK Consulting (Canada) Inc. 2023. Mount Polley Mine Geochemical Source Terms – 2023 Update. FINAL. Prepared for Mount Polley Mining Corporation: Likely, BC. Project number: CAPR002434. Issued October. 2023.

Cover Image(s):
Springer Pit in 2023. Photo credit: MPMC

Copyright © 2023

Disclaimer. SRK Consulting (Canada) Inc. has prepared this document for Mount Polley Mining Corporation, our client. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this report by a third party.

The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

Contents

1 Introduction 1

2 Background 2
2.1 Site Overview and Closure 2
2.2 Geological Setting 4
2.3 ML/ARD Management 7
2.3.1 Classification of Mine Waste 7
2.3.2 Mine Waste Rock and Tailings Management 7
2.3.3 Waste Rock Inventory 8
2.3.4 Stockpiled Ore 8
2.4 Springer Pit Expansion 10

3 Geochemical Characteristics 11
3.1 Rock 11
3.1.1 Overview 11
3.1.2 ARD Potential 12
3.1.3 Trace Element Content 17
3.1.4 Extraction Tests 19
3.1.5 Kinetic Testing 19
3.2 Tailings 25
3.2.1 Overview 25
3.2.2 ARD Potential 25
3.2.3 Trace Element Content 26
3.2.4 Kinetic Testing 26
3.3 Other Sources 30

4 Conceptual Geochemical Models 31
4.1 Purpose 31
4.2 Ex-Pit NAG Waste Rock and Construction Fills 31
4.3 NAG Waste Rock Influenced by the Sulphur Stockpile 32
4.4 Ex-Pit PAG Waste Rock 32
4.5 Ore Stockpiles 33
4.6 Pit Backfill 33
4.7 Pit Walls 33
4.8 Ore Processing 33
4.9 Tailings Solids 34
4.10 Nitrogen Leaching 35

5 Source Terms 36
5.1 General Approach 36
5.2 Incorporating Uncertainty 36
5.3 NAG Waste Rock and Construction Fills 37
5.3.1 Method 37
5.3.2 Inputs 38
5.3.3 Results 48
5.4 NAG Waste Rock Influenced by the Sulphur Stockpile 48

5.5 PAG Waste Rock....48
5.6 Ore Stockpiles....48
5.7 Pit Backfill....48
5.8 Pit Walls....49
5.8.1 Method....49
5.8.2 Inputs....49
5.8.3 Results....52
5.9 Ore Processing....52
5.9.1 Method....52
5.9.2 Inputs....52
5.9.3 Results....52
5.10 Tailings....52
5.10.1 Method....52
5.10.2 Inputs....53
5.10.3 Results....56
5.11 Magnetite Stockpiles....56
5.12 Nitrogen Leaching....56

6 Conclusions....58

References....60

Tables

Table 1: Waste Rock Disposal Locations as of September 30, 2023....9
Table 2: Stockpiled Ore Inventory....9
Table 3: Static Test Inventory for Rock Samples with Known Source as of the End of 2022....11
Table 4: Characteristics of Samples in Waste Rock Humidity Cells....20
Table 5: Static Test Inventory for Tailings....25
Table 6: Waste Rock Seepage Statistics....43
Table 7: Humidity Cell Rates (mg/kg/wk) Used for Pit Wall Terms....51
Table 8: Tailings Seepage Statistics....54
Table 9: Waste Rock Nitrogen Source Terms....57
Table 10: Waste Rock Source Terms....63
Table 11: Pit Wall Source Terms....65
Table 12: Ore Processing Source Terms....67
Table 13: Tailings Source Terms....69

Figures

Figure 1: Pits and Waste Rock Dumps 3
Figure 2: Geological Map of the Mount Polley Mine 6
Figure 3: Comparison of Total Carbon and Total Inorganic Carbon 12
Figure 4: Total Sulphur (Top) and Sulphate (Bottom) Distributions by Zone 13
Figure 5: Sobek Neutralization Potential Versus Total Inorganic Carbon by Zone 14
Figure 6: Total Inorganic Carbon versus Acid Potential of Drill Core Samples from Springer Deep (top left), WX Zone (top right), and All Other Zones (bottom) 15
Figure 7: Total Inorganic Carbon versus Acid Potential of Blast Hole Samples from Springer Pit (top right), Cariboo Pit (top left), Boundary Zone (bottom left), Southeast Zone (bottom middle), and Pond Zone (bottom right) 16
Figure 8: Copper Concentrations Versus Selenium Concentrations (All Zones) 17
Figure 9: Box and Whisker Distribution for Selenium Content 18
Figure 10: Box and Whisker Distribution for Selenium-to-Sulphur Ratios 18
Figure 11: Correlation of Sulphur Content with Oxidation Rate for Waste Rock Humidity Cells 21
Figure 12: Cation Release Ratio versus Oxidation Rate 23
Figure 13: Distribution of t_{onset} for PAG Waste Rock at Mount Polley Mine 24
Figure 14: Total Inorganic Carbon versus Acid Potential of Mount Polley Mine Tailings 26
Figure 15: Selected Leachate Chemistry for Tailings Humidity Cells 28
Figure 16: Selected Leachate Chemistry for Tailings Columns 29
Figure 17: Box and Whisker Distributions for the Cation Ratio 38
Figure 18: Seep Sampling Locations 40
Figure 19: Se/SO_4 Ratios in Waste Rock Seepage 41
Figure 20: Nitrate Concentrations in Waste Rock Seepage 42
Figure 21: Timeseries of Nitrate Concentrations from the North Bell Dump 42
Figure 22: Gypsum Saturation Indices Compared to Sulphate Concentrations 45
Figure 23: Partial Pressure of CO_2 in Waste Rock Seepages 45
Figure 24: Copper Mineral Saturation Indices Compared to Copper Concentrations 46
Figure 25: $CaMoO_4$ Saturation Indices Compared to Molybdenum Concentrations 46
Figure 26: Relationships between Selenium Concentrations and Saturation Indices for Gypsum (top left), $CaMoO_4$ (top right), and Tenorite (bottom) 47
Figure 27: Gypsum Saturation Indices for Tailings Seepage and Column Data 55
Figure 28: Comparison of P95 and P99 Statistics for Ratio of Column/Seepage 56

Appendices

Appendix A ML/ARD Management Procedure Manual
Appendix B Waste Rock Source Terms
Appendix C Pit Wall Source Terms
Appendix D Ore Processing Source Terms
Appendix E Tailings Source Terms

Definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

ABA	Acid-base accounting
AP	Acid Potential
$CaSO_4 \cdot 2H_2O$	gypsum
CGM	conceptual geochemical model
$(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$	chrysocolla
$Cu_2CO_3(OH)_2$	malachite
Cu_5FeS_4	bornite
Cu_9S_5	digenite
$CuFeS_2$	chalcopyrite
CuO	tenorite
CuS	covellite
FeS_2	pyrite
HCT	Humidity Cell Test
LSW	Low Sulphur Waste
ML/ARD	metal leaching and acid rock drainage
MPIC	Mount Polley Intrusive Complex
MPM	Mount Polley Mine
MPMC	Mount Polley Mining Corporation
NAG	Non-Acid Generating
NEZ	Northeast Zone
NP	Neutralization Potential
NW	Northwest
PAG	Potentially Acid Generating
SERDS	South East Rock Disposal Site
SFE	Shake Flask Extraction
TC	Total Carbon
TIC	Total Inorganic Carbon
TSF	Tailings Storage Facility

Executive Summary

Mount Polley Mining Corporation is preparing a Joint Mines Act and Environmental Management Act Permit Amendment Application to support the Springer Pit Expansion Project. The scope of the application includes an extension of the South East Rock Disposal Site (SERDS), an expansion of the Springer Pit, an extension to the duration of treated water discharge to Quesnel Lake to be throughout mining operations, and an extension of the Northwest Potentially Acid Generating (PAG) Stockpile disposal date. This application involves modelling of water quality at the site and in the receiving environment. Inputs to this model are geochemical source terms which are estimations of the chemistry of water in contact with materials and surfaces exposed by mining activity. Source terms mainly consider the potential for metal leaching and acid rock drainage (ML/ARD).

The purpose of this report is to characterize the materials that will be mined as part of the Project, including an assessment outlining the estimated time to onset of acid rock drainage and how it relates to the proposed timeline of the Project, and to describe the derivation and use of the source terms.

The Mount Polley deposit is classified as an alkalic porphyry copper gold deposit. The deposit has been mined from several mineralized zones (Springer, Cariboo, Bell, Southeast, Northeast, Boundary). The proposed extension of the existing Springer and Cariboo pits includes mining in three new zones: Springer Deep Zone, WX Zone, and C2 Zone). With the exception of the distinctive small Pond Zone skarn deposit, all other zones have common geological features including mainly a monzonitic plutonic host rock, association with breccia bodies in the intrusion, dominantly potassic hydrothermal alteration, lack of pronounced pyrite haloes, enrichment in copper and selenium relative to global norms, pervasive calcite, and natural oxide alteration. As a result, geochemical characteristics are consistent between zones, allowing a site-wide approach to geochemical characterization.

PAG and non-PAG waste rock materials occur locally as pyrite zones but non-PAG dominates. ARD potential was used to segregate waste rock, with non-PAG waste rock being placed in several waste rock dumps and PAG waste rock either deposited in completed pits that are projected to flood at the closure of the mine (in accordance with the management practice of subaqueous disposal) or placed in a temporary stockpile for final disposal in the Springer-Cariboo Pit. Based on review of operational processes and data, non-PAG waste rock is expected to be non-acidic in perpetuity.

Tailings are classified as non-PAG based on operational monitoring and testing of tailings spilled into Hazeltine Creek in August 2014.

Major geochemical sources were identified as waste rock stockpiles and the tailings. Other sources include backfilled waste rock, ore processing, pit walls, ore stockpiles, and magnetite stockpiles. Source terms were mainly developed from conceptual geochemical models then interpretation of rock geochemical characteristics and seepage data rather than scale-up of laboratory kinetic test data. Pit wall source terms (including PAG walls) were obtained by scaling of kinetic test data. Source terms were not specifically developed for the magnetite stockpiles because they are small sources.

1 Introduction

Mount Polley Mining Corporation (MPMC), a wholly owned subsidiary of Imperial Metals Corporation, has been operating the Mount Polley Mine (MPM), located approximately 56 km northeast of Williams Lake and approximately 15 km southwest of the community of Likely in British Columbia, Canada, since 1996. MPMC recovers copper and gold from porphyry-style mineralization by open pit and underground mining. The plant is capable of processing 22,000 t/d of ore using standard mineral flotation technology.

MPMC is preparing a Joint Mines Act and Environmental Management Act Permit Amendment Application to support the Springer Pit Expansion Project (the Project). The scope of the application includes an extension of the South East Rock Disposal Site (SERDS), an expansion of the Springer Pit, an extension to the duration of treated water discharge to Quesnel Lake to be throughout mining operations, and an extension of the Northwest Potentially Acid Generating (PAG) Stockpile disposal date. This application involves modelling of water quality at the site and in the receiving environment. Inputs to this model are geochemical source terms which are estimations of the chemistry of water in contact with materials and surfaces exposed by mining activity. Source terms mainly consider the potential for metal leaching and acid rock drainage (ML/ARD).

The purpose of this report is to characterize the materials that will be mined as part of the Project, including an assessment outlining the estimated time to onset of acid rock drainage and how it relates to the proposed timeline of the Project, and to describe the derivation and use of the source terms.

2 Background

2.1 Site Overview and Closure

Figure 1 shows the locations of the open pits at MPM. Full scale mining began in the Cariboo Pit by mining high oxide and high gold parts of the ore body then transitioning to the Bell Pit in 1999. Mining was suspended in 2001 due to unfavorable market conditions. The mine re-opened in 2005 after a three-and-a-half-year care-and-maintenance period. The following zones have been mined since 2005:

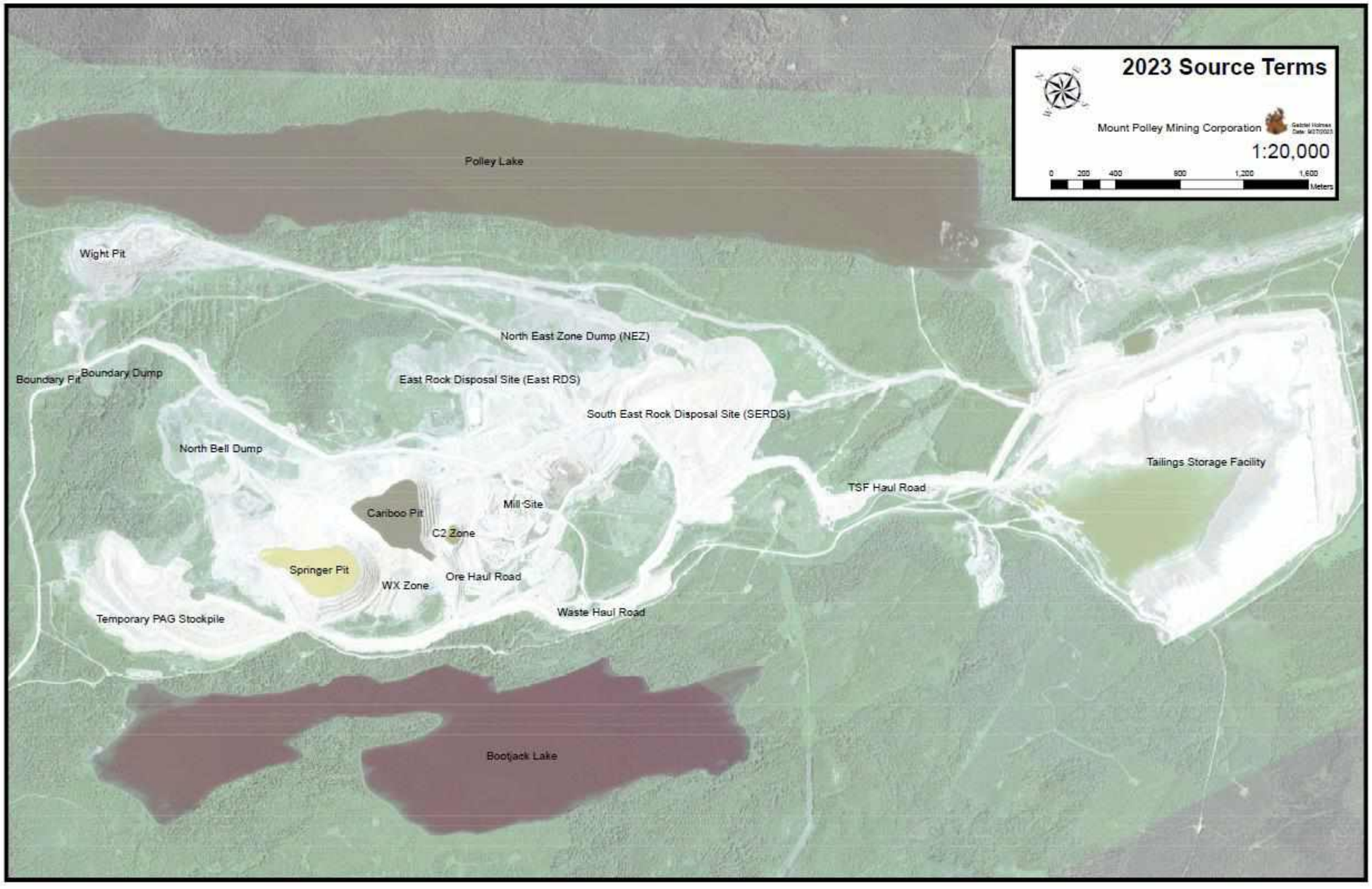
- Completed mining and backfilling of the Bell Pit.
- Completed mining and backfilling of the small Southeast Zone and Pond Zone Pits.
- Completed mining and flooding of the Wight Pit (Northeast Zone).
- Completed mining of the Boundary Pit.
- Completed permitted mining and flooding of Northeast Zone underground (access from the Wight Pit).

In August 2014, mining was suspended due to the breach of the tailings dam. Mining restarted in 2015 with tailings being deposited in the Springer Pit. In 2016, tailings were deposited in the Tailings Storage Facility (TSF) following reconstruction of the dam.

In May 2019, mining was again suspended due to unfavourable market conditions, but mining operations restarted in November 2021 and milling operations resumed in June 2022. Active mining is currently focussed on the Cariboo and Springer Pits (which will merge to a single pit).

Upon completion of mining, the Springer-Cariboo Pit will be backfilled by rock from the Temporary Northwest (NW) PAG Stockpile (the NAG/PAG Pad) and allowed to flood. The TSF will be decommissioned with a minimal water cover.

Figure 1: Pits and Waste Rock Dumps



Sources: Provided by MPMC

2.2 Geological Setting

The Mount Polley deposit is classified as an alkalic porphyry copper gold deposit (BC MINFILE No. 093A 008). With the exception of the distinctive small Pond Zone, it has been mined from several mineralized zones which have the following common features:

- The host rock for porphyry mineralization is the Mount Polley Intrusive Complex (MPIC) which intruded into Nicola Group Volcanics (Figure 2). The intrusion is primarily monzonite to monzo-diorite in composition. Smaller phases vary in composition from diorite to syenite.
- Mineralization is associated with magmatic-hydrothermal breccias. Alteration and mineralization occurs in the matrix of the breccias, and in veins and swarms distributed around the breccias. BX1 is the main host for the bulk of the mineralization at MPM which is mined in the Cariboo and Springer Pits (Figure 2). BX1 is characterized by alteration which resulted in the strongest destruction of both primary and breccia textures. Breccia bodies BX2 host satellite mineralization in the Southeast Zone, Wight Pit, and Boundary Zone. BX2 is less intensively altered and original textures are more apparent. BX3 is unmineralized and has not been mined.
- Alteration at MPM is classified as potassic (sodic and calcic) with salmon-pink potassium feldspar as the main alteration mineral. Biotite is less common. Sodic alteration is defined by albite and calcic alteration (actinolite, diopside, epidote, clinozoisite, and sporadic andraditic garnet). Calcite is pervasive. Alteration is zoned with the strongest calcic-potassic alteration in the core associated with BX1. Nicola Group rocks and fringing MPIC rocks are propylitically-altered and characterized by stronger epidote and pyrite.
- Like other alkalic porphyry deposits (e.g., Copper Mountain, Brenda), MPM lacks the strong hydrothermal alteration zoning that is commonly observed in calc-alkalic porphyry deposits (e.g., Highland Valley Copper, Island Copper, Gibraltar). In particular, phyllic alteration is absent at MPM. A common feature of calc-alkalic porphyry deposits is often a pronounced pyritic halo that surrounds the copper mineralization and is associated with phyllic and propylitic alteration. At MPM, discontinuous pyritic zones are present but do not appear to be mineralization halos. MPM geological staff identified a pyritic zone in the south wall of the Springer Pit which extends into the adjacent Cariboo Pit. Samples from Bell Pit blast holes collected in the early years of operations were identified as being from a Pyrite Zone but the location of this feature is not known.
- Sulphide mineralization consists mainly of chalcopyrite ($CuFeS_2$) and pyrite (FeS_2), with lesser bornite (Cu_5FeS_4), covellite (CuS), and digenite (Cu_9S_5). Bornite is relatively more abundant in the Northeast and Boundary Zones.
- Carbonate mineralization is principally calcite, with occurrences of malachite ($Cu_2CO_3(OH)_2$) formed as a natural weathering product. Iron carbonates have not been reported.
- A significant portion of the copper at the MPM is not associated with sulphides (upwards of 50% in the upper portions of each pit). This fraction has been termed ‘copper oxide’ by MPM personnel and is associated primarily with chrysocolla ($(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$) and malachite ($Cu_2CO_3(OH)_2$) in equal proportions (Henry 2009). SRK (2015b) has shown that chlorite is a significant host for copper. It is assumed that chlorite formed hydrothermally and incorporated

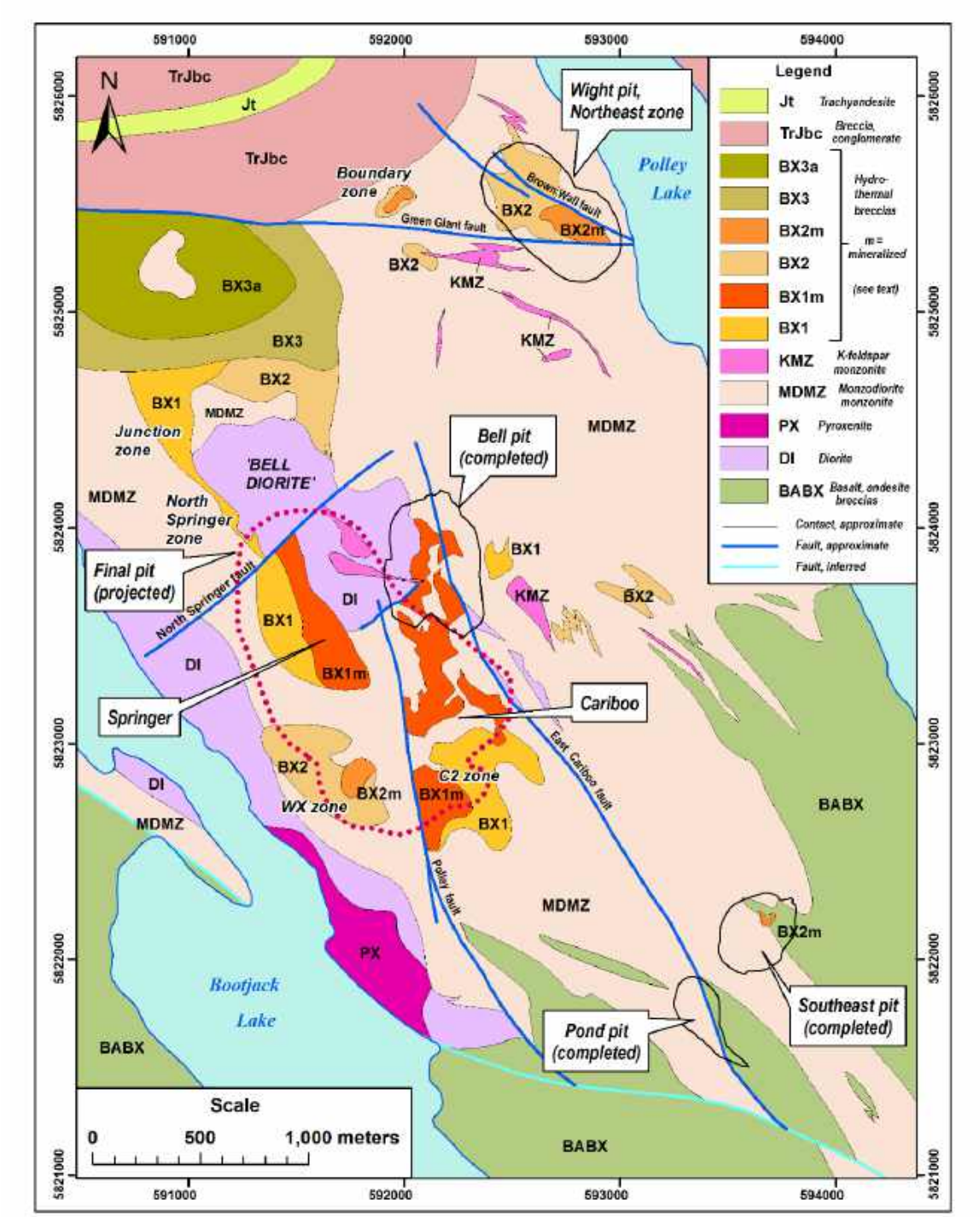
copper as part of the mineralizing event rather than due to weathering. Suarez et al. (2009) found that the form of copper in chlorite at the Aguablanca Ni-Cu-PGE Sulfide Deposit was native copper between silicate layers rather than as a substitution in the crystal lattice. The mineral is suspected to have formed during hydrothermal alteration rather than by natural weathering processes. It is not known whether this same form of copper is also present at MPM.

The small Pond Zone is andradite-clinopyroxene-magnetite skarn mineralization occurring at the contact between a diorite to monzodiorite intrusion and Nicola Group volcanic rocks of andesite to basalt composition. It appears to be linked to the presence of a limestone unit in the Nicola Group.

From an ML/ARD perspective, a significant feature of the Mount Polley mineralization is the lack of reported arsenic, lead, and zinc minerals which are commonly associated with porphyry deposits elsewhere in British Columbia and globally. Since arsenic, zinc, and associated cadmium are relatively mobile under non-acidic conditions, the lack of the minerals hosting these elements indicates that potential for leaching concerns is lower than other porphyries. Based on the copper sulphide and copper oxide dominated mineralogy, the primary metal leaching concern is expected to be for copper.

In addition, the lack of a distinctive pyrite halo means that pyrite abundance is lower than other porphyry deposits and ARD potential is expected to be lower.

Figure 2: Geological Map of the Mount Polley Mine



Sources: Rees (2013)

2.3 ML/ARD Management

2.3.1 Classification of Mine Waste

According to the *Mines Act* Permit M-200 (referred to as the M-200 Permit in this document), potentially acid generating (PAG) and ML materials are defined as:

- Neutralization potential (NP) is calculated using total inorganic carbon (TIC).
- Acid potential (AP) is calculated using total sulphur.
- All waste rock, quarry rock, borrow materials, and tailings are classified as PAG if they have an NP/AP ratio of less than 2.0.
- Borrow material or waste rock containing soluble metal levels (as determined by the shake flask test) higher than the receiving water objectives are defined as having potential for metal leaching.

2.3.2 Mine Waste Rock and Tailings Management

The M-200 Permit specifies the following requirements for waste management:

- Waste Rock
  - PAG waste rock can only be disposed in the Cariboo, combined Cariboo/Springer, Wight, and Southeast Zone pits, where it is submerged permanently beneath a water cover.
  - A maximum of 62 million tonnes of PAG waste rock can be stored in the Temporary NW PAG Stockpile.
  - Isolated pockets of PAG materials (less than 1,000 tonnes) may be blended with non-PAG materials within the waste rock dumps, at a minimum non-PAG:PAG ratio of 20:1.
- Quarry Rock
  - Quarry rock can be used as construction material in the TSF if the NP/AP is greater than 2.0 and the total copper solid concentration is less than 180 mg/kg.
- Tailings
  - PAG tailings may not be cycloned for use in dam construction.
  - Cyclone tailings must have an NP/AP ratio greater than 2.0.
  - Cycloned tailings may be used for construction of the following TSF components:
    - The upstream and downstream faces of the Perimeter Embankment.
    - The upstream side of the Main Embankment.
    - The maintenance of a till core in the Perimeter and Main Embankments.

The procedure used by MPMC to identify and segregate PAG waste rock is attached in Appendix A.

2.3.3 Waste Rock Inventory

Table 1 summarizes major waste rock disposal locations as of September 30, 2023, which are shown in Figure 1. The primary NAG rock disposal locations are the North Bell Dump, which includes backfill in the Bell Pit, the South East Rock Disposal Site (SERDS), which also includes the backfilled Southeast Zone and Pond Zone Pits, and the Northeast Zone (NEZ) Dump. NAG rock has been used for construction purposes (Waste Haul Road and the TSF). NAG rock from the open pits has been disposed at a variety of different locations resulting in waste rock dumps containing non-unique source materials. The exception is that the NEZ Dump received waste primarily from the Wight Pit.

As described in SRK (2016), prior to 2005 (i.e., before operations were re-started), limited PAG waste rock was mined and was dumped into the bottom of the Bell Pit. A small amount was dumped over the north end of the Cariboo Pit, but it was re-handled to the bottom of the Cariboo Pit. Acid-base accounting (ABA) analyses were performed by an external lab.

Since 2005, PAG waste rock has primarily been disposed in the Temporary NW PAG Stockpile (which includes the NAG/PAG Pad and called Ex-pit PAG in this report) which is planned to be backhauled to the Springer-Cariboo Pit at closure for subaqueous disposal. PAG rock has also been disposed sub-aqueously in the Cariboo Pit backfill and Southeast Zone Pit. PAG rock mainly originates from the Cariboo Pit and Springer Pit. The PAG waste rock in the North Bell Dump originated from the Southeast Zone Pit which was dominated by PAG waste rock.

An amendment to Mines Act Permit M-200 on July 8, 2009 allowed the placement of low sulphur (less than 0.3%) waste (LSW) as 2 m layers with Springer Zone NAG waste rock to create a NAG waste rock blend. The quantity of PAG rock mined from the Pond Zone was 6,615 t, which was disposed in a portion of the Northeast Zone Dump referred to as the Sandwich Dump.

2.3.4 Stockpiled Ore

Stockpiled ore is not classified by ARD potential, but the quantities are insignificant relative to waste rock. The current quantity of stockpiled ore is summarized in Table 2.

Table 1: Waste Rock Disposal Locations as of September 30, 2023

Placement Location	NAG		PAG	
	Mass (kt)	Percent of NAG	Mass (kt)	Percent of PAG
Bell Pit Rock Disposal	74,891	30%	530[1]	1%
Boundary Pit Rock Disposal	821	0.3%	-	0%
Temporary NW PAG Stockpile	7,461	3.0%	34,560	78%
East Rock Disposal Site	28,502	11%	-	0%
South East Rock Disposal Site	66,617	26%	-	0%
SERDS Co-Disposal	3,146	1.2%	-	0%
Northeast Zone Dump	34,590	14%	-	0%
Sandwich Dump	275[2]	0.1%	-	0%
Southeast Pit Backfill	36	0.01%	1,017[1]	2%
Wight Pit Backfill	363	0.1%	8,089	18%
Crusher Haul Road	4,116	1.6%	-	0%
SERD Lower Haul Road	6,953	2.8%	-	0%
TSF Access and Haul Roads	6,624	2.6%	-	0%
TSF Dam	15,230	6.0%	-	0%
Other (Minor Road Construction and Maintenance)	2,999	1.2%	-	0%
Total Tonnes	**252,625**		**44,197**	

Sources: MPMC, https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsx

Notes:

[1] Submerged.

[2] Includes 6,615 t of low sulphur waste from the Pond Zone.

Table 2: Stockpiled Ore Inventory

Stockpile	Mass (kt)
#1 Stockpile	70
Upper Super High Grade & High Oxide	12
Low Grade Stockpiles[1]	800
Springer Ore Muck (in pit)	162
#3 Stockpile	1,538
High Oxide	2,564
Total	**5,147**

Sources: MPMC, https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsx

Notes:

[3] Total of two low grade stockpiles.

2.4 Springer Pit Expansion

MPM is proposing to extend the LOM to 2032 by mining approximately 65 million tonnes of additional ore from an extension of MPM Site's existing pit infrastructure. The project will include the following modifications:

- **Pit and waste rock dump extensions:** extension of the existing Springer and Cariboo pits (i.e., into Springer Deep Zone, WX Zone, and C2 Zone) and associated waste rock dumps (SERDS and Temporary NW PAG Stockpile).
- **PAG waste rock disposal date:** To allow for mining to continue in the Springer Pit for the proposed LOM, the date in which the Springer-Cariboo Pit will be backfilled by PAG rock from the Temporary NW PAG Stockpile will need to be extended to December 31, 2034. This accounts for three years of rehandling PAG material (2032 to 2034).
- **Tailings storage expansion:** incremental expansion of the existing TSF to accommodate additional tailings form the extended mine life.

3 Geochemical Characteristics

3.1 Rock

3.1.1 Overview

Understanding of waste rock geochemical characteristics has been accumulated from a variety of sources including diamond drill core tested prior to mining, blast hole cuttings to inform waste rock management operations in the pit during operations, and post-depositional monitoring (Table 3). The database is dominated by the data gathered to operationally characterize waste rock in the Springer Pit, including the Springer Deep Zone. However, the database is incomplete because some of the earlier data were lost, and blast hole data are lacking for Cariboo Pit and Bell Pit. For Cariboo Pit and Wight Pit, confirmatory post-depositional data partly address this gap. For Cariboo Pit, data gathered to operationally characterize waste rock during more recent mining operations in the pit from 2016 – 2019 also addresses this gap.

Table 3: Static Test Inventory for Rock Samples with Known Source as of the End of 2022

Source	Drill Core	Blast Hole	Confirmatory[1]	Total
Boundary Zone	16	123	0	139
Bell Pit	0	78	25	103
Wight Zone	102	0	0	102
SE Zone	52	132	0	184
Pond Zone	27	174	0	201
Springer Pit	131	4,929	9	5,069
Cariboo Pit	1,004	2,877	60	3,941
C2 Pit	604	0	0	604
Springer Deep	16,391	0	0	16,391
WX Zone	5,267	0	0	5,267
Total	23,594	8,313	94	32,001

Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

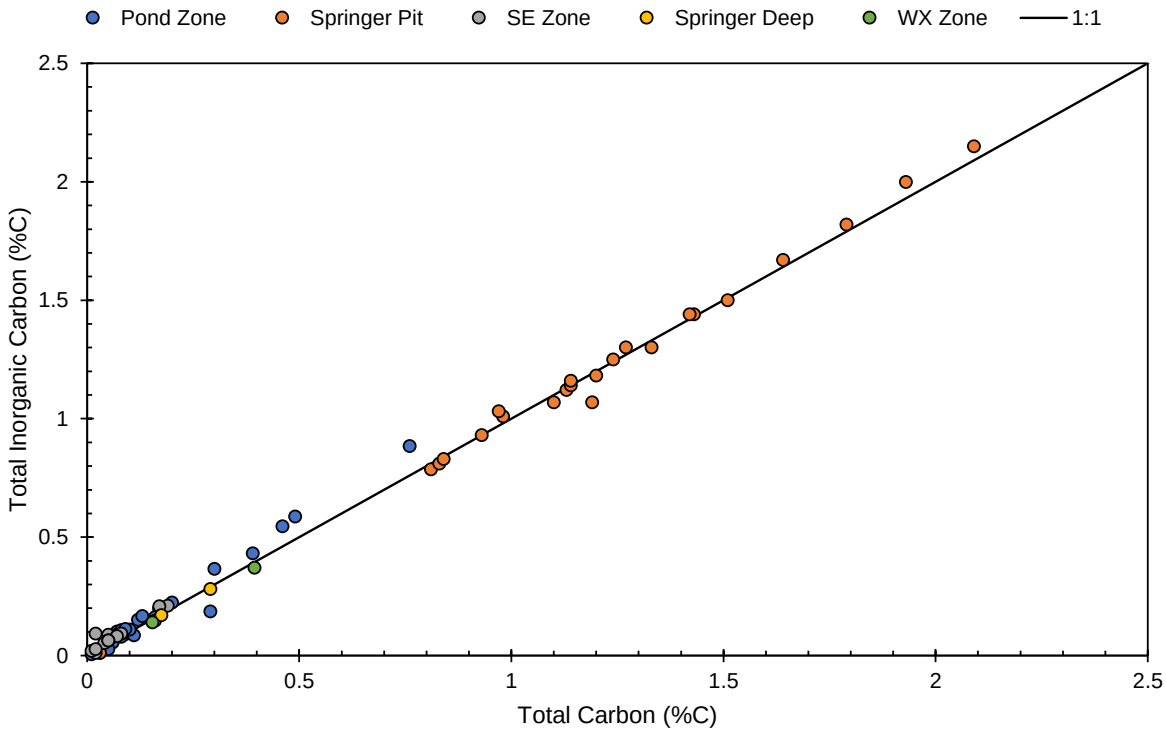
Notes:

[1] Includes blast muck and post-depositional samples where source of rock is known.

The inventory primarily contains static ARD potential data, though trace element scans are also available for all zones except the Boundary Pit. Drill core analyses were primarily performed by off-site laboratories and included total sulphur, sulphate, sulphide by difference, total carbonate, neutralization potential (NP by Sobek method), and paste pH. For some samples, a trace element scan was performed. On-site tests were total sulphur and total carbon. The former is assumed to be a proxy for sulphide sulphur because other forms of sulphur (including sulphate) are not common at MPM. The

latter is assumed to be a proxy for reactive carbonate minerals. The assumption is supported by the observed dominance of calcite, the lack of reported iron carbonate and the strong correlation and equivalence of total carbon and total inorganic carbon (TIC) (Figure 3). The dominant plutonic geological setting supports the lack of non-carbonate carbon. As TC equals TIC, NP is represented by carbonate content as represented by TC (NP*).

Figure 3: Comparison of Total Carbon and Total Inorganic Carbon

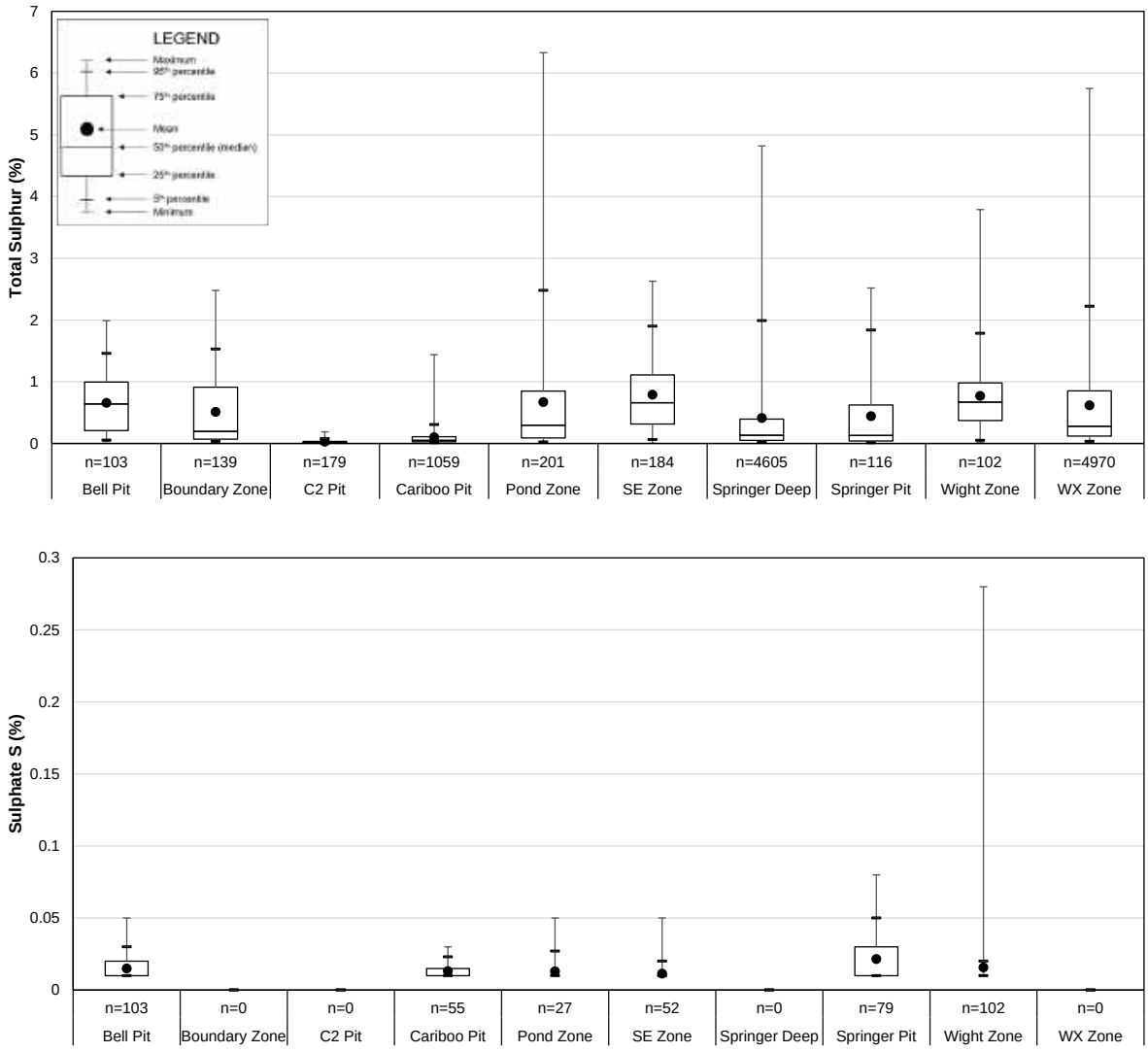


Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

3.1.2 ARD Potential

Figure 4 shows the distribution of total sulphur and sulphate by zone. Sulphate concentrations are uniformly low (averages near the detection limit of 0.01%) with no substantial differences between zones. Total sulphur, which therefore provides an approximation of sulphide content, shows some differences by zone as there is variability in higher end concentration values (95th percentiles range from 0.08% to 2.5%). The Southeast Zone and Wight Zone have the highest mean total sulphur concentrations at 0.79% and 0.77%, respectively, whereas C2 Pit and Cariboo Pit have the lowest at 0.029% and 0.098%. No sulphate data were available for the Boundary Zone, C2, Springer Deep, and WX Zone.

Figure 4: Total Sulphur (Top) and Sulphate (Bottom) Distributions by Zone



Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

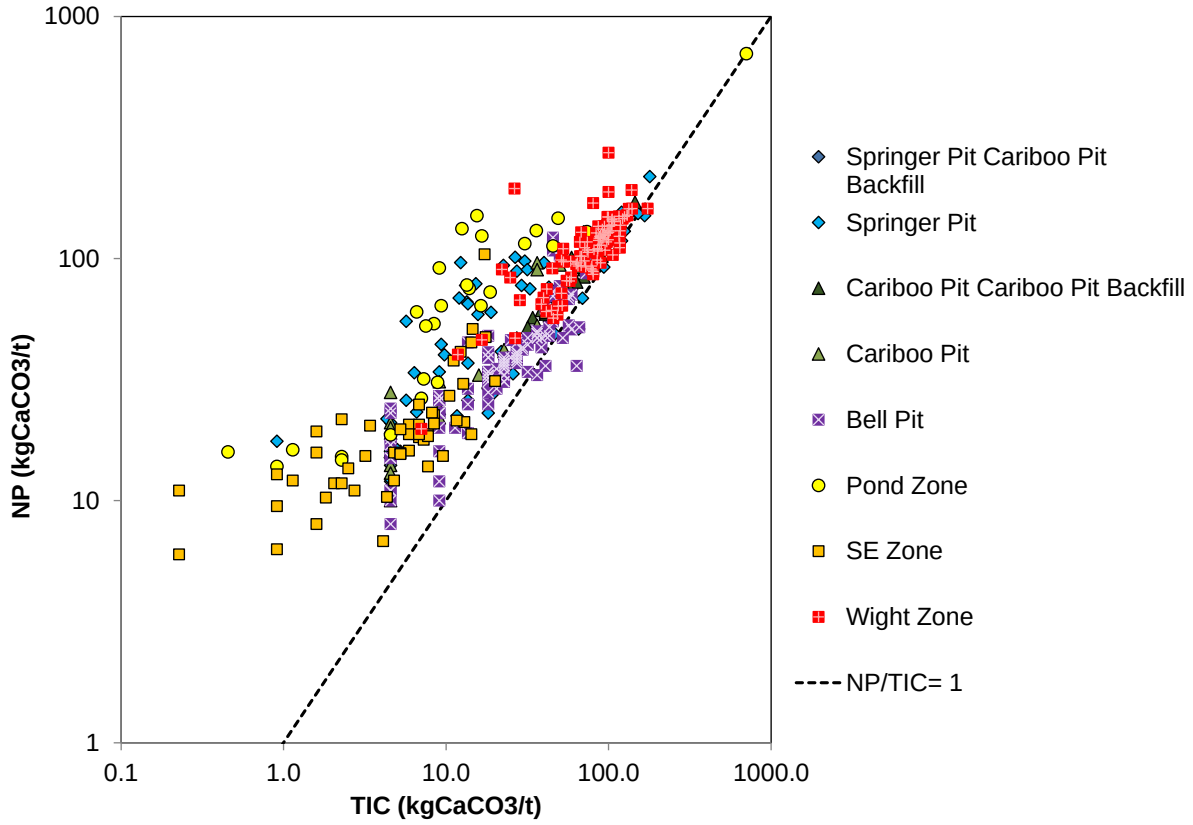
Comparison of carbonate content with NP shows that, except for few samples, Sobek NP exceeds TIC (Figure 5). This reflects the digestion of silicates during the NP determination. The difference between NP and TIC varies by zone. The skarn mineralization of the Pond Zone shows the greatest NP relative to TIC reflecting the presence of epidote that digests more readily in acid than feldspars which dominate in the other rock types. The Springer Pit (including Cariboo Pit backfill samples), the Southeast Zone and the Cariboo Pit show the next greatest difference followed by the Wight Zone, and the Bell Pit.

The difference between NP and TIC at MPM led to the adoption of total carbon as a proxy for TIC content rather than relying on NP (see Figure 6). Comparison of AP and TIC for drill core samples

shows that the Southeast Zone is dominantly PAG whereas the Wight Zone, the Cariboo Pit, and the C2 Pit are dominantly NAG (Figure 6). Other zones show characteristics overlapping the NAG and PAG, including the Springer Deep and WX zones, which were plotted individually due to a large number of data points for these localities (Figure 6).

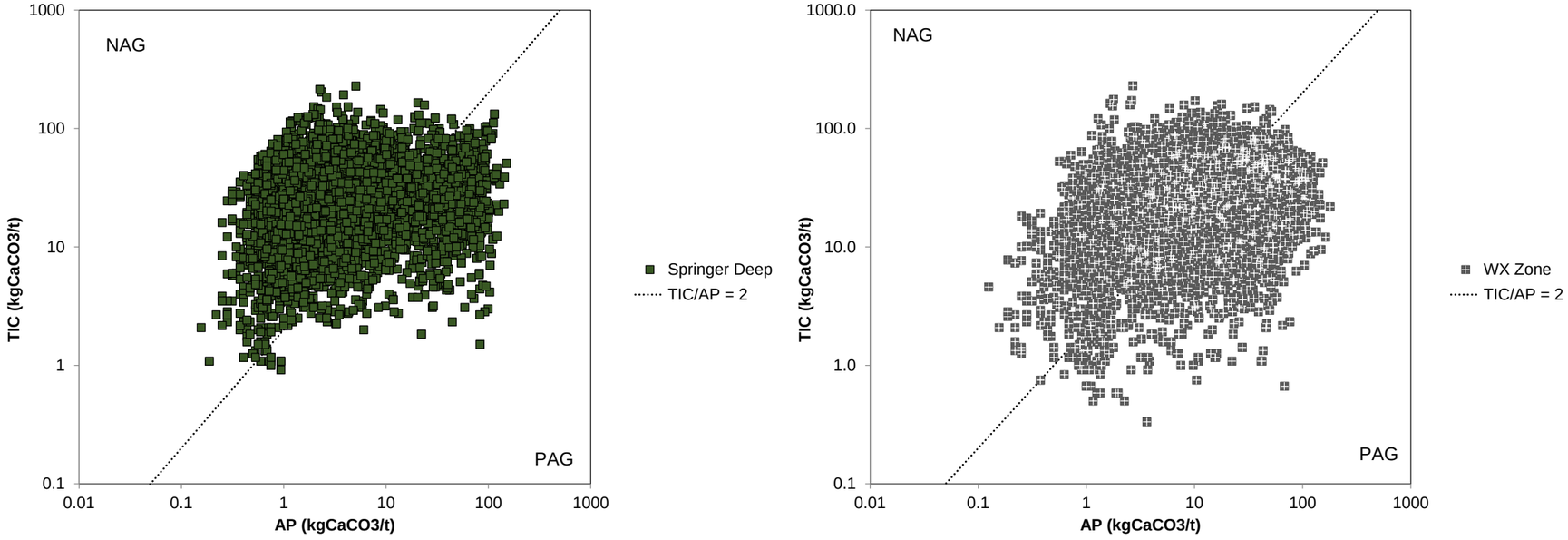
Figure 7 shows results of blast hole sampling for comparison. Bell Pit blast hole data are presented as part of the above descriptions because pre-mining ABA data were not available. The presence of PAG rock in all zones is apparent and resulted in segregation. This figure illustrates that for the most part, PAG rock has higher sulphide content than NAG rock because TIC-NP is relatively consistent regardless of sulphide content.

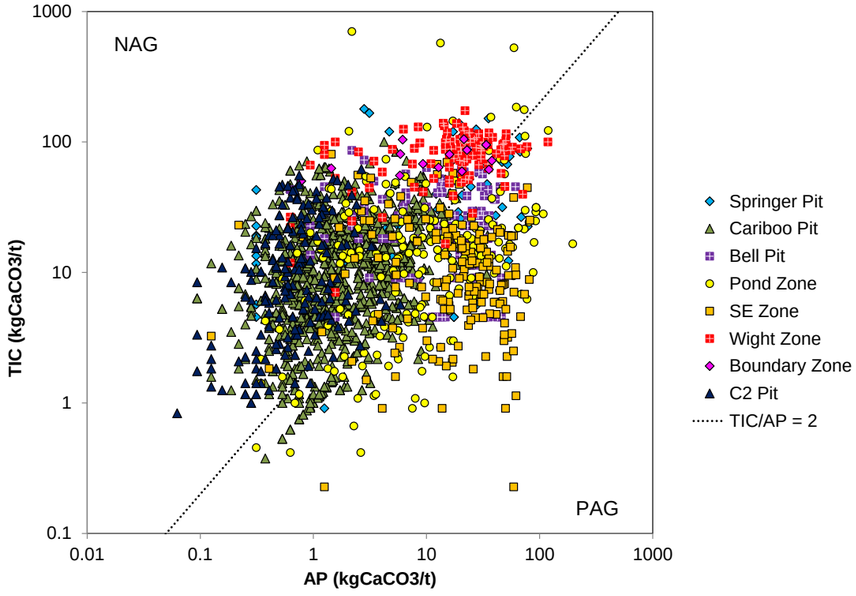
Figure 5: Sobek Neutralization Potential Versus Total Inorganic Carbon by Zone



Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

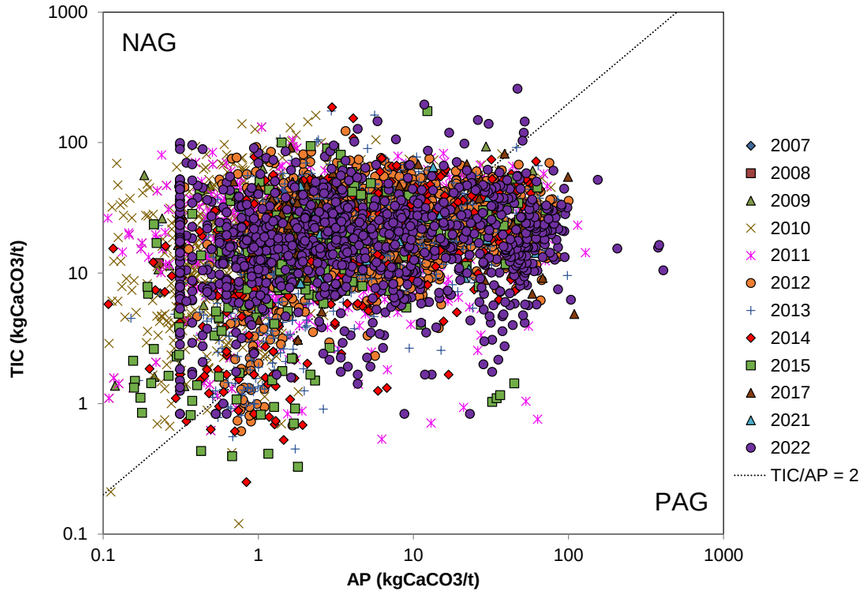
Figure 6: Total Inorganic Carbon versus Acid Potential of Drill Core Samples from Springer Deep (top left), WX Zone (top right), and All Other Zones (bottom)

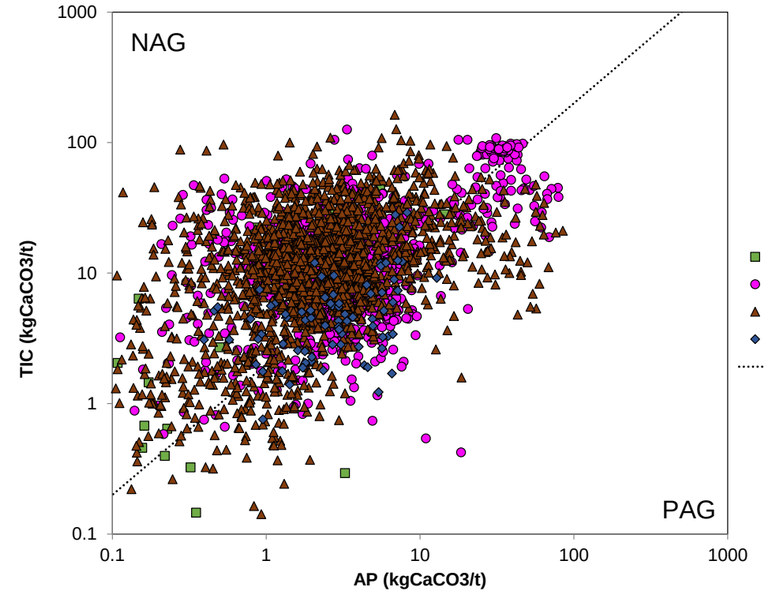


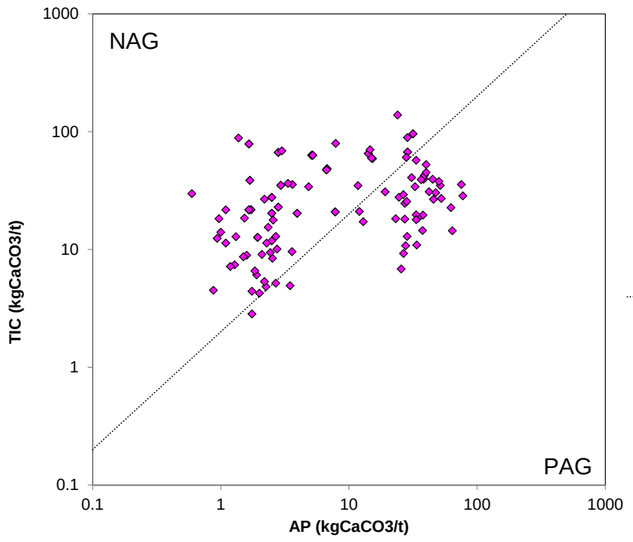


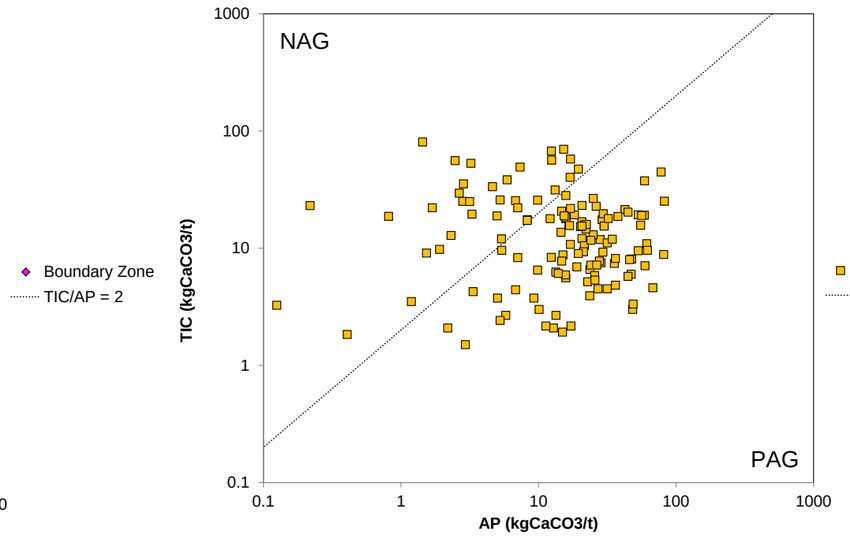
Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

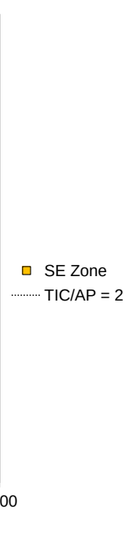
Figure 7: Total Inorganic Carbon versus Acid Potential of Blast Hole Samples from Springer Pit (top right), Cariboo Pit (top left), Boundary Zone (bottom left), Southeast Zone (bottom middle), and Pond Zone (bottom right)

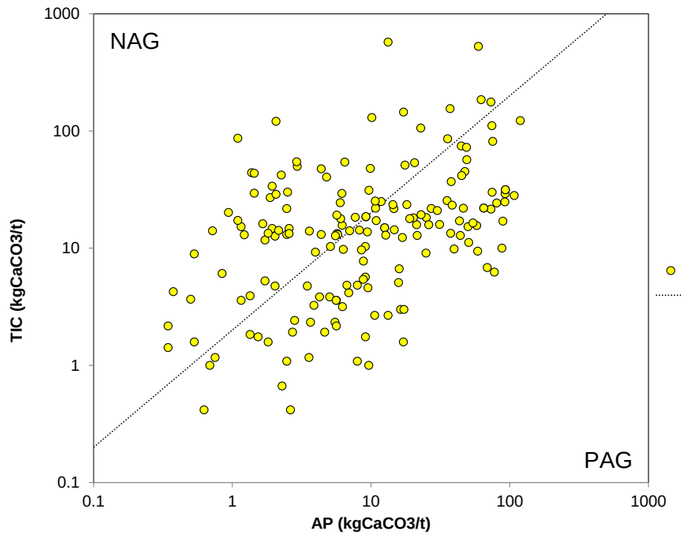


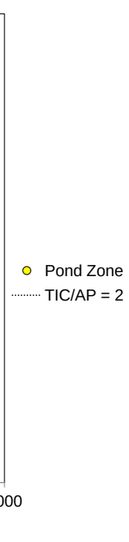












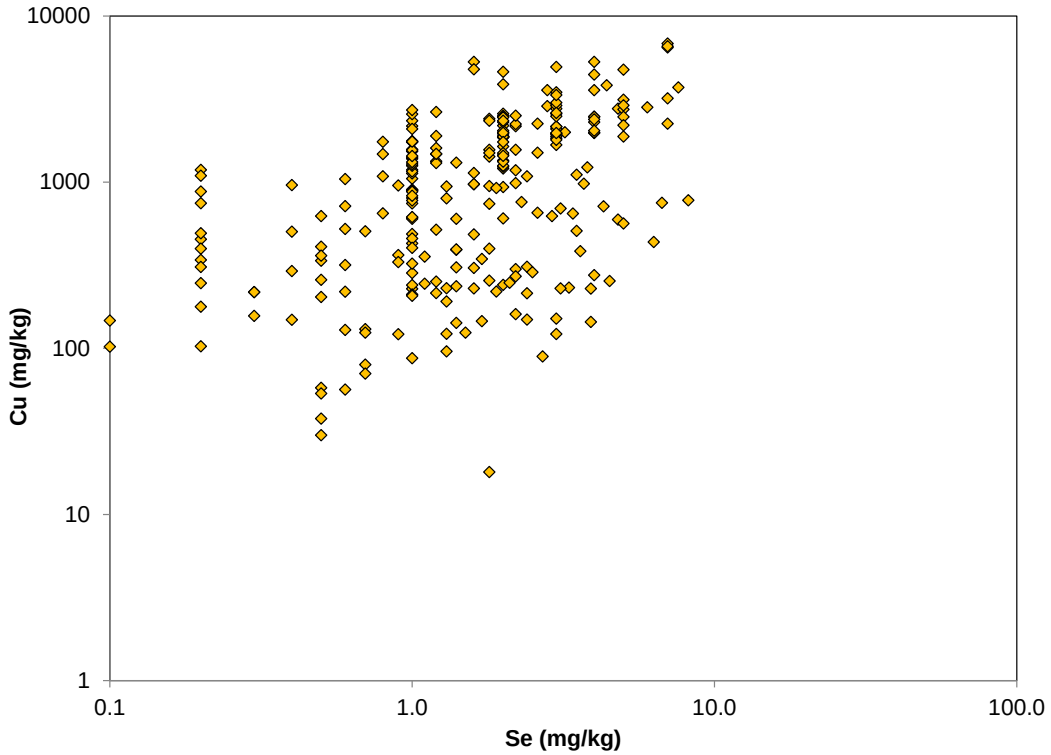
Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

3.1.3 Trace Element Content

When compared to the global average for igneous rocks (Price 1997), some of the rocks (greater than 75% of samples) at MPM have concentrations an order of magnitude higher for antimony, arsenic, copper, molybdenum, selenium, and silver. Median copper concentrations exceed this threshold in the Bell Pit, Cariboo Pit, Pond Zone, Springer Pit, and Wight Zone. Median selenium concentrations exceeded this threshold in the Bell Pit, Cariboo Pit, Pond Zone, and Southeast Zone. Trace element data were not collected for the Boundary Zone and C2 Pit, and copper and selenium concentrations were not available for Springer Deep or WX Zone. Copper concentrations correlate with selenium concentrations (Figure 8).

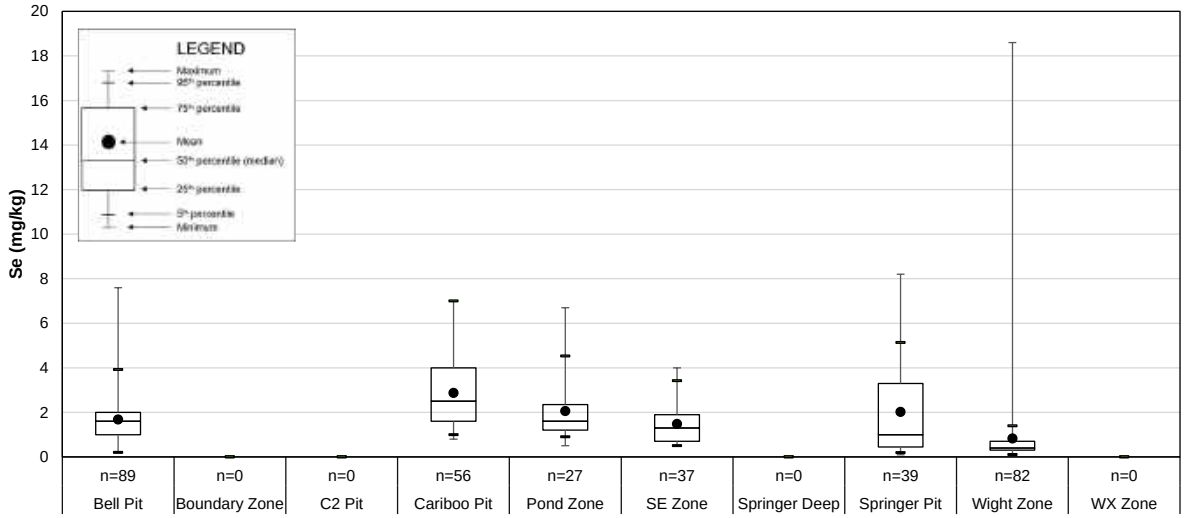
Within the site, selenium concentrations were elevated in the Cariboo Pit and Springer Pit rocks and lowest at the Wight Pit (Figure 9). Selenium-to-sulphur ratios were examined because selenium is typically released by oxidation of sulphide and the ratios can be indicative of differences in selenium release. The ratio is notably higher for the Cariboo Pit and Springer Pit, intermediate for the Bell Pit and Pond Zone and lowest for the Southeast Zone and Wight Zone (Figure 10). The distributions imply spatial zoning of selenium relative to sulphide. Selenium data were not collected for Boundary Zone, C2 Pit, Springer Deep, and WX Zone.

Figure 8: Copper Concentrations Versus Selenium Concentrations (All Zones)



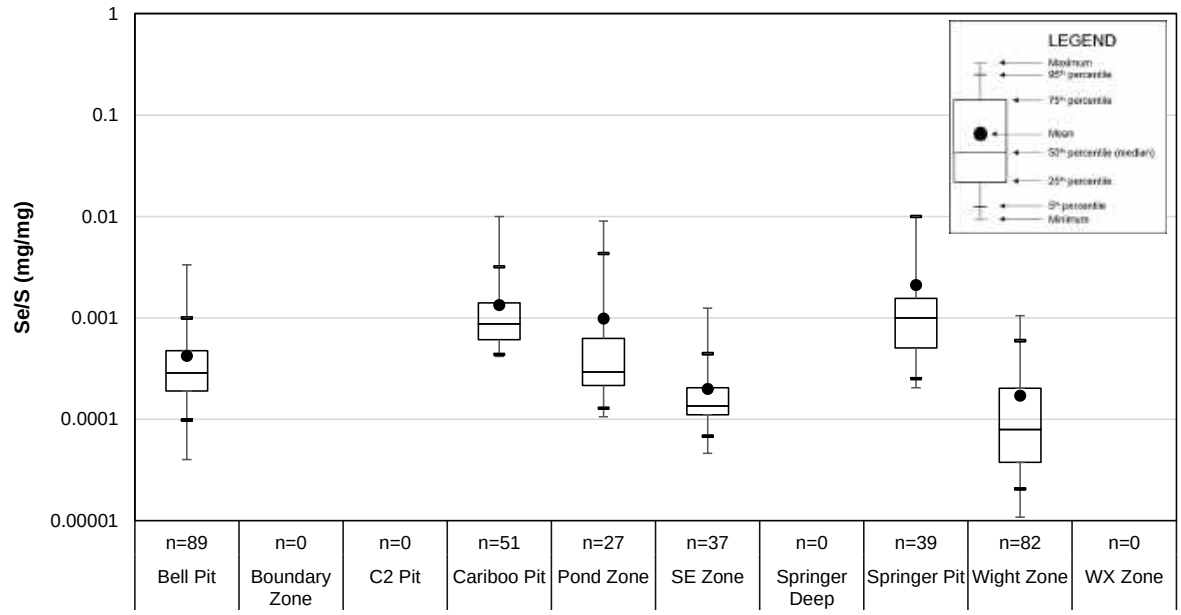
Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsx]

Figure 9: Box and Whisker Distribution for Selenium Content



Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

Figure 10: Box and Whisker Distribution for Selenium-to-Sulphur Ratios



Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm]

3.1.4 Extraction Tests

The Mines Act Permit M-200 amended on August 2, 2000 required that “oxidized” samples be tested for solubility using the Shake Flask Extraction (SFE) method of Price (2009). The definition of oxidized was not provided in the permit. Nine samples of the -2 mm fraction of blasted rock were submitted for the procedure in 2001. Eight samples of ore stockpile rock were also tested in 2015 as part of a Mines Act Permit M-200 requirement to evaluate closure requirements for the stockpiles (SRK 2015b).

Leachates from all extraction tests were non-acidic with leachate chemistry dominated by sulphate, alkalinity, and calcium. The 2015 tests were more useful than the 2001 tests for understanding trace element leachability due to the use of lower detection limits and testing of stockpiled waste rock. Average arsenic, copper, molybdenum and selenium concentrations were 4, 5, 29 and 15 µg/L, respectively. A number of trace elements were not detected or yielded concentrations close to detection limits including cadmium (0.05 µg/L), chromium (0.5 µg/L), cobalt (0.1 µg/L), lead (0.1 µg/L), mercury (0.05 µg/L), nickel (0.5 µg/L) and zinc (10 µg/L).

3.1.5 Kinetic Testing

Laboratory kinetic (humidity cell) tests were performed on nineteen samples in support of geochemical characterization for permitting of mining of the Wight Pit (Northeast Zone), Southeast Zone, Boundary Zone, Pond Zone, an earlier expansion of the Springer Pit, Springer Deep, and WX Zone (Table 4). Results have been reported annually as part of Mines Act Permit M-200 requirements. The samples were generally selected to evaluate oxidation rates for typical and elevated sulphide concentrations.

Samples from the Pond Zone were submitted for an acid-leaching procedure to remove carbonate and evaluate the reactivity of silicate minerals.

Table 4: Characteristics of Samples in Waste Rock Humidity Cells

HCT	Sample ID	Zone	Rock Type[1]	Date Started	Date Stopped	Paste pH	TIC	Total S	SO4-S	AP	NP	NP/AP	TIC/AP	Ag	As	Ca	Cd	Co	Cu	Hg	Mg	Mn	Mo	Ni	Pb	Sb	Se	V	Zn
							%C	%	%S	kg $CaCO_3$/t	kg $CaCO_3$/t			ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
HC2	31576	NE	PPp	7/21/2004	1/7/2013	8	0.79	1.4	<0.01	44	83	1.9	1.5	0.4	19	3.0	1.1	8.7	330	0.57	0.6	1400	13	1.2	38	0.3	0.7	85	170
HC3	32491	NE	Bx	7/21/2004	8/11/2008	8.3	1.1	0.45	<0.01	14	140	10	6.4	1.1	12	4.4	0.6	19	1700	0.39	1.3	1900	5.8	3.3	17	0.2	1	260	150
HC4	31943	NE	Bx	7/21/2004	8/11/2008	8.4	1.1	0.99	<0.01	31	130	4.1	2.9	1.2	10	4.2	0.9	20	1300	0.25	0.7	2000	7.6	4.2	21	0.3	1.4	210	170
HC5	32519	NE	PPp	7/21/2004	8/11/2008	8.6	0.62	0.54	<0.01	17	88	5.2	3.1	0.7	18	3.4	0.1	14	1700	0.19	1.2	1400	1.9	4.1	13	0.5	1.3	200	100
HC6	SE-05-17 Comp #1	SE	MZ	9/26/2005	1/7/2013	8.4	0.12	0.72	<0.01	23	21	0.91	0.43	0.3	17	0.87	<0.1	8.1	710	0.1	0.6	420	170	1.7	7.6	0.7	0.9	88	34
HC7	SE-05-30 Comp #1	SE	MZ	9/26/2005	1/7/2013	8.7	0.12	0.37	<0.01	12	40	3.5	0.85	<0.1	15	1.7	0.1	11	180	0.02	0.9	480	6.1	12	10	0.4	0.5	110	30
HC8	SE-07-66-72.5-75.13	SE	-	8/11/2008	1/7/2013	9.2	0.082	1	0.01	32	19	0.59	0.21	0.12	10	1.3	0.1	7.9	160	0.02	0.9	460	6	2.7	7.5	0.92	1.5	100	40
HC9	476111	Springer	-	8/11/2008	10/6/2009	7.9	0.011	0.04	0.01	0.94	18	19	0.97	0.34	11	1.7	0.42	21	710	0.08	1.3	1100	1.1	9.3	7.8	0.21	0.5	160	89
HC10	146677	Boundary	-	8/11/2008	10/6/2009	8.4	2	0.1	0.01	2.8	150	53	59	0.13	14	6.3	0.21	30	510	0.04	1.5	2800	1.4	12	7.8	0.64	0.7	160	110
HC11	146794	Boundary	-	8/11/2008	10/6/2009	8.4	1.4	0.15	0.01	4.4	160	35	27	0.17	17	4.7	0.37	23	250	0.12	1.2	2300	3	9.2	10	0.54	1.3	150	110
HC12	50033-1; Composite-4	Pond	MZ	4/20/2009	6/8/2009	6.6	<0.01	0.51	<0.01	16	8.4	0.53	<0.03	0.48	14	1.2	0.15	10	340	0.02	0.7	610	4.9	4.7	5.7	0.37	1.9	66	47
HC13	50033-1; Composite-5	Pond	DI	4/20/2009	Ongoing	7.7	<0.01	0.19	<0.01	5.9	7.9	1.3	<0.08	0.25	12	0.89	0.11	8.8	250	0.01	0.6	520	3.5	4.1	6	0.4	1.2	65	49
HC14	465240; SD-07-23	Springer	BX	10/12/2009	1/7/2013	8.1	0.48	0.39	-	12	96	7.9	3.3	0.62	34	2.6	0.98	14	720	0.4	1	1500	6	2.8	10	0.28	4.3	130	86
HC15	475695; SD-07-48	Springer	DI	10/12/2009	1/7/2013	8.1	0.27	2.5	-	79	94	1.2	0.29	0.88	18	2.3	0.09	20	780	0.02	1	500	18	5	11	0.07	8.2	150	41
HC16	480684; SD-07-57	Springer	MZ	10/12/2009	1/7/2013	8.9	0.14	0.06	-	1.9	69	37	6.4	0.52	13	2.2	0.43	14	360	0.14	0.7	730	3.5	2.4	10	0.16	0.5	130	92
HC17	HC-17 SD MZ	Springer Deep	MZ	8/5/2022	Ongoing	8.8	0.28	1.4	0.03	43	32	0.75	0.55	0.41	18	3.2	0.28	17	519	0.1	0.86	556	39	4.0	15	0.3	6.0	146	53
HC18	HC-18 SD FBXm	Springer Deep	FBXm	8/5/2022	Ongoing	8.8	0.17	2.0	0.02	61	36	0.59	0.23	0.61	20	1.5	0.19	28	1368	0.1	1.6	626	47	5.0	5.9	0.5	8.0	205	49
HC19	HC-19 WX MZ	WX	MZ	8/5/2022	Ongoing	8.6	0.14	2.0	0.03	63	23	0.36	0.19	0.36	11	2.3	0.3	12	577	0	0.82	430	36	1.0	14	0.1	5.0	152	53
HC20	HC-20 WX FBXm	WX	FBXm	8/5/2022	Ongoing	8.5	0.37	2.5	0.02	78	40	0.51	0.39	0.43	15	2.7	0.17	14	830	0.2	0.89	611	44	2.0	11	0.4	7.0	144	45

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Report_Tables_CAPR002434_Rev01_KWJ.xlsm

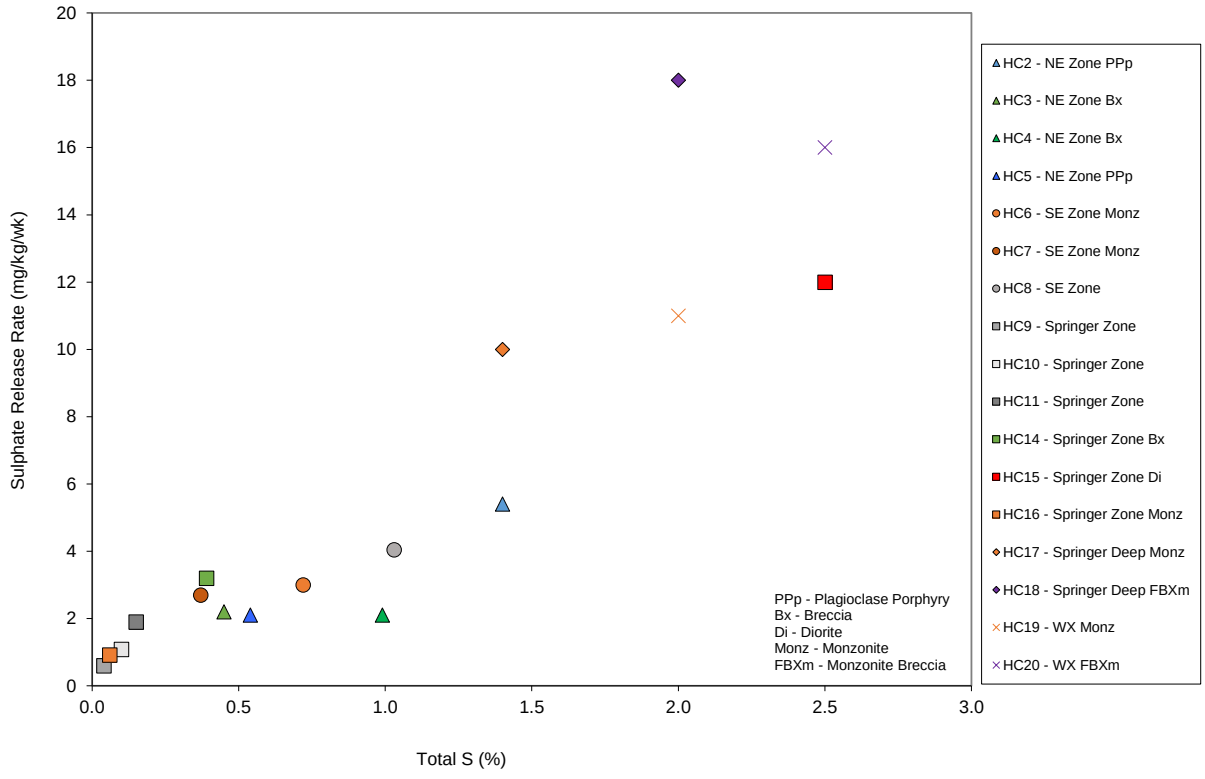
Notes:

[1] Rock types for some humidity cells were not recorded. PPp = Plagioclase porphyry, Bx = Breccia, DI = Diorite, Monz = Monzonite, FBXm = Monzonite breccia.

One Pond Zone test is continuing. Two Springer Deep tests and two WX Zone tests were initiated in August 2022 and are continuing. The other tests ran for 1 to 9 years. General findings were as follows:

- Except for the Pond Zone tests which were artificially depleted of carbonate to induce acidification, no other tests generated acid. Six samples were classified as PAG from ABA but carbonate content prevented acid generation for the duration of the test. Preliminary tests of Springer Deep and WX Zone rock classified as PAG have not generated acid as of 44 weeks.
- Sulphate release was strongly correlated with sulphur content regardless of zone (Figure 11).
- There was a lack of correlation between trace element content and trace element release rates, and sulphide content and trace element content.
- Comparison of relative utilization of carbonate minerals to oxidation rates indicated that an NP/AP ratio of 2 or lower is appropriate for classification of ARD potential.

Figure 11: Correlation of Sulphur Content with Oxidation Rate for Waste Rock Humidity Cells



Sources: https://srk.sharepoint.com/sites/NA1CM017.011/Internal/!020_Project_Data/030_Lab Data/Kinetic Data/Calculations/[Mt_Polley_HCT_WR_Outcomes_1CM017.011_rtc_rev00.xlsx]

Determination of Critical NP/AP

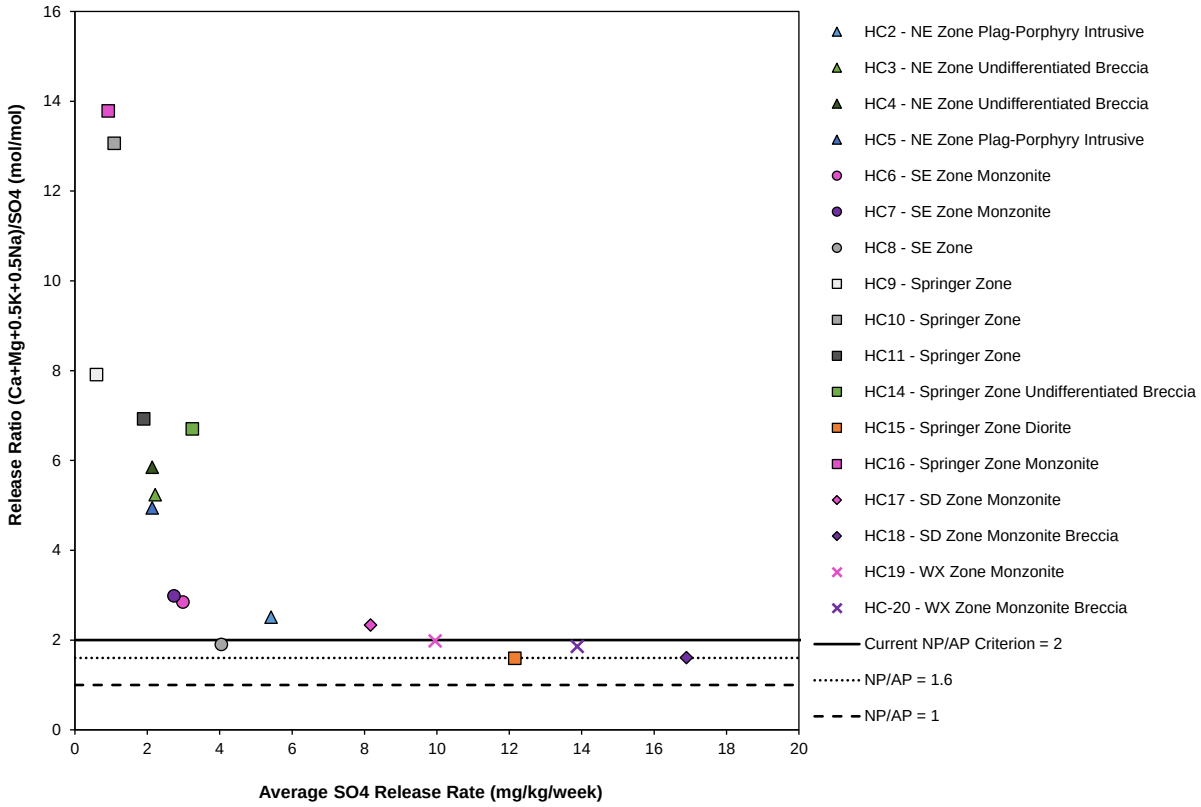
The current operational NP*/AP for classifying waste rock as NAG (or non-PAG) is specified in the Permit as 2. However, the critical NP/AP ratio (NP/AP_{crit}) can be developed using data from humidity cell tests. NP/AP_{crit} was derived from the comparison of cation release ratios and sulphate release rates (Figure 12).

Cation release ratios reflect carbonate dissolution, while sulphate release rates reflect sulphide oxidation. The trend of these data approaches a cation release ratio value between 1 and 2 and none of these cells have generated acid thus far. Relative rates expressed as the molar ratio of the stable release rates of the four cations to sulphate [$(Ca+Mg+0.5Na+0.5K)/SO_4$] mol/mol were used directly to estimate the NP/AP_{crit} for the waste rock. These ratios were compared to sulphate release rates from the HCTs to differentiate between dissolution of carbonates by sulphuric acid (from pyrite oxidation) and by carbonic acid (formed by carbon dioxide dissolved in the deionized water). The consideration of Na and K reflects the potential for Ca and Mg liberated by carbonate dissolution to exchange with Na and K in phyllosilicates. The release rate for Na and K are halved to account for their lower charge. Inclusion of Na and K also limits the possibility of under-stating carbonate mineral utilization thereby resulting in a lower NP/AP_{crit}.

At low oxidation rates (lower sulphate release), the dominant process in the test is assumed to be dissolution of carbonates by carbonic acid and the $(Ca+Mg+0.5Na+0.5K)/SO_4$ ratio is high. As the influence of sulphide oxidation increases (shown by increase in sulphate release), the $(Ca+Mg+0.5Na+0.5K)/SO_4$ ratio greater reflects the interaction of sulphuric acid with carbonates which is the expected dominant process at full scale in waste rock dumps.

A lack of testing on samples with high oxidation rates hampered previous estimations of NP/AP_{crit} (SRK 2016). The initiation of the four HCTs in 2022, which have run for 48 weeks thus far, all have higher oxidation rates than previous HCTs and were used to define $NP/AP_{crit.}$ SRK recommends defining NP/AP_{crit} of 1.6 based on the new HCTs.

Figure 12: Cation Release Ratio versus Oxidation Rate



Sources: https://srk.sharepoint.com/sites/NA1CM017.011/Internal/!020_Project_Data/030_Lab Data/Kinetic Data/Calculations/[Mt_Polley_HCT_WR_Outcomes_1CM017.011_rtc_rev00.xlsx]

Delay to Onset of Acid Generation

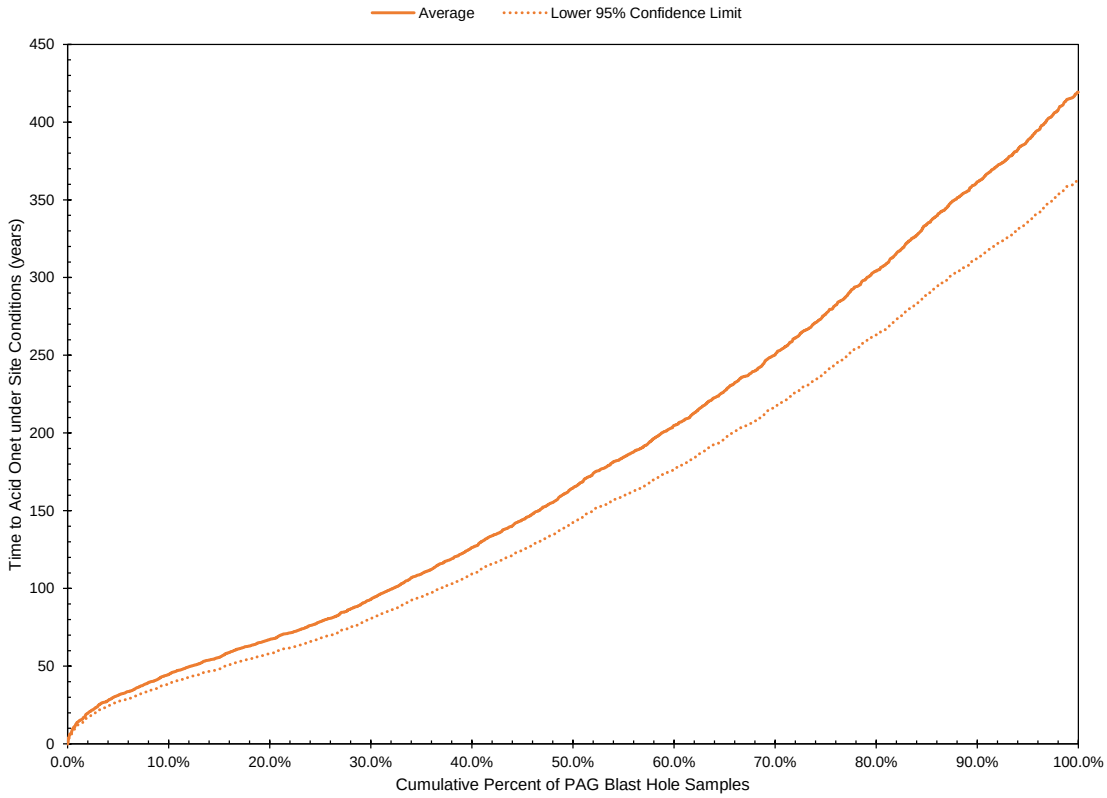
Following the same method used in SRK (2016) and SRK (2010), the straight-line average of the correlation between initial NP/AP (i.e., at time = 0, NP/AP_0) and calculated time for the onset of acidification (t_{onset}, in years) for all humidity cells from MPM was updated using NP/AP_{crit} of 1.6:

$$t_{onset} = 63 \times \left(\frac{NP}{AP}\right)_0$$

The equation indicates that a sample with NP/AP of 1 might be expected to generate acid in 63 years. The calculated lower 95% confidence on the 63 years coefficient was 55 years.

To estimate the exposure time PAG waste rock can be stored sub-aerially before the onset of acidification, t_{onset} (average and lower 95% confidence limit) was calculated for samples classified as PAG from the MPM blast hole database. A temperature correction of 0.3 to reflect slower reaction rates under cooler site conditions was included in the calculation.

Figure 13: Distribution of t_{onset} for PAG Waste Rock at Mount Polley Mine



Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/TimeOnset_CAPR002434_Rev00_SJL.xlsx

The distribution for faster-reacting components represented by the lower dashed line indicates that about 2% of the rock might become acidic in 20 years, and 10% after 40 years. The majority of the rock with higher NP/AP might take over 100 years to become acidic A number of factors complicate the actual estimate for higher NP/AP materials. Increasing acidification along with heating would result in accelerated oxidation and NP depletion though decreasing oxidation rates due to sulphide depletion and formation of secondary mineral coatings would result in lower oxidation rates and greater time to onset of acidic conditions.

The general finding from the kinetic testing is that acidification of PAG materials at MPM will take on the order of decades to centuries to develop. This is consistent with the widespread pH neutral weathering conditions at MPM in both natural and mined materials. Initial mining at Mount Polley was 25 years ago but waste rock has not acidified.

The Temporary NW PAG Stockpile contains less than 0.1% of rehandled PAG waste rock that was mined between 2001 – 2007 and initial construction of the NAG/PAG Pad began in 2011 (12 years ago). The Springer Pit Expansion Project proposes to rehandle PAG waste rock stored in the Temporary NW PAG Stockpile starting in 2032 and finishing by the end of 2034. Based on the assessment above, the risk of developing widespread acidic conditions within this timeframe is low (24 years after initial construction of the Temporary NW PAG Stockpile).

3.2 Tailings

3.2.1 Overview

A summary of available data is presented in Table 5. Monthly composite samples of tailings have been collected in the mill when processing since 1997. Tailings samples were also collected from the banks of Hazeltine Creek in 2014 after the TSF breach ("spilled tailings") along eighteen parallel transects oriented perpendicular to the course of Hazeltine Creek, as described in SRK (2015a). Two types of tailings-bearing samples were observed along Hazeltine Creek. They were classified in the field as 'grey tailings' and 'magnetite sands'. This classification was based on physical and mineralogical characteristics as follows:

- Grey tailings were dominantly grey in colour and had a finer texture (silty sand) than the magnetite sands. They had a strong reaction (referred to as "fizz") with 10% HCl and did not contain sulphide minerals that were visible by examination with a hand lens. Mineral identification was difficult due to small grain size, but the dominant minerals included potassium feldspar and plagioclase, with minor biotite mica and quartz.
- Magnetite sands were speckled pinkish-orange and black. They were strongly magnetic and coarser (sand) than the grey tailings. They had weak fizz and trace (less than 1%) sulphide minerals were infrequently noted. The dominant minerals identified included plagioclase feldspar and magnetite. Biotite mica and quartz appeared more abundant than in the grey tailings.

Similar to waste rock, total sulphur is assumed to be a proxy for sulphide sulphur because other forms of sulphur are not common in Mount Polley tailings (SRK 2015a).

Table 5: Static Test Inventory for Tailings

Tailings Type	Number of Samples
Monthly Composite – Final Tailings	166
Grey Tailings	40
Magnetite Sand	20
Grey Tailings/Magnetite Sand Mix	8

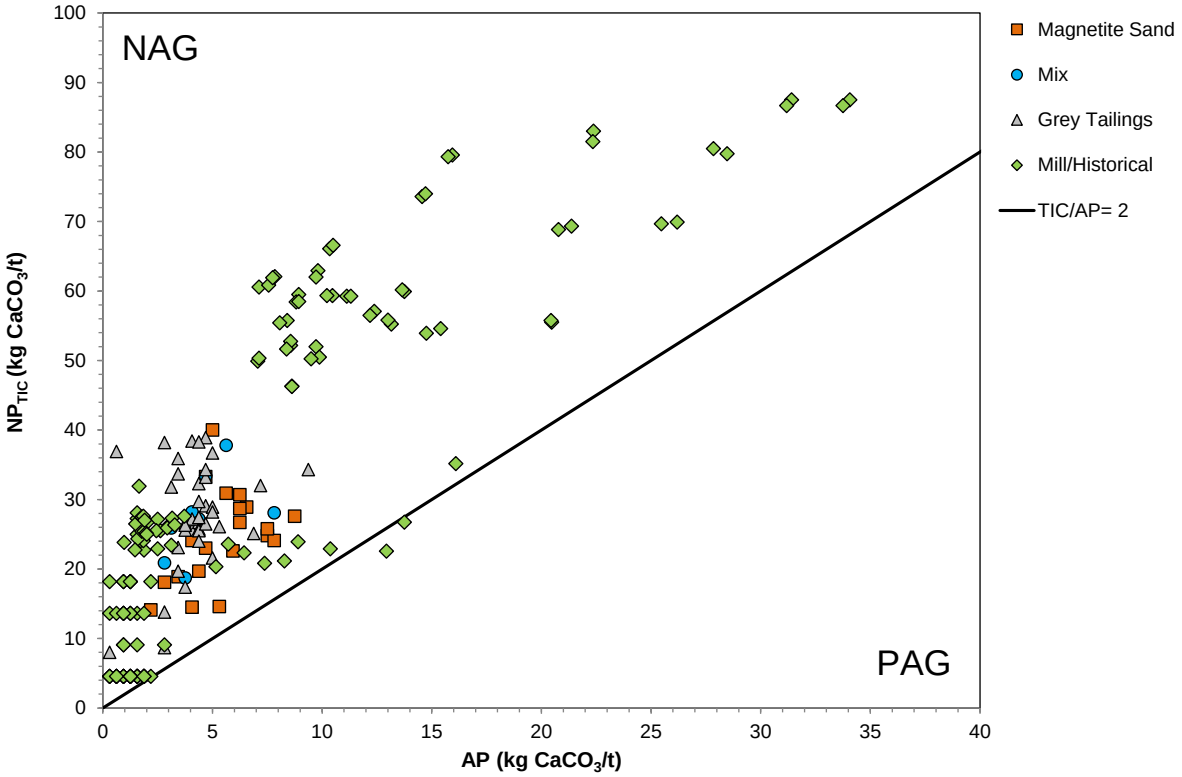
Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm

3.2.2 ARD Potential

ARD potential of tailings is assessed based on sulphide content (approximated from total sulphur) and NP derived from TIC. The resulting TIC/AP is used to classify Mount Polley tailings as PAG (TIC/AP ≤ 2) or NAG (TIC/AP< 2).

Sulphur concentrations in Mount Polley tailings are uniformly low, with total sulphur ranging from 0.01% to 1.1% (median concentration of 0.10%). The majority of tailings samples (99%) were found to be NAG based on their TIC/AP values (Figure 14).

Figure 14: Total Inorganic Carbon versus Acid Potential of Mount Polley Mine Tailings



Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Compiled_Geochem_Data_CAPR002434_Rev02_SJL_KWJ.xlsm

3.2.3 Trace Element Content

Median concentrations of copper and selenium were present in the tailings at an order of magnitude higher concentrations compared to average crustal concentrations for igneous rocks. Copper is partially deported as silicate minerals. Selenium is associated with the sulphide component of the tailings and is also correlated with copper content. Kinetic testing on tailings samples has to-date confirmed they are non-acid generating.

3.2.4 Kinetic Testing

Six samples of tailings collected from Hazeltine Creek following the dam failure were tested in humidity cells starting in 2015. Currently, two of these tests (HC-3 and HC-4) are continuing, while the rest were terminated after 64 weeks (Figure 15). HC-3 has relatively high sulphide content (0.33% pyrite) and elevated copper and selenium concentrations. HC-4 has lower copper and selenium concentrations, but copper is leaching at higher concentrations than in HC-3, which is thought to be attributed to higher dissolved organic carbon (DOC) leaching from HC-4 (2 mg/L) compared to HC-3 (1 mg/L) which may

form humic complexes with copper increasing it solubility. The tests are continuing with the purpose of evaluating the role of breakdown of organic matter on metal mobility (SRK 2023).

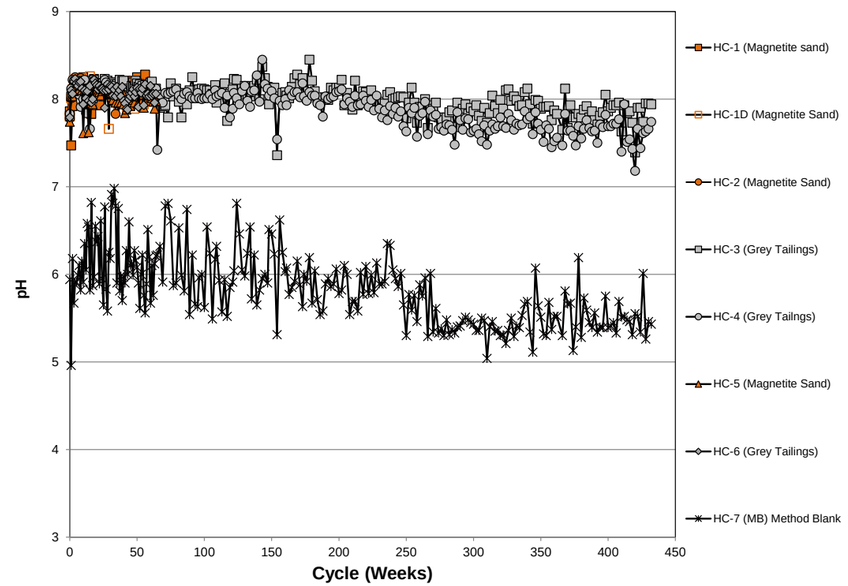
Three of the samples are also being tested in columns using a trickle leach applied at less than 0.1 L/kg/week (compared to flood leach of 0.5 L/kg/week for humidity cells). The samples were selected to represent visually distinctive tailings materials (magnetite sand and grey tailings). The samples are dominated by tailings solids but also contained native materials (mineral and organic soils, and glacial sediments entrained in the debris flow). The samples characterize weathering behaviour for a range of sulphur concentrations which align with typical characteristics of tailings in the impoundment. The columns have operated for over 400 weeks and SRK have requested them be terminated as copper release rates, which were initially unstable, have now stabilized at low levels (Figure 15).

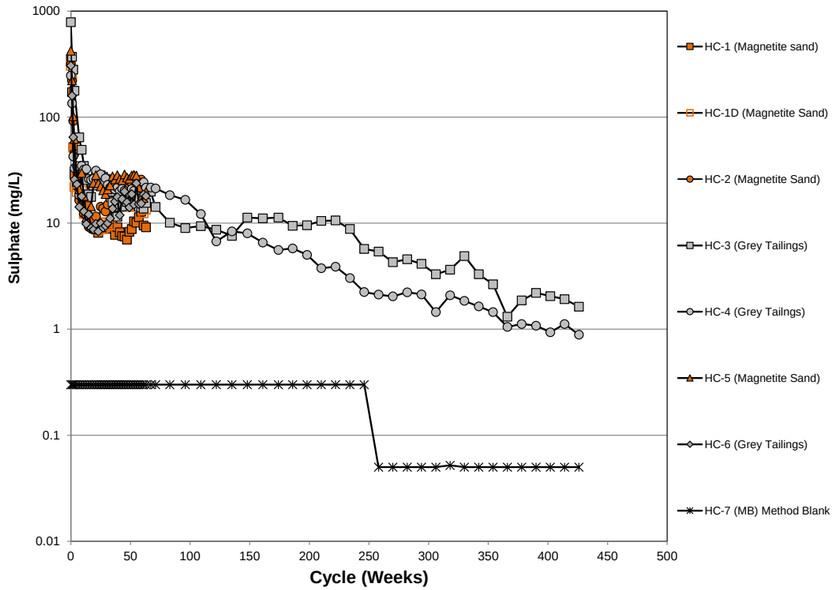
All tests have yielded leachate pHs typically between 7.7 and 8.3. Sulphate concentrations were initially near 1000 mg/L for humidity cells and above 1000 mg/L for columns. Both types of tests showed decreasing sulphate concentrations which have stabilized at lower concentrations. They have also showed decreasing metals concentrations, including those originally enriched (copper and selenium), which have stabilized at low concentrations. Maximum copper and selenium concentrations in both tests were as follows:

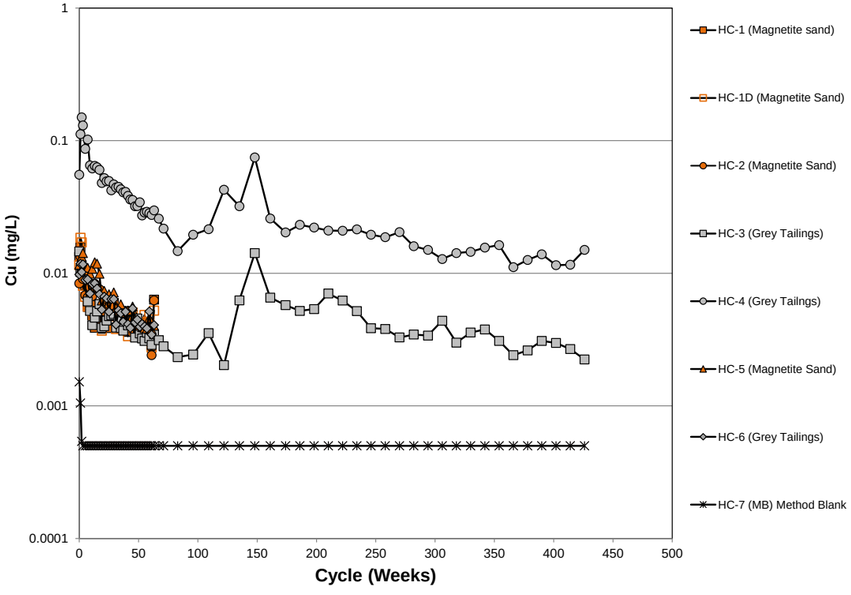
- The highest copper concentration in one HCT was 0.15 mg/L, but typical maximum copper concentrations were 0.02 mg/L in HCT leachates and 0.05 mg/L in column test leachates.
- The highest selenium concentrations were 0.01 mg/L in HCT leachates and 0.06 mg/L in column test leachates.

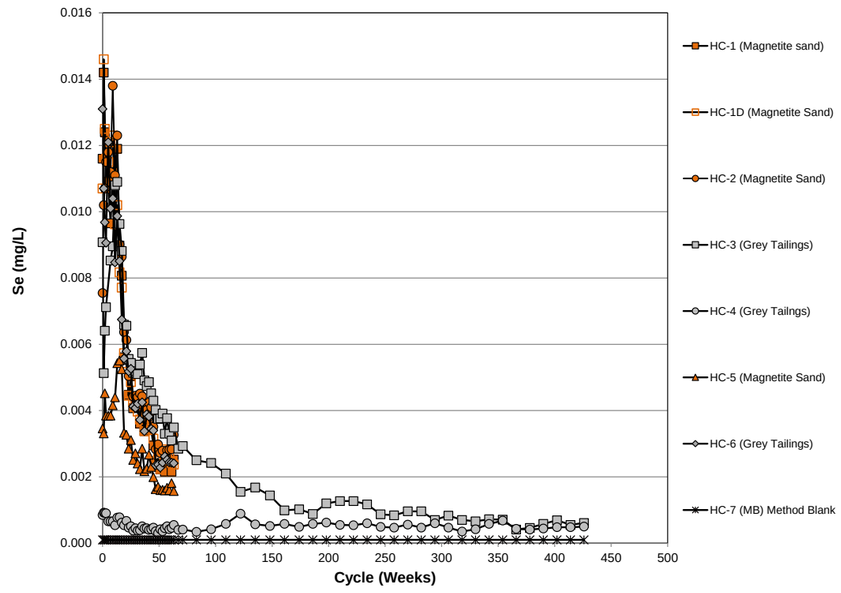
For other parameters, notable results were initial molybdenum concentrations between 2 and 3 mg/L in column leachates. These have since stabilized to concentrations between 0.01 and 0.02 mg/L.

Figure 15: Selected Leachate Chemistry for Tailings Humidity Cells



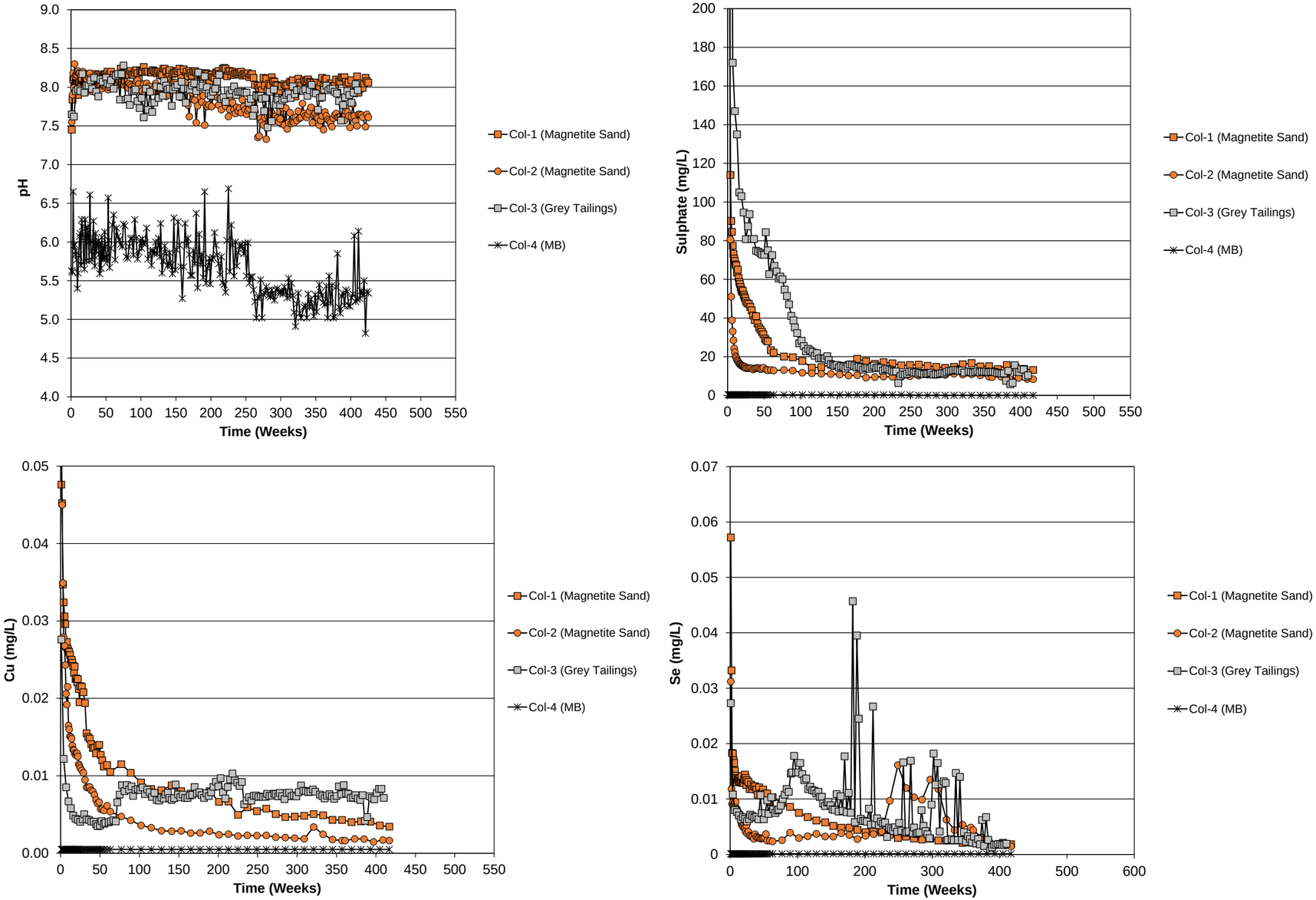






Sources: https://srk.sharepoint.com/sites/NA1CI008.003/Internal/410_Kinetic_Tests/Calculations+Charts/HCTs/Mt.%20Polley_HCT_Conc%20Charts%20_1CI008-003_rtc_rev02.xlsx

Figure 16: Selected Leachate Chemistry for Tailings Columns



Sources: https://srk.sharepoint.com/sites/NA1CI008.003/Internal/410_Kinetic_Tests/Calculations+Charts/COLs/Mt.%20Polley_Col_Conc%20Charts_1CI008-003_rtc_rev02.xlsx

3.3 Other Sources

Two other sources were identified as potentially requiring geochemical source terms.

Magnetite is recovered from MPM tailings to generate a concentrate for use as a dense medium in coal processing. The magnetite stockpiles are located adjacent to the ore processing plant. No geochemical data are available for the magnetite.

Sulphur was imported in 2004 as part of evaluations of recovery of copper present as oxide. Excess sulphur was stored in a nearby stockpile, first in the Cariboo Pit (2006-2009) and then moved to a crushed rock pad beside the heap leach pad (2009-2018) when mining resumed in the Cariboo Pit. SRK (2022) found the elemental sulphur was composed of about 90% sulphur, and assumed the material had no neutralization potential. Oxidation of the sulphur generated sulphuric acid, which markedly increased the solubility of metals in the surrounding materials that would not otherwise be leachable at neutral pH. In 2018, the excess sulphur was relocated on top of the lined leach pad after evidence showed that water quality on the mine may be affected by contaminated drainage from below the sulphur stockpile (Litke et al. 2019). The affected drainage is seepage from the NEZ Dump, located east of the Test Heap Leach Facility.

4 Conceptual Geochemical Models

4.1 Purpose

The purpose of conceptual geochemical models (CGMs) is to describe the anticipated geochemical performance of each source at MPM which is then implemented as a numerical model to generate source terms. CGMs consider the current understanding of geochemical characteristics (as described in Sections 3.1 and 3.2).

The following sources were evaluated and CGMs for each are described below:

- NAG waste rock and construction fills.
- NAG waste rock influenced by the sulphur stockpile.
- PAG waste rock.
- Ore stockpiles.
- Pit backfills.
- Pit walls.
- Ore processing.
- Tailings.

4.2 Ex-Pit NAG Waste Rock and Construction Fills

Processes in NAG waste rock under non-acidic conditions include:

- Oxidation of sulphides (pyrite, chalcopyrite, and bornite) to release iron, acidity, sulphate, and trace elements contained in the sulphides. Copper is expected to be primarily released by oxidation of chalcopyrite and bornite. Iron released by oxidation of sulphides replaces pyrite and other sulphides as solid iron (III) oxyhydroxides. Iron concentrations in the drainage are expected to be at or near detection limits.
- The oxidation reaction is exothermic (releases heat) and is expected to result in average internal temperatures that are higher than ambient average temperatures. During winter, internal temperatures will be higher than ambient temperatures.
- Due to the temperature difference in winter, air will move by advection through the waste rock by convection. Cold air will be drawn in through coarser materials at the base formed by end-dumping. The heated air will exit the dump at a higher elevation. This process is expected to result in deep penetration of oxygen and generally an over-supply of oxygen for oxidation of sulphides.
- Neutralization of acidity produced by the oxidation reaction will be by reaction with calcium carbonate minerals or mixing with alkaline waters resulting in neutral to basic pHs. The pH of contact waters will be determined by the partial pressure of carbon dioxide in pore gases (lower pH with higher CO_2).

- For non-PAG waste rock the neutral pH weathering environment will result in precipitation of metals as various secondary minerals, including gypsum ($CaSO_4 \cdot 2H_2O$), metal oxides (tenorite - CuO), metal carbonates (malachite – $Cu_2CO_3(OH)_2$), and metal silicates (e.g., chrysocolla). Adsorption to secondary oxides will also occur. The resulting concentrations of metals (principally copper) in contact waters will be controlled by the relatively low solubility of the secondary minerals and the tendency to be adsorbed at these pHs.
- Selenium and molybdenum originate from oxidation of pyrite, but form oxyanions that are mobile at the expected pH. The concentrations of these trace elements are expected to increase.
- There is a hydraulic lag between when waste is placed, and its signature appears at monitoring locations.

Due to the solubility control exerted by secondary minerals, contact water chemistry is expected to be constrained so that chemical loadings are directly proportional to infiltrating water volume. Sulphate is expected to increase as new waste is added but will be constrained by gypsum solubility.

4.3 NAG Waste Rock Influenced by the Sulphur Stockpile

Elevated sulphate and metal concentrations at NEZ Seep 1 and NEZ Seep 2 since 2014 are believed to be influenced by elemental sulphur stockpile oxidation and leaching. The stockpile was stored on the East RDS near the leach pad until its removal in 2018. For context, monitoring of the drainage from the leach pad containing ore, waste rock, and elemental sulphur showed average pH, sulphate, and copper of 3.3, 15 g/L, and 750 mg/L, respectively. There was a risk that depletion of acid neutralizing minerals from the waste rock could have triggered acidification of the waste rock on the infiltrating water flowpath but this does not seem to have occurred based on sampling of the foundation materials (Litke et al. 2019). It is expected that the seeps influenced by the sulphur stockpile will show a downward trend in parameters such as sulphate and copper now that the elemental sulphur was removed.

The seeps from the NEZ Dump that are influenced by the sulphur stockpile leachate (NEZ Seep 1 and NEZ Seep 2) are collected and managed separately from the other waste rock seepages.

4.4 Ex-Pit PAG Waste Rock

Segregated and exposed ex-pit PAG waste rock is present in the Temporary NW PAG Stockpile located adjacent to the Springer Pit. PAG rock at MPM is not defined by a particular rock type but is associated with pyrite halos formed by hydrothermal alteration. Sulphide content is higher than NAG waste rock.

Due to the higher sulphide content of PAG waste rock, the overall oxidation rate of PAG waste rock is expected to be greater than NAG waste rock. However, before acidification occurs, PAG and NAG weathering conditions are expected to be similar with secondary minerals exerting solubility controls. For example, the solubility of sulphate is expected to be controlled by gypsum which will be similar regardless of the sulphide oxidation rate.

Acidification is expected to take decades to progress with early contact waters remaining basic and having metal concentrations controlled by the solubility of secondary minerals. The timeframe for acidification effects is expected to be on the order of decades.

4.5 Ore Stockpiles

Ore stockpiles will perform the same as NAG and PAG waste rock depending on composition. The presence of more copper sulphides than waste rock will result in more leachable copper being generated but similar solubility controls are expected for the elements of interest.

4.6 Pit Backfill

Existing backfilled pits are the Bell Pit (completely full), the Southeast Zone Pit (completely full), the Pond Zone Pit (completely full), the Wight Pit (partially full), and Cariboo Pit (partially full). PAG rock from Temporary NW PAG Stockpile will be backfilled into the Springer-Cariboo Pit at completion of mining. Backfilling of currently filled pits occurred during operation so that run-of mine waste rock was directed immediately to a backfill location. The water level has risen in most of these pits resulting in complete submergence of PAG rock and partial submergence of NAG rock. PAG rock in the Cariboo Pit remains unsubmerged due to drawdown of the water table as operations continue in these pits.

4.7 Pit Walls

Exposed pit walls will remain in the Springer-Cariboo Pit, Wight Pit and Boundary Pit. All other pits have been backfilled resulting in pit wall reactive surfaces becoming part of the backfill.

Pit walls are composed of fractured walls and rubble resulting from over-blast and physical weathering. Localized wall failures will contribute additional talus. Reactive surface area for pit walls is contained primarily in the broken rock rather than fractured walls.

For source terms, pit walls are assumed to perform the same as waste rock dumps composed of PAG and NAG waste but flow paths are much shorter.

During flooding of pit walls, accumulated soluble weathering products will be flushed into pit walls. Following submergence, oxidation of walls will effectively be stopped due to reduction in availability of oxygen. Highwalls above final flood levels will continue to weather.

4.8 Ore Processing

Ore processing results in crushing and grinding of ore in contact water. Soluble components of the ore are dissolved and become part of the process water. Modification of process water chemistry may occur in the cleaner circuit where lime is added to increase pH. The change in pH may cause copper to precipitate.

The ore source term is expressed as mass leached per mass of ore. Except for the possible effects of pH adjustment described above, process water concentrations are expected to be too low to be controlled by secondary minerals.

The ore processing terms will depend on the degree of oxidation of the ore. Freshly blasted ore will contribute less load than ore re-handled from stockpiles, and deep fresh ore will contribute less load than near surface ore that has been naturally oxidized.

4.9 Tailings Solids

During operations, tailings are deposited by spigotting from the TSF embankments, resulting in tailings beaches and slimes migrating to the centre of TSF. Cycloned tailings were also used for dam construction.

Under normal operational conditions, slimes in the centre would be fully saturated and below the process pond. Due to the finger drains in the dam, the water table drops from surface at the edge of the pond in the centre of the facility to the finger drains. As a result, tailings near the embankments are partially saturated. Oxygen enters the unsaturated tailings in the beaches and embankments by diffusion resulting in near surface tailings oxidizing most rapidly and consuming oxygen. An oxygen concentration profile will be present in the tailings which decreases most rapidly near surface and eventually results in negligible oxygen concentrations at depth. For tailings containing sulphur concentrations near 0.1%, the expectation is that oxidation of tailings will occur to tens of metres in depth.

Due to the acid-consuming characteristics of the tailings, the weathering environment is pH-basic and overall processes are comparable to NAG waste rock (Section 4.2). Pore water chemistry during operations is dominated by process water with less effect from weathering processes because tailings are continually deposited, resulting in re-setting of the oxidation profile.

Process water contains low levels of dissolved organic carbon from flotation process reagents (e.g., methyl isobutyl carbinol). These compounds may act as a source of reduced carbon to facilitate reductive dissolution processes in the saturated components of the tailings such as dissolution of iron oxides and release of contained trace elements. SRK (2015a) assessed this susceptibility and concluded the tailings were stable under chemically-reducing conditions.

Following the tailings dam failure in August 2014, the water table dropped, allowing more of the tailings to become unsaturated than under operational conditions. Draindown of pore waters will have occurred allowing oxidation processes to influence pore water chemistry. Reactivation of the tailings pond resulted in the water table rising again into the tailings. As the water table rose, oxidation products formed following partial draindown were dissolved by process waters. Pore waters were therefore expected to reflect a mixture of process water effects and flushing of oxidation products in the years following the reactivation of the pond. However, with the return to operational conditions in 2022, process water will be dominate.

After operations cease, the process pond will decrease and the water table will again drop resulting in more tailings becoming unsaturated. Draindown of the tailings will result in a transition from process

water dominated chemistry to oxidation effects becoming dominant. Eventual pore water chemistry will be controlled by equilibration of water chemistry with tailings weathering products which will include oxides and sulphates.

4.10 Nitrogen Leaching

Nitrogen leaching is covered separately from the foregoing conceptual models because it originates from explosives residuals rather than mineral weathering. Since the rock does not generate leachable nitrogen, the leaching of residuals provides a flush of nitrogen which occurs with water contact. It is expected that the load of nitrogen flushed is greatest initially then decaying in proportion to the remaining soluble nitrogen. In terms of cumulative leaching, a newly constructed waste rock dump would be expected to show increasing loads for several years then stable loads as the volume of rock added each year becomes small relative to the total volume. “Tailing off” at closure will occur. Delays and lag effects may be expected due to hydrological factors.

For a mature site such as MPM, active and long closed waste rock dumps indicate nitrogen release under operational and closed conditions. Sump waters from open pits indicate leaching from pit walls.

Leaching of explosive residual from ore will occur due to flushing in the milling process. Tailings solids themselves will not leach nitrogen because flushing during processing is very efficient. Nitrogen leaching from the TSF will reflect the influence of process water.

5 Source Terms

5.1 General Approach

MPM operations started in 1997, resulting in generation of waste rock and tailings. These full-scale waste facilities provide a more appropriate basis for predicting current and future water chemistry than scaling laboratory tests to full-scale conditions, provided that near source monitoring locations are available and appropriate allowance for local dilution effects at monitoring locations are included. The general approach for MPM has been to use interpreted full scale monitoring data to develop source terms supplemented by laboratory data where needed. This approach removes most of the uncertainty related to predicting source term chemistry.

The approach for each term described below follow the same methods outlined in SRK (2016). The update incorporates recent monitoring and testing data.

5.2 Incorporating Uncertainty

The CGMs described in Section 4 indicate that geochemical processes reflected in source terms consist of weathering of primary minerals, which is determined by rates of mineral conversions, and dissolution processes which combine rates and solubility constraints. The latter consists of the rate at which minerals dissolve and the eventual concentrations achieved when equilibrium with the contact water is reached. For example, chalcopyrite oxidizes at some rate to produce copper sulphate. The copper sulphate then dissolves at a rate adding copper and sulphate to the water until copper and sulphate concentrations in the water are in equilibrium with the solid copper sulphate.

As described in Section 5.1, the general methodology used to develop the source terms relies mainly on-site monitoring data which reflects the end product of weathering and dissolution of weathering products. The assumption is that the monitoring data contain indications of the endpoint solubility of the weathering products with the proviso that dilution needs to be considered. Higher end concentrations in the dataset are used as the starting point to develop source terms because these are most likely to be closest to a solubility limit. To represent uncertainty in the underlying solubility limits, the statistics from water chemistry databases used are the 95th and 99th percentile concentrations. Maximum concentrations are not used to eliminate the bias caused by spurious concentrations resulting from sampling and analytical errors. The two high end percentiles are used because concentrations constrained by the solubility of minerals are not fixed but dependent on total solution chemistry including, particularly, pH.

Other approaches to incorporating uncertainty are described in the following sections.

5.3 NAG Waste Rock and Construction Fills

5.3.1 Method

The method for the NAG waste rock source terms is similar to the method in SRK (2016) and is as follows:

- Evaluate partitioning of reactive minerals during blasting.
- Evaluate potential for acidification due to included PAG rock.
- Evaluate seepage chemistry for geochemical controls.
- Prepare statistical summaries for seeps from major rock dumps.
- Scale-up maximum concentrations to account for dilution effects to yield source terms.

The basis for the latter step is that seepage chemistry may be diluted from true contact water and therefore needs to be scaled to remove dilution effects. Scaling was approached by assuming that gypsum is likely to exert a strong solubility control on major ion chemistry due to the interaction between oxidizing sulphides (yielding sulphate) and dissolving carbonates (yielding calcium). It also has well-defined behaviour in which chemistry matches thermodynamic models and is expected to be one of the most soluble secondary minerals in this setting. The high solubility indicates that it will likely be the last to reach equilibrium with contact water compared to other major primary minerals.

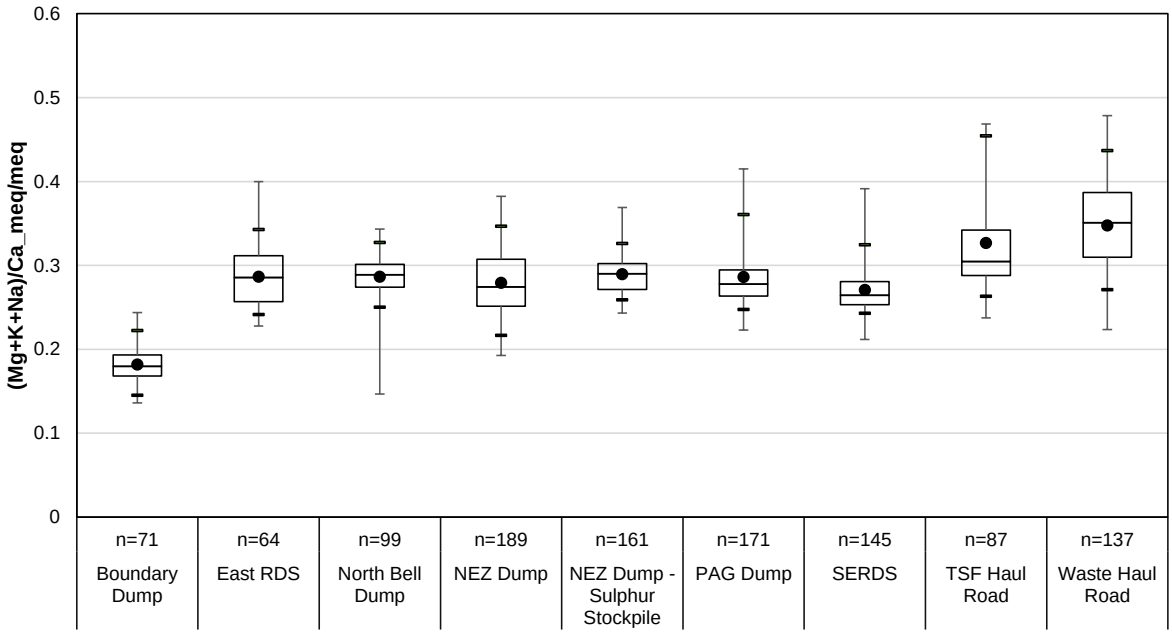
Scaling is therefore achieved using the following equation:

$$[M]_{corrected} = \left(\frac{[SO_4]_{theoretical}}{[SO_4]_{observed}}\right) \cdot [M]_{observed}$$

Where $[M]_{corrected}$ is the scaled element concentration, $[SO_{4,\ theoretical}]$ is the maximum sulphate concentration indicated by the solubility of gypsum, $[SO_{4,\ observed}]$ is the observed sulphate concentration, and $[M]_{observed}$ is the observed element concentration. The $[SO_{4,\ observed}]$ values are the 95th and 99th percentile seep concentrations selected to be at the upper end of the distribution so that the need for correction is minimized.

$[SO_{4,\ theoretical}]$ depends on bulk chemistry being lowest for waters containing only calcium as the balancing cation. As other major ions (K, Mg, and Na) increase in significance, $[SO_{4,\ theoretical}]$ increases. The ratio (Mg+K+Na)/Ca shows variation within MPM (Figure 17), with the lowest ratio for the Boundary Dump and highest for seeps from the two haul roads. For the purpose of determining a range of $[SO_{4,\ theoretical}]$, the 50th and 95th percentiles for each dump group were used. The 50th percentile indicates median predicted sulphate whereas the 95th percentile is a conservative limit. The actual range of the ratio is fairly narrow. For the Boundary Dump, the resulting range is 1510 mg/L to 1550 mg/L whereas for the Waste Haul Road, the range is 1670 mg/L to 1750 mg/L.

Figure 17: Box and Whisker Distributions for the Cation Ratio



Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/[Source_Terms_CAPR002434_Rev00_SJL.xlsx

5.3.2 Inputs

Mineral Partitioning During Blasting

Mineral partitioning during blasting was evaluated using blast hole cuttings because this can have an effect on the classification of waste for ARD potential (Day et al. 2015). If carbonate minerals preferentially partition into the blast fines, the use of a bulk NP/AP classification factor can lead to misclassification of rock that will probably not generate acid as PAG. The reverse can also occur if sulphide minerals preferentially classify into the fines.

In 2001, blast muck samples from the Bell and Cariboo Pits were collected and the +2 mm and -2 mm fractions were tested separately for acid-base accounts. SRK (2016) describes the interpretation for mineral partitioning for these samples. Both sulphur and carbonate preferentially partitioned into the -2 mm fraction but the effect was much stronger for carbonate. For the Cariboo Pit, there was no correlation between the fractions so the observed partitioning was qualitative only, but for the Bell Pit, a regression was derived. The finding from this assessment was that the classification of PAG using TIC/AP of 2 in blast hole cuttings has probably led to misclassification of some NAG rock as PAG. This finding was not used directly but primarily to confirm that under-classification of PAG rock (i.e., increased likelihood of PAG rock in NAG rock) is not a concern for MPM.

Potential for Acidification

The potential for acidification of NAG rock is described in SRK (2016) and considered:

- The likelihood that misclassified PAG waste rock occurs as large, segregated volumes (resulting in hotspots).
- The mass balance ABA resulting from misclassified PAG rock.

SRK (2016) concluded acidification of NAG waste rock at more than a very local scale is not expected because the percentage of PAG rock that could have been inadvertently included in the NAG waste risk is likely no more than a few percent. As there is a good understanding of the occurrence of PAG rock based on geological controls, it is expected that unaccounted for PAG rock is probably not more than a few percent. Therefore, NAG rock can be expected to remain permanently non-acidic and that long term changes in the NAG rock source term do not need to be considered.

Waste Rock Seepage Database

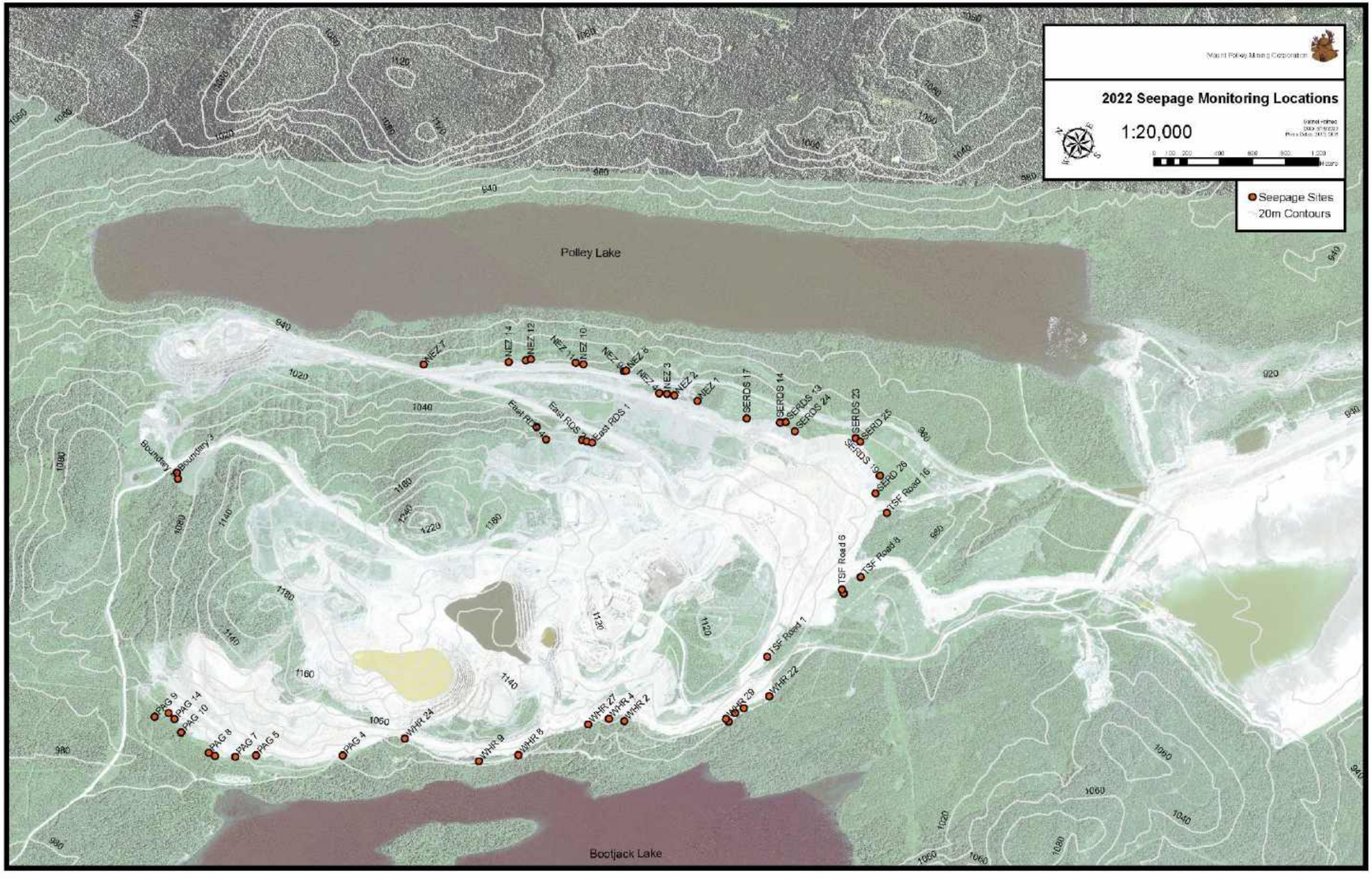
The seepage database was interpreted to understand what mineralogical controls may be constraining water chemistry, determine if seasonal variations are apparent, and derive statistics for the input into source term derivation.

As a general interpretation effort, relationships between rock composition and seepage chemistry were evaluated. However, except for the Wight Pit (Northeast Zone Dump) and Boundary Pit waste rock dumps, waste rock from all pits has been placed in several different locations limiting the opportunity to link rock composition to seepage chemistry.

Description of the Database

The current database as of the end of 2022 contains 1124 water analyses for seeps located as shown in Figure 18. Seeps have been sampled biannually since 2013. Filtering of samples has occurred in the field since 2014. Samples are analyzed for a full range of major and trace ions.

Figure 18: Seep Sampling Locations



Sources: MPMC

General Description of Water Chemistry

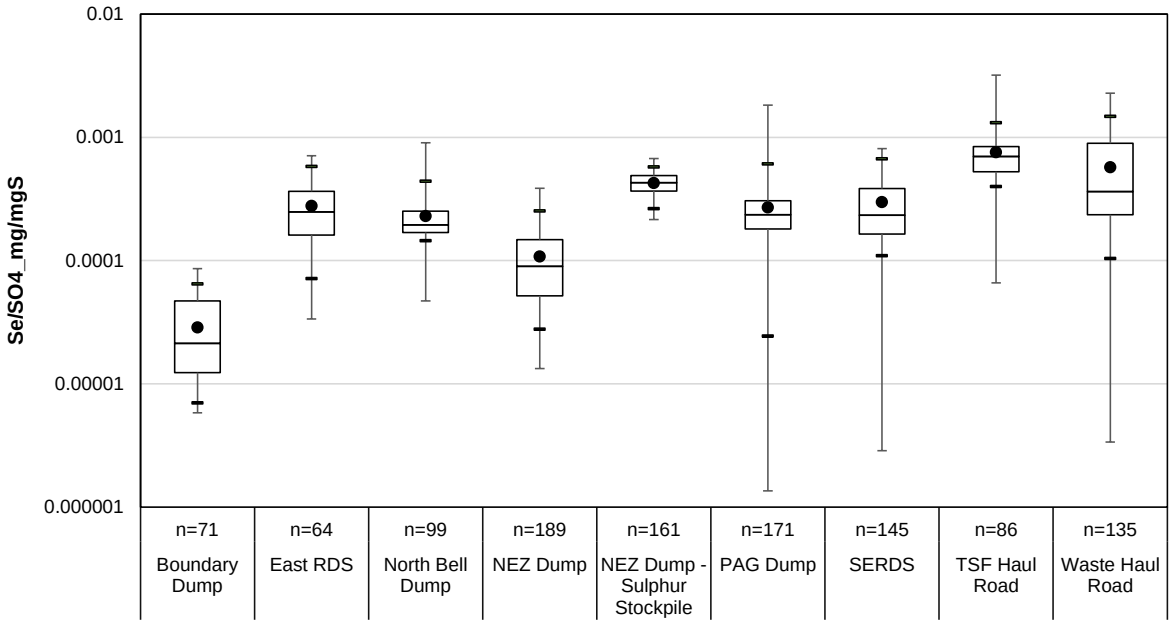
Water chemistry statistics are grouped according to the areas indicated in Table 6.

All seeps are non-acidic with medians above 7 and more typically nearer 8. The major anion is sulphate followed by bicarbonate (indicated by alkalinity) which is balanced mainly by calcium and magnesium. As discussed with reference to Figure 17, some differences in major ion chemistry were reflected in the cation ratio but differences in seepage chemistry were generally absent, except for NEZ Dump seeps influenced by the sulphur stockpile, reflecting consistencies with the geological setting and placement of waste rock from the pits at multiple locations for all other waste rock dumps.

Selenium to sulphate ratios were examined for comparison with ratios in the rocks. Rock chemistry showed some distinctive variations in the ratio with typical ratios between 0.0001 and 0.001 mg Se/mg S. Likewise, the ratio was in the same range for seeps (Figure 19). Wight Pit extended to lower ratios in both rock and seeps. SRK concluded that selenium leaching is due to oxidation of sulphides and that leaching effects are similar throughout the site.

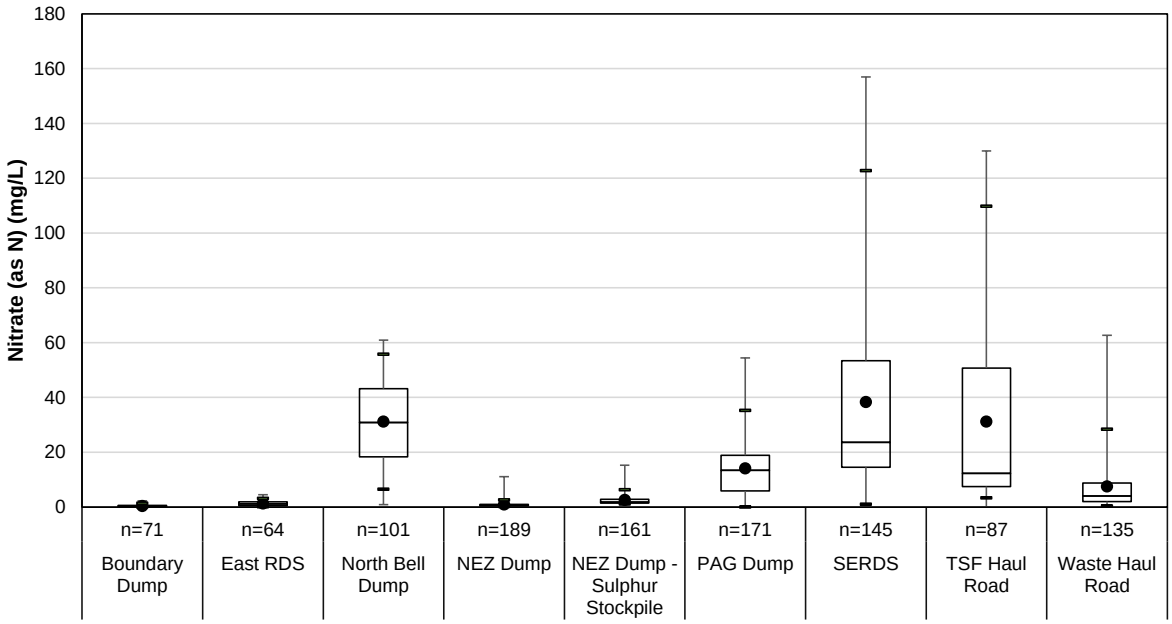
Nitrate concentrations varied considerably by source area (Figure 20). Distinctively higher concentrations were found for the Southeast Dump, the Temporary NW PAG Stockpile, TSF Haul Road, and the North Bell Dump. The differences are linked to placement activity with lowest concentrations for dumps less recently active. Notably, nitrate concentrations in the North Bell Dump have decreased in recent years (Figure 20).

Figure 19: Se/SO_4 Ratios in Waste Rock Seepage



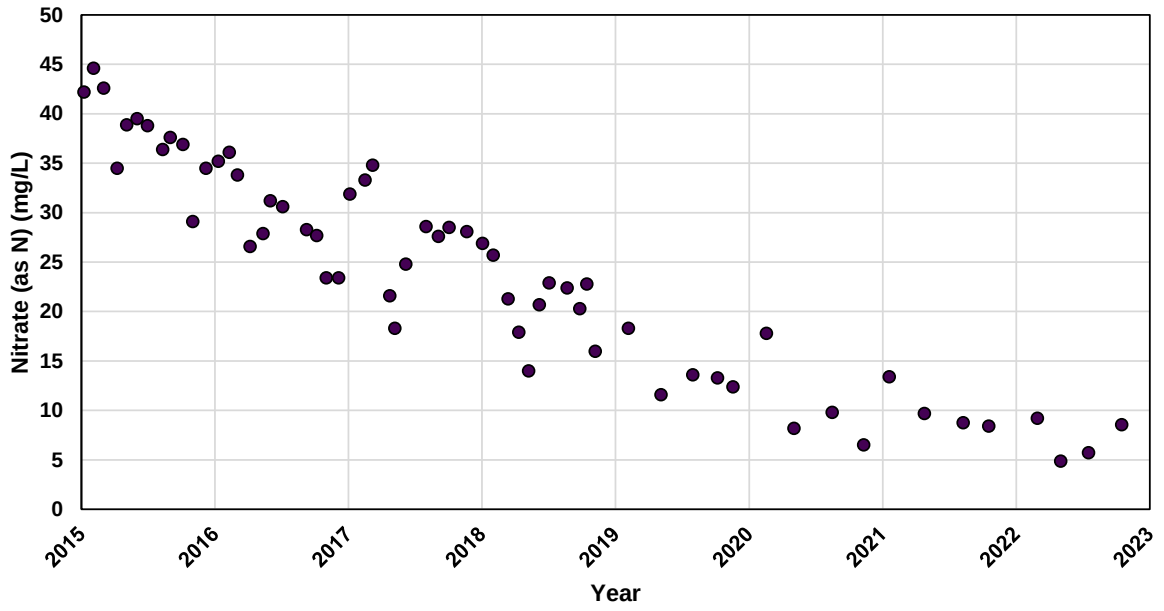
Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

Figure 20: Nitrate Concentrations in Waste Rock Seepage



Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

Figure 21: Timeseries of Nitrate Concentrations from the North Bell Dump



Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Annual_Reporting/Contact_Water/2022_ContactWQ_CAPR002434_rev0_SJL.xlsb

Table 6: Waste Rock Seepage Statistics

Statistic	Zone	n	pH[1]	Alkalinity[1]	Cl	F	NO_3	NO_2	SO_4	Al-D	As-D	Cd-D	Ca-D	Co-D	Cu-D	Fe-D	Mg-D	Mn-D	Mo-D	Ni-D	Se-D	Zn-D
				mg/L	mg/L	mg/L	mg-N/L	mg-N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
P95	Boundary	92	7.0	110	5.0	0.29	1.5	0.012	640	0.0077	0.0018	0.000071	260	0.00077	0.0087	0.26	40	0.41	0.053	0.0005	0.010	0.0035
	Wight	215	6.9	63	10	0.40	2.7	0.02	1200	0.014	0.00061	0.00020	370	0.00051	0.021	0.09	88	0.44	0.18	0.0015	0.050	0.0081
	NEZ Dump - Sulphur Stockpile	176	6.7	25	10	0.80	6.4	0.02	1200	0.069	0.00031	0.0011	380	0.014	1.8	0.06	78	1.1	0.25	0.017	0.21	0.11
	All Non-PAG	886	7.0	43	10	0.59	89	0.086	1300	0.018	0.0028	0.00067	490	0.0014	0.022	0.06	94	0.85	0.37	0.0012	0.32	0.068
	All PAG - Pre-Acid	202	7.0	81	10	0.40	35	0.93	1300	0.017	0.0018	0.00033	450	0.0059	0.012	0.37	71	3.3	0.58	0.0011	0.15	0.0063
P99	Boundary	92	7.0	78	6.2	0.38	2.2	0.022	730	0.02	0.0023	0.000082	260	0.0013	0.0095	0.33	43	0.51	0.074	0.00055	0.013	0.0045
	Wight	215	6.8	58	10	0.42	5.7	0.02	1300	0.02	0.00079	0.00036	400	0.0010	0.039	0.87	92	2.3	0.25	0.0022	0.062	0.019
	NEZ Dump - Sulphur Stockpile	176	6.1	9.7	17	1.4	10	0.02	1300	0.75	0.00061	0.0020	410	0.031	16	0.076	79	1.8	0.31	0.031	0.24	0.23
	All Non-PAG	886	6.7	33	17	0.69	130	0.82	1500	0.032	0.0034	0.0015	590	0.0073	0.043	0.49	110	3.2	0.55	0.0027	0.52	0.18
	All PAG - Pre-Acid	202	6.7	52	15	0.40	51	3.6	1300	0.16	0.0025	0.00052	470	0.018	0.024	1.8	76	8.1	0.66	0.0018	0.24	0.023

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

Notes:

[1] Statistics reported for pH and alkalinity are 5th percentile (for P95) and 1st percentile (for P99).

Interpretation of Water Chemistry

Water chemistry was interpreted by using PHREEQC and the minteq.v4 database to calculate mineral saturation indices thereby providing an indication of possible constraining minerals.

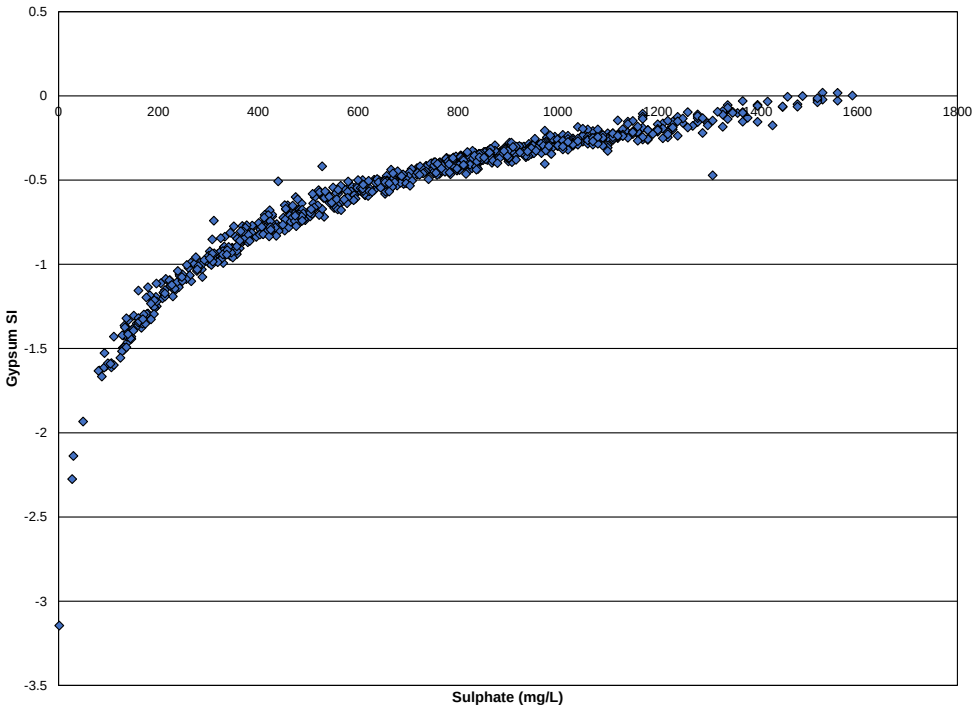
Saturation indices for sulphate were consistent with gypsum as a strong solubility control (Figure 22). At higher sulphate concentrations, gypsum saturation indices approached 0. Most seeps had sulphate concentrations well below those required to be at gypsum saturation indicating possible dilution effects, lack of gypsum, or incomplete equilibration. Regardless, the general observation is gypsum likely controls major ion (calcium and sulphate) chemistry with pH control by carbonate. Saturation indices greater than 0 for calcite were consistent with its dissolution and partial pressures for CO_2 were above -3.4 (Figure 23).

Saturation indices for malachite were well above 0 showing that copper concentrations were higher than would be predicted if malachite is controlling copper (Figure 24). Tenorite saturations indices were between 0 and 1 at higher copper concentrations indicating that it is more likely that a copper oxide is controlling copper concentrations. The finding that malachite does not appear to be controlling copper concentration is not consistent with the observed presence of malachite which formed by natural oxidation of the orebody. The likely controls on copper concentrations are secondary minerals resulting from oxidation of the waste rock following mining.

Other indications that higher end concentrations indicate mineral saturation included molybdenum which may be controlled by calcium molybdate (Figure 25). Trace elements occurring at concentrations well below saturation in indices of 0 for their discrete minerals are probably adsorbed or co-precipitated with major secondary minerals (for example, iron oxyhydroxides).

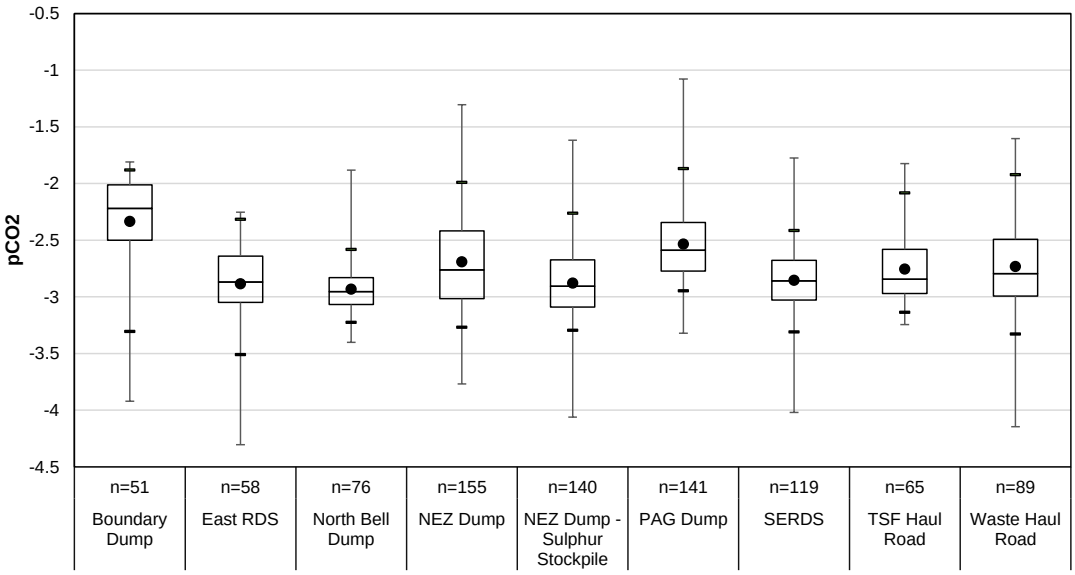
Like the majority of trace elements, saturation indices for selenium minerals were well below 0, reflecting that discrete selenium minerals are not likely to be forming. Relationships between selenium concentrations and saturation indices for major ions that do appear to be controlling solution chemistry were examined (Figure 26). The relationship with tenorite saturation indices showed that selenium concentrations appear to be constrained as copper concentrations were constrained. This may indicate that selenium is co-precipitating or adsorbing with an oxide or that the conditions resulting in copper oxide precipitation also result in selenium removal from solution. These interpretations do not provide a conclusive mechanism for constraining selenium concentrations but suggest that higher selenium concentrations in the dataset may be constrained. On this basis, seepage concentrations were used as the basis to calculate source terms.

Figure 22: Gypsum Saturation Indices Compared to Sulphate Concentrations



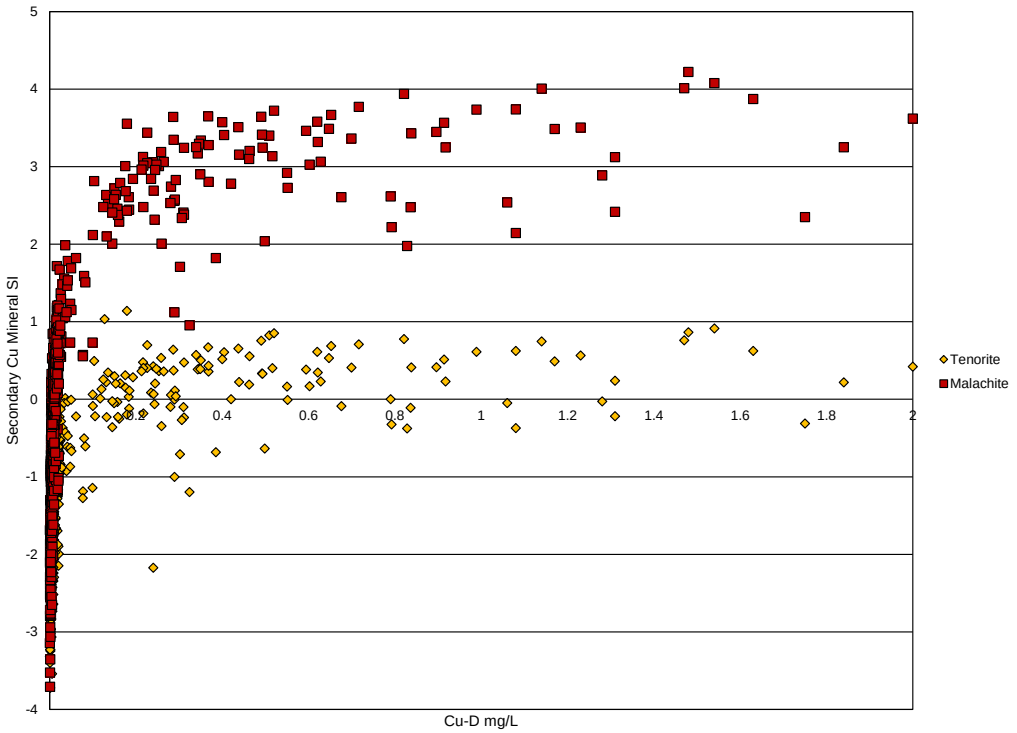
Source: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

Figure 23: Partial Pressure of CO_2 in Waste Rock Seepages



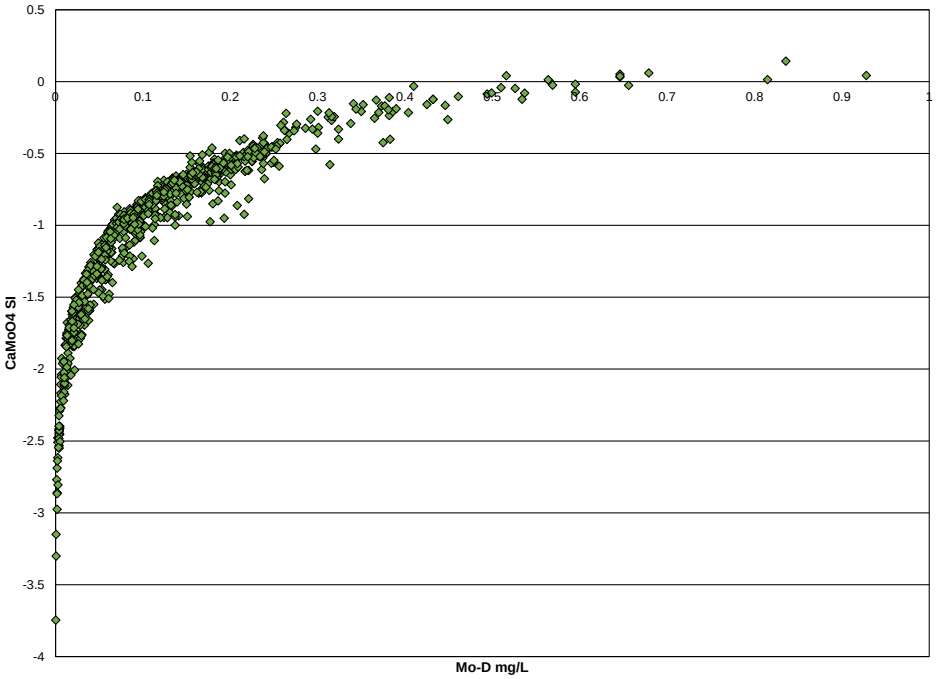
Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

Figure 24: Copper Mineral Saturation Indices Compared to Copper Concentrations



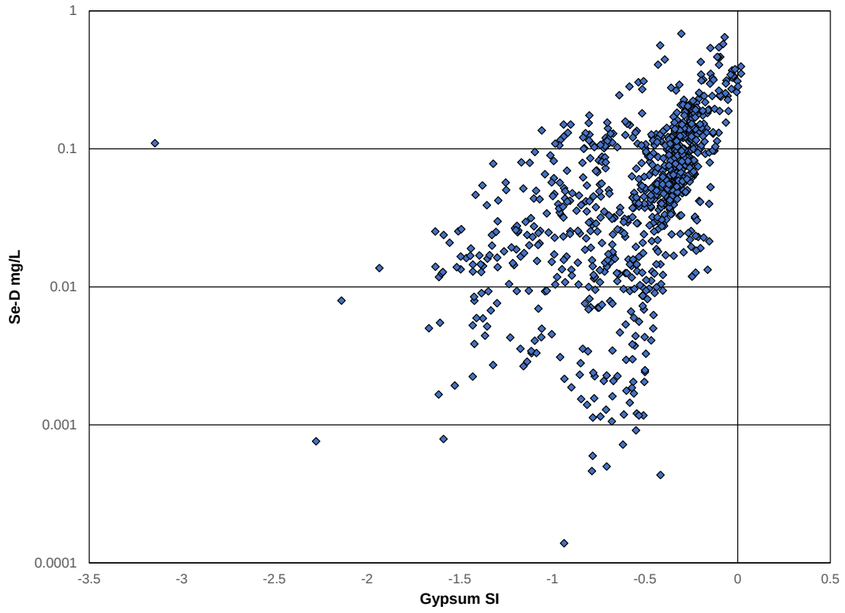
Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

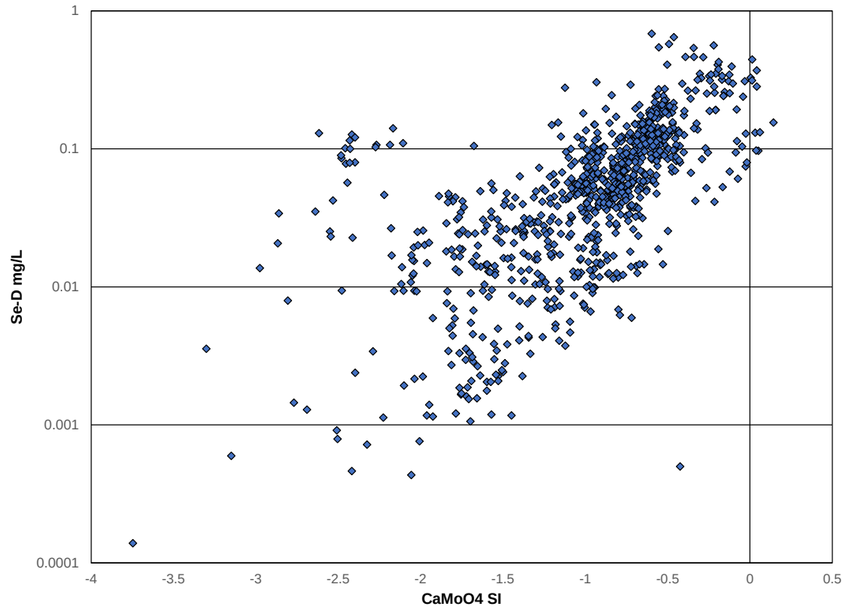
Figure 25: $CaMoO_4$ Saturation Indices Compared to Molybdenum Concentrations

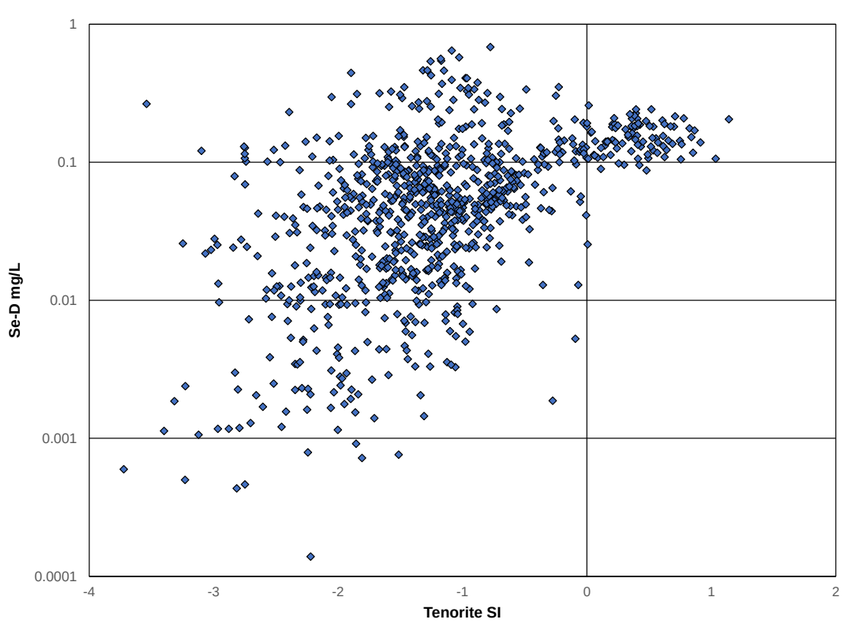


Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

Figure 26: Relationships between Selenium Concentrations and Saturation Indices for Gypsum (top left), $CaMoO_4$ (top right), and Tenorite (bottom)







Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/[Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx]

5.3.3 Results

Source terms for NAG waste rock are provided in Appendix B.

5.4 NAG Waste Rock Influenced by the Sulphur Stockpile

Because acidification of the waste rock on the infiltrating water flowpath from the sulphur stockpile does not seem to have occurred based on sampling of the foundation materials and the sulphur stockpile has been relocated, no separate waste rock term was derived. Because the stockpile has been removed, the influence from the sulphur stockpile on these seeps may dimmish with time. The waste rock term for the seeps influenced by the sulphur stockpile is that shown as “NEZ Dump - Sulphur Stockpile” in Appendix B.

5.5 PAG Waste Rock

Since ex-pit PAG waste rock will be re-handled to the Springer-Cariboo Pit at closure before acidification is predicted to occur, and the same solubility controls are expected as NAG, no separate PAG waste rock term was generated. The PAG waste rock term is that shown as “All-PAG Pre-acid” in Appendix B.

Acidification of PAG walls is discussed subsequently in Section 5.8.

5.6 Ore Stockpiles

Ore stockpiles are composed of rock with similar composition to waste rock with the exception of higher copper concentrations. Overall controls on water chemistry are expected to be similar to NAG waste rock and no separate term was developed. The effects of processing oxidized ore are considered separately in Section 5.9.

5.7 Pit Backfill

Exposed components of pit backfill are assigned the same source term as NAG waste rock. Following submergence, the same source term is assigned to the pore water chemistry assuming that pore waters equilibrate with the same previously formed secondary minerals. Over time, leaching of these minerals will result in decreasing concentrations; however, this process has not been quantified and it is conservatively assumed that constant pore water chemistry will be maintained in perpetuity.

5.8 Pit Walls

5.8.1 Method

Similar to the approach outlined in SRK (2016), pit wall source terms prior to flooding consider the loading from weathering of rubble in exposed walls. Walls covered by waste rock backfill are not assigned a loading because the reactive surface area in waste rock far exceeds that in the rubble on pit walls.

The process of flushing walls by rising water levels was not considered because the relative volume water involved and flushing of pit walls weathering under non-acidic conditions will be small relative to ongoing flushing of exposed walls and flushing of backfilled waste rock.

Pit walls covered by water are also assumed to yield negligible loading because oxidation processes are effectively altered by a water cover. Ongoing leaching may occur (as described for waste rock backfill) but the volume involved is relatively small.

The load of parameter *i* released by weathering of rubble on pit benches (W_i) is calculated from:

$$W_i = M \cdot R_i \cdot k_O \cdot k_T \cdot k_p$$

Where R_i is the rate of release indicated by HCTs scaled to allow for oxygen availability (k_O), differences in temperature (k_T), and differences in reactive surface area (k_p), and applied to as mass M. Mass is calculated on a per m^2 planar wall basis, using a rock density (ρ) and an assumed reacting thickness (h):

$$M = 1 \cdot h \cdot \rho$$

The load leached (L_i) is calculated from:

$$L_i = W_i \cdot k_c$$

k_c is a factor to account for incomplete leaching of weathering products.

The resulting concentration [M_i] in wall area runoff over infiltration area, I, is obtained:

$$[M_i] = \frac{L_i}{I}$$

Concentrations obtained for non-acidic walls are constrained to the NAG waste rock if concentrations greater than for NAG waste rock are obtained. For PAG walls, concentrations were not constrained assuming that low pHs will result in high solubility of secondary minerals.

5.8.2 Inputs

R_is for non-acidic conditions were estimated from three humidity cells (HC14, HC15, and HC16) performed on Springer Pit rock and two humidity cells (HC (3) and HC (4)) performed on WX Zone rock (Table 4). The average of the five tests was used to estimate R. Scaling factors used for k_O, k_T, k_p, and

k_C were 1, 0.3, 0.1, and 1, respectively, and assume that oxygen is not limited, temperatures are lower under site conditions, rock is coarser than humidity cells, and weathering products are completely leached.

No naturally progressing humidity cells have yielded acidic leachate for MPM but rates obtained from HCTs on Pond Zone rock forced to generate acid by stripping of carbonate (HC12 and HC13 in Table 4) were used to estimate an acidic source term. Since these samples were selected to evaluate oxidation rates following carbonate depletion for samples containing lower sulphide in the Pond Zone, the HCT weathering rates $R_{i,HCT}$ were scaled to sulphide concentrations in the acidic Springer Pit walls ($S_{i,Wall}$) using:

$$R_{i,acid}=R_{i,HCT}\left(\frac{S_{acid,wall}}{S_{HCT}}\right)$$

$S_{acid,wall}$ was estimated from the blast hole cuttings database from the Springer Pit. For each PAG sample in the database, the sulphur remaining following depletion of all NP was calculated from the measured sulphide content (S_0) and carbonate content ($NP_{TIC,0}$) and the rate ratio for depletion of carbonate (R_{ratio}):

$$S_{acid,wall}=S_0-\left(\frac{NP_{TIC,0}}{R_{ratio}\cdot 31.25}\right)$$

R_{ratio} is equivalent to the PAG/NAG segregation criterion of 2. The 95th percentile of the resulting distribution of $S_{acid,wall}$ was calculated to be 2.3% compared to the 95th percentile of measured values of 2.8%. The resulting rates are shown in Table 7.

The weathering thickness (h) was set to 2 m to be equivalent to typical over-blast thickness. The bulk density, ρ, was used as 2.65 t/m^3.

Total annual precipitation of 620 mm/year (MPMC 2022) was used to estimate infiltration of 560 mm/year assuming that 90% of precipitation contacts wall rocks.

Table 7: Humidity Cell Rates (mg/kg/wk) Used for Pit Wall Terms

HCT	Zone	Alkalinity	SO_4	Al	As	Cd	Ca	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Se	U	Zn
HC-12	Pond	0	14	0.063	0.0014	0.000078	2.6	0.0037	0.068	0.037	0.00010	0.52	0.19	0.00038	0.0013	0.0030	0.000050	0.056
HC-13	Pond	0	4.6	0.025	0.000058	0.000035	1.2	0.0051	0.088	0.0054	0.000043	0.22	0.12	0.00013	0.0011	0.00014	0.0000044	0.011
HC-14	Springer	18	3.2	0.022	0.00068	0.000029	7.2	0.000031	0.0024	0.018	0.000037	1.0	0.0020	0.0067	0.000052	0.0064	0.000068	0.0014
HC-15	Springer	6.3	12	0.17	0.00013	0.0000048	7.2	0.00013	0.0061	0.063	0.00014	0.12	0.0028	0.0042	0.000054	0.00017	0.000035	0.0013
HC-16	Springer	13	0.92	0.068	0.00063	0.0000051	4.0	0.000013	0.00089	0.0039	0.000028	0.38	0.00034	0.0022	0.000046	0.00019	0.000032	0.0010
HC-17	Springer	8.2	9.9	0.039	0.00036	0.0000194	7.2	0.000015	0.0010	0.0038	0.000045	0.33	0.00124	0.0427	0.000093	0.00082	0.000095	0.0010
HC-18	Springer	7.5	18	0.021	0.00044	0.0000162	9.1	0.000020	0.0013	0.0038	0.000141	0.29	0.00138	0.0333	0.000103	0.00124	0.000188	0.0014
HC-19	WX	7.0	10.5	0.030	0.00041	0.000012	5.8	0.000011	0.0007	0.0037	0.000060	0.21	0.0015	0.018	0.000091	0.00067	0.000164	0.0010
HC-20	WX	7.9	15	0.022	0.00055	0.000025	9.0	0.000004	0.0011	0.0055	0.00005	0.31	0.0003	0.060	0.00012	0.0006	0.00018	0.0014

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

5.8.3 Results

Pit wall source terms of non-acidic and acidic walls are shown in Appendix C.

5.9 Ore Processing

5.9.1 Method

The method and resulting source terms are the same as presented in SRK (2016). The mass leached from ore as it is processed was calculated from shake flask extraction test data. Concentrations in the shake flask tests (in mg/L) were converted to mass leached as (mg/t) by multiplying by factors of 3 L/kg which is the leach ratio in the test, and 1000 kg/t. The mass leached is used to determine the load added to the process water from each tonne of rock processed.

5.9.2 Inputs

Shake flask data from characterization of eight samples from four ore stockpiles were used (SRK 2015b). The data were used to calculate 5th, 50th and 95th percentile of the loads leached. Since the rock in the stockpiles varied in age from one to nine years, they were not representative of freshly blasted ore. To account for this, the 5th percentile was used to indicate leaching of freshly blasted ore and the 95th percentile was used for processing of the stockpiles.

5.9.3 Results

The resulting source terms are provided in Appendix D.

5.10 Tailings

5.10.1 Method

Tailings source terms were developed for operating conditions (i.e., when tailings are being discharged) and closure conditions when contact waters are assumed to represent oxidation of tailings following draindown of process waters. Re-flooding resulting from reactivation of the impoundment would result in seepage chemistry intermediate between these conditions.

For operational conditions, observed seepage chemistry from tailings dam drains was assumed to be representative of future tailings contact water. Seepage chemistry is assumed to reflect mainly the influence of entrained process water with less influence from oxidation of tailings. Since localized influence from groundwater and non-contact surface can be expected, the range of concentrations assumed was the 95th and 99th percentiles.

For closure conditions, the preferred approach was to obtain direct chemistry from contact waters in the current unsaturated zone because these would likely represent the conditions when the tailings are

fully drained down. No suitable monitoring locations were identified with likely contact water chemistry, so data from the tailings columns were used, similar to the approach outlined in SRK (2016).

Interpretation of leach column data (see below) indicated that early chemistry provided a good indication of contact water chemistry reflecting the influence of oxidation processes. The following method was used to estimate contact water chemistry for drained down tailings:

- The 95th and 99th percentile concentrations of column data were calculated (for alkalinity, the 5th and 1st percentile, respectively, were used).
- For the majority of parameters, drain down chemistry was characterized by the column data percentiles.
- For selenium, interpretation of the column data resulted in the conclusion that attenuation of selenium may be occurring in the early stages of testing as a result of reductive process converting selenate to selenite. To address this possible effect, selenium concentrations were calculated using the sulphate statistics and the range of Se/SO_4 ratios indicated by later data:

$$[Se] = \left(\frac{Se}{SO_4}\right)_{ratio} \times [SO_4]$$

- The equivalent dam drain percentile was used for ammonia because it was not measured in column leachates.
- Manganese concentrations were markedly lower in column leachates compared to seepage. This difference may reflect that conditions in desaturated tailings favour lower mobility of manganese, but the seepage data were selected.

5.10.2 Inputs

Seepage data statistics were calculated for all seepage collection points collected between 1998 and 2022 (Table 8).

Seepage and column data were evaluated for solubility controls using the same approach as waste rock (Section 5.3). Sulphate concentrations in the early column data were close to 2000 mg/L and found to yield gypsum saturation indices near 0, and therefore consistent with solubility control by gypsum (Figure 27). Seepage saturation indices tended to be well below 0. Other parameters showing possible secondary mineral controls were copper (tenorite) and molybdenum (calcium molybdate). Based on similar reasoning as waste rock, the early column data appear to indicate secondary mineral solubility controls for these elements and provide a good indication of the solubility of other elements.

Table 8: Tailings Seepage Statistics

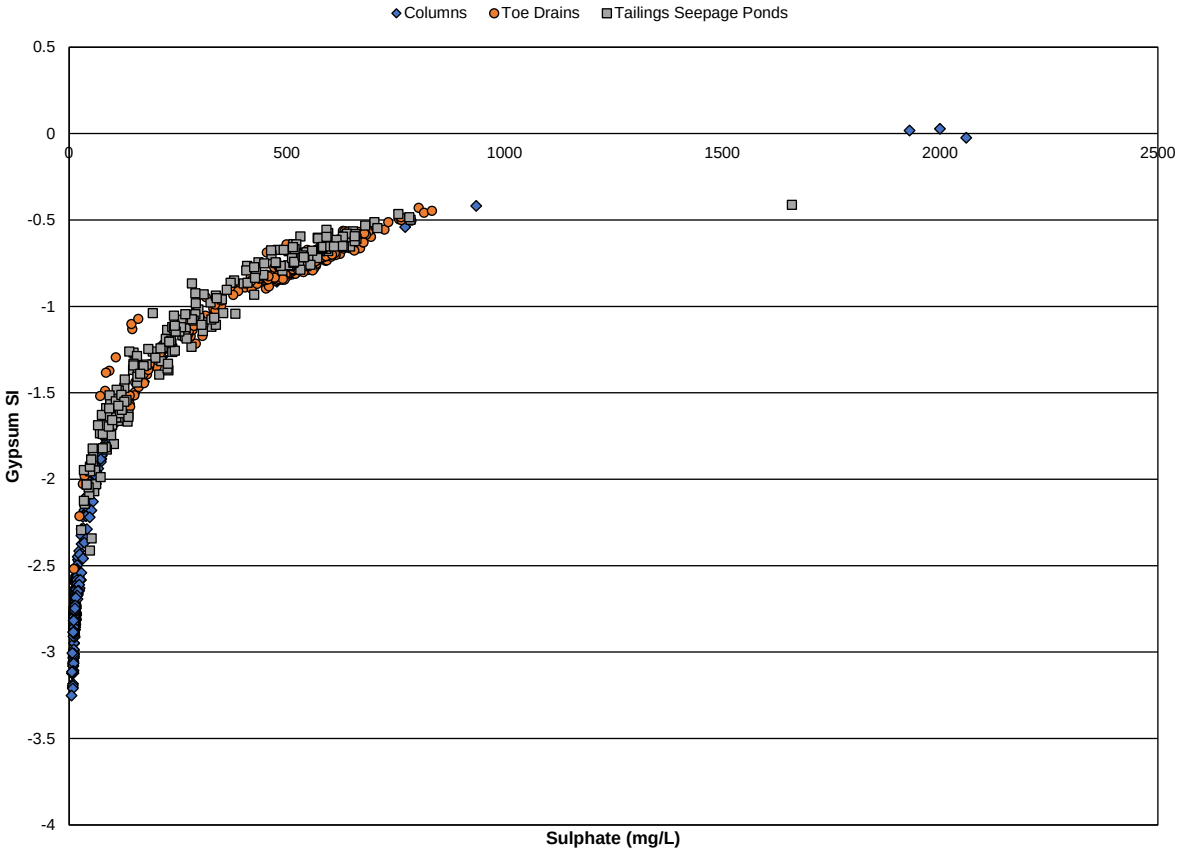
Statistic	Type	n	pH[1]	Alkalinity[1]	Cl	F	NO_3	NO_2	SO_4	Al-D	As-D	Cd-D	Ca-D	Co-D	Cu-D	Fe-D	Mg-D	Mn-D	Mo-D	Ni-D	Se-D	Zn-D
				mg/L	mg/L	mg/L	mg-N/L	mg-N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
P95	Toe Drain	802	7.2	62	29	1.0	4.6	0.29	680	0.007	0.0024	0.00030	210	0.0016	0.013	0.40	29	1.2	0.29	0.0012	0.019	0.018
	Seepage Pond	417	7.3	65	26	0.80	9.4	0.18	650	0.036	0.0027	0.00019	220	0.00063	0.013	0.14	35	0.49	0.25	0.0016	0.037	0.014
P99	Toe Drain	802	6.9	52	31	1.1	6.4	0.39	780	0.044	0.0033	0.00033	240	0.0022	0.025	0.47	33	1.6	0.39	0.0017	0.032	0.026
	Seepage Pond	417	7.0	48	30	0.84	16	0.26	760	0.10	0.0031	0.00027	240	0.00085	0.025	0.25	42	0.83	0.30	0.0042	0.062	0.038

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

Notes:

[1] Statistics reported for pH and alkalinity are 5th percentile (for P95) and 1st percentile (for P99).

Figure 27: Gypsum Saturation Indices for Tailings Seepage and Column Data

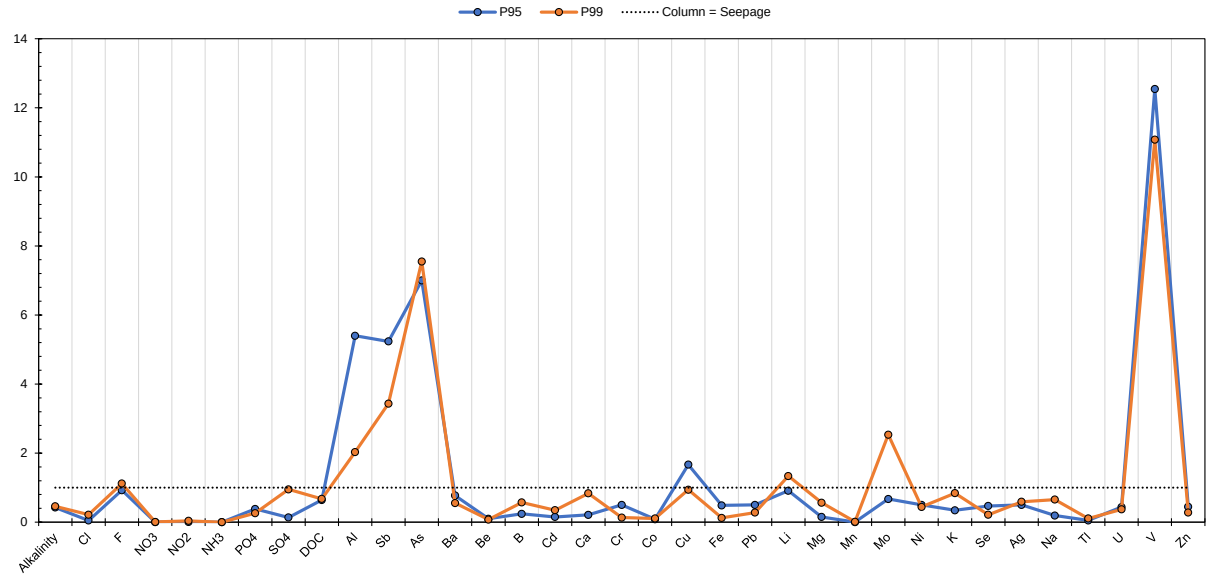


Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

Figure 28 shows the ratio of Column to Seepage for the two statistics. The columns showed higher concentrations than seepage for some elements (Al, As, Sb, V), but were within an order of magnitude for all except arsenic. The high concentrations of arsenic (> 0.01 mg/L) in the column leachates were not associated with an initial flush and may be evidence of some desorption during testing. Concentrations have been < 0.01 mg/L since cycle 233.

Most parameters linked to acid generation and neutralization processes (SO_4, Ca, Mg) and related elements (Cu, Mo, Se) are now similar to or lower in the columns compared to what was reported in SRK (2016), reflecting depletion as the tests proceeded. Those lower in column data also include nitrogen forms (which would be introduced by leaching in the process plant), and manganese and iron. Manganese and iron may be higher in seepage due to reducing conditions in drains.

Figure 28: Comparison of P95 and P99 Statistics for Ratio of Column/Seepage



Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

5.10.3 Results

Tailings source terms are provided in Appendix E.

5.11 Magnetite Stockpiles

No separate source term was developed for the magnetite stockpiles. Relative to other sources, these stockpiles are not expected to be significant sources.

5.12 Nitrogen Leaching

Nitrogen leaching was included for each source term as follows:

- **Waste Rock:** Nitrogen sources terms were developed from existing seepage by grouping waste rock dumps into active (PAG Ex-Pit and SERDS), and inactive (Boundary Dump and NEZ Dump). For each group, mean concentrations and 95% confidence limits on the means were calculated to consider uncertainty (Table 9).
- **Pit Walls:** Pit walls were assumed to have zero contribution due to the small mass involved and expected results of meteoric leaching which is expected to result in any leaching effects having short duration and being insignificant relative to waste rock reporting to pit water sumps.
- **Backfill:** Backfill source terms are the same as those for waste rock (Table 9).

- **Ore Processing:** Leaching of nitrogen forms by processing were based on the shake flask extraction data (Appendix D).
- **Tailings:** Tailings source terms are based on the observed seepage for operational conditions and column data for draindown conditions (Appendix E).

Table 9: Waste Rock Nitrogen Source Terms

Phase	Statistic	Ammonia	Nitrate	Nitrite
		mg-N/L	mg-N/L	mg-N/L
Inactive	Low 95% Confidence Limit	0.013	0.84	0.0065
	Mean	0.027	1.6	0.0078
	Upper 95% Confidence Limit	0.04	2.4	0.0092
Active	Low 95% Confidence Limit	0.017	19	0
	Mean	0.057	26	0.38
	Upper 95% Confidence Limit	0.098	33	1.0

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

6 Conclusions

This report presents source term geochemical predictions that are inputs into the site wide water quality model. The main conclusions that provided input into the source terms are:

- While several ore zones at MPM have been mined since 1997, all except the relatively small Pond Zone are alkalic porphyry mineralization centred on magmatic-hydrothermal breccia bodies with similar geological characteristics. The host rock for the mineralization is the MPIC which is mainly monzonite. The similarities of the mineralized zones, including their host rocks, indicate that source terms can appropriately be developed on a site-wide basis rather than considering significant differences between the zones.
- As a result of geochemical segregation of waste rock based on ARD potential through the mine life, PAG waste rock has been or will be placed in open pits where it will be permanently flooded thereby preventing ARD from developing.
- It is expected that operational inefficiencies will have resulted in PAG waste being incorporated into the NAG waste rock but the segregation approach was conservative and mass balance excess of acid neutralizing minerals over acid generating minerals means that future development of ARD is unlikely. Weathering conditions are predicted to be pH-basic in perpetuity.
- Tailings are non-PAG.
- As a result of the pH-basic weathering conditions, chemistry of seepage from the existing full-scale facilities reflects solubility limits for weathering minerals. Chemistry is affected by dilution which was corrected using the solubility limit of gypsum.

Closure

This report, Mount Polley Mine Geochemical Source Terms – 2023 Update, was prepared by



Shauna Litke, PEng
Senior Consultant (Geochemistry)

and reviewed by



Stephen Day, PGeo
Corporate Consultant (Geochemistry)

EGBC Permit to Practice: 1003655

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

References

Day, S., Forsyth, B. and Desjardins, M. 2015. Influence of Size-Fraction Partitioning of Sulphide and Carbonate Minerals in Blasted Rock on ARD Potential Classification, Copper Mountain Mine. Proceedings of 22nd Annual British Columbia-MEND ML/ARD Workshop, December 2 and 3, 2015, Vancouver, BC.

Henry, C. 2009. Semi-Industrial Scale Testing of Biologically-Induced Copper Heap Leaching at Imperial Metals Corporation - Mount Polley Mine. M.Sc. Thesis. University of Northern British Columbia.

Litke, S., Day, S., Liu, W. 2019. Geochemical Performance of Mine Rock Beneath an Elemental Sulfur Stockpile and Implications for Water Quality Management Following Removal of the Stockpile. From Proceedings of the 2019 Conference of Metallurgists

MPMC. 2022. 2021 Annual Environmental Report for the Mount Polley Mine. March 31, 2022.

Price, W.A. 2009. Prediction Manual for Drainage Chemistry from Sulphidic Materials. Report prepared for MEND Program. MEND Report 1.20.1. 579p.

Price, W. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. Reclamation Section, British Columbia Ministry of Energy and Mines. April 1997.

SRK. 2015a. Mount Polley Mine Tailings Dam Failure: Geochemical Characterization of Spilled Tailings. Prepared for Mount Polley Mining Corporation. SRK Project No. 1CI008.003. June 2015.

SRK. 2015b. Mount Polley Mine Geochemical Characterization of Ore Stockpiles. Report prepared for Mount Polley Mining Corporation. SRK Project 1CI008.005. October 2015.

SRK. 2016. Derivation of Geochemical Source Terms, Mount Polley Mine. Prepared for Mount Polley Mining Corporation. SRK Project No. 1CI008.007. September 2016.

SRK. 2022. Mount Polley Heap Leach Decommissioning Plan. FINAL. Prepared for Mount Polley Mining Corporation: Likely, BC. Project number: CAPR002047. Issued August. 2022.

SRK. 2023. Metal Leaching/Acid Rock Drainage Characterization and Monitoring Program – 2022 Annual Report, Mount Polley Mine. Prepared for Mount Polley Mining Corporation. SRK Project No. CAPR002434. March 2023.

Suárez, S., Nieto, F., and Velasco, F. 2009. Copper Inclusions in Chlorite from the Aguablanca Ni-Cu-PGE Sulfide Deposit (SW Spain). Macla 11, p. 173-174

Appendix A ML/ARD Management Procedure Manual

Prepared by Mount Polley Mining Corporation

MOUNT POLLEY MINING CORPORATION
IMPERIAL METALS CORPORATION

ML/ARD MANAGEMENT PROCEDURE MANUAL

OBJECTIVE

The objective of this Metal Leaching/Acid Rock Drainage (ML/ARD) Management Procedure Manual is to provide detail on how ML/ARD potential is considered in material management at the Mount Polley Mine (MPM). This document summarizes all the various procedures and considerations related to ML/ARD potential through mine life processes.

DOCUMENT REVISION HISTORY

This document replaces earlier versions of similar documents that directed ML/ARD Management at MPM in response to *Mines Act* Permit M-200 issued on August 3, 1995. The procedures as described have been in the place since that date.

Document Update Summary

Revision Date	Author	Comment
June 30, 2016	Chad Cameron Ben Harding Katie McMahen Luke Moger Ryan Brown Stephen Day (SRK)	Original Document
August 04, 2022	Mathieu O'Leary Gabriel Holmes Aaron Zwiebel (DWB) Shauna Litke (SRK)	Added contacts, water treatment plant waste ML/ARD characterization, QA/QC sampling, and PAG misplacement action plan.

KEY CONTACTS AND QUALIFIED PROFESSIONALS

Numerous personnel at Mount Polley are responsible for carrying out the procedures written in this plan. Key mine personnel and their contact information are as follows.

Name	Role	Phone	Email
Don Parson	General Manager	604-488-2652	don.parsons@imperialmetals.com
Mathieu O'Leary	Technical Services Superintendent	236-317-4938	mathieu.oleary@mountpolley.com
Gary Roste	Senior Mine Geologist	250-991-0438	gary.roste@mountpolley.com
Gabriel Holmes	Environmental Coordinator	236-317-4939	gabriel.holmes@mountpolley.com
Bill Grieves	Foreman	236-602-3203	bill.grieves@mountpolley.com
Al Trottier	Mill Ops Foreman	236-602-3203	al.trottier@mountpolley.com
Bill Smith	Lab Manager	236-597-1181	goldag2700@gmail.com

Any update to this document is reviewed by a Qualified Professional (QP) in the area of practice of ML/ARD management, as required by *Mines Act* Permit M-200 Condition A.5. Qualified professionals reviewing this document are as follows:

Version	Qualified Professional	Phone	Email
June 30, 2016	Stephen Day, PGeo (SRK)	604-862-4097	sday@srk.com
August 04, 2022	Shauna Litke, PEng (SRK) Stephen Day, PGeo (SRK)	604-235-8542 604-862-4097	slitke@srk.com sday@srk.com

BACKGROUND

Metal leaching and acid generation are naturally occurring chemical processes which may have negative impacts on the receiving environment. The potential environmental impact of ML/ARD will depend on their magnitude, the sensitivity of the receiving environment, dilution and/or attenuation, as well as any mitigation measures that are in place.

Metal leaching occurs as a result of: weathering of metal-containing minerals (i.e., exposure to water and oxygen), drainage conditions that increase solubility, and flow of water through source materials. Acid generation occurs when minerals containing reduced sulphur (e.g. sulphide and elemental sulphur) are exposed to the weathering effects of oxygen and water. In iron sulphide minerals (e.g. pyrite) acidity is also generated when ferric iron precipitates. Other minerals in the source rock, primarily calcium and magnesium carbonates can neutralize the acid. ARD occurs when the amount of acid-generation exceeds the ability of the source rock to neutralize this acid. Any surplus acid is entrained in water and can create acidic and metal-containing run-off.

Pre-mining and operational geochemical characterization has shown that ARD potential at MPM is restricted due to the abundance of acid-consuming carbonate minerals compared to acid generating sulphide minerals. In addition, the presence of natural carbonate and oxide copper minerals in the pre-mining weathering zone reinforce the expectation that weathering conditions are dominantly basic. However, due

to the potential consequences of acid generation for long term management of the site, Mount Polley Mining Corporation (MPMC) actively manages waste rock based on its ARD potential as described in the following sections.

MPMC has focused on managing potential for ARD due to the link between acid generation and enhanced solubility of copper which is expected to be the primary concern for ML. Selenium leaching has also been identified as occurring at MPM. Selenium is released by oxidation of sulphide minerals but leaching is not necessarily associated with pH depression. Selenium leaching occurs regardless of whether waste rock is classified as potentially ARD generating (PAG) or non-PAG (referred to as NAG at MPM).

UNDERSTANDING OF THE DISTRIBUTION OF ARD POTENTIAL

Like other alkalic porphyry deposits (e.g. Copper Mountain, Brenda), MPM lacks the strong hydrothermal alteration zoning that is commonly observed in calc-alkalic porphyry deposits (e.g. Highland Valley Copper, Island Copper, Gibraltar). In particular, phyllic alteration is absent at MPM. A common feature of calc-alkalic porphyry deposits is often a pronounced pyritic halo that surrounds the copper mineralization and is associated with phyllic and propylitic alteration. At MPM, discontinuous pyritic zones are present but do not appear to be mineralization halos. MPMC geological staff identified a pyritic zone in the south wall of the Springer Pit which extends into the adjacent Cariboo Pit.

This ML/ARD Management Procedure Manual applies to waste rock and ore stockpiles. Tailings are consistently NAG due to removal of copper sulphides by ore processing.

MANAGEMENT OF PAG ROCK

Best practice for management of PAG rock is subaqueous disposal in a configuration that provides permanent and low maintenance containment. At MPM, this has been implemented by disposing of waste rock in completed open pits that will subsequently fill with water. Mine planning is carried out at MPM such that the open pits have sufficient capacity that PAG material can be re-handled into the open pits and stored subaqueously at closure. The following pits are available for subaqueous disposal (in sequence):

- Cariboo Pit
- Bell Pit
- Pond Zone Pit
- Southeast Zone Pit
- Wight Pit
- Cariboo-Springer Pit.

For the Springer Pit, backfill locations are not currently available. The PAG rock is therefore stockpiled adjacent to the open pit in the Temporary Northwest PAG Stockpile for backhauling to the Cariboo-Springer Pit upon completion of mining.

For the small Pond Zone Pit, low sulfur PAG waste rock is layered with NAG waste rock.

Onset of acidic conditions in waste rock at MPM takes at least decades as shown by humidity cells, and the lack of acidification in the natural exposure of the deposit indicates that flooding of PAG waste rock does not need to be immediate. The current approaches of backfilling into dry pits and stockpiling following by backfilling allows PAG rock to be submerged before it acidifies.

DETERMINATION OF ML/ARD POTENTIAL

Waste rock on site is separated into two categories, NAG and PAG, using Neutralizing Potential Ratio (NPR) defined as:

NPR = NP/AP.

Acid Potential (AP) (in kg $CaCO_3$/t) is measured from:

- Total sulphur (%) x 31.25

Neutralizing Potential (NP) (in kg $CaCO_3$/t) is measured from total carbonate NP determined from:

- Total carbon (%C) x 83.33.

Due to the dominantly intrusive rock host at MPM, total carbon is an appropriate proxy for carbonate.

As required by *Mines Act* Permit M-200, PAG is defined as:

- NPR≤2 and total S>0.1%.

This *Mines Act* Permit M-200 requirement was specified in terms of NP determined by a whole-rock acid extraction and titration method; however, MPMC chose to use total carbonate which yields lower NP than the titration methods.

MATERIAL CHARACTERIZATION OVERVIEW

This section provides an overview of characterization procedures.

The MPM program characterizes all material types that will be handled during the mine life. Analysis is completed on site by Mount Polley's LECO™ instrument , allowing MPMC to best manage mine waste by directing it to suitable storage sites, or to construction usage when required (and if deemed suitable).

On each bench, a sample of cuttings is collected from each blast hole and analyzed for total copper, non-sulphide copper, iron, and gold. Areas of ore and waste are identified by interpolation of these assay results and the economic analysis of the resulting metal grades. Ore/waste boundaries are then established based on the calculated mill head values.

In areas which have proven to be consistently NAG on previous adjacent benches in blasthole samples, the waste tonnage in each blast is divided by 40,000 in order to determine the number of ABA samples to be

submitted (i.e., one per 40,000 tonnes (t) of waste). However, in areas where PAG has been modelled through either exploration sampling, or results of previous blasthole sampling on other benches, (or where NAG and PAG may coincide), the sample density is doubled to one per 20,000 t. This approach results in greater sampling density in areas of suspected NAG/PAG boundaries, and increases the certainty of defining PAG. Typically structures at MPM are vertically oriented, and relatively continuous. This provides some assurance that blasthole samples from previously mined benches have relevance for determining where additional samples should be taken on new benches.

Any ore that will be stockpiled rather than processed immediately is sampled at a frequency of one (1) per 20,000 t to determine if it is classified as PAG or NAG. Millfeed ore areas are excluded from ABA analysis, as this material is processed through the Mill.

Composite tailings samples are collected and analyzed every month when processing of ore occurs to represent the tonnage of tailings deposited.

Water treatment wastes are quantified monthly and sampled quarterly, with material characterization performed to assess ML/ARD potential and contribute to a material inventory.

As a confirmatory sampling measure, the Environmental Department takes random weekly grab samples from the NAG waste dump when NAG is being dumped and/or used for construction, to verify that material is being appropriately characterized and handled.

In the event that a confirmatory sample or other activities result in the discovery of PAG material in a NAG-designated area, a QP is to be informed without delay, who will dictate the response actions in coordination with site contacts. Mount Polley is permitted to blend pockets of less than 1,000 t of PAG materials with non-PAG materials at a ratio of 20:1, as described in *Mines Act* Permit M-200 Section D.3.(c)(i)(d). If these conditions cannot be met, it may be necessary to remove PAG material from NAG areas.

Water chemistry monitoring of seepage from rock dumps, water treatment plant wastes, and contact water from the site water collection systems is also conducted by the Environmental Department to inform development of geochemical source terms and long-term water quality predictions. Similarly, tailings composites and monthly random drill pulp samples are sent to a third-party laboratory for metals analysis as an additional source of data for site geochemical models.

IN-PIT SEGREGATION

Blasthole Samples:

1. After the production drill has completed and moved away from the hole, the sample may be taken.
2. Using a tube sampler, the Driller will take a representative sample of the cuttings pile.
3. Samples are to be collected in a clean plastic sample bag.
4. The Driller is to complete a Blasthole Sample Tag, tearing off the tag once completed and inserting it into sample bag.
5. The sample bag is to be tied off using ribbon.

6. In the case where multiple composite samples are to be taken from a single hole, the remaining cuttings after the sample are to be removed by the Driller so a clean new pile of cuttings can be formed.
7. Completed samples are to be left on the drill by the Driller. At the end of shift, the Mine Operations Pit Supervisor (or designate) will collect all samples and deliver them to the Bucking Room.

Bucking Room:

1. Each sample is to be transferred from the sample bag to a clean metal tray. The Blasthole Sample Tag is to be kept with the sample.
2. The sample is to be dried at 105°C.
3. The sample is then to be crushed in the Primary Crusher.
4. The sample is then to be crushed in the Fine Crusher.
5. The sample is to be split until the sample size is approximately 200 g.
    a. Reject from the sample is to be wasted.
6. The sample is then to be pulverized for 75 seconds.
7. The sample is to be placed in a pouch with the Blasthole Sample Tag stapled to the pouch.
8. If the pouch is a pit sample, it is to be sent to Assay Lab 1. If the sample is an ABA sample, it is to be sent to Assay Lab 2.

Assay Lab 1:

1. The Assay Lab is to run the sample through the atomic absorption analyzer which automatically transfers the copper (CU), non-sulphide copper (CUNS) and iron (FE) values into the LIMS database.
2. The samples for gold analysis are to be fire assayed and analyzed by atomic absorption which automatically transfers the gold (AU) value into the LIMS database.
3. The sample is then to be placed into storage. Pit samples are to be stored for 21 days.

Ore Control Technician 1:

1. Once assays have been entered into the LIMS database, the Ore Control Technician will review the data and roughly determine where in the blast any Mill Feed Ore will be located.
2. Once the Ore Control Technician drafts the Mill Feed Ore locations, the Ore Control Technician will evenly select holes in the non-Mill Feed Ore areas (including materials designated for ore stockpiles) at a ratio of one (1) sample per 20,000 t of rock. This equates to about one for every nine blast holes. Additional samples can be requested whenever additional data is desired for improving understanding of the geological conditions. An example of a sample layout is included as Figure 1.

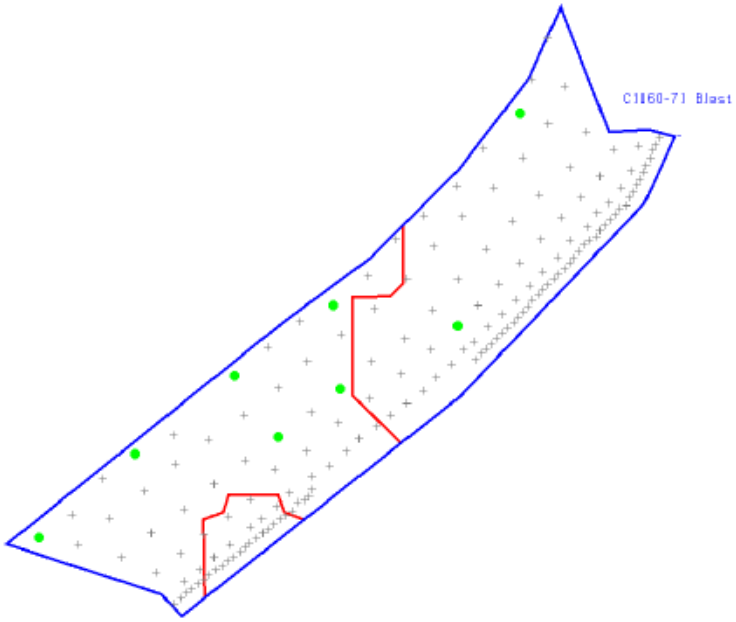


Figure 1: Location of ABA samples (green dots) within a blast. Red polygons denote mill feed ore, remainder is waste. The Ore Control Technician focuses sampling on areas which are designated waste and/or stockpile ore by the blasthole model. Reference blast = 149,173 t.

3. The Ore Control Technician is to then make an Analysis Request with the holes selected to the Assay Lab.

Assay Lab 2:

1. If the Assay Lab receives an Analysis Request, they will retrieve the sample pouch from storage, otherwise the sample will be delivered to the Bucking Room.
2. The Assay Lab will run the sample through the LECO CS230 Carbon Sulphur Analyzer.
3. Once analyzed, the machine transfers the carbon percentage (C%) and the sulphur percentage (S%) to a spreadsheet where NPR, NP and AP are calculated.
4. The NPR, NP, AP, C% and S% are transferred automatically to the LIMS database.
5. The sample is then to be placed into storage. ABA samples are to be stored for 14 days.

Ore Control Technician 2:

1. Once all the assays and ABAs have been entered into the LIMS database, the Ore Control Technician is to review the data and model the blast.
2. Modeling the blast
    a. The software used is MineSight.
    b. The model is based on a 5 metre (m) x 5 m x 12 m block system.
    c. The block closest to the ABA sample will closely match the sample.
    d. The blocks between the samples receive a weighted average of the sample carbon and sulfur grades.

e. Once each block gets the weighted C% and S%, then the AP, NP and NPR is calculated for each block.
f. Using the calculated NPR value, the model is to be coded as Ore/NAG/PAG by the Ore Control Technician and the resulting markup design is to be provided to the Surveyor.

3. The Ore Control Technician is responsible for the release of the final ore markup to the Surveyor. An example of a sample layout is included as Figure 2.

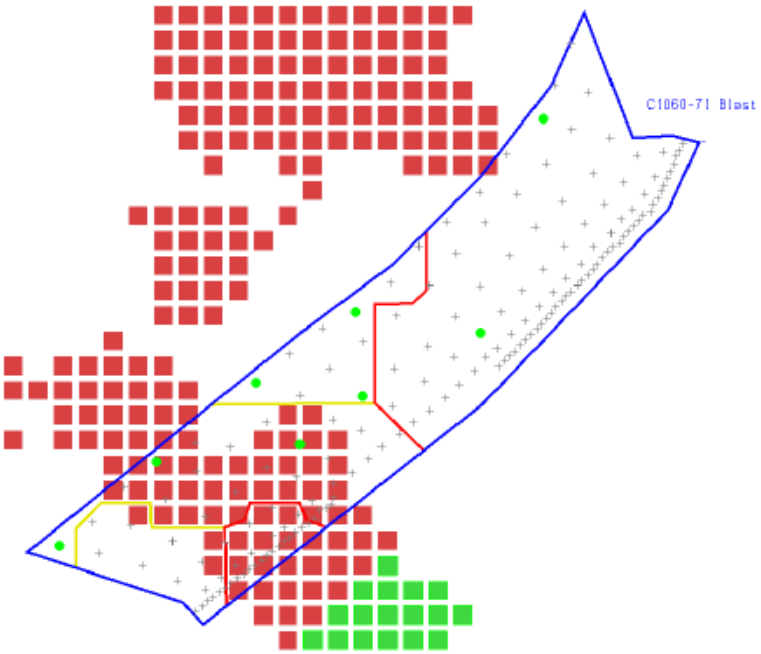


Figure 2. ABA results from samples shown in Figure 1 are used to update the blasthole PAG model item which identifies blocks which meet PAG criteria (red). The Ore Control Technician then marks up the PAG waste (yellow polygon) and the complete ore/waste markup is released to the Surveyor.

Surveyor:

1. The Surveyor will be responsible for the layout all Ore/NAG/PAG, as determined by the Ore Control Technician, in the field.

2. Using four (4) foot stakes spaced approximately 5 m apart, the Surveyor will mark out the contacts using marked placards.
   a. Red Placard = High Grade Ore
   b. White Placard = Super High Grade Ore
   c. Green Placard = Low Grade Ore
   d. Yellow Placard = PAG
   e. Blue Placard = NAG
   f. Pink Ribbon = High Grade Mill Feed Ore
3. Once complete, the Surveyor will print out maps of the area delineating material types for the shovel operator(s), and, if required, provide field verification of material types.

MATERIAL HANDLING

Shovel/Haul Truck Operators:

1. The Shovel Operator will mine the rock, following the contacts laid out by the Surveyor.
2. The Shovel Operator will ensure that all material contained within the contact stakes is routed as described by the markup and that any uncertainty in material classification is resolved by seeking the assistance of either the Pit Supervisor or the Engineering Department.
3. Upon loading a haul truck, the Shovel Operator shall direct the Haul Truck Driver as to the material type being hauled, and destination, using a horn sequence. The Haul Truck Driver will then take the material to the designated area.

IN-PIT MONITORING

Shovel Operator:

The Shovel Operator follows the staking of the Surveyor. Any material marked out as PAG is only to be hauled to approved locations. If a discrepancy is found, the Surveyor is to be called out to verify the material markup.

Pit Supervisor:

Throughout the shift, the Pit Supervisor will check in with the Shovel Operator and confirm the material type being loaded and that the destination is correct.

Haul Truck Driver:

If the Haul Truck Driver is uncertain of the material loaded, the Haul Truck Driver will confirm with the Shovel Operator or the Pit Supervisor.

Ore Control Technician:

The Ore Control Technician is to check Shovel Operator dig faces and confirm that the markup is appropriate and material is being routed appropriately.

Surveyor:

The Surveyor is to verify that material staking is visible and correct.

Environmental Department:

Once a month, the Environmental Department is to send a randomly selected drill hole pulp sample that MPMC analyzed for total sulfur and total carbon at the Assay Lab to a third-party laboratory (typically ALS Environmental in Burnaby, BC) for element analysis by ICP-MS following aqua regia digestion as an additional source of data to support site geochemical models.

Additionally, the Environmental Department takes water samples from all pit sumps to inform long-term geochemical predictions. Samples are collected as per MPMC-SOP-002: Surface Water Quality Monitoring. Monitoring locations and frequencies are regularly updated to reflect site developments and are summarized in the Comprehensive Environmental Management Plan.

TAILINGS MONITORING

Mill Metallurgy

1. The Mill Metallurgy Department is to take a monthly composite sample of the tailings generated through the month.
    - Slurry is to be sampled every two (2) hours and made into a composite for the shift.
    - The shift composite is then to be added to a monthly composite.
    - At the end of the month, the monthly composite is to be given to the Bucking Room and prepared for ABA total sulfur and carbon analysis.
2. The Environmental Department is to send the monthly tailings composite sample to a third-party laboratory (typically ALS Environmental in Burnaby, BC) for element analysis by ICP-MS following aqua regia digestion to provide data for site geochemical modelling.

WATER TREATMENT PLANT WASTE

Environmental Department:

1. Record the value on the waste line totalizer monthly when Water Treatment Plant (WTP) data are downloaded.
2. Collect samples of waste which has exited the WTP quarterly to characterize WTP wastes. Samples shall be taken of material that has exited the sludge line, to the West of the WTP and down-flow from where microsand is cycloned for re-use.
3. Sampling Method for liquid wastes (adapted from MPMC-WORK-002):
    - Record in-situ measures: pH, temperature, conductivity, and turbidity.
    - Take a water sample from the pipe outflow and send for lab analysis corresponding with other contact water samples as described in the Comprehensive Environmental Monitoring Plan, including but not limited to: physical parameters, pH, total and dissolved metals.
4. Sampling method for solid wastes (adapted from MPMC-WORK-016):
    - Take a composite sample of solids from the sludge pile adjacent to the WTP, with samples from at least 5 locations on the pile.
    - Send to an external laboratory for total sulfur, total inorganic carbon, elemental analysis by ICP-MS following aqua regia digestion and shake flask extraction testing to assess the ML/ARD potential of solids.
5. Review and archive lab data in a timely manner for use by personnel responsible for the Annual Reclamation Report.
6. The TSS concentration in wastewater will be used along with the waste line totalizer values to quantify the solids delivered to the TSF. The relationship between total and dissolved metals in the WTP waste line sample will be used to quantify the suspended (filterable) metals in this sample.

7. This information will be included in the MLARD materials inventory, and reported to EMLI in the Annual Reclamation Report as per Code Section 10.5.7 on water treatment wastes and by-products.

NAG Material Monitoring

Environment Department

1. As a confirmatory sampling measure, the Environmental Department is to take ABA grab samples from the NAG Dump and any area where NAG rock is used for construction on a weekly basis, while NAG dumping and/or NAG rock construction is occurring. Sampling will conform with MPMC-SOP-016: ABA and Soil Sampling.
2. To assure data quality, as recommended in the BC Field Sampling Manual, a minimum of one in ten samples will be a duplicate sample, as written in MPMC-SOP-016.
3. Seeps and contact water collected on site are sampled to provide data for site geochemical modelling. Samples are collected as per MPMC-SOP-002: Surface Water Quality Monitoring. The frequency and locations of these monitoring sites are updated regularly to reflect changes to the mine site are summarized in the Comprehensive Environmental Management Plan.

Response to Finding PAG in NAG Areas

Environmental Department

1. Upon reviewing data indicating PAG material has been found in a NAG area, without delay contact one or more Qualified Professionals listed in this document, and the Pit Supervisor or designate to pass along the relevant data and sampling location.
2. Return to the location where PAG material was discovered and stake the sampling location. Note that material may have been dozed, buried or pushed down the dump face, in which case personnel are to mark as close as possible.
3. At the discretion of Qualified Professionals, undertake additional ABA sampling to assess the prevalence of PAG material.

Pit Supervisor:

1. Discuss NAG/PAG separation with shovel and haul truck operators and investigate the possibility of a loading or dumping mix-up. This is not a punitive activity but meant to identify potential causes and estimate material volume.
2. At the discretion of Qualified Professionals, organize the removal of PAG material from the non-PAG area.

ML/ARD Qualified Professional

1. Work with site contacts to develop an appropriate plan of action to address the situation.
2. If it is not possible to demonstrate that PAG material meets conditions outlined in M-200 Section D.3.(c)(i)(d), it may be necessary to remove recoverable PAG material.

REVIEW OF RESULTS AND PROGRAM EFFICACY

Data collected and corresponding interpretation regarding the ML/ARD program are included in the Annual Environmental and Reclamation Report (AERR), due annually to the British Columbia Ministry of Environment and Ministry of Energy and Mines on March 31 of each year, reflective of the previous calendar year. Personnel responsible for the AERR may recommend updates to the ML/ARD program based on operational changes or findings of annual reporting. The AERR includes sections on: waste rock characterization and disposal; drainage water quality monitoring; and, updates to long-term predictions (kinetic testing).

Appendix B Waste Rock Source Terms

Table 10: Waste Rock Source Terms

	pH	Alkalinity	Cl	F	P-D	SO4	Al-D	Sb-D	As-D	Ba-D	Be-D	Bi-D	B-D	Cd-D	Ca-D	Cr-D	Co-D	Cu-D
		mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Median Cation Ratio																		
Boundary	7.0	110	10	0.63	0.37	1400	0.032	0.00046	0.0043	0.098	0.0019	0.00093	0.14	0.00014	490	0.00093	0.0022	0.018
Wight	6.9	63	10	0.41	0.023	1400	0.021	0.00039	0.0008	0.076	0.001	0.001	0.28	0.00036	400	0.00059	0.00096	0.037
NEZ Dump - Sulphur Stockpile	6.7	25	21	1.7	0.015	1600	0.9	0.00095	0.00076	0.079	0.0025	0.0013	0.13	0.0025	510	0.0013	0.034	15
All Non-PAG	7.0	43	13	0.59	0.071	1400	0.025	0.0026	0.0031	0.1	0.0018	0.00091	0.22	0.0012	500	0.00091	0.0042	0.028
All PAG - Pre-Acid	7.0	81	14	0.4	0.055	1400	0.072	0.00057	0.0025	0.15	0.001	0.001	0.37	0.0005	470	0.001	0.017	0.024
High Cation Ratio																		
Boundary	7.0	78	10	0.63	0.38	1400	0.032	0.00046	0.0043	0.099	0.0019	0.00094	0.14	0.00014	490	0.00094	0.0022	0.018
Wight	6.8	58	10	0.42	0.023	1400	0.022	0.00039	0.00081	0.077	0.001	0.001	0.28	0.00036	400	0.0006	0.00097	0.037
NEZ Dump - Sulphur Stockpile	6.1	9.7	40	3.1	0.029	3000	1.7	0.0018	0.0014	0.15	0.0047	0.0024	0.24	0.0047	970	0.0024	0.065	28
All Non-PAG	6.7	33	14	0.59	0.072	1400	0.025	0.0026	0.0031	0.1	0.0018	0.00092	0.22	0.0013	500	0.00092	0.0042	0.028
All PAG - Pre-Acid	6.7	52	14	0.41	0.055	1400	0.073	0.00058	0.0025	0.15	0.001	0.001	0.37	0.0005	470	0.001	0.017	0.024

	Fe-D	Pb-D	Li-D	Mg-D	Mn-D	Mo-D	Ni-D	K-D	Se-D	Si-D	Ag-D	Na-D	Sr-D	Tl-D	Sn-D	Ti-D	U-D	V-D	Zn-D
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Median Cation Ratio																			
Boundary	0.61	0.00033	0.0056	78	0.94	0.13	0.00097	3.6	0.024	14	0.000019	17	6.7	0.00002	0.0005	0.038	0.0026	0.0026	0.0078
Wight	0.8	0.0001	0.0037	93	2.1	0.23	0.0022	4.0	0.062	7.2	0.00002	28	6.6	0.00002	0.0002	0.021	0.0048	0.002	0.018
NEZ Dump - Sulphur Stockpile	0.088	0.00025	0.028	98	2.1	0.38	0.035	3.5	0.3	7.7	0.00005	33	7.5	0.000064	0.0005	0.029	0.0023	0.0034	0.26
All Non-PAG	0.21	0.000091	0.013	99	1.8	0.44	0.0023	4.9	0.41	11	0.000018	30	7.0	0.00018	0.00018	0.019	0.0068	0.0029	0.15
All PAG - Pre-Acid	1.8	0.00013	0.0072	76	7.9	0.66	0.0017	7.0	0.24	9.5	0.000021	53	1.7	0.00002	0.0002	0.026	0.0027	0.0039	0.021
High Cation Ratio																			
Boundary	0.61	0.00033	0.0056	78	0.94	0.13	0.00097	3.6	0.024	14	0.000019	17	6.7	0.00002	0.0005	0.038	0.0026	0.0026	0.0078
Wight	0.81	0.0001	0.0038	93	2.2	0.24	0.0022	4.1	0.062	7.3	0.00002	28	6.6	0.00002	0.0002	0.021	0.0049	0.002	0.018
NEZ Dump - Sulphur Stockpile	0.17	0.00047	0.052	190	4.0	0.72	0.067	6.6	0.57	15	0.000095	62	14	0.00012	0.00095	0.055	0.0044	0.0065	0.49
All Non-PAG	0.21	0.000092	0.013	100	1.8	0.44	0.0023	5.0	0.42	11	0.000018	30	7.1	0.00018	0.00018	0.019	0.0069	0.003	0.15
All PAG - Pre-Acid	1.8	0.00013	0.0072	76	7.9	0.66	0.0017	7.0	0.24	9.6	0.000021	53	1.7	0.00002	0.0002	0.026	0.0027	0.0039	0.021

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

Appendix C Pit Wall Source Terms

Table 11: Pit Wall Source Terms

Case	Alkalinity	Cl	F	P-D	SO_4	Al-D	Sb-D	As-D	Ba-D	Be-D	Bi-D	B-D	Cd-D	Ca-D	Cr-D	Co-D	Cu-D	Fe-D
	mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PAG Low	0	85	4.8	9.3	1300	4.6	0.0063	0.057	2.5	0.013	0.0035	2.3	0.0057	180	0.0083	0.54	11	1.5
PAG High	0	120	7.1	18	1800	5.2	0.011	0.11	3	0.02	0.0066	3.2	0.0066	190	0.0091	0.85	18	2.4
NAG Average	140	10	0.59	0.067	140	0.025	0.0017	0.0028	0.026	0.000078	0.000058	0.15	0.00025	110	0.00071	0.00067	0.022	0.14

Case	Pb-D	Li-D	Mg-D-D	Mn	Mo-D	Ni-D	K-D	Se-D	Si-D	Ag-D	Na-D	Sr-D	Tl-D	Sn-D	Ti-D	U-D	V-D	Zn-D
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
PAG Low	0.0069	0.19	32	13	0.018	0.14	21	0.1	380	0.0017	91	0.65	0.00067	0.012	0.038	0.002	0.018	2.7
PAG High	0.0072	0.28	32	15	0.031	0.2	30	0.19	510	0.0017	140	0.74	0.0009	0.017	0.042	0.0033	0.02	3.5
NAG Average	0.000092	0.0066	6.6	0.024	0.23	0.0011	1.8	0.03	11	0.000018	13	0.26	0.000026	0.00018	0.007	0.0014	0.003	0.019

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

Notes:

[1] MPMC estimates PAG rock above 1030 masl is 13%. Acidification will be progressive.

[2] Concentrations are "annual". Seasonal variation can be expected but these concentrations are intended to reflect seasonal worst for each case.

[3] Probabilities cannot be attached to the terms. Use the terms to assess proximity to trigger levels but not to assess probability of exceedance.

Appendix D Ore Processing Source Terms

Table 12: Ore Processing Source Terms

Case	Alkalinity	Cl	F	NO_3	NO_2	NH_3	PO_4	SO_4	DOC	Al	Sb	As	Ba	Be	B	Cd	Ca	Cr
	mg $CaCO_3$/t	mg/t	mg/t	mg-N/t	mg-N/t	mg-N/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
P5	73000	1500	11000	93	20	610	2800	33000	0	280	0.47	6.3	33	1.5	33	0.15	26000	1.5
P50	87000	1500	14000	230	26	810	2800	48000	0	480	1.2	9	42	1.5	39	0.15	30000	1.5
P95	92000	2800	15000	3600	33	1000	2800	96000	0	580	2.3	20	120	1.5	75	0.15	46000	1.5

Case	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	K	Se	Ag	Na	Tl	U	V	Zn
	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t	mg/t
P5	0.3	3	90	0.3	15	2100	2.2	51	1.5	2900	12	0.15	12000	0.3	0.11	12	30
P50	0.3	8.1	90	0.3	15	4100	3.1	69	1.5	5800	49	0.15	14000	0.3	0.22	30	30
P95	0.3	26	90	0.3	15	5500	14	130	1.5	8100	61	0.15	18000	0.3	0.34	53	30

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

Appendix E Tailings Source Terms

Table 13: Tailings Source Terms

Case		Alkalinity	Cl	F	NO_3	NO_2	NH_3	PO_4	SO_4	DOC	Al-D	Sb-D	As-D	Ba-D	Be-D	B-D	Cd-D	Ca-D
		mg $CaCO_3$/L	mg/L	mg/L	mg-N/L	mg-N/L	mg-N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Seepage	P95	63	29	1.0	9.3	0.27	0.2	0.029	700	6.9	0.017	0.00099	0.0026	0.087	0.001	0.18	0.00041	220
Seepage	P99	51	30	1.1	25	0.31	0.32	0.056	1200	9.3	0.069	0.0017	0.0032	0.15	0.0016	0.25	0.0006	370
Drained Down	P95	27	1.4	0.94	0.014	0.002	0.2	0.011	95	4.4	0.094	0.0052	0.018	0.067	0.0001	0.043	0.000061	47
Drained Down	P99	23	6.6	1.2	0.19	0.012	0.32	0.015	1100	6.3	0.14	0.0059	0.024	0.085	0.00012	0.14	0.00021	310

Case		Cr-D	Co-D	Cu-D	Fe-D	Pb-D	Li-D	Mg-D	Mn-D	Mo-D	Ni-D	K-D	Se-D	Ag-D	Na-D	Tl-D	U-D	V-D	Zn-D
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Seepage	P95	0.001	0.0012	0.016	0.062	0.0001	0.011	34	1.0	0.3	0.001	19	0.036	0.00002	110	0.0002	0.004	0.002	0.0083
Seepage	P99	0.0038	0.002	0.048	0.24	0.0003	0.021	68	1.5	0.4	0.0022	21	0.16	0.00002	120	0.0002	0.0097	0.0031	0.023
Drained Down	P95	0.0005	0.0001	0.026	0.03	0.00005	0.01	5.1	1.0	0.2	0.0005	6.5	0.047	0.00001	20	0.00001	0.004	0.025	0.0037
Drained Down	P99	0.0005	0.00021	0.045	0.03	0.000082	0.028	38	1.5	1.0	0.00098	18	0.56	0.000012	78	0.000021	0.0097	0.034	0.0063

Sources: https://srk.sharepoint.com/sites/NACAPR002434/Internal/!020_Project_Data/010_SRK/Source_Terms/Source_Terms_CAPR002434_Rev00_SJL.xlsx

APPENDIX 2-3: Site Wide Water Balance Model Update and Calibration Technical Memorandum

TECHNICAL MEMORANDUM

DATE March 21, 2024 **Reference No.** CA0020527.4505-026-TM-Rev0-31141

TO Matt O'Leary
Mount Polley Mining Corporation

FROM Stella Cheng, Gonzalo Donoso, and Peter Morgan **EMAIL stella.cheng@wsp.com; gonzalo.donoso@wsp.com; peter.morgan@wsp.com**

2023 SITE WIDE WATER BALANCE MODEL UPDATE AND CALIBRATION – MOUNT POLLEY MINE

1.0 INTRODUCTION

Mount Polley Mining Corporation (MPMC) retained WSP Canada Inc. (WSP) to provide water balance modelling services to update and calibrate the Site Wide Water Balance Model (SWWBM) in support of MPMC's 2023 Annual Report. This exercise is a requirement of Section 4.2.1 (f) of MPMC's Discharge Permit 11678, issued under the *Environmental Management Act* and most recently amended through a Consent Order on December 31, 2020 (BC ENV 2020).

The SWWBM was developed using GoldSim™, a highly graphical software package for carrying out dynamic, probabilistic simulations to support decision-making (GoldSim 2018). GoldSim™ is frequently used to evaluate water management alternatives, perform sensitivity analyses, and conduct mass balance simulations.

The SWWBM was developed as part of the Mount Polley Mine Resumed Operations and Closure Water Management Plan Permit Amendment Application and Technical Assessment Report (Golder 2016a) to model water management across the site (e.g., runoff, water transfers, and storage). The details of the SWWBM were first presented in the Mount Polley Mine Water Balance report (Golder 2016b).

On May 26, 2019, Mount Polley Mine (the Mine) entered a care and maintenance phase. On June 1, 2022, the Mine resumed operations under the current EMA Permit 11678. Mining and tailings deposition occurred throughout 2023.

WSP updated the SWWBM in March 2023 to calibrate water volumes, water levels and discharges in the Tailings Storage Facility (TSF) for the period from January 1, 2022 to December 31, 2022 (WSP 2023a). An updated Water Balance Report was presented in 2023 (WSP 2023b) as part of the Water Management Plan for the Springer Expansion Life-of-Mine update (WSP 2023c).

This technical memorandum describes updates to the SWWBM to reflect site conditions in 2023, and calibration to measured water levels in the TSF for the period from January 1, 2023 to December 31, 2023. A summary of the model updates, the assumptions made in the calibration process, a discussion of the calibration results, and the end-of-year water balance for the Mine, is included in this document.

2.0 MODEL UPDATE

2.1 Data Received

MPMC provided WSP with measured data from site (MPMC 2024a). The following data were received from MPMC (2024a):

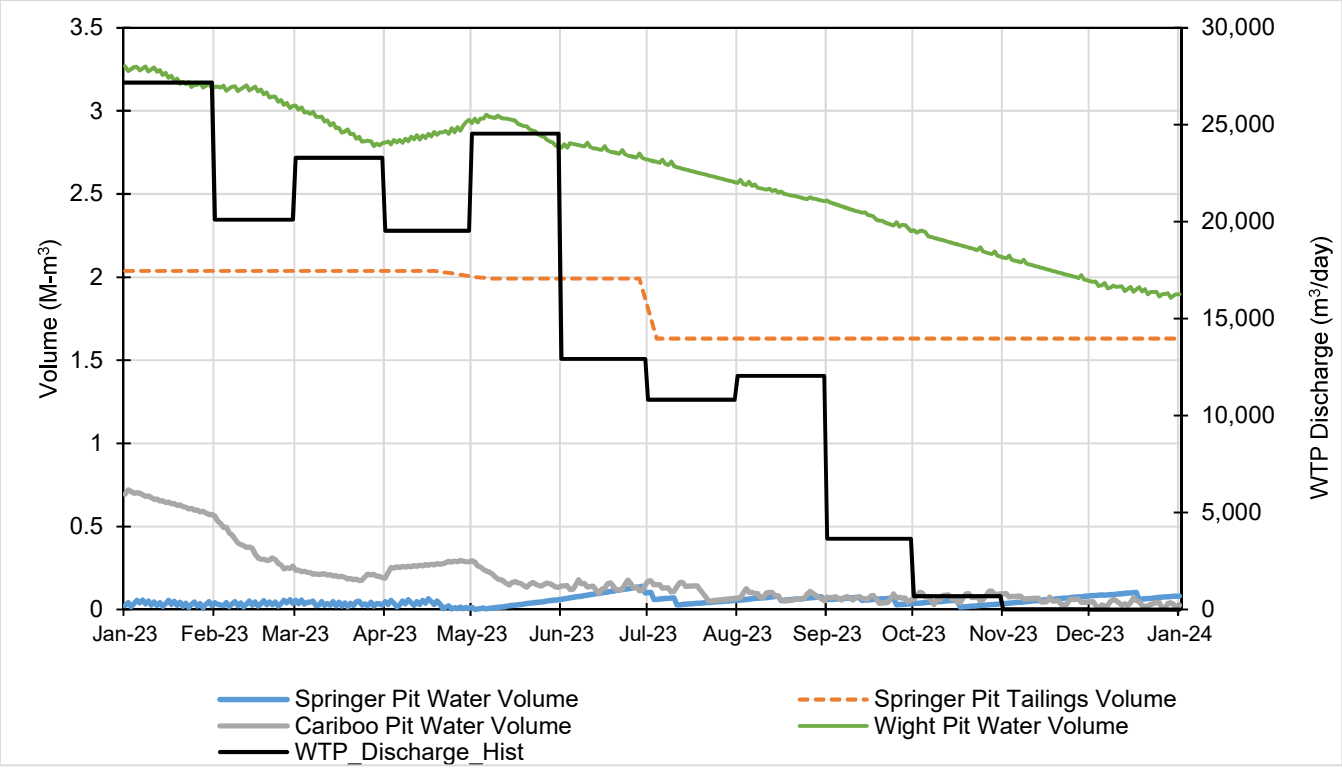
- "Snow Pack 2023.xlsx" Periodic snowpack measurements (snow water equivalent [SWE] in cm).
- "TSF Water Balance Jan 24, 2023 v3.xlsx" Periodic Springer Pit, Cariboo Pit and Wight Pit water level measurements in 2023 (m, mine grid).
- "2023 all weather station data.xlsx" Q1 to Q4 2023 climate data from site – including rainfall (mm), daily temperature (ºC) and evaporation (mm).
- "HMI WTP 2023 Total.xlsx" Monthly discharge of treated water (m^3) through the water treatment plant (WTP).
- "Weekly TSF Reports.pdf" TSF reclaim pond water level measurements (m, tailings grid) and Springer Pit remaining tailings (M-m^3) throughout 2023
- "2023 DSI Report Data Request.msg" Tailings deposited in the TSF throughout 2023 (tonnes).

2.2 Summary of Model Updates

Through discussions with MPMC, the SWWBM was updated to reflect site water management operations for the period of January 1, 2023 to December 31, 2023. The model updates were as follows:

- Tailings discharge from the ore processing plant to the TSF throughout 2023.
- Discharge to the environment through the WTP was updated. The volume of WTP discharge saw a significant decline beginning in September 2023. This decrease occurred because the WTP has been offline since September 13, 2023, as water has been redirected from Wight Pit to TSF (MPMC 2024a). Monthly discharge volumes through the WTP are shown on Figure 1.
- Water from Wight Pit was transferred to the WTP via Long Ditch for treatment and discharge in 2023. A time series plot of the modelled total water volume in Wight Pit is shown in Figure 1.
- Water from Springer Pit was transferred to the WTP via West Ditch for treatment and discharge throughout 2023. A time series plot of the modeled total water volume in Springer Pit is shown in Figure 1.
- Water from Cariboo Pit was transferred to the WTP via West Ditch for treatment and discharge throughout 2023. A time series plot of the modeled total water volume in Cariboo Pit is shown in Figure 1.

Additional details related to use of available surveys are provided in the following section.



Note: The primary y-axis unit (M-m3) denotes millions of cubic meters.

Stored water volume = surface water volume + voids water volume

Figure 1: Springer, Cariboo, Wight Pits Volumes and WTP Discharge Flow Rate

2.3 Site Surveys

2.3.1 TSF

Topographic surveys of the TSF were conducted by MPMC on October 30, 2023. A bathymetric survey within the TSF was conducted on August 25, 2023. The storage-elevation curve was developed using the combined bathymetry and topography, and it is used in the SWWBM to infer the TSF free water volume from measured water level data, recognizing that the surfaces described are a triangulation of a bathymetry survey (tailings surface under water) and a topographic survey (tailings surface above water). The triangulation of survey points near the transition between water and land, as well as the use of different dates for the Topographic and Bathymetric Surveys, introduce uncertainty into the resulting storage-elevation curves. However, the accuracy is considered acceptable for the required resolution of the model results.

Storage-elevation curves for the TSF up to a dam crest elevation of 974 m developed from the August 25, 2023 TSF survey were used in support of the free water volumes projection affected by tailings deposition after the survey date of October 30, 2023. Storage-elevation curves were used to model the facilities with linear interpolation throughout 2023.

2.3.2 Springer-Cariboo

A bathymetric and topographic survey of Springer-Cariboo Pit was conducted by MPMC on January 25, 2024, indicating that the Springer and Cariboo pits were divided up to the saddle level (approximate elevation of 964 m), and then combined from that level upward. Based on the recorded pit elevation data from MPMC (MPMC 2024a) and the fact that the Springer Pit was completely dewatered as of April 18, 2023 (MPMC 2024b), the Springer Pit and Cariboo Pit should be considered as separate reservoirs for modeling purposes in 2023. Storage-elevation curves for Springer Pit and Cariboo Pit were generated individually to infer the free water volumes within the pits from measured water level data in the SWWBM.

Springer Pit storage-elevation curves based on the bathymetric and topographic survey on November 7, 2019 were utilized in the model until April 18, 2023. These were then projected to the Springer Pit storage-elevation curve based on the January 25, 2024 survey. Projected storage-elevation curves were used to model the facilities with linear interpolation. Tailings were excavated during the calibration period, it is assumed that the excavation is reflected in the survey data. Figure 1 shows a time series plot of Springer Pit tailings volume.

Cariboo Pit storage-elevation curves (dated January 30, 2023, refer to MPMC 2023) were utilized until the end of 2022. These were then projected to the Cariboo Pit storage-elevation curve based on the January 25, 2024 survey. Projected storage-elevation curves were used to model the facilities with a daily linear interpolation between dates, throughout 2023.

2.3.3 Wight Pit

Wight Pit storage-elevation curves (dated March 1, 2022; MPMC 2022) were provided by MPMC. The curves include underground workings and pore space assumptions. Measured water level data from MPMC were used to infer the water volumes in the pit based on the storage-elevation curves provided.

3.0 MODEL CALIBRATION

3.1 Overview

The SWWBM was calibrated by adjusting outflows of the reservoirs and comparing modelled water levels to measured water levels recorded at the TSF. The TSF temporarily retains high runoff inflows experienced during freshet and storm events. The resulting modelled water levels in the TSF are the balance of site-wide inflows and outflows, including pumping to and from the pits and the booster station, which are temporary storage locations for surplus water on site.

An input climate dataset was generated (Section 3.2) and seasonal runoff coefficients were used during freshet (Section 3.3) to better represent measured site runoff conditions (i.e., reduction in measured snowpack depth) in 2023 and to facilitate the calibration.

3.2 Climate Data

A climate dataset at the Mine for 2023 was generated and used to represent site climatic conditions for the calibration.

The dataset consisted of the following:

- January through December rainfall data from MPMC.

- Freshet (March through April) snowmelt as determined from decreases in snowpack SWE depth recorded at the Mine.

3.3 Runoff Coefficients

Runoff coefficients in the SWWMB are adjustable loss parameters that translate measured climate trends and ground conditions into estimates of modelled runoff. Model performance from historical climate data for the year 2023 supported the delineation of runoff coefficients into two distinct seasonal climate periods:

- Freshet (March to June; inclusive) – Highest runoff coefficients to represent expected higher soil moisture content, and therefore greater runoff.
- General (January to February; inclusive and July to December; inclusive) – Mid range coefficients to represent soil moisture contents for intermittent runoff events. A 30% increase to the general coefficients is applied to the subsequent month if the previous month had a cumulative rainfall plus snowmelt depth greater than 50 mm.

The seasonal runoff coefficients defined for the catchment types remained unchanged from those used in the 2022 SWWBM calibration and are listed in Table 1.

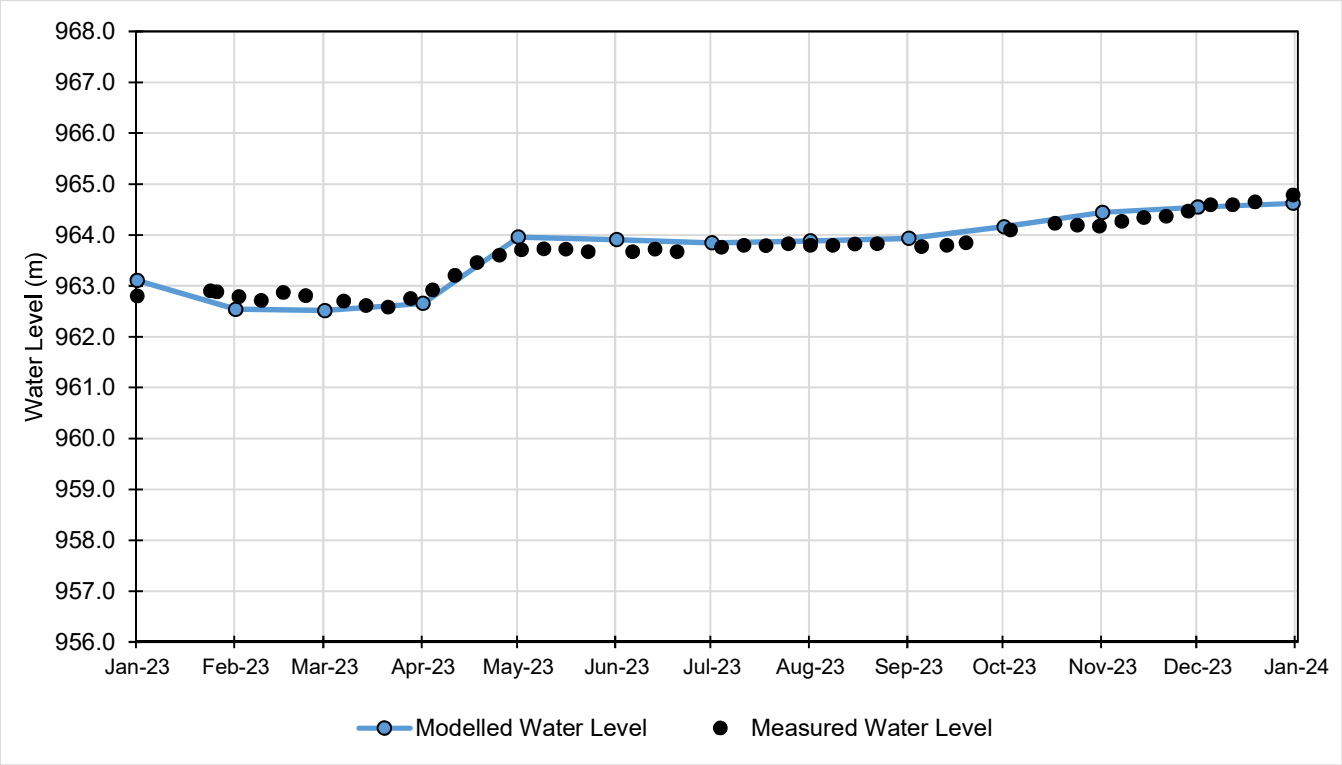
Table 1: Seasonal Runoff Coefficients

Catchment Type	General	Freshet
Exposed tailings	0.6	0.9
Disturbed areas	0.3	0.9
Rock disposal site areas	0.1	0.6
Open pits	0.75	0.9
Undisturbed catchments	0.4	0.42
Haul roads and access roads	0.15	0.9
Mill site area	0.1	0.1

Source: Golder 2020

4.0 CALIBRATION RESULTS

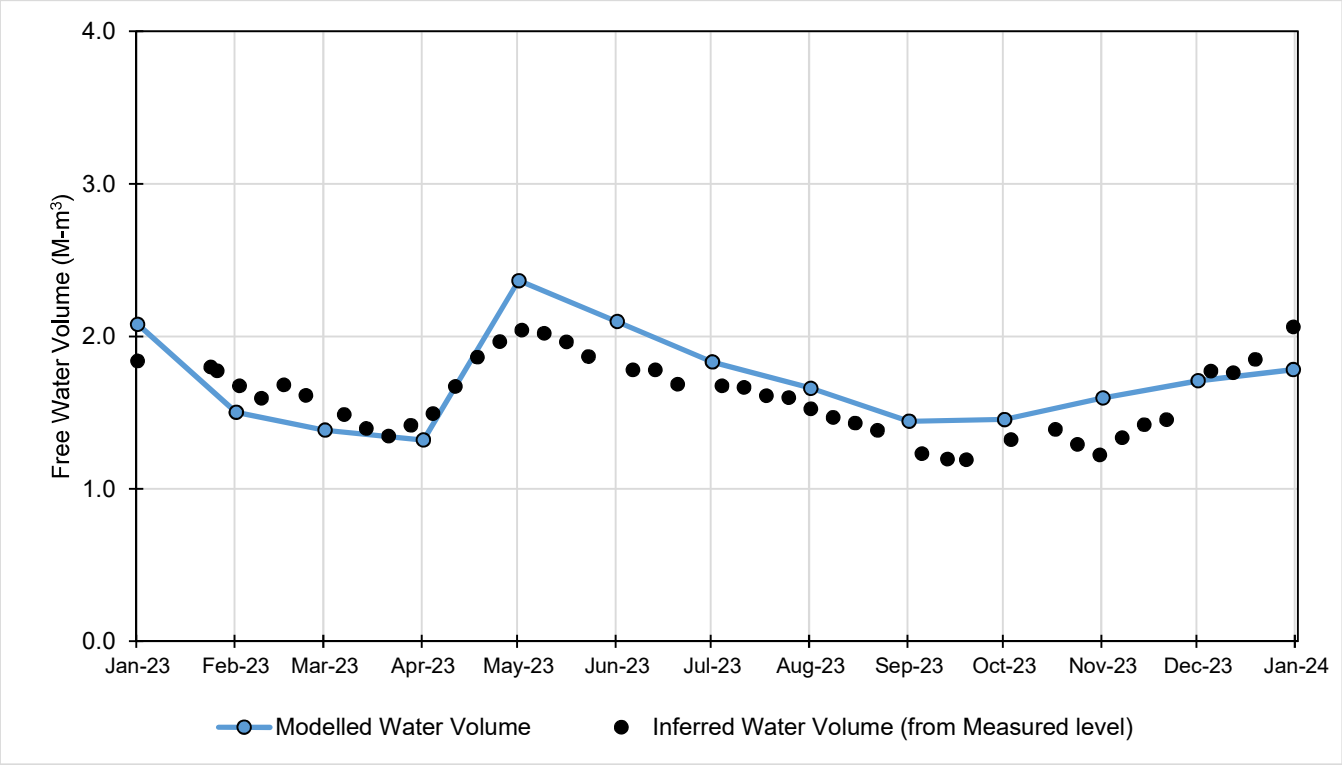
Figure 2 shows the modelled and measured water levels within the TSF for the 2023 calibration period. The modeled water levels were estimated from the modeled volume estimated using the storage-elevation storage curves. The average difference between modelled and measured water levels is approximately 0.14 m, which is considered acceptable for the purposes of the calibration exercise.



Note: Last measured water level occurred on 31 December 2023.

Figure 2: Water Levels in the TSF

Figure 3 shows the modelled free water volume in the TSF along with the inferred free water volume from measured water levels. The measured water levels were converted to an inferred water volume using the storage-elevation curves described in Section 2.3.



Note: Last measured water level occurred on December 31, 2023. The y-axis unit (M-m^3) denotes million cubic meters.

Figure 3: Free Water Volume in the TSF

Figure 2 and Figure 3 indicate that the model is reasonably calibrated and there is general alignment between measured free water levels and the inferred free water volume in the TSF. Differences between modelled and measured values may have several explanations:

- Variability in runoff coefficient throughout the year.
- Uncertainties in the climate data (e.g., snowpack surveys can miss intermittent snowmelt if conducted infrequently and the use of composite datasets may over or under-estimate actual conditions).
- Uncertainties in the TSF bathymetric survey (e.g., the transition between exposed tailings surface [i.e., beach] and free water can be complex).
- Uncertainties associated with the tie-in of the October 30, 2023 TSF storage curve with those utilized in the 2022 calibration, specifically referring to the projected storage curves from the 2020 TSF survey to the 987 m dam crest elevation.
- Uncertainties related to the projection of the Cariboo Pit storage curve from 2022 Calibration to the January 25, 2024 survey could lead to a situation where less storage capacity is modeled for the Cariboo Pit. Consequently, the volumes for the TSF and other pits may over estimated.
- Potential inaccuracies in water level measurements.

- Potential inaccuracies and/or missing WTP discharge data. The TSF weekly report noted that WTP ceased operations after September 13, 2023. However, there were still low volumes of WTP discharge recorded in October and November 2023. Additionally, the WTP discharge data are available for only 6 days in December 2023 (MPMC 2024a).
- Potential differences between modeled water transfer rates and actual transfers on site.
- There were minor discrepancies in the tailings deposition data between TSF Water Balance Spreadsheet and 2023 DSI Report data request (MPMC 2024a). WSP proceeded with tailings production umbers from the 2023 DSI Report data request to ensure consistency with the data used in the DSI.

The modelled results for the 2023 SWWBM calibration provide a reasonable approximation of site conditions and are considered suitable for water management planning.

5.0 END-OF-YEAR WATER BALANCE

Table 1 presents End of Year (EoY) modelled site water balance from 2017 through 2023. The modelled balance is the net storage of free water volume (total water) on site and net annual inflow. Storage locations include the TSF, pits, sumps, and ponds.

Table 2: EoY Modelled Site Water Balance Volume

Date	Total Water on Site[(a)(b)] (M-m^3)	Annual Water Net Inflow[(c)] (M-m^3)
December 31, 2017	6.0	4.6
December 31, 2018	3.9	5.3
December 31, 2019	3.8	6.4
December 31, 2020	8.2	9.5
December 31, 2021	7.5	6.1
December 31, 2022	6.0	6.4
December 31 ,2023	4.0	5.6

(a) End of year sum of water in TSF, pits, sumps, and ponds.
(b) Includes Wight Pit stored water volume.
(c) Net Inflows = Direct Precipitation + Runoff + Baseflows + Groundwater Inflow - Evaporation - Groundwater Outflow (for calendar year).

6.0 RECOMMENDATIONS

Based on the results of the 2023 SWWBM calibration, the following recommendations are provided to enable more robust water balance modelling:

- Increase the frequency of periodic snowpack measurements in the spring and fall seasons to generate more representative snowmelt data (e.g., in case mid-season snowmelt occurs outside of the freshet period).
- Record both snowfall and rainfall data measurements in the winter to produce more representative climate data (only rainfall and snowpack is recorded currently).

- Conduct both topographic and bathymetric surveys in spring and fall annually to achieve a more precise TSF storage curve progression.
- Review and validate available flow data on site to supplement the calibration of the SWWBM.
- Refine the runoff coefficients as part of future model updates.
- Refine the catchment areas to confirm various land types annually, thereby enhancing the precision of runoff estimations in the model through future updates.

7.0 CLOSURE

This technical memorandum summarizes the SWWBM calibration and end-of-year water balance for the model run period January 1, 2023 to December 31, 2023 (inclusive). The reader is referred to the Study Limitations section, which follows the text and forms an integral part of this memorandum.

We trust that this technical memorandum satisfies your current requirements. Please contact the undersigned should you have any questions.

WSP Canada Inc.

Stella Cheng, B.Sc., P.Eng.
Water Resources Engineer

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
G.A. DONOSO QUIROGA
211694
2024-03-21

Gonzalo Donoso, M.Sc., P.Eng.
Senior Water Resources Engineer

PERMIT TO PRACTICE #1000200
Engineers & Geoscientists BC

Peter W. Morgan, P.Eng.
Fellow, Mine Water

SC/GD/PWM/ar/ca/anr

https://golderassociates.sharepoint.com/sites/10023g/ca00205274505 deliverables/002_issued/026-tm-31141-2023 site wide water balance model update and calibration/rev0/ca0020527.4505-026-tm-rev0-31141-2023 wb calibration 21mar_24.docx

REFERENCES

BC ENV. 2020. British Columbia Ministry of Environment and Climate Change Strategy. Effluent Discharge Permit 11678. Issued to Mount Polley Mining Corporation on February 1, 2020 and Amended December 31, 2020.

Golder (Golder Associates Ltd.). 2016a. Mount Polley Mine Long Term Water Management Plan Permit Amendment Application under the Environmental Management Act: Technical Assessment Report. Prepared for Mount Polley Mining Corporation. No. 1411734-162-R-Rev0-16000. October 17, 2016.

Golder. 2016b. Operations and Closure Mount Polley Mine Water Balance Model. Prepared for Mount Polley Mining Corporation. No. 1411734-167-R-Rev0-16000. October 17, 2016.

Golder. 2020. Mount Polley Mine. Water Management Plan (Mine Operations). Prepared for Mount Polley Mining Corporation. Ref No.19133363-066-R-Rev0-31550. November 27, 2020.

GoldSim (GoldSim Technology Group). 2018. GoldSim User's Guide Version 12.1, Issaquah, WA. June 2018.

MPMC (Mount Polley Mining Corporation) 2022. Mount Polley 2021 Annual Calibration Data. Files sent via electronic transfer. January 18, 2022.

MPMC. 2023. Mount Polley 2022 Annual Calibration Data. Files sent via electronic transfer. January 30, 2023.

MPMC. 2024a. Mount Polley 2023 Annual Calibration Data. Files sent via electronic transfer. February 9, 2024.

MPMC. 2024b. Mount Polley - RFI - 2023 Water Balance Calibration - Springer Pit Dewatering Information. Matt O'Leary. Emailed on January 15, 2024.

WSP (WSP Canada Inc.). 2023a. Mount Polley Mine 2022 Site Wide Water Balance Model Update and Calibration. Prepared for Mount Polley Mining Corporation. No. 23590671-013-TM-Rev1-31141. March 30, 2023.

WSP. 2023b. Mount Polley Mine Water Balance Model – Springer Expansion Life-of-Mine. Prepared for Mount Polley Mining Corporation. No. 23590671-084-TM-Rev0-31182. December 4, 2023.

WSP. 2023c. Mount Polley Mine Water Management Plan – Springer Expansion Life-of-Mine. Prepared for Mount Polley Mining Corporation. No. 23590671-091-TM-Rev0-31191. December 4, 2023.

STUDY LIMITATIONS

WSP Canada Inc. (WSP) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by WSP for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents WSP's professional judgement based on the knowledge and information available at the time of completion. WSP is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to WSP by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

APPENDIX 2-4: 2023 Annual Reclamation Report for the Mt Polley Mine

Mount Polley Mining Corporation
an Imperial Metals company
Box 12 • Likely, BC V0L 1N0 • T 250.790.2215 • F 250.790.2613

2023 Annual Reclamation Report for the Mount Polley Mine

Submitted to:

BC Ministry of Energy, Mines, and Low Carbon Innovation
***(Mines Act* Permit M-200)**

Prepared by:

Mount Polley Mining Corporation
Technical Services Department
Box 12, Likely BC
V0L 1N0
(250) 790-2215

Mine Manager: Kelly Parker
Chief Engineer: Richard Tuohey

March 29, 2024

EXECUTIVE SUMMARY

The 2023 Annual Reclamation Report is submitted by Mount Polley Mining Corporation (MPMC) to the Ministry of Energy, Mines and Low Carbon Innovation (EMLI) in accordance with both operating permit M-200 and the *Mines Act*, Health, Safety and Reclamation Code for Mines in British Columbia (February 2021), Section 10.4.4(a). The contents of this report also include applicable information as specified in the document titled, "Mines Act Permit Annual Reclamation Report – General Information and Format Requirements" (Updated January 2021).

The Mount Polley Mine is a copper-gold open pit mine located approximately 56 km northeast of Williams Lake, BC that went into production in 1998. On August 4, 2014, a breach occurred in the Perimeter Embankment of the Tailings Storage Facility released tailings, water, and embankment construction materials to the downstream environments of Polley Lake, Hazeltine Creek and Quesnel Lake. Following the breach, the mine commenced restricted operations, with tailings being deposited in the Springer Pit in August 2015. In June 2016, the mine was approved to return to full operations permitting mining of Phase 4 Cariboo-Springer Pits. In January 2019, MPMC announced a decision to go on suspended operations (Care and Maintenance) on May 31, 2019 citing low metal prices. EMLI provided a Cessation of Operations Acknowledgement letter to MPMC on July 25, 2019.

Mining operations resumed in late 2021. Currently authorized operations allow for: open pit mining of the Phase 4 Cariboo-Springer Pit; milling of up to a maximum of 8,200,000 t of ore per year with deposition in the TSF; and construction and operation of the TSF up to an elevation of 970 metres above sea level (masl).

The current active project infrastructure consists of the mill site, mining in the Cariboo-Springer 4 Pit, two rock disposal sites (RDS) (the Southeast Rock Disposal Site (SERDS), and the Temporary Northwest (NW) Potentially-Acid Generating (PAG) Stockpile), the TSF, as well as access roads, power lines, a tailings pipeline, drainage collection systems, and sediment/seepage control pond. Back-filling of the Bell Pit and Pond Zone Pit with waste rock was completed in 2012, and the SEZ Pit was backfilled in 2013.

In 2023, mining of the Phase 4 Cariboo-Springer 4 Pit continued with development of the SP4 1000 through to the SP4 928 benches. Material classified as potentially-acid generating (PAG) was dispatched to the Temporary Northwest (NW) Potentially-Acid Generating (PAG) stockpile. Material classified as non-acid generating (NAG) was dispatched to the Southeast Rock Disposal Site (SERDS). Ore was dispatched to the crushing facility and or to the stockpiles.

Crushing of ore and milling operations continued throughout the year.

As permitted by the *Environmental Management Act* Permit 11678, the Water Treatment Plant operated almost continuously in 2023 and discharged a total of 4,439,062 m^3 of water. The annual average discharge

rate was 17,895 m^3/day and daily maximum discharge rates ranged from 0 m^3/day to 31,811 m^3/day. Reporting to Environment and Climate Change Canada under the Federal Metal and Diamond Mining Effluent Regulations continued accordingly.

Environmental management and monitoring in 2023 followed guidelines and procedures contained in the Comprehensive Environmental Monitoring Plan and was in accordance with regulations contained in *Environmental Management Act* Permit 11678 and *Mines Act* Permit M-200. Monitoring followed the updated 2019 Comprehensive Environmental Monitoring Plan which was approved on February 10, 2021, and immediately came into effect. Mining activities including production summaries and reclamation follow requirements contained in *Mines Act* Permit M- 200. Water chemistry results from monitoring sites were compared with appropriate permitted limits and British Columbia Water Quality Guidelines for aquatic life.

In 2023, there was one unauthorized release of mine-affected water and two spills reported to Emergency Management BC. There was one instance of results triggering the *Environmental Management Act* Permit 11678 limits. Proper notification was sent to the Director and other required parties, the Water Treatment Plant was promptly shut down, investigations were undertaken, and mitigation works were completed as required.

CONTENTS

Executive Summary i
List of Tables viii
List of Figures x
List of Appendices xi
List of Units xv
List of Consultants and Laboratories xvi
1 Introduction 17
1.1 Project History 17
1.1.1 Tailings Storage Facility Embankment Breach 20
1.1.2 Post TSF Embankment Breach Reporting 20
1.2 Post TSF Embankment Breach Project Status 21
1.2.1 Mine Operations 21
1.3 Site Description 22
1.3.1 Topography and Climate 22
1.3.2 Hydrogeology 22
1.3.3 Deposit Geology 25
1.3.4 Reclamation Objectives 27
2 Mining Program 29
2.1 2022 Exploration 29
2.2 Surface Development to Date 29
2.2.1 Underground Mining Program 38
2.3 Current Life of Mine Plan 38
2.4 Surface Development in the Past Year 39
2.5 Surface Development Projected Over the Next 5 Years 39
2.6 Salvaging and Stockpiling of Surficial Materials 40
2.6.1 Volumes and Storage Locations 40
2.6.2 Soil Stockpile Inspections 42
2.6.3 Soil Stockpile Quality 42
3 Environmental Protection Program 43
3.1 Environmental Management Systems 43
3.2 Environmental System Audits 44
3.3 Water Management 45
3.3.1 Evaluation of Effectiveness of Water Management 45
3.3.2 Water Management System Update 45
3.3.3 Water Discharge Background 48
3.3.4 Long-Term Water Management Plan Development 50
3.3.5 Water Balance 52
3.3.6 Water Management System Upgrades 55
3.4 ML/ARD Characterization and Mine Waste Management 55

3.4.1 Waste Rock Characterization and Disposal 55
3.5 Sediment and Erosion Control 61
3.6 Waste Management 61
3.6.1 Storage 62
3.6.2 Chemical, Reagent, and Contaminated Waste Disposal 62
3.6.3 Recycling 62
3.7 Incidents 63
3.7.1 Spills of Hydrocarbon or Dangerous Goods 63
3.7.2 Water Releases 63
3.8 Archaeological Resources 63
4 Environmental Monitoring 64
4.1 Data Quality Assurance/ Quality Control 64
4.2 Scheduling 64
4.3 Field Methods 64
4.3.1 Sample Collection 64
4.3.2 Sample Suites 65
4.3.3 Field Meters and Monitoring Equipment 65
4.4 Quality Control and Data Quality Objectives 66
4.4.1 Duplicates and Blanks 67
4.4.1.1 Field QA Results and Discussion 68
4.5 Data Quality Review and Data Management 80
4.5.1 Rating Curve Development 81
4.6 Climate 83
4.6.1 Wind Monitoring 84
4.6.1.1 Weather Station 1 – Leach Pad 84
4.6.1.1 Weather Station 2 – Orica 85
4.6.2 Temperature 85
4.6.3 Precipitation 86
4.6.4 Evaporation 87
4.7 Surface Water Monitoring 88
4.7.1 Hazeltine Creek 88
4.7.1.1 BC WQG at HAC-10 89
4.7.1.2 BC WQG at HAC-13 89
4.7.1.3 BC WQG at HAC-05a 89
4.7.1.4 BC WQG at HAC-08 90
4.7.1.5 BC WQG at HAC-01c 90
4.7.1.6 Supplemental Sites: POF-1 and POF-5 90
4.7.2 Aquatic Receiving Environment 90
4.7.2.1 Site W1 – Morehead Creek (E225084) 92
4.7.2.2 Site W4a – North Dump Creek below Wight Pit Road (E298551) 93

4.7.2.3 Site W5 – Bootjack Creek (E208039) 94
4.7.2.4 Site W8 – Northeast Edney Creek Tributary (E216743) 95
4.7.2.5 Site W8z – Southwest Edney Creek Tributary (E223292) 95
4.7.2.6 Site W10 – Edney Creek (E291209) 96
4.7.2.7 Site EDC-01a – Edney Creek below confluence with Hazeltine Creek (E303014) 96
4.7.2.8 Site W12 – 6K Creek at Road (E216744) 97
4.7.2.9 Site W20 – W20 Creek (E297070) 98
4.7.3 Lake Sampling 98
4.7.3.1 Bootjack Lake 100
4.7.3.2 Polley Lake 101
4.7.3.3 Quesnel Lake 103
4.8 Hydrology 107
4.8.1 Site H1 - Upper Hazeltine Creek 107
4.8.2 Site H2 - Lower Hazeltine Creek 107
4.8.3 Site H4 - Polley Lake Weir 108
4.8.4 Hydrology – Mine Site 108
4.8.5 Site W1b – Upper Morehead Creek 108
4.8.6 Site W4a – North Dump Creek 109
4.8.7 Site W5 – Bootjack Creek above Hazeltine Creek 109
4.8.8 Site W12 – 6 km Creek at Bootjack Road 109
4.8.9 Site H3a – Lower Edney Creek 109
4.8.10 Supplemental Sites 110
4.9 Groundwater Monitoring 110
4.9.1 Mine Site 110
4.9.2 Hazeltine Creek 111
4.10 Contact Water Chemistry 111
4.10.1 Site E1a – Tailings Supernatant (E225309) 113
4.10.2 Long-Term Predictions 115
4.10.3 Heap Leach Research 116
4.10.4 Sulphur Pile 117
4.11 Seepage Water Chemistry 117
4.12 Discharge System and Monitoring 119
4.12.1 Discharge System 119
4.12.1.1 Treatment Works and Source Control Optimization 119
4.12.1.2 WTP Operations 120
4.12.1.3 Water Treatment plant Costs 124
4.12.1.4 Outfall and Pipeline Commissioning and Inspection 124
4.12.2 Discharge Monitoring 124
4.12.2.1 Permit Compliance 125
4.12.2.2 Influent Chemistry – E19 126

4.12.2.3 Effluent Chemistry – HAD-03 126
4.12.2.4 HAD-03 Permit Limit Exceedance Events 128
4.12.2.5 Plume Dispersion Model 129
4.12.2.6 Receiving Environment Chemistry – Quesnel Lake 130
4.12.2.7 Receiving Environment Chemistry – Quesnel River 137
4.12.3 Discharge Toxicity Testing Results 137
4.12.3.1 Acute toxicity testing 138
4.12.3.2 Chronic toxicity testing 138
4.13 Sediment Quality 139
4.14 Benthic Invertebrates 139
4.15 Plankton, Chlorophyll *a*, and Secchi Disk 139
4.15.1 Plankton and Chlorophyll *a* 139
4.15.2 Secchi Disk 144
4.16 Periphyton 145
4.17 Fish 145
4.17.1 Fish and Habitat Surveys 145
4.18 Terrestrial Monitoring 145
4.18.1 Wildlife Monitoring 146
4.19 Soil 148
4.20 Soil Invertebrates 148
4.21 Vegetation 148
5 Reclamation Program 150
5.1 End Land Use 150
5.2 Land Capability 150
5.3 Stability of Works 151
5.3.1 Rock Disposal Sites (RDS) 151
5.3.2 Pit Walls Stability 152
5.3.3 Road Stability 152
5.3.4 Tailings Storage Facility and Associated Works 153
5.3.5 Underground Stability 155
5.4 Revegetation 155
5.4.1 Invasive Plant Management 156
5.5 Growth Medium 156
5.6 Landforms 157
5.7 Structures and Equipment 157
5.8 Waste Dump Reclamation 157
5.8.1 Waste Dumps: North Bell Dump 158
5.8.2 Waste Dumps: NEZ Dump 158
5.8.3 Waste Dumps: Boundary Dump 158
5.8.4 Waste Dumps: East RDS 158

5.8.5 Watercourse Reclamation 159
5.8.6 Pit Reclamation 159
5.8.7 TSF Reclamation 159
5.8.8 Road Reclamation 159
5.8.9 Securing of Mine Openings 159
5.9 Disposal of Hazardous Materials, Chemicals and Reagents 159
5.9.1 Recycling 159
5.10 Reclamation Research 160
5.10.1 Biosolids 161
5.10.1 Water Treatment Technology Development 163
5.11 Five Year Reclamation Plan 163
Notice of Departures 166
6 Reclamation Liability Cost Estimates 168
7 Signatures 169
8 References 170

List of Tables

Table 1.1 Summary of *EMA* Permit 11678 amendments 18
Table 2.1 Mount Polley Mine Site SUMMARY OF AREAS DISTURBED AND RECLAIMED TO DECEMBER 31, 2023, represents EMLI Standard Table 30
Table 2.2 2023 Quantity of Waste Rock 36
Table 2.3 Summary of monthly milling rates in 2023 37
Table 2.4 2023 mill production summary 38
Table 2.5 Changes in disturbed areas with closure footprints 40
Table 2.6 2023 soil stockpiling and transfers 40
Table 2.7 MPMC Soil Inventories as of December 31, 2023 41
Table 3.1 Outstanding orders from EMLI inspections 44
Table 3.2 Summary of *EMA* Permit 11678 authorizations for water discharge from the Mount Polley Mine 50
Table 3.3 Water storage conditions at end of each year, 2018-2023. 53
Table 3.4 Monthly Springer Pit elevations, 2019-2023. 53
Table 3.5 Quantities of waste rock, tailings, low grade ore, and other mine waste for 2023 57
Table 3.6 Summary of ABA data from the operating pits in 2023 59
Table 3.7 ABA results from 2023 monthly tailings composite samples 59
Table 3.8 Summary of monthly milling rates 2023 60
Table 3.9 2023 mill production summary 61
Table 3.10 Approximate volumes of treatment and processing chemicals stored at the Mount Polley Mine site 62
Table 3.11 Approximate volumes of blasting chemicals and reagents stored at the Mount Polley Mine site 62
Table 4.1 MPMC full sampling suite 65
Table 4.2 Water chemistry QC sample frequencies for MPMC monitoring programs 67
Table 4.3 Duplicate Sample RPD acceptance criteria 68
Table 4.4 Field duplicate sample locations collected in 2023 68
Table 4.5 Trip blanks sent for analysis in 2023 73
Table 4.6 Summary of trip blank results that are above the lab detection limit 75
Table 4.7 Summary of field blank results that are above the lab detection limit 75
Table 4.8 Field blanks sent for analysis in 2023 76
Table 4.9 Equipment blanks taken in 2023 78
Table 4.10 Summary of KEM2 blank results that are 5x detection limit, 2023 79
Table 4.11 Summary of groundwater equipment blanks 79
Table 4.12 Summary of GW-Grundfos/GW-LowFlow blank results that are 5x detection limit, 2023 80
Table 4.13 Mount Polley 2023 monthly precipitation, evaporation, and temperature data 84
Table 4.14 2023 sampling events in Hazeltine Creek 88
Table 4.15 Summary of 2023 acute BC WQG for aquatic life exceedances in Hazeltine Creek 89
Table 4.16 2023 Sampling events at surface water quality sites. 91

Table 4.17 Summary of 2023 acute BC WQG exceedances for aquatic life at surface water monitoring sites 92
Table 4.18 2023 Lake water quality sampling locations 99
Table 4.19 2023 Lake BC WQG acute exceedance events 99
Table 4.20 2023 Sampling events at contact water quality sites 112
Table 4.21 Heap leach sump level in 2023 116
Table 4.22 Site drainage water quality monitoring locations, and sampling periods and frequencies 118
Table 4.23 Instances and reasons for discharge stoppages in 2023 121
Table 4.24 – 2023 WTP costs 124
Table 4.25 Sampling events in 2023 at discharge monitoring sites 125
Table 4.26 Effluent discharge condition during IDZ sampling at QUL-58 130
Table 4.27 Toxicity sampling events in 2023 138
Table 4.28 Chlorophyll *a* sample events from 2019-2023 141
Table 4.29 Secchi depth measurement events in 2023 144
Table 4.30 2023 wildlife observations at Mount Polley Mine. 147
Table 5.1 Aggressive and native seed mixes for reclamation 156
Table 5.2 Progressive reclamation completed at Mount Polley Mine as of December 31, 2023 158
Table 5.3 Metro Vancouver biosolids deliveries and applications at Mount Polley (2000 – Present) 162
Table 5.4 Tentative schedule for research projects in the projected 5-year Reclamation Research Plan 164

LIST OF FIGURES

Figure 1.1 Mount Polley Mine property location 19
Figure 1.2 Mount Polley Mine Site and Surrounding Area Water Bodies and Topography 24
Figure 1.3 Simplified Geology of the Mount Polley Intrusive complex 26
Figure 3.2- Veolia ACTIFLO mobile rental water treatment plant 46
Figure 3.3 – Water treatment plant facility layout 47
Figure 4.1 Wind data at Weather Station #1 in 2023 84
Figure 4.2 Wind data at Weather Station #2 in 2023 85
Figure 4.3 Maximum, mean and minimum monthly temperature data for Mount Polley (2023 versus average) 86
Figure 4.4 Monthly rainfall at Mount Polley (2023 versus average) 87
Figure 4.5 Monthly snowpack at Mount Polley (2023 versus average) 87
Figure 4.6 Mount Polley 2023 monthly precipitation and evaporation 88
Figure 4.7 Total phosphorus concentrations at QUL-120a, QUL-2a, and QUL-18 from 2019 to 2023 105
Figure 4.8 Total and dissolved copper results at QUL-18 from 2019 to 2023 105
Figure 4.9 Total and dissolved copper results at QUL-120a from 2019 to 2023 106
Figure 4.10 Total and dissolved copper concentrations at QUL-2a from 2019 to 2023 106
Figure 4.11 Total copper concentrations in influent (E19) and effluent (HAD-03) in 2023 127
Figure 4.12 Total suspended solids concentrations in influent (E19) and effluent (HAD-03) in 2023 128
Figure 4.13 Total copper results at the IDZ (QUL-58) from 2019-2023 133
Figure 4.14 Calculated assimilative capacity of total copper on a daily basis for 2023 134
Figure 4.15 Chronic average BC WQG for aquatic life dissolved copper concentrations at QUL-58 in 2023 135
Figure 4.16 Acute BC WQG for aquatic life dissolved copper concentrations at QUL-58 in 2023 136
Figure 4.17 Total phosphorus WQG compared with QUL-58 values 137
Figure 4.18 Depth-integrated chlorophyll *a* results from Bootjack Lake from 2019 to 2023 142
Figure 4.19 Depth-integrated chlorophyll *a* results from Polley Lake from 2019 to 2023 142
Figure 4.20 Chlorophyll *a* results from Quesnel Lake from 2019 to 2023 143
Figure 5.1 Mine reclamation activities and their relationships, under the 2021 Reclamation Research Program 160
Figure 5.2 Adaptive Management Cycle, under the Mine Plan and Reclamation Program Update 2022 161

List of Appendices

Appendix A – EMA Permit 11678 and CEMP (Electronic format only)
Appendix B – Site locations and Maps
Appendix C – Annual Status Report
Appendix D – Quality Assurance/Quality Control (Electronic format only)
Appendix E – Climate Monitoring Results (Electronic format only)
Appendix F- Surface, Contact, and Drainage Water Quality Results (Electronic format only)
Appendix G- Groundwater Review (WSP) (Electronic format only)
Appendix H- Discharge Water Quality and Toxicity Test Results (Electronic format only)
Appendix I- Annual Discharge Plan
Appendix J- Quesnel Lake Dispersion Modeling (Electronic format only)
Appendix K- Minnow Environmental Reports (Electronic format only)
Appendix L- Hydrological Monitoring
Appendix M- Lake Water Quality and Zooplankton Results (Electronic format only)
Appendix N- Terrestrial Monitoring (DWB) (Electronic format only)
Appendix O- Water Quality Comparison and Water Balance Calibration (WSP) (Electronic format only)
Appendix P- Archaeological Report (WSP) (Electronic format only)
Appendix Q- ML/ARD Characterization and Monitoring Program Annual Report (SRK) (Electronic format only)
Appendix R – Investigation Reports (Electronic format only)
Appendix S – Compliance Inspection Findings
Appendix T – Reclamation Research Report (Electronic format only)
Appendix U – Biosolids Management Plan (Electronic format only)
Appendix V – ML/ARD Management Procedure Manual Update
Appendix W – Progress Reports #12 and #13)
Appendix X – Invasive Plant Monitoring Report (DWB) (Electronic format only)

ACRONYMS AND ABBREVIATIONS

ABA	Acid-Base Accounting
ABR	Anaerobic Biological Reactor
ADSI	Annual Dam Safety Inspection
AER	*Annual Environmental Report*
AERR(s)	*Annual Environmental and Reclamation Report*
ADP	*Annual Discharge Plan*
ARD	Acid Rock Drainage
ARD/ML	Acid Rock Drainage/Metal Leaching
ARR	Annual Reclamation Report
BAT	Best Achievable Technology
BC	British Columbia
BCR	Biochemical Reactors
BC WQG	British Columbia ENV Water Quality Guideline
BC WWQG	British Columbia ENV Working Water Quality Guideline
CCS	Central Collection Sump
CEMP	*Comprehensive Environmental Monitoring Plan*
CFIA	Canadian Food Inspection Agency
CMDRC	Cariboo Mine Development Review Committee
COC	Chain of Custody
COPC	Contaminant(s) of Potential Concern
CRP	*Conceptual Remediation Plan*
CWTS(s)	Constructed Wetland Treatment System
DFO	Department of Fisheries and Oceans
DGR	Dangerous Good Regulations
DGT	Diffusive Gradient in Thin Films Device
DI	Deionized water
DQO	Data Quality Objectives
DSR	Dam Safety Review
EDC	Edney Creek
EEM	*Environmental Effects Monitoring*
ELS	Early Life Stage
EMA	*Environmental Management Act*
EMP	Environmental Management Plans
EMPR	Ministry of Energy, Mines and Petroleum Resources
EMLI	Ministry of Energy, Mines and Low Carbon Innovation
ENV	Ministry of Environment and Climate Change Strategy
EoR	Engineer of Record
ERA	*Ecological Risk Assessment*
FMP	Flocculant Management Plan
GW	Groundwater
HAC	Hazeltine Creek
HHRA	*Human Health Risk Assessment*
HSRC	*Health, Safety and Reclamation Code for Mines in British Columbia*

IC	Implementation Committee
IDZ	Initial Dilution Zone
IM	Imperial Metals
JCP	Joe's Creek Pipe
KEM1/KEM2	Kemmerer water sampler
LCRS	Leachate Collection Recycle System
LD	Long Ditch
LTWMP	*Long-Term Water Management Plan*
MAC	Mining Association of Canada
MDL	Method Detection Limit
MESCP	Main Embankment Seepage Collection Pond
MDMER	*Metal and Diamond Mine Effluent Regulations*
MPMC	Mount Polley Mining Corporation
MMO	Major Mines Office
MPIC	Mount Polley Intrusive Complex
MTD	Main Toe Drain
NAG	Non-Acid Generating
NBD	North Bell Dump
NEZ	Northeast Zone
NoD	Notice of Departure
NPR	Neutralizing Potential Ratio
NW	Temporary Northwest
OMS	Operation, Maintenance and Surveillance [Manual]
ORP	Oxidation Reduction Potential
PAG	Potentially Acid Generating
PAO	*Pollution Abatement Order*
PEEIAR	*Post-Event Environmental Impact Assessment Report*
PETBP	Perimeter Embankment Till Borrow Pit
PESCP	Perimeter Embankment Seepage Collection Pond
PLC	Public Liaison Committee
POI(s)	Parameter(s) Of Interest
PTD	Perimeter Toe Drain
PVR	Post Verification Review
QA/QC	Quality Assurance/Quality Control
QP	Qualified Professional
QPO	Quantitative Performance Objectives
QUL	Quesnel Lake
QUR	Quesnel River
RCP	*Reclamation and Closure Plan*
RDS	Rock Disposal Site
RO	Reverse Osmosis
RPD	Relative Percent Difference
SCFN	Soda Creek First Nation
SERDS	Southeast Rock Disposal Site
SEZ	Southeast Zone

STD	South Toe Drain
STWMP	*Short-Term Water Management Plan*
SWE	Snow Water Equivalent
TAR	*Technical Assessment Report*
TDAR	Tailings Dam Access Road
ToR	Terms of Reference
TRCR	Technical Research Committee on Reclamation
TRP	*Trigger Response Plan*
TSF	Tailings Storage Facility
TSM	Towards Sustainable Mining
TSS	Total Suspended Solids
WHR	Waste Haul Road
WLFN	Williams Lake First Nation
WTP	Water Treatment Plant

List of Units

°C	degrees Celsius
Dt	dry tonnes
Ft	feet
g/t	grams per tonne
Ha	hectare(s)
Kg	kilogram(s)
Km	kilometer(s)
L	liter(s)
Lbs	pounds
M	metre(s)
masl	metres above sea level
m^3	cubic metre(s)
m^3/s	cubic metre(s) per second
mm	millimeter(s)
mg/L	milligrams per litre
Oz	ounce(s)
µS/cm	micro Siemens per centimeter
%	percent
ppm	parts per million
T	tonne(s)
Tpd	tonne(s) per day

List of Consultants and Laboratories

ALS	ALS Environmental Inc.
Biologica	Biologica Environmental Services Ltd.
Contango	Contango Strategies Ltd.
DWB	DWB Consulting Services Ltd.
Ensero	Ensero Solutions
WSP	WSP Canada Inc. (Formerly Golder Associates Ltd.)
Minnow	Minnow Environmental Inc.
Nautilus	Nautilus Environmental Inc.
Spectrum	Spectrum Resources Group Inc.
SRK	SRK Consulting Inc.
Tetra Tech	Tetra Tech Inc.
WaterSmith	WaterSmith Research Inc.

1 Introduction

1.1 Project History

The Mount Polley Mine, operated by MPMC (a wholly owned subsidiary of Imperial Metals (IM) Corporation), is an open pit copper/gold mine with an underground component located in south-central British Columbia. It is located eight kilometers (km) southwest of Likely and 56 km (100 km by road) northeast of Williams Lake, British Columbia (BC; Figure 1.1). The Mount Polley Mine has the capacity to process 20,000 to 22,000 tonnes per day (tpd) of ore when in normal operations. The mine property covers 24,096 hectares (ha), consisting of 7 mining leases totaling 2,007 ha, and 52 mineral claims encompassing 22,089 ha. Mount Polley Mine concentrates are trucked to facilities at the Port of Vancouver, then shipped to overseas smelters or transported by rail to smelters in North America.

Clearing of the site and construction of the entire facility began in 1995, with the mill commissioned in June 1997. In May 1997, the Mine received an ENV (previously the Ministry of Water, Land and Air) Effluent Permit, *EMA* Permit 11678, issued under the provisions of the provincial *EMA*. This permit authorized the discharge of concentrator tailings, mill site runoff, mine rock runoff, open pit water, and septic tank effluent to a tailings storage facility (TSF). Approval of the original Mount Polley Mine Reclamation and Closure Plan by the EMLI (previously EMPR) resulted in the issuance of *Mines Act* Permit M–200 in July 1997. The first full year of mining and milling at Mount Polley Mine took place in 1998. The Mine suspended operations in October 2001 due to low metal prices, then reopened in December 2004, with mill production commencing in March 2005.

Mount Polley mine phased out of care and maintenance and entered into full operations in November 2022, having been in care and maintenance since May 31, 2019. In June 2022, the mill restarted operations and tailings deposition into the TSF resumed. The operational period of the mine is planned to extend to 2034.

A summary of EMA Permit 11678 amendments is provided in Table 1.1.

Table 1.1 Summary of *EMA* Permit 11678 amendments

Date	Scope of Amendment
30-May-1997	Original permit
20-Oct-1997	Amended authorized tailings discharge rate (10,000 tpd increase)
12-Jun-1998	Amended reporting requirements
8-Sep-1999	Amended monitoring requirements
1-Feb-2000	Amended authorized tailings discharge rate (4,500 tpd increase)
7-Feb-2002	Approval to discharge effluent from the Perimeter Embankment Seepage Collection Pond (PESCP) and Main Embankment Seepage Collection Pond (MESCP); approval to store TSF supernatant and Mine site contact water in the Cariboo and Bell Pits
4-May-2005	Amended authorized tailings discharge rate (5,000 tpd increase); discharge of groundwater to Polley Lake; updates to reference analytical procedures and monitoring program
17-Apr-2009	Amended monitoring, water level and supernatant characteristic requirements for the Cariboo and Bell Pits
7-Nov-2012	Approval to discharge to Hazeltine Creek
7-Jun-2013	Sulphate guidelines
9-Jul-2015	Tailings discharge to the Springer Pit
29-Nov-2015	Approval to discharge to Hazeltine Creek
4-Apr-2016	Discharge of additional tailings to the Springer Pit
9-Sep-2016	Hazeltine Creek discharge total suspended solids limit change
7-Apr-2017	Direct pipeline from water treatment plant to Quesnel Lake
2-Oct-2018	Amendment to Sections 1.2.3, 1.2.6 and 2.7 of existing 11678 permit (Appendix A)
14-Mar-2019	Amendment to revisions for November 9, 2018 CEMP approval letter conditions including 3, 4, 8, 9, 11, 14 and 15
15-Jul-2019	Amendment to Section 6.14 of the approved August 15, 2018 CEMP
1-Feb-2020	Amendment to Sections 1.2, 1.2.5, 1.2.6, 2.7, 2.8, 2.8.1, 2.8.3, 2.9 2.10, 3.3, 3.5, 3.5.5 and 4.1.4 of existing 11678 permit (Appendix A)
18-Sep-2020	Consent Order amendments to Sections 2.8, 2.9, 2.10, and 4.2.1 of existing 11678 permit (Appendix A)
31-Dec-2020	Approved and amended Permit 11678 (Appendix A)
10-Feb-2021	Conditional approval received for the October 31, 2019 CEMP, replacing the 2018 CEMP and introducing a number of conditions which are in effect regulatory requirements.
1-Dec-2022	Amendment to Sections 2.3, 2.4, 2.5, 2.6, 2.10, 2.11, 2.12, 2.17, 3.7, 3.8, 4.1, 4.2, 4.3 and 4.4.

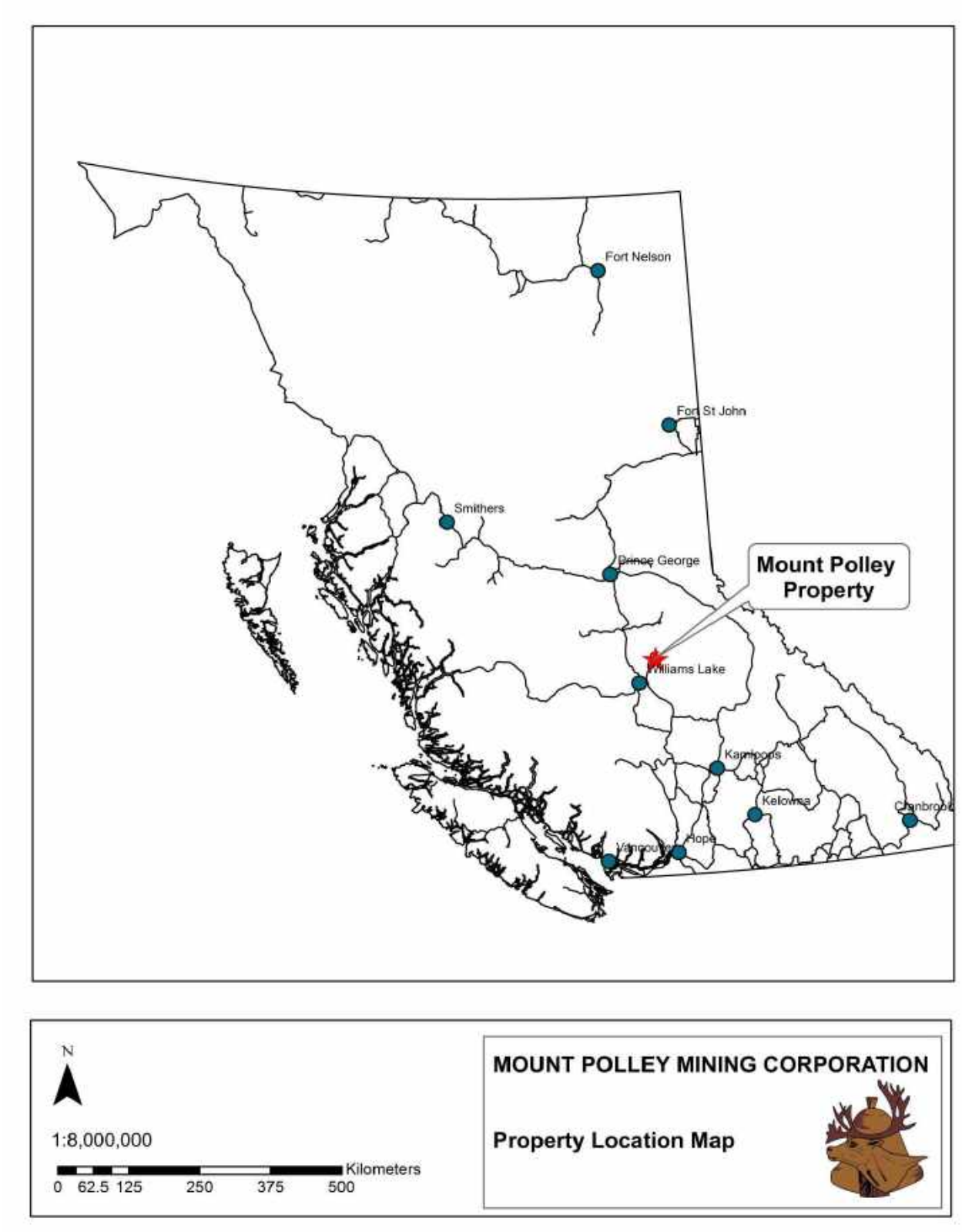


Figure 1.1 Mount Polley Mine property location

In 1995 and 1996, an environmental monitoring program, which expanded on previous studies from 1989 and 1990, was designed and implemented to support mine planning, operations, and reclamation activities at the Mount Polley Mine. The program included baseline studies documenting the pre-development land uses and the conditions of the aquatic and terrestrial ecosystems. This information provides the foundation upon which operational environmental monitoring programs were, and continue to be, based. The November 29, 2015, *EMA* Permit 11678 amendment included a revised condition, to develop a Comprehensive Environmental Management Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek (HAC), Edney Creek (EDC), Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake (QUL), Quesnel River (QUR), and associated riparian and upland areas. The CEMP was submitted to the ENV on June 23, 2016, and an updated CEMP was submitted to the ENV on August 15, 2018 and was approved on November 9, 2018. The CEMP was updated in October 2019 in consultation with MPMC, Golder Associates, and BC-ENV. The 2019 CEMP was approved in February 2021, and was immediately implemented. The next revision of the CEMP was submitted on March 21, 2023, and is under review.

1.1.1 Tailings Storage Facility Embankment Breach

On August 4, 2014, a breach occurred in the Perimeter Embankment of the Tailings Storage Facility (TSF); this event is herein referred to as the "TSF embankment breach". The TSF embankment breach released tailings, water, and embankment construction materials to the downstream environments of Polley Lake, Hazeltine Creek and Quesnel Lake. The ENV issued MPMC *Pollution Abatement Order* (PAO) 107461, dated August 5, 2014, ordering MPMC to attend to the environmental impacts of the TSF embankment breach. The *PAO* was lifted on September 12, 2019.

1.1.2 Post TSF Embankment Breach Reporting

Following the TSF embankment breach, an environmental monitoring program was initiated in areas downstream of the TSF including Polley Lake and Hazeltine Creek, both of which were previously monitored under *EMA* Permit 11678 (***Appendix A***). Monitoring of these areas in 2014 and 2015 was carried out under the PAO; consequently, these monitoring results were presented in the *Post-Event Environmental Impact Assessment Report* (*PEEIAR*; MPMC, 2015a) and *PEEIAR* Version 2 (MPMC, 2016a). Results from monitoring conducted in 2016 were presented in the *Human Health Risk Assessment* (*HHRA*), (MPMC, 2017b) and *Ecological Risk Assessment (ERA*), (MPMC, 2017c) which have both been approved by ENV. Monitoring results from 2017 are presented in the 2017 *AERR*, (MPMC 2018a). A Conceptual Remediation Plan (*CRP)* was required by the PAO to address the remedial actions based on the findings, results, and conclusions on the risk assessments, and has been integrated in the updated CEMP. This plan was submitted on January 31, 2018, to ENV. Review comments were received from the ENV and the Government to Government Working Group on December 11, 2018, just prior to consultation meetings with local communities. All conditions of the PAO were met, and the PAO has since been rescinded. An updated CEMP was submitted to ENV in October 2019 and was approved February 2021. CEMP updates are a regular requirement in *EMA* Permit 11678. All current post breach reporting to ENV is done under *EMA* Permit 11678.

1.2 Post TSF Embankment Breach Project Status

1.2.1 Mine Operations

Following the TSF embankment breach, mine operations ceased. Restricted operations, with tailings being deposited in the Springer Pit, commenced on August 4, 2015. On November 6, 2015, MPMC applied for an amendment to *Mines Act* Permit M–200 to allow for the return to full operations at the Mount Polley Mine, with use of the TSF for tailings deposition. A corresponding *Mines Act* Permit M–200 amendment was received from the EMLI (previously the EMPR) on June 23, 2016. Authorization to resume deposition of tailings in the TSF under *EMA* Permit 11678 was received from the ENV on June 23, 2016. MPMC resumed deposition of tailings in the TSF on June 27, 2016.

On January 7, 2019, MPMC announced a decision to go on suspended operations (Care and Maintenance) on May 31, 2019, citing low metal prices. EMLI, formerly EMPR, provided a Cessation of Operations Acknowledgement letter to MPMC on July 25, 2019. During Care and Maintenance, MPMC committed to continue environmental monitoring and sampling as well as rehabilitation of Hazeltine Creek and any other commitments as required in the permits and CEMP.

Mining operations resumed in late 2021. Currently authorized operations allow for: open pit mining of the Phase 4 Cariboo-Springer Pit; milling of up to a maximum of 8,200,000 t of ore per year with deposition in the TSF; and construction and operation of the TSF up to an elevation of 970 metres above sea level (masl).

The current active project infrastructure consists of the mill site, mining in the Cariboo-Springer 4 Pit, two rock disposal sites (RDS) (the Southeast Rock Disposal Site (SERDS), and the Temporary Northwest (NW) Potentially-Acid Generating (PAG) Stockpile), the TSF, as well as access roads, power lines, a tailings pipeline, drainage collection systems, and sediment/seepage control pond. Back-filling of the Bell Pit and Pond Zone Pit with waste rock was completed in 2012, and the SEZ Pit was backfilled in 2013. A detailed Mount Polley Mine site map is included in ***Appendix B***.

In 2023, mining of the Phase 4 Cariboo-Springer 4 Pit continued with development of the SP4 1000 through to the SP4 924 benches. Material classified as potentially-acid generating (PAG) was dispatched to the Temporary Northwest (NW) Potentially-Acid Generating (PAG) stockpile. Material classified as non-acid generating (NAG) was dispatched to the Southeast Rock Disposal Site (SERDS). Ore was dispatched to the crushing facility and or to the stockpiles.

In 2023, 22,115,054 tonnes of material were removed from the pit of which 6,814,144 tonnes was ore. This material was directly fed into the crusher and or stockpiled.

Approximately, 12,032,329 tonnes of waste were removed from the pit, of which 3,784,284 tonnes were classified as PAG and dispatched to the PAG stockpile. Approximately, 8,248,045 tonnes were classified as NAG, of which 1,093,900 tonnes were dispatched to the PAG stockpile and 7,154,145 tonnes were

dispatched to SERDS. Additionally, approximately 3,268,581 tonnes of In-Pit Tailings were removed from the pit and dispatched to the SERDS.

Identified ore reserves indicate a viable mine life of 10 years expected to continue to 2034. Given the uncertainty around future operations and mine life, reclamation and closure planning described in this document are subject to review and updates.

Crushing/milling of ore continued in 2023.

1.3 Site Description

1.3.1 Topography and Climate

The Mount Polley Mine property is located on the eastern edge of the Fraser Plateau physiographic sub-division, characterized by rolling topography and moderate relief. Elevations range from 920 masl at Polley Lake to 1266 masl at the summit of Mount Polley. Volcanic rocks generally underlay this part of the plateau with inclusions of intrusive rocks. Most of the area is covered by a deposit of unconsolidated till which contains fluvial, lacustrine, and colluvial deposits. Some patches of organic soils are present in poorly drained areas (i.e., wetlands). The property is in an alkali porphyry copper-gold deposit hosted in the Central Quesnel Belt along the Intermontaine Belt of BC.

The site is located within the Interior Cedar Hemlock bio geoclimatic zone. Local forests consist of western red cedar, Douglas-fir, hybrid spruce, and subalpine fir, with a lesser presence of trembling aspen, black cottonwood, and paper birch. Much of the area was historically harvested in commercial logging operations and is also used for cattle grazing.

The average annual precipitation in the area is ~625 millimetres (mm). Precipitation typically occurs as snowfall from November through March, with an average maximum of snowpack of 187 mm snow water equivalent occurring at the end of March. Average monthly temperatures at the Mount Polley Mine range from -5.6 degrees Celsius (°C) in December to 16.1 °C in July (Section 4.6). Prevailing winds are from the northwest (and to a lesser extent in the northeast) near the TSF, and from the southwest (and to a lesser extent from the northwest) near the mill.

1.3.2 Hydrogeology

The groundwater flow at the site occurs primarily in the bedrock units in response to recharge from precipitation in the area between Polley Lake and Bootjack Lake. Flow in the overburden is less significant due to its limited thickness and discontinuous nature. Prior to mining, the water table at the site generally followed the surface topography, but the water table was deeper below the topographic heights and shallower in the low areas. At that time, the direction of groundwater flow was inferred to be from the top of the ridge between Polley Lake and Bootjack Lake towards the low-lying areas associated with these lakes' northeast and southwest from the ridge. The regional topography, water bodies, and pre-mining

watersheds are shown in Figure 1.2.

Mine dewatering has altered the groundwater flow pattern at the site, with the open pits and underground workings acting as sinks for groundwater flow. Mine dewatering lowered the water table elevation and created radial patterns of groundwater flow towards these facilities. In 2018, Springer Pit water levels continued to be drawn down by dredging. Near the end of 2018, when dredging operations ceased, water levels became static and remained static the rest of 2018 and 2019. The currently available information suggests that some seepage from the pit lake towards Bootjack Lake could occur once the Springer Pit lake level reaches 1020 to 1030 masl elevation (Golder 2015a). From June 2020 to June 2021, the Springer Pit was used for temporary storage of surplus water by following the Quantitative Performance Objectives (QPO) outlined by the EoR. The water level in the pit reached a maximum elevation of 1004 masl during this period. From June 2021 to December 2021, the Springer Pit water level had been steadily lowered to the elevation of 983 masl to dewater the pit lake and resume mining operations in the area. Dewatering activities continued in 2022 and 2023 to facilitate mining activities. While tailings remain in the pit awaiting removal the interstitial water is being pumped out via three dewatering wells that were installed in 2022.

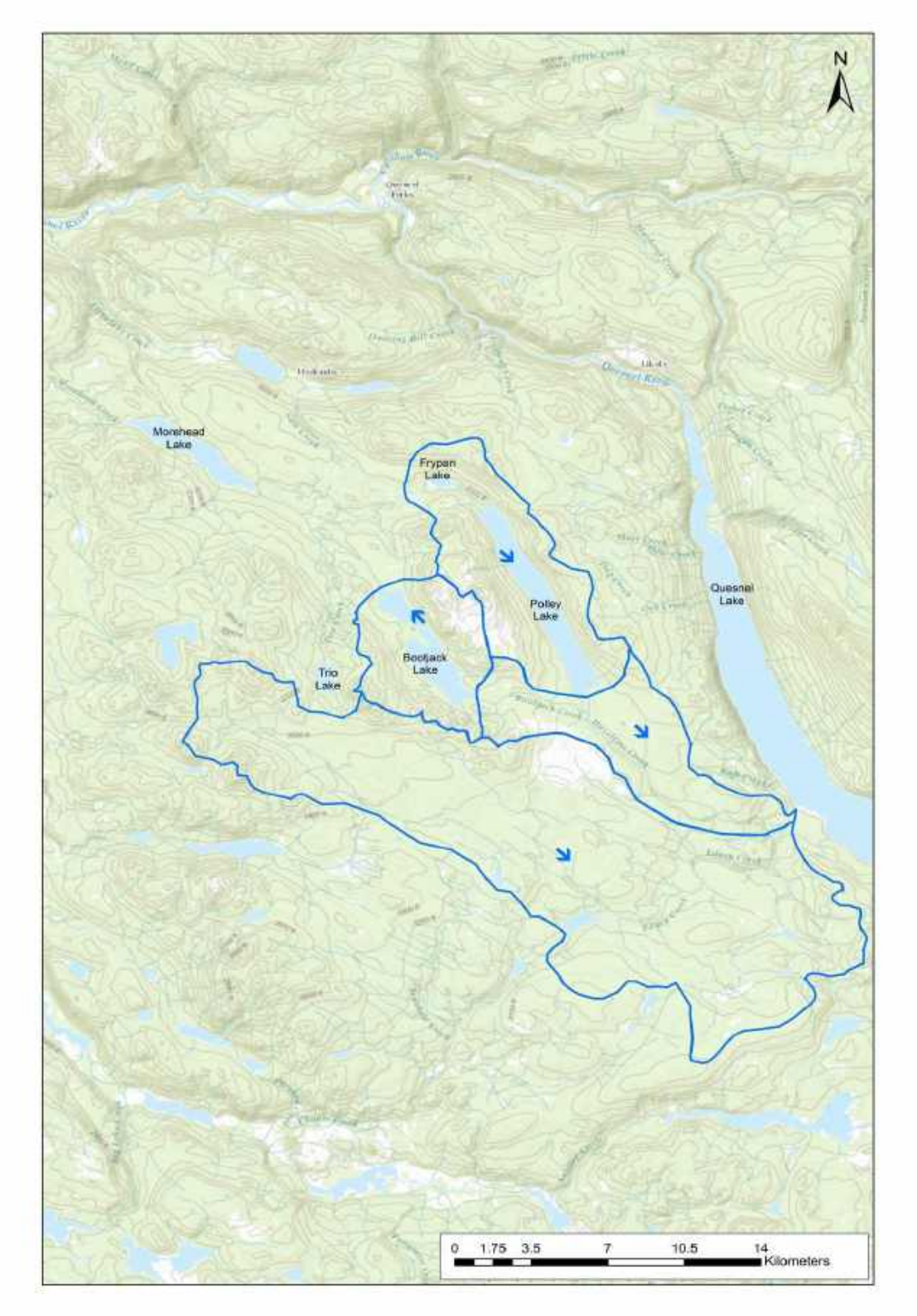


Figure 1.2 Mount Polley Mine Site and Surrounding Area Water Bodies and Topography

1.3.3 Deposit Geology

The Mount Polley Intrusive Complex (MPIC) hosts the Mount Polley copper-gold porphyry deposit (Figure 1.3). It is a Late Triassic magmatic center approximately 6 km by 4 km, elongate in a NNW direction. It consists of alkalic, marginally silica-undersaturated intrusions, and magmatic-hydrothermal breccias. The age of the deposit is approximately 205 million years, based on uranium-lead isotopic dating; there is close agreement between age determinations from MPIC intrusions and minerals associated with sulfide mineralization. Mineralization occurs in almost all constituent rock types of the MPIC, and thus occurred late in its formation. Nearly all economic mineralization is in breccias, or in mineralized stockwork veins in adjacent wall rock intrusion. Country rocks of the Nicola Group closest to the MPIC are mafic to intermediate volcanic and subvolcanic coherent rocks, and related breccias, and may form components of mineralized hydrothermal breccias in the periphery of the MPIC (MPMC 2016c).

As is typical of alkalic porphyry copper systems, mineralization at Mount Polley formed in a number of several distinct zones rather than as a simple zoned deposit. The most important (remaining) ore zones can be divided into two main groups: the Springer-Cariboo area and the Northeast-Boundary area. The original discovery at Mount Polley was in the Springer zone in the center of the MPIC, which was followed by the adjacent Cariboo Zone to the east across the Polley fault (MPMC 2016c).

The Springer-Cariboo area represents the largest volume of mineralization in the MPIC, has contributed most of the historic production at Mount Polley This area has the most intense alteration, and likely formed on the main feeder or conduit from the parent magma source at depth. The smaller but copper and gold-enriched Northeast-Boundary area of brecciation was caused by a different, probably more focused magma-fluid feeder, 1 to 2 km away to the north. This deposit area differs from the Springer-Cariboo group by coarser sulfide mineralization and a much higher bornite content (MPMC 2016c).

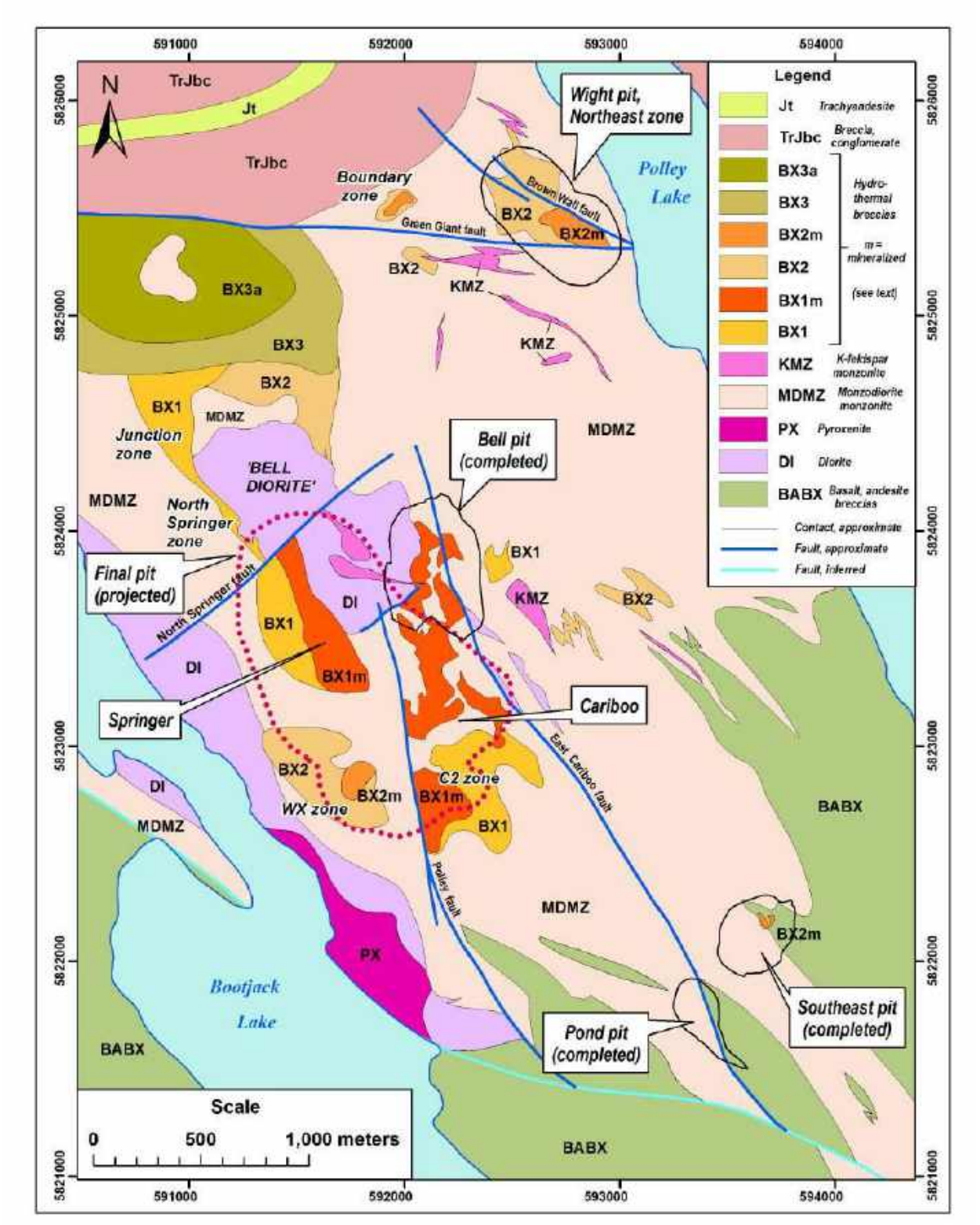


Figure 1.3 Simplified Geology of the Mount Polley Intrusive complex

1.3.4 Reclamation Objectives

The main objective of the reclamation program is to return all areas that have been disturbed by mining operations (except pit walls) to equivalent or greater land capability than existed prior to mining, on an average property basis. To help achieve this overarching goal, an End Land Use Plan has been developed, which focusses on ecosystem rehabilitation as the main goal with a target towards ecosystems that occurred prior to disturbance.

The End Land Use Plan also estimates shifts in the end land use objectives over time as the ecological trajectories of the ecosystem evolve. This allows for end land use planning to be considered over the long-term and considers that a variety of end land uses can occur on the landscape over different temporal scales. To achieve successful closure of the Mine Site, the following objectives must be achieved:

- Long-term stability of engineered structures, including the RDSs, TSF and open pits, as well as all exposed erodible materials
- Removal and proper disposal of access roads, structures, and equipment not required after the Mine Site closes
- Sufficient cover soil (e.g., reclamation material) to achieve the desired target ecosystems on the post-closure landscape
- Geochemical stability of WRDs, open pits, the TSF, and all other major components of the Mine Site in the post-closure landscape
- Long-term preservation of water quality within and downstream of decommissioned operations
- A water balance that meets the requirements for a functional landscape that aligns with the targeted end land use
- Natural integration of disturbed lands into surrounding landscape, and restoration of the natural appearance of the area after mining ends, to the extent practicable
- Self-sustaining vegetation covers established, consistent with the end land uses and desired ecosystems
- Use of reclaimed ecosystems by their desired stakeholders (e.g., recreational users, wildlife, and traditional use practitioners)

Once these aspects are in place, flexibility exists to modify ecosystem composition, patch size, and vegetation mosaic and to provide additional structural components, as desired. By reclaiming disturbed land to stable, functioning, and locally appropriate ecosystems that can reasonably be expected to thrive on a specific landform or location, a variety of end land use objectives can also be met.

To track progress towards closure objectives and overall adherence with the End Land Use Plan, Success criteria, which are more specific than closure objectives, were developed. These success criteria are used as milestones that indicate progress to achieving specific land use objectives. The success criteria include parameters such as:

- landform stability
- erosion control
- visual and functional integration into the surrounding environment
- establishment of self-sustaining native vegetation consistent with target site series
- vegetation quality

End land use objectives envelop a multitude of values that may exist beyond biocentric ecological conditions and are driven by what regulators, MPMC, First Nations, and local communities prefer for the landscape once the Mine is closed. End land use decisions are influenced by several factors, including:

- Permit obligations;
- Regulatory requirements;
- Landform design;
- Surface and subsurface materials at closure;
- Surface water hydrology;
- Slope;
- Aspect,
- Elevation;
- Input from First Nations, local communities and stakeholders; and
- Traditional and cultural land use.

End land use objectives may be adapted over time as interests evolve; however, once a landform is constructed, the end land uses are limited to the conditions and ecological trajectories associated with the particular abiotic rehabilitation.

2 Mining Program

2.1 2022 Exploration

In early 2023, two phases of diamond drilling were completed at Mount Polley Mine. The objective of the diamond drill programs was to explore in an area surrounding and below the Springer and Cariboo mineralized zones. The first phase consisted of five drill holes totaling 2720 meters. Phase one was successful at delineating new zones of copper and gold mineralization adjacent to the current mine plan. The second phase consisted of 10 drill holes totaling 2885 meters and were oriented as step-out and infill-drill holes from the phase one drilling. The program was successful and adding copper and gold mineralization surrounding and below the Springer and Cariboo open pits. Exploration diamond drilling is planned for early 2024 to continue following the new zones delineated from 2023 diamond drilling.

2.2 Surface Development to Date

At the end of 2023, the total disturbed area at the Mount Polley Mine site was 1195.19 ha. Discussion of disturbed areas in this report does not include areas disturbed due to the TSF embankment breach as this area is beyond the scope of *Mines Act* Permit M-200. Table 2.1 provides a breakdown of disturbed areas by Mine component and serves to fulfill the annual reclamation reporting requirement for Standard Table 1 in the guidelines. These areas are also shown on the site facilities map in the *RCP* (MPMC, 2017a). Concurrently with surface development, progressive reclamation is ongoing. In 2023 a review of the required shapefile submission was complete and identified several duplicate polygons. The duplicate polygons were removed, and this resulted in a small net reduction of total disturbed and reclaimed areas when compared to 2022 reported areas.

Table 2.1 Mount Polley Mine Site SUMMARY OF AREAS DISTURBED AND RECLAIMED TO DECEMBER 31, 2023, represents EMLI Standard Table

Mount Polley Mining Corporation Annual Reclamation Report Table 1 - Summary of Areas Disturbed and Reclaimed

Exempt | Reclaimed

~~FID~~	OBJECTID	Shape_Area (m)	Hectares	MINE_NO	PERMIT_NO	MINE_NM	MINE_TYP	YEAR	DSTB_ID	DSTB_TYPE	DSTB_DATE	Comments	RECL_ID	RECL_ACT	RECL_YEAR
~~9~~	18	910			M-200	MPMC	M	2023		DI					0
~~18~~	29	59489			M-200	MPMC	M	2023		DI					0
~~22~~	35	15629			M-200	MPMC	M	2023		DI					0
~~23~~	36	15057			M-200	MPMC	M	2023		DI					0
~~61~~	100	168042			M-200	MPMC	M	2023		DI	2015-01-01				0
~~73~~	122	21192			M-200	MPMC	M	2023		DI	2014-09-01				0
~~13~~	22	8377			M-200	MPMC	M	2023		DI					0
~~15~~	24	3937			M-200	MPMC	M	2023		DI					0
~~26~~	46	34			M-200	MPMC	M	2023		DI					0
~~17~~	28	61530			M-200	MPMC	M	2023		DI					0
~~14~~	23	2855			M-200	MPMC	M	2023		DI					0
-															
-	**Total Ditches**	**357053**	**35.71**												
~~27~~	47	1193482			M-200	MPMC	M	2023		PIT					0
~~28~~	48	105187			M-200	MPMC	M	2023		PIT					0
~~29~~	50	118196			M-200	MPMC	M	2023		PIT					0
~~30~~	51	322942			M-200	MPMC	M	2023		PIT					0
-															
-	**Total Pits**	**1739806**	**173.98**												
-	**Total Pit Exempt**	**1739806**	**173.98**												
~~10~~	19	12952			M-200	MPMC	M	2023		PS					0
~~11~~	20	11832			M-200	MPMC	M	2023		PS					0
~~12~~	21	5385			M-200	MPMC	M	2023		PS					0
~~19~~	30	133337			M-200	MPMC	M	2023		PS					0
~~20~~	31	189131			M-200	MPMC	M	2023		PS					0
~~21~~	32	39831			M-200	MPMC	M	2023		PS					0
~~68~~	117	13975			M-200	MPMC	M	2023		PS	2018-07-01				0
~~108~~	160	15073			M-200	MPMC	M	2023		PS	2023-06-01				0
~~109~~	161	2306			M-200	MPMC	M	2023		PS	2023-06-01				0
-															
-	**Total Plant Site**	**423822**	**42.38**												
~~4~~	9	36287			M-200	MPMC	M	2023		RD					0
~~16~~	27	36601			M-200	MPMC	M	2023		RD					0
~~31~~	57	71333			M-200	MPMC	M	2023		RD					0
~~32~~	58	67046			M-200	MPMC	M	2023		RD					0
~~33~~	60	22495			M-200	MPMC	M	2023		RD					0
~~34~~	61	99437			M-200	MPMC	M	2023		RD					0
~~35~~	62	416935			M-200	MPMC	M	2023		RD					0
~~36~~	63	102019			M-200	MPMC	M	2023		RD					0
~~37~~	65	147002			M-200	MPMC	M	2023		RD					0

~~38~~	69	16168			M-200	MPMC	M	2023		RD					0
~~39~~	71	284993			M-200	MPMC	M	2023		RD					0
~~40~~	73	1524			M-200	MPMC	M	2023		RD					0
~~41~~	74	148611			M-200	MPMC	M	2023		RD					0
~~42~~	75	19561			M-200	MPMC	M	2023		RD					0
~~43~~	76	90809			M-200	MPMC	M	2023		RD					0
~~44~~	77	7130			M-200	MPMC	M	2023		RD					0
~~45~~	78	146905			M-200	MPMC	M	2023		RD					0
~~46~~	79	59393			M-200	MPMC	M	2023		RD					0
~~47~~	83	34672			M-200	MPMC	M	2023		RD					0
~~75~~	125	21462			M-200	MPMC	M	2023		RD	2013-06-01			O	2013
~~76~~	126	17447			M-200	MPMC	M	2023		RD	2013-01-01			O	2013
~~110~~	162	5144			M-200	MPMC	M	2023		RD	2023-06-01				0
~~111~~	163	4413			M-200	MPMC	M	2023		RD	2022-02-02				0
-															
-	**Total Roads**	**1857387**	**185.74**												
-	**Total Reclaimed**	**38909**	**3.89**												

~~6~~	15	22051			M-200	MPMC	M	2023		ROW					0
~~7~~	16	4138			M-200	MPMC	M	2023		ROW					0
~~8~~	17	4197			M-200	MPMC	M	2023		ROW					0
~~71~~	120	12739			M-200	MPMC	M	2023		ROW	2014-06-01				0
-															
-	**Total Right of Ways**	**43124**	**4.31**												

~~0~~	1	744926			M-200	MPMC	M	2023		SP					0
~~48~~	85	28783			M-200	MPMC	M	2023		SP					0
~~49~~	86	3531			M-200	MPMC	M	2023		SP					0
~~50~~	87	27003			M-200	MPMC	M	2023		SP					0
~~51~~	88	91437			M-200	MPMC	M	2023		SP					0
~~52~~	89	102912			M-200	MPMC	M	2023		SP					0
~~53~~	90	68495			M-200	MPMC	M	2023		SP					0
~~54~~	91	106593			M-200	MPMC	M	2023		SP					0
~~55~~	92	121465			M-200	MPMC	M	2023		SP					0
~~56~~	93	97433			M-200	MPMC	M	2023		SP					0
~~57~~	95	3531			M-200	MPMC	M	2023		SP	2015-06-01				0
~~69~~	118	24582			M-200	MPMC	M	2023		SP	2022-06-01				0
~~70~~	119	46035			M-200	MPMC	M	2023		SP	2022-06-01				0
~~78~~	128	33616			M-200	MPMC	M	2023		SP	2014-01-01			O	2014
~~107~~	159	9073			M-200	MPMC	M	2023		SP	2014-01-01				0
-															
-	**Total Stockpile**	**1509416**	**150.94**												

~~58~~	97	118992			M-200	MPMC	M	2023		TSF					0
~~59~~	98	67081			M-200	MPMC	M	2023		TSF	2014-08-01				0
~~60~~	99	424803			M-200	MPMC	M	2023		TSF					0
~~62~~	101	82508			M-200	MPMC	M	2023		TSF					0

~~63~~	102	59394			M-200	MPMC	M	2023		TSF	2015-06-01				0
~~64~~	113	2131321			M-200	MPMC	M	2023		TSF	1996-01-01				0
~~65~~	114	105794			M-200	MPMC	M	2023		TSF	1996-01-01				0
~~66~~	115	266880			M-200	MPMC	M	2023		TSF	1996-01-01				0
~~67~~	116	167849			M-200	MPMC	M	2023		TSF	2009-01-01	Borrow		O	0
~~72~~	121	50137			M-200	MPMC	M	2023		TSF	2022-06-01				0
~~74~~	124	242672			M-200	MPMC	M	2023		TSF	2009-01-01	Borrow		O	2010
-															
-	**Total TSF Areas**	**3717431**	**371.74**												
-	**Total TSF Exempt**	**2131321**	**213.13**												

~~1~~	5	47327			M-200	MPMC	M	2023		WD	2010-01-01			O	2014
~~2~~	6	410416			M-200	MPMC	M	2023		WD					0
~~3~~	7	142919			M-200	MPMC	M	2023		WD					0
~~5~~	14	1055621			M-200	MPMC	M	2023		WD					0
~~77~~	127	671			M-200	MPMC	M	2023		WD	2014-01-01			O	2014
~~79~~	129	48426			M-200	MPMC	M	2023		WD				O	2010
~~80~~	130	24707			M-200	MPMC	M	2023		WD	1997-01-01			O	2010
~~81~~	131	119247			M-200	MPMC	M	2023		WD	1997-01-01			O	2014
~~82~~	132	31081			M-200	MPMC	M	2023		WD	1997-01-01			O	1998
~~83~~	133	11723			M-200	MPMC	M	2023		WD	1997-01-01			O	2000
~~99~~	134	42771			M-200	MPMC	M	2023		WD	1997-01-01			O	1998
~~84~~	135	9796			M-200	MPMC	M	2023		WD	2009-01-01			O	2018
~~85~~	136	24625			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~86~~	137	3310			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~87~~	138	3364			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~88~~	139	3396			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~89~~	140	3309			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~90~~	141	4086			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~91~~	142	3333			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~92~~	143	28619			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~93~~	144	12933			M-200	MPMC	M	2023		WD	2009-01-01			O	2012
~~94~~	145	47619			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~95~~	146	4605			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~96~~	147	4580			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~97~~	148	4608			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~98~~	150	4747			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~99~~	151	4127			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~100~~	152	327			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~101~~	153	4482			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~102~~	154	2297			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~103~~	155	22156			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~104~~	156	19176			M-200	MPMC	M	2023		WD	2009-01-01			O	2013
~~105~~	157	109807			M-200	MPMC	M	2023		WD	2009-01-01			O	2011
~~106~~	158	259155			M-200	MPMC	M	2023		WD	2009-01-01			O	0
-															

-	**Total Waste Dumps**	**2402758**	**240.28**												
-	**Total Waste Dumps Reclaimed**	**791163**	**79.12**												

Total Disturbance (Ha)		**1205.08**
Total Exempt (Ha)		**387.11**
Total Reclaimed (Ha)		**83.01**

Notes: This table is a shapefile export. Attributes correspond with shapefile submission. All reclamation is "ongoing" and not complete. Exempt areas include pit walls and lakes only.

Waste disposal sites are separated into Potentially Acid Generating (PAG) and Non-Acid Generating (NAG). Details of the disposal/storage locations and tonnage are outlined in Table 2.2 and serves to fulfill the annual reclamation reporting requirement for Table 2 in the guidelines.

Table 2.2 2023 Quantity of Waste Rock

QUANTITIES OF WASTE ROCK, TAILINGS, LOW GRADE ORE, COARSE REJECT

AND OTHER MINE WASTE AS OF DECEMBER 31,2023

COMPANY: Mount Polley Mining Corporation **PERMIT NO.: M-200**

Use the space below to enter information for each waste dump, tailings pond or low grade ore pile. All quantities should be given in tonnes

Name of Waste Pile or Pond	Acid Generating Waste		Potentially Acid Generating Waste		Non-Acid Generating Waste	
Waste Dumps						
	2023	**Total**	**2023**	**Total**	**2023**	**Total**
1. Southeast Rock Dump	0	0	0	0	7,083,080	69,815,254
2. NAG/PAG Dump	0	0	3,789,784	34,768,129	1,093,900	9,557,116
3. WTP Sludge Pond	0	0	17	1,306	0	0
Total	0	0	3,789,801	34,769,435	8,176,980	79,372,370
Tailings Ponds						
1. Tailings Storage Facility	0	0	0	31,641,511	37,960	366,985
Total	0	0	0	31,641,511	37,960	366,985
Low Grade Ore / Coarse Reject / Other Mine Waste						
1. Belt Cleanup Stockpile	0	0	0	0	0	0
2. #3 Ore Stockpile (LG)	0	0	0	165,600	0	0
3. Leach Stockpile (LG)	0	0	0	2,564,475	0	0
4. Southeast Rock Dump	0	0	0	0	0	0
5. Cariboo LG Stockpile	0	0	0	267,921	10,700	10,700
Total	0	0	0	2,997,996.00	10,700	10,700

The total amount of ore sent to the crusher in 2023 was 6,345,006 tonnes. A monthly summary of the various ore feeds and stockpiling movement is provided in Table 2.3. The following tables serve to fulfill the annual reclamation reporting requirement for Table 3 and Table 4 in the guidelines.

Table 2.3 Summary of monthly milling rates in 2023

Truck Count - Crusher Feed Summary				
Month	Source			
	Springer Pit Crusher Feed (t)	Stockpiles to Crusher Feed (t)	Total Crusher Feed (t)	Springer Ore to Stockpiles (t)
23-Jan	447,435	66,735	514,170	80,270
23-Feb	294,240	79,765	374,005	68,495
23-Mar	515,735	45,440	561,175	94,895
23-Apr	384,992	87,841	472,833	33,460
23-May	416,754	70,975	487,729	60,311
23-Jun	427,509	28,000	455,509	131,050
23-Jul	447,035	86,710	533,745	49,975
23-Aug	548,414	56,795	605,209	201,640
23-Sep	476,986	76,385	553,371	144,127
23-Oct	348,170	113,305	461,475	160,825
23-Nov	571,825	97,970	669,795	64,575
23-Dec	583,395	72,655	656,050	92,460
Total	**5,462,490**	**882,576**	**6,345,066**	**1,182,083**

The total ore milled in 2023 was 5,948,239 t. A summary is provided in Table 2.4.

Table 2.4 2023 mill production summary

Mill Production Summary								
Month	Mill Feed Tonnage (t)	Tail Tonnage (t)	Feed Grades			Metal Produced		
			Copper (%)	Gold (g/t)	Oxide Ratio	Cu (lbs)	Au (oz)	Ag (oz)
23-Jan	510,935	507,183	0.257	0.294	6.76	2,334,532	3,326	5,171
23-Feb	350,719	348,117	0.248	0.309	7.58	1,512,720	2,499	3,521
23-Mar	527,982	522,273	0.294	0.333	5.57	2,830,842	4,155	7,632
23-Apr	457,219	452,378	0.230	0.259	4.95	1,827,545	2,516	5,060
23-May	479,036	473,823	0.327	0.376	7.87	2,698,806	3,906	6,609
23-Jun	494,587	490,059	0.282	0.334	5.22	2,536,485	3,764	6,758
23-Jul	490,897	456,759	0.284	0.301	6.42	2,458,577	3,356	6,311
23-Aug	573,640	568,393	0.297	0.331	6.07	3,061,855	4,464	7,652
23-Sep	495,733	491,264	0.303	0.332	7.51	2,536,138	3,500	6,947
23-Oct	429,527	425,599	0.293	0.260	8.12	2,085,215	2,829	5,521
23-Nov	588,259	583,149	0.272	0.273	7.76	2,787,609	3,506	6,890
23-Dec	549,705	542,719	0.342	0.320	4.70	3,475,075	4,014	8,617
Total	**5,948,239**	**5,861,715**	**0.287**	**0.311**	**6.50**	**30,145,400**	**41,835**	**76,688**

2.2.1 Underground Mining Program

No mining occurred in the Wight Pit in 2021. It has been in Care and Maintenance since May 2017.

2.3 Current Life of Mine Plan

The mine came out of Care and Maintenance in November 2021 with limited production out of the Phase 4 mine plan. Mining continued throughout 2023 with the development of SP4 benches 1000 though to SP4 924. The permitted Phase 4 mine plan includes three years of production in the Springer followed by one year of PAG waste re-handled back into the Springer Pit. MPMC has been in discussions with EMLI, ENV and the Major Mines Office (MMO) since August 2021 for an application to extend the LoM by following the Joint Applications Information Requirements (JAIR) for *Mines Act* and E*nvironmental Management Act* Permits. The JAIR pre-application was submitted to the MMO in Q4 2023 and proposes to extend the LoM to approximately 2034 for the following factors:

-delayed by an interval approximately equal to the duration of the temporary Care and Maintenance period

-increase in reserves due to increase in commodity prices

2.4 Surface Development in the Past Year

In 2023 mining of the Phase 4 Cariboo-Springer 4 Pit continued with development of the SP4 1000 through to the SP4 924 benches. Material classified as potentially-acid generating (PAG) was dispatched to the Temporary Northwest (NW) Potentially-Acid Generating (PAG) stockpile. Material classified as non-acid generating (NAG) was dispatched to the Southeast Rock Disposal Site (SERDS). Ore was dispatched to the crushing facility and or to the stockpiles.

Milling of the ore continued in 2023.

In 2023, 22,115,054 tonnes of material were removed from the pit of which 6,814,144 tonnes was ore. This material was directly fed into the crusher and or stockpiled.

Approximately, 12,032,329 tonnes of waste were removed from the pit, of which 3,784,284 tonnes were classified as PAG and dispatched to the PAG stockpile. Approximately, 8,248,045 tonnes were classified as NAG, of which 1,093,900 tonnes were dispatched to the PAG stockpile and 7,154,145 tonnes were dispatched to the SERDS.

2.5 Surface Development Projected Over the Next 5 Years

MPMC submitted a JAIR on December 8, 2023 to extend the LoM to 2034.

Identified ore reserves indicate a viable mine life for 8 to 10 years expected to continue to 2031. Given the uncertainty around future operations and mine life, reclamation and closure planning described in this document are subject to review and updates.

- Mining will consist of Springer Phase 4 and Springer Expansion. When the mine is unable to provide all the mill feed directly, mill feed will be supplemented by feed from the low-grade stockpile. Underground mining is not included in the update LoM (Springer Expansion).
- PAG waste will be hauled into the mined-out Springer Pit during the last 3 years of the mine plan totaling 68 million tonnes.

The projected closure disturbance area for the proposed LoM plan is 1,302.01 ha. This increase in disturbance is the result of the development of components under the authorized Mine plan, including pits (continued mining), SERDS and Temporary NW PAG Stockpile development (material placement), and road infrastructure (i.e., the Tailings Dam Access Road; TDAR).

The projected changes in disturbed areas with the closure footprint are outlined in Table 2.5. Further information on projected surface development can be found in *RCP* (MPMC, 2017a) and later in *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022).

Table 2.5 Changes in disturbed areas with closure footprints

Area	Existing Area (ha)	Closure Area (if changed) (ha)	Delta	Description
Dumps				
North Bell Dump	62.47	*62.07*	-0.40	Cariboo-Springer Pit Expansion
SERDS	109.97	*110.27*	0.30	Final re-sloped footprint
Temporary NW PAG Stockpile	80.48	*77.93*	-2.55	Final re-sloped footprint
Pits				
Boundary Pit	12.26	*19.41*	7.15	Boundary Pit Development
Cariboo-Springer Pit	145.77	*163.57*	17.80	Cariboo-Springer Pit Development
Stockpiles				
#1 Stockpile	10.76	*10.06*	-0.70	Cariboo-Springer Pit Expansion
SERDS Soil Stockpile	12.76	*12.09*	-0.67	SERDS Expansion
Roads				
West Haul Road	59.21	*103.72*	44.51	Assumes completion of TDAR; if not, no additional disturbance.
Miscellaneous				
Old Orica Sites	1.73	*0.76*	-0.97	TDAR Construction (West Haul Road)
South SERDS Ditch	2.61	*0.40*	-2.21	TDAR Construction (West Haul Road)
CWTS	1.05	*1.05*		CWTS Construction 9k Sump

2.6 Salvaging and Stockpiling of Surficial Materials

2.6.1 Volumes and Storage Locations

As per the *MPMC Soil Management Plan*, MPMC tracks volumes and locations of soil stockpiles and has a sampling program in place to characterize soil suitability for reclamation. 2023 soil stockpiling and transfers are shown in Table 2.6 below. Mining activities in November and December occurred in areas from which soil had already been stockpiled.

Table 2.6 2023 soil stockpiling and transfers

Soil Volume (M^3)	Transfers and Stockpiling
68776	Upper Cariboo Stockpile to Upper Cariboo Stockpile
3969	TSF to TDAR Sand/Soil Stockpile
563,000	SEZ-3 surveyed and volume updated to replace previous estimation
38634	Till borrow to TDAR Sand Soil Stockpile

Table 2.7 summarizes the quantities of soil at the Mine site and meets the requirements for EMLI reporting for Table 5 in the guidelines document.

Table 2.7 MPMC Soil Inventories as of December 31, 2023

Stockpile Name	Location	Soil Volumes (m^3)
TSF Corner 1 - Windrow	TSF Corner 1	5,100
Upper Plug Acces Road (PAR) - Windrow	Along upper PAR	1,700
Plug - tockpiles	Polley Lake Plug	127,017
Perimeter Pond - Stockpile	Bottom of Corner One (near old Perimeter Pond)	4,700
Till Borrow - Windrow	North of (Perimeter) Till Borrow	42,800
Perimeter Embankment - Windrow	Edge of Perimeter Embankment	3,800
Main Embankment - Stockpile	SE of Main Embankment	94,900
South Till Borrow - Stockpile 1	NW stockpile in South Till Borrow	11,600
South Till Borrow - Stockpile 2	S stockpile in South Till Borrow	65,300
South Till Borrow - Stockpile 3	NE stockpile in South Till Borrow	9,600
Gavin Lake Road - Windrow	Gavin Lake Road (along South/Main Embankment)	24,200
TSF Access Road (TAR) - Windrow	Adjacent to TAR	43,500
Tailings Reclaim Road - Windrow	Tailings Reclaim Road	44,300
Cariboo Stockpile - Stockpile	Below Cariboo Stockpile	33,967
Upper Cariboo Stockpile	Upslope from Cariboo Stockpile	3,300
Mill Site - Stockpile	East of Mill/Admin Building (includes berms)	10,700
Access Road km 11.5 - Stockpile	Across from NBD Reclamation Parcels 1 - 10	8,200
Access Road km 12 - Stockpile	S-SW of Mount Polley Peak (by km 12 on Acces Rd)	83,700
East RDS - Stockpile	Top of East RDS	58,500
Leach Pad - Stockpile	Top of East RDS	4,800
Highway to Heaven - Windrow	Highway to Heaven Access Road	21,500
NEZ Dump Top - Stockpile	Top of NEZ Dump	6,500
		14,365
		25,000
NEZ Dump Lower - Stockpile	Off Wight Pit Haul Road	71,300
Wight Pit Till - Stockpile	Bottom of Wight Pit Haul Rd	135,100
Wrap Around Road - Windrow	Wight Pit - TSF Connector Road (below NEZ Dump)	101,600
North Bell Dump Till - Stockpile	North Bell Dump	164,000
North Bell Dump Top - Stockpile	Top of North Bell Dump	8,500
Springer North	Between North Bell Dump and Springer Pit	20,000
Northwest Sump Road - Windrow	Northwest Sump Road	7,500
PAG Dump - Windrow	Below PAG Dump	39,300
SEZ 1 - Stockpile	Top of Old Pond Zone Pit	108,687
SEZ 2 - Stockpile	Top of SERDS (near SEZ - 1)	14,000

SEZ-3	Below Co-mingling Project	563,000
SERDS - Stockpile	Below SERDS Dump	58,000
SERDS - 3	Edge of SERD near old Pond Zone	14,800
Old TSF Haul Road	Along old TSF Haul Road (SERDS)	27,200
Lower SERDS - Stockpile 1	Below SERDS Dump	27,870
Lower SERDS - Stockpile 2	Below SERDS Dump	27,539
Lower SERDS - Stockpile 3	Below SERDS Dump	140,100
TDAR Sand/Soil Stockpile	Tailings Dam Access Road	89,028
	Total Volume of Stockpiled Soils	**2,366,573**

Further details regarding soil balance and usage during progressive and final reclamation can be found in *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022).

2.6.2 Soil Stockpile Inspections

All non-active soil stockpiles on site are periodically inspected for erosion and vegetative cover and any non-active stockpiles requiring additional vegetative cover and/or showing signs of erosion are added to the bi-annual (spring and fall) seeding list. Most soil stockpiles are well vegetated and do not demonstrate issues with erosion, sedimentation or invasive species which would trigger remedial actions.

2.6.3 Soil Stockpile Quality

MPMC did not undertake stockpile sampling and characterization in 2023. A stockpile sample program was undertaken in 2013 and 2014. Information regarding stockpile quality can be found in MPMC 2013 and 2014 *AERR*s (MPMC, 2014, 2015b).

MPMC has collaborated with researchers from the Department of Forest and Conservation Sciences at the University of British Columbia to assess changes in the biological communities of stockpiled soil. Soil organisms play a critical role in nutrient cycling, contribute to development of soil structure and form symbiotic mutualistic relationships with plants. Yet during storage, soil can undergo degradation (e.g., die-off of vegetative propagules and decreases in available nutrients) reducing its quality for use in reclamation. This project aimed to quantify changes in soil biological communities and understand the time periods over which they occur.

3 Environmental Protection Program

3.1 Environmental Management Systems

An Environmental Management System (EMS) is a framework that helps an organization achieve their environmental targets through regular review, evaluation, and improvement of its environmental performance (ISO 2015). This framework relies on a cycle of planning, implementation, monitoring, and improvement, and is broadly similar to the adaptive management paradigm (Westgate et al., 2013). Regular review and evaluation of environmental practices reduces the risk of non-compliance and allows opportunities for improvement to be identified and implemented. The objective of these procedures is scientifically informed management of local natural systems, and a minimization of environmental impact. MPMC's EMS consists of procedures and processes for training of staff, monitoring environmental systems, and documenting performance. Environmental targets and reporting requirements are based on those outlined in *EMA* Permit 11678 and *Mines Act* Permit M-200.

The following Environmental Management Plans (EMP) are part of MPMC's EMS:

- Annual Discharge Plan
- Comprehensive Environmental Management Plan
- Water Management Plan (Mine Operations)
- Dust Management Plan
- Environmental Emergency Response Plan
- Hazeltine Creek Fish Exclusion Plan
- Invasive Plant Management Plan
- Erosion and Sediment Control Plan
- Soil Management Plan
- Biosolids Management Plan
- Wildlife Management Plan
- Nitrogen Management Plan
- Flocculant Management Plan

MPMC also maintains a QAQC Manual that consists of Standard Operating Procedures and Work Methods including but not limited to: water chemistry and toxicity monitoring and sampling (groundwater, surface water, lake water and seep water), periphyton sampling, phytoplankton sampling, vegetation sampling, soil sampling, hydrological sampling, meteorological sampling, snowpack measurements and the associated sample preservation and shipping and field sample record keeping as well as safety protocols including safe boating and check-in and check-out procedures.

Periodic inspections of infrastructure on the Mount Polley Mine site are also conducted and documented as part of MPMC's EMS. The following inspections and their corresponding frequencies were conducted in 2023:

- Waste Inspections – Weekly/Monthly
- Sump/Ditch Inspections – Monthly by MPMC staff, bi-annually by a QP
- Quesnel Lake Pipeline Inspections – Monthly by MPMC staff, annually by a QP
- Tailings Storage Facility Inspections – Weekly

3.2 Environmental System Audits

EMPs are scheduled for updating and submitting according to the requirements set out by the *EMA* Permit 11678 and *Mines Act* Permit M–200. The following EMPs were reviewed and/or updated in 2023:

- Erosion and Sediment Control Plan
- Soil Management Plan
- Environmental Emergency Response Plan
- Annual Discharge Plan
- Dust Management Plan
- Invasive Plant Management Plan
- Biosolids Management Plan

MPMC also maintains a QAQC Manual that consists of the aforementioned Standard Operating Procedures and Work Methods that is updated annually. The most recent update is ongoing at the time of writing, occurring from January-March 2024.

Geotechnical (2), Geoscience (1) and Safety (15) inspections were conducted by EMLI in 2023. There are a total of 2 outstanding orders from EMLI inspections and details are located in Table 3.1 below.

Table 3.1 Outstanding orders from EMLI inspections

Date	Permit	Type	Requirement/ Description	Compliance	Findings/Details	Response/ Action	Status
05-Oct-22	M-200	Ergonomics Inspection #197466	Order 197466-S1-O1	Out	The site does not have a written Musculoskeletal Disorder (MSD) Prevention Program.	Mount Polley currently has training materials to address MSD prevention and awareness. A review of the current program will be conducted and a plan of action for the 2023 program will be provided on or before 2023-01-06.	In progress

22-Nov-23	M-200	Occupational Health Inspection #218024	Order 218024-S1-O1	Out	During discussions on site, it was reported that the site Workplace Monitoring Program is not up to date and that work is being done to create and prioritize Similar Exposure Groups.	A draft 2023 Workplace Monitoring Program was submitted on Jan 5, 2024. Updates and a final copy of the WMP as well as testing results will be submitted by the April 1st deadline for this order.	In progress

A summary of non-compliance and not determined findings as well as MPMC's responses/actions is provided in ***Appendix S***.

The MPMC ML/ARD Management Procedure Manual was reviewed by SRK, as part of a permit amendment application in 2023. SRK recommended and implemented updates to the ML/ARD Management Procedure Manual. The updated ML/ARD Management Procedure Manual is included in ***Appendix V***.

In 2023 a Flocculant Management Plan (FMP) was developed and implemented for WTP operations. The objective of the plan is as follows: "The objective of the FMP is to describe the methods for settling of solids at the Plant using settling aids including coagulant (polyaluminum chloride), flocculant (polymer), and ballast (microsand), while preventing potential detrimental effects such as toxicity in the receiving environment. The FMP also describes the procedures and equipment used for storage and dosing of settling aids, including monitoring of influent and effluent water quality." (WSP, 2023).

3.3 Water Management

A map of all drainages and watersheds around the Mount Polley Mine site is shown in Figure 1.2 in Section 1.3.2. Further information regarding pre-mining drainage and watershed can be found in the *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022a). The water management system is designed to accommodate flows all flows up to a 1 in 10-year 24-hour storm event and withstand all flows up to a 1 in 200 year 24-hour storm event, without significant damage.

3.3.1 Evaluation of Effectiveness of Water Management

MPMC continually evaluates water management infrastructure through routine inspections to ensure that it performs as expected. On March 27, 2023, a 30" pipeline in the Mount Polley Mine site contact water collection system became obstructed and contact water spilled to the environment. More details of this water release are in Section 3.7.2. A rental Veolia water treatment plant was commissioned in April 2022 to increase treatment throughput. The rental unit was decommissioned and removed from site May 18, 2023. Ditches and pipelines are inspected by Environmental personnel monthly and a QP twice annually.

3.3.2 Water Management System Update

A map of the water management system as of the December 31, 2023, is presented in ***Appendix B***. There

are two updates to the Water Management System in 2023.

1. Removal of the Veolia Water Treatment Plant May 2023
2. Notice of Departure to remove the Mill Site Sump

Mount Polley Mining Corporation (MPMC) has retained a mobile water treatment plant from Veolia Water Solutions (Veolia) on a temporary basis until the site water balance has been significantly reduced. The mobile plant is a portable Veolia ACTIFLO® water treatment plant with a maximum design capacity of 250 m^3/hour (Figure 3.1). The treatment process is the same as the MPMC permitted Veolia Water treatment plant (WTP) which has been authorized and in operation at the mine site since 2015.



Figure 3.1- Veolia ACTIFLO mobile rental water treatment plant

The mobile unit will be installed inside the existing WTP facility. The layout of the mobile plant inside of the WTP facility is shown in Figure 3.2.

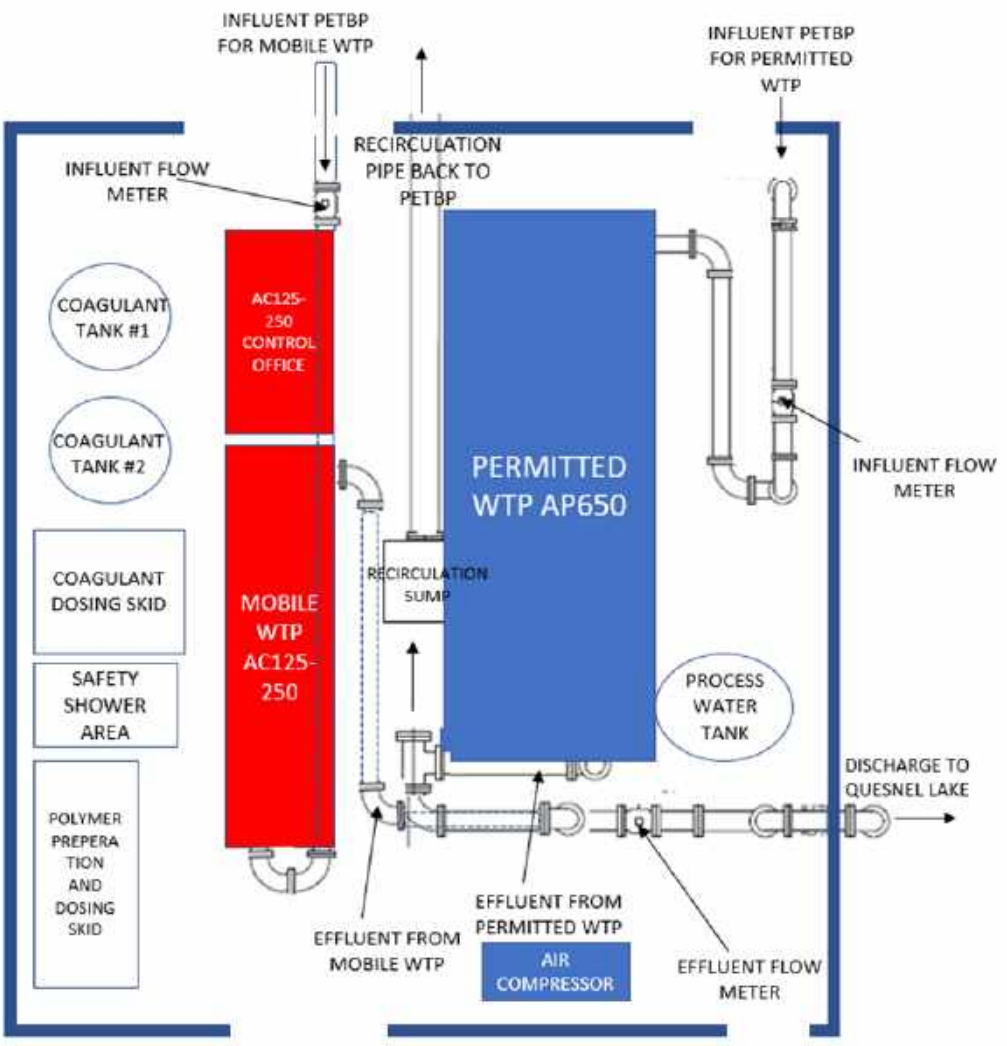


Figure 3.2 – Water treatment plant facility layout

Electrical utilities are drawn from the same source as the permitted WTP, with a transformer to meet the specific voltage requirements of the portable system being installed. No concrete foundation or permanent infrastructure was needed for the mobile rental plant. Influent is pumped using existing infrastructure and flow is monitored using a flow meter. The effluent discharge is directed into the permitted WTP discharge pipe and a new sampling port End-of-Pipe (HAD-3) was installed outside of the building. Both plants have the ability to go into recirculation mode independently from one another by way of inline sensors set to trigger limits or by operator intervention.

To simplify operation, the mobile plant utilizes the larger capacity polymer mixing tank and coagulant tank which is currently used for the permitted WTP. Mount Polley pipe fitters and Veolia technicians completed the assembly of all components prior to commissioning the plant. Commissioning of the plant was completed on March 31, 2022. The mobile Veolia water treatment plant was decommissioned and removed from site in May 2023 once the site water balance was reduced to management amounts.

The Mill Site sump is an existing water management facility and grouped into Mill Site Dewatering infrastructure. Water in this facility is pumped into the Tailings line to be conveyed to the Tailings Storage Facility. This sump is classified as a Dam and was outlined in EMLI by Mark Smith (Inspection 200443). During commissioning of the mill in 2022, refurbishment and upgrades to the mill basement sumps has been completed and the majority of water that flowed into the Mill Site sump is now directed into the mill basement. The mill basement sumps are pumped to the tailings box and water is conveyed to the TSF. The surface water remaining will be diverted to an existing sump located near the Magnetite facility. This sump will be pumped into the Tailings line to convey water to the TSF.

Due to these upgrades in the mill and potential to divert surface water to another existing sump, the Mill Site sump is no longer required for water management and can be removed. The Notice of Departure was approved on June 12, 2023.

3.3.3 Water Discharge Background

The Mount Polley Mine site has historically had a positive water balance, meaning more yearly precipitation occurs at the site than evaporation. This means that water discharge is needed regardless of whether the Mount Polley Mine operates or manages the site on Care and Maintenance, or in operations.

The water surplus was forecast before the Mine started operation and was discussed with neighboring communities during the original consultations that were carried out, along with the Environmental Assessment process, during the 1990s. At that time, the authorized plan was to settle the surplus water in sedimentation ponds and discharge to the local lakes and creeks near the Mine.

During the development and operation phases of the Mine, MPMC continued to assess and plan for water management at the Mine, obtaining and utilizing effluent discharge permits during the Mine's construction and operating period between 1997 and 2000, Care and Maintenance period between 2001 and 2005, and during operations between 2005 and 2014. Effluent was permitted to discharge into Edney Creek during Care and Maintenance until 2005. In years following 2005 the Mine site operated at an annual water balance surplus in excess of water recycling, dust suppression and evaporation. The excess water inventory was stored in mined-out pits and the TSF.

The effluent discharge permit of 2012 authorized 1.4 million cubic meters (Mm^3) per annum into Hazeltine Creek of which 12% could be discharged due to constraining discharge volumes. In 2013, MPMC sought authorization for an additional interim measure to alleviate the critical need to discharge surplus water accumulating on the Mine site.

A reverse osmosis (RO) system was pursued as a short-term solution in 2014; however, MPMC did so knowing that RO would not be a suitable technology for the long-term management of site contact water. In fact, the RO system was proposed as an "interim" discharge strategy, to be employed to address the site water surplus inventory existing at the time, while allowing a sustainable long-term water management plan to be developed. The preferred long-term water management strategy continued to envision passive

treatment and distributed discharge. Notably, at the time, MPMC had already been researching, trialing and operating passive treatment systems in partnership with the University of British Columbia and Genome BC since 2009 and had recently started a partnership with Thompson Rivers University for research into wetland treatment systems.

Following the failure of the TSF foundation in 2014, all water management planning was essentially 'reset', as the existing effluent authorizations were no longer practicable, and the site conditions for what was then the "interim" (RO) water management planning work was significantly advanced in 2014 were no longer applicable. MPMC had no permitted discharge, and all contact water was being stored in the Springer Pit. However, the Mine site continued to have a positive water balance (Golder 2015a), with open pits having finite capacity. Golder estimated that once the Springer Pit water elevation reaches approximately 1,030 masl, the water will exfiltrate to the groundwater and discharge towards Bootjack Lake (Golder, 2015a). At 1,050 masl the Springer Pit will overflow.

With this new paradigm for water management planning, MPMC worked in collaboration with ENV, EMLI, First Nations, local communities, and stakeholders to develop a "roadmap" towards future water management. This "roadmap" recognized that a phased approach to water management planning (and corresponding *EMA* Permit 11678 amendments) would be required for the Mine and contemplated an initial phase (the authorized Short-term Water Management Plan [STWMP]), an operating phase (the current authorized Water Management Plan (Mine Operations), and transitioning toward the Long-term Water Management Plan (LTWMP), which includes plans and details for closure and post-closure conditions.

The effluent discharge strategy commonly referred to as the STWMP, was authorized on November 29, 2015, and reflects the effluent discharge authorized by *EMA* Permit 11678 to November 30, 2017. The STWMP includes discharge of treated effluent to Quesnel Lake via the Hazeltine Channel, and the key objective in its development and authorization was to manage contact water that had accumulated at the Mine site following the TSF foundation failure, while allowing time to develop the LTWMP.

MPMC have continued to follow the approach of this "roadmap" in accordance with the process established in collaboration with the aforementioned parties to ultimately return water flows to their original watersheds in what is known as distributed discharge, to the extent that is possible. Table 3.2 provides a summary of water discharge authorizations from the Mount Polley Mine. An interim permit amendment was authorized on December 1, 2022 to allow effluent discharge from to Quesnel Lake until June 30, 2025. This amendment allows time for the processing of a major permit amendment to be handled jointly by ENV and EMLI under both the *Environmental Management Act* and *Mines Act*, to seek a solution for water surplus to the planned end of mine life in 2034. The current authorized discharge is discussed in further detail in Section 4.12.

Table 3.2 Summary of *EMA* Permit 11678 authorizations for water discharge from the Mount Polley Mine

Date	Discharge Source Permitted	Discharge Location	Comments
7-Feb-2002	MESCP	Edney Creek	Discharge discontinued in 2005; no longer permitted.
7-Nov-2012	Dam filtered	Hazeltine Creek	Discharge discontinued in 2014; no longer permitted.
29-Nov-2015	Springer Pit, and site runoff and seepage collection water management systems	Quesnel Lake via Hazeltine Creek	Discharge discontinued in 2017; see Section 4.12.
30-Nov-2017	TSF, and site runoff and seepage collection water management systems	Quesnel Lake via direct pipeline	Active since 2017
1-Dec-2022	TSF, and site runoff and seepage collection water management systems	Quesnel Lake via direct pipeline	Active in 2022 (Interim solution sought to allow time for ENV/EMLI joint major permit amendment); See Section 4.12
Upcoming 2023-2025	Unknown	Unknown	ENV/EMLI joint EMA/MA major permit amendment for mine plan to 2034.

3.3.4 Long-Term Water Management Plan Development

MPMC retained qualified environmental professionals to review and modernize the previous water management plans and make sure that MPMC were applying best practices to manage surplus site water. This work has resulted in a detailed LTWMP Technical Assessment Report (TAR) submitted on October 17, 2016, in support of the currently authorized *EMA* Permit 11678. The TAR incorporated feedback from and comments by ENV, EMLI, and First Nations (and their respective consultants).

Subsequently, the Water Management Plan (Mine Operations), dated November 27, 2020, was developed for the planned period of mine operations to 2034, which includes management past the newly authorized date when discharge into Quesnel Lake ceases to be authorized under Permit 11678, June 30, 2025.

The *EMA* Permit 11678 allows MPMC to manage site contact water in accordance with the expectations laid out in the *EMA* and Ministry policy pertaining to effluents. The Veolia Actiflo® water treatment system, was commissioned in 2015 by MPMC has met the site water management and will remain as the primary treatment facility for the during of operations.

The *EMA* Permit 11678 authorized annual discharge is 10.5 Mm^3 when discharging to Quesnel Lake, sufficient to manage the 1:200-year wet annual rainfall while the Mine is in operation (LTWMP TAR).

The 2023 Annual Discharge Plan (ADP) is meant to outline, among other items, the expected volume, timing,

and quality of effluent released to Quesnel Lake, and plan the discharge in such a manner that avoids "pollution", as defined in the *EMA* and as determined by the evaluation of parameter concentrations at the edge of the Initial Dilution Zone (IDZ) in Quesnel Lake. Parameter concentrations at the edge of the IDZ will be monitored using a new, model-based approach as part of a Trigger Response Plan (TRP) (Section 4.12.2.6; Appendix I). The ADP was reviewed but not substantially revised in 2023.

A condition of *EMA* Permit 11678 is the development of a revised Water Management Plan (WMP) (Golder, 2020a) to address water management and treatment beyond the end of 2022 for the period from January 2023 to December 2031. The WMP revision does not address water management during closure or post-closure. During operations, the water management infrastructure (i.e., collection ditches, pipes, sumps, pumps, etc.) will remain in its current configuration. During the remainder of operations, plans will be put in place to develop the final design for water management and treatment into closure and post-closure.

A key component of developing the final design during operations is developing alternative treatment technologies that could be considered for closure of the site. The WMP provides an update on progress on a number of possible treatment technologies, included in the water treatment technology inventory. Good engineering practice typically requires a project to follow the requisite engineering design process for the selection and progressive refinement of options. The project progresses from a pre-concept phase for the identification of multiple treatment options, through concept, pre-feasibility, and feasibility phases to project execution. Generally, the engineering studies performed for each of the aforementioned project phases are supported by test work that progresses from proof-of-concept and detailed bench-scale testing to pilot-scale and demonstration-scale test work. It is MPMC's intent to follow this project framework to develop suitable and applicable treatment technologies for the site.

A proposed implementation schedule for developing these technologies has been included in the WMP. Additionally, operational events or changes that are expected to trigger future updates to the WMP are provided, as more site information becomes available. The need for changes to water treatment technologies will be evaluated for each operational trigger event. If it is determined that an operational trigger requires a change to the water treatment approach, the requisite engineering design process will be followed for the selection and progressive refinement of options.

Requirements under *EMA* Permit 11678 relating to water treatment technologies include the development and reporting of annual plans for BAT assessment, and twice-annual progress reports on the development of water treatment technologies. The 2024 BAT Assessment Plan was submitted in January 2023 (MPMC 2024). Water Treatment and Discharge Progress Reports #12 and #13 were submitted in June and December, 2023 (MPMC 2023a; MPMC 2023b) and are included in ***Appendix W***.

As part of closure planning and long-term water management, MPMC's objectives are to provide systems with long-term resilience and effectiveness so that water leaving the Mine site is the best alternative for the receiving environment. Moreover, MPMC are also seeking to distribute treated waters into the pre-mining

catchments, to the extent that is practical.

3.3.5 Water Balance

MPMC retains Golder to maintain a predictive water balance model for the Mount Polley Mine site using GoldSim™ software. This model generates probabilistic flow and water balance forecasts for site water management system components, and has been adapted to model conditions during operations, closure, and post-closure following reclamation work.

The GoldSim™ water balance model is used for planning purposes such as water discharge planning, with calibration and revised projections made based on actual observed site conditions (i.e., water levels and storage volumes). The model also undergoes routine validation through comparison of predicted and observed accumulations, based on actual climate conditions and water management data recorded from site. Model validation was most recently carried out in March 2024 for data covering the period January 2023 to December 2023. Golder provided Site Wide Water Balance Model and Water Quality Calibration Technical Memorandums and they are included in ***Appendix P***.

In addition to the GoldSim™ model developed by Golder, MPMC has an operational spreadsheet that is used to record, and track components of the onsite water balance for operational purposes. Water storage conditions on site from 2018-2023 are summarized in Table 3.3. Under conditions of *Mines Act* Permit M–200 authorizing the return to full operations and use of the TSF, Quantitative Performance Objectives (QPOs) were established. Some of the QPOs are specific to free water storage in the TSF. Under current authorizations, the TSF is operated with a normal operation free water surplus between 1,500,000 m^3 and 1,700,000 m^3 and is authorized for temporary detention of water for contingency (e.g., freshet) storage provided that a minimum freeboard of 1.1 m is maintained.

Under the *EMA* Permit 11678, elevations of the Springer Pit must be recorded monthly for water balance purposes. The Springer pit was dewatered for phase 4 mining operations to continue. The Springer Pit is not expected to be used as water storage for the remaining of the approved and projected mine life. Monthly elevations for the Springer Pit, Cariboo Pit and Wight Pit are provided in Table 3.4.

Table 3.3 Water storage conditions at end of each year, 2018-2023.

Item	2018 Year End	2019 Year End	2020 Year End	2021 Year End	2022 Year end	2023 Year end	Change from previous year
Springer Pit Elevation (masl)	986.96	982.87	1,003.66	982.88	975.31	0	-975.31
Springer Pit Water Volume (m^3)	426,226	2,447,925	2,817,333	508,511	42,061	0	-975
Springer Pit Tailings Volume (m^3)	2,537,251	2,109,030	2,109,030	2,109,030	2,109,030	691,000	-1,418,030.00
Cariboo Pit Water Elevation (masl)	920[(a)]	980	999.11	1,020.31	976.13	956.1	-20.03
Cariboo Pit Water Volume (m^3)	0[(a)]	1,174,691	2,451,580	4,603,358	766,835	235,953	-975
Wight Pit Water Elevation (masl)					916.24	900.46	-15.78
Wight Pit Water Volume (m^3)					3,010,477	1,658,553	-1,351,924.00
TSF Elevation (masl)	961.69	962.01	962.77	962.09	962.947	964.47	1.52
TSF Volume (m^3) - Total	13,45,222	17,683,495	17,760,450	16,336,288	16,705,491	17,387,876	-975
TSF Volume (m^3) – Tailings + Interstitial Water	12,551,668	15,726,999	15,906,067	14,476,633	14,476,633	15,863,836	1,387,203.00
Total Free Water Volume (Springer + Cariboo + TSF)	1,171,147	3,542,008	7,833,992	6,971,524	6,502,415.00	3,418,645.00	-975
Total Water Discharged (m^3)	5,265,722	3,480,268	5,024,328	6,733,553	7,216,768	4,478,726	-2,738,041.80

(a) Active mining was occurring in the Cariboo Pit at the end of 2018. 920 MASL represents bottom of pit elevation.

Table 3.4 Monthly Springer Pit elevations, 2019-2023.

	Springer Pit elevations (masl)	Wight Pit elevations (masl)	Cariboo Pit elevations (masl)
1-Jan-19	986.96		
1-Feb-19	987.3		
1-Mar-19	987.6		
1-Apr-19	987.96		
1-May-19	988.69		
1-Jun-19	989.19		952.64
1-Jul-19	987.95		960.24
1-Aug-19	986.22		961.66
1-Sep-19	984.71		962.87
1-Oct-19	982.1		968.5
1-Nov-19	980.61		971.1
1-Dec-19	- [(a)]		973.6
30-Jan-20	983.74		976.75
27-Feb-20	984.25		978.65

26-Mar-20	984.5		980
30-Apr-20	987.85		980.5
28-May-20	992.5		981
30-Jun-20	998.27		981.4
31-Jul-20	1002.75		985.8
27-Aug-20	1003.36		990.63
30-Sep-20	1003.5		994.27
31-Oct-20	1003.89		995.32
30-Nov-20	1004.34		995.96
31-Dec-20	1003.66		996.92
1-Jan-21	1002.09		997.26
1-Feb-21	1000.95		998.5
1-Mar-21	999.5		999.11
1-Apr-21	999.7		999.44
1-May-21	1000.14		999.92
1-Jun-21	998.91		1007.94
1-Jul-21	996.48		1015.77
1-Aug-21	993.35		1022.84
1-Sep-21	989.45		1023.01
1-Oct-21	986.1		1022.98
1-Nov-21	985.65		1022.02
1-Dec-21	982.88		1020.82
1-Jan-22	981.25		1019.99
1-Feb-22	980.15	869.8	1019.41
1-Mar-22	980.28	871.75	1020.31
1-Apr-22	981.25	873.06	1020.49
1-May-22	980.19	873.06	1020.34
1-Jun-22	977.93	903.15	1022.72
1-Jul-22	976.56	912.24	1027.14
1-Aug-22	975.8	913.96	1021.25
1-Sep-22	976.45	917.07	1014.18
1-Oct-22	975.85	916.89	1011.28
1-Nov-22	975.38	916.46	1003.55
1-Dec-22	975.25	915.99	998.55
1-Jan-23	974.9	916.24	989.35
1-Feb-23	975.2	915.3	980.74
1-Mar-23	975.1	914.6	976.16
1-Apr-23	(b)	912.5	956.1

1-May-23		913.7	957.3
1-Jun-23		912.4	955.2
1-Jul-23		910.7	954.9
1-Aug-23		908.71	950.99
1-Sep-23		906.52	951.52
1-Oct-23		904.67	952.94
1-Nov-23		902.87	952.97
1-Dec-23		901.79	952.11
1-Jan-24		900.46	956.1

(a) Due to safety and loss of GPS communication from power outages, last elevation for 2019 was November 6, 2019.

(b) The Springer Pit was dewatered and Phase 4 mining operations commenced

3.3.6 Water Management System Upgrades

Bi-annual sump and ditch inspections (required under *EMA* Permit 11678*)* were completed in 2023, as well as daily water management infrastructure inspections, environmental monitoring, and other observational activities as per MPMC's *Operation, Maintenance and Surveillance (OMS) Manual* (as well as part of MPMC's Sediment and Erosion Control Plan; Section 3.5). No upgrades to the water management system were conducted in 2023.

3.4 ML/ARD Characterization and Mine Waste Management

3.4.1 Waste Rock Characterization and Disposal

Active monitoring of ARD/ML potential in the Mount Polley waste rock continued in 2023 as part of the established protocol which encompasses two stand-alone acid-base accounting (ABA) procedures: ARD analysis of diamond drill core pulps to model a preliminary Potentially Acid Generating (PAG) body; and ongoing ABA determination of individual blast hole samples during mining operations to enhance the segregation of PAG from non-acid generating (NAG) waste (MPMC 2017a). The program characterizes all material types that will be handled during the Mine life. Analysis is completed on site by Mount Polley's LECO™ analytical machine which allows the Mine to characterize waste and direct it to suitable storage sites or designate it for construction usage when required and if deemed suitable. No acid-base accounting procedures occurred between May 2019 and November 2021 due to the mine being in Care and Maintenance. These procedures were reinstated as MPMC resumed mining operations.

On each bench, a sample of cuttings is collected from each blast hole and analyzed for total copper, total carbon, total sulfur, non- sulphide copper, iron, and gold. Areas of ore and waste are identified by indicator kriging and assigning assay values, mill head value, etc. using an inverse distance calculation. The ore control staff member then establishes ore/waste boundaries based on the calculated mill head values. Mill feed ore areas are excluded from ABA analysis, as this material is processed through the mill. Only waste rock is submitted for ABA analysis. Waste rock material was not sampled between May 2019 and November 2021

as no active mining was conducted at the mine site.

Samples with both a Neutralizing Potential Ratio (NPR) greater than 2 and a Sulphur content less than 0.1% are considered NAG, and samples with both an NPR less than 2 and a Sulphur content greater than 0.1% are considered PAG. PAG is currently stored in the Temporary NW PAG Stockpile to the northwest of the Springer Pit and will be relocated to the bottom of the Springer Pit and submerged upon Mine closure. This material rehandling is planned to take place near the end of mine life

A summary of quantities of waste rock, tailings, and other Mine waste added to site storage areas in 2023 and the total quantities on site as of December 31, 2023, are provided in Table 3.5.

Table 3.5 Quantities of waste rock, tailings, low grade ore, and other mine waste for 2023

Name of Waste Pile or Pond	Acid Generating Waste		Potentially Acid Generating Waste		Non-Acid Generating Waste	
Waste Dumps						
	2023	**Total**	**2023**	**Total**	**2023**	**Total**
1. Southeast Rock Dump	0	0	0	0	7,083,080	69,815,254
2. NAG/PAG Dump	0	0	3,789,784	34,768,129	1,093,900	9,557,116
3. WTP Sludge Pond	0	0	17	1,307	0	0
Total	0	0	3,789,801	34,769,435	8,176,980	79,372,370
Tailings Ponds						
1. Tailings Storage Facility	0	0	0	31,641,511	37,960	366,985
Total	0	0	0	31,641,511	37,960	366,985
Low Grade Ore / Coarse Reject / Other Mine Waste						
1. Belt Cleanup Stockpile	0	0	0	0	0	0
2. #3 Ore Stockpile (LG)	0	0	0	165,600	0	0
3. Leach Stockpile (LG)	0	0	0	2,564,475	0	0
4. Southeast Rock Dump	0	0	0	0	0	0
5. Cariboo LG Stockpile	0	0	0	267,921	10,700	10,700
Total	0	0	0	2,997,996.00	10,700	10,700

Springer Pit

MPMC provided a Mine Restart Notice on August 25th 2021 to EMLI indicating a departure from Care and Maintenance to Operational status per the Health, Safety and Reclamation Code for mines in B.C., part 6.2.1. Surface Mining in Cariboo-Springer Pit Phase 4 resumed in 2021 and continued throughout 2022. The remaining material in the permitted Phase 4 mine plan comprises of the saddle rock between the Cariboo and Springer pits as well as several benches below the Springer Pit.

In 2023 mining of the Phase 4 Cariboo-Springer 4 Pit continued with development of the SP4 1000 through to the SP4 924 benches. Material classified as potentially-acid generating (PAG) was dispatched to the Temporary Northwest (NW) Potentially-Acid Generating (PAG) stockpile. Material classified as non-acid generating (NAG) was dispatched to the Southeast Rock Disposal Site (SERDS). Ore was dispatched to the crushing facility and or to the stockpiles.

Milling operations continued in 2023.

In 2023, 22,115,054 tonnes of material were removed from the pit of which 6,814,144 tonnes was ore. This material was directly fed into the crusher and or stockpiled.

Approximately, 12,032,329 tonnes of waste were removed from the pit, of which 3,784,284 tonnes were classified as PAG and dispatched to the PAG stockpile. Approximately, 8,248,045 tonnes were classified as NAG, of which 1,093,900 tonnes were dispatched to the PAG stockpile and 7,154,145 tonnes were dispatched to the SERDS.

Identified ore reserves indicate a viable mine life for 8 to 10 years expected to continue to 2031. Given the uncertainty around future operations and mine life, reclamation and closure planning described in this document are subject to review and updates.

Cariboo Pit

The remaining mining in Phase 4 does not include mining in the Cariboo Pit. No productive mining occurred in the Cariboo Pit in 2023.

Wight Pit/Underground

No mining occurred in the Wight Pit in 2023. This facility has been in Care and Maintenance since May 2017 and used for surplus contact water storage since 2021.

ABA Data

There were 950 ABA samples analyzed in 2023. Of these, 608 were divided between NAG and PAG waste. The remaining ABA samples were taken in various types of ore. ABA samples were to be taken at a minimum rate of 1 sample per 20,000 tonnes. At 950 samples there was sufficient sampling density for a total tonnage of 19 mT. There was a total of 18.6 mT of ore and waste mined in 2023 therefore sampling density exceeded the minimum by 1.4 mT or 70 ABA samples.

These samples were collected to characterize the ML/ARD potential of possible materials milled. ABA samples are collected from blastholes in the pit and from waste stockpiles. No ABA samples were taken from ore stockpiles as the blasthole ABA samples will have already provided a profile of the material. The results of these analyses are summarized here in Table 3.6 and the raw data are tabulated in ***Appendix Q***.

Note that the differences in tonnages between tables reflect error margins on haul truck counts.

Table 3.6 Summary of ABA data from the operating pits in 2023

Pit	Samples	Tonnes	NPR	NP	C (%)	AP	S (%)
Springer - NAG	496	8,028,025	55.4	24.36	0.29	3.85	0.12
Springer - PAG	112	3,786,044	1.33	21.45	0.25	28.61	0.91
Total	608	11,814,069	28.43	22.91	0.27	16.23	0.51

Field Grab Samples

In 2023, 56 ABA grab samples were collected from active NAG waste rock dumps and construction areas for QA/QC purposes during periods when PAG was mined. This includes duplicate samples and confirmatory samples. Full details of the ABA field grab sample program can be found in *Metal Leaching/Acid Rock Drainage Characterization and Monitoring Program – Annual Report 2023* prepared by SRK in ***Appendix Q***.

Tailings

Representative composite tailings samples were collected and analyzed for ABA every month when processing of ore occurred to represent the tonnage of tailings. From January 1, 2023 to December 31, 2023, approximately 5,861,715 tonnes of tailings were deposited in the TSF with an average daily discharge rate of 16,059 m^3 per day. Table 3.7 shows the ABA data for all the tailings composite samples taken in 2023. The composite tailings samples had an average NPR value of 9.603 and range NPR values from 4.32 to 14.78.

Table 3.7 ABA results from 2023 monthly tailings composite samples

Month	Tailings Composite NPR
January 2023	4.80
February 2023	4.08
March 2023	12.6
April 2023	4.32
May 2023	5.60
June 2023	11.03
July 2023	10.01
August 2023	14.78
September 2023	13.16
October 2023	10.36
November 2023	12.04
December 2023	12.46
Average	9.603

Monthly Milling Rates

The total amount of ore sent to the crusher in 2023 was 6,345,066 tonnes. A monthly summary of the various ore feeds is provided in Table 3.8 and monthly custom milling production in Table 3.9.

Table 3.8 Summary of monthly milling rates 2023

Truck Count - Crusher Feed Summary				
Month	Source			
	Springer Pit Crusher Feed (t)	Stockpiles to Crusher Feed (t)	Total Crusher Feed (t)	Springer Ore to Stockpiles (t)
23-Jan	447,435	66,735	514,170	80,270
23-Feb	294,240	79,765	374,005	68,495
23-Mar	515,735	45,440	561,175	94,895
23-Apr	384,992	87,841	472,833	33,460
23-May	416,754	70,975	487,729	60,311
23-Jun	427,509	28,000	455,509	131,050
23-Jul	447,035	86,710	533,745	49,975
23-Aug	548,414	56,795	605,209	201,640
23-Sep	476,986	76,385	553,371	144,127
23-Oct	348,170	113,305	461,475	160,825
23-Nov	571,825	97,970	669,795	64,575
23-Dec	583,395	72,655	656,050	92,460
Total	**5,462,490**	**882,576**	**6,345,066**	**1,182,083**

The total ore milled in 2023 was 5,948,239 t. A summary is provided in Table 3.9. When in operation, the mill receives crushed ore from the crusher by conveyor belts, which measure the actual tonnage of material feeding the mill.

Table 3.9 2023 mill production summary

Mill Production Summary								
Month	Mill Feed Tonnage (t)	Tail Tonnage (t)	Feed Grades			Metal Produced		
			Copper (%)	Gold (g/t)	Oxide Ratio	Cu (lbs)	Au (oz)	Ag (oz)
23-Jan	510,935	507,183	0.257	0.294	6.76	2,334,532	3,326	5,171
23-Feb	350,719	348,117	0.248	0.309	7.58	1,512,720	2,499	3,521
23-Mar	527,982	522,273	0.294	0.333	5.57	2,830,842	4,155	7,632
23-Apr	457,219	452,378	0.230	0.259	4.95	1,827,545	2,516	5,060
23-May	479,036	473,823	0.327	0.376	7.87	2,698,806	3,906	6,609
23-Jun	494,587	490,059	0.282	0.334	5.22	2,536,485	3,764	6,758
23-Jul	490,897	456,759	0.284	0.301	6.42	2,458,577	3,356	6,311
23-Aug	573,640	568,393	0.297	0.331	6.07	3,061,855	4,464	7,652
23-Sep	495,733	491,264	0.303	0.332	7.51	2,536,138	3,500	6,947
23-Oct	429,527	425,599	0.293	0.260	8.12	2,085,215	2,829	5,521
23-Nov	588,259	583,149	0.272	0.273	7.76	2,787,609	3,506	6,890
23-Dec	549,705	542,719	0.342	0.320	4.70	3,475,075	4,014	8,617
Total	**5,948,239**	**5,861,715**	**0.287**	**0.311**	**6.50**	**30,145,400**	**41,835**	**76,688**

Rock Borrow Pit

No rock was extracted from the Rock Borrow Pit in 2023.

3.5 Sediment and Erosion Control

MPMC maintains a Sediment and Erosion Control Management Plan that was revised in 2023 following a review by WSP. The plan was reviewed by WSP and a review report prepared in 2023 as required by the permit.

3.6 Waste Management

Mount Polley practices responsible waste management, and training on this topic is a component of mandatory site orientation. Multiple waste streams exist to ensure that recyclable materials are recycled, and that wildlife attractant waste is disposed of off-site. MPMC holds an *EMA* permit, number 14590, to operate an on-site landfill, which receives most non-recyclable, non-food waste. Reporting to ENV under the landfill permit is performed under a separate cover. Waste management is discussed in greater detail in Section 5.9.

3.6.1 Storage

In its mining operations, Mount Polley utilizes a variety of chemicals, reagents, and other products. At any one time, the approximate volumes of materials in Table 3.10 could be on site.

Table 3.10 Approximate volumes of treatment and processing chemicals stored at the Mount Polley Mine site

Materials	On Hand (kg) on Jan 1, 2023	On Hand (kg on Jan 1, 2024
PAX (Mill Reagent)	17000	3400
Lime	38843	74723
Polyclear 3180M	3000	1814.38
Polyfroth W22C	5138	18833
NaHS	138000	117700

Blasting activities at Mount Polley Mine were carried out by Orica Ltd. Allowable limits on blasting product storage are listed in Table 3.11 below.

Table 3.11 Approximate volumes of blasting chemicals and reagents stored at the Mount Polley Mine site

Blasting Products	Maximum Allowable Limits Stored
Ammonium Nitrate Emulsion	50 t
Ammonium Nitrate Prill	100 t
Sodium Nitrite	3000 kg
Ethylene Glycol	4000 kg

3.6.2 Chemical, Reagent, and Contaminated Waste Disposal

Mount Polley Mine operations utilizes potentially hazardous chemicals, reagents, and other products that are subject to waste disposal procedures. In 2023, GFL Environmental Inc. routinely removed and disposed of waste products compliant with relevant regulations. In 2022, GFL Environmental Inc. Ltd. resumed the disposal of waste products at the mine, as waste production picked up in conjunction with the ramp-up to operations. Materials that are routinely segregated and removed include aerosol cans; contaminated gasoline and diesel; waste oil (in drums); waste oil filters; waste grease fuel or oil-soaked rags, debris, and floor dry; and leachable liquid toxic waste, such as glycol/anti-freeze mix. The site bulk waste oil tanks are emptied, and the oil removed from site. MPMC is registered with ENV under the *Hazardous Waste Regulation* (Ministry of Attorney General, 2017) for generation and temporary storage of these materials.

3.6.3 Recycling

MPMC recognizes the value of responsible waste management and recycling plays a big role in site waste management practices. Mount Polley continues to recycle used materials including waste oil, scrap steel,

batteries, plastic pails, electronic waste, light bulbs and associated fixtures, paper, cardboard, and beverage containers. In 2020, very little recyclable materials were generated at the mine and were stored temporarily. Removal of recycled materials resumed in late-2021 and continued in 2023. Mount Polley donates funds generated by its beverage container recycling program to the Big Brothers and Big Sisters of Williams Lake. Recycling and waste management educational presentations are a part of the mandatory site orientation given to Mount Polley employees, contractors and visitors.

3.7 Incidents

3.7.1 Spills of Hydrocarbon or Dangerous Goods

All spills of hydrocarbons, coolant, and chemicals are reported to the MPMC Environmental Department. In 2023, there were 2 reportable hydrocarbon and dangerous goods spills at the mine. On January 21, 2023, approximately 200L of antifreeze was spilled (DGIR #230286) and on September 5, 2023, approximately 40-60L of antifreeze was spilled (DGIR #233425). In addition to the reportable spills, 10 non-reportable spills were reported internally.

3.7.2 Water Releases

On March 27, 2023, a 30" pipeline in the Mount Polley Mine site contact water collection system became obstructed and contact water spilled to the environment. A contingency pipeline at that location was engaged but was also partially obstructed by a pneumatic knife gate valve that had slowly closed from approximately 2013 to present due to depressurization of the cylinder. The contingency pipeline accommodated the flow eventually but not the initial surge of water once the pipeline was fully obstructed. The contingency pipeline was working as intended within ~6.75 hours. Increased flows were occurring in the ditch due to pumping water from the Wight Pit to supplement the onsite water treatment plant. Details of the event can be found in DGIR #231129 Incident Report (MPMC, 2023c) in ***Appendix R***.

3.8 Archaeological Resources

First Nations with recognized claimed traditional territory for the Mount Polley Mine are the T'exelc (WLFN) and the Xatśūll (XFN). Pre-mining studies noted that the area had low heritage resource potential due to the extensive disturbance in the area from logging and earlier mining projects (Points West Heritage Consulting, 1989).

There were no archaeological or historic sites identified at Mount Polley Mine in 2023 however a preliminary field reconnaissance was conducted to support permitting activities and it identified an area of high archaeological potential that will be further investigated in 2024. The field reconnaissance report can be found in ***Appendix P***.

4 Environmental Monitoring

4.1 Data Quality Assurance/ Quality Control

The purpose of the data quality assurance/quality control (QA/QC) program is to verify the reliability of monitoring data through the implementation of procedures for controlling and monitoring the measurement and analysis process. The QA/QC program provides information for evaluation of the analytical and monitoring procedures, and identification of issues pertaining to possible contamination, both in the field and in the analytical laboratory. The QA/QC program includes:

- Quality assurance (QA): management and technical practices designed to confirm that data were consistent with the objectives of the water quality program.
- Quality control (QC): specific data quality objectives (DQOs), statistical assessment of data quality, and corrective measures taken whenever the DQOs were not met.

The QA/QC program is conducted at all stages of the sampling program: sample collection, transport, and analysis for all sites including contact water quality sites, surface water quality sites, lakes, and groundwater wells.

MPMC maintains a Quality Assurance/Quality Control Manual. The most recent version was updated for 2020 and submitted to ENV in January 2021, herein referred to as the "MPMC QA/QC Manual" (MPMC 2021a). This document is reviewed and audited annually, and most recently in January-March 2023. This manual oversees all the standard operating procedures and work methods pertaining to monitoring and sampling activities on the Mount Polley Mine site.

4.2 Scheduling

To coordinate sampling and schedule all planned monitoring, as per the CEMP and to be compliant with all applicable regulations MPMC prepares internal monthly sampling schedules. Effluent toxicity sampling and receiving environment sampling in Quesnel Lake is scheduled at least 30 days in advance, as required in MDMER Section 14 (2). An example of the monthly sampling schedules as used by MPMC can be found as Appendix C of the 2019 CEMP

4.3 Field Methods

4.3.1 Sample Collection

Sample collection was consistent with the procedures described in the current British Columbia Field Sampling Manual: 2013 – For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples (ENV, 2013) and MPMC QA/QC Manual (MPMC 2021a). Monitoring procedures for the discharge locations (see Section 4.12) were consistent with the Metal Mining

and Diamond Effluent Regulations (MDMER) (Environment Canada, 2019), as appropriate.

4.3.2 Sample Suites

Each full sampling suite for water chemistry analysis consists of a variety of bottles. As outlined in Table 4.1, the type and volume of bottle will depend on the analysis and is determined by the BC Field Sampling Manual (ENV 2013) and laboratory criteria (Section 4.4). In 2023, the full sampling suite for surface and lake water chemistry consisted of six bottles: Nutrients-1, TSS, total nitrogen and ammonia, dissolved organic carbon, total metals and dissolved metals bottles. The full sampling suite for groundwater chemistry consisted of three bottles: Nutrients-2, total nitrogen and ammonia and dissolved metals (Table 4.1).

Table 4.1 MPMC full sampling suite

Type and volume of bottle	Name of analysis	Type of analysis
250 mL plastic bottle	Nutrients-1 (surface and lake water)	pH, conductivity, turbidity, total dissolved, solids, nitrate, nitrite, hardness, alkalinity, chloride, fluoride, sulphate, and ortho-phosphorus
	Nutrients-2 (groundwater only)	pH, conductivity, hardness, alkalinity, chloride, fluoride, sulphate, nitrate, nitrite
145 mL plastic bottle	TSS	Whole bottle TSS
120 mL amber bottle	Total nitrogen and ammonia	Total nitrogen, ammonia, phosphorus total and dissolved
	Dissolved organic carbon	Dissolved organic carbon
60 mL plastic bottle	Total metals Dissolved metals	Inductively coupled plasma mass spectrometry, some physical tests

4.3.3 Field Meters and Monitoring Equipment

Field meters were used to measure dissolved oxygen, conductivity, pH, temperature, turbidity, oxidation reduction potential (ORP) and water flow. Meters and other field equipment were operated and calibrated following the manufacturers' instructions and the MPMC QA/QC Manual, which includes specific work methods for the equipment discussed below.

For measuring field parameters for surface water and lakes, YSI EXO multimeters were used. The YSI EXO multimeter was operated based on the equipment manual and guidance from the supplier (Hoskin Scientific), with specific MPMC calibration practices being followed.

In-situ turbidity was most often measured with the YSI EXO, but also with LaMotte 2020e and 2020we turbidity meters, when needed. Conductivity and pH meters were used for field analysis of seep samples

and groundwater. The WTW pH/Conductivity 340i and 3430 handheld multimeters, and Oakton 50 series pocket tester multimeter were used for this purpose. Calibration records were recorded in the calibration logbook, as outlined in the MPMC QA/QC Manual (MPMC, 2021a).

Flow measurements were taken using a Sontek FlowTracker2 Acoustic Doppler Velocimeter. The user measures flow rates across a creek or ditch cross section using the FlowTracker handheld device and the device then calculates the discharge rate based on these measurements and input parameters. The meter has QA/QC standards programed into it and provides error notifications if these standards are not met. An International Organization for Standardization and statistical U.S. Geology Survey percent error are calculated for each discharge reading based on depth, velocity, width, method, number of stations, and calibration accuracy to evaluate accuracy of the discharge measurement. The dry salt slug injection tracer method was used by WaterSmith during benchmarking surveys and station assessments in July 2023 and was subject to WaterSmith's QA/QC procedures.

The staff gauge benchmarking (calibrating) and hydrology station calibrating program occurs annually as required by Section 3.4 of *EMA* Permit 11678 and as per protocol in the MPMC QA/QC Manual (MPMC, 2021a). Station specific details are provided in Sections 4.8 and ***Appendix L***.

Field Secchi disk monitoring was undertaken during lake sampling (Section 4.15.2; ***Appendix M***). Chlorophyll a, phytoplankton and zooplankton samples were collected as per the protocol in the MPMC QA/QC Manual (MPMC, 2021a). Chlorophyll a and zooplankton tissue metals analysis was sent to ALS (see Section 4.4). Enumeration and species identification of phytoplankton community and zooplankton taxonomy samples were sent to specialized labs (Section 4.4) as described in the CEMP (***Appendix A***).

4.4 Quality Control and Data Quality Objectives

Analytical processing of samples collected by MPMC is ordinarily conducted by ALS Environmental (ALS) in Burnaby, BC. ALS is a Canadian Association for Laboratory Accreditation (CALA) accredited laboratory for the analyses requested. The Laboratory DQOs provided to MPMC by ALS are included in ***Appendix D***.

Bioassay (toxicity) testing is carried out by Nautilus Environmental (Nautilus) in Burnaby, BC. Nautilus is CALA accredited for these analyses. Acute and chronic bioassays methods are conducted as outlined in the MDMER Environmental Effects Monitoring (EEM) studies and *EMA* Permit 11678 requirements. The toxicity tests are scheduled 30 days prior to sampling as required by MDMER (see Section 4.12.3). The laboratory QA/QC measures provided to MPMC by Nautilus are included in ***Appendix D***.

Phytoplankton and zooplankton community samples from Quesnel, Polley and Bootjack lakes were sent to Biologica Environmental Services Ltd. in Victoria, BC. The laboratory QA/QC measures provided to MPMC by Biologica Environmental Services Ltd. are included in ***Appendix D***.

Samples submitted to labs were tracked to verify that sampling and analysis protocols were followed, including hold times, sample containers, preservatives, detection limits, and approved methodology. Instances in which these protocols were not followed were recorded in the sample tracking spreadsheet. This spreadsheet tracked individual samples and recorded the locations of samples, along with the date, duplicate and blank sample information, sample shipping information, laboratory correspondence, analytical results, and potential data integrity issues.

4.4.1 Duplicates and Blanks

For water chemistry, QC samples were collected as a component of the monitoring program as per the MPMC QA/QC Manual. The recommended minimum number of duplicates and blanks is 10% of the overall samples as set out by the current BC Field Sampling Manual (ENV, 2013). In 2023, MPMC achieved 20% of total QC samples. A combined QC schedule across the various MPMC monitoring programs as described in the CEMP is summarized in Table 4.2.

Table 4.2 Water chemistry QC sample frequencies for MPMC monitoring programs

QC Samples	Minimum Frequency
Duplicate samples	2 per month/10% of samples
Equipment blanks	Monthly/Quarterly per piece of equipment (when used)
Trip blanks	2 per month
Field blanks	2 per month
Filter blanks	Quarterly
Deionized (DI) water blanks	Annually
Inter-laboratory replicate	Annually

Field Duplicates

The semi-blind duplicates are intended to evaluate the QA/QC surrounding the sampling methods. Duplicates are prepared by collecting two full sample suites from one location at the same time, one after the other, labelling one with the sampling location name (e.g., E4, HAC-13) and labelling the second sample suite with a duplicate name in which a numeral is replaced with a letter (e.g., ED, HAC-M). When the results are reported back from the analytical laboratory, all parameters from the duplicate and the actual sample are screened to confirm likeness, or potential of sampling error or contamination. The screening process also considers accuracy of the analytical procedures and small-scale natural variations in water quality which may occur over the timescale of collection (approximately 10 minutes). In particular, there is considerable potential for variations in water quality over short-time scales during periods of high sediment loads.

Semi-blind field duplicates were compared to evaluate the precision of the methods used (i.e., combined precision of field methods, laboratory methods and the environmental variability between the side-by-side samples). A relative percent difference (RPD) is calculated to identify significant differences between the duplicate and sample, where the RPD (as %) can be defined as:

$$\text{RPD } (\%) = \frac{|X_x - X_y|}{\bar{X}} \times 100$$

Where X_x = the concentration of the original sample
X_y = the concentration of the blind field duplicate sample
$\bar{X}$ = the average of the original and duplicate samples

The acceptance criteria for RPDs for water chemistry are defined as 1.5x the laboratory RPD criteria, which is summarized in Table 4.3. For results less than five times the detection limit, significant differences are identified if the difference of the two results is greater than twice the detection limit. When either sample is less than detection limit, differences are not calculated.

Table 4.3 Duplicate Sample RPD acceptance criteria

Analyte Group	RPD Acceptance Criterion
Metals	30%
Inorganics	30%
Organics	45%
Other parameters	1.5 x Laboratory RPD

4.4.1.1 Field QA Results and Discussion

There were 112 field duplicate samples collected in 2023, as shown in Table 4.4. The raw data are available in ***Appendix D***. Note the prefixes refer to location areas (i.e., 'W' refers to non-contact water site, 'EDC-01', refers to Edney Creek); additional information on naming conventions are found in the CEMP (***Appendix A***). Groundwater duplicates (e.g., GW15-2a) do not include total metal analysis, as groundwater monitoring for metals involves only dissolved metals analysis. In addition, the BAC samples (e.g., BAC-01) are only analyzed for E-coli and total bacteria coliform, not for CEMP parameters. All results above the respected RPDs were requested to be rechecked by the analyzing laboratory, usually ALS.

Table 4.4 Field duplicate sample locations collected in 2023

Date Sampled	Location	Name
04-Jan-23	EDC-01a	EDC-Aa
05-Jan-23	E10	EJ
10-Jan-23	BAC-02	BAC-B
11-Jan-23	GW16-6a	GW16-Fa
11-Jan-23	WIP-30m	23916-30m
12-Jan-23	W4a	WDa
17-Jan-23	HAD-3	HAD-C
19-Jan-23	E4	ED
19-Jan-23	GW12-2a	GW12-Ba

Date Sampled	Location	Name
23-Jan-23	E14	EN
24-Jan-23	W12	WL
01-Feb-23	E8	EH
07-Feb-23	E19	ES
08-Feb-23	HAC-10	HAC-J
14-Feb-23	BAC-03	BAC-C
16-Feb-23	WIP-20m	23916-20m
21-Feb-23	E1a	EAa
02-Mar-23	WIP-S	23916-S
07-Mar-23	EDC-01a	EDC-Aa
08-Mar-23	W4a	WDa
09-Mar-23	WIP-10m	23916-10m
14-Mar-23	E10	EJ
20-Mar-23	WIP-20m	23916-20m
21-Mar-23	BAC-04	BAC-D
03-Apr-23	HAC-10	HAC-J
04-Apr-23	BAC-01	BAC-A
05-Apr-23	WIP-30m	23916-30m
12-Apr-23	W4a	WDa
13-Apr-23	E13	EM
20-Apr-23	E11c	EKc
24-Apr-23	E14	EN
26-Apr-23	E24	EX
01-May-23	GW96-4b	GW96-Db
01-May-23	HAC-05a	HAC-Ea
03-May-23	GW96-2a	GW96-Ba
03-May-23	GW16-2a	GW16-Ba
03-May-23	E11c	EKc
08-May-23	E21	EU
09-May-23	BAC-02	BAC-B
10-May-23	QUL-58-MID	QUL-EH-MID
10-May-23	QUL-120a-120m	QUL-ATa-120m
11-May-23	QUL-2a-0m	QUL-Ba-0m
11-May-23	QUL-18-20m	QUL-R-20m
15-May-23	E1a	EAa
16-May-23	SERDS 22	SERDS V

Date Sampled	Location	Name
16-May-23	NEZ 2	NEZ B
17-May-23	QUL-57-S	QUL-EG-S
24-May-23	B1-B	BA-B
25-May-23	QUL-58-B	QUL-EH-B
30-May-23	HAD-3	HAD-C
30-May-23	GW16-6a	GW16-Fa
30-May-23	QUL-58-MP	QUL-EH-MP
05-Jun-23	HAC-14	HAC-N
08-Jun-23	B1-S	BA-S
12-Jun-23	W5	WE
20-Jun-23	BAC-03	BAC-C
26-Jun-23	QUL-2a-20m	QUL-Ba-20m
27-Jun-23	QUL-58-AP	QUL-EH-AP
28-Jun-23	GW12-5a	GW12-Ea
06-Jul-23	HAC-10	HAC-J
10-Jul-23	E19	ES
12-Jul-23	B1-S	BA-S
25-Jul-23	BAC-04	BAC-D
26-Jul-23	P1-B	PA-B
26-Jul-23	QUL-ZOO-7	QUL-ZOO-7_WS_DI-1X
26-Jul-23	QUL-ZOO-7	QUL-ZOO-7_CHLA-1X
27-Jul-23	95-R-5	95-R-E
31-Jul-23	E22	EV
01-Aug-23	BAC-01	BAC-A
01-Aug-23	W4a	WDa
02-Aug-23	HAC-13	HAC-M
09-Aug-23	MDC	1343
10-Aug-23	GW11-1a	GW11-Aa
16-Aug-23	E26	EZ
16-Aug-23	E1a	EAa
21-Aug-23	GW11-2b	GW11-Bb
21-Aug-23	E10	EJ
22-Aug-23	E19	ES
24-Aug-23	P2-B	PB-B
31-Aug-23	E24	EX
05-Sep-23	W5	WE
06-Sep-23	HAC-05a	HAC-Ea

Date Sampled	Location	Name
07-Sep-23	B2-AT	BB-AT
11-Sep-23	QUL-2a-0m	QUL-Ba-0m
19-Sep-23	W12	WL
20-Sep-23	GW12-2a	GW12-Ba
20-Sep-23	GW12-1a	GW12-Aa
27-Sep-23	WIP-10m	23916-10m
28-Sep-23	P2-BT	PB-BT
03-Oct-23	HAC-08	HAC-H
05-Oct-23	E4	ED
05-Oct-23	PAG Seep 15	PAG Seep O
10-Oct-23	B1-B	BA-B
16-Oct-23	BAC-03	BAC-C
16-Oct-23	E24	EX
17-Oct-23	GW16-6a	GW16-Fa
18-Oct-23	P1-S	PA-S
19-Oct-23	GW12-4a	GW12-Da
30-Oct-23	SERDS23	SERDSW
30-Oct-23	QUL-18-20m	QUL-R-20m
31-Oct-23	QUL-59-B	QUL-EI-B
01-Nov-23	WIP-20m	23916-20m
02-Nov-23	EDC-01a	EDC-Aa
08-Nov-23	E1a	EAa
14-Nov-23	GW12-4a	GW12-Da
14-Nov-23	GW15-2a	GW15-Ba
22-Nov-23	GW16-1a	GW16-Aa
28-Nov-23	E19a	ESa
06-Dec-23	HAC-08	HAC-H
07-Dec-23	BAC-01	BAC-A
13-Dec-23	95-R-5	95-R-E
13-Dec-23	GW96-7	GW96-G

Total and Dissolved Metals

- For total metal analyses, the applicable duplicate criterion was exceeded in the following cases:
- Ten occasions for aluminum (seven RPDs of 60%, 42%, 32%, 154%, 113%, 70% and 54%; and three significant differences of 0.0105, 0.0102 and 0.0244 mg/L).
- One occasion for cadmium (RPD of 57%)
- Six occasions for copper (RPDs of 33%, 136%, 46% and 30%; and two significant differences of 0.0071 mg/L and 0.0022 mg/L).

- Four occasions for iron (RPDs of 40% and 66%; and two significant differences of 0.0650 mg/L and 0.1280 mg/L).
- Four occasions for manganese (RPDs of 65%, 108%, 74% and 39%).

Total metal comparisons are available in ***Appendix D***. There are 25 exceedances of the applicate duplicate criterion for total metals in 2023. This is greater than the 23 in 2022, 10 in 2021, 9 in 2020, 12 in 2019 and the 22 in 2018. In 2023 there were 11% of results that did not meet the duplicate criteria (several exceeded criteria for multiple parameters). Comparatively, 2017 retained 10%, 2018 retained 22%, 2019 retained 12%, 2020 retained 9%, 2021 retained 6% and 2022 retained 14%. Note that there is some degree of variability that can be expected in duplicate samples for parameters such as total metals, which are influenced by total suspended solids (TSS).

For dissolved metals analyses, the applicable duplicate criterion was exceeded on the following occasions:

- Eight occasions for aluminum (one RPD of 56%; seven significant differences of 0.0134, 0.0092, 0.0080, 0.0082, 0.0227, 0.0241 and 0.0430).
- One occasion for copper (significant difference of 0.00512 mg/L).
- One occasion for potassium (significant difference of 0.0869 mg/L).
- Two occasions for magnesium (one RPD of 48%; significant difference of 22 mg/L).
- One occasion for manganese (significant difference of 1.81 mg/L).
- One occasion for selenium (significant difference of 0.000114 mg/L).

All dissolved metal comparisons are available in ***Appendix D***. In 2023 there were 11% of results that did not meet the duplicate criteria. Comparatively, 2022 had 8% of results that did not meet the duplicate criteria, 2021 had 9% of results that did not meet the duplicate criteria, 2019 had 20% of results that did not meet the duplicate criteria, 2017 and 2018 have the same 9% while 2016 had 16% of its duplicates that did not meet the duplicate criteria. Failure to meet duplicate criteria is usually associated with high turbidity or suspended sediment in samples.

General Parameters

For general parameters (ammonia, total nitrogen, total phosphorus, TSS, TDS and turbidity), the applicable duplicate criterion was exceeded on the following occasions (***Appendix D***):

- Two occasions for ammonia (significant differences of 0.0308 and 0.0255 mg/L).
- Four occasions for total nitrogen (significant differences of 0.010, 0.006, 0.026 and 0.017 mg/L).
- Six occasions for total phosphorus (significant differences of 0.007, 0.0066, 0.0069, 0.0159, 0.0064 and 0.059 mg/L).
- One occasion for TSS (significant difference of 4.61 mg/L).

For E-coli and total coliform analysis, no differences were identified between samples. All duplicate results were below detection limit (***Appendix D***).

There was one inter-laboratory duplicate collected in 2023. This replicate is intended to evaluate the QA/QC surrounding the analytical laboratory. This replicate was prepared as described above; the sample with the sampling location name was sent to ALS in Burnaby, BC and the sample with the anonymous name was sent to CARO in Kelowna, BC. Results from CARO had not been received at the time of this report's writing. Results will be reviewed and RPDs calculated upon receipt.

Blanks

Trip/travel blanks and field blanks, prepared by the analytical laboratory, do not contain environmental media sampled from the field. The blanks are exposed to the same conditions and treatments as the water samples collected and are intended to monitor contamination that may occur during sampling or shipping. Field blanks are opened and preserved at a sample location to expose them to the natural environment and trip blanks remain closed at all times. Trip blanks are not opened and are pre-preserved, if required by the lab, and are submitted to the laboratory with sample sets for total suspended solids, total metals, and nutrient and anion analysis, as well as dissolved organic carbon analysis for field blanks.

Trip Blanks

In 2023, 50 trip blanks were submitted to ALS, as listed in Table 4.5.

Table 4.5 Trip blanks sent for analysis in 2023

Date Sampled	Area
10-Jan-23	Mine Site
11-Jan-23	Mine Site
19-Jan-23	Groundwater
23-Jan-23	Mine Site
07-Feb-23	Mine Site
16-Feb-23	Mine Site
21-Feb-23	Mine Site
06-Mar-23	Mine Site
07-Mar-23	Hazeltine Creek
04-Apr-23	Mine Site
13-Apr-23	Mine Site
02-May-23	Groundwater
09-May-23	Polley Lake
10-May-23	Quesnel Lake
15-May-23	Mine Site
15-May-23	Mine Site
16-May-23	Mine Site

Date Sampled	Area
17-May-23	Quesnel Lake
23-May-23	Mine Site
25-May-23	Mine Site
29-May-23	Mine Site
30-May-23	Quesnel Lake
12-Jun-23	Polley Lake
12-Jun-23	Mine Site
26-Jun-23	Quesnel Lake
27-Jun-23	Quesnel Lake
06-Jul-23	Hazeltine Creek
10-Jul-23	Mine Site
25-Jul-23	Mine Site
27-Jul-23	Bootjack Lake
31-Jul-23	Mine Site
02-Aug-23	Groundwater
09-Aug-23	Mine Site
15-Aug-23	Mine Site
14-Sep-23	Quesnel Lake
26-Sep-23	Mine Site
28-Sep-23	Polley Lake
05-Oct-23	Mine Site
11-Oct-23	Mine Site
16-Oct-23	Mine Site
25-Oct-23	Mine Site
30-Oct-23	Quesnel Lake
31-Oct-23	Mine Site
31-Oct-23	Quesnel Lake
08-Nov-23	Mine Site
15-Nov-23	Mine Site
22-Nov-23	Groundwater
12-Dec-23	Mine Site
13-Dec-23	Groundwater
19-Dec-23	Mine Site

Total phosphorus, total copper, total lead and total molybdenum were above detection limits in one or more of the trip blanks (***Appendix D***). None of these parameters were greater than five times the detection limit, indicating a high degree of reliability of the data. All above-detection limit samples from 2023 are listed in Table 4.6

Table 4.6. Full results are found in Table 6, ***Appendix D***.

Table 4.6 Summary of trip blank results that are above the lab detection limit

Date Sampled	Parameter	Detection Limit	Result
7-Feb-23	Total phosphorus	<0.0020 mg/L	0.0024 mg/L
7-Feb-23	Total molybdenum	<0.00005 mg/L	0.000136 mg/L
12-Dec-23	Total lead	<0.00005 mg/L	0.000148 mg/L
19-Dec-23	Total copper	<0.0005 mg/L	0.00058 mg/L
19-Dec-23	Total lead	<0.00005 mg/L	0.000187 mg/L

Field Blanks

Thirty-eight field blanks, listed in Table 4.8 were submitted to ALS in 2023. Total aluminum, total barium and total manganese were above detection limits in one or more of the field blanks. None of these results were above five times the detection limit, indicating a high degree of reliability of the data. All above-detection limit samples from 2023 are listed in Table 4.7. Full results are found in Table 7, ***Appendix D***.

Table 4.7 Summary of field blank results that are above the lab detection limit

Date Sampled	Parameter	Detection Limit	Result
26-Apr-23	Total aluminum	<0.0030 mg/L	0.0077 mg/L
1-May-23	Total aluminum	<0.0030 mg/L	0.0036 mg/L
1-May-23	Total barium	<0.00010 mg/L	0.00018 mg/L
23-May-23	Total aluminum	<0.0030 mg/L	0.0094 mg/L
23-May-23	Total barium	<0.00010 mg/L	0.00021 mg/L
23-May-23	Total manganese	<0.00010 mg/L	0.00016 mg/L
6-Jun-23	Total aluminum	<0.0030 mg/L	0.0061 mg/L
6-Jun-23	Total manganese	<0.00010 mg/L	0.00013 mg/L

The field blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the ALS results spreadsheet to indicate that the result was rechecked and verified. Investigations for the parameters above detection limit are on-going.

Table 4.8 Field blanks sent for analysis in 2023

Date Sampled	Area
05-Jan-23	Mine Site
11-Jan-23	Groundwater
30-Jan-23	Mine Site
08-Feb-23	Hazeltine Creek
13-Feb-23	Mine Site
02-Mar-23	Mine Site
06-Mar-23	Mine Site
15-Mar-23	Polley Lake
21-Mar-23	Mine Site
04-Apr-23	Mine Site
12-Apr-23	Mine Site
26-Apr-23	Mine Site
01-May-23	Hazeltine Creek
23-May-23	Mine Site
31-May-23	Groundwater
05-Jun-23	Quesnel Lake
13-Jun-23	Mine Site
20-Jun-23	Mine Site
29-Jun-23	Mine Site
04-Jul-23	Mine Site
26-Jul-23	Polley Lake
26-Jul-23	Quesnel Lake
01-Aug-23	Mine Site
02-Aug-23	Hazeltine Creek
09-Aug-23	Mine Site
23-Aug-23	Bootjack Lake
07-Sep-23	Bootjack Lake
11-Sep-23	Quesnel Lake
20-Sep-23	Groundwater
05-Oct-23	Mine Site
11-Oct-23	Mine Site
24-Oct-23	Mine Site
26-Oct-23	Mine Site
01-Nov-23	Mine Site
02-Nov-23	Hazeltine Creek
23-Nov-23	Mine Site
07-Dec-23	Mine Site
13-Dec-23	Groundwater

Filter Blanks

Filter blanks are prepared by filtering deionized water and submitting it for dissolved metals analysis. This tests for potential sample contamination during in-field filtering of dissolved metals samples. Four filter blanks were submitted in 2023. All parameters analyzed in the filter blanks were below reported detection limits with the exception of dissolved potassium in the February 6, 2023 sample (Detection limit of <0.050 mg/L; result of 0.080 mg/L) (***Appendix D***).

De-ionized Water Blanks

Deionized water blanks are prepared by submitting a full sample suite (minus dissolved metals since filter blanks are prepared) of deionized water. One deionized water blank was submitted in 2023. All parameters in this blank were below reported detection limits (***Appendix D***).

Equipment Blanks

Equipment blanks are collected to test for potential sample contamination being introduced from sampling equipment. When conducting lake water quality sampling, an equipment blank sample is taken with the Kemmerer (KEM 1 or KEM 2) sampler monthly during each sampling program. When groundwater samples are collected within the quarter according to the CEMP, an equipment blank is collected. MPMC has two groundwater pumps: Grundfos (GW-Grundfos) and Low-flow (GW Low-Flow). Equipment blanks (KEM 1 or KEM 2) are submitted to the laboratory for full sample suites for lake quality sampling (minus dissolved metals since filter blanks using syringes are also prepared); while groundwater equipment blanks (GW-Grundfos and/or GW Low-Flow) are submitted for physical tests, anions and nutrients and dissolved metals.

Eleven Kemmerer equipment blanks were taken in 2023 and are shown in Table 4.9.

Table 4.9 Equipment blanks taken in 2023

Date Sampled	Equipment
12-Jan-23	KEM2
28-Feb-23	KEM2
29-Mar-23	KEM2
25-Apr-23	KEM2
24-May-23	KEM2
29-Jun-23	KEM2
25-Jul-23	KEM2
24-Aug-23	KEM2
19-Sep-23	KEM2
19-Oct-23	KEM2
22-Nov-23	KEM2

In 2023, conductivity, hardness, turbidity, alkalinity, ammonia, sulphate, total aluminum, total arsenic, total barium, total calcium, total cobalt, total copper, total iron, total lead, total magnesium, total manganese, total molybdenum, total potassium, total silicon, total strontium, total titanium and total vanadium were above the detection limit in one or more equipment blanks (***Appendix D***). Ten results for the KEM blanks were greater than five times the detection limit (Table 4.10)

Table 4.10 Summary of KEM2 blank results that are 5x detection limit, 2023

Date Sampled	Parameter	Detection Limit	Result
12-Jan-23	Total strontium (mg/L)	<0.00020 mg/L	0.00627 mg/L
28-Feb-23	Total strontium (mg/L)	<0.00020 mg/L	0.00754 mg/L
29-Mar-23	Total strontium (mg/L)	<0.00020 mg/L	0.00722 mg/L
25-Apr-23	Total strontium (mg/L)	<0.00020 mg/L	0.00576 mg/L
29-Jun-23	Total aluminum (mg/L)	<0.0030 mg/L	0.169 mg/L
29-Jun-23	Total copper (mg/L)	<0.00050 mg/L	0.00753 mg/L
29-Jun-23	Total iron (mg/L)	<0.030 mg/L	0.165 mg/L
29-Jun-23	Total manganese (mg/L)	<0.00010 mg/L	0.00516 mg/L
29-Jun-23	Total strontium (mg/L)	<0.00020 mg/L	0.00163 mg/L
22-Nov-23	Total strontium (mg/L)	<0.00020 mg/L	0.00307 mg/L

Eighteen groundwater equipment blanks were taken in 2023, as shown in Table 4.11.

Table 4.11 Summary of groundwater equipment blanks

Date Sampled	Equipment
30-Jan-23	GW-Low Flow
30-Jan-23	GW-Grundfos
31-May-23	GW-Low Flow
31-May-23	GW-Grundfos
27-Jun-23	GW-Low Flow
27-Jun-23	GW-Grundfos
25-Jul-23	GW-Low Flow
25-Jul-23	GW-Low Flow
31-Aug-23	GW-Grundfos
31-Aug-23	GW-Low Flow
19-Sep-23	GW-Grundfos
19-Sep-23	GW-Low Flow
19-Oct-23	GW-Grundfos
19-Oct-23	GW-Low Flow

22-Nov-23	GW-Low Flow
22-Nov-23	GW-Grundfos
14-Dec-23	GW-Low Flow
14-Dec-23	GW-Grundfos

In 2023, hardness, alkalinity, dissolved aluminum, dissolved barium, dissolved cadmium, dissolved calcium, dissolved copper, dissolved lead, dissolved manganese, dissolved molybdenum, dissolved nickel, dissolved potassium, dissolved silver, dissolved sodium, dissolved strontium, dissolved tin and dissolved zinc were above detection limits in one or more of the equipment blanks (***Appendix D***). A summary of results for the GW-Grundfos/GW-LowFlow blanks that are greater than five times the detection limit is provided in Table 4.12.

Table 4.12 Summary of GW-Grundfos/GW-LowFlow blank results that are 5x detection limit, 2023

Date Sampled	Equipment	Parameter	Detection Limit	Result
31-May-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00464 mg/L
27-Jun-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00073 mg/L
25-Jul-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00135 mg/L
31-Aug-23	GW-Grundfos	Dissolved barium	<0.00010 mg/L	0.00146 mg/L
31-Aug-23	GW-Grundfos	Dissolved calcium	<0.050 mg/L	0.792 mg/L
31-Aug-23	GW-Grundfos	Dissolved copper	<0.00050 mg/L	0.00723 mg/L
31-Aug-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00147 mg/L
31-Aug-23	GW-Grundfos	Dissolved molybdenum	<0.000050 mg/L	0.000311 mg/L
31-Aug-23	GW-Grundfos	Dissolved nickel	<0.00050 mg/L	0.0036 mg/L
31-Aug-23	GW-Grundfos	Dissolved potassium	<0.050 mg/L	12.2 mg/L
31-Aug-23	GW-Grundfos	Dissolved strontium	<0.00020 mg/L	0.00576 mg/L
19-Sep-23	GW-Grundfos	Dissolved strontium	<0.00020 mg/L	0.00104 mg/L
19-Oct-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00352 mg/L
22-Nov-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00053 mg/L
14-Dec-23	GW-LowFlow	Dissolved cadmium	<0.0000050 mg/L	0.0000558 mg/L
14-Dec-23	GW-Grundfos	Dissolved manganese	<0.00010 mg/L	0.00205 mg/L

The equipment blank parameters that are above detection limit are rechecked by ALS laboratory. A code is associated with the parameters in the results spreadsheet to indicate that the result was rechecked and verified.

4.5 Data Quality Review and Data Management

A data quality review was conducted for results, including screening of laboratory QA/QC data, sample

integrity issues, detection limits achieved, and metadata accuracy, as well as potential outliers/extreme values. This information was catalogued in the MPMC sample tracking spreadsheet described in Section 4.4.

MPMC uses the MonitorPro database by EHS Data Limited for data management: soil, sediment, and tissue chemistry data were uploaded to separate MonitorPro databases prior to the 2017 cyberattack and the data are now currently managed via spreadsheets and filed on the MPMC network. After the cyberattack, the database responsible for water chemistry samples and in situ parameters was rebooted and water chemistry data using files generated by the analytical laboratory, as well as weather station downloads were uploaded into the database. Accompanying field data were manually entered and uploaded into the database. Original laboratory-produced results files are filed on the MPMC network according to location, and date, and are linked to the data stored in the database. Sample names, dates, and times are cross-referenced with the MPMC sample tracking sheet before final upload to the database and field data undergo a QC screening prior to upload. Parameter restrictions are in place in the MonitorPro database to reduce the likelihood of a typographical or laboratory reporting error being uploaded. Any errors identified by the database underwent further audit before final acceptance.

Non-chemistry data, including toxicity testing results, benthic invertebrate and plankton taxonomy data, and hydrology data (logger downloads and FlowTracker exports) are filed according to year and sample location on the MPMC network.

4.5.1 Rating Curve Development

A new hydrometric station was established on Lower Edney Creek (H3a) on July 17, 2023, mid-way through the monitoring season. The pre-existing station (located ~60 m downstream) was decommissioned on July 17 because of concerns with the configuration and function of the station (e.g., unstable channel cross-section from sediment mobility). Manual discharge measurements and stream temperature data are available from 2023 for both stations; however, a stage-discharge rating curve could not be developed for either station, resulting in no continuous (i.e., automated) stream discharge data for H3a in 2023.

A new hydrometric station was established on Lower Hazeltine Creek (H2) for the 2022 monitoring season. A new stage-discharge rating curve was developed for H2 in 2023; however, there is an absence of manual flow measurements on the lower end of the curve (below 0.1 m^3/s). A new stage-discharge rating curve was developed for the Polley Lake weir outlet (H4) in 2023 because of recent erosion of gravels and large cobbles from the rock weir that controls the water level for the hydrometric station. The staff gauge on Upper Morehead Creek (W1b) was relocated slightly (moved ~1.5-2 m downstream and toward the left bank) because of recent mobility in the channel substrates that resulted in a standing wave at the location of the old staff gauge. A stage-discharge rating curve was developed for this station using 2023 data.

The rating curve is well defined across a large range of flows for W1b and, thus, is not considered provisional. The rating curves are considered provisional for H2 and H4, and incomplete for the new H3a station. Once the rating curves are fully developed for H2, H4, and H3a, they will be applied retroactively to continuous

(i.e., automated) water level data being acquired at these stations. For all other stations, an updated stage-discharge rating curve was developed using multiple years of record, and the rating curves are not considered provisional.

All stage-discharge rating curves were developed by relating manual staff gauge and stream discharge measurements acquired by MPMC (velocity-based measurements using a SonTek FlowTracker2, and bucket flow method) and WaterSmith (dry salt slug injection tracer method [Hudson and Fraser, 2005]). The rating curves were fit statistically [R Development Core Team, 2010] using a least-squares regression model based on one of the following generic forms:

$$Q = a + b\,H \quad (1)$$

$$Q = 10^{(a + b \log10(H - c))} \quad (2)$$

where,

Q is discharge measured manually (m^3/s),

H is water level measured manually (i.e., stage) (m),

a, b, and c are regression coefficients.

Vented pressure transducers (model INW PT2x) were installed at multiple stations (Upper Hazeltine [H1], Lower Hazeltine [H2], Lower Edney [H3a], Polley Lake Weir [H4]) to continuously monitor water pressure (i.e., relating to water level) at 10-minute intervals during non-freezing months. According to the manual, PT2x sensors maintain a sensor accuracy of ±0.25% (Seametrics 2016). For stations with sufficient continuous pressure data from 2023 (H1, H2, and H4), a linear stage-pressure relation was developed between the continuous pressure recordings and the manual stage (i.e., staff gauge) readings. Continuous stage values were generated from the continuous pressure recordings using these stage-pressure relations. The continuous stage values were then substituted into the stage-discharge rating curve equations to estimate continuous discharge at 10-minute intervals throughout the 2023 monitoring season. Continuous discharge data were removed for periods with sustained freezing weather conditions and when the recorded water temperature was below 0.5ºC, due to an elevated potential for ice build-up on the weir crest.

With applying stage-discharge rating curves to continuous pressure data, any estimation above or below the highest or lowest manually measured discharge, respectively, is considered an extrapolation of the rating curve, which can result in substantially biased estimates of discharge. The level of extrapolation allowed when generating the continuous discharge data varied according to the richness of the data used for developing the rating curve, and according to the overall quality of the statistical fit (i.e., certainty) of the rating curve. The maximum allowable extrapolations were as follows:

- H1: maximum extrapolation to 150% greater than the highest manually measured discharge (unconstrained extrapolation for low flow).

- H2: maximum extrapolation to 150% greater than the highest manually measured discharge, and to 50% of the lowest manually measured discharge.
- H4: maximum extrapolation to 150% greater than the highest manually measured discharge, and to 50% of the lowest manually measured discharge.

Results from statistical analysis of the manual staff gauge readings are reported in Section 4.8 and in ***Appendix L***. Routine monitoring incorporated equipment inspections, including stilling wells and pressure transducers (e.g., to identify sedimentation inside the stilling well, or debris build-up in the transducer ports). QA/QC of all collected data was completed to identify spurious errors and/or drifts in the manual or continuous data, or potential station changes. This process included comparisons with previously collected data. As required by Section 3.4 of the *EMA* Permit 11678, verification measurements (dry salt slug injection tracer method) and benchmark surveys of hydrological stations were conducted by a qualified professional (Russell Smith, WaterSmith) on May 3-5, 2023 (discharge only) and July 18-19, 2023 (discharge and benchmarking). Details of the site visits are reported in Section 4.8 and ***Appendix L***.

4.6 Climate

EMA Permit 11678 Section 3.6 (***Appendix A***) requires the collection of detailed meteorology data. The objective of this data collection program is to provide site-specific precipitation, temperature, and evaporation data for use in water balance calculations and hydrological predictions. Mount Polley Mine maintains two automated HOBO weather stations. These stations monitor temperature, rainfall, solar radiation, relative humidity, wind direction, wind speed, and wind gust speed. Weather Station #1 is located approximately one km southeast of Polley Mountain and was installed in September 2012. Weather Station #2 is located northeast of the TSF (between the Rock Quarry and Biosolids Storage Facility) and was installed in November 2012. A summary of the monthly site precipitation, evaporation, and temperature data collected in 2023 is provided in Table 4.13. Further climactic data including daily summary of weather parameters from 2023, can be found in ***Appendix E***.

Evaporation is calculated by using the Penman-Monteith equation using the WaSIM software developed by Cranfield University. Snowfall measurements are based on monthly snowpack testing done at four locations across the mine site. These measurements are taken at the end of every month, as well as between melting and snowfall events, if forecasted. Snowpack sample data including field results are found in ***Appendix E***. The snow course method aligned with the Snow Survey Sampling Guide (ENV, 1981).

Table 4.13 Mount Polley 2023 monthly precipitation, evaporation, and temperature data

Month	Monthly Precipitation as Rain (mm)	Monthly Snowpack (mm Snow Water Equivalent)	Evaporation (mm)	Average Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	21.0	111	12.9	-3.02	5.49	-21.52
February	10.7	263	15.85	-6.23	3.16	-26.11
March	5.5	243	33.2	-3.30	9.81	-16.88
April	15.7	109	58.7	3.21	22.13	-6.23
May	37.70	0	54.60	13.70	26.81	4.22
June	54.6	0	61.65	14.50	30.07	2.72
July	32	0	61.5	17.15	29.72	5.06
August	52.4	0	51.3	29.11	16.36	5.34
September	18.2	0	31.65	11.81	26.15	1.89
October	23.23	0	23	5.38	20.67	-12.37
November	31.6	0	12.1	-0.06	8.20	-6.97
December	34.4	18.3	10.9	-0.47	7.92	-6.9

4.6.1 Wind Monitoring

Wind data is monitored continuously by two on-site weather stations. Data from 2023 show that high speed winds are typically observed from the northwest and southeast directions.

4.6.1.1 Weather Station 1 – Leach Pad

In 2023, the strongest and most common winds at Weather Station 1 were observed at around 140°-160°, corresponding with the SE-SSE direction. Other predominant wind directions are at 260-280° (W), and 320°-340° (NNW). Winds were rarely measured from the East, in the 60°–90° range.

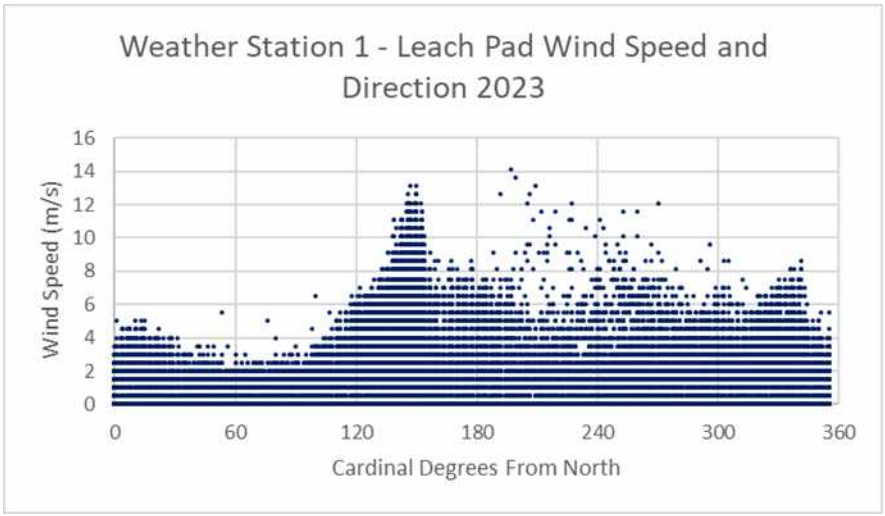


Figure 4.1 Wind data at Weather Station #1 in 2023

4.6.1.1 Weather Station 2 – Orica

Weather Station 2 corresponds with Station 1 but with some notable differences. Here, winds are relatively more common in the range from 280-320, from the NW direction. This is likely to be reflective of variations in topography between the stations, which are within a kilometer of each other. Strong winds in the 60–140-degree range, from the East, are more common. Winds from the South, at approximately 150-220 are relatively less common.

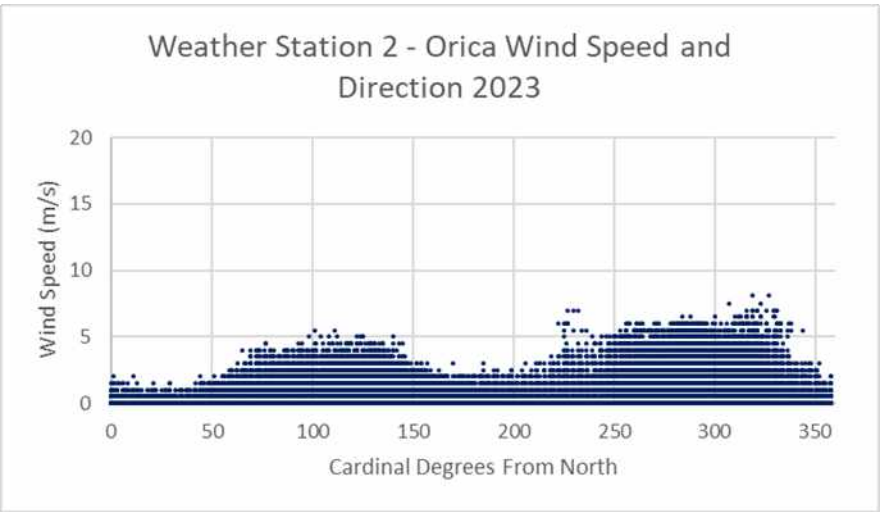


Figure 4.2 Wind data at Weather Station #2 in 2023

4.6.2 Temperature

In 2023, the lowest monthly mean temperature was -6.23°C recorded in February. The highest monthly mean temperature was 29.11°C recorded in August. Temperatures were colder than average in February, March and April but were warmer than average for the rest of the year when compared to site data collected since 1995. Figure 4.3 presents a comparison of 2023 maximum, mean, and minimum monthly temperatures with average monthly temperature data (based on data collected at Mount Polley since 1995). This data is shown in tabular form in Table 4.13.

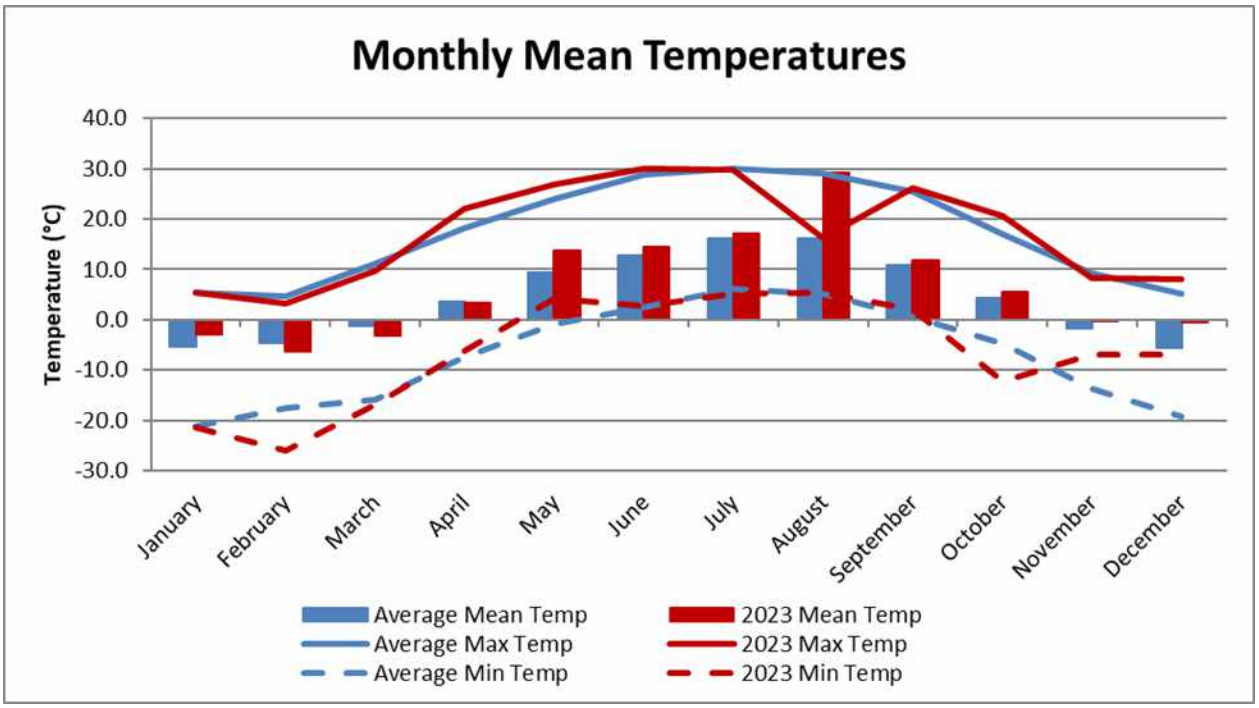


Figure 4.3 Maximum, mean and minimum monthly temperature data for Mount Polley (2023 versus average)

4.6.3 Precipitation

In 2023, 581 millimetres (mm) of precipitation was recorded: 337 mm as rain and 224 mm as snow water equivalent (SWE). This is below the average annual precipitation of 622 mm, with rainfall below its respective annual average but with snowfall above its respective annual average. The 2023 snowpack peaked in February at 263 mm SWE, above the annual average of 224 mm SWE. Total rainfall was lower compared to monthly averages for all months, except in August (52.4 mm), November (31.6 mm) and December (34.4 mm). The driest non-freezing month was April, with 15.7 mm of rain recorded. Precipitation data by month are presented in Table 4.13, Figure 4.4 and Figure 4.5. All precipitation averages are calculated based on data collected at the Mount Polley Mine since 1995.

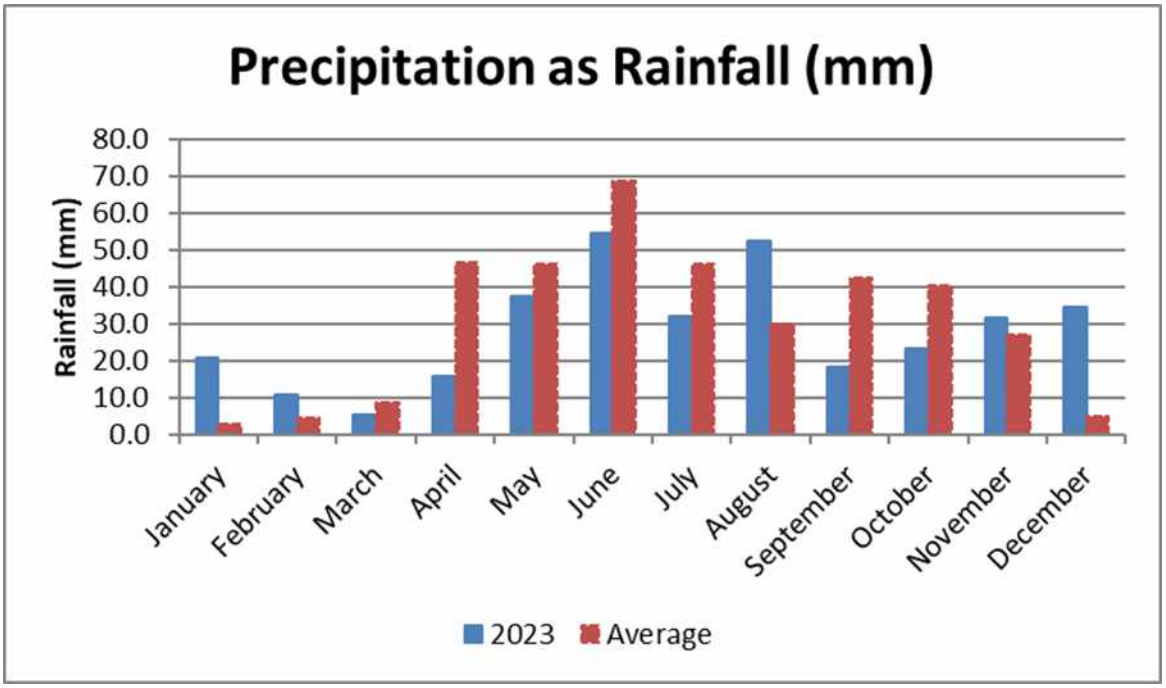


Figure 4.4 Monthly rainfall at Mount Polley (2023 versus average)

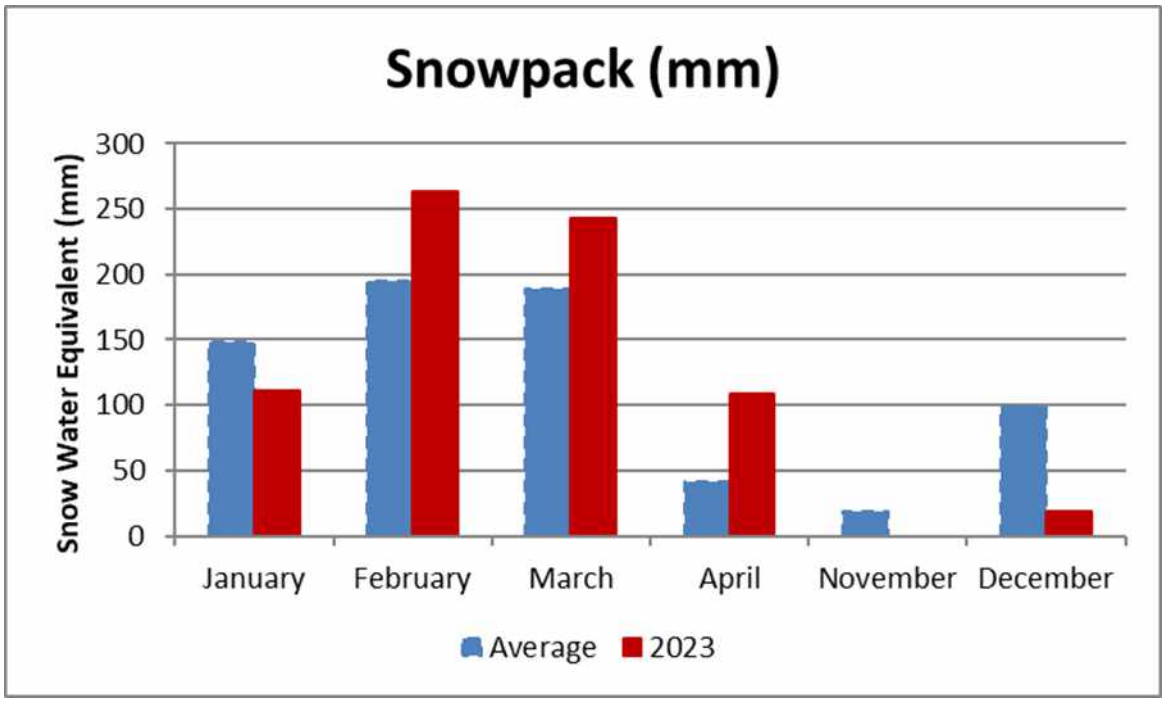


Figure 4.5 Monthly snowpack at Mount Polley (2023 versus average)

4.6.4 Evaporation

Total open water evaporation in 2023 was calculated to be 427 mm. June experienced the greatest amount

of evaporation at 61.7 mm. Monthly evaporation data are presented in Table 4.13. Figure 4.6 presents monthly comparisons of precipitation and evaporation for 2023.

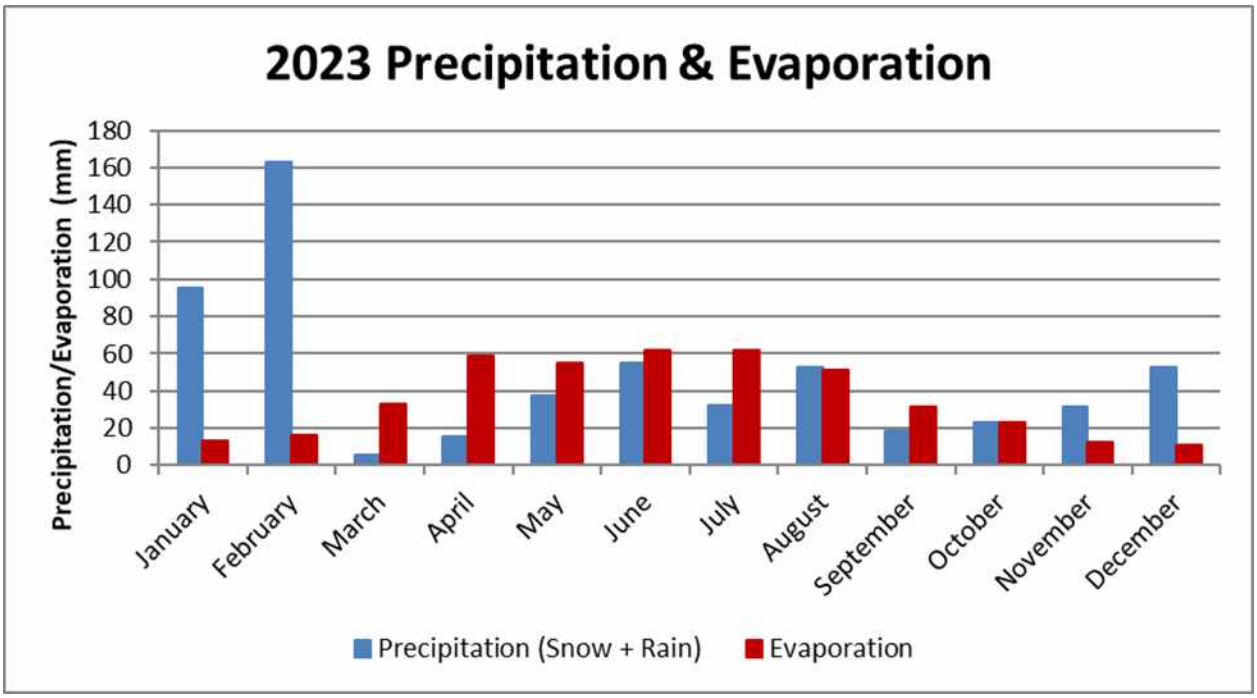


Figure 4.6 Mount Polley 2023 monthly precipitation and evaporation

4.7 Surface Water Monitoring

4.7.1 Hazeltine Creek

Water quality was monitored weekly and monthly at various sites throughout Hazeltine Creek in accordance with the 2019 CEMP (see Table 4.14). Flows in the creek are regulated by the Polley Lake weir structure.

Discharge from the WTP into Hazeltine Creek ceased in 2017. Full Hazeltine Creek water quality is provided in ***Appendix F***.

Table 4.14 2023 sampling events in Hazeltine Creek

Site Name	Site Identifier (EMS No.)	Full Sample Suite Frequency 2016 *CEMP*	Full Sample Suite Frequency 2018 *CEMP*	Full Sample Suite Frequency 2019 *CEMP*	Samples taken
HAC-05a	E304510	Monthly	Monthly	Monthly	12
HAC-08	E303013	Monthly	Monthly	Monthly	12
HAC-10	E303010	Monthly	Monthly	Monthly	12
HAC-13	E304810	Weekly	Monthly	Monthly	12
HAC-14	E331391	N/A	Monthly[(b)]	Monthly[(b)]	8

[(a)] HAC-01 was removed from the monitoring program per the 2019 CEMP approval letter dated February 10, 2021.
[(b)] Monthly only from May to November - not accessible during winter months.

Table 4.15 Summary of 2023 acute BC WQG for aquatic life exceedances in Hazeltine Creek

Site	Parameter	Date	Level (mg/L)	Acute BC WQG (mg/L)
HAC-05a	Dissolved aluminum	01-May-23	0.103	0.1
HAC-08	Dissolved aluminum	01-May-23	0.165	0.1
HAC-13	Dissolved aluminum	01-May-23	0.104	0.1
HAC-14	Dissolved aluminum	01-May-23	0.231	0.1

4.7.1.1 BC WQG at HAC-10

HAC-10 is located immediately downstream of the Polley Lake weir. The weir was open throughout the year, with the sluice gate at varying levels between 4 and 30 “turns”, corresponding with staff gauge elevations between approximately 920.0 and 920.5 MASL. Samples were collected monthly; therefore, chronic BC WQG for aquatic life are not applicable. No exceedances in acute BC WQG for aquatic life occurred at HAC-10 in 2023.

4.7.1.2 BC WQG at HAC-13

HAC-13 is located midway in Reach 1 in Upper Hazeltine Creek. Samples were collected monthly at this site, therefore the chronic BC WQG for aquatic life are not applicable. One exceedance in the acute BC WQG for aquatic life for dissolved aluminum occurred at HAC-13 in 2023 (Table 4.15). The exceedance occurred in May, corresponding with freshet. These results are associated with higher-than-normal turbidity and TSS measures, indicating chemical mobilization during periods of high flow.

4.7.1.3 BC WQG at HAC-05a

HAC-05a is located upstream of the Gavin Lake Road bridge. Samples were collected monthly; therefore, chronic BC WQG for aquatic life are not applicable. One exceedance in the acute BC WQG for aquatic life for dissolved aluminum occurred at HAC-05a in 2023 (Table 4.15). The exceedance occurred in May,

corresponding with freshet. These results are associated with higher-than-normal turbidity and TSS measures, indicating chemical mobilization during periods of high flow.

4.7.1.4 BC WQG at HAC-08

HAC-08 is located upstream of the Ditch Road bridge (on the Likely-Horsefly Forest service road) at Lower Hazeltine Creek. Samples were collected monthly; therefore, chronic BC WQG for aquatic life are not applicable. One exceedance in the acute BC WQG for aquatic life for dissolved aluminum occurred at HAC-08 in 2023 (Table 4.15). The exceedance occurred in May, corresponding with freshet. These results are associated with higher-than-normal turbidity and TSS measures, indicating chemical mobilization during periods of high flow.

4.7.1.5 BC WQG at HAC-01c

HAC-01c replaced HAC-12 in late 2017 and is located approximately 150 m downstream of HAC-12, representing the outlet of Hazeltine Creek into Quesnel Lake. Due to remedial construction, HAC-01c was requested to be removed from the CEMP in November 2020 and replaced by EDC-01a. This change was approved by ENV in their 2019 CEMP Approval letter, dated 10 February 2021, at which time sampling of this site ceased. For additional water quality data representing the flow from Hazeltine Creek to Quesnel Lake, see EDC-01a in Section 4.7.2.7.

4.7.1.6 Supplemental Sites: POF-1 and POF-5

Additional monitoring was continued in the Polley Flats to identify any potential influential sources seeping into Hazeltine Creek. Site POF-1 was established in 2016, and POF-5 was established in summer 2017. Both sites were sampled monthly (except when dry) in 2023. Influence from these sites is represented by monitoring sites in Hazeltine Creek upstream and downstream from the Polley Flats confluence. Sampling details are provided in Section 4.3 and the water quality is provided in ***Appendix F***.

4.7.2 Aquatic Receiving Environment

Surface water monitoring and analysis was conducted as outlined in the 2019 CEMP (***Appendix A***). Refer to Section 4.3 for a discussion of field sampling equipment and methodology. Sampling stations and frequency are summarized in Table 4.16 and locations are shown in ***Appendix B***.

Table 4.16 2023 Sampling events at surface water quality sites.

Site	Site Identifier (EMS No.)	Frequency			
		2016 *CEMP*	**2018 *CEMP***	**2019 *CEMP***	**Samples taken**
W1	E225084	Monthly	Quarterly	Quarterly	4
W4a	E298551	Monthly Weekly [(a)]	Monthly	Monthly	16
W5	E208039	Monthly Weekly [(a)]	Monthly	Monthly	18
W8	E216743	Quarterly Weekly [(a)]	Quarterly	Quarterly	8
W8z	E223292	Quarterly	Quarterly	Quarterly	2
W10	E291209	Monthly	Semi-annual	Semi-annual	2
EDC-01	E303014	Monthly	Semi-annual	Semi-annual	0
EDC-01a	E303014	-	-	Monthly[(b)]	12
W12	E216744	Quarterly	Quarterly	Quarterly	6
W20	E297070	Quarterly	Semi-annual	Semi-annual	2

[(a)] Weekly TSS and turbidity sampling for five weeks during spring freshet.

[(b)] EDC-01a to replace EDC-01 per 2019 CEMP Approval Letter, dated February 10, 2021.

Samples at aquatic receiving environment sites were submitted to ALS for analysis of:

- Physical parameters (pH, turbidity, TSS, total dissolved solids, and hardness);
- Anions and nutrients (alkalinity, chloride, fluoride, sulphate, total nitrogen, nitrate, nitrite, ammonia, phosphorus total and dissolved, and ortho-phosphorus);
- Organics (dissolved organic carbon); and
- Total and dissolved metals (metals suite as listed in CEMP; ***Appendix A***).

Water chemistry results from the surface sites were compared with the BC WQG for aquatic life for both short-term (maximum or acute) and long-term (chronic) exposures. In 2023, there were 7 exceedances, and two possible exceedances of the acute BC WQG for aquatic life at the permitted surface water monitoring sites (Table 4.17). Note that the list of analytes with concentrations greater than BC WQG is similar to baseline.

At sites W4a, W5, and W8 weekly intensive sampling of TSS and turbidity occurred during spring (freshet); and a 30-day average could be calculated; these were therefore appropriately compared to chronic TSS and turbidity BC WQG. Additional details for each site are provided in the following sections and ***Appendix F*** (which includes tables of results for the past five years and graphs of select parameters). Note that only parameters with trends and/or exceedances are discussed in the sections below. Note that results below method detection limit (MDL) are represented as half (0.5x) the MDL in statistical calculations and graphs.

Table 4.17 Summary of 2023 acute BC WQG exceedances for aquatic life at surface water monitoring sites

Site	Parameter	Date	Results	Acute BC WQG (mg/L)
W4a	Dissolved copper	2-May-23	0.0165 mg/L	0.008[a]
	Turbidity	24-Apr-23	14.3 NTU[b]	8 NTU change from background in 24 hours in all waters during clear flows or in clear waters
W5	Dissolved aluminum	12-Apr-23	0.252 mg/L	0.1
		2-May-23	0.266 mg/L	
	Turbidity	12-Jan-23	10.8 NTU[b]	8 NTU change from background in 24 hours in all waters during clear flows or in clear waters
W8	Dissolved aluminum	2-May-23	0.148 mg/L	0.1
W8z	Dissolved aluminum	28-Mar-23	0.186 mg/L	0.1
		25-May-23	0.284 mg/L	
W12	Dissolved iron	12-Oct-23	0.777 mg/L	0.35
	Total iron	12-Oct-23	1.05 mg/L	1
EDC-01a	Dissolved aluminum	1-May-23	0.160 mg/L	0.1

[a] Copper guideline calculated with BLM software.

[b] Turbidity events are considered possible exceedances, not actual exceedances, because it is unknown whether the change from background occurred for a duration of 24 hours.

4.7.2.1 Site W1 – Morehead Creek (E225084)

This site has been monitored since 1990. It was sampled 4 times in 2023. There is no notable increasing or decreasing trend in water quality at this location. Graphs for a subset of parameters are provided in *Appendix F*.

Dissolved aluminum: No exceedances of acute BC WQGs for dissolved aluminum occurred in 2023. In 2018, monitoring results in November showed one exceedance of the BC WQG for dissolved aluminum. This result appears to be an outlier (potentially a sampler or lab error) as it is the only observed exceedance for dissolved aluminum at this location, and there were no other elevated parameters observed in this sample. The mean value for dissolved aluminum at W1 between 2019 and 2023 was 0.0462 mg/L.

Copper: Though no monitoring results showed exceedances of acute BC WQG for copper in 2023, these types of exceedances have been observed since monitoring began in 1990 (before mining). From 2019 to 2023 the minimum recorded value for copper was 0.00272 mg/L, the maximum was 0.0125 mg/L, and the mean was 0.00662 mg/L. The mean value for copper in 2023 was 0.00786 mg/L.

Sulphate: A slight increase in sulphate levels has been recorded at W1 since 2005, though the levels remain well below appliable guidelines. From 2019 to 2023 the minimum recorded sulphate value was 2.41 mg/L, and the maximum was 11.7 mg/L with a mean of 6.01 mg/L. Note the applicable guideline for this environment is either 218 or 309 mg/L (hardness dependant).

Chloride: From 2019 to 2023 the minimum recorded chloride value was 0.25 mg/L, the maximum was 5.36 mg/L, and the mean was 1.30 mg/L.

4.7.2.2 Site W4a – North Dump Creek below Wight Pit Road (E298551)

This site has been monitored since 2014. W4a was sampled 12 times in 2023 for the full analytical suite, and 4 times for turbidity and TSS only. Graphs are provided in ***Appendix F***. There were acute exceedances in dissolved copper and turbidity at this location in 2023. Most exceedances at this location have occurred during freshet in spring, however, during periods of heavy rains in summer and fall, it is not uncommon to see spikes. There is no notable increasing or decreasing trend in water quality at this location.

Copper: In August 2019, the BC WQGs were amended to include a guideline for dissolved copper and removed the total copper guideline. The BC BLM software was used to calculate applicable WQGs. Copper concentrations in 2023 remained similar to historical values. One acute dissolved copper WQG exceedance occurred in 2023 (Table 4.17). This sampling event is associated with high flows and sediment loads. Between 2019 and 2023, the minimum concentration of total copper recorded at W4a is 0.00232 mg/L and the maximum concentration is 0.963 mg/L (likely sediment-influenced). The mean concentration between 2019 and 2023 is 0.0218 mg/L.

Dissolved aluminum: There were no acute exceedances in dissolved aluminum in 2023. From 2019 to 2023 the minimum recorded dissolved aluminum is 0.0015 mg/L, the maximum is 0.111 mg/L, and the mean is 0.0173 mg/L.

TSS: In 2023 there were no TSS exceedances. From 2019 to 2023, the minimum value is 0.50 mg/L, the maximum is 24.6 mg/L, and the mean is 2.280 mg/L. The mean value during the 30-day sampling event in the spring was similar to background.

Turbidity: In 2023, there was one possible acute BC WQG exceedance (Table 4.17). A recording on April 24 was 14.3 NTU, which is more than 2 NTU above the background value of 2.4 NTU. This event cannot be considered a WQG exceedance because it is unknown whether this turbidity value persisted for 24 hours. Between 2019 and 2023 the minimum value is 0.05 NTU, the maximum is 15.5 NTU and the mean is 2.41 NTU. In 2023 the mean value is 2.09 NTU.

Total iron: In 2023, there were no acute exceedances for total iron. The most recent WQG exceedance for this parameter took place in 2017. Between 2019 and 2023 the minimum value is 0.015 mg/L, the maximum

is 0.999 mg/L (occurring April 21, 2020; just on the edge of the WQG), and the mean is 0.135 mg/L. In 2023 the mean value is 0.108 mg/L.

Total selenium: While not considered a WQG exceedance, total selenium values were above the 0.001 mg/L chronic "Alert" level for selenium in 66 of 78 samples from 2019 to 2023. During this time the minimum recorded total selenium is 0.0006 mg/L, the maximum is 0.0471 mg/L (April 07, 2021; likely to be influenced by suspended sediment), and the average is 0.00377 mg/L. The average for 2023 was 0.0017 mg/L.

4.7.2.3 Site W5 – Bootjack Creek (E208039)

This site has been monitored since 1990. It was sampled 14 times in 2023 for the full parameter suite and 4 times for TSS and turbidity only. There is no notable increasing or decreasing trend in water quality at this location. Graphs for a subset of parameters are provided in ***Appendix F***.

Due to the TSF breach in August 2014, Bootjack Creek no longer flows directly to Hazeltine Creek resulting in a disconnection in fish habitat. In October 2014, fish were salvaged and are excluded from Bootjack Creek.

Sulphate: From 2019 to 2023, the minimum recorded sulphate was 0.82 mg/L, and the maximum was 147 mg/L with a mean of 19.43 mg/L. The mean for 2023 was 44.58 mg/L.

Dissolved aluminum: In 2023 there were 2 exceedances of the acute BC WQG for dissolved aluminum at this location (Table 4.17). Dissolved aluminum has been elevated at this monitoring location since before the mine was established and there is no observed increasing trend. Between 2019 and 2023 the minimum value recorded is 0.0076 mg/L, the maximum is 0.266 mg/L, and the mean is 0.10 mg/L. The mean for 2023 is 0.050 mg/L.

Copper: Prior to the August 2019 changes to the copper BC WQG-AL, exceedances at this site were common, with 22 acute total copper exceedances between 2016 and 2019. However, water chemistry here is favorable, and under the new dissolved copper guideline utilizing the Biotic Ligand Model, no acute copper exceedances have been recorded since 2019. As with dissolved aluminum, this site had elevated copper since before the mine was established and there is no observed increasing trend. Between 2019 and 2023 the minimum total copper value recorded is 0.00243 mg/L, the maximum is 0.0702 mg/L, and the mean is 0.00939 mg/L. The mean for 2023 is 0.0068 mg/L.

TSS: No TSS BC WQG exceedances were recorded in 2023. The minimum value recorded between 2019-2023 is 0.5 mg/L, the maximum is 102 mg/L, and the mean is 3.798 mg/L. The mean for 2023 is 6.22 mg/L.

Turbidity: In 2023 there was one possible exceedance of the acute BC WQG, occurring on January 12, at a value of 10.8 NTU (Table 4.17). This is not considered an exceedance because it is unknown whether this value was consistent over 24 hours. Between 2019 and 2023 the minimum value is 0.007 NTU, the maximum is 14.2 NTU and the mean is 1.87 NTU. In 2023 the mean value is 2.50 NTU.

4.7.2.4 Site W8 – Northeast Edney Creek Tributary (E216743)

This site has been monitored since 1995. It was sampled 4 times in 2023 for full metals suite and 4 times for TSS and turbidity only.

Dissolved aluminum: There was one acute exceedance at this location in 2023 (Table 4.17). This occurred in May and is associated with high spring freshet flows. Between 2019 and 2023 the minimum value recorded is 0.0047 mg/L, the maximum is 0.180 mg/L, and the mean is 0.0669 mg/L. The mean for 2023 is 0.0470 mg/L.

Copper: No acute dissolved copper exceedances were measured in 2023. BC BLM-calculated WQGs tended to be an order of magnitude higher than recorded values. From 2019 to 2023, total copper varied from a minimum value of 0.00052 mg/L to the maximum of 0.00656 mg/L and a mean of 0.00250 mg/L. The mean for 2023 is 0.00269 mg/L.

TSS: No TSS exceedances were observed in 2023. From 2019 to 2023, the minimum value recorded is 0.5 mg/L, the maximum is 16.2 mg/L, and the mean is 1.82 mg/L. The mean for 2023 is 2.73 mg/L.

Turbidity: In 2023 there were no exceedances for turbidity. Between 2019 and 2023, the minimum value recorded is 0.10 NTU, the maximum is 10.92 NTU and the mean is 1.40 NTU. The mean for 2023 is 2.52 NTU.

4.7.2.5 Site W8z – Southwest Edney Creek Tributary (E223292)

This site has been monitored since 1997. It was sampled twice in 2023.

Dissolved aluminum: There were two acute BC WQG exceedances at this location in 2023 (Table 4.17). All samples at this location since 1997 except for two have exceeded this threshold. Between 2019 and 2023 the minimum value recorded is 0.138 mg/L, the maximum is 0.340 mg/L, and the mean is 0.218 mg/L. The mean for 2023 is 0.235 mg/L.

Copper: Prior to 2020, exceedances of the acute guideline for total copper were common at this location (in August 2019 the BC WQG were amended and the total copper guideline was removed). However, between 2019-2023, there are no observed exceedances of the updated 2019 BLM-calculated WQGs. This site has had elevated copper since before the mine was established and there is no observed increasing trend. Between 2019 and 2023 the minimum total copper value recorded is 0.00222 mg/L, the maximum is 0.00713 mg/L, and the mean is 0.00413 mg/L. The mean for 2023 is 0.00681 mg/L.

Dissolved iron: There were no acute BC WQG exceedances at this site in 2023. As with dissolved aluminum, this site had elevated dissolved iron since before the mine was established and there is no observed increasing trend. Between 2019 and 2023 the minimum value recorded is 0.140 mg/L, the maximum is 0.425 mg/L, and the mean is 0.270 mg/L. The mean for 2023 is 0.3385 mg/L.

TSS: Between 2019 and 2023 there were no major fluctuations in TSS. The minimum value recorded during this time period is 0.50 mg/L, the maximum is 1.90 mg/L, and the mean is 0.593 mg/L. The mean for 2023 is <1.0 mg/L.

Turbidity: Between 2019 and 2023 turbidity remained stable. The minimum value recorded is 0.29 NTU, the maximum is 2.22 NTU and the mean is 1.07 NTU. The mean for 2023 is 0.57 NTU.

4.7.2.6 Site W10 – Edney Creek (E291209)

Prior to this becoming a permitted site there were only a few samples collected here since 1995. This site is a reference site, selected for comparisons to the sites downstream from the mine disturbance, including a site in the re-engineered channel of Edney Creek. Graphs are provided in ***Appendix F***. This site was sampled twice in 2023.

Dissolved aluminum: There were no acute BC WQG exceedances at this site in 2023. There were five exceedances of the BCWQG between 2019 and 2023. This site has had elevated dissolved aluminum since before the mine was established and there is no observed increasing trend. Between 2019 and 2023 the minimum value recorded is 0.0036 mg/L, the maximum is 0.161 mg/L, and the mean is 0.0563 mg/L. The mean for 2023 is 0.009 mg/L.

Copper: There were no acute BC WQG copper exceedances at this site in 2023. Between 2019 and 2023 the minimum total copper value recorded is 0.00093 mg/L, the maximum is 0.00383 mg/L, and the mean is 0.00233 mg/L. The mean for 2023 is 0.00091 mg/L.

TSS: No TSS exceedances were observed in 2023. From 2019 to 2023, the minimum value recorded is 0.5 mg/L, the maximum is 17.3 mg/L, and the mean is 4.14 mg/L. The mean for 2023 is < 1.0 mg/L.

Turbidity: No turbidity exceedances were observed in 2023. From 2019 to 2023, the minimum value recorded is 0.10 NTU, the maximum is 7.28 NTU, and the mean is 2.15 NTU. The mean for 2023 is 0.31 NTU.

4.7.2.7 Site EDC-01a – Edney Creek below confluence with Hazeltine Creek (E303014)

Sampling at EDC-01a began in 2021. This site was established to replace EDC-01, which was disrupted by remedial construction in Lower Hazeltine Creek. These sites are considered analogous, both representing water quality downstream from the confluence of Hazeltine and Edney Creeks, prior to their drainage into Quesnel Lake. EDC-01 was not sampled after 2020, and EDC-01a was not sampled prior to 2021. Water quality at these sites can be compared to W10, which is upstream in Hazeltine Creek and is relatively unimpacted by mining activities, remedial activities, and the 2014 tailings breach.

Dissolved aluminum: There was one acute BC WQG exceedance at this site in 2023 (Table 4.17). Between 2021 and 2023, the minimum value recorded is 0.0015 mg/L, the maximum is 0.160 mg/L, and the mean is 0.028 mg/L. Comparing these results to W10, the levels at EDC-01a were similar.

Copper: There were no acute BC WQG exceedances for copper at this site in 2023. The minimum total copper value recorded between 2021 and 2023 was 0.00492 mg/L, the maximum is 0.0123 mg/L, and the mean is 0.0070 mg/L. Comparing these results to W10, the levels at EDC-01a were similar.

Total iron: There were no acute BC WQG exceedances at this site in 2023. Between 2021 and 2023 the minimum value recorded is 0.015 mg/L, the maximum is 1.37 mg/L, and the mean is 0.176 mg/L. Comparing these results to W10, the levels at EDC-01a were similar.

Sulphate: In 2023, no sulphate WQG exceedances are recorded. The minimum value recorded is 3.10 mg/L, the maximum is 54.0 mg/L, and the mean is 35.75 mg/L. Comparing these results to W10, the levels at EDC-01a were similar.

TSS: In 2023, no TSS exceedances are noted. The minimum value recorded is 0.50 mg/L, the maximum is 25.7 mg/L, and the mean is 3.06 mg/L. Comparing these results to W10, the levels at EDC-01a were similar.

Turbidity: In 2023, no exceedances or possible exceedances are recorded. Between 2021 and 2023 the minimum value recorded is 0.22 NTU, the maximum is 9.77 NTU and the mean is 1.76 NTU. Comparing these results to W10, the levels at EDC-01a were similar.

4.7.2.8 Site W12 – 6K Creek at Road (E216744)

This site has been monitored since 1990. It was sampled six times in 2023. There is no notable increasing or decreasing trend in water quality at this location. Graphs for a subset of parameters are provided in *Appendix F*.

Dissolved aluminum: In 2023, no dissolved aluminum exceedances are noted. Between 2019 and 2023 the minimum value recorded is 0.0048 mg/L, the maximum is 0.0618 mg/L, and the mean is 0.0200 mg/L. The mean for 2023 is 0.0163 mg/L.

Copper: Between 2019 and 2023 there are no recorded exceedances of BCWQGs for copper. The minimum total copper value recorded is 0.00112 mg/L, the maximum is 0.00118 mg/L, and the mean is 0.00459 mg/L. The mean for 2023 is 0.00299 mg/L.

Sulphate: A slight increase in sulphate levels has been recorded at W12 since 2005, though the levels remain well below any applicable guidelines. Between 2019 and 2023 the minimum recorded sulphate was 0.15 mg/L, and the maximum was 23.0 mg/L with a mean of 8.50 mg/L. The mean for 2023 was 4.28 mg/L.

TSS: No TSS exceedances have been observed in 2023. Between 2019 and 2023 the minimum value recorded is 0.5 mg/L, the maximum is 6.7 mg/L, and the mean is 1.815 mg/L. The mean for 2023 is 2.77 mg/L.

Turbidity: Between 2019 and 2023 turbidity values are stable at W12, with no exceedances. The minimum value recorded is 0.0 NTU, the maximum is 3.26 NTU and the mean is 1.485 NTU. The mean for 2023 is 0.59 NTU.

4.7.2.9 Site W20 – W20 Creek (E297070)

This site has been monitored since 2013 when the West Ditch was constructed. In 2023, two samples were collected. There have been no trends or notable changes in water quality at this location. Graphs for a subset of parameters are provided in ***Appendix F***.

Dissolved aluminum: There were no acute BC WQG exceedances for dissolved aluminum in 2023. Historically, most samples at this location have high dissolved aluminum values. Between 2019 and 2023 the minimum value recorded is 0.0087 mg/L, the maximum is 0.299 mg/L, and the mean is 0.107 mg/L. The mean for 2023 is 0.030 mg/L.

Copper: In 2023, no acute copper WQG exceedances were recorded. The minimum total copper value recorded during this period is 0.00244 mg/L, the maximum is 0.00661 mg/L, and the mean is 0.00448 mg/L. The mean for 2023 is 0.00408 mg/L.

4.7.3 Lake Sampling

In 2023, lake sampling was completed as outlined in the 2019 CEMP in Section 6.6. Refer to Section 4.3 for a discussion of field sampling equipment and methodology and ***Appendix B*** for a site map. ***Appendix M*** includes tables of all results for the past five years and graphs of the parameters measured.

Table 4.18 2023 Lake water quality sampling locations

Site	Site Identifier (EMS No.)	Profile Frequency		Sample Frequency	
		CEMP	**Samples 2023**	**Permit Requirement**	**Samples 2023**
P1	E207974	Monthly[a], and as described in the Permit Requirement column.	7[c]	Spring overturn, twice in summer, fall overturn, once under ice	7[c]
P2	E207975	Monthly[a], and as described in the Permit Requirement column.	8	Spring overturn, twice in summer, fall overturn, once under ice	8
B1	E207972	Monthly[a]	6	Semi-annually	6
B2	E215897	Monthly[a]	6	Semi annually	6
B4	E216744	For closure only	0	For closure only	0
QUL-ZOO-1	E306455	Semi-annually	3	Semi-annually	3
QUL-ZOO-7	E306456	Semi-annually	3	Semi-annually	3
QUL-ZOO-8	E306457	Semi-annually	0[b]	Semi-annually	0[b]
QUL-2a	E303020	Four times annually	5[d]	Four times annually	5[d]
QUL-18	E303019	Four times annually	4	Four times annually	4
QUL-120a	E303022	Semi-annually	4	Semi-annually	4

[a] Between spring and fall overturn

[b] Site was removed from the sampling program in June 2019

[c] P1 could not be sampled on March 1, 2023; therefore, P1 and P2 were sampled under ice on March 15, 2023

[d] Sampling was conducted at QUL-2a on June 19, 2023 as a result of a total phosphorus exceedance at QUL-58 on June 6, 2023

Some WQG exceedances were noted in lake samples in 2023, as shown in Table 4.19.

Table 4.19 2023 Lake BC WQG acute exceedance events

Site	Depth	Parameter	Date	Level (mg/L)	Acute BC WQG (mg/L)
P1	Surface	Dissolved copper	9-May-23	0.00404	0.0040[a]
B1	Surface	Dissolved copper	12-Jul-23	0.00298	0.0017[a]
			10-Oct-23	0.00204	0.0013[a
	Bottom	Total manganese	23-Aug-23	1.0	≤1.06
		Dissolved iron	23-Aug-23	1.37	0.35
			7-Sept-23	1.38	
		Total iron	23-Aug-23	1.54	1.0
			7-Sep-23	1.48	
B2		Total manganese	23-Aug-23	0.927	≤1.05
		Total iron	7-Sept-23	1.12	1

	Bottom		10-Oct-23	1.30	
		Dissolved iron	7-Sept-23	1.13	0.35
			10-Oct-23	1.19	
QUL-120a-0m	Surface	Dissolved copper	10-May-23	0.00073	0.0006[(a)]

[(a)] Site-specific WQG calculated using BLM or hardness

4.7.3.1 Bootjack Lake

In Bootjack Lake, station B1 is located at the northwest end of the lake and station B2 is located at the southeast end. It was discovered that in late 2016, the previous stations were not at the deepest locations for the 2016 monitoring season and these sites were relocated to the deepest areas for monitoring in 2017 and continued from 2018 to present. Sampling occurred during spring turnover in May, in late summer in August and September and during fall turnover in October in 2023. Limnological profiles were taken monthly between spring and fall turnover at B1 and B2. Profile and chemistry data are presented in ***Appendix M***.

In 2016, four locations (B3, B4, B5, and B6) were created near areas of potential exfiltration from the Springer Pit supernatant. Based on the 2016 results it was determined in 2017 that one location, B4, would be profiled bi-monthly, as the Springer Pit supernatant is well below the recommended 1,030 masl (Golder, 2016a). This monitoring was discontinued in 2019 until post-closure. In 2023, monitoring took place at B1 and B2, representing the north and south ends of Bootjack Lake.

In Situ Data

In 2023, MPMC recorded profile data at B1 and B2 six times. Limnological profiles of pH, conductivity, dissolved oxygen, turbidity, and temperature as well as Secchi depth were measured at B1 and B2 on a monthly basis from approximately May to October, including during lake turnover events in spring and fall. In 2023, field parameters including conductivity and turbidity were consistent with previous years.

Lake Water Chemistry

Water samples for analytical chemistry were collected at surface, bottom, and mid depths when the lake is isothermal, and at surface, bottom, above and below the thermocline when the lake is not isothermal. These sampling depths are consistent between sites B1 and B2. ***Appendix M*** contains water chemistry data tables with results from the last five years. Bootjack Lake has been routinely sampled for water quality twice a year during spring turnover and in late August. In 2017, total iron, total manganese, and total phosphorus levels exceeded (outdated) aquatic BC WQGs for samples collected near the bottom of B1 and B2 during sampling events in September, though to be related to conditions at the bottom becoming anoxic with the fall turnover. More recently in the period from 2019-2023, a few WQG exceedances have been recorded for total and dissolved iron, dissolved copper, and total manganese; mostly associated with bottom samples taken in fall of 2019, 2022 and 2023.

Total and dissolved iron: There were 15 acute BC WQG for aquatic life exceedances in Bootjack Lake between 2019 and 2023 (seven total iron and eight dissolved iron). These occurred in August and September 2019, September 2021, September and October 2022, and August, September and October 2023. All exceedances were observed in bottom samples, and are likely to be related fall overturn, possibly attributable to fine sediment resuspension. Total iron levels in Bootjack Lake between 2019 and 2023 ranged from 0.030 to 1.64 mg/L, with an average of 0.155 mg/L. In 2023, the average total iron level was 0.247 mg/L.

Total manganese: Six total manganese acute BC WQG exceedances occurred in Bootjack Lake between 2019 and 2023, three of which happened on August 29, 2019 at B1-bottom, B2-surface and B2-bottom. Additional manganese exceedances occurred at B2-bottom in September 2021, B1-bottom in September 2022, and B1- and B2-bottom in August 2023. The cause of these manganese spikes is unknown; however, all of these events occurred at or around fall overturn, which is likely related. The August 29, 2019, sampling date resulted in many exceedances in Bootjack Lake for elements which are naturally present in sediment and would be expected to mobilize during overturn. Between 2019 and 2023, Bootjack Lake total manganese concentrations varied widely; between 0.0062 and 1.29 mg/L and with an average concentration of 0.121 mg/L.

Dissolved copper: Three acute dissolved copper BCWQG exceedances occurred between 2019 and 2023, at the B2-bottom site on June 10, 2021, and B1-surface on July 12, 2023 and October 10, 2023. The dissolved copper measures at these locations and times were lower-than-average for Bootjack Lake; however chemical conditions for biotic uptake were not favorable and the concurrent BLM-calculated WQGs for dissolved copper were exceeded. Dissolved copper concentrations in Bootjack Lake from 2019 and 2023 varied between 0.00103 and 0.00378 mg/L, with an average concentration of 0.00186 mg/L.

4.7.3.2 Polley Lake

In Polley Lake, station P1 is located at the deepest point at the north end of Polley Lake and station P2 is located at the deepest point at the south end of Polley Lake and are shown in ***Appendix B***. Sampling occurred monthly between spring and fall overturn; limnological profiles were conducted monthly along with the Secchi depth during the same period as per the CEMP (***Appendix A***). Sampling in Polley Lake took place in March (under ice) and then monthly during the ice-free season in 2023. A total of 8 sampling events took place in 2023. Profile and chemistry data are presented in ***Appendix M***.

Polley Lake was impacted by the TSF embankment breach that occurred in 2014 (MPMC, 2015a) and sample results for water quality show that some water chemistry results are elevated from historic and baseline levels. All results are included in ***Appendix M***.

In Situ Data

In 2023, MPMC recorded profile data at P1 seven times and P2 eight times. Profiles of pH, specific

conductivity, dissolved oxygen, turbidity and temperature were measured monthly at these locations during the ice-free season, and under-ice in February or March of each winter.

In Polley Lake, conductivity historically ranged from 121 to 215 µS/cm, with an average of 186 µS/cm. Following the breach, the conductivity increased to a maximum of 410 µS/cm at P1 and 396.9 µS/cm at P2 in September 2015, with an average of 284.2 µS/cm. Conductivity throughout Polley Lake appears to be decreasing slightly since the breach; however, it remains above historic levels. In 2023, the average conductivity recorded at P1 was 261 µS/cm and at P2 was 265 µS/cm. These values are lower than those recorded in 2015 and are similar to the period from 2016 onward.

In Polley Lake, pH historically ranged between 6.90 and 9.55, with an average of 8.27 at P1. At P2, pH has ranged from 7.12 to 9.55 with an average of 8.34. In the period from 2019-2023, pH remains similar, with a range of 6.89 to 8.46 at P1 with an average of 7.80 and from 6.93 to 8.79 with an average of 7.82 at P2. In 2023, the averages were 7.71 at P1 and 7.76 at P2.

Lake Water Chemistry

In 2023, water samples for analytical chemistry were collected at surface, bottom, and mid depths when the lake is isothermal, and at surface, bottom, above and below the thermocline when the lake is not isothermal. These data are presented in ***Appendix M***.

Total copper: Copper concentrations have been higher since 2014, with a post-breach average of 0.0044 mg/L compared with the average of 0.0024 mg/L pre-breach. In the period from 2019 to 2023, the mean total copper value was 0.00428 mg/L, and the lowest value was 0.00317 mg/L. The maximum total copper concentration recorded was 0.0112 mg/L.

Total selenium: Selenium concentrations on Polley Lake waters have decreased to below pre-breach levels. The pre-breach average was 0.0009 mg/L compared to the post-breach average of 0.0007 mg/L. The maximum recorded value between 2019 and 2023 was 0.000834 mg/L. While an initial increase was noted following the breach with a maximum of 0.0012 mg/L, the downward trend is apparent. The maximum concentrations in 2015, 2016 and 2017 are 0.00011 mg/L, 0.0008 mg/L, and 0.0007 mg/L, respectively, with maximal measures remaining near the 0.0006 mg/L level since 2018.

Minnow installed DGTs in Polley Lake from 2015 to 2021 and provided memos that have been appended to previous years' annual reports (MPMC 2016b, 2017d, 2018a, 2019, 2020). According to Minnow, total and dissolved metals over-represent the metal fraction that is potentially available for uptake by aquatic organisms in natural surface waters. Minnow's technical memos describe the methods and results for the DGT deployments. Key findings for Polley Lake include that mean DGT-labile copper concentrations are very low, however they are higher than in Bootjack Lake (reference), and DGT labile concentrations in Polley Lake of arsenic, molybdenum, selenium and vanadium were enriched compared to Bootjack Lake. However, total concentrations of these metals were below applicable BC WQGs.

4.7.3.3 Quesnel Lake

Quesnel Lake is the receiving environment for Quesnel Lake discharge and is extensively monitored as described in the CEMP (***Appendix A***). Note that this section contains information on Quesnel Lake sites away from the IDZ. Monitoring locations at the edge of the IDZ (QUL-57, -58, -59) are discussed in the context of the discharge system, in Section 4.12.2.6.

Quesnel Lake Zooplankton Sites

In Quesnel Lake, site QUL-ZOO-1 is in the center of the West Basin and QUL-ZOO-7 is located in front of Horsefly Bay (***Appendix B***). Sampling and limnological profiles occurred three times in the ice-free season, as per the CEMP (***Appendix A***). In 2023, samples were collected in June, July and August. There were no acute BC WQG exceedances at these sites between 2019 and 2023. MPMC continues to collect profile and surface water quality data from these sites to be used in the analysis of plankton results (see Section 4.15).

Quesnel Lake Receiving Environment and Reference Sites

According to the 2019 CEMP, the far-field receiving environment in Quesnel Lake is monitored at QUL-18 (the deepest area of the West Basin, downstream far-field exposure station) and QUL-2a (West Basin upstream of the mouth of Hazeltine Creek; to monitor for potential eastward flow of effluent due to seiche events). Sampling and limnological profiles at depths occurred five times at QUL-2a and four times at QUL-18 in 2023.

An upstream reference station, QUL-120a, is located east of Cariboo Island, and sampling in this location is stipulated in the 2019 CEMP approval letter, dated February 10, 2021. Sampling and limnological profiles at depths outlined in the CEMP (***Appendix A***) occurred four times in 2023.

Lake Water Chemistry

Quesnel Lake is an oligotrophic lake, therefore, it is common to see total phosphorus concentrations lower than the BC WQG for lakes containing salmonids (Total P between 0.005 and 0.015 mg/L), as was observed at all sites in Quesnel Lake (***Appendix M***), except for certain locations discussed below. One acute BC WQG exceedance (dissolved copper) was found at the receiving environment sites (QUL-120a) in 2023. Since only four times annual or semi-annual sampling is conducted at QUL-18, QUL-2a, and QUL-120a, the required five samples taken in 30 days to calculate the chronic average was not met. Therefore, these comparisons are for screening purposes only and are discussed below. Additional information related to the discharge water quality is in Section 4.12.2 and discharge plume modeling in Quesnel Lake are in ***Appendix J***.

At QUL-18, there were no observed changes or trends in the water quality between 2019 and 2023, compared to historic data. An increase in total phosphorus at the surface, 20m, and 50m depths in September of 2018 was noted. This may have been due to remnants of spawning and debris from the

wildfires; the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according to the BC WQG for total phosphorus – nutrients and algae), therefore, total phosphorus remained in compliance with the BC WQG. Total phosphorus concentrations at the surface, 20m and 50m depths decreased in August 2019 and remained at similar levels in 2020. In 2021, 7 of 16 samples were below detection limit (<0.002 mg/L) for total phosphorus. In 2022, 5 of 16 samples were below detection limit for total phosphorus. In 2023, 3 of 16 samples were below detection limit for total phosphorus. The average of total phosphorus from 2019-2023 at QUL-18 was 0.00364 mg/L and the maximum concentration was 0.0093 mg/L throughout the water column (Figure 4.7).

Historically, concentrations of total copper have exceeded chronic limits (since amended) at a 100m depth once in August 2019, once in August 2018, once in April 2017 and three times in 2016 (May, June, and November); and once at 20 m depth in November 2016 (Figure 4.8). With the 2019 revision of copper guidelines to rely on dissolved copper and the BLM-calculated limit, only one acute exceedance has been detected at the Quesnel Lake reference sites. Dissolved copper at QUL-120a-0m was 0.00073 mg/L on May 10, 2023 and exceeded the BLM-calculated guideline of 0.0006mg/L. This exceedance occurred at the surface and could be attributed to a number of environmental factors. The total copper at QUL-18 between 2019 and 2023 varied between 0.0005 and 0.0015 mg/L, with an average concentration of 0.0007 mg/L. The 2023 average concentration was 0.00068 mg/L.

At QUL-2a, there were no observed changes or trends in the water quality between 2019 and 2023, when compared to historic data. Elevated phosphorus concentrations (0.0488 mg/L) were observed in 2018 but have decreased since that time. Between 2019 and 2023, total phosphorus ranged from 0.002 to 0.0114 mg/L, with an average concentration of 0.0039 mg/L. In 2023, the average total phosphorus concentration was 0.0028 mg/L. There were two instances of total copper exceeding the (now outdated) chronic BC WQG at surface and at 40 m depth in July 2018. The only other time a result exceeded the chronic limit occurred at 60 m depth in May 2016. Since the introduction of the BLM-based dissolved copper guideline in 2019, no exceedances have been observed. Total copper concentrations between 2019 and 2023 at QUL-2a were between 0.00051 and 0.00175 mg/L throughout the water column, with an average concentration of 0.0007 mg/L. The average concentration in 2023 was 0.000642 mg/L.

At QUL-120a, there were no observed changes or trends in the water quality. Similar to other Quesnel Lake sites, an increase in total phosphorus was recorded in late 2018 (up to 0.077 mg/L). This may be due to remnants of spawning and debris from the wildfires; the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according to the BC WQG for total phosphorus – nutrients and algae), therefore, total phosphorus remains in compliance with the BC WQG (Figure 4.7). Total and dissolved copper concentrations remain similar to previous years at QUL-120a (Figure 4.9). There was one acute dissolved copper exceedance found at QUL-120a in May 2023. This exceedance occurred at the surface and could be attributed to a number of environmental factors.

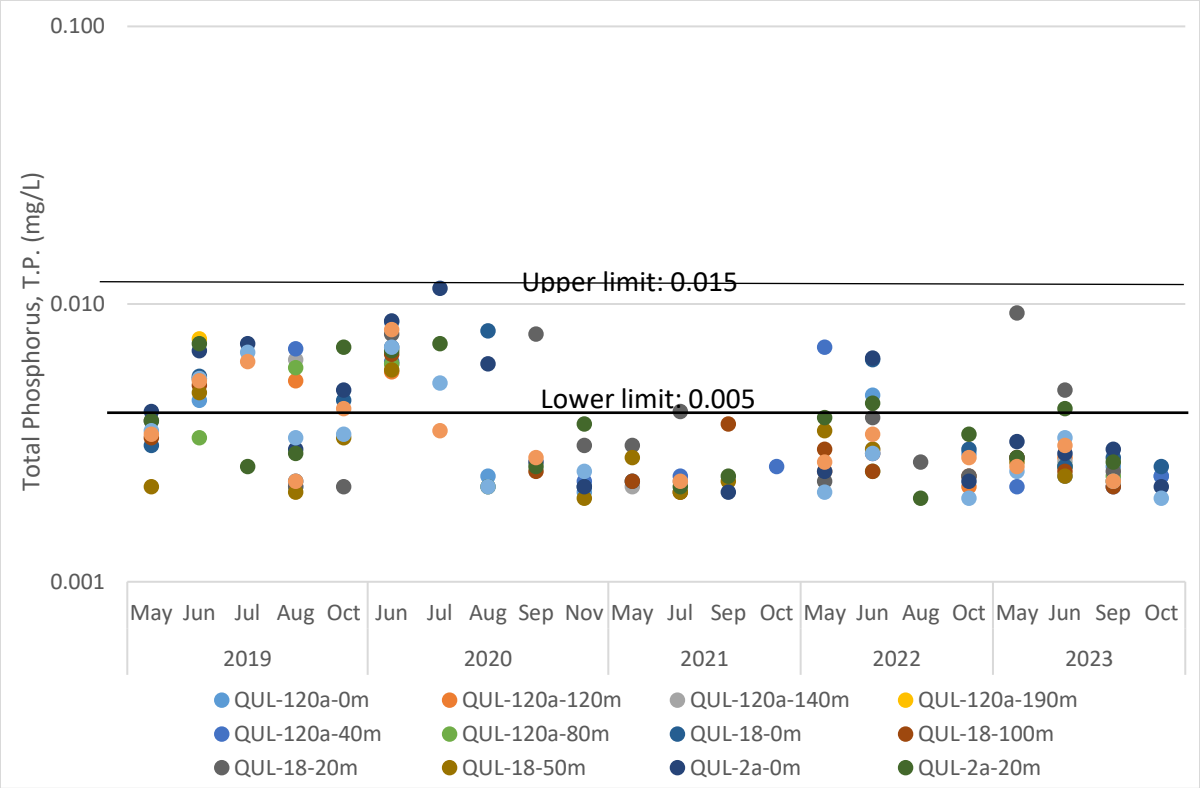


Figure 4.7 Total phosphorus concentrations at QUL-120a, QUL-2a, and QUL-18 from 2019 to 2023

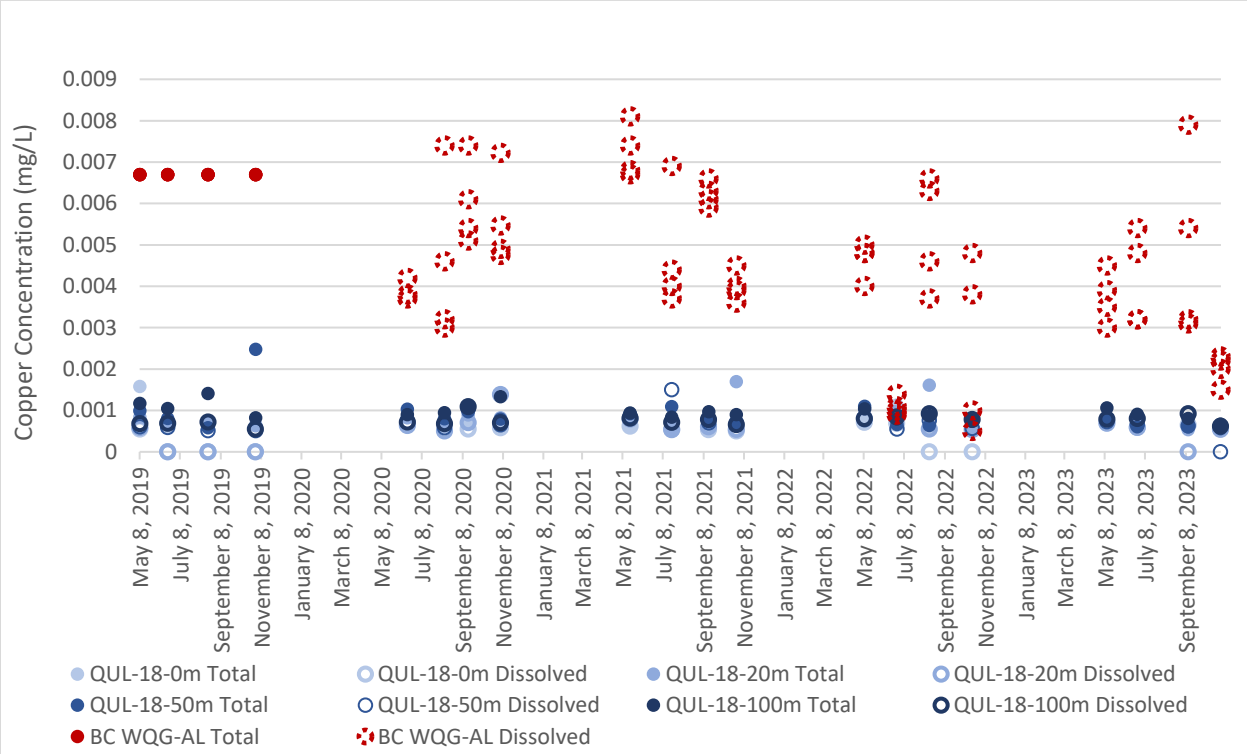


Figure 4.8 Total and dissolved copper results at QUL-18 from 2019 to 2023

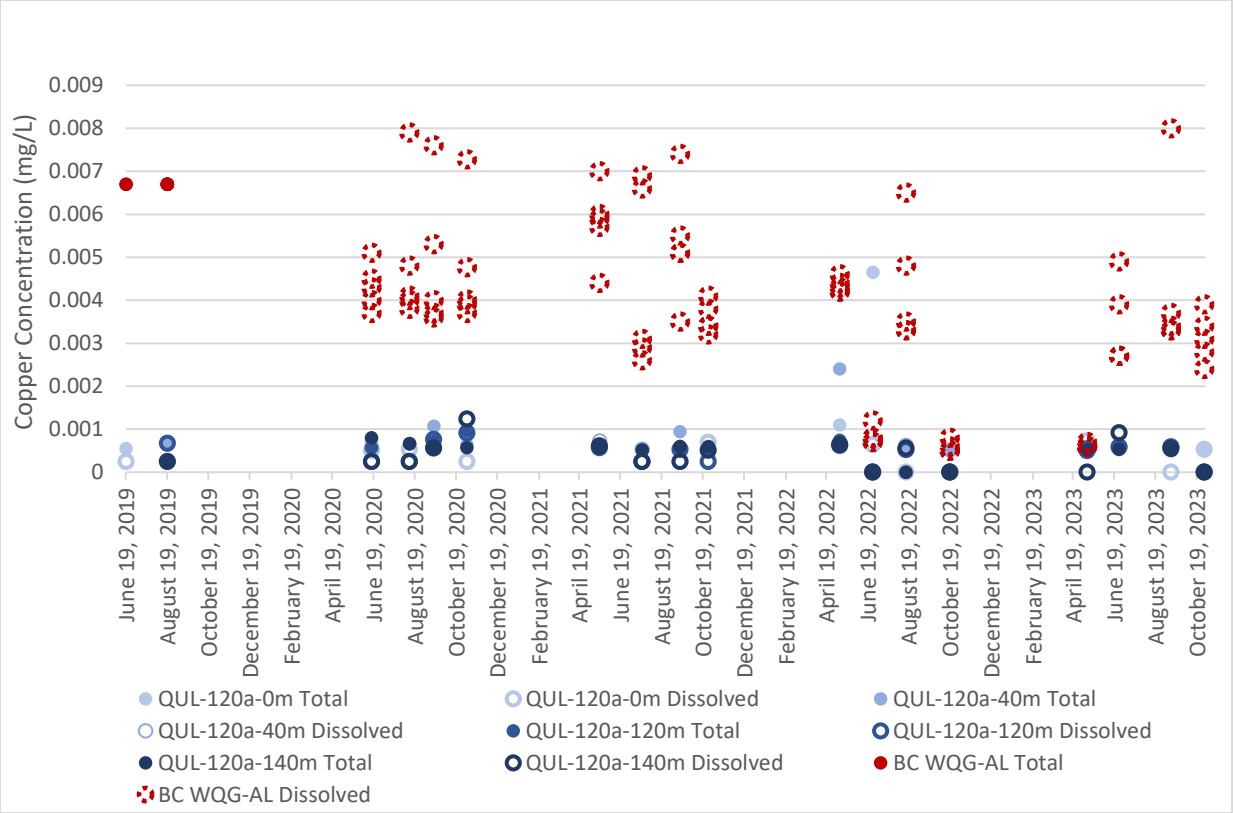


Figure 4.9 Total and dissolved copper results at QUL-120a from 2019 to 2023

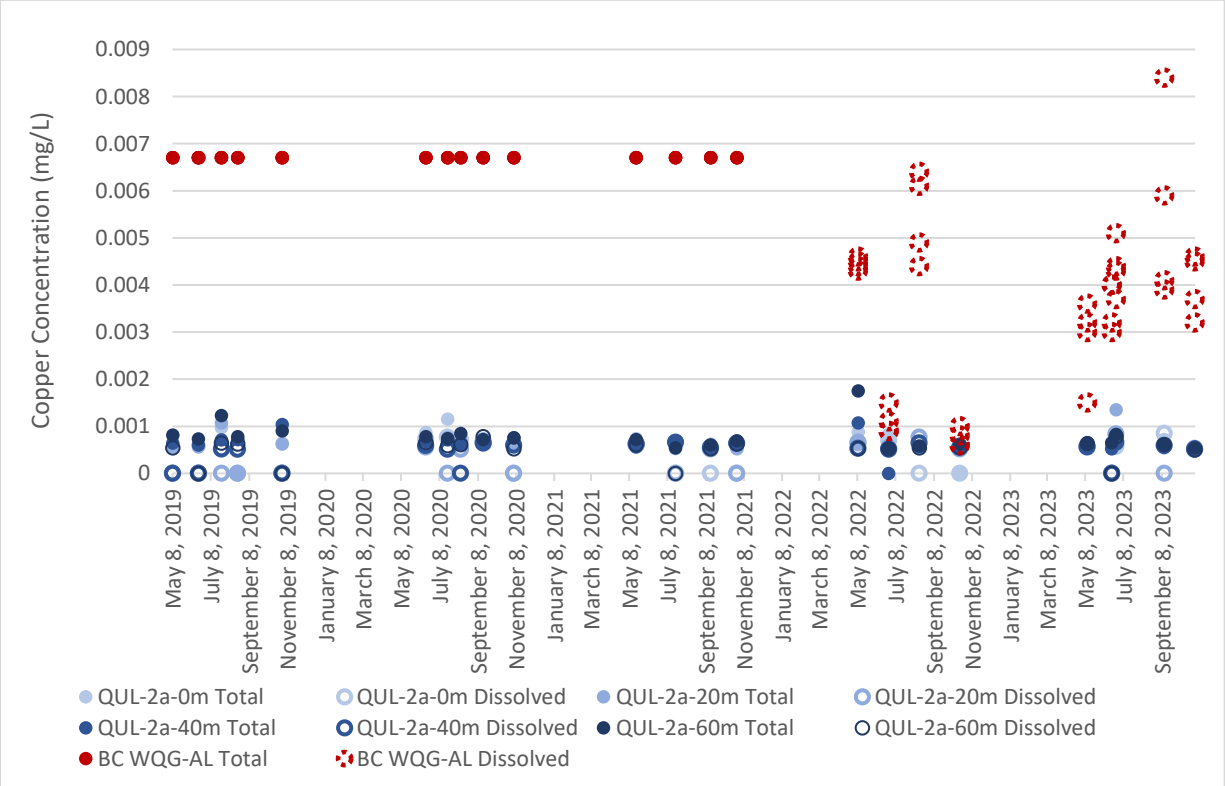


Figure 4.10 Total and dissolved copper concentrations at QUL-2a from 2019 to 2023

4.8 Hydrology

In 2023, hydrological monitoring in Hazeltine Creek was completed at Upper Hazeltine Creek (H1), Lower Hazeltine Creek (H2), and the Polley Lake weir outlet (H4), as required by Section 3.4 of *EMA* Permit 11678 and Section 6.7 in the CEMP. Streamflow was measured manually at these stations during the months of May through October. Flow was controlled by the Polley Lake weir continuously and, thus, was not indicative of the natural flow regime.

The 2023 hydrometric data are provided in ***Appendix L*** including hydrographs, stage-discharge rating curves, stage-pressure relations, goodness of fit statistics, and photographs.

4.8.1 Site H1 - Upper Hazeltine Creek

Ten staff gauge readings and manual flow measurements from the 2022-2023 period were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.72 m^3/s on May 4, 2023. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 8% and a standard error of 12%.

In 2023, pressure transducer data were recorded using a PT2x from April 19 to November 21. The transducer was removed in the mid-fall due to freezing temperatures. Continuous discharge data were removed from the dataset for April 20 and 22 (<6 hour gaps), and for all dates after October 21, due to freezing temperatures and, thus, an elevated potential for ice build-up on the weir crest. A benchmark survey conducted by WaterSmith on July 18 indicated the stilling well and staff gauge had been stable.

The 2023 peak flow period occurred primarily in late April and early May. Discharge receded through May, then remained low through the June-October period. The highest recorded continuous discharge in 2023 was 0.78 m^3/s on May 4.

4.8.2 Site H2 - Lower Hazeltine Creek

Seven staff gauge readings and manual flow measurements from the 2022-2023 period were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.93 m^3/s on June 22, 2022. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 4% and a standard error of 5%.

In 2023, pressure transducer data were recorded using a PT2x from April 19 to November 21. The transducer was removed in the mid-fall due to freezing temperatures. Continuous discharge data were removed from the dataset for all dates after October 21 due to freezing temperatures and, thus, an elevated potential for ice build-up on the weir crest. A benchmark survey conducted by WaterSmith on July 18 indicated the

stilling well and staff gauge had been stable.

The 2023 peak flow period occurred primarily in late April and early May. Discharge receded through May, then remained low through the June-October period. The highest recorded continuous discharge in 2023 was 0.95 m^3/s on May 4.

4.8.3 Site H4 - Polley Lake Weir

Seven staff gauge readings and manual flow measurements from the 2022-2023 period were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.70 m^3/s on May 4, 2023. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 4% and a standard error of 8%.

In 2023, pressure transducer data were recorded using a PT2x from April 19 to November 21. The transducer was removed in the mid-fall due to freezing temperatures. Continuous discharge data were removed from the dataset for all dates after October 21 due to freezing temperatures and, thus, an elevated potential for ice build-up on the weir crest. A benchmark survey conducted by WaterSmith on July 18 indicated the stilling well and staff gauge had been stable.

The 2023 peak flow period occurred primarily in late April and early May. Discharge receded through May, then remained moderate or low through the June-October period. The highest recorded continuous discharge in 2023 was 0.73 m^3/s on May 4.

4.8.4 Hydrology – Mine Site

In 2023, additional hydrological monitoring was completed at sites W1b (Morehead Creek), W4a (North Dump Creek), W5 (Bootjack Creek), W12 (6km Creek), and H3a (Lower Edney Creek), as required by Section 3.4 of *EMA* Permit 11678 and the Section 6.7 in the CEMP. Supplemental monitoring was carried out at the SERDS, the NW Ditch, Junction Zone Ditch, Joe's Creek Pipe, and the East Main and South Toe Drains at the TSF. Refer to ***Appendix B*** for a map of monitoring locations.

The 2023 hydrometric data are provided in ***Appendix L***, including hydrographs, stage-discharge rating curves, stage-pressure relations, and goodness of fit statistics.

4.8.5 Site W1b – Upper Morehead Creek

Five staff gauge readings and manual flow measurements from 2023 were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.48 m^3/s on May 5, 2023. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 5% and a standard error of 5%. No

pressure transducer was installed at the site in 2023. A benchmark survey conducted by WaterSmith on July 19 indicated the staff gauge had been stable.

4.8.6 Site W4a – North Dump Creek

Nineteen staff gauge readings and manual flow measurements from the 2021-2023 period were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.10 m^3/s on May 4, 2023. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 39% and a standard error of 71%. The high uncertainty in the rating curve is associated with imprecision in the bucket flow method for measuring discharge, and with large relative differences in discharge (i.e., measured vs. calculated discharge) under low flow conditions in this very small stream. Velocity based discharge measurements are not feasible at this station. No pressure transducer was installed at the site in 2023. A benchmark survey conducted by WaterSmith on July 18 indicated the staff gauge had been stable.

4.8.7 Site W5 – Bootjack Creek above Hazeltine Creek

Twenty-five staff gauge readings and manual flow measurements from the 2016-2023 period were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.22 m^3/s on May 4, 2023. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 46% and a standard error of 114%. The high uncertainty in the rating curve is associated with imprecision in the velocity method for measuring discharge under low flow conditions in this very small stream. No pressure transducer was installed at the site in 2023. A benchmark survey conducted by WaterSmith on July 18 indicated the staff gauge had been stable.

4.8.8 Site W12 – 6 km Creek at Bootjack Road

Eleven staff gauge readings and manual flow measurements from the 2021-2023 period were utilized for developing an updated stage-discharge rating curve. The highest manually measured discharge used for developing the rating curve was 0.57 m^3/s on May 4, 2023. An assessment of the goodness of fit of the manual discharge measurements to the rating curve yielded a mean absolute difference of 18% and a standard error of 29%. The high uncertainty in the rating curve is associated with imprecision in the velocity method for measuring discharge under low flow conditions in this very small stream. No pressure transducer was installed at the site in 2023. A benchmark survey conducted by WaterSmith on July 19 indicated the staff gauge had been stable.

4.8.9 Site H3a – Lower Edney Creek

Three staff gauge readings and manual flow measurements were obtained in 2023 at the new station that was established on July 17, 2023. All three measurements were acquired under low flow conditions, and were not sufficient for developing a stage-discharge rating curve. The highest manually measured discharge

in 2023 was 7.6 m^3/s on May 4 (combining manual data from the old station and the new station).

In 2023, pressure transducer data were recorded at the old station from April 19 to July 17 using a PT2x. The continuous water level data were removed from this dataset due to instability in the channel cross-section at the old station (discussed above). The continuous temperature data were removed for the May 30 to July 17 period because the old station became dewatered.

Pressure transducer data were recorded at the new station from July 17 to November 1 using a PT2x. The transducer was removed in the mid-fall due to freezing temperatures. Continuous water level data were removed from the dataset for all dates after October 21 due to freezing temperatures and, thus, an elevated potential for ice build-up on the weir crest. Once a rating curve is fully developed for the new station, it will be applied retroactively to the continuous water level data that were acquired. Benchmarks were established by WaterSmith on July 18 for the new station.

4.8.10 Supplemental Sites

Flow monitoring and/or staff gauge measurements were also collected at supplemental sites, including the SERDS, Long Ditch (LD), the NW Ditch, Junction Zone Ditch, Joe's Creek Pipe, South Toe Drain (STD), the East Main (East MTD) and West Toe Drain (West MTD) at the TSF. Results are presented in ***Appendix L***. These flow measurements from site water management system components are primarily used for verifying the site water balance.

4.9 Groundwater Monitoring

4.9.1 Mine Site

Based on the results of this monitoring program, the following conclusions are provided:

- Based on the review of the groundwater elevation on the west side of the mine site, it can be inferred that a groundwater divide between the Springer Pit and Bootjack Lake remains in the area of GW12-2(a,b), GW15-1(a,b) and GW15-2(a,b), as groundwater elevations at these wells remained higher than the surface water elevation in the Springer Pit. This groundwater divide results in groundwater flow both towards the east and west from the groundwater divide.
- Slightly increasing and/or decreasing POI concentration trends at some locations were noted.
- Based on requirements of monitoring/sampling frequency set out in the CEMP (varies dependent on well), no deficiencies were identified. Although select wells were not monitored/sampled, this was a result of the monitoring wells being dry, or containing an insufficient volume of water, which is not considered a permit deficiency. Wells not monitored/sampled included:
    - GW05-01 required quarterly groundwater sampling; however, only two samples were collected in 2023 (January and November). MPMC noted that groundwater beyond the capabilities of the pump were present during the May and September sampling events.
    - GW15-1a and GW15-1b required quarterly groundwater sampling; however, no samples were collected in 2023 due to groundwater being beyond pumping capabilities in GW15-

1a. GW15-1b was dry during each monitoring event.

- Concentrations of dissolved arsenic, dissolved copper, dissolved iron, dissolved zinc, pH, sulphate, ammonia (as N), and fluoride exceed either the applicable BC CSR standards and/or the BC WQGs.

Based on the results of the 2023 annual groundwater monitoring report (***Appendix O***), the following recommendations are provided:

- Continue the groundwater level and quality monitoring program at the mine site. This includes measuring the depth to groundwater at the various on-site monitoring wells as per the requirement of the 2019 CEMP (preferably on the same days during the various required sampling events in 2024).
- Static water levels at GW12-2a, GW12-2b. GW15-1a and GW16-1 should be obtained prior to removing and after replacement of transducers.
- Surface water elevations at Polley Lake, Bootjack Lake, and the TSF should be conducted within a similar time period as the groundwater elevations are collected to inform the groundwater contour figure.
- Springer Pit surface water elevations should be conducted throughout the full extent of the year to better inform seasonal and annual trends.
- Several samples gathered at the mine site surpassed the hardness, dissolved organic carbon (DOC), and pH-dependent copper standards concerning the chronic BC WQGs for aquatic life. However, a significant portion of these samples fell below the laboratory's detection limit. WSP advises MPMC engage with the laboratory and consider reducing the detection limit in 2024 to accurately evaluate the copper concentrations detected.

4.9.2 Hazeltine Creek

Following the TSF embankment breach an investigation of the groundwater quality in the Hazeltine Creek riparian area was conducted in 2015 to confirm the results of the geochemistry assessment conducted by SRK Consulting Inc. (SRK, 2015a). A second groundwater assessment was completed in 2016 in support of the risk assessments, and in 2017, a third assessment was completed by Golder. The 2017 assessment recommended one more year of sampling which was completed in 2018. The Golder groundwater review included a review of the 2016 to 2018 groundwater results but did not make recommendations and no trends were found. In 2022 additional groundwater monitoring was conducted to collect samples that were representative of freshet conditions from monitoring wells that are representative of background conditions as well as those within tailings impacted areas along Hazeltine Creek (WSP, 2024). No monitoring or sampling of groundwater wells in the vicinity of Hazeltine Creek was conducted in 2023 (***Appendix G***).

4.10 Contact Water Chemistry

Contact water sampling and analysis was conducted as outlined in Section 3.2 of *EMA* Permit 11678 (***Appendix A***). Contact water sampling is also outlined as per the 2019 CEMP (***Appendix A***). As described in the *CEMP*,

monitoring and changes of many contact water sites fall under *Mines Act* Permit M-200. Refer to Section 4.3 of this report for a discussion of field sampling equipment and methodology.

This section contains data for the permitted effluent site prefixed with the letter "E". Sample site and frequency are summarized in Table 4.20. Sample locations are shown in ***Appendix B***. As per the CEMP (***Appendix A***), legacy sites such as East and West Main Toe Drains, Main Embankment Seepage Collection Pond (MESCP) (E4) and Central Collection Sump (CCS) (E18) that no longer discharge into Hazeltine or Edney Creek have been removed. E11a (Springer Pit Supernatant) was a source of contact and discharge water under the 2016 *CEMP* and was sampled accordingly until the LTWMP discharge permit was approved in 2017 and dredging of the Springer Pit in January 2018, which made that location inaccessible. From 2018 to 2021, the Springer Pit was used for in-situ treatment and storage of water prior to transfer to the WTP and discharge. In 2022, dewatering of the Springer Pit commenced and mining resumed. Three dewatering wells were installed in the pit to facilitate pumping of interstitial water to a booster station, where it was sampled (E11c). The dewatering wells were used for a period in 2023. Once they were no longer required, the Springer Pit sump was once again developed and sampled (E11). Note that E19- Perimeter Embankment Till Borrow Pit (PETBP) was previously included as a surface contact water site, but in this report is discussed under Discharge System and Monitoring (Section 4.12).

E1a, previously E1, is the water chemistry sampling location for the TSF supernatant. The site, E1, was established in 1997 to monitor changes as it was the primary source of discharge water before the TSF embankment breach. No water was stored, or samples collected at the site after August 4, 2014. The TSF was operational once again in November 2016 and sampling resumed. Upon receipt of the 2017 *EMA* Permit 11678 amendment, the site name was changed to E1a to reflect the water chemistry post-TSF embankment failure.

Table 4.20 2023 Sampling events at contact water quality sites

Site	Site Identifier (EMS No.)	Frequency	
		Permit Requirement	Actual
E1a[(a)]	E225309	Monthly/Quarterly[(b)]	46

[(a)] Deposition of tailings into TSF is ongoing; TSF supernatant being used as reclaim water as of November 8, 2016. E1 has been replaced by E1a.
[(b)] Required monthly by the 2016 *CEMP* and quarterly by the 2018 and 2019 *CEMPs*.

Samples were submitted to ALS for analysis of:

- Physical parameters (pH, turbidity, TSS, total dissolved solids, and hardness);
- Anions and nutrients (alkalinity, sulphate, total nitrogen, nitrate, nitrite, ammonia, chloride, fluoride, total phosphorus, dissolved phosphorus, and ortho-phosphate);
- Organics (dissolved organic carbon); and
- Total and dissolved metals (metals suite as listed in the *CEMP*, ***Appendix A***).

Thirteen parameters of interest (POIs) were identified in the Chemical Characterization of the Proposed

Effluent for Discharge to Hazeltine Creek (Knight Piésold Ltd. 2009) based on site geochemistry and historical characteristics, as well as existing and projected waste and water management practices. To monitor changes in the effluent surface water quality, in the subsequent sections, these POIs were reviewed for each water quality site over time:

- **Physical Parameters**: Hardness, TSS;
- **Anions**: Chloride, sulphate;
- **Nutrients**: Nitrate, total phosphorus; and
- **Metals**: Dissolved aluminum, total cadmium, total and dissolved copper, total molybdenum, total and dissolved iron, total selenium.

Results for POI concentrations for the effluent sites are noted and included in tabular format in ***Appendix F***. Note that results below method detection limit (MDL) are represented as half (0.5x) the MDL in statistical calculations and graphs.

Water quality data, including summary statistics (number, minimum, maximum, mean, standard deviations, and method detection limit) are provided in ***Appendix F***.

4.10.1 Site E1a – Tailings Supernatant (E225309)

Water quality at this location was sampled 46 times in 2023. Graphs and results for a subset of parameters only for the post-breach years, are provided in ***Appendix F***. Notable observations in POI results are compared with data over the last five years (pre-breach: 2012-2014, and post-breach: 2019-2023):

Hardness: A general increase in concentration occurred after tailings deposition started post-breach in 2016. However, hardness (Expressed as CaCO3) concentrations are continuing to trend downward, stabilizing at around 400 mg/L, which is similar to levels seen prior to the breach during active mining. The 2014 mean hardness was 450.7 mg/L, and the mean hardness between 2019 and 2023 was 408.6 mg/L. The mean in 2023 was 412.9 mg/L, and the overall post-breach mean is 420.7 mg/L. The maximal hardness value measured from 2019 to 2023 was 717 mg/L, measured in October 2023.

TSS: Concentrations have remained stable post and pre-breach. The 2019 to 2023 mean was 6.18 mg/L, the 2023 mean is 7.53 mg/L and the overall post-breach mean is 7.45 mg/L. The maximum TSS post-breach is similar to pre-breach with concentrations of 46.9 mg/L and 54.9 mg/L, respectively.

Chloride: Concentrations remained similar pre- and post-breach during the period between 2008 and 2019, at around 20-35 mg/L. These concentrations fell markedly in early 2020, with concentrations between 3 and 17 mg/L. In 2023, chloride concentrations have increased but are still within the pre- and post breach range of 20-35 mg/L. The 2019 to 2023 mean value was 13.2 mg/L. The maximum measured value in between 2019 and 2023 was 30.7, recorded in February 2019.

Sulphate: Concentrations have remained stable post and pre-breach. The 2019 to 2023 mean was 477.9 mg/L. The overall post-breach mean of 493 mg/L is similar to, but lower than, the pre-breach mean of 542 mg/L. Since the resumption of TSF usage in 2016 until late 2023, sulphate concentrations have ranged from 400 to around 600 mg/L. In October, November and December 2023, sulphate concentrations increased to the 700-800 mg/L range. The maximum sulphate post-breach is 868 mg/L measured in December 2023.

Nitrate: Concentrations initially increased post-breach but have decreased markedly between 2017 and present, possibly due to the mine being in Care and Maintenance for much of that time. The maximum nitrate post-breach was 10.4 mg/L in February 2018 and steadily decreased through the end of 2021 to its lowest concentration of 0.0556 mg/L (pre-breach minimum was 4.93 mg/L). The 2019 to 2023 mean was 1.93 mg/L.

Total phosphorus: Concentrations have remained stable post and pre-breach. The 2019 to 2023 mean was 0.020 mg/L, while that in 2023 alone was similar, at 0.0158 mg/L. Two anomalously high recordings were sampled in November and December of 2021, at 0.087 and 0.118 mg/L, possibly a result of operational ramp-up and the resumption of blasting occurring at this time.

Dissolved aluminum: Concentrations have remained stable post and pre-breach (note that there are no data from February 2013 to 2014). The 2019 to 2023 mean was 0.0319 mg/L and the 2023 mean was 0.0302 mg/L. This is very similar to the overall post-breach mean 0.0302 mg/L (with the removal of outliers from March 2018 and April 2023). The pre-breach mean was 0.0215 mg/L. Concentrations of this compound are stable and do not display any particular trend.

Total cadmium: Concentrations have remained stable post and pre-breach as the vast majority of results were below detection limit. Between 2019 and 2023, only 21 of 142 samples were above detection limit; one in 2019, one in 2020, 11 in 2021, seven in 2022 and one in 2023. The increase in non-BDL samples in 2021 and 2022 could be perceived as a temporally increasing trend but is likely an artefact of a switch to weekly sampling; as opposed to monthly sampling as was performed in prior to March 2021.

Total copper: Concentrations have increased post-breach and were stabilizing in 2017 and 2018. The 2017 and 2018 annual means were stable at 0.019 mg/L. However, copper concentrations have varied widely between 2019 and 2023. In 2019 the annual mean was 0.028 mg/L, in 2020 the annual mean was 0.357 mg/L, in 2021 the annual mean was 0.193 mg/L, in 2022 the annual mean was 0.123 mg/L and in 2023 the annual mean was 0.122 mg/L. The overall post-breach mean of 0.109 mg/L is considerably higher than the pre-breach mean of 0.010 mg/L. In the period from 2019 to 2023, copper values were stable at approximately 0.02 mg/L from January to June 2019, then rose steadily to a peak value of 0.316 in May of 2020, before falling back to values around 0.08 in August to October 2020. Values subsequently spiked again, to 0.577 mg/L in November 2020, before falling steadily to approximately 0.1 mg/L in the summer of 2021. Copper values increased to 0.2 mg/L from November 2021 to February 2022 when they decreased to 0.1 mg/L. From March to December 2022, copper values decreased to 0.001 mg/L. Copper values remained

at similar concentrations throughout 2023 with a few slight increases experienced throughout the year. At the end of the five-year period, copper values in the TSF are again trending downward. These swings in copper concentration are likely to due to heap leachate being disposed of in the TSF on a periodic basis from 2019 to 2023. The recent decreasing trend in copper is likely the result of the resumption of milling and mining activities at the site in the fall of 2021.

Total molybdenum: Concentrations initially increased post-breach and have subsequently fallen and stabilized in 2020-2022. The 2023 annual mean was 0.206 mg/L compared to the 2022, 2021, 2020, 2019 and 2018 annual means of 0.160 mg/L, 0.140 mg/L, 0.158 mg/L 0.242 mg/L and 0.226 mg/L, respectively. The overall post-breach mean was 0.178 mg/L. The pre-breach mean was 0.184 mg/L. The maximum total molybdenum in 2023 was 0.246 mg/L and the maximum between 2019 and 2023 was 0.290 mg/L

Total iron: Concentrations have remained stable post and pre-breach. The 2019 to 2023 mean concentration of iron was 0.186 mg/L, and the mean in 2023 was 0.204 mg/L. These values can be compared to the 2022 annual mean of 0.190 mg/L, 2021 annual mean of 0.171 mg/L, 2020 annual mean of 0.188 mg/L, 2019 annual mean of 0.101 mg/L and 2018 annual mean of 0.184 mg/L. The overall post-breach mean is 0.189 mg/L and the pre-breach mean is 0.272 mg/L. The maximum total iron in between 2019 and 2023 is 1.19 mg/L.

Dissolved iron: Concentrations have remained below detection limits in pre- and post-breach results, except for three instances. One in December 2021, with a result of 0.047 mg/L, one in April 2023, with a result of 0.163 mg/L and another in May 2023 with a result of 0.036 mg/L.

Total selenium: Concentrations have remained approximately stable post and pre-breach. The 2019 to 2023 mean value was 0.026 mg/L, and the 2023 annual mean was 0.0274 mg/L. There appears to be a steady downward trend in selenium concentrations between January 2019 and 2021. Selenium concentrations measured in late-2021 were among the lowest since the breach, with values consistently below 0.02 mg/L from September to December 2021. Total selenium concentrations remained around 0.02 mg/L in 2022 and 2023.

Only three parameters have shown a relatively continuous increasing trend in concentration after post-breach deposition of tailings commenced. Total molybdenum and chloride have shown a general increasing trend, with total copper almost doubling in concentrations in post-breach and increasing significantly in 2020. Total copper has shown a decreasing trend in 2021-2023. Monthly monitoring was scheduled for E1a under the 2016 CEMP. Under the 2019 CEMP, the frequency has moved to quarterly, and tailings water is discharged through the WTP via the PETBP.

4.10.2 Long-Term Predictions

Kinetic rate information is an important component of drainage chemistry prediction that provides a

measure of the dynamic performance or "reactivity" of the material being tested. Stephen Day, MSc, PGeo, of SRK has been retained to interpret results of the ongoing kinetic-testing program and recommend additional testing, if required. SRK provided a report titled *Metal Leaching/ Acid Rock Drainage Characterization and Monitoring Program- 2023 Annual Report* is included in ***Appendix Q***. Additionally, SRK completed a report describing the derivation and use of the source terms (SRK, 2016) for the *TAR* submitted to ENV for the long-term water management application (Golder, 2016b).

The most recent data from kinetic testing from 2023 (***Appendix Q***) indicates that Pond Zone test water is increasing towards neutral pH. It is recommended this test be ceased based on positive results. Waste rock column tests appeared very stable and indicated low levels of weathering. Termination of this test is also recommended. It was recommended that humidity cell tests containing grey tailings released during the dam breach, and magnetite sand column tests continue. In addition, as NEZ Seep 1 is not representative of seepage from the NEZ Dump, it was recommended that an additional seep (NEZ Seep 3 was selected by MPMC Environmental personnel) be monitored quarterly. These recommendations can be found in full in ***Appendix Q***.

4.10.3 Heap Leach Research

In 2006, Mount Polley applied for an amendment to the *Mines Act* M-200 Permit allowing for the construction of a Heap Leach Pad and Copper Recovery facility. The amendment was granted on March 29, 2007. The *Mines Act* M-200 Permit requires that all monitoring data from the facility be included in this report.

In 2014, Mount Polley participated in a research project with Kemetco Research who has been developing a sulphur oxidation bioreactor system for potential use in generating sulphuric acid for copper oxide heap leaching. The heap leach at Mount Polley has been decommissioned until the research is complete. Three batch tests were started at Kemetco Research, but the project has been postponed since the TSF embankment breach. No samples were collected in 2023.

During Care and Maintenance, leachate is pumped from the facility into the mill for lime treatment. Lime is added to raise the pH to 8.2 to allow the dissolved copper to precipitate out of the solution. Lime treatment is a common practice during the operations phase as well. The leachate is then sent to the TSF once treated. Leachate is currently pumped to the concentrator building to supplement process water and ultimately reports to the TSF with tailings slurry.

Table 4.21 Heap leach sump level in 2023

Month	Heap Leach Sump Level (ft)
January 2023	13.275
February 2023	15.519
March 2023	16.785
April 2023	18.100
May 2023	19.267

June 2023	13.606
July 2023	16.606
August 2023	18.019
September 2023	13.450
October 2023	15.166
November 2023	7.607
December 2023	10.974

4.10.4 Sulphur Pile

Approximately 23,000 t of sulphur were acquired by MPMC from 2006-2008 to facilitate the production of sulphuric acid at the Heap Leach Pad. In 2014, elevated copper concentrations were discovered in the LD and, through an extensive investigation, traced back to NEZ Seep 1 and 2. Further investigations identified the sulphur pile as being a source of sulphuric acid which has leached into the underlying wast e rock (Litke, 2019). The rock has neutralized the acid, but it has resulted in elevated metal concentrations in the seepage. Research is ongoing into the geochemical characteristics of the affected rock. To prevent ongoing leaching, the sulphur pile was moved to the LCRS in October 2018. A sump was constructed at the base of the NEZ waste rock pile to collect the affected NEZ seeps. To isolate the seepage, dedicated sumps and pipelines were constructed to prevent the affected waters from reporting to the LD. Seepage water from NEZ Seeps 1 and 2 now report to the mill to supplement the process water supply. Once used in the concentrate processing the water reports to the TSF. Monitoring of the affected NEZ seeps will continue as part of the Source Control optimizations in *EMA* Permit 11678 Section 2.8.3.

4.11 Seepage Water Chemistry

An important component in determining and monitoring long-term chemical stability of drainage from the pits and waste rock dumps is water quality monitoring. Locations monitored by MPMC (in addition to sampling required under the *Mines Act* Permit M-200 and *EMA* Permit 11678 [refer to the CEMP in ***Appendix A***]), sampling periods, and sampling frequencies are provided in Table 4.22.

These water collection facilities and drainage monitoring locations are shown in ***Appendix B***. MPMC continued the bi-annual seep survey program of all rock waste dumps on site in 2023, with representative seeps being monitored monthly or quarterly, however numerous seeps stop flowing during dry periods. Seep monitoring locations are shown in ***Appendix B***. Note that when field parameters of adjacent seeps are consistent, typically only the seep with larger flow is sampled. Results are reported in ***Appendix F***. Collection of this data are used in long-term water quality predictions.

Table 4.22 Site drainage water quality monitoring locations, and sampling periods and frequencies

Sample Location	Drainage Area	Sampling Period	2016 *CEMP* Sampling Frequency	2018 *CEMP* Sampling Frequency	2019 *CEMP* Sampling Frequency
Cariboo Pit Sump (E8)	-	1997 – current	Bi-annually[1]	Bi-annually[1]	Bi-annually[1]
Wight Pit (E10)	-	2006 – current	Bi-annually	Bi-annually	Bi-annually
Pond Zone Pit Sump (E12)	-	2010 – 2012	N/A	N/A	N/A
Springer Pit Sump (E11)	-	2011 – current	Monthly[1]	Bi-annually[1]	Bi-annually[1]
Boundary Pit	-	2012 – current	Bi-annually	Bi-annually	Bi-annually[1]
Joe's Creek Pipe (JCP)	NBD Seep	2010 – current	Monthly	Quarterly	Quarterly
Long Ditch	East RDS, NEZ Dump, SERDS, Wight Pit dewatering	2008 – current	Quarterly	Quarterly	Quarterly
SERDS Ditch	SERDS, West Ditch, MDC Sump	2012 – current	Quarterly	Quarterly	Quarterly
NW Sump (E13)	Temporary NW PAG Stockpile, NW Ditch	2012 – current	Quarterly	Quarterly	Quarterly
Mine Drainage Creek Sump (E14)	Upper Mine Drainage Creek, West Ditch	2013 – current	Quarterly	Quarterly	Quarterly
Bootjack Creek Culvert Sump (E15)	TSF Access Road, Upper Bootjack Creek	2013 – current	Quarterly	Quarterly	Quarterly
9km Sump (E17)	Temporary NW PAG Stockpile, Junction Zone Ditch	2014 – current	Quarterly	Quarterly	Quarterly
TSF Supernatant (E1a)	Tailings slurry, seepage collection ponds	1997 – 2014, 2016 – current	Monthly[2]	Quarterly[2]	Quarterly[2]
MESCP (E4)	MTD, STD, Main Embankment foundation drains	2001 – current	Quarterly	Quarterly	Quarterly
PESCP (E7)	Long Ditch, SERDS Ditch, PTD	2001 – 2014	N/A	N/A	N/A
Central Collection Sump (E18)	Long Ditch, SERDS, Ditch, PTD, MESCP, South Embankment Seepage Collection Pond, TSF (as of 2016)	2014 – current	Quarterly	Quarterly	Quarterly
East/West Main Toe Drains (MTDs)	TSF Main Embankment toe drains	1998 – current	Quarterly	Quarterly	Quarterly
Perimeter Toe Drain (PTD)	TSF Perimeter Embankment toe drain	2009 – 2014	N/A	N/A	N/A
South Toe Drain (STD)	TSF South Embankment toe drain	2011 – current	Quarterly	Quarterly	Quarterly

[1] When pit is not storing water from other sources on site

[2] When barge in TSF is supplying reclaim water to mill; started sampling November 2016

No obvious trends in the water quality at the drainage location sampling sites have been observed. This is consistent with SRK ore characterization and geochemical source term reports (SRK 2015b; 2016; 2022; 2023).

4.12 Discharge System and Monitoring

The WTP is a Veolia ACTIFLO® system, which was commissioned in October 2015. Discharge began on December 1, 2015, and continues to present. MPMC commissioned an interim rental Veolia ACTIFLO® mobile WTP to increase discharge throughput and assist with management of onsite water inventory. Commissioning of the mobile WTP began on March 16, 2022, by Veolia automation and process technicians and was completed on April 1, 2022. The mobile WTP began discharging to Quesnel Lake on April 9, 2022 and ceased on May 10, 2023. The HAD-3 sample results from April 12, 2022 to May 10, 2023 represent the combined effluent from both plants. To properly represent end-of-pipe conditions, the sample port was located downstream from the wye where effluent from both plants was mixed. The total water discharged in 2023 was 4,439,062 m^3. The ADP (***Appendix I***) was prepared and submitted to ENV on July 30, 2018, and was approved on September 6, 2018. The ADP has been reviewed annually since that time, most recently in January 2023. It is likely that the ADP will be updated in 2024 to reflect the outcome of the currently ongoing permitting process, and the Numeric Performance Metric condition included in the most recent amendment to Permit 11678 (December 1, 2022).

4.12.1 Discharge System

Based on site water management objectives, site contact water can be conveyed to multiple locations around site to either discharge treated water via the WTP into the pipeline or store water as needed. Discharging treated water is often a priority for water management, as MPMC has a year-over-year positive water balance. Site contact water reports to the gravity-driven sections of the West Ditch or Long Ditch, which both ultimately flow to the CCS. Water in the CCS flows to the PETBP which is the source of the WTP influent. Pumping infrastructure also exists at the CCS and the PETBP such that it can be directed to the TSF. Water from the TSF is primarily pumped to the mill via the Booster Station to meet process requirements such as fire suppression, diverted to the Wight Pit for temporary water storage or be diverted to the CCS to increase the influent flow in the WTP. Storage of water in the TSF or pits can be used for:

- Process Plant milling requirements;
- Maintaining pond volume in the TSF to meet Quantified Performance Objectives
- In-situ treatment and particle clarification/ settling;
- Pit storage as contingency for large water events (freshet) or failures in the water management systems (power or equipment failure).

4.12.1.1 Treatment Works and Source Control Optimization

MPMC is required to assess and optimise the existing treatment process and works on a regular basis under Section 2.11 of *EMA* Permit 11678. MPMC undertakes ongoing maintenance, monitoring and improvements of water management systems and source control measures across the Mount Polley Mine site. This is a well-established part of operations at the Mine.

Numeric Performance Metric

As outlined in Section 2.11.2 (c) of Permit 11678, the NPM annual average of total copper is based on a 52-week rolling average, calculated using the average of 52 grab samples collected at HAD-3 when the WTP is discharging.

In 2023, the WTP samples achieved the NPM target 98% of the time, in 51 of 52 samples. This represents an improvement over 2022 when the NPM was achieved 71% of the time, 2021 when the NPM was achieved 43% of the time, which was an improvement over 2020, when the NPM was achieved 23% of the time. The NPM annual average of total copper was 0.00937 mg/L on December 21, 2023 and was trending down.

This year-over-year improvement in reaching the NPM target is a result of improved WTP optimization with the addition of the second ACTIFLO® WTP, and the establishment of pre-treatment processes developed as part of the water treatment train preceding the WTP; in-situ pit lake treatment and improved source control. Further discussion can be found in Progress Reports #12 and #13, included in ***Appendix W***.

NEZ Seeps Pipeline

The NEZ seeps have been identified as a source of high copper during flush events such as freshet and heavy rains and have contributed to permit exceedances in the effluent discharge in regard to copper levels on multiple occasions. A contributing factor used to be electrical power loss to the pump at the NEZ seeps. Previously, the NEZ seep water was pumped to the Wight Pit and upon power failure the pump stopped operating and NEZ seep water migrated to the Long Ditch and subsequently to the WTP influent pond (Perimeter Embankment Till Borrow Pond). Upgrades were made to this system in early-2021, and NEZ seep water now reports to Wight Pit on gravity drainage. The NEZ seep water has been reporting to the Wight Pit rockfill since April 2021.

4.12.1.2 WTP Operations

During treatment, the feed water of the WTP undergoes suspended solids removal using Veolia ACTIFLO® water treatment technology prior to discharge. The WTP doses the raw water with coagulant to a tank where a polymer is injected to create floc particles. Microsand is added to ballast the flocculants, which move on to another tank that allows them to swell and mature. The water flows to the next stage, which uses lamella to clarify the water and promote fast settling of the microsand ballasted sludge. The clarified water is discharged, and the sludge is separated from the microsand, which is reused. An on-line turbidity meter measures the turbidity every ten seconds and calculates the TSS using a calibrated factor based on a site-specific correlation between turbidity and TSS. If an on-line TSS measurement is above 11 mg/L for 10 minutes, or over 12 mg/L instantaneously, an alarm sounds to alert the operator and the WTP automatically goes into recirculation mode and ceases discharge.

In 2021, due to supply chain issues, a change was made to the polymer used in the WTP. Prior to July 2021,

the product "A-2501 polyclear" was used for treatment. From this point onward, the analogue product "Magnafloc 338" was used instead. Toxicity testing on this new polymer product was performed by Golder and Nautilus Environmental prior to its adoption at the WTP, finding that the product is not acutely toxic at the tested concentrations, which exceed those used in water treatment (Golder 2021).

In 2023, there were periodic times when the WTP was shut down or put into recirculation mode due to various issues described in Table 4.23. More shutdowns occurred in 2023 relative to past years because of limited water onsite for discharge. The annual average discharge rate was 0.207 m^3/sec, or 17,895 m^3/day and daily maximum discharge rates ranged from 0 m^3/day to 31,811 m^3/day. According to the *EMA* Permit 11678, the authorized annual average discharge rate is 29,000 m^3/day and a daily maximum discharge rate of 52,000 m^3/day. Daily maximum rates are provided in ***Appendix H***.

Table 4.23 Instances and reasons for discharge stoppages in 2023

Date	WTP	Discharge Action	Reason
07-Jan-23	Permanent	Ceased	Malfunction of the HMI
08-Jan-23	Permanent	Resumed normal operation	Repair of the HMI
15-Jan-23	Mobile	Ceased	Low water levels in the PETBP
17-Jan-23	Permanent	Ceased	Maintenance
18-Jan-23	Permanent	Resumed normal operation	Maintenance complete
19-Jan-23	Mobile	Resumed normal operation	Suitable water levels in the PETBP
09-Feb-23	Mobile	Ceased	Reduced throughout as a result of high turbidity in the influent
11-Feb-23	Mobile	Resumed normal operation	Reduced turbidity
14-Feb-23	Mobile	Ceased	Low water levels in the PETBP
18-Feb-23	Mobile	Resumed normal operation	Suitable water levels in the PETBP
22-Feb-23	Mobile	Ceased	No night shift personnel to operate the plant followed by a mechanical failure of the polymer mixing system
24-Feb-23	Mobile	Resumed normal operation	Repair of the polymer mixing system
21-Mar-23	Mobile	Ceased	High turbidity in the influent
24-Mar-23	Mobile	Resumed normal operation	Reduced turbidity

Date	WTP	Discharge Action	Reason
02-Apr-23	Mobile	Ceased	Low water levels in the PETBP
08-Apr-23	Mobile	Resumed normal operation	Suitable water levels in the PETBP
11-Apr-23	Permanent	Ceased	Site wide power outage
11-Apr-23	Mobile	Ceased	Site wide power outage followed by a lack of polymer reagent
14-Apr-23	Mobile	Resumed normal operation	Polymer reagent replenished
22-Apr-23	Permanent	Ceased	Maintenance and TSS sensor replacement
23-Apr-23	Mobile	Ceased	Maintenance and TSS sensor replacement
24-Apr-23	Permanent/ Mobile	Resumed normal operation	Maintenance complete
05-May-23	Permanent	Ceased	Unknown
05-May-23	Mobile	Ceased	Sludge line pump fault alarm
06-May-23	Permanent	Ceased	Power outage
06-May-23	Mobile	Ceased	Power outage
07-May-23	Mobile	Resumed normal operation	Power resumed
09-May-23	Permanent	Ceased	Scheduled cleaning
10-May-23	Mobile	Ceased	Decommissioning and removal from site
14-May-23	Permanent	Ceased	Scheduled cleaning
22-May-23	Permanent	Ceased	Scheduled cleaning
28-May-23	Permanent	Ceased	Scheduled cleaning and sensor replacement
02-Jun-23	Permanent	Ceased	Low water levels in the PETBP
05-Jun-23	Permanent	Resumed normal operation	Suitable water levels in the PETBP
07-Jun-23	Permanent	Ceased	Low water levels in the PETBP
09-Jun-23	Permanent	Resumed normal operation	Suitable water levels in the PETBP
19-Jun-23	Permanent	Recirculation	Total phosphorus exceedance at QUL-58
22-Jun-23	Permanent	Resumed normal operation	QUL-58 and HAD-3 sample results below the permit limits
25-Jun-23	Permanent	Ceased	Scheduled maintenance
02-Jul-23	Permanent	Ceased	Scheduled maintenance
03-Jul-23	Permanent	Ceased	Cleaning
11-Jul-23	Permanent	Ceased	Site wide power outage
13-Jul-23	Permanent	Resumed normal	Power resumed

Date	WTP	Discharge Action	Reason
		operation	
17-Jul-23	Permanent	Ceased	Calibration and to change pumps
19-Jul-23	Permanent	Ceased	Low water levels in the PETBP and no day shift operator
21-Jul-23	Permanent	Resumed normal operation	Suitable water levels in the PETBP
30-Jul-23	Permanent	Ceased	Calibration and maintenance
03-Aug-23	Permanent	Ceased	Unknown
09-Aug-23	Permanent	Ceased	Power outage
22-Aug-23	Permanent	Ceased	Unknown
04-Sep-23	Permanent	Ceased	Cleaning
10-Sep-23	Permanent	Ceased	Scheduled maintenance
14-Sep-23	Permanent	Ceased	Low water levels in the PETBP
15-Sep-23	Permanent	Resumed normal operation	Suitable water levels in the PETBP
15-Sep-23	Permanent	Ceased	Polymer pump fault
19-Sep-23	Permanent	Resumed normal operation	Polymer pump fault repaired
19-Sep-23	Permanent	Ceased	Low water levels in the PETBP and no operator
21-Sep-23	Permanent	Resumed normal operation	Suitable water levels in the PETBP
21-Sep-23	Permanent	Ceased	To facilitate the transfer of water from the Wight Pit to the TSF
15-Oct-23	Permanent	Recirculation	To allow for sample collection
15-Oct-23	Permanent	Ceased	Sample collected
16-Oct-23	Permanent	Recirculation	To allow for sample collection
16-Oct-23	Permanent	Ceased	Sample collected
19-Oct-23	Permanent	Recirculation	To allow for sample collection
19-Oct-23	Permanent	Ceased	Sample collected
24-Oct-23	Permanent	Recirculation	To allow for sample collection
24-Oct-23	Permanent	Ceased	Sample collected
30-Oct-23	Permanent	Resumed normal operation	In conjunction with Quesnel Lake sampling
31-Oct-23	Permanent	Ceased	Low water levels in the PETBP
24-Nov-23	Permanent	Ceased	Low water levels in the PETBP
21-Dec-23	Permanent	Recirculation	To allow for sample collection
21-Dec-23	Permanent	Ceased	Sample collected

4.12.1.3 Water Treatment plant Costs

As required by M-200 Permit Section C.6(b)(ii); the total annual costs associated with the Veolia WTP is $1,383,564.94. The breakdown is located in Table 4.24 below.

Table 4.24 – 2023 WTP costs

	2023 Costs		Comments
Power (Electric)	$	154,916.62	
Labor	$	488,608.43	4 operators
Polymer	$	73,664.64	
Flocculant	$	66,482.69	
Clarifier Sand	$	86,534.83	
Rental	$	495,348.72	Temporary rental unit from Veolia and removed from site May 2023
Trucking / Freight	$	18,009.01	
Total per annum	$	1,383,564.94	

4.12.1.4 Outfall and Pipeline Commissioning and Inspection

As required by Section 3.5 of *EMA* Permit 11678 (***Appendix A***), routine visual inspection of the outfall into Quesnel Lake, along with the pipeline, must be conducted. MPMC conducts routine monthly inspections and maintains records of these routine inspections.

A comprehensive inspection and testing program of the outfall must be conducted, and an underwater inspection of the diffuser every 5 years. A comprehensive inspection of the diffusers was conducted on September 5, 2018 and November 2, 2023, and next needs to occur by the end of 2028. The inspection at the Quesnel Lake diffusers has been conducted annually from 2015 to 2023 by a QP. The 2023 detailed inspection occurred on September 18.

The annual pipeline inspection report found the pipeline to be in generally good condition, but with some recommendations for improved performance or preventative maintenance.

4.12.2 Discharge Monitoring

This section provides an assessment of the compliance with the amended *EMA* Permit 11678 limits with respect to the data collected at the WTP discharge end-of-pipe site (HAD-3) and at the edge of the initial dilution zone (IDZ) site (QUL-58) in Quesnel Lake. These data were collected in accordance with the approved CEMP (***Appendix A***) and the ADP (***Appendix I***). This compliance is primarily based on the permit conditions stipulated in the *EMA* Permit 11678 dated April 7, 2017, October 2, 2018, February 1, 2020, December 31, 2020 and December 1, 2022. This section addresses the *EMA* Permit 11678 Section 4.2 requirements:

- *(h) a summary of any non-compliance with the permit and other incidents that may have led to*

impacts to the receiving environment;

- *(m) a comparison of monitoring data with water quality guidelines, predictions, and targets.*

This discharge requires monitoring and reporting under MDMER to Environment and Climate Change Canada. These activities occurred in 2023 as outlined in the MDMER. Table 4.25 outlines the number of sampling events at each site in 2023 (a map of these locations is provided in ***Appendix B***).

Table 4.25 Sampling events in 2023 at discharge monitoring sites

Site Name	Site Identifier (EMS No.)	Full Sample Suite Frequency 2016 *CEMP*	Full Sample Suite Frequency 2018 *CEMP*	Full Sample Suite Frequency 2019 *CEMP*	2023 Sampling Events
E19	E305050	Weekly [(a)]	Weekly [(a)]	Weekly [(a)]	52
HAD-3	E304230	Weekly [(a)]	Weekly [(a)]	Weekly [(a)]	52
QUL-57	E304874	Weekly/Monthly [(b)]	4 times per year	4 times per year	5
QUL-58	E304876	Weekly/Monthly [(c)]	4 times per year	4 times per year	9
QUL-59	E304875	Weekly/Monthly [(b)]	4 times per year	4 times per year	5
QUL-2a	E303020	Monthly	4 times per year	4 times per year	5[(f)]
QUL-18	E303019	Monthly	4 times per year	4 times per year	4
QUL-120a	E303022	Seasonally	Bi-annually	4 times per year[(e)]	4
QUR-11	E306454	Monthly	Removed [(d)]	Removed	1[(g)]

[(a)] When discharging.

[(b)] Limnological profiles occur weekly for 5 weeks during spring and fall turnover; monthly all other times of the year.

[(c)] Samples and limnological profiles occur weekly for 5 weeks during spring and fall turnover; monthly all other times of the year.

[(d)] Effective as of on November 9, 2018 with the acceptance of the 2018 *CEMP*.

[(e)] Stipulated in CEMP Approval letter issued in February 2021.

[(f)] Additional sampling was conducted at QUL-2a on June 19, 2023 because of a total phosphorus exceedance at QUL-58 on June 6, 2023.

[(g)] Supplemental sampling conducted.

4.12.2.1 Permit Compliance

The *EMA* Permit 11678 requires the following regulatory compliance be met:

1. Effluent chemistry data from end-of-pipe at HAD-3 (WTP outflow) must be equivalent to or less than specified values in Section 1.2.5 of the Permit (***Appendix A***). In addition, the trigger and response plan required under Section 2.8 (c) must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake specified in Section 1.2.5 of the Permit.
2. Effluent must meet the acute toxicity requirement of less than 50% mortality in 100% effluent in

96-hour rainbow trout (*Oncorhynchus mykiss*) and *48-hour Daphnia magna* toxicity tests (*EMA* Permit 11678 Section 3.3 and Section 4.5). These results are presented in Section 4.12.3.

4.12.2.2 Influent Chemistry – E19

In accordance with the CEMP, E19 (WTP feed) water samples were collected weekly and concurrently with HAD-3 samples during effluent discharge. E19 represents the water entering (influent) into the WTP; the influent is pumped from the PETBP which collects the contact water from the Mount Polley Mine site. The influent results are compared with the effluent results to gauge treatment efficiency. The WTP monitors the influent flow rate, turbidity, and temperature.

4.12.2.3 Effluent Chemistry – HAD-03

To meet the requirements of the *EMA* Permit 11678 and MDMER requirements, water chemistry samples were collected weekly at the end-of-pipe site at the WTP outlet (site HAD-3) when discharging. This requirement was met by the collection of 52 samples at HAD-3 in 2023. Note that the mobile WTP was commissioned in April 2022, and samples collected after April 12 included treated water from both the permanent and mobile plants. The mobile WTP was decommissioned on May 10, 2023, and the samples collected thereafter included treated water from the permanent plant only. There were periodic times when there was no discharge; see Table 4.23 for details. All parameters were met or were below the concentration limits in Section 1.2.5 of the Permit except for a few instances (Section 4.12.2.4).

The permit limit for total copper according to Section 1.2.5 of the *EMA* Permit 11678 is 0.033 mg/L. There were no sampling events in 2023 where total copper exceeded the permit limit (Section 4.12.2.4). The maximum result for total copper at HAD-3 in 2023 was 0.0193 mg/L on April 25, 2023; the annual average was 0.00959 mg/L. Results for the influent and effluent are shown below in Figure 4.11.

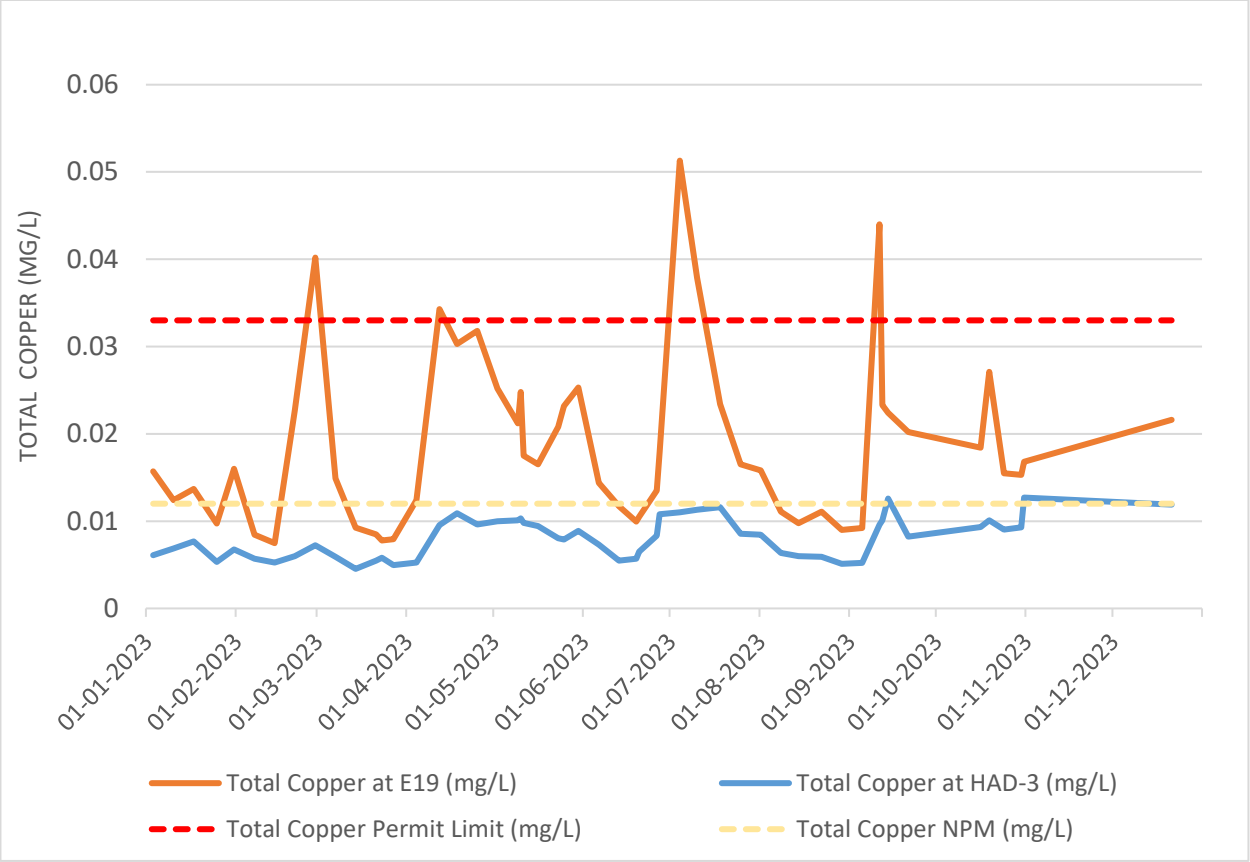


Figure 4.11 Total copper concentrations in influent (E19) and effluent (HAD-03) in 2023

There were no exceedances of TSS in 2023. The maximum total TSS limit must be equivalent to or less than 30 mg/L with a monthly average equivalent to or less than 15 mg/L. Results for influent and effluent are shown in Figure 4.12.

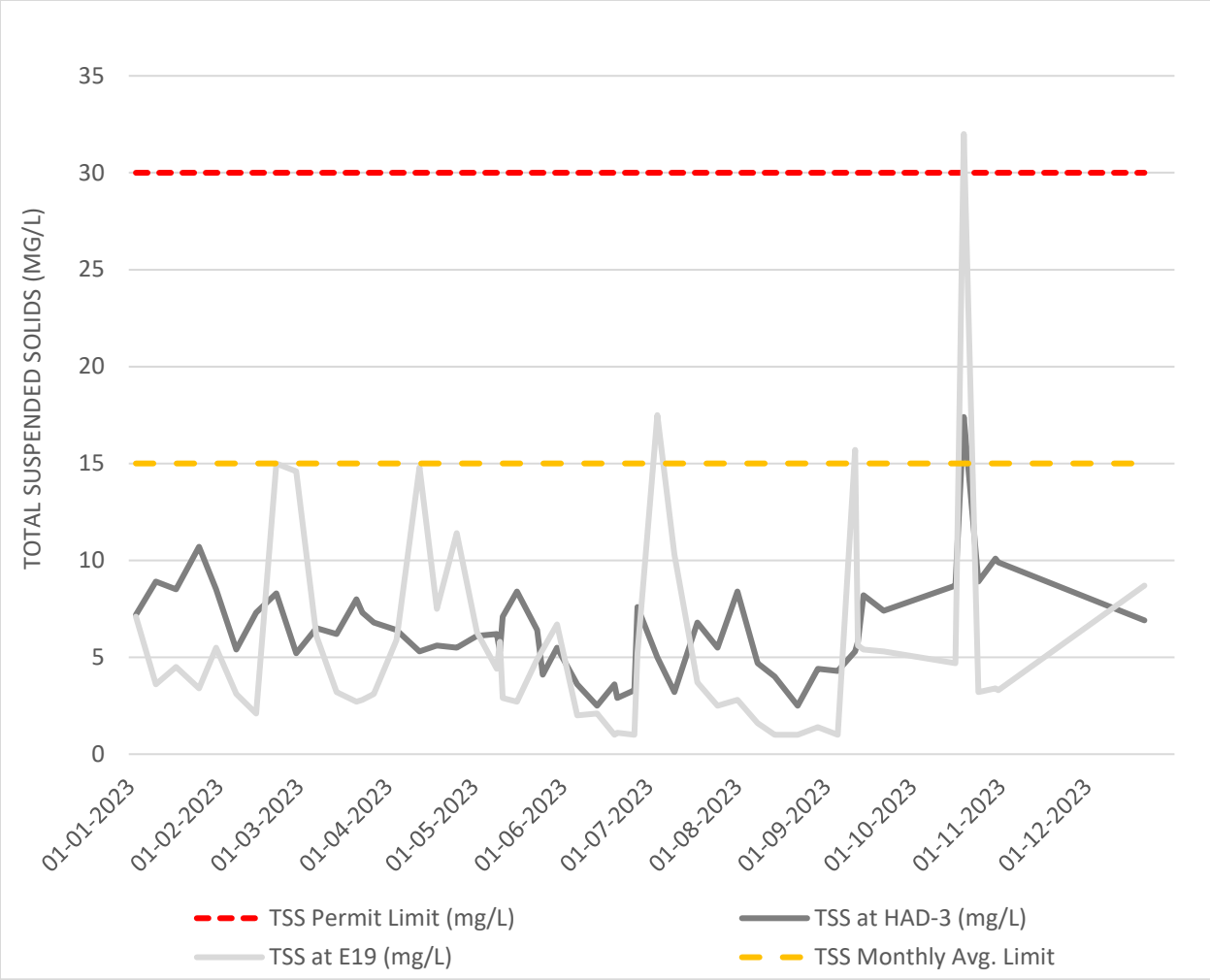


Figure 4.12 Total suspended solids concentrations in influent (E19) and effluent (HAD-03) in 2023

4.12.2.4 HAD-03 Permit Limit Exceedance Events

In 2023, there were no instances where results from HAD-3 samples were above the permit limits. However, there were two instances where the sulphate results from HAD-3 were within 80% of the permit limit prompting a Level 1 Trigger per MPMC's ADP.

Sulphate

Permit 11678 ADP Level 1 Triggers

- Sulphate was within 80% of the Permit 11678 limit in the August 1 and 8, 2023 HAD-3 samples. Upon receipt of the August 1, 2023 HAD-3 sample results on August 9, 2023, priority analysis of the August 8, 2023 HAD-3 sample was requested from the laboratory. The August 8, 2023 HAD-3 sample results were received and reviewed on August 10, 2023, and yielded a sulphate concentration which is within 80% of the Permit 11678 limit. At this time, a Level 1 Trigger Response

per MPMC's Annual Discharge Plan was initiated. The WTP throughput was reduced by 20% and the Ministry of Environment and Climate Change Strategy and Public Liaison Committee were notified of the Level 1 Trigger. An additional sample was collected at HAD-3 on August 14, 2023 and priority analysis requested from the laboratory. Results were received on August 16, 2023 and the sulphate concentration was below 80% of the Permit 11678 limit. In spite of the reduction in sulphate observed on August 16, 2023, management at Mount Polley Mine maintained the WTP throughput at 80% for the remainder of August.

- Sulphate concentrations were within 80% of the permit limit in the October 16 and October 19, 2023 HAD-3 samples; however, the WTP was in recirculation mode and not discharging. All parameters in the October 24, 2023 sample were below the permit limits and 80% thresholds and as such the WTP resumed normal discharge on October 30, 2023.

4.12.2.5 Plume Dispersion Model

Tetra Tech Inc. (Tetra Tech) was retained by MPMC to assess the long-term and far-field fate of effluent discharged from the diffusers in Quesnel Lake. Tetra Tech applied the existing hydrodynamic model of Quesnel Lake to simulate effluent concentrations throughout the lake as a result of the discharge. After the simulations were completed, MPMC requested advice with respect to the likely position of the effluent plume by month, to support monitoring in the field (Tetra Tech, 2016).

In 2017, Tetra Tech was retained to determine the relationship between the volumetric dilution by a dilution test and dilution calculated from observed specific conductivity from limnological profiles in Quesnel Lake. The results improved the confidence of the estimated dilution factor applied to the profiles. Tetra Tech ran the near-field model to discuss the plume width and dilution and concluded that there was only a 3% chance of detecting the plume at the IDZ. In addition, the field models suggest the plume concentrations are generally less than 1% at the edge of the IDZ (MPMC, 2018a). In 2018 and 2019, Tetra Tech was requested to conduct analyses of the limnological profiles and data from Quesnel Lake and provide conclusions and recommendations in order to better understand the lake circulation, and the interaction of the lake with the effluent discharge. Tetra Tech's 2018 and 2019 reviews identified some of the specific conductivity spikes observed at shallower depths stemmed from surrounding creek sources. Other observations noted that the effluent's density during certain periods of the year may be greater than originally modeled. This may be contributing to a gradual increase of dilute effluent under the thermocline and is expected to flush out during the spring and fall overturns (Tetra Tech, 2018; Tetra Tech, 2019).

To support an Environmental Effects Monitoring study, as required by MDMER, MPMC retained DWB to perform additional effluent plume dilution modelling in 2020-2021. Using the CORMIX software, this model utilized effluent volume and water quality data from 2015-2021, as well as lake profiles in Quesnel Lake, to model both discharge and receiving environment conditions as accurately as possible (***Appendix N***). This model was validated successfully using conductivity data from Quesnel Lake sites near the discharge point. Three different seasonal scenarios are modelled, to represent different limnological profiles in the lake with differing depth and strength of stratification. The finding was that under the modelled scenarios, effluent

concentrations rarely exceed 1% volumetric concentration beyond 100m from the discharge point. The modelled concentrations in excess of this threshold were between 1.01% and 1.09%. The highest concentrations beyond 100 m distance are found when the thermocline in Quesnel Lake is deep in the profile, trapping effluent in a narrow layer near the bottom of the lake.

4.12.2.6 Receiving Environment Chemistry – Quesnel Lake

The receiving environment for the water discharge plan is Quesnel Lake and further downstream Quesnel River. In accordance with the CEMP, (see Table 4.25), monitoring at the edge of the IDZ, site QUL-58, in Quesnel Lake occurred at least 4 times per year, with intensive sampling during overturn periods, when treated effluent was discharging.

In situ limnological profiles, Secchi measurement (see Section 4.15.2) and grab samples were collected for water chemistry at the inferred centerline of the effluent plume (when discharging) at the compliance site QUL-58 (when weather conditions were safe). A reasonable amount of effort was spent looking for the discharge plume by observing any increases in specific conductivity. If the plume was detected, grab samples were taken at surface (QUL-58-S), 5 m above the plume (QUL-58-AP), middle of plume (QUL-58-MP), 5m below the plume (QUL-58-BP), and at bottom (QUL-58-B), with additional profiling at supplemental stations, QUL-57 and QUL-59, located at the edge of the IDZ, 25 m on either side of QUL-58 (plume centerline). If the plume could not be detected, then sampling occurred at the default QUL-58 site at the surface (QUL-58-S), bottom (QUL-58-B), mid-depth (QUL-58-MID) (if no thermocline) or 1 m above (QUL-58-AT) and below (QUL-58-BT) the thermocline (if present).

In 2023, there were 9 sampling events at edge of the IDZ (QUL-58). The plume may have been detected during the field investigations along the IDZ on May 17, May 25, May 30, June 6, June 27, September 14 and October 31, 2023 when the WTP was discharging treated effluent.

Table 4.26 Effluent discharge condition during IDZ sampling at QUL-58

Date sampled	Treated effluent condition
10-May-23	Discharging
17-May-23	Discharging
25-May-23	Discharging
30-May-23	Discharging
06-Jun-23	Discharging
19-Jun-23	Not discharging
27-Jun-23	Discharging
14-Sep-23	Discharging
31-Oct-23	Discharging

Permit Limits at the edge of Quesnel Lake IDZ

The amended *EMA* Permit 11678 includes compliance limits at the edge of the Quesnel Lake IDZ. There was one instance where total phosphorus exceeded the concentration limit in Section 1.2.5 of the Permit (***Appendix H***).

Permit 11678 ADP Level 3 Trigger

On June 6, 2023, MPMC Environmental Department staff collected routine water samples at the discharge point of the WTP into Quesnel Lake, identified as QUL-58, and referenced as E304876. This data was reviewed by MPMC staff on June 19, 2023 at approximately 9:00am. At this time, it was confirmed that the sample results for total phosphorus at QUL-58-AP (above plume) and QUL-58-MP (mid plume) were 0.0378 mg/L and 0.0126 mg/L, respectively, both of which exceeded the EMA Permit 11678 edge of Quesnel Lake Initial Dilution Zone (IDZ) limit of 0.010 mg/L. MPMC staff notified the Director and site management, and put the WTP into recirculation mode immediately. These elevated total phosphorus concentrations initiated a Level 3 Trigger: Exceedance of Receiving Environment Trigger Levels- Monitoring and Response as per the MPMC 2022 Annual Discharge Plan (ADP), Section 5.1.2.1.

Samples were collected at QUL-58 and the background site QUL-2a (E303020) on June 19, 2023 and priority service was requested from the lab. A sample was also collected from the WTP before it was put into recirculation on June 19, 2023. The results from the samples collected on June 19, 2023 were received by email on June 21, 2023 and reviewed by MPMC. The sample results indicated total phosphorus concentrations of 0.0036 mg/L at QUL-58-AP and 0.0029 mg/L at QUL-58-MP, which are below the permit limit of 0.010 mg/L. The samples collected at QUL-2a, also yielded total phosphorus concentrations less than the permit limit. Modelled QUL-58 data was compared to the receiving environment trigger levels with no exceedances identified. The Director was notified via email on June 21, 2023 and the WTP resumed normal operation in accordance with the ADP on June 22, 2023.

In the *Permit 11678- Total Phosphorus Exceedance at QUL-58, February 26, 2019- Follow Up Report* previously submitted to ENV, it was noted that investigations from 2016 and 2017 revealed that the elevated phosphorus in Quesnel Lake was the result of an equipment cleaning agent containing phosphate. The cleaning agent was replaced with a non-phosphate cleaner. It was also noted in the February 26, 2019 follow up report that the elevated total phosphorus concentrations in Quesnel Lake in 2018 were suspected to have been from Hazeltine and Edney Creeks.

Total phosphorus data from 2019 to 2023 supports the belief that the higher concentrations of phosphorus in Quesnel Lake are coming from Hazeltine and Edney Creeks. Four of the 6 total phosphorus concentrations recorded at EDC-01 (Edney Creek outlet) in 2019 and 2020 were above the permit limit with an average of 0.0177 mg/L. The outlet of Edney Creek changed from EDC-01 to EDC-01a in 2021. Seventeen of the 29 total phosphorus concentrations recorded at EDC-01a in 2021-2023 were above the permit limit with an average of 0.0136 mg/L. The outlet of Hazeltine Creek to Quesnel Lake changed from HAC-12 to HAC-01c

in 2018 and the WTP was no longer discharging into Hazeltine Creek. The maximum concentration of total phosphorus at HAC-01c in 2019 and 2020 was 0.041 mg/L in May 2020 and the average was 0.018 mg/L. The outlet of Hazeltine Creek to Quesnel Lake changed from HAC-01c to HAC-08 in 2021. Eighteen of the 28 total phosphorus concentrations recorded at HAC-08 in 2021-2023 were above the permit limit with an average of 0.0146 mg/L. The maximum concentration of total phosphorus at HAC-08 was 0.0435 mg/L in August 2022.

Historical total phosphorus data from Horsefly River from 2016 to 2021 also indicates that higher concentrations of phosphorus in Quesnel Lake are the result of tributary inputs to the lake. Ten of the 12 total phosphorus concentrations recorded at HOR-2 (Horsefly River outlet) were above the permit limit with an average of 0.025 mg/L.

HAD-3 total phosphorus concentrations fluctuated above and below 0.010 mg/L from 2018 to 2023 with an overall maximum of 0.0305 mg/L in May 2023, and averages of 0.0093 mg/L in 2019, 0.0104 mg/L in 2020, 0.0069 mg/L in 2021, 0.010 mg/L in 2022 and 0.015 mg/L in 2023.

HAD-3 results were above 0.010 mg/L when total phosphorus at the IDZ was above the permit limit, except at the time that the July 9 and 25, 2019, June 9, 2020 and June 6, 2023 Quesnel Lake samples were collected.

MPMC will continue to monitor total phosphorus concentrations of the effluent at the discharge point and at the Quesnel Lake IDZ.

ADP – Trigger Response Plan

The ADP was submitted to ENV on July 30, 2018 as required per Section 2.7 of *EMA* Permit 11678 and accepted on September 6, 2018 (***Appendix I***). The permit was amended on October 2, 2018 to reflect the changes brought forth with the updated ADP (***Appendix A***). The major requirement of the ADP was to include a TRP, which outlines the steps in the event that the water quality results are within 80% of the limits at HAD-3 and/or exceed permit limits at HAD-3 and/or QUL-58. The ADP was reviewed in 2019, 2020, 2021, 2022 and 2023; however, updates were not made and therefore, the plans were not resubmitted to ENV.

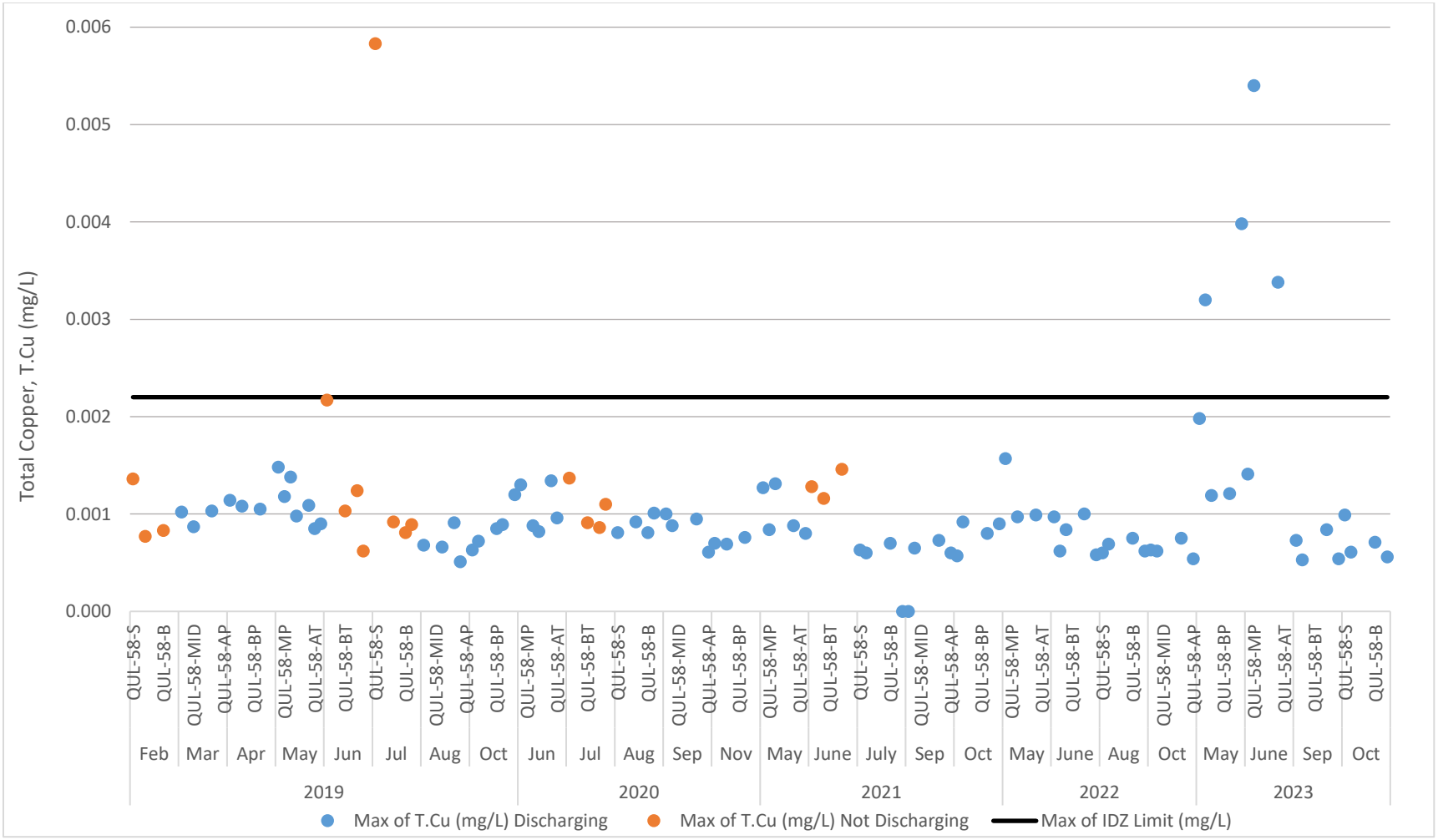


Figure 4.13 Total copper results at the IDZ (QUL-58) from 2019-2023

In addition, the ADP contains an analysis of the remaining capacity of Quesnel Lake using the dispersion model and background concentrations (Figure 4.14). MPMC maintains this tool to check if permit limits and water quality guidelines are being met at the IDZ without monitoring on the lake during unsafe conditions (***Appendix I***).

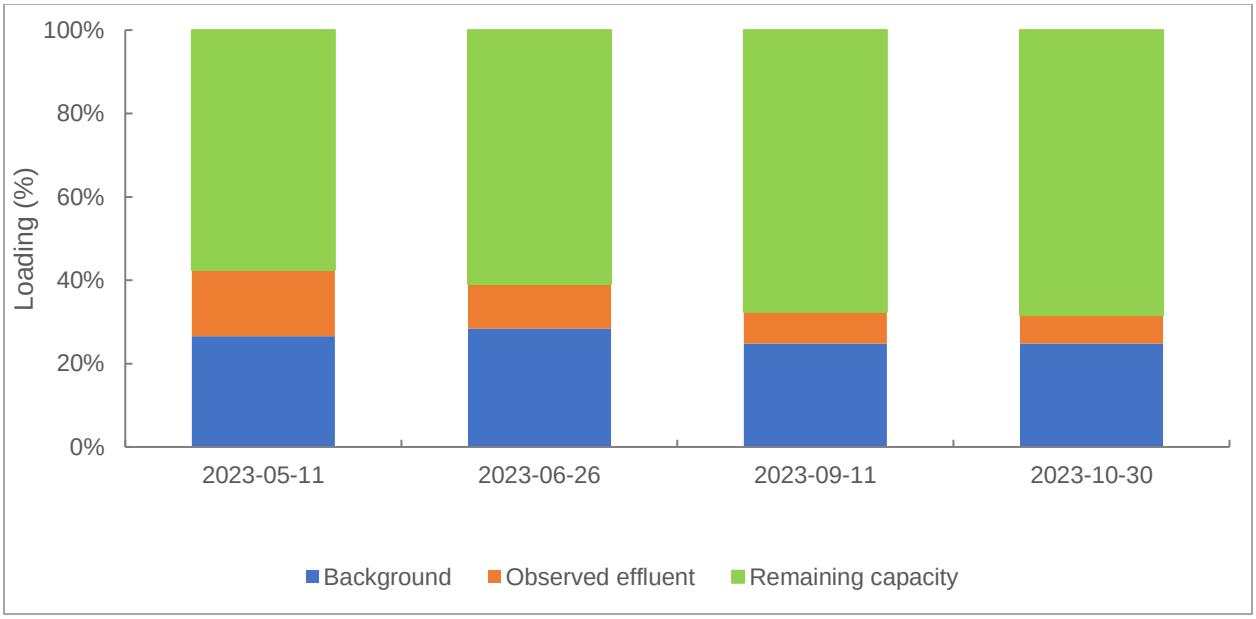


Figure 4.14 Calculated assimilative capacity of total copper on a daily basis for 2023

Further to the ADP, Golder completed two memos: 2023 Verification of Near-Field Modelling in Quesnel Lake and a Comparison of Water Quality Model Predictions and 2023 Measured Concentrations-Mount Polley Mine (***Appendix J***). These documents provided updates to the previous near field dispersion modelling validation and water quality models at the discharge with 2023 data. The first memo involved calculating the dilution factors in Quesnel Lake during periods of discharge and no discharge from the WTP. The calculated dilution factors ranged from 40 to above 100 when the discharge was active. These results confirm the conservative model predictions (***Appendix O***). The second memo compares the 2023 data with predictions described in the Water Management Plan Report (Golder, 2020a). The comparison indicates the measured concentrations are below model predictions and *EMA* Permit 11678 limits with some exceptions (***Appendix O***).

BC WQG at the edge of Quesnel Lake IDZ

Short-term maximum and long-term average BC WQG for aquatic life concentrations were compared with the water chemistry data from QUL-58. These limits are not considered compliance limits as MPMC is regulated with *EMA* Permit 11678 requirements at the IDZ. In 2023, dissolved copper (Figure 4.15) and other parameters for the acute BC WQGs for aquatic life were met, including total phosphorus (Figure 4.17).

Note that samples were taken four times per year at QUL-58, with annual intensive sampling during spring turnover (dependent on weather conditions and safety). As summarized in Table 4.25, spring intensive sampling occurred during May-June 2023. This 5-samples-in-30-days event can be compared to chronic WQGs (Figure 4.15). The data in Figure 4.15 are depth-integrated average concentrations, which is necessary because sample depths are not consistent, varying depending on thermocline presence, whether the plume is encountered, and how deep the plume is. Note that all concentrations from QUL-58 were below the short-term maximum BC WQG for total copper in 2023 except for QUL-58-S, QUL-58-MID and QUL-58-B on May 11, 2023. All concentrations from QUL-58 were above the long-term average BC WQG for total copper except for samples collected on September 14 and October 31, 2023, and the sample collected from above the plume on June 27, 2023. Figure 4.16 shows acute guidelines and measured concentrations data for 2023.

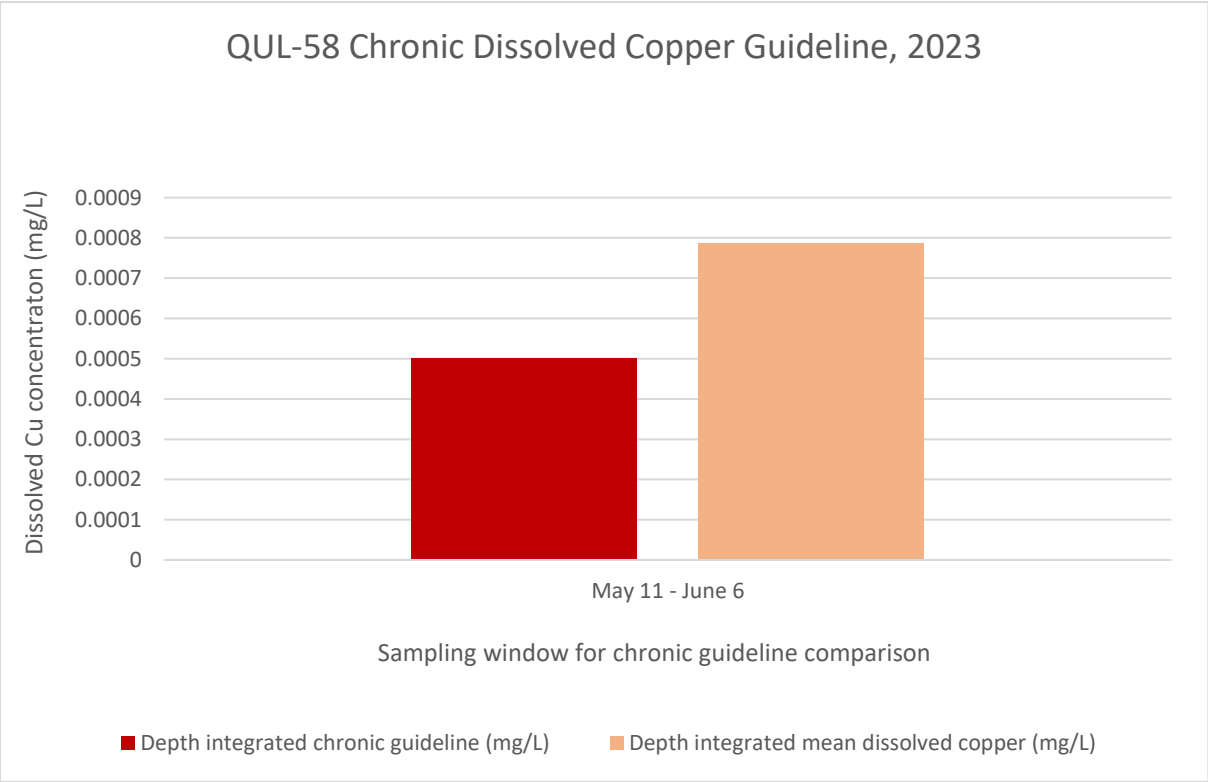


Figure 4.15 Chronic average BC WQG for aquatic life dissolved copper concentrations at QUL-58 in 2023

When comparing QUL-58 copper values to the acute guidelines, as shown in Figure 4.16, dissolved copper levels from 2023 are always below the applicable WQG values with the exception of the surface sample collected on June 27, 2023. Depth integration is not performed for comparison with acute WQGs because spatial and temporal averaging is not required, and individual point values can be compared to the WQG.

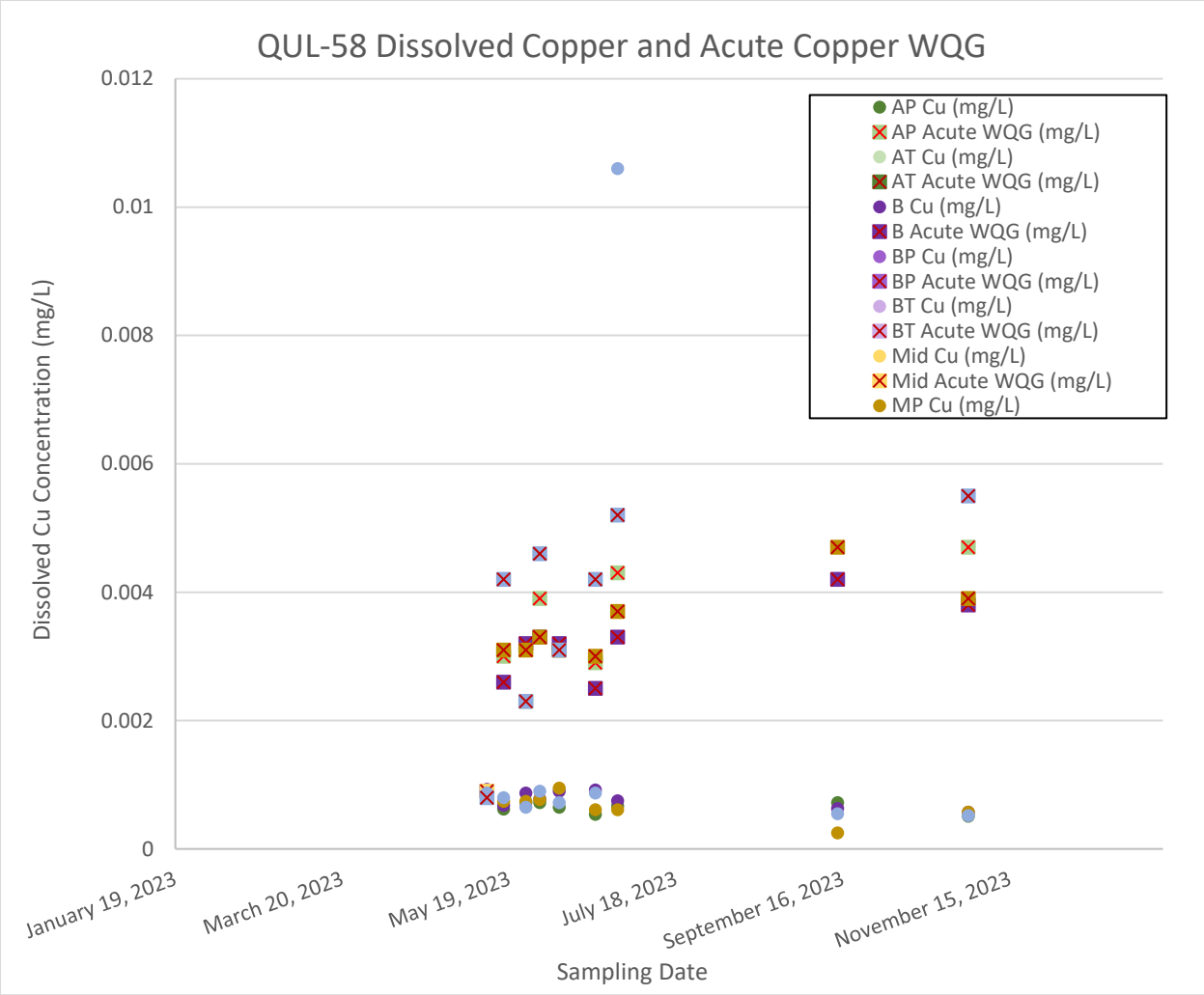


Figure 4.16 Acute BC WQG for aquatic life dissolved copper concentrations at QUL-58 in 2023

Historically, total phosphorus in Quesnel Lake and at QUL-58 has often failed to meet the BC WQG for aquatic life in lakes (where salmonids are the predominant fish species). The BC WQG limit is a range from 0.0050 mg/L to 0.0150 mg/L (ENV, 2021) and in 2023, the monthly mean results range from 0.00282 mg/L to 0.00709 mg/L at QUL-58 (including data from the surface, above plume or above thermocline sites [representing the WQG qualifiers]). While it has met the BC WQG during all 2023 sampling events, except for the above plume sample on June 6, 2023, the total phosphorus limit is only applicable during spring overturn at the epilimnetic water if residence time exceeds 6 months (according to the BC WQG for total phosphorus – nutrients and algae [ENV, 2022]).

Total phosphorus measurements at QUL-58 in 2023 are shown in Figure 4.17, in comparison to the WQG. Note that all depths are shown (and not distinguished), and many samples in this chart do not technically apply temporally to the WQG, but the full data set is shown for explanatory purposes. As mentioned above, while total phosphorus met the WQG during all sampling events at QUL-58 in 2023 with the exception of the above plume sample on June 6, 2023, the total phosphorus limit is only applicable during spring

overturn at the epilimnetic water if residence time exceeds 6 months (according to the BC WQG for total phosphorus – nutrients and algae [ENV, 2022]).

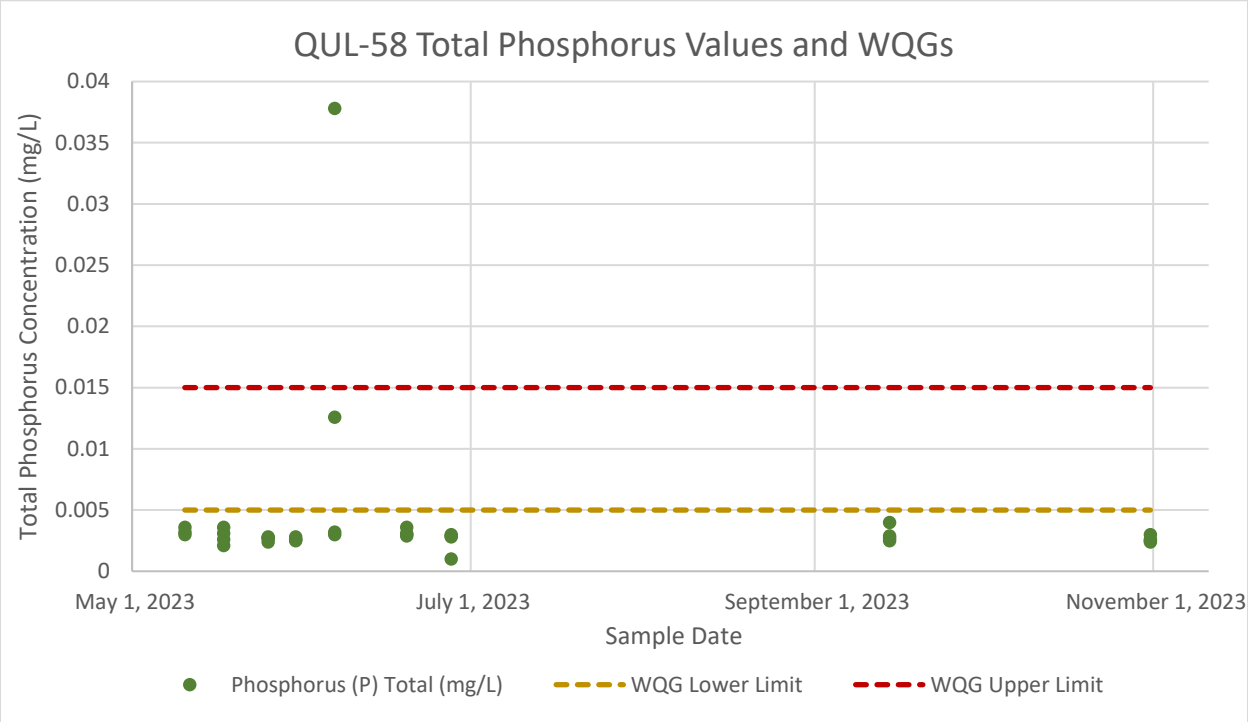


Figure 4.17 Total phosphorus WQG compared with QUL-58 values

4.12.2.7 Receiving Environment Chemistry – Quesnel River

Quesnel River, site QUR-11, was sampled monthly by MPMC as a downstream site in the receiving environment according to the 2016 CEMP. Grab samples and in situ parameters were collected off the Likely Bridge using the Kemmerer sampler. MPMC previously provided payment for a joint federal and provincial water quality monitoring site that is monitored at this same location; however, this program has been discontinued. QUR-11 was removed as a monitoring site in the 2018 CEMP; however, one sample was collected in 2023 for supplemental data.

4.12.3 Discharge Toxicity Testing Results

As per Section 3.3 of the *EMA* Permit 11678 issued on April 7, 2017 (amended last on December 1, 2022), monthly acute toxicity testing is required at the discharge, location HAD-3. Further toxicity test sampling occurred as required by the 2019 CEMP and MDMER; testing was completed at Nautilus.

Table 4.27 Toxicity sampling events in 2023

Site Name	Site Identifier (EMS No.)	Test Type	Frequency	Actual Sampling Events
HAD-3	E304230	96-h rainbow trout LC50	Monthly	11[(a)]
		48-h *D. magna* LC50	Monthly	11[(a)]
		7-d *C. dubia* survival and reproduction	Semi-annually	2
		7-d rainbow trout embryo-alevin	Semi annually	2
		72-h *P. subcapitata* growth inhibition	Semi-annually	2
		7-d *L. minor* growth inhibition	Quarterly	4

[(a)] Monthly toxicity samples were not collected in November as the WTP was not discharging

4.12.3.1 Acute toxicity testing

Monthly acute toxicity testing occurred at HAD-3 throughout 2023, when the WTP was discharging (see Table 4.27). These tests were conducted on 100% (i.e. full strength) treated effluent in accordance with the following standard methods as required by *EMA* Permit 11678 and MDMER:

- 96-hour acute lethality to juvenile rainbow trout (procedures described by Environment Canada (2000a))
- 48-hour acute lethality to the water flea *D. magna* (procedures described by Environment Canada (2000b))

Acute toxicity tests of rainbow trout and *D. magna* both met the *EMA* Permit 11678 requirement of no acute toxicity by determining that the mortality was less than 50% in 100% effluent (results are provided in ***Appendix H***). Note that the lab control had 20% mortality which invalidated the test conducted on the October 31, 2023 sample.

4.12.3.2 Chronic toxicity testing

Chronic toxicity tests at HAD-3 (see Table 4.27) were conducted on 100% treated effluent according to the following standard methods as required by *EMA* and MDMER requirements:

- 7-day survival and reproduction of the water flea *C. dubia*
- 7-day early life stage with salmonid (rainbow trout embryo-alevin)
- 7-day growth inhibition in the aquatic plant *Lemna minor*
- 72-hour growth inhibition in the alga *Pseudokirchneriella subcapitata*

C.dubia and rainbow trout early life stage met the permit requirement of no chronic toxicity by determining that the inhibition of both tests was less than 25% (results are provided in ***Appendix H***).

Effects were noted for *L. minor* during the chronic toxicity testing in 2023. Inhibitory effects on frond growth and/or dry weight of *L. minor* were observed with an IC25 and IC50 (%v/v) for frond growth and dry weight, however these are not considered toxicity failures.

4.13 Sediment Quality

Sediment quality and toxicity samples were collected in Quesnel Lake, Hazeltine Creek and Edney Creek at various periods in 2023 by Minnow Environmental to support 14-day *Hyalella azteca* toxicity testing and benthic invertebrate community monitoring. These results are presented in the Minnow (Minnow Environmental Inc.) report provided in ***Appendix K***.

4.14 Benthic Invertebrates

Benthic invertebrate community samples were collected in Quesnel Lake in 2023 by Minnow. These results are presented in the CEMP 2023 – Sediment and Aquatic Life Minnow report provided in ***Appendix K***.

Benthic invertebrate sampling was conducted by Minnow in Hazeltine and Frypan creeks to meet the CEMP requirements (***Appendix A***). Benthic invertebrate total biomass, tissue quality, and community samples as well as composite taxa and single taxon (caddisfly) tissue samples were collected. These results are presented in the Minnow report provided in ***Appendix K***.

4.15 Plankton, Chlorophyll *a*, and Secchi Disk

4.15.1 Plankton and Chlorophyll *a*

Minnow recommended modifications to the Mount Polley Mine plankton monitoring plan in a letter provided to ENV (Zooplankton and Phytoplankton Program Recommendations provided to ENV by Minnow, dated May 28, 2019). These modifications included the initiation of a depth-integrated sampling methodology for the collection of phytoplankton productivity and community samples. Depth-integrated sampling methods involve the collection of phytoplankton from depths throughout the photic zone (the layer of the water column receiving sunlight). Since phytoplankton inhabit the entire photic zone, Minnow recommended depth-integrated sampling methodology as a more effective means of characterizing phytoplankton community and productivity conditions than surface grabs (which were previously implemented for monitoring). The recommendations provided by Minnow were incorporated into a CEMP approval amendment letter issued by ENV on July 15, 2019 (Re: Amendment of the November 9, 2018 and March 14, 2019 Approval of the August 15, 2018 Comprehensive Environmental Monitoring Plan [CEMP] – Mount Polley Mine Permit #11678) and into the updated CEMP (which was submitted on October 31, 2019 and approved with conditions on February 10, 2021). The collection of both surface and depth-integrated phytoplankton samples was outlined as a requirement for 2019 monitoring in the CEMP approval condition letter dated July 15, 2019 to serve as a bridge between the two methodologies. This requirement was fulfilled in 2019, with results of this comparison between the surface and depth-integrated methodologies

presented by Minnow (***Appendix K***). Phytoplankton monitoring in 2023 was completed using depth-integrated methods in accordance with conditions outlined by ENV in the CEMP Amendment letter dated July 15, 2019 since the requirement for sampling using both surface and depth-integrated methods was satisfied in 2019.

Historically, chlorophyll *a* samples in Polley and Quesnel Lakes were generally collected two times (i.e. June and August) per growing season (Table 4.28). In 2016, chlorophyll *a* was collected three times at QUL-58, P1, and P2 for additional data. In 2017, an additional sample was collected at QUL-58; no samples were collected at QUL-ZOO-8 due to unsafe conditions from wildfires. In 2018, some chlorophyll *a* samples were collected in July and September as samples were missed at QUL-58 and QUL-2a in June, and QUL-ZOO-1, -7, and-8 and QUL-2a in August due to the proximity of forest fires limiting visibility and deteriorating air quality. An additional sample was collected at QUL-18 in May 2018. In 2019, only one sample was collected from QUL-ZOO-8 as it was removed from the sampling program later in the year. Chlorophyll *a* results from Polley Lake since 2019 are included in Figure 4.19. Chlorophyll *a* results from Quesnel Lake since 2019 are included in Figure 4.20. Comparison of the surface and depth-integrated methodologies is included in Minnow's report in ***Appendix K***.

Results from 2023 are in ***Appendix M***, and discussion for 2023 results are in Minnow's report in ***Appendix K***

Table 4.28 Chlorophyll *a* sample events from 2019-2023

Sample Name	2019 Sample Dates		2020 Sample Dates		2021 Sample Dates			2022 Sample Dates		2023 Sample Dates	
QUL-120a-0m	19/06/2019,	19/08/2019									
QUL-18-0m	19/06/2019,	19/08/2019									
QUL-2a-0m	19/06/2019,	20/08/2019									
QUL-58-S	19/06/2019,	20/08/2019									
QUL-ZOO-1	25/06/2019,	29/08/2019									
QUL-ZOO-1-1-DI	30/07/2019		28/07/2020					27/07/2022		26/07/2023	
QUL-ZOO-1-1-S	30/07/2019										
QUL-ZOO-1-2-DI	30/07/2019		28/07/2020		28/07/2021			27/07/2022		26/07/2023	
QUL-ZOO-1-2-S	30/07/2019										
QUL-ZOO-1-3-DI	30/07/2019		28/07/2020		28/07/2021			28/07/2022		26/07/2023	
QUL-ZOO-1-3-S	30/07/2019										
QUL-ZOO-1-4-DI	30/07/2019		28/07/2020		28/07/2021			28/07/2022		26/07/2023	
QUL-ZOO-1-4-S	30/07/2019										
QUL-ZOO-1-5-DI	30/07/2019		28/07/2020		28/07/2021			28/07/2022		26/07/2023	
QUL-ZOO-1-5-S	30/07/2019										
QUL-ZOO-1-DI	25/06/2019,	29/08/2019	23/06/2020,	27/08/2020	23/06/2021,	28/07/2021,	29/08/2021	22/06/2022,	28/08/2022	21/06/2023,	27/08/2023
QUL-ZOO-7	25/06/2019,	29/08/2019									
QUL-ZOO-7-1-DI	30/07/2019		28/07/2020					27/07/2022		26/07/2023	
QUL-ZOO-7-1-S	30/07/2019										
QUL-ZOO-7-2-DI	30/07/2019		28/07/2020		28/07/2021			27/07/2022		26/07/2023	
QUL-ZOO-7-2-S	30/07/2019										
QUL-ZOO-7-3-DI	30/07/2019		28/07/2020		28/07/2021			27/07/2022		26/07/2023	
QUL-ZOO-7-3-S	30/07/2019										
QUL-ZOO-7-4-DI	30/07/2019		28/07/2020		28/07/2021			27/07/2022		26/07/2023	
QUL-ZOO-7-4-S	30/07/2019										
QUL-ZOO-7-5-DI	30/07/2019		28/07/2020		28/07/2021			27/07/2022		26/07/2023	
QUL-ZOO-7-5-S	30/07/2019										
QUL-ZOO-7-DI	25/06/2019,	29/08/2019	23/06/2020,	27/08/2020	23/06/2021,	28/07/2021,	29/08/2021			21/06/2023,	27/08/2023
QUL-ZOO-8-0m	25/06/2019										
BOL-B2-1-DI	31/07/2019		29/07/2020		27/07/2021			26/07/2022		27/07/2023	
BOL-B2-1-S	31/07/2019										
BOL-B2-2-DI	31/07/2019		29/07/2020		27/07/2021			26/07/2022		27/07/2023	
BOL-B2-2-S	31/07/2019										
BOL-B2-3-DI	31/07/2019		29/07/2020		27/07/2021			26/07/2022		27/07/2023	
BOL-B2-3-S	31/07/2019										
BOL-B2-4-DI	31/07/2019		29/07/2020		27/07/2021			26/07/2022		27/07/2023	
BOL-B2-4-S	31/07/2019										
BOL-B2-5-DI	31/07/2019		29/07/2020		27/07/2021			26/07/2022		27/07/2023	
BOL-B2-5-S	31/07/2019										
BOL-B2-S	04/09/2019										
BOL-B2-DI	25/06/2019,	04/09/2019	22/06/2020,	30/08/2020	22/06/2021,	30/08/2021		21/06/2022,	28/08/2022	21/06/2023,	28/08/2023
POL-P1-S	24/06/2019										
POL-P2-DI	24/06/2019,	28/08/2019	22/06/2020,	30/08/2020	22/06/2021,	30/08/2021		21/06/2022,	25/08/2022	21/06/2023,	28/08/2023
POL-P2-S	24/06/2019,	28/08/2019									
POL-P2-1-DI	29/07/2019		27/07/2020		26/07/2021			25/07/2022		27/07/2023	
POL-P2-1-S	29/07/2019										
POL-P2-2-DI	29/07/2019		27/07/2020		26/07/2021			25/07/2022		27/07/2023	
POL-P2-2-S	29/07/2019										
POL-P2-3-DI	29/07/2019		27/07/2020		26/07/2021			25/07/2022		27/07/2023	
POL-P2-3-S	29/07/2019										
POL-P2-4-DI	29/07/2019		27/07/2020		26/07/2021			25/07/2022		27/07/2023	
POL-P2-4-S	29/07/2019										
POL-P2-5-DI	29/07/2019		27/07/2020		26/07/2021			25/07/2022		27/07/2023	
POL-P2-5-S	29/07/2019										

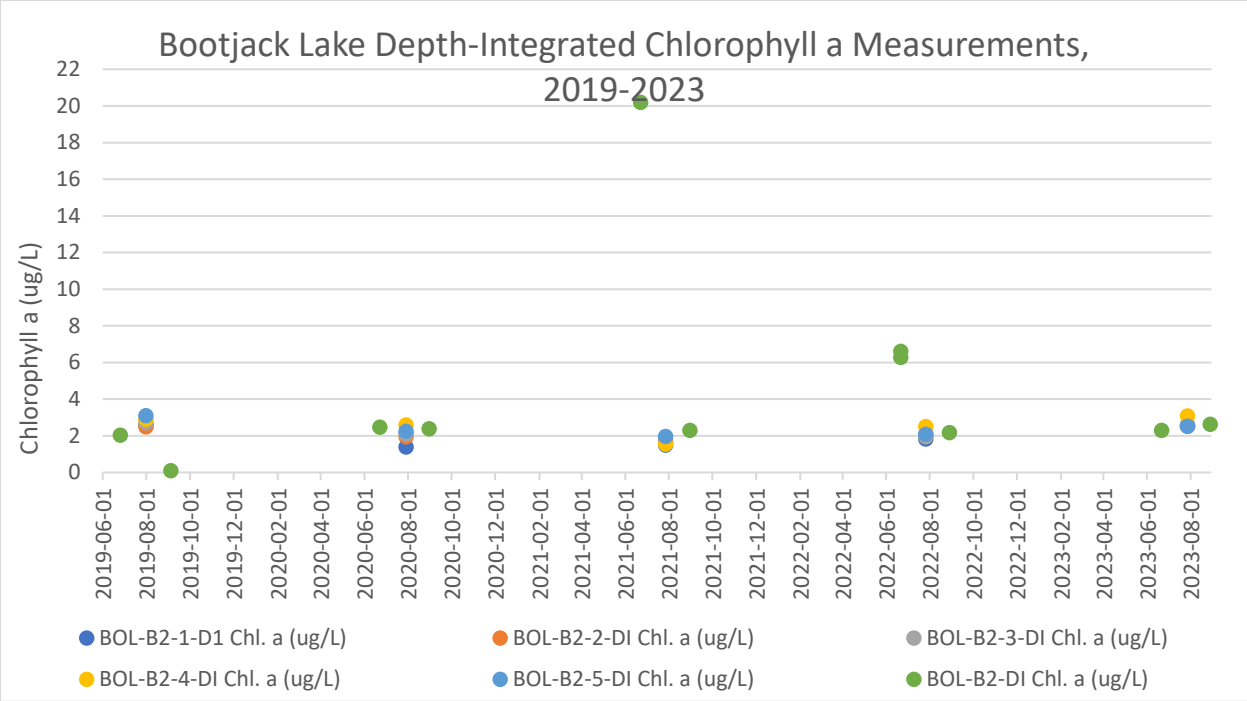


Figure 4.18 Depth-integrated chlorophyll *a* results from Bootjack Lake from 2019 to 2023

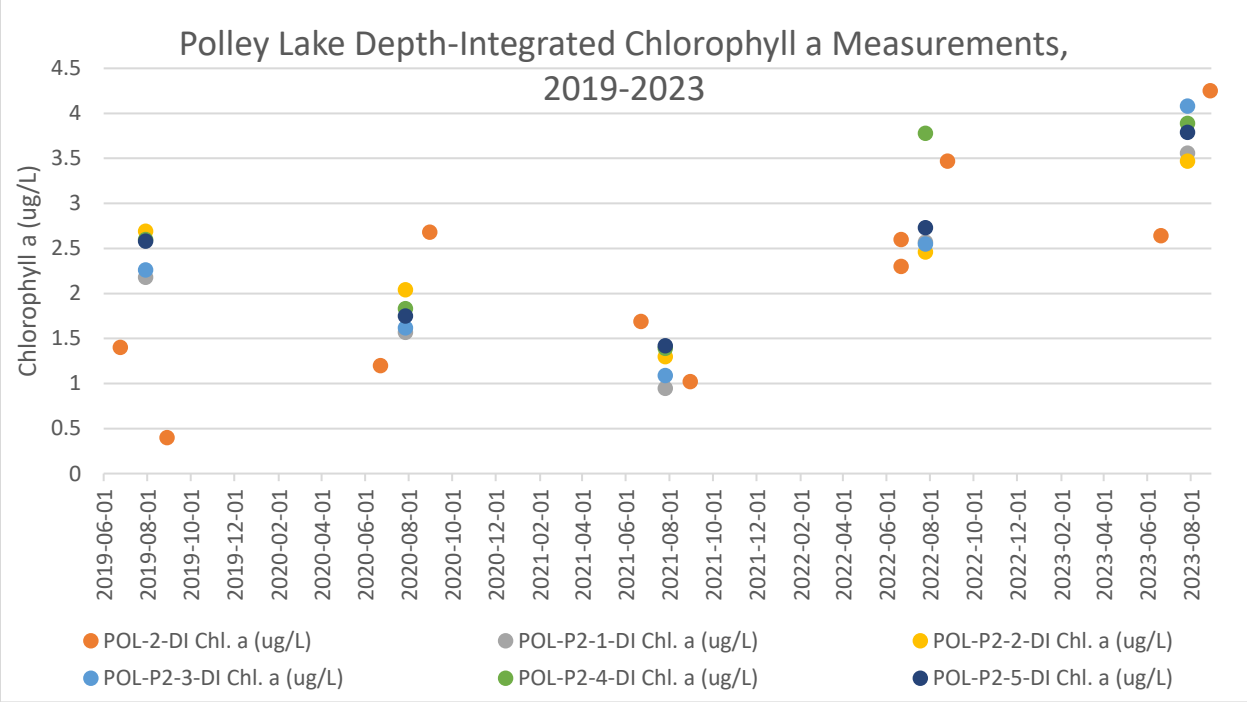


Figure 4.19 Depth-integrated chlorophyll *a* results from Polley Lake from 2019 to 2023

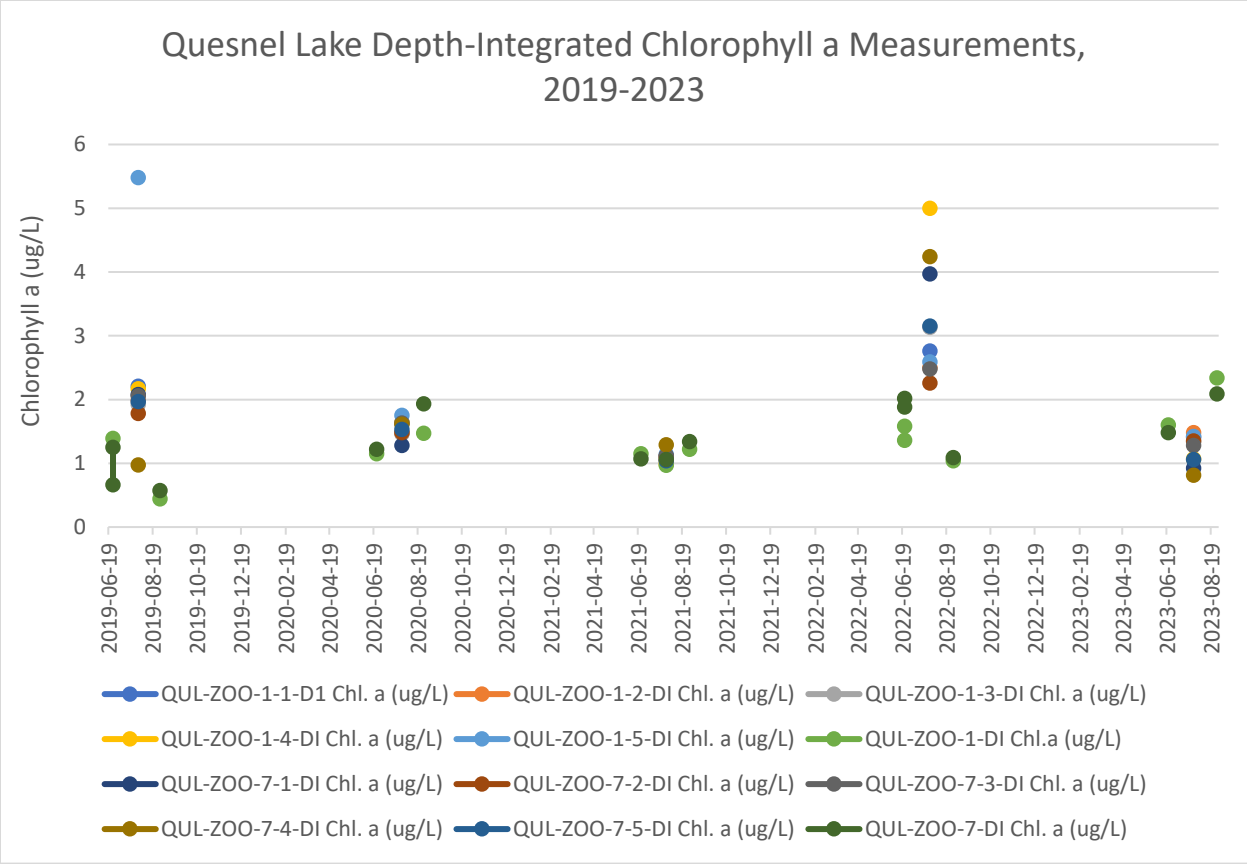


Figure 4.20 Chlorophyll *a* results from Quesnel Lake from 2019 to 2023

As explained above, zooplankton and phytoplankton samples were also historically collected at surface depth rather than depth-integrated, twice per growing season (June and August) at the same water quality monitoring stations in Polley Lake (P1 and P2). Quesnel Lake monitoring was conducted at three stations historically sampled by Department of Fisheries and Oceans (DFO) Station 1. (QUL-ZOO-1) is located in the center of the West Basin and station 7 (QUL-ZOO-7) is located in front of Horsefly Bay. In 2023, zooplankton and phytoplankton samples were collected in Polley Lake (P2), Bootjack Lake (B2) and Quesnel Lake (QUL-ZOO-1 and QUL-ZOO-7). Station 8 (QUL-ZOO-8) was removed from the program in 2019 and was not sampled in 2023. In 2023, zooplankton and phytoplankton samples were collected by Minnow in June, July and/or August. Results are in ***Appendix M***.

Phytoplankton productivity results are not directly comparable between the surface and depth-integrated monitoring methodologies. Comparison of the two sampling methods in 2019 (surface and depth-integrated) indicated that chlorophyll-a concentrations in depth-integrated samples were significantly higher than surface samples from Polley and Bootjack Lake, while the opposite was true at QUL-ZOO-7 in Quesnel Lake. Despite these differences in results between the two methodologies, phytoplankton sampling efforts in 2023 focused solely on the depth-integrated method in accordance with the CEMP Amendment letter dated July 15, 2019, and to ensure that the complete phytoplankton community was being evaluated. Depth-integrated sampling methods will continue to be used going forward, as it is the expert opinion of

Minnow and MPMC personnel that this methodology represents an improvement over discreet-depth sampling.

Depth-integrated chlorophyll a sampling results from 2023 indicate that productivity in Polley Lake, Quesnel Lake and Bootjack Lake has remained relatively stable over the period from 2019 to 2023. Chlorophyll a measurements may demonstrate an upward trend in all three water bodies, with most 2023 results having higher concentrations than in 2022, 2021 and/or 2020, however, 2019 data was more variable, there is one outlying result of in Bootjack Lake of 20.2 ug/L, and the trend is not striking, most likely a result of seasonal variation. Additional review of phytoplankton, and zooplankton are presented in Minnow's report in ***Appendix K***. The raw Quesnel Lake Plankton taxonomy are included in ***Appendix M***.

4.15.2 Secchi Disk

During each sampling and profiling event, a Secchi depth measurement (Table 4.29) was collected (except if conditions were too windy/wavy) as per the 2019 CEMP (***Appendix A***). Secchi depth data are included in ***Appendix M***.

Table 4.29 Secchi depth measurement events in 2023

Site	Site Identifier (EMS No.)	Secchi Measurement Events
P1	E207974	6
P2	E207975	7
B1	E207972	6
B2	E215897	6
B4	E216744	0
QUL-ZOO-1	E306455	3
QUL-ZOO-7	E306456	3
QUL-ZOO-8	E306457	0
QUL-120a	E303022	4
QUL-18	E303019	4
QUL-58	E304876	9
QUL-57	E304874	5
QUL-59	E304875	5
QUL-2a	E303020	5

All Secchi depths measured in 2023 were within the range of measurements from previous years.

4.16 Periphyton

Periphyton sampling was conducted by Minnow in Hazeltine, Frypan and Edney Creeks to meet the CEMP requirements (***Appendix A***). Periphyton biomass (ash-free-dry-mass), productivity (chlorophyll *a*), community samples, and tissue chemistry were collected for analysis in 2023. These results are presented in the Minnow report provided in ***Appendix K***.

4.17 Fish

Several fish studies were conducted by Minnow in 2023. Spring sampling was completed in Polley and Bootjack lakes. Fish tissue quality monitoring was conducted in Quesnel Lake (north, east and west arms) and the Quesnel River. Discussion of these results will be presented in the Minnow report provided in ***Appendix K***.

4.17.1 Fish and Habitat Surveys

Fish surveys were conducted twice in 2023: spring sampling was completed in May in Polley Lake, with Bootjack Lake serving as a reference and fall sampling was completed in October in Polley Lake. The 2023 monitoring was conducted to provide data for the evaluation of fish population structure and abundance in Polley Lake and to provide data for the evaluation of fish tissue quality in Polley Lake compared to the reference (Bootjack Lake). Discussion of these results is presented in much greater detail in the Minnow report provided in ***Appendix K***.

Minnow continued to document rainbow trout spawning and Young of the Year (YOY) abundance in Hazeltine Creek as well as habitat suitability in 2023. The CEMP 2023 – Sediment and Aquatic Life Minnow report will be provided under a separate cover.

4.18 Terrestrial Monitoring

2023 was a period of extensive terrestrial monitoring and planning for future monitoring programs. Terrestrial monitoring under the supervision of QP's from DWB occurred in the Hazeltine Creek corridor. In 2021, DWB completed an updated Study Design for Wildlife Monitoring in the Hazeltine Creek Corridor (DWB 2021a), which received revisions from MPMC regulators and advisory groups, and was implemented to build on the work previously completed by Golder. This wildlife monitoring plan is a 10-year program currently in year 4, with intensive analysis and reporting planned for years 5 and 10.

In 2021, DWB completed a Wildlife Management Plan (DWB 2021b) for the mine site, which is a requirement of the most recent M-200 permit amalgamation for wildlife management and not a study component.

4.18.1 Wildlife Monitoring

The Mount Polley site and surrounding area is home to a wide variety of wildlife including ungulates, carnivores, raptors, waterfowl, songbirds, mustelids, amphibians and a host of terrestrial and aquatic organisms. With extensive wildlife activity on the mine site, MPMC provides training to all employees regarding management of food waste and bear awareness. This training and information are intended to help keep MPMC employees and the wildlife safe.

To meet requests by the ENV, first nations, and various stakeholders, to provide valuable data for evaluating the effects of the mine on wildlife, and to monitor wildlife habitat creation through reclamation, the MPMC Environmental Department records wildlife observations and incidents on the mine site. In addition, MPMC maintains seven motion triggered wildlife cameras which are staged in various locations, primarily in the Hazeltine Corridor. This information is considered valuable for future reclamation and land use planning, and is incorporated into wildlife monitoring programs, elaborated in Appendix N.

Following the TSF embankment breach, MPMC submitted the Post Event Environmental Impact Assessment Report (PEEIAR) (MPMC, 2015a) that included an investigation of the impacts to wildlife. The findings indicated that there was no evidence of direct impacts to local populations of larger mammals such as deer, moose or bear, but impacts due to bioavailability of metals was yet unknown. The ERA (MPMC, 2017c) evaluated the possible risks of metal bioaccumulation in various animals. The findings showed that metals were likely to have low bioavailability and a low risk of bioaccumulation. The ERA also compared the frequency of wildlife observations in 2015 to 2016, and noted that the observation of deer, small mammals and birds increased, possibly due to increased forage ability. Ongoing remediation of the impacted areas are providing habitat and food for a variety of mammals and birds, which is an important step to rebuilding the ecosystems.

In 2023 there were 198 recorded wildlife observations excluding photo captures from wildlife cameras. The total number of individuals is higher than the number of observations because many wildlife observations encountered a group size greater than one. Since normal operations have resumed, more wildlife observations are expected when there are more employees and workers on site. The observations include actual sightings, and observations of scat and tracks (

Table 4.30). Observations comprise a wide range of different birds, carnivores, moose, and deer. It is assumed that the number of reported observations is only a fraction of the actual observations but suggests regular use of the site by wildlife.

Table 4.30 indicates some generic observations such as "Deer", these entries refer to sightings with no positive species identification.

One wildlife incident occurred at Mount Polley Mine in 2023. A BC Conservation Officer was called to dispatch 3 nuisance bears that were regularly interacting with MPMC staff, parked vehicles, and garbage bins.

Table 4.30 2023 wildlife observations at Mount Polley Mine.

Onsite		
Wildlife Observed	# of Observations	Tracks
Bald Eagle	4	
Black Bear	98	
Chipmunk	2	
Deer	76	
Duck	43	
Frog	1	
Garter Snake	1	
Golden Eagle	1	
Goose	5	
Gray Jay	5	
Grouse	22	
Hawk	3	
Lynx		1
Mule Deer	11	
Moose	8	
Muskrat	1	
Red Tailed Hawk	1	
Snowshoe Hare	1	
Squirrel	1	
Swan	1	
Offsite		
Wildlife Observed	# of Observations	Tracks
Black Bear	11	
Cougar	1	
Coyote	2	
Goose	6	
Deer	3	
Lynx	1	
Mule Deer	1	
Swan	12	
Wolf		4
Breach Effected		
Wildlife Observed	# of Observations	Tracks
Deer	2	

Sockeye Salmon	183	
Rainbow Trout	Unknown	
Water Fowl	1	

4.19 Soil

No soil works were completed in 2023.

4.20 Soil Invertebrates

No soil invertebrate works were completed in 2023. Soil invertebrate sampling is planned in the future as part of the 2021 Wildlife Monitoring Program (Appendix N) which is a 10-year study currently in year 4.

4.21 Vegetation

An ecological risk assessment was performed by Golder in 2019, which determined that the risk of terrestrial uptake and trophic transfer of trace metals is low, especially when compared to the ecological risk posed by the physical impact of the spill, and disrupted Hazeltine Creek ecological communities. Golder also wrote a Terrestrial Monitoring Plan (2019c) which included the establishment and monitoring of vegetation plots in Hazeltine Creek, which were carried out starting in 2020 by DWB. The terrestrial monitoring plan was subsequently modified by DWB (2021) to align with the timeline and goals of the bird and mammal monitoring program, and to respond to comments made by the Government-to-Government Technical Working Group.

DWB conducted vegetation surveys along the Hazeltine Creek corridor in July of 2023. These activities represent Year 4 of the planned study. The results indicate that approximately 113 species of plants were detected within the Hazeltine Creek corridor, including 9 species of trees, 20 species of shrubs, approximately 84 species of herbs and an unrecorded number of moss and lichens. The results of the surveys from Year 1 to 4 will be incorporated into the final trend analysis in 2025. Year 5 of the 5-year study will be conducted during the recommended period for vegetation surveys, which has been identified as early-July, 2024.

A summary of the current status of the endpoints for vegetation monitoring following Year 4 of the study is below:

Objective 1: Vegetation cover is "self sustaining"

- Most seedling mortality at the site does not appear to be occurring as the result of anthropogenic factors and is expected to be a result of extreme weather conditions observed over recent years.

- Vegetation cover does not appear to be reducing over time; depending on soil conditions, some areas vegetation cover is increasing and some areas, vegetation cover remains consistent.
- Vegetation overall throughout the reclaimed areas appears resilient to dry periods due to species diversity.
- Recruitment is occurring and will likely continue to occur for most reclaimed areas. Further recruitment in areas where soil surface conditions are limiting will likely continue to see low or no recruitment until surface conditions change.
- In most reclaimed areas, vegetation cover is very diverse and similar to early successional forest ecosystems.

Objective 2: Vegetation cover is following the natural successional trajectory that aims to satisfy the end land use objective

- A diversity of native tree and shrub species are well established throughout most reclaimed areas.
- Although some invasive plants and noxious weeds have been identified, they currently do not pose a risk to limiting natural succession. Areas dominated by agronomic grass cover have become successionally stagnant and are limiting for native plant species.
- Limiting factors will likely remain long term unless remedial actions are taken in those areas where they are present.

The full 2023 vegetation report is included in ***Appendix N***. More information on reclamation is found in the following section.

5 Reclamation Program

The objectives of the reclamation program are outlined in Section 1.3. To achieve these objectives, as outlined in the most recent *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022a), and Reclamation Research Program (MPMC 2021e). MPMC has established projects at the site to research reclamation and closure methods, including soil amendments and application methods, re-vegetation, vegetation metal uptake, and passive/semi-passive water treatment. The Reclamation Research Program is included in ***Appendix T***. The *Mine Plan and Reclamation Program Update 2022* was submitted under a separate cover. Based on the results of these research projects, larger scale progressive reclamation has been ongoing at Mount Polley since 2010, with two primary benefits:

1. Conducting reclamation during the operating life of the Mine reduces the size of disturbed area requiring reclamation at closure and minimizes liabilities.
2. Sites undergoing progressive reclamation can be continually monitored, and reclamation prescriptions modified based on findings. Using this approach, it is anticipated that a refined prescription for meeting reclamation objectives will be developed and can be applied site-wide at Mine closure.

No reclamation work was conducted in 2023 but is anticipated to begin again in 2024.

5.1 End Land Use

End land use is discussed in Section 1.3.4 under the heading "Reclamation Objectives".

5.2 Land Capability

MPMC plans to re-establish a sustainable, diverse, functional landscape that, on a property average basis, is greater than or equal to the capability that existed prior to mining. By restoring functional, locally common ecosystems to the reclaimed landscape, similar land uses will be available as were present prior to Mine Site disturbance. This will involve mimicking natural systems wherever possible by:

- Creating natural looking, irregular landforms;
- Restoring effective drainage patterns;
- Replacing soil to the depth that mimics natural conditions based on elevation, slope, and aspect (i.e., biogeoclimatic zone site series); and
- Revegetating each area of the site with locally common, native vegetation appropriate to the target site series, that can be expected to thrive on each polygon, including culturally important species.

This, in turn, will result in equivalent land capability.

By planning for multiple end land use objectives occurring in the same areas, the result is a more holistic approach to reclamation planning and prescription development. The entire process can also be quantitatively assessed by measuring reclaimed areas and comparing them to pre-existing ecosystem conditions or relative local benchmarks, if pre-existing ecosystem community data is not available.

Success criteria may include parameters such as:

- Landform stability;
- Erosion control;
- Visual and functional integration into the surrounding environment;
- Establishment of self-sustaining native vegetation consistent with target site series;
- Vegetation quality; and
- Presence of culturally important and rare or listed species.

5.3 Stability of Works

5.3.1 Rock Disposal Sites (RDS)

Consideration of physical long-term stability of RDSs begins prior to dumping of waste rock, continues through the construction phase, and is completed when reclamation techniques are implemented. A chronology of events to ensure this stability is as follows:

- A QP conducts a footprint stability assessment to determine if any special construction techniques are required to ensure the long-term stability of the RDS;
- The soft organic soils within the footprint of the RDS are removed and stockpiled, so that they can be used for future reclamation. By removing the soft organic materials prior to dumping, the stability of the waste dump will be improved, as it will be constructed on more solid materials such as naturally occurring tills and bedrock;
- When the RDS is under construction, a QP conducts annual (at a minimum) visits to determine if the construction technique being utilized is consistent with long-term stability objective;
- When the RDS is complete, it is re-sloped from an angle of 37° to 26.5° (from the angle-of-repose to a slope ratio of 2H:1V); and
- While the currently approved final configuration for the RDS includes a uniform slope angle of 2H:1V, geomorphic approaches to RDS closure will be investigated and, if implemented, may result in local variations in slope angle. Part of the application of geomorphic design would include reassessment of stability as needed from any proposed modifications to final dump configuration.

Greater long-term physical stability can be achieved at locations where excavated pits are backfilled with waste as compared to RDSs being constructed exclusively on flat to gently sloping terrain.

This is the case with the North Bell Dump over top of the Bell Pit, and the SERDS over top of Pond Zone and SEZ Pits.

Examinations of RDSs are made in accordance with Section 6.10.1 of the *Health, Safety and Reclamation Code for Mines in British Columbia (HSRC),* (EMPR, 2017). Monitoring of RDSs occurs according to the terms and conditions of a variance granted by the EMLI on February 9, 2001. A report on the 2023 RDS inspection, prepared by a QP will be submitted to the EMLI by March 31, 2024.

5.3.2 Pit Walls Stability

During the excavation of the pits, stability of the surrounding surfaces and pit walls is a priority, as this is necessary for the safety of the Mine workers. As such, ensuring the needed degree of long-term stability is relatively straightforward. A chronology of events to ensure this stability is as follows:

- The pits are excavated with wall angles that have been discussed and agreed to with a qualified geotechnical consultant. The angle of the walls is to be chosen to ensure the stability of the pits throughout the excavation phase, as well as for long-term stability;
- Routine inspection of pit walls and benches is completed, and maintenance is completed as required (i.e., wall scaling and bench cleaning). A formal annual (at minimum) inspection of all pit walls is conducted by a qualified professional;
- Prior to the excavation of benches below the top surfaces, all soils and tills are removed and pulled away from the area immediately surrounding the maximum boundary of the pits. This is completed to prevent the sloughing of loose materials down the pit walls; and
- The closure approach for the Cariboo-Springer Pit includes backfilling of the pit with PAG rock from the Temporary NW PAG stockpile. While this backfilling is planned to promote chemical stability of the PAG waste with subaqueous disposal once the pit re-floods, the placement of material in the pits will also effectively buttress the pit walls, further promoting the long-term post-closure stability of the pit. Partial backfilling of the Wight Pit is also planned and will also enhance pit wall stability.

Pit walls are monitored for stability using surface inspections. Pit wall stability is reviewed annually by a third party QP from an engineering services firm. A report on the 2023 pit slope inspection, prepared by a QP, will be submitted to the EMLI by March 31, 2024.

5.3.3 Road Stability

The large access and haul roads are constructed with NAG waste rock and are essentially waste rock dumps. There long-term stability will be ensured using techniques similar to those employed for the RDSs, with specific differences as described below. A chronology of events to meet long-term stability objectives is as follows:

- The roads have been constructed for stability. The soft organic soils from within the footprint of the roads were stripped to ensure adequate foundation conditions under the roads for stability. The soil that was stripped was stockpiled for future use in reclamation;
- Culverts that were used in the construction of the road and have potential to affect fish-bearing streams will be removed and water bars will be dug across the roads to continue to facilitate the movement of water past the structure to the downstream slopes.

When roads are no longer needed, if possible (without encroaching on watercourses or sensitive undisturbed areas), road edges will be re-sloped from an angle of 37° to 26.5° (from the angle-of-repose to a slope ratio of 2:1). There will be limitations on the re-sloping possible in specific areas of the Mine Site.

5.3.4 Tailings Storage Facility and Associated Works

MPMC received authorization to proceed with construction activities at the TSF to a maximum elevation of 970 m under the *Mines Act* Permit M-200 June 23, 2016 amendment. Construction of the Main Embankment and Perimeter Embankment Buttresses for the 970 m approved design were deemed completed by the Engineer of Record (EoR) in 2016 and the embankment elevation reached 970m in Fall 2023. Full details of the design are available in Golder (2017d).

The embankment slopes to satisfy the 970m design are at approximately 1.3H:1V ("repose"). This angle satisfies the stability requirements for the embankments at their designed height. Proceeding above 970m will require flattening the downstream embankment slopes to 2H:1V and extending some of the buttresses to maintain the desired Factor of Safety. The 2H:1V reslope and buttress design was finalized by the Engineer of Record on December 6, 2023 and permit application amendment being compiled for submission to EMLI in early 2024.

The base case (2015 Golder design to 970m) TSF reclamation configuration considers the re-sloping of the TSF embankment downstream slope to a 2H:1V slope by flattening the repose slope embankment. This will not be required once the resloping to go above 970m is completed, as it will be constructed at the closure angle.

A spillway, sized with capacity for the probable maximum flood, will also be installed so that the long-term water table will be maintained at a safe elevation.

Ongoing monitoring through operations and closure is planned to help assure compliance with all needs for maintaining physical stability of the TSF. Monitoring instruments, including vibrating wire piezometers, slope inclinometers, and ShapeAccelArray, will continue to be monitored as per the *Operations, Maintenance and Surveillance (OMS) Manual*. The *OMS Manual* is a "live" document administered by MPMC, created in collaboration with the Engineer of Record (EoR) for the facility., and updated copies are submitted to EMLI. The TSF will continue to be monitored by the EoR to ensure the facility is operated and performs according to its design, that stability is maintained and to provide changes to the monitoring program, if required.

Relevant aspects of the current monitoring program are as follows:

- The EoR administers, reviews and approves quality assurance/quality control (QA/QC) in accordance with the construction monitoring manual, the EMLI M-200 Permit, and all BC-ENV permits. Results are reported annually to BC-ENV in an as-built report (documenting construction activities) and annual review;
- An annual TSF inspection is performed by the EoR and submitted as the Annual Dam Safety Inspection (DSI) Report, which conforms to the Health, Safety and Reclamation Code (HSRC) and Canadian Dam Association requirements.
- A Summary of the construction activities performed in a given year are provided to BC-ENV in an annual as-built report (documenting construction activities).
- MPMC has an Independent Engineering Review Panel (IERP), to whom technical and operational developments are presented, such that they can provide review and recommendations, as necessary. The MPMC IERP is specifically used to review water management, engineering-related aspects of reclamation, and TSF performance and design;
- Re-sloping of the embankment, or any other modifications of the embankment to meet final closure and reclamation configuration needs, will be performed according to the requirements of the EoR..

Construction to raise the embankments to elevation 970 m resumed in July 2022 and continued through 2023, with a break during the winter months. The final working height of 970m was attained for all Embankment elements in November 2024 (Upstream Sand, Till Core, Filter, Transition, and Downstream Rockfill). Official certification by the EoR of heights attained will be documented within the DSI for 2023 and submitted to EMLI and BC-ENV by March 31, 2024.

Tailings have been deposited as a low-density slurry since the restart of operations of the TSF in 2016. The tailings slurry has been conveyed from the mill to the TSF via gravity driven tailings discharge pipelines. Tailings were not deposited in the TSF in 2020 and 2021 while the mine was in care and maintenance.

In 2022, tailings slurry deposition resumed in the TSF and continued through 2023. Deposition was managed to maintain beach widths and freeboard and occurred at various locations along the embankments, with the only exception being the mid-way point along the Main Embankment.

The following inspections occurred at the TSF in 2023:

- 2023 Spring Site Visit – MPMC Tailings Storage Facility, conducted by the EoR between May 8 and 10, 2023
- Annual Dam Safety Inspection (DSI), conducted by the EoR on October 3 and 4, 2023 as required by Section 4.2 of the *HSRC* (EMPR, 2017).

In addition to the physical activities, MPMC also submitted the following reports:

- The 2023 DSI report, as required under the *HSRC* (EMPR, 2017) to be submitted to EMLI by March 31, 2024.

5.3.5 Underground Stability

For the closure of underground mine works, one of the key issues related to stability is the potential for subsidence, which at some sites may be caused by the collapse of underground mine voids, leading to movement of the ground surface. As documented in the MPMC analysis in Appendix R in the *RCP*, the risk of subsidence at the Mine Site is minimal due to the depth and size of the voids below ground surface, the quality of the rock, and the mining methodology. The only additional closure work planned for reclamation of the underground mine will be backfilling of the Alimak Raise, which will be done primarily for access control.

The location of the underground works is presented in Section 2.3.1 in the *RCP*. The stability of the underground during operations is a priority for the safety of mine workers and for personnel entering the mine. During operations, the long-term stability of the underground mine is promoted by the mining method used, which is conventional long hole open stoping with backfilling. After mining of each stope, the opening is backfilled with cemented rock fill before mining the next stope. The purpose of the cemented rock fill is to fill the empty stopes and provide lateral support and stability to the stoping block. In terms of closure, this operational measure ensures a decrease in the deformation of the surrounding host rock that may tend to fill in the void, and also assures the long-term stability of the ground. The combination of the rock support used during operation and the backfilling of the mined-out stopes maximizes long-term stability of the openings and will minimize long-term monitoring needs.

5.4 Revegetation

MPMC recognizes re-vegetation as a critical aspect of site maintenance and reclamation. Disturbed areas are grass seeded on an ongoing basis to prevent erosion and invasive species establishment. Soil stockpiles and areas that are unlikely to be disturbed are typically prescribed a native seed mix Table 5.1). Sites that may be re-disturbed (or where preventing establishment of native species is the primary goal) are typically prescribed an aggressive seed mix (Table 5.1). This mixture is intended to grow rapidly in the short term but dies off allowing the ingress of native species from surrounding areas.

All non-active soil stockpiles on site are routinely inspected for erosion and vegetative cover and any non-active stockpiles requiring additional vegetative cover and/or showing signs of erosion are added to the bi-annual (spring and fall) seeding list. This seeding list serves to track areas that require seeding, their size, description and type of seed.

Ground cover seeding was limited in 2023 and was completed on new soil stockpiles.

In addition to seeding ground cover (herbaceous) vegetation, the primary re-vegetation objectives at the Mine include the establishment of woody shrubs and trees (coniferous and deciduous). MPMC recognizes

the importance of appropriate seed source and selection for long-term success and endeavors to use local seed sources. All the conifer management at the Mine is consistent with provincial forest management practices as governed by the *Forest and Range Practices Act* (FLNRO 2021). This includes participation in regional silviculture strategies, stocking standards, tree species selection, and seed planning and registration. Additional erosion control is provided through re-vegetation associated with site progressive reclamation

Table 5.1 Aggressive and native seed mixes for reclamation

Species	% by Weight
Aggressive Seed Mix	
Dahurian Wildrye	25
Slender Wheatgrass	30
Perennial Ryegrass	15
Timothy	5
Native Seed Mix	
Mountain Brome	25
Native Red Fescue	10
Rocky Mountain Fescue	14.31
Bluebunch Wheatgrass	25
Blue Wildrye	25
Fireweed	0.014
Big Leaf Lupine	0.68

5.4.1 Invasive Plant Management

Invasive plant species are managed under MPMC *Invasive Plant Management Plan*. This plan was reviewed in 2023 (as required by *Mines Act* Permit M-200). In 2023 MPMC retained DWB to survey and monitor invasive plant presence within stockpiled soil. The monitoring report can be found in ***Appendix X***.

The invasive species currently known to be present at Mount Polley Mine that are listed in the *2018 Regional Strategic Plan for Invasive Plant Management* (the most recent regional plan) by the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC, 2018) are oxeye daisy, Canada thistle, orange hawkweed, yellow hawkweeds (non-native), and scentless chamomile. All these plants have the priority ranking "3 – Established", and are common and widespread, with widespread control not currently possible. As such, MPMC's approach is to manage invasive species at this site such that they do not inhibit reclamation activities, with recognition that all outside sources (for example, cattle, wildlife, wind, and water) pose challenges to eradicating invasive plants at the Mine site that are widespread in the surrounding areas.

5.5 Growth Medium

Salvaging and stockpiling of surficial materials is recognized as an essential component of reclamation planning. Mount Polley implements the *MPMC Soil Management Plan* which can be found in the *Mine Plan*

and Reclamation Program Update 2022 (MPMC, 2022a). Volumes and locations of soil stockpiles are tracked and inspected.

5.6 Landforms

Creating natural looking and stable landforms are reclamation objectives as described in Section 5.2 on Land Capability. Additionally, restoration of the pre-disturbance watersheds and natural hydrology, with distributed discharge, are objectives described in detail in the Mine Plan and Reclamation Program Update 2022 (MPMC, 2022). Reclamation research is ongoing to achieve these objectives, including soil cover test plot design and geomorphic slope guidance, as discussed in Section 5.10 on Reclamation Research.

5.7 Structures and Equipment

No structures or equipment was reclaimed in 2023.

5.8 Waste Dump Reclamation

Progressive reclamation is being practiced by MPMC as described in the following sections. Table 5.2 details the progressive reclamation completed to date.

Table 5.2 Progressive reclamation completed at Mount Polley Mine as of December 31, 2023

Area	Parcel	Re-contoured (ha)		Soil/Till Applied (ha)		Seeded (ha)		Fertilizer/Biosolids (ha)		Tree-Planted (ha)	
		2018	Total	2018	Total	2018	Total	2018	Total	2018	Total
NEZ Dump	2a, 2b1, 2b2	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13	0.00	5.13
	Beside 2a/2b	0.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NBD	Parcels 1 - 10	0.00	9.45	0.00	11.59	0.00	11.59	0.00	11.59	0.00	11.59
	South Triangle	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30	0.00	1.30
	Phase 1	0.00	2.21	0.00	2.21	0.00	2.21	0.00	2.21	2.21	2.21
	Phase 2	0.00	2.87	0.00	2.87	0.00	2.87	0.00	2.87	2.87	2.87
	Metro Van Research 1	0.00	2.81	0.00	2.81	0.00	1.87	0.00	2.34	0.00	2.34
	Wrap Around Toe	0.00	0.00	0.00	2.20	0.00	2.20	0.00	0.00	0.00	0.00
	Beside Research 1	0.00	4.76	0.00	1.99	0.00	0.00	0.00	0.00	0.00	0.00
	Metro Van Research 2	0.00	2.00	0.00	2.00	0.00	1.33	0.00	1.66	0.00	2.00
	Beside Research 2	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Beside BJ FSR	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boundary Zone	Dump	0.00	4.70	0.00	4.70	0.00	0.00	0.00	0.00	4.70	4.70
East RDS	Above Access Road	0.00	3.42	0.00	4.06	0.00	4.06	0.00	0.00	2.75	2.75
	Highway to Heaven	0.00	11.53	2.89	9.47	0.00	6.58	0.00	0.00	9.47	9.47
	Tree Plots	0.00	2.31	0.00	2.31	0.00	2.31	0.00	1.20	0.00	2.31
Waste Haul Road	Above WHR	0.00	1.81	0.00	1.81	0.00	1.81	0.00	0.00	0.00	0.00
	Below Helipad	0.00	1.53	0.00	1.53	0.00	1.53	0.00	1.53	0.00	1.53
South Till Borrow		0.00	23.25	0.00	0.00	0.00	14.75	0.00	12.00	0.00	0.00
	TOTAL	0.00	85.18	2.89	55.98	0.00	59.54	0.00	41.83	22.00	48.20

5.8.1 Waste Dumps: North Bell Dump

No new reclamation work was completed on the North Bell Dump in 2023. Monitoring of past reclamation work is ongoing.

5.8.2 Waste Dumps: NEZ Dump

No new reclamation work was completed on the North East Zone Dump in 2023. Monitoring of past reclamation is ongoing.

5.8.3 Waste Dumps: Boundary Dump

No new reclamation work was completed on the Boundary Dump in 2023. Monitoring of past reclamation is ongoing.

5.8.4 Waste Dumps: East RDS

No new reclamation work was completed on the East Rock Disposal Site in 2023. Monitoring of past reclamation is ongoing.

5.8.5 Watercourse Reclamation

No watercourse reclamation was conducted in 2023.

5.8.6 Pit Reclamation

No pit reclamation was conducted in 2023. The Bell Pit, Pond Zone Pit, and Southeast Zone (SEZ) Pit have been backfilled by waste dumps and will not require reclamation. The Wight pit remained flooded in 2023.

5.8.7 TSF Reclamation

No reclamation was conducted at the TSF in 2023.

5.8.8 Road Reclamation

No road reclamation was conducted in 2023.

5.8.9 Securing of Mine Openings

There was no sealing or securing of any Mine entrances in 2023. The only underground portal is located in the flooded Wight Pit and is currently submerged.

5.9 Disposal of Hazardous Materials, Chemicals and Reagents

Mount Polley Mine operations utilizes potentially hazardous chemicals, reagents, and other products that are subject to waste disposal procedures. In 2023, hazardous and non-hazardous waste was generated and GFL Environmental Ltd. routinely removed and disposed of waste products compliant with relevant regulations. Materials that are routinely segregated and removed include aerosol cans; contaminated gasoline and diesel; waste oil (in drums); waste oil filters; waste grease fuel or oil-soaked rags, debris, and floor dry; and leachable liquid toxic waste, such as glycol/anti-freeze mix. The site bulk waste oil tanks are emptied, and the oil removed from site by GFL Environmental Ltd. GFL Environmental Ltd. acts as an advisor for waste management activities that are not routine. MPMC is registered with ENV under the *Hazardous Waste Regulation* (Ministry of Attorney General, 2017) for generation and temporary storage of these materials.

5.9.1 Recycling

MPMC recognizes the value of responsible waste management and recycling plays a big role in site waste management practices. Mount Polley continues to recycle used materials including waste oil, scrap steel, batteries, plastic pails, electronic waste, light bulbs and associated fixtures, paper, cardboard, and beverage containers. In 2020, very little recyclable materials were generated at the mine and were stored temporarily. Removal of recycled materials from site continued in 2023. Mount Polley donates funds generated by its

beverage container recycling program to the Big Brothers and Big Sisters of Williams Lake. Recycling and waste management educational presentations are a part of the mandatory site orientation given to Mount Polley employees, contractors and visitors.

5.10 Reclamation Research

In 2021, a Reclamation Research Program (MPMC 2021e) was submitted to EMLI under Permit M-200. It outlines future planned and ongoing reclamation research. A large number of topics are covered in this document, including water management, revegetation, culturally important species, post-closure ecosystems, disturbance mitigation, ecological succession, soil amendment, landform modelling, erosion control, and many others. Figure 5.1 illustrates how these activities are inter-related, and link to reclamation objectives outlined in 2017 Reclamation and Closure Plan (MPMC, 2017a) and further built upon in the *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022).

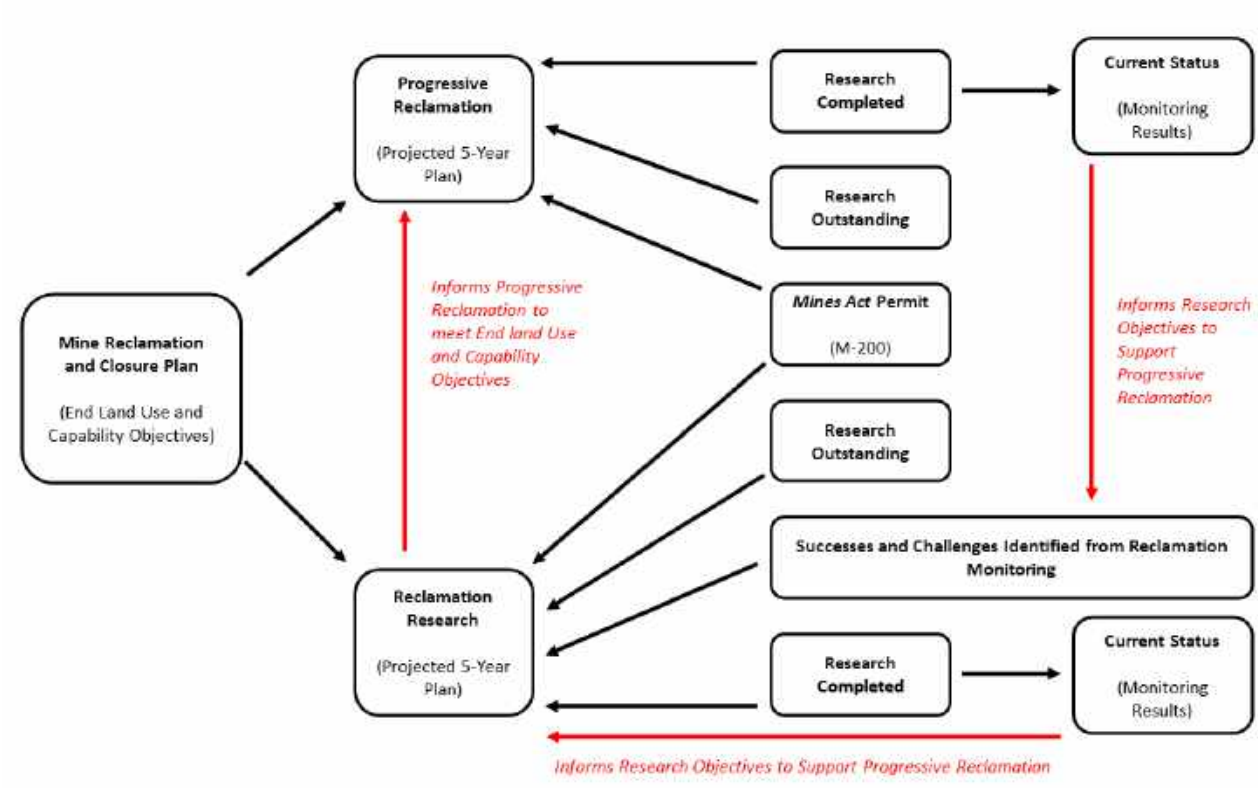


Figure 5.1 Mine reclamation activities and their relationships, under the 2021 Reclamation Research Program

In 2023 water management including long-term planning, passive treatment, and distributed discharge was a focus for reclamation research. Information on ongoing and past reclamation research can be found in

the MPMC AERRs and AERs from 2010 to 2022. Additional information can be found in MPMC's biannual Water Treatment and Discharge Program Progress Reports from 2018-2023. The *Mine Plan and Reclamation Program Update 2022* further builds on concepts outlined in the 2017 *RCP* (MPMC, 2017) and includes an adaptive management and planning framework. As part of adaptive management, results from research programs will be incorporated where opportunities exist. MPMC relies upon experience, topic specific experts, and research findings to identify methods for achieving reclamation and closure activities. Figure 5.2 shows the Adaptive Management Cycle.

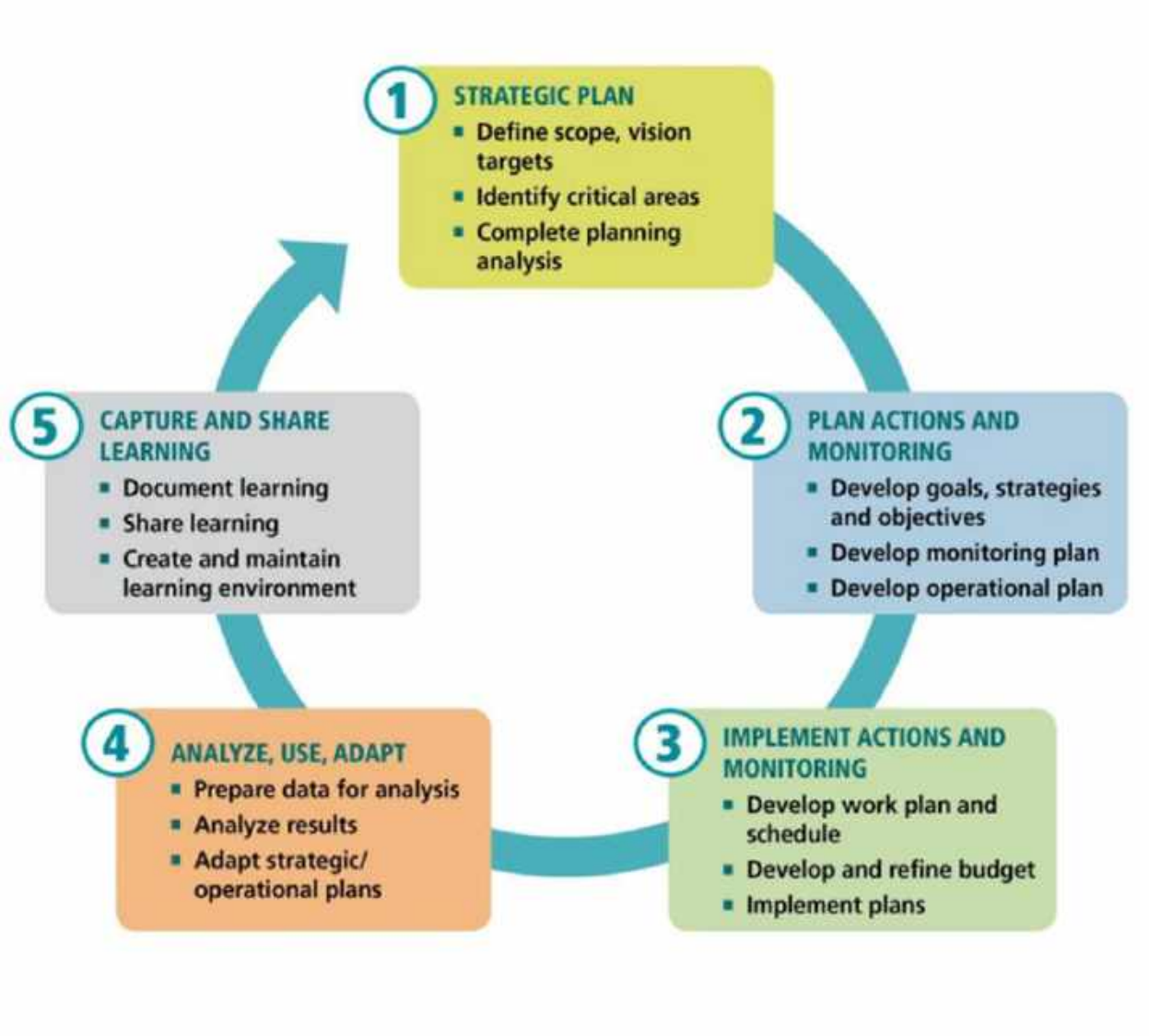


Figure 5.2 Adaptive Management Cycle, under the Mine Plan and Reclamation Program Update 2022

5.10.1 Biosolids

In 1999, the ENV issued MPMC a permit to import biosolids from the Greater Vancouver Regional District (now Metro Vancouver) for the purpose of mine site reclamation (*EMA* Permit 15968). After initial receipt

and stockpiling of the biosolids shipments in 2000, the program was suspended due to the temporary closure of the Mine; biosolids shipment recommenced in 2007. In 2014, *EMA* Permit 15968 was amended to include:

- An increase in the maximum rate of land application from 150 dry tonnes (dt)/ha to 165 dt/ha;
- An increase in the maximum cumulative discharge from 90,000 dt to 99,000 dt;
- Revised references to MPMC land claims and an updated site plan; and
- The allowance of two designated storage facilities.

Currently there is only one biosolids stockpile on site, located near the TSF. Table 5.3 provided by Metro Vancouver, summarizes biosolids deliveries and applications at Mount Polley from 2000 to 2014. No biosolids were used on site in 2023 and no changes to storage facility volumes have been made since 2014. Results from the annual storage facility sample can be found in ***Appendix U***.

Table 5.3 Metro Vancouver biosolids deliveries and applications at Mount Polley (2000 – Present)

Mt Polley Inventory, Updated: Mar. 7, 2018							
Stockpile Location	**Delivery Date**			**Biosolids Delivered**			
				Annacis	Lulu	Total (wt)	Total (*dt*)
Tailings Storage Facility Stockpile (Area 1)	2000/01 inventory				10,754	10,754	*2581*
	Feb 7 - Nov 2, 2007				4,641	4,641	*1114*
	Aug 5 - Nov 1, 2009			7,101	124	7,225	*2160*
	Jan 1 - Nov. 12, 2010			16,136	42	16,178	*4367*
	Apr 4 - 14; July 4, 2011			1,206		1,206	*338*
	Apr 25 - Sept. 4, 2013			9,664		9,664	*2706*
NEZ	Sep 28 - Nov 19, 2008			3,875		3,875	*1163*
	Apr 15 - May 29, 2011			5,058		5,058	*1416*
North Bell	2012 deliveries: MPMC "Area 2" (May 30 - June 17)			1,060		1,060	*297*
	2012 deliveries: MPMC "Area 1" (June 18 - July 31)			1,482		1,482	*415*
	2013 Deliveries: Tree Trial Plots (Sept. 28 - Oct. 6)			960		960	*269*
	2014 Deliveries : Tree Trial Plots (May 21 - 27)			706		706	*198*
	Delivered 2000-to-present			**47,247**	**15,561**	**62,808**	***17022***
Applications	**Site ID**	**ha**	**rate (dt/ha)**	**Biosolids Utilized**			
				Annacis	Lulu	Total (wt)	Total (*dt*)
	tree research plots (circa 2000/01)				234	234	*56*
	NEZ - **2008**			3,875		3,875	*1,163*
	North Bell Roadside Slopes (Areas 1 - 10) - **2011**	11.6	122	5,058		5,058	*1,416*
	North Bell (Areas 11 - 19) - **2012**	5.1	140	2,542		2,542	*712*
	North Bell Tree Trial Plots (Plots 2-6) - **2013**	2.3	104	960		960	*269*
	North Bell Tree Trial Plots (Plots 8-12) - **2014**	1.7	118	706		706	*198*

						-	
	CONFIRMED - APPLIED/USED to date			13,141	234	13,375	*3,813*
	Carry Over (at TSF)			34,106	15,327	49,433	*13,209*

5.10.1 Water Treatment Technology Development

Multiple water treatment technologies continue to be investigated for the operational, closure and post-closure phases of the mine. Details of the development of these technologies can be found in the bi-annual Water Treatment and Discharge Program Progress Reports that are prepared in compliance of Section 2.12 of Permit 11678. Progress Reports #12 (January 1 to June 30, 2023) and #13 (July 1 to December 31, 2023) can be found in ***Appendix W***. Additional details can be found in the *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022), which will be submitted under a separate cover.

Geomorphic Slope Guidance

A Geomorphic Slope Guidance (Golder, 2017b) document was developed to provide guidelines for site slope recontouring and stream rehabilitation at and around the Mount Polley Mine and will also provide guidance for engineering works that would result in a natural looking slope upon closure. This guidance document will aid in long-term water management.

Soil Cover Test Plot Design

The Soil Cover Test Plot (Golder, 2018a) work, when completed may provide guidance to determine a reclamation cover soil design that reduces infiltration of water into and mass loading of constituents from waste rock disposal sites. This work may also become part of long-term water management.

5.11 Five Year Reclamation Plan

MPMC has an updated *Mine Plan and Reclamation Program Update 2022* (MPMC, 2022) which outlines the development of further reclamation planning. It should be noted that several areas have been identified as candidates for progressive reclamation but there are no immediate plans for completing the work. Work in the next five years will focus on monitoring of progressive reclamation and research projects. Table 5.4 outlines the tentative schedule for Reclamation Research as outlined in the Reclamation Research Plan (MPMC 2021e).

Table 5.4 Tentative schedule for research projects in the projected 5-year Reclamation Research Plan

Task	Duration	Start	Finish	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10 (mine closure)
Water Management Strategies and Post-Closure Maintenance and Contingency Requirements: Research Requirement (c)	Year 1-Year 10	Year 1	Year 10[1]	Dependent on water management system									
Species-Specific Planting Trials: Research Requirement (d)	Year 1 - Year 10	Year 1	Year 10	Establish New Test Plots	Continue Current Monitoring			Establish Test Plots surrounding the TSF	Monitor				
Methods for Reducing High Competing Grass Cover: Research Requirement (g)	5 year period	Any year	5 years from initiation	As required									
Soil Replacement Plan: Research Requirement (i) **does not include TSF	5 year periods	Year 1	Year 10	Establish Test Plots within areas that do not have plots	Monitor								
Management for Invasive Plants: Research Requirement (i)	As needed	Year 1	Year 10	Survey & Treat	Monitor treatment effectiveness, retreat as required								
Reclamation Prescription for the TSF: Research Requirement (j)	5 year period	5 years prior to mine closure	Year 10					Establish Test Plots	Monitor				
Assessment of Soil Decompaction Methodologies: Research Requirement (k)	5 year period	5 years prior to mine closure	Year 10					Determine Areas of Severe Compaction & Establish Test Plots	Monitor				
Cumulative Effects of Fertilization and Biosolids Application: Research Requirement (o)	Up to 30 days	Prior to application of fertilizer/biosolids	Up to 30 days post-treatment	As required									

Note: current mine closure date estimated to be 2031.

[1]Passive water treatments and watercourse restorations may not have a finish date.

Notice of Departures

TABLE 6

ANNUAL SUMMARY OF NEW DISTURBANCE THROUGH DEPARTURE OF APPROVALS TO DECEMBER 31, 2023

COMPANY: Mount Polley Mining Corporation

PERMIT NO.: M-200

Name of Notice of Departure Activity*	Area of New Disturbance (ha)**	Reclamation Activities Completed (Yes/No)***	Estimated Reclamation Liability for Disturbance.
Custom Milling of Bonanza Ledge Ore issued March 23, 2023	0	No	0
Mill Site Sump Removal issued June 12, 2023	0	No	0
TSF Foundation Preparation issued Nov 16, 2023	0	No	0
SERDS Cell Modification	0	No	0
	Total Area:0		**Total Cost:0**

* Provide the name of Notice of Departure activity (e.g. North Pit geotechnical drill program).

** Identify the area of new disturbance (include disturbance to previously revegetated areas).

*** Indicate whether reclamation activities have also completed for the associated NoD disturbance

6 Reclamation Liability Cost Estimates

As per the "Mines Act Permit Annual Reclamation Report – General Information and Format Requirements" (EMLI 2022), MPMC will be file reclamation liability cost estimate information under a separate, confidential report.

7 Signatures



_____

Gabriel Holmes
Environmental Coordinator
Mount Polley Mining Corporation



_____

Richard Tuohey
Chief Engineer
Mount Polley Mining Corporation

8 References

Cariboo Chilcotin Coast Invasive Plant Committee [CCCIPC]. (2018). *2018 Regional Strategic Plan for Invasive Plant Management* and *Executive Summary*. Retrieved from the CCCIPC website: http://cccipc.ca/index.php/S=0/resources/regional-strategic-plans

Environment and Climate Change Canada [ECCC], (2019). *Metal and Diamond Mining Effluent Regulations*. Fisheries Act SOR/2002-22. Retrieved from Justice Laws website: https://laws-lois.justice.gc.ca/PDF/SOR-2002-222.pdf

Ministry of Energy, Mines, and Petroleum Resources [EMLI]. (2017). *Health, Safety and Reclamation Code for Mines in British Columbia*. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/health-and-safety/code-review/health_safety_and_reclamation_code_2017_rev.pdf

EMLI. (2022). Mines Act Permit Annual Reclamation Report – General Information and Format Requirements. Updated December, 2022.

EMLI and ENV. (2019). *Joint Application Information Requirements for Mines Act and Environmental Management Act Permits (JAIR)*. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/environment/waste-management/industrial-waste/industrial-waste/mining-smelt-energy/2019_09_24_joint_application_information_requirements.pdf

DWB Consulting Services, Ltd. [DWB]. (2021a). *Updated Scope for Terrestrial Wildlife Monitoring Plan for the Hazeltine Creek Corridor*. Submitted to MPMC, October 27, 2021.

DWB. (2021b). Mount Polley Mine Wildlife Management Plan. Submitted to MPMC, March 11, 2021.

Ministry of Environment and Climate Change [ENV]. (1981). *Snow Survey Sampling Guide*. Surface Water Section, Water Management Branch, Province of British Columbia. Retrieved from the BC government website: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/snow/snow_survey_sampling_guide.pdf

ENV. (2013). *British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples*. Retrieved from the BC government website: https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

ENV. (2021). *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary.* Water Quality Guideline Series, WQG-20. Prov. B.C., Victoria B.C.

Ministry of Forests, Lands, and Natural Resource Operations [FLNRO]. (2021). *Forest and Range Practices Act*. SBC 2002 Chapter 69.

Golder Associates Ltd., [Golder]. (2015). *Mount Polley Mine: Short Term Effluent Discharge Technical Assessment Report in Support of an Effluent Permit Amendment*. Report prepared for MPMC. May 29, 2015.

Golder. (2016a). *Mount Polley Mine – Prediction of Water Level and Seepage from the Springer Pit and Bootjack Lake Water Quality Technical Memorandum*. Prepared for MPMC, March 7, 2016.

Golder. (2016b). *Mount Polley Mine: Long-Term Water Management Plan Permit Amendment Application under the Environmental Management Act Technical Assessment Report.* Prepared for MPMC, October 17, 2016.

Golder. (2017a). *Geomorphic Slope Guidance Document*. Prepared for MPMC, December 15, 2017.

Golder (2017b). *Assessment of a Full Scale In Situ Pit Lake Treatment for Springer Pit and Wight Pit*. Prepared for MPMC, January 31, 2017.

Golder. (2018). *Soil Cover Test Plots Design, Construction, and Performance Monitoring*. Prepared for MPMC, June 1, 2018.

Golder. (2020). *Mount Polley Water Management Plan (Mine Operations)*. Prepared for MPMC, November 27, 2020.

Golder (2021) *Toxicity Testing Evaluation of Magnafloc 338.* Prepared for MPMC, 20 December 2021.

Hudson, R., and J. Fraser, (2005). *Introduction to salt dilution gauging for streamflow measurement, part IV: the mass balance (or dry injection) method.* Streamline Watershed Management Bulletin, 9(1), 6-12.

ISO Standard 14001. (2015). Environmental Management Systems. International Organization for Standardization.

Knight Piésold Ltd, (2009). *Chemical Characterization of the Proposed Effluent for Discharge to Hazeltine Creek*. Letter to Mr. Ron Martel, Mount Polley Mining Corporation from Amanda Strouth, Greg Smythe and Ken Brouwer. May 11, 2009.

Litke. 2019. *An Investigation into Determining the Source of Elevated Metal Concentrations in Seepage at Mount Polley Mine*, Thesis, Applied Science, Materials Engineering, University of British Columbia, Vancouver

Ministry of Attorney General. (2017). *Hazardous Waste Regulations.* Environmental Management Act. Retrieved from the BC government website: https://www2.gov.bc.ca/gov/content/environment/waste-management/hazardous-waste/legislation-regulations

MPMC. (2014). *2013 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2014.

MPMC. (2015a). *Post-Event Environmental Impact Assessment Report – Key Findings Report*. Prepared for MPMC by Golder Associates. Submitted to Ministry of Environment, June 5, 2015.

MPMC. (2015b). *2014 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2015.

MPMC. (2016a). *Update Report: Post-Event Environmental Impact Assessment Report*. Submitted to Ministry of Environment, June 3, 2016.

MPMC. (2016b). *2015 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2016.

MPMC. (2017a). *Mine Reclamation and Closure Plan Update January 2017*. Submitted to Ministry of Energy and Mines, March 15, 2017.

MPMC. (2017b). *Human Health Risk Assessment Technical Report*. Prepared by Golder Associates for Mount Polley. Submitted to the Ministry of Environment, May 11, 2017.

MPMC. (2017c). *Ecological Risk Assessment Technical Report*. Prepared by Golder Associates for Mount Polley. Submitted to the Ministry of Environment, December 15, 2017.

MPMC. (2018). *2017 Annual Environmental and Reclamation Report*. Submitted to Ministry of Environment and Ministry of Energy and Mines, March 31, 2018.

MPMC. (2021a). *Quality Assurance/Quality Control Manual*. Submitted to the Ministry of Environment, January 20, 2021.

MPMC. (2021b). *Reclamation Research Program*. Submitted to Ministry of Energy and Mines, May 18, 2021.

MPMC. 2022. *Mine Plan and Reclamation Program Update 2022*. Submitted to Ministry of Environment, December 2022.

MPMC. 2023a. *Water Treatment and Discharge Progress Report #12*. Submitted to Ministry of Environment, June 19, 2023.

MPMC. 2023b. *Water Treatment and Discharge Progress Report #13*. Submitted to Ministry of Environment, December 31, 2023.

MPMC. 2023c. Dangerous Goods DGIR#231129 End of Spill Report. Submitted to Ministry of Environment, April 25, 2023.

MPMC. 2024. 2024 BAT Assessment Plan. Submitted to Ministry of Environment on January 31, 2024.

Seametrics. (2016). *INW PT2x Pressure/Temperature Smart Sensor and Data Logger Instructions*. Seametrics, Kent Washington, USA.

SRK Consulting Inc. [SRK] (2015a). *Mount Polley Mine Tailings Dam Failure: Update on Geochemical Characterization of Spilled Tailings Technical Memorandum.* Prepared for and submitted to MPMC, November 2015.

SRK. (2015b). *Mount Polley Geochemical Characterization of Ore Stockpiles Technical Memorandum*. Prepared for and submitted to MPMC, October 2015.

SRK. (2016). *Derivation of Geochemical Source Terms, Mount Polley Mine Technical Memorandum*. Prepared for MPMC, September 2016.

SRK. (2022). *Metal Leaching/Acid Rock Drainage Characterization and Monitoring Program- 2022 Annual Report*. Prepared for MPMC, March 2023.

SRK. (2023). *Metal Leaching/Acid Rock Drainage Characterization and Monitoring Program- 2023 Annual Report*. Prepared for MPMC, March 2024.

Tetra Tech Inc. (2016). *Expected Plume Location by Month Technical Memorandum*. Prepared for MPMC, December 19, 2016.

Tetra Tech Inc. (2018). Quesnel Lake Monitoring Review: 2018 Technical Memorandum. Prepared for MPMC, March 7, 2019.

Tetra Tech Inc. (2019). *Quesnel Lake Monitoring Review: 2019 Technical Memorandum.* Prepared for MPMC, March 23, 2020.

WSP Canada Inc. [WSP]. 2024. *2022 Hazeltine Channel Groundwater Monitoring Program*. Prepared for MPMC, February 1, 2024.

Westgate, M.J., E.L. Gene, B.L. Lindenmayer. (2013). Adaptive Management of Biological Systems: A Review. Biological Conservation 158: 128-139.

Appendix A – EMA Permit 11678 and CEMP (Electronic format only)

Appendix B – Site locations and Maps

Appendix C – Annual Status Report

Appendix D – Quality Assurance/Quality Control (Electronic format only)

Appendix E – Climate Monitoring Results (Electronic format only)

Appendix F- Surface, Contact, and Drainage Water Quality Results (Electronic format only)

Appendix G- Groundwater Review (WSP) (Electronic format only)

Appendix H- Discharge Water Quality and Toxicity Test Results (Electronic format only)

Appendix I- Annual Discharge Plan

Appendix J- Quesnel Lake Dispersion Modeling (Electronic format only)

Appendix K- Minnow Environmental Reports (Electronic format only)

Appendix L- Hydrological Monitoring

Appendix M- Lake Water Quality and Zooplankton Results (Electronic format only)

Appendix N- Terrestrial Monitoring (DWB) (Electronic format only)

Appendix O- Water Quality Comparison and Water Balance Calibration (WSP) (Electronic format only)

Appendix P- Archaeological Report (WSP) (Electronic format only)

Appendix Q- ML/ARD Characterization and Monitoring Program Annual Report (SRK) (Electronic format only)

Appendix R – Investigation Reports (Electronic format only)

Appendix S – Compliance Inspection Findings

Appendix T – Reclamation Research Report (Electronic format only)

Appendix U – Biosolids Management Plan (Electronic format only)

Appendix V – ML/ARD Management Procedure Manual Update

Appendix W – Progress Reports #12 and #13)

Appendix X – Invasive Plant Monitoring Report (DWB) (Electronic format only)

Appendix A

Permit 11678 and CEMP

(Electronic format only)



BRITISH COLUMBIA

File: 11678

March 14, 2019

Dale Reimer
Mount Polley Mining Corporation
Suite 200 – 580 Hornby St
Vancouver BC V6C 3B6

Dear Mr. Reimer:

RE: Amendment of the November 9, 2018 Approval of the August 15, 2018 Comprehensive Environmental Monitoring Plan (CEMP) – Mount Polley Mine Permit #11678

The August 15, 2018 CEMP was approved in my letter of November 9, 2018 (see attached).

On December 6, 2018, the Mount Polley Mining Corporation (MPMC) met with the Ministry of Environment & Climate Change Strategy (ENV) and the Government to Government Technical Working Group (G2G TWG) via phone conference to receive some clarification on the CEMP approval conditions in the November 9, 2018 letter.

On January 7, 2019, MPMC submitted to ENV a letter requesting clarification and changes to some of the November 9, 2018 CEMP Approval letter conditions.

The January 7, 2019 request by MPMC has been reviewed by the G2G TWG and comments have been provided to ENV based on this review.

Based on the recommendations from the G2G TWG, this letter provides clarification and revisions to the November 9, 2018 approval letter. The conditions of the November 9, 2018 approval letter are revised as follows:

Condition 3) is replaced by the following wording:
Sampling at Quesnel Lake operational surface water monitoring stations (stations identified in Table 6.6 of the August 15, 2018 CEMP) must occur while the discharge to Quesnel Lake is occurring, for those sites where water quality monitoring happens less frequently than monthly (i.e., four times per year or semi-annually). In the event of an unexpected shutdown of the water treatment plant, MPMC must extend reasonable efforts to re-sample within the timeframe of the quarterly or other specified time period sampling upon restart of effluent discharge to Quesnel Lake.

Condition 4) is replaced by the following wording:
For this condition, samples include both water chemistry samples and depth profile samples.

Ministry of Environment and Climate Change Strategy
Mining Operations
Environmental Protection Division
Mailing Address:
Suite 400-640 Borland Street
Williams lake BC V2G 4T1
Telephone: 250 398-4542
Facsimile: 250 398-4514
Website: www.gov.bc.ca/env

Samples from HAD-3 must be collected on the same day as samples are collected at any Quesnel Lake sample location (i.e. QUL-58, -57, or -59) in order for comparisons to be made between water quality in the lake and in the discharge. QUL-57, QUL-58 and QUL-59 must all be sampled within a one-week period. Sampling at QUL-57 and QUL-59 must include consistent sample depths with QUL-58. The profiling depths at each Quesnel Lake sample location must be matched to the water chemistry sample depths to allow comparisons over time and between sites.

The sample depths shall be the following:
a) if plume is detected samples must be collected mid plume, 5m above plume and 5m below plume; and
b) if plume is not detected samples must be collected from surface, 1m above thermocline and 1m below thermocline (or mid-depth if no thermocline exists), and from bottom

Condition 8) is replaced by the following wording:
MPMC must report in the Quarterly and Annual Reports the results of all toxicity testing conducted as required in the permit and by the Metal and Diamond Mine Effluent Regulation (MDMER).

Condition 9) is replaced by the following wording:
Phytoplankton community composition and chlorophyll a often vary significantly from month to month during the summer. To ensure representative and meaningful data, three samples of phytoplankton community and chlorophyll a samples must be collected in Polley and Quesnel Lakes between June and September. These samples must be collected at least 30 days apart.

Condition 11) is replaced by the following wording:
To help understand what caused the discrepancy between the copper concentration in overlying water in the test and the DGT results, MPMC must continue to conduct monitoring in the shallow areas of Polley and Quesnel Lakes using DGTs. The DGTs must be deployed in a manner and frequency that will allow for monitoring of mobile metals. If the results of DGT monitoring indicate a significant increasing trend between years and potential effects to aquatic receptors are reasonably anticipated, MPMC must submit to the Director for approval a monitoring plan to assess the potential effects of increased metal concentrations detected by the DGTs.

MPMC must conduct toxicity tests with Hyalella azteca using sediment of shallow habitat from Polley and Quesnel Lakes for at least one year to determine potential effects. During 2019, five replicates of sediment samples each must be collected from shallow areas of Polley and Quesnel Lakes where tailings and breach materials were deposited to be used for a 14-day sediment toxicity test on Hyalella azteca and for sediment chemistry analysis. If no effect to Hyalella

azteca is detected in these tests, Hyalella azteca toxicity testing in Polley and Quesnel Lakes may be discontinued upon approval by the Director following submission of a summary report.

Conditions 14) and 15) are rescinded.

Condition 17) remains as approved in the November 9, 2018 CEMP approval letter.

Submission date for an updated CEMP that is to include all items as listed under a) to m) of Approval Condition 20) of the November 9, 2018 CEMP approval letter, is hereby changed to October 31, 2019.

All other conditions in the November 9, 2018 CEMP approval letter remain in effect.

If you have any questions regarding this letter, please contact Gabi Matscha at 250-371-6296 or Gabriele.Matscha@gov.bc.ca.

Sincerely,

Douglas Hill, P. Eng.
for Director, *Environmental Management Act*

ec: Aaron Higginbottom, Sr. Natural Resources & Economic Development Manager, Williams Lake Indian Band, T'exelc
Scott Scholefield, Natural Resources Manager, Soda Creek First Nations, Xatśūll

BRITISH COLUMBIA

July 15, 2019 Authorization Number: 11678

Dale Reimer
Mount Polley Mining corporation
Suite 200 – 580 Hornby St.
Vancouver BC V6C 3B6

Dear Mr. Reimer:

RE: Amendment of the November 9, 2018 and March 14, 2019 Approval of the August 15, 2018 Comprehensive Environmental Monitoring Plan (CEMP) – Mount Polley Mine Permit #11678

The August 15, 2018 CEMP was approved in my letter of November 9, 2018 (see attached). My letter of March 14, 2019 (see attached) provided a few amendments to the original approval letter of November 9, 2018.

On May 29, 2019, we received a request for changes to Section 6.14 of the approved CEMP via e-mail. The requested changes were outlined in a letter of May 28, 2019 by Minnow Environmental Inc. to the Mount Polley Mining Corporation (MPMC), which recommends changes to the Mount Polley zooplankton and phytoplankton monitoring programs.

The request by MPMC has been reviewed by the Government to Government Technical Working Group (G2G TWG).

Based on the recommendations from the G2G TWG, this letter provides the following revisions to the November 9, 2018 and March 14, 2019 approval letters and Section 6.14 of the approved August 15, 2018 CEMP:

- **For phytoplankton (community and biomass), zooplankton (community, biomass and tissue chemistry) and chlorophyll *a* from Quesnel Lake, Polley Lake and Bootjack Lake, three samples must be collected between June 15 and September 15. These samples must be collected at least 30 days apart. During the 2nd of the three sampling events (preferably in July), 5 replicate samples are to be collected at each site. One sample is to be collected at each site during the 1st and 3rd sampling event.**
- **Zooplankton and phytoplankton samples from a given lake must be collected on the same day.**

.../2

Ministry of Environment and Climate Change Strategy
Mining Operations
Environmental Protection Division
Mailing Address:
Suite 400-640 Borland Street
Williams Lake BC
V2G 4T1
Telephone: 250 398-4530
Facsimile: 250-398-4514
Website: www.gov.bc.ca/env

- **Sample sites for the above zooplankton and phytoplankton program must include:**
  - **In Quesnel Lake, one exposed area (QUL-ZOO-1, west of the mouth of Hazeltine Creek) and one reference area (QUL-ZOO-7, east of Horsefly Bay);**
  - **In Polley Lake one exposed area at P2;**
  - **In Bootjack Lake one reference area at B1.**
- **Sampling methods must include the following:**
  - **50-micron mesh zooplankton nets must be used at all sample sites. At sites where a 150-micron mesh net had been used so far, sampling must occur with both mesh sizes, the 50-micron mesh size and the 150-micron mesh size, in 2019 to enable an assessment of the difference in results and to allow comparisons of historical results with data collected in the future.**
  - **Zooplankton sample nets must have a mouth diameter that is larger than 0.5 metres and must be equipped with a flow meter. The zooplankton collection must be conducted using a modified horizontal tow method.**
  - **The phytoplankton collection must be conducted using a depth-integrated methodology. This can be achieved by collecting water from at least four discrete depths per station (surface, one-third Secchi depth, two-thirds Secchi depth, and total Secchi depth) using a sampler such as a Kemmerer or Van Dorn sampler, by using a length of flexible tubing modified for this purpose with or without a peristaltic pump.**
    - **In order to determine if results of historic surface collection of phytoplankton is comparable to the depth integrated method going forward, additional phytoplankton surface samples must be collected at and analysed for each site in 2019.**
  - **Secchi-depth and in situ water-chemistry supporting data should be collected at each station within each area (n = 5 in July, n= 1 in June and August) during all three sampling seasons and recorded.**
- **Sample Analysis:**
  - **Laboratory analysis should be completed by a single lab for all zooplankton community monitoring (as opposed to one lab for Quesnel Lake and a different one for Polley Lake).**
  - **Laboratory QC reanalysis of 10% of all samples shall be completed for zooplankton and phytoplankton community samples.**
  - **Biomass shall continue to be measured for zooplankton and phytoplankton samples from Quesnel Lake, as well as the addition of biomass estimates for Polley Lake.**

All other conditions in the November 9, 2018 and the March 14, 2019 CEMP approval letters remain in effect.

If you have any questions regarding this letter please contact Gabi Matscha at 250-371-6296 or Gabriele.Matscha@gov.bc.ca.

Sincerely,

Douglas Hill, P. Eng.
for Director, *Environmental Management Act*
Regional Director – Mining

cc: Aaron Higginbottom, Williams Lake Indian Band, T'exelc
Edna Boston, Soda Creek Indian Band, Xatśūll First Nation

Attachments:

- CEMP Approval Letter of November 09, 2018
- CEMP Letter with revised conditions of March 14, 2019

Mount Polley Mining Corporation

an Imperial Metals company
Box 12 • Likely, BC V0L 1N0 • T 250.790.2215 • F 250.790.2613

Comprehensive Environmental Monitoring Plan 2019

Submitted to:

Ministry of Environment and Climate Change Strategy
Environmental Protection Division
South Interior Region – Cariboo

Prepared by:

Mount Polley Mining Corporation
Environmental Department

Box 12, Likely BC
V0L 1N0

(250) 790-2215

Date: October 31, 2019

Table of Contents

LIST OF TABLES **IV**

LIST OF FIGURES **VI**

LIST OF APPENDICES **VII**

ACRONYMS **VIII**

1 INTRODUCTION **1**

1.1 Objectives 4

2 INTEGRATION OF MONITORING ACTIVITIES **6**

2.1 Monitoring Drivers and Objectives 7

2.2 Monitoring Components and Conceptual Site Model 8

2.3 Adaptive Management Framework 15

3 FIRST NATIONS AND STAKEHOLDERS **16**

3.1 First Nations Engagement 16

3.2 Public Liaison Committee 16

3.3 Communication Plan 16

4 MOUNT POLLEY MINE PROJECT OVERVIEW **17**

4.1 Project History 17

4.2 Current Operations 18

4.3 Environment 18

5 ENVIRONMENTAL MANAGEMENT **22**

5.1 Water Management 22

5.2 Sediment and Erosion Control Management Plan 24

5.3 Invasive Plant Management Plan 24

5.4 Dust Management Plan 24

5.5 Project Environmental Monitoring Plans 24

5.6 Waste Management 24

5.7 Incident Reporting 25

5.8 Inspections 25

6 MONITORING 26

6.1 SCHEDULING 26

6.2 FIELD METHODS 26

6.3 LABORATORY ANALYSIS 26

6.4 DATA QUALITY REVIEW AND DATA MANAGEMENT 27

6.5 CLIMATE MONITORING 27

6.6 SURFACE WATER MONITORING 31

6.7 HYDROLOGY MONITORING 44

6.8 GROUNDWATER MONITORING 52

6.9 CONTACT WATER QUALITY MONITORING 60

6.10 SEEP MONITORING 65

6.11 EFFLUENT MONITORING 70

6.12 SEDIMENT QUALITY MONITORING 79

6.13 BENTHIC INVERTEBRATE MONITORING 81

6.14 PLANKTON AND CHLOROPHYLL *A* MONITORING 83

6.15 PERIPHYTON MONITORING 90

6.16 FISH MONITORING 92

6.17 WILDLIFE MONITORING 94

6.18 AMPHIBIAN AND REPTILE MONITORING 98

6.19 SOIL MONITORING 99

6.20 SOIL INVERTEBRATE MONITORING 101

6.21 VEGETATION MONITORING 103

6.22 BIOSOLIDS MONITORING 105

7 CEMP UPDATES AND REVISIONS 106

8 RECLAMATION AND REMEDIATION 107

9 REPORTING 108

9.1 MONTHLY REPORTING 108

9.2 QUARTERLY REPORTING 108

9.3 ANNUAL REPORTING 108

9.4 THREE-YEAR REPORTS 108

10 FUTURE OUTLOOK **110**

11 REFERENCES **111**

LIST OF TABLES

Table 4.1 Summary of Permit 11678 amendments 17
Table 6.1 Climate monitoring overview 28
Table 6.2 Summary of climate monitoring 30
Table 6.3 Surface water chemistry parameters 34
Table 6.4 Surface water monitoring overview 35
Table 6.5 Summary of surface water monitoring 40
Table 6.6 Operational monitoring changes since the 2016 CEMP 41
Table 6.7 Post-breach monitoring changes since the 2016 CEMP 43
Table 6.8 Water chemistry QC sample frequencies for surface water monitoring 43
Table 6.9 Hydrology monitoring overview 46
Table 6.10 Summary of hydrology monitoring and findings 49
Table 6.11 Summary of operational hydrology sites 50
Table 6.12 Summary of post-breach monitoring hydrology sites 51
Table 6.13 Groundwater chemistry parameters 53
Table 6.14 Groundwater monitoring overview 54
Table 6.15 Summary of groundwater monitoring and findings 58
Table 6.16 Water chemistry QC sample frequencies for groundwater water monitoring 59
Table 6.17 Contact water chemistry parameters 61
Table 6.18 Contact water monitoring overview 62
Table 6.19 Summary of contact water monitoring and findings 64
Table 6.20 Water chemistry QC sample frequencies for contact water monitoring 65
Table 6.21 Seepage water chemistry parameters 66
Table 6.22 Seep monitoring overview 67
Table 6.23 Pit seepage monitoring overview 67
Table 6.24 Summary of seep monitoring and findings 69
Table 6.25 Water chemistry QC sample frequencies for seep monitoring 70
Table 6.26 Permit 11678 and MDMER Schedule 4 treated effluent compliance limits for direct discharge to Quesnel Lake 72
Table 6.27 Effluent chemistry parameters 73

Table 6.28 Effluent monitoring overview 74
Table 6.29 Summary of effluent monitoring and findings 76
Table 6.30 Plankton and chlorophyll *a* parameters 84
Table 6.31 Plankton and chlorophyll *a* monitoring overview 85
Table 6.32 Summary of plankton and chlorophyll *a* monitoring and findings 88
Table 6.33 Summary of wildlife monitoring and findings 96

LIST OF FIGURES

Figure 1.1 Mount Polley Mine property location....2
Figure 2.1 CEMP integration framework....6
Figure 2.2 CEMP Study Areas and Monitoring Components....9
Figure 2.3 Tailings Storage Facility Section....10
Figure 2.4 Mine Site Section....11
Figure 2.5 Conceptual Site Model for the mine site....13
Figure 2.6 Conceptual Site Model for TSF breach affected areas, as developed for the ERA (from Golder 2017)....14
Figure 2.7 Adaptive Management Framework....15
Figure 4.1 Mount Polley Mine site facilities....19
Figure 4.2 Mount Polley area pre-mining watersheds....21
Figure 5.1 Mount Polley Mine water management system....23
Figure 6.1 CEMP monitoring locations: Climate monitoring....29
Figure 6.2 CEMP monitoring locations: Surface water monitoring....38
Figure 6.3 CEMP monitoring locations: Hydrology monitoring....48
Figure 6.4 CEMP monitoring locations: Groundwater monitoring....56
Figure 6.5 CEMP monitoring locations: Contact water monitoring....63
Figure 6.6 CEMP monitoring locations: Seep monitoring....68
Figure 6.7 CEMP monitoring locations: Effluent monitoring....75
Figure 6.8 Total suspended solids concentrations in influent (E19) and effluent (HAD-03) in 2017....77
Figure 6.9 Total copper concentrations in influent (E19) and effluent (HAD-03) in 2017....77
Figure 6.10 CEMP monitoring locations: Plankton and chlorophyll *a* monitoring....86
Figure 6.11 Chlorophyll *a* data collected from Polley Lake from 2013 - 2017....89

List of Appendices

Appendix A – Approved CEMP Terms of Reference (April 28, 2017)
Appendix B – Detailed Study Designs for CEMP Components
Appendix C – Sample of Monthly Monitoring Schedule
Appendix D – Site Matrix
Appendix E – Declarations of Competency

ACRONYMS

°C	degrees Celsius
µm	micrometer
µS/cm	micro Siemens per centimetre
ADP	Annual Discharge Plan
AERR	Annual Environmental and Reclamation Report
ARD	acid rock drainage
BC	British Columbia
CALA	Canadian Association of Laboratory Accreditation
CCS	Central Collection Sump
CEMP	Comprehensive Environmental Monitoring Plan
cm	centimetre(s)
COPC	constituents of potential concern
CRM	certified reference material
CRP	Conceptual Remediation Plan
CSM	Conceptual Site Model
CSR	Contaminated Sites Regulation
DFO	Fisheries and Oceans Canada
DGT	diffusive gradients in thin-film
DQO	data quality objectives
EEM	Environmental Effects Monitoring
EMA	*Environmental Management Act*
EMP	Environmental Monitoring Plan
EMPR	Energy, Mines, and Petroleum Resources
ENV	Ministry of Environment and Climate Change Strategy
ERA	Ecological Risk Assessment
Golder	Golder Associates Ltd.
ha	hectares
HHRA	Human Health Risk Assessment
IDZ	initial dilution zone
km	kilometre(s)
km^2	square kilometre(s)
LOR	limit of reporting
LTWM	long term water management
m^3/s	cubic metres per second
masl	metres above sea level
MDL	method detection limit
Minnow	Minnow Environmental Inc.
mL	millilitre(s)
ML	metal leaching
mm	millimetre(s)
MPMC	Mount Polley Mining Corporation
MDMER	Metal and Diamond Mining Effluent Regulations
PAG	potentially acid-generating

PAO	Pollution Abatement Order
PEEIAR	Post-event environmental impact assessment report
PETBP	Perimeter Embankment Till Borrow Pond
PLC	Public Liaison Committee
QA	quality assurance
QC	quality control
RCP	Reclamation and Closure Plan
RPD	relative percent difference
SCIB	Soda Creek Indian Band
SFS	Society for Freshwater Science
SOP	standard operating procedure
SWL	static water level
TAR	Technical Assessment Report
TOR	terms of reference
TSF	Tailings Storage Facility
TSS	total suspended solids
WaterSmith	WaterSmith Research Inc.
WLIB	Williams Lake Indian Band
WM	work method
WTP	water treatment plant

1 INTRODUCTION

The Mount Polley Mine is located eight kilometres (km) southwest of Likely and 56 km (100 km by road) northeast of Williams Lake, British Columbia (BC; Figure 1.1). On November 29, 2015, Mount Polley Mining Corporation (MPMC), which operates the mine, received an amendment to Permit 11678 (herein referred to as the Permit) issued by the BC Ministry of Environment and Climate Change Strategy (ENV; previously known as the Ministry of Environment) pursuant to the *Environmental Management Act* (EMA; SBC 2003, Chapter 53) for a short-term water management strategy to discharge treated mine effluent into Quesnel Lake via Hazeltine Creek. The most recent amendment of the Permit was granted April 7, 2017 for a long-term water management strategy to discharge treated mine effluent directly to Quesnel Lake. Section 3.2 of the amended Permit requires MPMC to develop and implement a Comprehensive Environmental Monitoring Plan (CEMP) for the Mount Polley Mine site and surrounding receiving environment that combines pre-existing monitoring programs into an integrated plan as follows:

> *"The Permittee must continue to develop, submit, and implement an ongoing Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek, Edney Creek, Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake, Quesnel River, and associated riparian and upland areas.*
>
> *The CEMP will consolidate and integrate all of the pre-existing monitoring programs that are being conducted in the vicinity of the mine site and include, at minimum, surface water (quality and quantity), groundwater (characterization and interactions with surface water), sediments, soils, periphyton, phytoplankton, benthic invertebrates, zooplankton, fish, floodplain and upland vegetation, and wildlife.*
>
> *The CEMP must at minimum address a three year time span, as well as at a minimum include all sampling sites, frequency of sampling, variables to be analysed, method detection limits, sampling methods, sample analysis methods, and data analysis methods."*

The June 23, 2016 version of the CEMP was approved in the April 7, 2017 Permit amendment. Subsequently, in 2017, MPMC submitted several versions of a CEMP to ENV for review, however, a plan for 2017 was not approved. This CEMP covers the 2018 to 2020 time period and was developed based on the approved updated Terms of Reference (TOR) included as Appendix A. Based on the requirements of the permit, the next CEMP will be submitted in March 2020.

This CEMP is a unique and integrated monitoring plan that has been developed to capture a number of independent and interdependent monitoring programs, including; site monitoring, water discharge, *Metal and Diamond Mining Effluent Regulations* (MDMER) requirements, and Tailings Storage Facility (TSF) embankment breach response and remediation. Monitoring programs are normally developed by requirements of sector-specific regulations (e.g., MDMER of the federal *Fisheries Act* [Government of

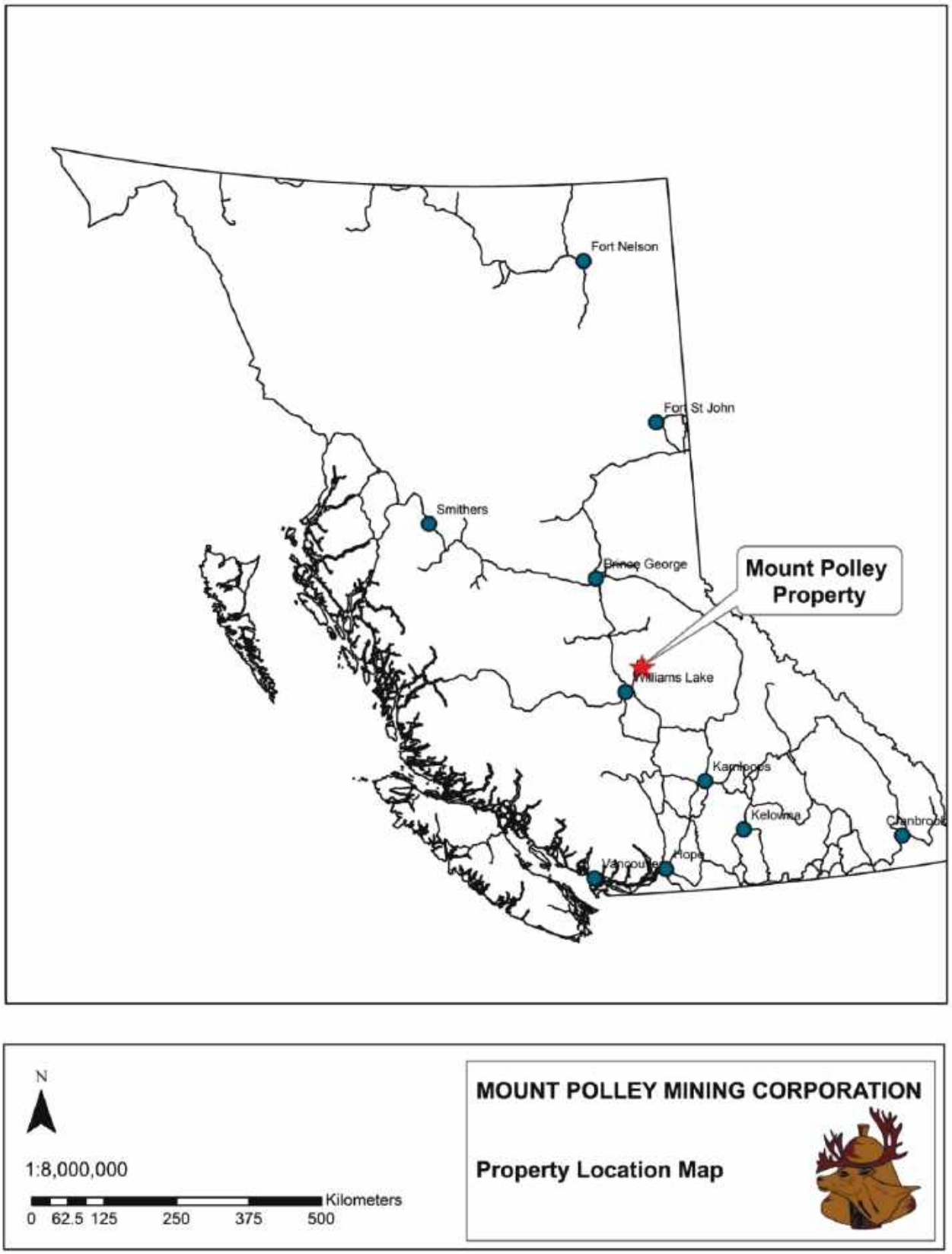


Figure 1.1 Mount Polley Mine property location

Canada 2018]) or by conditions in a permit with a specific monitoring plan that ties together permit-required and MDMER-required monitoring. As there is no ENV Technical Guidance document for this type of plan, this CEMP has been developed through an extensive consultative process that encompasses a number of permitting and other regulatory processes. Through these efforts, it has been suggested by various parties that all of the monitoring programs (e.g., water discharge monitoring, MDMER, TSF embankment breach response, etc.) be combined into one overarching program that takes advantage of the broader data set. This integrated monitoring plan offers the additional benefit of facilitating more efficient monitoring plan review by regulatory agencies, First Nations, and stakeholders. A constraint on this CEMP is where there are specific programs compelled by regulation such as the Environmental Effects Monitoring (EEM) Program that is required under the MDMER. In such instances, transparency of objectives and best efforts will be required to consolidate these different programs to the extent possible.

The CEMP is structured as follows:

- **Section 1:** Describes the CEMP objectives, a brief summary of the monitoring programs that have been integrated into the CEMP, and regulatory requirements.
- **Section 2:** Provides an overview of the integration of the various environmental monitoring programs being undertaken at the mine. Conceptual Site Models (CSMs) for the mine site and the TSF breach affected areas have also been provided, along with further details of the monitoring plans that have been integrated into the CEMP.
- **Section 3:** Provides an overview of First Nations and Stakeholders.
- **Section 4:** Provides a summary of the mine operations and the receiving environment.
- **Section 5:** Describes the environmental management practices in place, including water management.
- **Section 6:** Describes all monitoring components, including climate, surface water, hydrology, groundwater, contact water, seepage water, effluent, sediment quality, benthic invertebrate, plankton and chlorophyll *a*, periphyton, fish, wildlife, amphibian and reptile, soil, soil invertebrate, vegetation, and biosolids.
- **Section 7:** Describes the process for CEMP revisions and updates, along with a summary of changes made since the approved plan was submitted on June 23, 2016.
- **Section 8:** Summarizes relevant components of the post-TSF breach reclamation and remediation plans and interactions with CEMP components.
- **Section 9:** Provides an overview of the reporting of CEMP results.
- **Section 10:** Provides an overview of the future outlook.

The appendices attached to the CEMP are summarized below:

- **Appendix A:** Approved CEMP TOR (April 28, 2017).
- **Appendix B:** Contains the Detailed Study Designs for CEMP components, as referenced in document.
- **Appendix C:** Sample of Monthly Monitoring Schedule, which is a sample of the monthly environmental monitoring schedule provided to environmental department staff.

- **Appendix D:** Site Matrix, which describes all water sample locations in the CEMP, including site descriptions, site locations, access or safety concerns, and rationale for monitoring.
- **Appendix E** Declarations of Competency forms for Qualified Professionals contributing to the CEMP

1.1 OBJECTIVES

As specified in the Permit, the CEMP describes monitoring activities intended to support the evaluation of the potential for effects of mine-related activities on the physical, chemical, and biological characteristics of Bootjack Lake and Morehead Creek in the Springer Pit area, the Hazeltine and Edney Creek drainages, Polley Lake, Quesnel Lake, and Quesnel River, and associated riparian and upland areas. Specifically, the CEMP objectives are:

1. To evaluate if pollution[1] is occurring in the receiving environment as a result of the existing water discharge or mine-related activities;
2. To evaluate the environmental impacts of the August 2014 TSF embankment breach, to inform the rehabilitation plan, as well as to evaluate the effects of mitigation measures that are implemented as part of the rehabilitation strategy;
3. To integrate, to the extent feasible, the requirements of the MDMER; and
4. To inform reclamation and closure (*Mines Act* Permit M-200).

This CEMP includes monitoring of: effluent, surface water, groundwater, sediment, periphyton, plankton, benthic invertebrates, and fish in the aquatic environments; and soil, floodplain and upland vegetation, and wildlife in the terrestrial environments. Specific objectives for individual monitoring program components are stated in the subsequent sections. Supporting summary tables and maps are also provided.

Since the original integration of these plans and submission of the CEMP on March 31, 2016, many iterations of the CEMP have been reviewed, revised, and submitted in 2016 and 2017. Pre-existing monitoring plans that were integrated into the initial CEMP and have subsequently been revised within CEMP revisions (instead of individually) are:

- The *Monitoring Plan for Discharge of Treated Effluent to Quesnel Lake via Hazeltine Creek* (MPMC 2016a);
- The *Annual Monitoring Plan* for surface water and groundwater (MPMC 2015a);
- The *Biological Monitoring and Lake Sampling Plan* (MPMC 2015b); and
- The *Post-TSF Breach Monitoring Plan – 2015 Revision 1* (MPMC 2015c), which references the *Post Breach Fish Tissue Collection Plan – 2015* (MPMC 2015d) and the *Sampling and Analysis Plan: Detailed Site Investigation and Human Health and Ecological Risk Assessment* (Golder 2015a).

[1] Pollution as defined in the BC EMA (S.1(1)) means "*…the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment*".

Previous results were used to inform and structure this version of the CEMP and are summarized below in their respective sections or provided in Appendix B, as appropriate. A summary of results along with a discussion is provided in each relevant section. Throughout the CEMP, references are made to semi-x monitoring. This refers to monitoring that occurs twice per unit time, for example semi-annual monitoring indicates twice per year, and semi-monthly monitoring indicates twice per month.

It is expected that monitoring will be updated from time to time, consistent with an adaptive monitoring program (see Section 2.3). When changes are made to the monitoring, this amended plan (or relevant replacement pages) will be resubmitted to the Director and MPMC's Implementation Committee.

Work plans will be developed for all future monitoring programs and submitted to the ENV at least 30 days prior to commencing the program. These programs will be developed by a Qualified Professional (QP) and will consider linkages and dependencies with existing programs using previous data and review of the CSMs, which are presented in Section 2.2.

2 INTEGRATION OF MONITORING ACTIVITIES

The CEMP integrates environmental monitoring programs being carried out at the mine to meet multiple requirements which have different drivers and, therefore, objectives. Figure 2.1 shows the linkage between these drivers and associated monitoring objectives, as well as the resulting monitoring components that addresses those objectives. Further discussion is provided on these linkages in the sections following.

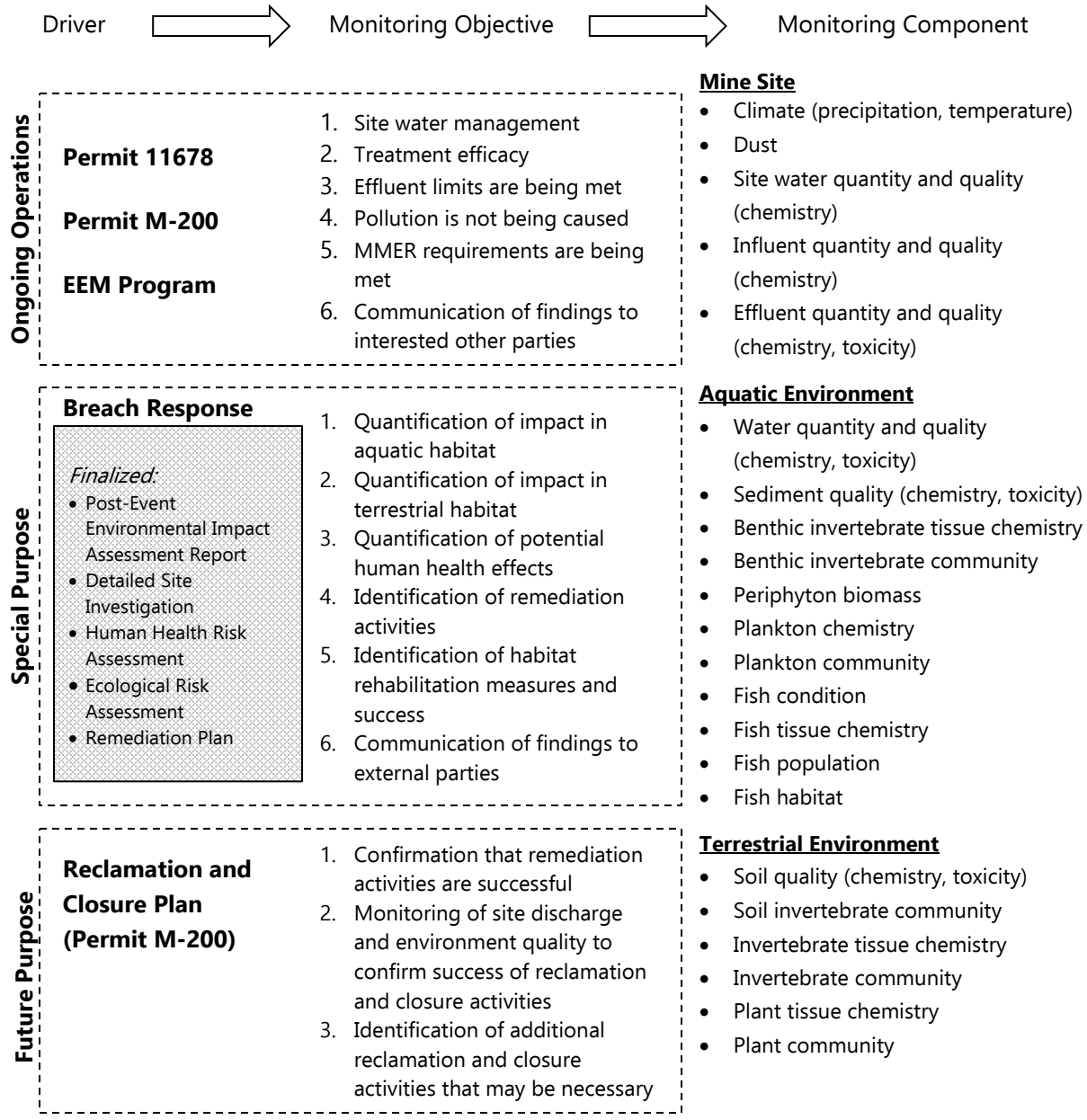


Figure 2.1 CEMP integration framework

2.1 MONITORING DRIVERS AND OBJECTIVES

There are three different drivers for current monitoring activities: ongoing operations, the TSF embankment breach response (special purpose program distinct from normal mine operations monitoring), and reclamation and closure planning (future purpose; note that some progressive reclamation has been done to date). These drivers and their associated monitoring objectives are described below. Previous monitoring results are continually reviewed to inform and structure the monitoring as well.

2.1.1 ONGOING OPERATIONS

Mount Polley Mine is an operational facility that is governed by provisions of the provincial EMA and *Mines Act* and the federal MDMER (a sector-specific regulation of the *Fisheries Act*). These permits and regulations contain specific requirements for on-going monitoring of site activities and downstream aquatic receiving environments. The objectives of ongoing operations monitoring are to:

1. Evaluate and plan for site water management.
2. Evaluate treatment efficacy to provide information for the ongoing management of the water treatment system installed at the time.
3. Verify that effluent limits are being met.
4. Verify that pollution is not being caused.
5. Verify that MDMER requirements are being met.
6. Communicate the findings to all interested parties.

Monitoring in accordance with conditions contained within BC *Mines Act* Permit M 200 is also summarized in the CEMP. This monitoring is only described in the CEMP for completeness purposes. Monitoring is summarized and future changes will be presented in CEMP revisions, but changes to this monitoring are subject to BC *Mines Act* Permit M-200 and not Section 7 in the CEMP or Section 5 in the CEMP TOR (Appendix A). This permit requires monitoring for metal leaching and acid rock drainage (ML/ARD) characteristics, water quality of on-site contact water (Section 6.11), and water quality of seeps from open pits and waste rock piles (Section 6.10). Permit M-200 also contains conditions related to reclamation and closure planning and monitoring. Results of monitoring conducted under the M-200 permit will continue to be reported annually, along with the monitoring results directed under the CEMP, in a combined AERR (Annual Environmental and Reclamation Report) that is submitted to ENV and the BC Energy, Mines, and Petroleum Resources (EMPR; formerly Ministry of Energy and Mines). Refer to Section 9 for information on reporting associated with the CEMP.

MPMC is also subject to the conditions of the BC *Water Sustainability Act* (which replaced the *Water Act* in 2016) that includes provisions related to sediment and erosion control and working around water. MPMC holds conditional water licences and is subject to Order 76930-40 following the TSF embankment breach, both of which were issued under the former *Water Act*.

2.1.2 SPECIAL PURPOSE

On August 4, 2014, a foundation failure of the Mount Polley TSF perimeter embankment occurred. ENV issued a Pollution Abatement Order (PAO) that specified the need for specific impact studies and monitoring to address impacts of the breach event, inform remedial measures, and evaluate changes over time. These studies are referred to as "special purpose" studies (now primarily monitoring) because they relate to a unique event with program objectives that differ considerably from an operating mine. The objectives of the special purpose monitoring are to:

1. Monitor and assess impact to aquatic habitat.
2. Monitor and assess impact to terrestrial habitat.
3. Monitor and assess potential human health risks.
4. Identify remediation activities needed to address identified impacts.
5. Identify habitat rehabilitation measures and related works as well as the success of those works.
6. Communicate findings of the impact assessment and ongoing monitoring to external parties.

2.1.3 FUTURE PURPOSE

As an operating mine, MPMC is required to plan for eventual closure. Reclamation and closure monitoring takes place after the closure plan is implemented. Although progressive reclamation and reclamation research have already been initiated at the site, the Reclamation and Closure Plan (RCP) continues to be refined during operations in preparation for closure and is not yet finalized. However, in the context of a CEMP, future monitoring needs are appropriate to start considering. Because this CEMP is intended to be an adaptive plan, these will be updated as reclamation and closure planning progresses and greater certainty of locations, measurement endpoints, etc. are available.

The objectives of the future monitoring program are to:

1. Confirm that mine site reclamation activities are successful in achieving their stated objectives.
2. Monitor site discharge quality and receiving environment quality as appropriate to confirm that reclamation and closure works have been successful in preventing pollution and that discharges are compliant with applicable requirements.
3. Identify additional reclamation and closure activities that may be necessary.

Additional and more specific objectives will be developed as the reclamation and closure planning process progresses.

2.2 MONITORING COMPONENTS AND CONCEPTUAL SITE MODEL

Figure 2.2 provides an overview of the Mount Polley Mine, in particular the CEMP study areas along with their respective monitoring components. Figure 2.3 and Figure 2.4 show greater detail of the TSF area and the mine site, respectively, of the sources of mine-contact water to the surrounding aquatic receiving environment and areas of ground disturbance. The measurement endpoints are detailed in the applicable sections later in this plan.

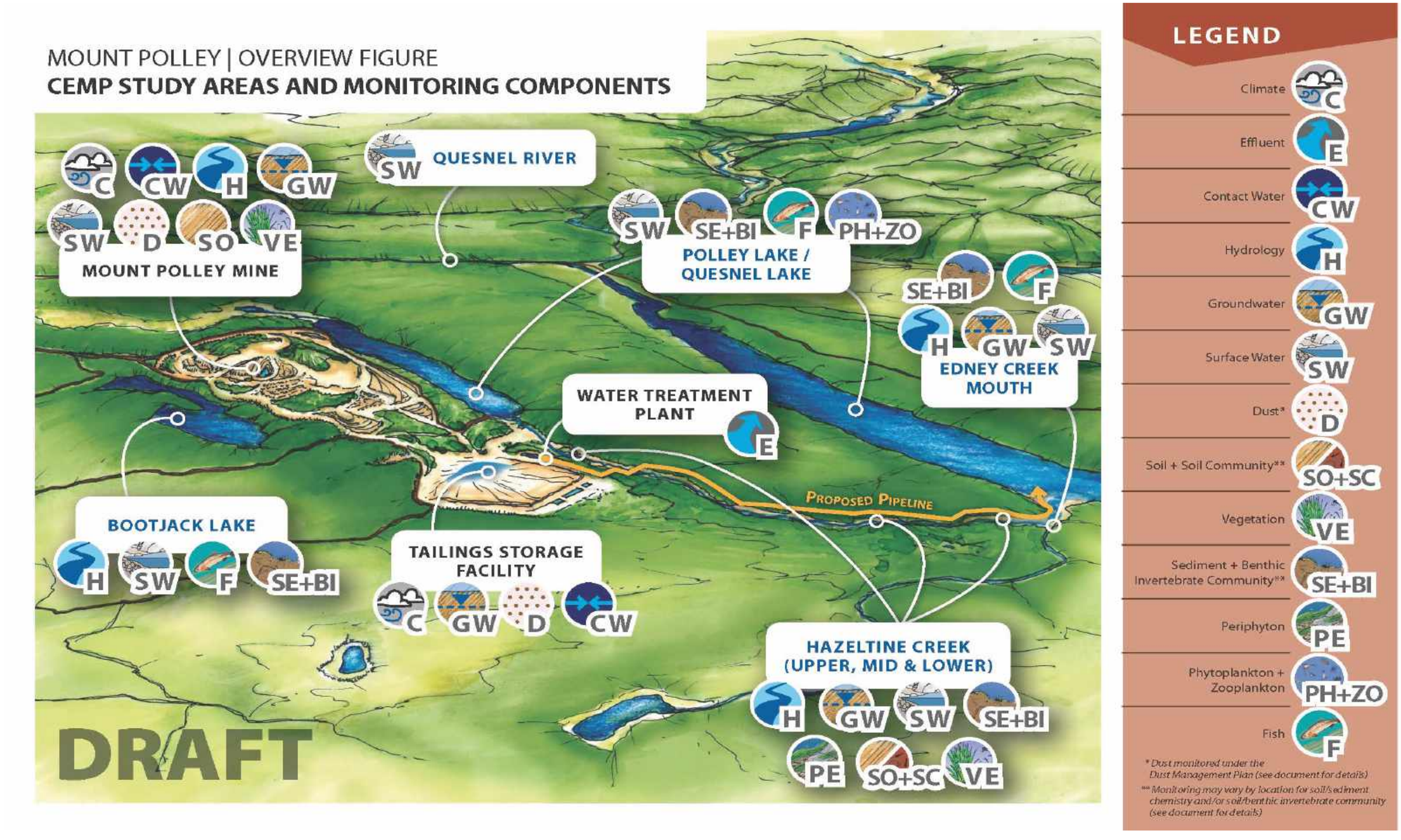


Figure 2.2 CEMP Study Areas and Monitoring Components

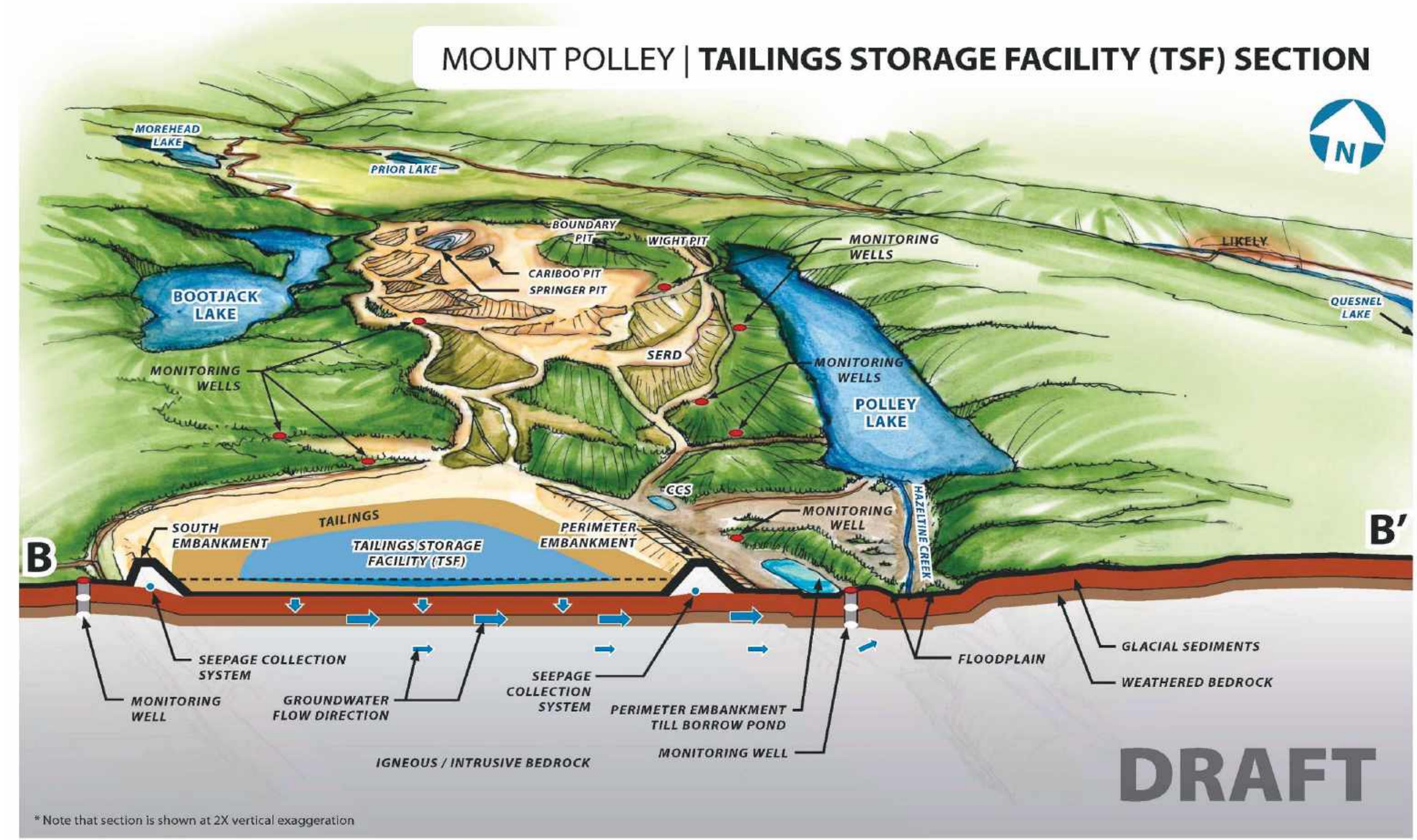


Figure 2.3 Tailings Storage Facility Section

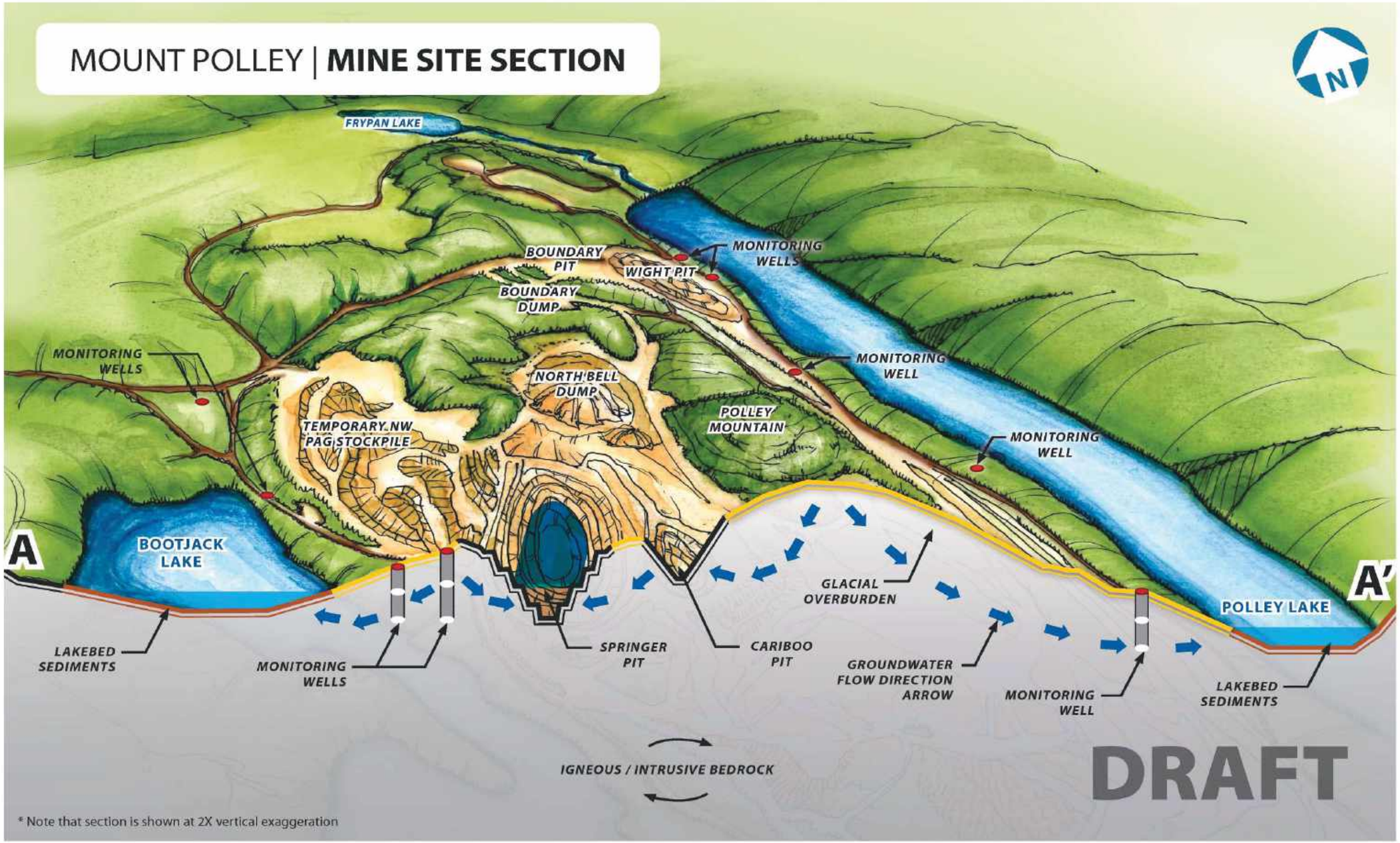


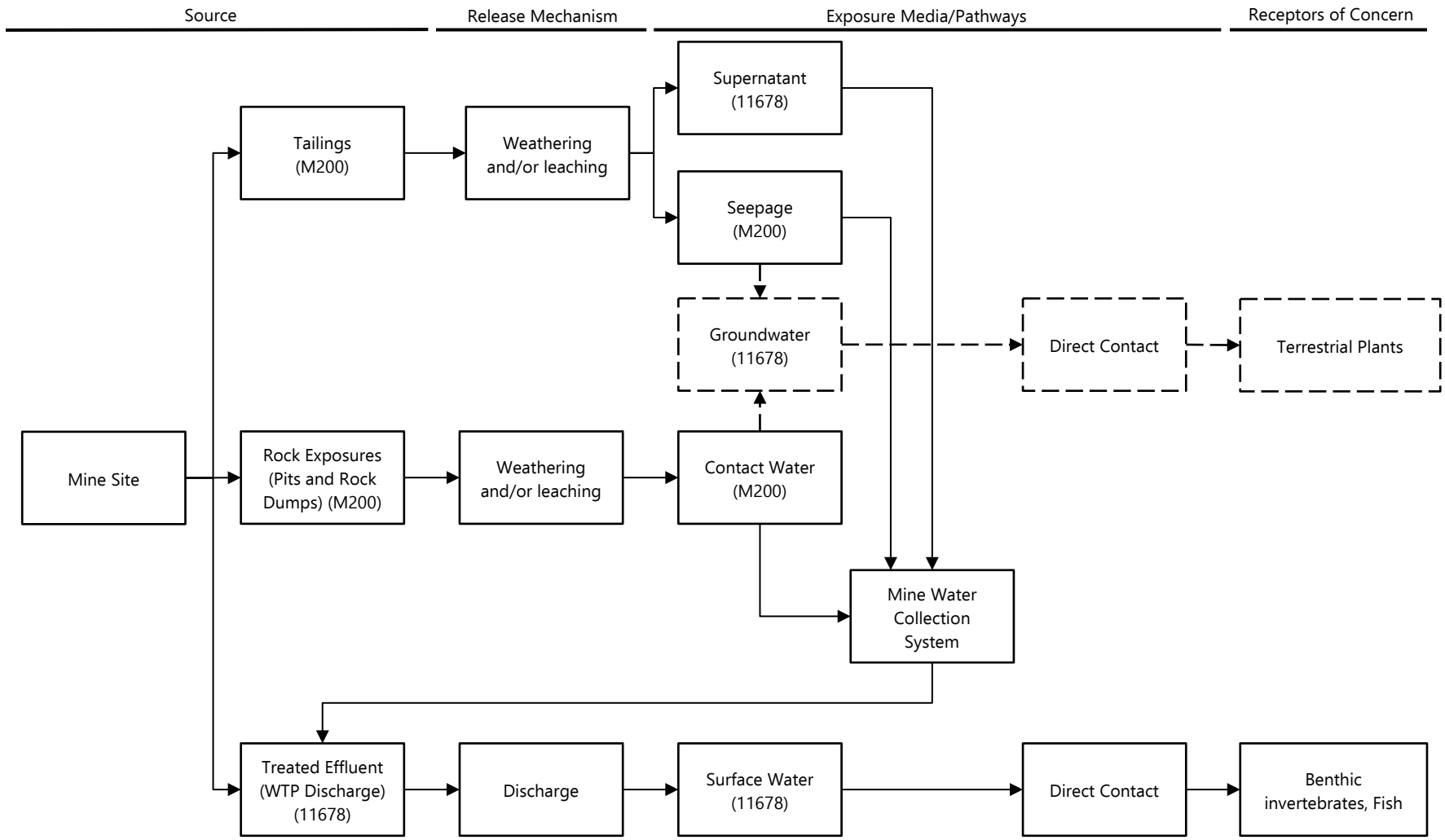
Figure 2.4 Mine Site Section

A CSM helps provide the basis for selecting appropriate monitoring components and suitable locations for those measurements. A CSM provides a graphical articulation of the understanding upon which the CEMP is based including movement of substances, pathways by which organisms (receptors) might become exposed to and interact with those substances in the environment. CSMs are often used in risk assessments to communicate similar concepts; however, in this CEMP, the focus of the study on specific constituents of potential concern (COPCs) has not been an objective because the monitoring program includes broader purposes and will include, for example, the full commercial analytical package for elemental analysis (frequently called "metals analysis"). Groups of substances that will be analyzed for, however, are those related to the potential sources. A CSM specific to the mine site was developed and is shown in Figure 2.5. A CSM for the TSF breach affected areas was developed for the Ecological Risk Assessment (ERA; Golder 2017) and is shown in Figure 2.6.

As discussed in Section 2.1.1, the mine has ongoing operational monitoring needs that centre on permit compliance that include management of site water and ultimately treated water discharges. The mine also needs to address disturbed ground through dust management in the short term. The measurable characteristics or components that contribute information to the stated monitoring objectives can then be identified as variables such as: precipitation and temperature (i.e., climate); dust; mine contact water, groundwater, and surface water quantity and quality; and influent and effluent quantity and quality. These are considered "Site" monitoring components (Figure 2.1). This information contributes to understanding the site water balance, function of site water collection systems, and management of the water treatment plant (WTP; e.g., capacity and treatment efficacy). This information is also useful in understanding the groundwater and seepage flow pathways to Bootjack and Polley lakes.

Ongoing operational activities at the site also have the potential to influence aquatic receiving environments related to effluent discharges. Under the long-term water management plan effluent is discharge from the WTP to Quesnel Lake. Relevant monitoring components for "Aquatic Habitat" include receiving water and sediment chemistry and toxicity, as well as biotic (e.g., plankton, benthos, fish) communities and tissue chemistry as summarized in Figure 2.1.

Following the TSF embankment failure in 2014, the environmental monitoring program was expanded to either incorporate additional monitoring components or increase the frequency of sampling. Many of the same existing operational monitoring components applied to this program and others were added. Additional measurements, related to physical impacts from the event, were collected to contribute to the Post-event Environmental Impact Assessment Report (PEEIAR) and to contribute to the Human Health Risk Assessment (HHRA) and the ERA. This "special purpose" monitoring information is relevant to the Remediation Plan for which an annotated table of contents has been submitted to ENV. As noted in the Risk Monitoring Considerations section of the ERA, further sample collection and evaluation of monitoring data will be done to further refine toxicity reference values for wildlife and confirm bioavailability of copper continues to be low and does not present a risk to wildlife.



Notes:
Solid lines indicate pathways that are likely to be complete or operative.
Dotted lines indicate pathways that are likely to be incomplete or inoperative.

Figure 2.5 Conceptual Site Model for the mine site

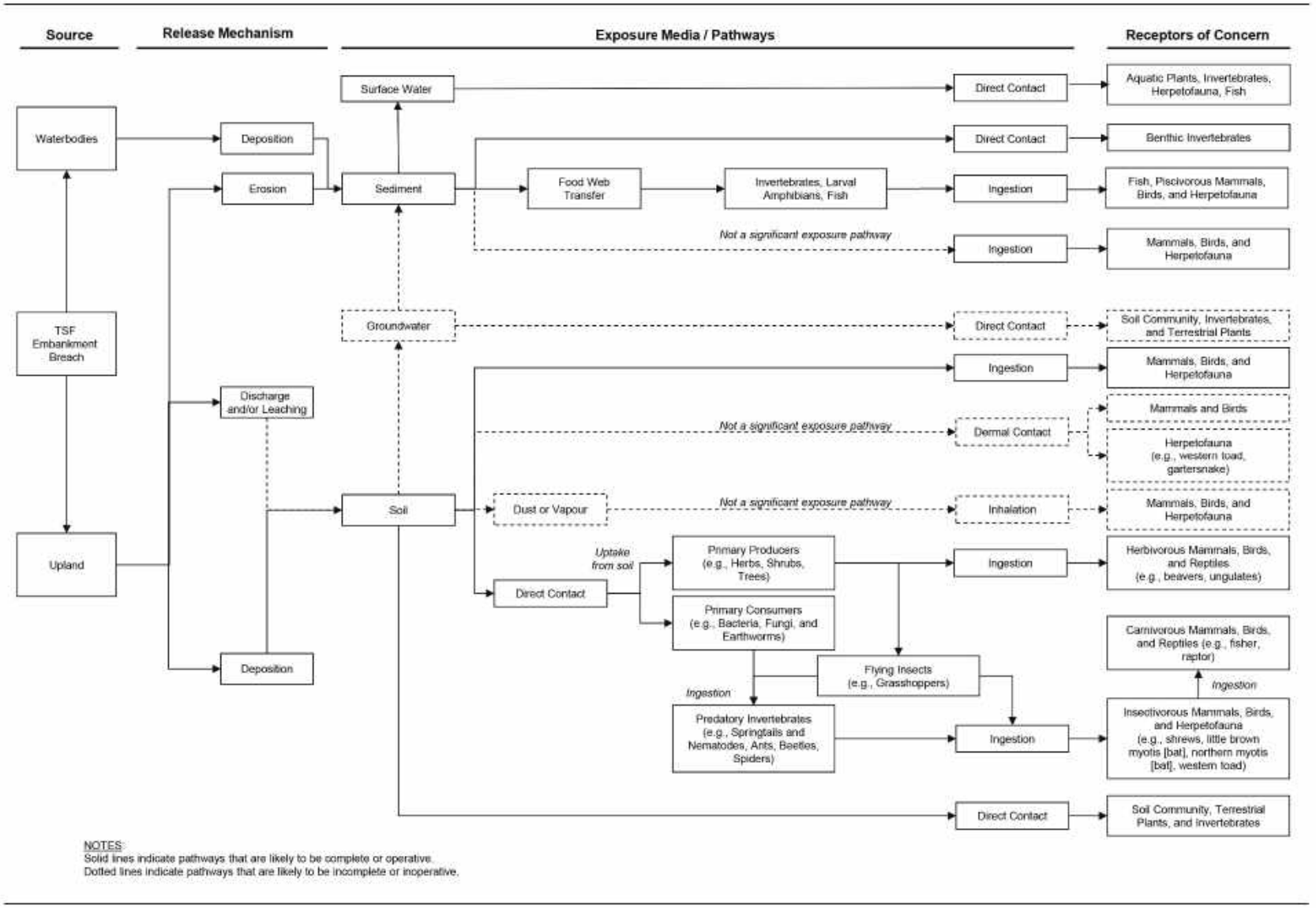


Figure 2.6 Conceptual Site Model for TSF breach affected areas, as developed for the ERA (from Golder 2017)

2.3 Adaptive Management Framework

The CEMP will be adaptive based on the results of ongoing operational and special purpose monitoring (illustrated in Figure 2.7) and based on the developing RCP. The adaptive framework recognizes that studies and monitoring can lead to new information that should be used to inform future monitoring. The framework provides feedback of this new information into the decision-making process that links monitoring and management actions that may need to be implemented to keep MPMC in compliance. For example, more immediate management actions may need to be undertaken in response to pre-defined triggers for unexpected changes in condition. The progressive implementation of the adaptive management framework will also include an annual review of the monitoring program to determine the potential need for revisions to planned sampling and analysis tasks. This review could include cessation of monitoring components that data show may no longer be necessary, or increase of monitoring based on changing conditions or monitoring results. Recommendations for monitoring related to the findings of post-breach-related studies have been included in this CEMP with the intention of forecasting monitoring that may be undertaken in the next three years. Monitoring for a specific year will be verified in monitoring program work plans following the adaptive management framework.



Figure 2.7 Adaptive Management Framework

3 FIRST NATIONS AND STAKEHOLDERS

3.1 FIRST NATIONS ENGAGEMENT

First Nations with recognized claimed traditional territory for the Mount Polley Mine are the T'exelc (Williams Lake Indian Band; WLIB) and the Xatśūll First Nation (Soda Creek Indian Band; SCIB). In 2011 and 2012, MPMC executed Participation Agreements with the WLIB and the SCIB, respectively. Through these respective Participation Agreements, Implementation Committees were formed to facilitate open dialogue between each of the First Nations and MPMC, providing a formalized and regular venue to discuss environmental, social, and economic matters related to mine development, operation, reclamation, and closure (e.g., mine updates, permitting, environmental protection, reclamation, employment opportunities, and potential joint ventures). Meetings with the WLIB have taken place since March 16, 2012 and since July 19, 2012 with the SCIB. Effective October 18, 2012, Joint Implementation Committee meetings have been held with representatives from MPMC, the WLIB, and the SCIB, replacing the previous MPMC/SCIB and MPMC/WLIB Implementation Committee meetings. Joint Implementation Committee meetings are held at minimum quarterly, but typically more frequently. These meetings and associated documentation (TOR, minutes, and action items) provide a well-defined, constructive forum in which issues, reviews, and comments relating to the current and anticipated future operations of the Mount Polley Mine may be discussed. This CEMP and the AERR will be provided in their current form to the SCIB and the WLIB for review, and discussion regarding any comments or concerns will be facilitated through the Joint Implementation Committee.

3.2 PUBLIC LIAISON COMMITTEE

The Public Liaison Committee (PLC) for the Mount Polley Mine was formed in 1999, and meetings have been maintained through the operating years of the Mine. Meetings were historically scheduled in conjunction with updates on proposed developments and projects, with a minimum frequency of one meeting per year. An annual PLC meeting became a requirement of the Permit in 2013 and quarterly meetings became a requirement in 2015. The PLC is intended to provide an opportunity for MPMC to share information about mine activities and the results of monitoring programs with its members, and for members to share such information with their respective membership. The PLC does not replace or diminish the use of other communication procedures that MPMC will use regularly to inform the public, including but not limited to: public meetings, newsletters, emails, and internet websites. The PLC is seen as a medium to add value to parties with interest in the Mount Polley Mine, including, but not limited to: MPMC and its personnel, the public and public interest groups, local communities, First Nations, and regulators.

3.3 COMMUNICATION PLAN

The Permit requires a Communication Plan between MPMC and the WLIB, SCIB, Cariboo Regional District, and the Community of Likely to be in place. The original Communication Plan was submitted to the Director (ENV Statutory Decision Maker) on March 20, 2016 and was approved by the Director on May 11, 2016. The amended Permit required that an updated Communication Plan be submitted by June 30, 2017. The final Communication Plan was submitted to ENV on March 20, 2016.

4 MOUNT POLLEY MINE PROJECT OVERVIEW

4.1 PROJECT HISTORY

Mount Polley Mine, operated by MPMC (a wholly-owned subsidiary of Imperial Metals Corporation), is an open pit copper/gold mine with an underground component, and has the capacity to process 20,000 to 22,000 tonnes per day (tpd) of ore. The Mount Polley property covers 18,892 hectares (ha), which consist of seven mining leases totaling 2,007 ha, and 43 mineral claims encompassing 16,855 ha, as of March 2018.

Clearing of the site and construction of the entire facility began in 1995, with the mill being commissioned in June 1997. In May 1997, the Mine received an ENV (known as the Ministry of Water, Land and Air Protection at that time) Effluent Permit, issued under the provisions of the provincial EMA. This permit authorized the discharge of concentrator tailings, mill site runoff, mine rock runoff, open pit water, and septic tank effluent to a tailings impoundment. Approval of the "Mount Polley Mine Reclamation and Closure Plan" by the EMPR resulted in the issuance of Permit M-200 in July 1997. The first full year of mining and milling at Mount Polley Mine took place in 1998. The mine suspended operations in October 2001 due to low metal prices, then reopened in December 2004 with mill production commencing again in March 2005. A summary of Permit 11678 amendments is provided in Table 4.1.

Table 4.1 Summary of Permit 11678 amendments

Date	Scope of Amendment
30-May-1997	Original permit
20-Oct-1997	Amended authorized tailings discharge rate (10,000 tpd increase)
12-Jun-1998	Amended reporting requirements
08-Sep-1999	Amended monitoring requirements
01-Feb-2000	Amended authorized tailings discharge rate (4,500 tpd increase)
07-Feb-2002	Approval to discharge effluent from the PESCP and MESCP; approval to store TSF supernatant and Mine Site contact water in the Cariboo and Bell Pits
04-May-2005	Amended authorized tailings discharge rate (5,000 tpd increase); discharge of groundwater to Polley Lake; updates to reference analytical procedures and monitoring program
17-Apr-2009	Amended monitoring, water level and supernatant characteristic requirements for the Cariboo and Bell Pits
07-Nov-2012	Approval to discharge to Hazeltine Creek
07-Jun-2013	Sulphate guidelines
09-Jul-2015	Tailings discharge to the Springer Pit
29-Nov-2015	Approval to discharge to Hazeltine Creek
04-Apr-2016	Discharge of additional tailings to the Springer Pit
09-Sep-2016	Hazeltine Creek discharge total suspended solids limit change
07-Apr-2017	Approval to discharge directly to Quesnel Lake

Notes: tdp: tonnes per day; PESCP: Perimeter Embankment Seepage Collection Pond; MESCP: Main Embankment Seepage Collection Pond; TSF: Tailings Storage Facility

As a result of a foundation failure of the perimeter embankment of the TSF on August 4, 2014 (see Section 2.1.2), the mine was placed in care and maintenance until August 5, 2015, when restricted operations under a short-term permit commenced. This restricted operations permit allowed processing of up to 4 million tonnes of ore over a one-year period, with tailings deposition into the Springer Pit.

The Mount Polley Mine became subject to the MDMER on April 10, 2014, following a planned discharge of mine effluent into Hazeltine Creek. The MDMER are also applicable to the long-term discharge approved for the Mount Polley Mine.

4.2 CURRENT OPERATIONS

MPMC was granted full restart permits on June 23, 2016 and has been operating at full capacity since June 27, 2016. The Mount Polley Mine site includes a crusher and mill (includes office spaces), a TSF, waste rock disposal sites, seepage collection ponds, haul roads, access roads, and various small buildings and storage areas (Figure 4.1). Concentrate is transported by truck from the site to the Port of Vancouver, where it is shipped to smelters overseas.

4.3 ENVIRONMENT

4.3.1 TOPOGRAPHY AND CLIMATE

The Mount Polley property is located on the eastern edge of the Fraser Plateau physiographic sub-division, characterized by rolling topography and moderate relief. Elevations range from 920 metres above sea level (masl) at Polley Lake to 1266 masl at the summit of Mount Polley. Volcanic rocks generally underlay this part of the plateau with inclusions of intrusive rocks. Most of the area is covered by a deposit of unconsolidated till which contains fluvial, lacustrine, and colluvial deposits. Some patches of organic soils are present in poorly drained areas (i.e., wetlands). The property is located in an alkali porphyry copper-gold deposit hosted in the Central Quesnel Belt along the Intermontaine Belt of BC.

The site is located within the Interior Cedar Hemlock biogeoclimatic zone. Local forests consist of Western red cedar, Douglas-fir, hybrid spruce, and subalpine fir, with a lesser presence of trembling aspen, black cottonwood, and paper birch. Much of the area has been harvested in commercial logging operations and is also used for cattle grazing.

Average annual precipitation in the study area is 670 millimetres (mm). Precipitation typically occurs as snowfall from November through March, with an average maximum of snowpack of 178 mm snow water equivalent occurring at the end of March (Golder 2015b). Average monthly temperatures at the Mount Polley Mine range from -6.0 degrees Celsius (°C) in January to 15.3°C in July and August (MPMC 2016b). Prevailing winds are from the north-north-east and from the south-south-west near the TSF, and from the northwest (and to a lesser extent the southeast) near the mill, with a predominance of winds designated as calm (below 3 metres per second; Golder 2015b).

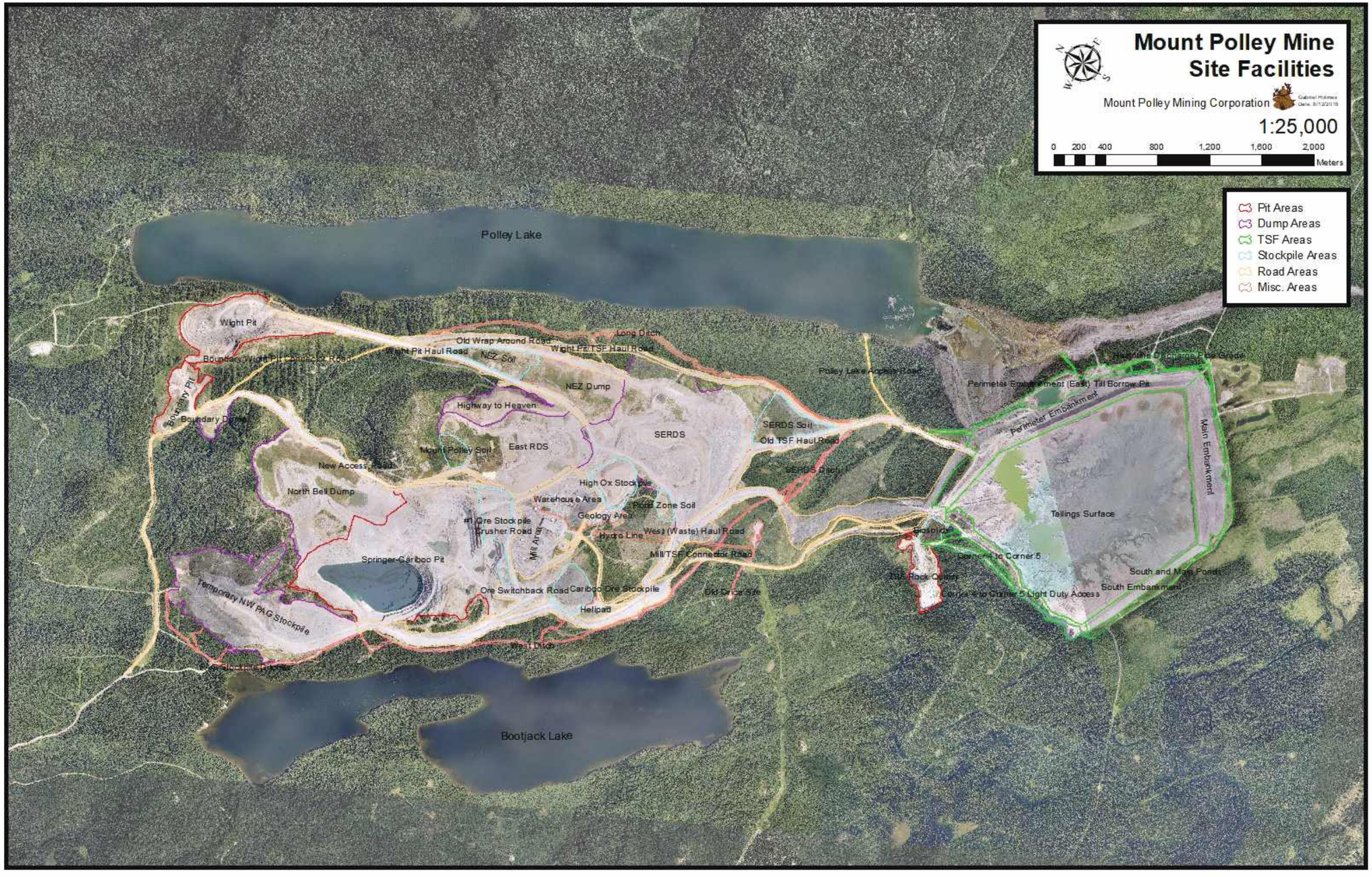


Figure 4.1 Mount Polley Mine site facilities

4.3.2 HYDROGEOLOGY

The groundwater flow at the site occurs primarily in the bedrock units in response to recharge from precipitation in the area between Polley Lake and Bootjack Lake. Flow in the overburden is less significant due to its limited thickness and discontinuous nature. Prior to mining, the water table at the site generally followed the surface topography, but the water table was deeper below the topographic heights and shallower in the low areas. At that time, the direction of groundwater flow was inferred to be from the top of the ridge between the Polley Lake and the Bootjack Lake towards the low lying areas associated with these lakes northeast and southwest from the ridge.

Mine dewatering has altered the groundwater flow pattern at the site, with the open pit and underground workings acting as sinks for groundwater flow. Mine dewatering lowered the water table elevation and created radial patterns of groundwater flow towards these facilities. Following the formation of the pit lake in the Cariboo Pit, seepage from this pit started to provide a contribution to groundwater inflow to the Springer Pit. At present, Springer Pit and Cariboo Pit continue to act as groundwater sinks. The currently available information suggests that some seepage from the Springer Pit lake towards Bootjack Lake occurred when the pit lake level exceeded 1030 m elevation in 2016 (Golder 2016b).

4.3.3 DRAINAGE AND HYDROLOGY

The mine is located on the divide of two sub-watersheds within the Quesnel Lake watershed. Quesnel is a large, deep fjord lake with a surface area of 255 square kilometres (km^2), and is composed of East, West, and North Arms. It is the deepest fjord-type lake in the world, with a maximum depth of more than 511 m in the East Arm (Laval et al. 2008). The West Basin is a shallower (113 m maximum depth) portion of the west arm that is demarcated in the east by a shallow sill near Cariboo Island that is approximately 35 m deep (Laval et al. 2008). The lake drains to the west via the Quesnel River to the Fraser River. The Horsefly River, Mitchell River, and Niagara Creek are the main tributaries to Quesnel Lake, entering from east of the sill.

The western watershed, which includes drainage from Bootjack Lake, Trio Lake, and Morehead Lake, discharges to Quesnel River via Morehead Creek and drained approximately 60% of the Mount Polley area prior to mine construction.

The eastern watershed includes Polley Lake (surface area of 3.8 km^2), which discharges to the east via Hazeltine Creek and then to the western arm of Quesnel Lake. The Hazeltine Creek and Edney Creek watershed areas at Quesnel Lake are currently approximately 30.2 km^2 and 87.4 km^2, respectively. Approximately 10.5 km^2 that historically reported to this watershed is now within the mine contact water runoff collection system catchment.

Bootjack Creek is a small tributary that previously flowed into Hazeltine Creek downstream of Polley Lake. Following the TSF embankment breach, Bootjack Creek was re-routed to Polley Lake; fish access is currently restricted. Historically, Bootjack Lake (surface area of 1.2 km^2) discharged into Hazeltine Creek via Bootjack Creek, but in 1913 a dam was constructed at the south end of Bootjack Lake and the flow direction was reversed in order to direct water into Morehead Lake for hydropower production. This resulted in 14 km^2

being diverted from the Hazeltine Creek catchment. The Morehead Creek watershed, including the Bootjack Lake catchment area, is approximately 11.2 km^2. Approximately 2.3 km^2 that historically reported to this watershed is now within the mine contact water runoff collection system catchment.

Pre-mining watersheds are shown in Figure 4.2. In general, the hydrology of the Mount Polley area is snowmelt driven, with the majority of annual runoff occurring in April and May during snowmelt (i.e., freshet; Knight-Piésold 2014).

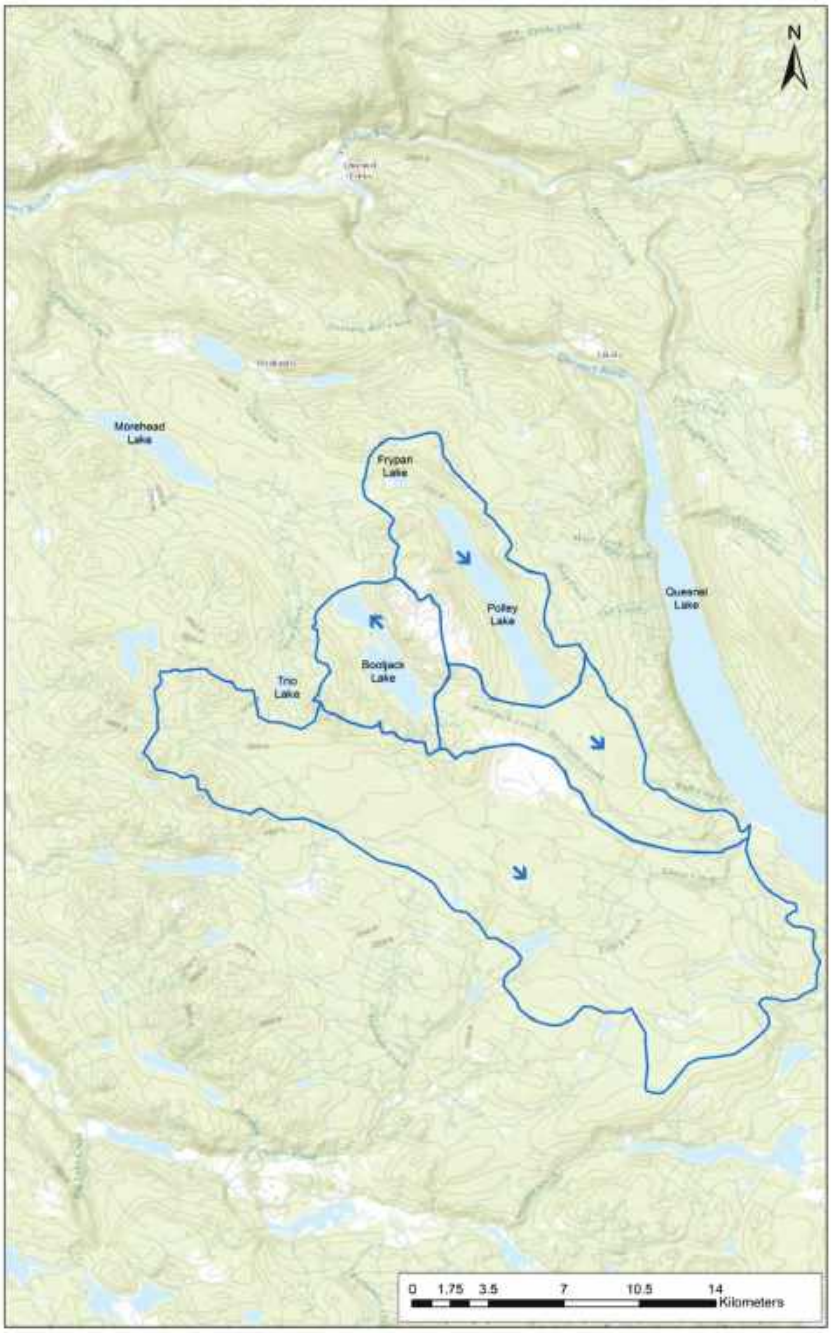


Figure 4.2 Mount Polley area pre-mining watersheds

5 ENVIRONMENTAL MANAGEMENT

5.1 WATER MANAGEMENT

To protect natural watercourses from mine-influenced contact water from roads, haul roads, waste rock piles, and other Mine areas, water is collected in a system of ditches and sumps located around the Mine site. Based on site water management objectives, site contact water is either pumped directly to the TSF or reports to the gravity-driven sections of the West Ditch or Long Ditch, the latter two of which both flow to the Central Collection Sump (CCS). Water in the CCS is currently allowed to overflow to the Perimeter Embankment Till Borrow Pond (PETBP) where it is pumped to the WTP or can be returned to the TSF. Pumping infrastructure also exists at the CCS such that it can be directed to the TSF. Water from the TSF is primarily pumped to the Mill via the Booster Station to meet process requirements, but can also be diverted to the CCS. A map of water collection infrastructure, including site collection ditches (including flow direction) and sumps, is shown in Figure 5.1. All water, primarily rain and snow melt, ultimately reports to the PETBP from which it is pumped to the WTP. At the time of writing, any contact water that requires temporary storage on site (i.e., when flows exceed those able to be treated and discharged) is pumped to the TSF. Tailings and process water from the Mill reports by gravity from the Mill to the TSF.

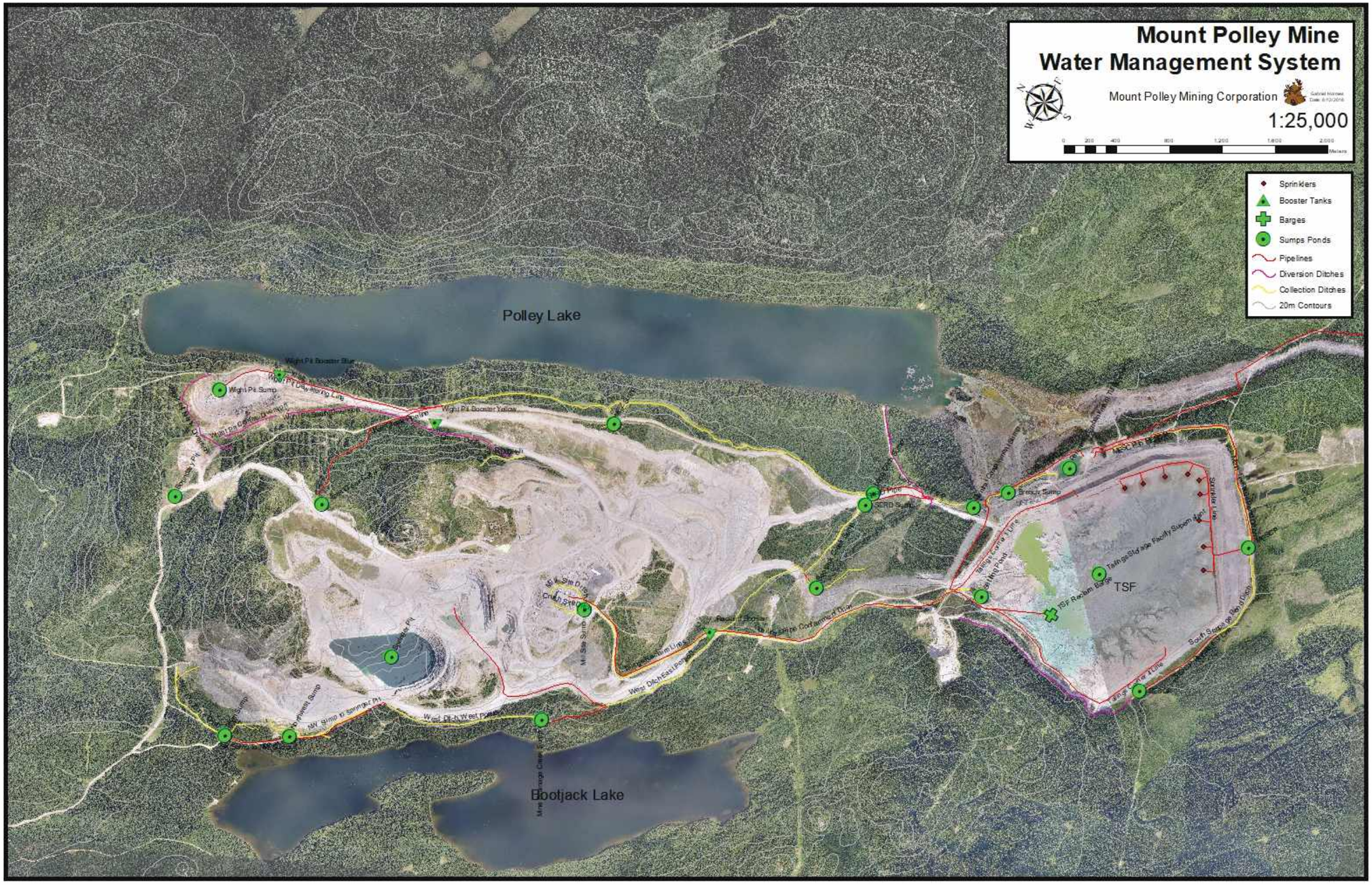
The Mount Polley site has a positive water balance, and a permit for a long-term water discharge system was received on April 7, 2017. Treatment is conducted for removal of suspended solids and associated metals using a Veolia ACTIFLO® system, which is described in detail in Section 5.1.2. Under the long-term water management strategy, treated mine effluent is discharged to Quesnel Lake via a direct pipeline to the submerged diffusers installed in the lake. A continuous discharge of up to 0.6 m^3/s, with an annual average of 0.33 m^3/s is currently permitted until December 31, 2022.

5.1.1 ANNUAL DISCHARGE PLAN

Permit 11678 requires the yearly submission of an Annual Discharge Plan (ADP). The intent of the plan is to identify the specific sources and quantities of water that will be discharged; however, the discharge system (which is described in Section 5.1.2) at Mount Polley is not designed to be able to solely discharge from specific sources and it is not realistic for MPMC to estimate the volumes of precipitation that will occur from year to year. The overall water management at the mine is described in detail in the Long-Term Water Discharge Technical Assessment Report (TAR) that was submitted to ENV October 17, 2016 (Golder 2016e).

5.1.2 DISCHARGE SYSTEM

The WTP sources water from the PETBP. During treatment, the feed water of the WTP undergoes suspended solids removal using Veolia ACTIFLO® water treatment technology. The WTP doses the raw water with coagulant to a tank where a polymer is injected to create floc particles. Microsand is added to ballast the flocculants, which move on to another tank that allows them to swell and mature. The water flows to the next stage, which uses lamella to clarify the water and promote fast settling of the microsand ballasted sludge. The clarified water is discharged and the sludge is separated from the microsand, which is reused.


Mount Polley Mine
Water Management System
Mount Polley Mining Corporation
1:25,000
Sprinklers
Booster Tanks
Barges
Sumps Ponds
Pipelines
Diversion Ditches
Collection Ditches
20m Contours
Polley Lake
Bootjack Lake
TSF
Wight Pit Sump
Wight Pit Booster Yellow
Wight Pit Booster Blue
Wight Pit Discharge Line
Wight Pit Control Diversion
Wight Pit Diversion Ditch
Wight Pit Diversion Line
Wight Pit Diversion
Wight Pit Diversion Pipeline

An on-line turbidity meter measures the turbidity every ten seconds, where the WTP human-machine interface calculates the total suspended solids (TSS) using a calibrated factor based on a site-specific correlation between turbidity and TSS for the treated effluent. If the calculated on-line TSS is greater than 13 mg/L for 10 minutes, or greater than 14 mg/L instantaneously, an alarm sounds to alert the operator and the WTP automatically goes into recirculation mode and ceases discharge.

Treated water from the WTP is discharged, by gravity, to Quesnel Lake via a pipeline (installed as of November 2017) connected to two submerged diffusers. Effluent discharge to the Hazeltine Creek channel ceased as of September 30, 2017.

5.2 Sediment and Erosion Control Management Plan

MPMC has developed a RCP that has been submitted to EMPR under the *Mines Act* Permit M-200. This plan includes several Environmental Management Plans including a Sediment and Erosion Control Plan.

5.3 Invasive Plant Management Plan

MPMC developed an Invasive Plant Management Plan in 2010 and has regularly updated this plan to include newly disturbed areas and to follow the Cariboo Regional District Strategic Plan for Invasive Plant Management. This plan is included in the RCP.

5.4 Dust Management Plan

MPMC maintains a Dust Management Plan that is also included in the RCP.

5.5 Project Environmental Monitoring Plans

MPMC develops a project specific Environmental Monitoring Plans (EMPs) for any development project that has potential to impact the environment. The requirement for these EMPs is outlined in the Erosion and Sediment Control Plan (Section 5.2).

5.6 Waste Management

MPMC recognizes the value of responsible waste management and recycling. MPMC Recycling and Waste Management Awareness presentations are given to Mount Polley employees annually and MPMC promotes several recycling programs for used materials including waste oil, scrap steel, batteries, plastic pails, electronic waste, light bulbs and associated fixtures, paper, cardboard, and beverage containers. Waste management information is also presented to employees and contractors during site orientation. Each year, Mount Polley donates the funds generated by its beverage container recycling program to local charities.

In the course of its ongoing operations, Mount Polley utilizes potentially hazardous chemicals, reagents, and other products. Sumas Environmental Services Ltd. routinely removes and disposes of these waste products in an environmentally safe manner compliant with all relevant waste management legislation. Products removed include: aerosol cans; contaminated gasoline and diesel; waste oil (in drums); waste oil filters; waste grease fuel or oil soaked rags, debris, and floor dry; and leachable liquid toxic waste, such as

glycol/anti-freeze mix. The site waste oil tanks are emptied and the oil removed from site by a third party contractor. MPMC is registered (BCG-01559) with the ENV under the *Hazardous Waste Regulation* for generation and temporary storage of these materials.

5.7 INCIDENT REPORTING

All non-compliance incidents are reported to the Director or to Emergency Management BC. All incidents are recorded and tracked, and are included in the AERR. As outlined in the Communication Plan (see Section 3.3) and required by Section 2.5 of the permit, incidents or emergencies that have the potential to have adverse impacts on the environment will be reported to the SCIB, WLIB, Cariboo Regional District and community of Likely.

5.8 INSPECTIONS

MPMC Environmental Department staff conduct weekly inspections on the site with a focus toward regulatory compliance and waste management (Section 5.6). These inspections are documented and communicated regularly to the site management and their respective departments. Guidance is provided by the Environmental Department for proper internal reporting and follow-up. The goal of these inspections is to provide all departments the capability to engage in proper environmental management practices and open lines of communication with the Environmental Department.

6 MONITORING

The subsections below outline general procedures at MPMC for scheduling of environmental monitoring and data review and management. Field methods, laboratory analysis, data quality control and objectives, as well as data analysis methods are included in the following sections with their respective monitoring components. Note that frequencies may change due to weather conditions or construction work and will be dependent on accessibility and, most importantly, safety of the field crews. Declarations of Competency for relevant Qualified Professionals are provided in Appendix E.

6.1 SCHEDULING

To coordinate sampling and schedule all planned monitoring, as per the CEMP, MPMC prepares internal monthly sampling schedules. An example monthly sampling schedule has been included as Appendix C.

6.2 FIELD METHODS

Monitoring procedures that will be used in carrying out the CEMP are consistent with the *BC Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (2013 or most recent version, herein referred to as the "BC Field Sampling Manual"; MoE 2013a). As appropriate, monitoring procedures will also be consistent with the *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012) and the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (MoE 2012). MPMC's procedures are also consistent with applicable sections of the *British Columbia Environmental Laboratory Manual* (MoE 2015), such as sample collection and preservation requirements.

Quality assurance/quality control (QA/QC) methods will follow procedures outlined in the *MPMC Environmental Department QA/QC Manual* (most recent version: MPMC 2016c, herein referred to as the "QA/QC Manual", developed for the Mount Polley Mine. This manual provides detailed Standard Operating Procedures (SOPs) and Work Methods (WMs) of the protocols for environmental monitoring at MPMC and is a requirement of the Permit (April 7, 2017: Section 3.8). Procedures described in the manual are consistent with the BC Field Sampling Manual (MoE 2013a). The QA/QC Manual is reviewed and updated as appropriate (at minimum annually) to reflect changes to the ENV procedures and recommendations, and industry best practices. Should the manual be updated, the ENV Environmental Protection Division will be notified within 30 days of implementation as required by the Permit.

The QA/QC Manual protocols include collection of samples by trained personnel using standardized procedures, and use of field notebooks and chain of custody forms for sample documentation and tracking. These protocols are summarized for the different CEMP monitoring components below, where appropriate.

6.3 LABORATORY ANALYSIS

Sample analysis will be conducted at a laboratory registered for the designated parameter under the *Environmental Data Quality Assurance Regulation*. MPMC will participate in QA audits as required by the regulation.

6.4 Data Quality Review and Data Management

A data quality review of results will be conducted, including screening of laboratory QA/QC data, sample integrity issues, detection limits achieved, and metadata accuracy, as well as potential outliers/extreme values. This information will be catalogued in the MPMC sample tracking spreadsheets and the laboratory is contacted if any problem is identified. Water, soil, sediment, and tissue chemistry data as well as weather station data will be uploaded into the MP-5 database using files generated by the analytical laboratory. Accompanying field data will be manually entered and uploaded into the MP-5 database. Original laboratory-produced results files are filed on the MPMC network by date, and are linked to the data stored in the MP-5 database. Field data undergo a QC screening prior to upload and parameter restrictions are in place to reduce the likelihood of a typographical or laboratory reporting error being uploaded.

Non-chemistry data, including toxicity testing results, benthic invertebrate and plankton taxonomy data, and hydrology data (logger downloads and FlowTracker exports) are filed according to year and site on the MPMC network.

6.5 Climate Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.5.1 Section Authors and Study Component Design Professionals

This section was written by MPMC and is guided by Section 3.6 of the Permit (April 7, 2017).

6.5.2 Monitoring Objectives

The objective of the climate monitoring program is to track site weather data to support maintenance of the site water balance, water flow and accumulation predictions, and the design of water management infrastructure. Climate data are also considered important basic site characterization information that inform a number of other activities, such as reclamation revegetation prescriptions or building snow load requirements. Climate monitoring is also required under the Permit Section 3.6 (April 7, 2017).

6.5.3 Monitoring Overview

MPMC maintains two automated HOBO weather stations. Both stations are connected via telemetry allowing real time viewing of weather conditions. Four snow course sites are located around the mine site to target different exposure conditions. Table 6.1 provides an overview of the climate monitoring. Further details of monitoring sites, including site access descriptions, access or safety concerns, and a brief rationale for monitoring, is provided in the Site Matrix in Appendix D. Figure 6.1 shows monitoring locations of the meteorological monitoring locations.

Table 6.1 Climate monitoring overview

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
Weather Station #1	N/A	Continuous monitoring weather station beside tree plots near Mill Site	Logged every 5 minutes	Temperature, wind speed and direction, solar radiation, relative humidity, rainfall	N/A
Weather Station #2	N/A	Continuous monitoring weather station adjacent to the TSF	Logged every 5 minutes	Temperature, wind speed and direction, solar radiation, relative humidity, rainfall	N/A
JCP	N/A	Snow course site located east of the start of the Long Ditch in a clearing	End of month and after major snowfall and melting events	Snow depth, snow volume	N/A
Weather Station #1	N/A	Snow course site located near Weather Station #1	End of month and after major snowfall and melting events	Snow depth, snow volume	N/A
PAG Stockpile	N/A	Snow course site located beside the NW sump	End of month and after major snowfall and melting events	Snow depth, snow volume	N/A
TSF	N/A	Snow course site located near Weather Station #2, near the TSF	End of month and after major snowfall and melting events	Snow depth, snow volume	N/A

Notes: N/A: not applicable, TSF: tailings storage facility, JCP: Joe's Creek Pipe, PAG: potentially acid generating; NW: Northwest

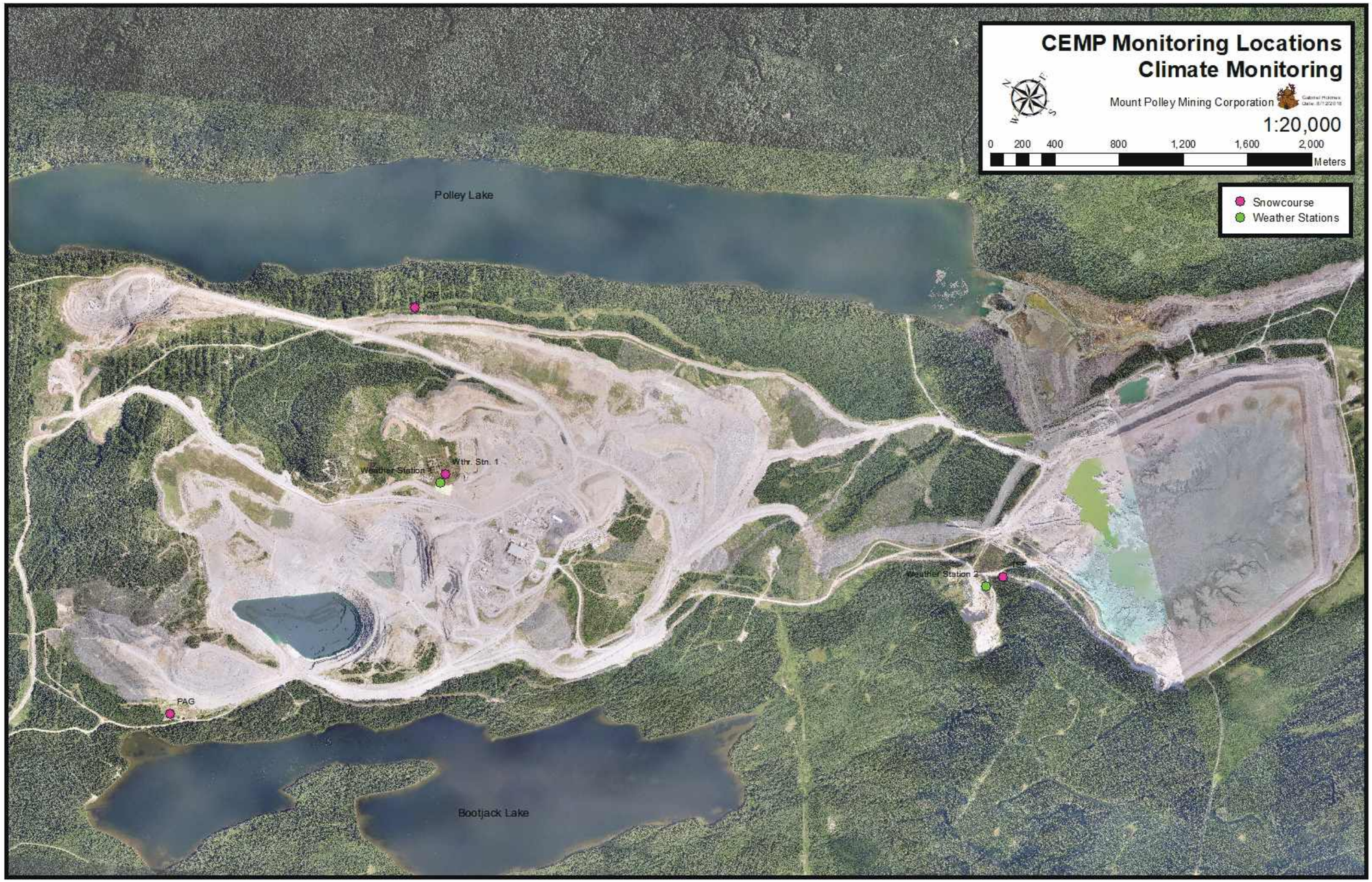


Figure 6.1 CEMP monitoring locations: Climate monitoring

6.5.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Meteorological monitoring will occur as per the SOPs and WMs for Meteorological Data Collection and Snowpack Measurements in the QA/QC Manual. There are two automated HOBO weather stations located on the mine site that continuously record wind speed and direction, precipitation, solar radiation, relative humidity, and temperature. Evaporation is calculated based on data collected from these stations. The data are downloaded from the automated weather stations monthly or as required by remote radio telemetry. If necessary, data are also stored for 30 days on the weather logger and can be downloaded manually using a data shuttle.

The snowpack measurement method will change in 2018 to align with the *Snow Survey Sampling Guide* written by ENV (MoE 2016). A workshop will be given to the Environmental Staff at first snowfall in fall 2018. The SOP and WM for Snowpack Measurements will be updated at this time and submitted to ENV for review.

Table 6.2 is a summary of previous climate monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.2 Summary of climate monitoring

Summary of Monitoring and Findings	**Monitoring Objective**		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	Two weather stations collect temperature, wind speed and direction, solar radiation, and precipitation data. Snowpack data was collected at four representative snow course sites. The weather and snow course stations are situated to encompass the topographical and geographic range of the mine site.	N/A	N/A
Summary of findings	Weather data collected were compared to site averages. Evaporation was calculated using measured parameters.	N/A	N/A
Recommendations for 2018-2020 monitoring	The snowpack measurement method will be changed to align with the *Snow Survey Sampling Guide*. The program will otherwise continue unchanged because the two current weather stations and snow course sites provide adequate information for the conditions on site.	N/A	N/A

Notes: N/A – not applicable

6.5.5 Data Quality Control, Objectives, and Review

Data ranges are set in the MP-5 database to detect erroneous data collected during station malfunctions. Weather station data that are erroneous (e.g., sensor malfunctions) will be investigated.

6.5.6 Laboratory Analysis

No laboratory analysis is required for climate monitoring.

6.5.7 Data Analysis and Reporting

Climate statistics, including mean, minimum, and maximum temperature, will be calculated and reviewed monthly. Daily evaporation is calculated using the Penman-Monteith equation for open water in the WaSIM software (developed by Cranfield University), based on data collected from the weather stations and site-specific factors, such as weather station elevation. These data are reported annually in the AERR.

6.6 Surface Water Monitoring

Surface water monitoring is characterised below into the following locations: Hazeltine Creek, streams and creeks adjacent to the mine site (receiving environment of the mine site), Bootjack Lake, Polley Lake, Edney Creek, Quesnel Lake, and Quesnel River.

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.6.1 Section Authors and Study Design Professionals

The mine site environmental monitoring was developed during the Environmental Assessment process in 1995, which included input from several QPs. For the purpose of the CEMP, MPMC will continue to monitor with the understanding that this program is well-established to monitor any mine-related effects. The mine site monitoring described below was written by MPMC.

6.6.2 Monitoring Objectives

The objective of water chemistry monitoring in Hazeltine Creek is to evaluate the Hazeltine Creek aquatic environment following the TSF embankment breach and track changes to the aquatic environment over time and/or as a result of implementation of rehabilitation and sediment and erosion control work.

The objective of water chemistry monitoring in streams and creeks adjacent to the mine site, as well as Bootjack Lake and Polley Lake, is to identify water quality changes in waterbodies that run through or are adjacent to the mine site to assess efficacy of the mine water management systems and to stimulate applicable management actions.

The objective of water chemistry monitoring in Polley Lake, Quesnel Lake, and Quesnel River is to support ongoing evaluation of water chemistry following the TSF embankment breach in the downstream environments.

The objective of water chemistry monitoring in Quesnel Lake at the boundary of the initial dilution zone (IDZ) is to verify that the discharge of treated effluent is not causing an exceedance of the applicable ambient BC Water Quality Guidelines at the edge of the IDZ, as required by the Permit, and to verify the discharge model, as described in the ADP.

Monitoring of the far-field receiving environment in Quesnel Lake in the West Basin will be carried out downstream and upstream (for reference) of the mouth of Hazeltine Creek for the verification of the discharge model as described in the ADP.

6.6.3 MONITORING OVERVIEW

Table 6.3 summarizes the parameters analysed for surface water quality. The lake field parameters are measured at each sampling depth and for each limnological profile (excluding Secchi depth, which is taken from the surface of each lake sampling point). Table 6.4 provides an overview of the surface water monitoring. The location "Mine Site" refers to the streams and creeks adjacent to the mine site. Further details of monitoring sites, including site access descriptions, access or safety concerns, and a brief rationale for monitoring, is provided in the Site Matrix in Appendix D. Figure 6.2 shows monitoring locations of the surface water sampling locations.

Table 6.3 Surface water chemistry parameters

Parameter	LOR	Unit
Field Parameters - Lake		
pH	-	pH
Specific conductance	-	µS/cm
Temperature	-	°C
Turbidity	-	NTU
Dissolved oxygen	-	%, mg/L
Secchi depth	-	m
Field Parameters - General		
pH	-	pH
Conductivity	-	µS/cm
Temperature	-	°C
Turbidity	-	NTU
Physical Tests		
Conductivity	2	µS/cm
Hardness (as $CaCO_3$)	0.5	mg/L
pH	0.1	pH
Total Suspended Solids	1	mg/L
Total Dissolved Solids	10	mg/L
Turbidity	0.1	NTU
Anions and Nutrients		
Alkalinity, Total (as $CaCO_3$)	1	mg/L
Ammonia, Total (as N)	0.005	mg/L
Chloride (Cl)	0.5	mg/L
Fluoride (F)	0.02	mg/L
Nitrate and Nitrite (as N)	0.003	mg/L
Nitrate (as N)	0.001	mg/L
Nitrite (as N)	0.005	mg/L
Total Nitrogen	0.03	mg/L
Orthophosphate-Dissolved (as P)	0.001	mg/L
Phosphorus (P)-Total Dissolved	0.002	mg/L
Phosphorus (P)-Total	0.002	mg/L
Sulfate (SO_4)	0.3	mg/L
Organic / Inorganic Carbon		
Dissolved Organic Carbon	0.5	mg/L

Parameter	LOR	Unit
Total and Dissolved Metals		
Aluminum (Al)	0.003	mg/L
Antimony (Sb)	0.0001	mg/L
Arsenic (As)	0.0001	mg/L
Barium (Ba)	0.0001	mg/L
Beryllium (Be)	0.0001	mg/L
Bismuth (Bi)	0.00005	mg/L
Boron (B)	0.01	mg/L
Cadmium (Cd)	0.000005	mg/L
Calcium (Ca)	0.05	mg/L
Chromium (Cr)	0.0005	mg/L
Cobalt (Co)	0.0001	mg/L
Copper (Cu)	0.0005	mg/L
Iron (Fe)	0.03	mg/L
Lead (Pb)	0.00005	mg/L
Lithium (Li)	0.001	mg/L
Magnesium (Mg)	0.1	mg/L
Manganese (Mn)	0.0001	mg/L
Molybdenum (Mo)	0.00005	mg/L
Nickel (Ni)	0.0005	mg/L
Potassium (K)	0.05	mg/L
Selenium (Se)	0.00005	mg/L
Silicon (Si)	0.1	mg/L
Silver (Ag)	0.00001	mg/L
Sodium (Na)	0.05	mg/L
Strontium (Sr)	0.0002	mg/L
Thallium (Tl)	0.00001	mg/L
Tin (Sn)	0.0001	mg/L
Titanium (Ti)	0.01	mg/L
Uranium (U)	0.00001	mg/L
Vanadium (V)	0.0005	mg/L
Zinc (Zn)	0.003	mg/L
EEM Parameters		
Mercury (Hg)-Total	0.000005	mg/L

Notes: LOR: Limit of Reporting; EEM: Environmental Effects Monitoring

Table 6.4 Surface water monitoring overview

Location	Station Name	EMS Code	Description	Frequency	Depths	Parameters Measured	Guidelines
Mine Site	W1	E225084	Morehead Creek	Quarterly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W4a	E298551	North Dump Creek below Wight Pit Road	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W5	E208039	Bootjack Creek Above Hazeltine Creek	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W8	E216743	NE Edney Creek Tributary	Quarterly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W8Z	E223292	SW Edney Creek Tributary	Quarterly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W10	E291209	Lower Edney Creek (upstream of breach impact)	Semi-annually[1]	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W12	E216744	6 km Creek at Road	Quarterly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Mine Site	W20	E297070	W20 Creek Tributary to Bootjack Lake	Semi-annually	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Edney Creek	EDC-01	E303014	Lower Edney Creek (remediated reach)	Semi-annually[1]	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Hazeltine Creek	HAC-10	E303010	Upper Hazeltine Creek at Polley Lake outlet	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Hazeltine Creek	HAC-13	E304810	End of Reach 1 in Hazeltine Creek	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Hazeltine Creek	HAC-14	pending	Middle Hazeltine Creek upstream of the canyon	Monthly[2]	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Hazeltine Creek	HAC-05a	E304510	Upper Hazeltine Creek at Gavin Lake FSR Bridge	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Hazeltine Creek	HAC-08	E303013	Lower Hazeltine Creek at Ditch Road Bridge	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL

Location	Station Name	EMS Code	Description	Frequency	Depths	Parameters Measured	Guidelines
Hazeltine Creek	HAC-01c	E303953	Lower Hazeltine Creek outflow to Quesnel Lake	Monthly	Surface	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Bootjack Lake	B1	E207975	Bootjack Lake deepest area at north end	Semi-annually[3]	Surface (0 m), 1 m above thermocline (AT) and 1 m below thermocline (BT) OR mid-depth if no thermocline (MID), bottom (B)	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
				Monthly[4]	Limnological profile	Field parameters - lake	BC WQG - AL
Bootjack Lake	B2	E215897	Bootjack Lake deepest area at south end	Semi-annually[3]	Surface (0 m), 1 m above thermocline (AT) and 1 m below thermocline (BT) OR mid-depth if no thermocline (MID), bottom (B)	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
				Monthly[4]	Limnological profile	Field parameters - lake	BC WQG - AL
				Three times annually [10]	Limnological profile, surface	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Bootjack Lake	B4	E216744	Bootjack Lake (potential zone of influence from seepage from Springer Pit)	For closure only[5]	For closure only[5]	For closure only[5]	-
Polley Lake	P1	E207974	Polley Lake deepest area at north end	Spring overturn, twice in summer, fall overturn, once under ice[6]	Surface (0 m), 1 m above thermocline (AT) and 1 m below thermocline (BT) OR mid-depth if no thermocline (MID), bottom (B)	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
				Monthly[4]	Limnological profile	Field parameters - lake	BC WQG - AL
Polley Lake	P2	E207975	Polley Lake deepest area at south end	Spring overturn, twice in summer, fall overturn, once under ice[6]	Surface (0 m), 1 m above thermocline (AT) and 1 m below thermocline (BT) OR mid-depth if no thermocline (MID), bottom (B)	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
				Monthly[4]	Limnological profile	Field parameters - lake	BC WQG - AL
				Three times annually [10]	Limnological profile, surface	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Quesnel Lake	QUL-58	E304876	Quesnel Lake discharge IDZ	Four times annually[7, 11, 12]	Limnological profile, If plume detected: middle of plume (MP), 5 m above (AP), 5 m below plume (BP) If plume not detected: surface (S), 1 m above thermocline (AT) and 1 m below thermocline (BT) OR mid-depth if no thermocline (MID), bottom (B)	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals, EEM parameter (total mercury)[8]	BC WQG - AL
Quesnel Lake	QUL-57	E304874	Quesnel Lake IDZ	Four times annually[7, 11, 12]	Limnological profile, sample depths as for QUL-58	Field parameters - lake	BC WQG - AL
Quesnel Lake	QUL-59	E304875	Quesnel Lake IDZ	Four times annually[7, 11, 12]	Limnological profile, sample depths as for QUL-58	Field parameters - lake	BC WQG - AL
Quesnel Lake	QUL-18	E303019	Quesnel Lake far-field, downstream of Hazeltine Creek	Four times annually[7, 11]	Limnological profile, 0 m, 20 m, 50 m, 100 m[9]	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Quesnel Lake	QUL-2a	E303020	Quesnel Lake far-field, upstream of Hazeltine Creek (reference)	Four times annually[7, 11]	Limnological profile, 0 m, 20 m, 40 m, 60 m	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals, EEM parameter (total mercury)[8]	BC WQG - AL

Location	Station Name	EMS Code	Description	Frequency	Depths	Parameters Measured	Guidelines
Quesnel Lake	QUL-ZOO-1	E306455	Quesnel Lake in centre of West Basin (zooplankton station)	Three times annually [10, 11]	Limnological profile, surface	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL
Quesnel Lake	QUL-ZOO-7	E306456	Quesnel Lake near Cariboo Island (reference zooplankton station)	Three times annually [10, 11]	Limnological profile, surface	Field parameters - lake, physical tests, anions and nutrients, DOC, total and dissolved metals	BC WQG - AL

Notes: [1] In June and October due to access; [2] May to November only due to restricted access in winter; [3] At spring overturn and late summer; [4] Between spring and fall overturn; [5] Monitoring will depend on closure conditions; [6] if ice and weather conditions meet safety requirements; [7] Taken at evenly spaced time series plus or minus one month; [8] Total mercury will be collected at MID or BT for QUL-58 and at 40 m for QUL-2a as part of EEM four times per year (no less than 1 month apart). Parameter only reported to MDMER; [9] QUL-18 is approximately 110 m deep. 100 m sample depth is collected for historical consistency; [10] Taken in conjunction with plankton sampling (see Section 6.14); [11] When sampling is less frequent than monthly, sampling at Quesnel Lake operational surface water monitoring stations (as identified in Table 6.6) will be undertaken when effluent discharge to Quesnel Lake is discharging. In the event of an unexpected shutdown of the water treatment plant, reasonable efforts will be made to re-sample within the timeframe of the quarterly or other specified time period sampling upon restart of effluent discharge to Quesnel Lake; [12] Samples will be taken at HAD-3 on the same day as samples collected from QUL-57, -58, and -59.

DOC: dissolved organic carbon; BC WQG: British Columbia Water Quality Guidelines; AL: aquatic life; FSR: Forest Service Road; EEM: Environmental Effects Monitoring; IDZ: initial dilution zone

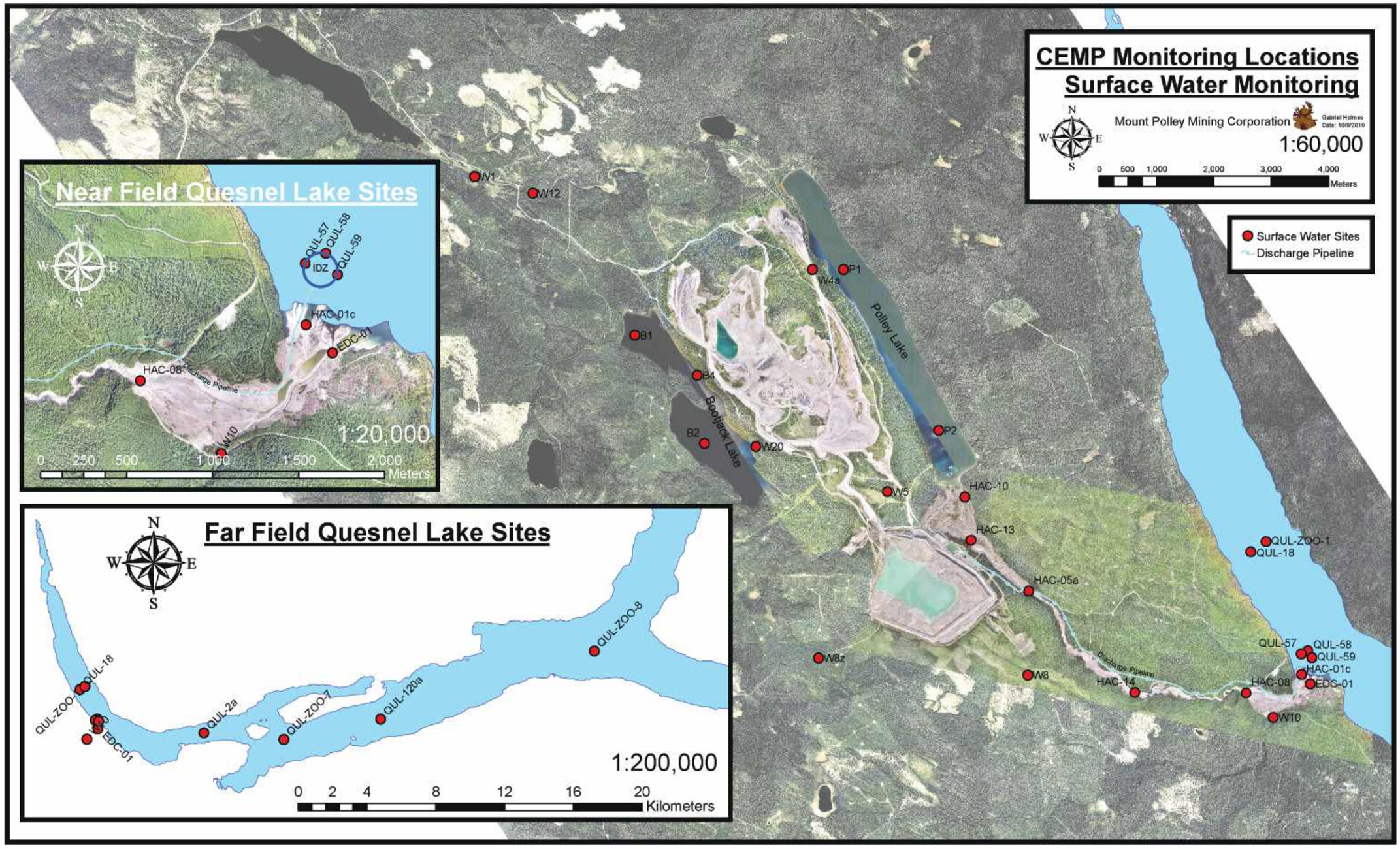


Figure 6.2 CEMP monitoring locations: Surface water monitoring

6.6.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Field parameter collection, sample collection, preparation, and shipping will be conducted following the SOPs and WMs for the associated field meters, Surface Water Quality Monitoring and Lake Water Monitoring, as appropriate as described in the QA/QC Manual. These procedures include use of lab-verified clean or appropriately rinsed sampling bottles and steps to reduce risk of sampling contamination. *In-situ* parameters will be measured when samples for chemistry are collected. Water samples will be analyzed as described in Section 6.6.3. Limnological profiles of field parameters will be conducted where described in Table 6.4.

For the edge of the IDZ sampling, limnological profiles of field parameters (specific conductance, temperature, and turbidity) will be carried out in an attempt to identify the location of the plume from the outfall (i.e., direction of flow). MPMC is committed to spending a reasonable level of effort and time to detect the plume and direction of flow. The reasonable level of effort and time will vary depending on the health and safety risks associated with the weather conditions and season. Vertical profiles of field measurements and water chemistry samples will be taken at the inferred centerline of the plume at the edge of the IDZ (station QUL-58).

A plume dispersion model was developed by Golder for the nearfield (i.e., in the vicinity of the IDZ), and a hydrodynamic model of Quesnel Lake has been developed and calibrated by Tetra Tech EBA to predict effluent transfer throughout the West Basin of Quesnel Lake and potential for buildup (Golder 2015b). Monitoring at the near-field station, along with monitoring of other Quesnel Lake receiving environment stations, will be used to verify the near-field and lake-wide hydrodynamic models. It should be noted that the nearfield and the hydrodynamic models, as described in the Long Term Water Management Plan, serve as the basis for the Trigger Response Plan incorporated into the 2018 ADP.

Table 6.5 is a summary of previous surface water monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.5 Summary of surface water monitoring

Summary of Monitoring and Findings	Monitoring Objective		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	Monitoring included streams adjacent to the mine site to determine if there are any changes in water quality. Bootjack and Polley lakes were monitored as receiving environment of the mine. Bootjack Lake was monitored to evaluate potential for exfiltration from Springer Pit. The monitoring sites in Bootjack Lake were moved to two deeper monitoring locations in 2017, as described in the 2016 AERR. For the discharge receiving environment, Quesnel Lake and Quesnel River were monitored.	Post-breach monitoring overlapped with operational monitoring in Polley Lake, Quesnel Lake, and Quesnel River. Monitoring occurred at sites selected to capture major inputs and mixing of Hazeltine Creek. Supplemental sampling of 3 stations flowing into Hazeltine Creek in the Polley Flats area was undertaken to support a geochemical conceptual model in 2016 (SRK and Minnow 2016).	N/A
Summary of findings	The results for the creeks and lakes from 2016-2017 identified no significant trends. No indication of exfiltration from the Springer Pit was found in Bootjack Lake.	Results from Quesnel River show no indications of further effects post-breach since 2016. The 2016 and 2017 results showed that the lower sedimentation pond was effective at decreasing the TSS concentration of Hazeltine Creek. The modelling concluded that 93 to 99% of copper was organically complexed and generally not bioavailable.	N/A
Recommendations for 2018-2020 monitoring	A summary of all changes from the 2016 CEMP is provided in Section 6.6.4.1.	A summary of changes from the 2016 CEMP is provided in Sections 6.6.4.1 and 6.6.4.2.	N/A

Notes: AERR: Annual Environmental and Reclamation Report; N/A: not applicable; TSS: total suspended solids

6.6.4.1 OPERATIONAL MONITORING

Table 6.6 summarizes all changes in operational surface water monitoring form the 2016 CEMP.

Table 6.6 Operational monitoring changes since the 2016 CEMP

Sample Site(s)	Change from 2016 CEMP	Purpose/Justification
W1	Reduced frequency from monthly to quarterly	W1 monitors water quality in Morehead Creek, the outflow of Bootjack Lake. As of time of writing, Springer Pit water level is below 990 masl and no indication of exfiltration from the Springer Pit was found in Bootjack Lake. The monitoring frequency will be reviewed by a QP if Bootjack Lake shows any mine-related changes in the future.
W10	Reduced frequency from monthly to semi annually (in June and October)	The monitoring of this site overlaps with Post-Breach Monitoring as it acts as a reference location for the remediated section of Edney Creek. The reduced frequency aligns with frequency of EDC-01 (see Section 6.6.4.2).
W20	Reduced frequency from quarterly to semi-annually	This creek is not directly influenced by mine activities as mine-affected water is diverted away from this creek catchment. Less intense monitoring is required. The frequency will be reviewed by a QP if Bootjack Lake water quality shows any mine-related changes.
QUL-58	Reduced frequency from monthly to 4 times per year (taken at evenly spaced time series plus or minus one month)	Monitoring As per the ADP, QUL-58 monitoring is for model verification.
QUL-57	Reduced frequency from monthly to 4 times per year (taken at evenly spaced time series plus or minus one month)	As per the ADP, QUL-57 monitoring is for model verification.
QUL-59	Reduced frequency from monthly to 4 times per year (taken at evenly spaced time series plus or minus one month)	As per the ADP, QUL-59 monitoring is for model verification.
QUL-18	Reduced frequency from monthly to 4 times per year (taken at evenly spaced time series plus or minus one month)	As per the ADP, QUL-18 monitoring is for model verification.
QUL-2a	Reduced frequency from monthly to 4 times per year (taken at evenly spaced time series plus or minus one month) Considered Quesnel Lake reference site	As per the ADP, QUL-2a monitoring is for model verification and is now considered the Quesnel Lake reference site.

Sample Site(s)	Change from 2016 CEMP	Purpose/Justification
QUL-120a	Reduced from seasonally to semi-annually (taken at evenly spaced time series plus or minus one month) No longer considered Quesnel Lake reference site	As per the ADP, QUL-120a monitoring is for model verification.
QUR-1	Continuous monitoring removed	Continuous monitoring was conducted at this site from August 12, 2014 to May 30, 2016. In consultation with ENV, given the lack of variation in the results, continuous monitoring was deemed to be no longer necessary.
QUR-11	Removed	This site is regularly monitored by the provincial and federal government agencies with financial support from MPMC. An annual side-by-side sample will be collected by MPMC at the request of the regulator.
P1, P2	Reduced sampling from monthly to spring overturn, twice in summer, fall overturn, and once in winter under ice Change in sampling depths	The monitoring of these sites overlap with Post-Breach Monitoring. The reduction in monitoring frequency (both sampling and limnological profiles) is because the water quality in Polley Lake appears to be stable. If changes are observed in water quality reflecting breach- or mine-related impacts, frequency of monitoring will be reviewed by a QP. These sample depths align with pre-breach monitoring as agreed upon with ENV staff biologist.
B1, B2	Reduced monitoring of limnological profile from semi-monthly to monthly Change in sampling depths	The reduction in monitoring frequency is because the water quality in Bootjack Lake appears to be stable. If changes are observed in water quality reflecting mine-related impacts, frequency of monitoring will be reviewed by a QP. These sample depths align with pre-breach monitoring as agreed upon with ENV staff biologist.

Notes: CEMP: Comprehensive Environmental Monitoring Plan; masl: meters above sea level; QP: Qualified Professional; ADP: Annual Discharge Plan

6.6.4.2 POST-BREACH MONITORING

Table 6.7 summarizes all changes in operational surface water monitoring form the 2016 CEMP.

Table 6.7 Post-breach monitoring changes since the 2016 CEMP

Sample Site(s)	Change from 2016 CEMP	Purpose/Justification
HAC-13	Reduced from weekly to monthly	This site used to be upstream of the Hazeltine Creek Discharge and was monitored under the EEM. Currently, this site monitors water quality in Hazeltine Creek after Reach 1. Monitoring frequency has been reduced to align with other Hazeltine Creek samples.
HAC-14	Added	This site was added to monitor effects of remediation activities on Hazeltine Creek water quality. The frequency aligns with other Hazeltine Creek samples.
HAC-12	Removed	In consultation with ENV (C. Danyluk, personal communication, February 8, 2018), this site has been removed as it is no longer necessary with the connection of the pipeline from the WTP to the diffusers.
HAC-01c	Added	This site represents Hazeltine Creek water quality before entering Quesnel Lake. The frequency aligns with other Hazeltine Creek samples.
EDC-01	Reduced from monthly to semi-annually	No significant trends have been identified at EDC-01. Because of reduced site access in winter and stable water quality, sampling frequency has been reduced to semi-annually.

Notes: CEMP: Comprehensive Environmental Monitoring Plan; EEM: Environmental Effects Monitoring; ENV: BC Ministry of Environment and Climate Change Strategy; WTP: Water Treatment Plant

6.6.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

For water chemistry, QC samples will be collected as a component of the monitoring program as per the MPMC QA/QC Manual. A combined QC schedule for all surface water monitoring (i.e., operational, post-breach, reclamation) is summarized in Table 6.8.

Table 6.8 Water chemistry QC sample frequencies for surface water monitoring

QC Samples	Frequency
Duplicate samples	10% of surface water samples
Equipment blanks	Monthly per piece of equipment (when used)
Trip blanks	Twice per month
Field blanks	Twice per month
Filter blanks	Quarterly
Deionized water blanks	Annually
Laboratory replicate[1]	Annually

Note: [1] Split sample

For results greater than five times the method detection limit (MDL), a relative percent difference (RPD) will be used to identify differences between original and duplicate samples. These data quality objectives (DQOs) are the same as the RPDs used by the lab. If one or both results are less than five times the MDL, a difference between original and duplicate samples greater than two times the MDL is used to identify differences. Blanks in which any parameters exceed the reported MDL will be flagged.

6.6.6 Laboratory Analysis

Samples will be submitted to and processed by a Canadian Association of Laboratory Accreditation (CALA) accredited analytical laboratory, typically ALS Environmental Inc. in Burnaby, BC, where standard testing procedures will be used as specified in the most recent editions of the *BC Environmental Laboratory Manual* (MoE 2015).

Laboratory precision will be assessed on the basis of laboratory duplicate results and laboratory accuracy will be assessed using certified reference materials (CRMs) and matrix spikes. Potential laboratory contamination will be assessed using a DQO of ≤ 2 times the laboratory MDL in laboratory method blank results.

6.6.7 Data Analysis and Reporting

In Hazeltine Creek, data analysis and interpretation for reporting purposes will include calculation of summary statistics (e.g., mean, minimum, maximum, and 95th percentile values over the period of interest) and evaluation of any spatial (e.g., down the creek) and temporal changes or trends. Results will also be compared to the BC aquatic life WQGs.

In the other surface water monitoring sites, statistical analysis will be carried out to compare data to reference sites and to assess trends over time. Results will also be compared to the BC aquatic life WQGs.

6.7 Hydrology Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.7.1 Section Authors and Study Design Professionals

This section was written by MPMC, and is guided by Section 3.4 of the Permit (April 7, 2017).

6.7.2 MONITORING OBJECTIVES

The objective of hydrological monitoring in Hazeltine Creek is to characterize the hydrology of the Hazeltine Creek system, assess fish habitat (only in reaches accessible to fish), interpret water quality and water balance, and evaluate changes over time as rehabilitation works are carried out and system recovery occurs (e.g., establishment of riparian vegetation).

The objective of hydrological monitoring in Edney Creek is to characterize the hydrology of Edney Creek in the remediated section, asses fish habitat, interpret water quality, and evaluate changes over time as rehabilitation works are carried out and system recovery occurs (e.g., establishment of riparian vegetation).

The objective of the hydrological monitoring of the streams and creeks that run through or adjacent to the mine site is to characterize the hydrology of the drainages, interpret water quality, and evaluate any changes over time.

6.7.3 MONITORING OVERVIEW

MPMC maintains eight hydrology stations as required by the Permit. Table 6.9 provides an overview of the hydrology monitoring. No large changes have been made from the 2016 CEMP, but wording has been changed to more align with the wording in Section 3.4 in the Permit. Further details of monitoring sites, including site access descriptions, access or safety concerns, and a brief rationale for monitoring, is provided in the Site Matrix in Appendix D. Figure 6.3 shows monitoring locations of the hydrology monitoring locations.

Staff gauges will be benchmarked (calibrated) once per year between June 15 and August 31, as defined by the Permit. Staff gauge readings will be recorded during water chemistry sampling events at the associated stations and each manual flow measurement. Note that there is currently no staff gauge installed at station W4a (North Dump Creek), as it is a very low flow creek; however, as recommended by WaterSmith Research Inc. (WaterSmith; Appendix K in MPMC 2016e), MPMC will endeavor to install a staff gauge at this location that provides adequate information. Continuous stage monitoring equipment (pressure transducers) will be installed at hydrometric locations specified in Table 6.9 during non-freezing conditions.

Manual flow gaugings will be conducted at all sites during high, moderate, and low flows in non-freezing conditions. These measurements will be conducted at minimum three times per year for validation of the stage-discharge rating curves. If stage-discharge stability is not demonstrated, the frequency of monitoring will be increased to five times per year during the non-freezing period (across the spectrum of high to low flows) to meet Resources Information Standards Committee Grade A standards for hydrometric monitoring (MoE 2009). Due to site characteristics and difficult operating conditions, often the sites meet Grade B/C standards. MPMC will continue to work with a QP to move toward meeting Grade A standards for all hydrological stations. A stage discharge curve that encompasses the non-freezing period flows will be maintained for all hydrological stations with staff gauges.

Table 6.9 Hydrology monitoring overview

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
H4	-	Upper Hazeltine Creek at Polley Lake outlet	Continuous[1]	Water head pressure, temperature	N/A
			Weekly (daily during high runoff periods)	Stage (staff gauge)	Permit 11678
			Monthly[1]	Manual flow gauging	
H1	-	Upper Hazeltine Creek hydrometric station (at Gavin Lake FSR Bridge)	Continuous[1]	Water head pressure, temperature	Permit 11678
			Monthly[1]	Stage (staff gauge)	
			Monthly[1]	Manual flow gauging	
H2	-	Lower Hazeltine Creek hydrometric station (downstream of the Ditch Road Bridge)	Continuous[1]	Water head pressure, temperature	Permit 11678
			Monthly[1]	Stage (staff gauge)	
			Monthly[1]	Manual flow gauging	
W1b	E291449	Morehead Creek	Water quality sample and when flows are measured[1]	Stage (staff gauge)	Permit 11678
			High, moderate and low flows[1]	Manual flow gauging (3 time/year; 5 times if rating curve stability not demonstrated)	
W4a	E298551	North Dump Creek below Wight Pit Road	Monthly[1]	Manual flow gauging	Permit 11678
W5	E208039	Bootjack Creek Above Hazeltine Creek	Water quality sample and when flows are measured[1]	Stage (staff gauge)	Permit 11678
			High, moderate, and low flows[1]	Manual flow gauging (3 time/year; 5 times if rating curve stability not demonstrated); only when sufficient flow	

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
W12	E216744	6 km Creek at Road	Water quality sample; when flows are measured[1]	Stage (staff gauge)	Permit 11678
			High, moderate and low flows[1]	Manual flow gauging (3 time/year; 5 times if rating curve stability not demonstrated)	
H3	-	Lower Edney Creek	Continuous[1]	Water head pressure, temperature	N/A
			When flows are measured[1]	Stage (staff gauge)	Permit 11678
			High, moderate and low flows[1]	Manual flow gauging (3 time/year; 5 times if rating curve stability not demonstrated)	

Notes: [1] In non-freezing conditions; N/A: not applicable

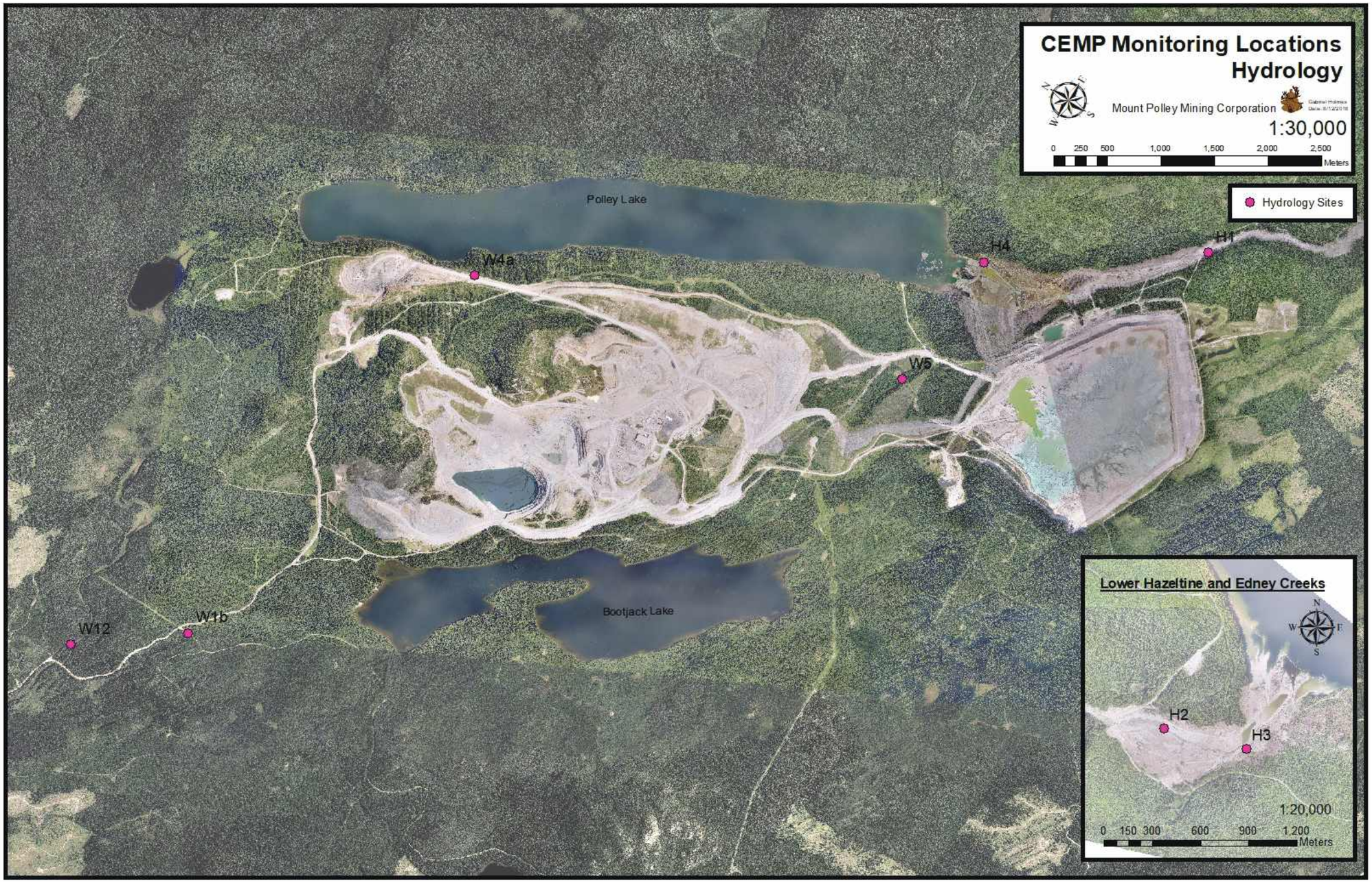


Figure 6.3 CEMP monitoring locations: Hydrology monitoring

6.7.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Hydrological monitoring will be conducted as per the SOPs and WMs for Hydrological Monitoring (which includes installing and downloading continuous loggers) and Benchmarking, as well as the specific WM for operating the FlowTracker acoustic Doppler velocity meter.

Note that some streams do not flow year-round; if there is no flow and a sample or measurement cannot be taken as scheduled, the attempt will be documented in the field notebook.

To verify the accuracy of established rating curves (i.e., confirm that the channel morphology at the station and outflow control point have not changed) and, where possible, extend the upper and lower bounds of the curves, manual flow gaugings will be taken according to Table 6.9 in non-freezing conditions. Manual flow monitoring requirements will be re-evaluated each year, following refinement of the stage-discharge rating curves.

Table 6.10 is a summary of previous hydrology monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.10 Summary of hydrology monitoring and findings

Summary of Monitoring and Findings	**Monitoring Objective**		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	W1b, W5, and W12 were established prior to 2014. W4a was established in 2014. More detail for each site is provided in Section 6.7.4.1.	H1 and H2 hydrology sites were established in 2015, when channeling of Hazeltine Creek was completed. H4 hydrology site was established in 2016 in the remediated section of upper Hazeltine Creek. H3 hydrology site in the remediated section of Edney Creek was established in 2015. More detail of each station is provided in Section 6.7.4.2.	N/A
Summary of findings	Manual measurements were used to confirm and refine rating curves.	Manual measurements confirmed the rating curves for H1, H2, and H3. Increased manual measurements for H4 will confirm the ratings curve.	N/A

Summary of Monitoring and Findings	Monitoring Objective		
	Operational	Post-Breach	Reclamation
Recommendations for 2018-2020 monitoring	Manual measurements will be collected to confirm the rating curves. One hydrology station is not configured for staff gauge and its establishment will be explored.	Continuous monitoring of levels will continue using the established rating curve. Manual measurements will be collected to confirm the rating curves.	N/A

Notes: N/A: not applicable

6.7.4.1 Operational Monitoring

Table 6.11 summarizes the operational hydrology sites. Flows around the MPMC site are freshet driven; therefore, many hydrology stations are low flow during the rest of the year and cannot be measured. No continuous monitoring devices are installed at these sites due to the very low flow nature of the creeks.

Table 6.11 Summary of operational hydrology sites

Site	Comment
W1b	Site W1b was established in 2012. Benchmarking of this station has occurred annually. In 2016, WaterSmith made significant changes to the site and a new stage-discharge curve was developed. MPMC will continue to conducted manual measurements to confirm the rating curve.
W4a	Site W4a was established downstream, and replaced site W4 in 2014. Only manual bucket flow measurements are recorded from a constructed pipe weir at this site and will continue until recommendations for installation of a staff gauge are explored.
W5	Site W5 at Bootjack Creek was re-established in 2008. Benchmarking of this station has occurred annually. A new staff gauge was installed in 2016 by WaterSmith and a new stage-discharge curve was developed. MPMC will continue to conducted manual measurements to confirm the curve.
W12	Site W12 was established in 1990. Benchmarking of this station has occurred annually. A new stage-discharge curve was developed in 2016. MPMC will continue to conducted manual measurements to confirm the curve.

Notes: WaterSmith: WaterSmith Research Inc.; MPMC: Mount Polley Mining Corporation

6.7.4.2 Post-Breach Monitoring

Table 6.12 summarizes the post-breach hydrology sites.

Table 6.12 Summary of post-breach monitoring hydrology sites

Site	Comment
H1	Site H1 was established in upper Hazeltine Creek in 2015. Benchmarking of this station has occurred annually. A new stage-discharge curve was developed in 2016. A continuous monitoring device will be installed at this station to provide continuous water head pressure measurements during non-freezing periods. In addition, MPMC will continue to conducted manual measurements to confirm the rating curve.
H2	Site H2 was established in upper Hazeltine Creek in 2015. Benchmarking of this station has occurred annually. A new stage-discharge curve was developed in 2016. A continuous monitoring device will be installed at this station to provide continuous water head pressure measurements during non-freezing periods. In addition, MPMC will continue to conducted manual measurements to confirm the rating curve.
H3	Site H3 was established in the remediated area of lower Edney Creek in 2015. Benchmarking of this station has occurred annually. A new stage-discharge curve was developed in 2016. A continuous monitoring device will be installed at this station to provide continuous water head pressure measurements during non-freezing periods. In addition, MPMC will continue to conducted manual measurements to confirm the curve.
H4	Site H4 was established in upper Hazeltine Creek at the Polley Lake Weir in 2016. Benchmarking of this station has occurred annually. A new stage-discharge curve was developed in 2016. A continuous monitoring device will be installed at this station to provide continuous water head pressure measurements during non-freezing periods. In addition, MPMC will continue to conducted manual measurements to confirm the curve.

Notes: MPMC: Mount Polley Mining Corporation

6.7.5 Data Quality Control, Objectives, and Review

The FlowTracker has built in error messages associated with measurements that are outside of set QC bounds, and reports an International Standard Calculation error and statistical (US Geological Survey calculation) error output following each discharge measurement as a QC measure.

Benchmarking, as described above and as per the protocol in the QA/QC Manual, will occur annually between June 15 and August 31 as per the Permit, or as described by the Permit.

Routine monitoring includes inspections of equipment, including stilling wells and loggers (e.g., to identify sedimentation inside the stilling well or debris build up in logger ports). Identification of potential station changes or issues also occurs through data analysis when data are inconsistent or unusual in comparison with previously collected data.

6.7.6 Laboratory Analysis

No laboratory analysis is required for hydrology monitoring.

6.7.7 Data Analysis and Reporting

Data analysis will include building and validating the stage-discharge rating curves, as well as production of annual hydrographs. These will be presented in the AERR.

6.8 GROUNDWATER MONITORING

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.8.1 SECTION AUTHORS AND STUDY DESIGN PROFESSIONALS

This section was written by MPMC.

6.8.2 MONITORING OBJECTIVES

The primary objective of the groundwater monitoring program on the mine site is to determine the direction, volume, and quality of groundwater flow from the mine site and other disturbed areas to receiving environment.

6.8.3 MONITORING OVERVIEW

Groundwater monitoring wells around the mine site are installed in the area around the TSF, the Springer Pit, downstream of waste rock dumps and haul roads, and in other areas on or surrounding the mine. The monitoring program was developed on the recommendation of the groundwater program review by Golder conducted in March 2016. This review was submitted to ENV on March 31, 2016. An annual review of the groundwater monitoring program was also conducted by Golder in March 2017 and was submitted as Appendix F in the 2017 AERR (MPMC 2018). Recommendations from the 2017 review have been incorporated into the monitoring program outlined below. Sampling events at times of maximum and minimum hydrologic conditions to account for seasonal variability will be conducted when appropriate (i.e., spring and late summer/fall). Static water level (SWL) of all wells will be monitored on the same day at minimum once annually to allow for comparison across the site.

Groundwater monitoring wells were also installed along the Hazeltine Creek in 2015 and 2016. From Golder (2017), groundwater "was not screened for the terrestrial risk assessment because wildlife do not consume groundwater". Monitoring of surface water in Hazeltine Creek captures the potential effects of groundwater discharged to the Hazeltine Channel system (Golder 2017; see Section 6.6). No further monitoring is planned at these groundwater wells.

Table 6.13 summarizes the parameters analysed for groundwater quality. Table 6.14 provides an overview of the groundwater monitoring. Further details of monitoring sites, including site access descriptions, access or safety concerns, and a brief rationale for monitoring, is provided in the Site Matrix in Appendix D. Figure 6.4 shows monitoring locations of the groundwater sampling locations.

Table 6.13 Groundwater chemistry parameters

Parameter	LOR	Unit
Field Parameters		
pH	-	pH
Conductivity	-	µS/cm
Temperature	-	°C
Physical Tests		
Conductivity	2	µS/cm
Hardness (as $CaCO_3$)	0.5	mg/L
pH	0.1	pH
Turbidity	0.1	NTU
Anions and Nutrients		
Alkalinity, Total (as $CaCO_3$)	1	mg/L
Ammonia, Total (as N)	0.005	mg/L
Chloride (Cl)	0.5	mg/L
Fluoride (F)	0.02	mg/L
Nitrate and Nitrite (as N)	0.003	mg/L
Nitrate (as N)	0.001	mg/L
Nitrite (as N)	0.005	mg/L
Total Nitrogen	0.03	mg/L
Phosphorus (P)-Total Dissolved	0.002	mg/L
Phosphorus (P)-Total	0.002	mg/L
Sulfate (SO_4)	0.3	mg/L

Parameter	LOR	Unit
Dissolved Metals		
Aluminum (Al)	0.003	mg/L
Antimony (Sb)	0.0001	mg/L
Arsenic (As)	0.0001	mg/L
Barium (Ba)	0.0001	mg/L
Beryllium (Be)	0.0001	mg/L
Bismuth (Bi)	0.00005	mg/L
Boron (B)	0.01	mg/L
Cadmium (Cd)	0.000005	mg/L
Calcium (Ca)	0.05	mg/L
Chromium (Cr)	0.0005	mg/L
Cobalt (Co)	0.0001	mg/L
Copper (Cu)	0.0005	mg/L
Iron (Fe)	0.03	mg/L
Lead (Pb)	0.00005	mg/L
Lithium (Li)	0.001	mg/L
Magnesium (Mg)	0.1	mg/L
Manganese (Mn)	0.0001	mg/L
Molybdenum (Mo)	0.00005	mg/L
Nickel (Ni)	0.0005	mg/L
Potassium (K)	0.05	mg/L
Selenium (Se)	0.00005	mg/L
Silicon (Si)	0.1	mg/L
Silver (Ag)	0.00001	mg/L
Sodium (Na)	0.05	mg/L
Strontium (Sr)	0.0002	mg/L
Thallium (Tl)	0.00001	mg/L
Tin (Sn)	0.0001	mg/L
Titanium (Ti)	0.01	mg/L
Uranium (U)	0.00001	mg/L
Vanadium (V)	0.0005	mg/L
Zinc (Zn)	0.003	mg/L

Notes: LOR: Limit of Reporting

Table 6.14 Groundwater monitoring overview

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
GW96-2a	E229681	Tailings Impoundment East Well (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW96-2b	E229682	Tailings Impoundment East Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW96-3a	E229683	Tailings Impoundment SE Well (deep)	Annually[1]	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly[1]	SWL	N/A
GW96-4a	E229685	Tailings Impoundment SW Well (deep)	Annually[1]	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly[1]	SWL	N/A
GW96-4b	E229686	Tailings Impoundment SW Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW96-7	E229690	SE Sed Pond Well	Annually[1]	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly[1]	SWL	N/A
GW00-1a	E242385	Tailings Impoundment West Well (deep)	Annually[1]	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly[1]	SWL	N/A
GW00-1b	E242384	Tailings Impoundment West Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW00-2a	E242387	Tailings Impoundment West Well (deep)	Annually[1]	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly[1]	SWL	N/A
GW00-3a	E242389	Tailings Impoundment West Well (deep)	Annually[1]	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly[1]	SWL	N/A
GW00-3b	E242388	Tailings Impoundment West Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
95-R-5	E229695	Lower SERDS Well (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW05-01	E258923	Wight Pit/Polley Lake Interface Well	Quarterly[2]	Field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW11-1a	E291210	Below Temporary PAG Dump (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW11-1b	E291211	Below Temporary PAG Dump (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW11-2a	E291212	Below SERDS (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW11-2b	E291213	Below SERDS (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-1a	E291969	NW of Temporary PAG Dump (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-1b	E291970	NW of Temporary PAG Dump (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-2a	E291971	Springer Pit Well (deep)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Continuous	SWL (level logger installed in well)	N/A
GW12-2b	E291972	Springer Pit Well (shallow)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Continuous	SWL (level logger installed in well)	N/A
GW12-3a	E291973	Below Waste Haul Road (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-3b	E291974	Below Waste Haul Road (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-4a	E291976	Below NEZ Dump (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-4b	E291977	Below NEZ Dump (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-5a	E291978	Below Wight Pit Road (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW12-5b	E291979	Below Wight Pit Road (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW14-1	E301973	Groundwater well at New Orica Site	Quarterly[2]	Field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW15-1a	E303210	Springer Pit Well North (deep)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Continuous[3]	SWL (level logger installed in well)	N/A
GW15-1b	E303211	Springer Pit Well North (shallow)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Continuous[3]	SWL (level logger installed in well)	N/A
GW15-2a	E303212	Springer Pit Well South (deep)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Weekly	SWL (if required under the Springer Pit Response Plan)	N/A

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
GW15-2b	E303213	Springer Pit Well South (shallow)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Weekly	SWL (if required under the Springer Pit Response Plan)	N/A
GW16-1a	E308529	Below SERDS (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-1b	E308530	Below SERDS (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-2a	E308531	Tailings Impoundment North Well (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly	SWL	N/A
GW16-2b	E308532	Tailing Impoundment North Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-3a	E308533	Tailings Impoundment SE Well (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly	SWL	N/A
GW16-3b	E308534	Tailings Impoundment SE Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-4a	E308535	Tailings Impoundment S Well (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly	SWL	N/A
GW16-4b	E308536	Tailings Impoundment S Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-5a	E308537	Tailings Impoundment W Well (deep)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
			Quarterly	SWL	N/A
GW16-5b	E308538	Tailings Impoundment W Well (shallow)	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-6a	E308539	West of Cariboo Pit (deep)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-6b	E308540	West of Cariboo Pit (shallow)	Quarterly	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-7	E308541	Between Wight Pit and Polley Lake	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG
GW16-8	E308542	Between Wight Pit and Polley Lake	Semi-annually	SWL, field parameters, physical tests, anions and nutrients, dissolved metals	CSR Schedule 3.2 AL Standards; BC WQG

Notes: [1] Wells show stable chemistry. If an unexpected change in SWL is observed, well water will be sampled; [2] Wells provide domestic water for personnel; BC WQG – British Columbia water quality guideline; SWL: static water level; CSR: Contaminated Sites Regulations; AL: aquatic life; [3] Leveloggers have been removed from GW15-1a and 1b as wells are dry. Leveloggers will be reinstalled once water is above well screen.

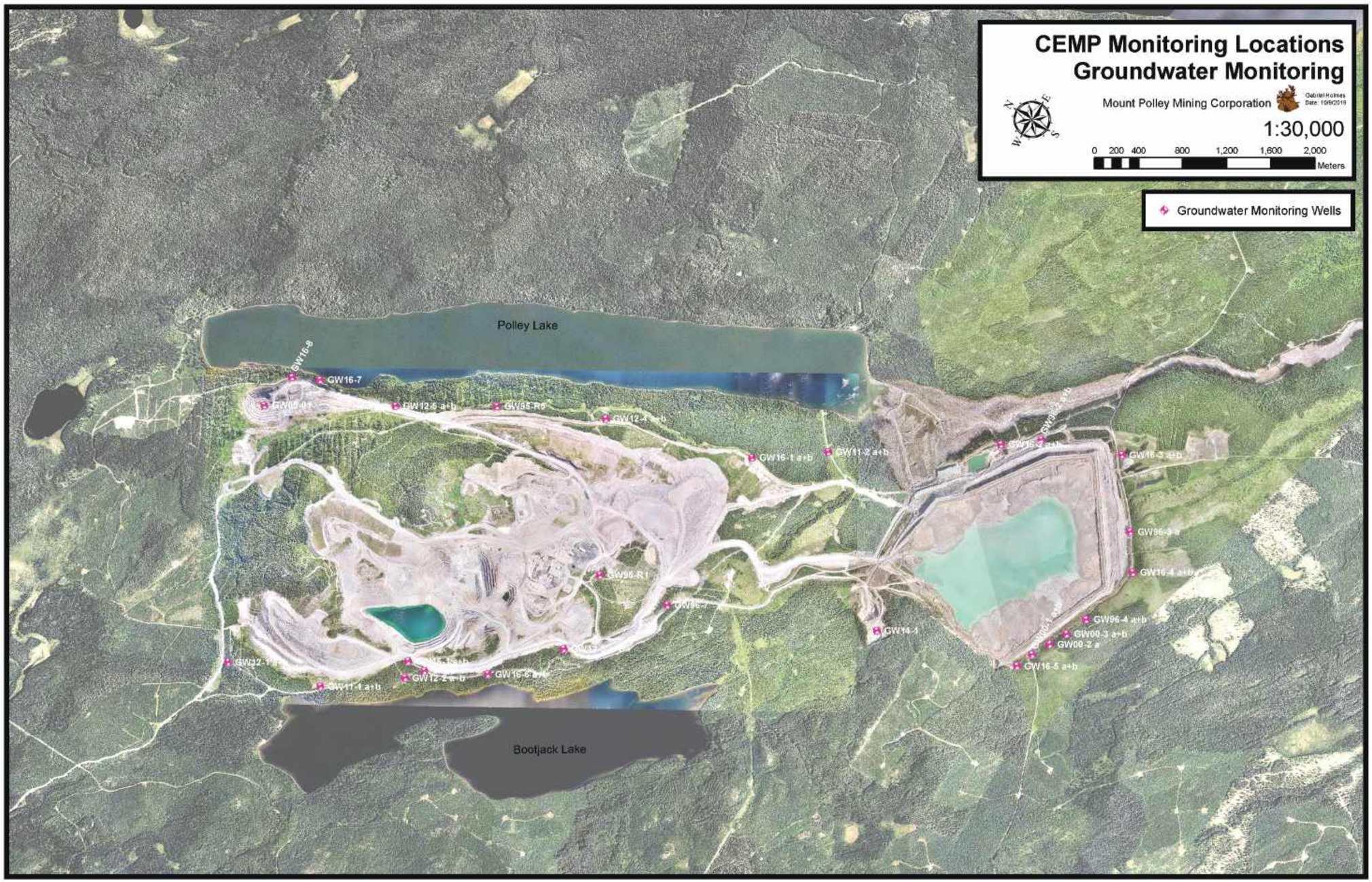


Figure 6.4 CEMP monitoring locations: Groundwater monitoring

6.8.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

As outlined in the SOPs, groundwater monitoring involves use of an automated depth to water meter to measure SWL and a submersible pump powered by a generator for sampling. These protocols also require routine inspections of the well housing.

Sample collection, preparation, and shipping will be conducted following the SOPs and WMs for Groundwater Monitoring and use of associated field meters in the QA/QC Manual. These procedures include use of lab-verified clean or appropriately rinsed sampling bottles and steps to reduce risk of sampling contamination. *In-situ* parameters will be measured when samples for chemistry are collected. Water samples will be analyzed as described in Section 6.8.3.

Table 6.15 is a summary of previous groundwater monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.15 Summary of groundwater monitoring and findings

Summary of Monitoring and Findings	Monitoring Objective		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	Groundwater locations in both shallow and deep bedrock downstream of mine activities. Higher frequency monitoring occurred at wells near the Springer Pit in 2015, 2016, and 2017 because the pit water level was above 1025 masl. Dredging of the Springer Pit commenced in 2017, and the water level in the pit is less than 1000 masl at the time of writing.	An updated groundwater program was implemented for the ERA (Golder 2017). Wells installed in 2015 were resampled and additional wells were installed along the creek in 2016. Groundwater was analyzed for dissolved metals, TSS, pH, anions, nutrients, hardness and acidity.	N/A
Summary of findings	Monitoring of the groundwater wells near the Springer Pit showed exfiltration from the Springer Pit towards Bootjack Lake occurred during 2016. This exfiltration was reversed after the Springer Pit was dewatered, which was confirmed by continued monitoring of these wells. No groundwater leakage from Springer Pit to Bootjack Lake in 2107 was inferred based on the levels measured. No significant changes to groundwater quality were identified in the 2017 annual groundwater review (MPMC 2018).	Although copper was the primary metal of concern in the tailings outwash material deposited in Hazeltine Creek, groundwater copper concentrations were lower than the CSR standard. Other substances that exceeded CSR standards are believed to be associated with natural conditions and were not derived from the tailings.	N/A
Recommendations for 2018-2020 monitoring	New groundwater wells were drilled at the end of 2016 as per recommendations in the Groundwater Program Review. These wells were incorporated into the current program in 2017. One pair of wells was removed due to likely contamination and were replaced (see Golder 2016c). See Section 6.8.4.1 for more detail on the recommendations for future monitoring.	No further sampling is planned for groundwater in Hazeltine Creek. If the water quality declines in the creek, monitoring of these wells will be reviewed and considered.	N/A

Notes: masl: metres above sea level; CSR: Contaminated Sites Regulation; ERA: ecological risk assessment; TSS: total suspended solids

6.8.4.1 OPERATIONAL MONITORING

The monitoring frequencies of the Springer Pit wells were decreased from monthly to quarterly due to the ongoing dewatering at Springer Pit, which has resulted in a significant drop in water levels in some of these wells. For example, dataloggers have been removed from GW15-1a and b as these wells are now dry (J. Foley, personal communication, August 10, 2018). According to J. Foley, "due to the ongoing dewatering at Springer Pit, Golder would consider it acceptable to move to quarterly monitoring, if groundwater is present within the wells." Once dewatering stops and the pit is refilled, consideration to move back to monthly monitoring for a period of time will be given.

A further change to the recommendations put forth in Appendix F of MPMC (2018) is that "quarterly groundwater monitoring should continue at GW16-6 a and b, but semi-annual monitoring can be completed at the remaining GW16 well series. Note that some of the remaining 2016 well series (other than GW16-6 a/b) were monitored one to three times in the 2017 calendar year" (J. Foley, personal communication, August 10, 2018).

6.8.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

For water chemistry, QC samples will be collected as a component of the monitoring program as per the MPMC QA/QC Manual. A combined QC schedule for all the groundwater monitoring is summarized in Table 6.16.

Table 6.16 Water chemistry QC sample frequencies for groundwater water monitoring

QC Samples	Frequency
Duplicate samples	10% of groundwater samples
Equipment blanks	Quarterly per piece of equipment (when used)
Trip blanks	Quarterly/semi-annually[1]
Field blanks	Quarterly/semi-annually[1]

Notes: [1] Quarterly for quarterly groundwater samples, semi-annually for semi-annual groundwater samples (i.e., six per year)

For results greater than five times the MDL, an RPD will be used to identify differences between original and duplicate samples. These DQOs are the same as the RPDs used by the lab. If one or both results are less than five times the MDL, a difference between original and duplicate samples greater than two times the MDL is used to identify differences. Blanks in which any parameters exceed the reported MDL will be flagged.

6.8.6 LABORATORY ANALYSIS

Samples will be submitted to and processed by a CALA accredited analytical laboratory, typically ALS Environmental Inc. in Burnaby, BC for chemistry samples, where standard testing procedures will be used as specified in the most recent editions of the *BC Environmental Laboratory Manual* (MoE 2015).

Laboratory precision will be assessed on the basis of laboratory duplicate results and laboratory accuracy will be assessed using certified reference materials (CRMs) and matrix spikes. Potential laboratory contamination will be assessed using a DQO of ≤ 2 times the laboratory MDL in laboratory method blank results.

6.8.7 Data Analysis and Reporting

Data analysis and interpretation for reporting purposes will include calculation of summary statistics (e.g., mean, minimum, maximum, and 95th percentile values over the period of interest) and evaluation of water chemistry or water level changes and/or trends. Groundwater chemistry will be compared to the Schedule 3.2, Column 3 (Aquatic Life) standards in the ENV Contaminated Sites Regulation (CSR) under the EMA, and BC WQGs per Technical Guidance 15 (MOE 2017a). These data will also be used by a third party qualified professional for the three-year groundwater monitoring program review, and updates to hydrogeological models, including the Springer Pit groundwater model. Hazeltine Creek groundwater data will be used to support the geochemical characterization of materials in the Hazeltine Creek corridor.

6.9 Contact Water Quality Monitoring

Monitoring in this subsection falls under BC *Mines Act* M-200 and is only described here for completeness. Monitoring is summarized and changes will be presented in the CEMP, but changes to this monitoring are subject to BC *Mines Act* Permit M-200 and not Section 7 in the CEMP or Section 5 in the CEMP TOR (Appendix A).

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.9.1 Section Authors and Study Design Professionals

This section was written by MPMC.

6.9.2 Monitoring Objectives

The objective is to monitor trends in contact water quality on site, including runoff and mill process water, specifically at locations that represent the WTP source water. These data are applied to understand trends in site water chemistry and inform water management planning, including water discharge strategies.

6.9.3 Monitoring Overview

Table 6.17 summarizes the parameters analysed for contact water quality. Table 6.18 provides an overview of the contact water monitoring. Figure 6.5 shows monitoring locations of the contact water sampling locations.

Table 6.17 Contact water chemistry parameters

Parameter	LOR	Unit
Field Parameters - General		
pH	-	pH
Conductivity	-	µS/cm
Temperature	-	°C
Turbidity	-	NTU
Physical Tests		
Conductivity	2	µS/cm
Hardness (as $CaCO_3$)	0.5	mg/L
pH	0.1	pH
Total Suspended Solids	1	mg/L
Total Dissolved Solids	10	mg/L
Turbidity	0.1	NTU
Anions and Nutrients		
Alkalinity, Total (as $CaCO_3$)	1	mg/L
Ammonia, Total (as N)	0.005	mg/L
Chloride (Cl)	0.5	mg/L
Fluoride (F)	0.02	mg/L
Nitrate and Nitrite (as N)	0.003	mg/L
Nitrate (as N)	0.001	mg/L
Nitrite (as N)	0.005	mg/L
Total Nitrogen	0.03	mg/L
Orthophosphate-Dissolved (as P)	0.001	mg/L
Phosphorus (P)-Total Dissolved	0.002	mg/L
Phosphorus (P)-Total	0.002	mg/L
Sulfate (SO_4)	0.3	mg/L
Organic / Inorganic Carbon		
Dissolved Organic Carbon	0.5	mg/L

Parameter	LOR	Unit
Total and Dissolved Metals		
Aluminum (Al)	0.003	mg/L
Antimony (Sb)	0.0001	mg/L
Arsenic (As)	0.0001	mg/L
Barium (Ba)	0.0001	mg/L
Beryllium (Be)	0.0001	mg/L
Bismuth (Bi)	0.00005	mg/L
Boron (B)	0.01	mg/L
Cadmium (Cd)	0.000005	mg/L
Calcium (Ca)	0.05	mg/L
Chromium (Cr)	0.0005	mg/L
Cobalt (Co)	0.0001	mg/L
Copper (Cu)	0.0005	mg/L
Iron (Fe)	0.03	mg/L
Lead (Pb)	0.00005	mg/L
Lithium (Li)	0.001	mg/L
Magnesium (Mg)	0.1	mg/L
Manganese (Mn)	0.0001	mg/L
Molybdenum (Mo)	0.00005	mg/L
Nickel (Ni)	0.0005	mg/L
Potassium (K)	0.05	mg/L
Selenium (Se)	0.00005	mg/L
Silicon (Si)	0.1	mg/L
Silver (Ag)	0.00001	mg/L
Sodium (Na)	0.05	mg/L
Strontium (Sr)	0.0002	mg/L
Thallium (Tl)	0.00001	mg/L
Tin (Sn)	0.0001	mg/L
Titanium (Ti)	0.01	mg/L
Uranium (U)	0.00001	mg/L
Vanadium (V)	0.0005	mg/L
Zinc (Zn)	0.003	mg/L

Notes: LOR: Limit of Reporting

Table 6.18 Contact water monitoring overview

Station Name	EMS Code	Description	Drainage	Inspection Frequency	Sample Frequency	Parameters Measured	Guidelines	Permit[1]
E1a	E225309	TSF Supernatant	Tailings slurry, seepage collection ponds	Daily	Quarterly[2]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
Long Ditch	-	Long Ditch	East RDS, NEZ Dump, SERDS, Wight Pit dewatering	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
SERDS Ditch	-	SERDS Ditch	SERDS, West Ditch, MDC Sump	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
E13	-	NW Sump	Temporary NW PAG Stockpile	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
E14	-	Mine Drainage Creek Sump	Upper Mine Drainage Creek, West Ditch	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
E15	-	Bootjack Creek Culvert Sump	TSF Haul Road, Upper Bootjack Creek	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
E17	-	9km Sump	Temporary NW PAG Stockpile	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
E4	-	Main Embankment Seepage Collection Pond	MTD, STD, Main Embankment foundation drains	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
E18	-	Central Collection Sump	Long Ditch, SERDS Ditch	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
East MTD	-	East Main Toe Drain	East TSF Main Embankment toe drain	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
West MTD	-	West Main Toe Drain	West TSF Main Embankment toe drain	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
STD	-	South Toe Drain	TSF South Embankment toe drain	Monthly	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	BC *Mines Act* Permit M-200
Gavin's Ditch	-	-	Undisturbed area east of Polley Mountain	Semi-annually	Semi-annually[3]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	Permit 11678[4]
TSF Clean Water Diversion	-	-	Undisturbed area west of TSF	Semi-annually	Semi-annually[3]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	Permit 11678[4]
Wight Pit Clean Water Diversion	-	-	Undisturbed area north of Wight Pit	Semi-annually	Semi-annually[3]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A	Permit 11678[4]

Notes: [1] Permit regulating the sample; [2] When reclaim water is sourced from TSF; [3] In spring and fall, coinciding with ditch inspections; [4] Under Section 2.4.1 of Permit 11678, surface runoff from undisturbed areas must be diverted away from mine workings. These clean water ditches are monitored to ensure water quality is maintained; N/A: not applicable; TSF: Tailings Storage Facility; PAG: potentially acid generating

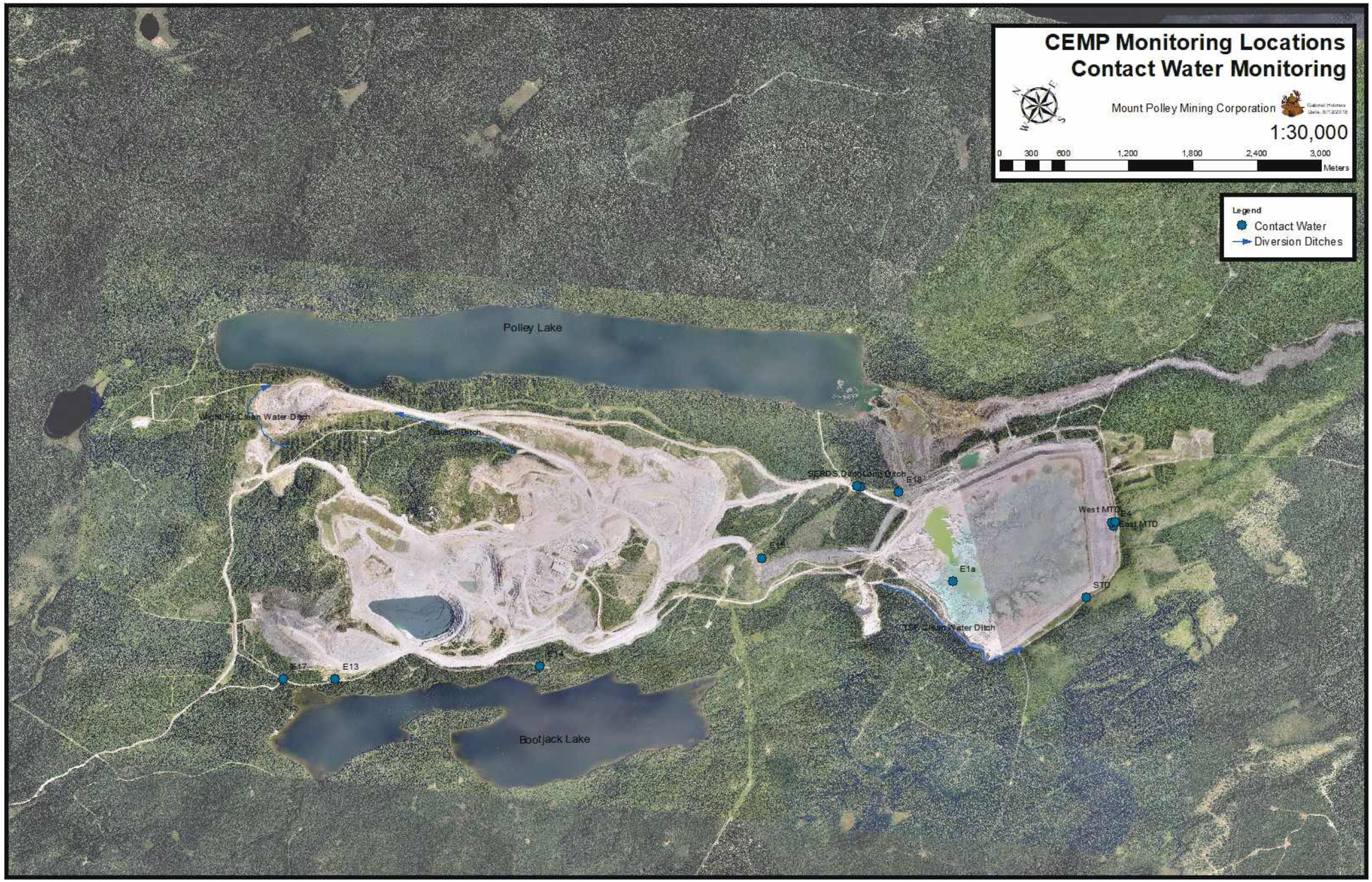


Figure 6.5 CEMP monitoring locations: Contact water monitoring

6.9.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Sample collection, preparation, and shipping will be conducted following the SOPs and WMs for Surface Water Quality Monitoring, and use of associated field meters in the QA/QC Manual. These procedures include use of lab-verified clean or appropriately rinsed sampling bottles and steps to reduce risk of sampling contamination. *In-situ* parameters will be measured when samples for chemistry are collected. Water samples will be analyzed as described in Section 6.9.3.

Table 6.19 is a summary of previous contact water monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.19 Summary of contact water monitoring and findings

Summary of Monitoring and Findings	**Monitoring Objective**		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	Sumps that collect and temporarily store water as well as ditches that convey water from many different sources were monitored.	N/A	N/A
Summary of findings	There were no notable trends in 2017 contact water monitoring that suggested the monitoring program needs to be changed.	N/A	N/A
Recommendations for 2018-2020 monitoring	The Springer Pit Sump (E11) is no longer representative of the pit lake water quality and has not been the source of influent for the WTP since 2016. Tailings supernatant (E1a) is also not the source for the WTP. Therefore, these sites has been removed from monitoring under the Permit; E11 continues to be monitored under the *Mines Act* Permit M-200 (see Section 6.10).	N/A	N/A

Notes: N/A: not applicable; WTP: Water Treatment Plant

6.9.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

For water chemistry, QC samples will be collected as a component of the monitoring program as per the MPMC QA/QC Manual. A combined QC schedule for all contact water monitoring is summarized in Table 6.20. For results greater than five times the MDL, an RPD will be used to identify differences between original and duplicate samples. These DQOs are the same as the RPDs used by the lab. If one or both results are less than five times the MDL, a difference between original and duplicate samples greater than two times the MDL is used to identify differences. Blanks in which any parameters exceed the reported MDL will be flagged.

Table 6.20 Water chemistry QC sample frequencies for contact water monitoring

QC Samples	Frequency
Duplicate samples	10% of contact water samples
Trip blanks	Combined with surface water QC schedule
Field blanks	Combined with surface water QC schedule

6.9.6 Laboratory Analysis

Samples will be submitted to and processed by a CALA accredited analytical laboratory, typically ALS Environmental Inc. in Burnaby, BC, where standard testing procedures will be used as specified in the most recent editions of the *BC Environmental Laboratory Manual* (MoE 2015).

Laboratory precision will be assessed on the basis of laboratory duplicate results and laboratory accuracy will be assessed using certified reference materials (CRMs) and matrix spikes. Potential laboratory contamination will be assessed using a DQO of ≤ 2 times the laboratory MDL in laboratory method blank results.

6.9.7 Data Management and Analysis

Data analysis and interpretation for reporting purposes will include calculation of summary statistics (e.g., mean, minimum, maximum, and 95th percentile values over the period of interest). These data, including spatial and temporal trends in relation to mine features and their geochemistry, will be used in long-term water management planning (Section 5.1).

6.10 Seep Monitoring

Monitoring included in this subsection fall under BC *Mines Act* Permit M-200 and is only described here for completeness. Monitoring is summarized and changes will be presented in the CEMP, but changes to this monitoring are subject to BC *Mines Act* Permit M-200 and not Section 7 in the CEMP or Section 5 in the CEMP TOR (Appendix A).

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.10.1 Section Authors and Study Design Professionals

This section was written by MPMC.

6.10.2 Monitoring Objectives

An important component in determining and monitoring long-term chemical stability of drainage from the pits and waste rock dumps is water quality monitoring. The seep sampling is conducted under the BC *Mines Act* Permit M-200.

6.10.3 MONITORING OVERVIEW

Under the BC *Mines Act* Permit M-200 seepage monitoring program, monitoring of waste rock dump seepages is conducted under a bi-annual seep survey program of all waste rock dumps on site, with representative seeps being monitored more frequently when possible (numerous seeps stop flowing during dry periods). Table 6.21 summarizes the parameters analysed for seepage water quality. A list of dumps and pits that are sampled, along with the representative sample locations, is provided in Table 6.22 and Table 6.23, respectively. Figure 6.6 shows monitoring locations of the seepage sampling locations.

Table 6.21 Seepage water chemistry parameters

Parameter	LOR	Unit
Field Parameters - General		
pH	-	pH
Conductivity	-	µS/cm
Temperature	-	°C
Turbidity	-	NTU
Physical Tests		
Conductivity	2	µS/cm
Hardness (as $CaCO_3$)	0.5	mg/L
pH	0.1	pH
Total Suspended Solids	1	mg/L
Total Dissolved Solids	10	mg/L
Turbidity	0.1	NTU
Anions and Nutrients		
Alkalinity, Total (as $CaCO_3$)	1	mg/L
Ammonia, Total (as N)	0.005	mg/L
Chloride (Cl)	0.5	mg/L
Fluoride (F)	0.02	mg/L
Nitrate and Nitrite (as N)	0.003	mg/L
Nitrate (as N)	0.001	mg/L
Nitrite (as N)	0.005	mg/L
Total Nitrogen	0.03	mg/L
Orthophosphate-Dissolved (as P)	0.001	mg/L
Phosphorus (P)-Total Dissolved	0.002	mg/L
Phosphorus (P)-Total	0.002	mg/L
Sulfate (SO_4)	0.3	mg/L
Organic / Inorganic Carbon		
Dissolved Organic Carbon	0.5	mg/L

Parameter	LOR	Unit
Total and Dissolved Metals		
Aluminum (Al)	0.003	mg/L
Antimony (Sb)	0.0001	mg/L
Arsenic (As)	0.0001	mg/L
Barium (Ba)	0.0001	mg/L
Beryllium (Be)	0.0001	mg/L
Bismuth (Bi)	0.00005	mg/L
Boron (B)	0.01	mg/L
Cadmium (Cd)	0.000005	mg/L
Calcium (Ca)	0.05	mg/L
Chromium (Cr)	0.0005	mg/L
Cobalt (Co)	0.0001	mg/L
Copper (Cu)	0.0005	mg/L
Iron (Fe)	0.03	mg/L
Lead (Pb)	0.00005	mg/L
Lithium (Li)	0.001	mg/L
Magnesium (Mg)	0.1	mg/L
Manganese (Mn)	0.0001	mg/L
Molybdenum (Mo)	0.00005	mg/L
Nickel (Ni)	0.0005	mg/L
Potassium (K)	0.05	mg/L
Selenium (Se)	0.00005	mg/L
Silicon (Si)	0.1	mg/L
Silver (Ag)	0.00001	mg/L
Sodium (Na)	0.05	mg/L
Strontium (Sr)	0.0002	mg/L
Thallium (Tl)	0.00001	mg/L
Tin (Sn)	0.0001	mg/L
Titanium (Ti)	0.01	mg/L
Uranium (U)	0.00001	mg/L
Vanadium (V)	0.0005	mg/L
Zinc (Zn)	0.003	mg/L

Notes: LOR: Limit of Reporting

Table 6.22 Seep monitoring overview

Waste Rock Dump	Representative Sample	Representative Sample Frequency	Parameters Measured	Guidelines
North Bell Dump	Joe's Creek Pipe	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
Boundary Dump	Boundary Seep 2	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
East RDS	-	-	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
NEZ Dump	NEZ Seep 1	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
Waste Haul Road	Mine Drainage Creek Culvert	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
Temporary NW PAG Dump	PAG Seep 15	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
TSF Haul Road	-	-	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
SERDS	SERD Seep 13	Quarterly	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A

Table 6.23 Pit seepage monitoring overview

Pit	Station Name	Sample Frequency	Parameters Measured	Guidelines
Cariboo Pit	E8	Semi-annually[1]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
Wight Pit	E10	Semi-annually[1]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
Springer Pit	E11	Semi-annually[1]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
Boundary Pit	Boundary Pit	Semi-annually[1]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A

Notes: [1] When pit is not storing water from other sources on site

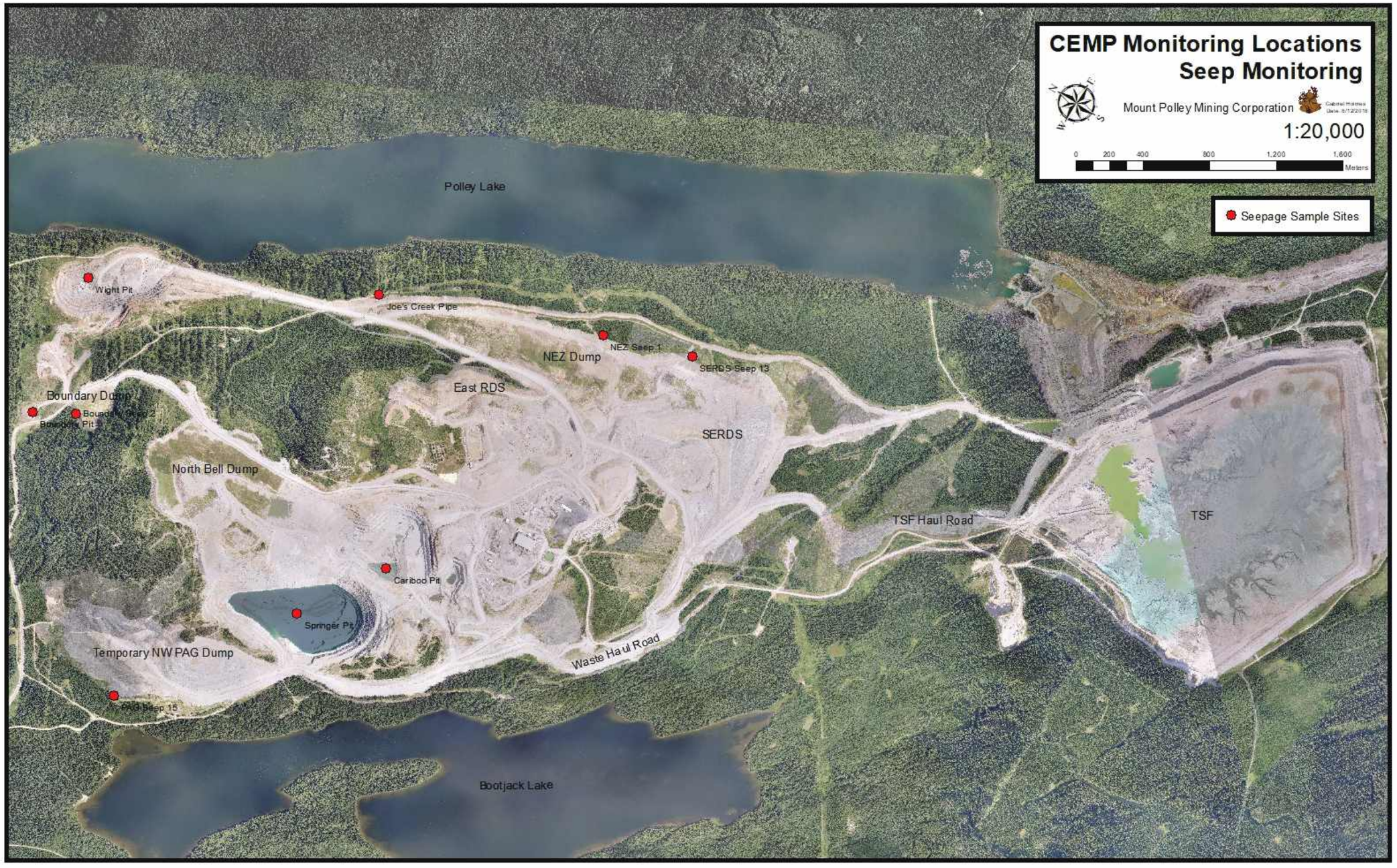


Figure 6.6 CEMP monitoring locations: Seep monitoring

6.10.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Sample collection, preparation, and shipping will be conducted following the SOPs and WMs for Surface Water Quality Monitoring, and use of associated field meters in the QA/QC Manual. These procedures include use of lab-verified clean or appropriately rinsed sampling bottles and steps to reduce risk of sampling contamination. *In-situ* parameters will be measured when samples for chemistry are collected. Water samples will be analyzed as described in Section 6.10.3.

Table 6.24 is a summary of previous seep monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.24 Summary of seep monitoring and findings

Summary of Monitoring and Findings	Monitoring Objective		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	N/A	N/A	Seeps were sampled at the toe of waste rock piles and from pits that are not storing water from other locations.
Summary of findings	N/A	N/A	The results are used to inform long-term planning for reclamation and closure. It has been identified that two seeps from the NEZ Dump have elevated metal concentrations. See Section 6.10.4.1 for more detail.
Recommendations for 2018-2020 monitoring	N/A	N/A	The program will continue unchanged because bi-annual monitoring (i.e., in spring and fall) captures representative conditions.

Notes: N/A: not applicable; NEZ: North-East Zone

6.10.4.1 RECLAMATION AND CLOSURE MONITORING

NEZ Seep 1 and NEZ Seep 2 have elevated metal concentrations compared to other seeps on site. To address this, research into the source of the elevated metals has been launched, as well as possible treatment options. A new collection system for these two seeps has been constructed to isolate the water from the mine site collection infrastructure; this water will be pumped to the mill for the short-term while the research is conducted.

6.10.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

For water chemistry, QC samples will be collected as a component of the monitoring program as per the MPMC QA/QC Manual. A combined QC schedule for all seep monitoring is summarized in Table 6.25.

Table 6.25 Water chemistry QC sample frequencies for seep monitoring

QC Samples	Frequency
Duplicate samples	10% of seep monitoring samples
Trip blanks	Quarterly/Semi-annually[1]
Field blanks	Quarterly/Semi-annually[1]

Notes: [1] Quarterly for quarterly sampling events; semi-annually for semi-annual sampling events

For results greater than five times the MDL, an RPD will be used to identify differences between original and duplicate samples. These DQOs are the same as the RPDs used by the lab. If one or both results are less than five times the MDL, a difference between original and duplicate samples greater than two times the MDL is used to identify differences. Blanks in which any parameters exceed the reported MDL will be flagged.

6.10.6 Laboratory Analysis

Samples will be submitted to and processed by a CALA accredited analytical laboratory, typically ALS Environmental Inc. in Burnaby, BC, where standard testing procedures will be used as specified in the most recent editions of the *BC Environmental Laboratory Manual* (MoE 2015).

Laboratory precision will be assessed on the basis of laboratory duplicate results and laboratory accuracy will be assessed using certified reference materials (CRMs) and matrix spikes. Potential laboratory contamination will be assessed using a DQO of ≤ 2 times the laboratory MDL in laboratory method blank results.

6.10.7 Data Analysis and Reporting

Collection of this data is used in long-term effluent water quality predictions. These results are presented in the AERR and are applied to understand long-term ML/ARD potential, develop site source terms, and inform water management planning.

6.11 Effluent Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.11.1 Section Authors and Study Design Professionals

This section was written by MPMC.

6.11.2 MONITORING OBJECTIVES

The objective of the effluent monitoring program is to verify the water chemistry complies with the applicable regulatory limits at the point of discharge (MDMER Schedule 4 and the Permit limits in Table 6.26; see Section 1.2.3 in the Permit), and that the discharge flow rate does not exceed the permitted rates of a maximum of 52,000 m^3/day and an annual average of 29,000 m^3/day (see Section 1.2.1 in the Permit). The influent is also sampled to allow for analysis of treatment efficacy.

6.11.3 MONITORING OVERVIEW

The flow rate, temperature, and TSS of the effluent will be continuously monitored and recorded in the Veolia WTP HMI. MPMC may consider less frequent sampling (MDMER minimum is quarterly) if the monthly mean concentrations of parameters are <10% of the MDMER guidelines for 12 months, as described Section 13 (1) of the MDMER. To make this change if these conditions are met, MPMC will follow the process outlined in Section 7. Table 6.27 summarizes the parameters analysed for effluent quality and Table 6.28 provides an overview of the effluent monitoring. Further details of monitoring sites, including site access descriptions, access or safety concerns, and a brief rationale for monitoring, is provided in the Site Matrix in Appendix D. Figure 6.7 shows monitoring locations of the effluent sampling locations. Reporting of the monitoring data is outlined in Section 9.

Table 6.26 Permit 11678 and MDMER Schedule 4 treated effluent compliance limits for direct discharge to Quesnel Lake

		Permit Limit		MDMER Schedule 4: Authorized Limits	
Constituent	**Units**	**Interim [1]**	**Final [2]**	**MAX Monthly Mean**	**MAX Grab Sample**
Non-Metal Constituents					
pH	pH	6.0 - 9.5	6.0 - 9.5	6.0 - 9.5	6.0 - 9.5
Total Suspended Solids	mg/L	15 (mean)/30 (max)		15	30
Total Sulphate	mg/L	720	1,100	-	-
Total Ammonia	mg/L (as N)	0.41	1.21	-	-
Total Nitrate	mg/L (as N)	9.7	34	-	-
Total Nitrite	mg/L (as N)	0.78		-	-
Total Phosphorus	mg/L	0.09		-	-
Fluoride	mg/L	17			
Cyanide [3]	mg/L	-		1	2
Radium 226 [4]	Bq/L	-		0.37	1.11
Total Metals					
Arsenic	mg/L	0.0034	0.028	0.5	1
Chromium	mg/L	0.0011	0.004	-	-
Copper	mg/L	0.012	0.033	0.3	0.6
Iron	mg/L	1		-	-
Lead	mg/L	-		0.2	0.4
Manganese	mg/L	3.4		-	-
Molybdenum	mg/L	0.36		-	-
Selenium	mg/L	0.06	0.075	-	-
Silver	mg/L	0.00024		-	-
Zinc	mg/L	0.059		-	-
Dissolved Metals					
Aluminum	mg/L	0.75		-	-
Cadmium	mg/L	0.00034		-	-
Iron	mg/L	0.35		-	-
Acute Toxicity Testing Results					
96h LC50 Rainbow Trout	Mortality in 100% effluent	50%		-	LC50 >100%
48h LC50 *D. magna*		50%		-	LC50 >100%

Notes: [1] Maximum discharge limits until toxicity testing on final effluent concentrations is conducted; [2] Maximum discharge limits applicable after ENV is satisfied that toxicity testing demonstrates that the final effluent will not cause mixture toxicity. This requirement has been met; [3] MDMER requirement only; if cyanide is not used in the mining/milling process, then it does not have to be analysed. Since cyanide is not used in the mining/milling process at Mount Polley, the effluent is not analysed for cyanide; [4] MDMER requirement only; if 10 consecutive samples show radium 226 as less than 0.037 Bq/l then frequency of sampling for radium 226 can be reduced to once a quarter. This has been satisfied, and radium 226 analysis is currently conducted quarterly.

Table 6.27 Effluent chemistry parameters

Parameter	LOR	Unit
Field Parameters - General		
pH	-	pH
Conductivity	-	µS/cm
Temperature	-	°C
Turbidity	-	NTU
Physical Tests		
Conductivity	2	µS/cm
Hardness (as $CaCO_3$)	0.5	mg/L
pH	0.1	pH
Total Suspended Solids	1	mg/L
Total Dissolved Solids	10	mg/L
Turbidity	0.1	NTU
Anions and Nutrients		
Alkalinity, Total (as $CaCO_3$)	1	mg/L
Ammonia, Total (as N)	0.005	mg/L
Chloride (Cl)	0.5	mg/L
Fluoride (F)	0.02	mg/L
Nitrate and Nitrite (as N)	0.003	mg/L
Nitrate (as N)	0.001	mg/L
Nitrite (as N)	0.005	mg/L
Total Nitrogen	0.03	mg/L
Orthophosphate-Dissolved (as P)	0.001	mg/L
Phosphorus (P)-Total Dissolved	0.002	mg/L
Phosphorus (P)-Total	0.002	mg/L
Sulfate (SO_4)	0.3	mg/L
Organic / Inorganic Carbon		
Dissolved Organic Carbon	0.5	mg/L

Notes: LOR: Limit of Reporting

Parameter	LOR	Unit
Total and Dissolved Metals		
Aluminum (Al)	0.003	mg/L
Antimony (Sb)	0.0001	mg/L
Arsenic (As)	0.0001	mg/L
Barium (Ba)	0.0001	mg/L
Beryllium (Be)	0.0001	mg/L
Bismuth (Bi)	0.00005	mg/L
Boron (B)	0.01	mg/L
Cadmium (Cd)	0.000005	mg/L
Calcium (Ca)	0.05	mg/L
Chromium (Cr)	0.0005	mg/L
Cobalt (Co)	0.0001	mg/L
Copper (Cu)	0.0005	mg/L
Iron (Fe)	0.03	mg/L
Lead (Pb)	0.00005	mg/L
Lithium (Li)	0.001	mg/L
Magnesium (Mg)	0.1	mg/L
Manganese (Mn)	0.0001	mg/L
Molybdenum (Mo)	0.00005	mg/L
Nickel (Ni)	0.0005	mg/L
Potassium (K)	0.05	mg/L
Selenium (Se)	0.00005	mg/L
Silicon (Si)	0.1	mg/L
Silver (Ag)	0.00001	mg/L
Sodium (Na)	0.05	mg/L
Strontium (Sr)	0.0002	mg/L
Thallium (Tl)	0.00001	mg/L
Tin (Sn)	0.0001	mg/L
Titanium (Ti)	0.01	mg/L
Uranium (U)	0.00001	mg/L
Vanadium (V)	0.0005	mg/L
Zinc (Zn)	0.003	mg/L

Table 6.28 Effluent monitoring overview

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
E19	E305050	WTP influent	Weekly[1]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals	N/A
HAD-3	E304230	WTP treated effluent	Continuous[1]	TSS (calculated), temperature, flow rate	Permit 11678
			Weekly[1]	Field parameters, physical tests, anions and nutrients, DOC, total and dissolved metals, radium 226[2], total mercury[3]	Permit 11678; MDMER; EEM
			Monthly	Acute toxicity tests: - Rainbow trout: *Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout* (Reference Method EPS1/RM/13) - Daphnia Magna: *Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna* (Reference Method EPS1/RM/14) - or most recent methods, as per MDMER	Permit 11678; MDMER[4]
			Semi-annually[5]	Chronic toxicity tests: - Biological Test Method: *Toxicity Tests Using Early Life Stages of Salmonid Fish* (Rainbow Trout) (Reference Method EPS 1/RM/28) - Invertebrate species: *Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia* (Report EPS 1/RM/21) - Plant species: *Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte, Lemna minor* (Reference Method EPS 1/RM/37) - Algal species: *Biological Test Method: Growth Inhibition Test Using Freshwater Alga Selenastrum capricornutum* (Report Method EPS 1/RM/25)	MDMER

Notes: [1] Only when discharging; [2] MDMER requirement only; if 10 consecutive samples show radium 226 as less than 0.037 Bq/l then frequency of sampling for radium 226 can be reduced to once a quarter. This has been satisfied and radium 226 analysis is currently conducted quarterly; [3] EEM requirement only; can be discontinued if concentration is less than 0.10 µg/L in 12 consecutive samples. This has been satisfied and mercury analysis has been discontinued; [4] MDMER June 2018 Part 2 Division 2 16 (1): frequency may be reduced to quarterly if discharge is determined not to be acutely lethal for 12 consecutive months; [5] Chronic/sub-lethal toxicity tests are conducted semi-annually for 3 years. MDMER June 2018 Schedule 5, 6 (1-3): after 3 years, frequency will be increased to once per calendar quarter on the sub lethal species whose results of sub lethal tests produce the lowest geometric mean, taking into account the inhibition concentration that produces a 25% effect or effective concentration of 25%; N/A: not applicable; TSS: total suspended solids; DOC: dissolved organic carbon; MDMER: Metal and Diamond Mining Effluent Regulations; EEM: Environmental Effects Monitoring

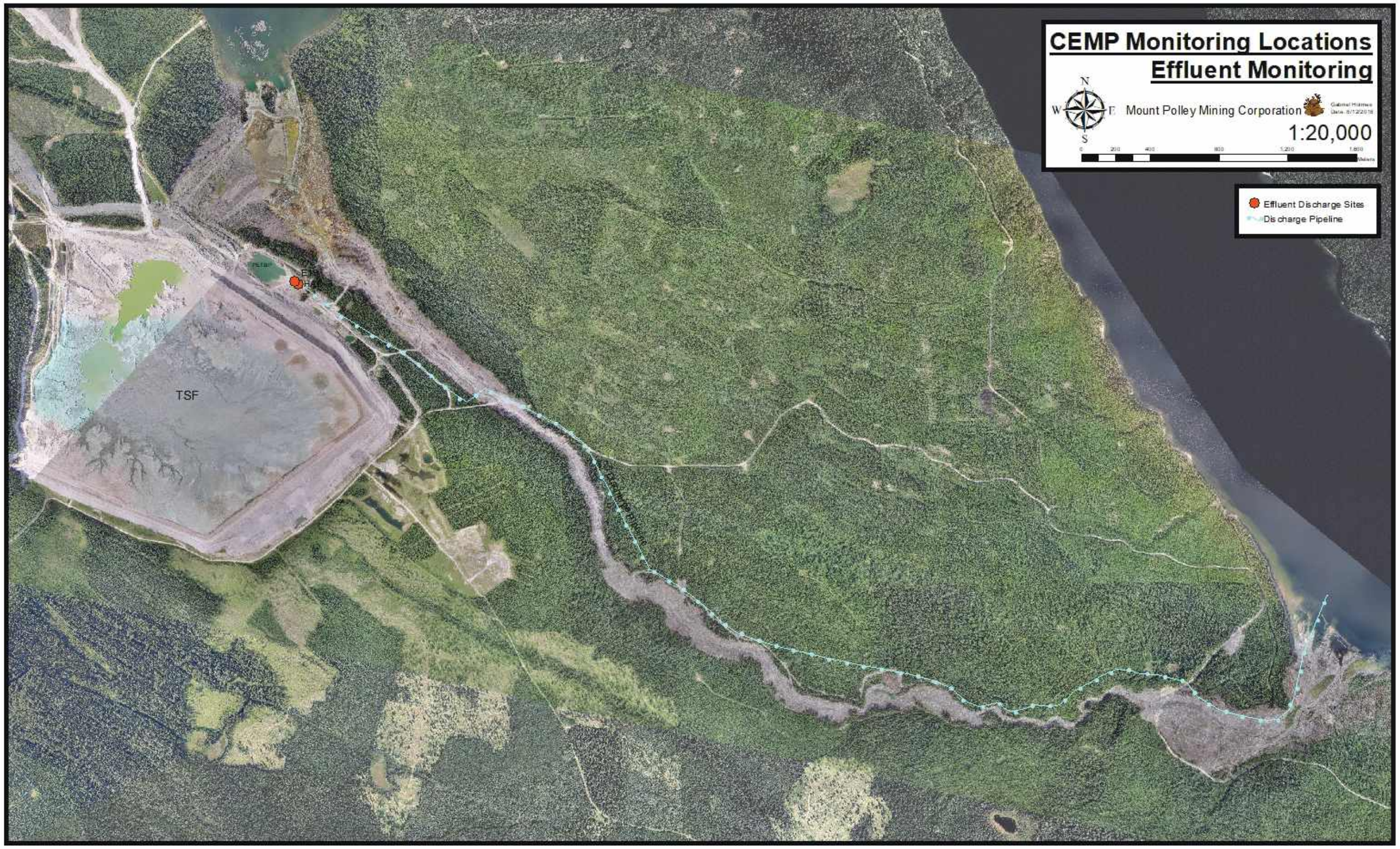


Figure 6.7 CEMP monitoring locations: Effluent monitoring

6.11.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Sample collection, preparation, and shipping will be conducted following the SOPs and WMs for Surface Water Quality Monitoring, and use of associated field meters in the QA/QC Manual. These procedures include use of lab-verified clean or appropriately rinsed sampling bottles and steps to reduce risk of sampling contamination. *In-situ* parameters will be measured when samples for chemistry are collected. Water samples will be analyzed for the parameters described in Section 6.11.3.

Table 6.29 is a summary of previous effluent monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.29 Summary of effluent monitoring and findings

Summary of Monitoring and Findings	**Monitoring Objective**		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	Discharge monitoring included the influent and treated effluent.	N/A	N/A
Summary of findings	All samples were at or below permit limits for the treated effluent in 2017; in 2016, the majority of samples were at or below the permit limits. When samples did not meet permit limits, ENV was notified and an investigation into the cause was undertaken. Comparing the influent concentrations to treated effluent concentrations verified reduction in parameters interest. See Section 6.11.4.1 for more details.	N/A	N/A
Recommendations for 2018-2020 monitoring	Monitoring of the influent (E19) will be increased from monthly to weekly to align with monitoring of HAD-03 for better efficiency analysis of the WTP.	N/A	N/A

Notes: N/A: not applicable; ENV: Ministry of Environment and Climate Change Strategy; WTP: water treatment plant

Should there be an extreme weather event or equipment failure in the WTP that could affect water quality in the effluent, MPMC has the ability to request rush analysis from the analytical lab (ALS). MPMC maintains an Emergency Response Plan for the effluent discharge as required by the MDMER and the Permit.

6.11.4.1 OPERATIONAL MONITORING

Figure 6.8 shows total copper concentrations and Figure 6.9 shows TSS in the influent (E19) and effluent (HAD-03) in 2017. No exceedances were recorded in 2017 in the effluent.

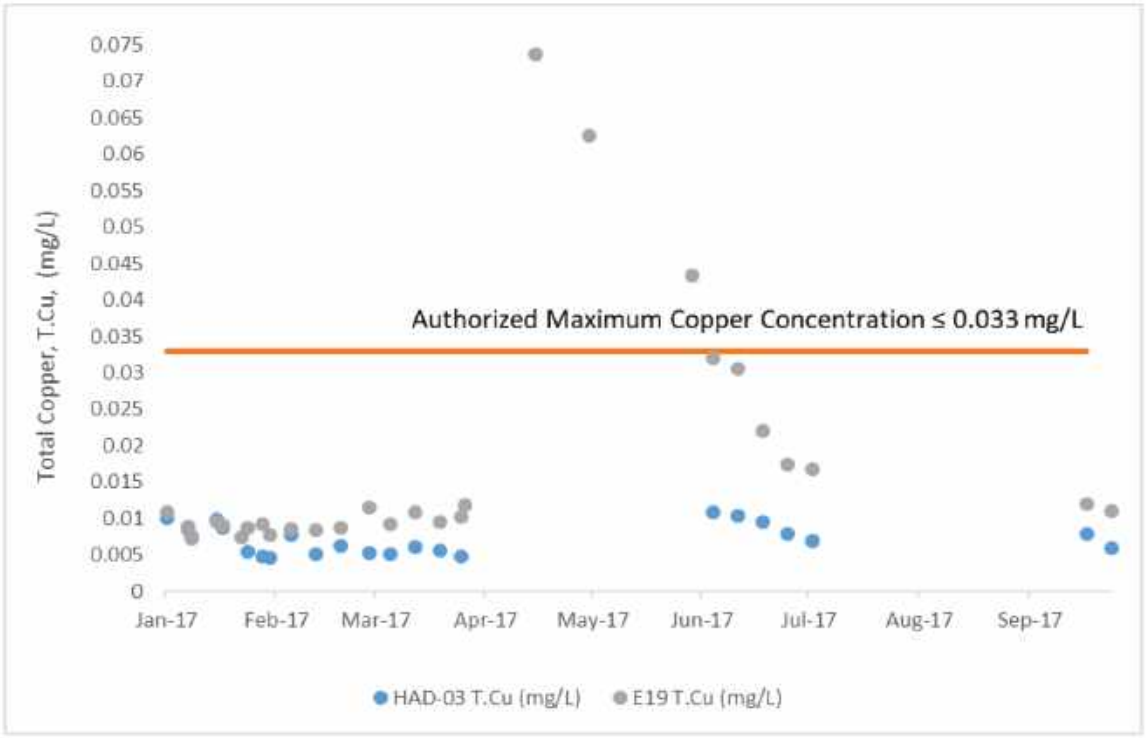


Figure 6.8 Total suspended solids concentrations in influent (E19) and effluent (HAD-03) in 2017

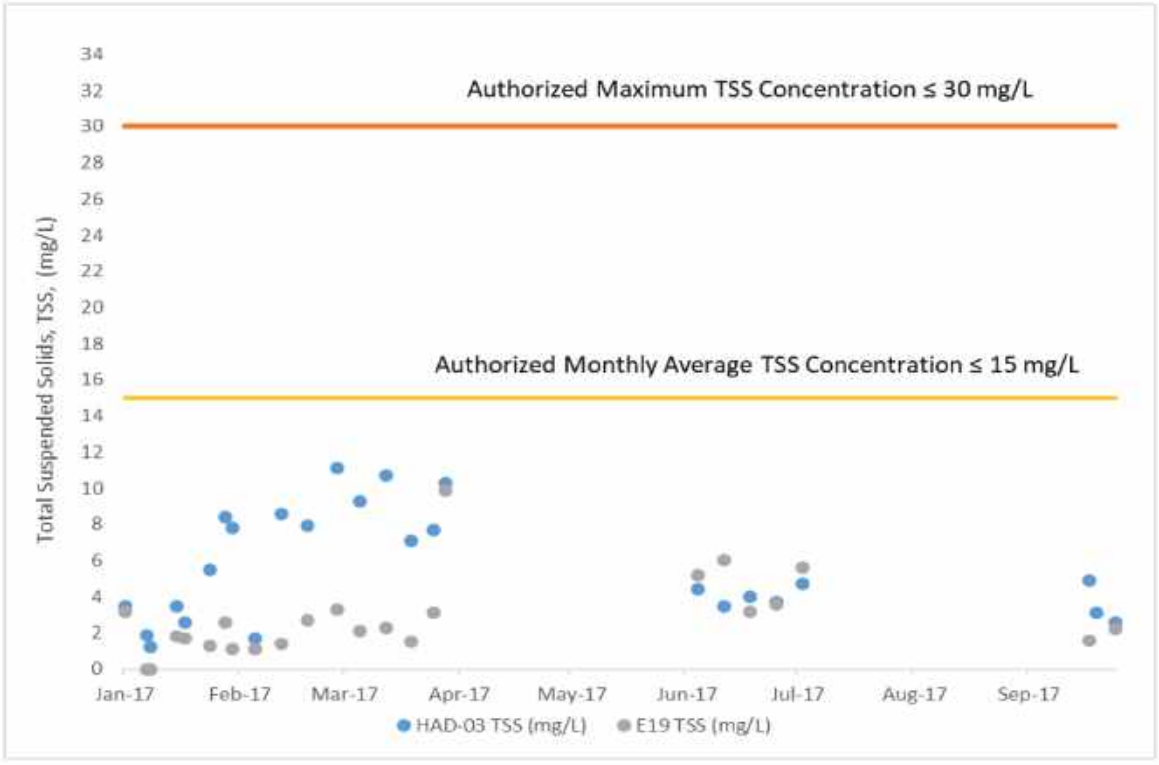


Figure 6.9 Total copper concentrations in influent (E19) and effluent (HAD-03) in 2017

MPMC conducts acute toxicity tests monthly for LC50 Rainbow trout and LC50 *Daphnia magna*. Under the new MDMER, *D. magna* is now a compliance parameter. MPMC will continue to conduct these acute lethality tests as required.

MDMER has changed the frequency of acute toxicity tests for effluent discharge. In accordance with Part 2, Division 2, paragraph 16 (1), acute lethality tests at the final discharge point (HAD-3) will become quarterly if the effluent is determined to be non-lethal for 12 consecutive months (Government of Canada 2018). Effluent at HAD-3 since discharge has started (December 2015) has been shown to be non-lethal.

MPMC has conducted chronic toxicity tests on the effluent discharge since December 7, 2015 on a quarterly and semi-annual basis. Under MDMER requirements, after three years (after December 2018 at HAD-3), the chronic toxicity tests results will be reviewed by a QP and will be streamlined to one test only. This test will be based on the most sensitive organism to the effluent according to historical geometric means and will be tested quarterly. The reduction of frequency from the 2016 CEMP for the chronic toxicity tests, as described in Table 6.28, aligns with the MDMER, as no actionable effects have been recorded at HAD-03 and the MDMER protocol is established to characterise the impacts on the most sensitive aquatic life.

6.11.5 Data Quality Control, Objectives, and Review

For water chemistry, QC samples will be collected as a component of the monitoring program as per the MPMC QA/QC Manual. Effluent monitoring samples are combined in the surface water QC schedule (see Section 6.6.5), as laid out in Table 6.8.

6.11.6 Laboratory Analysis

Samples will be submitted to and processed by a CALA accredited analytical laboratory, typically ALS Environmental Inc. in Burnaby, BC for chemistry samples and Nautilus Environmental in Burnaby, BC for toxicity testing, where standard testing procedures will be used as specified in the most recent editions of the *BC Environmental Laboratory Manual* (MoE 2015) and the MDMER (where applicable; i.e., discharge water toxicity testing).

Laboratory precision will be assessed on the basis of laboratory duplicate results and laboratory accuracy will be assessed using certified reference materials (CRMs) and matrix spikes. Potential laboratory contamination will be assessed using a DQO of ≤ 2 times the laboratory MDL in laboratory method blank results.

QC monitoring for toxicity testing will be carried out at the laboratory, as per the test methods, with requirements to meet criteria such as test organism health history, and control acceptability. Uncertainty associated with test results will be described by the standard deviation around the mean and/or the confidence limits around the point estimate.

6.11.7 Data Analysis and Reporting

Data analysis and interpretation for reporting purposes will include calculation of summary statistics (e.g., mean, minimum, max, and 95th percentile values over the period of interest) and screening of results

against applicable regulatory benchmarks (see Table 6.26). Screening will include evaluation of results at the treated effluent discharge against MDMER and the Permit limits. Alerts are set up in the MP-5 database so that MPMC Environmental Department staff receives an email if specified benchmarks are exceeded.

6.12 SEDIMENT QUALITY MONITORING

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.12.1 SECTION AUTHORS AND STUDY DESIGN PROFESSIONALS

This section was written by MPMC, and is a summary of the study design provided by Minnow Environmental Inc. (Minnow). The detailed study design is provided in Appendix B.1. Golder prepared the study design for selecting an alternate reference lake for Polley Lake (Appendix B.7).

6.12.2 MONITORING OBJECTIVES

As outlined in Appendix B.1, the objectives of sediment quality monitoring are to:

- "Evaluate the influence of mine activities on the receiving environments (e.g., Hazeltine Creek, Polley Lake, and Quesnel Lake) in comparison to baseline and/or reference conditions";
- "Determine potential implications to aquatic life by applying a variety of interpretive tools";
- "Provide data to support exposure assessment as part of the ERA and HHRA";
- "Provide supporting information for benthic invertebrate community monitoring"; and,
- "Advance technical understanding of the stability or mobility and potential bioavailability of metals and metalloids in lake sediments affected by the TSF Breach".

6.12.3 MONITORING OVERVIEW

Sediment quality monitoring under the CEMP is proposed to meet the combined needs of:

1) Operational monitoring (including the discharge of treated effluent to Quesnel Lake);
2) Monitoring of the impact of the 2014 perimeter embankment failure; and
3) Monitoring of response to reclamation activity following the perimeter embankment failure.

An overview of the proposed sediment quality monitoring program is provided in Table 2 and Figures 5 and 6 of Appendix B.1. Sediment quality monitoring is focused on Polley Lake, Hazeltine Creek, and Quesnel Lake, with reference areas identified for each mine-influenced sampling area (i.e., Bootjack Lake for Polley Lake, unaffected areas of Quesnel Lake for impacted areas of Quesnel Lake). Table 3 in Appendix B.1 summarizes the analytes and laboratory reporting limits for the sediment quality monitoring program.

The monitoring program is divided into lake monitoring and creek monitoring and will include physical and chemical characterisation of deposited sediments. Sediment quality sampling will be supported by

measurements of temperature, dissolved oxygen, pH, and specific conductance near the sediment-water interface at all sampling stations. Some additional monitoring of the stability and potential bioavailability of metals associated with sediments impacted by the TSF Breach may be undertaken (e.g., deployment of Diffusive Gradients in Thin Films [DGT] devices to monitor labile metal concentrations; toxicity testing using *Hyalella azteca*). More detail is provided in Appendix B.1.

6.12.4 High-Level Monitoring Design Description

Appendix B.1 provides a summary of sediment monitoring history previously conducted in the vicinity of the mine in the surrounding lakes and creeks, including baseline, and pre- and post-breach monitoring. The sample collection methods are also summarized in Appendix B.1 for lake sediment sampling, creek sediment sampling, and DGT sampling. A study design for evaluating alternate reference lakes for Polley Lake is provided in Appendix B.7.

6.12.5 Data Quality Control, Objectives, and Review

Appendix B.1 summarizes the QAQC program for the sediment monitoring plan. It includes specific QA/QC protocols, including collection of QC samples and collection of replicate samples to allow for statistical calculations and to capture within-area variability. As described in Appendix B.1, "comparisons between duplicate samples will be made by calculating the RPD between concentrations of paired duplicates. If the RPD <40% for concentrations that are >5 times the detection limit, then the duplicate sample results will be considered acceptable. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective detection limits." See Appendix B.1 for more details.

6.12.6 Laboratory Analysis

Chemical analyses will be completed at a CALA accredited analytical laboratory and will include moisture content, pH, particle size distribution, total organic carbon (TOC), total nitrogen, total sulphur, and total metal concentrations, as summarized in Table 3 in Appendix B.1.

Toxicity testing will be conducted at a CALA accredited testing laboratory using a 10 day test of the survival and growth of *Chironomus dilutus.* DGT analysis is described in detail in Appendix B.1 in Section 4.3.

6.12.7 Data Analysis and Reporting

As described in Appendix B.1, data will be provided to the QP and summarized by calculating mean, median, standard deviation, standard error, minimum, maximum, 5th percentile, and 95th percentile for each analyte for all replicated data. Appendix B.1 describes how "sediment quality data will then be evaluated in comparison to British Columbia Working Sediment Quality Guidelines for the protection of aquatic life (WSQGs; MOE 2017b) and reference concentrations. Reference 95th percentile values will be used to screen exposed-area mean concentrations to efficiently identify analytes with concentrations that are beyond the range of reference.

"The overall interpretation of sediment quality data will include integration of a weight-of-evidence that includes other components of the MPMC CEMP (e.g., benthic invertebrate community data). Thus, within

the CEMP, sediment quality data interpretation will specifically include the integration of data on sediment quality, the results of specialized evaluations (e.g., DGT results), and the results of bio-assessment (e.g., sediment toxicity testing and benthic invertebrate communities).

"An interpretive report based on the sediment quality data will be prepared to be integrated into the AERR for the Mount Polley Mine that is prepared annually by MPMC (see Section 9.3). The interpretive report will provide all data in an Appendix and will include the data quality review, the results of the screening against BCWSQG, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots."

6.13 BENTHIC INVERTEBRATE MONITORING

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.13.1 SECTION AUTHORS AND STUDY DESIGN PROFESSIONALS

This section was written by MPMC, and is a summary of the study design provided by Minnow. The detailed study design is provided in Appendix B.2. Golder prepared a study design for selecting an alternate reference lake for Polley Lake (Appendix B.7).

6.13.2 MONITORING OBJECTIVES

As outlined in Appendix B.2, the objectives of benthic invertebrate monitoring are to:

- "Evaluate the influence of Mount Polley Mine activities on benthic invertebrate communities, productivity, and tissue quality in receiving environments (e.g., Polley Lake, Hazeltine Creek, Edney Creek, and Quesnel Lake) in comparison to baseline and/or reference conditions";
- "Determine potential implications to aquatic life (e.g., through assessment of benthic invertebrate community and productivity endpoints, and comparison of benthic tissue quality results to available guidelines; MoE 2014) and to aquatic ecosystem health by providing supporting information for the assessment of potential effects to higher trophic levels (e.g., fish and fish habitat quality; Section 6.16)"; and,
- "Provide data to support exposure assessment as part of the ERA and HHRA."

Benthic invertebrate community monitoring is also required as part of EEM under the MDMER. The objective of the MDMER EEM benthic invertebrate monitoring identified in Appendix B.2 is to "evaluate whether there are effects to benthic invertebrate community characteristics between the area of Quesnel Lake exposed to Mount Polley mine effluent and a reference area (Environment Canada 2012)."

6.13.3 MONITORING OVERVIEW

Benthic invertebrate monitoring under the CEMP is designed to meet the combined needs of:

1) Operational monitoring (including the discharge of treated effluent to Quesnel Lake);
2) Monitoring of the impact of the 2014 TSF embankment breach; and
3) Monitoring of the response to reclamation activity following the TSF embankment breach.

An overview of the proposed benthic invertebrate monitoring program is provided in Table 3 of Appendix B.2, and includes benthic invertebrate community, productivity, and tissue quality. Benthic invertebrate monitoring is focused on Polley Lake, Hazeltine Creek, lower Edney Creek, Quesnel Lake, and associated reference areas (Figures 6 and 7 of Appendix B.2). Table 4 in Appendix B.2 summarizes the analytes and laboratory reporting limits for the benthic invertebrate monitoring program. The sampling frequency at this time is once every three years.

6.13.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Appendix B.2 provides a summary of benthic invertebrate monitoring history previously conducted in the vicinity of the mine in the surrounding lakes and creeks, including baseline, and pre- and post-breach monitoring. The sample collection methods are also summarized in Appendix B.2 for community and productivity sampling, and tissue quality sampling. A study design for evaluating alternate reference lakes for Polley Lake is provided in Appendix B.7.

6.13.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

Appendix B.2 summarizes the QAQC program for the benthic invertebrate monitoring plan. It includes specific QA/QC protocols, including collection of QC samples and collection of replicate samples to allow for statistical calculations and to capture within-area variability. As stated in Appendix B.2, "for benthic invertebrate tissue quality samples, comparisons between duplicate samples will be made by calculating the RPD between concentrations of paired duplicates. If the RPD <25% for concentrations that are >5 times the detection limit, then the duplicate sample results will be considered acceptable. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective detection limits.

"For benthic invertebrate community samples, reanalysis for quality control endpoints (organism sorting efficiency, subsampling precision and accuracy error, and taxonomic identification error) will be performed on 10% of samples, and results of quality control measures will be evaluated relative to pre-established DQOs." See Appendix B.2 for more details.

6.13.6 LABORATORY ANALYSIS

As described in Appendix B.2, "taxonomic identification of benthic invertebrate community samples will be completed by a qualified laboratory certified under the Taxonomic Certification Program of the Society for Freshwater Science (SFS). Benthic invertebrate tissue quality samples will remain frozen until overnight shipment on ice with completed COCs to ALS Environmental, Burnaby BC, which is an analytical laboratory accredited by the CALA."

6.13.7 DATA ANALYSIS AND REPORTING

As described in Appendix B.2, data will be provided to the QP and summarized by calculating mean, median, standard deviation, standard error, minimum, maximum, 5th percentile, and 95th percentile for each endpoint for all replicated data. Data analysis will be completed for each monitoring component (community, productivity, and tissue quality). More detail for each monitoring component is provided in Section 4.5 of Appendix B.2.

As stated in Appendix B.2, "an interpretive report based on the benthic invertebrate data will be prepared to be integrated into the AERR for the Mount Polley Mine that is prepared annually by MPMC (see Section 9.3). The interpretive report will provide all data in an appendix and will include the date quality review, the results of the screening against BCWQG, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots."

6.14 PLANKTON AND CHLOROPHYLL *A* MONITORING

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.14.1 SECTION AUTHORS AND STUDY DESIGN PROFESSIONALS

This section was written by MPMC.

6.14.2 MONITORING OBJECTIVES

The objective of phytoplankton and zooplankton monitoring at lake stations is to assess potential changes in plankton community abundance and diversity, as well as temporal and special changes in zooplankton metal concentrations. Chlorophyll *a* sampling will be conducted and analyzed to provide support data that can be interpreted with other biological monitoring and water chemistry data in a broader analysis of lake productivity.

This monitoring will be conducted to aid in assessing lake productivity following the TSF embankment breach (Post-Breach Monitoring: Polley Lake and Quesnel Lake) and to identify any changes related to the chemistry of the discharged treated effluent (Operational Monitoring: Quesnel Lake).

6.14.3 MONITORING OVERVIEW

Table 6.30 summarizes the parameters analysed for plankton and chlorophyll *a* monitoring. Chlorophyll *a*, phytoplankton taxonomy and biomass, and zooplankton taxonomy and metal tissue samples will continue to be collected concurrently with water chemistry samples (including field parameters) three times per year to capture early and late growing seasons as outlined in Table 6.31. Growing seasons were determined after monthly sampling was conducted in 2015; data analysis of zooplankton community is presented in Golder (2016d). Further details of monitoring sites, including site access descriptions, access or safety concerns,

and a brief rationale for monitoring, is provided in the Site Matrix in Appendix D. Figure 6.10 shows monitoring locations of the plankton and chlorophyll *a* sampling locations.

Table 6.30 Plankton and chlorophyll *a* parameters

Parameter	LOR	Unit
Taxonomy		
Phytoplankton	-	-
Zooplankton	-	-
Total Metals in Tissue		
Aluminum (Al)	2	mg/kg
Antimony (Sb)	0.01	mg/kg
Arsenic (As)	0.02	mg/kg
Barium (Ba)	0.05	mg/kg
Beryllium (Be)	0.01	mg/kg
Bismuth (Bi)	0.01	mg/kg
Boron (B)	1	mg/kg
Cadmium (Cd)	0.005	mg/kg
Calcium (Ca)	20	mg/kg
Chromium (Cr)	0.005	mg/kg
Cobalt (Co)	0.05	mg/kg
Copper (Cu)	0.02	mg/kg
Iron (Fe)	0.1	mg/kg
Lead (Pb)	3	mg/kg
Lithium (Li)	0.02	mg/kg
Magnesium (Mg)	0.5	mg/kg
Manganese (Mn)	2	mg/kg
Molybdenum (Mo)	0.05	mg/kg
Nickel (Ni)	0.02	mg/kg
Potassium (K)	0.2	mg/kg
Selenium (Se)	10	mg/kg
Silicon (Si)	20	mg/kg
Silver (Ag)	0.05	mg/kg
Sodium (Na)	0.05	mg/kg
Strontium (Sr)	20	mg/kg
Thallium (Tl)	0.05	mg/kg
Tin (Sn)	0.02	mg/kg
Titanium (Ti)	0.002	mg/kg
Uranium (U)	0.1	mg/kg
Vanadium (V)	0.002	mg/kg
Zinc (Zn)	0.1	mg/kg
Plant Pigments (Water)		
Chlorophyll *a*	0.01	µg

Notes: LOR: Limit of Reporting

Table 6.31 Plankton and chlorophyll *a* monitoring overview

Station Name	EMS Code	Description	Frequency	Parameters Measured	Guidelines
P2	E307975	Polley Lake deepest area at south end	Three times between June 15 and September 15, at least 30 days apart	Chlorophyll *a*, Phytoplankton taxonomy and biomass Zooplankton metals, taxonomy, and biomass	N/A
B2	E215897	Bootjack Lake deepest area at south end	Three times between June 15 and September 15, at least 30 days apart	Chlorophyll *a*, Phytoplankton taxonomy and biomass Zooplankton metals, taxonomy, and biomass	N/A
QUL-ZOO-1	E306455	Quesnel Lake zooplankton station at Hazeltine	Three times between June 15 and September 15, at least 30 days apart	Chlorophyll *a*, Phytoplankton taxonomy and biomass Zooplankton metals, taxonomy, and biomass	N/A
QUL-ZOO-7	E306456	Quesnel Lake zooplankton station at Horsefly	Three times between June 15 and September 15, at least 30 days apart	Chlorophyll *a*, Phytoplankton taxonomy and biomass Zooplankton metals, taxonomy, and biomass	N/A

Notes: N/A: not applicable; IDZ: initial dilution zone

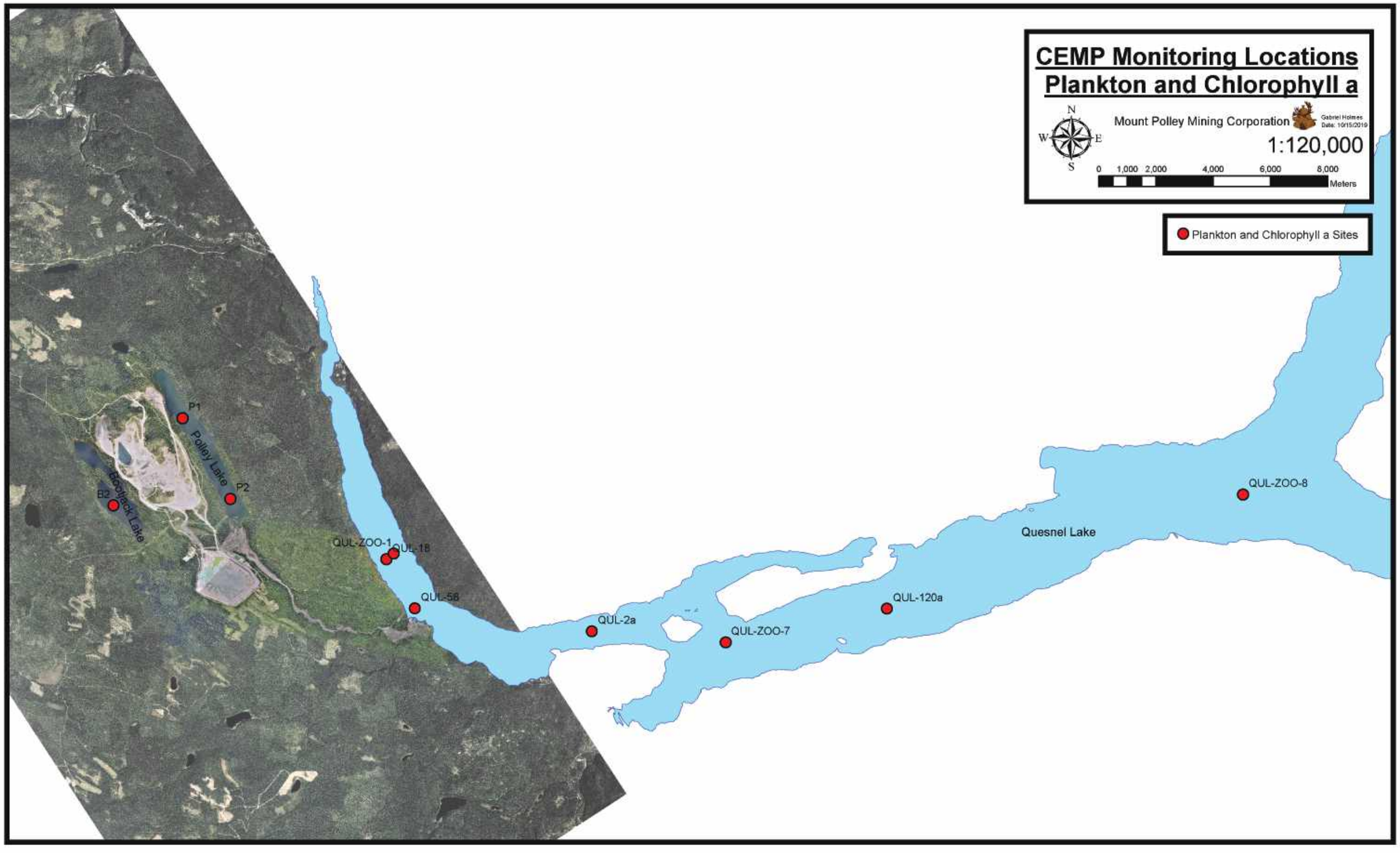


Figure 6.10 CEMP monitoring locations: Plankton and chlorophyll *a* monitoring

6.14.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Sample collection, preparation, and shipping will be conducted following procedures outlined in the SOPs and WMs on Lake Water Monitoring and Zooplankton Sampling in the MPMC QA/QC Manual.

In brief, sampling at all stations will be conducted as follows:

- Zooplankton samples:
  - will be collected using 50 µm mesh nets with a mouth diameter ≥0.5 m, and equipped with a flow meter. In 2019, for stations previously sampled with a 150-µm mesh net, samples will be collected with both a 50- and a 150-µm mesh net to enable an assessment of the difference between the two net mesh sizes and to facilitate comparison with historical data.
  - will be collected using a modified horizontal tow.
  - for taxonomy/biomass will be transferred to a Nalgene container and preserved with buffered formalin.
  - for tissue chemistry will consist of a composite of multiple tows to achieve a minimum required tissue mass for analysis (i.e., 1.5 g).
- Phytoplankton samples
  - will be collected as a depth-integrated sample. Water will be collected from at least four discrete depths at each station (surface, one-third Secchi depth, two-thirds Secchi depth, total Secchi depth), with a grab sampler (e.g., Kemmerer, Van Dorn) or with a length of flexible tubing modified for this purpose, with or without a peristaltic pump.
  - will be collected as surface and depth-integrated samples in 2019 to allow for an assessment of the difference between the two methods and to facilitate comparison with historical data.
  - for Chlorophyll *a* analysis will be transferred to a container wrapped in aluminum foil.
  - for taxonomy/biomass will be preserved with Lugol's solution

One replicate will be collected in each of June and August, and five replicates will be collected during the July sampling event, and samples for zooplankton and phytoplankton will be collected on the same day for each lake. Secchi depth and *in situ* water-chemistry supporting data will be collected concurrently at each station.

Table 6.32 is a summary of previous plankton and chlorophyll *a* monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable. Monitoring for plankton and chlorophyll *a* overlaps with operational monitoring in Quesnel Lake, as described in Section 6.14.2.

Table 6.32 Summary of plankton and chlorophyll *a* monitoring and findings

Summary of Monitoring and Findings	Monitoring Objective		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	Plankton (phyto and zoo) taxonomy and chlorophyll *a* sampling frequency was semi-annually in 2016 and 2017 (June/July and August) at two stations in Polley Lake and three stations in Quesnel Lake. Some sampling events were missed in 2017 due to safety concerns.		N/A
Summary of findings	Zooplankton and phytoplankton results will be analysed in the three-year interpretive report (see Section 9.4) and recommendations for changes may be made, if required, in this report. Some chlorophyll *a* data were collected prior to the TSF breach. Results from 2013 – 2017 are shown in Section 6.14.4.1.		N/A
Recommendations for 2017-2020 monitoring	The sampling program outlined in Table 6.31 will be repeated annually.		N/A

Notes: N/A: not applicable

6.14.4.1 POST-BREACH MONITORING

Figure 6.11 shows chlorophyll *a* data collected from Polley Lake from 2013 – 2017. Data from P2 will continue to be collected to analyse potential trends.

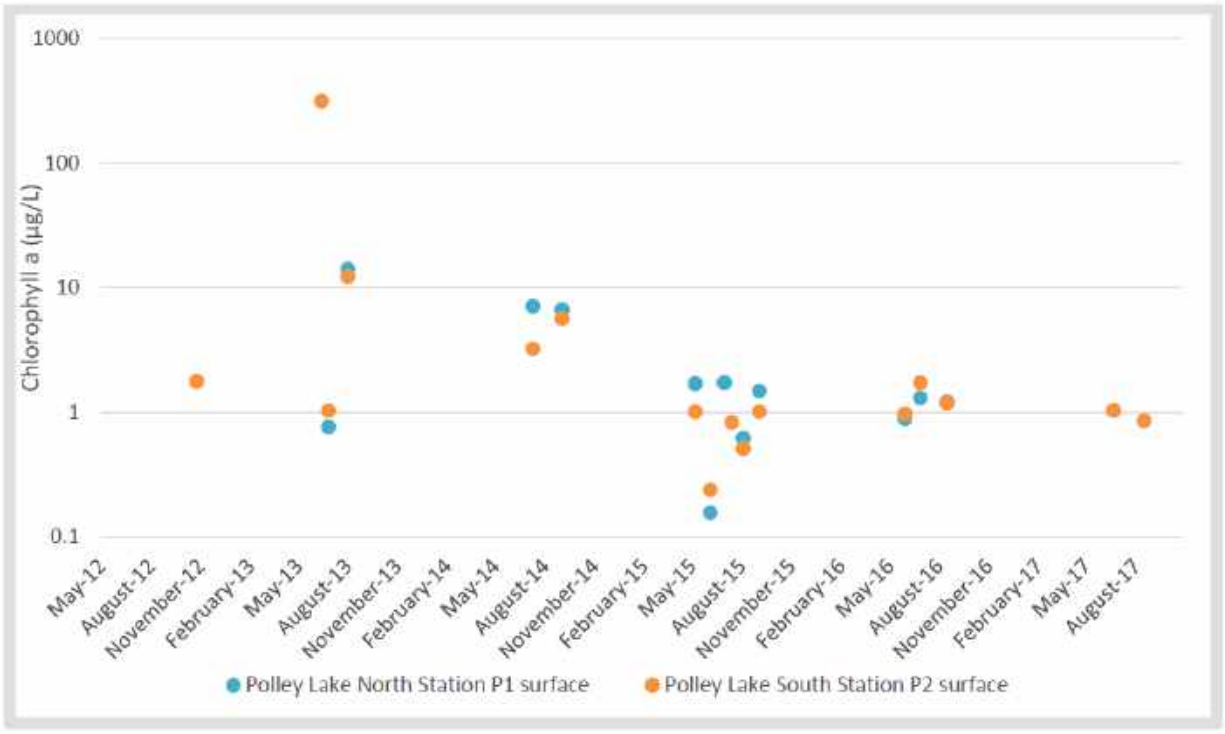


Figure 6.11 Chlorophyll *a* data collected from Polley Lake from 2013 - 2017

6.14.5 Data Quality Control, Objectives, and Review

QA/QC procedures will consist of re-analysis of 10% of phytoplankton and zooplankton taxonomy samples, and analysis of a duplicate metals sample for tissue chemistry once annually. For taxonomy, replicate counts should meet the DQO of within 20% of the original count. For metals, the RPD data quality of greater than 40% for concentrations greater than or equal to five times the MDL will be used to identify differences between original and duplicate samples for metals.

6.14.6 Laboratory Analysis

Plankton taxonomy samples will be shipped to the following laboratories for processing[2]:

- Biologica environmental Services Ltd., Victoria, BC: plankton taxonomy.
- ALS Environmental Inc., Burnaby, BC[3] – chlorophyll *a* and zooplankton tissue chemistry.

6.14.7 Data Analysis and Reporting

Statistical analysis will be carried out to evaluate trends over time by comparing results with data collected annually. In Quesnel Lake, near-field data will be compared with far-field and reference data to evaluate

[2] No accreditation program exists for plankton taxonomy

[3] Accredited by the Canadian Association of Laboratory Accreditation (CALA)

potential mine impact and spatial trends. These data will also be used to assess implications for lake productivity and fish populations.

6.15 PERIPHYTON MONITORING

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.15.1 SECTION AUTHORS AND STUDY DESIGN PROFESSIONALS

This section was written by MPMC, and is a summary of the study design provided by Minnow. The detailed study design is provided in Appendix B.3.

6.15.2 MONITORING OBJECTIVES

As outlined in Appendix B.3, the objectives of periphyton monitoring are to:

- "Evaluate the influence of mine activities (related to mine operations, the TSF breach, and/or rehabilitation activities) on Hazeltine Creek (the creek receiving environment directly influenced by mine activity) and lower Edney Creek (a creek environment directly influenced by the TSF breach)";
- "Serve as supporting information for the determination of potential effects to aquatic life at higher trophic levels (benthic invertebrates and fish; Sections 6.13 and 6.16, respectively)";
- "Provide supporting information for the assessment of benthic invertebrate tissue quality, benthic invertebrate community condition, and fish habitat productivity"; and,
- "Provide data to support exposure assessment as part of the ERA and HHRA".

Periphyton monitoring will include assessment of productivity, community composition, and tissue quality, with comparison to previous and/or reference conditions, to applicable guidelines (i.e., chlorophyll *a*; MoE 2018), and to literature-based criteria (or classification ranges) for productivity.

6.15.3 MONITORING OVERVIEW

Periphyton monitoring under the CEMP is proposed to meet the combined needs of:

1) Operational monitoring (including the previous discharge of treated effluent to Hazeltine Creek);
2) Monitoring of the impact of the 2014 TSF breach; and
3) Monitoring of the response to reclamation activity following the TSF breach.

An overview of the proposed periphyton monitoring program is provided in Table 1 and Figure 4 of Appendix B.3. Periphyton monitoring is focused on Hazeltine Creek and lower Edney Creek with reference areas identified for each mine-influenced sampling area (i.e., upper Edney Creek and Frypan Creek for upper Hazeltine Creek, and an unaffected area of lower Edney Creek for rehabilitated areas of lower Edney Creek

and lower Hazeltine Creek). Table 2 in Appendix B.3 summarizes the analytes and laboratory reporting limits or the periphyton monitoring program.

6.15.4 High-Level Monitoring Design Description

Appendix B.3 provides a summary of periphyton monitoring history previously conducted in the vicinity of the mine in the surrounding creeks, including pre- and post-breach monitoring. The sample collection methods are also summarized in Appendix B.3 for biomass and chlorophyll *a* sampling, community sampling, and tissue quality sampling.

6.15.5 Data Quality Control, Objectives, and Review

Appendix B.3 summarizes the QAQC program for the periphyton monitoring plan. It includes specific QA/QC protocols, including collection of QC samples and collection of replicate samples to allow for statistical calculations and to capture within-area variability. As stated in Appendix B.3, "comparisons between duplicate samples will be made by calculating the RPD between concentrations of paired duplicates. If the RPD < 25% for concentrations that are > 5 times the detection limit, then the duplicate sample results will be considered acceptable. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective detection limits. Specific QC sampling and associated reporting will for tissue quality and periphyton productivity endpoints be requested of the analytical laboratory, including reagent blank results, laboratory replicate results, and laboratory accuracy results (i.e., matrix spikes, laboratory control samples, and/or certified reference materials). QC reporting will also be requested of the laboratory performing taxonomic analysis of the periphyton community samples, including organism enumeration checks for a minimum of 10% of samples." See Appendix B.3 for more details.

6.15.6 Laboratory Analysis

The laboratory responsible for the physical or chemical analyses will be accredited by the CALA for these analyses.

6.15.7 Data Analysis and Reporting

For all replicated data (typically based on a sample size of five or eight stations per area), data will be provided to the QP and summarized by calculating mean, median, standard deviation, minimum, and maximum for each analyte. Data analysis will be completed for each monitoring component (productivity, community, and tissue quality). More detail for each monitoring component is provided in Section 4.5 of Appendix B.3.

As outlined in Appendix B.3, "an interpretive report based on the periphyton monitoring data will be prepared to be integrated into the AERR for the Mount Polley Mine that is prepared annually by MPMC (see Section 9.3). The interpretive report will provide all data in an appendix and will include the data quality review, the results of the screening against BCWSQG and other guidelines or classification schemes, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots."

6.16 FISH MONITORING

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.16.1 SECTION AUTHORS AND STUDY DESIGN PROFESSIONALS

This section was written by MPMC, and is a summary of the study design provided by Minnow. The detailed study design is provided in Appendix B.4.

6.16.2 MONITORING OBJECTIVES

As outlined in Appendix B.4, the objectives of fish monitoring are to:

- "Evaluate the influence of Mount Polley Mine activities on fish communities, populations, and tissue quality in receiving environments (Hazeltine Creek, Polley Lake, and Quesnel Lake) in comparison to baseline and/or reference conditions";
- "Determine potential implications to aquatic ecosystem health and human health (e.g., relative to available fish tissue quality guidelines [MoE 2014; CFIA 2015])";
- "Provide data to support exposure assessment as part of the ERA and HHRA"; and,
- "Document fish habitat utilization in creek and lake areas that were physically impacted by the TSF breach (most notably Hazeltine Creek and the lower segment of Edney Creek), thereby documenting the effectiveness of fish habitat rehabilitation efforts".

From Appendix B.4, the objective of the MDMER EEM fish monitoring is to "evaluate whether there are differences in population endpoints (survival, growth, and reproduction) of sentinel fish species between the area of Quesnel Lake exposed to Mount Polley mine effluent and a reference area (Environment Canada 2012)." Evaluation of selenium in fish tissues is also triggered under the MDMER on the basis of current selenium concentrations in effluent.

6.16.3 MONITORING OVERVIEW

Fish monitoring under the CEMP is designed to meet the combined needs of:

1) Operational monitoring (including the discharge of treated effluent to Quesnel Lake);
2) Monitoring of the impact of the 2014 TSF embankment breach; and
3) Monitoring of the response to remediation following the TSF embankment breach.

As previously indicated, fish monitoring includes fish tissue quality monitoring, sentinel fish population monitoring, fish habitat characterization and fish usage monitoring, and fish community monitoring. An overview of the proposed fish monitoring program is provided in Table 8 and Figures 5 and 6 of Appendix B.4. Table 9 in Appendix B.4 summarizes the fish tissue analytes and laboratory reporting limits for the fish monitoring program.

6.16.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Appendix B.4 provides a summary of fish monitoring history previously conducted in the vicinity of the mine in the surrounding creeks, including baseline monitoring, and pre- and post-breach monitoring. The sample collection methods and monitoring are also summarized in Appendix B.4 for tissue sampling, sentinel fish population monitoring, fish community monitoring, and fish habitat characterization and usage monitoring.

In addition to the monitoring outlined in Appendix B.4, visual spawning surveys of upper Hazeltine Creek to evaluate the success of re-introduction of spawning access by Polley Lake rainbow trout, and at the mouth of Hazeltine/Edney Creek to confirm access to that stream reach following a monitoring program developed in conjunction with the Habitat Remediation Working Group (HRWG). The surveys consisted of two field staff walking the bank of the creek channel and documenting visual observations of species, life stage, and behaviour of fish in the creek, and in lower Hazeltine/Edney, the presence of redds was noted. In upper Hazeltine Creek 25 surveys were conducted through the 2018 ice-free period and in the Hazeltine/Edney Creek mouth, 12 surveys were conducted. Spawning surveys were conducted in Hazeltine/Edney again in 2019.

6.16.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

Appendix B.4 summarizes the QAQC program for the fish monitoring plan. It includes specific QA/QC protocols, including collection of QC samples and collection of replicate samples to allow for statistical calculations and to capture within-area variability. For fish tissue samples, comparisons between duplicate samples will be made by calculating the RPD between concentrations of paired duplicates. If the RPD <25% for concentrations that are >5 times the detection limit, then the duplicate sample results will be considered acceptable. Specific QC samples will include laboratory blanks, laboratory replicates, and laboratory accuracy samples (i.e., matrix spikes, laboratory control samples, and/or certified reference materials). The QC sample results will be assessed as part of the data quality review. See Appendix B.4 for more details.

6.16.6 LABORATORY ANALYSIS

All chemical analyses will be completed by a laboratory that is accredited by CALA, and will be required to include specific QC samples and report associated results.

6.16.7 DATA ANALYSIS AND REPORTING

Catch-per-unit-effort and summary statistics for meristic measurements taken in the field will be calculated. Although community and population data is collected during every phase or component of the fish monitoring program, the sample size will be defined by the study objectives and may be insufficient to address corollary questions. For example, the sample size required for tissue quality analyses (n = 8) is not large enough to support formal contrasts of population endpoints. To this end, evaluation of fish community data will rely on qualitative comparisons, and conclusions regarding fish populations will be supported by non-lethal measurements and sampling under the MDMER EEM (with larger sample size), as described in Appendix B.4. Analysis methods for the MDMER EEM fish population data, as described in Appendix B.4 will be "consistent with EEM technical guidance (Environment Canada 2012). Summary statistics, including mean, median, minimum, maximum, standard deviation, standard error, and sample

size, will be calculated for fish age, fork length, total length, body weight, condition, liver weight, gonad weight, and fecundity; calculations will be completed according to species and area. All data sets will be assessed for normality and equality of variance in order to determine the suitability of parametric statistical procedures. An effect on the fish population will be evaluated for each of these measures and is defined as a statistically significant difference between the effluent-exposed area and the reference area (Environment Canada 2012). For each endpoint, statistically significant differences between effluent-exposed and reference areas (by species and sex) will be assessed using ANOVA, Analysis of Covariance (ANCOVA), or non-parametric equivalents, as appropriate, following technical guidance (Environment Canada 2012).

"For the fish tissue data sets, statistical comparisons of age, length, weight, and concentrations of metals in fish tissues (n = 8) will be completed among years and locations. The sample size, mean, median, standard deviation, standard error, minimum, maximum, 5th percentile, and 95th percentile will be calculated for each analyte. Means will be calculated using the Kaplan-Meier (K-M) method. The standard deviation and the median for each analyte will also be calculated using the K-M method. When a standard deviation cannot be estimated (i.e., when an analyte has a high proportion of censored values), it will be reported as "not calculated".

"Results of the fish habitat characterizations for Upper Hazeltine, Lower Hazeltine, and Lower Edney creeks will be summarized, along with fish usage results, according to season (spring, summer, and fall) and year. Fish habitat characterization measures will be summarized by season, reach, and area (rehabilitated and reference), with summary statistics (mean and standard deviation) calculated for all numerical parameters."

More detail for each monitoring component is provided in Section 4.5 of Appendix B.4.

An interpretive report based on the fish monitoring data was prepared to be integrated into the AERR for the Mount Polley Mine that is prepared annually by MPMC (see Section 9.3). The interpretive report will provide all data in an appendix and will include the data quality review, the results of the screening against BCWQGs, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots.

With respect to the spawning surveys, rainbow trout were observed spawning in upper Hazeltine Creek, confirming that the fish were successfully re-introduced to the reconstructed channel. A majority of spawning activity occurring from May 10 to 25, 2018, when 488 rainbow trout redds were counted, and emergence of young-of-year trout began in late June (Minnow 2019). In 2018, rainbow trout, longnose sucker and redside shiner were observed lower Hazeltine/Edney (Minnow 2019) and in fall 2019, sockeye salmon were observed using the reconstructed habitat (data will be reported in 2020).

6.17 WILDLIFE MONITORING

Wildlife monitoring described below includes observational monitoring and monitoring using wildlife cameras. A study design for wildlife monitoring in the Hazeltine Creek corridor will be provided in 2020. This subsection will be updated accordingly.

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.17.1 Section Authors and Study Design Professionals

This section was written by MPMC (wildlife observations) and Golder (tissue collection and food chain model – related to follow up tasks for the ERA).

6.17.2 Monitoring Objectives

The current objective of the wildlife monitoring is to document the presence of mammals and birds using or migrating through the mine site and adjacent areas. This information is used for land use planning and to monitor the potential for effects of mine-related activities on animals in the area.

The study design concept in Appendix B.5 focuses on reducing the sources of uncertainty from the terrestrial ERA (Golder 2017).

6.17.3 Monitoring Overview

Operational Monitoring - Wildlife occurrences will be recorded throughout the year by MPMC Environmental Department staff, and by other MPMC employees and contractors, when possible. Observations will include wildlife sightings and evidence of wildlife, such as tracks and droppings. Documentation will include the date, initials of the observer, location of the observation, wildlife observed, and comments (such as size of group, sex, or activity of an animal).

Data files from wildlife cameras installed in three locations (Hazeltine Creek, Mine Site, Reference site) are downloaded and reviewed monthly. Any changes to the location of the cameras are documented. Details including frequency of use by wildlife near each camera and variety of wildlife are documented. These details will be included in the AERR.

Supplemental Tasks - A tiered approach was been recommended, as outlined in Appendix B.5. Only Tasks 1A, 2A, 2B and 3 will be undertaken as part of the current CEMP. If risks are found to be unacceptable at the end of Step 2, further investigation following the proposed tiered approach described in Appendix B.5 will be conducted, which may include a development of a study design.

6.17.4 High-Level Monitoring Design Description

Table 6.33 is a summary of previous wildlife monitoring undertaken and includes recommendations for future monitoring. Further rationale is provided in the following sub-sections, if appropriate, and is referenced in the table where applicable.

Table 6.33 Summary of wildlife monitoring and findings

Summary of Monitoring and Findings	Monitoring Objective		
	Operational	**Post-Breach**	**Reclamation**
Previous monitoring undertaken	General wildlife observations (animals, scat, and tracks) documented.	N/A	N/A
Summary of findings	734 observations of wildlife were documented in 2017.	N/A	N/A
Recommendations for 2018-2020 monitoring	General wildlife observations will continue to be made per Permit requirements. A study design for wildlife monitoring in the Hazeltine Creek corridor will be provided in 2020.	Reconnaissance-level field surveys to support updated food chain modelling for potential bioaccumulation in wildlife.	N/A

Notes: N/A: not applicable

6.17.4.1 Operational Monitoring

This section will be updated when a study design is submitted in 2020.

6.17.4.2 Post-Breach Monitoring

In 2018, a reconnaissance-level survey was undertaken to support an update of the food chain model first presented in the ERA. Soil sampling is presented in Section 6.19, soil invertebrate sampling in Section 6.20, and vegetation monitoring in Section 6.21. An additional component considered in the food chain model was flying insects.

Samples of flying invertebrates (bees/wasps [order Hymenoptera], moths [order Lepidoptera], and crickets/grasshoppers [order Orthoptera]) were collected from the impacted area and background areas. Information about the tissue chemistry of this important food item for insectivorous birds and bats was not previously available in Golder (2017). The samples were collected through a combination of manual foraging and trapping. Manual foraging generally involved surveying flowering plants for bees or the ground surface for grasshoppers and using a sweep net to capture target invertebrates. Moths were predominantly collected using black light traps. Terrestrial invertebrate trapping was conducted using methods adapted from the RISC guidelines for terrestrial arthropod inventory (RIC 1998), guidance from the Biological Survey of Canada (Marshall et al. 1994; Danks 1996) and the US Department of Agriculture (Schauff 1998). Terrestrial invertebrate trapping methods employed on the Site included malaise traps, black light traps, pan/window traps and Berlese funnels.

Irrespective of the specific capture method, the following steps consistent with the *BC Field Sampling Manual* (BC ENV 2013) were followed to process the flying invertebrate samples:

- Samples were collected using nitrile gloves and transferred to clean Ziploc bags.
- Flying invertebrates of the same order from a single sample location (limited to 25 meters squared [m2]) were composited.
- Flying invertebrates were left in sample containers stored at ambient temperature overnight to allow samples to depurate.
- Flying invertebrate samples were rinsed using DI water and blotted dry with lint-free wipes before being transferred to clean Ziploc bags.
- Samples were transferred to a freezer to kill the invertebrates.
- Samples were kept frozen until they were submitted to the laboratory for analysis.

The invertebrate tissue samples were submitted for analysis of metals and moisture content, and the data were used, with other data collected as part of the reconnaissance survey, to update the food chain model developed to evaluate the potential for bioaccumulation of metals in wildlife. The food chain model update is described in Section 6.17.7.

6.17.5 Data Quality Control, Objectives, and Review

Wildlife observations data will undergo a QC screening prior to upload to the network.

Twelve duplicate flying invertebrate samples were collected and laboratory QC samples consisted of duplicates, method and equipment blanks, and certified reference materials. RPDs exceeded DQOs for most metals in at least one duplicate sample. A higher variability in flying invertebrate samples is expected because the field duplicates are not splits of a composite—they are two composites of different individual organisms. In terms of copper, RPDs of 58 and 86% were noted in two of twelve duplicate pairs for wet weight concentrations and in one of twelve (RPD = 50%) of dry weight concentrations For vanadium, RPDs of 65 to 126% were noted in three of twelve duplicate sample pairs for wet weight concentrations and in zero of twelve duplicate sample pairs for dry weight. The data were considered reliable and suitable for there intended purpose

6.17.6 Laboratory Analysis

Laboratory analyses of the invertebrate tissue samples were undertaken by a CALA-accredited laboratory.

6.17.7 Data Analysis and Reporting

Number of wildlife observations will be tabulated and reported in the AERR.

The flying insect chemistry data (Golder 2019a) and updated food chain model (Golder 2019b) were submitted to ENV as an attachment to the 2018 Annual Report.

The wildlife food chain model presented in the ERA (Golder 2017) provided screening-level risk estimates for receptors exposed to copper and vanadium (the only contaminants of concern identified in the ERA),

which were based on calculated area-weighted hazard quotients (HQs) of <1 to 2.8, and a maximum HQ of 5.1 (for masked shrew in the Polley Flats area). Although the HQs were considered not to represent an unacceptable risk to wildlife, the food chain model was refined in 2018 by:

- Adding bats (*Myotis* sp.) as a receptor.
- Improving the quality of information with respect to tissue concentrations in invertebrates and plants by expanding the existing bioaccumulation sampling (as part of the reconnaissance-level survey conducted in 2018).
- Replacing the conservative assumption that flying insects have the same tissue concentrations as soil-dwelling insects by collecting site-specific data (as part of the reconnaissance-level survey conducted in 2018).
- Refining the toxicity reference values (i.e., the denominator in the HQ) to consider more than a highly conservative threshold

Revised screening-level risk estimates resulted in lower HQs. Screening-level HQs were <1 for all receptors except robin, shrew, and bat exposed to copper. The aggregate area-weighted HQs for those three receptors ranged from 1.0 to 1.7, and the maximum observed HQ for a sub-area was 2.1 for robin in the Polley Flats area. When a refined TRV was used to provide an additional level of protection to listed species, no HQs greater than 1 were identified and therefore, risks to wildlife associated with copper and vanadium in soils at the site are considered to be acceptable.

6.18 Amphibian and Reptile Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.18.1 Section Authors and Study Design Professionals

This section was written by Golder. The detailed study design concept is provided in Appendix B.6. Note that Appendix B.6 is a study design concept; a study design may be submitted at a later date depending on results of a preliminary review (Steps 1 and 2 as outlined in Figure 1 in Appendix B.6).

6.18.2 Monitoring Objectives

The study design concept in Appendix B.6 focuses on reducing the sources of uncertainty from the terrestrial ERA (Golder 2017). As outlined in Appendix B.6, the objectives of amphibian monitoring will be to "continue the risk assessment process by proceeding through tiers to the point needed to support an informed risk management decision". More detail is provided in Appendix B.6.

6.18.3 Monitoring Overview

A tiered approach has been recommended, as outlined in Appendix B.6. Only Steps 1 and 2 will be completed as part of the current CEMP, with Step 1 undertaken in 2018. If risks are found to be unacceptable

at the end of Step 2, further investigation following the proposed tiered approach described in Appendix B.6 will be conducted, which may include a development of a study design.

6.18.4 High-Level Monitoring Design Description

In 2018, Step 1 of the study design concept was undertaken, specifically, a hazard evaluation. Existing soil, sediment and surface water chemistry data were screened for different habitat units against a conservative amphibian-specific screening value, as follows:

1. Review of existing guidelines: the purpose of the review was to determine if existing guidelines, criteria or standards contained sufficient amphibian-specific data to allow their use as a screening value for this assessment.
2. Derivation of screening values: the existing guidelines were determined to be unsuitable for the amphibian hazard assessment, and therefore screening values were developed through the review of scientific literature. Toxicity testing data were compiled, an uncertainty analysis was conducted on the compiled data, and safety factors were applied as applicable to mitigated identified uncertainties.
3. Application of derived screening values to site data: site monitoring data for water, sediment and soils were compared to the screening values for water and hydric soils/sediment.

6.18.5 Data Quality Control, Objectives, and Review

The study was a desktop review of guideline derivation documents and scientific literature.

6.18.6 Laboratory Analysis

No laboratory analysis were undertaken as part of the amphibian hazard assessment.

6.18.7 Data Analysis and Reporting

The amphibian hazard assessment (Golder 2019c) was submitted to ENV as an attachment to the 2018 Environmental and Reclamation Report (the "2018 Annual Report"), prepared in fulfillment of *Mines Act* permit M-200, and *Environmental Management Act* permit 11678. In summary, a toxicity reference value of 0.018 mg/L dissolved copper was derived for evaluating hazards associated with surface water, and 800 mg/kg copper for evaluating hazards associated with hydric soils or sediment. The available surface water and soil data for the Mount Polley site were compared to these conservative screening values, and overall, there was no evidence that environmental concentrations were routinely or notably higher than those screening value on a site-wide basis. Hazards to amphibians as a result of exposure to soil or surface water are considered to be low under these circumstances.

6.19 Soil Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description;

data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.19.1 Section Authors and Study Design Professionals

This section was written by Golder, and the detailed study design concept is provided in Appendix B.5.

6.19.2 Monitoring Objectives

The study design concept in Appendix B.5 focuses on reducing the sources of uncertainty from the terrestrial ERA (Golder 2017). As outlined in Appendix B.5, the objective of soil monitoring will be to "refine site-specific relationships between copper concentrations in soil and copper concentrations in various soil invertebrate and plant tissues". More detail is provided in Appendix B.5.

6.19.3 Monitoring Overview

Monitoring of soil stockpiles on the mine site for reclamation and closure is outlined in the Soil Management Plan included in the RCP. It is covered under BC *Mines Act* Permit M-200.

In 2018, Task 1A of the study design concept was undertaken, specifically, a reconnaissance-level sampling program.

6.19.4 High-Level Monitoring Design Description

Operational Sampling - Monitoring of soil stockpiles on the mine site for reclamation and closure is outlined in the Soil Management Plan included in the RCP. It is covered under BC *Mines Act* Permit M-200.

Supplemental Sampling - Soil samples were collected from 69 locations (co-located with tissue samples – described in Sections 6.20 and 6.21) to refine the exposure estimate for post-breach rehabilitated areas. The soil chemistry data were used, with other data collected as part of the reconnaissance survey, to update the food chain model developed to evaluate the potential for bioaccumulation of metals in wildlife. The food chain model update is described in Section 6.17.

Each sample was a composite of three aliquots of soil collected from within a 5 m radius of the tissue sample. The aliquots were collected from the top 20 cm of soil using a hand shovel, and then homogenized in a stainless-steel bowl prior to transfer to clean, laboratory-supplied 125-mL, glass sample jars with Teflon™ lined lids. Samples were kept on ice in a cooler after collection and kept cool until submitted to ALS for analysis of metals and pH.

6.19.5 Data Quality Control, Objectives, and Review

Supplemental soil sampling was undertaken using methods consistent with those used for the HHRA and ERA. Eight field duplicates were collected and laboratory QC consisted of duplicates, method blanks and matrix spike recovery. Copper and vanadium (the metals of interest for the food chain model) met the field DQOs. The soil sample results met the laboratory DQOs for precision, accuracy, method blanks, duplicate sample analysis and matrix spike recovery, with the exception of a method blank that had a detected

concentration of copper. This could be a potential bias in samples that are near the limit of reporting but was not an issue in the current samples because all copper results were substantially higher than detection limits. Overall, the data were considered representative and suitable for their intended use.

6.19.6 Laboratory Analysis

Laboratory analyses were undertaken by a CALA-accredited laboratory.

6.19.7 Data Analysis and Reporting

The results of the reconnaissance survey (Golder 2019a) were submitted to ENV as an attachment to the 2018 Annual Report. Data from the 2018 soil sampling were integrated with the relevant historical data to update the soil concentrations used in the food chain model. All samples were compared to the applicable CSR standards, and an overview of those findings is provided below for each of the different rehabilitated areas that were sampled in Tables 1 through 3. Overall, the results of the soil chemistry were consistent with results from previous sampling in those areas and no new contaminants of concern were identified. The use of the soil chemistry data is further discussed in Section 17 (vis-à-vis the food chain model update).

6.20 Soil Invertebrate Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.20.1 Section Authors and Study Design Professionals

This section was written by Golder, and the detailed study design concept is provided in Appendix B.5.

6.20.2 Monitoring Objectives

The study design concept in Appendix B.5 focuses on reducing the sources of uncertainty from the terrestrial ERA (Golder 2017). As outlined in Appendix B.5, the objectives of soil invertebrate monitoring will be to:

- "Focus on establishing a long-term trend analysis of soil invertebrate community rather than to support a multitude of pair-wise comparisons that would have limited value for making site management decisions";
- "Refine site-specific relationships between copper concentrations in soil and copper concentrations in various soil invertebrate tissues"; and,
- "Improve the quality of data with respect to tissue concentrations in invertebrates, particularly for flying insects."

6.20.3 Monitoring Overview

In 2018, Task 2A of the study design concept was undertaken, specifically, a reconnaissance-level sampling program.

6.20.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Additional sampling was conducted to improve the spatial coverage of soil invertebrate samples, and to obtain sufficient samples of each main invertebrate type from the range of soil concentrations present at the site. Invertebrate (i.e., ants, beetles, spiders and worm) samples were collected through a combination of manual foraging and trapping. Manual foraging involved surveying the ground surface and searching below woody debris. Sampling was conducted if sufficient volume of soil invertebrates were noted or if a larger soil invertebrate (e.g., a large beetle) was found.

Terrestrial invertebrate trapping was conducted using methods adapted from the RISC guidelines for terrestrial arthropod inventory (RIC 1998), guidance from the Biological Survey of Canada (Marshall et al. 1994; Danks 1996) and the US Department of Agriculture (Schauff 1998). These documents guided the selection of the trapping method, locations of samples, sampling design and trapping protocols. Terrestrial invertebrate trapping methods employed on the Site included pitfall traps and Berlese funnels. Irrespective of the specific capture method, the following steps consistent with the *BC Field Sampling Manual* (BC ENV 2013) were followed to process the soil invertebrate samples:

- Samples were collected using nitrile gloves and transferred to either clean, laboratory supplied glass jars or clean Ziploc bags.
- Invertebrates of the same order from a single sample location (limited to 25 m^2) were composited.
- Soil invertebrates were left in partially open sample containers stored at ambient temperature overnight to allow samples to depurate.
- Invertebrate samples were rinsed using DI water and blotted dry with lint-free wipes before being transferred to clean Ziploc bags.
- Samples were transferred to a freezer to kill the invertebrates.
- Samples were kept frozen until they were submitted to the laboratory for analysis.

The soil invertebrate tissue samples were submitted for analysis of metals and moisture content, and the data were used, with other data collected as part of the reconnaissance survey, to update the food chain model developed to evaluate the potential for bioaccumulation of metals in wildlife. The food chain model update is described in Section 6.17.

6.20.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

Soil invertebrate sampling were undertaken using methods consistent with those used for the HHRA and ERA. Eight field duplicates were collected and laboratory QC consisted of duplicates, method blanks and certified reference materials. RPDs were greater than 50% for most metals in at least one duplicate sample. A higher variability in soil invertebrate samples is expected because the field duplicates are not splits of a composite—they are two composites of different individual organisms. In terms of copper, an RPD of 65% was noted for the wet weight concentration in one duplicate pair, but the dry weight data had an acceptable RPD (48%). There was less variability in copper results than most other metals, and Golder concludes that the data are reliable and suitable for its intended purpose. RPDs of 55 to 106% were noted in four of eight duplicate sample pairs for wet weight concentrations and in two of eight duplicate sample pairs for dry

weight with respect to vanadium. However, this variability does not impact the overall conclusion that vanadium bioaccumulation is limited, nor does it change the conclusion that vanadium risks to wildlife from consumption of dietary items was low. The tissue samples met the laboratory DQOs with respect to copper and vanadium (the parameters of interest for the food chain model).

6.20.6 Laboratory Analysis

Laboratory analyses were undertaken by a CALA-accredited laboratory.

6.20.7 Data Analysis and Reporting

The results of the reconnaissance survey (Golder 2019a) were submitted to ENV as an attachment to the 2018 Annual Report. The use of the soil chemistry data is further discussed in Section 17 (vis-à-vis the food chain model update).

6.21 Vegetation Monitoring

The following sections give a synopsis of the objectives; sample locations along with parameters measured, site description, sampling frequency, and applicable guidelines; a high-level monitoring design description; data quality control, objectives, and review; laboratory analysis; and data analysis and reporting, where applicable.

6.21.1 Section Authors and Study Design Professionals

This section was written by MPMC, and is a summary of the study design concept provided by Golder. The detailed study design concept is provided in Appendix B.5. Note that Appendix B.5 is a study design concept; a study design will be submitted in Q1 2019 after completion of tasks outlined in Figure 2 in Appendix B.5.

6.21.2 Monitoring Objectives

The study design concept in Appendix B.5 focuses on reducing the sources of uncertainty from the terrestrial ERA (Golder 2017). As outlined in Appendix B.5, the objectives of vegetation monitoring will be to:

- "Focus on establishing a long-term trend analysis of plant community rather than to support a multitude of pair-wise comparisons that would have limited value for making site management decisions"; and,
- "Refine site-specific relationships between copper concentrations in soil and copper concentrations in various plant tissues."

More detail is provided in Appendix B.5.

6.21.3 Monitoring Overview

In 2018, Task 2A of the study design concept was undertaken, specifically, a reconnaissance-level sampling program.

6.21.4 HIGH-LEVEL MONITORING DESIGN DESCRIPTION

Samples of the edible portions of plants (were collected following the same approach used in 2015 and 2016. The focus of plant sampling was on rehabilitated areas to increase sample density in these areas and to provide more information about plants growing in soils that have lower copper concentrations than the non-reclaimed areas. The following plant tissue samples were collected in 2018:

- Berry—Berry samples were collected from raspberry [*Rubus occidentalis]*, high bush cranberry [*Viburnum trilobum*], and thimbleberry [*Rubus parviflorus*]) plants that were rooted in soil.
- Leaf—Willow (*Salix* sp.) and alder (*Alnus crispa*) leaf samples were collected from shrubs planted in the impacted area. Only shrubs planted in the floodplain before spring 2016 were sampled. Plants sampled included willow planted in lower Hazeltine Channel in early 2015, above the canyon in late 2015, and in upper Hazeltine Channel late 2015 (near Gavin Lake Bridge).
- Grass— Slender wheatgrass *(Elymus trachycaulus*) samples were collected from a variety of areas. The objective of the sampling was to reduce the uncertainty in the existing soil-to-grass bioaccumulation relationship, and therefore, sampling was limited to a single species which was commonly found across the entire site. Only the edible, above-ground portion of grass was collected.

Sampling methods were consistent with the *BC Field Sampling Manual* (MoE 2013) and consisted of the following steps:

- Plant tissue was hand-picked by field staff using nitrile gloves from an area of 25 m^2 or less. Plant tissue was composited from multiple plants within the area if sufficient volume could not be collected from one plant.
- Plant samples were rinsed using DI water and blotted dry with lint-free wipes before being transferred to clean Ziploc bags.
- Samples were placed in a cooler containing ice until they could be transferred to a freezer for storage prior to shipping to the laboratory for analysis.

The plant tissue samples were submitted for analysis of metals and moisture content, and the data were used, with other data collected as part of the reconnaissance survey, to update the food chain model developed to evaluate the potential for bioaccumulation of metals in wildlife. The food chain model update is described in Section 6.17.

6.21.5 DATA QUALITY CONTROL, OBJECTIVES, AND REVIEW

Vegetation sampling was undertaken using methods consistent with those used for the HHRA and ERA. Five replicate plant samples were collected and laboratory QC consisted of duplicates, method blanks and certified reference materials. Data quality objectives were met for copper and vanadium (the parameters of interest for the food chain model) in vegetation samples for both field and laboratory QC samples.

6.21.6 Laboratory Analysis

Laboratory analyses were undertaken by a CALA-accredited laboratory.

6.21.7 Data Analysis and Reporting

The results of the reconnaissance survey (Golder 2019a) were submitted to ENV as an attachment to the 2018 Annual Report. The use of the soil chemistry data is further discussed in Section 17 (vis-à-vis the food chain model update).

6.22 Biosolids Monitoring

MPMC is in possession of an EMA permit (15968) for the use of biosolids. This permit requires that MPMC retain the services of a qualified professional to develop a monitoring plan for the biosolids application program. MPMC will submit this plan to ENV and EMPR prior to receiving any additional shipments of biosolids to the mine site.

7 CEMP UPDATES AND REVISIONS

When possible, MPMC will provide written notice of planned changes to the CEMP to the ENV Director a minimum of 30 days prior to implementation to allow for review and feedback on the revision. Proposed changes will be shared with First Nations and stakeholders, as per MPMC's Communication Plan (MPMC 2016d). Additionally, changes that occur but are unplanned, such as the collection of additional samples, will be discussed with the ENV Director as soon as possible after the sampling occurs. When changes are made to the monitoring, this amended plan (or relevant replacement pages) will be resubmitted to the Director.

Given the dynamic nature of environmental investigation, rehabilitation, and water management plan development at Mount Polley Mine, it is anticipated that the CEMP will evolve in alignment with site activities and findings, as described in Section 2.3, and will be updated as required. It is anticipated that larger CEMP revisions in response to these activities and findings will be made with consideration of maintaining continuity in spatial and temporal coverage to meet the global objectives of the CEMP, as described in Section 1.1.

As required by the Permit, following the three-year detailed monitoring program interpretive report to the Director, MPMC will submit a summary of proposed changes to the CEMP to the Director by April 30 of that year (one month following the interpretive report deadline). In order to incorporate recommended changes in a timely fashion, MPMC would appreciate feedback on the proposed changes from the ENV by May 31 of that year.

8 RECLAMATION AND REMEDIATION

Rehabilitation of the aquatic and terrestrial receiving environments that were impacted by the TSF embankment breach and associated remediation activities is continuing as outlined in the Rehabilitation Strategy (November 2015 update; MPMC 2015f), as required by the PAO 107461. Under this broader Rehabilitation Strategy:

- Terrestrial rehabilitation works are being conducted as per the *Planning Concepts for Rehabilitation of Terrestrial Ecosystems at Mount Polley* technical memorandum prepared by Golder (2015e). The reclamation and monitoring steps described in this memorandum are based on the TSF embankment breach environmental impact assessment results to date.
- Rehabilitation of aquatic systems is being conducted under guidance of the Habitat Remediation Working Group, which includes representatives of DFO, ENV, the BC Ministry of Forest, Lands and Natural Resource Operations, the SCIB, and the WLIB. This group provides recommendations and feedback on aquatic ecosystem rehabilitation plans developed by MPMC's consultants.

Monitoring associated with the Hazeltine Creek channel rehabilitation construction activity is undertaken under the *Post-Breach Rehabilitation Work Environmental Management Plan* (Golder 2015f), which pertains to monitoring of any construction works and associated construction specifications. While the lower reaches of Hazeltine Creek remain non-fish bearing (with the exception of the lower sedimentation pond), the *MPMC Fish Exclusion and Response Plan* (MPMC 2015f) is in effect. MPMC will conduct monthly visual inspections for fish in the non-fish bearing areas of the creek when the creek is free of snow and ice (in case any fish have evaded the barriers), as well as weekly inspections of fish exclusion structures. The plan outlines response actions in the event that fish are observed.

As Hazeltine Creek is rehabilitated and returned to fish-bearing status, this environmental management plan will be phased out and be replaced by routine monitoring for evaluating performance of the works as a component of the CEMP.

The Habitat Remediation Working Group made up of provincial and federal regulators, qualified professionals and First Nations representatives, agreed upon a monitoring plan for the return of rainbow trout in Hazeltine Creek in 2018. This plan includes week fish surveys, detailed habitat usage surveys, benthic, sediment, water (quality and quantity), and fish tissue sampling. Reporting on these results will be included in the AERR.

The steps in the aforementioned terrestrial rehabilitation plan include establishment of permanent monitoring plots for ongoing assessment, feedback (to inform adaptive management) and demonstration. As terrestrial rehabilitation works progress, monitoring to this end will be implemented.

A Conceptual Remediation Plan (CRP) was submitted to ENV on January 31, 2018 (Golder 2018) and following receipt of comments on the CRP, a Remediation Plan submitted on March 29, 2019 (Golder 2019d). The Remediation Plan identifies remedial options for the sites impacted by the TSF breach, including creek habitats, lake habitats, and terrestrial habitats, as well as proposed monitoring components to verify the success of the planned remediation. The Remediation Plan was approved by ENV on July 3, 2019.

9 REPORTING

9.1 MONTHLY REPORTING

As required by Section 3.9 in the Permit (April 7, 2017) a monthly report will be submitted to the Director in each month that discharge occurs. The report will summarize the volume of treated effluent discharged, a summary of continuous turbidity readings of the treated effluent discharged, and the most recently available water quality results for the effluent discharged, including a summary of acute and/or chronic toxicity testing results.

9.2 QUARTERLY REPORTING

All data and information collected under the CEMP will be provided to the Director, in electronic format, on a quarterly basis or as required by the Permit.

Under the most recent version of PAO 107461 (June 9, 2017) Section 6.0, a quarterly report detailing the implementation status of requirements of the order, a summary of communications with stakeholders and public relating to the breach, and any remediation activities undertaken in Hazeltine Creek, Polley Lake and Quesnel Lake for the previous and upcoming three months must be submitted to the director.

9.3 ANNUAL REPORTING

As required by the Permit Section 3.9, MPMC will continue to submit an AERR on or before March 31 of each year. This report is combined with the Annual Reclamation Report prepared for the EMPR, with the combined document submitted to both agencies. These reports will include the details required by the permit, as well as an analysis of the linkages between program components, where appropriate. MPMC will refer to *Technical Guidance 4, Environmental Monitoring under the Environmental Management Act* such that the ENV's expectations for reporting are achieved.

The AERR will continue to be in a format suitable for public release and will be deposited at the Cariboo Regional District Library as well as submitted to the SCIB and WLIB within 30 days of being submitted to the ENV.

As required by the Permit (April 7, 2017) Section 2.5, MPMC will continue to submit an annual Environmental Emergency Response Plan and will include updated procedures and notification protocols. MPMC will also continue to submit an Annual Discharge Plan on or before April 15 of each year and include the details required by the Permit Section 2.7.

9.4 THREE-YEAR REPORTS

Under the Permit, a detailed monitoring program interpretive report is required every three years with the first report due on March 31, 2019 and every three years thereafter. The March 2019 interpretive report will include data collected in 2016, 2017, and 2018. This report will be completed by one or more qualified professionals and will be more comprehensive than the synoptic review of data presented in the annual reports. It will include recommendations for changes to the CEMP.

In addition, a groundwater monitoring program review including, but not limited to, sampling, well locations, site water balance, interpretation of data trends, and suitable recommendations is required every three years, with the first presented in March 2016. The next report will be submitted on March 31, 2019. Monitoring data and the analysis of those data presented in the report will be reviewed by a third party qualified professional.

10 FUTURE OUTLOOK

This CEMP represents a unique and specialized variation of a typical mine environmental monitoring plan. This plan seeks to integrate all environmental monitoring programs that are carried out on the Mount Polley mine site and in the local area related to:

(a) Ongoing mine operations (including EMA and *Mines Acts* permit requirements and MDMER requirements of the *Fisheries Act*);
(b) TSF embankment breach-related impacts and remediation; and,
(c) Reclamation and closure planning (*Mines Act* permit requirement).

The overall goals of this CEMP are to provide science-based evidence: for evaluation of environmental impacts of mine operations; for evaluation of the effects of any ongoing impacts of, and remediation measures undertaken in response to, the TSF embankment breach; and to inform ongoing reclamation and closure planning. These goals are guided by an intent to return the impacted areas of the mine site and its surroundings to viable and diverse ecosystems that reflect pre-breach land uses, or those identified by Communities of Interest as representing values of importance. These values of importance are identified through ongoing consultation with local Communities of Interest.

Mount Polley fosters a culture of research and innovation. In addition to the extensive monitoring and research work that was undertaken as part of the impact and risk assessments of the TSF embankment breach, there are a number of research projects underway (and several recently completed) that the mine has supported. The results of these projects may contribute directly to improving the mine's understanding of breach impacts (Cuervo et al, 2017; Garris et al, 2018; Byrne et al, 2018), new approaches to remediation, reclamation and closure (McMahen, PhD in progress, UBC; Litke MASc in progress, UBC), and to mitigating environmental impacts of ongoing operations.

With respect to mitigating environmental impacts of ongoing operations and planning for reclamation and closure, Mount Polley is embarking on passive water treatment research and pilot projects to test the suitability of constructed wetland water treatment systems for dispersed water treatment and discharge on the mine site. These research projects will include lab and site testing, monitoring of water quality, vegetation, and microbial communities, and will be reported annually in the AERR or in a technical memo.

As the results of monitoring programs and environmental research projects are generated, analyzed, and interpreted, this CEMP will be reviewed and updated where warranted. MPMC will aim to review the requirements of the CEMP on a quarterly basis and will submit a list of proposed changes based on the review to the Director within 45 days from the end of the quarter.

11 REFERENCES

Byrne, P., Hudson-Edwards, K.A.; Bird, G.; Macklin, M.; Brewer, P.A.; Williams, R.D.; Jamieson, H.E. 2018. Water quality impacts and river system recovery following the 2014 Mount Polley mine tailings dam spill, British Columbia, Canada. Applied Geochemistry, 91 (2018): 64-74.

CFIA (Canadian Food Inspection Agency). 2015. Canadian Food Inspection Agency Fish Products Standards and Methods Manual: Appendix 3, Canadian Guidelines for Chemical Contaminants and Toxins in Fish and Fish Products. Ottawa, ON, Canada.

Cuervo, V., Burge, L., Beaugrand, H., Hendershot, M., Evans, S.G. 2017. Downstream geomorphic response of the 2014 Mount Polley Tailings Dam Failure, British Columbia. *Advancing Culture of Living with Landslides*. M. Mikos et al (eds.): 281-289.

Danks HV. 1996. How to Assess Insect Biodiversity Without Wasting Your Time. Biological Survey of Canada (Terrestrial Arthropods). Reprint edition 2006.

Environment Canada. 2012. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada Report EEM/2002/1. June.

Garris, H.W., Baldwin, S.A., Taylor, J., Gurr, D.B., Denesiuk, D.R., Van Hamme, J.D., Fraser, L.H. 2018. Short-term microbial effects of a large-scale mine-tailing storage facility collapse on the local natural environment. PLoS ONE 13(4): e0196032.

Government of Canada. 2018. Metal and Diamond Mining Effluent Regulations - Consolidation. SOR/2002-222. Last amended June 1, 2017. Current to June 10, 2018.

Golder (Golder Associates Ltd.). 2015a. Sampling and Analysis Plan: Detailed Site Investigation and Human Health and Ecological Risk Assessment and Confirmation of Remediation. Report prepared for MPMC. July 15, 2015.

Golder. 2015b. Technical Assessment Report in Support of an Effluent Permit Amendment. Report prepared for MPMC. May 29, 2015.

Golder. 2015c. Mount Polley Mining Corporation Post Event Environmental Impact Assessment Report. Report prepared for MPMC. June 5, 2015.

Golder. 2015d. Planning Concepts for Rehabilitation of Terrestrial Ecosystems at Mount Polley. Memorandum prepared for MPMC. September 17, 2015.

Golder. 2015e. Environmental Management Plan, Mount Polley Post-Breach Rehabilitation Work. Report prepared for MPMC. July 7, 2015.

Golder. 2016a. Human Health and Ecological Risk Assessment Problem Formulation. Report prepared for MPMC. January 29, 2016.

Golder. 2016b. Detailed Site Investigation Mount Polley Tailings Dam Failure Mount Polley, BC. Report prepared for MPMC. January 29, 2016.

Golder. 2016c. Mount Polley Mine – Prediction of Water Level and Seepage from the Springer Pit and Bootjack Lake Water Quality. Memorandum prepared for MPMC. March 7, 2016.

Golder. 2016d. Update Report: Post-Event Environmental Impact Report. Report prepared for MPMC. June 3, 2016.

Golder. 2016e. Permit Amendment Application under the Environmental Management Act: Technical Assessment Report. Report prepared for MPMC. October 17, 2016.

Golder. 2017. Mount Polley Rehabilitation and Remediation Strategy: Ecological Risk Assessment. Report prepared for MPMC. December 15, 2017.

Golder. 2018. Conceptual Remediation Plan. Report prepared for MPMC. Submitted to ENV January 31, 2018.

Golder. 2019a. Supplemental soil and terrestrial tissue sampling and evaluation of bioaccumulation relationships for the terrestrial food chain model. Submitted to MPMC. Ref. No. 1894924-064-TM-Rev0-23136.

Golder. 2019b. Update to Wildlife Food Chain Model – Mount Polley Mine. Submitted to MPMC. Ref. No. 1894924-069-R-Rev0-23196.

Golder. 2019c. Amphibian hazard assessment (Comprehensive Environmental Monitoring Plan). Submitted to MPMC. Ref no. 1894924-062-R-Rev0-23151.

Golder. 2019d. Remediation Plan – Mount Polley Mine Perimeter Embankment Breach. Submitted to MPMC. Ref. No. 1894924-076-R-Rev0-23197.

Knight-Piésold. 2014. Hazeltine Creek Hydrologic Analysis Report. Report prepared for MPMC. February 2014.

Laval, B.E., Morrison, J., Potts, D.J., Carmack, E.C., Vagle, S., James, C., McLaughlin, F.A. and Foreman, M. 2008. Wind-driven summertime upwelling in a fjord-type lake and its impact on downstream river conditions: Quesnel Lake and River, British Columbia, Canada. *Journal of Great Lakes Research* 34(1): 189-203.

Marshall SA, Anderson RS, Roughley RE, Behan-Pelletier V, Danks HV. 1994. Terrestrial Arthropod Biodiversity: Planning a Study and Recommended Sampling Techniques. Biological Survey of Canada (Terrestrial Arthropods). Reprint edition 2007.

Minnow. 2015a. Sediment Quality Data Report – August 2015 Collections. Letter to Mr. Dale Reimer, Mount Polley Mining Corporation from Pierre Stecko and Katharina Batchelar. October 29, 2015.

Minnow. 2015b. Mount Polley Tailings Dam Failure – Sediment Quality Impact Characterization. Prepared for Mount Polley Mining Corporation, May 2015.

Minnow. 2016. Application of the SEM-AVS Method and Selective Extraction Analysis in Evaluating Sediments Collected in the Vicinity of the Mount Polley Mine. Letter to Mr. Dale Reimer, Mount Polley Mining Corporation from Pierre Stecko and Katharina Batchelar. January 29, 2016.

Minnow. 2019. 2018 Hazeltine Creek Monitoring Report. Submitted to Mount Polley Mining Corporation.

MoE (BC Ministry of Environment). 2009. Manual of British Columbia Hydrometric Standards. Science and Information Branch for the Resources Information Standards Committee. Retrieved from https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/science-data/man_bc_hydrometric_stand_v10.pdf

MoE. 2012. Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators. October 2012.

MoE. 2013a. British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Sample, 2013 Edition. Retrieved from https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/bc_field_sampling_manual_complete.pdf

MoE. 2014. Ambient Water Quality Guidelines for Selenium. Technical Report Update. Water Protection and Sustainability Branch. April 2014.

MoE. 2015. British Columbia Environmental Laboratory Manual, 2015 Edition. Water & Air Monitoring and Reporting Section Knowledge Management Branch. Retrieved from https:/www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/lab-manual/title-page.pdf

MoE. 2016. Snow Survey Sampling Guide. Retrieved from: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/snow/snow_survey_sampling_guide.pdf (update of: www.geoscientific.com/technical/tech_references_pdf_files/snow_surveys_manual.pdf

MoE. 2017a. Technical Guidance 15 (Contaminated Sites): Concentration Limits for the Protection of Aquatic Receiving Environments. Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/technical-guidance/tg15.pdf

MoE. 2017b. British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Water Protection and Sustainability Branch. June 2017.

MoE. 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture – Summary Report. Updated March 2018. Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approvedwqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

MPMC. 2015a. Annual Monitoring Plan – 2015; Permit 11678. Submitted to the ENV January 28, 2015.

MPMC. 2015b. Biological Monitoring and Lake Monitoring Plan – 2015 Revision 1. Submitted to the ENV April 7, 2015.

MPMC. 2015c. Post-TSF Breach Monitoring Plan – 2015 Revision 1. Submitted to the ENV April 8, 2015.

MPMC. 2015d. Post Breach Fish Tissue Collections Plan – 2015. Submitted to the ENV March 31, 2015.

MPMC. 2015e. Hazeltine Creek Fish Exclusion and Response Plan. Submitted to the ENV December 7, 2015.

MPMC. 2015f. Rehabilitation Strategy: Summary Table. November 5, 2015. Retrieved from http://www.imperialmetals.com/assets/docs/mt-polley/12.01.15.MP-NOTICE.pdf

MPMC. 2016a. Monitoring Plan for Discharge of Treated Effluent to Quesnel Lake via Hazeltine Creek. January 30, 2016.

MPMC. 2016b. Mine Reclamation and Closure Plan Update November 2015. Submitted to EMPR. November 4, 2016.

MPMC. 2016c. Quality Assurance/Quality Control Manual [Environmental Department]. March 31, 2016.

MPMC. 2016d. [MPMC Permit 11678] Communication Plan. March 20, 2016.

MPMC. 2016e. 2015 Annual Environmental and Reclamation Report for the Mount Polley Mine. Submitted to ENV and EMPR. March 31, 2016.

MPMC. 2018. 2017 Annual Environmental and Reclamation Report for the Mount Polley Mine. Submitted to ENV and EMPR. March 31, 2018.

RIC (Resource Inventory Committee). 1998. Inventory Methods for Terrestrial Arthropods: Standards for Components of British Columbia's Biodiversity No. 40. Ver. 2.0. Victoria BC: Ministry of Environment, Lands and Parks Resource Inventory Branch. 19 October 1998.

Shauff ME. 1998. Collecting and Preserving Insects and Mites: Techniques and Tools. Washington DC: Systematic Entomology Laboratory, US Department of Agriculture.

WaterSmith (WaterSmith Research Inc.). 2015. Mount Polley Mine hydrometric monitoring – program update. Memorandum prepared for MPMC. August 12, 2015.

Appendix A

CEMP Terms of Reference – 4 July 2017

Mount Polley Mining Corporation

Mount Polley Mining Corporation
an Imperial Metals company

Terms of Reference

Comprehensive Environmental Monitoring Plan – 4 July 2017

1 BACKGROUND AND CONTEXT

Mount Polley Mining Corporation (MPMC) is the owner and operator of the Mount Polley Mine, a property comprising, among other things, a copper-gold mine and mill complex located near Likely, British Columbia (BC).

MPMC is authorized by the BC Ministry of Environment (MoE) to discharge effluent to the land and to surface water from the Mount Polley Mine, subject to the terms and conditions of *Environmental Management Act* (*EMA*) Permit 11678. *EMA* Permit 11678 was originally issued to MPMC by the MoE on 30 May 1997, and has been the subject of numerous amendments since.

As is typical of owners of mines in BC, MPMC undertakes extensive environmental monitoring for a variety of purposes and objectives. In many instances, data collected as part of one monitoring program are beneficial to other programs, even though programs may have been established specifically for unique purposes.

Under Section 3.2 of *EMA* Permit 11678, MPMC is required to implement a Comprehensive Environmental Monitoring Plan (CEMP). In previous versions of *EMA* Permit 11678, MPMC was required to implement a number of individually defined monitoring plans for various aspects of Mount Polley Mine operations to which this MoE authorization was subject. As stated in Section 3.2 of *EMA* Permit 11678, the CEMP is intended to consolidate and integrate all such pre-existing monitoring programs.

2 OBJECTIVES AND DRIVERS

As described in Section 3.2 of *EMA* Permit 11678, the objective of the CEMP is to evaluate the effects of mining-related activities on the physical, chemical and biological characteristics of Hazeltine Creek, Edney Creek, Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake, Quesnel River, and associated riparian and upland areas.

Environmental monitoring has the broad objective of verifying that environmental controls are in place that protect the environment and are sufficient to confirm compliance with applicable statutory requirements to which operations are subject. Environmental monitoring also has the broad objective of providing data to support evidence-based communication to parties who might be affected by the Mount Polley Mine.

For the Mount Polley Mine, the main drivers (which govern the objectives) are:

- Regulatory Drivers;
    - Federal (e.g., *Metal Mining Effluent Regulation* [MMER])
    - Provincial (e.g., *EMA, Mines Act*)
- MPMC Commitments:
    - The respective Participation Agreements (PAs) that MPMC have in place with the Soda Creek Indian Band (SCIB; Xatśūll First Nation) and the Williams Lake Indian Band (WLIB).

Subject to the requirements of the various drivers, the CEMP is intended to be an adaptive plan. This means that the CEMP is anticipated to change over time, as it is informed by findings obtained from preceding stages of work.

3 SCOPE AND CONTENT

The scope of the CEMP will be built around the Objectives and Drivers, will provide an appropriate level of scientific robustness, and will utilize provincially and federally acknowledged methodology. It is noted that failing to utilize methods common to the various objectives undermines the value of a comprehensive monitoring program. The scope of the CEMP will not include studies of general research (e.g., academic), nor will it include collection of regional data that are not directly linked to the Objectives and Drivers.

As per Section 3.2 of *EMA* Permit 11678, the scope of the CEMP must be such that it consolidates and integrates monitoring programs that are being conducted in the vicinity of the Mount Polley Mine site. At minimum, the CEMP must consider programs addressing surface water (quality and quantity), groundwater (characterization and interactions with surface water), sediments, soils, periphyton, phytoplankton, benthic invertebrates, zooplankton, fish, floodplain and upland vegetation, and wildlife.

As described in Section 3.2 of *EMA* Permit 11678, the CEMP must address, at minimum, a three-year time span, as well as, at minimum, include all sampling sites, frequency of sampling, variables to be analyzed, method detection limits, sampling methods, sample analysis methods, and data analysis methods.

As noted in the Background and Context of this Terms of Reference, environmental monitoring is a tool used by mining companies (and others) to inform them (and other parties), of the adequacy of their source control efforts. The content of the CEMP will be reflective of its use as such a monitoring tool. The CEMP will serve as the document that provides the context and linkages demonstrating how the monitoring program developed provides an appropriate mechanism by which to meet the Objectives and Drivers of the CEMP. In providing this purpose, the CEMP's content is anticipated to provide: a statement of its objectives; an overview of its subject (the Mount Polley Mine); a discussion of the various components that comprise environmental management in the context of the Mount Polley Mine; presentation of monitoring procedures and considerations (e.g., previous data) specific to each environmental monitoring component; and, an outline for control of the CEMP (e.g., updating and revising) and its reporting outputs.

A comprehensive monitoring plan requires a response framework as the monitoring program is the linkage between monitoring plan design, implementation, and effective use. The level and urgency

of response will have due regard to the level of potential risk to the environment (which includes people). The CEMP response framework will be updated in parallel with the CEMP, or as otherwise appropriate.

4 DEPENDENCIES AND ASSUMPTIONS

The CEMP is intended to support an interdependent program. The dependencies across the monitoring programs will be evaluated with the benefit of a conceptual site model (CSM). The CSM will aid in understanding and addressing the dependencies by allowing a visual representation of release and transport mechanisms (e.g., sources and water flow) and exposure by environmental receptors. The CEMP is predicated on the understanding that people (i.e., humans) are part of the environment. The CEMP response framework will have due regard to linkages and dependencies, and the CSM.

The CSM will be reviewed for dependencies in the context of:

- The Objectives and Drivers and Scope for the CEMP, as described in this Terms of Reference.
- The basal understanding of sources, pathways, contaminants of potential concern (COPC), and receptors.
- An analysis of the linkages between program components, in a tabular format.
    - Linkages will include a rationalization of methods used across program components to make the methodology as consistent as possible.
- Current and planned activities at the Mount Polley Mine site, especially how those activities might impact on the CSM.

The following assumptions guide the continued development and implementation of the CEMP required under Section 3.2 of *EMA* Permit 11678:

- The CEMP is developed, reviewed and revised by Qualified Professionals (QPs), QPs being as defined by the Province of BC (e.g., R.P.Bio.).
    - MPMC notes that there are certain aspects of CEMP scoping (particularly in defining the objectives and drivers), where a QP is not necessary. For example, the reasonable study questions from members of the public are outside of the domain of expertise for a QP who would develop a CEMP; however, the scientific approach by which those questions would be answered are within the QP's domain of expertise.
- The CEMP will be based on information that is available, verifiable and can be relied upon by a QP.
- With the exception of regulatory requirements, a pattern of decrease or stasis in environmental condition is a suitable basis for gradual decrease in monitoring locations, frequencies, or parameters.

5 REVISION

The Mount Polley Mine is an operating site, changes to which are anticipated to transpire as development and closure activities co-occur; thus, an adaptive approach is both necessary and appropriate for documents such as the CEMP. Review of the CEMP content is an integral aspect of its effectiveness. In this application, 'effectiveness' means that the CEMP delivers on the regulatory drivers, some of which have rigid statutory obligations (e.g., MMER), satisfies the Objectives and Drivers for the CEMP, and undertakes that work with due regard to financial impact (without limiting the ability to meet the Objectives and Drivers established) and the adaptive nature of the CEMP.

To fulfill the adaptive approach, the CEMP will be reviewed and revised considering data collected in previous years (as interpreted by QPs). Such data will include that collected and interpreted directly under the CEMP, or as may be available from other assessments, studies or reports commissioned by MPMC as relating to the Objectives and Drivers for the CEMP. In the case of the latter, the CEMP will be modified, as appropriate, in consideration of the results and recommendations of such assessments, studies or reports. Based on collected data (and subsequent interpretation by QPs), the CEMP will include rationale for existing monitoring as well as any changes to the monitoring plan. It is anticipated that larger CEMP revisions in response to these activities will be made with consideration of maintaining continuity in spatial and temporal coverage to meet the Objectives and Drivers of the CEMP.

When possible, MPMC will provide written notice of planned changes to the CEMP to the MoE Director a minimum of 30 days prior to implementation to allow for review and feedback on the revision. Such written notice shall describe the planned changes as well as the rationale for the changes, including a summary of relevant data considered.

Under Section 3.2 of *EMA* Permit 11678, MPMC must submit a three-year detailed monitoring program interpretive report and updated CEMP to the MoE Director, for approval, by 31 March 2019, and every three years thereafter. Following the three-year detailed monitoring program interpretive report to the Director, MPMC will submit a summary of proposed changes to the CEMP to the MoE Director by April 30 of that year (one month following the interpretive report deadline).

A key component of the CEMP will be the monitoring program itself. The monitoring program will be designed, reviewed and revised by QPs such that, in their professional opinion, it satisfies the Objectives of the Drivers for the CEMP and allows MPMC to be informed of the adequacy of their source control efforts. Changes to the monitoring program that occur but are unplanned, such as the collection of additional samples, will be formally submitted with the MoE Director as soon as possible after the sampling occurs. Such written notice shall describe the planned changes as well as the rationale for the changes.

Notification of any CEMP or CEMP monitoring program changes must be provided to the MoE Director in writing for approval.

Notwithstanding the above, as per Section 3.2 of *EMA* Permit 11678, the MoE Director may require revisions to the CEMP or monitoring program based on review of monitoring data and/or any other relevant information.

6 CONSTRAINTS AND PROJECT RISKS

In the context of the CEMP and the content of this Terms of Reference, the following constraints and project risks have been identified by MPMC:

- The Mount Polley Mine, and by it, MPMC as owner and operator of the mine, is constrained to comply with applicable laws and statutory requirements.
- The health and safety of persons engaged in the monitoring work is a paramount consideration. Samples that cannot be obtained safely, using practical methods, will not be obtained. Certain seasonal conditions may preclude safe sampling.
- MPMC has voluntarily entered into (respective) PAs with the SCIB and the WLIB. MPMC will honour the respective PAs in full, and expects the SCIB and WLIB to reciprocate. Certain aspects of the CEMP pertain to subjects that fall within the bounds of the PAs.

7 ROLES AND RESPONSIBILITIES

In the context of the CEMP and the content of this Terms of Reference, the following roles and responsibilities are established:

- The MPMC Environmental Superintendent (or designate) will be responsible for implementing the CEMP, and revising it as appropriate.
    - Deliverables will be prepared by, or under the direct supervision of, QPs.
- Monitoring that is part of the CEMP will be coordinated by MPMC.
- All parties' reviewers of technical elements of the CEMP are required to be QPs if they are providing recommendations on the content or implementation of its subject matter.
- Participants involved in the design and review of the CEMP acknowledge that study designs, monitoring methods, and interpretation will be carried out in accordance with federal and provincial laws, policy and guidance.

Appendix B

Detailed Study Designs for CEMP Components

Appendix B - Addendum

Subsequent to the Issuance of the August 2018 CEMP, the following changes were made to study programs described in Appendix B:

Study	Change
Appendix B.1: Diffusive Gradient in Thin Film (DGT) sampling and toxicity testing with *Hyalella azteca*.	Sampling was conducted in 2019 and laboratory results are pending. When received, the data will be reviewed and recommendations for additional sampling, if any, will be presented to ENV in 2020.
Appendix B.2: Replication of tissue samples at Edney Creek location E1	Eight replicates of periphyton and benthic invertebrate tissues for chemistry were collected from E1 in 2019. The results are pending from the analytical laboratory.
Appendix B.4: Monitoring frequency	Monitoring frequencies applicable from 2018 to 2019, will be reviewed following data interpretation and modifications may be made in response to QP recommendations, subject to approval by the Director.
Appendix B.4: Spawning surveys	Visual spawning surveys (counts of adults and redds) were conducted in Upper Hazeltine Creek (2018) and lower Hazeltine/Edney Creek (2018 and 2019) per a monitoring plan developed in conjunction with the Habitat Remediation Working Group.

Appendix B.1

Sediment Monitoring

Minnow Environmental Inc.

Sediment Quality Monitoring Plan

Prepared for:

Mount Polley Mining Corporation
Likely, British Columbia

Prepared by:

Minnow Environmental Inc.
Georgetown, Ontario

June 2018

minnow environmental inc.
A Trinity Consultants Company

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Monitoring Objective 2

2 SUMMARY OF HISTORICAL FINDINGS 3
2.1 Polley Lake 3
2.2 Hazeltine Creek 4
2.3 Quesnel Lake 5

3 STUDY DESIGN OVERVIEW AND RATIONALE 7

4 METHODOLOGY 10
4.1 Quality Assurance / Quality Control 10
4.2 Sample Collection Methods 10
4.2.1 Lakes 10
4.2.2 Creeks 13
4.2.3 DGT Sampling 14
4.3 Sample Handling and Laboratory Analysis 15
4.4 Data Quality Review 16
4.5 Data Handling, Interpretation, and Reporting 17

5 REFERENCES 21

LIST OF TABLES **FOLLOWING PAGE**

Figure 1: Concentrations of Copper in Polley Lake and Reference Sediment, 2012 to 2016 4
Figure 2: Concentrations of Total Organic Carbon in Polley Lake and Reference Sediment, 2012 to 2016 4
Figure 3: Concentrations of Copper in Quesnel Lake Sediment, 2014 to 2016 5
Figure 4: Concentrations of Total Organic Carbon in Quesnel Lake Sediment, 2014 to 2016 5
Figure 5: Mount Polley CEMP Sediment Monitoring Locations, Lakes 7
Figure 6: Mount Polley CEMP Sediment Monitoring Locations, Creeks 7

LIST OF TABLES **FOLLOWING PAGE**

Table 1: History of Sediment Quality Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine 3
Table 2: Mount Polley CEMP Sediment Quality Monitoring Program Overview 7
Table 3: History of Sediment Quality Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine 15

1 INTRODUCTION

1.1 Background

Sediment is an important sink and potential source of metals, metalloids, and nutrients[1] in aquatic environments (e.g., Horowitz 1991; Ingersoll et al. 1997; Simpson and Batley 2016). Sediment quality of receiving environments adjacent to mine sites can be influenced by the direct input of solids as well as by the introduction of dissolved constituents (e.g., metals) into water that subsequently associate with reactive materials on sediment surfaces (e.g., oxides, organic carbon) by surface complexation (Santschi et al. 1990; Stumm and Morgan 1996; Sposito 2004). Sediment also represents a pathway for the exposure of aquatic life to metals and other substances (e.g., nutrients, organic substances). Therefore, sediment quality is an important component of the CEMP.

The influence of the Mount Polley Mine on sediment quality can occur (or, at some locations, has occurred) by several key mechanisms: 1) general mine influence from physical impingement, dustfall, and/or uncontained surface or groundwater flows: 2) direct discharge of mine effluent to Hazeltine Creek (April to August 2014) and Quesnel Lake (December 2015 to present [via Hazeltine Creek from December 2015 to December 2017, and directly since January 2018]); 3) the TSF embankment breach on August 4, 2014; and 4) reclamation activities following the TSF embankment breach. Sediment quality in waterbodies adjacent to the Mount Polley Mine has been monitored since baseline investigations in 1989, 1995, and 1996 (Imperial Metals 1990; HKP 1996, 1997). Results of sediment quality monitoring are reviewed in Section 2 and provide context for a CEMP sediment quality monitoring program that is guided by a combination of historical findings, representative locations downstream of Mount Polley Mine operations, representative reference locations, and considerations for a statistically-based design that will facilitate the detection of spatial and temporal differences in addition to providing data to evaluate concentrations relative to effects-based guidelines (e.g., British Columbia Working Sediment Quality Guidelines [BCWSQG]; BCMOE 2017). In addition to sediment quality monitoring required as part of the Mount Polley CEMP, sediment quality monitoring is required to support benthic invertebrate community monitoring conducted as part of Environmental Effect Monitoring (EEM) under the Metal Mining Effluent Regulations (MDMER) of the federal *Fisheries Act*.

The following sections of the CEMP Sediment Quality Monitoring Plan provide the objectives of sediment quality monitoring, a summary of historical sediment quality findings, an overview of the CEMP study design and associated rationale (including sampling locations, replication,

[1] Through the remainder of this section, the term “metals” will be used to include metals, metalloids, and nutrients for ease of communication

frequency, and analytes), and detailed methodology for sediment quality monitoring (quality assurance/quality control [QA/QC], sample collection methods, sample handling and laboratory analysis, data quality review, data handling, interpretation, and reporting).

1.2 Monitoring Objective

The objective of sediment quality monitoring is to evaluate the influence of Mount Polley Mine activities on receiving environments (Hazeltine Creek, Polley Lake, and Quesnel Lake) in comparison to baseline and/or reference conditions, and to determine potential implications to aquatic life by applying a variety of interpretive tools (e.g., Working Sediment Quality Guidelines [BCMOE 2017], biological assessment). Sediment quality monitoring also provides supporting information for benthic invertebrate community monitoring, and to support exposure assessment as part of ecological risk assessment (ERA) and human health risk assessment (HHRA). An additional objective is to advance the technical understanding of the stability or mobility and the potential bioavailability of metals in lake sediments affected by the TSF embankment breach.

2 SUMMARY OF HISTORICAL FINDINGS

Sediment has been monitored in the vicinity of the Mount Polley Mine since 1989, with most of the sediment quality samples collected in Polley Lake, Bootjack Lake, Hazeltine Creek, and Edney Creek (Table 1). Hazeltine Creek and Edney Creek are primarily comprised of erosional habitat, with few locations of sediment deposition. This has made sediment sampling challenging relative to lake environments, and some unconventional methodologies were applied in baseline studies.

Sediment quality sampling in the vicinity of the Mount Polley Mine has spanned four distinct time periods:

1. Baseline monitoring (1989, 1995, 1996);
2. Pre-breach operational monitoring (1999, 2009, 2012);
3. Post-breach operational monitoring (2014, 2015); and
4. Post-breach and post-discharge monitoring (2016).

Data collected prior to the breach were summarized in an Aquatic Environmental Description Report prepared concurrent with an application for water discharge to Polley Lake in 2014 (Minnow 2014), and general findings of the historical sampling, as well as sediment monitoring data collected from 2014 to present, are provided, by sampling area to support the design of the sediment quality monitoring plan.

2.1 Polley Lake

Baseline sediment quality of Polley Lake was characterized by concentrations of a number of metals that were naturally elevated above sediment quality guidelines, including arsenic, chromium, copper, iron, manganese, nickel, and selenium (Minnow 2014). Concentrations of copper, iron, and manganese were particularly elevated, with concentrations naturally exceeding upper sediment quality guidelines (also known as probable effect levels) in some samples (HKP 1996, 1997).

Sediment quality monitoring in Polley Lake during operations but before the TSF embankment breach in 2014 indicated that concentrations of most of the elevated analytes remained similar to baseline. One apparent exception was selenium, which increased from 1.7 – 2.6 mg/kg dry weight (dw) in baseline to 2.5 – 3.7 mg/kg dw in 2009, and 5.0 to 6.9 mg/kg dw in 2012 (Minnow 2014). This increase was considered to be due to uncontrolled surface runoff from a north waste rock dump which reported to Polley Lake via North Dump Creek. This runoff contained elevated concentrations of selenium from 2006 until control in 2009 with the construction of the Long Ditch.

Table 1: History of Sediment Quality Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine

A) Lakes

Year	Locations	Report
1989	Polley Lake, Bootjack Lake	Imperial Metals 1990
1995	Polley Lake, Bootjack Lake	HKP 1996
1996	Polley Lake, Bootjack Lake	HKP 1996
1999	Polley Lake, Bootjack Lake	Beak 2000
2009	Polley Lake	Minnow 2011
2012	Polley Lake	Minnow 2013a
2014	Polley Lake, Bootjack Lake, Quesnel Lake	Minnow 2015a
2015	Polley Lake, Bootjack Lake, Quesnel Lake	Minnow 2015b
2016	Polley Lake, Bootjack Lake, Quesnel Lake	Minnow 2016

B) Creeks

Year	Locations	Report
1995	Upper Hazeltine, Lower Hazeltine, Edney	HKP 1996
1996	Upper Hazeltine, Lower Hazeltine, Edney	HKP 1997
1999	Upper Hazeltine, Lower Hazeltine, Edney	Beak 2000
2007	Upper Hazeltine, Lower Hazeltine	Minnow 2009
2009	Upper Hazeltine	Minnow 2011
2010	Upper Hazeltine, Lower Hazeltine	Minnow 2011
2011	Edney	Minnow 2012
2012	Upper Hazeltine, Lower Hazeltine, Edney	Minnow 2013a
2013	Upper Hazeltine	Minnow 2013b
2014	Upper Hazeltine, Lower Hazeltine	Minnow 2015a
2015	Sedimentation Pond	Minnow 2015b
2016	Sedimentation Pond	Minnow 2016

Following the TSF embankment breach, sediment quality monitoring in Polley Lake indicated that concentrations of arsenic, copper, and iron were elevated at one or more monitoring locations relative to guidelines and baseline concentrations (Minnow 2015a). Changes in sediment quality were greatest for copper, with concentrations increasing from a baseline range of 262 – 370 mg/kg dw to 630 – 722 mg/kg dw in September 2014 (Minnow 2015a). Due to very low organic content of the breach-derived materials, sediment organic carbon content was also lower following the breach (Minnow 2015a). Sediment quality monitoring completed in 2015 and 2016 indicated very similar sediment quality from 2014 to 2016 (Minnow 2015b; 2016a; Figures 1 and 2). Evaluation of sediment deposition rates have indicated relatively low rates of sediment deposition in Polley Lake (average 0.66 mm/yr; 15 years for the accumulation of 1 cm of sediment; Minnow 2018). Sediment toxicity testing completed in 2014 and in 2016 indicated no effects to survival or growth of *Chironomus dilutus* and *Hyalella azteca* in standard tests completed on sediments from the Polley Lake basins (the deepest locations of the lake, known as P1 and P2), but a moderate reduction in growth of *H. azteca* at mid-depth areas (Minnow 2015a; Minnow 2017a). The benthic invertebrate community of the two deep basins in Polley Lake showed consistent recovery from 2014 to 2016 to a condition similar to the reference area in terms of density and richness in 2016 (Minnow 2017b). Lastly, a variety of sediment quality investigations conducted to characterize the potential mobility and bioavailability of sediment-associated metals (humidity cell tests, shake flask tests, selective extractions, ratios of simultaneously extracted metals to acid volatile sulphides [SEM/AVS], porewater chemistry, and Diffusive Gradients in Thin Films [DGT] devices) have all supported low mobility and bioavailability of sediment-associated metals (e.g., SRK 2015a,b; Minnow 2015a, 2016c, 2016d, 2017c, 2017d)

2.2 Hazeltine Creek

Baseline sediment quality of Hazeltine Creek was characterized in 1995 and 1996 (HKP 1996, 1997), but the latter included suspected errors (i.e., sampling in 1996 yielded unusually high concentrations of some metals [e.g., up to 2.2% copper] that were not observed in 1995 and have not been observed since). Based on the sampling conducted in 1995 (HKP 1996) and consistency with sampling conducted in 1999 (Beak 2000), concentrations of arsenic, copper, iron, and manganese (although reported as much lower than in 1996) were naturally elevated above lower sediment quality guidelines (Minnow 2014).

Sediment quality monitoring in Hazeltine Creek during operations but before the TSF embankment breach in 2014 indicated that concentrations of most of the elevated analytes remained similar to baseline. One possible exception was selenium, which, despite some uncertainty associated with different sampling methods and locations, had concentrations that were slightly greater than the sediment quality guideline of 2 mg/kg dw (i.e., up to 3.14 mg/kg dw

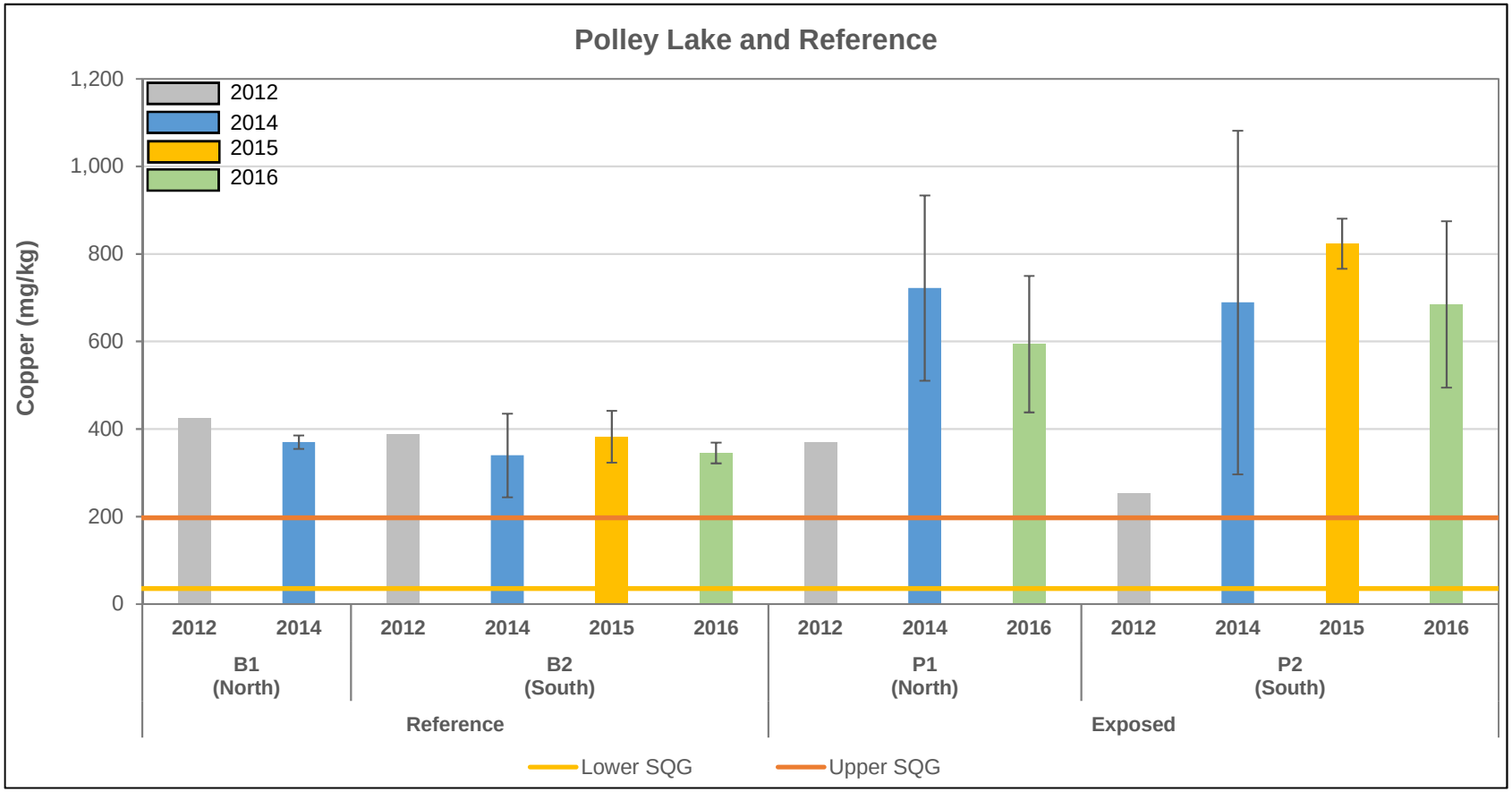


Figure 1: Concentrations of Copper in Polley Lake and Reference Sediment, 2012 to 2016

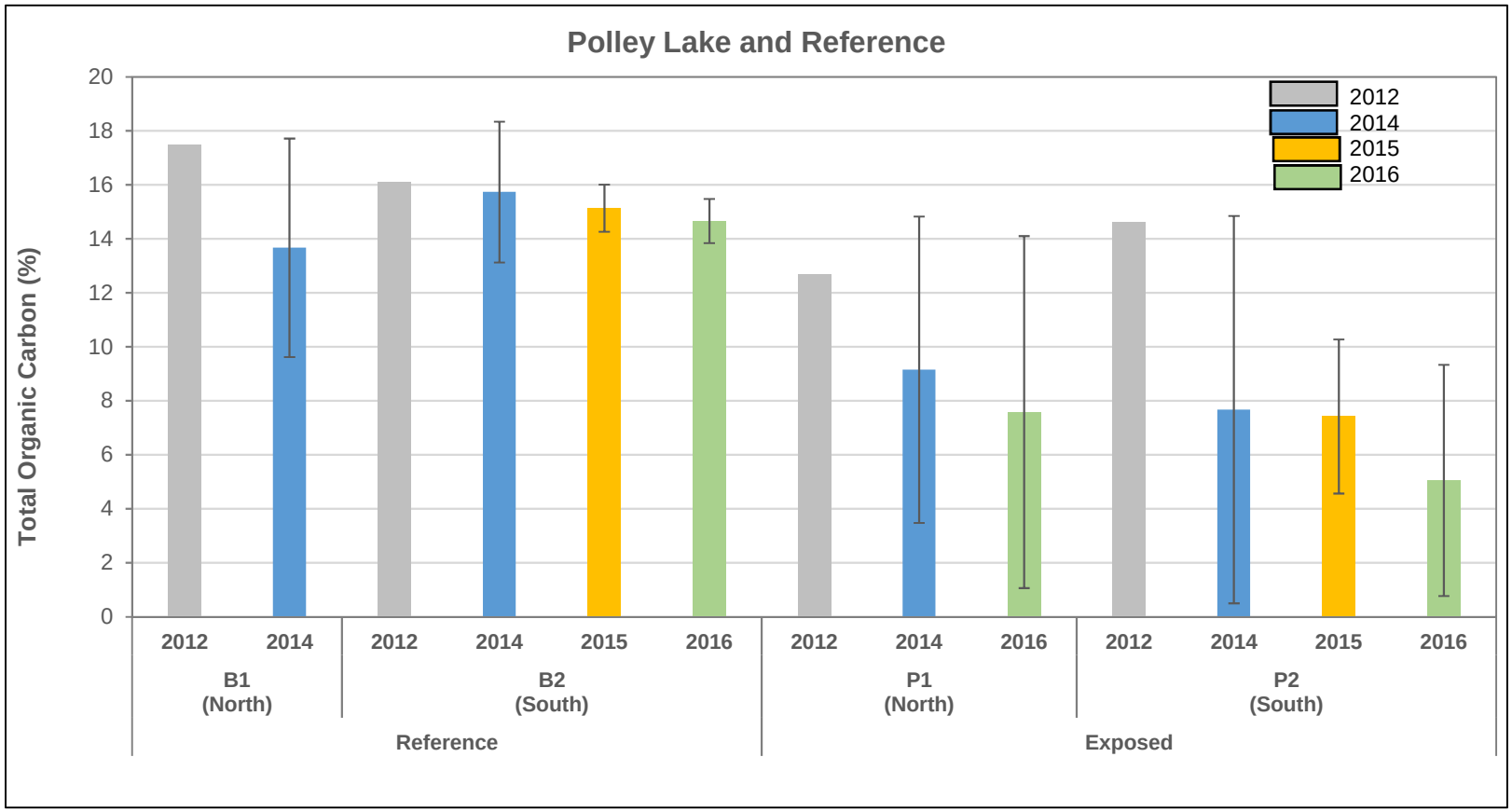


Figure 2: Concentrations of Total Organic Carbon in Polley Lake and Reference Sediment, 2012 to 2016

in a beaver pond in the fall of 2013; Minnow 2014). It is uncertain whether this difference was associated with the uncontrolled surface runoff that occurred from 2006 to 2009 (as described in Section 2.1) or if it was associated with the exclusive availability of fine sediment (that would naturally be expected to have higher metal concentrations) at a beaver pond sampled in 2013.

Following the TSF embankment breach, sediment quality monitoring was conducted in Hazeltine Creek in 2014. This sampling was prior to substantial rehabilitation from 2015 to 2017 and represented breach-material, believed to be mostly tailings. Accordingly, these "sediments" had very low organic carbon content, concentrations of copper and iron greater than upper sediment quality guidelines, and concentrations of arsenic and nickel greater than lower sediment quality guidelines (Minnow 2015a). Sediment quality monitoring of the Hazeltine Creek upper sedimentation pond completed in 2015 and 2016 indicated that concentrations of arsenic and nickel occurred at concentrations greater than reference and lower sediment quality guidelines, and concentrations of copper and iron occurred at concentrations greater than reference and upper sediment quality guidelines (Minnow 2015b; 2016).

2.3 Quesnel Lake

Sediment quality data for Quesnel Lake collected prior to the TSF embankment breach are limited to a few samples collected in the north arm near the mouth of the Mitchell River in 2012. These data documented a mean selenium concentration of 0.37 mg/kg dw (Minnow 2015a).

Following the TSF embankment breach, sediment quality monitoring in Quesnel Lake was completed at impacted areas and reference areas. A total of 121 sediment samples were collected from deep habitat of Quesnel Lake and 60 sediment samples were collected from shallow habitat of Quesnel Lake between 2014 and 2016 to characterize sediment quality (Minnow 2015a, 2015b, 2016). These sediment quality investigations indicated that the majority of breach-derived material was deposited to deep habitat. As with other habitats (i.e., Polley Lake and Hazeltine Creek), the chemical influence of the breach was most evident in copper concentrations greater than reference and upper sediment quality guidelines in impacted areas. Arsenic, iron, and manganese were elevated to concentrations greater than lower sediment quality guidelines, but concentrations of these metals were not elevated relative to reference or far-field concentrations. The influence of the breach was also evident in very low organic carbon content in impacted areas relative to reference. Sediment quality monitoring completed in 2015 and 2016 indicated very similar sediment quality from 2014 to 2016 (Figures 3 and 4; Minnow 2015b; 2016b), although the repositioning of two stations in area PNF in 2016 resulted in higher mean concentrations and lower variability. Some sediment consolidation (i.e., compaction) appears to be occurring in Quesnel Lake. Temporal change is expected to be primarily associated with deposition (i.e., covering of impacted sediment with non-impacted

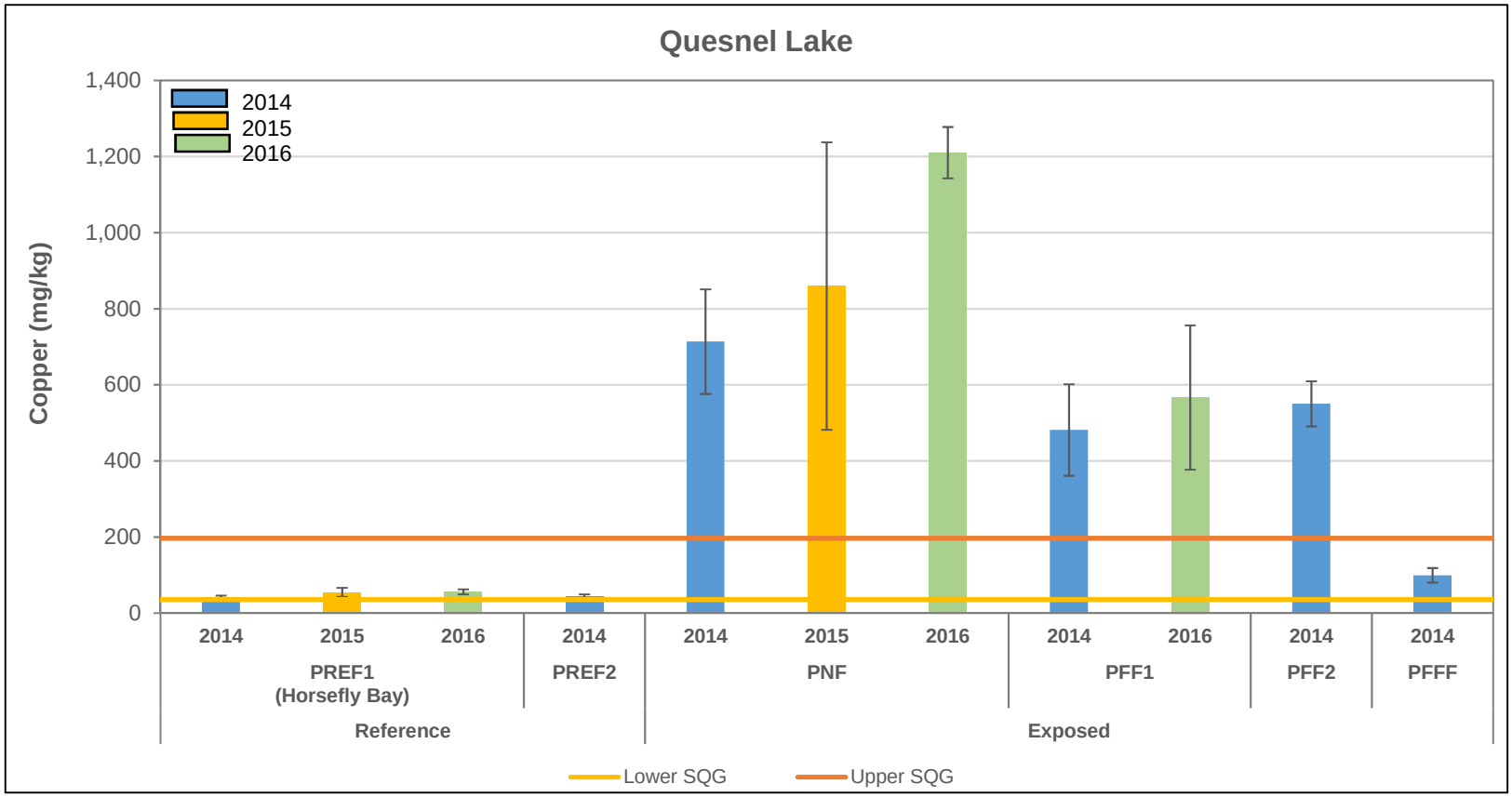


Figure 3: Concentrations of Copper in Quesnel Lake Sediment, 2014 to 2016

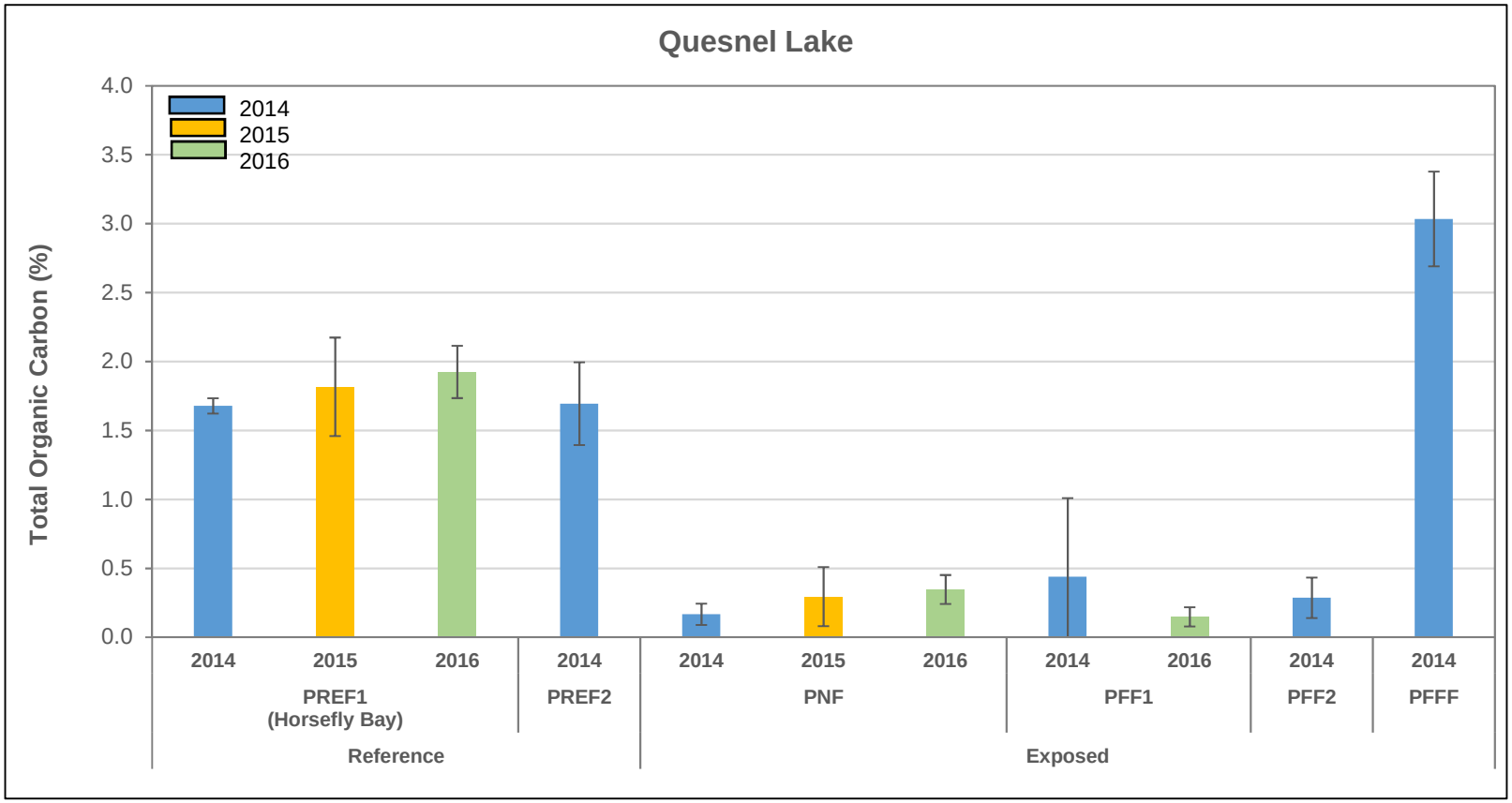


Figure 4: Concentrations of Total Organic Carbon in Quesnel Lake Sediment, 2014 to 2016

sediment), and evaluation of sediment deposition rates have indicated relatively low rates of sediment deposition in Quesnel Lake (range 1.4 to 1.7 mm/yr; 6 to 7 years for the accumulation of 1 cm of sediment; Minnow 2018).

Sediment toxicity testing completed in 2014, 2015, and 2016 indicated no responses to *C. dilutus* survival, but clear reductions in growth (Minnow 2017a). Clear responses to *H. azteca* survival and growth were observed, but *H. azteca* has low site-relevance as it is not present in deep areas of local lakes. Evaluation of relationships between observed responses and sediment quality indicated that combinations of high copper concentrations and low sediment organic carbon content were the best determinants of the observed responses (Minnow 2017a). Despite the observed responses in sediment toxicity tests, benthic invertebrate community monitoring, which is considered to be a measure of greater ecological relevance than toxicity testing (due to the fact that it evaluates in-situ habitat use by site organisms), indicated consistent recovery of organism density and taxon richness from 2014 through 2016. Although these endpoints remain lower than reference and the exposed area communities are not identical to reference, the observed increases are indicative of continued recolonization of these impacted areas. Lastly, a variety of sediment quality investigations conducted to characterize the potential mobility and bioavailability of sediment associated metals (humidity cell tests, shake flask tests, selective extractions, ratios of simultaneously extracted metals to acid volatile sulphides [SEM/AVS], porewater chemistry, and DGT devices) have supported low mobility and bioavailability of sediment-associated metals (e.g., SRK 2015a,b; Minnow 2015a, 2016c, 2017c).

3 STUDY DESIGN OVERVIEW AND RATIONALE

Sediment quality monitoring under the CEMP is designed to meet the combined needs of: 1) operational monitoring (including the discharge of treated effluent to Quesnel Lake); 2) monitoring of the impact of the 2014 TSF embankment breach; and 3) monitoring of the response to reclamation activity following the TSF embankment breach. An overview of the proposed sediment quality monitoring program is provided in Table 2 and Figures 5 and 6. Sediment quality monitoring is focused on Polley Lake, Hazeltine Creek, and Quesnel Lake, with reference areas identified for each mine-influenced sampling area (i.e., Bootjack Lake [and Jacobie Lake in 2018] for Polley Lake, unaffected areas of Quesnel Lake for impacted areas of Quesnel Lake). In Polley Lake, sediment sampling will focus on the two basins (deepest locations in Polley Lake, representing locations of sediment accumulation/fate), with the deepest location in Bootjack Lake (and Jacobie Lake in 2018) serving as reference. In Quesnel Lake, sediment quality monitoring for MDMER EEM will focus on the area near the point of effluent discharge (per Minnow 2016b) with two reference areas serving as reference (one unaffected by the breach and one affected by the breach but outside of the influence of effluent discharge). Additional sediment sampling in Quesnel Lake will focus on the deep areas that were previously monitored as near-field areas, with concurrent sampling of suitable reference areas. Hazeltine Creek is an erosional creek, and sediment sampling will be opportunistic, focussed on the collection of fines deposited on the declining hydrograph. All sediment quality monitoring includes sediment physical condition and sediment chemistry at all proposed sampling locations, as well as supporting sediment toxicity testing at a subset of areas (Table 2). Data interpretation will be based on a combination of: 1) statistical comparison to previous conditions; 2) statistical comparison to reference conditions; and 3) concentrations relative to sediment quality guidelines for the protection of aquatic life (BCMOE). Accordingly, five stations per area are proposed for each to provide replication for the statistical contrasts.

Sediment quality monitoring will include physical and chemical characterization of deposited sediments, including particle size distribution, organic matter content, nutrients, and metals (see Section 4.2 below for greater detail). In accordance with BCMOE (2016) and in consideration that lake samples analyzed at the <63 µm fraction and <2.0 mm fraction yielded similar results (Minnow 2015a), sediment organic matter content, nutrients, and metals will be determined in the <63 µm fraction (silt and clay). Sediment toxicity testing (at Polley Lake, Quesnel Lake deep habitat, and associated references) will focus on larvae of the non-biting midge *Chironomus dilutus*. This organism is an ideal test organism for these sediments due to the ubiquitous presence of Chironomidae in these areas (Minnow 2015a) and the in-benthic habit of these organisms (in contrast to the epi-benthic habitat of other test organisms such as the amphipod

Table 2: Mount Polley CEMP Sediment Quality Monitoring Program Overview

A) Lakes

Water Body	Sampling Area	Type	Components [1]	Replication [2]	Rationale
Polley Lake	POL - P1 (Northwest Basin)	Exposed	C, T	5	immediately adjacent to mine and breach-influenced
	POL - P2 (Southeast Basin)	Exposed	C, T, D	5	immediately adjacent to mine and breach-influenced
Bootjack Lake	BOL - B2 (Southeast Basin)	Reference	C, T, D	5	reference for Polley Lake [3]
Quesnel Lake	QUL - EEMEXP	Exposed	C	5	adjacent to effluent discharge and breach-influenced
	QUL - EEMREF1	Reference	C	5	reference for EEMNF - breach-influenced reference
	QUL - EEMREF2	Reference	C	5	reference for EEMNF - non-breach-influenced reference
	QUL - PNF	Exposed	C, T, D	5	breach-influenced deep habitat
	QUL - PFF1	Exposed	C	5	breach influenced deep habitat
	QUL - PREF1	Reference	C, T, D	5	reference for exposed deep habitat areas of Quesnel Lake

[1] sediment monitoring components: C = chemistry (see Table 3 for analytes), T = toxicity (10-day test of *Chironomus dilutus*), and D = Diffusive Gradients in Thin Films

[2] number of replicate stations within the specified sampling area

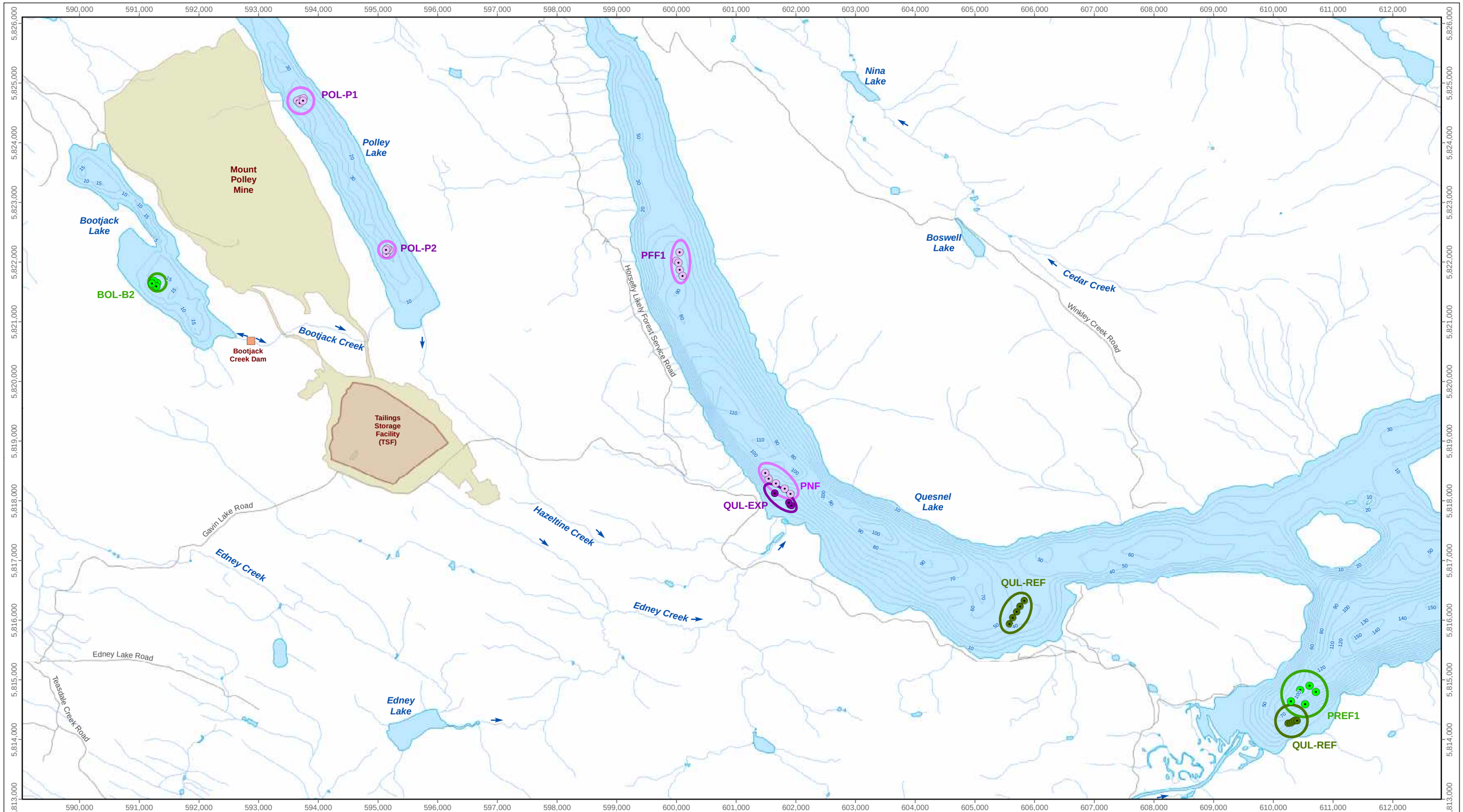
[3] Bootjack Lake is retained as the reference for Polley Lake due to the fact that it has not been notably affected by the mine, there is a long-term dataset available for it, and its watershed includes similar geology to Polley lake. The latter is not true for other potential reference areas.

B) Creeks

Water Body	Sampling Area	Type	Components [1]	Replication [2]	Rationale
Hazeltine Creek	HAC - U	Exposed	C	5	immediately adjacent to mine and breach-influenced
	HAC - D	Exposed	C	5	immediately adjacent to mine and breach-influenced
Edney Creek	EDC - U	Reference	C	5	reference for HAC - U
	EDC - D	Reference	C	5	reference for HAC - D

[1] sediment monitoring components: C = chemistry (see Table 3 for analytes), T = toxicity (10-day test of *Chironomus dilutus*), and D = Diffusive Gradients in Thin Films

[2] number of replicate stations within the specified sampling area



Sediment Quality Monitoring Station

- Reference Deep
- Exposed Deep
- Reference EEM
- Exposed EEM

Sediment Quality Monitoring Area

- Reference Deep
- Exposed Deep
- Reference EEM
- Exposed EEM

Please note: Quesnel Lake bathymetry lines are an approximate representation only and may not precisely delineate accurate depths at larger scales.

0 1 2 4 km

N W E S

Projection: North American Datum 1983 UTM Zone 10U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

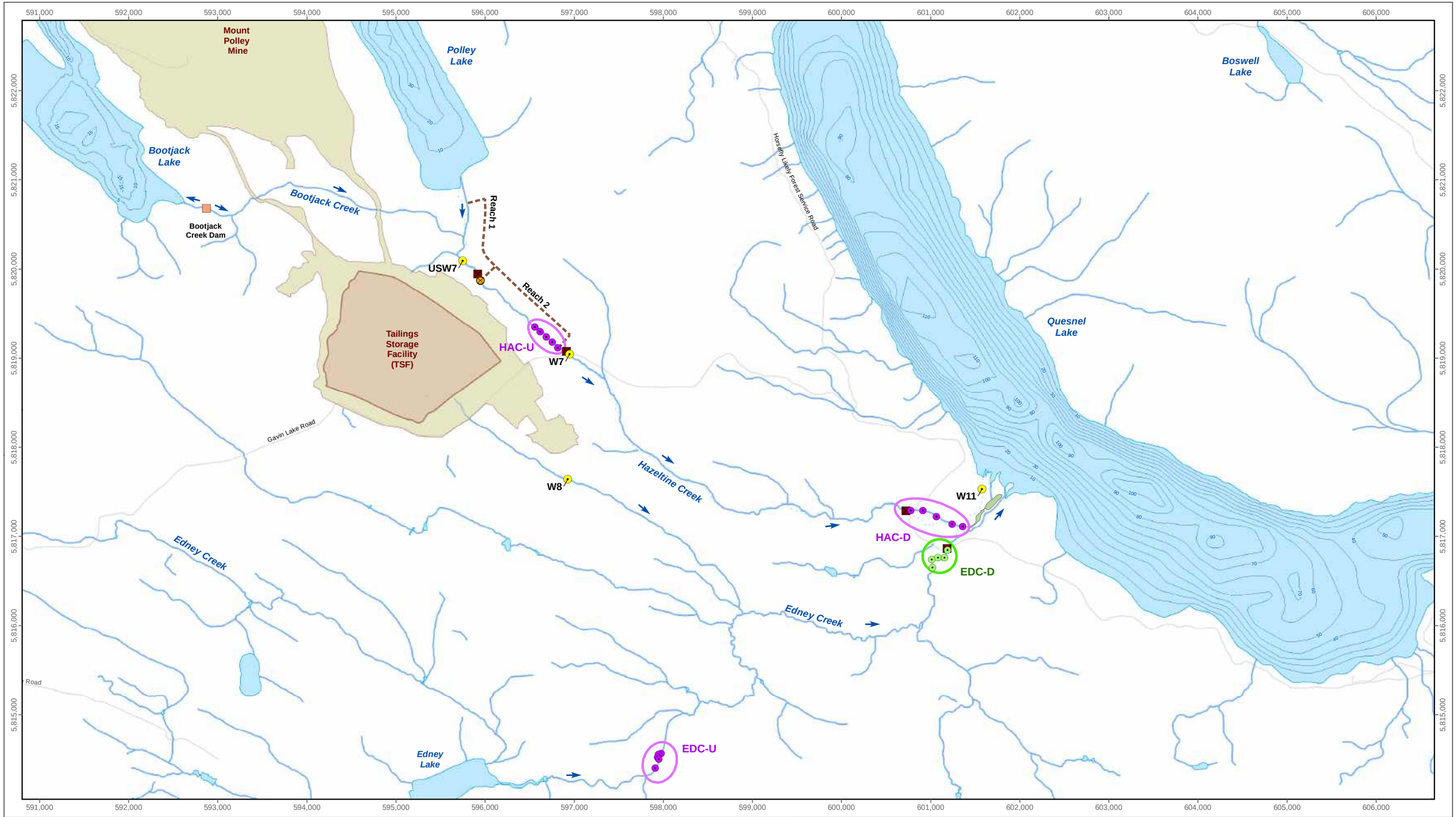
Mount Polley CEMP Sediment Monitoring Locations, Lakes

Date: June 2018
Project 177202.0042

minnow environmental inc

Figure 5

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\3-Sediment\17-42 Fig 5 CEMP Sediment.mxd



Sampling Locations

- Rehabilitated
- Reference
- Pre-Breach
- Routine Water Quality Station
- Effluent Discharge from 2014 to 2017
- Rehabilited Reaches (Golder 2017a,b)
- Tailings Storage Facility
- Active Mine Operation
- Bootjack Lake Bathymetry (5 m Intervals)
- Quesnel Lake Bathymetry (10 m Intervals)
- Polley Lake Bathymetry (10 m Intervals)
- Historic Watercourse

Note: Sampling Location in 2018 does not need to be exactly in the location identified on the map.

0 0.5 1 2 km

N W E S

Projection: North American Datum 1983 UTM Zone 10U

Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Mount Polley CEMP Sediment Monitoring Locations, Creeks

Date June 2018
Project 177202.0042

minnow environmental inc.

Figure 6

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\3-Sediment\17-42 Fig 6 CEMP Sediment Monitoring Locations, Creeks.mxd

Hyalella; Wang et al. 2004). Lastly, DGT devices will be deployed above the sediment water interface in areas most impacted by the TSF embankment breach (Polley Lake and Quesnel Lake deep areas) to provide annual feedback on whether there has been any change in the concentrations and/or proportion of labile metals above the sediment water interface (which would be suggestive of the potential instability or the temporal stability of sediment-associated metals).

Sediment quality and toxicity sampling will be supported by measurements of temperature, dissolved oxygen, pH, and specific conductance near the sediment-water interface at all sampling stations. Additional information to be collected includes GPS coordinates of each station and supporting photographs of the sampling location and samples. Some additional monitoring of the stability and potential bioavailability of metals associated with sediments impacted by the TSF embankment breach will be undertaken (e.g., deployment of Diffusive Gradients in Thin Films [DGT] devices to monitoring labile metal concentrations), as recommended by a QP and approved by ENV.

Sediment sampling will be completed in August or September consistent with previous data collections (HKP 1996, 1997; Beak 2000; Minnow 2015a,b; 2016). The frequency of sediment quality monitoring at the federal EEM sampling areas (where sediment is collected to support a benthic invertebrate community survey to evaluate potential effects of effluent discharge) is initially at a prescribed frequency of every three years, subject to modification based on the findings of at least two EEM phases (Environment Canada 2012). The frequency of sediment sampling at the lake areas is also guided by the results of sediment quality monitoring undertaken from 2014 to 2017. Evaluation of sediment deposition rates have indicated relatively low rates of sediment deposition in Polley Lake (average 0.66 mm/yr; 15 years for the accumulation of 1 cm of sediment) and Quesnel Lake (range 1.4 to 1.7 mm/yr; 6 to 7 years for the accumulation of 1 cm of sediment; Minnow 2018). This is consistent with limited change in sediment quality of these lakes which were sampled annually from 2014 to 2016 (e.g., Figures 1 to 4; Minnow 2016). Therefore, sediment sampling in lakes will be completed in 2018 and then every three years concurrent with EEM (2018, 2021, etc.). It is anticipated that a three-year frequency will be sufficient to track recovery associated with the deposition of approximately 2.0 mm of new sediment in Polley Lake and approximately 4.7 cm of new sediment in Quesnel Lake over the three-year period. As sediment samples are composed of the top 3 cm (30 mm) of deposited sediment (to represent exposure to benthic organisms and consistent with technical guidance; BCMOE 2016), this is equivalent to approximately 6.6% and 16% of the sample volume being comprised of new material. Water quality above the sediment water interface will be monitored in 2018-2020, including the deployment of Diffusive Gradients in Thin Films (DGTs). If monitoring of labile metal concentrations using DGT devices indicate increases above the sediment-water

interface, design modification (e.g., changes to monitoring frequency or locations) will be made in response to QP recommendations in future interpretive reports.

The initial frequency of sediment quality monitoring at the creek areas (Hazeltine and Edney Creeks) is annual. This is because post-breach / post-rehabilitation conditions have not been established. Frequency should be reviewed following interpretation of the data collected in 2020, with particular consideration of whether sediment, which is quantitatively rare in these erosional creeks, provides value as an independent monitor given the intensive monitoring of water, periphyton, and benthic invertebrates.

Sediments will be sampled, processed, analyzed, and associated data interpreted using methodology consistent with previous assessment at Mount Polley (e.g., Minnow 2015a,b; 2016), which is also consistent with technical guidance (e.g., Environment Canada 2012; BCMOE 2013, 2016). Detailed methodology is provided in Section 4, including: quality assurance/quality control, sample collection methods, sample handling and laboratory analysis, data quality review, data handling, interpretation, and reporting.

4 METHODOLOGY

4.1 Quality Assurance / Quality Control

All sampling will be performed by qualified field staff experienced in the implementation of sediment quality monitoring programs. Quality assurance and quality control measures will be consistent with requirements outlined in the BC Field Sampling Manual (BCMOE 2013), and will include program review prior to implementation, adequate resources for all field teams including field checklists and field data sheets, the availability and maintenance of clean sampling equipment and sampling containers, and sampling in a manner that minimizes any risk of sample contamination.

Quality control (QC) samples will be collected to support the sediment quality monitoring program. Five replicate samples (samples from 5 separate stations to represent the sampling area) will be collected from each sampling area in order to capture within-area variability. Specific field QC samples will include duplicates (i.e., splits) collected at a frequency of 10% of the total number of samples to assess field precision as part of the Data Quality Review (DQR; Section 4.4). Duplicate water samples will be collected at a frequency of 10% to assess field precision associated with the water samples that support DGT monitoring. In addition to field QA/QC, any laboratory conducting the physical or chemical analyses will be accredited by the Canadian Association for Laboratory Accreditation (CALA) for these analyses. Specific QC sampling and associated reporting will be requested of the analytical laboratory, including reagent blank results, laboratory replicate results, and laboratory accuracy results (i.e., matrix spikes, laboratory control samples, and/or certified reference materials). These results will be assessed as part of the DQR (Section 4.4).

All raw field data will be transcribed from field sheets into an electronic spreadsheet. Data will then checked by a separate individual for data entry errors as part of routine Quality Assurance/Quality Control (QA/QC) procedures.

4.2 Sample Collection Methods

4.2.1 Lakes

Sampling of lake sediments will be consistent with previous monitoring (Minnow 2015a,b; 2016a). In Polley Lake (and the associated reference – Bootjack Lake [and Jacobie Lake in 2018]), sediments will be collected at five replicate stations per area, with sediments for the analysis of total organic carbon, total sulphur, total nitrogen, and metals collected using a Kajak-Brinkhurst corer or a Tech Ops corer in accordance with technical guidance for gravity coring outlined in the BC Field Sampling Manual (BCMOE 2013) and the Metal Mining Technical Guidance for EEM

(Environment Canada 2012). Sediment samples for particle size distribution will be collected using a Petite Ponar grab sampler. Briefly, the KB corer is a gravity corer that collects samples in 2" (5.08 cm) diameter core tubes. Core collection relies on a combination of surface tension within the core and suction supplied by a plunger that seals the top of the core tube after being deployed by a messenger. The Tech Ops corer is a gravity corer that collects samples in 4" (10.16 cm) diameter core tubes. Core collection relies on a combination of surface tension within the core and suction supplied by an automatic seal (plunger assembly) that shuts in response to sampler retrieval (upward pull). Success rates for each of the core devices tend to vary with sampling location in accordance with sediment characteristics and both devices may be used in the program.

Collection of sediment by coring requires careful application and experience to obtain good quality sediment samples (i.e., sediment samples that capture an undisturbed sediment-water interface). During coring, care will be taken to control the rate at which the coring device is lowered, to maintain the corer in a vertical position during descent, and to allow the corer to penetrate the sediment with minimal sediment disturbance. The corer will then be carefully retrieved to surface. At surface, an extruder head-piece will be inserted into the bottom of the core tube to prevent sediment slippage. Core samples will be rejected if there was evidence of slippage, that the core did not penetrate the substrate vertically, or that the sediment-water interface was disturbed within the core. Accepted samples will then be processed by removing the core tube from the corer and using the extruder to push the sediment upwards towards the top of the core tube in a controlled fashion with care taken to minimize suspension of fines. In the event of suspension, momentum will be stopped, allowing the suspended solids to re-settle. Once the sediment is extruded to near the top of the tube, an extrusion collar marked in 1-cm intervals will be carefully aligned on the top of the tube and the sediment will be extruded upwards into the extrusion collar to the 3-cm mark. A core slicer will then be carefully inserted between the tube and the collar to collect the top 3-cm of sediment, which will then be transferred into a 250 mL glass sampling jar labeled with the project number, sample location, and collection date. The procedure will then be repeated twice more (at minimum) in order to provide a composite sample of sufficient volume for the required analyses. All sampling equipment will be rinsed between stations using site water. As indicated above, duplicate (split) sediment samples will be collected at a target frequency of 10% for quality assurance/quality control (QA/QC) purposes (associated composite samples will be composed of twice the number of grabs to support the split samples). In addition, supporting information will be collected at each sampling site as outlined below. Immediately after collection, sediment samples will be placed into a cooler with ice packs, where they will be maintained cool prior to transport to the field laboratory where they will then be transferred to a refrigerator and held until shipment to the analytical laboratory.

Sediment samples for particle size analysis in Polley Lake, Bootjack Lake, and Jacobie Lake will be collected using a stainless steel Petite Ponar grab sampler in accordance with technical guidance outlined in the BC Field Sampling Manual (BCMOE 2013) and the Metal Mining Technical Guidance for EEM (Environment Canada 2012). Briefly, the Petite Ponar is a 6" x 6" (15.24 cm x 15.24 cm) grab sampler with jaws that can be held open by shear-pressure on a spring-loaded pin. The grab sampler is lowered to the substrate at which point shear-pressure is eliminated and the pin springs out. Upon upward pull at the initiation of retrieval, the jaws of the ponar close to grab surficial sediment. As with coring, care must be taken to control the rate at which the ponar is lowered to allow appropriate sediment penetration and to minimize sediment disturbance. The ponar will then be carefully retrieved to surface and each grab will be placed into a plastic tote and observed for completeness and any unusual characteristics. If the sample is deemed acceptable (i.e., the sampler is full to each end and is representative of surface sediment), surficial material to a depth of 3 cm will be transferred to a second tote using a stainless steel spoon, and the remaining sediment discarded. At each station, composite samples of the top 3 cm of surficial sediment of three acceptable grabs will be collected. The sediment within the tote will then be homogenized using a stainless steel spoon and transferred into 250 mL glass sampling jars labeled with the project number, sample location, and collection date. Sampling equipment will be rinsed between stations using site water.

Sediment samples for toxicity testing of *Chironomus dilutus* will also be collected using a Petite Ponar grab sampler. The same methodology as above will be applied, with the exception that, at stations that require both sediment chemistry and toxicity testing, a composite sample will be composed of a minimum of five grabs and will be placed into a 250 mL glass sampling jar for chemical analysis (as above) and another 500 mL jar for toxicity testing. As noted above, all jars will be labelled with the project number, sample location, and collection date.

In Quesnel Lake, all sediment samples (for total organic carbon, total sulphur, total nitrogen, and metals) will be collected using a stainless steel Petite Ponar (15.24 cm x 15.24 cm; 0.023 m^2 sampling area) or a stainless steel standard ponar (22.86 cm x 22.86 cm; 0.052 m^2 sampling area) in accordance with federal and provincial technical guidance (Environment Canada 2012; BCMOE 2013). Attempts to collect sediment from Quesnel Lake by gravity coring have yielded poor success rates due to the substantial depth of sampling (approximately 100 meters) and the non-cohesive nature of the sediment. Samples will be retrieved with the assistance of a coMDMERcial line hauler (Ace Line Hauler - Brutus Plus 40) using methodology consistent with that described above for collection of the Polley Lake (and Bootjack Lake) sediment particle size samples. Composite samples of the top three centimeters of surficial sediment of a minimum of three acceptable grabs (i.e., full to each edge of the sampler) will be collected at stations where toxicity testing is not required, and composite samples of the top three centimeters of surficial

sediment of a minimum of five acceptable grabs (i.e., full to each edge of the sampler) will be collected at stations where toxicity testing is required (Table 2 and Figure 5). Sediment homogenization and transfer to sampling jars will be as described above. All sampling equipment will be rinsed between stations using site water. Duplicate (i.e., split) sediment samples will be collected at a target frequency of 10% for quality assurance/quality control (QA/QC) purposes (associated composite samples will be composed of twice the number of grabs to support the split samples). In addition, supporting information will be collected at each sampling station as outlined below. Immediately after collection, sediment samples will be placed into a cooler with ice packs, where they will be maintained cool prior to transport to the field laboratory where they will be placed in a refrigerator and held until shipment to the analytical laboratory.

Supporting information collected at each of the lake sediment monitoring stations will include GPS (Geographic Positioning System) coordinates, sampling depth, Secchi depth, field meter measurements of temperature, specific conductance, dissolved oxygen and pH, photographs of sediment samples, notes of the presence or absence of aquatic vegetation, and other physical observations (sediment texture, colour, density, etc.). In addition, one full vertical profile of the field meter measurements will collected at one station per area.

4.2.2 Creeks

Hazeltine Creek and the associated reference creek (Edney Creek) are predominantly erosional (HKP 1996, 1997; Minnow 2007) and there are few locations of true sediment deposition. The limited sediment within these creeks tends to wash through during spring freshet and deposit as a thin layer of fines in quiescent areas on the lowering hydrograph. Thus, collection of true sediment (i.e., fines in the silt and clay size category) cannot be completed by conventional grab sampling as applied in lakes (as described above) and typically applied in depositional creeks (i.e., due to the dominant presence of sand, gravel, and cobble). An alternative method will therefore be applied – sampling by spoon. This sampling will target the fine sediment fraction (i.e., silt and clay). Sampling will be undertaken in late suMDMER when low flows support some sediment deposition, even if only as a thin layer over sand, gravel, or cobble. As with lake sampling, sediments will be collected at five replicate stations per area. However, due to the non-uniform nature of sediment deposition in erosional creeks, the actual sampling stations will be determined opportunistically with each field sampling campaign and may vary slightly over time (i.e., a priority will be placed on the quality of the five replicate sediment samples collected within each area rather than the precise location of each sample within each area).

Sediment samples from creeks will be collected using a clean stainless steel spoon. All samples will be collected from wetted sampling stations that support the accumulation of fine materials (i.e., small pools or backwaters). Sampling locations will be approached by foot in a manner that

does not disturb sediment prior to sampling. At locations of sediment deposition, surficial sediment will be carefully collected by slowly placing the spoon on the sediment surface in a manner that minimizes disturbance. The spoon will then be inserted into the sediment to capture sediment to a depth of no greater than 3 cm and moved horizontally to fill the spoon. In reality, the collection depth may be much less than 3 cm, as fines often settle in a thin layer over coarser material (and sampling seeks to avoid coarse material as indicated above). The spoon will then be slowly retrieved to surface to avoid sample washout. The content of the spoon will then be inspected to ensure that it represents fine sediment (i.e., is predominantly silt and clay) and, if accepted, will be placed into a 250 mL glass sampling jar labeled with the project number, sample location and collection date. This procedure will be repeated a minimum of four more times to form a composite sample representative of the sampling station. Sampling equipment will be rinsed between stations using site water. Duplicate sediment samples will be collected at a target frequency of 10% for quality assurance/quality control (QA/QC) purposes (associated composite samples will be composed of twice the number of spoons to support the split samples). In addition, supporting information will be collected at each sampling site as outlined below. Immediately after collection, sediment samples will be placed into a cooler with ice packs, where they will be maintained cool prior to transport to the field laboratory where they will then be transferred to refrigerator and held until shipment to the analytical laboratory.

Supporting information collected at each of the creek sediment monitoring stations will include GPS (Geographic Positioning System) coordinates, average water depth at the sample locations, average sediment depth collected, field meter measurements of temperature, specific conductance, dissolved oxygen and pH, photographs of sediment samples, notes of the presence or absence of aquatic vegetation, and other physical observations (sediment texture, colour, density, etc.).

4.2.3 DGT Sampling

Diffusive Gradients in Thin Films (DGT) sampling devices (DGT model C-LSNX; DGT Research, Lancaster, UK) as described in Minnow (2017a) will be installed in the lower water column at one sediment sampling area in Polley Lake (POL-P2; with an area in Bootjack Lake [BOL-2] as reference) and at one sediment sampling area in Quesnel Lake (QUL-PNF; with an area in Quesnel Lake [QUL-PREF1] as reference; Table 2). Five replicate DGT devices will be placed in exposed areas and three replicates will be placed in reference areas. The purpose of the DGT device monitoring is to provide data on the concentrations of DGT-labile metals above of the sediment-water interface, and most importantly to monitor DGT-labile metals above the sediment-water interface to determine if those concentrations are changing over time. Low and unchanging concentrations of DGT-labile metals would be indicative of stability of metals and metalloids in

lake sediments affected by the TSF embankment breach. Conversely, increasing concentrations of DGT-labile metals would be indicative of instability of metals and metalloids in lake sediments.

The DGT devices will be installed in the lower water column approximately one meter above the sediment surface. This will be achieved by placing a line with anchor and float at each sample location. The DGT devices will be deployed with care (including not touching the DGT window) while wearing metal free disposable nitrile gloves and will be left in place for a total period of 35 to 50 days. Upon retrieval, DGT devices will be handled with care while wearing metal free disposable nitrile gloves. Upon retrieval, each DGT device will be gently rinsed with metal free water (provided by the laboratory) and placed into a labelled glass soil jar with a few drops of metal free water to prevent desiccation. Jars will then be placed into clean Ziploc™ bags and then into a dedicated cooler with ice packs, where they were maintained cool prior to transport.

Supporting information collected at each DGT deployment location will include GPS (Geographic Positioning System) coordinates, sampling depth, field meter measurements of temperature, specific conductance, dissolved oxygen and pH, site photographs (including photographs of the DGT devices), and notes on the presence or absence of any fouling of the DGT devices. Supporting water samples will also be collected from each sampling area, including samples for total and dissolved constituents (including metals), the latter prepared by field filtration using a 0.45 µm syringe filter. Water samples will be placed into a dedicated cooler with frozen ice packs, and kept cool prior to transport to the field laboratory.

4.3 Sample Handling and Laboratory Analysis

At the termination of the field program or at intervals of no more than seven days, sediment samples will be shipped in coolers with ice packs to the analytical laboratory and/or toxicity testing laboratory. Shipment transit time will be less than one day.

Chemical analyses will be completed at an analytical laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA) using methods that are consistent with those specified in the British Columbia Environmental Laboratory Manual (BCMOE 2015) and will include moisture content, pH, particle size distribution, total organic carbon (TOC), total nitrogen, total sulphur, and total metal concentrations (Table 3). All analyses except for particle size distribution will be completed on the silt/clay fraction (<63 µm diameter) in accordance with recent recommendations by BCMOE (2016) and because sediment quality characterization conducted in 2014 indicated similar results in <63 µm and <2 mm sediments (Minnow 2015a). Analysis of metals will be based on the BC Strong Acid Leachable Metals digestion (SALM; BCMOE 2016). Analyses of pH will be completed by electrode, particle size analysis will be completed by sieve and pipette, total organic carbon will be completed by combustion and titration (total carbon minus total inorganic carbon), total nitrogen and total sulphur will be completed by combustion, metals

Table 3: Analytes and Laboratory Reporting Limits for Mount Polley CEMP Sediment Quality Monitoring

Analyte	Units	Target LRLs	Concensus DLs [1]	British Columbia Sediment Quality Guidelines [2]	
				Lower	Upper
Physical Tests					
% Sand (2.0mm - 0.063mm)	%	0.1	1	-	-
% Silt (0.063mm - 4um)	%	0.1	1	-	-
% Clay (<4um)	%	0.1	1	-	-
Moisture	%	0.25	1		
pH (1:2 soil:water)	pH	0.1	-	-	-
Nitrogen and Carbon			-		
Total Nitrogen	%	0.02			
Total Organic Carbon	%	0.1	0.05	-	-
Sulphur					
Sulphur	%	200	200	-	-
Metals					
Aluminum	mg/kg	50	100	-	-
Antimony	mg/kg	0.1	0.1	-	-
Arsenic	mg/kg	0.05	0.2	5.9	17
Barium	mg/kg	0.5	1	-	-
Beryllium	mg/kg	0.1	0.1	-	-
Bismuth	mg/kg	0.1	0.1	-	-
Boron	mg/kg	10	5	-	-
Cadmium	mg/kg	0.05	0.05	0.6	3.5
Calcium	mg/kg	50	100	-	-
Chromium	mg/kg	0.5	1	37.3	90
Cobalt	mg/kg	0.1	0.3	-	-
Copper	mg/kg	0.5	0.5	35.7	197
Iron	mg/kg	50	100	21,200 [a]	43,776 [b]
Lead	mg/kg	0.1	0.1	35	91
Lithium	mg/kg	5	-	-	-
Magnesium	mg/kg	10	10	-	-
Manganese	mg/kg	0.2	0.2	460	1,100
Mercury	mg/kg	0.005	0.05	0.17	0.49
Molybdenum	mg/kg	0.1	0.1	-	-
Nickel	mg/kg	0.5	0.8	16	75
Phosphorus	mg/kg	50	10	-	-
Potassium	mg/kg	100	100	-	-
Selenium	mg/kg	0.1	0.1	2	-
Silver	mg/kg	0.05	0.1	0.5	-
Sodium	mg/kg	100	100	-	-
Strontium	mg/kg	0.1	0.1	-	-
Thallium	mg/kg	0.05	0.1	-	-
Tin	mg/kg	0.2	0.2	-	-
Titanium	mg/kg	1	1	-	-
Uranium	mg/kg	0.05	0.05	-	-
Vanadium	mg/kg	0.2	2	-	-
Zinc	mg/kg	1	2	123	315

[1] from Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BCMOE 2016)

[2] British Columbia Sediment Quality Guidelines; from British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (BCMOE 2017)

[a] approximately 2%

[b] approximately 4%

will be completed by collision reaction cell inductively coupled plasma – mass spectrometry (ICP-MS [USEPA Method 6020A; USEPA 1998]), and mercury will be completed by cold vapor atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (USEPA Method 245.7; USEPA 2005).

Toxicity testing will be completed at a testing laboratory accredited by CALA. Testing will be completed using a standard 10 day test of the survival and growth of *Chironomus dilutus* (a midge larva; Environment Canada 1997). In accordance with recent recommendations for toxicity testing, test replicates (n = 5) will be field-collected replicates. In addition to the exposed area field replicates and the reference area field replicates, a laboratory control (beach sand in accordance with the standard biological test methods) will also be included (also to be set up with five laboratory replicates).

At the termination of the DGT device collections or at intervals of no more than four days, DGT devices will be shipped in coolers with ice packs to the analytical laboratory. Laboratory analysis of the DGT devices will involve dismantling the devices followed by digestion of the resins to determine total metal concentrations in the resin by ICP-MS (USEPA Method 6020A; USEPA 1998). DGT-labile metal concentrations will subsequently be calculated by the analytical laboratory based on total metal in the resin, mean water temperature during deployment at each area, total deployment time, and manufacturer-supplied peer-reviewed diffusion coefficients, which, in turn, are based on Fick's first law of diffusion (Zhang and Davison 1995; Panther et al. 2014). Supporting water samples will be treated in a manner identical to the routine water quality samples collected as part of the CEMP (Section 6.6).

Each of the laboratories will provide a sample receipt confirmation when the samples are received and logged. These receipts will be reviewed to ensure that all samples are received and that the analytical requests are properly logged. Upon completion of the analyses, each laboratory will provide a data report in Microsoft (MS) Excel™ and as an Adobe Acrobat Portable Document Format (PDF). Reporting will include the results of the laboratory QC sample results.

4.4 Data Quality Review

Upon receipt of sediment quality data and supporting water quality data from the analytical laboratory, a Data Quality Review (DQR) will be performed. The DQR will confirm that all requested analyses are complete, and that acceptable LRLs have been achieved. The DQR will also include an evaluation of differences between duplicate samples, as well as the QA/QC data reported by the laboratory. Completion of the DQR promptly following receipt of the sediment quality data will ensure timely communication with the laboratory should any issues be identified.

Comparisons between duplicate samples will be made by calculating the relative percent difference (RPD) between concentrations between paired duplicates. If the RPD is <40% for concentrations that are >5 times the LRL, then the duplicate sample results will be considered acceptable. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective LRLs, and the results will be used to identify potential contamination associated with equipment (e.g., cleanliness) and sample collection and handling procedures (e.g., collection, shipping).

4.5 Data Handling, Interpretation, and Reporting

Upon receipt of data from the analytical laboratories, all laboratory data files will be managed by the Mount Polley Mining Corporation (MPMC) Environment Department. In addition, data provided by the primary analytical laboratories as an Electronic Data Deliverable (EDD) will be imported directly into the MPMC's database following completion of the DQR. Following the completion of the DQR, all sediment quality data and supporting data will be managed in Microsoft (MS) Excel™. For all replicated data (typically based on a sample size of five stations per area), data will be provided to the QP and summarized by calculating mean, median, standard deviation, standard error, minimum, maximum, 5th percentile, and 95th percentile for each analyte. Sediment quality data will then be evaluated in comparison to British Columbia Working Sediment Quality Guidelines for the protection of aquatic life (WSQGs; BCMOE 2017) and reference concentrations. Reference 95th percentile values will be used to screen exposed-area mean concentrations to efficiently identify analytes with concentrations that are beyond the range of reference. Analytes with concentrations greater than guidelines and reference will be the focus of more detailed interpretation, which may include, as required for data interpretation: graphical comparisons to reference and historical data, and formal statistical contrasts of exposed versus reference concentrations and/or over time.

WSQGs are numerical criteria that are protective of sediment-dwelling organisms based on long-term exposure. Most British Columbia WSQGs have been adopted from the CCME (CCME 1999) or from Ontario (OMOE 1993) and have two levels – a Lower WSQG (also known as a Threshold Effect Level [TEL] or a Lowest Effect Level [LEL]) and a Higher WSQG (also known as a Probable Effect Level [PEL] or a Severe Effect Level [SEL]). The Lower WSQG is intended to represent a concentration that will protect aquatic life from adverse effects of a toxic substance in most situations (BCMOE 2017). The Upper WSQG is intended to represent a concentration that, if exceeded, will likely cause severe effects on aquatic life (BCMOE 2017). However, WSQGs – even the Upper WSQGs - are often naturally exceeded in mineralized areas, as was the case for copper, iron, and manganese in Polley Lake (Section 2.1). In addition, SQGs were developed based on co-occurring bulk surficial sediment data and biological effect data (CCME 1995). Bulk

sediment chemistry can differ substantially from the <63 µm fraction, and this discrepancy between measurement (<63 µm fraction) and exposure (to bulk sediment to which SQGs are most applicable) should be considered in interpretation as "caution should be used in interpreting the biological significance of chemical concentrations in sediments for different types based on these guidelines" (CCME 1995).

Multivariate statistical tools may also be applied to assist with sediment quality data interpretation. Specifically, ordination techniques such as Principal Components Analysis (PCA), Correspondence Analysis (CA), or Nonmetric Multidimensional Scaling (NMDS) may be applied to assist in the identification of key spatial or temporal differences in sediment chemistry. Perhaps more importantly, these techniques will be used in the analysis of potential physical and/or chemical causes of differences in biological metrics (e.g., benthic invertebrate community condition) as a means of reducing data to focus on a small list of key components for correlation analysis (see Section 6.13 – Benthic Invertebrate Monitoring).

As indicated above, analytes with concentrations greater than guidelines and reference 95th percentile concentrations will be the focus of more detailed interpretation, which may include, as required for data interpretation: graphical comparisons to reference and historical data, and formal statistical contrasts of exposed versus reference concentrations and/or over time. This will include the following: graphical plots in relation to all guidelines, reference values, and historical values and examination of relationships to physical variables. Plots of the analytes of interest (those greater than SQG and reference) will be prepared in MSExcel. At a sample size of 5, plots will include of each replicate by area. Available guidelines (BCWSQG), reference concentrations, and background concentrations (as available) will be added to the plots as lines to facilitate comparison of concentrations to these benchmarks.

Relationships between the analytes of interest and physical features (i.e., particle size) and other chemical variables (total organic carbon content) will be evaluated using correlation analysis. Spearman correlation (often referred to a Spearman Rank-Order correlation) will be completed. Following the derivation of correlation coefficients, a Bonferroni-type correction (i.e., p-value [0.05] divided by the total number of correlations examined for independent variables) will be applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the Bonferroni-adjusted p-value or at a p-value of 0.01 will be further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were "leveraged" by outlying points (or groups of points).

Sediment toxicity test results (survival and growth of *C. dilutus*) will be interpreted based on a combination of effect size and statistical contrasts. Results associated with each exposed area will be contrasted against the matched reference area and against the laboratory control. Results will then be evaluated using a stepwise procedure similar to that of Southern California Coastal Water Research Project (SCCWRP) California Sediment Quality Objectives (CASQO; Bay et al. 2014):

1. mean responses (percent survival and growth [dry weight per surviving organism]) will be expressed as a percentage of the mean laboratory control result and the mean field reference result; and

2. results of the statistical contrasts of mean responses in tests of impacted sediment against the laboratory control and the field reference sediment will be compiled.

Results will then be categorized as follows:

1. no unacceptable response is a mean response within 20% of the mean field reference response (i.e., survival or growth were ≥80% of the field reference);

2. a low to moderate response is a mean response of between 20% and 50% of the mean field reference response (i.e., survival or growth were 50% to 80% of the field reference); and

3. a large response is a mean response of >50% of the mean field reference response (i.e., survival or growth were <50% of the field reference).

Low and moderate responses will be distinguished based on whether the results differ significantly from reference (moderate response) or not (low response). Application of a 20% reduction in survival relative to the field reference to define acceptability is consistent with thresholds used elsewhere (e.g., BCMELP 1998; Government of Canada 2010; Bay et al. 2014). If low, moderate, or high responses are observed in sediment toxicity testing, relationships between the effect endpoint (i.e., survival or growth) and sediment quality will be evaluated in consideration of WSQGs, effect thresholds, and the results of correlation analysis. Although it is recognized that a significant correlation or regression does not indicate causation (e.g., Norton et al. 2015), it is desirable to not only characterize the nature of a response (e.g., reduced survival or growth in sediment toxicity tests), but to also obtain evidence of cause. Correlation / regression analyses are commonly applied tools for identifying potential cause (e.g., Norton et al. 2015). Evidence of causation obtained from correlation or regression analysis will be carefully considered in light of the strength, range, and continuity of the relationships as well as mechanistic knowledge/understanding of potential cause.

The overall interpretation of sediment quality data will include integration of a weight-of-evidence that includes other components of the MPMC CEMP (e.g., water quality data, periphyton data for creeks, benthic invertebrate community data for lakes and creeks). Thus, within the CEMP, sediment quality data interpretation will specifically include the integration of data on sediment quality, the results of specialized evaluations (e.g., DGT results), and the results of bio-assessment (e.g., sediment toxicity testing and benthic invertebrate communities).

An interpretive report based on the sediment quality data will be prepared to be integrated into the Annual Environmental and Reclamation Report for the Mount Polley Mine that is prepared annually by MPMC and submitted to the regulators and other stakeholders by March 31 of the following year. The interpretive report will provide all data in an appendix and will include the DQR, the results of the screening against BCWSQG, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots.

5 REFERENCES

Bay, S.M., D.J. Greenstein, J.A. Ranasinghe, D.W. Diehl and A.E. Fetscher. 2014. Sediment Quality Assessment Technical Manual. Southern California Coastal Water Research Project. Technical Report 777. January 2014.

BCMELP (British Columbia Ministry of Environment, Lands, and Parks). 1998. Recommended Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia. Prepared for British Columbia Ministry of Environment, Lands, and Parks by W.G. Landis, A.J. Markiewicz and V. Wilson. January 1998.

BCMOE (British Columbia Ministry of Environment). 2013. British Columbia Field Sampling Manual For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples. 2013 Edition.

BCMOE. 2015. British Columbia Environmental Laboratory Manual. 2015 Edition. Prepared and Published by the Ministry of Environment with the assistance of The British Columbia Environmental Laboratory Technical Advisory Committee. February 2015.

BCMOE. 2016. Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators. Version 2. June 2016.

BCMOE. 2017. British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Water Protection and Sustainability Branch. June 2017.

Beak (Beak International Incorporated). 2000. Mount Polley Biological Monitoring Program - 1999. Report Prepared for the Mount Polley Mining Corporation. April 2000.

Campbell, P.G.C. and A. Tessier. 1996. Ecotoxicology of Metals in the Aquatic Environment: Geochemical Aspects. In: M.C. Newman and C.H. Jagoe (Eds.). Ecotoxicology: A Hierarchical Treatment. pp. 11-58. Lewis Publishers, Boca Raton.

CCME (Canadian Council of Ministers of the Environment). 1995. Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. March 1995.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life - Introduction. In: Canadian Environmental Quality Guidelines for the Protection of Aquatic Life. 1999.

Chapman, P.M. 1990. The Sediment Quality Triad Approach to Determining Pollution-Induced Degradation. Sci. Tot. Env. 97-98: 815-825.

Environment Canada. 1997. Biological Test Method: Test for Survival and Growth in Sediment Using the Larvae of Freshwater Midges (*Chironomus tentans* or *Chironomus riparius*). Report EPS 1/RM/32. December 1997.

Environment Canada. 2012. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada Report EEM/2002/1. June, 2012.

Government of Canada. 2010. Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance. Module 1: Toxicity Test Selection and Interpretation. March 2010.

Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, New York. 257 pp.

HKP (Hallam Knight Piésold Ltd.). 1996. Mount Polley Project - Environmental Baseline and Monitoring Report: 1995. March 1996.

HKP (Hallam Knight Piésold Ltd.). 1997. Mount Polley Mining Corporation - Mount Polley Project - Environmental Baseline and Monitoring Report: 1996. June 1997.

Horowitz, A.J. 1991. A Primer on Sediment-Trace Element Chemistry. Second Edition. Lewis Publishers.

Imperial Metals. 1990. Stage 1 Environmental and Socioeconomic Impact Assessment Report for the Mount Polley Project. Prepared for the BC Mine Development Steering Committee by Imperial Metals Corporation. July 1990.

Ingersoll, C.G., T. Dillon, and G.R. Biddinger (Eds.). 1997. Ecological Risk Assessment of Contaminated Sediments. SETAC Press, Pensacola.

Luoma, S.N and P.S. Rainbow. 2008. Metal Contamination in Aquatic Environments: Science and Lateral Management. Cambridge University Press, Cambridge, UK.

Minnow (Minnow Environmental Inc.) 2007. Hazeltine Creek Habitat Characterization. Report Prepared for Mount Polley Mining Corporation. Report Prepared By Minnow Environmental Inc. April 2007.

Minnow. 2009. Mount Polley Mine - Aquatic Environmental Characterization - 2007. Report Prepared for Mount Polley Mining Corporation. Report Prepared By Minnow Environmental Inc. July 2009.

Minnow. 2011. Mount Polley Mine Selenium Monitoring 2009/2010. Report Prepared for Mount Polley Mining Corporation. March, 2011.

Minnow. 2012. Mount Polley Mine Supplemental Aquatic Monitoring - 2011. Report Prepared for Mount Polley Mining Corporation. March, 2012.

Minnow. 2013a. Mount Polley Mine Selenium Monitoring 2012. Report Prepared for Mount Polley Mining Corporation. March, 2013.

Minnow. 2013b. Mount Polley Mine Selenium Monitoring 2013 Update Report. Report Prepared for Mount Polley Mining Corporation. December, 2013.

Minnow. 2014. Aquatic Environmental Description Report Mount Polley Mine Discharge of Treated Water to Polley Lake. Report Prepared for Mount Polley Mining Corporation. July, 2014.

Minnow. 2015a. Mount Polley Tailings Dam Failure – Sediment Quality Impact Characterization. Prepared for Mount Polley Mining Corporation, May 2015.

Minnow. 2015b. Sediment Quality Data Report – August 2015 Collections. Prepared for Mount Polley Mining Corporation, October 2015.

Minnow. 2016a. Sediment and Sediment Porewater Data Report – August 2016 Collections. Prepared for Mount Polley Mining Corporation, December 2016.

Minnow. 2016b. Investigation of the Influence of Sediment Total Organic Carbon and Particle Size on Sediment Toxicity Test Results. Prepared for Mount Polley Mining Corporation, January 2016.

Minnow. 2016c. Application of the SEM-AVS Method and Selective Extraction Analysis in Evaluating Sediments Collected in the Vicinity of the Mount Polley Mine – August 2015. Prepared for Mount Polley Mining Corporation, January 2016.

Minnow. 2016d. Results of Diffusive Gradients in Thin Films Device Deployment – August to October 2015. Prepared for Mount Polley Mining Corporation, April 2016.

Minnow. 2017a. Polley Lake and Quesnel Lake Sediment Toxicity Evaluation, 2016. Prepared for Mount Polley Mining Corporation, June 2017.

Minnow. 2017b. Benthic Invertebrate Community Monitoring in the Vicinity of the Mount Polley Mine, 2016. Prepared for Mount Polley Mining Corporation, June 2017.

Minnow. 2017c. Application of the SEM-AVS Method in Evaluating Sediments Collected in the Vicinity of the Mount Polley Mine – August 2016. Prepared for Mount Polley Mining Corporation, January 2017.

Minnow. 2017d. Results of Diffusive Gradients in Thin Films Device Deployment, 2016. Prepared for Mount Polley Mining Corporation, April 2017.

Minnow. 2018a. Assessment of Sediment Deposition Rates and the Chemistry of Depositing Sediment in the Vicinity of Mount Polley Mine – 2015 and 2017 Sediment Trap Deployments. Prepared for Mount Polley Mining Corporation, March 2018.

Minnow. 2018b. Results of Diffusive Gradients in Thin Films Device Deployment, 2017. Prepared for Mount Polley Mining Corporation, March 2018.

Norton, S.B., S.M. Cormier and G.W. Suter II. 2015. Ecological Causal Assessment. CRC Press, Boca Raton pp. 17-251-270.

Panther, J., W. Bennett, D. Welsh, and P. Teasdale. 2014. Simultaneous Measurement of Trace Metals and Oxyanion Concentrations in Water using Diffusive Gradients in Thin Films with a Chelex-Metsorb Mixed Binding Layer. Anal. Chem. 86: 427-434.

Santschi, P., P. Hohener, G. Banoit, and M. Bucholtz-ten-Brink. 1990. Chemical Processes at the Sediment-Water Interface. Mar. Chem. 30: 269-315.

Simpson, S. and G. Batley (Eds.). 2016. Sediment Quality Assessment: A Practical Guide. Second Edition. CSIRO Publishing, Clayton South, AU.

Sposito, G. 2004. The Surface Chemistry of Natural Particles. Oxford University Press. 242 pp.

SRK (SRK Consulting). 2015a. Mount Polley Mine Tailings Breach: Geochemical Characterization of Spilled Tailings. Prepared for Mount Polley Mining Corporation. May 2015.

SRK (SRK Consulting). 2015b. Mount Polley Mine Tailings Failure: Update on Geochemical Characterization of Spilled Tailings. Prepared for Mount Polley Mining Corporation. November 2015.

Stumm, W. and J.J. Morgan. 1996. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters. Third Edition. Wiley Interscience, New York. 1022 pp.

USEPA (United States Environmental Protection Agency). 1998. Method 6020A (SW-846): Inductively Coupled Plasma – Mass Spectrometry. Revision 1. January 1998.

USEPA (United States Environmental Protection Agency). 2005. Method 245.7. Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry. Revision 2.0. February 2005.

Wang, F., R.R. Goulet and P.M. Chapman. 2004. Testing Sediment Biological Effects with the Freshwater Amphipod Hyalella azteca: The Gap between Laboratory and Nature. Chemosphere 57: 1731-1724.

Zhang, H. and W. Davison. 1995. Performance Characteristics of Diffusion Gradients in Thin Films for the In Situ Measurement of Trace Metals in Aqueous Solution. Anal. Chem. 67: 3391-3400.

Appendix B.2

Benthic Invertebrate Monitoring

Minnow Environmental Inc.

Benthic Invertebrate Monitoring Plan

Prepared for:

Mount Polley Mining Corporation
Likely, British Columbia

Prepared by:

Minnow Environmental Inc.
Georgetown, Ontario

June 2018

minnow environmental inc.
A Trinity Consultants Company

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Monitoring Objective 2

2 SUMMARY OF HISTORICAL FINDINGS 4
2.1 Polley Lake 4
2.1.1 Community 4
2.1.2 Tissue Quality 5
2.2 Hazeltine and Edney Creeks 6
2.2.1 Community 6
2.2.2 Tissue Quality 8
2.3 Quesnel Lake 9
2.3.1 Community 9
2.3.2 Tissue Quality 10

3 STUDY DESIGN OVERVIEW AND RATIONALE 11
3.1 Community and Productivity 11
3.1.1 Lakes 11
3.1.2 Creeks 12
3.2 Tissue Quality 14

4 METHODOLOGY 16
4.1 Quality Assurance / Quality Control 16
4.2 Sample Collection Methods 17
4.2.1 Community and Productivity 17
4.2.2 Tissue Quality 19
4.3 Sample Handling and Laboratory Analysis 20
4.3.1 Community and Productivity 20
4.3.2 Tissue Quality 21
4.4 Data Quality Review 21
4.5 Data Handling and Interpretation 22
4.5.1 Community and Productivity 23
4.5.2 Tissue Quality 25

5 REFERENCES 27

LIST OF TABLES **FOLLOWING PAGE**

Figure 1: Benthic Invertebrate Community Endpoints in Polley Lake Deep Areas, Mount Polley Mine, 2014-2016 4
Figure 2: Selenium Concentrations in Benthic Invertebrate Tissue at a) Hazeltine Creek and b) Polley Lake with Associated Reference Areas, Mount Polley, 2009 to 2017 5
Figure 3: Benthic Invertebrate Tissue Copper Concentrations at A) Polley Lake, B) Hazeltine Creek, C) Quesnel Lake and Associated Reference Areas in the Vicinity of the Mount Polley Mine, 2009 to 2017 5
Figure 4: Benthic Invertebrate Community Endpoints for Rehabilitated Areas of A) Upper Hazeltine Creek (Kick-and-Sweep Sampling), B) Lower Hazeltine Creek (250 µm Surber Sampling), C) Lower Edney Creek (250 µm Surber

Sampling), and Associated Reference Areas in the Vicinity of the Mount Polley Mine, 2007 to 2017 7
Figure 5: Benthic Invertebrate Community Endpoints in Quesnel Lake Deep Areas, Mount Polley Mine, 2014-2016 10
Figure 6: Mount Polley CEMP Benthic Invertebrate Monitoring Location, Lakes 11
Figure 7: Mount Polley CEMP Benthic Invertebrate Monitoring Locations, Creeks 11

LIST OF TABLES **FOLLOWING PAGE**

Table 1: History of Benthic Invertebrate Community Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine 4
Table 2: History of Benthic Invertebrate Tissue Chemistry Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine 4
Table 3: Mount Polley CEMP Benthic Invertebrate Monitoring Program Overview 11
Table 4: Target Laboratory Reporting Limits (LRL) and Analytical Methods for Benthic Invertebrate Tissue Quality Analytes 21

1 INTRODUCTION

1.1 Background

Benthic invertebrates are excellent biomonitors for assessing potential effects of physical and/or chemical habitat changes in aquatic systems (Barbour et al. 1999; Feltmate and Fraser 1999; Beatty et al. 2006). Due to the complexity of benthic invertebrate community structure and known tolerances and sensitivities to sediment and water quality (e.g., Barbour et al. 1999; Mandaville 2002), benthic invertebrate community analysis is typically a highly sensitive bio-monitor. Benthic invertebrate are sessile, therefore evaluation of benthic invertebrate tissue quality can provide an important measure of localized chemical conditions and of spatial extent of an effect, as well as of potential direct or indirect exposure of fish and wildlife to metals, metalloids, and nutrients[1]. Therefore, benthic invertebrate community and tissue quality monitoring is an important component of the Mount Polley CEMP.

The influence of the Mount Polley Mine on benthic invertebrate communities, productivity, and/or tissue quality can occur by several key mechanisms: 1) general mine influence from dustfall and/or uncontained surface or groundwater flows: 2) direct discharge of mine effluent to Hazeltine Creek (April to August 2014) and Quesnel Lake (December 2015 to present [via Hazeltine Creek from December 2015 to December 2017, and directly since January 2018]); 3) the TSF embankment breach on August 4, 2014; and 4) reclamation activities following the TSF embankment breach. Reclamation activities in Hazeltine Creek and lower Edney Creek were initiated in 2014 following the TSF embankment breach, and were completed in lower Edney Creek in August 2015 (Golder 2017a). Construction / rehabilitation in areas of upper Hazeltine Creek (Reaches 1 and 2) were completed between July and September of 2016 and 2017, respectively (Golder 2017b,c). Reach 2 of the rehabilitation works encompassed a sampling area established prior to the TSF embankment breach (UHC; Minnow 2009). In lower Hazeltine Creek, initial channel rehabilitation was completed in 2015, and further rehabilitation has yet to be completed in this area of creek. The geomorphology of Hazeltine Creek was drastically altered as a result of the TSF embankment breach such that Fisheries and Oceans Canada considered it not to be fish habitat (Golder 2015a), and the creek was inaccessible to fish from August 2014 (following the breach) until the spring of 2018 when it was reopened as fish habitat.

Benthic invertebrate communities in waterbodies adjacent to the Mount Polley Mine have been monitored since baseline investigations in 1989, 1995, and 1996 (Imperial Metals 1990; HKP 1996, 1997). Benthic invertebrate tissue quality has been monitored since prior to the TSF

[1] Through the remainder of this section, the term “metals” will be used to include metals, metalloids, and nutrients for ease of communication.

embankment breach (2009, 2010, 2012, and 2013; Minnow 2011, 2013a,b). Results of benthic invertebrate community and tissue quality monitoring are reviewed in Section 2 and provide context for a CEMP benthic invertebrate monitoring program that is guided by a combination of historical findings, representative locations downstream of Mount Polley Mine operations, representative reference locations, and considerations for a statistically-based design that will facilitate the detection of spatial and/or temporal differences in benthic invertebrate productivity, community, and/or tissue quality, in addition to providing data to evaluate tissue quality results (i.e., tissue selenium concentrations) relative to effects-based guidelines (e.g., British Columbia Water Quality Guidelines [BCWQG]; BCMOE 2014). In addition to monitoring required as part of the Mount Polley CEMP, benthic invertebrate community monitoring is required as part of Environmental Effect Monitoring (EEM) under the Metal Mining Effluent Regulations (MDMER) of the federal *Fisheries Act*.

The following sections of the CEMP Benthic Invertebrate Monitoring Plan provide the objectives of benthic invertebrate community and tissue quality monitoring, a summary of historical benthic invertebrate findings, an overview of the CEMP study design and associated rationale (including sampling locations, replication, frequency, and analytes), and detailed methodology for benthic invertebrate community and tissue quality monitoring (quality assurance/quality control, sample collection methods, sample handling and laboratory analysis, data quality review, data handling, interpretation, and reporting).

1.2 Monitoring Objective

The objective of benthic invertebrate monitoring is to evaluate the influence of Mount Polley Mine activities on benthic invertebrate communities, productivity, and tissue quality in receiving environments (Polley Lake, Hazeltine Creek, Edney Creek, and Quesnel Lake) in comparison to baseline and/or reference conditions, and to determine potential implications to aquatic life (e.g., through assessment of benthic invertebrate community and productivity endpoints, and comparison of benthic tissue quality results to available guidelines; BCMOE 2014) and to aquatic ecosystem health by providing supporting information for the assessment of potential effects to higher trophic levels (e.g., fish and fish habitat quality; Section 6.16). Benthic invertebrate monitoring also provides data to support exposure assessment as part of the ecological risk assessment (ERA) and human health risk assessment (HHRA). Benthic invertebrate community monitoring is also required as part of Environmental Effect Monitoring (EEM) under the Metal and Diamond Mining Effluent Regulations (MDMER) of the federal *Fisheries Act* (Government of Canada 2018). The objective of the MDMER EEM benthic invertebrate monitoring is to evaluate whether there are effects to benthic invertebrate community characteristics between the area of



Quesnel Lake exposed to Mount Polley mine effluent and a reference area (Environment Canada 2012a).

2 SUMMARY OF HISTORICAL FINDINGS

Benthic invertebrate community has been monitored in the vicinity of the Mount Polley Mine since 1989, and benthic invertebrate tissue quality has been monitored since 2009. The majority of benthic invertebrate community and tissue quality samples have been collected from Polley Lake, Bootjack Lake, Quesnel Lake, Hazeltine Creek, and Edney Creek (Tables 1 and 2).

Benthic invertebrate community sampling in the vicinity of the Mount Polley Mine has spanned the four distinct time periods listed below:

1. Baseline monitoring (1989, 1995, 1996);
2. Pre-breach operational monitoring (1999, 2007, 2009, 2010, 2012, 2013);
3. Post-breach operational monitoring (2014, 2015); and
4. Post-breach and post-discharge monitoring (2016, 2017).

Benthic invertebrate tissue quality sampling in the vicinity of the Mount Polley has spanned operational time periods only (time periods 2 to 4). Data collected prior to the breach were summarized in a Technical Assessment Report (MPMC 2009) and an Aquatic Environmental Description Report (Minnow 2014a) prepared concurrently with applications for water discharge in 2009 and 2014, respectively. General findings associated with baseline, pre-breach, post-breach operational, and post-breach post-discharge monitoring are summarized, by sampling area, in the following sections.

2.1 Polley Lake

2.1.1 Community

The benthic invertebrate community of Polley Lake during baseline studies (Table 1; 1995 and 1996; HKP 1996, 1997) and pre-breach operational monitoring (1999; Beak 2000) was characterized by a dominance of Chironomidae (midges) and Oligochaeta (worms) in the two deep basins of the lake (P1 and P2). A temporal increase in density and richness at these stations was observed between baseline period and pre-breach operational monitoring, but due to unavailability of detailed sample collection and laboratory methods for baseline studies (e.g., HKP 1996, 1997) the reason for this difference is not clear (Minnow 2014a).

Following the TSF embankment breach, the benthic community in Polley Lake differed dramatically from conditions prior to the breach (1999; Beak 2000) and from reference in both deep basins of the lake (Figure 1). Specifically, no benthic organisms were present in the south basin (POL-P2) indicating an unequivocal impact, and organism density and taxon richness in the

Table 1: History of Benthic Invertebrate Community Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine

A) Lakes

Year	Locations	Report
1989	Polley Lake, Bootjack Lake	Imperial Metals 1990
1995	Polley Lake, Bootjack Lake	HKP 1996
1996	Polley Lake, Bootjack Lake	HKP 1997
1999	Polley Lake, Bootjack Lake, Jacobie Lake	Beak 2000
2007	Quesnel Lake	Minnow 2009
2014	Quesnel Lake, Polley Lake, Bootjack Lake	Minnow 2015a
2015	Quesnel Lake, Polley Lake, Bootjack Lake	Minnow 2016b
2016	Quesnel Lake, Polley Lake, Bootjack Lake	Minnow 2016e, 2017a
2017	Quesnel Lake	Minnow 2018a

B) Creeks

Year	Locations	Report
1995	Bootjack Creek, Edney Creek, Edney Creek Tributaries, Hazeltine Creek	HKP 1996
1996	Bootjack Creek, Edney Creek, Edney Creek Tributary, Hazeltine Creek	HKP 1997
1999	Edney Creek, Edney Creek Tributary, Bootjack Creek, Jacobie Creek, Hazeltine Creek, Morehead Creek	Beak 2000
2002	Edney Creek	Morrow/Azimuth 2003
2007	Edney Creek, Edney Creek Tributary, Hazeltine Creek, Whiffle Creek, Bootjack Creek, Cedar Creek	Minnow 2009
2013	Bootjack Creek	Minnow 2014b
2014	Blackwater Creek, Clearwater River, Cariboo River, Quesnel River	Minnow 2015a
2015	Edney Creek, Hazeltine Creek, Cariboo River, Quesnel River	Minnow 2016b
2016	Edney Creek	Minnow 2017a
2017	Edney Creek, Hazeltine Creek, Frypan Creek	Minnow 2018a

Table 2: History of Benthic Invertebrate Tissue Chemistry Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine

A) Lakes

Year	Locations	Report
2009	Main Embankment Seepage Pond, Polley Lake	Minnow 2011
2012	Bootjack Lake, Frypan Lake, Main Embankment Seepage Pond, Polley Lake, Quesnel Lake, Trio Lake	Minnow 2013a
2015	Bootjack Lake, Polley Lake, Quesnel Lake	Minnow 2016a
2016	Bootjack Lake, Polley Lake, Quesnel Lake	Minnow 2017b

B) Creeks

Year	Locations	Report
2009	Hazeltine Creek	Minnow 2011
2010	Hazeltine Creek	Minnow 2011
2012	Hazeltine Creek, Edney Creek, North Dump Creek	Minnow 2013a
2013	Edney Creek, Hazeltine Creek, Jacobie Creek, Morehead Creek , Trio Creek	Minnow 2013b
2014	Cariboo River, Blackwater Creek, Clearwater River, Quesnel River	Minnow 2015a
2015	Edney Creek, Hazeltine Creek, Cariboo River, Quesnel River	Minnow 2016a
2016	Edney Creek, Hazeltine Creek	Minnow 2017b
2017	Edney Creek , Hazeltine Creek	Minnow 2018b

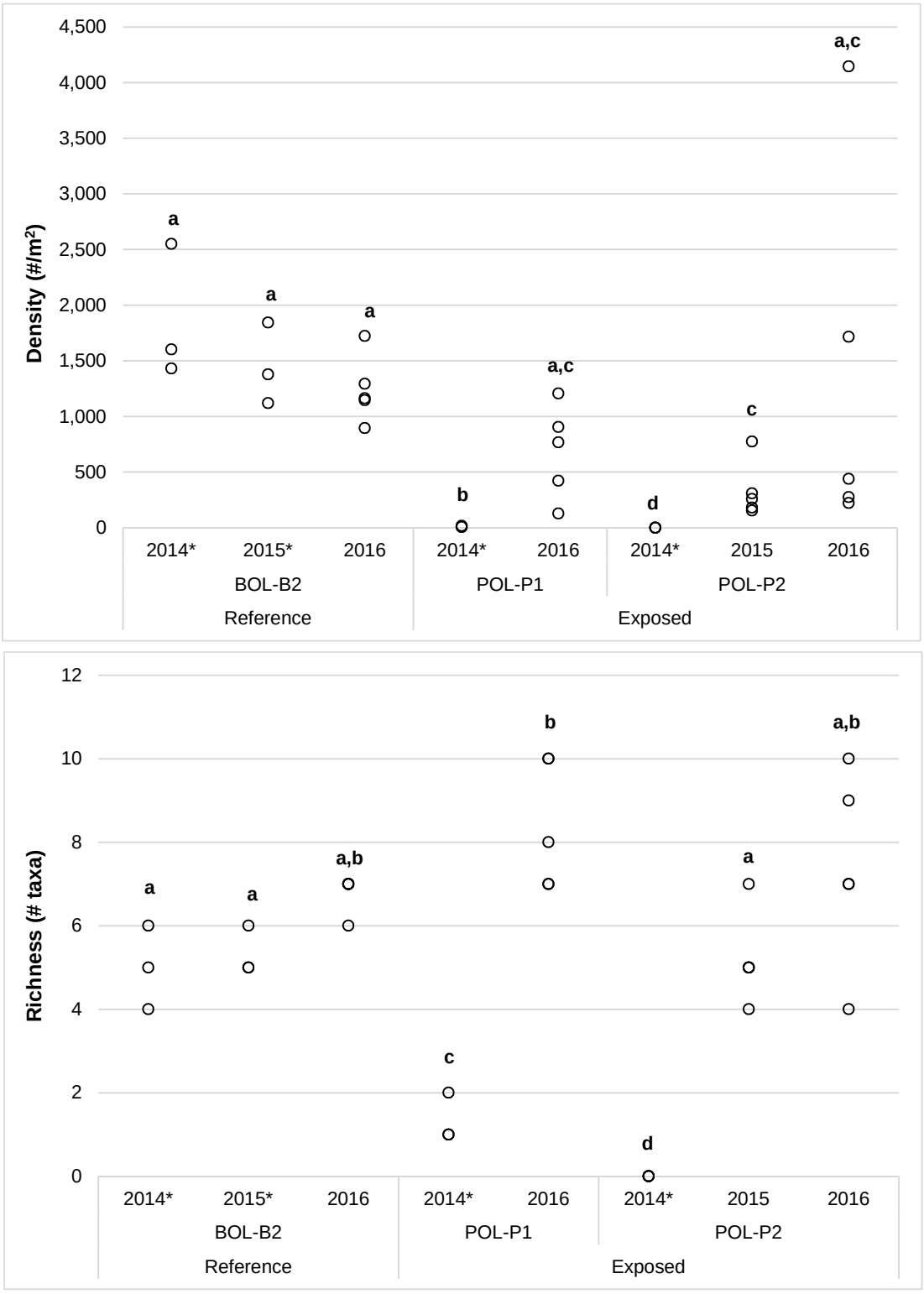


Figure 1: Benthic Invertebrate Community Endpoints in Polley Lake Deep Areas, Mount Polley Mine, 2014-2016 [a]

[a] Values shown beside data points indicate number of stations sharing a similar result. Areas not sharing a letter differed significantly ($p < 0.1$).

* Sample size = 3 indicated by an asterisk, all other sample sizes = 5.

north basin (POL-P1) was also substantially impacted (9 to 17 organisms/m^2; 1 to 2 taxa, respectively) relative to reference (1,431 to 2,551 organisms/m^2; 4 to 6 taxa, respectively) and pre-breach conditions (300 to 614 organisms/m^2; 10 to 15 taxa; Figure 1; Minnow 2015a). Benthic invertebrate community monitoring completed in 2015 and 2016 indicated substantial recovery of the benthic community in both deep basins of Polley Lake relative to 2014 conditions. Organism density (mean = 686 to 1,360 organisms/m^2) and taxon richness (mean = 7.4 to 8.4 taxa) at both areas in 2016 were similar to reference, and density was similar to pre-breach conditions as determined by Before-After/Control-Impact analysis (1999 and 2016; Minnow 2017a). Some differences in community composition relative to reference were observed in 2015 and 2016 (Minnow 2016b, 2017a); however, the primary difference (lower relative proportion of *Chaoborus* in Polley Lake in comparison to reference) was observed prior to the embankment breach (i.e., Beak 2000).

2.1.2 Tissue Quality

Benthic invertebrate tissue quality in Polley Lake was not assessed as part of baseline studies (1989-1996; Table 2). Selenium-specific aquatic environmental monitoring was initiated in 2009 after an uncontrolled surface runoff event from the north waste rock dump which reported to Polley Lake via North Dump Creek (Minnow 2011; see CEMP Sections 6.12 and 6.16). This runoff started in 2006, was controlled in 2009 with the construction of the Long Ditch, and was characterized by elevated concentrations of sulphate and selenium. Mean selenium concentrations observed during pre-breach operational monitoring (2009 and 2012; 6.0 to 7.8 mg/kg dw) were greater than reference and the interim BCWQG of 4 mg/kg dry weight, and were generally similar among sampling years (Figure 2; Minnow 2011, 2013a).

Following the TSF embankment breach, mean benthic invertebrate concentrations of selenium remained significantly higher than the BCWQG and reference, but were significantly lower in 2016 (5.4 mg/kg dw) relative to 2009 and 2012 indicating no breach-related increase (Figure 2; Minnow 2017b). Benthic invertebrate tissue quality investigations following the TSF embankment breach were also focussed on a suite of analytes identified as indicative of the chemical influence of the breach on sediment quality in the receiving environment (Minnow 2015a): Parameters of Interest (POIs: arsenic, copper, iron, manganese, nickel, and zinc), and Indicator Parameters (IPs: calcium, cobalt, molybdenum, phosphorus, selenium, silver, sodium, titanium, and vanadium). Mean concentrations of a number these POIs and IPs were higher than reference in 2015 (manganese, tin, and titanium), in 2016 (arsenic, iron, and vanadium), and in both 2015 and 2016 (copper and molybdenum; Minnow 2016a, 2017a). In particular, mean benthic invertebrate copper concentrations were approximately 5.8 to 6.9 times higher than reference (Figure 3). These results are not unexpected, given that sediment copper concentrations were approximately

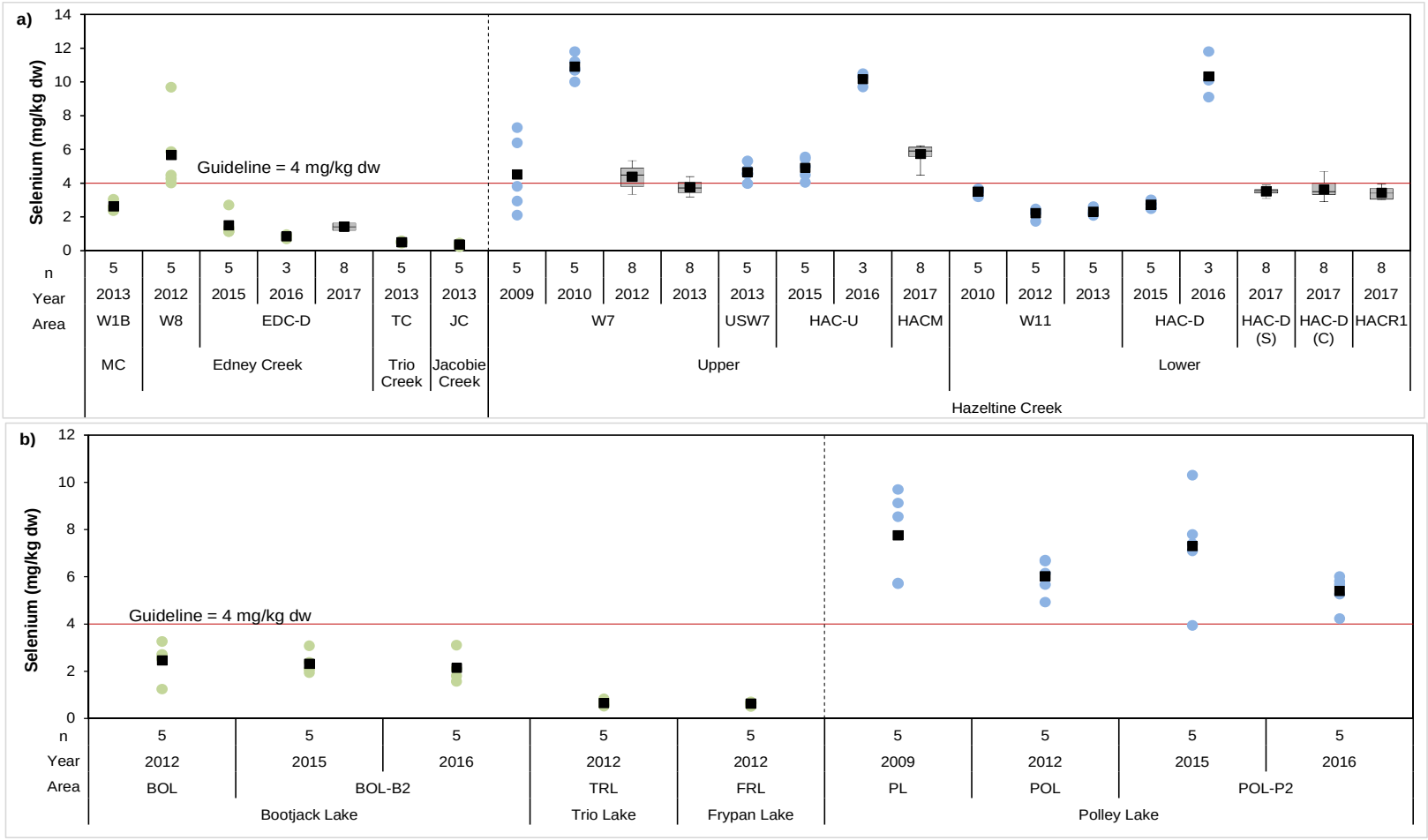


Figure 2: Selenium Concentrations in Benthic Invertebrate Tissue at a) Hazeltine Creek and b) Polley Lake with Associated Reference Areas, Mount Polley, 2009 to 2017

Notes: Dashed line used to separate reference (left side) and exposed (right side) areas. Black squares represent means and whiskers represent minimum and maximum values. Box plots are presented when there are 8 or more samples.
MC = Morehead Creek.
S = Stonefly single taxon sample.
C = Caddisfly single taxon sample.

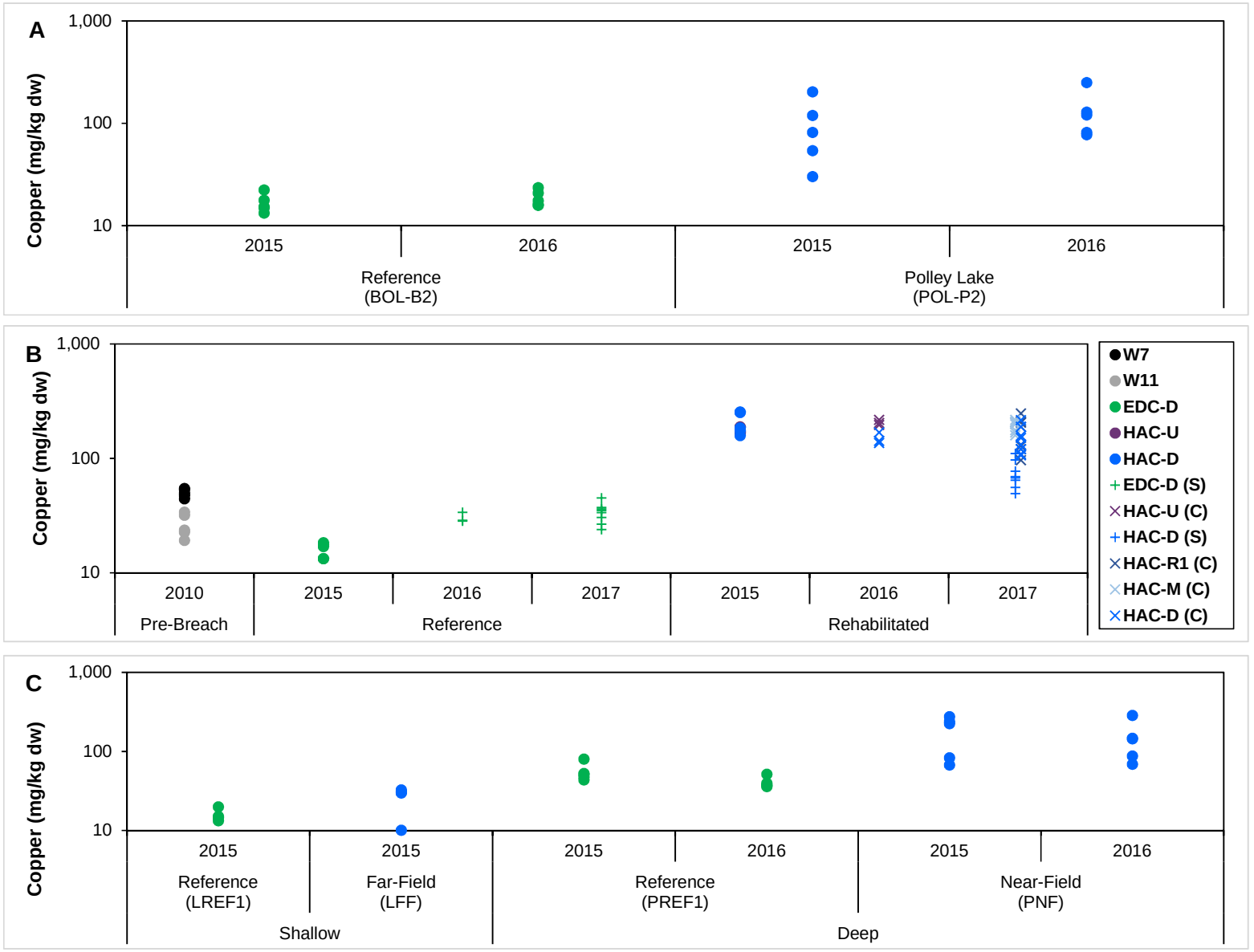


Figure 3: Benthic Invertebrate Tissue Copper Concentrations at A) Polley Lake, B) Hazeltine Creek, C) Quesnel Lake and Associated Reference Areas in the Vicinity of the Mount Polley Mine, 2009 to 2017

Notes: Dots indicate composite-taxa results, + symbols indicate stonefly samples, and × symbols indicate caddisfly observations. For lakes, non-depurated results are shown.

twice reference values (see CEMP Section 6.12). Although whole benthic invertebrate tissue concentrations accurately represent concentrations associated with food for higher trophic level organisms that consume benthic invertebrates, they may not accurately represent metal concentrations in the tissues of benthic organisms due to a known confounding influence of gut content on the determination of tissue metal concentrations in invertebrates, and therefore on the evaluation of potential biological effects associated with these metal concentrations (i.e., Chapman 1985, 2016). Metal concentrations were evaluated in both depurated and non-depurated benthic invertebrate samples in 2016 from Polley Lake in order to minimize the confounding influence of gut content. However, depuration made little difference to results (Minnow 2017a). Due to the uncertainties associated with depositional benthic invertebrate tissue monitoring, and similarities with results of other sampling methods (Diffusive Gradients in Thin Films [DGT] devices), DGTs will be used to monitor temporal changes in labile metal concentrations in Polley Lake (see CEMP Section 6.12).

Ratios of benthic invertebrate tissue metal concentrations to sediment concentration ([benthic invertebrate sample]/[sediment]) are referred to as Biota Sediment Accumulation Factors (BSAFs) and are often used to describe the accumulation of sediment-associated analytes in tissues of ecological receptors (i.e., Burkhard 2009). BSAFs for benthic invertebrate tissues from Polley Lake were generally higher than reference following the TSF embankment breach, however remained stable between 2015 and 2016, as did benthic invertebrate tissue chemistry results (Minnow 2016a, 2017a). The only exception was copper, with BSAF results indicative of greater bioavailability in 2016 versus 2015 (Minnow 2017a). Continued monitoring of potential temporal changes in labile metal concentrations in Polley Lake will be implemented using DGTs, which are not subject to the confounding influences (i.e., gut content) described for benthic invertebrate tissue quality monitoring.

2.2 Hazeltine and Edney Creeks

2.2.1 Community

The benthic invertebrate community of Hazeltine Creek was relatively stable between baseline studies in 1995, 1996 (HKP 1997, 1997), and operational monitoring in 1999 (Beak 2000) and 2007 (Minnow 2009), although unusual methodologies were applied to data collection in the 1996 baseline that appeared to affect results of certain endpoints such as density and the proportions of different taxon groups (MPMC 2009). Overall, benthic communities in both upper and lower Hazeltine Creek (with the exception of 1996 data) had high organism densities (25,000 to 43,000 and 6,000 to 33,000 organisms/m^2, respectively) and taxon richness (36 to 50 and 26 to 46 taxa, respectively) with a high proportion of metal sensitive taxa of the orders Ephemeroptera,

Plecoptera, and Trichoptera (EPT; mayflies, stoneflies, and caddisflies) indicating good ecosystem health (Minnow 2014a).

Monitoring in 2015 following the TSF embankment breach indicated that benthic invertebrate community recovery was incomplete and the community was dominated by pollution tolerant organisms (e.g., blackflies and oligochaete worms), particularly in the upper creek area (Minnow 2016b). In lower Hazeltine Creek, further recovery was documented in 2017, evidenced by taxon richness similar to reference (28 to 40 taxa) and a proportion of sensitive EPT taxa similar to reference and historic conditions despite significantly lower organism density (3,738 to 5,788 organisms/m^2; Figure 4). Productivity monitoring initiated in 2017 corroborated the low organism density, with biomass in lower Hazeltine Creek (0.70 to 2.5 g/m^2 dw) below that of upper Hazeltine Creek (2.9 to 20 g/m^2 dw) and reference (5.5 to 33 g/m^2 dw; Minnow 2018a). In upper Hazeltine Creek, the benthic community documented in 2017 (approximately one year following completion of final rehabilitation activities) was dominated primarily by Trichoptera (caddisflies), and to a lesser degree by Ephemeroptera (mayflies), and Chironomidae. The presence of these sensitive taxa suggests limited chemical effect on recolonization, and total organism abundances similar to reference in 2015 indicate a benthic community supportive of fish habitat productivity (Figure 4; Minnow 2018a).

Similar to Hazeltine Creek, the benthic invertebrate community of Edney Creek was evaluated during baseline studies in 1995, 1996 (HKP 1996, 1997), and during the pre-breach operational time period in 1999 (Beak 2000), 2002 (Morrow/Azimuth 2003), and again in 2007 (Minnow 2009). Benthic invertebrate communities appeared to be relatively stable over this time (with the exception of the 1996 data discussed above), with organism densities of 15,500 to 62,000 organisms/m^2 and taxon richness of 32 to 55 taxa, and a relatively high proportion of metal sensitive EPT taxa (MPMC 2009; Minnow 2014a).

Monitoring following the TSF embankment breach indicated recovery of the benthic invertebrate community between 2015 and 2017 in the rehabilitated area of lower Edney Creek. Specifically, although organism density was lower than reference in 2017 (due mainly to an increase in density at the reference area), taxon richness in 2016 and 2017 was similar to reference (Figure 4), and the relative proportion of Trichoptera increased significantly between 2016 and 2017 while the proportion of Chironomidae decreased, which is indicative of recovery (Minnow 2018a). Initial benthic invertebrate productivity sampling in 2017 indicated that total biomass in the rehabilitated area of lower Edney Creek (0.44 to 3.37 g/m^2 dw) was slightly lower than reference (0.79 to 3.44 g/m^2 dw; Minnow 2018a).

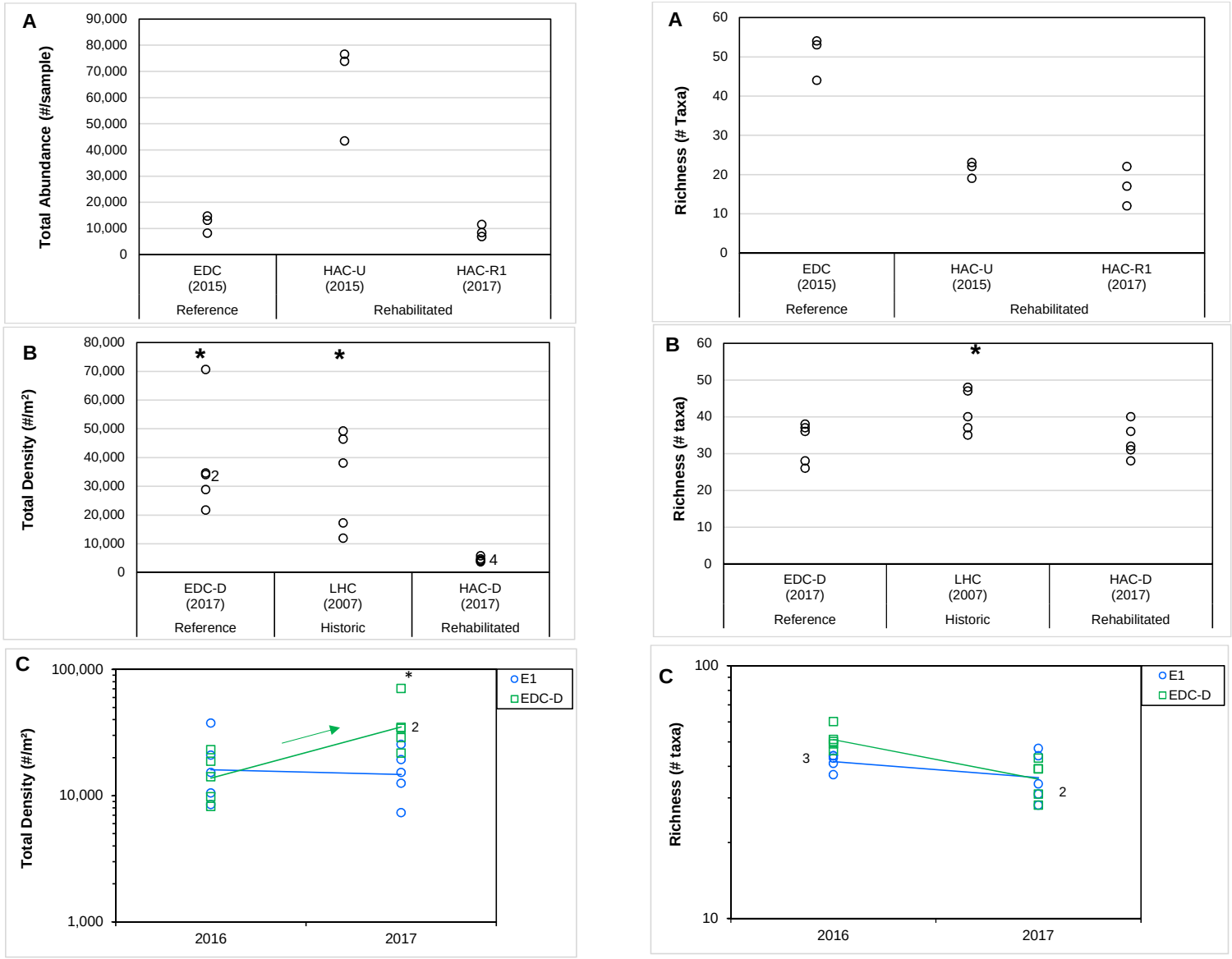


Figure 4: Benthic Invertebrate Community Endpoints for Rehabilitated Areas of A) Upper Hazeltine Creek (Kick-and-Sweep Sampling), B) Lower Hazeltine Creek (250 µm Surber Sampling), C) Lower Edney Creek (250 µm Surber Sampling), and Associated Reference Areas in the Vicinity of the Mount Polley Mine, 2007 to 2017[1]

Notes: For Lower Hazeltine Creek, areas displayed with an asterisk differed significantly from HAC-D (2017, $P < 0.1$). For Lower Edney Creek, statistical comparisons were conducted using a two-way ANOVA with factors Area and Year (* = significant difference ($\alpha = 0.1$) between areas for the given year; ** = significant difference ($\alpha = 0.1$) between areas in 2017 and magnitude of effect is different from ~~2016;~~ ► = significant ($\alpha = 0.1$) year effect ~~for E1~~► = significant ($\alpha = 0.1$) year effect for EDC-D).

[1] Values shown beside data points indicate number of stations sharing a similar result.

2.2.2 Tissue Quality

Benthic invertebrate tissue quality monitoring in Hazeltine Creek was initiated in 2009 as part of the ongoing characterization of selenium incorporation into the aquatic food chain in the vicinity of the Mount Polley Mine. Throughout the pre-breach operational period (2009 to 2013) mean benthic invertebrate tissue selenium concentrations at erosional habitats in upper Hazeltine Creek were higher than the interim BCWQG (4 mg/kg dw; BCMOE 2014) and generally higher than reference, while mean concentrations at erosional habitats in lower Hazeltine Creek were below the BCWQG (Figure 2; Minnow 2011, 2013a,b). In addition, selenium concentrations in benthic invertebrates from exposed erosional habitats were noted to be higher than those from nearby depositional areas (Minnow 2011, 2013b).

Following the TSF embankment breach, data interpretation focused on the POIs and IPs identified in Section 2.1.2 (which included selenium). In 2015 prior to initiation of effluent discharge to Hazeltine Creek, mean tissue concentrations of a number of these POIs and IPs were significantly higher in Hazeltine Creek than reference (arsenic, copper, iron, manganese, nickel, barium, calcium, cobalt, selenium, silver, sodium, strontium, titanium, and vanadium; Minnow 2016a). In addition, concentrations of copper and vanadium were higher in both upper and lower Hazeltine Creek areas relative to pre-breach conditions (3.5 and 8 times for copper, respectively; Figure 3; Minnow 2016a), whereas selenium concentrations were similar to pre-breach conditions (Figure 2). Examination of Bioconcentration Factors (BCFs; which are used to describe the extent to which an analyte is taken up by an organism from the surrounding environment through exposure routes other than diet; i.e, Arnot and Gobas 2006), indicated suggested that bioavailability did not differ from pre-breach conditions (Minnow 2016a).

Effluent was discharged directly to Hazeltine Creek between December 2015 and November 2017, however Hazeltine Creek was not considered to be fish habitat during this time by Fisheries and Oceans Canada (Golder 2015a) and was inaccessible to fish. Mean selenium concentrations in benthic invertebrates from Hazeltine Creek were higher than the majority of pre-breach results and the BCWQG in 2016 (10 mg/kg dw in both upper and lower Hazeltine Creek; Figure 2; Minnow 2017b), however these tissue concentrations corresponded with elevated mean dissolved selenium concentrations related to the conveyance of effluent that were 143-times higher than reference, and at least 46-times higher than at the same locations prior to the breach (Minnow 2013a, Minnow 2017b). Mean concentrations in 2017 were more similar to pre-breach results and were below the BCWQG in lower Hazeltine Creek (mean = 3.4 to 5.7 mg/kg dw; Figure 2; Minnow 2017b), presumably due to limited effluent discharge in 2017. Tissue concentrations of a number of POIs and IPs at effluent-exposed sampling areas were significantly

higher than reference in 2016[2] (barium, manganese, strontium, titanium), in 2017 (calcium), and in both years (arsenic, cobalt, copper, iron, molybdenum, nickel, selenium, vanadium; Minnow 2017b, 2018b). In particular, copper concentrations during this effluent discharge period (49 to 217 mg/kg dw) were elevated above reference and pre-breach concentrations but were generally similar to 2015 (prior to discharge; 158 to 254 mg/kg dw; Figure 3). Examination of BCFs indicated higher copper bioavailability relative to reference during the effluent discharge period (Minnow 2017b, 2018b), which was consistent with findings of higher labile copper concentration determined by DGTs (Minnow 2017c). Direct effluent discharge to Hazeltine Creek ceased in January 2018 prior to the reopening of upper Hazeltine Creek as fish habitat in spring 2018.

2.3 Quesnel Lake

2.3.1 Community

Benthic invertebrate community data for Quesnel Lake collected prior to the TSF embankment breach are limited to a few samples collected near the mouth of Hazeltine Creek in 2007 (Table 1). These data documented a mean density of approximately 31,100 organisms/m^2 and a mean taxonomic richness of 30 (Minnow 2009).

Benthic invertebrate community monitoring following the TSF embankment breach indicated that impacts to the community in shallow habitats were primarily limited to near-field areas and did not extend to far-field areas (Minnow 2015a). Impacts to the benthic community of the near-field area documented in 2014 included significantly lower mean organism density (159 to 294 organisms/m^2) and taxon richness (5.6 to 10 taxa) than reference (1,400 to 7,900 organisms/m^2 and 19 to 21 taxa, respectively; Minnow 2015a). Further monitoring in 2016 and 2017 confirmed these impacts, and indicated that limited recovery had occurred relative to: 1) a fine substrate reference with aquatic vegetation (2016; Minnow 2017a); and 2) two shallow sandy reference areas which more closely matching the habitat present in the near-field area in 2016 and 2017 (2017; Minnow 2018a). Benthic biomass sampling initiated in 2017 corroborated these results, with significantly lower biomass at the near-field area (mean = 0.28 g/m^2 ww) than reference (mean = 1.0 to 3.6 g/m^2 ww; Minnow 2018a).

Sediment investigations following the TSF embankment breach indicated that the majority of breach-derived material was deposited to deep habitat of Quesnel Lake (Minnow 2015a,b, 2016c). Immediately following the TSF embankment breach (2014), benthic invertebrate communities in deep exposed areas were characterized by particularly low mean organism

[2] Benthic invertebrate tissue quality results reflect single-taxon samples in 2016 and 2017 (caddisflies and/or stoneflies), and composite-taxa samples in 2015.

densities at the exposed near-field (PNF; 39.7 organisms/m^2) and far-field areas (3.4 to 22.6 organisms/m^2) relative to reference (5,840 organisms/m^2), and significantly lower mean taxon richness (0.2 to 2.6 taxa at near-field and far-field areas, 7.8 taxa at reference; Figure 5). Overall, results suggested that the biological effects were breach-related, but it was uncertain whether the effects were physical (due to smothering and/or low dissolved oxygen and low TOC content) or chemical (Minnow 2015a). Monitoring in 2015 and 2016 documented some recovery in mean organism density at the near-field (216 to 588 organisms/m^2 in 2015 and 2016, respectively), and far-field areas (266 organisms/m^2 in 2016; Figure 5), however density remained significantly lower than reference (Figure 5; Minnow 2016b, 2017a). Recovery of taxon richness was also documented (particularly at the near-field area; 4.6 to 6.2 taxa in 2015 and 2016, respectively), although differences in community composition remain (Minnow 2017a). Sediment transplant experiments indicated an increase in organism density and richness in exposed area sediment transplanted to the reference area, suggesting that sediment quality is not prohibitive of re-colonization (Minnow 2016b).

2.3.2 Tissue Quality

Benthic invertebrate tissue quality in Quesnel Lake was not assessed as part of baseline studies (1989-1996) for the Mount Polley mine (Table 2). Monitoring was initiated in 2012 as part of the ongoing characterization of selenium incorporation into the aquatic food chain in the vicinity of the Mount Polley Mine (see Sections 2.1.2 and 2.2.1). Sampling documented mean tissue selenium concentrations below the BCWQG in all areas of Quesnel Lake; 1.7 mg/kg dw near the Hazeltine Creek outlet, and 2.1 mg/kg dw at a reference area in the north arm of the lake (Minnow 2013a).

Following the TSF embankment breach, mean concentrations of all analytes identified as POIs and IPs in benthic invertebrate tissue (see Section 2.1.2) at the exposed shallow and deep areas of Quesnel Lake were similar to reference (including selenium), with the exception of copper which was significantly higher than reference at the deep exposed area in both 2015 and 2016 (147 to 178 mg/kg dw at exposed areas; 40 to 54.9 mg/kg dw at reference; Figure 3; Minnow 2016a, 2017b). As described previously (Section 2.1.2), these elevated benthic invertebrate concentrations could be attributed to higher sediment copper concentrations observed in this area and the confounding influence of gut contents (i.e., Chapman 1985; 2016). BSAFs for copper in the Quesnel Lake deep areas indicated relatively similar bioavailability between the exposed and reference areas (Minnow 2016a, 2017b), which is consistent with results of labile copper concentrations determined by DGTs (Minnow 2016d, Minnow 2017c).

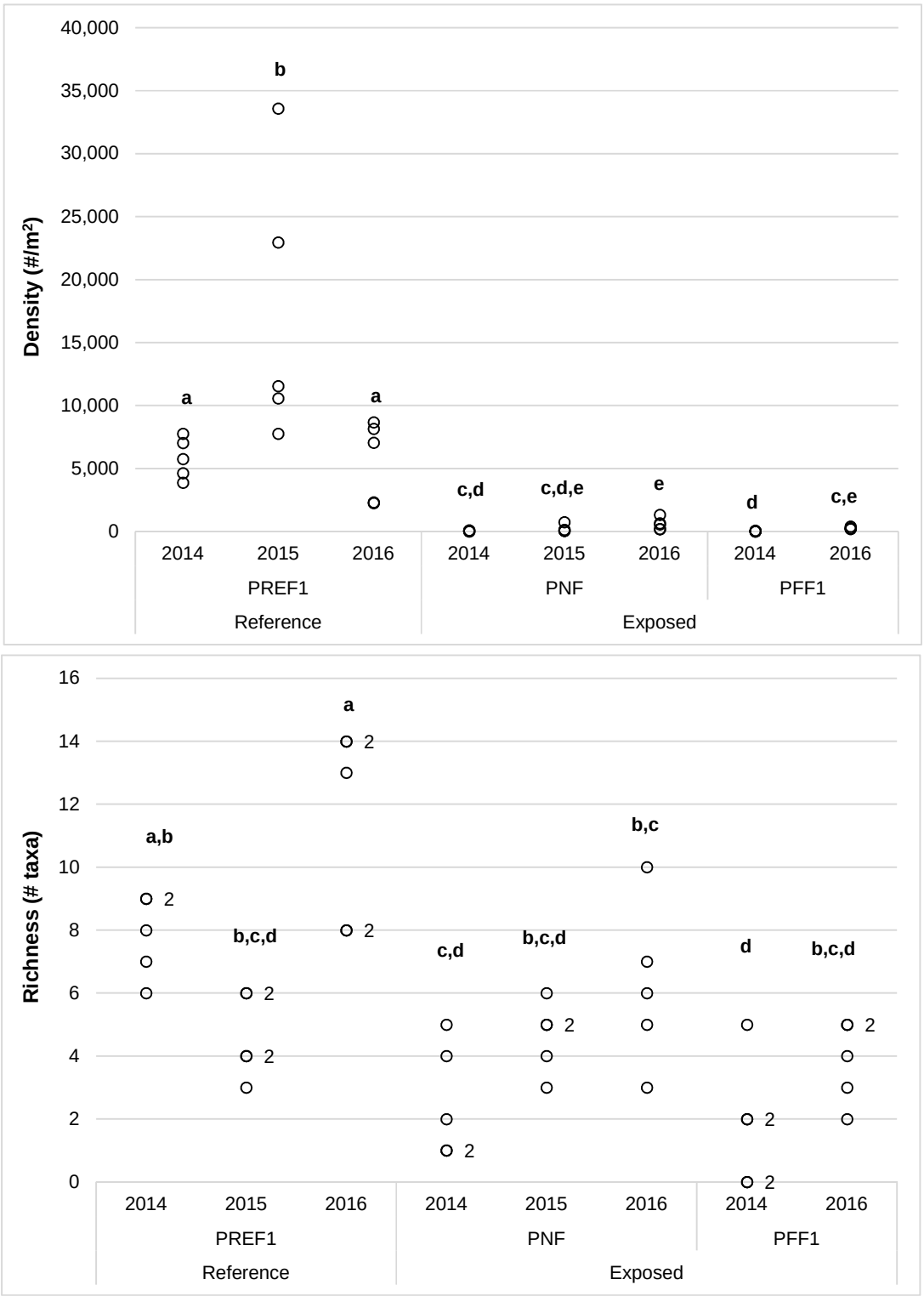


Figure 5: Benthic Invertebrate Community Endpoints in Quesnel Lake Deep Areas, Mount Polley Mine, 2014-2016 [a]

[a] Values shown beside data points indicate number of stations sharing a similar result. Areas not sharing a letter differed significantly ($p < 0.1$).

Note: Sample size = 5.

3 STUDY DESIGN OVERVIEW AND RATIONALE

Benthic invertebrate monitoring under the CEMP is designed to meet the combined needs of: 1) operational monitoring (including the discharge of treated effluent to Quesnel Lake); 2) monitoring of the impact of the 2014 TSF embankment breach; and 3) monitoring of the response to reclamation activity following the TSF embankment breach. An overview of the proposed benthic invertebrate monitoring program is provided in Table 3, and includes benthic invertebrate community, productivity, and tissue quality. Benthic invertebrate monitoring is focused on Polley Lake, Hazeltine Creek, lower Edney Creek, Quesnel Lake, and associated reference areas (Figures 6 and 7).

3.1 Community and Productivity

3.1.1 Lakes

Benthic invertebrate community monitoring in lakes is focused on Polley Lake and Quesnel Lake, with reference areas identified for each mine-influenced sampling area (i.e., Bootjack Lake for Polley Lake, unaffected areas of Quesnel Lake for impacted areas of Quesnel Lake; Table 3; Figure 6). In Polley Lake, benthic invertebrate community sampling will focus on the two basins (deepest locations in Polley Lake, representing locations of sediment accumulation/fate, and long-term monitoring locations), with the deepest location in Bootjack Lake serving as reference. In Quesnel Lake, benthic invertebrate community sampling for MDMER EEM will focus on the area near the point of effluent discharge (per Minnow 2016e) with two areas serving as reference (one unaffected by the breach and one affected by the breach but outside of the influence of effluent discharge; Minnow 2018c). Sediment investigations following the TSF embankment breach indicated that the majority of breach-derived material was deposited to deep habitat of Quesnel Lake (Minnow 2015a,b, 2016c), therefore benthic invertebrate community sampling in Quesnel Lake will focus on the deep areas that were previously monitored as near-field and far-field areas, with concurrent sampling of suitable reference areas.

Benthic invertebrate community sampling will be completed in August or September using a petite-ponar, consistent with previous data collections (HKP 1996, 1997; Beak 2000; Minnow 2015a, 2016b,e, 2017a), and with technical guidance (e.g., Environment Canada 2012a; BCMOE 2013, 2016). Detailed methodology is provided in Section 4, including: quality assurance/quality control, sample collection methods, sample handling and laboratory analysis, data quality review, data handling, interpretation, and reporting. Sampling will be supported by sediment quality sampling (see CEMP Section 6.12), measurements of *in situ* water quality near the sediment-water interface (temperature, dissolved oxygen, pH, and specific conductance), water depth, GPS coordinates, and supporting photographs at all sampling stations. Data

Table 3: Mount Polley CEMP Benthic Invertebrate Monitoring Program Overview

A) Lakes

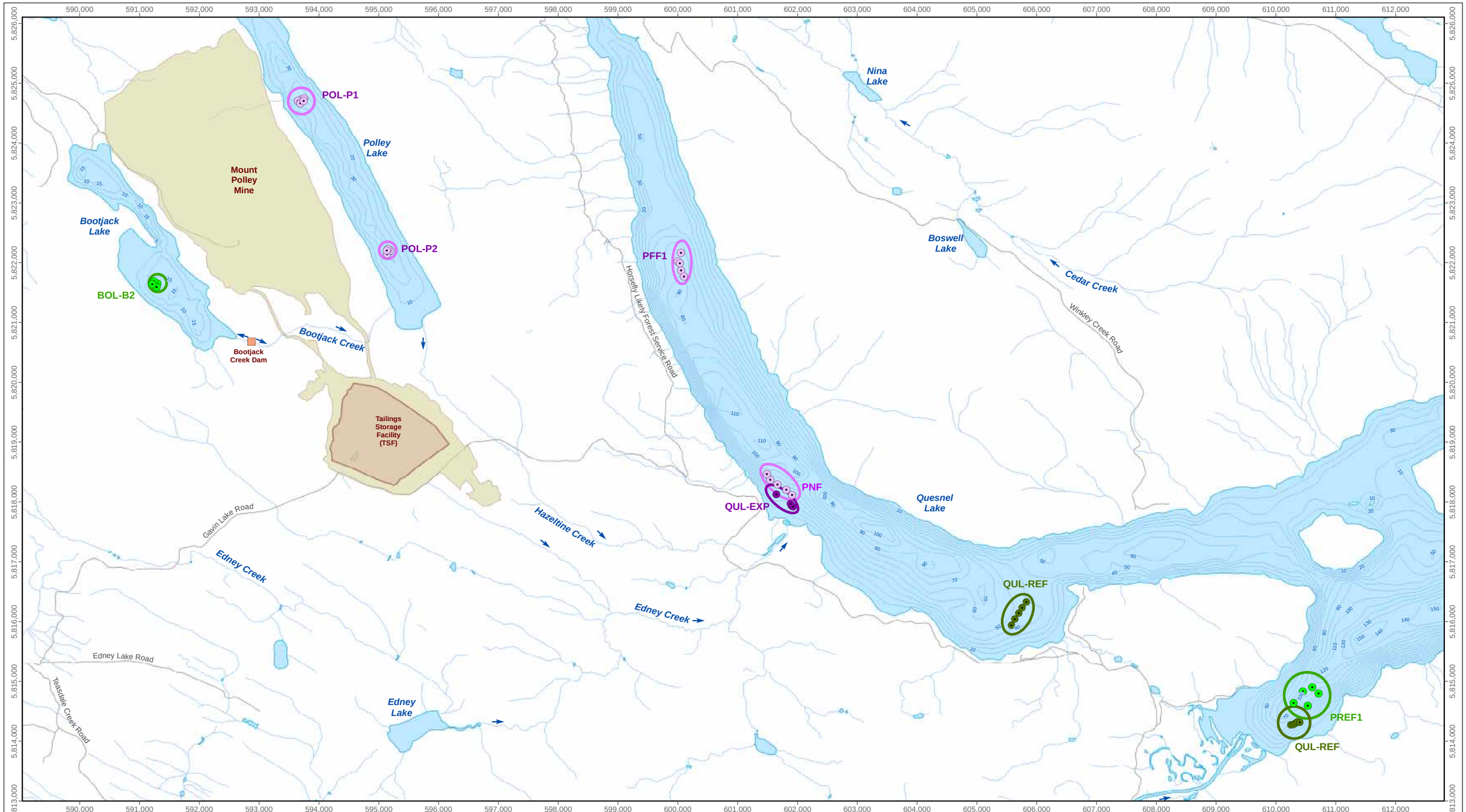
Water Body	Sampling Area	Type	Components [a]	Replication [b]	Rationale
Polley Lake	POL - P1 (Northwest Basin)	Exposed	T	5	immediately adjacent to mine and breach-influenced
	POL - P2 (Southeast Basin)	Exposed	T	5	immediately adjacent to mine and breach-influenced
Bootjack Lake	BOL - B2 (Southeast Basin)	Reference	T	5	reference for Polley Lake
Quesnel Lake	QUL - EEMNF	Exposed	T	5	adjacent to effluent discharge and breach-influenced
	QUL - EEMREF1	Reference	T	5	reference for EEMNF - breach-influenced reference
	QUL - EEMREF2	Reference	T	5	reference for EEMNF - non-breach-influenced reference
	QUL - PNF	Exposed	T	5	breach-influenced deep habitat
	QUL - PFF1	Exposed	T	5	breach influenced deep habitat
	QUL - PREF1	Reference	T	5	reference for exposed deep habitat areas of Quesnel Lake

[a] Core benthic invertebrate monitoring components: T = community taxonomy (Lowest-Practicable-Level).
[b] Number of replicate stations within the specified sampling area.

B) Creeks

Water Body	Sampling Area	Type	Monitoring Frequency	Components [a]	Replication [b]			Rationale
					T	P	C	
Hazeltine Creek	HAC-R1 (Upper, Reach 1)	Exposed	Annual	T,P,C	5	5	8	adjacent to mine and breach-influenced
	HAC-U (Upper)	Exposed	Annual	T,P,C	5	5	8	adjacent to mine, previously effluent-exposed, and breach-influenced
	HAC-D (Lower)	Exposed	Bi-annual [c]	T,P,C	5	5	8	adjacent to mine, previously effluent-exposed, and breach-influenced
Frypan Creek	FPC-R3 (Reach 3)	Reference	2018 only	P, C	-	5	8	reference for upper Hazeltine Creek
Edney Creek	EDC-U (Upper)	Reference	Annual	T,P,C	5	5	8	reference for upper Hazeltine Creek
	E1 (Lower)	Exposed	Bi-annual [c]	T,P	5	5	-	adjacent to mine and breach-influenced
	EDC-D (Lower, unimpacted)	Reference	Bi-annual [c]	T,P,C	5	5	8	reference for lower Hazeltine Creek [d]

[a] Core benthic invertebrate monitoring components: T = community taxonomy (Lowest-Practicable-Level), P = productivity (wet and dry benthic biomass), and C = chemistry (see Table 4 for analytes).
[b] Number of replicate stations within the specified sampling area for a given program component.
[c] Bi-annual indicates sampling will occur every other year for all parameters indicated with the exception of tissue chemistry, which will be monitored annually. The next bi-annual sampling event will occur in 2019.
[d] Lower Edney Creek reference area will be located in an unimpacted area upstream of the breach influence (see Figure 7).



Benthic Invertebrate Monitoring Station

- Reference Deep
- Exposed Deep
- Reference EEM
- Exposed EEM

Benthic Invertebrate Monitoring Area

- Reference Deep
- Exposed Deep
- Reference EEM
- Exposed EEM

Please note: Quesnel Lake bathymetry lines are an approximate representation only and may not precisely delineate accurate depths at larger scales.

0 1 2 4
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 10U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

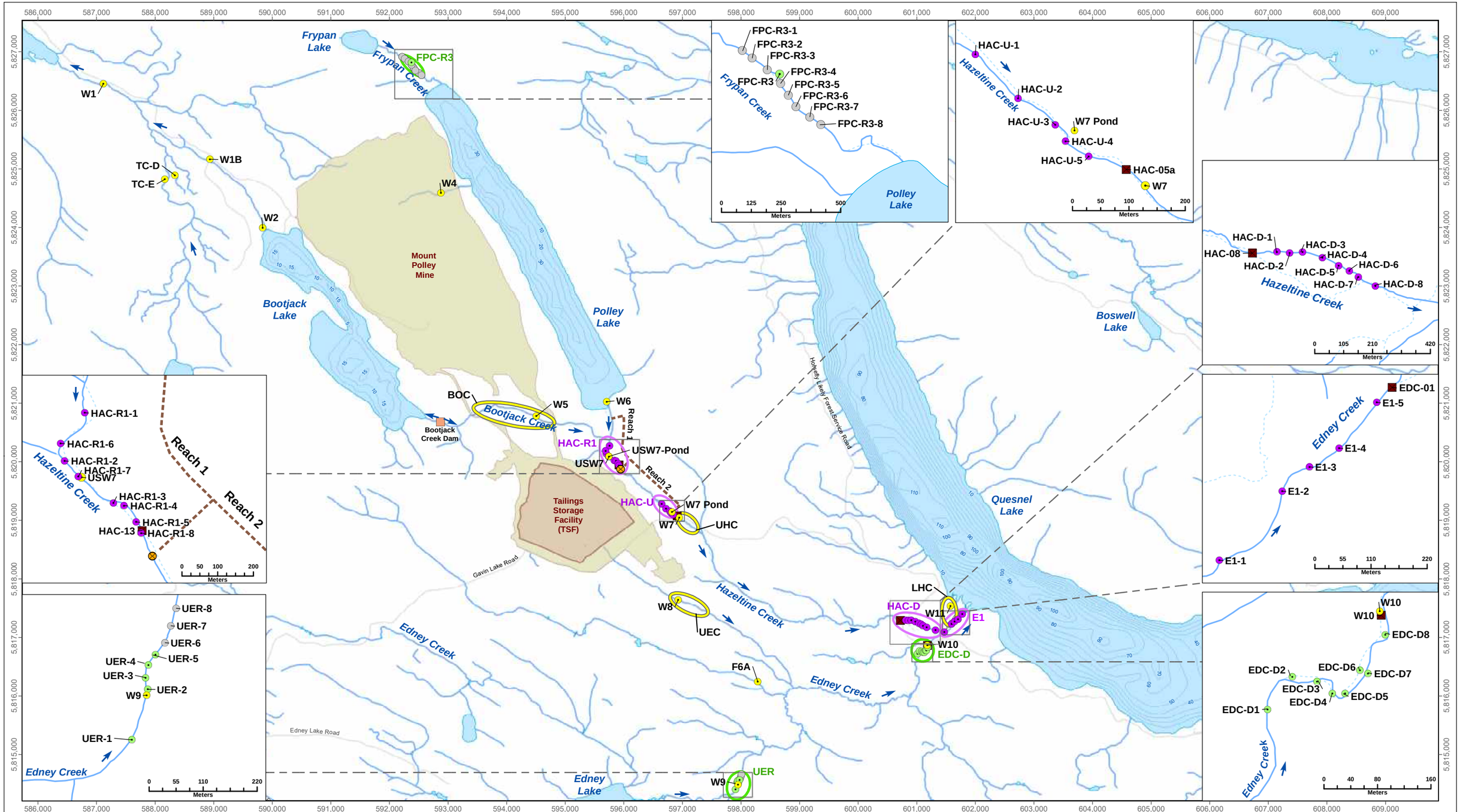
Mount Polley CEMP Benthic Invertebrate Monitoring Location, Lakes

Date: June 2018
Project 177202.0042

minnow environmental inc

Figure 6

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\1-Benthos\17-42 Fig 6 CEMP Benthic.mxd



Benthic Invertebrate Monitoring Station

- Rehabilitated
- Reference
- Pre-Breach (n ≥ 5 at location)
- Conceptual
- Effluent Discharge from 2014 to 2017
- Routine Water Quality Station
- Rehabilited Reaches (Golder 2017a,b)
- Tailings Storage Facility
- Active Mine Operation

Benthic Invertebrate Monitoring Area

- Rehabilitated
- Reference
- Pre-Breach (n ≥ 5 within area)
- Historic Watercourse Pathway

Note: Sampling Location may be adjusted from those shown displayed based on field survey information.

0 1 2 4 km

N W E S

Projection: North American Datum 1983 UTM Zone 10U

Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Mount Polley CEMP Benthic Invertebrate Monitoring Locations, Creeks

Date June 2018
Project 177202.0042

minnow environmental inc.

Figure 7

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\1-Benthos\17-42 Fig 7 MP PER and BI Creek.mxd

interpretation will be based on a combination of: 1) statistical comparison to previous conditions; and 2) statistical comparison to reference conditions. Accordingly, five stations per area are proposed for each sampling area to provide replication for the statistical contrasts.

The frequency of benthic invertebrate community monitoring at the federal EEM sampling areas in Quesnel Lake (to evaluate potential effects of effluent discharge) is initially at a prescribed frequency of every three years, subject to modification based on the findings of at least two EEM phases (Environment Canada 2012a). Additional benthic invertebrate community sampling in Quesnel Lake and Polley Lake (not associated with EEM) will also initially be completed in 2018 and then every three years concurrent with EEM (2018, 2021, etc.). Based on results of benthic invertebrate community monitoring undertaken from 2014 to 2017 which demonstrated some recovery following the TSF embankment breach (see Section 2 for details), and on low sediment deposition rates documented in Polley Lake and Quesnel Lake (see CEMP Section 6.12), it is anticipated that a three-year frequency will be sufficient to track benthic invertebrate recovery. Monitoring frequencies will be reviewed following interpretation of data collected in 2020, and design modifications (e.g., changes to monitoring frequency or locations) may be made in response to QP recommendations. These may include further reduction in monitoring frequency if continued recovery of benthic community results relative to reference is demonstrated.

3.1.2 Creeks

Benthic invertebrate community monitoring in creeks is focused on rehabilitated areas of Hazeltine Creek and lower Edney Creek, with reference areas identified for each mine-influenced sampling area (i.e., upper Edney Creek and Frypan Creek for upper Hazeltine Creek, and an unaffected area of lower Edney Creek for rehabilitated areas of lower Edney Creek and lower Hazeltine Creek; Table 3; Figure 7). Benthic invertebrate monitoring in Hazeltine Creek will focus on three areas (Figure 7)[3], including one area in Reach 1 (HAC-R1; where rehabilitation was completed in 2016), one area in Reach 2 (HAC-U; where rehabilitation was completed in 2017), and one area in lower Hazeltine Creek (HAC-D; where initial rehabilitation activities have been completed but additional rehabilitation will be conducted). The locations of sampling areas in upper and lower Hazeltine Creek (HAC-U and HAC-D) are generally consistent with those monitored prior to the TSF embankment breach, as is the location of the upper Edney Creek reference area (UER; Figure 7). Monitoring in lower Edney Creek will focus on one rehabilitated area (E1; where rehabilitation was completed in 2015). Suitable reference areas will be sampled concurrently. In Frypan Creek, the reference sampling area was selected to match habitat

[3] Note that previous creek sampling station locations are presented in Figure 7. These locations may change slightly depending on substrate, water depth, and water velocity. Similarly, conceptual station locations are displayed for Frypan Creek and Upper Edney reference areas, and will be established during the field campaign.

conditions in upper Hazeltine Creek as closely as possible, based on results of preliminary fish habitat assessment and benthic invertebrate monitoring (area selection was based primarily on substrate type and size; Minnow 2018d). The location of all benthic invertebrate community sampling stations will align with those proposed for periphyton monitoring (see CEMP Section 6.15).

Benthic invertebrate community sampling will be completed in August or September using a Hess or Surber sampler[4], consistent with previous data collections (HKP 1996, 1997; Beak 2000; Minnow 2009, 2016b, 2017a, 2018a). Detailed methodology is provided in Section 4. All benthic invertebrate community samples collected from creeks will also be evaluated for benthic invertebrate productivity (biomass; through the documentation of benthic invertebrate community sample weight by the laboratory) for the purposes of relating productivity to the assessment of fish habitat. Sampling at each station will be supported by measures of sampling depth, water velocity, in situ water quality measurements (as outlined in Section 3.1.1), GPS coordinates, notes of the presence of aquatic vegetation/bryophytes on sampled substrate and other physical observations, and supporting photographs of the sampling location and samples. Supporting grab water samples will also be collected during the sampling event in areas where water quality is not routinely monitored by the Mount Polley Mine (i.e., Frypan Creek and upper Edney reference). Data interpretation will be based on a combination of: 1) statistical comparison to previous conditions; and 2) statistical comparison to reference conditions. Accordingly, five stations per area are proposed to provide replication for the statistical contrasts.

The initial frequency of benthic invertebrate community and productivity monitoring in Reaches 1 and 2 of upper Hazeltine Creek (and associated reference areas) is annual given the recent disturbance to these rehabilitated areas, and recent reopening of upper Hazeltine Creek as fish habitat to Polley Lake fish. The frequency in rehabilitated areas of lower Hazeltine Creek and lower Edney Creek (and associated reference areas) is every second year because these areas have been undisturbed since 2015 and the benthic community monitoring in these areas has demonstrated recovery (Minnow 2016b, 2017a, 2018a; see Section 2.2). Monitoring frequencies will be reviewed following interpretation of data collected in 2020, and design modifications (e.g., changes to monitoring frequency or locations) may be made in response to QP recommendations. If results indicate stabilizing benthic communities and productivity during this period, then a reduction of monitoring frequency to every second year will be considered for upper Hazeltine Creek areas. The Frypan Creek reference area will only be sampled in 2018 (Table 3) to provide

[4] If sufficient sampling locations with habitat attributes suitable for Hess/Surber sampling cannot be located (particularly in the recently rehabilitated areas of upper Hazeltine Creek), kick and sweep sampling consistent with CABIN guidance (Environment Canada 2012a) may be implemented instead of Hess/Surber sampling.

comparison for benthic community data from upper Hazeltine Creek following the initial reopening of upper Hazeltine Creek as fish habitat (Minnow 2018e).

3.2 Tissue Quality

Benthic invertebrate tissue quality monitoring is focused on upper and lower areas of Hazeltine Creek, with reference areas identified for each mine-influenced sampling area (i.e., upper Edney Creek and Frypan Creek for upper Hazeltine Creek, and lower Edney Creek for lower Hazeltine Creek; Table 3; Figure 7). Benthic invertebrate tissue quality monitoring in Hazeltine Creek is undertaken to monitor the combined influence of uncontrolled surface runoff from the north dump and downstream influence on Hazeltine Creek (which occurred from 2006 to 2009), the conveyance of mine effluent between December 2015 to December 2017, and the TSF embankment breach. Benthic invertebrate tissue quality monitoring will focus on three areas of Hazeltine Creek, including one area in Reach 1 (HAC-R1) and one in Reach 2 (HAC-U) of upper Hazeltine Creek, and one area in lower Hazeltine Creek (HAC-D). As described in Section 3.1.2, the locations of sampling areas in upper and lower Hazeltine Creek are generally consistent with those monitored prior to the TSF embankment breach (Figure 7). It should be noted that sampling areas HAC-U and HAC-D were previously exposed to the discharge of treated mine effluent (December 2015 to December 2017), whereas HAC-R1 is located upstream of the previous discharge point (Figure 7). As of November 2017, treated effluent is no longer discharged into Hazeltine Creek, and upper Hazeltine Creek has been reopened as fish habitat to Polley Lake fish as of spring 2018.

Benthic invertebrate tissue quality sampling will be completed in August or September concurrent with benthic invertebrate community sample collections described in Section 3.1.2, and will be consistent with previous data collections (Minnow 2011, 2013a,b, 2016a, 2017b, 2018b). Tissue samples collected from each station will include one composite-taxa sample that contains a mixture of taxa that is proportional to biomass at the station, and one single-taxon sample[5] (e.g., a sample of only one taxon). Composite-taxa benthic invertebrate tissue samples are reflective of dietary exposure for fish, and can therefore be used in assessment of fish habitat. Alternatively, single-taxon samples are beneficial for limiting variability associated with different benthic invertebrate taxon composition. The collection of both sample types will ensure temporal comparability with previous data collections which have included both composite-taxa and single-taxon tissue samples (e.g., Minnow 2011, 2013a,b, 2016a, 2017b, 2018b). Tissues will be collected for the analytical determination of moisture content, metals, and mercury (Section 4.3.2). Supporting measures at each station will include *in situ* water quality measurements as outlined

[5] Single-taxon sampling will be completed only if adequate sample material from any one taxon can be collected with a reasonable sampling effort.

above (Section 3.1.1), GPS coordinates, physical observations, and supporting photographs. Supporting grab water samples will also be collected during the sampling event in areas where water quality is not routinely monitored by the Mount Polley Mine (i.e., Frypan Creek and upper Edney reference areas). Data interpretation for all parameters will be based on a combination of: 1) statistical comparison to previous conditions; 2) statistical comparison to reference conditions; and 3) comparison relative to BCWQG (i.e., tissue selenium concentrations; BCMOE 2014). A replication level of eight samples per area will be used to support the statistical contrasts.

The initial frequency of benthic invertebrate tissue quality monitoring at Hazeltine Creek (and associated reference areas) is annual given the recent disturbance of upper creek areas related to rehabilitation activities, and changes to the effluent exposure status. Monitoring frequencies will be reviewed following interpretation of data collected in 2020, and design modifications (e.g., changes to monitoring frequency or locations) may be made in response to QP recommendations. If results indicate stabilizing or decreasing benthic tissue concentrations during this period, then a reduction of monitoring frequency to every second year will be considered. The Frypan Creek reference area which is included for comparison with upper Hazeltine Creek will be sampled in 2018 only (see Table 3). Benthic invertebrate tissue quality sampling at this reference area will support rainbow trout tissue quality sampling in these areas only in 2018 following the initial reopening of upper Hazeltine Creek as fish habitat (Minnow 2018e).

4 METHODOLOGY

4.1 Quality Assurance / Quality Control

All sampling will be performed by qualified field staff experienced in the implementation of benthic invertebrate community, productivity, and tissue chemistry monitoring programs. All sample collection, quality assurance and quality control, and laboratory analysis methods will be implemented in accordance with technical guidance (BCMOE 2013, 2015, 2016). Specifically, quality assurance and quality control measures will include program review prior implementation, adequate resources for all field teams including field checklists and field data sheets, the availability and maintenance of clean sampling equipment and sampling containers, and sampling in a manner that minimizes any risk of sample contamination.

Quality control (QC) samples will be collected to support the benthic invertebrate tissue quality monitoring program. To capture within-area variability, eight replicate composite-taxa and up to eight replicate single-taxa tissue quality samples will be collected from each sampling area. Field duplicate samples (i.e. splits samples of the benthic invertebrate tissue collected from one sampling station) will be collected for 10% of samples to assess field precision as part of the Data Quality Review (DQR; Section 4.4). Duplicate water samples will be collected at a frequency of 10% to assess field precision associated with the water samples that support benthic invertebrate community and tissue quality monitoring. In addition to field QA/QC, the laboratory responsible for chemical analyses will be accredited by the Canadian Association for Laboratory Accreditation (CALA) for these analyses. Specific QC sampling and associated reporting for tissue quality results will be requested of the analytical laboratory, including reagent blank results, laboratory replicate results, and laboratory accuracy results (i.e., matrix spikes, laboratory control samples, and/or certified reference materials). Laboratory Reporting Limits (LRLs) will also be evaluated in comparison to targets established by the analytical laboratory.

QC samples to assess field precision (field duplicates) will not be collected for benthic community or productivity monitoring endpoints due to the high inherent natural variability of these parameters. However, composite benthic invertebrate community samples will be collected at all sampling locations to ensure that each sample is representative of the station. Taxonomic identification of benthic invertebrate community samples will be completed by a qualified laboratory certified under the Taxonomic Certification Program of the Society for Freshwater Science (SFS; formerly the North American Benthological Society). Quality control for benthic invertebrate taxonomic analyses will be consistent with federal requirements for metal mining EEM (Environment Canada 2012a). Specific QC sampling and associated reporting will be requested from the taxonomic laboratory, including an assessment of sub-sampling error, sorting

efficiency, and identification accuracy (Environment Canada 2012a, 2014). These results will be assessed as part of the DQR (Section 4.4).

All raw field data will be transcribed from field sheets into an electronic spreadsheet. Data will then checked by a separate individual for data entry errors as part of routine Quality Assurance/Quality Control (QA/QC) procedures.

4.2 Sample Collection Methods

4.2.1 Community and Productivity

Benthic invertebrate sampling in lakes for community analysis will be collected using a stainless steel petite ponar grab sampler, consistent with previous monitoring (e.g., Minnow 2015a, 2016b,d, 2017a, 2018a) and in accordance with provincial and federal technical guidance (i.e., BCMOE 2013; Environment Canada 2012a). Briefly, the petite ponar is a 6" x 6" (15.24 cm x 15.24 cm) grab sampler with jaws that can be held open by shear-pressure on a spring-loaded pin. The grab sampler is lowered to the substrate at which point shear-pressure is eliminated and the pin springs out. Upon upward pull at the initiation of retrieval, the jaws of the ponar close to grab surficial sediment. Care must be taken to control the rate at which the petite ponar is lowered to allow appropriate sediment penetration and to minimize sediment disturbance. The petite ponar will be carefully retrieved to surface and each grab will be placed into a plastic tote and observed for completeness and any unusual characteristics. In Quesnel Lake, samples will be retrieved with the assistance of a commercial line hauler (Ace Line Hauler - Brutus Plus 40). Only high quality, comparable samples will be retained. If the sample is deemed acceptable, the sample will rinsed from the ponar into the tub to ensure the complete removal of all material The sample material will then be placed into a 250 µm mesh sieve bag and sieved free of all material less than 250 µm in diameter. At each station, a composite sample of five acceptable grabs will be collected (0.116 m^2 of bottom area in total) to ensure that each sample is representative of the station. After sieving, the retained material (sample) from the five composited grabs will then be carefully transferred to 1 or 2-L wide mouth plastic jars using a wash bottle while working over a plastic tub to avoid any potential loss of organisms. Any organisms that adhere to the inside of the sieve bag will be retrieved and added to the sample jar. Each jar will receive an internal and external label with the station number, area identifier, project number, date, and the initials of the field personnel. Each sample will be preserved with a 10% buffered formalin solution within six hours of collection to eliminate the potential effects of within-sample predation, which could affect abundance estimates. Sampling will be conducted at five replicate stations in each area (see Table 3).

Supporting information collected at all lake sampling stations will include sediment quality measures (see CEMP Section 6.12), GPS (Geographic Positioning System) coordinates; water depth; *in situ* water quality near the sediment-water interface (temperature, dissolved oxygen, pH, and specific conductance), site and sample photographs, notes of the presence or absence of aquatic vegetation, and other physical observations (sediment texture, colour, density, etc.). In addition, a full vertical profile of the field meter measurements will collected at one station per area. Supporting water samples will also be collected from each sampling area associated with EEM (see Table 3), including samples for total and dissolved constituents (including metals), the latter prepared by field filtration using a 0.45 µm syringe filter. Water samples will be placed into a dedicated cooler with frozen ice packs, and kept cool prior to transport to the field laboratory.

Sampling of benthic invertebrates in creeks for community and productivity analysis will be consistent with previous monitoring (e.g., Minnow 2009, 2016b, 2017a, 2018a), and with technical guidance (BCMOE 2013). A Hess sampler with a 0.1 m^2 diameter and upstream (incurrent) and downstream (excurrent) openings will be used if water depth allows. The incurrent opening will be covered with a mesh to prevent contamination of the sample with organisms from upstream. The excurrent opening will consist of a conical net equipped with 250 µm mesh attached to a removable collection cup that has mesh on the downstream end to allow water to exit. If creek environments are too shallow to accommodate Hess sampling, a Surber sampler (30.5 x 30.5 cm; 0.093 m^2) equipped with 250 µm mesh will be used. Each Hess/Surber sample will be collected by firmly and carefully placing the sampler on undisturbed substrate to a depth of 5 to 10 cm. All cobble and gravel within the sampler area (to a depth of approximately 10 cm) will be scrubbed and the current will be allowed to carry all dislodged organisms into the 250 µm net. The sampler net and collection cup will be rinsed and the contents will be carefully transferred to internally and externally labelled 1 or 2 L wide mouth plastic jars. Any remaining invertebrates found clinging to the sampling equipment will be removed and placed in the sample jar. At each station, one composite sample of three sub-samples (i.e., approximately 0.3 m^2 of creek surface area if a Hess sampler is used, 0.279 m^2 if a Surber sampler is used) will be collected to ensure that each sample is representative of the station. Each sample will be preserved with a 10% buffered formalin solution as described above. Sampling will be conducted at five replicate stations in each area (see Table 3), and each station will be established at a minimum distance of approximately three bankfull widths from adjacent stations, where habitat allows. A concerted effort will be made to

ensure that water velocity, water depth, and substrate characteristics are comparable among sub-samples and among respective stations to minimize natural influences on community variability[6].

Supporting information collected at each creek sampling station will include those parameters listed above for lakes, with the addition of substrate size measurements wherein 100 randomly selected substrate pebbles per station will be measured along their intermediate axis and the percent embeddedness 10% of the pebbles will be recorded, consistent with the CABIN protocol (Environment Canada 2012b). Supporting grab water samples will also be collected during the sampling event in areas where water quality is not routinely monitored by the Mount Polley Mine (e.g., in Frypan Creek and upper Edney Creek). Water samples will be collected as described above.

4.2.2 Tissue Quality

Benthic invertebrate tissue samples will be collected using a combination of hand picking and kick-and-sweep, consistent with previous monitoring (e.g., Minnow 2011, 2013a,b, 2016a, 2017b, 2018b) and with technical guidance (e.g., BCMOE 2016). Hand picking entails overturning rocks in the streambed and collecting any of benthic invertebrates observed. The kick-and-sweep method involves a field technician moving upstream and across the stream channel (in a zig-zag pattern) while holding a kick net (a net with a triangular opening and a 400 µm mesh bag) immediately downstream, and disturbing the substrate with his or her feet to dislodge benthic organisms into the net (a method modified from the Canadian Aquatic Biomonitoring Network [CABIN] 3-minute travelling kick-and-sweep; Environment Canada 2012b). The net will then be rinsed with water to move all debris and invertebrates to the collection cup at the bottom of the net. The collection cup will be removed and its contents (i.e., invertebrates and debris) will be placed into a plastic tote. Organisms will then be picked free of debris, and transferred into a labeled scintillation vial, without rinsing, to minimize the amount of water in each sample. One composite-taxa sample (containing a mixture of taxa that is proportional to biomass at the station), and one single-taxon sample (containing one taxon only) will be collected at each station. As possible, the taxa selected for the single-taxon samples will be consistent among sampling areas, and consistent with previous monitoring (Minnow 2017b, 2018b). However, single-taxon sampling will only be completed at each station if adequate sample material can be collected with a reasonable sampling effort[7]. Sampling will be conducted at eight replicate stations in each area

[6] If five stations with closely matching habitat attributes cannot be located (particularly in the recently rehabilitated areas of upper Hazeltine Creek), kick and sweep sampling consistent with CABIN guidance (Environment Canada 2012a) may be implemented instead of Hess/Surber sampling.

[7] A reasonable sampling effort will be considered approximately 1 hour per sample. If sample collection is nearly complete within this time frame, additional sampling effort will be applied to complete the sample collection.

(see Table 3). Samples will stored in a cooler containing ice packs for transport to the mine, where they will be frozen.

4.3 Sample Handling and Laboratory Analysis

4.3.1 Community and Productivity

Preserved benthic invertebrate community samples will be stored at room temperature until shipment to the laboratory for taxonomic identification and enumeration. Samples will be shipped with completed Chain-of-Custody (COC) forms immediately after the completion of the field campaign, however there are no recommended hold times for analysis.

Taxonomic identification of benthic invertebrate community samples will be completed by a qualified laboratory using standard methods that incorporate QA/QC measures (e.g., Environment Canada 2012a; 2014). Upon sample receipt, the laboratory will provide a sample receipt confirmation which will be reviewed to ensure that all samples are received and that the analytical requests are properly logged. All samples will be sieved and processed in the laboratory using the same mesh size as used in during field collections (250 µm), with the exception of those collected for MDMER EEM which will be identified and enumerated based on both the 250 µm and 500 µm fractions (Minnow 2018c). If the estimated number of invertebrates in a sample is greater than 600 individuals and the sample is fine and non-clumping, a subsample will be taken using a Marchant Box (Marchant 1989) as described by Environment Canada (2014). Samples (or sub-samples) will then be sorted using a gridded Petri dish under a low power stereo microscope into family/order while maintaining counts (but totals exclude Porifera, Nemata, Platyhelminthes, Ostracoda, Copepoda, Cladocera, and any terrestrial drop-ins). All samples will be processed to a minimum 300 organism count, and if 300 organisms have not been reached by the 50th cell of the Marchant Box, then the entire sample will be sorted (i.e., all 100 cells). All sorted organisms will be stored in 80% ethanol by family/order in separate labeled vials and debris will be preserved and labeled separately. Identifications of all insects to the lowest practicable level (LPL; typically genus or species) and non-insects to the genus/species level (where possible, but to a minimum of family level) will be conducted by experienced, certified taxonomists using up-to-date taxonomic keys, comparisons to an externally-verified reference collection, and effort lists compiled by CABIN, SAFIT (Southwest Association of Freshwater Invertebrate Taxonomists), and PNAMP (Pacific Northwest Aquatic Monitoring Partnership). Following identification, representative specimens may be preserved and retained for inclusion in a voucher collection for Mount Polley.

Following taxonomic identification, the wet and dry biomass of total organisms in each sample from creek environments (benthic invertebrate productivity) will be determined. For wet biomass,

samples will be poured through a piece of pre-weighed 212 µm Nitex mesh and dried gently between two pieces of absorbent paper. Each sample will then be weighed to the nearest 0.0001 g, and the weight of the mesh will be subtracted from the total weight to determine total sample wet weight. For dry biomass, wet samples will be then placed on a piece of pre-dried and pre-weighed glass fiber filter before being dried at 160^0F (71°C) for six hours. Following a short period of cooling, samples will be weighed as described above, and total sample dry weight will be calculated.

4.3.2 Tissue Quality

Benthic invertebrate tissue quality samples will remain frozen until overnight shipment on ice with completed COCs to ALS Environmental, Burnaby BC; an analytical laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA). Samples will be sent to the laboratory with sufficient time to complete analyses within the recommended sample hold times. Analyses will be completed using methods that are consistent with those specified in the British Columbia Environmental Laboratory Manual (BCMOE 2015). Upon sample receipt, the laboratory will provide a sample receipt confirmation when the samples are received and logged. These receipts will be reviewed to ensure that all samples are received and that the analytical requests are properly logged. Tissue quality samples will be analysed for metals by CRC-ICP-MS (Collision Cell Inductively Coupled Plasma-Mass Spectrometry; USEPA Method 200.3 [USEPA 1991]/6020A [USEPA 2004]) or HR-ICP-MS (High Resolution Inductively Coupled Plasma-Mass Spectrometry; USEPA Method 200.3 [USEPA 1991]/ 200.8 [USEPA 1994]), mercury by CVAFS (Cold Vapour Atomic Fluorescence Spectrophotometry; USEPA Method 200.3 [USEPA 1991]/Method 245.7 [USEPA 2001]), and moisture content. The method selected for metals analysis will depend on sample weight, with HR-ICP-MS employed for smaller sample sizes. Tissue quality analytes are provided in Table 4, with the associated target LRLs, detection limit objectives outlined in technical guidance (“consensus detection limits”; BCMOE 2016), and available BCWQG (i.e., selenium; BCMOE 2014). Upon completion of the analyses, the laboratory will provide a data report in Microsoft (MS) Excel™ and as an Adobe Acrobat Portable Document Format (PDF). Reporting will include the results of the laboratory QC sample results.

4.4 Data Quality Review

Upon receipt of all analytical data, a Data Quality Review (DQR) will be performed. The DQR will confirm that all requested analyses are complete, and that acceptable LRLs have been achieved. The DQR will also include an evaluation of differences between duplicate (split) samples, as well as the QA/QC data reported by the laboratory. Completion of the DQR promptly following receipt of the benthic invertebrate monitoring data will ensure timely communication with the laboratory should any issues be identified

Table 4: Target Laboratory Reporting Limits (LRL) and Analytical Methods for Benthic Invertebrate Tissue Quality Analytes

Parameter	Metals in Tissue by HR-ICPMS Micro (USEPA 1991, 1994)		Metals in Tissue by CMC ICPMS (USEPA 1991, 2004)		Consensus DLs [a]	British Columbia Water Quality Guidelines [b]
Units	mg/kg wwt	mg/kg dw	mg/kg wwt	mg/kg dw	mg/kg wwt	mg/kg dw
Aluminum (Al)	1.0	5.0	0.40	2.0	0.40	-
Antimony (Sb)	0.0020	0.010	0.0020	0.010	0.0020	-
Arsenic (As)	0.0060	0.030	0.0040	0.020	0.0050	-
Barium (Ba)	0.010	0.050	0.010	0.050	0.010	-
Beryllium (Be)	0.0020	0.010	0.0020	0.010	0.0020	-
Bismuth (Bi)	0.0020	0.010	0.0020	0.010	0.0200	-
Boron (B)	0.20	1.0	0.20	1.0	-	-
Cadmium (Cd)	0.0020	0.010	0.0010	0.0050	0.0020	-
Calcium (Ca)	4.0	20	4.0	20	2.0	-
Cesium (Cs)	0.0010	0.0050	0.0010	0.0050	-	-
Chromium (Cr)	0.040	0.20	0.010	0.050	0.010	-
Cobalt (Co)	0.0040	0.020	0.0040	0.020	0.0040	-
Copper (Cu)	0.040	0.20	0.020	0.10	0.010	-
Iron (Fe)	1.0	5.0	0.60	3.0	1.0	-
Lead (Pb)	0.010	0.050	0.0040	0.020	0.0040	-
Lithium (Li)	0.10	0.50	0.10	0.50	-	-
Magnesium (Mg)	0.40	2.0	0.40	2.0	2.0	-
Manganese (Mn)	0.010	0.050	0.010	0.050	0.020	-
Mercury (Hg) [c]	0.0010	0.0050	-	-	0.002	-
Molybdenum (Mo)	0.0080	0.040	0.0040	0.020	0.010	-
Nickel (Ni)	0.040	0.20	0.040	0.20	0.010	-
Phosphorus (P)	2.0	10	2.0	10	5.0	-
Potassium (K)	4.0	20	4.0	20	10	-
Rubidium (Rb)	0.010	0.050	0.010	0.050	-	-
Selenium (Se)	0.020	0.10	0.010	0.050	0.020	4.0
Sodium (Na)	4.0	20	4.0	20	2.0	-
Strontium (Sr)	0.020	0.10	0.010	0.050	0.010	-
Tellurium (Te)	0.0040	0.020	0.0040	0.020	-	-
Thallium (Tl)	0.00040	0.0020	0.00040	0.0020	0.0010	-
Tin (Sn)	0.020	0.10	0.020	0.10	0.020	-
Uranium (U)	0.00040	0.0020	0.00040	0.0020	0.0010	-
Vanadium (V)	0.020	0.10	0.020	0.10	0.020	-
Zinc (Zn)	0.20	1.0	0.10	0.50	0.10	-
Zirconium (Zr)	0.040	0.20	0.040	0.20	-	-

[a] From Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BCMOE 2016).

[b] British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (BCMOE 2018).

[c] Method for total mercury analysis will be according to USEPA (1991, 2001).

For benthic invertebrate tissue quality samples, LRLs will be evaluated relative to targets established for the analytes, to "consensus detection limits" (Table 4), and to relevant British Columbia guidelines (i.e., selenium; BCMOE 2014). Comparisons between duplicate samples will be made by calculating the relative percent difference (RPD) of metal concentrations between paired duplicates. If the RPD is <25% for concentrations that are >5 times the LRL, then the duplicate sample results will be considered acceptable. Results for laboratory blanks, precision, and accuracy will be evaluated relative to Data Quality Objectives (DQO) established by the analytical laboratory that performed the analyses. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective LRLs, and the results will be used to identify potential contamination associated with equipment (e.g., cleanliness) and sample collection and handling procedures (e.g., collection, shipping). For benthic invertebrate community samples, reanalysis for quality control endpoints (organism sorting efficiency, subsampling precision and accuracy error, and taxonomic identification error) will be performed on 10% of samples, and results of quality control measures will be evaluated relative to pre-established DQOs. Specifically, evaluation of organism sorting efficiency will involve reprocessing previously sorted material from randomly selected samples, and then determining the number of invertebrates that were not recovered during processing of the original sample, and an efficiency of < 10% missed organisms will be considered acceptable. Evaluation of subsampling error provides a measure of analytical accuracy by comparing the numbers of benthic invertebrates recovered between at least two sub-samples, and of analytical precision by comparing sub-sample derived benthic invertebrate community numbers with the densities determined for whole benthic invertebrate community samples. An error of < 20% will be considered acceptable for subsampling accuracy and precision. Evaluation of taxonomic identification error involves an internal quality control audit of taxonomic identification results whereby blind re-enumeration and re-identification of random samples will be performed by an analyst not involved in the original sample processing, and an error of < 5% for this endpoint will be considered acceptable.

4.5 Data Handling and Interpretation

Upon receipt of data from the analytical laboratories, all laboratory data files will be managed by the Mount Polley Mining Corporation (MPMC) Environment Department. In addition, chemical data provided by the primary analytical laboratories as an Electronic Data Deliverable (EDD) will be imported directly into the MPMC's database following completion of the DQR. Following the data quality review described above (Section 4.4), all benthic invertebrate community, benthic invertebrate tissue chemistry data, and supporting data will be managed in Microsoft (MS) Excel™. For all replicated data (typically based on a sample size of five or eight stations per area), data will be provided to the QP for analysis and summarized by calculating mean, median,

standard deviation, minimum, and maximum for each endpoint. Data analysis will be completed for each monitoring component (community, productivity, and tissue quality).

4.5.1 Community and Productivity

Benthic invertebrate communities will be evaluated using metrics of organism density (organisms per m²; grab samples, and Hess/Surber samples) or abundance[8] (organisms per sample; kick-and-sweep samples), taxonomic richness, Simpson's Index of Diversity, Simpson's Index of Evenness (calculated as in Smith and Wilson 1996; Environment Canada 2012a). The Bray-Curtis Index of Dissimilarity will also be used in the evaluation of samples collected for MDMER EEM as per technical guidance (Environment Canada 2012a). These primary indices will be calculated at the LPL of taxonomy for the 250 µm fraction of all samples, with the exception of samples collected for EEM which will be calculated using family-level data for the 500 µm sample fraction (Minnow 2018c). The densities and relative densities of the most abundant taxa will also be calculated (relative densities calculated as the abundance of each respective dominant/indicator taxon relative to the total number of organisms in the sample and expressed as a percentage). Dominant/indicator taxon groups will be defined as those groups representing more than 5% of total organism abundance within each set of areas being compared, or any taxon groups considered to be important indicators of environmental stress. In addition, benthic invertebrate productivity in creeks will also be evaluated using wet and dry total biomass converted to a standard area-based measurement (g/m^2). Summary statistics for all endpoints will be reported by area and year as described above (sample size, mean, median, minimum, maximum, and standard deviation).

Correspondence analysis (CA) or Nonmetric Multidimensional Scaling (NMDS) multivariate ordination methods will be used to further examine benthic invertebrate community structure. These are multivariate ordination methods used to reduce multivariate data into a manageable number of variables and will be applied to assist in the identification of key spatial or temporal differences in benthic invertebrate community (i.e., which stations have distinct benthic communities but also how these benthic communities differ among stations). The results of these multivariate analyses will be incorporated into the comparison of benthic invertebrate indices described below.

Benthic invertebrate community and productivity metrics from exposed areas will be compared to reference results in a control-impact study design, as well as compared temporally to previous monitoring results if data are available. Comparisons will be completed primarily using Analysis

[8] Abundance (as opposed to density) will be calculated only if kick-and-sweep sampling methods are used in creek due to lack of suitable Hess/Surber sampling habitat. See Section 3.1.2 for details.

of Variance (ANOVA) to test for statistically significant differences. For these analyses, the assumptions of normality and homogeneity of variances will be tested on the residuals of the ANOVA model using the Shapiro-Wilk test and Levene's test based on median values, respectively, using a significance level (α) of 0.1. Data will be transformed as necessary to satisfy assumptions of normality and homogeneity of variance. In instances where the residuals of the ANOVA model do not meet the assumptions of normality and homogeneity of variances, a non-parametric Kruskal-Wallis test will be conducted. When the overall results of an ANOVA or Kruskal-Wallis test are significant, differences between specific areas will be evaluated using post-hoc contrasts for ANOVA or Dunn's test for the Kruskal-Wallis test. A Bonferroni correction on the p-values will be used to conserve the overall Type I error rate. Statistical temporal contrasts may also be completed using Two-Way ANOVA (with factors *Area* and *Year*) if data are available for both the exposed and reference areas for all years being evaluated. For the Two-Way ANOVA model, assumptions of normality and homogeneity will be tested on the residuals of the model as described above using the Shapiro-Wilk test and Levene's test based on median values, respectively ($\alpha = 0.05$). Data will be transformed as necessary to satisfy assumptions of normality and homogeneity of variance and if these assumptions are not met, the analysis will be conducted on ranks (equivalent to a non-parametric test). When the interaction between *Area* and *Year* is significant ($\alpha = 0.1$) the following post-hoc contrasts will be conducted, and when the interaction between *Area* and *Year* is not significant, the effect of area and year will be assessed ($\alpha = 0.1$) using the *Area* and *Year* terms in the ANOVA model. Further detailed analyses will be completed as required for data interpretation, and may include graphical comparisons to reference and historical data, and formal spatial statistical contrasts using methods similar to those described above.

If exposed versus reference or temporal differences in benthic invertebrate community and/or productivity results are noted, potential relationships between benthic invertebrate community metrics and physical and chemical conditions of the study areas will be explored using Spearman correlation (often referred to a Spearman Rank-Order correlation). For lake sampling areas, these physical/chemical endpoints may include results of multivariate statistical analyses used to identify key sediment quality parameters (e.g., CA or PCA axis scores; see CEMP Section 6.12). For most areas, correlation analyses will likely only include data from a single year of sampling in order to focus the analysis on differences between rehabilitated and exposed areas relative to reference, rather than on differences among years. Following the derivation of correlation coefficients, a Bonferroni-type correction (i.e., p-value [0.05] divided by the total number of correlations examined for independent variables) will be applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the

Bonferroni-adjusted p-value or at a p-value of 0.01 will be further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were "leveraged" by outlying points (or groups of points). Although it is recognized that a significant correlation or regression does not indicate causation (e.g., Norton et al. 2015), it is desirable to not only characterize the nature of a response (e.g., differences in benthic invertebrate community), but to also obtain evidence of cause. Correlation / regression analyses are commonly applied tools for identifying potential cause (e.g., Norton et al. 2015). Evidence of causation obtained from correlation or regression analysis will be carefully considered in light of the strength, range, and continuity of the relationships as well as mechanistic knowledge/understanding of potential cause.

4.5.2 Tissue Quality

Data analysis and interpretation of benthic invertebrate tissue quality results will focus on Parameters of Interest (POIs [representing the chemical influence of the TSF embankment breach on sediment quality]: arsenic, copper, iron, and nickel), and on Indicator Parameters (IPs [identified in evaluations of water, soil, or fish tissue quality for Hazeltine Creek]: calcium, cobalt, molybdenum, phosphorus, selenium, silver, sodium, titanium, and vanadium; Golder 2015b, 2016, Minnow 2015a). Benthic invertebrate tissue quality results for these analytes will be compared to available pre-breach data (for selenium only in 2009, 2012 and 2013, and for all analytes in 2010; Minnow 2011, 2013a,b), contrasted between exposed and reference areas, and also compared temporally within exposed areas. In addition, tissue quality results for selenium will be compared to the relevant BCWQG (BCMOE 2014). Detailed analyses and interpretation related to these comparisons will be completed as required, and may include: graphical comparisons to reference and historical data, and formal statistical contrasts of exposed versus reference concentrations tissue concentrations (control-impact study design using Analysis of Variance [ANOVA]) as described above. Formal statistical temporal and spatial contrasts may also be completed using ANOVA methods similar to those described for benthic invertebrate community data analysis to augment interpretation, where data allows.

Concentrations of the POIs and IPs in benthic invertebrate tissue will also be evaluated relative to concentrations in water. These ratios of concentrations will be calculated as: [tissue sample concentration]/[dissolved water concentration], and are referred to as Bioconcentration Factors (BCFs). BCFs are often used to describe the extent to which an analyte is taken up by an organism from the surrounding environment through exposure routes other than diet (i.e., Arnot and Gobas 2006), and are applicable to erosional areas where sediment is generally not present. BCFs will be calculated using tissue metal concentrations (dry weight) and mean dissolved metal concentrations in water from each sampling area. Calculated BCFs will then be qualitatively

compared among areas to identify differences in the uptake of metals by benthic invertebrate in areas impacted by effluent discharge and/or the TSF embankment breach.

Additionally, concentrations of POIs and IPs in benthic invertebrates will be evaluated relative to concentrations in periphyton, based on Trophic Transfer Factors (TTFs; the ratio of tissue concentrations in benthic invertebrates relative to concentrations in periphyton (i.e., TTF = [benthic invertebrate sample]/[periphyton sample]). TTFs can be used to generally describe the extent to which the concentration of an analyte increases between lower and higher trophic levels (e.g., Presser and Luoma 2010). TTFs greater than 1 indicate that the analyte is accumulating in benthic invertebrates to a greater extent than would be expected if ingestion of periphyton was the sole source of that analyte to the benthic invertebrates (assuming uptake and excretion of the analyte by the benthic invertebrates are equal). Co-located observations of benthic invertebrate and periphyton tissue chemistry will be used to calculate TTFs for each replicate station. Comparisons of TTFs will then be made between exposed and reference areas as well as with pre-breach results.

An interpretive report based on the benthic invertebrate monitoring data will be prepared for integration into the Annual Environmental and Reclamation Report for the Mount Polley Mine that is prepared annually by MPMC and submitted to the regulators and other stakeholders by March 31 of the following year. The interpretive report will provide all data in an appendix and will include the DQR, the results of the screening against BCWQG, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots.

5 REFERENCES

Arnot, J.A., and F.A.P.C. Gobas. 2006. A Review of Bioconcentration Factor (BCF) and Bioaccumulation Factor (BAF) Assessments for Organic Chemicals in Aquatic Organisms. Environ. Rev.14: 257 – 297.

BCMOE (British Columbia Ministry of Environment). 2013. British Columbia Field Sampling Manual For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples. 2013 Edition.

BCMOE. 2014. Ambient Water Quality Guidelines for Selenium. Technical Report Update. Water Protection and Sustainability Branch. April 2014.

BCMOE. 2015. British Columbia Environmental Laboratory Manual. 2015 Edition. Prepared and Published by the Ministry of Environment with the assistance of The British Columbia Environmental Laboratory Technical Advisory Committee. February.

BCMOE. 2016. Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators. Version 2. June.

BCMOE. 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture, Summary Report. Water Protection and Sustainability Branch. March 2018.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Beak (Beak International Incorporated). 2000. Mount Polley Biological Monitoring Program - 1999. Report Prepared for the Mount Polley Mining Corporation. April.

Beatty, J.M., L.E. McDonald, F.M. Westcott, and C.J. Perrin. 2006. Guidelines for Sampling Benthic Invertebrates in British Columbia Streams. British Columbia Ministry of Environment. Updated January.

Burkhard, L. 2009. Estimation of Biota Sediment Accumulation Factor (BSAF) from Paired Observations of Chemical Concentrations in Biota and Sediment. U.S. Environmental Protection Agency, Ecological Risk Assessment Support Center, Cincinnati, OH. EPA/600/R-06/047.

Chapman P.M. 1985. Effects of Gut Sediment Contents on Measurements of Metal Levels in Benthic Invertebrates - A Cautionary Note. Bull. Environ. Contam. Toxicol. 35:345–347.

Chapman, P.M. 2016. Sediment Contaminant Bioaccumulation: With or Without Gut Contents? Bull. Environ. Contam. Toxicol. DOI 10.1007/s00128-016-1785-8.

Environment Canada. 2012a. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada Report EEM/2002/1. June.

Environment Canada. 2012b. CABIN (Canadian Aquatic Biomonitoring Network) Field Manual: Wadeable Streams. Environment Canada. March.

Environment Canada. 2014. CABIN (Canadian Aquatic Biomonitoring Network) Laboratory Methods: Processing, Taxonomy, and Quality Control of Benthic Macroinvertebrate Samples. Environment Canada. May.

Feltmate, B.W., and B.G. Fraser. 1999. Determining Metal Related Impacts Utilizing Benthic Macroinvertebrate Population Level Fitness Parameters: Discussion Paper. Prepared for

Canada Centre for Mining and Energy Technology (CANMET) and Mining Association of Canada (MAC) for the Aquatic Effects Technology Evaluation (AETE) Program. February.

Golder (Golder Associates Ltd.). 2015a. Mount Polley Mine Phase 1 Environmental Effects Monitoring Study Design – Updated. Prepared for Mount Polley Mining Corporation, Likely, BC.

Golder. 2015b. Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment. Report Number 1411734-036-R-Rev0-10000 Prepared for Mount Polley Mining Corporation, June.

Golder. 2016. Mount Polley Mine Tailings Storage Facility, Perimeter Embankment Breach. Update Report: Post-Event Environmental Impact Assessment Report. Submitted to Mount Polley Mining Corporation. June.

Golder. 2017a. Technical Memorandum: Edney Creek Habitat Assessment – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. April.

Golder. 2017b. Hazeltine Creek: Reach 1 Record Drawings and Habitat Rating. Prepared for Mount Polley Mining Corporation, Likely, BC. March.

Golder. 2017c. Hazeltine Creek Reach 2 Record Drawings and Habitat Rating. Prepared for Mount Polley Mining Corporation, Likely, BC. December.

Government of Canada. 2018. Metal and Diamond Mining Effluent Regulations - Consolidation. SOR/2002-222. Last amended June 1, 2017. Current to June 10, 2018.

HKP (Hallam Knight Piésold Ltd.). 1996. Mount Polley Project - Environmental Baseline and Monitoring Report: 1995. March.

HKP. 1997. Mount Polley Mining Corporation - Mount Polley Project - Environmental Baseline and Monitoring Report: 1996. June.

Imperial Metals. 1990. Stage 1 Environmental and Socioeconomic Impact Assessment Report for the Mount Polley Project. Prepared for the BC Mine Development Steering Committee by Imperial Metals Corporation. July.

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwaters – Taxa Tolerance Values, Metrics, and Protocols. Project H-1, Soil & Water Conservation Society of Metro Halifax.

Marchant, R. 1989. A Subsampler for Samples of Benthic Invertebrates. Bull. Austral. Soc. Limnol. 12: 49-52.

Minnow Environmental Inc. (Minnow). 2009. Mount Polley Mine - Aquatic Environmental Characterization - 2007. Report Prepared for Mount Polley Mining Corporation. Report Prepared By Minnow Environmental Inc. July. Project 2120.

Minnow. 2011. Mount Polley Mine selenium monitoring 2009/2010. Prepared for Mount Polley Mining Corporation, Likely, BC. March. Project 2290.

Minnow. 2013a. Mount Polley Mine Selenium 2012. Prepared for Mount Polley Mining Corporation, Likely, BC. March. Project 2450.

Minnow. 2013b. Mount Polley Mine Selenium Monitoring 2013 Update Report. Prepared for Mount Polley Mining Corporation, Likely, BC. December. Project 2475.

Minnow. 2014a. Aquatic Environmental Description Report Mount Polley Mine Discharge of Treated Water to Polley Lake. Report Prepared for Mount Polley Mining Corporation. July. Project 2507.

Minnow. 2014b. Project Introduction report for the Mount Polley Mine Southeast Rock Disposal Site. DRAFT Report Prepared for Mount Polley Mining Corporation. Draft: Report Not Finalized due to the TSF Embankment Breach. Project 2505.

Minnow. 2015a. Mount Polley Tailings Dam Failure – Sediment Quality Impact Characterization. Prepared for Mount Polley Mining Corporation, May. Project 2542.

Minnow. 2015b. Sediment Quality Data Report – August 2015 Collections. Prepared for Mount Polley Mining Corporation, October 2015.

Minnow. 2016a. Chemical Analysis of Benthic Invertebrates Collected in the Vicinity of the Mount Polley Mine - August. Prepared for Mount Polley Mining Corporation, Likely, BC. May. Project 2574.

Minnow. 2016b. Benthic Invertebrate Community Monitoring in the Vicinity of the Mount Polley Mine, 2015. Memorandum prepared for Mount Polley Mining Corporation. November. Project 2574.

Minnow. 2016c. Sediment and Sediment Porewater Data Report – August 2016 Collections. Prepared for Mount Polley Mining Corporation. 2016. Project 2574.

Minnow. 2016d. Results of Diffusive Gradients in Thin Films Device Deployment – August to October 2015. Prepared for Mount Polley Mining Corporation, April. Project 2574

Minnow. 2016e. Mount Polley Mine Phase 1 Environmental Effects Monitoring Program Interpretive Report. Prepared for Mount Polley Mining Corporation, Likely, BC. October. Project 167202.0057.

Minnow. 2017a. Benthic Invertebrate Community Monitoring in the Vicinity of the Mount Polley Mine, 2016. Memorandum prepared in Draft for Mount Polley Mining Corporation. June. Project 2574.

Minnow. 2017b. Chemical Analysis of Benthic Invertebrates Collected in the Vicinity of the Mount Polley Mine - August 2016. Prepared for Mount Polley Mining Corporation, Likely, BC. April. Project 2574.

Minnow. 2017c. Results of Diffusive Gradients in Thin Films Device Deployment, 2016. Prepared for Mount Polley Mining Corporation, Likely, BC. March. Project 2574.

Minnow. 2018a. Benthic Invertebrate Community and Productivity Monitoring in the Vicinity of the Mount Polley Mine, 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. March. Project 177202.0042.

Minnow. 2018b. Chemical Analysis of Periphyton and Benthic Invertebrate Tissue Samples Collected in the Vicinity of the Mount Polley Mine, September to October 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. April. Project 177202.0042.

Minnow. 2018c. Phase 2 EEM Study Design for the Mount Polley Mine. Prepared for Mount Polley Mining Corporation, Likely, BC. March. Project 187202.0002.

Minnow. 2018d. Polley Lake and Frypan Creek 2017 Fish Monitoring. Prepared for Mount Polley Mining Corporation, Likely, BC. March. Project 177202.0036.

Minnow. 2018e. Scope of Work for Monitoring the Success of Fish Production in Upper Hazeltine Creek, 2018. Memorandum Prepared for Mount Polley Mining Corporation, Likely, BC. April. Project 187202.0016.

MPMC (Mount Polley Mining Corporation). 2009. Mount Polley Mine Technical Assessment for a Proposed Discharge of Mine Effluent. July.

Morrow/Azimuth (Morrow Environmental Consultants and Azimuth Consulting Group). 2003. Mount Polley Mining Corporation Biological Monitoring Program - 2002. Report Prepared for the Mount Polley Mining Corporation. April.

Norton, S.B., S.M. Cormier and G.W. Suter II. 2015. Ecological Causal Assessment. CRC Press, Boca Raton pp. 17-251-270.

Presser, T.S. and S.N. Luoma. 2010. A Methodology for Ecosystem-Scale Modeling of Selenium. Integ. Environ. Assess. Manag. 6: 685-710.

Smith, B. and J.B. Wilson. 1996. A Consumer's Guide to Evenness Indices. Oikos 76: 70-82.

USEPA (United States Environmental Protection Agency). 1991. EPA Method 200.3, Metals, Total Recoverable in Biological Tissues. Washington, DC, USA.

USEPA. 1994. Method 200.8, Revision 5.4. Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry. Revision 5.4. 1994.

USEPA. 2001. EPA Method 245.7, Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry. Washington, DC, USA.

USEPA. 2004. EPA Method 6020A, Inductively Coupled Plasma-Mass Spectrometry (Revision 6). SW-846 Online: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Washington, DC, USA.

Appendix B.3

Periphyton Monitoring

Minnow Environmental Inc.

Periphyton
Monitoring Plan

Prepared for:

Mount Polley Mining Corporation
Likely, British Columbia

Prepared by:

Minnow Environmental Inc.
Georgetown, Ontario

June 2018

minnow environmental inc.
A Trinity Consultants Company

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.1 Monitoring Objectives 2

2 SUMMARY OF HISTORICAL FINDINGS 3
2.1 Productivity 3
2.2 Tissue Quality 3

3 STUDY DESIGN OVERVIEW AND RATIONALE 5

4 METHODOLOGY 8
4.1 Quality Assurance / Quality Control 8
4.2 Sample collection methods 9
4.2.1 Biomass and Chlorophyll-a 9
4.2.2 Community 9
4.2.3 Tissue Quality 10
4.3 Sample Handling and Laboratory Analysis 10
4.4 Data Quality Review 11
4.5 Data Handling, Interpretation, and Reporting 12

5 REFERENCES 15

LIST OF FIGURES **FOLLOWING PAGE**

Figure 1: Chlorophyll-a and Ash-Free-Dry-Mass (AFDM) for Frypan, Edney and Hazeltine Creeks, 2017 3
Figure 2: Selenium Concentrations in Periphyton Tissue at Hazeltine Creek with Associated Reference Areas, Mount Polley, 2010 to 2017 3
Figure 3: Periphyton Tissue Copper Concentrations at Rehabilitated and Effluent Exposed (HAC-M, HAC-D), Rehabilitated (HAC-R1), and Reference (EDC-D) Area, Mount Polley Mine, 2017 3
Figure 4: Mount Polley CEMP Periphyton Monitoring Locations 5

LIST OF TABLES **FOLLOWING PAGE**

Table 1: Mount Polley CEMP Periphyton Monitoring Program Overview 5
Table 2: Target Laboratory Reporting Limits (LRL) and Analytical Methods for Periphyton Productivity and Tissue Quality Endpoints 11

1 INTRODUCTION

1.1 Background

Periphyton represents an important component of aquatic food webs in creeks, and consists of a complex matrix of organisms. Periphyton generally includes algae, fungi, bacteria, and protozoa attached to submerged substrate (e.g., rocks, bedrock, woody debris). These organisms are representative of the lowest trophic level in running water and take up nutrients such as nitrogen (e.g., nitrate, nitrite) and phosphorus (e.g., ortho-phosphate), as well as other substances dissolved in water (e.g., major ions, metals) to serve physiological functions, which thereby become available via dietary pathways to consumer organisms at higher trophic levels. Periphyton productivity and community characteristics can be influenced by factors such as physical disturbance (i.e., changes to surface water hydrology) and water quality (relating to toxicity or changes in productivity due to nutrient chemistry), and periphyton tissue quality can be influenced by water and/or sediment quality (although the latter is primarily present in suspended form in erosional streams). Therefore, periphyton monitoring is an important tool for both the assessment of creek productivity (through measures of periphyton productivity and community) and the evaluation of the trophic transfer of substances (through measures of periphyton tissue quality), and these monitoring components have been incorporated into the CEMP.

The influence of the Mount Polley Mine on periphyton productivity, community, and tissue quality can occur by several key mechanisms: 1) general mine influence from dustfall and/or uncontained surface or groundwater flows: 2) direct discharge of mine effluent to Hazeltine Creek (April to August 2014) and Quesnel Lake (December 2015 to present [via Hazeltine Creek from December 2015 to December 2017, and directly since January 2018]); 3) the TSF embankment breach on August 4, 2014; and 4) reclamation activities following the TSF embankment breach. Reclamation activities in lower Edney Creek and Hazeltine Creek were initiated in 2014 following the TSF embankment breach, and were completed in lower Edney Creek in August 2015 (Golder 2017b). Construction / rehabilitation in areas of upper Hazeltine Creek (Reaches 1 and 2) were completed between July and September of 2016 and 2017, respectively (Golder 2017a,c), with Reach 2 encompassing an upper Hazeltine Creek monitoring area established prior to the TSF embankment breach (W7; Minnow 2009). In lower Hazeltine Creek, initial channel rehabilitation was completed in 2015, and further rehabilitation has yet to be completed.

Periphyton tissue quality in creeks adjacent to the Mount Polley Mine has been monitored since prior to the TSF embankment breach (2010, 2012, and 2013; Minnow 2011, 2013a, 2013b). Periphyton productivity (chlorophyll-a and Ash-Free-Dry-Mass [AFDM]) has been monitored since 2013 (Minnow 2013c, 2018a,b), and periphyton community characteristics have not been

documented in these waterbodies. Results of previous periphyton productivity and tissue quality monitoring are reviewed in Section 2. These results provide context for a periphyton monitoring program that is guided by a combination of available historical findings, representative locations downstream of Mount Polley Mine operations (taking into consideration recent stream rehabilitation activities), representative reference locations, and considerations for a statistically-based design that will facilitate the detection of potential spatial and/or temporal differences in periphyton endpoints (productivity, community, and tissue quality), in addition to providing data to evaluate productivity endpoints (i.e., chlorophyll-a) against provincial water guidelines for the protection of aquatic life (e.g., BCWQG; BCMOE 2018) and literature-based productivity classification values (e.g., Biggs 1996).

The following sections of the CEMP Periphyton Monitoring Plan provide the objectives of periphyton productivity and tissue quality monitoring, a summary of historical periphyton monitoring results, an overview of the CEMP study design and associated rationale (including sampling locations, replication, frequency, and analytes), and detailed methodology for periphyton productivity and tissue quality monitoring (sampling methods, analytical methods, quality control methods, data interpretation, and reporting).

1.1 Monitoring Objectives

The objective of periphyton monitoring in the Mount Polley receiving environment is to evaluate the influence of Mount Polley Mine activities (related to mine operations, the TSF embankment breach, and/or rehabilitation activities) on Hazeltine Creek (the creek receiving environment directly influenced by Mount Polley Mine activity) and lower Edney Creek (a creek environment directly influenced by the TSF embankment breach), and to serve as supporting information for the determination of potential effects to aquatic life at higher trophic levels (benthic invertebrates and fish; Sections 6.13 and 6.16). Periphyton monitoring will include assessment of productivity, community composition, and tissue quality, with comparison to previous and/or reference conditions, to applicable guidelines (i.e., chlorophyll-a; BCMOE 2018), and to literature-based criteria (or classification ranges) for productivity. Periphyton monitoring results also provide supporting information for the assessment of benthic invertebrate tissue quality, benthic invertebrate community condition, and fish habitat productivity, as well as supporting the exposure assessment for the ecological risk assessment (ERA) and human health risk assessment (HHRA).

2 SUMMARY OF HISTORICAL FINDINGS

2.1 Productivity

Periphyton productivity monitoring completed during mine operations but before the TSF embankment breach indicated that productivity was low in a creek adjacent to the Mount Polley Mine (Bootjack Creek; 1.42 mg/m^2 of chlorophyll-a; Minnow 2013c) relative to the BCWQG of 100 mg/m^2 (BCMOE 2018). Following the TSF embankment breach, periphyton productivity in rehabilitated areas of upper and lower Hazeltine Creek and lower Edney Creek were also generally low (1.76 to 40.1 mg/m^2 of chlorophyll-a; Minnow 2018a; Figure 1), as evidenced by results well below the BCWQG and generally below chlorophyll-a levels associated with moderately enriched streams (21 mg/m^2; Biggs 1996) despite full sun exposure in these recently rehabilitated areas. Periphyton chlorophyll-a results from these rehabilitated areas following the TSF embankment breach were generally within the range documented in the associated reference areas (4.6 to 40.1 mg/m^2), as was periphyton biomass (AFDM; Figure 1; Minnow 2018a,b).

2.2 Tissue Quality

Periphyton tissue quality has been monitored since 2010 in the vicinity of the Mount Polley Mine (primarily within Hazeltine Creek), with a focus on selenium monitoring relative to reference (Minnow 2011, 2013a,b, 2018c), although additional analytes were included in analyses completed in 2010 (Minnow 2011). Mean periphyton selenium concentrations in upper and lower Hazeltine Creek have shown limited temporal change over the monitoring period, with the most recent results (2017) being similar to, or lower than, concentrations documented prior to the TSF embankment breach (Figure 2).

The inclusion of additional analytes in periphyton tissue quality monitoring continued in 2017 (Minnow 2018d), with tissue quality characterized in three rehabilitated areas of Hazeltine Creek (2 of which were effluent exposed during sample collection), relative to reference (an unimpacted area of lower Edney Creek). Data interpretation of these additional analytes focused on Parameters of Interest (POIs [representing the chemical influence of the TSF embankment breach on sediment quality]: arsenic, copper, iron, and nickel), and on Indicator Parameters (IPs [identified in evaluations of water, soil, or fish tissue quality for Hazeltine Creek]: calcium, cobalt, molybdenum, phosphorus, selenium, silver, sodium, titanium, and vanadium; Golder 2015, 2016, Minnow 2015). Periphyton tissue quality from all rehabilitated Hazeltine Creek areas (both effluent exposed and not exposed) was characterized by copper concentrations that were significantly higher than reference (Figure 3), while concentrations of a number of additional analytes were higher than reference in at least one Hazeltine Creek area (two POIs: arsenic, iron;

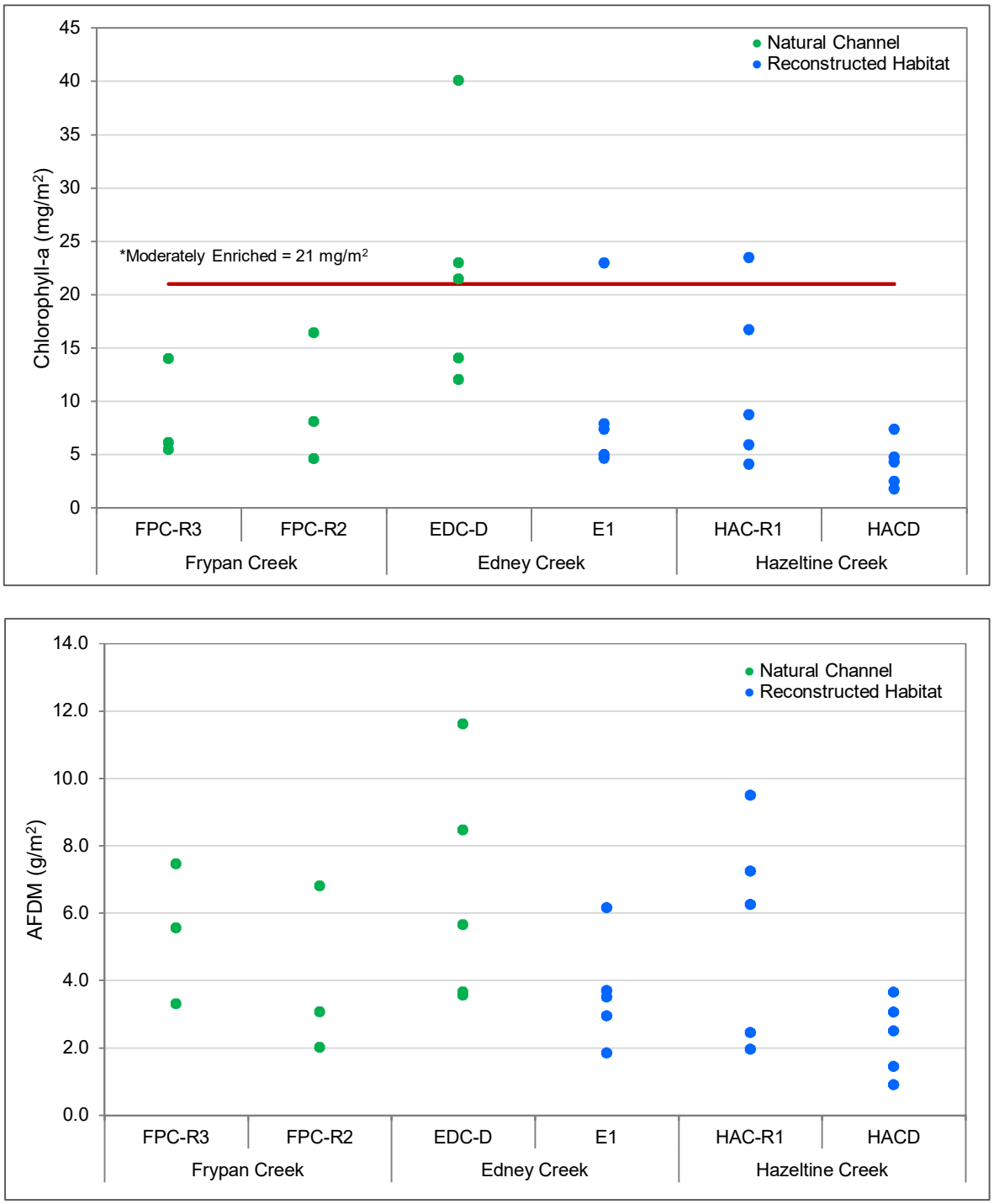


Figure 1: Chlorophyll-a and Ash-Free-Dry-Mass (AFDM) for Frypan, Edney and Hazeltine Creeks, 2017

* Value taken from Biggs 1996

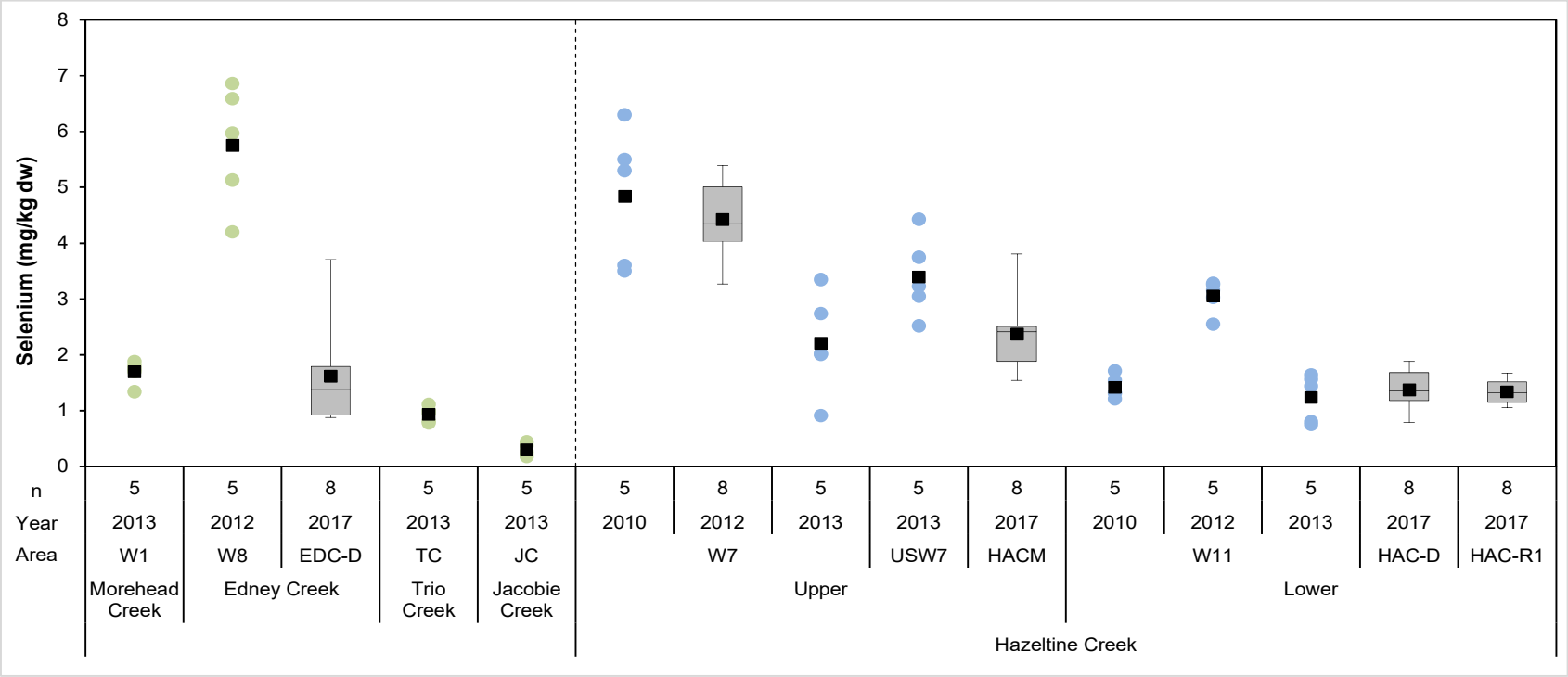
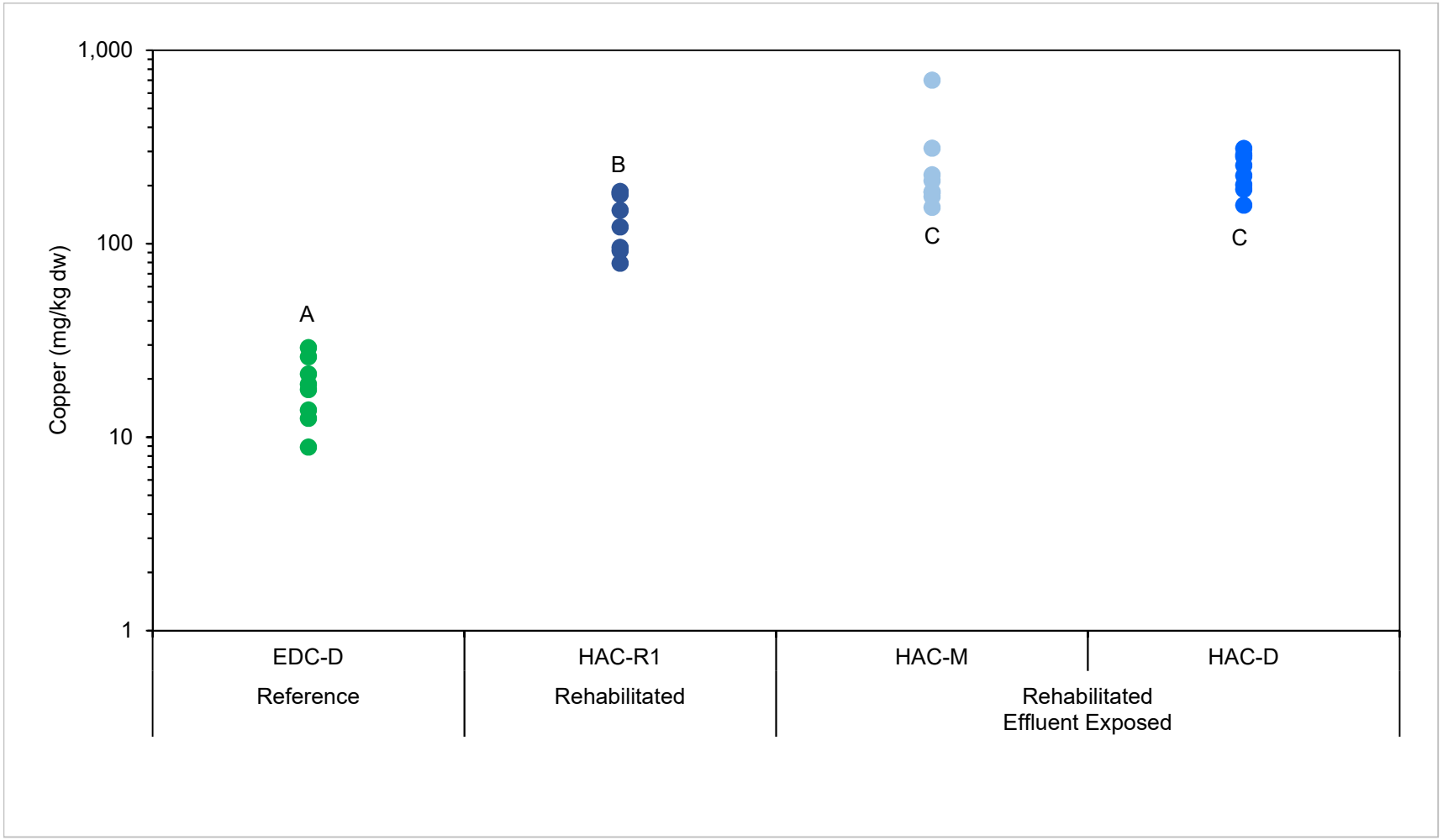


Figure 2: Selenium Concentrations in Periphyton Tissue at Hazeltine Creek with Associated Reference Areas, Mount Polley, 2010 to 2017

Note: Dashed line used to separate reference (left side) and exposed (right side) areas. Black squares represent means and whiskers represent minimum and maximum values. Box plots are presented when there are 8 or more samples.



Note: Groups that share a letter (e.g., AB) are not significantly different from each other.

Figure 3: Periphyton Tissue Copper Concentrations at Rehabilitated and Effluent Exposed (HAC-M, HAC-D), Rehabilitated (HAC-R1), and Reference (EDC-D) Area, Mount Polley Mine, 2017

and six IPs: calcium, cobalt, molybdenum, phosphorus, sodium, and vanadium; Minnow 2018d) These results were consistent with the higher water concentrations of most of these analytes in Hazeltine Creek due to a combination of breach influence and effluent conveyance preceding and during sample collection.

3 STUDY DESIGN OVERVIEW AND RATIONALE

Periphyton monitoring under the CEMP is proposed to meet the combined needs of: 1) operational monitoring (including the previous discharge of treated effluent to Hazeltine Creek); 2) monitoring of the impact of the 2014 TSF embankment breach; and 3) monitoring of the response to reclamation activity following the TSF embankment breach. An overview of the proposed periphyton monitoring program is provided in Table 1 and Figure 4. Periphyton monitoring is focused on Hazeltine Creek and lower Edney Creek with reference areas identified for each mine-influenced sampling area (i.e., upper Edney Creek and Frypan Creek for upper Hazeltine Creek, and an unaffected area of lower Edney Creek for rehabilitated areas of lower Edney Creek and lower Hazeltine Creek; Table 1; Figure 4). As described in Section 1.1, reclamation activities in Hazeltine Creek and lower Edney Creek were initiated in 2014 following the TSF embankment breach, and were completed in lower Edney Creek in August 2015 (Golder 2017b), and in 2016 and 2017 in sections of upper Hazeltine Creek in (Reaches 1 and 2, respectively; Golder 2017a,b). As such, periphyton monitoring in Hazeltine Creek will focus on three areas (Figure 4)[1], including one area in Reach 1 (HAC-R1; where rehabilitation was completed in 2016), one area in Reach 2 (HAC-U; where rehabilitation was completed in 2017), and one area in lower Hazeltine Creek (HAC-D, where initial rehabilitation activities have been completed but additional rehabilitation will be conducted). Monitoring in lower Edney Creek will focus on one rehabilitated area (E1; where rehabilitation was completed in 2015). These sampling areas also align with those proposed for benthic invertebrate community and tissue quality monitoring (see CEMP Section 6.13). It should be noted that sampling areas HAC-U and HAC-D were previously exposed to the discharge of treated mine effluent (December 2015 to December 2017), whereas HAC-R1 is located upstream of the previous discharge point (Figure 4). As of January 2018, treated effluent is no longer discharged into Hazeltine Creek. Concurrent sampling of suitable reference areas will be conducted in lower Edney Creek and Frypan Creek. In Frypan Creek, the reference sampling area was selected to match habitat conditions in upper Hazeltine Creek as closely as possible, based on results of preliminary fish habitat assessment and benthic invertebrate monitoring (area selection was based primarily on substrate type and size; Minnow 2018b).

Periphyton monitoring includes assessment of productivity (chlorophyll-a and AFDM) at all sampling locations. Periphyton community will also be monitored at all locations with the exception of Frypan Creek, which will be sampled in 2018 only for the purposes of comparison of

[1] Note that previous creek sampling station locations are presented in Figure 4. These locations may change slightly depending on substrate, water depth, and water velocity. Similarly, conceptual station locations are displayed for upper Edney Creek and Frypan Creek, and will be established during the field campaign.

Table 1: Mount Polley CEMP Periphyton Monitoring Program Overview

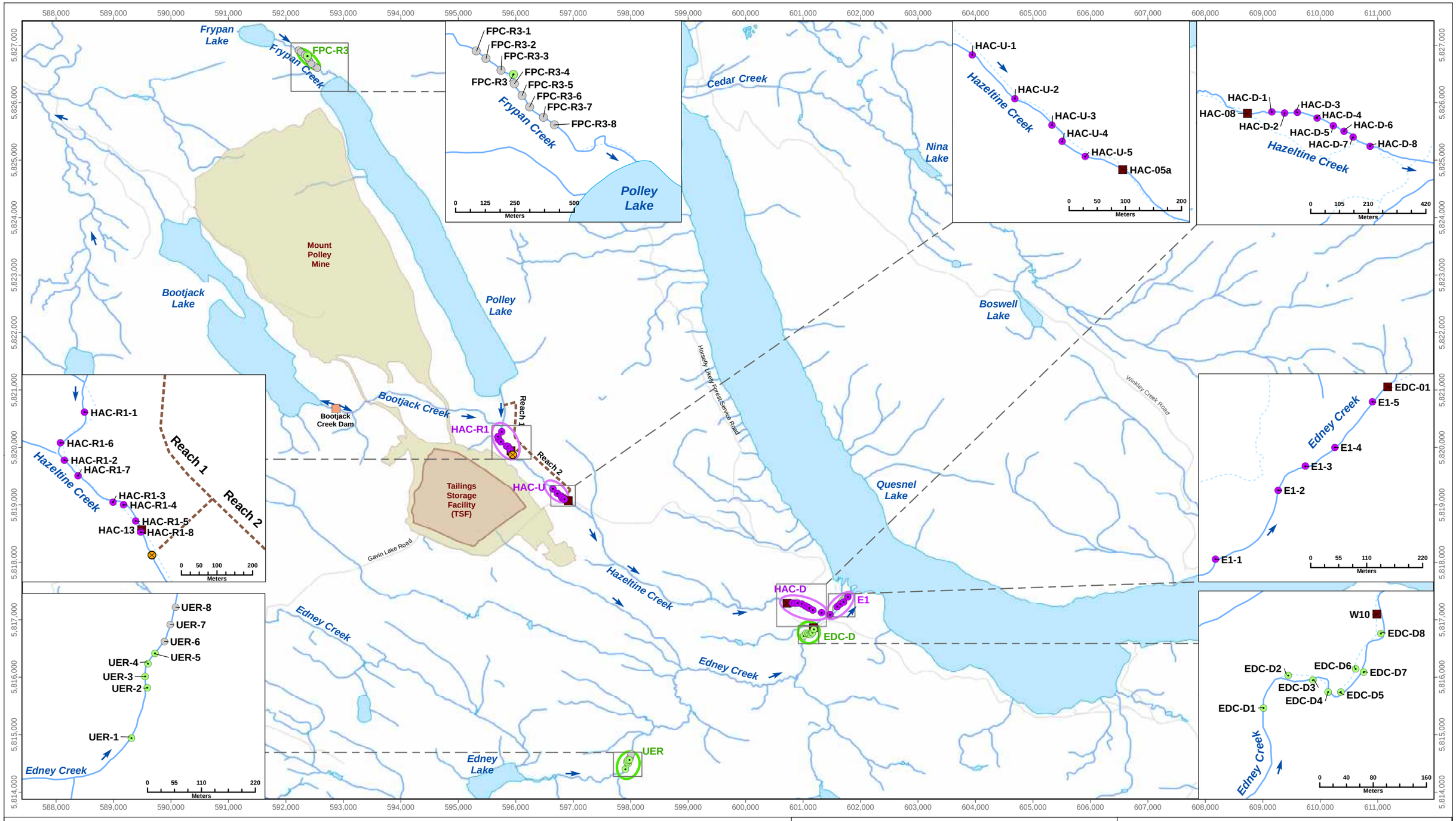
Water Body	Sampling Area	Type	Monitoring Frequency	Components [a]	Replication [b]			Rationale
					T	P	C	
Hazeltine Creek	HAC-R1 (Upper, Reach 1)	Rehabilitated	Annual	T,P,C	5	5	8	adjacent to mine and breach-influenced
	HAC-U (Upper)	Rehabilitated	Annual	T,P,C	5	5	8	adjacent to mine, previously effluent-exposed, and breach-influenced
	HAC-D (Lower)	Rehabilitated	Bi-annual [c]	T,P,C	5	5	8	adjacent to mine, previously effluent-exposed, and breach-influenced
Frypan Creek	FPC-R3 (Reach 3)	Reference	2018 only	P, C	-	5	8	reference for upper Hazeltine Creek
Edney Creek	UER (Upper)	Reference	Annual	T,P,C	5	5	8	reference for upper Hazeltine Creek
	E1 (Lower)	Exposed	Bi-annual [c]	T,P	5	5	-	adjacent to mine and breach-influenced
	EDC-D (Lower, unimpacted)	Reference	Bi-annual [c]	T,P,C	5	5	8	reference for lower Hazeltine Creek [d]

[a] core periphyton monitoring components: T = community taxonomic analysis, P = productivity (chlorophyll-a and Ash-Free-Dry-Mass, see Table 2), C = chemistry (see Table 2 for analytes).

[b] number of replicate stations within the specified sampling area for a given program component.

[c] Bi-annual indicates sampling will occur every other year for all parameters indicated with the exception of tissue chemistry, which will be monitored annually. The next bi-annual sampling event will occur in 2019.

[d] Lower Edney Creek reference area will be located in an unimpacted area upstream of the breach influence (see Figure 4).



Periphyton Monitoring Station
- Rehabilitated
- Reference
- Conceptual

- Effluent Discharge from 2014 to 2017
- Routine Water Quality Station
- Rehabilited Reaches (Golder 2017 a,b)
- Tailings Storage Facility
- Active Mine Operation

Periphyton Monitoring Area
- Rehabilitated
- Reference
- Historic Watercourse Pathway

Note: Sampling locations may be adjusted from those shown displayed based on field survey information.

0 1 2 4 km

N W E S

Projection: North American Datum 1983 UTM Zone 10U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Mount Polley CEMP Periphyton Monitoring Locations

Date June 2018
Project 177202.0042

minnow environmental inc

Figure 4

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\2-Periphyton\17-42 Fig 4 MP PER and BI Creek.mxd

fish habitat productivity (Table 1). Periphyton community monitoring provides a means for evaluating re-establishment of the periphyton community in these recently disturbed areas, and is an additional line of evidence for assessing temporal changes in periphyton productivity. Periphyton tissue quality monitoring, which includes evaluation of concentrations of metals[2] and moisture content, will be included at all sampling locations with the exception of the rehabilitated area of lower Edney Creek (E1; Table 1). Data interpretation will be based on a combination of: 1) statistical comparison to previous conditions; 2) statistical comparison to reference conditions; 3) comparison of productivity results relative to BCWQG and literature-based classification values. Accordingly, five stations per area for the assessment of productivity and community, and eight stations per area for the assessment of tissue quality are proposed to provide replication for the statistical contrasts.

Periphyton monitoring will be supported by measures of sampling depth, water velocity, and *in situ* water quality measurements (temperature, dissolved oxygen, pH, and specific conductance) at each sampling station. Additional information to be collected includes GPS coordinates of each station, notes of the presence of aquatic vegetation/bryophytes on sampled substrate and other physical observations, and supporting photographs of the sampling location and samples. Supporting grab water samples will also be collected during the sampling event in areas where water quality is not routinely monitored by the Mount Polley Mine (e.g., in Frypan Creek and upper Edney Creek).

Periphyton sampling will be completed in August or September consistent with previous data collections (Minnow 2011, 2013a,b, 2018a,b,c,d). The initial frequency of periphyton community, productivity, and tissue quality monitoring at upper Hazeltine Creek (and associated reference areas) is annual given the recent disturbance to these rehabilitated areas, and changes to the effluent exposure status (Table 1). This frequency will enable tracking of recovery in these recently disturbed habitats. The frequency of periphyton community and productivity monitoring in rehabilitated areas of lower Hazeltine Creek and lower Edney Creek (and associated reference areas) is every second year because these areas have been undisturbed since 2015, however the frequency of tissue quality monitoring in lower Hazeltine Creek (and the associated reference area) is annual. Monitoring frequencies will be reviewed following interpretation of data collected in 2020, and design modifications (e.g., changes to monitoring frequency or locations) will be made in response to QP recommendations. If results indicate stable periphyton productivity, community, and tissue quality during this period, then a reduction of monitoring frequency to every second year will be considered for upper Hazeltine Creek areas. The Frypan Creek reference area will only be sampled in 2018 (Table 1) to provide comparison for periphyton biomass and

[2] For simplicity, the term metals is used herein to include metalloids.

tissue quality data from upper Hazeltine Creek following the initial reopening of upper Hazeltine Creek as fish habitat (see CEMP Section 6.16).

Periphyton samples will be collected, processed, analyzed, and the associated data interpreted using methodology consistent with previous assessment at Mount Polley (e.g., Minnow 2011, 2013a,b, 2018a,b,c,d), which is also consistent with technical guidance (e.g., BCMOE 2013, 2016). Detailed methodology is provided in Section 4, including: quality assurance/quality control, sample collection methods, sample handling and laboratory analysis, data quality assessment, and data handling and interpretation.

4 METHODOLOGY

4.1 Quality Assurance / Quality Control

All sampling will be led by qualified field staff experienced in the implementation of periphyton monitoring programs, and all sample collection methods, quality assurance and quality control measures, and laboratory analysis methods will be implemented in accordance with technical guidance (BCMOE 2013, 2015, 2016). Specifically, quality assurance and quality control measures will include program review prior implementation, adequate resources for all field teams including field checklists and field data sheets, the availability (and maintenance) of clean sampling equipment and sampling containers, and sampling in a manner that minimizes any risk of sample contamination.

Quality control (QC) samples will be collected to support the periphyton monitoring program. Replicate samples will be collected from each sampling area in order to capture within-area variability (samples from 5 and 8 separate stations will be collected to represent the sampling area for productivity/community and tissue quality endpoints, respectively). Specific field QC samples will include duplicates (i.e., splits) of periphyton tissue quality samples collected at a frequency of 10% of the total number of samples to assess field precision as part of the Data Quality Review (DQR; Section 4.4). QC samples to assess field precision (field duplicates) will not be collected for periphyton productivity (chlorophyll-a and AFDM) or community monitoring endpoints due to high the inherent natural variability in these parameters. In addition to field QA/QC, the laboratory responsible for the physical or chemical analyses will be accredited by the Canadian Association for Laboratory Accreditation (CALA) for these analyses. Specific QC sampling and associated reporting will for tissue quality and periphyton productivity endpoints be requested of the analytical laboratory, including reagent blank results, laboratory replicate results, and laboratory accuracy results (i.e., matrix spikes, laboratory control samples, and/or certified reference materials). QC reporting will also be requested of the laboratory performing taxonomic analysis of the periphyton community samples, including organism enumeration checks for a minimum of 10% of samples. These results will be assessed as part of the DQR (Section 4.4).

All raw field data will be transcribed from field sheets into an electronic spreadsheet. Data will then checked by a separate individual for data entry errors as part of routine Quality Assurance/Quality Control (QA/QC) procedures.

4.2 Sample Collection Methods

4.2.1 Biomass and Chlorophyll-a

Periphyton samples for chlorophyll-a analysis and biomass (AFDM) will be collected by selecting five representative submerged rocks from each monitoring station. Representative rocks from each station will be selected from locations with similar habitat (depth, velocity, and substrate characteristics), while attempting to match depth and velocity among periphyton collection stations and areas as closely as possible. Selected rocks (excluding those that are too small, highly angular, or uncharacteristic in surface texture) will be taken to shore. For chlorophyll-a sample collection, a thin acetate template with a 2x2 cm opening in the middle will then be placed firmly on each rock, and the periphyton within this area will be scraped off using a stainless-steel razor blade or scalpel. Sample material from each of the five rocks will then be transferred from the razor blade or scalpel to a large (47 mm) 0.45 µm pore diameter Whatman mixed cellulose ester (MCE) filter paper until a single composite sample of approximately 200 mg to 1 g wet weight is obtained per station. If material collected from the five rocks sampled is insufficient, additional rocks will be sampled from the same area with similar habitat characteristics until the required sample volume is obtained. The filter paper will then be folded and placed into a labeled opaque centrifuge tube. The total surface area sampled at each station (0.002 m^2: 5 x 4 cm^2, or any deviations from this surface area), will be recorded to allow calculation of chlorophyll-a on a unit area basis for comparison to the British Columbia Water Quality Guideline (BCWQG; 100 mg/m^2; BCMOE 2018). The same five rocks sampled for chlorophyll-a analysis (and additional rocks if they were required) will be used to collect separate scrapings for analysis of AFDM. For AFDM sampling, sampling methods will follow those outlined above for chlorophyll-a, however material on the razor blade or scalpel from scraping of each rock will be rinsed into a small pre-labelled plastic jar with additional water added to cover the tissue (as necessary). Sampling will be conducted at five replicate stations in each area (see Table 1). Immediately after collection, all chlorophyll-a and AFDM samples will be placed in a cooler on ice for transport to the mine, where they will be frozen.

4.2.2 Community

Periphyton community samples will be collected from the same five rocks used for chlorohyll-a and biomass sampling whenever possible (and additional rocks if they were required), or from rocks of a similar size collected from the same general location and habitat (depth and velocity). Sample collection methods will be similar to those outlined for chlorophyll-a and AFDM. Briefly, a thin acetate template with a 2x2 cm opening in the middle will be placed firmly on each rock and all of the periphyton within this area will then be removed using a scalpel and/or brush and a squirt bottle filled with site water (BCMOE 2013, 2016; Stevenson and Bahls 2006). The collected

periphyton will then be transferred into a labelled sample jar, and this process will be repeated for the five rocks, resulting in a single composite sample from each station. The total surface area sampled at each station (0.002 m^2: 5 x 4 cm^2, or any deviations from this surface area if additional rocks are sampled) will be recorded. Immediately after collection, the sample will be preserved with Lugol's iodine solution until the sample is the colour of weak tea (approximately 1 mL of Lugol's per 250 mL of sample; BCMOE 2013), and will be mixed gently by inverting the sampling jar. All samples will be stored at room temperature. Sampling will be conducted at five replicate stations in each area (see Table 1).

4.2.3 Tissue Quality

Periphyton samples collected for tissue quality analysis will be collected by scraping periphyton from the surface of rocks using a scalpel until sufficient sample weight for analysis is attained (more than 500 mg wet weight). A minimum of five rocks will be sampled to ensure the sample is representative of the sampling station. Rocks sampled for productivity and community will be used preferentially, plus additional rocks (as necessary) to obtain the required sample weight. Periphyton scrapings will be transferred directly from the scalpel onto the wall of a labeled scintillation vial, without rinsing, to minimize the amount of water in each sample. Sampling will be conducted at eight replicate stations in each area (see Table 1). Samples will be placed in a cooler on ice for transport to the mine, where they will be frozen.

4.3 Sample Handling and Laboratory Analysis

Periphyton productivity (chlorophyll-a and AFDM) and tissue quality samples will remain frozen until overnight shipment on ice to the analytical laboratory. Samples will be sent to the laboratory with sufficient time to complete analyses within the recommended sample hold times (28 days for chlorophyll-a, 6 months for AFDM, 1 year for tissue quality [metals analysis]). Analyses will be completed at an analytical laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA) using methods that are consistent with those specified in the British Columbia Environmental Laboratory Manual (BCMOE 2015). Upon sample receipt, the laboratory will provide a sample receipt confirmation which will be reviewed to ensure that all samples are received and that the analytical requests are properly logged. Analysis of chlorophyll-a will follow procedures adapted from USEPA Method 445.0 (USEPA 1997). Briefly, chlorophyll-a will be determined by routine acetone extraction followed by fluorescence detection using a non-acidification procedure (a method that is not subject to interferences from chlorophyll-b). Determination of total AFDM will follow procedures adapted from APHA Method 10300 C (APHA 2010). Total AFDM will be calculated as the difference between the dried sample weight and the ash weight, both of which will be determined gravimetrically. Dry weight will be determined by drying the sample at 105 °C, and the ash weight will be subsequently determined

by ashing the dried sample at 500 °C. Tissue quality samples will be analysed for metals by CRC-ICP-MS (Collision Cell Inductively Coupled Plasma-Mass Spectrometry; USEPA Method 200.3 [USEPA 1991]/6020A [USEPA 2004]) or HR-ICP-MS (High Resolution Inductively Coupled Plasma-Mass Spectrometry; USEPA Method 200.3 [USEPA 1991]/ 200.8 [USEPA 1994]), mercury by CVAFS (Cold Vapour Atomic Fluorescence Spectrophotometry; USEPA Method 200.3 [USEPA 1991]/Method 245.7 [USEPA 2001]), and moisture content. The method selected for metals analysis will depend on sample weight, with HR-ICP-MS employed for smaller sample sizes. Periphyton productivity and tissue quality parameters are provided in Table 2, with the associated target laboratory reporting limits (LRLs) and detection limit objectives outlined in technical guidance ("consensus detection limits"; BCMOE 2016). Upon completion of the analyses, the laboratory will provide a data report in Microsoft (MS) Excel™ and as an Adobe Acrobat Portable Document Format (PDF). Reporting will include the results of the laboratory QC sample results.

Periphyton community samples will be stored at room temperature until shipment to the taxonomy laboratory for taxonomic identification and enumeration. Samples will be shipped immediately after the completion of the field campaign, however there are no recommended hold times for analysis. Sample analysis will be completed as follows. Briefly, samples will be homogenized, settled in Ütermohl chambers for 24 h, and all cells within randomly selected fields of view will be enumerated until a minimum count of 300 algal units (1 unit = >1 cell for colonial or filamentous taxa) is reached. Identification will be performed using an inverted phase contrast microscope, and algal taxa will be identified to minimum of genus-level according to the most up-to-date taxonomic references. Periphyton density will be determined using the area sampled, proportion subsampled, and the total area of the selected fields of view. Biomass estimates will be generated for each taxon using taxon-specific biovolume formulae (Hillebrand et al. 1999) for cell measurements, and taxon-specific densities.

4.4 Data Quality Review

Upon receipt of all analytical data, a Data Quality Review (DQR) will be performed. The DQR will confirm that all requested analyses are complete, and that acceptable LRLs have been achieved. The DQR will also include an evaluation of differences between duplicate (split) samples, as well as the QA/QC data reported by the laboratory. Completion of the DQR promptly following receipt of the periphyton monitoring data will ensure timely communication with the laboratory should any issues be identified

Specifically, LRLs will be evaluated relative to targets established for the analytes and to "consensus detection limits" (Table 2), and to relevant British Columbia guidelines (i.e., chlorophyll-a for productivity samples; BCMOE 2018). Comparisons between duplicate samples

Table 2: Target Laboratory Reporting Limits (LRL) and Analytical Methods for Periphyton Productivity and Tissue Quality Analytes

A) Tissue Quality Parameters

Parameter	Metals in Tissue by HR-ICPMS Micro (USEPA 1991, 1994)		Metals in Tissue by CMC ICPMS (USEPA 1991, 2004)		Concensus DLs [a]
Units	**mg/kg wwt**	**mg/kg dw**	**mg/kg wwt**	**mg/kg dw**	**mg/kg wwt**
Aluminum (Al)	1.0	5.0	0.40	2.0	0.40
Antimony (Sb)	0.0020	0.010	0.0020	0.010	0.0020
Arsenic (As)	0.0060	0.030	0.0040	0.020	0.0050
Barium (Ba)	0.010	0.050	0.010	0.050	0.010
Beryllium (Be)	0.0020	0.010	0.0020	0.010	0.0020
Bismuth (Bi)	0.0020	0.010	0.0020	0.010	0.0200
Boron (B)	0.20	1.0	0.20	1.0	-
Cadmium (Cd)	0.0020	0.010	0.0010	0.0050	0.0020
Calcium (Ca)	4.0	20	4.0	20	2.0
Cesium (Cs)	0.0010	0.0050	0.0010	0.0050	-
Chromium (Cr)	0.040	0.20	0.010	0.050	0.010
Cobalt (Co)	0.0040	0.020	0.0040	0.020	0.0040
Copper (Cu)	0.040	0.20	0.020	0.10	0.010
Iron (Fe)	1.0	5.0	0.60	3.0	1.0
Lead (Pb)	0.010	0.050	0.0040	0.020	0.0040
Lithium (Li)	0.10	0.50	0.10	0.50	-
Magnesium (Mg)	0.40	2.0	0.40	2.0	2.0
Manganese (Mn)	0.010	0.050	0.010	0.050	0.020
Mercury (Hg) [b]	0.0010	0.0050	-	-	0.002
Molybdenum (Mo)	0.0080	0.040	0.0040	0.020	0.010
Nickel (Ni)	0.040	0.20	0.040	0.20	0.010
Phosphorus (P)	2.0	10	2.0	10	5.0
Potassium (K)	4.0	20	4.0	20	10
Rubidium (Rb)	0.010	0.050	0.010	0.050	-
Selenium (Se)	0.020	0.10	0.010	0.050	0.020
Sodium (Na)	4.0	20	4.0	20	2.0
Strontium (Sr)	0.020	0.10	0.010	0.050	0.010
Tellurium (Te)	0.0040	0.020	0.0040	0.020	-
Thallium (Tl)	0.00040	0.0020	0.00040	0.0020	0.0010
Tin (Sn)	0.020	0.10	0.020	0.10	0.020
Uranium (U)	0.00040	0.0020	0.00040	0.0020	0.0010
Vanadium (V)	0.020	0.10	0.020	0.10	0.020
Zinc (Zn)	0.20	1.0	0.10	0.50	0.10
Zirconium (Zr)	0.040	0.20	0.040	0.20	-

[a] from Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BCMOE 2016).

[b] Method for total mercury analysis will be according to USEPA (1991, 2001).

B) Productivity Parameters

Parameter	Units	Method	LRL
Chlorophyll-a	µg	USEPA 1997	0.02
Ash Free Dry Weight	g	APHA 2010	0.001

will be made by calculating the relative percent difference (RPD) between concentrations between paired duplicates. If the RPD is <25% for concentrations that are >5 times the LRL, then the duplicate sample results will be considered acceptable. Results for laboratory blanks, precision, and accuracy will be evaluated relative to Data Quality Objectives (DQO) established by the analytical laboratory that performed the analyses. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective LRLs, and the results will be used to identify potential contamination associated with equipment (e.g., cleanliness) and sample collection and handling procedures (e.g., collection, shipping).

4.5 Data Handling, Interpretation, and Reporting

Upon receipt of data from the analytical laboratories, all laboratory data files will be managed by the Mount Polley Mining Corporation (MPMC) Environment Department. In addition, data provided by the primary analytical laboratories as an Electronic Data Deliverable (EDD) will be imported directly into the MPMC's database following completion of the DQR. Following the DQR, all periphyton data and supporting data will be managed in MS Excel. For all replicated data (typically based on a sample size of five or eight stations per area), data will be provided to the QP and summarized by calculating mean, median, standard deviation, minimum, and maximum for each analyte. Data analysis will be completed for each monitoring component (productivity, community, and tissue quality).

Periphyton productivity (chlorophyll-a and AFDM) results will be converted to a standard area-based measurement (mg/m^2 and g/m^2 for chlorophyll-a and AFDM, respectively), and chlorophyll-a results will be compared to water quality guidelines for the protection of aquatic life (BCWQG = 100 mg/m^2; BCMOE 2018) and to literature-based criteria for moderately enriched streams (21 mg/m^2; Biggs 1996). Periphyton productivity results will also be compared to previous data (where possible), and to reference results. For periphyton community, endpoints including density, taxon richness, diversity indices, and dominant community composition endpoints will be calculated, and compared to reference results. Temporal comparisons of periphyton community results will be made once data are available (2018 represents the first year of periphyton community sample collection). More detailed evaluation of periphyton productivity and community results will include analyses using a control-impact study design. Specifically, Analysis of Variance (ANOVA) will be used to test for differences in periphyton productivity and community endpoints between rehabilitated areas of Hazeltine Creek and lower Edney Creek, and associated reference areas. For these analyses, the assumptions of normality and homogeneity of variances will be tested on the residuals of the ANOVA model using the Shapiro-Wilk test and Levene's test based on median values, respectively, using a significance level (α) of 0.05. Data will be transformed as necessary to satisfy assumptions of normality and

homogeneity of variance as required. In instances where the residuals of the ANOVA model do not meet the assumptions of normality and homogeneity of variances, a non-parametric Kruskal-Wallis test will be conducted. When the overall results of an ANOVA or Kruskal-Wallis test are significant, differences between specific areas will be evaluated using post-hoc contrasts for ANOVA or Dunn's test for the Kruskal-Wallis test. A Bonferroni correction on the p-values will be used to conserve the overall Type I error rate. Further detailed analyses will be completed as required for data interpretation, and may include: graphical comparisons to reference and historical data (if available), graphical plots in relation to guidelines and criteria, and formal statistical temporal and spatial contrasts using methods similar to those described above.

If exposed versus reference or temporal differences in periphyton productivity and community results are noted, relationships between periphyton productivity and community endpoints and supporting water quality will be evaluated using Spearman correlation (often referred to a Spearman Rank-Order correlation). Following the derivation of correlation coefficients, a Bonferroni-type correction (i.e., p-value [0.05] divided by the total number of correlations examined for independent variables) will be applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the Bonferroni-adjusted p-value or at a p-value of 0.01 will be further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were "leveraged" by outlying points (or groups of points). Although it is recognized that a significant correlation or regression does not indicate causation (e.g., Norton et al. 2015), it is desirable to not only characterize the nature of a response (e.g., changes in periphyton productivity or community), but to also obtain evidence of cause. Correlation / regression analyses are commonly applied tools for identifying potential cause (e.g., Norton et al. 2015). Evidence of causation obtained from correlation or regression analysis will be carefully considered in light of the strength, range, and continuity of the relationships as well as mechanistic knowledge/understanding of potential cause.

Data analysis and interpretation of periphyton tissue quality results will focus on Parameters of Interest (POIs [representing the chemical influence of the TSF embankment breach on sediment quality]: arsenic, copper, iron, and nickel), and on Indicator Parameters (IPs [identified in evaluations of water, soil, or fish tissue quality for Hazeltine Creek]: calcium, cobalt, molybdenum, phosphorus, selenium, silver, sodium, titanium, and vanadium; Golder 2015, 2016, Minnow 2015). Periphyton tissue quality results for these analytes will be compared to available pre-breach data (for selenium only [2010, 2012, and 2013]; Minnow 2011, 2013a, 2013b), contrasted between exposed and reference areas, and also compared temporally within exposed areas. Detailed analyses and interpretation related to these comparisons will be completed as required, and may

include: graphical comparisons to reference and historical data, and formal statistical contrasts of exposed versus reference concentrations tissue concentrations as described above

Concentrations of the POIs and IPs in periphyton tissue will also be evaluated relative to concentrations in water. These ratios of concentrations will be calculated as: [tissue sample concentration]/[dissolved water concentration], and are referred to as Bioconcentration Factors (BCFs). BCFs are often used to describe the extent to which an analyte is taken up by an organism from the surrounding environment through exposure routes other than diet (i.e., Arnot and Gobas 2006), and are applicable to erosional areas where sediment is generally not present. BCFs will be calculated using tissue metal concentrations (dry weight) and mean dissolved metal concentrations in water from each sampling area. Calculated BCFs will then be qualitatively compared among areas to identify differences in the uptake of metals by periphyton in areas impacted by effluent discharge and/or the TSF embankment breach. Mean BCFs will also be qualitatively compared between or among years to examine any broad temporal changes in metal accumulation in periphyton tissue at exposed sites. In addition, concentrations of POIs and IPs in periphyton tissue will be used in the evaluation of Trophic Transfer Factors (TTFs) to benthic invertebrates; the ratio of tissue concentrations in benthic invertebrates relative to concentrations in periphyton (i.e., TTF = [benthic invertebrate sample]/[periphyton sample]). TTFs can be used generally to describe the extent to which the concentration of an analyte increases between lower and higher trophic levels (e.g., Presser and Luoma 2010; see CEMP Benthic Invertebrate Section 6.13 for details).

An interpretive report based on the periphyton monitoring data will be prepared for integration into the Annual Environmental and Reclamation Report for the Mount Polley Mine that is prepared annually by MPMC and submitted to the regulators and other stakeholders by March 31 of the following year. The interpretive report will provide all data in an appendix and will include the DQR, the results of the screening against BCWQG and other guidelines or classification schemes, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots.

5 REFERENCES

APHA (American Public Health Association). 2010. Standard Methods for the Examination of Water and Wastewater, 21st edn. In A. D. Easton, L. S. Clesceri, E. W. Rice, A. E. Greenburg (Eds). Washington D.C.: American Public Health Association, American Water Works, Water Environment Federation.

Arnot, J.A., and F.A.P.C. Gobas. 2006. A Review of Bioconcentration Factor (BCF) and Bioaccumulation Factor (BAF) Assessments for Organic Chemicals in Aquatic Organisms. Environ. Rev.14: 257 – 297.

BCMOE (British Columbia Ministry of Environment). 2013. British Columbia Field Sampling Manual For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples. 2013 Edition.

BCMOE. 2015. British Columbia Environmental Laboratory Manual. 2015 Edition. Prepared and Published by the Ministry of Environment with the assistance of The British Columbia Environmental Laboratory Technical Advisory Committee. February 2016.

BCMOE. 2016. Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators. Version 2. June 2016.

BCMOE 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture – Summary Report. Updated March 2018. Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

Biggs, B.J.F. 1996. Patterns in Benthic Algae of Streams, in Stevenson, R.J., and others, eds., Algal Ecology Freshwater Benthic Systems: New York, Academic Press, p. 31-51

Golder (Golder Associates). 2015. Mount Polley Tailings Dam Failure – Surface Water Quality Impact Assessment. Report Number 1411734-036-R-Rev0-10000 Prepared for Mount Polley Mining Corporation, June 2015.

Golder. 2016. Mount Polley Mine Tailings Storage Facility, Perimeter Embankment Breach. Update Report: Post-Event Environmental Impact Assessment Report. Submitted to Mount Polley Mining Corporation. June 3, 2016.

Golder. 2017a. Hazeltine Creek: Reach 1 Record Drawings and Habitat Rating. Prepared for Mount Polley Mining Corporation, Likely, BC. March 2017.

Golder. 2017b. Technical Memorandum: Edney Creek Habitat Assessment – Mount Polley Mine. Prepared for Mount Polley Mining Corporation. April 2017.

Golder. 2017c. Hazeltine Creek Reach 2 Record Drawings and Habitat Rating. Prepared for Mount Polley Mining Corporation, Likely, BC. December 2017.

Hillebrand, H, C.-D. Dürselen, D. Kirschtel, U. Pollingher, and T.Zohary. 1999. Biovolume Calculation for Pelagic and Benthic Microalgae. Journal of Phycology 35.(2): 403-24.

Minnow (Minnow Environmental Inc.). 2009. Mount Polley Mine - Aquatic Environmental Characterization - 2007. Report Prepared for Mount Polley Mining Corporation. Report Prepared By Minnow Environmental Inc. July 2009. Project 2120.

Minnow. 2011. Mount Polley Mine selenium monitoring 2009/2010. Prepared for Mount Polley Mining Corporation, Likely, BC. March 2011.

Minnow. 2013a. Mount Polley Mine Selenium 2012. Prepared for Mount Polley Mining Corporation, Likely, BC. March 2013.

Minnow. 2013b. Mount Polley Mine Selenium Monitoring 2013 Update Report. Prepared for Mount Polley Mining Corporation, Likely, BC. December 2013.

Minnow. 2013c. Project Introduction Report for the Mount Polley Mine Southeast Rock Disposal Site. Prepared for Mount Polley Mining Corporation, Likely, BC. Draft. Project 2505.

Minnow. 2015. Mount Polley Tailings Dam Failure – Sediment Quality Impact Characterization. Prepared for Mount Polley Mining Corporation, May 2015.

Minnow. 2018a. Benthic Invertebrate Community and Productivity Monitoring in the Vicinity of the Mount Polley Mine, 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. March 2018.

Minnow. 2018b. Polley Lake and Frypan Creek 2017 Fish Monitoring. Prepared for Mount Polley Mining Corporation, Likely, BC. March 2018.

Minnow. 2018c. Selenium Summary Report, Mount Polley Mine, 2009 to 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. March 2018.

Minnow. 2018d. Chemical Analysis of Periphyton and Benthic Invertebrate Tissue Samples Collected in the Vicinity of the Mount Polley Mine, September to October 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. April 2018.

Norton, S.B., S.M. Cormier and G.W. Suter II. 2015. Ecological Causal Assessment. CRC Press, Boca Raton pp. 17-251-270.

Presser, T.S. and S.N. Luoma. 2010. A Methodology for Ecosystem-Scale Modeling of Selenium. Integ. Environ. Assess. Manag. 6: 685-710.

Stevenson, R. J. and L. L. Bahls. 2006. Chapter 6: Periphyton Protocols. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, 2nd Edition. US EPA Office of Water, Washington DC.

USEPA (United States Environmental Protection Agency). 1991. EPA Method 200.3, Metals, Total Recoverable in Biological Tissues. Washington, DC, USA.

USEPA. 1994. Method 200.8, Revision 5.4. Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry. Revision 5.4. 1994.

USEPA. 1997. EPA Method 445.0, In Vitro Determination of Chlorophyll a and Pheophytin a in Marine and Freshwater Algae by Fluorescence. Cincinnati, Ohio, USA.

USEPA. 2001. EPA Method 245.7, Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry. Washington, DC, USA.

USEPA. 2004. EPA Method 6020A, Inductively Coupled Plasma-Mass Spectrometry (Revision 6). SW-846 Online: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Washington, DC, USA.

Appendix B.4

Fish Monitoring

Minnow Environmental Inc.

Fish
Monitoring Plan

Prepared for:

Mount Polley Mining Corporation
Likely, British Columbia

Prepared by:

Minnow Environmental Inc.
Georgetown, Ontario

June 2018

minnow environmental inc.
A Trinity Consultants Company

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Monitoring Objective 2

2 SUMMARY OF HISTORICAL FINDINGS 3
2.1 Polley Lake 3
2.1.1 Fish Community / Population 3
2.1.2 Fish Tissue Quality 4
2.2 Hazeltine Creek 5
2.2.1 Fish Community / Population 5
2.2.2 Fish Tissue Quality 6
2.3 Quesnel Lake 6
2.3.1 Fish Community / Population 6
2.3.2 Fish Tissue Quality 7
2.4 Quesnel River 8
2.4.1 Fish Community / Population 8
2.4.2 Fish Tissue Quality 8

3 STUDY DESIGN OVERVIEW AND RATIONALE 9
3.1 Fish Tissue Quality 9
3.2 Sentinel Fish Populations 11
3.3 Fish Habitat Characterization and Usage 13
3.4 Fish Community 14

4 METHODOLOGY 16
4.1 Quality Assurance / Quality Control 16
4.2 Sample Collection Methods 16
4.2.1 Fish Collection 16
4.2.2 Fish meristic data 20
4.2.3 Fish Tissue Quality 21
4.2.4 Fish Habitat Characterization and Usage 21
4.3 Sample Handling and Laboratory analysis 23
4.4 Data Quality Review 24
4.5 Data Handling, Interpretation, and Reporting 24

5 REFERENCES 29

LIST OF FIGURES **FOLLOWING PAGE**

Figure 1: Rainbow trout age frequency distribution in Polley Lake (data from Lirette 2014 and 2016, and Minnow 2017a) 4
Figure 2: Rainbow trout fork length frequency distribution in Polley Lake (data from Lirette 2014 and 2016, and Minnow 2017a) 4
Figure 3: Selenium Concentrations in Rainbow Trout a) Muscle and b) Ovaries from Polley Lake, Hazeltine Creek, and Associated Reference Areas, Mount Polley, 2009 to 2017 4
Figure 4: Mercury Concentrations (mg/kg ww) in Muscle Tissue of Fish from Polley Lake (2015 to 2017) Relative to Reference Areas (Bootjack Lake and Trio Lake; 2015 to 2017) and Pre-Breach (Polley Lake; 2010) 5

Figure 5: Mount Polley CEMP Fish Monitoring Areas, Lakes and Quesnel River 9
Figure 6: Mount Polley CEMP Fish Monitoring Areas,Creeks 9

LIST OF TABLES **FOLLOWING PAGE**

Table 1: History of Fish Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine 3
Table 2: Catch-Per-Unit-Effort (CPUE) Data for Rainbow Trout and Longnose Sucker in Polley Lake, 1995 - 2017 4
Table 3: Summary of Fish Collected in Hazeltine Creek and Associated Reference Areas, Mount Polley, 1989 to 2017 5
Table 4: Fish Species Documented in Quesnel Lake 6
Table 5: Summary of Fish Collected in Quesnel Lake, Mount Polley, 2009 to 2017 6
Table 6: Comparison of Muscle and Whole Body Samples Collected in Quesnel Lake to Consumption Guidelines for Protection of Human Health or Guidelines for the Protection of Aquatic Life, MPMC, 2015 to 2017 7
Table 7: Summary of Fish Collected in Quesnel River, Mount Polley, 2014 to 2017 8
Table 8: Mount Polley CEMP Fish Monitoring Plan Overview 9
Table 9: Analytes and Laboratory Reporting Limits for Mount Polley CEMP Fish Tissue Quality Monitoring 23
Table 10: Survival, Energy Storage, and Energy Use Endpoints for Mount Polley EEM Fish Population Evaluation 25

1 INTRODUCTION

1.1 Background

Fish are important and highly valued aquatic ecosystem components. Fish community composition, fish population characteristics (e.g., survival, growth, and reproduction), and fish tissue quality can be effective monitors of potential biological effects associated with water quality, sediment quality, and/or physical disturbance. Fish tissue quality is also an important measure of potential exposure to metals, metalloids, nutrients[1], and other substances to humans and wildlife that consume fish. Lastly, the use of fish habitat by fish is an important monitor of the physical and chemical quality of aquatic habitat.

The influence of the Mount Polley Mine on fish communities, populations, and/or tissue quality can occur by several key mechanisms: 1) general mine influence on creeks and lakes from physical impingement, dustfall, and/or uncontained surface or groundwater flows; 2) direct discharge of mine effluent to Hazeltine Creek (April to August 2014) and Quesnel Lake (December 2015 to present [via Hazeltine Creek from December 2015 to November 2017, and directly since January 2018]); 3) the Tailings Storage Facility (TSF) embankment breach on August 4, 2014; and 4) reclamation activities following the TSF embankment breach. Potential effects associated with effluent discharge are chemical, while those associated with general mine influence, the TSF embankment breach, and subsequent remediation can be both physical and chemical.

Fish in waterbodies adjacent to the Mount Polley Mine have been monitored historically by the provincial government (Burns and Klein 1973; Lirette and Tredger 1991; Bruce and Slaney 1991) and by the Mount Polley Mine starting with baseline investigations in 1989, 1995, and 1996 (Imperial Metals 1990; HKP 1996a,b,c, 1997a). Results of fish monitoring are reviewed in Section 2 and provide context for a CEMP fish monitoring program (community, population, and tissue quality) that is guided by a combination of historical findings, representative locations downstream of Mount Polley Mine operations, representative reference locations, and considerations for a statistically-based design that will facilitate the detection of spatial and temporal differences. Fish tissue quality monitoring data will also be evaluated relative to guidelines for the protection of aquatic life and/or human health (e.g., the British Columbia Water Quality Guideline for selenium [BCMOE 2014] and the Health Canada guideline for mercury [CFIA 2015]). In addition, fish population monitoring is required as part of Environmental Effects Monitoring (EEM) under the Metal and Diamond Mining Effluent Regulations (MDMER) of the

[1] Through the remainder of this section, the term “metals” will be used to include metals, metalloids, and nutrients for ease of communication.

federal *Fisheries Act* (Government of Canada 2018). The focus of the federal EEM fish survey is to determine if there are effects to sentinel fish population characteristics (e.g., survival, growth, and/or reproduction) associated with the discharge of mine effluent (currently to Quesnel Lake). Lastly, fish habitat characterization and fish usage monitoring serves to document and track the effectiveness of fish habitat that has been reconstructed/rehabilitated following the TSF embankment breach.

The following sections of the CEMP Fish Monitoring Plan provide the objectives of fish monitoring, a summary of historical fish community, population, and tissue quality findings, an overview of the CEMP study design and associated rationale (including sampling locations, replication, frequency, and analytes), and detailed methodology for fish monitoring (quality assurance/quality control, sample collection methods, sample handling and laboratory analysis, data quality review, data handling, interpretation, and reporting).

1.2 Monitoring Objective

The objective of fish monitoring is to evaluate the influence of Mount Polley Mine activities on fish communities, populations, and tissue quality in receiving environments (Hazeltine Creek, Polley Lake, and Quesnel Lake) in comparison to baseline and/or reference conditions, and to determine potential implications to aquatic ecosystem health and human health (e.g., relative to available fish tissue quality guidelines [BCMOE 2014; CFIA 2015]). Fish monitoring also provides data to support exposure assessment as part of post-breach ecological risk assessment (ERA) and human health risk assessment (HHRA). Lastly, fish monitoring documents fish habitat utilization in creek and lake areas that were physically impacted by the TSF embankment breach (most notably Hazeltine Creek and the lower segment of Edney Creek), thereby documenting the effectiveness of fish habitat rehabilitation efforts. The objective of the MDMER EEM fish monitoring is to evaluate whether there are differences in population endpoints (survival, growth, and reproduction) of sentinel fish species between the area of Quesnel Lake exposed to Mount Polley mine effluent and a reference area (Environment Canada 2012). As prescribed by the MDMER, there is no requirement to monitor fish tissue quality under the MDMER because the concentration of mercury in Mount Polley Mine effluent is less than 0.1 µg/L (0.0001 mg/L; Government of Canada 2018).

2 SUMMARY OF HISTORICAL FINDINGS

Fish monitoring in the vicinity of the Mount Polley Mine has been undertaken since 1989, with most of the monitoring conducted in Polley Lake, Bootjack Lake, Hazeltine Creek, and Edney Creek (Table 1). Fish in Quesnel Lake have also been intensively monitored since the TSF embankment breach in August 2014 and following the initiation of effluent discharge to Quesnel Lake in December 2015. Fish monitoring in the vicinity of the Mount Polley Mine has spanned four distinct time periods:

1. Baseline monitoring (1989, 1991, 1995, 1996);
2. Pre-breach operational monitoring (1997, 1998, 1999, 2007, 2009, 2010, 2012, 2013, 2014);
3. Post-breach operational monitoring (2014, 2015); and
4. Post-breach and post-discharge operational monitoring (2016, 2017).

For Polley Lake and Hazeltine Creek, the second time period can be sub-divided into periods of: 1) prior to; 2) during; and 3) after, an uncontrolled surface runoff event from the north waste rock dump which reported to Polley Lake via North Dump Creek. This runoff started in 2006, was controlled in 2009 with the construction of the Long Ditch, and was characterized by elevated concentrations of sulphate and selenium. In addition to the construction of the Long Ditch, Mount Polley initiated selenium-specific aquatic environmental monitoring in 2009.

Fish community, population, and/or tissue quality data collected prior to the breach were summarized in an Aquatic Environmental Description Report prepared concurrent with an application for water discharge to Polley Lake in 2014 (Minnow 2014a). General findings of the historical monitoring, as well as fish monitoring data collected from 2014 to present, are provided in the following sections, by sampling area, to support the design of the CEMP Fish Monitoring Plan.

2.1 Polley Lake

2.1.1 Fish Community / Population

Baseline monitoring in Polley Lake and reference lakes (Bootjack, Trio, Morehead, and Frypan lakes) was conducted in 1989, 1995, and 1996 and documented the presence of rainbow trout, longnose sucker, and redside shiner. Peamouth chub and largescale sucker have also been reported in Bootjack Lake (in 2014 and 2016, respectively). The fish species composition of Polley and Bootjack lakes has remained the same through operational monitoring and following the perimeter embankment breach. Catchability of rainbow trout and longnose sucker in Polley

Table 1: History of Fish Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine

A) Lakes

Year	Locations	Endpoints[1]	Report
1989	Bootjack, Morehead	C, P, T[2]	Imperial Metals 1990
1995	Polley, Bootjack	C, P, T	HKP 1996a
1996	Polley, Bootjack	C[3]	HKP 1997a
1999	Polley, Bootjack	C, P, T	Beak 2000
2009	Polley, Bootjack, Trio, Frypan, Quesnel (near Hazeltine Creek)	C, P, T	Minnow 2011
2010	Polley, Quesnel (near Hazeltine Creek and North Arm)	C, P, T	Minnow 2011
2012	Polley, Bootjack, Trio, Frypan, Quesnel (near Hazeltine Creek and North Arm)	C, P, T[4]	Minnow 2013a
2014	Polley, Bootjack, Quesnel (multiple locations)	C, P[5], T	Lirette 2015; Golder 2016
2015	Poley[6], Bootjack, Quesnel (multiple locations), Trio	C, P, T	Golder 2016; Zirnhelt 2016; Zirnhelt and Dolighan 2015
2016	Polley, Quesnel (multiple locations)	C, P, T	Minnow 2016, 2017a,b; Lirette 2017
2017	Polley, Bootjack, Quesnel	C, P, T	Minnow 2018a

[1] C = Community, P = Population, and T = Tissue.

[2] Rainbow trout in Bootjack Lake only.

[3] Recreational angling use survey only.

[4] Selenium concentrations only.

[5] Population estimates only taken at Polley Lake (Lirette 2015).

[6] Rainbow trout collected from Frypan Creek and pooled with samples from Polley Lake.

Table 1: History of Fish Monitoring in Waterbodies in the Vicinity of the Mount Polley Mine

B) Creeks and Rivers

Year	Locations	Endpoints[1]	Report
1989	Upper Hazeltine, Lower Hazeltine, Upper Edney, Lower Edney, Bootjack, Morehead, Lower Morehead, 4K, 6K	C	Imperial Metals 1990
1990	Hazeltine, Bootjack	C, P	Bruce and Slaney 1991
1995	Upper Edney (multiple tributaries)	C, P	HKP 1996b,c
1996	Upper Edney (multiple tributaries)	C, P	HKP 1997a
1997	Upper Edney (multiple tributaries)	C, P	HKP 1997b
1998	Upper Edney (multiple tributaries)	C, P	Beak 1999
2007	Upper Hazeltine, Lower Hazeltine, Upper Edney (NE trib), Reference (Upper Edney [SW trib], Upper Cedar, Lower Whiffle)	C, P	Cariboo Envirotech 2008; Minnow 2009
2009	Upper Hazeltine	C, P, T[2]	Minnow 2011
2010	Upper Hazeltine	T[2]	Minnow 2011
2012	Upper Hazeltine	C, P, T[2]	Minnow 2013a
2013	Upper Hazeltine	T[2]	Minnow 2013b
	Bootjack	C, P	Minnow 2014b
2014	Upper Hazeltine, Horsefly, Quesnel, Soda, Edney	C, T[2]	DWB 2014; Golder 2016
2015	Frypan[3], Quesnel, Edney	C, P, T	DWB 2015; Golder 2016
2016	Edney	C, P	Minnow 2018b
2017	Edney, Quesnel	C, P, T	Minnow 2018a,b

[1] C = Community, P = Population, and T = Tissue.

[2] Selenium concentrations only.

[3] Rainbow trout collected from Frypan Creek and pooled with samples from Polley Lake.

Lake and Bootjack Lake by gill netting has remained reasonably consistent from baseline to the most recent gill netting effort in 2016 (Table 2). More recent hoop netting efforts (adopted as a preferred method as captures are non-lethal) document good catchability of both large-bodied species (Table 2).

After the perimeter embankment breach (August 2014), a barrier was installed at the outlet of Polley Lake preventing Polley Lake fish from accessing Hazeltine Creek. There was a noticeable decline in rainbow trout recruitment post-breach as evident in the smaller relative sizes of the age 1 and 2 cohorts in 2016, and the age 1 to 3 cohorts in 2017 (Figures 1 and 2; Minnow 2017a). The barrier preventing fish from entering Hazeltine Creek from Polley Lake was removed in the early spring of 2018 and recruitment is expected to increase accordingly.

2.1.2 Fish Tissue Quality

Tissue quality of Polley Lake (and Bootjack Lake) fish was evaluated in 1989, 1995, 1996, and 1999[2], providing baseline metal concentrations in muscle and liver tissue of rainbow trout and longnose sucker (Imperial Metals 1990; HKP 1996a, 1997a; Beak 2000). Fish tissue quality monitoring was subsequently undertaken in 2009 in response to the uncontrolled surface runoff event from a north waste rock dump which reported to Polley Lake via North Dump Creek (Minnow 2011). Results of the post-runoff but pre-breach monitoring (2009 to 2012) indicated that selenium concentrations in rainbow trout muscle and ovary tissue[3] were stable, that concentrations in muscle tissue were near the British Columbia water quality guideline (BCWQG; BCMOE 2014), and that concentrations in ovary tissue were below the BCWQG (Figure 3). A decrease in selenium concentrations in rainbow trout muscle and ovary concentrations appeared to occur from 2012 to 2014 (pre-breach; Figure 3). Ovary tissue is the best tissue for evaluating the potential adverse effects of selenium to fish (which are considered the most selenium sensitive organisms; Presser and Luoma 2009; Janz et al. 2010; DeForest et al. 2012; Janz 2012). Concentrations in selenium were also well below the effect threshold of 20 mg/kg dw developed by DeForest et al. (2012). Following the TSF embankment breach, an increase in concentrations of selenium in rainbow trout muscle (to above BCWQG) and ovary (below BCWQG) were observed (Figure 3), but the latter remained below the effect threshold.

Following the TSF embankment breach, fish tissue quality investigations were expanded to focus on a suite of analytes that included selenium and also included metals that: 1) were identified as

[2] Although the 1999 collections occurred after mine startup, the results of the collections were verified against previous data and, based on similar results, were used to augment the baseline database to a sample size of ten fish.

[3] Adult rainbow trout were collected either from Polley Lake or from upper Hazeltine Creek. The latter were adult fish from Polley Lake that had moved into Hazeltine Creek to spawn and are considered indistinct from Polley Lake fish for tissue quality monitoring purposes.

Table 2: Catch-Per-Unit-Effort (CPUE) Data for Rainbow Trout and Longnose Sucker in Polley Lake, 1995 - 2017

Year	Data source	Fishing Method	Effort (h)	Rainbow Trout		Longnose Sucker	
				Catch	CPUE	Catch	CPUE
1995	**HKP (1996a)**	Experimental gill net [a] (0.5" - 4" mesh)	15.72	16	0.0006	37	0.0014
2012	**Minnow (2013a)**	Multiple gill nets [b]	48.42	30	0.0006	68	0.0013
2014	**Lirette (2015)**	Four panel sinking net	15.17	75	0.0031	107	0.0044
		Four panel floating net	15.92	69	0.0027	33	0.0013
		All nets combined	15.50	144	0.0029	140	0.0028
2016	**Lirette (2017)**	Four panel sinking net	15.80	45	0.0018	154	0.0061
		Four panel floating net	15.77	79	0.0032	26	0.0010
		All nets combined	15.79	124	0.0025	180	0.0036
2016	**Minnow (2017b)**	Hoop Net [c]	804	1,737	51.9	2,422	72.4
2017	**Minnow (2018a)**	Hoop Net [c]	20.88	8	9.2	247	285
		Seine Net [d]	-	31	3.1	-	-

[a] CPUE values calculated using reported fishing effort time (15h 43min), and gillnet dimensions (67.5m x 2.35m) (HKP 1996a).
[b] CPUE values calculated as (caught / [ft^2 * h]).
[c] CPUE values calculated as number of fish per trap-day.
[d] CPUE values calculated as number of fish captured per m^2 (Area = 10 m^2).

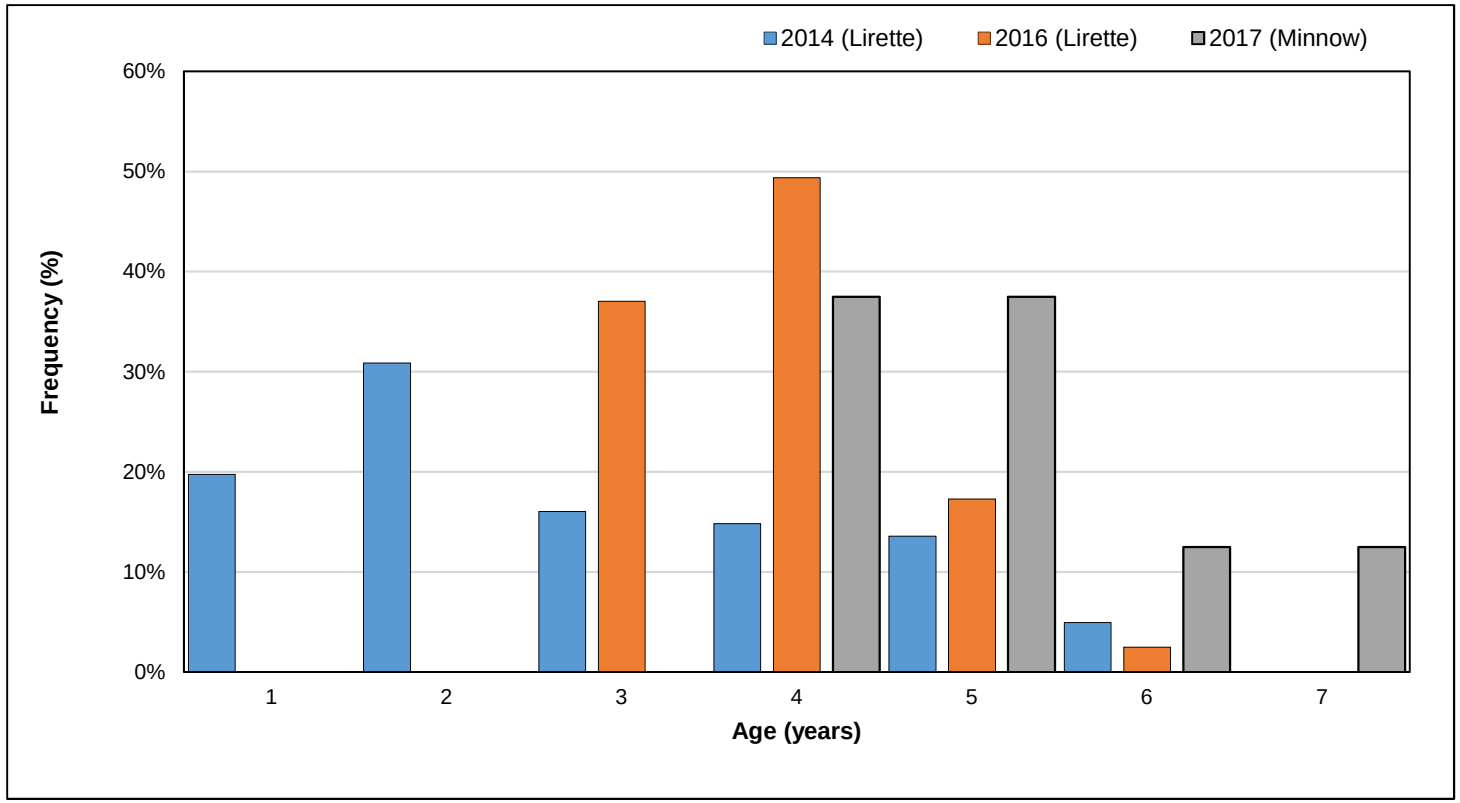


Figure 1: **Rainbow trout age frequency distribution in Polley Lake (data from Lirette 2014 and 2016, and Minnow 2017a)**

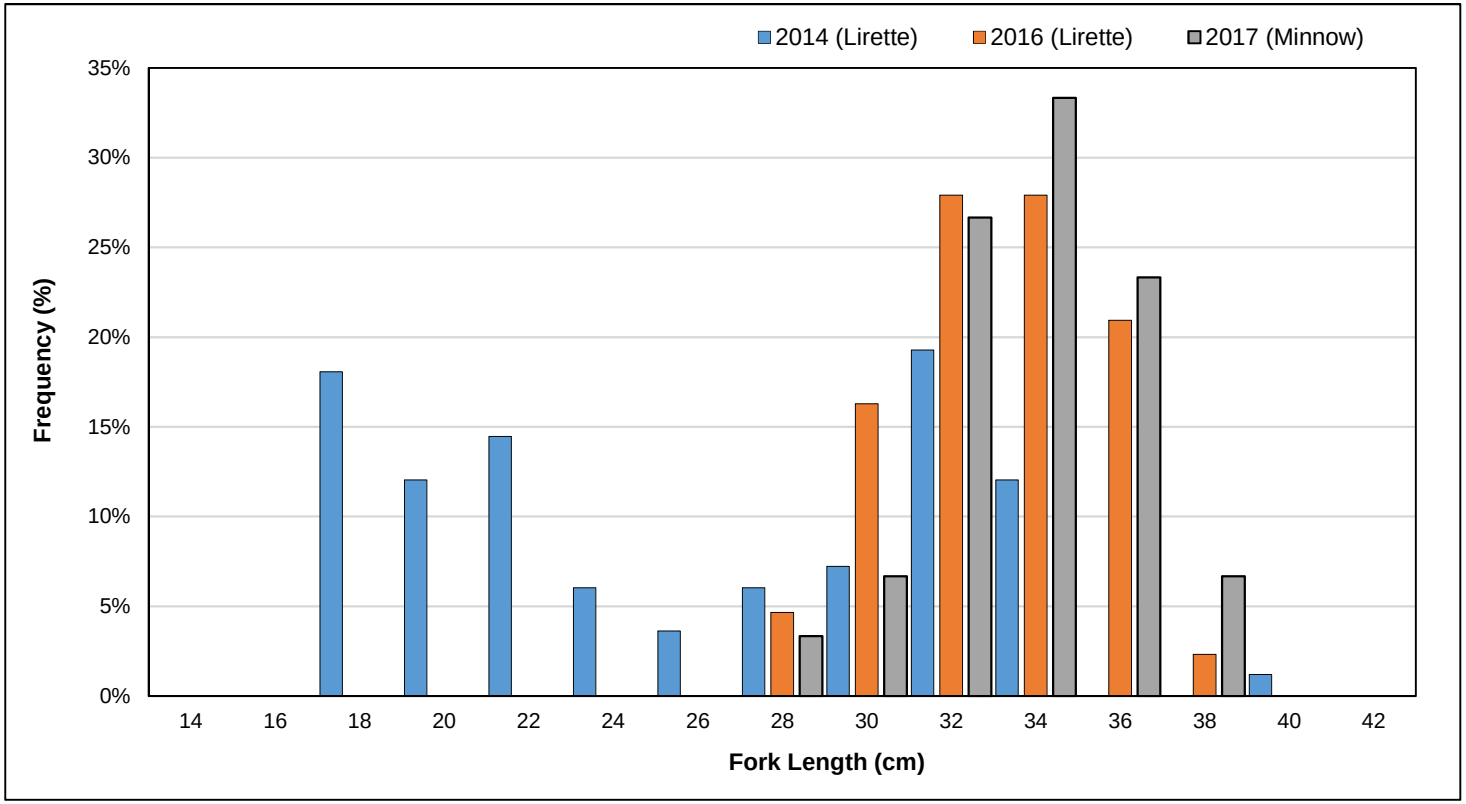


Figure 2: Rainbow trout fork length frequency distribution in Polley Lake (data from Lirette 2014 and 2016, and Minnow 2017a)

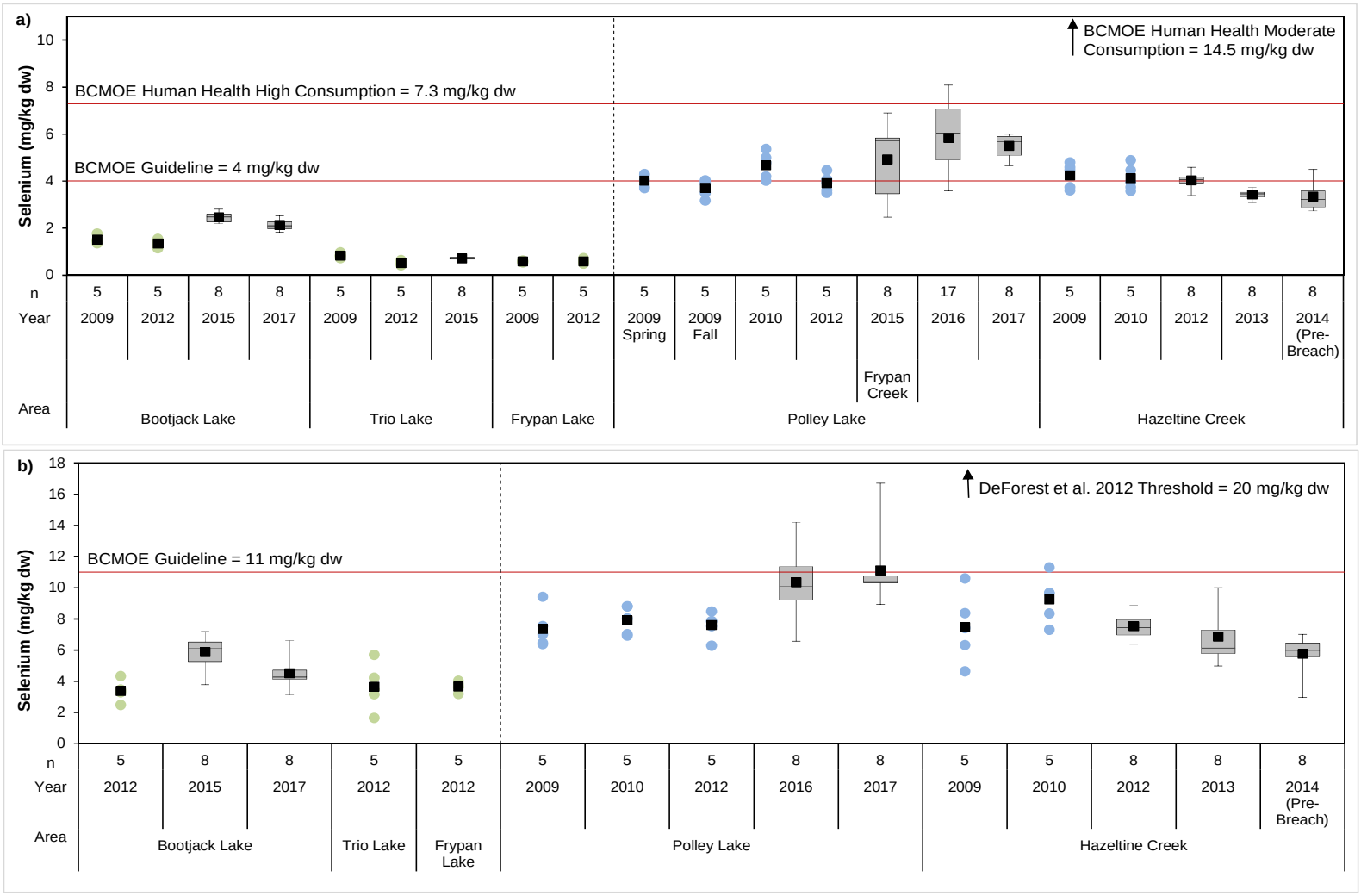


Figure 3: Selenium Concentrations in Rainbow Trout a) Muscle and b) Ovaries from Polley Lake, Hazeltine Creek, and Associated Reference Areas, Mount Polley, 2009 to 2017

Notes: Dashed line used to separate reference (left side) and exposed (right side) areas. Black squares represent means and whiskers represent minimum and maximum values. Box plots are presented when there are 8 or more samples.

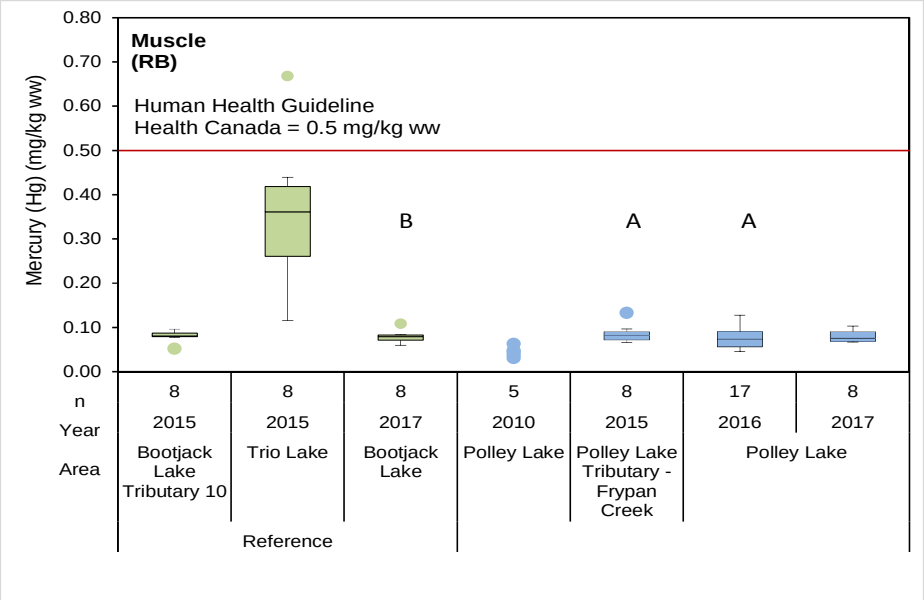
indicative of the influence of the TSF embankment breach on the receiving environment (arsenic, copper, iron [Minnow 2015], molybdenum, phosphorus, selenium [Golder 2015, 2016a]; and/or 2) had tissue quality guidelines (mercury and selenium). Concentrations of mercury and selenium in tissues of rainbow trout and longnose sucker collected in Polley Lake in 2015 to 2017 were lower than guidelines for the protection of human health (Figures 3 and 4), indicating that the fish can be safely consumed at consumption levels typical of the general population (Minnow 2017b, 2018a). Statistical contrasts of concentrations of the expanded suite of analytes in the tissues of Polley Lake fish relative to Bootjack Lake fish showed little agreement in terms of significant differences among species and/or tissues for almost all analytes, nor in the direction of differences when they were observed. This pattern indicates that, if there was any breach-related influence on Polley Lake fish tissue quality, it was minor. In Polley Lake, the only corroborated (reasonably unequivocal) differences were in selenium concentrations in the ovaries of Polley Lake rainbow trout, which were higher than reference and pre-breach in 2016 and 2017, potentially indicative of a breach-related influence (Minnow 2017b, 2018a). The same was not observed in longnose sucker; concentrations in longnose sucker tissues from Polley Lake (2017) were elevated relative to Bootjack Lake (2017), but were significantly lower than selenium concentrations in Polley Lake in 2010. For both species (rainbow trout and longnose sucker), selenium concentrations in ovary tissue were not at levels where adverse effects to fish would be expected (i.e., were not above the effect threshold).

2.2 Hazeltine Creek

2.2.1 Fish Community / Population

The fish community of Upper Hazeltine Creek has been dominated by juvenile rainbow trout during every sampling effort (Table 3). The fish community of Lower Hazeltine Creek (and Lower Edney Creek; both of which flow into Quesnel Lake) included bridgelip sucker, burbot, chinook salmon, coho salmon, kokanee, largescale sucker, longnose dace, longnose sucker, mountain whitefish, northern pikeminnow, peamouth chub, rainbow trout, and redside shiner (Table 3). Most of the fish species documented in Lower Hazeltine Creek or Lower Edney Creek in baseline (1989; Imperial Metals 1990) and in 2007 (Minnow 2009) were also observed in the rehabilitated section of Lower Edney Creek in 2016 and 2017 (Minnow 2018b).

The majority of rainbow trout collected in upper Hazeltine Creek and Edney Creek (79%; SNC-Lavalin 2015) have been young-of-the-year (YOY). In baseline, the density of rearing rainbow trout was 710 fish/100 m^2 and in lower Hazeltine Creek was 325 fish/100 m^2 (Imperial Metals 1990). By comparison, density in Bootjack Creek was 1,500 fish/100 m^2 (Imperial Metals 1990). Sampling in 1991 documented rainbow trout YOY density of 287 to 444 fish/100 m^2 in Hazeltine Creek compared to Bootjack Creek which had a density of 465 fish/100 m^2 (Bruce



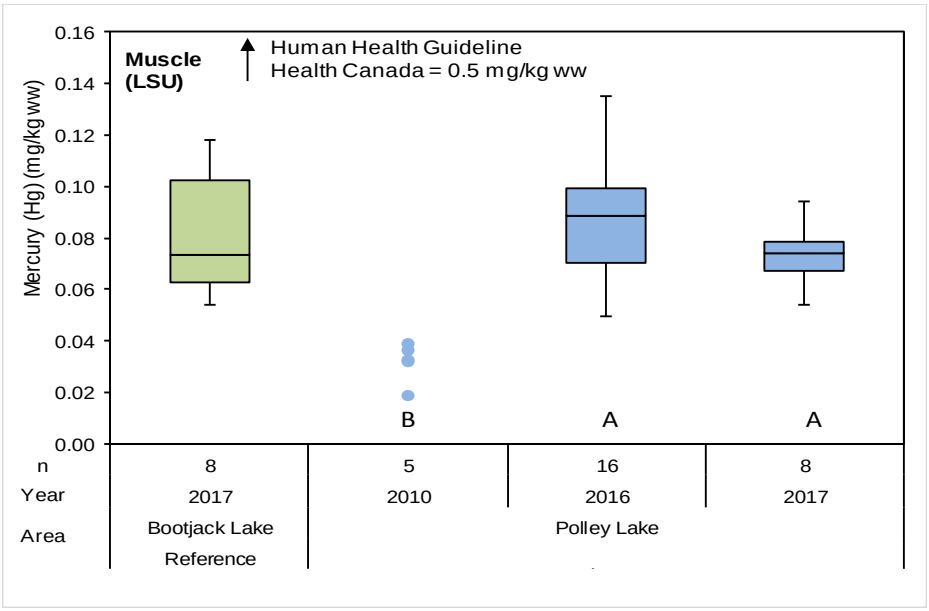


Figure 4: Mercury Concentrations (mg/kg ww) in Muscle Tissue of Fish from Polley Lake (2015 to 2017) Relative to Reference Areas (Bootjack Lake and Trio Lake; 2015 to 2017) and Pre-Breach (Polley Lake; 2010) [a,b,c]

[a] Concentrations in rainbow trout (RB) and longnose sucker (LSU) tissues from Polley Lake (2017) that differed significantly ($p<0.05$) from Bootjack Lake (2017) are denoted by an asterisk (*).

[b] Among-year comparisons were completed for Polley Lake only (2010, 2016 and 2017). The absence of letters (A,B,C) for 2010, 2016, and 2017 indicates no significant difference exists among years. Where significant differences were identified (family-wise $\alpha=0.05$), the years that were not significantly different from each other were assigned a common letter (A,B,C). The year with the greatest mean is assigned "A".

[c] Data summarized as boxplots when sample size was 8 or more; dot plots when sample size was 8 or fewer, or fewer than 8 results were detectable.

Table 3: Summary of Fish Collected in Hazeltine Creek and Associated Reference Areas, Mount Polley, 1989 to 2017

Area	Year	Report	Fishing Method	Bridgelip Sucker	Burbot	Chinook Salmon	Coho Salmon	Kokanee	Largescale Sucker	Longnose Dace	Longnose Sucker	Mountain Whitefish	Northern Pikeminnow	Peamouth Chub	Rainbow Trout	Redside Shiner	Sockeye Salmon	Salmon fry [c]	Juvenile Sucker sp.
Upper Hazeltine Creek	1989	Imperial Metals 1990	minnow trap, electrofishing	-	-	-	-	-	-	-	-	-	-	-	48	-	-	-	-
	1990	Bruce and Slaney 1991	electrofishing	-	-	-	-	-	-	-	-	-	-	-	616	-	-	-	-
	2007	Minnow 2009	electrofishing	-	-	-	-	-	-	-	-	-	-	-	198	-	-	-	-
	2012	Minnow 2013a	electrofishing	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
	2013	Minnow 2013b	electrofishing	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-
	2014 [a]	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-
Lower Hazeltine Creek	1989	Imperial Metals 1990	minnow trap, electrofishing	-	-	-	-	-	-	-	-	2	-	-	142	-	8	-	-
	2007	Minnow 2009, Cariboo Envirotech 2008	electrofishing	6	158	38	9	-	9	24	-	-	-	18	96	6	-	-	-
Upper Edney Creek [b]	1989	Imperial Metals 1990	minnow trap, electrofishing	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-
	1995	HKP 1996b	electrofishing	-	-	-	-	-	-	-	-	-	-	-	295	-	-	-	-
	1996	HKP 1997a	electrofishing	-	-	-	-	-	-	-	-	-	-	-	435	-	-	-	-
	1997	HKP 1997b	minnow trap, electrofishing	-	-	-	-	-	-	-	1	-	-	-	200	-	-	-	-
	1998	Beak 1999	electrofishing	-	-	-	-	-	-	-	-	-	-	-	156	-	-	-	-
	2007	Minnow 2009, Cariboo Envirotech 2008	electrofishing	-	-	-	-	-	-	-	-	-	-	-	155	-	-	-	-
Lower Edney Creek	1989	Imperial Metals 1990	minnow trap, electrofishing	-	12	16	-	-	-	-	7	3	-	-	24	-	869	-	-
	1995	HKP 1996b	electrofishing	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-
	1996	HKP 1996b, 1997a	electrofishing	-	-	-	-	-	-	-	-	-	-	-	158	-	-	-	-
	1997	HKP 1996b, 1997b	electrofishing	-	-	-	-	-	-	-	-	-	-	-	111	-	-	-	-
	1998	Beak 1999	electrofishing	-	-	-	-	-	-	-	-	-	-	-	111	-	-	-	-
	2007	Cariboo Envirotech 2008	unknown	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-
	2014	DWB 2014	electrofishing	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-
	2015	DWB 2015	electrofishing	-	16	-	-	-	-	11	27	-	18	-	125	4	-	39	-
Lower Edney Creek (Rehabilitated)	2016	Minnow 2018b	minnow trap, electrofishing, hoop net	-	17	6	11	-	4	58	2	8	9	-	245	33	-	-	10
	2017	Minnow 2018b	minnow trap	-	2	-	181	-	-	35	19	-	32	4	66	56	-	-	17
Lower Edney Creek (Reference)	2016	Minnow 2018b	minnow trap, electrofishing	-	4	3	21	-	-	12	-	1	1	-	93	1	-	-	-
	2017	Minnow 2018b	minnow trap	-	-	1	96	3	-	6	-	-	-	-	76	-	-	-	-
Horsefly River	2014 [a]	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-
Lower Whiffle Creek	2007	Minnow 2009	unknown	-	27	-	-	-	-	-	-	-	-	-	118	-	-	-	-
Soda Creek	2014 [a]	Golder 2016	electrofishing	-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-

[a] Catch numbers are amount of fish retained for tissue analysis, more fish may have been collected.
[b] Upper Edney Creek includes all stations on Upper Edney as well as two tributaries of Edney Creek
[c] Fry could not be identified to species level but suspected to include Coho, Chinook, and Sockeye

and Slaney 1991). In 2007, Upper Hazeltine Creek had a higher density of rainbow trout (400 to 700 fish/100 m^2) compared to the reference area, upper Edney Creek in 2007 (200 to 640 fish/100 m^2; Minnow 2009). Rainbow trout densities in Edney Creek varied considerably over time, with baseline densities of 169 fish/100 m^2 in 1996 and 17 fish/100 m^2 in 1997 (Minnow 2014b).

2.2.2 Fish Tissue Quality

Fish tissue quality evaluations have focussed on lake fish (see above). Adult rainbow trout have been collected from Hazeltine Creek for tissue quality characterization, and the associated data interpretation is integrated with the data for Polley Lake (above) as adult rainbow trout captured in Hazeltine Creek migrate into the creek to spawn.

2.3 Quesnel Lake

2.3.1 Fish Community / Population

The fish community of Quesnel Lake has been well characterized and includes a total of 20 species (Table 4). Prior to the TSF embankment breach, fish monitoring in Quesnel Lake was limited to collections for tissue quality analysis (2009, 2012, and 2014). These collections resulted in the capture of burbot, lake trout, largescale sucker, longnose sucker, mountain whitefish, peamouth chub, and rainbow trout (Table 5). Fish collections, primarily for tissue quality, have been undertaken annually since the TSF embankment breach in 2014, with community composition similar to that documented previously (Table 5). Additional collections for federal Environmental Effects Monitoring (EEM) were undertaken in 2016 (Minnow 2016).

The Mount Polley Phase 1 EEM included a population study of two sentinel species – northern pikeminnow and largescale sucker (with a supporting evaluation of peamouth chub; Minnow 2016). The objective of this monitoring was to determine if exposure to Mount Polley mine effluent (discharged to Quesnel Lake starting in December 2015) has an effect on the survival, growth, or reproduction of sentinel fish populations as compared to reference populations. Some differences in fish population endpoints (i.e., survival and energy use) were observed for northern pikeminnow, largescale sucker, and peamouth chub captured from effluent-exposed versus reference areas (Minnow 2016). However, there was no concordance between the results of comparisons of effluent-exposed populations to the two reference area populations (i.e., the metrics for effluent-exposed populations were often intermediate between the two references) nor among the three species. Overall, it was concluded that fish communities in the effluent-exposed and reference areas were similar and that effluent discharges from the mine were not affecting fish populations or fish health (Minnow 2016).

Table 4: Fish Species Documented in Quesnel Lake

Common Name	Latin Name
Sockeye Salmon	*Oncorhynchus nerka*
Coho Salmon	*Oncorhynchus kisutch*
Chinook Salmon	*Oncorhynchus tshawytscha*
Kokanee	*Oncorhynchus nerka*
Rainbow Trout	*Oncorhynchus mykiss*
Bull Trout	*Salvelinus confluentus*
Lake Trout	*Salvelinus namaycush*
Pygmy Whitefish	*Prosopium coulteri*
Mountain Whitefish	*Prosopium williamsoni*
Lake Whitefish	*Coregonus clupeaformis*
Burbot	*Lota lota*
Largescale Sucker	*Catostomus macrocheilus*
Longnose Sucker	*Catostomus catostomus*
Slimy Sculpin	*Cottus cognatus*
Northern Pikeminnow	*Ptychocheilus oregonensis*
Peamouth Chub	*Mylocheilus caurinus*
Leopard Dace	*Rhinichthys falcatus*
Longnose Dace	*Rhinichthys cataractae*
Redside Shiner	*Richardsonius balteatus*
Lake Chub	*Couesius plumbeus*

Table 5: Summary of Fish Collected in Quesnel Lake, Mount Polley, 2009 to 2017

	Area	Year	Report	Fishing Method	Bull Trout	Burbot	Chinook Salmon	Coho Salmon	Kokanee	Lake Trout	Largescale Sucker	Longnose Dace	Longnose Sucker	Mountain Whitefish	Northern Pikeminnow	Peamouth Chub	Rainbow Trout	Redside Shiner	Sockeye Salmon	Juvenile Sucker sp.
Exposed	Quesnel Lake (near Hazeltine Creek)	2009	Minnow 2011	gill net, angling	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
		2010	Minnow 2011	gill net, angling	-	-	-	-	-	-	-	-	5 [b]	-	-	-	5	-	-	-
		2012	Minnow 2013a	gill net	-	1	-	-	-	7	28	-	9	15	-	41	13	-	-	-
		2014 [a]	Golder 2016	unknown	-	12	-	-	-	51	-	1	1	4	36	1	-	2	-	-
		2015	Zirnhelt and Dolighan 2015, Zirnhelt 2016	gill net, trap net	-	4	-	-	-	10	72	-	-	-	53	18	-	18	-	-
		2016	Minnow 2017b	hoop net	-	16	2	-	-	-	65	20	-	21	123	444	18	33	-	-
		2017	Minnow 2018a	gill net, minnow trap	1	3	-	-	2	-	-	-	-	-	27	-	2	-	1	2
	Quesnel Lake (near Likely) [a]	2014	Golder 2016	unknown	-	1	-	-	10	-	-	-	-	1	7	12	1	-	-	-
		2015	Golder 2016	unknown	-	-	-	-	8	-	-	-	-	-	-	-	8	-	-	-
	Quesnel Lake (Middle) [a,c]	2014	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-
		2015	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-
	Quesnel Lake (West) [a]	2014	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-
		2015	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-
Reference	Quesnel Lake (North Arm)	2010	Minnow 2011	gill net, angling	-	-	-	-	-	-	-	-	5 [b]	-	-	-	5	-	-	-
		2012	Minnow 2013a	gill net	-	-	-	-	-	-	3	-	-	6	-	-	7	-	-	-
		2014 [a]	Golder 2016	unknown	-	-	-	-	10	-	-	-	-	-	31	2	-	-	13	-
		2015	Zirnhelt and Dolighan 2015, Zirnhelt 2016, Golder 2016	gill net, trap net	-	7	-	-	-	10	39	-	-	-	12	8	-	70	10 [a]	-
		2016	Minnow 2017b	hoop net	-	14	-	-	-	-	23	-	2	2	53	5	-	130	-	-
		2017	Minnow 2018a	gill net	2	-	-	-	1	-	-	-	-	5	-	-	-	-	2	-
	Quesnel Lake (East Arm) [a]	2014	Golder 2016	unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-
		2015	Golder 2016	unknown	-	7	-	-	-	10	-	-	-	-	-	-	-	-	10	-
	Quesnel Lake (near Horsefly)	2014 [a]	Golder 2016	unknown	-	1	-	-	-	-	-	2	-	-	10	6	-	-	-	-
	Quesnel Lake (Peninsula Bay)	2016	Minnow 2017b	hoop net	2	25	-	1	-	-	100	7	4	63	67	24	1	189	-	-
		2017	Minnow 2018a	gill net	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-

[a] Catch numbers are amount of fish retained for tissue analysis, more fish may have been collected, Golder 2016 Summary Report.
[b] Sample presented as longnose sucker but could possibly be largescale sucker.
[c] Potentially exposed.

2.3.2 Fish Tissue Quality

Tissue quality of Quesnel Lake fish was evaluated following the TSF embankment breach in 2014. This monitoring has included 12 fish species and variously included whole body, muscle tissue, liver tissue, Kidney tissue, and ovary tissue samples (Golder 2016; Minnow 2017b, 2018a). Fish tissue quality investigations were focussed on a suite of analytes that included metals that: 1) were identified as potentially indicative of the influence of the TSF embankment breach on the receiving environment (arsenic, cadmium, copper, iron, mercury, molybdenum, phosphorus, selenium, vanadium, and zinc; and/or or 2) had tissue quality guidelines (mercury and selenium).

Concentrations of mercury and selenium in tissues of fish collected in Quesnel Lake from 2015 to 2017 (burbot, kokanee, lake trout, largescale sucker, northern pikeminnow, peamouth chub, redside shiner) were lower than guidelines for the protection of human health in all cases except for mercury in large burbot and lake trout (Table 6; Minnow 2017b, 2018a). Large burbot and large lake trout (greater than approximately 66 cm in length [fork length and total length, respectively]) had mercury concentrations at levels where consumption limitation should be considered in accordance with provincial and federal guidance (e.g., BCMOE 2014; CFIA 2015). Smaller burbot and lake trout, as well as all other species can be safely consumed at consumption levels typical of the general population. There was no evidence that the Mount Polley Mine had any influence on mercury concentrations in burbot or lake trout. Rather, these species are piscivores (eat other fish) and are expected to have naturally higher concentrations of mercury (which is known to biomagnify). Concentrations of selenium in all fish species and tissues collected in Quesnel Lake were below BCWQGs for the protection of aquatic life.

In Quesnel Lake, uncertainty over fish movement between the exposed and reference areas and the absence of pre-breach datasets (of similar species) made interpretation of fish tissue quality results challenging. In Quesnel Lake, the only corroborated (reasonably unequivocal) differences in tissue metal concentrations of fish collected from exposed versus reference areas were higher concentrations of arsenic, cadmium, mercury, and selenium in tissues or whole bodies of northern pikeminnow and/or peamouth chub collected from exposed areas relative to reference areas. However, results of Environmental Effects Monitoring (EEM) undertaken in 2016 indicated that populations of northern pikeminnow and peamouth chub collected at the exposed area had very slightly (but not biologically meaningful) lower condition than reference fish (3.6% lower; Minnow 2016). Accordingly, the few corroborated differences in tissue metal concentrations were not associated with any adverse effect on the health of peamouth chub or northern pikeminnow. In 2017, no corroborated (reasonably unequivocal) temporal changes were identified for northern pikeminnow (whole bodies) collected from Quesnel Lake (relative to 2016; Minnow 2018a). This

Table 6: Comparison of Muscle and Whole Body Samples Collected in Quesnel Lake to Consumption Guidelines for Protection of Human Health or Guidelines for the Protection of Aquatic Life, MPMC, 2015 to 2017

Sample Collection Timing	Area	Species (Species Code)	Tissue	Sample Size	Mercury (Hg) mg/kg ww		Selenium (Se) mg/kg dw				
					Health Canada Human Health (0.5 mg/kg ww)		BCMOE Human Health (Moderate = 14.5 mg/kg dw) (High = 7.3 mg/kg dw)			BCMOE Guideline (4 mg/kg dw)	
					Mean	Frequency > guideline	Mean	Frequency > moderate	Frequency > high	Mean	Frequency > guideline
Fall 2015	near Hazeltine Creek	Burbot (BB)	Muscle	4	0.35	0%	2.8	0%	0%	2.8	0%
		Lake Trout (LT)	Muscle	10	0.22	10%	1.9	0%	0%	1.9	0%
		Largescale Sucker (CSU)	Muscle	8	0.12	0%	3.1	0%	0%	3.1	13%
		Northern Pikeminnow (NSC)	Muscle	7	0.24	0%	2.0	0%	0%	2.0	0%
		Peamouth Chub (PCC)	Whole Body	8	-	-	-	-	-	3.1	13%
		Redside Shiner (RSC)	Whole Body	8	-	-	-	-	-	2.7	0%
	near Likely	Kokanee (KO)	Muscle	8	0.092	0%	2.4	0%	0%	2.4	0%
	East Arm (Reference)	Burbot (BB)	Muscle	7	0.26	14%	2.4	0%	0%	2.4	0%
		Lake Trout (LT)	Muscle	10	0.26	10%	1.6	0%	0%	1.6	0%
	Near Grain Creek (North Arm, Reference)	Largescale Sucker (CSU)	Muscle	8	0.11	0%	1.6	0%	0%	1.6	0%
		Peamouth Chub (PCC)	Whole Body	8	-	-	-	-	-	2.2	0%
		Redside Shiner (RSC)	Whole Body	8	-	-	-	-	-	2.0	0%
Spring 2016	near Hazeltine Creek	Largescale Sucker (CSU)	Muscle	8	0.11	0%	2.8	0%	0%	2.8	0%
		Northern Pikeminnow (NSC)	Whole Body	8	-	-	-	-	-	3.1	0%
		Peamouth Chub (PCC)	Muscle	8	0.24	0%	2.8	0%	0%	2.8	0%
	Near Grain Creek (North Arm, Reference)	Largescale Sucker (CSU)	Muscle	8	0.11	0%	1.6	0%	0%	1.6	0%
		Northern Pikeminnow (NSC)	Whole Body	8	-	-	-	-	-	2.1	0%
		Peamouth Chub (PCC)	Muscle	8	0.15	0%	1.6	0%	0%	1.6	0%
Fall 2017	near Hazeltine Creek	Northern Pikeminnow (NSC)	Whole Body	8	-	-	-	-	-	2.3	0%

Note: ww = wet weight; dw = dry weight.

Indicates mean mercury concentration greater than Health Canada's Human Health concentration for muscle tissue in fish (0.5 mg/kg ww; CFIA 2015).

Indicates mean selenium concentration greater than the BCMOE Human Health guideline for moderate fish consumption (14.5 mg/kg dw; BCMOE 2014).

Indicates mean selenium concentration greater than the BCMOE guideline for muscle tissue or whole body in fish (4 mg/kg dw; BCMOE 2014).

pattern indicates that, if there was any breach-related influence on Quesnel Lake fish tissue quality, it was minor.

2.4 Quesnel River

2.4.1 Fish Community / Population

Fish were sampled in the Quesnel River in 2014, 2015, and 2017, targeting rainbow trout, primarily by angling (Table 7). Other species were captured, including burbot, mountain whitefish, and peamouth chub (Table 7). Rainbow trout that were collected in the Quesnel River in 2017 were of similar age and size to those collected in 2015 (Minnow 2018a).

2.4.2 Fish Tissue Quality

Tissue quality of rainbow trout collected from the Quesnel River in 2015 and 2017 did not exceeded Health Canada's Human Health guideline for mercury (Minnow 2018a). In 2015, selenium concentrations in rainbow trout were below the BCMOE guideline for human health and for the protection of aquatic life, but in 2017, one sample exceeded these guidelines (Minnow 2018a). As observed in Quesnel Lake, no corroborated (reasonably unequivocal) temporal changes were identified for rainbow trout (muscle, liver, and kidney tissue) collected from the Quesnel River in 2017 (relative to 2015; Minnow 2018a).

Table 7: Summary of Fish Collected in Quesnel River, Mount Polley, 2014 to 2017

Area	Year	Report	Fishing Method	Burbot	Mountain Whitefish	Peamouth Chub	Rainbow Trout
Quesnel River	2014	Golder 2016	unknown	-	-	3	12
	2015	Zirnhelt and Dolighan 2015	angling	-	-	-	8
	2017	Minnow 2018a	angling	1	2	-	8

3 STUDY DESIGN OVERVIEW AND RATIONALE

Fish monitoring under the CEMP is designed to meet the combined needs of: 1) operational monitoring (including the discharge of treated effluent to Quesnel Lake); 2) monitoring of the impact of the 2014 TSF embankment breach; and 3) monitoring of the response to remediation following the TSF embankment breach. As previously indicated, fish monitoring includes fish tissue quality monitoring, sentinel fish population monitoring, fish habitat characterization and fish usage monitoring, and fish community monitoring. An overview of the proposed fish monitoring program is provided in Table 8 and Figures 5 and 6.

3.1 Fish Tissue Quality

Fish tissue quality monitoring is focused on Polley Lake and Quesnel Lake, with un-impacted reference areas identified for each mine-influenced sampling area (i.e., Bootjack Lake for Polley Lake, unaffected areas of Quesnel Lake for exposed areas of Quesnel Lake; Table 8; Figures 5 and 6). In Polley Lake, fish tissue quality monitoring is undertaken to monitor the combined influence of general mine proximity, uncontrolled surface runoff from the north dump (2006 to 2009), and influence of the TSF embankment breach. In Quesnel Lake and Quesnel River, fish tissue quality monitoring is undertaken to monitor the combined influence of the TSF embankment breach and the discharge of Mount Polley mine effluent (December 2015 to present). In Polley Lake (and reference), fish tissue quality monitoring will focus on rainbow trout and longnose sucker. Because selenium was elevated in the 2006 to 2009 surface runoff, this monitoring will be focussed on the collection of females in the spring so that ripe ovaries can be collected. The full complement of tissues to be collected will include muscle, liver, kidney, and ovary (Table 8). Scientific consensus is that the best tissues for evaluating the potential adverse effects of selenium to fish (which are considered to be the most selenium sensitive organisms) are ripe ovaries or eggs (Presser and Luoma 2009; Janz et al. 2010; DeForest et al. 2012; Janz 2012). Tissues will be collected for the analytical determination of moisture content, metals, and mercury (Section 4.3). Supporting data will include catch per unit effort, length, weight, and age (see below). Data interpretation will be based on a combination of: 1) statistical comparison to previous conditions; 2) statistical comparison to reference conditions; and 3) concentrations relative to fish tissue quality guidelines for the protection of aquatic life and human health (BCMOE 2014; CFIA 2015). A sample size of eight fish per species per area will provide replication for the statistical contrasts. Fish tissue quality monitoring in Polley and Bootjack lakes will be undertaken at an annual monitoring frequency from 2018 to 2020, and the annual frequency will re-evaluated prior to 2021 based on QP recommendations.

Table 8: Mount Polley CEMP Fish Monitoring Plan Overview

A) Fish Tissue Quality Monitoring [1]

Water Body	Type	Fish Species	Tissues [2,3]	Replication	Frequency [4]	Rationale
Polley Lake	Exposed	RB, LSU	M,L,K,O	8	annual	immediately adjacent to mine and breach-influenced
Bootjack Lake	Reference	RB, LSU	M,L,K,O	8	annual	reference for Polley Lake [5]
Quesnel Lake	Exposed	RB, LT, KO, NSC, PCC	M,L,K,O	8	annual	adjacent to effluent discharge and breach-influenced
	Reference	RB, LT, KO, NSC, PCC	M,L,K,O	8	annual	reference for Quesnel Lake exposed
Quesnel River	Far-Field Exposed	RB	M,L,K,O	8	annual	far-field exposed area near Quesnel Lake outlet

[1] All fish tissues will be evaluated for the following analytes: percent moisture, metals by ICP-MS scan, and total mercury (Table 9).

[2] Fish tissues: M = muscle, L = liver, K = kidney, O = ovary (as available/developed; note that females will only be specifically targeted in Polley and Bootjack lakes).

[3] Except for small bodied fish (PCC and juvenile NSC), which will be submitted whole.

[4] Monitoring frequencies applicable from 2018 to 2010 will be reviewed following data interpretation and modifications may be made in response to QP recommendations.

[5] Bootjack Lake is retained as the reference for Polley Lake due to the fact that it has not been notably affected by the mine, there is a long-term dataset available for it, and its watershed includes similar geology to Polley lake. The latter is not true for other potential reference areas.

B) Fish Population Monitoring

Water Body	Type	Fish Species	Endpoints	Replication	Frequency [3]	Rationale
Polley Lake	Exposed	RB, LSU	L,W,C [1]	100	annual	immediately adjacent to mine and breach-influenced
Quesnel Lake	Exposed	NSC, RSC	Federal EEM [2]	20 / sex	every 3 years [4]	adjacent to effluent discharge and breach-influenced
	Reference	NSC, RSC	Federal EEM [2]	20 / sex		reference for Quesnel Lake exposed

[1] L = length-frequency distribution (indicative of recruitment and survival), W = weight, C = condition (indicative of overall health / energy storage).

[2] Fish population endpoints prescribed for federal EEM will be applied. These differ for lethal and non-lethal designs as described in Section 4.2.

[3] Monitoring frequencies applicable from 2018 to 2010 will be reviewed following data interpretation and modifications may be made in response to QP recommendations.

[4] Frequency prescribed for federal EEM.

C) Fish Habitat Characterization and Usage Monitoring

Water Body	Type	Fish Species	Measures	Frequency [5]	Rationale
Upper Hazeltine Creek	Impacted [1]	RB, LSU	Fish habitat characterization [3], fish occupancy and meristics [4]	annual	immediately adjacent to mine and breach-impacted
Lower Hazeltine Creek	Impacted [1]	all / any [2]		every 2 years	breach-impacted
Lower Edney Creek	Impacted [1]	all / any [2]		every 2 years	breach impacted

[1] Impacted by the TSF embankment breach.

[2] A total of 20 fish species have been documented in Quesnel Lake (SNC-Lavalin 2015) and would have access to Lower Hazeltine and Lower Edney creeks.

[3] Fish habitat characterization using methodology applied in 2016 and 2017 (Minnow 2018b), as adapted from Johnston and Slaney 1996.

[4] Fish occupancy as determined by observation (including spawning, and general presence) and by fishing with record of catch/effort and meristic measures (length and weight).

[5] Monitoring frequencies applicable from 2018 to 2010 will be reviewed following data interpretation and modifications may be made in response to QP recommendations.

D) Fish Community Monitoring

** qualitative fish community data will be collected to support all fish tissue, fish population, and fish habitat usage collections

Water Body	Collection Methods [1,2,3]	Endpoint	Frequency [6]	Rationale
Polley Lake	HN, MT, FT, SN, EF, GN	CPUE [5]	annual	to support fish tissue quality and population monitoring
Bootjack Lake	HN	CPUE [5]	annual	to support fish tissue quality and population monitoring
Quesnel Lake	HN, MT, FT, SN, GN	CPUE [5]	annual	to support fish tissue quality and population monitoring
Upper Hazeltine Creek	MT, FT, SN, EF [4]	CPUE [5]	annual	to support fish population and habitat usage monitoring
Lower Hazeltine Creek	MT, FT, SN, EF [4]	CPUE [5]	every 2 years	to support fish habitat usage monitoring
Lower Edney Creek	MT, FT, SN, EF [4]	CPUE [5]	every 2 years	to support fish habitat usage monitoring
Quesnel River	AG	CPUE [5]		to support fish tissue quality monitoring

[1] In order of preference for non-lethal fish collection methods whenever possible (e.g., hoop netting, minnow trapping, electrofishing).

[2] HN = hoop netting, MT = minnow trapping, FT = fry trapping, SN = seining, EF = electrofishing, GN = gill netting, AG = angling.

[3] Prohibited in waters over twenty degrees Celsius.

[4] Subject to electrofishing prohibition during spawning and incubation periods and in waters below five degrees Celsius.

[5] CPUE = catch per unit effort. For HN, MT, and FT, CPUE will be expressed as catch per unit deployment time; for SN, CPUE will be expressed as catch per unit area; for EF, CPUE will be expressed as catch per unit electroshocking time and per unit area; for GN, CPUE will be expressed as catch per unit net surface area-time; and for AG, CPUE will be expressed as catch per unit of angling effort.

[6] Monitoring frequencies applicable from 2018 to 2010 will be reviewed following data interpretation and modifications may be made in response to QP recommendations.

590,000 595,000 600,000 605,000 610,000 615,000 620,000

5,830,000 5,825,000 5,820,000 5,815,000

Likely

Frypan Lake

Cedar Creek

Horsefly Likely Forest Service Road

Nina Lake

Polley Lake

Mount Polley Mine

Bootjack Lake

Boswell Lake

Winkley Creek Road

Bootjack Creek Dam

Tailings Storage Facility (TSF)

Gavin Lake Road

Hazeltine Creek

Quesnel Lake

Edney Creek

Near Hazeltine Creek

Edney Lake Road

Near Grain Creek

Peninsula Bay

Near Hazeltine Creek

0 2.5 5 10 km

BRITISH COLUMBIA

ALBERTA

Fort Nelson

Fort St. John

Prince George

Mount Polley 592,000 mE 5,822,000 mN

Williams Lake

Vancouver

United States

LEGEND

- Rainbow Trout from Quesnel River for Tissue
- Small Bodied Fish for Tissue and EEM- Reference
- Small Bodied Fish for Tissue and EEM - Exposed
- Exposed Lake
- Reference Lake
- Tailings Storage Facility
- Active Mine Operation

0 1.25 2.5 5 km

N W E S

Projection: North American Datum 1983 UTM Zone 10U

Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Mount Polley CEMP Fish Monitoring Areas, Lakes and Quesnel River

Date June 2018
Project 177202.0042

minnow environmental inc.

Figure 5

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\4-Fish\17-42 - Fig 5 Fish Monitoring in Lakes.mxd



LEGEND

- Stream Segments Subject to Habitat Characterization and Fish Habitat Use Assessment
- Rehabilited Reaches (Golder 2017a,b)
- Historic Watercourse

0 0.5 1 2
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 10U

Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Mount Polley CEMP Fish Monitoring Areas, Creeks

Date June 2018
Project 177202.0042

minnow environmental inc.

Figure 6

Document Path: S:\Projects\177202\177202.0042 - MPMC Fall 2017 Monitoring\Mapping\CEMP\4-Fish\17-42 - Fig 6 Fish Monitoring in Creeks.mxd

In Quesnel Lake (exposed and reference), fish tissue quality monitoring will focus on sentinel species. Sentinel species were selected on the basis of their trophic position, their status as sportfish or non-sportfish, their typical home range sizes, and the availability of historical tissue quality data. Rainbow trout (to be collected in the Quesnel River near the lake outlet; see below) and lake trout were selected as the sentinel sportfish species to monitor potential changes in tissue quality over time relative to human consumption of sportfish. In 2018, kokanee will also be monitored for this purpose (as there is a dataset from 2014 to which they can be compared). Northern pikeminnow and peamouth chub were selected as sentinel species with small home ranges to monitor potential changes in fish tissue quality associated with the TSF embankment breach and effluent discharge from the perspective of aquatic ecosystem health. Redside shiner may be used as an alternate sentinel species for this purpose depending upon future capture success. Fish species with small home ranges are better monitors of the potential effects of defined point sources (due to the fact that they are more continuously exposed) than fish with larger home ranges (e.g., Environment Canada 2012). The larger bodied fish will be subject to sampling the full complement of tissues, including muscle, liver, kidney, and ovary (Table 8). Ovary will only be sampled when available (i.e., when fully developed in mature females); additional fish will not be targeted and sacrificed to achieve the target sample size for ovary tissues (i.e., it is expected that ovary sample sizes will be less than eight). The small bodied fish (i.e., small northern pikeminnow, peamouth, and/or redside shiner) will be submitted as headless carcasses (as the heads will be submitted for otolith extraction and age determination). Data interpretation will be based on a combination of: 1) statistical comparison to previous conditions; 2) statistical comparison to reference conditions; and 3) concentrations relative to fish tissue quality guidelines for the protection of aquatic life and human health (for selenium and mercury; BCMOE 2014; CFIA 2015). It is noted that comparison to reference conditions has previously proven to be challenging due to uncertainty over exposure given the large home ranges of the sportfish species and the apparent absence of a strong mine influence (Golder 2016; Minnow 2017b, 2018a). Thus, the greatest utility of fish tissue monitoring is as a temporal monitor and for comparison to available guidelines. A sample size of eight fish per species per area will provide replication for the statistical contrasts. Fish tissue quality monitoring in Quesnel Lake will be undertaken at an annual monitoring frequency from 2018 to 2020 (although, as previously noted, kokanee will only be collected in 2018), and the annual frequency will re-evaluated prior to 2021 based on QP recommendations.

In the Quesnel River, rainbow trout were selected as a sentinel sportfish species to monitor potential changes in tissue quality over time. Rainbow trout will be collected in the late summer and will be subject to sampling the full complement of tissues, including muscle, liver, kidney, and ovary (Table 8). As noted above, ovary will only be sampled when available (i.e., when fully

developed in mature females); additional fish will not be targeted and sacrificed to achieve the target sample size for ovary tissues (i.e., it is expected that ovary sample sizes will be less than eight). Data interpretation will be based on a combination of: 1) statistical comparison to previous conditions; and 2) concentrations relative to fish tissue quality guidelines for the protection of aquatic life and human health (BCMOE 2014; CFIA 2015). A sample size of eight fish per species per area will provide replication for the statistical contrasts. Fish tissue quality monitoring in the Quesnel River will be undertaken at an annual monitoring frequency from 2018 to 2020, and the annual frequency will re-evaluated prior to 2021 based on QP recommendations.

Fish community and population data will be collected to support all fish tissue quality monitoring (as discussed in greater detail below). All collections will be supported by capture records for all species and documentation of effort that will be used to calculate Catch-Per-Unit-Effort (CPUE). All fish selected for tissue quality will be subject to measurement of length, weight (total and fork), and the collection of structures for age determination. Detailed methodology for fish collection, measurement, tissue sample collection, tissue sample processing, sample handling and laboratory analysis, quality control/quality assurance, data quality review, data handling, interpretation, and reporting is provided in Section 4.

3.2 Sentinel Fish Populations

Fish population monitoring is focused on Polley Lake and Quesnel Lake (Table 8; Figures 5 and 6). In Polley Lake, population monitoring is focused on tracking the population structure of rainbow trout. Specifically, with the inaccessibility of Hazeltine Creek (the major spawning and juvenile rearing location for Polley Lake Fish) between August 2014 and spring 2018, recruitment of Polley Lake rainbow trout was substantially diminished for four years (i.e., juvenile fish in Hazeltine were eliminated with the breach in August 2014 and recruitment from Hazeltine was unavailable in 2015, 2016, and 2017). Following the re-opening of Upper Hazeltine Creek in spring 2018, Polley Lake rainbow trout will again have access to the major spawning and rearing habitat and fish population monitoring will document changes in population structure over time (i.e., recovery of age-class balance). Polley Lake fish population monitoring will be conducted by hoop netting in the spring and fall. This non-lethal technique has previously proven effective for the collection of adult rainbow trout, adult longnose sucker, and larger redside shiner. All captured fish will be identified and counted, and all captured rainbow trout will be measured (total length, fork length, and weight) to provide data that can be used to characterize size-frequency distributions indicative of recruitment and survival. In 2018 only, an additional gill netting effort will be completed in the fall using methodology identical to that applied in 2014 and 2016 (Lirette 2015, 2017). This effort will apply experimental gill nets to achieve a high level of comparability to the previous work. The same measurements as noted above will be collected.

As this technique is destructive (lethal), age structures will also be collected and will allow age-frequency distributions to be determined in addition to the size frequency distributions noted above. Summary rainbow trout population metrics (mean age, mean size, size-at-age, and condition [weight-at-length]) as well as community metrics (CPUE, relative species proportions, as discussed in greater detail below) will be calculated and compared between areas (Polley Lake and Bootjack Lake), and over time. A target sample size of 50 (100 preferred) will provide replication for statistical contrasts. Data collected by the two different techniques in 2018 (hoop netting and gill netting) will be compared to determine if the non-destructive technique adequately addresses key questions, in which case future destructive sampling will be considered unnecessary. Fish population monitoring in Polley Lake will be undertaken at an annual monitoring frequency from 2018 to 2020, and the annual frequency will re-evaluated prior to 2021 based on QP recommendations.

Additional fishing efforts in Polley Lake shoreline areas will be undertaken to monitor the presence and abundance of juvenile rainbow trout. This will serve to monitor the recovery of rainbow trout in Polley Lake and to specifically augment the monitoring of juvenile trout recruitment determined for Upper Hazeltine Creek (as discussed in more detail in Section 3.3 below). Juvenile rainbow trout will be collected from shoreline areas in Polley Lake by minnow trapping, fry trapping, and backpack electrofishing. All captured fish will be identified, recorded, measured (fork length, total length, and weight) and released. Endpoints of CPUE, mean length, mean weight, size-frequency distributions, and condition will be calculated and monitored for comparison over time. Monitoring of juvenile rainbow trout in Polley Lake will be undertaken annually in the fall from 2018 to 2020, and the annual frequency will re-evaluated prior to 2021 based on QP recommendations.

In Quesnel Lake, populations of sentinel fish species (northern pikeminnow and redside shiner) will be monitored to evaluate potential effects associated with Mount Polley mine effluent discharge in accordance with requirements for EEM under the MDMER of the federal *Fisheries Act* (Environment Canada 2012; Government of Canada 2018). The fish population survey will be undertaken using prescribed methodology (Environment Canada 2012) and as described in detail in the Study Design report for the Phase 2 EEM (Minnow 2018c). Briefly, sentinel fish population monitoring in Quesnel Lake will evaluate population health (survival, growth, reproduction, and condition) of the two sentinel species. The study will be completed as a conventional (lethal) design (Environment Canada 2012) and will target 20 mature males and 20 mature females of each of the two sentinel species at the exposed area (near the Mount Polley effluent discharge) and at a reference area (Table 8; Figure 5). Fish collections will be completed by hoop netting and gill netting, and all fish measurements will be completed as prescribed by Environment Canada (2012) and as described in detail in Section 4.2. Quesnel Lake fish population monitoring will be completed in early spring when the sentinel species are fully

developed prior to spawning (McPhail 2007; Barrett and Munkittrick 2010). Northern pikeminnow typically spawn in the spring at a threshold temperature of 12 °C and redside shiner typically spawn in the spring at a threshold temperature of 10 °C (McPhail 2007). Both species typically spawn in flowing water over clean gravel substrates, but can also spawn in lakes. Sentinel fish species (up to the target sample size) will be subject to sacrifice and collection of the following measures prescribed for EEM: fork length, total length, weight, liver weight, gonad weight, and fecundity (Environment Canada 2012). Sentinel fish population endpoints (survival, growth, and reproduction) will be calculated for each species-area combination and statistically contrasted between effluent-exposed and reference areas as prescribed under EEM (Environment Canada 2012) and described in Section 4. Fish population monitoring in Quesnel Lake will be undertaken at the prescribed frequency of once every three years, with next collection in the spring of 2019. As outlined in EEM technical guidance, future frequency can change is response to findings. Detailed methodology for fish collection, measurement, tissue sample measurement, sample handling and laboratory analysis, quality control/quality assurance, data quality review, data handling, interpretation, and reporting is provided in Section 4.

3.3 Fish Habitat Characterization and Usage

Fish habitat characterization and usage monitoring is focused on Hazeltine Creek and lower Edney Creek, both of which were physically impacted by the TSF embankment breach (Table 8; Figure 6). Fish habitat characterization will monitor key characteristics of rehabilitated Hazeltine and Edney creek habitat in order to document recovery. Fish habitat usage monitoring will document the use of these rehabilitated creek habitats by all fish species and life stages, including the specific documentation of spawning and rearing in spring, summer, and fall months (May to October). Fish habitat characterization methods will be similar to those previously applied (Minnow 2018b) which are adapted from Johnston and Slaney (1996) and described in detail in Section 4.2. Fish habitat will be characterized in spring, summer, and fall in relation to the needs of fish that could potentially use the habitat (i.e., Polley Lake fish in the case of Upper Hazeltine Creek and Quesnel Lake fish in the case of Lower Hazeltine creek and Lower Edney Creek), and will include documentation of in-stream barriers and cover, spawning and overwintering habitat, riparian features, channel hydrology, bank condition, and water quality parameters. Fish habitat usage will be determined by a combination of visual observation and fish collection with measurement. Fish habitat usage monitoring will commence in the spring (May) once fish have begun to aggregate for spawning, and will be conducted again in the summer (August), and in the fall (September / October, including when fish are spawning). Fish collections will be completed using hoop netting, minnow trapping, fry trapping, seining, and backpack electrofishing (the latter only when appropriate based on non-spawning/egg incubation periods and when juvenile salmonids are not present). All captured fish will be identified and enumerated, and

fishing efforts will be documented for CPUE or density calculations (see following section). Up to 100 individuals from each collected species will be temporarily retained for length and weight measurements, which will be used to calculate summary statistics of length, weight, condition, and size-frequency distributions that will be monitored over time to document recovery. Fish habitat characterization and fish usage monitoring in lower Hazeltine Creek and lower Edney Creek will be undertaken at frequency of every two years starting in 2019[4], and the frequency will re-evaluated prior to 2021 based on QP recommendations. Detailed methodology for fish collection, fish measurement, quality control/quality assurance, data quality review, data handling, interpretation, and reporting is provided in Section 4.

For Upper Hazeltine Creek, fish collection will also include closed-station electrofishing that will provide the best possible estimate of the density of rearing rainbow trout (using removal calculators as outlined in Section 4). Fish capture data will be utilized to document the production of rainbow trout and any temporal changes therein including comparison to historical estimates (e.g., Minnow 2009). Fish meristic data will be used to calculate summary statistics of length, weight, condition, and size-frequency distributions that will also be compared to historical results (e.g., Minnow 2009). Fish habitat characterization and fish usage monitoring in upper Hazeltine Creek will be undertaken at an annual frequency from 2018 to 2020, and the frequency will re-evaluated prior to 2021 based on QP recommendations. Detailed methodology is provided in Section 4.

3.4 Fish Community

Fish community monitoring is a supporting measure to be determined in association with all fish collections (i.e., fish tissue quality monitoring, fish population monitoring, and fish habitat usage monitoring). Fish community monitoring effort will only be as required to collect the fish needed for these other purposes. Thus, the locations, timing, and frequency of fish community monitoring will be as outlined above (Sections 3.1 to 3.3, inclusive). In association with each fishing effort, all captured fish will be identified and counted. Details of each fishing effort (GPS coordinates, gear type and dimensions, and actual fishing time) will be recorded to provide the most quantitative record of fish community results possible. Specifically, the effort details will be collected to support the expression of CPUE on the basis of time (catch per time), area (catch per area), or the combination of gear-dimension and time (e.g., catch per 100 m net-hour). Interpretation of CPUE data will be based on a combination of: 1) comparison to previous conditions; 2) comparison to reference conditions; and 3) comparison of species proportions temporally and spatially (e.g., has the relative abundance rainbow trout versus longnose sucker

[4] Note that fish habitat characterization and usage monitoring in lower Hazeltine Creek will only be initiated after lower Hazeltine Creek is opened up as fish habitat (i.e., ponds and/or fish fences are removed).

changed over time and/or relative to the reference lake). Detailed methodology for fish collection, quality control/quality assurance, data quality review, data handling, data interpretation, and reporting is provided in Section 4.

4 METHODOLOGY

4.1 Quality Assurance / Quality Control

All sampling will be performed by qualified field staff experienced in the implementation of fish and fish habitat monitoring programs. Quality Assurance/Quality Control (QA/QC) measures will be consistent with requirements outlined in the BC Field Sampling Manual (BCMOE 2013) and the Water and Air Baseline Guidance Document for Mine Proponents and Operators (BCMOE 2016). Specific QA/QC measures will include program review prior implementation, adequate resources for all field teams including field checklists and field data sheets, the availability and maintenance of appropriate sampling equipment and sampling containers, and sampling in a manner that minimizes any risk of sample contamination (i.e., for tissue quality samples).

To capture within-area variability and support the tissue quality component of the fish monitoring program, eight replicate tissue chemistry samples will be collected from each sampling area. Fish tissue samples will include muscle, liver, kidney, and ovary tissues (or whole body analysis for smaller fish). Field duplicates (i.e., split samples collected from the same fish tissue) will be collected at a frequency of 10% of the total number of tissue samples to assess field precision, and will be evenly distributed among species and tissue types, to the extent possible. A Data Quality Objective (DQO) of <25% RPD will be applied to the duplicate (i.e., split) QC samples.

All chemical analyses will be completed by a laboratory that is accredited by the Canadian Association for Laboratory Accreditation (CALA), and will be required to include specific QC samples and report associated results. Specific QC samples will include laboratory blanks, laboratory replicates, and laboratory accuracy samples (i.e., matrix spikes, laboratory control samples, and/or certified reference materials). The QC sample results will be assessed as part of the Data Quality Review (DQR; Section 4.4). Laboratory reporting Limits (LRLs) will also be evaluated in comparison to targets established by the analytical laboratory.

Raw field data recorded on field sheets will be transcribed into an electronic spreadsheet and data collected using digital data collection devices will be exported from a geodatabase to electronic spreadsheets. Electronic spreadsheets will be checked by a separate individual for entry errors as part of routine QA/QC procedures.

4.2 Sample Collection Methods

4.2.1 Fish Collection

All fish monitoring will be undertaken under fish collection permits from the British Columbia Ministry of Forests, Lands and Natural Resource Operations (FNLNRO) and all fish monitoring in

waters frequented by salmon (e.g., Quesnel Lake and Quesnel River) will also be undertaken under fish collection permits from Fisheries and Oceans Canada (DFO). All conditions associated with the fish collection permits will be strictly adhered to (including the general prohibition of fishing in waters with temperatures >20°C).

Fish collections will be completed in accordance with applicable technical guidance outlined in the BC Field Sampling Manual (BCMOE 2013), the Water and Air Baseline Guidance Document for Mine Proponents and Operators (BCMOE 2016), and/or the Technical Guidance Document for EEM (Environment Canada 2012). A variety of fish collection techniques will be applied to collecting the fish required for the monitoring of fish tissue quality, fish populations, and habitat usage. To the extent possible, preference will be for non-destructive fish collection methods (e.g., hoop nets, minnow traps, fry traps, backpack electrofishing) in order to minimize the potential impact of fish monitoring on fish populations and/or communities. The following fish collection techniques will be used to support the CEMP fish monitoring plan:

- hoop netting;
- gill netting;
- minnow trapping;
- fry trapping;
- seining; and
- backpack electrofishing.

Hoop netting will be applied to the collection of large-bodied fish in lakes as the preferred collection method due to the fact that it is a non-lethal method. Hoop nets ranging in size from 0.6 m diameter, 2 cm stretched mesh to 0.75 m diameter, 3.8 cm stretched mesh with four to eight hoops and leads of approximately 30.5 m in length will be set as appropriate to target the fish required for tissue quality monitoring and fish population monitoring, and will be checked at a minimum frequency of every other day (although daily checks will be most common). The location of each net set will be recorded using a handheld GPS accompanied by notes on the set configuration (depth, lead to shore, trap to shore, etc.) and the time of deployment. Upon collection, the time of collection will be recorded and fish will be identified and counted as they are removed from the trap. Target species will be identified, counted, and then retained or measured (depending on the objective of the monitoring component). Non-target species will be identified, counted, and released at the location of capture. Individuals of the target fish species will be measured as outlined in Sections 4.2.2 and 4.2.3, per requirements of the particular monitoring component of the CEMP Fish Monitoring Plan.

Gill nets will be used as required to support hoop netting for fish tissue collection in lakes, as required, with application minimized and short deployment duration. Gill netting will also be applied in Polley Lake in late summer 2018 as a repeat of previous efforts (Lirette 2015, 2017). As required, gill nets will be set in lakes to collect large-bodied fish, consistent with historical sampling (e.g., Minnow 2018a) and recommendations from the Water and Air Baseline Guidance Document for Mine Proponents and Operators (BCMOE 2016). Net size and deployment configuration will be as required to most effectively capture target fish. For example, lake trout will be targeted in Quesnel Lake using a Profundal Index Netting methodology similar to the Summer Profundal Index Netting (SPIN) method (e.g., Jessup and Millar 2011). Fall 2018 gill netting in Polley Lake will employ experimental gill nets (two multi-panel gill nets of mesh size 38, 64, 38, and 89 mm), which will be set overnight. The nets will be set perpendicular to shore, with the smallest mesh orientated closest to shore. Set locations and configurations will be similar to those used in 2014 and 2016 (Lirette 2015, 2017). The location of each gill net set will be recorded using a handheld GPS accompanied by notes on the set configuration and the time of deployment. Check and retrieval times will be recorded and fish will be identified and counted as they are removed from the net. For experimental nets, fish counts will be recorded for each gill net panel. Non-target species will be identified, counted, and released at the location of capture. Depending on the objective of the monitoring component, individual fish of the target species will be measured immediately or retained for measurement as outlined in Sections 4.2.2 and 4.2.3.

Minnow traps (galvanized mesh – 42 cm length, 0.6 cm mesh, 2.5 cm diameter opening) will be set in lakes and creeks to capture small-bodied fish and juveniles. Juvenile rainbow trout (1+ or 2+ rainbow trout) will be targeted in Polley Lake. Minnow traps will be baited and will be tied off on shore or set on the substrate and marked with a float. Minnow traps set in creeks will be set so that the openings will be oriented upstream and downstream. Minnow traps will be checked at a minimum frequency of every other day (although daily checks will be most common). The location of each trap will be recorded using a handheld GPS accompanied by notes on the set configuration and the time of deployment. The retrieval time will be recorded and fish will be identified and counted as they are removed from the trap. Non-target species will be enumerated by species and released at the location of capture. Depending on the objective of the monitoring component, individual fish of the target species will be measured immediately or retained for measurement as outlined in Sections 4.2.2 and 4.2.3.

Fry traps will be set in selected lakes and creeks (Polley Lake, Hazeltine Creek, Edney Creek, and Frypan Creek) to augment minnow trap catches. Traps will be placed in habitat deemed suitable for juveniles (e.g., in slow flowing water near undercut banks, behind woody debris) and oriented with the closed end angled upstream. Traps will be weighed down on the streambed using small stones and will be checked daily. The location of each trap will be recorded using a

handheld GPS accompanied by notes on the set configuration and the time of deployment. Fry traps will be checked at a minimum frequency of every other day (although daily checks will be most common). The retrieval time will be recorded and fish will be identified and counted as they are removed from the trap. Non-target species will be enumerated by species and released at the location of capture. Depending on the objective of the monitoring component, individual fish of the target species will be measured immediately or retained for measurement as outlined in Sections 4.2.2 and 4.2.3.

Seining may also be completed in lakes and creeks to augment catches by other techniques. A 15 m long seine with a 0.3 mm mesh size will be used. The seine net will be pulled through shallow habitats by wading through the sampling area; in deeper areas, a boat may be used to pull one end of the seine (BCMOE 2013). Care will be taken to ensure that the lead line remains in contact with the substrate and the float-line remains at the surface to prevent fish from escaping. The contents of the seine will be brought to shore, and depending catch numbers, may be emptied into a water-filled tote and the seine will be inspected to confirm that all fish are removed. The location of each effort will be recorded using a handheld GPS accompanied by notes regarding habitat features and the area and maximum depth sampled. The date and time will be recorded and fish will be enumerated by species. Non-target species will be released at the location of capture. Depending on the objective of the monitoring component, individual fish of the target species will be measured immediately or retained for measurement as outlined in Sections 4.2.2 and 4.2.3.

Open-station and/or closed-station backpack electrofishing will be completed in Polley Lake (along the shoreline) and in creeks. All electrofishing will be completed by an experienced and certified electrofishing team, consisting of a backpack electrofisher operator and one or more netters using electrofisher settings appropriate for the target species (i.e., frequencies and pulse width) and starting with lowest possible power output (voltage and duty cycle). Open stations will be fished by single electrofishing pass in an upstream direction. During open-station electrofishing, the operator will create a series of smooth, zig-zagging sweeps with the anode. Fish will follow the anode; therefore, the operator will move the anode towards the netter, who will net the stunned fish. Closed stations will be created using 3/8” mesh stop nets and care will be taken to ensure that the enclosed habitat is suitable for the potential presence of target fish. The dimensions (length and wetted and bankfull widths) and water depth (average of three measures) of each open and closed station will be measured at equally-spaced transects using a measuring tape and meter stick, respectively. During each closed station electrofishing effort, the electrofisher operator and netter will employ a multiple pass removal method at each station whereby one upstream pass (or “sweep”) of the enclosed reach is repeated three or more times to yield a fish removal pattern (i.e., diminishing catches) that can be used to determine fish density

using removal method equations. Fish captured during each open electrofishing pass or closed station sweep will be placed in separate buckets of aerated water. The location of each effort will be recorded using a handheld GPS accompanied by the start and end times and active electrofishing seconds. The total sampling area will be documented, along with a habitat descriptions that include observations of stream morphology and substrate characteristics, riparian vegetation and relative stream shading, as well as any potential confounding influences or other observations deemed relevant to interpretation of the fish survey data. The fish in each bucket will be enumerated by species. Non-target species will then be released at the location of capture. Depending on the objective of the monitoring component, individual fish of the target species will be measured immediately or retained for measurement as outlined in Sections 4.2.2 and 4.2.3.

Fish will be captured from the Quesnel River by angling (targeting rainbow trout for fish tissue quality monitoring). Angling will be conducted using barbless, single hook lures, and/or flies. The general location of each effort will be recorded using a handheld GPS accompanied by notes on the hooks/lures/flies used, effort duration, and habitat. Captured fish will be identified and counted. Non-target species will be released at the location of capture and target species will be retained or measured. Retained rainbow trout will be measured as outlined in Sections 4.2.2 and 4.2.3, per requirements of the particular monitoring.

All fishing effort data will be recorded on field sheets or digital data collection devices. *In situ* water quality measurements (i.e., temperature, pH, dissolved oxygen, conductivity, and specific conductance) will also be recorded to support fishing efforts.

4.2.2 Fish meristic data

Meristic measurements on fish that will not be retained for lethal sampling will be recorded prior to releasing the fish at their point of capture. Fish retained for lethal sampling will be anesthetized using a clove oil solution or will be euthanized with a decisive blow to the head and spinal severance. Fish will be subjected to measurement of fork length, total length, and body weight (BCMOE 2013). Fork and total length of large-bodied fish will be measured to the nearest millimeter using a measuring board and fork and total length of small-bodied fish will be measured to the nearest 0.1 mm using digital calipers. Fresh body weight will be measured using an analytical balance or a set of Pesola™ spring scales (depending on fish weight). The Pesola™ scales are demarcated at intervals of 1 to 2% of the total scale range, providing an accuracy of plus or minus (±) 0.3% of the fish mass. The Pesola™ spring scale for individual weight measurement will be selected so that the fish weight is near the top of the scale's range to ensure that measurements achieve a resolution near 1%. Northern pikeminnow and redside shiner that will be lethally sampled as part of MDMER/EEM will also undergo an external health assessment

(Environment Canada 2012). Following external health assessment, each fish will be cut open and sex will be recorded. Gonads and liver will be removed for weighing and sampling as required. Tissues will be weighed to the nearest milligram using a portable analytical balance (capable of measurement to 0.001 g). For EEM, whole ovaries from sexually mature females will be placed in individually labelled sample vials and preserved with a 10% buffered formalin solution for determination of fecundity.

Age structures will be retained for all fish collected for fish tissue quality monitoring using available guidance for the best age structure for each species (e.g., Environment Canada 2012). Otoliths will be removed and used as the primary aging structure for all fish species except for sucker. Pectoral fin rays will be removed and used as the primary aging structure for sucker. Scales will also be collected for use as backup structures for age determination. Aging structures will be wrapped in waxed paper, and placed in labelled coin envelopes, which will then be frozen prior to submission to a qualified fish aging laboratory.

4.2.3 Fish Tissue Quality

For large-bodied fish targeted for tissue quality monitoring, tissue quality samples will be collected after meristic measures are collected and will include muscle, liver, kidney, and ovary (the latter as available). For small-bodied fish targeted for tissue quality monitoring (i.e., juvenile northern pikeminnow and peamouth chub), whole body samples will be analyzed for tissue chemistry. Tissue samples (muscle, liver, kidney, and/or ovary) will be removed, weighed to the nearest 0.001 g (±1% precision) using an analytical balance, placed in labelled Whirl-Pak™ bags, and frozen until analysis. All tissue samples will be collected using clean implements (cutting boards, filet knives, and tweezers; BCMOE 2016). Livers and kidneys will be collected whole, whereas approximately 10 to 50 g of boneless, skinless muscle will be collected, and a similar sized ovary sub-sample will be collected when available (or will be collected whole if smaller than this). Duplicate QC samples (i.e., split samples collected from the same fish tissue) will be collected for 10% of tissue samples to assess field precision, and will be evenly distributed among species and collected tissue types, to the extent possible. A DQO of <25% RPD will be applied to the duplicate (i.e., split) QC samples.

4.2.4 Fish Habitat Characterization and Usage

Habitat characterization methods will include those applied in 2016 and 2017 (Minnow 2018b; adapted from Johnston and Slaney 1996). Data will be recorded on field data sheets or using digital data collection devices. The following characteristics will be documented:

- stream dimensions (i.e., wetted and bankfull width, length, and depth) within each habitat unit;

- channel gradient;
- substrate type;
- in-stream barriers and cover;
- the presence/absence of spawning and overwintering habitat;
- riparian features (e.g., vegetation types and canopy cover);
- channel hydrology;
- bank condition; and
- *in situ* water quality.

Habitat characterization methods will be a composite of two standard methods: 1) Reconnaissance Fish Habitat Inventory (RIC 2001); and 2) Level 1 Field Fish Habitat Assessment ("Habitat Unit Assessment"; Johnston and Slaney 1996). Habitat characterization using methods adapted from RIC (2001) will be completed at replicate stations (three per area) and will include include measures of channel dimensions, water velocity, and in situ water quality at each station. Channel dimensions (bankfull width, wetted width, and a minimum of 5 incremental wetted depth measures), will be measured using a tape measure and metre stick. Water velocity will be measured using a portable velocity meter. At each velocity transect, water velocity, wetted depth, and bankfull-wetted depth will be measured at a minimum of five incremental distances (points) along one wetted channel cross-sectional width. Water velocity measurements will be obtained at 60 percent of depth as an estimate of the mean vertical velocity at each measurement point. In situ water quality measures will include temperature, specific conductance, dissolved oxygen, and pH using a calibrated handheld portable field meter. Additional habitat characteristics to be assessed at each station will include description of channel bed features (substrate type, relative proportion of each substrate type, etc.), channel and bank gradient, substrate size, bank stability, riparian vegetation (vegetation types, overhead shading), and in-stream cover (as the relative proportion that each contributed to total creek surface area at each station). Substrate size will be assessed (100 randomly selected rocks per station) for the purpose of monitoring temporal changes in substrate size distribution. Photographs of representative habitat will be taken at each station in each season to further support the habitat descriptions. During each seasonal survey, any unique or significant physical or biological features (e.g., tributaries, groundwater seeps, partial or seasonal fish barriers to fish migration) will be documented, including a brief description of the feature, together with its GPS coordinates. In addition, the GPS coordinates of pools present in the rehabilitated and reference reaches, and physical dimensions of the pools (length, width, and maximum depth) will be recorded.

Habitat assessment using Level 1 Field Fish Habitat Assessment methods ("Habitat Unit Assessment"; Johnston and Slaney 1996) will also be undertaken. At least seven consecutive habitat units (i.e., pool, glide, or riffle) will be identified towards the center of each reach and the dimensions of each habitat unit will be recorded. Specifically, the length, mean width (wetted and bankfull; mean of at least 3 measures), and mean depth (wetted and bankfull; mean of at least 5 measures) will be determined for each habitat unit using a tape measure and meter stick. For pools, the maximum and residual (maximum minus crest depth) wetted depth will also be measured, as well as pool type. A minimum residual depth of 0.2 m is required for classification of a habitat unit as a pool (Johnston and Slaney 1996). Additional habitat characteristics assessed at each habitat unit will include included channel gradient, substrate type, riparian vegetation (vegetation types, growth stage, and canopy cover), in-stream cover, access to off-channel habitat, the number of pieces of large woody debris (LWD) present, and indicators of disturbance.

Fish habitat usage monitoring will document the use of these rehabilitated creek habitats by all fish species and life stages, including the specific documentation of spawning and rearing in spring, summer, and fall months (May to October). Fish habitat usage will be determined by a combination of visual observation and fish collection using techniques described above (hoop netting, minnow trapping, fry trapping, seining, and backpack electrofishing; the latter only when appropriate based on non-spawning/egg incubation periods and when juvenile salmonids are not present). All captured fish will be identified and enumerated, and fishing efforts will be documented for CPUE or density calculations (as described above). Any observations of specific behaviours (e.g., spawning) will be noted.

4.3 Sample Handling and Laboratory analysis

To the extent possible, sample handling and laboratory analyses will be completed in accordance with technical guidance outlined in the BC Field Sampling Manual (BCMOE 2013), the Water and Air Baseline Guidance Document for Mine Proponents and Operators (BCMOE 2016), the Technical Guidance Document for EEM (Environment Canada 2012), and the BC Environmental Laboratory Manual (BCMOE 2015).

At the termination of each field program or at intervals of no more than seven days, fish tissue samples will be shipped in coolers with ice packs and chain-of-custody forms (COCs) to the analytical laboratory. Shipment transit time will be less than one day. Chemical analyses will be completed by a CALA-accredited analytical laboratory and will include moisture content and total metal concentrations (Table 9). Concentrations of mercury and other metals will be analyzed using Cold Vapour Atomic Fluorescence Spectrophotometry (CVAFS; USEPA [United States Environmental Protection Agency] Method 200.3/245.7) and Collision Cell Inductively Coupled

Table 9: Analytes and Laboratory Reporting Limits for Mount Polley CEMP Fish Tissue Quality Monitoring

Analyte	Target LRLs	Units	Consensus DLs [1]	Units	Consensus DLs [1] as dw [2]	Units	Tissue Quality Guidelines
Physical Tests							
Moisture		% ww	1	% ww	-	% ww	-
Metals							
Aluminum	2	mg/kg dw	0.4	mg/kg ww	1.6	mg/kg dw	-
Antimony	0.01	mg/kg dw	0.002	mg/kg ww	0.008	mg/kg dw	-
Arsenic	0.02	mg/kg dw	0.005	mg/kg ww	0.02	mg/kg dw	-
Barium	0.05	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Beryllium	0.01	mg/kg dw	0.002	mg/kg ww	0.008	mg/kg dw	-
Bismuth	0.01	mg/kg dw	0.02	mg/kg ww	0.08	mg/kg dw	-
Boron	1	mg/kg dw	-	mg/kg ww	-	mg/kg dw	-
Cadmium	0.005	mg/kg dw	0.002	mg/kg ww	0.008	mg/kg dw	-
Calcium	5	mg/kg dw	2	mg/kg ww	8	mg/kg dw	-
Chromium	0.05	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Cobalt	0.02	mg/kg dw	0.004	mg/kg ww	0.016	mg/kg dw	-
Copper	0.05	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Iron	3	mg/kg dw	1	mg/kg ww	4	mg/kg dw	-
Lead	0.02	mg/kg dw	0.004	mg/kg ww	0.016	mg/kg dw	-
Lithium	0.5	mg/kg dw	-	mg/kg ww	-	mg/kg dw	-
Magnesium	2	mg/kg dw	2	mg/kg ww	8	mg/kg dw	-
Manganese	0.05	mg/kg dw	0.02	mg/kg ww	0.08	mg/kg dw	-
Mercury	0.005	mg/kg dw	0.002	mg/kg ww	0.008	mg/kg dw	0.5 mg/kg ww [3]
Molybdenum	0.02	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Nickel	0.2	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Phosphorus	10	mg/kg dw	5	mg/kg ww	20	mg/kg dw	-
Potassium	20	mg/kg dw	10	mg/kg ww	40	mg/kg dw	-
Selenium	0.05	mg/kg dw	0.02	mg/kg ww	0.08	mg/kg dw	11 mg/kg dw [4]
Silver	0.05	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Sodium	20	mg/kg dw	2	mg/kg ww	8	mg/kg dw	-
Strontium	0.05	mg/kg dw	0.01	mg/kg ww	0.04	mg/kg dw	-
Thallium	0.002	mg/kg dw	0.001	mg/kg ww	0.004	mg/kg dw	-
Tin	0.1	mg/kg dw	0.02	mg/kg ww	0.08	mg/kg dw	-
Titanium	0.2	mg/kg dw	0.06	mg/kg ww	0.24	mg/kg dw	-
Uranium	0.002	mg/kg dw	0.001	mg/kg ww	0.004	mg/kg dw	-
Vanadium	0.1	mg/kg dw	0.02	mg/kg ww	0.08	mg/kg dw	-
Zinc	0.5	mg/kg dw	0.1	mg/kg ww	0.4	mg/kg dw	-

[1] From Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (BCMOE 2016).

[2] Calculated based on a 75% moisture content.

[3] Health Canada guideline for mercury (CFIA 2015).

[4] British Columbia Water Quality Guideline for aquatic life for selenium in fish ovary tissue (BCMOE 2014). Additional guidelines for the protection of aquatic life of 4 mg/dw in fish muscle or whole fish and for the protection of human health at moderate consumption levels (14.5 mg/kg dw for the general population) will also be applied.

Plasma-Mass Spectrometry (CRC-ICP-MS; USEPA Method 200.3/6020A) or High Resolution Inductively Coupled Plasma-Mass Spectrometry (HR-ICP-MS; USEPA Method 200.3/200.8), respectively (USEPA 1991, 1994, 2001, 2004). All samples will be submitted to the laboratory with a chain-of-custody (COC) record, a list of expected Laboratory Reporting Limits (LRLs), and laboratory QA/QC requirements.

Aging structures will be shipped to a qualified fish ageing laboratory, along with a chain-of-custody form (COC), for determination of fish ages. At the fish aging laboratory, samples will be thawed, otoliths extracted from heads if required, and the otoliths and fin rays will be sectioned, mounted on a glass slide using a mounting medium, and then read under a compound microscope using transmitted light. For each structure, age and edge condition will be recorded along with a confidence rating for the age determination. Scales collected as backup structures will only be used as required. Similarly, preserved egg samples will be shipped to a qualified laboratory, along with a chain-of-custody form (COC), for determination of fecundity. Methods for determining fish age and fecundity will be fully consistent with the technical guidance (Environment Canada 2012).

4.4 Data Quality Review

Upon receipt of fish tissue quality data from the analytical laboratory, a Data Quality Review (DQR) will be performed. The DQR will confirm that all requested analyses are complete, and that acceptable LRLs are achieved. The DQR will also include an evaluation of differences between duplicate (i.e., split) samples, as well as the QA/QC data reported by the laboratory. Completion of the DQR promptly following receipt of the tissue quality data will ensure timely communication with the laboratory should any issues be identified.

Comparisons between duplicate samples will be made by calculating the RPD for concentrations measured in paired samples. If the RPD is <25% for concentrations that are >5 times the LRL, then the duplicate sample results will be considered acceptable. Analyte concentrations in laboratory blank samples will be evaluated in relation to their respective LRLs, and the results will be used to identify potential contamination associated with equipment (e.g., cleanliness) and sample collection and handling procedures (e.g., collection, shipping).

4.5 Data Handling, Interpretation, and Reporting

Catch-per-unit-effort (CPUE) and summary statistics for meristic measurements taken in the field will be calculated. CPUE will be calculated for each fish species by fishing method and sampling area. For hoop netting, minnow trapping, and fry trapping efforts, CPUE will be expressed as number of fish per day. For seining, CPUE will be calculated as the number of fish per square metre. CPUE will be calculated as the number of fish per 100 electrofishing seconds for open-

station electrofishing efforts. For closed station electrofishing, density will be determined using removal calculators (i.e., number of fish per unit area determined using Moran-Zippin estimators; Ricker 1971). CPUE for gill netting and angling will be calculated as the number of fish captured per square metre-hour and the number of fish per angler day, respectively.

Although community and population data is collected during every phase or component of the fish monitoring program, the sample size will be defined by the study objectives and may be insufficient to address corollary questions. For example, the sample size required for tissue quality analyses (n = 8) is not large enough to support formal contrasts of population endpoints. To this end, evaluation of fish community data will rely on qualitative comparisons, and conclusions regarding fish populations will be supported by non-lethal measurements and sampling under the MDMER/EEM (with larger sample size), as described in Section 4.2.2 and below. Analysis methods for the MDMER/EEM fish population data will be consistent with EEM technical guidance (Environment Canada 2012). Summary statistics, including mean, median, minimum, maximum, standard deviation, standard error, and sample size, will be calculated for fish age, fork length, total length, body weight, condition, liver weight, gonad weight, and fecundity; calculations will be completed according to species and area. In a lethal design EEM fish survey, detailed statistical analyses will focus on indicators of survival, energy use, and energy storage and will be completed based on guidance from Environment Canada (2012). These indicators include fish age, size-at-age, gonad size relative to body weight, condition, liver size relative to body weight, and fecundity, and egg size relative to body weight (Table 10). In a non-lethal design, histograms will be used to examine length-frequency distributions by species and area, and indicators include fish size and condition. All data sets will be assessed for normality and equality of variance in order to determine the suitability of parametric statistical procedures. An effect on the fish population will be evaluated for each of these measures and is defined as a statistically significant difference between the effluent-exposed area and the reference area (Environment Canada 2012). For each endpoint, statistically significant differences between effluent-exposed and reference areas (by species and sex) will be assessed using ANOVA, Analysis of Covariance (ANCOVA), or non-parametric equivalents, as appropriate, following technical guidance (Environment Canada 2012).

For the fish tissue data sets, statistical comparisons of age, length, weight, and concentrations of metals in fish tissues (n = 8) will be completed among years and locations. Following completion of the DQR, fish tissue quality data will be provided to the QP and summarized according to species, tissue type, and area. The LRL for each analyte and the number of samples below the LRL will be determined. Censored data will be managed using methods described in Helsel (2012), and those used in the R package NADA: Non-detects and Data Analysis for Environmental Data (Lee 2017). Any value below a LRL (i.e., a <LRL result) that exceeds the

Table 10: Survival, Energy Storage, and Energy Use Endpoints for Mount Polley EEM Fish Population Evaluation

Response		Measurement Endpoints [a]	Statistical Procedure
Effects on Fish [a]	Survival	Age	ANOVA[c]
	Energy Use	Size-at-age (body weight against age)	ANCOVA[c,d]
		Relative gonad size (gonad weight against body weight)	ANCOVA[c,d]
	Energy Storage	Condition (body weight against length)	ANCOVA[c,d]
		Relative liver size (liver weight against body weight)	ANCOVA[c,d]
Supporting Response Variables [b]	Energy Use	Relative fecundity (# of eggs/female against body weight)	ANCOVA[c,d]
		Relative egg size (mean egg weight against body weight)	ANCOVA[c,d]

Notes: ANOVA = Analysis of Variance; ANCOVA = Analysis of Covariance; # = number.

[a] Endpoints to be used for determining "effects" as designated by statistically significant differences between effluent-exposed and reference areas.

[b] These analyses are for informational purposes and significant differences between exposure and reference areas are not necessarily used to designate an effect (Environment Canada 2012).

[c] Or appropriate non-parametric equivalent, as required.

[d] For the ANCOVA analyses, the first term in parentheses is the endpoint (dependent variable Y) that is analyzed for an effluent effect. The second term in parentheses is the covariate, X (age, weight, or length).

maximum detected value for that parameter at the given station will be removed. The removal of the poor LRLs does not influence the estimation of the mean or standard deviation, but does influence the overall sample size. The sample size, mean, median, standard deviation, standard error, minimum, maximum, 5th percentile, and 95th percentile will be calculated for each analyte. Means will be calculated using the Kaplan-Meier (K-M) method. The standard deviation and the median for each analyte will also be calculated using the K-M method. When a standard deviation cannot be estimated (i.e., when an analyte has a high proportion of censored values), it will be reported as "not calculated".

Statistical comparisons of age, length, weight, and concentrations of metals in fish tissues will be completed among years and locations. Statistical comparisons among groups will completed using an analysis of variance (ANOVA) if assumptions of normality and homogeneity of variances are met. These assumptions will tested using the Shapiro Wilk's test and Levene's test (α=0.05), respectively. Data will be transformed, as required, to meet these assumptions. If the assumptions cannot be met, the Kruskal-Wallis test will be used. Response variables with censored observations will be compared among groups using the Wilcoxon score test. Specific contrasts will be conducted after an overall significant difference among groups. Bonferroni adjustments to the p-values will be made to maintain the family-wise Type I error rate at α=0.05. A magnitude of difference (MOD) will be calculated for each contrast. For metals for which information is available on accumulation in specific organs (e.g., copper accumulation in fish liver; Grosell 2012), interpretation will focus on the results associated with that organ.

Statistical comparisons of concentrations of mercury in fish tissue will be compared using analysis of covariance (ANCOVA) with fork length as a covariate (as mercury is known to bioaccumulate in fish tissue; e.g., Kidd and Batchelar 2012). The response variable and covariate will be $\log_{10}$-transformed, as required, for analysis. The significance of the interaction term of the ANOVA model will be assessed to compare regression slopes between groups. If the interaction term is not significant (α=0.05) it will be removed and the parallel slope ANCOVA model will be fit. If the fork length is not a significant predictor of mercury concentration in the parallel slope ANCOVA model, it will be removed from the model and comparisons of mercury concentrations between groups will be conducted using a t-test. If the fork length is a significant predictor of mercury concentration in the parallel slope ANCOVA model, comparisons of mercury concentrations between groups will be assessed using the group term of the model. Adjusted means will be reported for the average (geometric mean) fork length from the parallel slope ANCOVA model. A MOD will be calculated for each contrast.

Fish tissue quality data will also be evaluated in comparison to tissue quality guidelines for human health and/or for aquatic ecosystem health (available for mercury and selenium). Tissue quality

guidelines will include the Canadian Food Inspection Agency/Health Canada mercury guideline for the protection of human health (0.5 milligrams per kilogram wet weight [mg/kg ww]; CFIA 2015) and the BC selenium guidelines (BCMOE 2014). Selenium guidelines for BC include guidelines for the protection of human health, which are based on fish consumption levels (7.3 milligrams per kilogram dry weight [mg/kg dw] for subsistence consumers, 14.5 mg/kg dw for the general population, and 75 mg/kg dw for the recommended two servings of fish per week). Selenium guidelines for BC also include guidelines for the protection of aquatic life, which are 4 mg/kg dw in muscle tissue and whole body samples, and 11 mg/kg dw in egg/ovary tissues. Selenium concentrations in fish ovaries will also be compared to the threshold for reproductive effects in eggs and ovaries (20 mg/kg dw; DeForest et al. 2012).

Results of the fish habitat characterizations for Upper Hazeltine, Lower Hazeltine, and Lower Edney creeks will be summarized, along with fish usage results, according to season (spring, summer, and fall) and year. Fish habitat characterization measures will be summarized by season, reach, and area (rehabilitated and reference), with summary statistics (mean and standard deviation) calculated for all numerical parameters. These summarized variables will then be compared to general habitat preferences for relevant fish species. Additionally, recorded habitat measures will also be compared to "optimal" ranges of habitat parameters indicated in Habitat Suitability Index (HSI) models (i.e., suitability index value = 1) or in the literature (where available) for those fish species identified in rehabilitation design criteria and objectives. Specifically, mean results for habitat measures collected in each season at each reach will be compared to the tabulated optimal "habitat suitability criteria" ranges and identified as either meeting or not meeting these criteria. The proportions of habitat measures meeting the habitat suitability criteria in the rehabilitated and reference areas, respectively, will also be compared.

Habitat unit assessment measures will be summarized by habitat unit type within each reach, with mean values calculated for all numerical parameters. Measures will be used to calculate endpoints such as bankfull width to depth ratio, channel complexity, % pool, pool frequency, and LWD pieces per bankfull channel width. These endpoints and other observational measures (presence of off-channel habitat) will then be evaluated relative to diagnostics of salmonid habitat condition modified from Johnston and Slaney (1996), rated as poor, fair, or good. Lastly, quantitative (closed station) data will be used to determine fish density (number of fish per unit area determined using Moran-Zippin estimations; Ricker 1971). The presence and abundance of juvenile rainbow trout in these creeks will be compared to densities previously observed in Edney and Bootjack creeks (Minnow 2014a).

An interpretive report based on the fish monitoring data will be prepared to be integrated into the Annual Environmental and Reclamation Report for the Mount Polley Mine that is prepared

annually by MPMC and submitted to the regulators and other stakeholders by March 31 of the following year. The interpretive report will provide all data in an appendix and will include the DQR, the results of the screening against BCWQGs, and the results of temporal and spatial comparisons. All data interpretation will be summarized in clear text form supported by tables and data plots.

5 REFERENCES

Barrett, T.J., and K.R. Munkittrick. 2010. Seasonal Reproductive Patterns and Recommended Sampling Times for Sentinel Fish Species used in Environmental Effects Monitoring Programs in Canada. Environmental Reviews 18: 115-135.

BCMOE (British Columbia Ministry of Environment). 2013. British Columbia Field Sampling Manual For Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples. 2013 Edition.

BCMOE. 2014. Ambient Water Quality Guidelines for Selenium. Technical Report Update. Water Protection and Sustainability Branch. April 2014.

BCMOE. 2015. British Columbia Environmental Laboratory Manual. 2015 Edition. Prepared and Published by the Ministry of Environment with the assistance of The British Columbia Environmental Laboratory Technical Advisory Committee. February 2016.

BCMOE. 2016. Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators. Version 2. June 2016.

Beak (Beak International Incorporated). 1999. Mount Polley Corporation Fish Monitoring Program Fall 1998. Report Prepared for the Mount Polley Mining Corporation. February 1999.

Beak. 2000. Mount Polley Biological Monitoring Program - 1999. Report Prepared for the Mount Polley Mining Corporation. April 2000.

Bruce, J.A. and T.L. Slaney. 1991. Polley Lake Tributary Assessment. Prepared by Aquatic Resources Ltd. for British Columbia Environment, Williams Lake, BC. Regional Fisheries report No. CA915.

Burns, J. and B. Klein. 1973. Polley Lake reconnaissance lake survey. Data on file Ministry of Forest, Lands and Natural Resource Operations, Williams Lake B.C., June 20, 1973.

Cariboo Envirotech (Cariboo Envirotech Ltd.). 2008. The 2007 Adult Coho Assessment of Tributaries of Quesnel Lake. Prepared for Tolko Industries Ltd. 41p.

CFIA (Canadian Food Inspection Agency). 2015. Canadian Food Inspection Agency Fish Products Standards and Methods Manual: Appendix 3, Canadian Guidelines for Chemical Contaminants and Toxins in Fish and Fish Products. Ottawa, ON, Canada.

DeForest, D.K., G. Gilron, S.A. Armstrong, and E.L. Robertson. 2012. Species sensitivity distribution evaluation for selenium in fish eggs: Considerations for development of a Canadian tissue-based guideline. Integrated Environmental Assessment and Management 8: 6-12.

DWB (DWB Consulting Services Ltd.). 2014. Fish Salvage of Edney Creek. Letter Report. Prepared for Imperial Metals. 10p.

Environment Canada. 2012. Metal Mining Environmental Effects Monitoring Technical Guidance Document. Environment Canada National Environmental Effects Monitoring Office. June 2012.

Golder (Golder Associates). 2016. Summary of Available Fish Tissue Chemistry Data (2014-2015) for assessment of Potential Changes in Concentrations Related to the Mount Polley Tailings Dam Failure. Memorandum from Trish Miller to Colleen Hughes. May 27, 2016.

Government of Canada. 2018. Metal and Diamond Mining Effluent Regulations - Consolidation. SOR/2002-222. Last amended June 1, 2017. Current to June 10, 2018.

Grosell, M. 2012. Copper. In: C.M. Wood, A.P. Farrell and C.J. Brauner (eds.), pp. 53-133, Homeostasis and Toxicology of Essential Metals. Elsevier / Academic Press, New York, NY.

Helsel, D.R. 2012. Statistics for Censored Environmental Data using Minitab and R, 2nd edition. John Wiley and Sons, New York, New York.

HKP (Hallam Knight Piésold Ltd.). 1996a. Mount Polley Project - Environmental Baseline and Monitoring Report: 1995. March 1996.

HKP. 1996b. Mount Polley Fish Habitat Impact Report.

HKP. 1996c. Mount Polley Project Fisheries Compensation Plan – Final Proposal.

HKP. 1997a. Mount Polley Mining Corporation - Mount Polley Project - Environmental Baseline and Monitoring Report: 1996. June 1997.

HKP. 1997b. Mt. Polley Mining Corporation, Mt. Polley Mine 1997 Fisheries Monitoring Program. Prepared for Imperial Metals Corporation. October 1997.

Imperial Metals. 1990. Stage 1 Environmental and Socioeconomic Impact Assessment Report for the Mount Polley Project. Prepared for the BC Mine Development Steering Committee by Imperial Metals Corporation. July 1990.

Janz, D.M., D.K. Deforest, J.L. Brooks, P.M. Chapman, G. Gilron, D. Hoff, A. Hopkins, D.O. McIntyre, C.A. Mebane, V.P. Palace, J.P. Skorupa, and M. Wayland. 2010. Selenium toxicity to aquatic organisms. In: P. Chapman et al. (Eds.), pp. 141-231, Ecological Assessment of Selenium in the Aquatic Environment. CRC Press, Boca Raton, FL.

Janz, D.M. 2012. Selenium. In: C.M. Wood, A.P. Farrell, and C.J. Brauner (Eds.), pp. 327-374, Homeostasis and Toxicology of Essential Metals. Elsevier/Academic Press, New York, NY.

Jessup, L., and N. Millar. 2011. Application of a New Method for Monitoring Lake Trout Abundance in Yukon: Summer Profundal Index Netting (SPIN). Yukon Fish and Wildlife Branch Report TR-11-11, Whitehorse, Yukon, Canada.

Johnston, N.T., and P.A. Slaney. 1996. Fish Habitat Assessment Procedures. Watershed Restoration Tech. Circ. No. 8. Ministry of Environment, Lands and Parks and Ministry of Forests, Vancouver, BC.

Kidd, K., and K. Batchelar. 2012. Mercury. In: C.M. Wood, A.P. Farrell, and C.J. Brauner (Eds.), pp. 237-295, Homeostasis and Toxicology of Non-Essential Metals, Elsevier/Academic Press, New York, NY.

Lee, L. 2017. Nondetects and data analysis for environmental data. Package “NADA” for R. March 31, 2017. https://cran.r-project.org/web/packages/NADA/NADA.pdf

Lirette, M.G.. 2015. Polley Lake Fish Assessment, 2014. Prepared for Mount Polley Mining Corporation. February 2015.

Lirette, M.G.. 2017. Polley Lake Fish Assessment, 2016. Prepared for Mount Polley Mining Corporation. February 2017.

Lirette, M.G. and D. Tredger. 1991. Polley and Bootjack Lakes Creel Survey, 1990. BC Environment, Williams Lake. Regional Fisheries Report No. 911.

McPhail, J.D. 2007. The Freshwater Fishes of British Columbia. University of Alberta Press, Edmonton, AB.

Minnow (Minnow Environmental Inc.). 2009. Mount Polley Mine - Aquatic Environmental Characterization - 2007. Report Prepared for Mount Polley Mining Corporation. Minnow Project 2120. July 2009.

Minnow. 2011. Mount Polley Mine Selenium Monitoring 2009/2010. Report Prepared for Mount Polley Mining Corporation. Minnow Project 2290. March, 2011.

Minnow. 2013a. Mount Polley Mine Selenium Monitoring 2012. Report Prepared for Mount Polley Mining Corporation. Minnow Project 2450. March, 2013.

Minnow. 2013b. Mount Polley Mine Selenium Monitoring 2013 Update Report. Report Prepared for Mount Polley Mining Corporation. Minnow Project 2475. December, 2013.

Minnow. 2014a. Aquatic Environmental Description Report Mount Polley Mine Discharge of Treated Water to Polley Lake. Report Prepared for Mount Polley Mining Corporation. Minnow Project 2507. July, 2014.

Minnow. 2014b. Project Introduction report for the Mount Polley Mine Southeast Rock Disposal Site. DRAFT Report Prepared for Mount Polley Mining Corporation. Minnow Project 2505. Report not finalized due to the perimeter embankment breach.

Minnow. 2016. Mount Polley Mine Phase 1 Environmental Effects Monitoring Program Interpretive Report. Report Prepared for Mount Polley Mining Corporation, Likely, BC. Minnow Project 16-57. October 2016.

Minnow. 2017a. Polley Lake Fish Monitoring, 2016. Report Prepared for Mount Polley Mining Corporation, Likely, BC. Minnow Project 16-55. March 2017.

Minnow. 2017b. Sentinel Fish Tissue Quality in the Vicinity of Mount Polley Mine, 2015-2016. Prepared for Mount Polley Mining Corporation, Likely, BC. Minnow Project 2574. March 2017.

Minnow. 2018a. Sentinel Fish Tissue Quality in the Vicinity of Mount Polley Mine, 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. Minnow Project 17-42. April 2018.

Minnow. 2018b. Edney Creek Fish Usage and Fish Habitat Characterization, 2016 and 2017. Prepared for Mount Polley Mining Corporation, Likely, BC. Minnow Project 17-21. March 2018.

Minnow. 2018c. Phase 2 EEM Study Design for the Mount Polley Mine. Prepared for Mount Polley Mining Corporation, Likely, BC. Minnow Project 18-02. March 2018.

MPMC (Mount Polley Mining Corporation). 2009. Mount Polley Mine Technical Assessment Report for a Proposed Discharge of Mine Effluent. 174p.

Presser, T.S., and S.N. Luoma. 2009. A methodology for ecosystem-scale modeling of selenium. Integrated Environmental Assessment and Management 6(4): 685-710.

RIC (Resources Inventory Committee). 2001. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures, Version 2.0. BC Fisheries Information Services Branch for the Resources Inventory Committee. April 2001.

SNC-Lavalin. 2015. Mount Polley Tailings Storage Facility Failure – Fish and Fish Habitat Impact Assessment. Final Report / V-01. 621717-626348. Prepared for Mount Polley Mining Corporation, Likely, BC. June 2015.

USEPA (United States Environmental Protection Agency). 1991. Method 200.3. Sample Preparation Procedure for Spectrochemical Determination of Total recoverable Elements in Biological Tissues. Revision 1.0. April 1991.

USEPA. 1994. Method 200.8, Revision 5.4. Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry. Revision 5.4. 1994.

USEPA. 2001. EPA Method 245.7, Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry. Washington, DC, USA.

USEPA. 2004. EPA Method 6020A, Inductively Coupled Plasma-Mass Spectrometry (Revision 6). SW-846 Online: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Washington, DC, USA.

Zirnhelt, N. 2016. Mount Polley Mining Corporation EEM Fish Collection 2015: Report on Field Program. February 2016.

Zirnhelt, N. and R. Dolighan. 2015. Mount Polley Mining Corporation Fish Tissue Collection 2015: Report on Field Program. December 2015.

Appendix B.5

Wildlife, Soil, Soil Invertebrate, and Vegetation Monitoring

Golder Associates Ltd.

TECHNICAL MEMORANDUM

DATE 9 August 2018 **Reference No.** 1894924-025-TM-Rev1-23182

TO Stephen Monninger
Mount Polley Mining Corporation

CC Colleen Hughes

FROM Blair McDonald and Barbara Wernick **EMAIL Blair_McDonald@golder.com; Barbara_Wernick@golder.com**

STUDY DESIGN CONCEPT: TERRESTRIAL COMPONENT FOR THE MOUNT POLLEY MINE COMPREHENSIVE ENVIRONMENTAL MONITORING PLAN – MOUNT POLLEY MINE

1.0 INTRODUCTION

1.1 Purpose of the Study Design Concept

Mount Polley Mining Corporation (MPMC) is preparing a Comprehensive Environmental Monitoring Plan (CEMP) to integrate the environmental monitoring components from a variety of regulatory processes applicable to the Mount Polley Mine into a single document. An Ecological Risk Assessment (the ERA; Golder 2017) was prepared that integrated the available chemical and biological information to provide an overall conclusion about the magnitude and extent of ecological risks associated with the deposit of tailings. The ERA was accepted by the Ministry of Environment & Climate Change Strategy (ENV) on 31 January 2018, contingent on the implementation of additional monitoring in relation to specific areas of uncertainty identified in the ERA. There were several points of uncertainty in the terrestrial ERA with respect to plants, soil invertebrates and wildlife and these are outlined in Table 53 of the ERA. The purpose of this memorandum is to outline the monitoring concept proposed to MPMC to address those terrestrial ERA uncertainties in the CEMP. Contingent on acceptance by ENV, a detailed study design document and specific work instructions will be prepared by Golder as the basis for executing of the CEMP process.

1.2 Scope and Approach of the Risk Assessment

The ERA evaluated the site conditions as they existed in the first few years after the failure of the glacial lacustrine layer beneath the Perimeter Embankment of the Tailings Storage Facility. The terrestrial ERA included the “floodplain” area where the forest and native soils were removed by the debris flow, and the “halo” area where the forest floor was relatively undisturbed but buried to varying depths by scoured material and tailings. Tailings can limit the successful re-establishment of ecological communities because of a variety of chemical and/or physical limitations in the soil (Hossner and Hons 1992). The ERA used a “triad” style approach to evaluate the relative influence of physical issues versus chemical issues for a given receptor group using three different types of information:

- What is the magnitude of the exposure associated with tailings?
- What is the magnitude of effects associated with tailings under controlled experimental conditions?
- What is the magnitude of effects associated with tailings under field conditions?

Golder and the G logo are trademarks of Golder Associates Corporation **golder.com**

Copper was identified as the primary contaminant of concern. The ERA also found that the bioavailability of copper in tailings at the site was low. A low bioavailability does not mean that bioaccumulation was zero as copper has bioaccumulated in different parts of the ecosystem at concentrations that are greater than reference areas. However, the overall conclusion, based on a weight-of-evidence integration of the available information collected over several years, was that risks associated with copper were low, and that the effects associated with nutrient deficiencies and soil structural limitations were likely to be a larger influence on the long-term management goal of reintroducing a biologically diverse, functional and self-sustaining ecosystem. As with any complex risk assessment, there was uncertainty associated with the risk conclusions which were described in the risk assessment.

1.3 Summary of Main Areas of Uncertainty

The study design concept focuses on reducing the main sources of uncertainty described in Table 53 of the ERA. In brief, the main sources of uncertainty in the terrestrial ERA were:

1) Field-based monitoring of the diversity or abundance of plants, soil invertebrates or other parts of the soil ecosystem is valuable in an ecological risk assessment but was not practical in the current application because of the expected variability related to natural successional changes.

2) The ability to quantify the relative influence of copper versus the physical limitations of the soil is important from a theoretical perspective. This would typically be evaluated using controlled experiments. However, further experiment-based studies are not warranted unless there is evidence (from field monitoring) that natural succession is not progressing. It is reasonable to continue refining the site-specific understanding of copper bioaccumulation in plants and soil invertebrates in lieu of further experimental studies while the long-term field monitoring is executed.

3) Risks to wildlife are assessed with a single technique (a food chain model). Conservative assumptions were used in the model. Hazard quotients were less than 1 for eleven of the 15 receptor species evaluated in the model. Further refinement of the wildlife food chain model was requested with respect to the four receptor species that had a hazard quotient greater than 1.

Each of these main sources of uncertainty are addressed in further detail in Section 3.

2.0 BASIS OF DESIGN

Golder understands that MPMC is structuring the CEMP to be a stand-alone document that does not require reviewers to have a detailed understanding of the ERA. A summary of the available data and how those data were evaluated in the ERA (Golder 2017) is provided in this section as context for the specific recommendations in Section 4.

2.1 Plants

Information relevant to plants that was evaluated in the ERA included:

- Concentrations of metals in tailings were lower than numerical standards for the protection of soil invertebrates and plants, except for copper (and marginally, vanadium).
  - For copper, the numerical standard is 150 mg/kg. The 95% upper confidence limit of the mean (UCLM) concentration in untreated tailings was 737 mg/kg. Treatment (scarification, intermixing or transplanting soils) resulted in 95% UCLMs ranging from 197 to 538 mg/kg.
  - For vanadium, the numerical standard is 200 mg/kg. The 95% UCLM vanadium concentration in untreated tailings and the three treatment types were less than the numerical standard. Vanadium was retained as a contaminant of potential concern because the 90th percentile concentration in untreated tailings was marginally greater than the standard (213 mg/kg versus 200 mg/kg).
- A 42-d lodgepole pine (*Pinus contorta*) and bluebunch wheatgrass (*Pseudorogneria spicata*) germination and growth toxicity test was conducted on two representative samples of tailings (Section 3.3.3 of the ERA). Seedling emergence or survival was not impacted, but greater than 20% reductions in growth were observed for both species compared to the performance of a negative control consisting of clean silica sand of a similar grain size. All plants demonstrated some degree of growth over the 42-day exposure, despite copper concentrations ranging from approximately 800 to 1100 mg/kg.
- Multiple lines of evidence in the ERA demonstrated that copper had low bioavailability. The lines of evidence included geochemical modeling and three different chemical surrogate measurements in tailings samples (water soluble fraction; humidity cell and leach tests; physiological-based extraction tests – see Section 3.2.2 of the ERA). The toxicity testing (see above) also included a side-by-side trial where an equivalent concentration of copper was added to clean silica sand (in the form of copper sulphate). The bioavailability of copper from tailings was much lower than copper added to the tailings.
- There were physical effects of tailings on plant growth. The toxicity testing (see above) found that tailings tended to form hard crusts and germination was highest in the surface cracks. The measured bulk densities of tailings, till and lacustrine deposits at the site were greater than values from the literature that correspond to reductions in plant growth. Nutrient levels in the tailings were also limited and in a range that could limit plant growth (see Section 3.2.3.2 of the ERA).
- Plants appeared to bioaccumulate copper, but bioaccumulation factors were less than 1 and the bioaccumulation was concentration-dependent. There were no obvious differences in copper bioaccumulation during the 42-d toxicity testing (see above) between tailings and copper added to soils. There was no consistent pattern where copper concentrations in field-collected plant samples were greater in the impacted areas than in background and/or baseline samples (see Section 3.3.2.2 of the ERA). Copper concentrations were within the range of concentration considered to be adequate for plant growth (see Section 3.3.2.4 of the ERA) despite being collected over a wide range of soil concentrations. Overall, these lines of evidence demonstrate that many plants can control the uptake of copper.

2.2 Soil Invertebrates

The ERA involved fewer lines of evidence for soil invertebrates because: a) the findings of low copper bioavailability from plants would be expected to be consistent for soil invertebrates, and b) the physical alterations to the soil and habitat would be expected to have a more significant effect on soil invertebrates. Further discussion about the overall ecological succession expected at the site is provided below in Section 3.1. Additional information specific to soil invertebrates that was considered in the ERA included:

- There were relatively few soil invertebrates collected in 2015 and 2016. Composite samples were collected for beetles/ants (n = 15), spiders (n = 4), and worms/slugs (n = 8). Between two and four tissue samples of each soil invertebrate type were collected from background areas and the data used in a control chart (i.e., the average ± 2 standard deviations [SD]). There was a high degree of variability between individual samples in a given tissue composite type, but the average concentration of copper in beetle/ant composite samples was higher than the average (+ 2SD) upper limit of the control chart.
- The limited number of worm/slug samples had an average copper concentration that was within the range of copper tissue concentrations from laboratory studies that had the potential for reduced survival, growth or reproduction of soil invertebrates. There was not sufficient data to determine the relationship between soil concentrations and the tissue concentration of specific types of soil invertebrates, and many of the papers that evaluated the critical body residue of copper in soil invertebrates acknowledge that there are many factors that can limit site-specific bioavailability. The available data were thus not definitive that a risk to soil invertebrates is present but did provide a qualitative indicator that monitoring was appropriate.

2.3 Wildlife

Risks to wildlife were evaluated using a food chain model. In brief:

- A total of 15 surrogate species were selected from different feeding guilds (e.g., herbivores, carnivores; Table 1). Species-specific variables such as body weight, ingestion rates, and dietary preferences were adopted from federal risk assessment guidance or other reputable sources.
- Realistic worst-case exposure concentrations were determined for soil, water and the various dietary items, typically based on the 95% upper confidence limit of the mean. Site-specific bioaccumulation models were developed and used to predict tissue concentrations from soil concentrations. Bioaccumulation factors for small mammal tissue concentrations (needed to evaluate risk to carnivores) were taken from the literature.
- Relative bioavailability was used to calculate the dose for the wildlife receptors. Relative bioavailability of copper in water was assumed to be 100%. Relative bioavailability of copper in soil was based on site-specific physiologically-based extraction test (PBET) data. Relative bioavailability of copper in dietary items was assumed to be 40% based on information from the literature.
- The total amount of copper ingested per day was compared to conservative toxicity reference values. The food chain model was run separately for different areas and different soil rehabilitation approaches (i.e., transplanted, scarified or intermixed). A risk estimate for each surrogate species was calculated for the entire study area using area weighting. Risks were also calculated for background areas for context.

- Hazard quotients (HQ) were less than 1 for all receptors exposed to vanadium, and most receptors exposed to copper. HQs were greater than 1 for robin, common nighthawk, olive-sided flycatcher and masked shrew. The aggregate HQs (i.e., the area-weighted HQ for the site as a whole) for those four receptors ranged from 1.7 to 2.8. The maximum observed HQ for an individual subarea was 5.1 for masked shrew in the Polley Flats area.
- A hazard quotient greater than 1 does not mean that there are risks to wildlife. The food chain model used many conservative assumptions which were identified in the terrestrial ERA. HQs were also greater than 1 for olive-sided flycatcher and masked shrew exposed to background copper concentrations.

Table 1: Wildlife receptors evaluated with the food chain model

Receptor Group	Feeding Guild	Surrogate Species
Birds	Herbivore	Dark-eyed junco
	Insectivore	Robin; olive-sided flycatcher; common nighthawk
	Omnivore	Raven
	Carnivore	Northern pygmy owl
	Piscivore	Osprey, great blue heron
Mammals	Herbivore	Meadow vole; mule deer
	Insectivore	Masked shrew
	Omnivore	Deer mouse
	Carnivore	Ermine, fisher
	Piscivore	River otter

3.0 FURTHER CONSIDERATION OF UNCERTAINTY

3.1 Uncertainty Related to Ecological Succession

A “triad” style approach (exposure, experimental effects, field effects) is common in weight-of-evidence because the three different types of information are complementary. A well-designed field study provides a meaningful evaluation of risks because it provides direct information about what is being protected under realistic conditions. However, field studies are not always able to determine the cause of effects (if any are observed) and can be confounded by many different variables. Many of those variables (e.g., weather) are unrelated to the management question being evaluated.

A “triad” approach was used in the terrestrial ERA but it was not possible to assess every terrestrial receptor with a field study. In areas of the site that were subjected to extensive scouring, there was a near-complete loss of natural soils and their related ecological communities (i.e., soil microbes, fungi, invertebrates and plants). Quantitative assessment to establish the magnitude of that physical impact was unnecessary. Field measurement of the structure of the plant or soil invertebrate community was not possible because recolonization and ecological succession had only just started. Nevertheless, field studies are expected to be an important aspect of long-term monitoring because they will help to determine if the soil ecosystem is recovering as expected over time.

3.1.1 Summary of Expected Ecological Succession

An example of ecological succession in a hypothetical plant community is provided in Figure 1. Succession progresses through several distinct phases:

- Early succession is dominated by opportunistic species that have high growth or reproductive output, or some specialized ability to occupy a niche that other species cannot. An example would be an invasive, weedy species with a high output of wind-carried seeds. Species that can grow in nutrient-poor soil because they can convert nitrogen to a useable form (“nitrogen fixation”) would also have an advantage. Mites are an example of a primary colonizer from the soil invertebrate community because they have a high dispersal capacity, can tolerate low nutrient levels, and reproduce quickly (Hagvar et al. 2009).
- Middle succession involves increasing competition for resources (i.e., the limited nutrients that are introduced by the decay of leaf litter from the early stages). An example of the middle stages of succession would be the proliferation of alder which have a similar capacity for nitrogen fixation as grasses, but also the ability to outcompete grasses for moisture and light through root and shoot growth. Examples of invertebrates at this stage include ground-dwelling beetles or ants.
- Late succession continues competition in an increasingly diverse number of niches. At a late succession stage, the humic layer has regenerated through the decay and processing of organic material, and there is an ongoing cycle of nutrients in soils from the activity of microbes, fungi and soil invertebrates. Earthworms and other invertebrates that process organic material would be common. The overall ecological function (e.g., production of biomass, respiration, diversity) in the ecosystem has reached its maximum capacity, and the ecosystem has settled into a dynamic equilibrium.

Golder has identified several examples of natural ecological succession from the literature in Table 2, including recolonization of a landscape after a landslide or retreat of a glacier, or reclamation from non-metal mining such as quarrying.

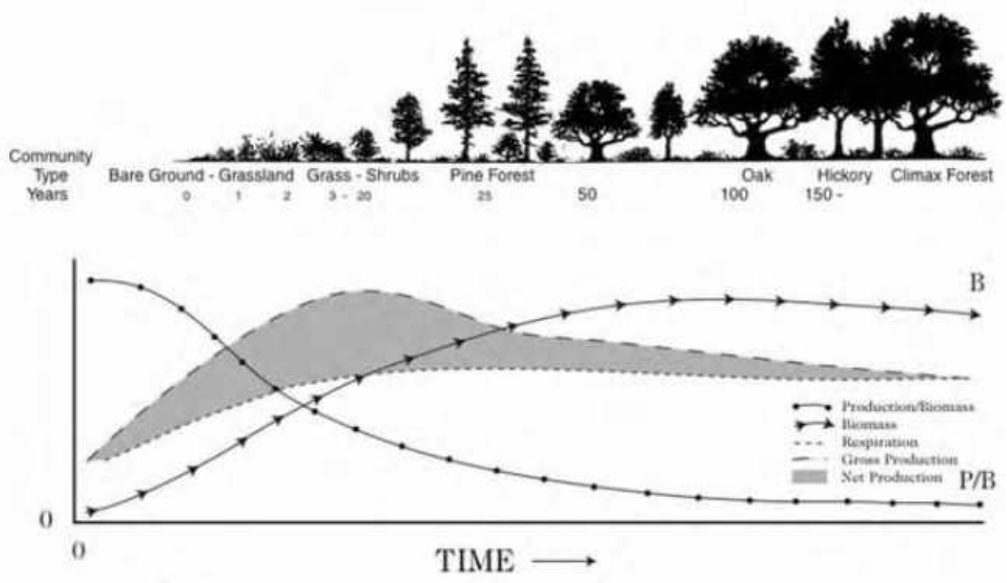


Figure 1: General schematic of vegetative succession over time (from Schneider 2008)

Table 2: Examples of Ecological Succession

Authors	Site Context	Observations
Russell and La Roi (1986)	34-hectare spoil heap of overburden generated from coal mining activities in Rocky Mountain foothills, Alberta.	Vegetative cover limited by coarseness of material and low nutrient levels. Total plant cover is less than 10% despite relatively long length of time since formation of the spoil heap (34 years). Perennial grass and forbs are the dominant species.
Frouz et al. (2008)	Chronosequence of 27 sites on four different coal mine spoil heaps (100+ km^2) in Europe. Total length of time since disturbance was 40 years.	Plant and soil invertebrate communities were assessed. Statistical analysis found that succession was driven by the formation of the humic layer. Sites tended to switch from “no humus” to “humus forming” at roughly 15 years, and from “humus forming” to “humus present” at roughly 25 years.
Miles and Swanson (1986)	Chronosequence of 25 landslides in Oregon. Total length of time since disturbance was 30 years.	Total vegetation cover ranged from 51% (in the primary scar) to 78% (in the primary deposition area). Cover consisted of trees (approximately 50% of the total), shrubs (25% of total) and herbs (25% of total), suggesting that succession had progressed to a mature state.

Authors	Site Context	Observations
Smith et al (1986)	Chronosequence of 49 landslides in Haida Gwaii. Total length of time since disturbance was 150 years. Logged and non-logged areas included for comparison.	Humic layer reformed relatively quickly but had decreased nutrient levels until Year 30. There was a relatively thick cover of red alder (an early colonizing tree species) within 20 years, but the total vegetative cover in the slide areas did not reach the undisturbed areas for 50 years. (For context, a logged area returned to a total cover like the undisturbed area within 20 years).
Gobbi et al. (2006).	Chronosequence of soil invertebrates colonizing a receding terminal glacier moraine. Total length of time was 150 years.	Species richness increased from 2 to 26 genera. Spiders and beetles were the primary colonizers, while ants and centipedes are only present in the older sites. The pattern of succession was consistent with the available information about the habitat preference and life history strategies of each species.

Note: A chronosequence is an ecological study that investigates a set of similar sites that share similar attributes and a similar disturbance but have different ages in order to understand the time-dependent aspects of succession.

3.1.2 Influence of Natural Succession on the Design of the CEMP

Although MPMC has conducted a variety of actions over the last two years to facilitate natural ecological succession, the plant and soil invertebrate community in the area impacted by tailing deposition is likely still in the early, opportunistic stages of recolonization. Further information about the following activities conducted to date can be found in the Conceptual Remediation Plan (Golder 2018):

- Soil manipulation (e.g., scarification to create a “rough and loose” soil material with better physical structure)
- Blending and placement of native topsoils to improve moisture retention and nutrient levels, and to reintroduce native microbes, fungi, seeds and soil invertebrates
- Mounding and placement of coarse woody debris to create preferential microsites where plant recolonization can be accelerated
- Placement of wood chip mulch to increase organic carbon and nutrient levels as the mulch decays
- Riparian planting of native shrubs and conifers
- Seeding of upland areas with a mix of native grasses

The net effect of the original impact and the subsequent rehabilitation effort is that a high degree of variability between areas is still expected because the treated and untreated areas are still in the first few years of succession. The total length of time to reach a mature, dynamic equilibrium is unknown, but likely on the order of 20 to 30 years based on the examples from Table 2. The rehabilitation activities described above would be expected to accelerate and enhance that process. A field study to measure the difference between "control" and "impact" that could separate the relative influence of copper versus physical limitations would be challenging in this early phase. Specifically:

- Comparison to reference is not expected to be practical in the near-term (i.e., one can reasonably conclude that there will be substantive changes between the impacted areas and areas that have not covered with tailings). No suitable reference areas (i.e., an area that has been logged and all vegetation and humic material removed) are currently known.
- Comparison between individual years may not add significant value because differences in weather (e.g., rainfall, snowpack, temperature) would also introduce significant year-to-year variability.

Instead, monitoring of the plant and soil invertebrate community should focus on establishing a long-term trend analysis rather than to support a multitude of pair-wise comparisons that would have limited value for making site management decisions. This would involve:

- **Selecting representative, permanent monitoring plots.** The number of plots will depend on the number of different habitat units to be monitored. These units could be based on copper concentrations, remedial areas, the types of rehabilitation already applied, or other attributes that will influence succession (e.g., slope, moisture content, distance from undisturbed edge).
- **Monitoring each plot in a consistent manner to support analysis of trends over time.** No consensus exists at this time about which specific metrics are needed to monitor progress towards a biologically diverse, functional and self-sustaining ecosystem. Input from other subject matter experts (e.g., mine reclamation specialists) is likely required given that the timelines for monitoring will extend into the mine closure process.
- **Sufficient sampling effort to make informed management decisions.** A defensible trend analysis needs to consider statistical power. Statistical power is influenced by the minimum measurable change and the variability amongst replicates of a given habitat unit. Even if a formal power analysis is not needed, the study design needs a common understanding about how the trend analysis would be used to make future decisions. For example, trend analysis may benefit more from measuring 5 metrics at 50 plots for three years followed by a 5-year hiatus than measuring 10 metrics at 20 plots every year. The 750 measurements in the first option may be more meaningful than the 1,600 measurements in the second option because option 1 provides more spatial coverage and measures inter-year variability.

3.2 Uncertainty about the Relative Influence of Copper on Soil Invertebrates and Plants

The ERA concluded that risks from copper were low, and therefore, further focused investigations to determine the relative influence of copper on soil invertebrates and plants versus physical variables (such as through toxicity testing or greenhouse experiments) were not warranted until there was information from the field monitoring that succession was not progressing towards the long-term management goal of reintroducing a biologically diverse, functional and self-sustaining ecosystem (Table 53 of the ERA). A trend analysis will not provide a definitive check on progress towards this management goal for several years. In the meantime, continued refinement of the site-specific relationships between copper concentrations in soil and copper concentrations in various soil invertebrate and plant tissues is recommended because:

- The presence of sufficient plants or invertebrates for sampling across the range of copper concentrations in soil provides important qualitative evidence (pending confirmation from the trend analysis) that copper is not exerting a significant effect on the survival of soil invertebrates or plants. If areas with the upper range of copper concentrations in soil lack soil invertebrates, or show visual evidence of copper toxicity to plants, it would be a trigger for the more focused investigation (or, could lead directly to supplemental remediation as part of the overall adaptive management strategy).
- Refining the soil-to-tissue relationships provides direct evidence about copper bioavailability and bioaccumulation. This helps to clarify potential differences in copper bioaccumulation between different species or taxonomic groups, and the site-specific relationships can be compared to similar relationships from the scientific literature or other copper-contaminated sites to provide further support to the ERA conclusion that copper bioavailability is relatively low.
- The site-specific bioaccumulation relationships are also used as part of the wildlife food chain model. Some of the existing relationships are based on limited data sets, which have added uncertainty to the results of the food chain model. A more robust relationship between soil and tissue concentrations increases the overall sophistication and future application of the food chain model as part of the CEMP.

3.2.1 Uncertainty in Risk Estimates for Wildlife Species

The food chain model used appropriately conservative assumptions and model parameters consistent with common practices for a screening-level risk assessment.

In terms of risk management decisions, some qualified professionals default to a prescriptive interpretation that any HQ than 1 represents a potential risk that requires further assessment or remediation. Realistically, marginal HQs (e.g., less than 2 or 3) are unlikely to present an unacceptable risk but there is no consensus on a specific threshold between acceptable or unacceptable risk beyond the prescriptive guidance about HQ = 1. The existing HQs are not considered to represent an unacceptable risk but are sufficiently higher than 1 to warrant further refinement of the model to reduce uncertainty. The uncertainty in the HQs generated from the food chain model is the product of the uncertainty in each of the variables used. Not all variables need to be refined. The variables that would benefit most from refinement are:

- Improving the quality of data with respect to tissue concentrations in invertebrates. This can be accomplished by expanding on the bioaccumulation sampling as described in Section 3.2. The food chain model has also conservatively assumed that flying insects have the same tissue concentrations as soil-dwelling insects, which is a data gap that should be addressed by further sampling.

- Refining the toxicity reference values (i.e., the denominator in the HQ). The current toxicity reference value was taken from the ECO-SSL guidance (USEPA 2018) and is based on a conservative “no-observed adverse effect level” from the available literature. This toxicity reference value may be substantially lower than a true “acceptable” concentration that corresponds to low (i.e., not statistically significant) effects on growth or reproduction. A common area for refinement in a wildlife risk assessment is to update the toxicity reference value to reflect an effects-based threshold in lieu of a highly conservative screening threshold.
- Reviewers of the ERA identified the use of relative bioavailability as an uncertainty in the food chain model but did not reach a consensus about whether this issue was significant in terms of the final risk conclusion. There are unresolved differences in professional opinion on this topic which would ideally be addressed as part of the food chain model refinement. Golder notes that ENV has previously accepted the approach used in the current ERA at other sites and believes that further dialogue on this point prior to initiating additional investigation is warranted.

Refinement (or resolution) on these three topics is expected to reduce the overall uncertainty in the food chain model. Golder understands that the refined model would be run for the same subareas and HQs presented for both individual subareas and for the aggregate of the entire study area. Golder also understand that ENV desires that bats (*Myotis* sp.) be added as an additional receptor.

4.0 CONCEPTUAL STUDY DESIGN

4.1 General Approach

A proposed approach to address the remaining areas of uncertainty in the terrestrial ERA is provided in Figure 2. In brief, the following activities are proposed for the remainder of 2018 and the first quarter of 2019:

- Conduct a reconnaissance-level assessment and conduct limited pilot-scale investigation for candidate metrics for inclusion in the long-term trend analysis monitoring of ecological succession.
- Engage stakeholders and subject matter experts in a workshop to review the findings from the reconnaissance-level assessment and to obtain consensus about how a “biologically diverse, functional and self-sustaining ecosystem” will be measured.
- Conduct a one-time supplemental sampling program to refine the current information regarding copper bioaccumulation and relative bioavailability. Refine the toxicity reference values and use all three outputs from the one-time supplemental sampling program to update the food chain model.
- Develop the preliminary design for the trend monitoring in terms of specific metrics, sampling effort, frequency and interpretative approaches and submit for regulatory approval.

At the completion of these four activities, the CEMP will be updated to incorporate the specific design for long-term monitoring of the ecological succession expected to occur over time. The long-term monitoring will need triggers for when ecological succession will be deemed to be insufficient (even if such triggers are narrative). Additional rehabilitation or additional investigation regarding the cause of the insufficient progress would occur if those triggers are exceeded.

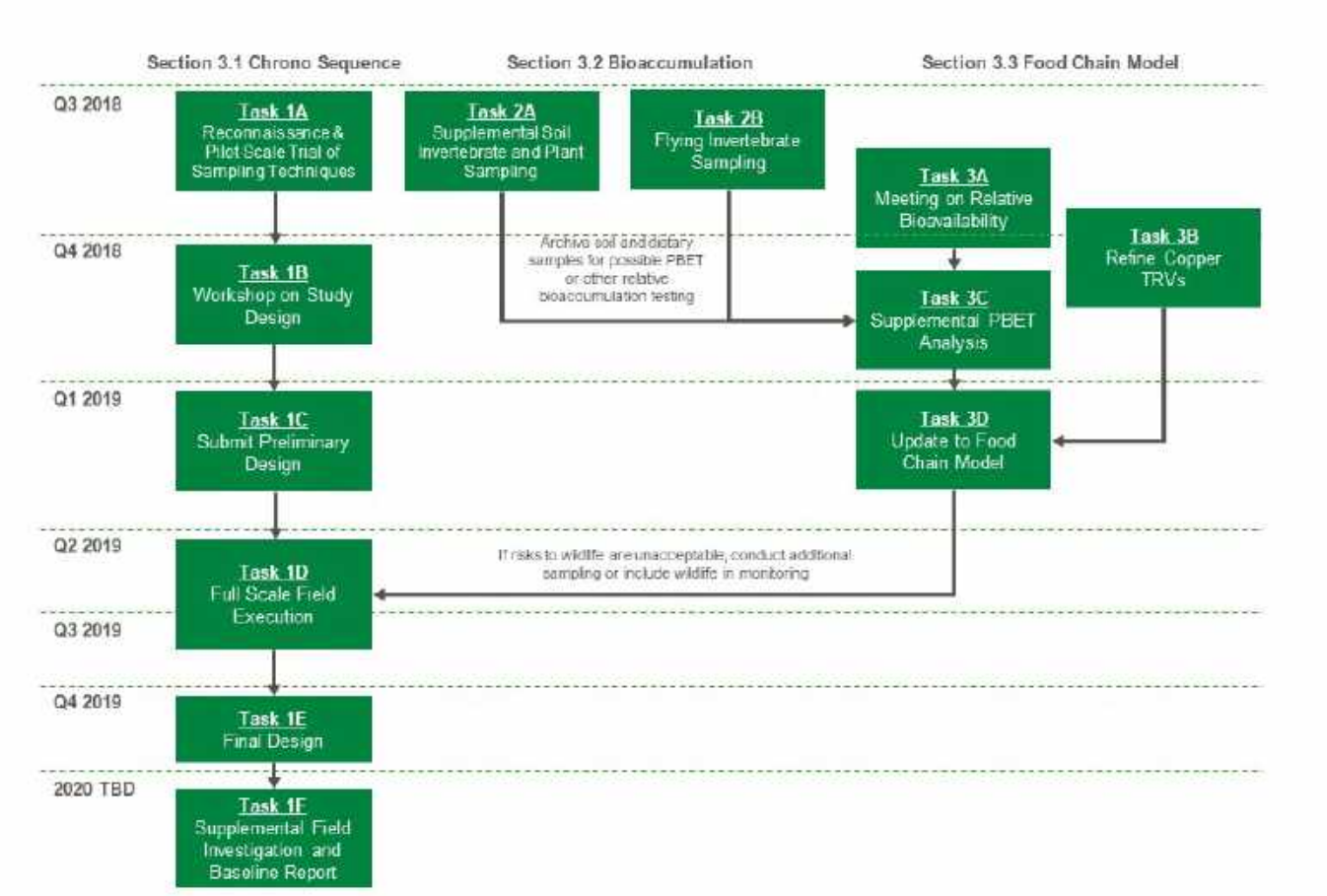


Figure 2: Proposed Approach for the Terrestrial CEMP Component

4.2 Additional Information

4.2.1 Task 1A – Reconnaissance and Pilot-Scale Sampling

There is value in conducting a reconnaissance-level sampling program in the summer of 2018 to provide at least a narrative description (supported by field measurement) of the current state of ecological succession. The reconnaissance-level sampling will focus on:

- Determining the diversity and percent cover of plants in three plots in each of the seven major terrestrial units (Halo; Untreated – Polley Flats; Untreated – Upper Hazeltine; Untreated – Lower Hazeltine; Transplanted; Intermixed; Scarified) for a total of 21 plots.
- Making detailed observations about plant succession in selected locations where additional rehabilitation was conducted (e.g., placement of large woody debris, mounding, placement of mulch).
- Conduct an overall site inspection to identify if there are areas that were subject to additional rehabilitation where no ecological succession appears to be occurring.

- Conducting a standardized bird survey at five locations (for spatial coverage) to document which species are using the available habitat. (Birds are selected for the survey because of the potential that listed species would use the habitat). Habitat monitoring for other wildlife species is not included in the scope of this reconnaissance-level sampling.

Data from the reconnaissance sampling will help to inform the design of the long-term trend analysis. Golder will also use the opportunity to conduct a pilot-scale trial of sampling techniques that could be used to measure other aspects of ecological succession. For example, the future trend analysis (see tasks below) may involve a metric related to soil invertebrate diversity, density or function. The literature describes a wide array of possible sampling techniques (e.g., a soil core to measure the diversity and abundance of mites; a bait-trap to measure the biomass of ants; a pit-fall trap to measure the diversity of ground-dwelling beetles). Golder is using malaise traps, pit-fall traps and Berlese funnels as part of the tissue sampling, any one of which could add value to the design of the long-term monitoring.

4.2.2 Task 1B – Workshop on Design of Trend Analysis

Golder expects that reviewers and stakeholders would comment extensively on the design of the trend analysis, and a variety of technical opinions are expected. There is a wide diversity of possible technical approaches, compounded by an absence of risk assessment guidance on how ecological succession should be monitored.

Golder expects that it will be necessary to draw on regulatory guidance from other relevant Ministries (e.g., Mines, Forestry) where landscape level changes in plant communities are more commonly assessed. For example, BCMOFR/BCMOE (2010) provides guidance on how to assess terrestrial ecosystems, but guidance on measuring successional state is limited to a semi-quantitative assessment that tracks the proportion of early colonizers (‘seral’ species) to later colonizers (‘climax’ species). No specific thresholds for the different states are described and therefore, the site could conceivably remain in a “pioneer” state for 60 or more years. This type of narrative assessment, although described in regulatory guidance, would not add value for site management decisions. Conversely, there are examples of how plant succession is being monitored for mine closure purposes in a quantitative manner (e.g., Highland Valley Copper focuses on plant diversity and functional contribution as a surrogate for the broader ecological succession; Smyth et al. 2016) but no specific thresholds are described beyond “continued progress”.

Golder proposes a one-day workshop where a focused overview of the findings from the reconnaissance-level sampling and tissue sampling can be presented, followed by discussion of relevant examples of risk-based mine closure and monitoring elsewhere in British Columbia. Potential examples where publicly-available information is likely available include the Britannia Mine, the Sullivan Mine, and Highland Valley Copper. It is important to establish at least a preliminary consensus with the regulators about the intended application of this part of the CEMP before effort is expended on the design and costing of specific methods. This workshop is intended to be similar to the Problem Formulation Workshop that helped to build consensus on how the ERA was ultimately executed.

4.2.3 Task 1C – Preliminary Design of Trend Analysis

Golder will develop a preliminary design for the long-term trend analysis based on the reconnaissance sampling, further consideration of relevant examples at other BC mine sites, and input from the reviewers.

4.2.4 Task 1D – Full Scale Field Execution

Golder proposes that the preliminary sampling design would be implemented in the spring and summer of 2019. The scope of this program is currently unknown, pending the outcome of the preliminary design.

4.2.5 Task 1E – Refinement to Design

Conceptually, Golder envisions that the preliminary design might specify a larger number of potential metrics which would be reduced to a final subset based on the data collected in 2019. The intent of the refinement step is to provide a formal check that the preliminary design has been fully optimized in terms of effectiveness and efficiency. A key aspect of optimization is that it is not necessary to continually monitor all aspects of the ecosystem as a conservative, precautionary approach. Instead, the goal is that the CEMP component provides a science-based framework for adaptive management. Adaptive management focuses on monitoring a smaller number of metrics (but monitoring them well) so that there is a clear baseline with pre-defined triggers for when one-time supplemental investigations might become necessary.

4.2.6 Task 1F – Baseline Report

Conceptually, the terrestrial monitoring component will focus on monitoring succession at pre-defined intervals rather than annually. The ERA and its supporting appendices contain information about conditions up to approximately D+3 (disturbance + 3 years). The reconnaissance sampling is effectively an interim snapshot about D+4, and the full field execution would provide the formal baseline that reflects conditions at D+6 (and possibly D+7, if year-to-year variability is included in the study design). Subsequent cycles of the terrestrial monitoring program would then document the ongoing ecological succession at defined intervals post-baseline (e.g., baseline + 2 years, B+5, B+10, B+20).

4.2.7 Task 2A – Soil Invertebrate and Plant Sampling

This task is a standalone activity intended to reduce the uncertainty in the existing site-specific bioaccumulation models (Figure 3) for soil invertebrates and plants. Both models could be improved by obtaining additional co-located soil and tissue samples so that the relationships are not based on composite samples (e.g., separate ‘surface insects’ into ‘ants’, ‘spiders’ and ‘beetles’; separate ‘grass’ into the main species that have been seeded on the site). Conceptually, Golder would target different specific taxa or species emphasizing areas that have not yet been sampled (i.e., the three reclamation treatments). These areas tended to have copper concentrations in the middle of the range bounded by the background and untreated areas. All data (i.e., data from Golder 2017 and data collected in August 2018) will be used to refine the existing bioaccumulation relationships (see Figure 3, below). Note that the total number of tissue samples submitted for analysis will be dependent on the trap effectiveness. A decision on whether the supplemental data are sufficient will be made in light of the uncertainty in the regression equation.

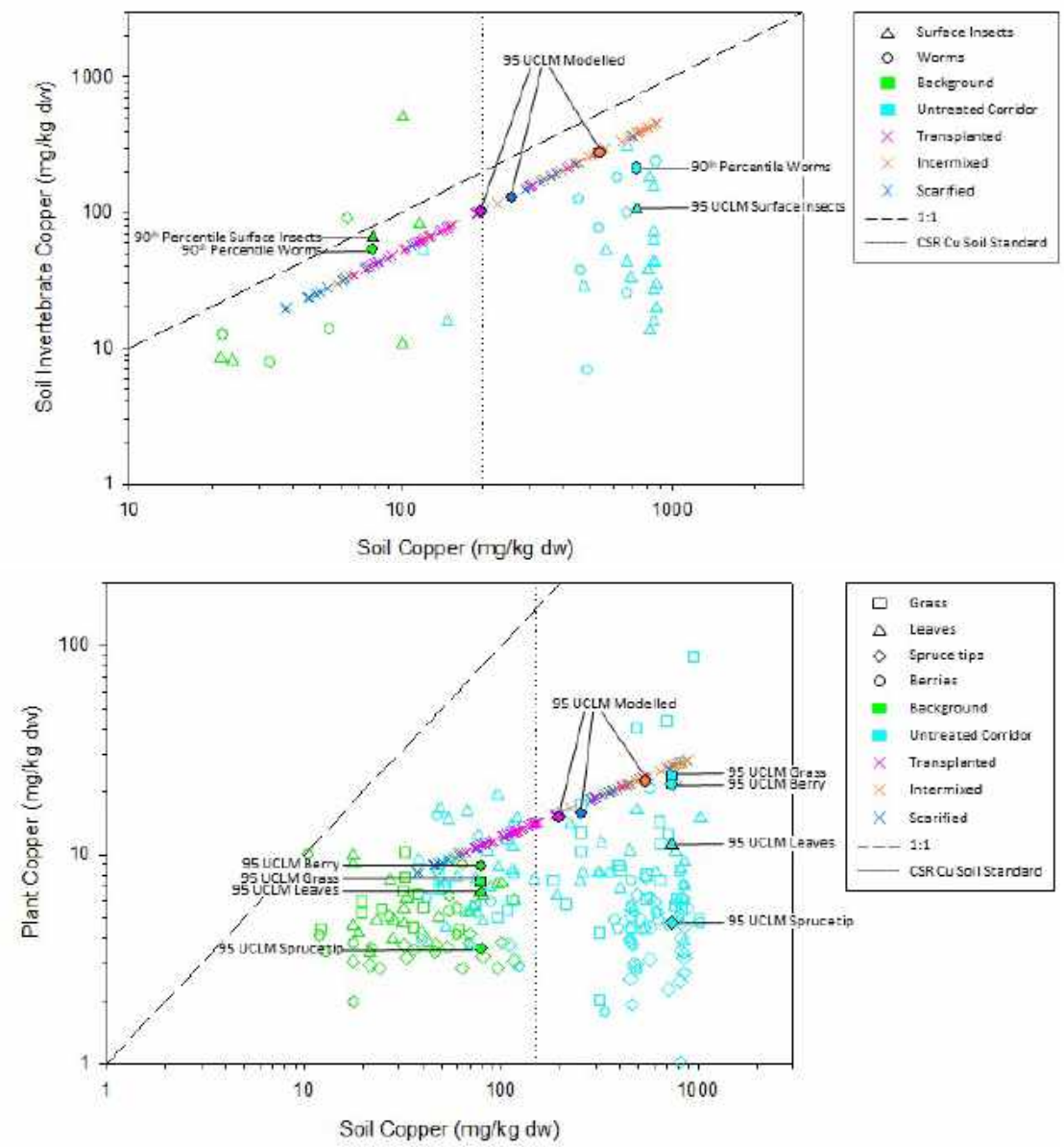


Figure 3: Existing bioaccumulation models for soil invertebrates and plants (from Golder 2017, Appendix F)

4.2.8 Task 2B – Flying Insect Sampling

This task is a standalone activity to address a data gap in the food chain model. Golder will collect flying insects (e.g., moths, flies, flying ants, grasshoppers) using malaise traps with lights. These taxonomic groups reflect the likely dietary items for insectivorous birds and bats. Hand collection with butterfly nets will also be employed. Ideally, sufficient biomass will be collected from a single location to allow for submission of taxa-specific composites (not a composite of all flying insects). Tissue concentrations are not expected to be directly related to local soil concentrations because flying insects are mobile, and therefore, the goal would be to focus on sampling from five broad zones (e.g., Polley Flats, Upper Hazeltine, Lower Hazeltine, Halo, and Background. The goal is to obtain at least seven tissue samples per taxonomic group per area (to allow for the calculation of a 95% upper confidence limit of the mean). The total number of tissue samples submitted for analysis will be dependent on the trap effectiveness.

4.2.9 Task 3A – Meeting on Relative Bioavailability

There was conflicting feedback from technical reviewers about how the food chain model incorporated the relative bioavailability of copper in water, food and dietary items once ingested by different ecological receptors. Golder assumed that copper in water would have a 100% bioavailability relative to the form of copper added to the food used in the original mammalian or avian toxicity test. Site-specific PBET data was used as a surrogate for the relative bioavailability of soil, and information from the literature was used to provide a conservative estimate of the relative bioavailability of copper once incorporated into biological tissues. Similar approaches have been approved by ENV at other sites, including the risk-based management of elevated copper in soils at the Britannia Mine. Relative bioavailability for soil and dietary items has also been evaluated in the risk assessment literature with specific consideration of the potential for differences in gastrointestinal bioavailability between mammals and birds (e.g., Sample et al., 2014; Kaufman et al., 2007).

Golder recommends holding a focused meeting on this specific technical topic with the subject matter experts and ENV. Eliminating relative bioavailability from the food chain model would be demonstrably over-conservative and inconsistent with the scientific principles that influence how an ingested dose is ultimately absorbed by birds and mammals. If the consensus from that meeting is that further quantitative assessment is needed to support the existing approach, it would be completed this fall in Task 3C. Golder proposes to collect archive tissue and soil samples in the summer sampling program (Task 2A) as a precaution (subject to the availability of sufficient tissue mass).

4.2.10 Task 3B – Refinement of Copper TRV

Golder will update the existing toxicity reference values for copper to use a multi-study concentration profile in lieu of the existing point-estimate based TRVs adopted from ECO-SSL. A similar approach has been proposed in the amphibian monitoring component of the CEMP. The development and application of ECx-based toxicity reference values in wildlife food chain model is well-established in the scientific literature (e.g., Allard et al. 2010) and has been adopted by provincial and federal risk assessment guidance manuals (e.g., Environment Canada 2010) as an accepted practice to refine screening-level ERAs.

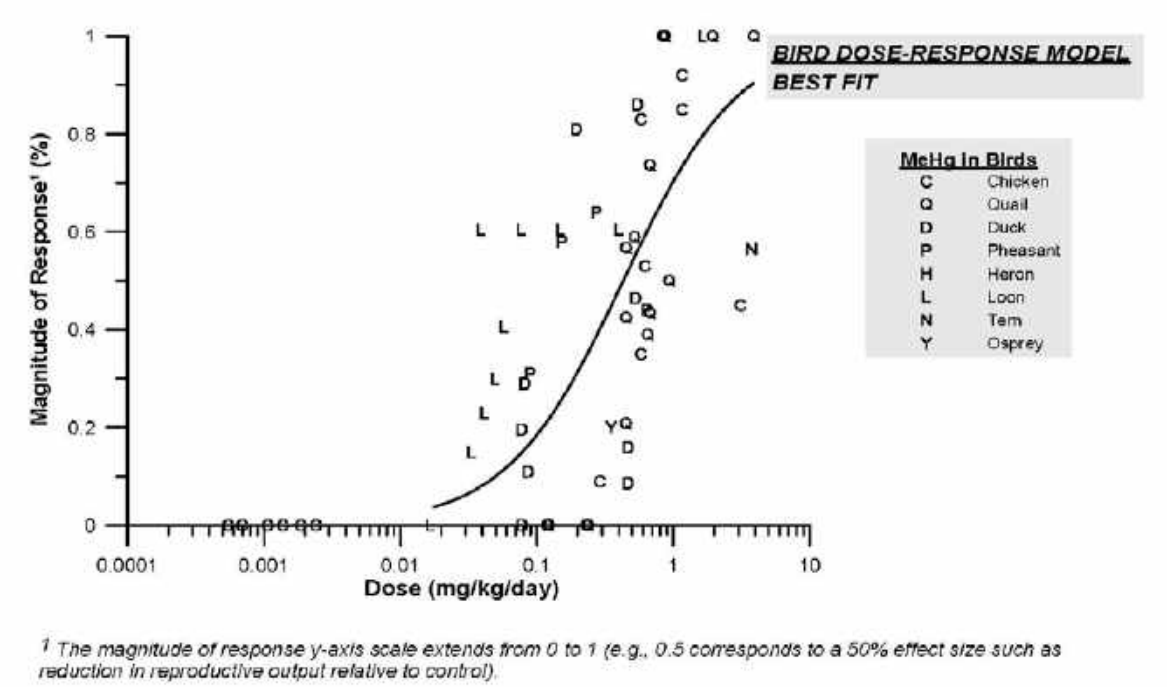


Figure 4: Example of a multi-study concentration response profile (from Environment Canada 2010, courtesy of Azimuth Consulting Group)

4.2.11 Task 3C – Supplemental Bioavailability Analysis

Golder believes that there is sufficient technical support and past precedents for the current use of relative bioavailability in the wildlife food chain model. However, if necessary based on Task 3A, Golder would conduct additional analysis on archived soil, plant and invertebrate tissue samples to provide further information about how bioavailability can be incorporated into the food chain model. Conceptually, relative bioavailability is about establishing a common modifying factor to interpret the total copper concentrations that are established by the chemical analytical laboratory. A focused assessment that involves the same bioavailability analysis on water, soil, food and representative “spiked-food” samples made to duplicate the original approach used in the key toxicology studies from the literature would create a common basis for relative bioavailability in the food chain model.

4.2.12 Task 3D – Update to Food Chain Model

This task is a standalone activity to update the food chain model with the information obtained in Tasks 2A, 2B, 3B, and 3C. Depending on the quantity of information from 2A and 2B, it may be possible to add additional refinement in terms of dietary preferences to more closely reflect how different receptors would be expected to use the site. A bat will also be added as an additional surrogate receptor per ENV’s request. The deliverable for this task would be an update to the existing food chain model report (Appendix F of the ERA).

5.0 SUMMARY

This memorandum describes a proposed approach for the terrestrial component of the CEMP. Not all tiers are recommended for immediate implementation, and there are significant technical and regulatory issues that would need to be resolved as part of the design and execution. Golder recommends that the current CEMP focus on executing the proposed tasks up to the end of Q1 2019. This includes progressing the proposed chrono sequence approach for the long-term CEMP up to the point of submitting a preliminary design for formal ENV approval. The proposed tasks also include activities to reduce the uncertainty in risk estimates to soil invertebrates and wildlife that addresses the content of Table 53 of the ERA.

6.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this technical memorandum.

Please do not hesitate to contact the undersigned if there are questions regarding this memorandum.

Golder Associates Ltd.

COLLEGE OF APPLIED BIOLOGY
Blair G. McDonald
R.P. Bio #1528
CAB

Blair McDonald, MET, R.P.Bio., CSAP (Risk)
Associate, Senior Environmental Scientist

COLLEGE OF APPLIED BIOLOGY
Barbara Wernick
R.P. Bio #1171
CAB

Barbara Wernick, M.Sc., R.P.Bio.
Principal, Senior Environmental Scientist

BM/BW/rs/cr

Attachment: Study Limitations

https://golderassociates.sharepoint.com/sites/10023g/documents_1894924/2. issued/025-tm-23182-terrestrialconcept/rev1/1894924-025-tm-rev1-23182-terrestrialdesignconcept_09aug_18.docx

REFERENCES

Allard P, Fairbrother A, Hope BK, Hull RN, Johnson MS, Kaputska L, Mann G, McDonald B, Sample BE. 2010. Recommendations for the development and application of wildlife toxicity reference values. Integ Environ Assess Manage 6: 28-37.

BCMOFR/BCMOE (British Columbia Ministry of Forests and Range / British Columbia Ministry of Environment). 2010. Field Manual for Describing Terrestrial Ecosystems, 2nd Edition. 261 pp.

Environment Canada. 2010. Ecological risk assessment guidance – Module 2: Selection or development of site-specific toxicity reference values. Available on-line: https://www.canada.ca/content/dam/eccc/migration/ fcs-scf/B15E990A-C0A8-4780-9124-07650F3A68EA/13-049-20EC-20ERA-20Module-202_ENG.PDF.

Frouz J, Prach K, Pizl V, Hanel L, Stary J, Tajovsky K, Materna J, Balik V, Kalcik J, Rehounkova K. 2008. Interactions between soil development, vegetation and soil fauna during spontaneous succession in post mining sites. European J Soil Sci 44: 109-121.

Gobbi M, De Bernadi F, Pelfini M, Rossaro B, Brandmayr P. 2006. Epigean arthropod succession along a 154-year glacial foreland chronosequence in the Forni Valley (Central Italian Alps). Arctic Antarc Alpine Res 38: 357-362.

Golder (Golder Associates Ltd). 2017. Mount Polley rehabilitation and remediation strategy: ecological risk assessment. Prepared for MPMC. Document 1662612-162-R-Rev1-22396. 15 December 2017.

Golder. 2018. Mount Polley Mine: conceptual remediation plan – perimeter embankment breach. Prepared for MPMC Document 1662612-202-R-Rev0-23192. 31 January 2018.

Hagvar S, Solhoy T, Mong CE. 2009. Primary succession of soil mites (Acari) in a Norwegian glacier foreland with emphasis on oribatid species. Arctic Antarc Alpine Res 41: 219-227.

Hossner LR, Hons FM. 1992. Reclamation of Mine Tailings. In: Advances in Soil Science: Soil Restoration, Volume 17. Lai R, Stewart BA (eds). Springer-Verlag: New York. 456 p.

Kaufman CA, Bennet JR, Koch I, Reimer KJ. 2007. Lead bioaccessibility in food web intermediates and the influence on ecological risk characterization. Environ Sci Technol 41: 5902-5907.

Miles DWR, Swanson FJ. 1986. Vegetation composition on recent landslides in the Cascade Mountains of western Oregon. Can J For Res 16: 739-744.

Russell WB, La Roi GH. 1986. Natural vegetation and ecology of abandoned coal-mined land, Rocky Mountain Foothills, Alberta, Canada. Can J Bot 64: 1286-1298.

Sample BE, Fairbrother A, Kaiser A, Law S, Adams B. 2014. Sensitivity of ecological soil screening levels for metals to exposure model parameterization and toxicity reference values. Environ Toxicol Chem 33: 2396-2398.

Schneider ED. 2008. Ecological Succession and its Role in Landscape Reclamation. In: Designing the Reclaimed Landscape. Berger A (eds). Taylor & Francis: New York. 167 p.

Smith RB, Commandeur PR, Ryan MW. 1986. Soils, vegetation and forest growth on landslides and surrounding logged and old-growth areas on the Queen Charlotte Islands. BC Ministry of Forests, Land Management Report No. 41. Available on-line: https://www.for.gov.bc.ca/hfd/pubs/Docs/Mr/Lmr/Lmr041.pdf.

Smyth CR, Melaschenko NC, Iverson MA, Anderson J, Dickson J, Doucette R, Straker J. 2016. An assessment of species-based, structural and functional diversity at the Teck Highland Valley Copper Partnership Mine. BC Mine Reclamation Symposium. Available on-line: https://open.library.ubc.ca/cIRcle/collections/59367/items/1.0354678.

USEPA (United States Environmental Protection Agency). 2018. Ecological soil screening level (ECO-SSL) guidance and documents. Available on-line: https://www.epa.gov/risk/ecological-soil-screening-level-eco-ssl-guidance-and-documents.

STUDY LIMITATIONS

Golder Associates Ltd. (Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by Golder for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents Golder's professional judgement based on the knowledge and information available at the time of completion. Golder is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to Golder by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

Appendix B.6

Amphibian and Reptile Monitoring

Golder Associates Ltd.

TECHNICAL MEMORANDUM

DATE 9 August 2018 **Reference No.** 1894924-018-TM-Rev1-23182

TO Stephen Monninger
Mount Polley Mining Corporation

CC Colleen Hughes

FROM Blair McDonald and Barbara Wernick **EMAIL Blair_McDonald@golder.com; Barbara_Wernick@golder.com**

STUDY DESIGN CONCEPT: AMPHIBIAN COMPONENT FOR THE MOUNT POLLEY MINE COMPREHENSIVE ENVIRONMENTAL MONITORING PLAN

Introduction

Golder Associates Ltd. (Golder) understands that Mount Polley Mine is preparing a Comprehensive Environmental Monitoring Plan (CEMP) to integrate the monitoring components from a variety of regulatory processes applicable to the mine into a single document. One element of the regulatory process involved the submission of an Ecological Risk Assessment (the ERA; Golder 2017) which integrated the available chemical and biological information to provide an overall conclusion about the magnitude and extent of ecological risks associated with the deposit of tailings. The ERA was accepted by Ministry of Environment & Climate Change Strategy (ENV) on 31 January 2018, contingent on the implementation of additional monitoring in relation to specific areas of uncertainty identified in the ERA. One of the identified areas of uncertainty at the conclusion of the ecological risk assessment (Table 53 of the ERA) was that amphibians were not formally assessed. The ERA identified amphibians and reptiles as a relevant receptor group (Section 2.3.3.4 of Golder 2017) with western toad and common gartersnake identified as possible receptors. Western toad was selected as the receptor of potential concern for the broader amphibian and reptile community because it is also a listed species.

This purpose of this memorandum is to outline the monitoring concept proposed to address the uncertainty associated with the amphibian component for the Mount Polley CEMP. If this concept meets ENV expectations, a detailed study design document and specific work instructions will be prepared by Golder as the basis for executing this component as part of the Mount Polley-led CEMP process.

Golder and the G logo are trademarks of Golder Associates Corporation

Basis of Design

The basis of design consists of a summary of the available data and how those data were evaluated in the ERA, provided for the convenience of the reviewers. Copper and vanadium were retained as the contaminants of potential concern in the terrestrial ERA, and copper was retained as the contaminant of potential concern in the aquatic risk assessment. Although no amphibian-specific toxicity reference values were available, these contaminants of potential concern were selected by comparing the maximum observed concentrations conservative, regulatory-approved standards and guidelines. The maximum observed vanadium concentration was only marginally greater than the generic soil standard, and therefore, copper is expected to be the primary contaminant of potential concern for amphibians. Other data relevant to amphibians were described in Section 3.4 of Golder (2017) and consisted of:

- Substantial numbers of tadpoles were observed in 2015 in pooled water that formed throughout the Hazeltine Creek corridor. These tadpoles were confirmed to be western toad (*Anaxyrus boreas*) which is listed on Schedule 1 of the federal *Species at Risk Act*. More than 75,000 individual western toads (approximately 66,000 tadpoles, 9,000 juveniles, 300 sub-adults and 50 non-breeding adults) were subsequently salvaged from 40 different standing water depressions over a two-month period in 2016 prior to the start of rehabilitation. Long-toed salamanders (*Ambystoma macrodactyllium*) and Columbia spotted frogs (*Rana luteiventris*) were also salvaged (at lower numbers). Golder (2017) concluded that the salvage provided qualitative information that amphibians were able to successfully survive, grow and reproduce despite direct contact with tailings and surface water.
- Tissue samples were collected from three amphibians (species not identified) were collected by ENV in August 2016. Golder was not able to confirm the methods used for sampling, processing or analysis and did not review the certificate of analysis with respect to quality assurance/quality control measures. Tissue concentrations in two samples collected from impacted areas ranged from 56.4 to 871 mg/kg Cu dry weight. A tissue sample collected from Gavin Lake (considered by ENV to be a background area) was 12.4 mg/kg Cu dry weight. Data were compared to literature that indicated that copper tissue concentrations corresponding to a lowest-observed effect concentration (LOEC) or no-observed effect concentration (NOEC) ranged from 60 to 325 mg/kg dw (Attachment F, Appendix J of Golder 2017). The average concentration of the two impacted samples was also considered in the uncertainty analysis for the wildlife food chain model (i.e., would the risk conclusion be different if piscivorous birds and mammals had a diet consisting entirely of amphibians). Beyond these qualitative observations, data were not formally evaluated because methods and quality assurance/quality control practices could not be verified.
- Multiple lines of evidence in the ERA demonstrated that copper had low bioavailability. The lines of evidence included geochemical modeling and three different chemical surrogate measurements in tailings samples (water soluble fraction; humidity cell and leach tests; physiological-based extraction tests – see Section 3.2.2 of Golder 2017). Speciation modelling of copper in water showed most of the dissolved copper in Quesnel Lake water would be bound to carbonates which have lower bioavailability than copper ions (see Section 4.2.1.3 of Golder 2017). Golder concluded that the bioavailability of copper would be unlikely to be high for amphibians if there were multiple lines of evidence showing that copper bioavailability to other receptors was low.

Further Consideration of Uncertainty

The purpose of this section is to expand on the specific uncertainties identified in the ERA to be evaluated by focussed monitoring as outlined in this conceptual design document. Golder (2017; Table 53) provided an overview of the uncertainties to assist with future risk management decisions, but a one or two sentence summary does not necessarily convey sufficient detail to show how the design of the amphibian monitoring is linked to the findings of the ERA.

For amphibians, uncertainty is because of the absence of quantitative risk assessment for amphibians. Notwithstanding the value of the inferences and qualitative observations described above, there was only a limited amount of direct measurement of exposure or effects relevant to amphibians at the time the ERA was undertaken. From a practical perspective, rehabilitation of the riparian areas, and restoration of Hazeltine Creek was ongoing throughout the risk assessment process and therefore the habitat suitability for amphibians was considered low. Moreover, completion of the ERA for other major groups of receptors (e.g., mammals, plants) was needed to determine if further remediation activities, which would further disrupt habitat suitability, was needed to address the residual concentrations of copper in the deposited material. Therefore, Golder (2017) determined that it would be inappropriate to arrive at a risk conclusion at that time without further evaluation.

The ERA found that risks for the major groups of receptors were generally low to moderate (reflecting the low bioavailability of copper in tailings) and therefore, extensive additional intrusive works are less likely. Thus, it is appropriate to now consider a monitoring plan that will contribute to confirming that the risk conclusions for other major groups of receptors are also applicable to amphibians.

Conceptual Approach

The amphibian component is essentially a continuation from the problem formulation already completed (Golder 2017) (which identified amphibians as a relevant receptor). In brief, the proposed approach is to continue the risk assessment process by proceeding through the following tiers to the point needed to support an informed risk management decision. The tiering is described in Figure 1, and consists of the following main tasks:

1) Conduct a hazard evaluation – Screen existing soil, sediment and surface water chemistry data for different habitat units against a conservative amphibian-specific screening value. Eliminate habitat units from consideration if copper concentrations are sufficiently low (i.e., the 90th percentile and 95% upper confidence limit of the mean) that risks are not expected.

2) Conduct an exposure assessment – For those areas that are not screened out in Step 1, compare the distribution of soil (or sediment, or water) concentrations for that area to a multi-study concentration response profile for copper. Areas where the average concentrations (e.g., 95% UCLM) are less than the toxicity reference value (TRV) (e.g., geometric mean of chronic, relevant no-observed effect levels) will be excluded from evaluation. Areas that cannot be excluded will be prioritized according to their potential risks (e.g., based on the degree of overlap between the distribution of concentration data and the response profile).

3) Conduct a laboratory-based effects assessment – The exposure assessment above assumes that copper in tailings is equally bioavailable as the original toxicity test. This is unlikely to be true because the ERA had multiple lines of evidence that showed bioavailability of tailings were low. If Step 2 demonstrates the potential for unacceptable risks, then laboratory-based toxicity testing will be used to establish a site-specific copper TRV and the representative soil, sediment and surface water data will be re-screened. Laboratory testing will likely need to include the physical nature tailings as a variable.

4) Refine the application of the toxicity reference values – The evaluation in Steps 2 and 3 assume that all soils, sediment and surface water are representative of a potential amphibian exposure. There may be portions of the terrestrial zone that are unlikely to be suitable amphibian habitat because of their distance from water, substrates or other factors. Refinement of the screening process from Step 3 to focus on the potential areas of habitat may be considered.

5) Conduct a field-based effects assessment – A field-based effects assessment is not contemplated unless concentrations in relevant amphibian habitats exceed both the literature-based and site-specific TRVs. Field-based measurements focus on comparison of population-level or organism-level endpoints between impacted and reference amphibian habitats. A mesocosm study could also be considered (e.g., transplant amphibian larvae between enclosures established in reference and impacted habitats and measure survival and growth at end of chronic exposure)

6) Integrate toxicity and habitat data in a population model – If a copper concentration response relationship has been established, it could be used in a population model to determine the relative influence of copper and physical stressors in the context of natural stressors (e.g., low precipitation) and habitat quality. This assumes that there is adequate information about the population dynamics of the western toad.

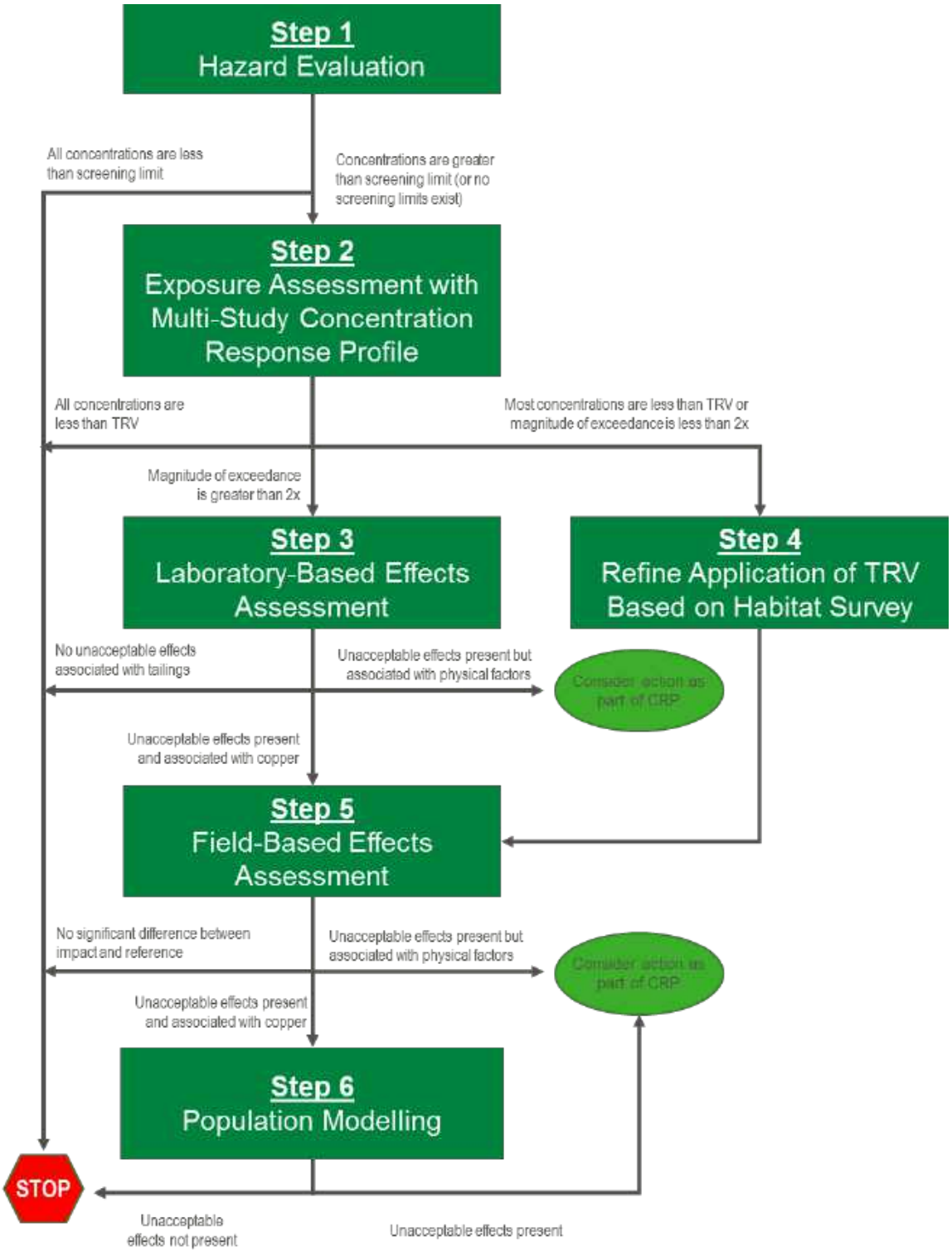


Figure 1: Proposed Tiering for Amphibian CEMP Component

Additional Information

This section expands on each tier in terms of potential sampling activities, levels of effort, and decision criteria. Further expansion of the rationale in the detailed study design is expected based on ENV feedback regarding the approach. The following guidance documents were reviewed as part of the development of this conceptual approach:

- FSCAP. 2016. Module 6: Ecological Risk Assessment for Amphibians on Federal Contaminated Sites. Draft (Not Approved as Guidance).
- Navfac (US Navy, Naval Facilities Engineering Command). 2004. Development of a standardized approach for assessing potential risks to amphibians exposed to sediment and hydric soils. TR-2245-ENV.

These documents provide amphibian-specific risk assessment information that was considered in the context of provincial guidance on conducted detailed ecological risk assessments at contaminated sites.

Step 1: Hazard Evaluation

FSCAP (2016) comment that there are relatively few summaries of amphibian toxicity data that provide generic screening limits. Golder will conduct a brief literature search to seek out amphibian-specific screening limits and review the available environmental quality guidelines to determine the degree to which they are protective of amphibians. The screening limits (if available) will be used to provide an initial evaluation of the soil, sediment and surface water data that is representative of the current-day exposure scenario for amphibians. The purpose of this initial hazard evaluation is to determine if portions of the site can be excluded from the amphibian assessment. An area will be excluded if: a) there is sufficient data to characterize the defined unit; and b) if the 90th percentile and 95% upper confidence limit of the mean concentrations in the unit are less than screening limit. If multiple screening limits are identified, an area will be excluded only if it has concentrations that are less than all limits. If no defensible screening limits are identified, we will proceed directly to Step 2.

Step 2: Multi-study Concentration Response Profile

FSCAP (2016) describe a process for integrating all available literature toxicity data into an overall concentration response profile for each media This “response profile” is then used to derive point-estimate screening limit (i.e., a single “safe” concentration) or effects-based TRVs (e.g., the range of values that correspond to a ECx effect). An example for zinc from FSCAP (2016) is provided in Figure 1.

Golder will develop multi-study concentration response profiles for copper in water and sediment/hydric soils consistent with FSCAP (2016). The overall process involves a literature review (with quality assurance procedures to eliminate unreliable data) consistent with ECO-SSL procedures. The general approach to integrating the literature data into a concentration-effect relationship is like that described by Allard et al. (2010) for wildlife TRVs. The ECO-SSL process is endorsed as a preferred approach in BC risk assessment by Technical Guidance 6 (guidance under the Contaminated Sites Regulation) and wildlife TRVs that consider the entirety of the available literature (instead of a single point estimate) are increasingly common in contaminated sites risk assessments.

Not all data have the same value in the derivation process:

1) Data that fail to meet basic test acceptability criteria (e.g., negative control are not present) will be rejected.

2) More weight will be given to North American species. Many toxicity studies use the African clawed toad (*Xenopus*) as a surrogate, but this species is not native to North America. Removing species that cannot be present at the site is consistent with provincial guidance about establishing site-specific water quality objectives (BCMOE 2013) and is also discussed by FSCAP (2016).

3) More weight will be given to studies that involved measured (instead of nominal) concentrations and/or involved field-collected samples instead of laboratory-spiked samples.

The specific derivation of a screening limit or a TRV is ultimately dependent on the quality and quantity of toxicity data available. It is likely that there will be a wide range of effects associated with a given concentration (e.g., Figure 2, which is for lead), and therefore, a specific derivation rule cannot be proposed at this time. FSCAP (2016) recommends that the data set should be explored to determine if there are significant differences in toxicity profiles for different species, exposure duration, endpoints and life stage. A specific decision about what constitutes an acceptable effect was not proposed by FSCAP (2016), but realistically, screening limits or toxicity reference values that are meant to be protective of western toads would need to reflect a low risk (e.g., EC10 or EC20). Moderate-to-high risk limits (e.g., an EC50-based TRV) may also be derived to help provide further context. Golder will need to consider the totality of the available data and provide a rationale for the TRV proposed. The available soil data will be compared to the TRVs using the same approach as described in Step 1.

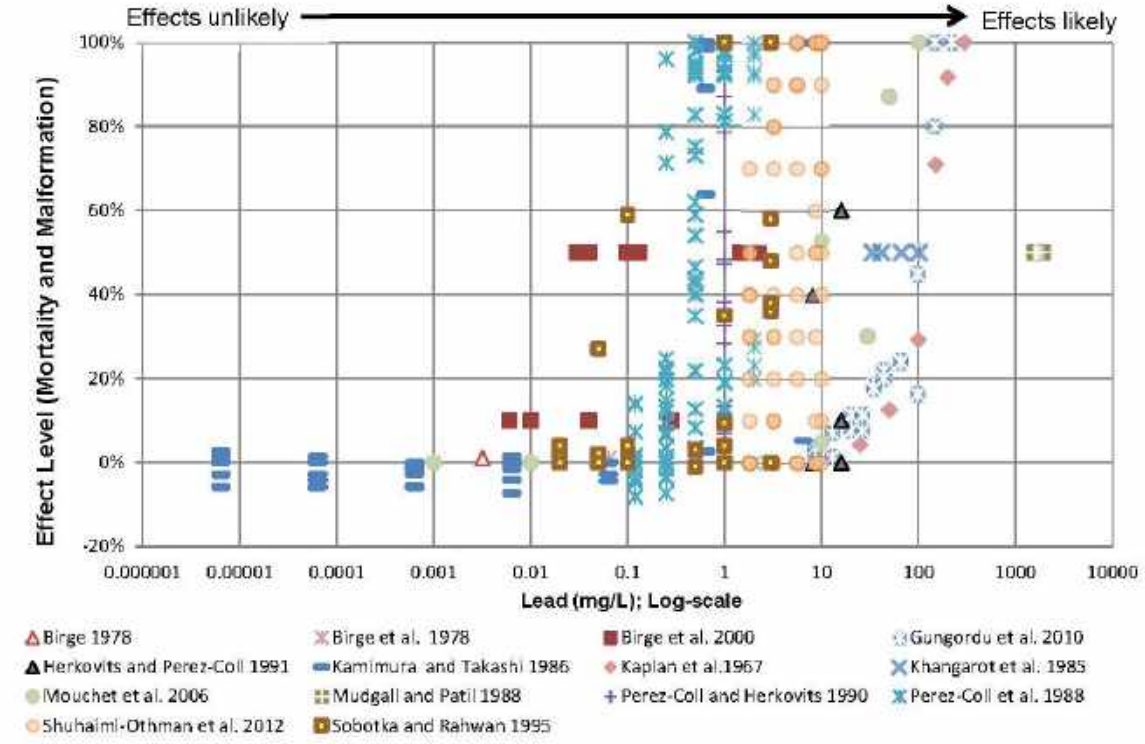


Figure 2: Example of a concentration-response profile (from FSCAP 2016)

Detailed reviewer comments were provided by ENV on May 29, 2018 and a teleconference was held on 9 July 2018 to discuss the conceptual approach and the reviewer comments. Golder understood from the teleconference that a topic of concern relates to how the results from the comparison of soil, sediment and surface water data to the amphibian-specific TRVs would account for amphibian habitat requirements.

Golder notes that there have been many soil samples collected from the site which were considered in the terrestrial risk assessment, and that additional soil sampling is being conducted in August 2018 as part of the supplemental terrestrial monitoring described under separate cover. Nevertheless, it would be a potential gap in the assessment if there were no data available regarding concentrations of copper in soil in areas that are important rearing or feeding habitat for amphibian species. Golder intends to present the data screening from Steps 1 and 2 in a manner that provides context for how the available data helps to inform hazards to amphibians. Specifically, a qualified biologist will provide a summary of habitat requirements for each of the individual amphibian species found in the area and will determine the extent of “high-quality” and “low-quality” habitat using existing information. This desktop-level review will help to place the hazard evaluation from Steps 1 and 2 in context. Further refinement of the hazard assessment based on a detailed habitat survey (Step 4) or a field-based assessment of effects (Step 5) will be considered based on the outcome of Steps 2 and 3.

Step 3: Site-specific Concentration-Response Relationship

A site-specific concentration response could be developed using amphibian toxicity testing in a manner similar to the approaches used for benthic organisms and plants in the ERA. Conceptually, the testing would include:

- Between 5 and 10 field-collected samples with varying copper concentrations that capture the range at which copper would be expected to exert a negative effect (based on Step 2).
- Additional negative controls to evaluate the physical nature of the tailings (e.g., low organic carbon; grain size and shape).
- Inclusion of spiked-copper samples (e.g., silica sand and natural soils spiked with a range of copper concentrations) to evaluate the difference in bioavailability between tailings and the typical literature values.

A detailed design for a laboratory-based toxicity test has not yet been developed, and there would need to be clarification from ENV about how the amphibian toxicity data would be used to make site management decisions before a suitable detailed design could be prepared. Amphibian toxicity testing is not a common approach and there are multiple laboratory-, organism- or sample-related factors that could lead to an unacceptable level of uncertainty in the results. For example:

- Nearly all available standardized protocols (ASTM, USEPA) use *Xenopus* which is not native to North America and it is not clear that this species is appropriate for the current application. Environment and Climate Change Canada (ECCC) is in the process of developing a standardized protocol with a relevant, Canadian species, but Golder understands that there are methodological challenges and organism supply issues yet to be resolved. The status of the draft method is unknown.

- Most standardized protocols are designed for spiked-water applications which would not necessarily provide value to the current application. One exception is NavFac (2004) which describes a method for exposing North American frog and toad tadpoles to field-collected sediment samples for a 10 to 14-day exposure. An ASTM test method is also available for sediment (but it uses *Xenopus*).
- It may be necessary to field-collect test organisms which would not be possible without applicable provincial scientific collection permits and/or federal permits under the Species at Risk Act.

Step 3 could provide value for site management decisions, but there are technical and regulatory issues to be resolved. Further development of a detailed study design for amphibian toxicity testing is not recommended until Step 2 has been completed, and only if there is consensus about how risk management decisions would factor in the possibility of high uncertainty associated with the use of a non-standard toxicity testing method. Ideally, an approved ECCC test method would be available at the time this step would be undertaken.

Step 4: Refinement of the TRV Application

A specific design for this step has not yet been developed. As a default, all soil, surface water and near-shore sediment data will be evaluated in Steps 2 and 3. The general concept for Step 4 is to refine how those TRVs are applied to different areas of the site based on whether the area provides (or will in the future) meaningful habitat for amphibians. The nearshore of the various waterbodies and their immediate riparian zones are likely amphibian habitat and would be included. Conversely, although western toads forage over relatively large areas and can use a range of different habitats (ECCC 2016), portions of the study area that are not suitable habitat for amphibians would then be excluded from the exposure estimates. Step 4 would involve a survey of the impacted area by biologists with specialized amphibian expertise. Areas of the site would be classified according to their suitability as amphibian breeding, hibernation, and foraging habitat (both at present, and in the future). This information would be used to refine how the TRVs are applied (e.g., exclude areas with minimal value to amphibians, and focus on understanding the risks in areas that are key to sustaining the amphibian population).

Step 5: Field-based Effects Assessment

From a risk assessment perspective, field programs provide valuable information because they provide a direct measurement of effects under field conditions. However, in the current application, direct measurement of effects does not necessarily help to differentiate the effects of the residual concentrations of metals associated with tailings from the physical effect of the tailings themselves. The physical alteration of habitat in the impacted areas was substantial, and as a result, a control-impact study design needs to account for the fact that risk management decisions will be different depending on whether the main stressor is physical or chemical.

FSCAP (2016) comments that amphibian risk assessment can incorporate field-based assessments and lists a number of standard methods for conducting field surveys for amphibians. Field assessment would involve a control-impact comparison (similar to the approach used for the benthic taxonomy studies in Quesnel and Polley Lake) and each type of area would preferably involve multiple locations to minimize the effect of natural variability of the risk management outcome. A variety of endpoints could be measured in a control-impact study design (e.g., number of egg masses per unit area; frequency of lesions or malformations per adult; abundance of amphibian larvae per unit catch effort).

Further development of a detailed study design for an amphibian field assessment is not recommended until Step 2 has been completed, and only if there is consensus about how risk management decisions would factor in the possibility of high uncertainty in its outcome. A key question is to determine the number of amphibian breeding sites within the impacted area, and to conduct a baseline survey to confirm that there is an adequate number of potential control sites available in the area. This baseline survey could be conducted as part of Step 4.

Step 6: Population Model

An additional line of evidence in an amphibian risk assessment is to combine the available toxicity and habitat data into a population model. A population model, in this context, simulates the stability of a given local population under a range of future conditions. The model is used to determine if reductions in survival, growth or reproduction from the physical or chemical stressors associated with tailings will impact the population as a whole. An example of a contaminant-habitat population model is provided for context.

Willson et al. (2012) used a population model (at a site unrelated to Mount Polley) to evaluate the impact of mercury on individual toads on the overall viability of population of American toads (*Bufo americanus*). The model simulated the population dynamics of toads to establish a baseline discrete-time model (e.g., how many toads will survive to each successive life-stage based on habitat quality; how big are the toads at reproductive age as a function of food availability; how many eggs will be produced as a function of adult toad size). The effect of mercury on the population was then added to the model as a reduction in the survival, growth and reproduction baseline as a function of mercury concentration. The net effect was a model that simulated how different concentrations of mercury would contribute to the stability of the toad population over time, and to determine which type (and how much) habitat enhancement was needed to off-set the influence of mercury.

In the current application, a model similar to Willson et al. (2012) would provide value by integrating the information from Steps 3, 4 and 5. However, a model like this would only be appropriate if there was evidence that copper was exerting an unacceptable effect which could not be readily remediated. Golder recognizes that habitat compensation to address residual contamination is a policy question that would need to be resolved, particularly for a listed species where the intent is to protect the individuals of the population, not just the population itself. There are also technical limitations to this type of model in terms of the quality and quantity of data available for parameterization. Golder assumes that there would be sufficient species-specific information for western toads because the species is listed and would be a priority for researchers (at least relative to other Canadian amphibians). It may also be reasonable to assume the population variables for western toads are similar to American toads.

Further development of a detailed study design for an amphibian population model is not recommended until Step 2 has been completed, and only if there is compelling evidence that there is a chemical-related impact that would be likely to cause an unacceptable outcome to amphibian populations. In the absence of a chemical-related impact, a model would not necessarily add any value (i.e., a decision to conduct habitat improvement to mitigate a physical stressor does not need to be based on a model).

Summary

This memorandum describes a proposed tiered approach for the amphibian component of the CEMP. Not all tiers are recommended for implementation, and there are significant technical and regulatory issues that would need to be resolved as part of the design and execution of Steps 3 onwards. However, Steps 1 and 2 provide a framework that is similar to a screening-level risk assessment for amphibians, and the process for accomplishing those steps has already been described by draft regulatory guidance (i.e., there is a basis for developing a clear process for those steps).

Golder recommends that Steps 1 and 2 should be completed as part of the current CEMP. No further action would be necessary if risks to amphibians can be shown to be low based on comparison of the relevant soil, surface water and chemistry data to toxicity reference values derived from the available literature. A preliminary review indicates that there will be sufficient data in the literature of suitable quality to support Step 2. If risks are found to be unacceptable at the conclusion of Step 2, further investigation following the tiered approach described in this memorandum may be necessary.

Closure

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this memorandum.

Please do not hesitate to contact the undersigned if there are questions regarding this memorandum.

Golder Associates Ltd.

COLLEGE OF APPLIED BIOLOGY
Blair G. McDonald
R.P. Bio
#1528
CAB

COLLEGE OF APPLIED BIOLOGY
Barbara Wernick
R.P. Bio
#1171
CAB

Blair McDonald, MET, R.P.Bio., CAEAP (Risk)
Associate, Senior Environmental Scientist

Barbara Wernick, M.Sc., R.P.Bio.
Principal, Senior Environmental Scientist

BM/BW/cr

Attachment: Study Limitations

https://golderassociates.sharepoint.com/sites/10023g/documents_1894924/2. issued/018-tm-23182-amphibiandesignconcept/rev1/1894924-018-tm-rev1-23182-amphibiandesignconcept_09aug_18.docx

References

Allard P, Fairbrother A, Hope BK, Hull RN, Johnson MS, Kaputska L, Mann G, McDonald B, Sample BE. 2010. Recommendations for the development and application of wildlife toxicity reference values. Integ Environ Assess Manage 6: 28-37.

BCMOE (British Columbia Ministry of Environment). 2013. Guidelines for the derivation and application of water quality objectives in British Columbia. Available online: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-objectives/wqo_proc_guidance.pdf

ECCC (Environment and Climate Change Canada). 2016. Management Plan for the Western Toad (*Anaxyrus boreas*) in Canada. Species at Risk Act Management Plan Series. Available online: http://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=3053

FCSAP (Federal Contaminated Sites Action Plan). 2016 Draft. Ecological Risk Assessment Guidance.

Golder (Golder Associates Limited). 2017. Mount Polley rehabilitation and remediation strategy: ecological risk assessment. Prepared for Mount Polley Mining Corporation. Golder Document 1662612-162-R-Rev1-22396. 15 December 2017.

Module 6: Ecological Risk Assessment for Amphibians on Federal Contaminated Sites.

NavFac (US Navy Naval Facilities Engineering Command). 2014. Development of a standardized approach for assessing potential risks to amphibians exposed to sediment and hydric soils. Technical Report TR-2245-ENV, prepared for Naval Facilities Engineering Service Center (NAVFAC), Port Hueneme, CA.

Willson JD, Hopkins WA, Bergeron CM, Todd BD. 2012. Making leaps in amphibian ecotoxicology: translating individual-level effects of contaminants to population viability. Ecol Appl 22: 1791-1802.

Study Limitations

Golder Associates Ltd. (Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by Golder for the sole benefit of Mount Polley Mining Corporation. It represents Golder's professional judgement based on the knowledge and information available at the time of completion. Golder is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, site conditions, design objective, development and purpose described to Golder by Mount Polley Mining Corporation, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder. Mount Polley Mining Corporation may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

Appendix B.7

Study Design for Developing Reference Conditions for Polley Lake

Golder Associates Ltd.

31 October 2019 Reference No. 1894924-111-L-Rev0-23185

Mr. Don Parsons
Mount Polley Mining Corporation
Box 12
Likely, BC V0L 1N0

STUDY DESIGN FOR DEVELOPING REFERENCE CONDITIONS FOR POLLEY LAKE – MOUNT POLLEY MINE

Dear Mr. Parsons,

Golder Associates Ltd. (Golder) is pleased to provide Mount Polley Mining Corporation (MPMC) with this study design for characterizing reference conditions for Polley Lake. This study design was prepared in response to a condition set by the Ministry of Environment and Climate Change Strategy (ENV) for approval of the Comprehensive Environmental Monitoring Plan (CEMP), specifically:

> *An updated study design must be provided, which includes the monitoring location, frequency, and methods for assessing reference conditions for Polley Lake, and which includes a description of the process for characterizing the relative differences between Bootjack Lake, Polley Lake, and the newly identified reference location.*[1]

1.0 OBJECTIVES

Polley Lake is adjacent to the Mount Polley Mine, and environmental monitoring is undertaken to assess the potential for mining activities to affect biological communities in the lake. At the present time, the reference lake for Polley Lake is Bootjack Lake, on the opposite side of the mine site from Polley Lake. Because there is potential for mine-contact water to enter Bootjack Lake in the future, ENV requested that MPMC identify one or more alternate lakes to function as references and to begin data collection early on to provide temporal and spatial continuity to the program. The purpose of this letter is to provide a decision framework and methods for selecting candidate alternate reference lakes for Polley Lake.

[1] 9 November 2018 letter from D. Hill, ENV, to D. Reimer, MPMC, "Approval of the August 15, 2018 Comprehensive Environmental Management Plan (CEMP) – Mount Polley Mine Permit PE-11678".

Golder and the G logo are trademarks of Golder Associates Corporation

2.0 IDENTIFICATION OF CANDIDATE LAKES

The decision framework for identifying potential candidate reference lakes is illustrated in Figure 1. The primary variables expected to have an influence on hydrodynamics and biological communities in a given lake, and which can be characterized at a desktop level, are: biogeoclimatic zone, size, depth, surrounding land use, and underlying geology. Ideally, reference areas will have as similar characteristics to the exposed area as is reasonably practicable. Once a subset of lakes is identified, collection of sediment and water samples will be needed to select the final candidate reference lake(s).

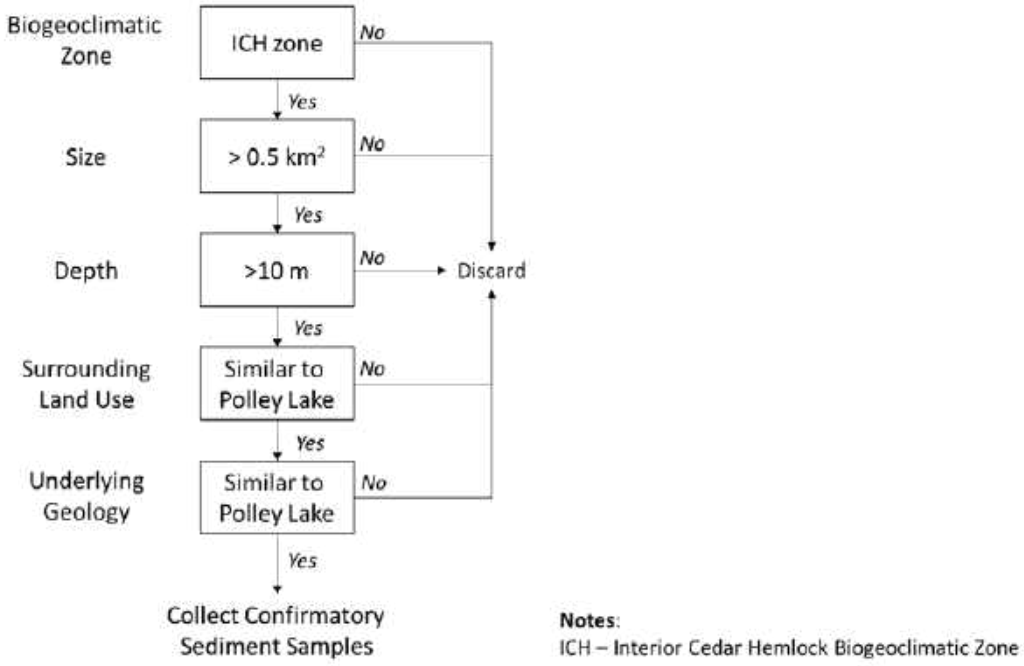


Figure 1: Decision Framework for Selection of Candidate Reference Lakes

Following this approach, Table 1 provides a summary of an initial subset of candidate reference lakes. Jacobie Lake was sampled in 2018 and the results confirm that the underlying geology is likely too dissimilar to Polley Lake to provide a suitable reference. It is also expected that Spanish Lake is unsuitable because it is in a wet subzone (wk2) of the Interior Cedar Hemlock (ICH) zone, has notably different underlying geology (arsenic and selenium is enriched in rocks on the opposite shore of Quesnel Lake), and is subject to mineral exploration and planned mine development (and therefore potential future mine-related activities).

Morehead and Gavin Lakes are both in the moist cool subzone (mk3) of the ICH zone, and Morehead coincides with at least one geological unit (LT_{Nvl}) that is similar to Polley Lake. Geological mapping will be further reviewed to evaluate similarity in the composition of the underlying geology vis-à-vis similarity to be a source of primary metals/metalloids of concern (e.g., copper, selenium, arsenic). However, Morehead Lake receives drainage from Bootjack Lake.

Table 1: Characteristics of Polley Lake and Candidate Reference Lakes

Lake	Elevation (m) [(a)]	Area (km^2) [(a)]	Depth: max (mean) (m) [(a)]	Underlying Geology [(b)]	Biogeoclimatic Zone [(c)]	Activities
Polley Lake	920	3.9	35 (18)	LT_{Nvl}, LT_{MPic}, LT_{Nav}	■ ICHmk3	■ Adjacent to Mount Polley Mine ■ Recreation (camping, fishing)
Bootjack Lake	983	2.6	15	LT_{Nvl}, LT_{Npt}	■ ICHmk3	■ Adjacent to Mount Polley Mine ■ Recreation (camping, fishing)
Jacobie Lake	1,122	0.86	20 (7)	LT_{Npv}, LT_{Nvb}	■ ICHmk3	■ Recreation (camping, fishing)
Morehead Lake	916	2	17	$LT_{Nvl,}$ Qal	■ ICHmk3	■ Recreation (camping, fishing)
Gavin Lake	963	0.94	24	MJ_{Qm}, LT_{Ns}	■ ICHmk3	■ Recreation (camping, fishing)
Spanish Lake	919	4.6	72.5 (29.6)	MLT_{Ns}	■ ICHwk2	■ Mineral exploration ■ Recreation (camping, fishing)

Notes:

(a) Activities, elevation and area identified from various angler and recreational use information websites.

(b) BC Forest Service Biogeoclimatic Ecosystem Classification System (ftp://ftp.for.gov.bc.ca/HRE/external/!publish/becmaps/PaperMaps/field/DHO_HorseflySubunit_Cariboo-ChilcotinResourceDistrict_CaribooRegion__field.pdf).

(c) BC EMPR Geoscience Map 2007-1 Regional Geology of the Mount Polley Area, central British Columbia (http://cmscontent.nrs.gov.bc.ca/geoscience/PublicationCatalogue/GeoscienceMap/BCGS_GM2007-01.pdf).

ICH: Interior Cedar Hemlock.

LT_{MPic}: Hydrothermal altered intrusive carapace holocrystalline monzonitic intrusions and volcaniclastic wall rock.

LT_{Nav}: Pink-white analcime pyroxene+/-olivine basalt breccia, flows and tuffs.

LT_{Npt}: Plagioclase phyric, pyroxene lapilli tuff, breccia and minor flows.

LT_{Npv}: Green and maroon pyroxene porphyry breccias, pyroxene-olivine basalt flows, and crystal-rich sediments.

LTNs: Grey siltstone, normal graded sandstone and cherty shale with pyroxene and plagioclase-rich crystal sandstones.

LTNvb: Massive, coarse polymictic volcanic breccias, graded sandstones, siltstone and rare limestone breccia horizons.

LTNvl: Red-brown, massive, polymictic breccia, feldspar, and hornblende crystal tuff.

MLTNs: Graphitic and quartzose phyllite, shale, siltstone and sandstone.

MJQm: Hornblende-biotite quartz monzonite.

mk3: moist cool zone.

wk2: wet cool zone.

3.0 VERIFICATION OF SUITABLE REFERENCE LAKE

Prior to the 2021 benthic invertebrate sampling program for Polley Lake, five sediment samples will be collected from lakes with similar geology to Polley Lake and analyzed for metals and grainsize distribution. Water samples will be collected from two locations and two depths (surface and depth) and analyzed for metals, hardness, total and dissolved organic carbon, and nutrients. At each of the two sampling locations, field measurements of pH, temperature, dissolved oxygen and conductivity will be recorded at 1 m intervals. Sampling methods (including quality assurance/quality control procedures) as outlined in the CEMP will be followed.

The resulting physico-chemical data will be compared to data from Polley Lake and Bootjack Lake. The comparisons may be made visually using graphs; through screening against sediment quality guidelines; and/or using statistical tests such as principle components analysis (PCA) or non-metric multidimensional scaling NMDS). The specific tests will be determined at the time of analysis, as factors such as variance and distribution (normal/non-normal) of the data and proportion of detectable versus non-detectable concentrations will need to be taken into account.

Sampling of the benthic invertebrate community of the selected lake will be conducted in 2021, along with sampling in Polley Lake.

4.0 CLOSURE

We trust that this letter provides sufficient information for your present needs. If you have any questions, please do not hesitate to contact the undersigned at 604-296-4200.

The reader is referred to the Study Limitations section, which follows the text and forms an integral part of this memorandum.

Yours very truly,

Golder Associates Ltd.

ORIGINAL SIGNED

Barbara Wernick, M.Sc., R.P.Bio.
Principal, Senior Environmental Scientist

ORIGINAL SIGNED

Lee Nikl, M.Sc., R.P.Bio.
Principal, Senior Environmental Scientist

BW/LN/lmi/et

Attachment: Study Limitations

https://golderassociates.sharepoint.com/sites/10023g/documents_1894924/2. issued/111-l-23185-studydesignpolleylake/rev0/1894924-111-l-rev0-23185-reference_lake_study_design_31oct_19.docx

STUDY LIMITATIONS

Golder Associates Ltd. (Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by Golder for the sole benefit of Mount Polley Mining Corporation (MPMC). It represents Golder's professional judgement based on the knowledge and information available at the time of completion. Golder is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document

pertain to the specific project, site conditions, design objective, development and purpose described to Golder by MPMC, and are not applicable to any other project or site location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder. MPMC may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

Appendix C

Combined Monitoring Schedule 2019

Mount Polley Mining Corporation

Monitoring Schedule

Task	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	31	1	2	3	4	5	6
					No staff on weekend		
Lakes							
Surface Water		Discharge: E19, HAD-3 Surface water sampling: W1, WA (W1 dup), W4a, W5, W8, W8z, W20, W21, Gavin's Ditch, WL (W12 dup), East 12204 (East MTD dup), West MTD, LD, SERD, E1a, ED (E4 dup), **2 ppl; 8**	Surface water sampling: E13, E14, E15, E17, E18, E19a, E20, E21, E22, E23, STD, TB + FB ; JCP, Boundary Seep 2, MDC, SERD Seep 13 **2 ppl; 8 hours**	SERD Seep Survey **2 ppl; 5 hours**			
Reclamation		Seeding/Monitoring as necessary					
Groundwater				GW15-1A/B & GW15-2A/B SWLs			
Hydrology							
Weather		Snowpack/Manual Rain Gauge		Manual Rain Gauge			
Inspections		Mill Potable Water Meter **2 per; 5 hours (winter)**	HAC Fish Spawning Survey **1 per; 6 hours** **2 ppl; 4 hours**	EDC Fish Spawning Survey; Waste Inspection			
Soil/Sediment		ABA (if dumping NAG waste)					
	7	8	9	10	11	12	13
Lakes	P1 (S+P)[1] + PA-B + P2 (S+P)[1] B1 IS+P) + B2 (S+P) + BB-S **2 ppl; 8 hours**						
Surface Water		**DO all locations:** HAC-01c, HAC-13 + HAC-08, HAC-05a, HAC-10 + HAC-J + HAC-10-FB, POF-1, POF-5, CSD Bridge photos Discharge:E19, HAD-3 + HAD-C BAC-01 (Ladies Dry) **2 ppl; 8**	PAG Seep Survey **2 ppl; 5 hours**	East RDS Seep Survey **2 ppl; 5 hours**			
Dustfalls				Dustfalls **2 ppl; 7 hours in winter** **1 per: 4 hours in summer**			
Reclamation	Seeding/Monitoring as necessary						
Groundwater	GW15-1A/B & GW15-2A/B SWLs						
Hydrology	W1b, W5, W12, SERD, H6 **if safe and not frozen**						
Weather	Manual Rain Gauge	snowpack if melting event forecast		Manual Rain Gauge			
Inspections	Waste inspection	Spring/Fall Ditch Inspections	HAC Fish Spawning Survey	EDC Fish Spawning Survey			
Soil/Sediment	ABA (if dumping NAG waste)						
	14	15	16	17	18	19	20
Lakes	QUL-ZOO-8 (S+C)[3] + QUL-ZOO-8-FB QUL-ZOO-7 (S+C)[3] QUL-ZOO-1 (S+C)[3]	QUL-58 (S+C)[1] + T.Hg + Ra-226 QUL-57 (C) + QUL-59 (C) QUL-2a (S+C)[1] + T.Hg + Ra-226	QUL-18 (S+C)[1] + QUL-R-50m QUL-120a (S+C[f] * + QUL-ATa-190m				
Surface Water		Discharge: E19, HAD-3 + T.Hg + Ra-226+ toxicity[4, g, h] (100L) BAC-02 (Pit shop sink)		NEZ Seep Survey + DO at all locations: NEZ Samples + 2119 NEZ Seep LD (US NEZ Seep LD dup)+ Martel Sump + NEZ Seep -TB			
Reclamation	Seeding/Monitoring as necessary						
Groundwater	GW15-1A/B & GW15-2A/B SWLs						
Hydrology	H1, H2, H3, H4 **if safe and not frozen**						
Weather	Manual Rain Gauge	snowpack if melting event forecast		Manual Rain Gauge			
Inspections	Waste inspection	Trailer Inventory	HAC Fish Inspection (if ice free)/Fish Spawning	EDC Fish Spawning Survey			
Soil/Sediment	ABA (if dumping NAG waste)						
	21	22	23	24	25	26	27
Lakes							
Surface Water		Discharge:E19, HAD-3 BAC-03 (3rd floor mill lunchroom)					
Reclamation	Seeding/Monitoring as necessary						
Groundwater	Quarterly GW: GW 15-1a & 1b GW 15-2a & 2b GW 12-2a + GWL-Ba & GW 12-2b GW96-7 95-R5 **2 ppl; 8 hours**	Quarterly GW: GW95R-1 + Ecoli + GWIER-A GW05-01 + Ecoli GW04-1 + Ecoli GW-Low Flow + GW-Grundfos GW16-6a & 6b **2 ppl; 8 hours**	Bi-annual GW: GW00-1a & 1b GW00-2a GW00-3a & 3b GW96-3a GW96-4a & 4b **2 ppl; 8 hours**	Bi-annual GW: GW96-2a & 2b GW16-4a & 4b GW16-3a & 3b GW16-5a & 5b GW16-2a & 2b **2 ppl; 8**			
Hydrology	W4a, JCP, NW Ditch, H5 (Junction Zone Ditch), STD, MTD, NEZ Seep 1, SERD Seep 13 **if safe and not frozen**						
Weather	Manual Rain Gauge	snowpack if melting event forecast	Check HOBO Link online	Manual Rain Gauge			
Inspections	Waste inspection	HAC Fish Spawning Survey	Pipeline Inspection	EDC Fish Spawning Survey			
Soil/Sediment	ABA (if dumping NAG waste)						
	28	29	30	31			
Lakes							
Surface Water		Discharge:E19, HAD-3 BAC-04 (Assay Lab Eyewash)					
Reclamation	Seeding/Monitoring as necessary						
Groundwater	GW15-1A/B & GW15-2A/B SWLs Bi-annual GW: GW11-1a & 1b GW11-2a & 2b GW12-1a & 1b GW12-3a & 3b GW12-4a & 4b **2 ppl; 8 hours**	Bi-annual GW: GW12-5a & 5b GW16-7 & 8 GW16-1a & 1b **2 ppl; 8 hours**	HAC Creek GW	HAC Creek GW			
Hydrology							
Weather	Manual Rain Gauge	snowpack if melting event forecast		Manual Rain Gauge			
Inspections	Waste inspection	Spring/Fall Ditch Inspections	HAC Fish Spawning Survey	EDC Fish Spawning Survey			
Soil/Sediment	ABA (if dumping NAG waste)						

C = cast + secchi
P = profile + secchi
S = sample

Special Sampling:
1) Chlorophyll a, phytoplankton, [zooplankton - POL only] (Jun/Aug)
3) Zooplankton, chlorophyll *a* , phytoplankton, surface sample

QA/QC Sampling:
Field Blank - 2x monthly minimum
Trip Blank - 2x monthly minimum
Equipment Blank KEM2 - monthly; GW - quarterly
Duplicates - 2x monthly minimum

Quarterly Wells (SWL): Complete Q1

~~GW96-1a~~	GW96-2a
GW96-4a	GW16-2a,3a,4a,5a
GW00-1a	GW96-3a
GW00-2a	GW00-3a

Flows:
Purple:Bucket Black: Tracker

Ongoing/When Time:
Crew Training
Battery recycling
Trailer Clean Up/Safety -test PFDs
Wash trucks (in and out)

Seep Sampling:

SERD	WHR
PAG	TSF
BOUNDARY	NBD
EAST RDS	NEZ

Reclamation Activities:
Grass Seeding

QUL Sample Depths (m):

QUL-18	0, 20, 50, 100
QUL-2a	0, 20, 40, 60
QUL-58	If detect plume: Middle of plume (MP) + 5m above (AP) + 5m below (BP) (all sites) If can't detect plume: S, 1m above thermo , 1m below thermo [or MID if no thermo], bottom * write sample depths in field book **4x per year: T.Hg taken at QUL-58 (depth at which plume expected), QUL-2a (close to same depth as QUL-58), & HAD-3 *** write field parameters for each sample taken and indicate if discharging in field book
QUL-55	0, 15, 30
QUL- 42:	0, 10, 20
QUL-120a:	0, 40, 80, 120, 140 well-mixed: 0, 80, 190

BJ + POL Sample Depths (m):
S, 1m above thermo , 1m below thermo [or MID if no thermo], bottom
* write sample depths in field book
** monthly profiles between spring and fall overturns

Toxicity:
a) 96h LC50 RBT, 48h LC50 *D. magna*
b) 7 day ELS RBT
c) 7d C. dubia S&R
d) 7d RBT S&G
e) 30d ELS RBT
f) 30d ELS top-up (100L)
g) 72h algal (MMER)
h) 7 day duckweed (MMER)

Chorophyll *a* :
250ml polyethylene bottle wrapped in aluminum foil

Phytoplanton:
polyethylene bottle, preserved with Lugol solution

Zooplankton taxonomy (1 haul):
Quesnel Lake --> 150µm mesh net to 30m depth (1 tow), preserved with buffered sucrose
Polley Lake --> 50µm mesh net to 28m depth (1 tow), preserved with 85% ethanol

Zooplankton metals:
minimum amount of water, kept frozen, multiple hauls (depending on biomass)
QUL --> 50 µm mesh net minimum amount of water, kept frozen, multiple hauls (depending on biomass)
POL --> 50 µm mesh net minimum amount of water, kept frozen, multiple hauls (depending on biomass)

Special Analyses:
T.Hg - 40ml glass vial with 1x HCl
Ra-226 - 1L plastic with 6x HNO3

Appendix D

Site Matrix

Mount Polley Mining Corporation

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
W1 Morehead Creek	E 587262 N 5826275	1990	Meandering creek with lots of willows and grass, no distinct trail. Large marsh to the North.	Drive to km 4.5 on Bootjack Road to a small opening in the trees, and walk down the bank on the south side for 50 m. Trail and site marked with orange flagging tape.	Radio communication must be used on the Bootjack Road (Channel RR-25). Ensure that vehicle is parked to the side of the road out of the way of traffic. Watch for wildlife. Watch for rotten logs while approaching site. Follow working in/near water procedures.	Downstream of mine impacted area. Provides opportunity to monitor potential changes in POI's in Bootjack Lake.
W1b Morehead Creek	E 588920 N 5825173	2003	Meandering creek that flows under a bridge.	Drive to approx. km 7 on Bootjack Road and turn south onto side road for approx. 90 m until you reach a bridge. Walk down an embankment on the upstream side of the bridge to the creek.	Radio communication must be used on Bootjack Rd (Channel RR-25). Watch for wildlife. Watch your footing when walking down embankment. Follow working in/near water procedures.	Monitoring flow out of Bootjack Lake.
W4a North Dump Creek	E 593152 N 5824689	2014	Small stream that flows under the Wight Pit road through a culvert.	Drive towards the Wight Pit, before entering pit there will be one last runaway lane on the left hand side, park vehicle on right side of the road. The sample site is located over the berm and down an embankment; there is a large log on the hillside to indicate the sample location.	Watch for wildlife. Watch your step while descending the embankment to monitoring location; there are loose rocks. Follow working in/near water procedures.	Downstream of mine impacted areas. Provides opportunity to monitor for non-contained seeps or run-off collection ditches.
W5 Bootjack Creek	E 594481 N 5820782	1990	Small stream runs through culvert	Drive down the TSF haul road towards Polley lake weir, turn left at the central collection sump. Turn left onto deactivated logging road across from SERD outlet pipe. At top of hill, turn right and at the valley in the road park truck. Trail down to the creek is on the upstream side of creek. Site trail is indicated by fallen tree across path.	Contact Pit Shifter prior to entering haul roads. Drive with caution on haul roads and give heavy equipment the right-of-way. Use 2-way radio communication (Channel 5 – Pit Ops 1). Watch for wildlife. Slippery slopes with quite a few willows and one fallen tree. Old logging road can be very rough and muddy, recommend 4X4 or walk in during snowy conditions. Follow working in/near water procedures.	Downstream of mine impacted areas. Provides an opportunity to monitor for seepage from the SERD.
W8 Edney Creek Tributary	E 597005 N 5817606	1995	Small stream with easy access from the road.	Turn S at the old ABR onto a narrow road. Drive for roughly 2 km, until you come to a small stream flowing under road through a culvert. Monitoring site is located on the downstream side of the road.	This road can be very muddy, recommend 4X4 or walk in during snowy conditions. Look for old orange ribbon. Watch for wildlife. Follow working in/near water procedures.	Downstream of mine impacted area. Provides opportunity to monitor for potential seepage from TSF.
W8z Edney Creek Tributary (control)	E 593290 N 5817920	1997	Small creek flows under road through a culvert. Many trees down over stream and many willows.	Drive to Gavin Lake Rd and turn right. Drive a few kms to about km 15 board, just before a junction with a deactivated logging road. The monitoring location is on the right hand side of the road (upstream side of the road) just before the second landing.	Look for pink ribbon. Park to the side of the road. Short steep incline to access the monitoring site. Watch your step; there is not much room near the creek. Watch for wildlife. Follow working in/near water procedures.	Upstream of mine. Allows for monitoring of seasonal variability of surface water.
W10 Edney Creek	E 601183 N 5816862	1995	Lower Edney Creek underneath a bridge.	Turn left onto Gavin Lake Rd. Continue on and turn right on Ditch Rd towards Horsefly. Travel to the second bridge crossing. On the right hand side of the road past the bridge (upstream side of the creek), there is a path down to the creek.	Watch for public traffic on the road and ensure vehicle is parked out of the way. Flows may be high during freshet. Ice can build up on edges of creek in winter conditions. Watch for wildlife. Follow working in/near water procedures.	Outside of mine impacted area. Allows the opportunity to monitor for changes in newly constructed creek downstream and to monitor for seasonal variability.

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
W12 6K Creek (Tributary to Morehead Creek)	E 588360 N 5825961	1990	Small stream that enters a marsh at the end of an old overgrown road. Small fish present in the stream.	Drive to km 5.5 on Bootjack Rd., to the chain-up pullout. Walk down old road on the NE side of Bootjack for roughly 150 m.	Radio communication must be used on the Bootjack Rd (Channel RR-25). Ensure that vehicle is parked to the side of the road out of the way of traffic. Watch for wildlife. Follow working in/near water procedures.	Upstream of mine. Allows for monitoring of seasonal variability of surface water.
W20 Un-named Tributary to Bootjack Lake	E 592161 N 5821586	2013	Small creek on the NE side of Bootjack Lake, lots of grass, willow, alder and fallen trees. Creek flows roughly parallel to the West Ditch.	Walk in or boat access only. Drive midway on the West Ditch Rd. between the Booster Station and Mine Drainage Creek Sump. Park and walk W to the creek. Follow creek to the lakeshore. Monitoring location is in the creek channel approx. 15 m from the lakeshore. Look for orange ribbon at monitoring location.	If accessing by boat, follow safe boating SOP. If walking, watch for wildlife. Watch for Devil's Club. Walk with caution, as there are lots of blowdown. Ensure vehicles are parked out of the way. Follow working in/near water procedures.	Downstream of mine impacted area. Provides the opportunity to monitor for any seepage from the west ditch.
E1a Tailings Storage Facility	E 594495 N5819187	1997	TSF Supernatant	Drive along the TAR to the TSF. Enter the TSF near corner 5 and follow road to the barge.	Use radio communication when travelling on haul roads and contact Pit Shifter prior to entering haul roads and TSF area (switch from Channel 5 to Channel 1 (Tailings) when entering TSF area). Give right-of-way to heavy equipment. Follow working in/near water procedures. Watch for slippery surfaces in freezing conditions.	Monitoring supernatant WQ in the TSF.
E11 Springer Pit	E 591701 N 5823327	2011	At bottom of the Springer Pit.	Travel down into the bottom of the Springer pit ramp and the monitoring location is near the pipes coming out of the springer pit.	Contact the Pit Shifter prior to entering and leaving the Springer Pit. Use caution when walking under highwalls.	When not storing water from other sources on site: source terms. When storing water from other sources on site: monitoring for potential discharge.
E19	E 595760 N 5819760	2015	Water Treatment Plant Influent	Travel down the TSF haul road towards corner 2 of the TSF. Approx. half way to corner 2 there is a road on the left that goes to the WTP. Monitoring site is located inside facility at the influent pipe at the main entrance to plant.	Use caution when driving on haul roads; contact the Pit Shifter prior to traveling to and from WTP. Watch for haul trucks on haul roads. Give the right-of-way to heavy equipment and used 2-way radio communication.	Provides ability to monitor efficacy of treatment.
HAD-3	E 595772 N 5823583	2015	Water Treatment Plant Effluent	Travel down the TSF haul road towards corner 2 of the TSF. Approx. half way to corner 2 there is a road on the left that goes to the WTP. Monitoring site is located inside facility at the effluent pipe located by the door that leads to the WTP office.	Use caution when driving on haul roads; contact the Pit Shifter prior to traveling to and from WTP. Watch for haul trucks on haul roads. Give the right-of-way to heavy equipment and used 2-way radio communication.	Compliance point for discharge to environment.

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
H1 Hazeltine Creek	E 597030 N 5818978	2015	Mid Hazeltine Creek hydrology station approximately 100 m downstream of Gavin Lake Bridge.	Travel to Gavin Lake Rd and turn left. Cross the Gavin lake bridge and park off to the side. Walk approx. 100 m downstream of the bridge to hydrological monitoring station and is marked with staff gage and metal pipes.	Used caution when driving on TSF haul road. Contact the Pit Shifter prior to traveling on haul roads. Give the right-of-way to heavy equipment and used 2-way radio communication. Watch your footing on loose rocks. Watch for wildlife. Use caution in high flow times. Follow working in/near water procedures. May need hip waders.	To monitor hydrology of mid Hazeltine Creek.
H2 Hazeltine Creek	E 601024 N 5817253	2015	Lower Hazeltine Creek hydrology station.	Travel to the Gavin Lake Rd and turn left. Continue on road until you reach the Ditch Rd, and turn right towards Horsefly. Before the Ditch Road bridge, turn left through the gate. The station is approx. 200m from the gate. Hydrology station is marked with staff gage and metal pipes.	Park vehicle to the side of road. Watch for wildlife. Call km boards on the radio while traveling in both directions. Watch for wildlife. Use caution in high flow times. Follow working in/near water procedures. May need hip waders.	To monitor hydrology of lower Hazeltine Creek.
H3 Edney Creek	E 601538 N 5817123	2015	Edney Creek Hydrology station.	Travel to the Gavin lake Rd and turn left. Continue on road until you reach the Ditch Rd, and turn right towards Horsefly. Drive past the Ditch Road bridge and turn left through the gate. Drive approx. 300 m and the hydrology station is marked with staff gage and metal pipes on the right hand side of the road.	Park vehicle to the side of road. Watch footing when walking to hydrology station – some loose rocks. Use caution in high flow times – do not complete task if flow is too strong. Follow working in/near water procedures. Watch for wildlife. May need hip waders.	To monitor hydrology of Edney Creek.
H4 Hazeltine Creek	E 595892 N 5819997	2015	Upper Hazeltine Creek hydrology station at Polley lake weir..	Drive down the TSF haul road to Polley lake weir. Hydrology station is marked by staff gauge approx. 50 m downstream, of the weir.	Use caution when driving on haul roads, radio contact the Pit Shifter prior to entering area. Give the right-of-way to heavy equipment and used 2-way radio communication. Watch for wildlife. Use caution in high flow times. Follow working in/near water procedures. Watch footing on loose rocks down to the creek. May need hip waders.	To monitor hydrology in upper Hazeltine Creek and out of Polley Lake.
HAC-05a Hazeltine Creek	E 596916 N 5819074	2015	Upper Hazeltine Creek just upstream of Gavin Lake bridge.	Travel as described above to H1. Monitoring location is the upstream side of Gavin Lake bridge.	Used caution when driving on TSF haul road. Radio contact the Pit Shifter prior to entering area. Give the right-of-way to heavy equipment and used 2-way radio communication. Watch your footing on loose rocks. Watch for wildlife. Use caution in high flow times and winter conditions. Follow working in/near water procedures.	Monitor WQ downstream of the effluent discharge - when discharging. To monitor WQ post creek reconstruction - when not discharging.
HAC-08 Hazeltine Creek	E 600723 N5817290	2015	Lower Hazeltine Creek just upstream of Ditch road bridge.	Travel as described above to H2, but instead of turning left before the bridge, drive to the bridge and park to the side. Monitoring location is just upstream of the Ditch road Bridge.	Park vehicle to the side of road. Watch for wildlife. Call km boards on the radio while traveling in both directions. Use caution in high flow times. Use caution in freezing conditions as ice can build up – may need swing sampler in these conditions. Follow working in/near water procedures.	This site was established to monitor WQ below the canyon. As Hazeltine Creek remediation continues there are opportunities to monitor the effect of remediation on the creek.

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
HAC-10 Hazeltine Creek	E 595793 N 5820738	2015	Upper Hazeltine Creek monitoring site just downstream of Polley Lake weir.	Travel as described above to H4. Sample location is just downstream of Polley lake weir, from a large rock on the west side bank.	Use caution when driving on haul roads, radio contact the Pit Shifter before entering area. Give the right-of-way to heavy equipment and used 2-way radio communication. Watch for wildlife. Use caution in high flow times and winter conditions. Follow working in/near water procedures.	Monitor the surface WQ of Polley Lake as the water flows out of the lake and into Hazeltine Creek. The data from this site provides quick feedback on important parameters for fish habitat in the creek (pH, DO, and temperature).
HAC-12 Hazeltine Creek upper settling pond	E 601577 N 5817292	2015	Lower Hazeltine Creek monitoring site at diffuser pipes in upper settling pond.	Travel as described above to H2, but drive approx. 500 m past it towards Quesnel Lake. Site is marked with two curved pipes sticking out of the ground.	Park vehicle to the side of road. Watch for wildlife. Call km boards on the radio while traveling in both directions. Use caution in high flow times and icy conditions as ice can build up on edges. Follow working in/near water procedures.	This site currently monitors the quality of the mixture of effluent discharge and Hazeltine Creek water prior to the outflow to Quesnel Lake – when discharging. Site will be removed from the sampling program once discharge pipeline is complete.
HAC-01c Hazeltine Creek outflow	E 601661 N 5817598	2015	Hazeltine Creek outflow to Quesnel Lake.	Travel as described to HAC-12, and then drive towards Quesnel Lake. Monitoring Site is located at the outflow of Hazeltine Creek into Quesnel Lake.	Park vehicle to the side of road. Watch for wildlife. Call km boards on the radio while traveling in both directions. Use caution in high flow times and icy conditions as ice can build up on edges. Follow working in/near water procedures.	Monitor WQ at the mouth Hazeltine creek at Quesnel lake once the discharge pipeline is complete. It will replace HAC-12 as the outflow site when it is removed from the sampling program.
HAC-14 Hazeltine Creek	E 598742 N 5817299	2017	Mid Hazeltine Creek monitoring site above the canyon.	Drive as described to H1, but continue down Gavin Lake road to approx. km 5.5 and turn right on the creek access road. Continue on road for approx. 2 km and turn right at the second road on the right hand side. Monitoring site is located at the bottom of the ramp marked by a red and white stripped flagging tape.	Use caution when driving on haul roads, radio contact the Pit Shifter before entering area. Give the right-of-way to heavy equipment and used 2-way radio communication. Watch for wildlife. Use caution in high flow times and winter conditions as ice can build up on edges of creek. May need snowshoes in winter. Follow working in/near water procedures.	Monitor WQ of Hazeltine creek above the canyon.
POF-5 Polley Flats	E 595682 N 5820174	2017	Drainage from Polley Flats into Hazeltine Creek	Drive as described to HAC-10. Just before the weir, turn right and follow road to the end. Site is on the left hand side towards Hazeltine Creek and is marked with an orange stake at the outflow to Hazeltine Creek.	Use caution when driving on haul roads, radio contact the Pit Shifter before entering area. Give the right-of-way to heavy equipment and used 2-way radio communication. Watch for wildlife. Use caution in high flow times and winter conditions. Follow working in/near water procedures.	Monitor WQ of the drainage from the Polley Flats.

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
EDC-01 Edney Creek	E 601811 N 5817445	2015	Lower Edney Creek Sample site approx. 20 m upstream of the flood channel.	Follow travel instructions as described above to H3. Follow Edney Creek downstream towards Quesnel Lake and the monitoring location is approx. 20 m upstream from the flood channel.	Park vehicle to the side of road. Watch footing over loose rocks to the creek. Use caution in high flow times and freezing conditions as ice can build up on edges of creek. Watch for wildlife. Follow working in/near water procedures.	Monitor WQ of Edney Creek post reclamation of the lower section and its input to Quesnel Lake.
B1 Bootjack Lake	E 590049 N 5823528	2001/2007	Bootjack lake north WQ monitoring site	Drive on the Bootjack Forest service road to the Bootjack lake campsite at km 8 on the access road.	Follow Safe Boating SOP. Contact Pit Shifter and Front Gate person when leaving mine site. Call kms on Channel RR-25 on the Bootjack FSR. Watch for wildlife. Follow working in/near water procedures.	Monitor WQ for potential mine influence in Bootjack Lake.
B2 Bootjack Lake	E 591263 N 5821647	2001/2007	Bootjack Lake south WQ monitoring site	Drive on the Bootjack Forest service road to the Bootjack lake campsite at km 8 on the access road.	Follow Safe Boating SOP. Contact Pit Shifter and Front Gate person when leaving mine site. Call kms on Channel RR-25 on the Bootjack FSR. Watch for wildlife. Follow working in/near water procedures.	Monitor water WQ for potential mine influence in Bootjack Lake
P1 Polley Lake	E 593708 N 5824693	2001/2007	Polley Lake north WQ monitoring site	Drive down the TSF haul road to Central collection sump near corner 1. Turn left as if going to the central collection sump but then drive approx. 500 m and then turn right onto Polley lake boat launch.	Follow Safe Boating SOP. Contact the Pit Shifter prior to traveling on Haul roads. Use caution on Haul roads, give the right-of-way to heavy equipment and use 2-way radio communication. Watch for wildlife. Follow working in/near water procedures.	Monitor WQ water quality for potential mine influence in Polley Lake
P2 Polley Lake	E 595348 N 5821863	2001/2007	Polley Lake south WQ monitoring site	Drive down the TSF haul road to Central collection sump near corner 1. Turn left as if going to the central collection sump but then drive approx. 500 m and then turn right onto Polley lake boat launch.	Follow Safe Boating SOP. Contact the Pit Shifter prior to traveling on Haul roads. Use caution on Haul roads, give the right-of-way to heavy equipment and use 2-way radio communication. Watch for wildlife. Follow working in/near water procedures.	Monitor WQ for potential mine influence in Polley Lake
QUR-11 Quesnel River	E 596625 N 5830438	2016	Quesnel River WQ monitoring site at Likely Bridge	Drive on the Likely Highway towards the town of Likely, approx. 30 km from the Bootjack Forest service road. Park in the pullout just before the bridge. Collect water from the bridge using the Kemmerer sampler. Monitoring site is indicated by darker brown coloured post in the middle of the bridge.	Wear reflective PPE, watch for traffic. Use caution in the winter as bridge can get slippery.	This site was established to mirror the Federal Provincial Monitoring site for the outlet of Quesnel Lake that is funded by MPMC. Monitor WQ in Quesnel River.
QUL-2a Quesnel Lake	E 607988 N 5817214	2014	Quesnel Lake post-breach and effluent discharge monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor WQ upstream of diffuser ports in Quesnel Lake.
QUL-120a Quesnel Lake	E 618271 N 5818030	2014	Quesnel Lake background WQ monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor Quesnel Lake WQ at background site.

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
QUL-18 Quesnel Lake	E 600795 N 5819749	2014	Quesnel Lake post-breach and effluent discharge monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor WQ downstream of diffuser ports in Quesnel Lake
QUL-58 Quesnel Lake	E 601791 N 5818025	2015	Quesnel Lake effluent discharge monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor the initial dilution zone of the effluent plume in Quesnel Lake. Default WQ monitoring site when not discharging.
QUL-ZOO-1 Quesnel Lake	E 601058 N 5819925	2015	Quesnel Lake zooplankton and WQ monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor WQ and zooplankton community and tissue in the West Basin of Quesnel Lake.
QUL-ZOO-7 Quesnel Lake	E 612469 N 5816656	2015	Quesnel Lake zooplankton and WQ monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor WQ and zooplankton community and tissue near Horsefly River in Quesnel Lake.
QUL-ZOO-8 Quesnel Lake	E 630691 N 5821991	2014	Quesnel Lake zooplankton and WQ monitoring site.	Quesnel Lake is accessed via the boat launch near the effluent discharge (see access description for HAC-12), at Mitchell Bay, or at Cedar Creek (Likely).	Follow Safe Boating SOP. Call the Pit Shifter and Front Gate person when leaving mine site. Use caution when hauling the boat. Watch for wildlife.	Monitor WQ and zooplankton community and tissue background in Quesnel Lake.
Weather Station #1	E 592792 N 5823182	2012	HOBO weather monitoring station.	Drive along the Wight Pit Haul road and turn left onto the road to the Leach Pad. Park beside the leach pad and walk up the grassy hill between the sulphur pile and the research tree plots. Weather station is located at the top of the hill.	Call the Pit Shifter prior to traveling on Haul roads. Give right-of-way to heavy equipment. Watch for wildlife. Use caution near sulphur pile and watch footing walking up hill. Snowshoes may be required in winter.	Monitor wind speed/gust/direction, rain, solar radiation, and min/mean/max temperature continuously for water balance monitoring on site.
Weather Station #2	E 591092 N 5819976	2012	HOBO weather monitoring station.	Drive along light duty road towards the Orica site. Drive up the Orica site road (approx. 30 m) and park slightly off the road as to not block access. The Weather Station is located on top of a small hill on the right hand side of the road.	Call the Pit Shifter prior to traveling on Haul roads. Give right-of-way to heavy equipment. Watch for wildlife. Watch footing walking up hill.	Monitor wind speed/gust/direction, rain, solar radiation, and min/mean/max temperature continuously for water balance monitoring on site.
Snow Course Site: Weather Stn #1	E 592792 N 5823182	1997	Snow course monitoring site.	Follow instructions as described above for Weather Station #1.	Call the Pit Shifter prior to traveling on Haul roads. Give right-of-way to heavy equipment. Use caution when driving in winter conditions. Watch for wildlife. Use caution near sulphur pile and watch footing walking up hill. Snowshoes may be required.	Monitor snowpack-water equivalent for water balance monitoring on site.
Snow Course Site: JCP	E 593632 N 5823895	2012	Snow course monitoring site.	Drive along Wight Pit haul road towards the Wight Pit. Turn right at the third road on the right hand side. Drive up to stream crossing. May need to walk in snowy conditions approx. 100 m to clearing on the left hand side. Snowpack course site is in that clearing.	Call Pit Shifter prior to traveling on haul roads and give right-of-way to heavy equipment. Used Caution when driving in winter conditions. Watch for wildlife. Snowshoes may be required.	Monitor snowpack-water equivalent for water balance monitoring on site.
Snow Course Site: TSF	E 594092	1997	Snow course monitoring site.	Drive as described above to Weather Station #2, but instead of turning at the Orica site, drive past it	Call Pit Shifter prior to traveling on haul roads and give right-of-way to heavy equipment. Used	Monitor snowpack-water equivalent for water balance monitoring on site.

Sampling Site	UTM	Monitored Since	Site Description	Site Location	Access or Safety Concerns	Rationale for Monitoring
	N 5819976			approx. 100 m. Pull over to side of road when a small clearing in the trees is reached on the right hand side. A ditch indicates the site.	Caution when driving in winter conditions. Watch for wildlife. Snowshoes may be required.	
Snow Course Site: PAG	E 590835 N 5823537	2015	Snow course monitoring site.	Drive along haul road towards the PAG dump. Take the small ramp on the left hand side towards the 9k sump. Drive to the NW sump. Site is located up ramp beside the sump.	Call Pit Shifter prior to traveling on haul roads and give right-of-way to heavy equipment. Used Caution when driving in winter conditions. Watch for wildlife. Snowshoes may be required.	Monitor snowpack-water equivalent for water balance monitoring on site.

Notes:
POI – Parameters of Interest
TSF – Tailings Storage Facility
TAR – Tailings Access Road
WQ – Water Quality

Appendix E

Declaration of Competency Forms

Ministry of
Environment and
Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

This declaration of competency is collected for the purposes of increasing government transparency and ensuring professional ethics and accountability. It will be disclosed to the public.

1. Name of Qualified Professional BARBARA WERNICK

   Title SENIOR ENVIRONMENTAL SCIENTIST

2. Are you a registered member of a professional association in B.C.? ☑ Yes ☐ No

   Name of Association: COLLEGE OF APPLIED BIOLOGY (# 1171)

3. Brief description of professional services:

   DEVELOPMENT OF APPROACH TO SELECTION OF REFERENCE LAKES, SUMMARIES OF AMPHIBIAN & TERRESTRIAL STUDY COMPONENTS

Declaration

I declare that I am a qualified professional with the required knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

x BWernick

Print Name: BARBARA WERNICK

Witnessed by:

x L. Nikl

Print Name: Lee Nikl

Date signed: 30 OCTOBER 2019

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably by relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA

Ministry of
Environment and
Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Blair McDonald

   Title Associate, Senior Environmental Scientist

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: College of Applied Biology Registration # 1528

3. Brief description of professional services:

   Environmental toxicology and ecological risk assessment

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X [signature]

Print Name: Blair McDonald

Witnessed by:

X [signature]

Print Name: NEIL McQUITTY

Date signed: 29 Oct 19

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Pierre Stecko

   Title Senior Aquatic Scientist

2. Are you a registered member of a professional association in B.C.? ☑ Yes ☐ No

   Name of Association: College of Applied Biology Registration # 1709

3. Brief description of professional services:

   Aquatic environmental assessment, water quality, sediment quality, aquatic ecotoxicology

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X 

Print Name: Pierre Stecko

Date signed: October 24 '19

Witnessed by:

X K Batchelar

Print Name: Katharina Batchelar

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

Ministry of Environment and Climate Change Strategy

BRITISH COLUMBIA

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional Katharina Batchelar

   Title Aquatic Scientist

2. Are you a registered member of a professional association in B.C.? ☑ Yes ☐ No

   Name of Association: College of Applied Biology Registration # 3103

3. Brief description of professional services:

   Aquatic ecotoxicology, aquatic environmental monitoring, sediment quality, metal toxicology

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature:

X K Batchelar

Print Name: Katharina Batchelar

Witnessed by:

X

Print Name: Pierre Stecko

Date signed: October 24, 2019

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

a) *is registered in British Columbia with a professional association, is acting under that organization's code of ethics, and is subject to disciplinary action by that association, and*

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

February 1, 2020

Tracking Number: 375053
Authorization Number: 11678

REGISTERED MAIL

MOUNT POLLEY MINING CORPORATION
SUITE 200
580 HORNBY ST
VANCOUVER, BC
V6C 3B6

Dear Permittee:

Enclosed is Amended Permit 11678 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the permit. An annual fee will be determined according to the Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. This permit is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with Section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the permittee to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties and comply with other applicable legislation that may be in force.

In the event that a reportable spill occurs, or there is an imminent risk of one occurring, the responsible person must ensure that it is reported in accordance with the Spill Reporting Regulation. Additional information on spill reporting requirements is available at gov.bc.ca/reportaspill

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this permit will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Plans, data and reports pertinent to the permit are to be submitted by email or electronic transfer to the Director, designated Officer, or as further instructed.

Ministry of Environment and Climate Change Strategy
Environmental Protection Division
Suite 400 – 640 Borland Street
Williams Lake BC V2G 4T1
Mining Operations
Telephone: (250) 398-4530
Facsimile: (250) 398-4214

For more information about how the Ministry will assesses compliance with your permit please refer to gov.bc.ca/environmentalcompliance.

For more information about how to make changes to your permit and to access waste discharge amendment forms and guidance, please refer to gov.bc.ca/wastedischarge-authorizations.

Yours truly,



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

**MINISTRY OF ENVIRONMENT
AND CLIMATE CHANGE
STRATEGY**

PERMIT

11678

Under the Provisions of the Environmental Management Act

MOUNT POLLEY MINING CORPORATION

**SUITE 200
580 HORNBY ST
VANCOUVER, BC
V6C 3B6**

is authorized to discharge effluent to land and surface water from a copper-gold mine and mill complex located near Likely, British Columbia, subject to the requirements listed below.

Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

This Authorization supersedes and replaces all previous versions of Permit 11678 issued under Section 14 of the Environmental Management Act.

1. AUTHORIZED DISCHARGES

1.1 Discharges to Tailings Storage Facility

This section applies to the discharge of effluent from a Copper-Gold Mine and Ore Concentrator to the tailings storage facility. The site reference number for this discharge is E225309.

1.1.1 The monthly average rate of discharge of tailings slurry is 55,500 cubic metres per day.

1.1.2 The authorized discharge period is continuous.

1.1.3 The characteristics of the discharge must be typical of concentrator tailings from the milling of ore or metal contaminated soil, mill site runoff, rock disposal site runoff, open pit water, and septic tank effluent from a copper-gold mine and mill complex.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

1.1.4 The authorized Works are the following; a septic tank, tailings discharge line, open pits, tailings storage facility, water treatment and discharge system, seepage collection and recycle system, surface water collection works, tailings supernatant recycle systems; sediment pond(s) and related appurtenances approximately located as shown on the attached Site Plan A.

1.1.5 The location of the facilities from which the discharge originates is within Mineral Leases No. 345731, No. 410495, No. 524068, No. 573346, No. 933970, and No. 933989 as well as Mineral Claims No. CB16 204475, No. PM5 206540, No. POL2 411010, No. 514039, and No. 514044, Cariboo Mining Division, Cariboo Land District.

1.1.6 The location of the point of discharge (tailings storage facility) is on Mineral Claim No. 514039, Cariboo Mining Division, Cariboo Land District.

1.2 Mine Site Runoff and Seepage

This section applies to the discharge of treated effluent from the site runoff and seepage water collection and management systems to Quesnel Lake as sampled at the Treatment Plant Outlet (HAD-03). The site reference for this discharge is E304230.

1.2.1 The authorized annual average rate of discharge is 29,000 m^3/day.

1.2.2 The maximum rate of discharge is 52,000 m^3/day.

1.2.3 The discharge period is authorized until December 31, 2022.

1.2.4 The characteristics of the discharge at the treatment plant outlet must be equivalent to or less than the values specified below in column 2 of Table 1 below.

1.2.5 The Annual Discharge Plan required under section 2.6 must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake as specified below in Table 1 below.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

Table 1

Parameter	**Treatment Plant Outlet** (1)	**Edge of Quesnel Lake IDZ** (1)(2)(3)
Rainbow Trout 96hrLC50	50 % Mortality in 100% effluent	-
Daphnia Magna 48hrLC50	50 % Mortality in 100% effluent	-
pH	< 9.5 and >6.0 pH units	-
Total Suspended Solids	30 mg/L, and 15 mg/L Monthly Average	-
Total Sulfate	1,100 mg/L	218 mg/L
Total Ammonia (as N)	1.3 mg/L	0.18 mg/l as N
Total Nitrate (as N)	34.0 mg/L	3.0 mg/l as N
Total Nitrite (as N)	0.78 mg/L	0.02 mg/L as N
Total Phosphorus	90.0 µg/L	10.0 µg/L
Fluoride	17.0 mg/L	1.0 mg/L
Total Arsenic	28 µg/L	5.0 µg/L
Total Chromium	4 µg/L	1 µg/L
Total Copper	33 µg/L	2.2 µg/L (30-day rolling average)
Total Iron	1.0 mg/L	1.0 mg/L
Dissolved Iron	0.35 mg/L	0.35 mg/L
Total Manganese	3.4 mg/L	0.84 mg/L
Total Molybdenum	0.36 mg/L	0.05 mg/L
Total Silver	0.24 µg/L	0.05 µg/L
Total Selenium	75 µg/L	2 µg/L
Total Zinc	59 µg/L	7.5 µg/L
Dissolved Aluminum	0.75 mg/L	0.05 mg/L

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

Dissolved Cadmium	0.34 µg/L	0.13 µg/L

(1) All values are maximum values from grab samples unless otherwise specified.

(2) Only applies while discharging directly to Quesnel Lake.

(3) The "Edge of Quesnel Lake IDZ" is a point located 100m from the Quesnel Lake outfall, represented by site QUL-58 mid and/or near bottom samples, or alternative location approved by the Director.

1.2.6 The Permittee must implement the response steps set out in the approved trigger response plan under section 2.6 (5) without delay if either:

(a) The effluent monitoring at the outlet of the treatment plant indicates that trigger levels set out in the approved trigger response plan are reached for any parameter set out in Table 1 above; or,

(b) An objective set for the Edge of Quesnel Lake IDZ in Table 1 above is exceeded, or is predicted to be exceeded, as determined in accordance with procedures in the approved trigger response plan.

Where the Permittee must cease discharging, the discharge may resume only in accordance with the approved trigger response plan. The requirement to implement the trigger response plan does not authorize an exceedance of the maximum values specified in section 1.2.4 for the characteristics of the discharge at the outlet of the treatment plant.

1.2.7 The discharge is authorized from the Authorized Works, which are the settling pond(s), tailings storage facility, mine contact water collection system, the Veolia Actiflo treatment system, flow control valve(s), continuous flow meter, pipeline and outfall system and associated appurtenances as generally shown in the attached Site Plans.

1.2.8 The location of the facilities from which the discharge originates is the same as in section 1.1.5 above.

1.2.9 The location of the discharge is the Quesnel Lake outfall at a point within Mineral Claim No. 501479 when discharging to Quesnel Lake.

1.3. Springer Pit Discharge to Ground

This section applies to the discharge of seepage water from Springer Pit to Ground. The site reference for this discharge is E307887.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

1.3.1. The Permittee must maintain Springer Pit water levels at less than 1025 meters above sea level (masl) to limit seepage towards Bootjack Lake.

1.3.2. The characteristics of the discharge are typical site runoff and seepage water.

1.3.3. The authorized works are Springer Pit, and its associated water management works and related appurtenances.

1.3.4. The location of the facilities from which the discharge originates and the point of discharge are as shown in the attached Site Plan A.

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works and Emergency Procedures

2.1.1. The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the Permittee which prevents effective operation of the authorized works or leads to an unauthorized discharge, the Permittee must take appropriate remedial action and notify the Director immediately. The Director may require the Permittee to reduce or suspend operations to protect the environment until the authorized works have been restored, and/or corrective steps taken to prevent unauthorized discharges.

2.1.2. All ponds, ditching, and other runoff or seepage collection and diversion works must be inspected at least twice per year, once in the spring after freshet and once in the fall before freeze-up. Records of these inspections must be maintained and made available for inspection by an Officer immediately upon request.

2.1.3. The authorized works must be complete and in operation while discharging.

2.2. Bypasses

Any bypass of the authorized works is prohibited unless prior approval of the Director is obtained and confirmed in writing.

2.3. Process Modifications

The Director must be notified prior to implementing changes to any process that may adversely affect the quality and/or quantity of the authorized discharges. Despite notification under this section, permitted levels must not be exceeded.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

2.4. Surface Runoff and Mine Drainage Control

2.4.1. Unless required for operational purposes, surface runoff from undisturbed areas and groundwater pumped from up gradient of pits or other undisturbed areas, must be diverted so that it does not flow to the tailings impoundment, or to the mine and mill areas.

2.4.2. Seepage and runoff from the open pits, rock disposal sites, and from down gradient of the tailings storage facility must be collected and conveyed to treatment works, the tailings storage facility, mill or open pits.

2.4.3. Inactive open pits may be used for storage of mine water, tailings storage facility supernatant or mill site runoff, provided records of volumes transferred to any pit are maintained and reported quarterly.

2.4.4. Recycling of on-site water and evaporation enhancing techniques must be practiced.

2.4.5. Surface water control works must be provided for all areas disturbed by roads, open pits, rock disposal/storage sites, the mill site and ore storage sites. The surface water control works must convey all flows up to a 1 in 10 year 24-hour storm event and must withstand all flows up to a 1 in 200 year 24-hour storm event, without significant damage.

2.4.6. The tailings storage facility must provide adequate storage, beach width and freeboard as required by Mines Act Permit M-200. All other effluent storage ponds, seepage ponds, and surface runoff ponds must provide at least 0.5 meters of freeboard.

2.4.7 Freeboard is defined as the difference in elevation between the contained liquid level and the top of the berm structure at its lowest point. The lowest point does not include a spillway where a discharge is authorized or where the supernatant over flows to a downstream collection pond that is part of the authorized works.

2.4.8. The Permittee must maintain and implement an Erosion and Sediment Control Plan developed by a qualified professional that will prevent sedimentation of watercourses during construction and operation of any mine structures or facilities. The Director may specify and require implementation of additional measures to prevent sedimentation of watercourses caused by construction or operational activity at the site.

2.5. Environmental Emergency Response Plan

2.5.1. The Permittee must maintain and implement an up to date Environmental Emergency Response Plan by January 31st of each year. The Environmental Emergency Response Plan must include all of the following:

(a) adequate procedures for responding to all probable environmental emergencies, including spills,

(b) permit exceedances associated with the Mount Polley Mine operations and mine site area,

(c) procedures for the suspension of the effluent discharge to Quesnel Lake.

(d) A notification protocol for immediate advising the Soda Creek Indian Band, the Williams Lake Indian Band, the Cariboo Regional District, and the community of Likely of significant emergency events, and permit exceedances at the mine site.

2.5.2. The Permittee must ensure mine personnel are trained on the contents of the Emergency Response Plan and is reviewed annually.

2.6. Annual Discharge Plan

2.6.1. The Permittee must maintain and implement an Annual Discharge Plan approved by the Director for the discharge authorised in section 1.2 above. The plan must include the following:

(a) An outline of the expected volume, timing, and duration of effluent released to Quesnel Lake;

(b) Consideration and account of hydrology and snowpack information, mine water balance information, Polley Lake discharge control, and background water quality information;

(c) Demonstrate how the objectives, set out in column 3 of Table 1 above, will be met at the Edge of Quesnel Lake IDZ in Quesnel Lake;

(d) A maximum turbidity target(s), as measured at the outlet of the treatment plant, which requires immediate reporting to the Director should the turbidity target(s) be exceeded for longer than one hour in duration;

(e) A trigger response plan for treatment system shutdown(s), and/or for suspension or reduction of discharge, and for the resumption of the discharge, if the effluent discharge limits at the outlet of the

treatment plant cannot be met, or if an objective for the Edge of Quesnel Lake IDZ in Quesnel Lake cannot be met;

(f) Identification of the sources of mine water and the percent of each source in the total effluent discharge for each day;

(g) Demonstrate how the discharge will be managed to minimize suspended solids deposition into Quesnel Lake; and,

(h) Identification of equipment, including calibration and maintenance schedules related to continuous measurements of flow, turbidity, specific conductance and temperature.

2.6.2 The Annual Discharge Plan must be reviewed at least once each year, and any necessary updates to the plan must be submitted to the Director for approval at least 30 days prior to adoption.

2.7. Nitrogen Management Plan

The Permittee must maintain and implement a Nitrogen Management Plan developed by a Qualified Professional. The plan must describe measures that prevent the loss of nitrogen species into the environment arising from the use of explosives and handling of waste rock. Any update to the plan must be provided to the Director within 30 days of implementation.

2.8. Water Treatment and Discharge Program

The Permittee must undertake a program to develop passive and semi-passive water treatment options necessary for distributed discharges across the mine site without the use of the Quesnel Lake outfall and to reduce the contaminant levels during and after mine operation. The water treatment and discharge program must include all mine site water treatment works and source control optimization activities which includes the following:

2.8.1. Best Achievable Technology (BAT) Assessment

(a) The Permittee must undertake a BAT assessment when developing treatment technologies for consideration in the water treatment and discharge program.

(b) The Permittee must undertake a BAT assessment when developing bench and pilot scale testing of potential alternative treatment technologies to inform the 2022 Water Management Plan required by Section 2.10.

(c) The Permittee must submit to the Director for approval by January 31st of each year a study plan that details bench and pilot scale testing and other BAT assessment planned for the year. The BAT assessments must be implemented without delay.

2.8.2. Water Treatment Plant Optimization

The Permittee must operate the Veolia Actiflo Water Treatment Plant (WTP) to remove contaminants present in the mine site contact water to meet the discharge requirements of Section 1.2.4.

(a) "Numeric Performance Metric" (NPM) means a measurable value that quantifies the outcome or result of water treatment and the ability of the treatment to remove specified chemical constituent. It forms the basis for a numeric comparison of untreated water, to water that has been treated by the treatment system.

(b) The Permittee must optimize and operate the treatment plant in a manner to target achievement of any prescribed NPM. The stated NPM target value represents operation that achieves average effluent quality that is at or below any specified NPM. Assessment of the attainment of NPM values must be included in the optimization update progress report. If the effluent quality does not achieve an NPM value specified by the Director, the Permittee must identify the reason and propose and implement without delay response actions to achieve the target value including treatment plant optimization and/or source control and/or water management improvements.

The following NPM is established:

Total copper 12 ug/L

(c) Based on the progress reports and any other relevant information available, the Director may amend or specify additional NPM that are suitable for evaluating the effectiveness of removal of parameters of potential concern by the WTP.

2.8.3. Source Control Optimization

The Permittee must undertake ongoing maintenance and surveillance of on-site water management systems and activities undertaken to increase source control of any potential contaminants of concern.

(a) The Permittee must undertake source control optimization yearly.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

(b) The Permittee must undertake an analysis of the treatment plant effluent to determine selenium species present and at a minimum determine the typical proportion of total selenium that is selenate, selenite, and organoselenium. Based on these results the Director may require additional analysis for selenium speciation of mine source waters.

2.8.4. Review of Discharge Alternatives

The Permittee must review discharge alternatives for direct discharge of treated mine water on and around the mine site including consideration of physical (geomorphological and hydrological), chemical, and biological characteristics of potential receiving environments. The Permittee must ensure the proposed discharge locations have the capacity to receive the additional discharges of treated water and meet applicable environmental benchmarks.

2.9. Water Management Progress Reporting

The Permittee must report on all aspects of Section 2.8 every 6 months, beginning June 30, 2020 and continuing until such time as the Director deems the reporting no longer required. The reporting is to include, but is not limited to, the results of all BAT assessments, bench and pilot testing of treatment systems, optimization studies, discussion of proposed discharge locations that have the capacity to receive the treated water and changes from the previous progress reports and any other studies related to the Water Treatment and Discharge Program outlined in section 2.8. The reporting out must include documentation that the testing and piloting programs are relevant for all the different types of mine influenced water on site and for the 2022 Water Management Plan needs.

2.10. The 2022 Water Management Plan

The Permittee must submit a revised water management plan (the "2022 Water Management Plan") and an implementation schedule to the Director for approval prior to December 1st, 2020, outlining the water management and treatment options informed by the requirements in Section 2.8 and the most recent Reclamation and Closure Plan for the site. The 2022 Water Management Plan must address water discharge plans from December 31, 2022 onward.

The 2022 Water Management Plan must meet all of the following requirements:

(a) Provide for the full treatment and/or management of 1 in 10 wet year flows, including the associated freshet flows for all mine influenced water sources on site that do not meet Water Quality Guidelines, once the works are fully complete, without requiring the use of the Quesnel Lake outfall.

(b) Include all the essential information necessary for review and support of the final design, assessing its expected performance and the impacts of the discharge(s) on the receiving environment.

(c) A review of discharge alternatives including assessment of physical (geomorphological and hydrological), chemical and biological assessment of potential receiving environments for direct discharge of treated water on and around the mine site. The Permittee must ensure the proposed discharge locations have the capacity to receive the additional discharges of treated water.

(d) Detailed bench scale, and pilot scale results for all the proposed works. Performance assurances from vendors for active treatment systems may also be considered in lieu of pilot scale tests.

(e) Discussion and documentation of the ability and/or design criteria necessary, for the works to treat all contaminants known to be above all relevant BC Water Quality Criteria at the edge of the IDZ to levels below appropriate water quality guidelines where possible.

(f) Discussion of how all the bench and pilot system findings, and/or other performance assurances have been incorporated into the final design of the individual components and/or the system as a whole to assure discharge standards and/or B.C. Water Quality Criteria at the edge of any IDZ is met.

(g) A siting map and implementation plan for commissioning of all works necessary for full scale operations. Siting must also allow for potential future mining operations or ongoing mining operations to take place.

(h) An updated and refined water balance and water quality model acceptable to the Director, with appropriate sensitivity analyses for both onsite and receiving waters, which predicts the impacts to the receiving environment. The water quality model must use updated site monitoring data to demonstrate how well the model is calibrated to observed site conditions.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

(i) The plan must be prepared by a Qualified Professional.

(j) The Permittee must implement the approved 2022 Water Management Plan according to the approved implementation schedule.

(k) Any updates to the 2022 Water Management Plan or the implementation schedule must be approved by the Director prior to their implementation.

2.11. Communication Plan

The Permittee must maintain and implement the Communication Plan dated March 20, 2016. The Communication Plan must demonstrate the sharing of environmental data with the Soda Creek Indian Band, the Williams Lake Indian Band, the Cariboo Regional District, and the Community of Likely. Any changes to the communication plan must be discussed with the Public Liaison Committee and submitted to the Director prior to adoption.

2.12. Public Liaison Committee

2.12.1. The Permittee must maintain a Public Liaison Committee (PLC), in accordance with the approved Terms of Reference dated November 21, 2018. The Permittee must submit any Terms of Reference updates to the Director for approval 30 days prior to adopting them.

2.12.2. The Committee must meet at least quarterly to share and receive information about mine activities and the results of monitoring programs with interested members of the public, the Soda Creek Indian Band, the Williams Lake Indian Band, and regulating agencies.

2.13. Posting of Security

The Permittee must maintain a Reclamation Security as required by *Mines Act* Permit M-200.

2.14. Metal Contaminated Soil Milling

Tailings from the processing of metal contaminated soils in the mill from off mine site sources may be discharged to the tailings storage facility subject to all the following:

(a) The soils must be contaminated only with metals.
(b) The Permittee must notify the Director 14 days prior to receiving these materials at the mine site and provide results of chemical analysis of the material at the time of notification.
(c) Records of the volumes processed must be maintained and reported as part

of the annual reporting requirements.

2.15. Qualified Professionals

All documents submitted to the Director must be signed by the author and where specifically required by this permit, authored and signed by a Qualified Professional.

A “Qualified Professional" means an applied scientist or technologist specializing in an applied science or technology applicable to the duty or function, including, if applicable and without limiting this, agrology, biology, chemistry, engineering, geology or hydrogeology and who:

(a) is registered with the appropriate professional organization, is acting under that organization's code of ethics and is subject to disciplinary action by that organization; and,

(b) through suitable education, experience, accreditation and/or knowledge, may be reasonably relied on to provide advice within their area of expertise.

3. MONITORING REQUIREMENTS

3.1. Springer-Cariboo Pit Hydrogeology Work Plan and Assessment

3.1.1. The Permittee must submit a summary, when requested by and to the satisfaction of the Director, all hydrogeological work that has been completed downgradient of the Springer Pit and Cariboo Pit relevant to the Springer Pit filling and drawdown. The summary must describe all monitoring, modelling, and drilling investigations, and must provide recommendations by a Qualified Professional for additional hydrogeological investigations required to manage water in the pits during any future refilling and for mine closure. Recommendations must consider ongoing collection of water quality and geology data as the mine advances, review of the groundwater monitoring network, and hydrogeological model refinements, as appropriate.

3.1.2. Based on the review of the summary, the Director may require additional hydrogeological investigation and assessment of the hydrogeology along the seepage path from the Springer-Cariboo Pit to Bootjack Lake. Any additional monitoring recommended in the summary of hydrogeological work or required by the Director must be incorporated into updates of the Comprehensive Environmental Monitoring Plan.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

3.1.3. The recommendations of the summary of hydrogeological work required above, and all ongoing hydrogeological data collected must be re-assessed as part of the annual reporting requirements under section 4.2 of this permit. This includes an annual update to the characterization of the groundwater system in the area between the pit and the lake, refinements and updates to the seepage model near the pit and reporting on the groundwater monitoring network near the pit.

3.1.4. In addition, updated results and interpretations of the Springer-Cariboo Pit Hydrogeology Assessment, including an updated calibration and verification of the seepage model near the pit, must be prepared by a Qualified Professional and must be submitted to the Director prior to any planned refilling of Springer Pit above 1025 masl.

3.2. Comprehensive Environmental Monitoring Plan

3.2.1. The Permittee must continue to develop, submit and implement an ongoing Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek, Edney Creek, Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake, Quesnel River, and associated riparian and upland areas.

3.2.2. An updated CEMP must be submitted to the Director for approval by March 31, 2020 and every three years thereafter.

3.2.3. The Permittee must undertake monitoring in accordance with the approved CEMP immediately following its approval.

3.2.4 The CEMP must meet all the following requirements:

(a) Consolidate and integrate all of the monitoring programs that are being conducted in the vicinity of the mine site and include, at minimum, surface water (quality and quantity), groundwater (characterization and interactions with surface water), sediments, soils, periphyton, phytoplankton, benthic invertebrates, zooplankton, fish, floodplain and upland vegetation, and wildlife.

(b) At a minimum address a three year time span.

(c) At a minimum include all sampling sites, frequency of sampling, variables to be analysed, method detection limits, sampling methods, sample analysis methods, and data analysis methods.

(d) The updated CEMP must be approved by the Director.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

3.2.5. The Permittee must provide all data and information collected under the CEMP to the Director, in electronic format, on a quarterly basis.

3.2.6. The Permittee must submit a three-year detailed monitoring program interpretive report to the Director by March 31, 2022, and every three years thereafter.

3.2.7. During the period of treated effluent discharge authorized by section 1.2 above, the Director may require expedited sampling, testing and reporting of treated effluent discharged during the spring freshet (March through July annually).

3.2.8. The Director may require revisions to the CEMP based on review of monitoring data and/or any other relevant information.

3.3. Effluent Toxicity Testing

Acute and chronic toxicity testing of discharges to Quesnel Lake authorized under section 1.2 of this permit must be conducted as follows:

Acute Bioassay	**Frequency**	**Source for Sample Collection**
96-hr LC50 Rainbow Trout	Monthly	HAD-03 - Effluent discharged to Quesnel Lake (E304230)
48-hr LC50 Daphnia magna	Monthly	HAD-03 - Effluent discharged to Quesnel Lake (E304230)
Chronic Bioassay	**Frequency**	**Source for Sample Collection**
7-day Ceriodaphnia dubia survival and reproduction, and 7-day ELS toxicity test with a salmonid fish and or other tests specified by the Director	Quarterly or as required by the approved CEMP	as specified in the approved CEMP when discharging direct to Quesnel Lake

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

3.4. Water Flow Measurement

3.4.1. The Permittee must provide and maintain suitable flow measuring devices and record staff gauge measurements, during open water, at surface water stations at W1B (Morehead Creek), W4A (North Dump Creek), W5 (Bootjack Creek) W12 (6K Creek), H1 (continuous, Upper Hazeltine Creek), H3 (Edney Creek), H4 (Polley Lake outlet) and H2 (continuous, Lower Hazeltine Creek), located approximately as shown on the attached Site Plan B, or at alternative monitoring stations satisfactory to the Director.

3.4.2. Springer Pit water level elevation shall be monitored and recorded on a monthly basis.

3.4.3. Staff gauge readings must be taken at the same time as stream flow measurements and/or water quality sampling are collected at the same or associated sites.

3.4.4. A stage discharge curve must be developed for all staff gauges.

3.4.5. All staff gauges and flow measuring devices must be checked and calibrated once per year, after June 15th but prior to August 31st of each calendar year.

3.5. Outfall and Pipeline Commissioning and Inspection

3.5.1. The Permittee must develop and implement a monthly visual inspection program for the pipeline from the Actiflo treatment plant to the outfall in Quesnel Lake. The monthly visual inspection program must include all of the following:

(a) The pipeline corridor must be visually inspected every month.

(b) Records of the monthly visual inspections must be made available for inspection by an Officer immediately upon request.

3.5.2. The Permittee must conduct a comprehensive annual inspection of the pipe line corridor by October 1st of each year.

3.5.3. The Permittee must conduct an underwater inspection of the diffusers every 5 years to ensure they remain in good working order.

3.5.4. An annual inspection report with recommended remedial actions must be prepared by a Qualified Professional and submitted to the Director within 60 days of completion of the comprehensive inspection.

3.5.5. The pipeline and outfall must have all the following signage:

(a) A sign must be maintained along the alignment of the outfall facing Quesnel Lake above the high water mark.

(b) Signs must identify the nature of works.

(c) Signs must be posted along the effluent pipeline right-of-way at points of public access to identify the right-of-way.

(d) All signs must include emergency contact information.

3.6. Climate Monitoring

The Permittee must maintain meteorological stations and measure continuous daily precipitation; daily maximum, minimum and mean temperature; and daily evaporation calculation or suitable alternative as approved by the Director. Climate Monitoring sites are as shown in Site Plan C.

3.7. Sampling and Analytical Procedures

3.7.1. The Permittee must carry out sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the Director.

3.7.2. The Permittee must carry out analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the Director.

Copies of the above manuals are available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual.

3.7.3. Bioassays must be conducted using the following methods:

(a) the "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout", Report EPS 1/RM/13 December 2000;

(b) the "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna", Reference Method EPS 1/RM/14 December 2000;

(c) the "Biological Test Method: Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout)", Report EPS 1/RM28, July 1998 - Embryo/Alevin;

(d) the "Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia", Report EPS l/RM/21, February 2007; or,

(e) by suitable alternative procedures as authorized by the Director.

3.8. Quality Assurance

3.8.1. The Permittee must maintain and implement a "Quality Assurance Manual" consistent with "British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples 2013 Edition (Permittee)", or most recent edition. The Permittee must ensure that all data submitted as a requirement of this permit is produced in accordance with the Quality Assurance Manual, that data is handled and reviewed in accordance with protocols established in the Manual and is accompanied by quality assurance data required by the Manual. The Permittee must provide the Director with any updates to this Manual within 30 days of adoption.

3.8.2. Analysis of samples for parameters designated under the Environmental Data Quality Assurance Regulation must be at a laboratory registered for the designated parameter under the Regulation. In addition, the Permittee must participate in quality assurance audits as required by the Regulation.

4. REPORTING

4.1. Routine Reporting

4.1.1. In each month that discharge occurs as authorized by section 1.2 above, the Permittee must submit a monthly report, suitably tabulated and formatted, to the Director summarizing:

(a) the volume of treated effluent discharged,

(b) a summary of continuous Turbidity readings of the treated effluent discharged, and

(c) the most recently available water quality results for the effluent discharged, including toxicity.

4.1.2. Each monthly report must be submitted within seven days of the end of previous month via email to EnvAuthorizationsReporting@gov.bc.ca. Each monthly report must also contain and present all data submitted in the previous 2 monthly reports in a manner that would identify potential trends.

4.1.3. Each monthly report must also be provided to the Williams Lake Indian Band and Xatsull First Nation and be made available to the Public Liaison Committee within 7 calendar days of the submission to the Ministry.

4.1.4. The Permittee must cause each data submission required by this Authorization to include a statement outlining the number of exceedances of permitted discharges that occurred during the reporting period, the dates of each such exceedance, an explanation as to the cause of the exceedances, and a description of the measures taken by the Permittee to rectify the cause of each such exceedance. If no exceedances occurred over the reporting period, the required statement may instead indicate that no exceedance of permitted discharges occurred during the reporting period.

4.1.5. The Permittee must submit all data required to be submitted under this section by email to the Ministry's Routine Environmental Reporting Submission Mailbox (RERSM) at envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the Director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox.

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

4.1.6. The Director may require modification to the monitoring program based on the evaluation of the monthly and annual reports and on any other information that pertains to the operations and or discharges.

4.1.7. The Permittee must upload monitoring data associated with this permit to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the three month period in which the data is collected.

4.2. Annual Report

4.2.1. The Permittee must also submit by March 31st of each year, a comprehensive annual report of all monitoring via email to the above email address, in a format suitable for public release. The annual report must include:

(a) all monitoring sample results required under the permit,

(b) an evaluation of quality assurance, including collection, sampling, and data handling protocols,

(c) an evaluation of the treatment plant operation and control,

(d) an evaluation of the impacts of the mining operation on the receiving environment from the previous year,

(e) a summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment,

(f) updates of the water balance, and a calibration assessment of the water balance and water quality models,

(g) assessment of the outfall dispersion and dispersion modelling for the Quesnel Lake discharge,

(h) an update to any modeling relating to the Springer Pit groundwater seepage and its impacts on Bootjack Lake as described in section 3.1,

(i) a progress update with respect to the 2022 Water Management Plan,

(j) a review and update of the assessment of acid rock drainage (ARD) potential and water quality impacts from mine waste management,

(k) a comparison of monitoring data with water quality guidelines, predictions and targets,

(l) an update on the progress of reclamation and any updates to the reclamation plan that impact on site water quality,

(m) an evaluation of the effectiveness of the Surface Runoff and Mine Drainage Control programs,

(n) a summary of the Public Liaison Committee meetings, including any issues and concerns presented,

(o) an evaluation of the Outfall and Pipeline Inspection program; and,

(p) trend analysis (graphs) of water monitoring data at each site for the past 5 years.

4.2.2. Monitoring data and the analysis of that data, as it will be presented in the annual report, must be reviewed by a third party Qualified Professional.

4.2.3. A groundwater monitoring program review, including but not limited to sampling, well locations, site water balance, interpretation of data trends and possible environmental impacts, and suitable recommendations, must be completed for the entire mine site at least every three years, with the next review required by March 31, 2022.

4.2.4. A copy of the annual report must be provided to the Williams Lake Indian Band and Xatsull First Nation within 30 days of the report being submitted to the Director.

4.3. Non-compliance Reporting

4.3.1. The Permittee must immediately notify the Director or designate of any noncompliance with the requirements of this Permit and take appropriate remedial action. Written confirmation of all non-compliance events, including available test results is required within 24 hours of the original notification unless otherwise directed by the Director.

4.3.2. Both the initial notice and the confirmation must also be emailed to EnvironmentalCompliance@gov.bc.ca.

4.3.3. Within 30 days of any non-compliant event, the Permittee must submit a follow-up report to the Director and the above mailbox that includes, but is not necessarily limited to the following:

(a) all relevant test results related to the non-compliance instance(s),

(b) an explanation of the most probable cause(s) of the noncompliance(s); and,

(c) remedial actions taken and planned to prevent similar noncompliance(s).

Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

4.4 **Reporting of Toxicity Failure**

4.4.1. The Permittee must immediately notify the Director of any toxicity failure according to the Non-Compliance Reporting requirements in Section 4.3. For the purpose of this section, a sample is considered to have failed the specific toxicity test if:

(a) 96-hr LC50 Rainbow Trout: Using 100% effluent concentration, more than 50% of the fish die within a 96 hour test period,

(b) 48-hr LC50 Daphnia magna: Using 100% effluent concentration, more than 50% of the organisms die within a 48 hour test period,

(c) 7-day Ceriodaphnia dubia reproduction: The water is determined to cause greater than 25% inhibition of survival and reproduction; or,

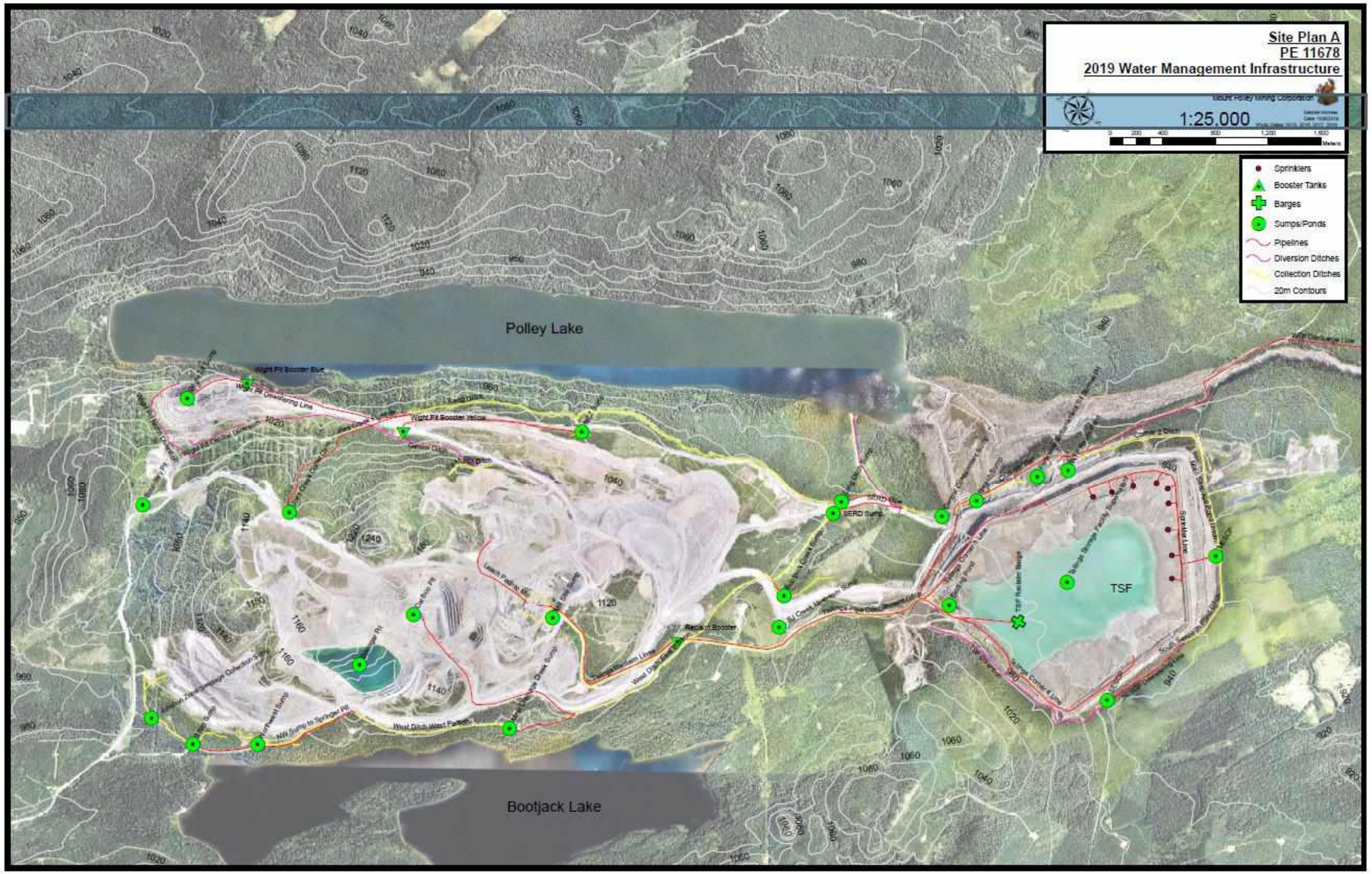
(d) 7-day ELS toxicity test with a salmonid fish: The water is determined to cause greater than 25% non-viable embryos.

4.4.2. The Permittee must investigate each toxicity failure to determine the cause(s). Reasonable efforts must be made to obtain preliminary and in progress results from the analytical laboratory during the toxicity testing. The Permittee must make immediate arrangements to retest in the event of potential and confirmed failures. The Director may require additional toxicity testing based on the evaluation of results from toxicity testing and the causes of failure.

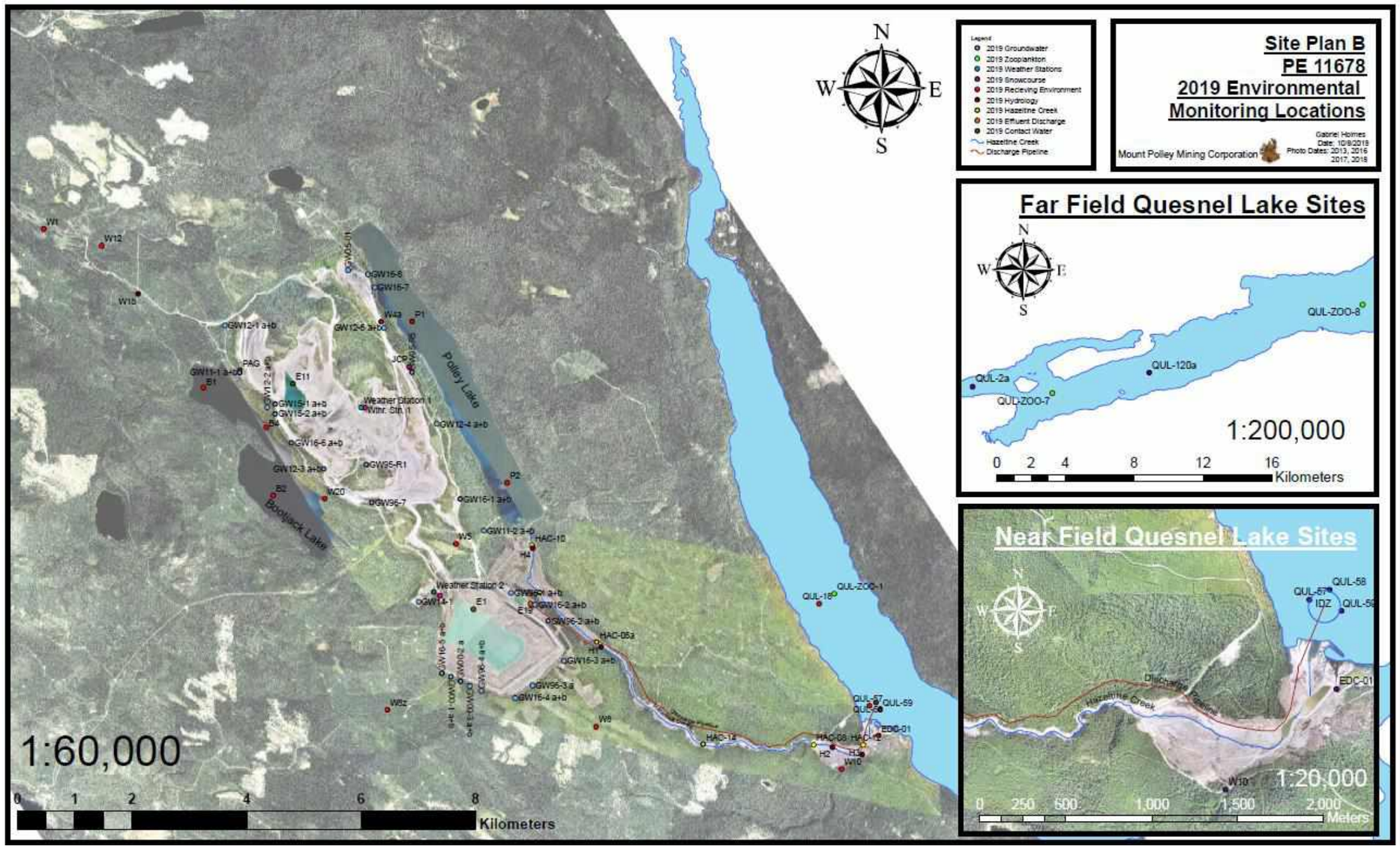
4.5. **Other Documents**

All documents to be submitted to the Director must be sent as a separate document and named according to the name listed in this permit.

Site Plan A – Water Management Works


Site Plan A
PE 11678
2019 Water Management Infrastructure
1:25,000
Sprinklers
Booster Tanks
Barges
Sumps/Ponds
Pipelines
Diversion Ditches
Collection Ditches
20m Contours
Polley Lake
Bootjack Lake
TSF
Wright Fit Booster Blue
Wright Fit Booster Yellow
Wright Fit Diversion Line
Wright Fit Channel Diversion
Wright Fit Diversion Ditch
Wright Fit Diversion Culvert
Wright Fit Sump
Wright Fit Sump to Springer Pit
Wright Fit Sump to Springer Pit Diversion Ditch
Springer Pit
Springer Pit Sump
Springer Pit Sump to Springer Pit Diversion Ditch
Springer Pit Diversion Culvert

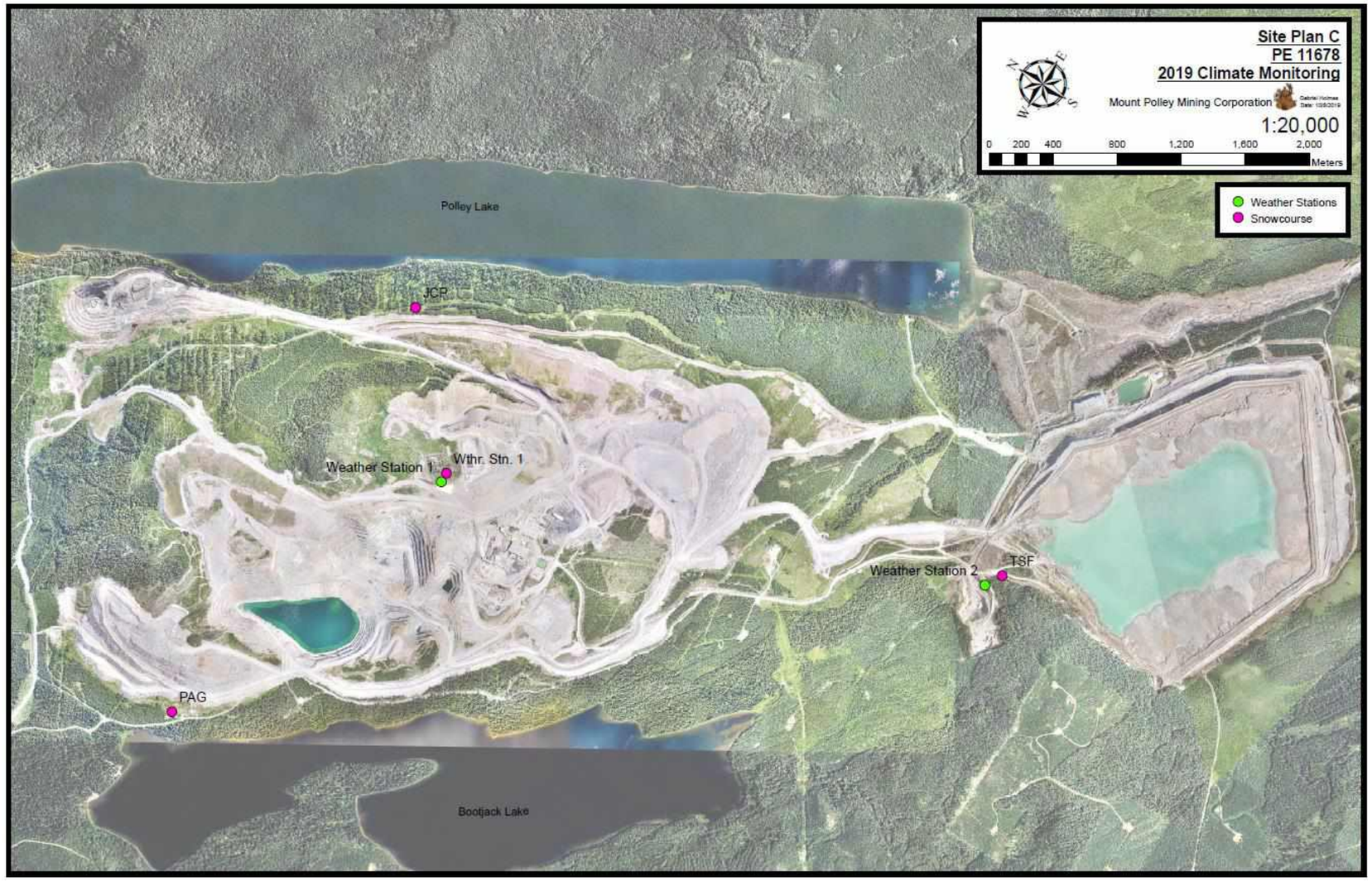
Site Plan B – Monitoring Sites



Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

Site Plan C – Climate Monitoring Locations



Date issued: May 30, 1997
Date amended: February 1, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*
Mining Operations

Permit Number: 11678

Environmental
Appeal Board

Fourth Floor, 747 Fort Street
Victoria BC V8W 3E9
Telephone: (250) 387-3464
Facsimile: (250) 356-9923

Mailing Address:
PO Box 9425 Stn Prov Govt
Victoria BC V8W 9V1

Website: www.eab.gov.bc.ca
Email: eabinfo@gov.bc.ca

Decision No. EAB-EMA-20-A003(a)

ENVIRONMENTAL APPEAL BOARD
IN THE MATTER OF THE *ENVIRONMENTAL MANAGEMENT ACT*
S.B.C. 2003, C. 53

BETWEEN:

MOUNT POLLEY MINING CORPORATION

APPELLANT

AND:

FEBRUARY 1, 2020 DECISION OF THE DIRECTOR, *ENVIRONMENTAL MANAGEMENT ACT* TO AMEND PERMIT 11678

RESPONDENT

CONSENT ORDER

ON THE APPLICATION of the parties, without a hearing and by consent:

THE BOARD ORDERS under section 16 of the *Administrative Tribunals Act*, S.B.C. 2004, c. 45 that:

1. Pursuant to section 103(c) of the *Environmental Management Act*, S.B.C. 2003, c. 53 (the "**Act**"), Mount Polley Mining Corporation ("**MPMC**")'s Permit 11678 ("**Permit**") is amended as follows:

a. The opening paragraph of Clause 2.8. is amended to read as follows:

2.8. Water Treatment and Discharge Program

The Permittee must undertake a program to investigate and develop passive and semi-passive water treatment options for distributed discharges across the mine site in accordance with the Long Term Water Management Plan dated October 17, 2016. The water treatment and discharge program must include all mine site water treatment works and source control optimization activities which includes the following:

b. Clause 2.8.1(a) is amended to read as follows:

2.8.1. Best Achievable Technology (BAT) Assessment

(a) The Permittee must undertake a BAT assessment of any treatment technologies identified in the water treatment and discharge program that the Permittee submits to the Director for consideration as part of an updated water management plan required by section 2.10.

c. Clause 2.8.1(b) is deleted in its entirety.

d. Clause 2.8.1(c) is renumbered "(b)" and amended to read as follows:

(b) The Permittee must submit to the Director for approval by January 31st of each year a study plan that details bench and pilot scale testing that will be undertaken.

e. The opening paragraph of Clause 2.8.2 is amended to read as follows:

2.8.2. Water Treatment Plant Optimization

The Permittee must operate and optimize the performance of the Veolia Actiflo Water Treatment Plant (WTP) to remove contaminants present in the mine site contact water to meet the discharge requirements of Section 1.2.4.

f. Clause 2.8.2(c) is deleted in its entirety.

g. Clause 2.9. is amended to read as follows:

2.9. Water Management Progress Reporting

The Permittee must report to the Director on all aspects of Section 2.8 every 6 months, beginning June 30, 2020 and continuing until such time as the Director deems the reporting no longer required. The reporting is to include, but is not limited to, the results of all BAT assessments, bench and pilot testing of treatment systems, optimization studies, discussion of proposed discharge locations that have the capacity to receive the treated water and changes from the previous progress reports and any other studies related to the Water Treatment and Discharge Program outlined in section 2.8. The reporting must include documentation that the testing and piloting programs are relevant for all the different types of mine influenced water on site and for the approved Water Management Plan needs.

h. Clause 2.10. is amended to read as follows:

2.10. Water Management Planning

The Permittee must submit a revised water management plan including an implementation schedule to the Director for approval prior to December 1st, 2020, outlining the water management and treatment options informed by the requirements in Section 2.8, the Long Term Water Management Plan dated October 17, 2016, and the most recent Reclamation and Closure Plan for the site. The revised Water Management Plan must address the development and implementation of water discharge plans from December 31, 2022 onward.

The revised Water Management Plan must meet the following requirements:

(a) Provide for development and implementation of treatment and management meeting BAT requirements of up to 1 in 10 wet year flows, including the associated freshet

flows, for all mine influenced water sources on site that do not meet Water Quality Guidelines once the works are fully complete.

(b) Include plans for restoring water courses, including the flow patterns, to sustain themselves without maintenance and achieve the original pre-mining productivity to the extent possible.

(c) Include all the essential information necessary for review and support of the final design, assessing its expected performance and the impacts of the discharge(s) on the receiving environment of any works that the Permittee submits to the Director for consideration.

(d) Review discharge alternatives including assessment of physical (geomorphological and hydrological), chemical and biological assessment of potential receiving environments for direct discharge of treated water on and around the mine site as required in Section 2.8.4. of this Authorization.

(e) Provide detailed bench scale, and pilot scale results for any works that the Permittee submits to the Director for consideration. Performance assurances from vendors for active treatment systems may also be considered in lieu of pilot scale tests.

(f) Discuss and document the ability and/or design criteria necessary, for any works submitted to the Director for consideration to treat all contaminants known to be above all relevant BC Water Quality Criteria at the edge of the IDZ to levels below appropriate water quality guidelines where possible.

(g) In any proposal submitted to the Director for consideration, discuss how all the bench and pilot system findings, and/or other performance assurances have been incorporated into the final design of the individual components and/or the system as a whole to assure discharge standards and/or B.C. Water Quality Criteria at the edge of any IDZ is met.

(h) Include a siting map and implementation plan for commissioning of all works necessary for full scale operations of works proposed. Siting must also allow for potential future mining operations or ongoing mining operations to take place.

(i) Include a process for updating and refining the water balance and water quality model acceptable to the Director, with appropriate sensitivity analyses for both onsite and receiving waters, which predicts the impacts to the receiving environment. The water quality model must use updated site monitoring data to demonstrate how well the model is calibrated to observed site conditions and must be updated from time to time to account for planned future mining operations and for ongoing mining operations.

(j) Include a process for ongoing review and updating of the revised Water Management Plan and the implementation schedule after it is approved.

(k) The revised Water Management Plan must be prepared by a Qualified Professional. The Permittee must implement the approved revised Water Management Plan according to the approved implementation schedule. Any updates to the revised Water Management Plan or the implementation schedule must be approved by the Director prior to their implementation.

i. Clause 4.2., sub-clause 4.2.1. (i) is amended to read as follows:

4.2. <u>Annual Report</u>

4.2.1. The Permittee must also submit by March 31st of each year, a comprehensive annual report of all monitoring via email to the above email address, in a format suitable for public release. The annual report must include:

(i) a progress update with respect to the Water Management Plan,

2. This order may be signed by the parties in counterpart.

THE FOLLOWING PARTIES APPROVE THE FORM OF THIS ORDER AND CONSENT TO EACH OF THE ORDERS NOTED ABOVE ON THIS 18th DAY OF SEPTEMBER 2020:

DocuSigned by:
4BADA1EA1A6A4A7...

Signature of Robert Lonergan,

Lawyer for **Mount Polley Mining Corporation**

Signature of Stephen E. King,

Lawyer for the **DIRECTOR**

Signature of Darrell LeHouillier

Chair, **Environmental Appeal Board**

December 31, 2020

Tracking Number: 398129
Authorization Number: 11678

REGISTERED MAIL

MOUNT POLLEY MINING CORPORATION
SUITE 200
580 HORNBY ST
VANCOUVER, BC
V6C 3B6

Dear Permittee:

Enclosed is Amended Permit 11678 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the permit. An annual fee will be determined according to the Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. This permit is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with Section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the permittee to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties and comply with other applicable legislation that may be in force.

In the event that a reportable spill occurs, or there is an imminent risk of one occurring, the responsible person must ensure that it is reported in accordance with the Spill Reporting Regulation. Additional information on spill reporting requirements is available at gov.bc.ca/reportaspill

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this permit will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Plans, data and reports pertinent to the permit are to be submitted by email or electronic transfer to the Director, designated Officer, or as further instructed.

Ministry of Environment and Climate Change Strategy
Environmental Protection Division
Suite 400 – 640 Borland Street
Williams Lake BC V2G 4T1
Mining Operations
Telephone: (250) 398-4530
Facsimile: (250) 398-4214

For more information about how the Ministry will assesses compliance with your permit please refer to gov.bc.ca/environmentalcompliance.

For more information about how to make changes to your permit and to access waste discharge amendment forms and guidance, please refer to gov.bc.ca/wastedischarge-authorizations.

Yours truly,



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

**MINISTRY OF ENVIRONMENT
AND CLIMATE CHANGE
STRATEGY**

PERMIT

11678

Under the Provisions of the Environmental Management Act

MOUNT POLLEY MINING CORPORATION

**SUITE 200
580 HORNBY ST
VANCOUVER, BC
V6C 3B6**

is authorized to discharge effluent to land and surface water from a copper-gold mine and mill complex located near Likely, British Columbia, subject to the requirements listed below.

Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

This Authorization supersedes and replaces all previous versions of Permit 11678 issued under Section 14 of the Environmental Management Act.

1. AUTHORIZED DISCHARGES

1.1 Discharges to Tailings Storage Facility

This section applies to the discharge of effluent from a Copper-Gold Mine and Ore Concentrator to the tailings storage facility. The site reference number for this discharge is E225309.

1.1.1 The monthly average rate of discharge of tailings slurry is 55,500 cubic metres per day.

1.1.2 The authorized discharge period is continuous.

1.1.3 The characteristics of the discharge must be typical of concentrator tailings from the milling of ore or metal contaminated soil, mill site runoff, rock disposal site runoff, open pit water, and septic tank effluent from a copper-gold mine and mill complex.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

1.1.4 The authorized Works are the following; a septic tank, tailings discharge line, open pits, tailings storage facility, water treatment and discharge system, seepage collection and recycle system, surface water collection works, tailings supernatant recycle systems; sediment pond(s) and related appurtenances approximately located as shown on the attached Site Plan A.

1.1.5 The location of the facilities from which the discharge originates is within Mineral Leases No. 345731, No. 410495, No. 524068, No. 573346, No. 933970, and No. 933989 as well as Mineral Claims No. CB16 204475, No. PM5 206540, No. POL2 411010, No. 514039, and No. 514044, Cariboo Mining Division, Cariboo Land District.

1.1.6 The location of the point of discharge (tailings storage facility) is on Mineral Claim No. 514039, Cariboo Mining Division, Cariboo Land District.

1.2 Mine Site Runoff and Seepage

This section applies to the discharge of treated effluent from the site runoff and seepage water collection and management systems to Quesnel Lake as sampled at the Treatment Plant Outlet (HAD-03). The site reference for this discharge is E304230.

1.2.1 The authorized annual average rate of discharge is 29,000 m^3/day.

1.2.2 The maximum rate of discharge is 52,000 m^3/day.

1.2.3 The discharge period is authorized until December 31, 2022.

1.2.4 The characteristics of the discharge at the treatment plant outlet must be equivalent to or less than the values specified below in column 2 of Table 1 below.

1.2.5 The Annual Discharge Plan required under section 2.6 must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake as specified below in Table 1 below.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

Table 1

Parameter	**Treatment Plant Outlet** (1)	**Edge of Quesnel Lake IDZ** (1)(2)(3)
Rainbow Trout 96hrLC50	50 % Mortality in 100% effluent	-
Daphnia Magna 48hrLC50	50 % Mortality in 100% effluent	-
pH	< 9.5 and >6.0 pH units	-
Total Suspended Solids	30 mg/L, and 15 mg/L Monthly Average	-
Total Sulfate	1,100 mg/L	218 mg/L
Total Ammonia (as N)	1.3 mg/L	0.18 mg/l as N
Total Nitrate (as N)	34.0 mg/L	3.0 mg/l as N
Total Nitrite (as N)	0.78 mg/L	0.02 mg/L as N
Total Phosphorus	90.0 µg/L	10.0 µg/L
Fluoride	17.0 mg/L	1.0 mg/L
Total Arsenic	28 µg/L	5.0 µg/L
Total Chromium	4 µg/L	1 µg/L
Total Copper	33 µg/L	2.2 µg/L (30-day rolling average)
Total Iron	1.0 mg/L	1.0 mg/L
Dissolved Iron	0.35 mg/L	0.35 mg/L
Total Manganese	3.4 mg/L	0.84 mg/L
Total Molybdenum	0.36 mg/L	0.05 mg/L
Total Silver	0.24 µg/L	0.05 µg/L
Total Selenium	75 µg/L	2 µg/L
Total Zinc	59 µg/L	7.5 µg/L
Dissolved Aluminum	0.75 mg/L	0.05 mg/L

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

Dissolved Cadmium	0.34 µg/L	0.13 µg/L

(1) All values are maximum values from grab samples unless otherwise specified.

(2) Only applies while discharging directly to Quesnel Lake.

(3) The "Edge of Quesnel Lake IDZ" is a point located 100m from the Quesnel Lake outfall, represented by site QUL-58 mid and/or near bottom samples, or alternative location approved by the Director.

1.2.6 The Permittee must implement the response steps set out in the approved trigger response plan under section 2.6 (5) without delay if either:

(a) The effluent monitoring at the outlet of the treatment plant indicates that trigger levels set out in the approved trigger response plan are reached for any parameter set out in Table 1 above; or,

(b) An objective set for the Edge of Quesnel Lake IDZ in Table 1 above is exceeded, or is predicted to be exceeded, as determined in accordance with procedures in the approved trigger response plan.

Where the Permittee must cease discharging, the discharge may resume only in accordance with the approved trigger response plan. The requirement to implement the trigger response plan does not authorize an exceedance of the maximum values specified in section 1.2.4 for the characteristics of the discharge at the outlet of the treatment plant.

1.2.7 The discharge is authorized from the Authorized Works, which are the settling pond(s), tailings storage facility, mine contact water collection system, the Veolia Actiflo treatment system, flow control valve(s), continuous flow meter, pipeline and outfall system and associated appurtenances as generally shown in the attached Site Plans.

1.2.8 The location of the facilities from which the discharge originates is the same as in section 1.1.5 above.

1.2.9 The location of the discharge is the Quesnel Lake outfall at a point within Mineral Claim No. 501479 when discharging to Quesnel Lake.

1.3. Springer Pit Discharge to Ground

This section applies to the discharge of seepage water from Springer Pit to Ground. The site reference for this discharge is E307887.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

1.3.1. The Permittee must maintain Springer Pit water levels at less than 1025 meters above sea level (masl) to limit seepage towards Bootjack Lake.

1.3.2. The characteristics of the discharge are typical site runoff and seepage water.

1.3.3. The authorized works are Springer Pit, and its associated water management works and related appurtenances.

1.3.4. The location of the facilities from which the discharge originates and the point of discharge are as shown in the attached Site Plan A.

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works and Emergency Procedures

2.1.1. The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the Permittee which prevents effective operation of the authorized works or leads to an unauthorized discharge, the Permittee must take appropriate remedial action and notify the Director immediately. The Director may require the Permittee to reduce or suspend operations to protect the environment until the authorized works have been restored, and/or corrective steps taken to prevent unauthorized discharges.

2.1.2. All ponds, ditching, and other runoff or seepage collection and diversion works must be inspected at least twice per year, once in the spring after freshet and once in the fall before freeze-up. Records of these inspections must be maintained and made available for inspection by an Officer immediately upon request.

2.1.3. The authorized works must be complete and in operation while discharging.

2.2. Bypasses

Any bypass of the authorized works is prohibited unless prior approval of the Director is obtained and confirmed in writing.

2.3. Process Modifications

The Director must be notified prior to implementing changes to any process that may adversely affect the quality and/or quantity of the authorized discharges. Despite notification under this section, permitted levels must not be exceeded.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

2.4. Surface Runoff and Mine Drainage Control

2.4.1. Unless required for operational purposes, surface runoff from undisturbed areas and groundwater pumped from up gradient of pits or other undisturbed areas, must be diverted so that it does not flow to the tailings impoundment, or to the mine and mill areas.

2.4.2. Seepage and runoff from the open pits, rock disposal sites, and from down gradient of the tailings storage facility must be collected and conveyed to treatment works, the tailings storage facility, mill or open pits.

2.4.3. Inactive open pits may be used for storage of mine water, tailings storage facility supernatant or mill site runoff, provided records of volumes transferred to any pit are maintained and reported quarterly.

2.4.4. Recycling of on-site water and evaporation enhancing techniques must be practiced.

2.4.5. Surface water control works must be provided for all areas disturbed by roads, open pits, rock disposal/storage sites, the mill site and ore storage sites. The surface water control works must convey all flows up to a 1 in 10 year 24-hour storm event and must withstand all flows up to a 1 in 200 year 24-hour storm event, without significant damage.

2.4.6. The tailings storage facility must provide adequate storage, beach width and freeboard as required by Mines Act Permit M-200. All other effluent storage ponds, seepage ponds, and surface runoff ponds must provide at least 0.5 meters of freeboard.

2.4.7 Freeboard is defined as the difference in elevation between the contained liquid level and the top of the berm structure at its lowest point. The lowest point does not include a spillway where a discharge is authorized or where the supernatant over flows to a downstream collection pond that is part of the authorized works.

2.4.8. The Permittee must maintain and implement an Erosion and Sediment Control Plan developed by a qualified professional that will prevent sedimentation of watercourses during construction and operation of any mine structures or facilities. The Director may specify and require implementation of additional measures to prevent sedimentation of watercourses caused by construction or operational activity at the site.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

2.5. Environmental Emergency Response Plan

2.5.1. The Permittee must maintain and implement an up to date Environmental Emergency Response Plan by January 31st of each year. The Environmental Emergency Response Plan must include all of the following:

(a) adequate procedures for responding to all probable environmental emergencies, including spills,

(b) permit exceedances associated with the Mount Polley Mine operations and mine site area,

(c) procedures for the suspension of the effluent discharge to Quesnel Lake.

(d) A notification protocol for immediate advising the Xatsull First Nation, the Williams Lake First Nation, the Cariboo Regional District, and the community of Likely of significant emergency events, and permit exceedances at the mine site.

2.5.2. The Permittee must ensure mine personnel are trained on the contents of the Emergency Response Plan and is reviewed annually.

2.6. Annual Discharge Plan

2.6.1. The Permittee must maintain and implement an Annual Discharge Plan approved by the Director for the discharge authorised in section 1.2 above. The plan must include the following:

(a) An outline of the expected volume, timing, and duration of effluent released to Quesnel Lake;

(b) Consideration and account of hydrology and snowpack information, mine water balance information, Polley Lake discharge control, and background water quality information;

(c) Demonstrate how the objectives, set out in column 3 of Table 1 above, will be met at the Edge of Quesnel Lake IDZ in Quesnel Lake;

(d) A maximum turbidity target(s), as measured at the outlet of the treatment plant, which requires immediate reporting to the Director should the turbidity target(s) be exceeded for longer than one hour in duration;

(e) A trigger response plan for treatment system shutdown(s), and/or for suspension or reduction of discharge, and for the resumption of the discharge, if the effluent discharge limits at the outlet of the

treatment plant cannot be met, or if an objective for the Edge of Quesnel Lake IDZ in Quesnel Lake cannot be met;

(f) Identification of the sources of mine water and the percent of each source in the total effluent discharge for each day;

(g) Demonstrate how the discharge will be managed to minimize suspended solids deposition into Quesnel Lake; and,

(h) Identification of equipment, including calibration and maintenance schedules related to continuous measurements of flow, turbidity, specific conductance and temperature.

2.6.2 The Annual Discharge Plan must be reviewed at least once each year, and any necessary updates to the plan must be submitted to the Director for approval at least 30 days prior to adoption.

2.7. Nitrogen Management Plan

The Permittee must maintain and implement a Nitrogen Management Plan developed by a Qualified Professional. The plan must describe measures that prevent the loss of nitrogen species into the environment arising from the use of explosives and handling of waste rock. Any update to the plan must be provided to the Director within 30 days of implementation.

2.8. Water Treatment and Discharge Program

The Permittee must undertake a program to investigate and develop passive and semi-passive water treatment options for distributed discharges across the mine site in accordance with the Long Term Water Management Plan dated October 17, 2016. The water treatment and discharge program must include all mine site water treatment works and source control optimization activities which includes the following:

2.8.1. Best Achievable Technology (BAT) Assessment

(a) The Permittee must undertake a BAT assessment of any treatment technologies identified in the water treatment and discharge program that the Permittee submits to the Director for consideration as part of an updated water management plan required by Section 2.10.

(b) The Permittee must submit to the Director for approval by January 31st of each year a study plan that details bench and pilot scale testing that will be undertaken.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

2.8.2. Water Treatment Plant Optimization

The Permittee must operate and optimize the performance of the Veolia Actiflo Water Treatment Plant (WTP) to remove contaminants present in the mine site contact water to meet the discharge requirements of Section 1.2.4.

(a) "Numeric Performance Metric" (NPM) means a measurable value that quantifies the outcome or result of water treatment and the ability of the treatment to remove specified chemical constituent. It forms the basis for a numeric comparison of untreated water, to water that has been treated by the treatment system.

(b) The Permittee must optimize and operate the treatment plant in a manner to target achievement of any prescribed NPM. The stated NPM target value represents operation that achieves average effluent quality that is at or below any specified NPM. Assessment of the attainment of NPM values must be included in the optimization update progress report. If the effluent quality does not achieve an NPM value specified by the Director, the Permittee must identify the reason and propose and implement without delay response actions to achieve the target value including treatment plant optimization and/or source control and/or water management improvements.

The following NPM is established:

Total copper 12 ug/L

2.8.3. Source Control Optimization

The Permittee must undertake ongoing maintenance and surveillance of on-site water management systems and activities undertaken to increase source control of any potential contaminants of concern.

(a) The Permittee must undertake source control optimization yearly.

(b) The Permittee must undertake an analysis of the treatment plant effluent to determine selenium species present and at a minimum determine the typical proportion of total selenium that is selenate, selenite, and organoselenium. Based on these results the Director may require additional analysis for selenium speciation of mine source waters.

2.8.4. Review of Discharge Alternatives

The Permittee must review discharge alternatives for direct discharge of treated mine water on and around the mine site including consideration of

physical (geomorphological and hydrological), chemical, and biological characteristics of potential receiving environments. The Permittee must ensure the proposed discharge locations have the capacity to receive the additional discharges of treated water and meet applicable environmental benchmarks.

2.9. Water Management Progress Reporting

The Permittee must report to the Director on all aspects of Section 2.8 every 6 months, beginning June 30, 2020 and continuing until such time as the Director deems the reporting no longer required. The reporting is to include, but is not limited to, the results of all BAT assessments, bench and pilot testing of treatment systems, optimization studies, discussion of proposed discharge locations that have the capacity to receive the treated water and changes from the previous progress reports and any other studies related to the Water Treatment and Discharge Program outlined in Section 2.8. The reporting out must include documentation that the testing and piloting programs are relevant for all the different types of mine influenced water on site and for the approved Water Management Plan needs.

2.10. Water Management Planning

The Permittee must submit a revised water management plan including an implementation schedule to the Director for approval prior to December 1st, 2020, outlining the water management and treatment options informed by the requirements in Section 2.8, the Long Term Water Management Plan dated October 17, 2016 and the most recent Reclamation and Closure Plan for the site. The revised Water Management Plan must address the development and implementation of water discharge plans from December 31, 2022 onward.

The revised Water Management Plan must meet the following requirements:

(a) Provide for development and implementation of treatment and management meeting BAT requirements of up to 1 in 10 wet year flows, including the associated freshet flows for all mine influenced water sources on site that do not meet Water Quality Guidelines, once the works are fully complete.

(b) Include plans for restoring water courses, including the flow patterns, to sustain themselves without maintenance and achieve the original pre-mining productivity to the extent possible.

(c) Include all the essential information necessary for review and support of the final design, assessing its expected performance and the impacts of the

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

discharge(s) on the receiving environment of any works that the Permittee submits to the Director for consideration.

(d) Review discharge alternatives including assessment of physical (geomorphological and hydrological), chemical and biological assessment of potential receiving environments for direct discharge of treated water on and around the mine site as required in Section 2.8.4 of this Authorization.

(e) Provide detailed bench scale, and pilot scale results for any works that the Permittee submits to the Director for consideration. Performance assurances from vendors for active treatment systems may also be considered in lieu of pilot scale tests.

(f) Discuss and document the ability and/or design criteria necessary, for any works submitted to the Director for consideration to treat all contaminants known to be above all relevant BC Water Quality Criteria at the edge of the IDZ to levels below appropriate water quality guidelines where possible.

(g) In any proposal submitted to the Director for consideration, discuss how all the bench and pilot system findings, and/or other performance assurances have been incorporated into the final design of the individual components and/or the system as a whole to assure discharge standards and/or B.C. Water Quality Criteria at the edge of any IDZ is met.

(h) Include a siting map and implementation plan for commissioning of all works necessary for full scale operations of works proposed. Siting must also allow for potential future mining operations or ongoing mining operations to take place.

(i) Include a process for updating and refining the water balance and water quality model acceptable to the Director, with appropriate sensitivity analyses for both onsite and receiving waters, which predicts the impacts to the receiving environment. The water quality model must use updated site monitoring data to demonstrate how well the model is calibrated to observed site conditions and must be updated from time to time to account for planned future mining operations and for ongoing mining operations.

(j) Include a process for ongoing review and updating of the revised Water Management Plan and the implementation schedule after it is approved.

(k) The revised Water Management Plan must be prepared by a Qualified Professional. The Permittee must implement the approved revised Water Management Plan according to the approved implementation schedule. Any updates to the revised Water Management Plan or the implementation schedule must be approved by the Director prior to their implementation.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

2.11. Communication Plan

The Permittee must maintain and implement the Communication Plan dated March 20, 2016. The Communication Plan must demonstrate the sharing of environmental data with the Xatsull First Nation, the Williams Lake First Nation, the Cariboo Regional District, and the community of Likely. Any changes to the communication plan must be discussed with the Public Liaison Committee and submitted to the Director prior to adoption.

2.12. Public Liaison Committee

2.12.1. The Permittee must maintain a Public Liaison Committee (PLC), in accordance with the approved Terms of Reference dated November 21, 2018. The Permittee must submit any Terms of Reference updates to the Director for approval 30 days prior to adopting them.

2.12.2. The Committee must meet at least quarterly to share and receive information about mine activities and the results of monitoring programs with interested members of the public, the Xatsull First Nation, the Williams Lake First Nation, and regulating agencies.

2.13. Posting of Security

The Permittee must maintain a Reclamation Security as required by *Mines Act* Permit M-200.

2.14. Metal Contaminated Soil Milling

Tailings from the processing of metal contaminated soils in the mill from off mine site sources may be discharged to the tailings storage facility subject to all the following:

(a) The soils must be contaminated only with metals.
(b) The Permittee must notify the Director 14 days prior to receiving these materials at the mine site and provide results of chemical analysis of the material at the time of notification.
(c) Records of the volumes processed must be maintained and reported as part of the annual reporting requirements.

2.15. Qualified Professionals

All documents submitted to the Director must be signed by the author and where specifically required by this permit, authored and signed by a Qualified Professional.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

A “Qualified Professional" means an applied scientist or technologist specializing in an applied science or technology applicable to the duty or function, including, if applicable and without limiting this, agrology, biology, chemistry, engineering, geology or hydrogeology and who:

(a) is registered with the appropriate professional organization, is acting under that organization's code of ethics and is subject to disciplinary action by that organization; and,

(b) through suitable education, experience, accreditation and/or knowledge, may be reasonably relied on to provide advice within their area of expertise.

3. MONITORING REQUIREMENTS

3.1. Springer-Cariboo Pit Hydrogeology Work Plan and Assessment

3.1.1. The Permittee must submit a summary, when requested by and to the satisfaction of the Director, all hydrogeological work that has been completed downgradient of the Springer Pit and Cariboo Pit relevant to the Springer Pit filling and drawdown. The summary must describe all monitoring, modelling, and drilling investigations, and must provide recommendations by a Qualified Professional for additional hydrogeological investigations required to manage water in the pits during any future refilling and for mine closure. Recommendations must consider ongoing collection of water quality and geology data as the mine advances, review of the groundwater monitoring network, and hydrogeological model refinements, as appropriate.

3.1.2. Based on the review of the summary, the Director may require additional hydrogeological investigation and assessment of the hydrogeology along the seepage path from the Springer-Cariboo Pit to Bootjack Lake. Any additional monitoring recommended in the summary of hydrogeological work or required by the Director must be incorporated into updates of the Comprehensive Environmental Monitoring Plan.

3.1.3. The recommendations of the summary of hydrogeological work required above, and all ongoing hydrogeological data collected must be re-assessed as part of the annual reporting requirements under section 4.2 of this permit. This includes an annual update to the characterization of the groundwater system in the area between the pit and the lake, refinements and updates to the seepage model near the pit and reporting on the groundwater monitoring network near the pit.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

3.1.4. In addition, updated results and interpretations of the Springer-Cariboo Pit Hydrogeology Assessment, including an updated calibration and verification of the seepage model near the pit, must be prepared by a Qualified Professional and must be submitted to the Director prior to any planned refilling of Springer Pit above 1025 masl.

3.2. Comprehensive Environmental Monitoring Plan

3.2.1. The Permittee must continue to develop, submit and implement an ongoing Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek, Edney Creek, Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake, Quesnel River, and associated riparian and upland areas.

3.2.2. An updated CEMP must be submitted to the Director for approval by March 31, 2020 and every three years thereafter.

3.2.3. The Permittee must undertake monitoring in accordance with the approved CEMP immediately following its approval.

3.2.4 The CEMP must meet all the following requirements:

(a) Consolidate and integrate all of the monitoring programs that are being conducted in the vicinity of the mine site and include, at minimum, surface water (quality and quantity), groundwater (characterization and interactions with surface water), sediments, soils, periphyton, phytoplankton, benthic invertebrates, zooplankton, fish, floodplain and upland vegetation, and wildlife.

(b) At a minimum address a three year time span.

(c) At a minimum include all sampling sites, frequency of sampling, variables to be analysed, method detection limits, sampling methods, sample analysis methods, and data analysis methods.

(d) The updated CEMP must be approved by the Director.

3.2.5. The Permittee must provide all data and information collected under the CEMP to the Director, in electronic format, on a quarterly basis.

3.2.6. The Permittee must submit a three-year detailed monitoring program interpretive report to the Director by March 31, 2022, and every three years thereafter.

3.2.7. During the period of treated effluent discharge authorized by section 1.2

above, the Director may require expedited sampling, testing and reporting of treated effluent discharged during the spring freshet (March through July annually).

3.2.8. The Director may require revisions to the CEMP based on review of monitoring data and/or any other relevant information.

3.3. Effluent Toxicity Testing

Acute and chronic toxicity testing of discharges to Quesnel Lake authorized under section 1.2 of this permit must be conducted as follows:

Acute Bioassay	**Frequency**	**Source for Sample Collection**
96-hr LC50 Rainbow Trout	Monthly	HAD-03 - Effluent discharged to Quesnel Lake (E304230)
48-hr LC50 Daphnia magna	Monthly	HAD-03 - Effluent discharged to Quesnel Lake (E304230)
Chronic Bioassay	**Frequency**	**Source for Sample Collection**
7-day Ceriodaphnia dubia survival and reproduction, and 7-day ELS toxicity test with a salmonid fish and or other tests specified by the Director	Quarterly or as required by the approved CEMP	as specified in the approved CEMP when discharging direct to Quesnel Lake

3.4. Water Flow Measurement

3.4.1. The Permittee must provide and maintain suitable flow measuring devices and record staff gauge measurements, during open water, at surface water stations at W1B (Morehead Creek), W4A (North Dump Creek), W5 (Bootjack Creek) W12 (6K Creek), H1 (continuous, Upper Hazeltine Creek), H3 (Edney Creek), H4 (Polley Lake outlet) and H2 (continuous, Lower Hazeltine Creek), located approximately as shown on the attached Site Plan B, or at alternative monitoring stations satisfactory to the Director.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

3.4.2. Springer Pit water level elevation shall be monitored and recorded on a monthly basis.

3.4.3. Staff gauge readings must be taken at the same time as stream flow measurements and/or water quality sampling are collected at the same or associated sites.

3.4.4. A stage discharge curve must be developed for all staff gauges.

3.4.5. All staff gauges and flow measuring devices must be checked and calibrated once per year, after June 15th but prior to August 31st of each calendar year.

3.5. Outfall and Pipeline Commissioning and Inspection

3.5.1. The Permittee must develop and implement a monthly visual inspection program for the pipeline from the Actiflo treatment plant to the outfall in Quesnel Lake. The monthly visual inspection program must include all of the following:

(a) The pipeline corridor must be visually inspected every month.

(b) Records of the monthly visual inspections must be made available for inspection by an Officer immediately upon request.

3.5.2. The Permittee must conduct a comprehensive annual inspection of the pipe line corridor by October 1st of each year.

3.5.3. The Permittee must conduct an underwater inspection of the diffusers every 5 years to ensure they remain in good working order.

3.5.4. An annual inspection report with recommended remedial actions must be prepared by a Qualified Professional and submitted to the Director within 60 days of completion of the comprehensive inspection.

3.5.5. The pipeline and outfall must have all the following signage:

(a) A sign must be maintained along the alignment of the outfall facing Quesnel Lake above the high water mark.

(b) Signs must identify the nature of works.

(c) Signs must be posted along the effluent pipeline right-of-way at points of public access to identify the right-of-way.

(d) All signs must include emergency contact information.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

3.6. Climate Monitoring

The Permittee must maintain meteorological stations and measure continuous daily precipitation; daily maximum, minimum and mean temperature; and daily evaporation calculation or suitable alternative as approved by the Director. Climate Monitoring sites are as shown in Site Plan C.

3.7. Sampling and Analytical Procedures

3.7.1. The Permittee must carry out sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the Director.

3.7.2. The Permittee must carry out analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the Director.

Copies of the above manuals are available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual.

3.7.3. Bioassays must be conducted using the following methods:

(a) the "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout", Report EPS 1/RM/13 December 2000;

(b) the "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna", Reference Method EPS 1/RM/14 December 2000;

(c) the "Biological Test Method: Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout)", Report EPS 1/RM28, July 1998 - Embryo/Alevin;

(d) the "Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia", Report EPS l/RM/21, February 2007; or,

(e) by suitable alternative procedures as authorized by the Director.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

3.8. Quality Assurance

3.8.1. The Permittee must maintain and implement a "Quality Assurance Manual" consistent with "British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples 2013 Edition (Permittee)", or most recent edition. The Permittee must ensure that all data submitted as a requirement of this permit is produced in accordance with the Quality Assurance Manual, that data is handled and reviewed in accordance with protocols established in the Manual and is accompanied by quality assurance data required by the Manual. The Permittee must provide the Director with any updates to this Manual within 30 days of adoption.

3.8.2. Analysis of samples for parameters designated under the Environmental Data Quality Assurance Regulation must be at a laboratory registered for the designated parameter under the Regulation. In addition, the Permittee must participate in quality assurance audits as required by the Regulation.

4. REPORTING

4.1. Routine Reporting

4.1.1. In each month that discharge occurs as authorized by section 1.2 above, the Permittee must submit a monthly report, suitably tabulated and formatted, to the Director summarizing:

(a) the volume of treated effluent discharged,

(b) a summary of continuous Turbidity readings of the treated effluent discharged, and

(c) the most recently available water quality results for the effluent discharged, including toxicity.

4.1.2. Each monthly report must be submitted within seven days of the end of previous month via email to EnvAuthorizationsReporting@gov.bc.ca. Each monthly report must also contain and present all data submitted in the previous 2 monthly reports in a manner that would identify potential trends.

4.1.3. Each monthly report must also be provided to the Williams Lake First Nation and Xatsull First Nation and be made available to the Public

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

Liaison Committee within 7 calendar days of the submission to the Ministry.

4.1.4. The Permittee must cause each data submission required by this Authorization to include a statement outlining the number of exceedances of permitted discharges that occurred during the reporting period, the dates of each such exceedance, an explanation as to the cause of the exceedances, and a description of the measures taken by the Permittee to rectify the cause of each such exceedance. If no exceedances occurred over the reporting period, the required statement may instead indicate that no exceedance of permitted discharges occurred during the reporting period.

4.1.5. The Permittee must submit all data required to be submitted under this section by email to the Ministry's Routine Environmental Reporting Submission Mailbox (RERSM) at envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the Director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox.

4.1.6. The Director may require modification to the monitoring program based on the evaluation of the monthly and annual reports and on any other information that pertains to the operations and or discharges.

4.1.7. The Permittee must upload monitoring data associated with this permit to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the three month period in which the data is collected.

4.2. Annual Report

4.2.1. The Permittee must also submit by March 31st of each year, a comprehensive annual report of all monitoring via email to the above email address, in a format suitable for public release. The annual report must include:

(a) all monitoring sample results required under the permit,

(b) an evaluation of quality assurance, including collection, sampling, and data handling protocols,

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

(c) an evaluation of the treatment plant operation and control,

(d) an evaluation of the impacts of the mining operation on the receiving environment from the previous year,

(e) a summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment,

(f) updates of the water balance, and a calibration assessment of the water balance and water quality models,

(g) assessment of the outfall dispersion and dispersion modelling for the Quesnel Lake discharge,

(h) an update to any modeling relating to the Springer Pit groundwater seepage and its impacts on Bootjack Lake as described in section 3.1,

(i) a progress update with respect to the Water Management Plan,

(j) a review and update of the assessment of acid rock drainage (ARD) potential and water quality impacts from mine waste management,

(k) a comparison of monitoring data with water quality guidelines, predictions and targets,

(l) an update on the progress of reclamation and any updates to the reclamation plan that impact on site water quality,

(m) an evaluation of the effectiveness of the Surface Runoff and Mine Drainage Control programs,

(n) a summary of the Public Liaison Committee meetings, including any issues and concerns presented,

(o) an evaluation of the Outfall and Pipeline Inspection program; and,

(p) trend analysis (graphs) of water monitoring data at each site for the past 5 years.

4.2.2. Monitoring data and the analysis of that data, as it will be presented in the annual report, must be reviewed by a third party Qualified Professional.

4.2.3. A groundwater monitoring program review, including but not limited to sampling, well locations, site water balance, interpretation of data trends and possible environmental impacts, and suitable recommendations, must be completed for the entire mine site at least every three years, with the next review required by March 31, 2022.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

4.2.4. A copy of the annual report must be provided to the Williams Lake First Nation and Xatsull First Nation within 30 days of the report being submitted to the Director.

4.3. Non-compliance Reporting

4.3.1. The Permittee must immediately notify the Director or designate of any noncompliance with the requirements of this Permit and take appropriate remedial action. Written confirmation of all non-compliance events, including available test results is required within 24 hours of the original notification unless otherwise directed by the Director.

4.3.2. Both the initial notice and the confirmation must also be emailed to EnvironmentalCompliance@gov.bc.ca.

4.3.3. Within 30 days of any non-compliant event, the Permittee must submit a follow-up report to the Director and the above mailbox that includes, but is not necessarily limited to the following:

(a) all relevant test results related to the non-compliance instance(s),

(b) an explanation of the most probable cause(s) of the noncompliance(s); and,

(c) remedial actions taken and planned to prevent similar noncompliance(s).

4.4 Reporting of Toxicity Failure

4.4.1. The Permittee must immediately notify the Director of any toxicity failure according to the Non-Compliance Reporting requirements in Section 4.3. For the purpose of this section, a sample is considered to have failed the specific toxicity test if:

(a) 96-hr LC50 Rainbow Trout: Using 100% effluent concentration, more than 50% of the fish die within a 96 hour test period,

(b) 48-hr LC50 Daphnia magna: Using 100% effluent concentration, more than 50% of the organisms die within a 48 hour test period,

(c) 7-day Ceriodaphnia dubia reproduction: The water is determined to cause greater than 25% inhibition of survival and reproduction; or,

(d) 7-day ELS toxicity test with a salmonid fish: The water is determined to cause greater than 25% non-viable embryos.

Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)



Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

4.4.2. The Permittee must investigate each toxicity failure to determine the cause(s). Reasonable efforts must be made to obtain preliminary and in progress results from the analytical laboratory during the toxicity testing. The Permittee must make immediate arrangements to retest in the event of potential and confirmed failures. The Director may require additional toxicity testing based on the evaluation of results from toxicity testing and the causes of failure.

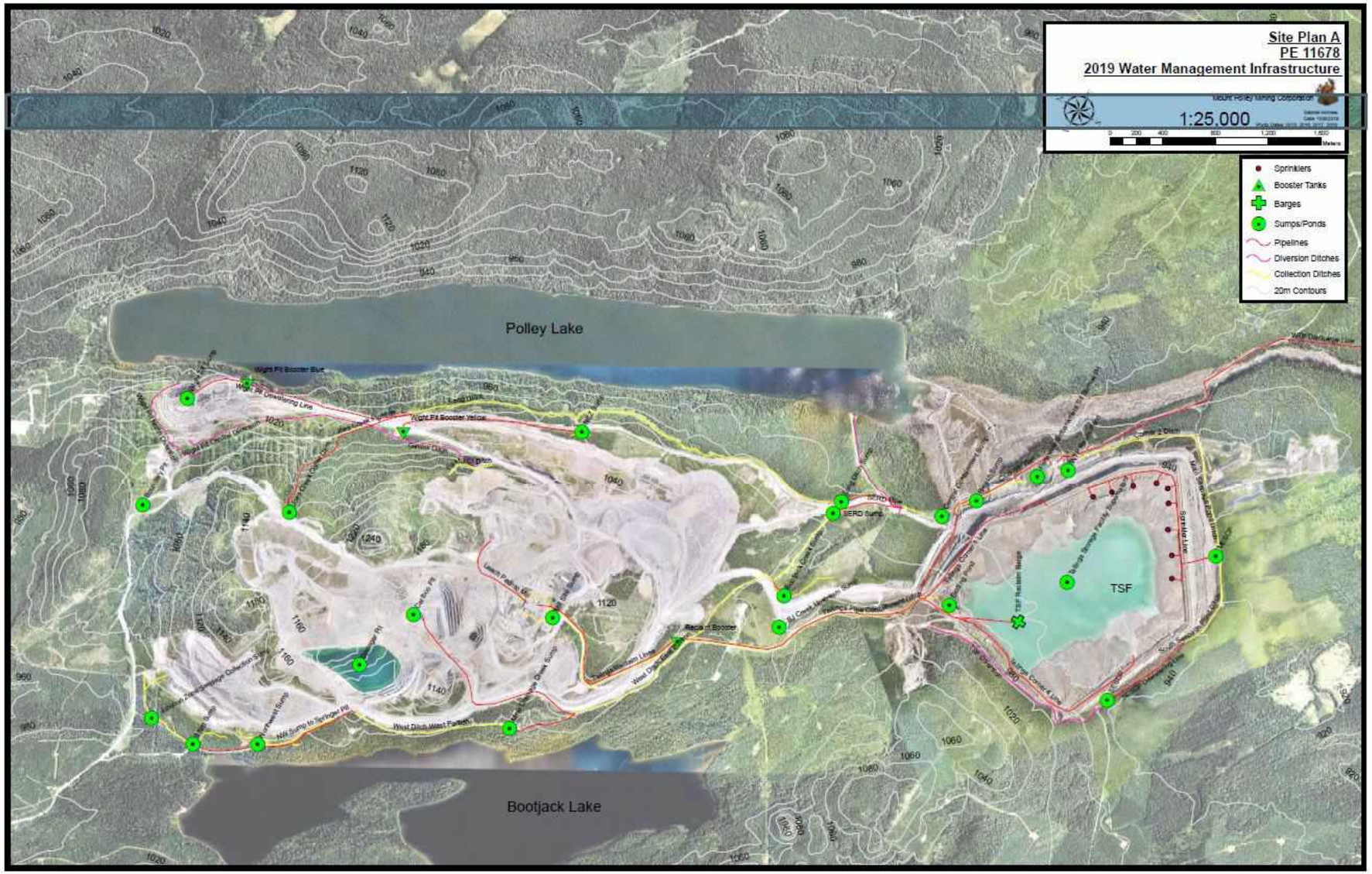
4.5. **Other Documents**

All documents to be submitted to the Director must be sent as a separate document and named according to the name listed in this permit.

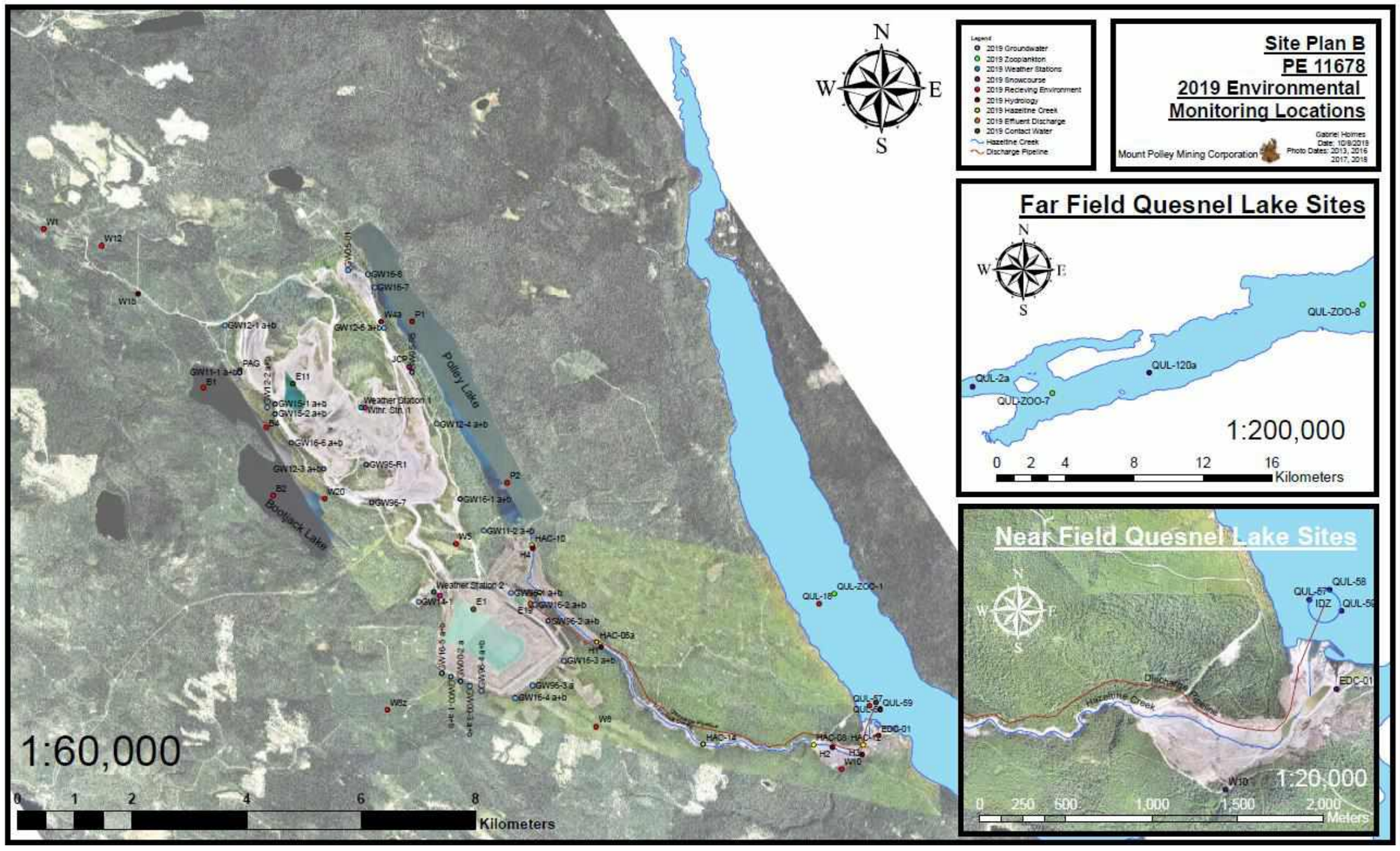
Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

Site Plan A – Water Management Works


Site Plan A
PE 11678
2019 Water Management Infrastructure
1:25,000
Sprinklers
Booster Tanks
Barges
Sumps/Ponds
Pipelines
Diversion Ditches
Collection Ditches
20m Contours
Polley Lake
Bootjack Lake
TSF
Wright Fit Booster Blue
Wright Fit Booster Yellow
Wright Fit Diversion Line
Wright Fit Channel Diversion
Wright Fit Diversion Ditch
Wright Fit Sump
Wright Fit Sump to Springer Pit
Springer Pit
Springer Pit Collection Sump
Springer Pit Sump
Springer Pit Diversion Line
Lower Path Sump
Lower Path to WF
Lower Path Diversion Line
Lower Path Diversion Ditch
Lower Path Collection Ditch
Lower Path Collection Sump
Lower Path Sump
Lower Path Diversion Line
Lower Path Diversion Ditch
West Ditch West Portion
West Ditch East Portion
Recirc Booster
Bulk Sump
Bulk Diversion Line
Bulk Diversion Ditch
Bulk Collection Ditch
Bulk Collection Sump
Bulk Sump
Bulk Collection Line

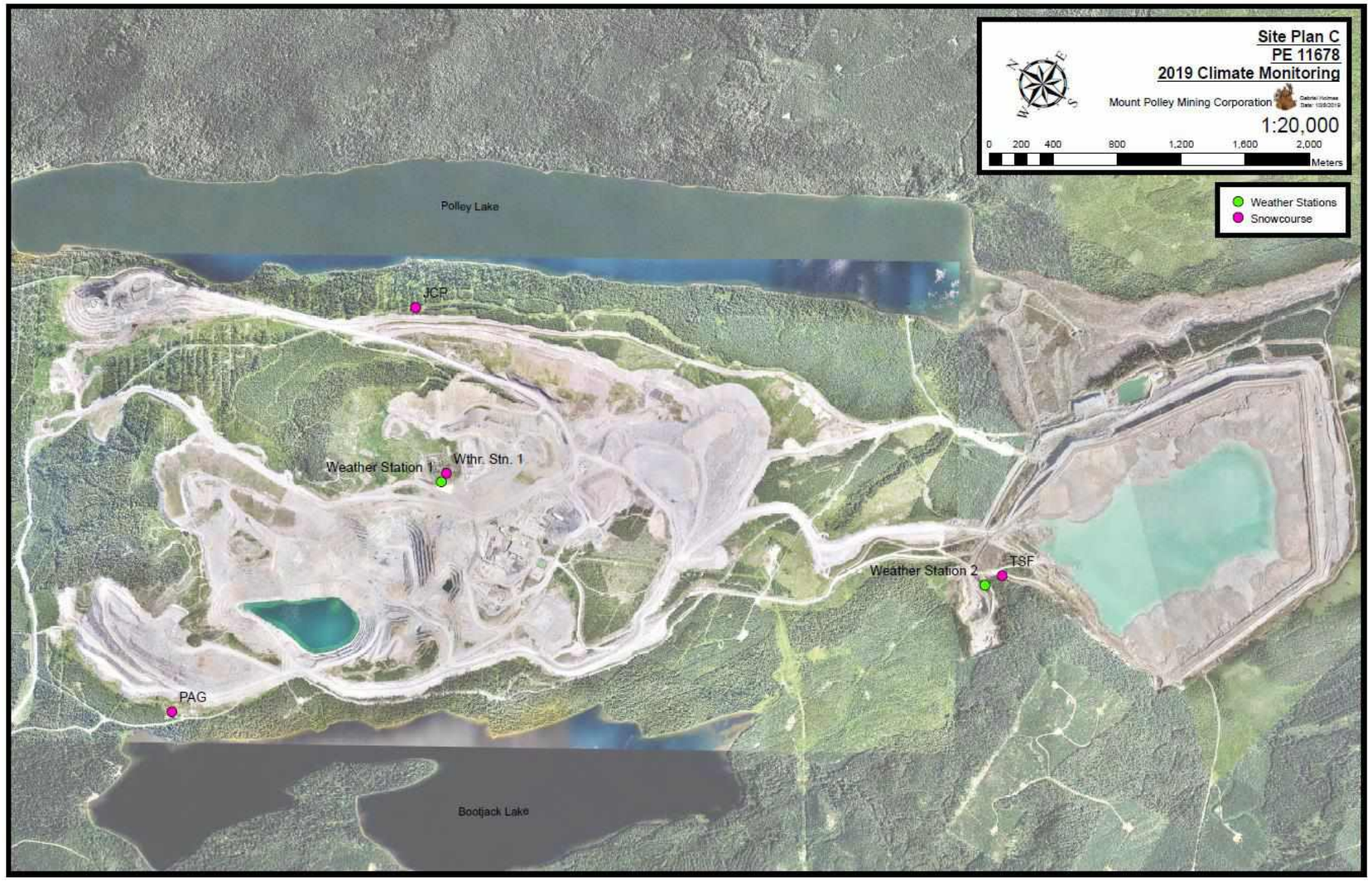
Site Plan B – Monitoring Sites



Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

Site Plan C – Climate Monitoring Locations



Date issued: May 30, 1997
Date amended: December 31, 2020
(most recent)

Douglas J. Hill, P.Eng.
for Director, *Environmental Management Act*

December 1, 2022

Tracking Number: 408523
Authorization Number: 11678

REGISTERED MAIL

MOUNT POLLEY MINING CORPORATION
SUITE 200
580 HORNBY ST
VANCOUVER, BC
V6C 3B6

Dear Permittee:

Enclosed is Amended Permit 11678 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the permit. An annual fee will be determined according to the Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. This permit is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the permittee to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties and comply with other applicable legislation that may be in force.

When a spill or the risk of a spill occurs, the responsible person (spiller) must report it immediately by calling 1-800-663-3456 in accordance with the Spill Reporting Regulation. More information is available at:
https://www2.gov.bc.ca/gov/content?id=1EAB9109A9E9407EA646050A9D431C41

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464 or by email at info@bceab.ca.

Administration of this permit will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Plans, data and reports pertinent to the permit are to be submitted by email or electronic transfer to the director, designated officer, or as further instructed.

Ministry of Environment and Climate Change Strategy
Environmental Protection Division
Suite 400 – 640 Borland Street
Williams Lake BC V2G 4T1
Mining Operations
Telephone: (250) 398-4530
Facsimile: (250) 398-4214

Please be reminded that the director may, for the protection of the environment in accordance with section 16 of the *Environmental Management Act*, require the permittee to do one or more of the following at any time:

- repair, alter, remove, improve or add to existing works, or construct new works, and submit plans and specifications for works specified in this authorization.
- conduct monitoring, and may specify procedures for monitoring and analysis, and procedures or requirements respecting the handling, treatment, transportation, discharge or storage of waste.
- provide security in the amount and form, and subject to the conditions, specified by the director.
- conduct studies and report information in accordance with the specifications of the director.
- recycle certain wastes and recover certain reusable resources, including energy potential from wastes, in accordance with the specifications of the director.
- submit copies of reports and notifications to specified Indigenous Groups, within specified timelines, in accordance with the specifications of the director.

For more information about how the Ministry will assess compliance with your permit please refer to gov.bc.ca/environmentalcompliance.

For more information about how to make changes to your permit and to access waste discharge amendment forms and guidance, please refer to gov.bc.ca/wastedischarge-authorizations.

Yours truly,



Luc Lachance, P.Eng
for Director, *Environmental Management Act*

**MINISTRY OF ENVIRONMENT
AND CLIMATE CHANGE
STRATEGY**

PERMIT

11678

Under the Provisions of the Environmental Management Act

MOUNT POLLEY MINING CORPORATION

**SUITE 200
580 HORNBY ST
VANCOUVER, BC
V6C 3B6**

is authorized to discharge effluent to land and surface water from a copper-gold mine and mill complex located near Likely, British Columbia, subject to the requirements listed below.

Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

This Authorization supersedes and replaces all previous versions of Permit 11678 issued under section 14 of the *Environmental Management Act*.

1. AUTHORIZED DISCHARGES

1.1 Discharges to Tailings Storage Facility

This section applies to the discharge of effluent from a Copper-Gold Mine and Ore Concentrator to the tailings storage facility. The site reference number for this discharge is E225309.

1.1.1 The monthly average rate of discharge of tailings slurry is 55,500 m^3/day.

1.1.2 The authorized discharge period is continuous.

1.1.3 The characteristics of the discharge must be typical of concentrator tailings from the milling of ore or metal contaminated soil, mill site

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

runoff, rock disposal site runoff, open pit water, and septic tank effluent from a copper-gold mine and mill complex.

1.1.4 The authorized Works are the following; a septic tank, tailings discharge line, open pits, tailings storage facility, water treatment and discharge system, seepage collection and recycle system, surface water collection works, tailings supernatant recycle systems; sediment pond(s) and related appurtenances approximately located as shown on the attached Site Plan A.

1.1.5 The location of the facilities from which the discharge originates is within Mineral Leases No. 345731, No. 410495, No. 524068, No. 573346, No. 933970, and No. 933989 as well as Mineral Claims No. CB16 204475, No. PM5 206540, No. POL2 411010, No. 514039, and No. 514044, Cariboo Mining Division, Cariboo Land District.

1.1.6 The location of the point of discharge (tailings storage facility) is on Mineral Claim No. 514039, Cariboo Mining Division, Cariboo Land District.

1.2 Mine Site Runoff and Seepage

This section applies to the discharge of treated effluent from the site runoff and seepage water collection and management systems to Quesnel Lake as sampled at the Treatment Plant Outlet (HAD-03). The site reference for this discharge is E304230.

1.2.1 The authorized annual average rate of discharge is 29,000 m^3/day.

1.2.2 The maximum rate of discharge is 52,000 m^3/day.

1.2.3 The discharge period is authorized until June 30, 2025.

1.2.4 The characteristics of the discharge at the treatment plant outlet must be equivalent to or less than the values specified in column 2 of Table 1 below.

1.2.5 The Annual Discharge Plan required under section 2.8 must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake as specified in column 3 below in Table 1.

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

Table 1

Parameter	**Treatment Plant Outlet** (1)	**Edge of Quesnel Lake IDZ** (1)(2)(3)
Rainbow Trout 96hrLC50	50 % Mortality in 100% effluent	-
Daphnia Magna 48hrLC50	50 % Mortality in 100% effluent	-
pH	< 9.5 and >6.0 pH units	-
Total Suspended Solids	30 mg/L, and 15 mg/L Monthly Average	-
Total Sulfate	1,100 mg/L	218 mg/L
Total Ammonia (as N)	1.3 mg/L	0.18 mg/l as N
Total Nitrate (as N)	34.0 mg/L	3.0 mg/l as N
Total Nitrite (as N)	0.78 mg/L	0.02 mg/L as N
Total Phosphorus	90.0 µg/L	10.0 µg/L
Fluoride	17.0 mg/L	1.0 mg/L
Total Arsenic	28 µg/L	5.0 µg/L
Total Chromium	4 µg/L	1 µg/L
Total Copper	33 µg/L	2.2 µg/L (30-day rolling average)
Total Iron	1.0 mg/L	1.0 mg/L
Dissolved Iron	0.35 mg/L	0.35 mg/L
Total Manganese	3.4 mg/L	0.84 mg/L
Total Molybdenum	0.36 mg/L	0.05 mg/L
Total Silver	0.24 µg/L	0.05 µg/L
Total Selenium	75 µg/L	2 µg/L
Total Zinc	59 µg/L	7.5 µg/L
Dissolved Aluminum	0.75 mg/L	0.05 mg/L
Dissolved Cadmium	0.34 µg/L	0.13 µg/L

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(1) All values are maximum values from grab samples unless otherwise specified.

(2) Only applies while discharging directly to Quesnel Lake.

(3) The "Edge of Quesnel Lake IDZ" is a point located 100 m from the Quesnel Lake outfall, represented by site QUL-58 mid and/or near bottom samples, or alternative location approved by the director.

1.2.6 The permittee must implement the response steps set out in the approved trigger response plan under section 2.8 (e) without delay if either:

(a) The effluent monitoring at the outlet of the treatment plant indicates that trigger levels set out in the approved trigger response plan are reached for any parameter set out in Table 1 above; or,

(b) An objective set for the Edge of Quesnel Lake IDZ in Table 1 above is exceeded, or is predicted to be exceeded, as determined in accordance with procedures in the approved trigger response plan.

Where the permittee must cease discharging, the discharge may resume only in accordance with the approved trigger response plan. The requirement to implement the trigger response plan does not authorize an exceedance of the maximum values specified in section 1.2.4 for the characteristics of the discharge at the outlet of the treatment plant.

1.2.7 The discharge is authorized from the Authorized Works, which are the settling pond(s), tailings storage facility, mine contact water collection system, the Veolia Actiflo treatment system, flow control valve(s), continuous flow meter, pipeline and outfall system and associated appurtenances as generally shown in the attached Site Plans.

1.2.8 The location of the facilities from which the discharge originates is the same as in section 1.1.5 above.

1.2.9 The location of the discharge is the Quesnel Lake outfall at a point within Mineral Claim No. 501479 when discharging to Quesnel Lake.

1.3 **Springer Pit Discharge to Ground**

This section applies to the discharge of seepage water from Springer Pit to Ground. The site reference for this discharge is E307887.

1.3.1 The permittee must maintain Springer Pit water levels at less than 1025 meters above sea level (masl) to limit seepage towards Bootjack Lake.

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

1.3.2 The characteristics of the discharge must be typical of site runoff and seepage water.

1.3.3 The authorized works are Springer Pit, and its associated water management works and related appurtenances.

1.3.4 The location of the facilities from which the discharge originates and the point of discharge are as shown in the attached Site Plan A.

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works and Emergency Procedures

2.1.1 The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the permittee which prevents effective operation of the authorized works or leads to an unauthorized discharge, the permittee must take appropriate remedial action and notify the director immediately. The director may require the permittee to reduce or suspend operations to protect the environment until the authorized works have been restored, and/or corrective steps taken to prevent unauthorized discharges.

2.1.2 All ponds, ditching, and other runoff or seepage collection and diversion works must be inspected at least twice per year, once in the spring after freshet and once in the fall before freeze-up. Records of these inspections must be maintained and made available for inspection by the Ministry immediately upon request.

2.1.3 The authorized works must be complete and in operation while discharging.

2.2. Bypasses

Any bypass of the authorized works is prohibited unless prior approval of the director is obtained and confirmed in writing.

2.3. Process Modifications

The director must be notified prior to implementing changes to any process that may affect the quality and/or quantity of the authorized discharges. The notification must be submitted to the Ministry's Routine Environmental Reporting Submission Mailbox envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the director. Despite notification under this section, permitted limits and objectives must not be exceeded.

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

2.4. **Surface Runoff and Mine Drainage Control**

2.4.1 Unless required for operational purposes, surface runoff from undisturbed areas and groundwater pumped from up gradient of pits or other undisturbed areas, must be diverted so that it does not flow to the tailings storage facility, or to the mine and mill areas.

2.4.2 Seepage and runoff from the open pits, rock disposal sites, and from down gradient of the tailings storage facility must be collected and conveyed to treatment works, the tailings storage facility, mill or open pits.

2.4.3 Inactive open pits may be used for storage of mine water, tailings storage facility supernatant or mill site runoff, provided records of volumes transferred to any pit are maintained and reported quarterly.

2.4.4 Recycling of on-site water and evaporation enhancing techniques must be practiced.

2.4.5 Surface water control works must be provided for all areas disturbed by roads, open pits, rock disposal/storage sites, the mill site and ore storage sites. The surface water control works must be designed to convey all flows up to a 1 in 10 year 24-hour storm event and must be designed to withstand all flows up to a 1 in 200 year 24-hour storm event, without significant damage.

2.4.6 The tailings storage facility must provide adequate storage, beach width and freeboard as required by *Mines Act* Permit M-200.

2.5. **Reporting of Storm Events**

2.5.1 In the event that the permittee reports an incident to the director that is the result of a storm event that is considered to exceed the 1 in 10 year 24-hour storm event or 1 in 200 year 24-hour storm event, the permittee must cause a Qualified Professional to complete a flow analysis to demonstrate the estimated magnitude and corresponding return period of the storm event.

2.5.2 The flow analysis must be submitted to the director 60 days following the reporting of the storm event.

2.5.3 The permittee must provide all available supporting information used in the flow analysis, including but not limited to:

(a) Date, time, and duration of storm event,

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(b) Total precipitation measured during storm event including source of data,

(c) Available measured flow data including source of data,

(d) Map showing the site watershed location and drainage area (in km^2) in proximity to any relevant regional watersheds used in the return period flow analysis, and

(e) Any other applicable supporting information.

2.6. **Erosion and Sediment Control Plan**

2.6.1 The permittee must maintain and implement the most recent version of the Erosion and Sediment Control Plan (ESCP) dated December 7, 2021. The objective of the ESCP is to outline management practices to prevent erosion and minimize transport of sediment laden water to the receiving environment that could result in exceedances at monitoring stations of water quality guidelines for aquatic life for non-filterable residue (Total Suspended Solids) in British Columbia Approved Water Quality Guidelines (BC WQGs): Aquatic Life, Wildlife & Agricultures (2021 version) or most recent version.

2.6.2 The permittee must cause a Qualified Professional to conduct a review of the ESCP and develop an ESCP Review Report based on the findings of the review. The first review must be conducted in 2023 and then every five years thereafter or earlier if proposed change(s) to the ESCP may affect the quality and/or quantity of the authorized discharges, as stated in section 2.3 of this permit. The permittee must submit the ESCP Review Report as part of the annual report required by section 4.2 for the year in which the review was required to be conducted.

2.6.3 The ESCP Review Report must include, but is not limited to:

(a) An assessment of whether the ESCP methods being employed on site are being undertaken in accordance with the most recent ESCP,

(b) An assessment of the effectiveness of the ESCP in achieving the objective of the plan,

(c) Recommended improvements to the ESCP, and

(d) Any comments, recommendations, or observations the Qualified Professional considers would be relevant to achieving the objective of the plan.

2.6.4 The permittee must cause a Qualified Professional to update the ESCP based on the recommended modifications included in the ESCP Review

Report and submit the updated ESCP to the director within 90 days of submission of the annual report that included the ESCP Review Report. The permittee must provide justification where any of the recommended modifications have not been included in the updated ESCP as part of a cover letter for the updated ESCP.

2.6.5 The permittee must maintain the most recent approved version of the ESCP onsite for inspection by the Ministry.

2.6.6 The permittee must cause a Qualified Professional to modify or amend the ESCP as required by the director and the permittee must, within the timeframe specified by the director, resubmit to the director the ESCP with required modifications or amendments.

2.7. **Environmental Emergency Response Plan**

2.7.1 The permittee must maintain and implement an up to date Environmental Emergency Response Plan by January 31st of each year. The Environmental Emergency Response Plan must include all of the following:

(a) Adequate procedures for responding to all probable environmental emergencies, including spills,

(b) Permit exceedances associated with the Mount Polley Mine operations and mine site area,

(c) Procedures for the suspension of the effluent discharge to Quesnel Lake, and

(d) A notification protocol for immediate advising the Xatśūll First Nation, the Williams Lake First Nation, the Cariboo Regional District, and the community of Likely of significant emergency events, and permit exceedances at the mine site.

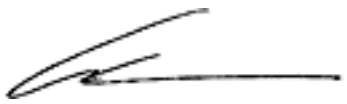
2.7.2 The permittee must ensure mine personnel are trained on the contents of the Emergency Response Plan and is reviewed annually.

2.8. **Annual Discharge Plan**

2.8.1 The permittee must maintain and implement an Annual Discharge Plan approved by the director for the discharge authorized in section 1.2 above. The plan must include the following:

(a) An outline of the expected volume, timing, and duration of effluent released to Quesnel Lake,

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)



Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(b) Consideration and account of hydrology and snowpack information, mine water balance information, Polley Lake discharge control, and background water quality information,

(c) Demonstrate how the objectives, set out in column 3 of Table 1 above, will be met at the Edge of Quesnel Lake IDZ in Quesnel Lake,

(d) A maximum turbidity target(s), as measured at the outlet of the treatment plant, which requires immediate reporting to the director should the turbidity target(s) be exceeded for longer than one hour in duration,

(e) A trigger response plan for treatment system shutdown(s), and/or for suspension or reduction of discharge, and for the resumption of the discharge, if the effluent discharge limits at the outlet of the treatment plant cannot be met, or if an objective for the Edge of Quesnel Lake IDZ in Quesnel Lake cannot be met,

(f) Identification of the sources of mine water and the percent of each source in the total effluent discharge for each day,

(g) Demonstrate how the discharge will be managed to minimize suspended solids deposition into Quesnel Lake, and,

(h) Identification of equipment, including calibration and maintenance schedules related to continuous measurements of flow, turbidity, specific conductance and temperature.

2.8.2 The Annual Discharge Plan must be reviewed at least once each year, and any necessary updates to the plan must be submitted to the director for approval at least 30 days prior to adoption.

2.9. **Nitrogen Management Plan**

The permittee must maintain and implement a Nitrogen Management Plan developed by a Qualified Professional. The plan must describe measures that prevent the loss of nitrogen species into the environment arising from the use of explosives and handling of waste rock. Any update to the plan must be provided to the director within 30 days of implementation.

2.10. **Flocculant Management Plan**

2.10.1 The permittee must cause a Qualified Professional to develop a Flocculant Management Plan (FMP) for the Veolia Actiflo treatment system, and the permittee must submit the FMP to the director by March 31, 2023. The objective of the FMP is to describe the method for

settling of solids while optimizing the use of coagulants and/or flocculants (settling aids) and limiting potential detrimental effects such as toxicity in the receiving environment.

2.10.2 The FMP must include, but is not limited to:

(a) A clear objective statement,

(b) A list of settling aids used and safety data sheets for each settling aid,

(c) Identification of locations where settling aids are applied,

(d) Description of works used for adding settling aids to waste streams,

(e) A plan for ensuring that sufficient inventory of settling aids is on site while avoiding excessive quantities of hazardous chemicals being on site and avoiding settling aids from becoming less effective due to age,

(f) Application rates at all locations for which settling aids are used and how toxicity in the discharge will be prevented,

(g) Justification for choice in settling aids and associated management works,

(h) Defined inspection schedule for works used to manage settling aids,

(i) Defined monitoring procedures; including inflow rates, outflow rates and dosing applications,

(j) Monitoring procedures of the influent and effluent to determine appropriate application rates, and

(k) Defined procedures for determining when settling aids will be used and when their use must be terminated, or dosages adjusted.

2.10.3 The permittee must implement the most recent version of the FMP.

2.10.4 The permittee must cause a Qualified Professional to conduct a review of the FMP every five years with the first review to be conducted in 2028 and develop an FMP Review Report based on the findings of the FMP review. The permittee must submit the FMP Review Report as part of the annual report required in section 4.2 for the year in which the review was required to be conducted.

2.10.5 The FMP Review Report must include, but is not limited to:

(a) An assessment of whether the settling aid management methods being employed on site are being undertaken in accordance with the most recent FMP,

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(b) An assessment of the monitoring data to evaluate whether the objective of the FMP is being met,

(c) Recommended improvements to the FMP in achieving the objective of the plan, and

(d) Any comments, recommendations, or observations the Qualified Professional considers relevant to achieving the objective of the plan.

2.10.6 The permittee must cause a Qualified Professional to update the FMP based on the recommended updates included in the FMP Review Report and submit to the director within 90 days of submission of the annual report that included the FMP Review Report. The permittee must provide justification where any of the recommended updates have not been included in the updated FMP as part of a cover letter for the updated FMP.

2.10.7 The permittee must maintain the most recent approved version of the FMP onsite for inspection by the Ministry.

2.10.8 The permittee must cause a Qualified Professional to modify or amend the FMP as required by the director and the permittee must, within the timeframe specified by the director, resubmit to the director the FMP with required modifications or amendments.

2.11. **Water Treatment and Discharge Program**

The permittee must undertake a program to investigate new and/or improved treatment technologies and develop a water treatment and discharge program for all mine site water treatment works and source control optimization activities which includes the following:

2.11.1 Best Achievable Technology (BAT) Assessment

(a) The permittee must undertake a BAT assessment of any treatment technologies identified in the Water Management Plan dated November 27, 2020 or any new and/or improved treatment technologies retained for permitting. The permittee must submit to the director for approval by January 31st of each year a study plan that details bench and pilot scale testing that will be undertaken.

2.11.2 Water Treatment Plant Optimization

The permittee must operate and optimize the performance of the Veolia Actiflo Water Treatment Plant (WTP) to remove contaminants present

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

in the mine site contact water to meet the discharge requirements of section 1.2.4.

(a) "Numeric Performance Metric" (NPM) means a measurable value that quantifies the outcome or result of water treatment and the ability of the treatment to remove specified chemical constituent(s). It forms the basis for a numeric comparison of untreated water, to water that has been treated by the treatment system.

(b) The permittee must operate and optimize the design and performance of the WTP to target achievement of any prescribed NPM. The stated NPM target value represents WTP operation that achieves annual average effluent quality that is at or below any specified NPM. Assessment of the attainment of NPM values must be reported in an annual optimization update progress report appended to the annual report required in section 4.2. If the effluent quality does not achieve an NPM value specified by the director, the permittee must identify and propose response actions to bring the effluent quality toward meeting the target value in the annual optimization update progress report. Response action may include treatment plant optimization and/or source control and/or water management improvements, and a schedule for implementing the response action must be included in the annual optimization update progress report.

The following NPM is established:

Total copper 12 ug/L

(c) "Annual average effluent quality" means the effluent concentration of total copper based on a 52-week rolling average, using the average of the 52 weekly grab samples at HAD-3 when the WTP is discharging.

2.11.3 Source Control Optimization

The permittee must undertake ongoing maintenance and surveillance of on-site water management systems and activities undertaken to increase source control of any potential contaminants of concern.

(a) The permittee must undertake source control optimization yearly.

(b) The permittee must undertake an analysis of the treatment plant effluent to determine selenium species present and at a minimum determine the typical proportion of total selenium that is selenate,

selenite, and organoselenium. Based on these results the director may require additional analysis for selenium speciation of mine source waters.

2.11.4 Review of Discharge Alternatives

The permittee must review discharge alternatives for direct discharge of treated mine water on and around the mine site considering the following mine phases: operations, care and maintenance, closure, and post-closure.

The review of discharge alternatives must include consideration of:

(a) Passive and semi-passive water treatment options for distributed discharges across the mine site informed by the Water Management Plan dated November 27, 2020, and most recent Reclamation and Closure Plan for the site,

(b) Physical (geomorphological and hydrological), chemical, and biological characteristics of potential receiving environments, and

(c) The capacity of the proposed discharge locations to receive the additional discharges of treated water and meet applicable environmental benchmarks.

2.12. **Water Management Progress Reporting**

The permittee must report to the director on all aspects of section 2.11 every 6 months, beginning June 30, 2020, and continuing until such time as the director deems the reporting no longer required. The report must include, but is not limited to:

(a) Results of all BAT assessments,

(b) Bench and pilot testing of treatment systems,

(c) Progress on implementation of response action(s) for attainment of the NPM target value,

(d) Source control optimization studies,

(e) Summary and discussion of proposed alternative discharge locations that have the capacity to receive the treated water and changes from the previous progress reports,

(f) Documentation that the testing and piloting programs are relevant for all the different types of mine influenced water on site, and

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)



Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(g) Any other studies related to the Water Treatment and Discharge Program outlined in section 2.11.

2.13. **Communication Plan**

The permittee must maintain and implement the Communication Plan dated March 20, 2016. The Communication Plan must demonstrate the sharing of environmental data with the Xatśūll First Nation, the Williams Lake First Nation, the Cariboo Regional District, and the community of Likely. Any changes to the communication plan must be discussed with the Public Liaison Committee and submitted to the director prior to adoption.

2.14. **Public Liaison Committee**

The permittee must maintain a Public Liaison Committee (PLC), in accordance with the approved Terms of Reference dated November 21, 2018. The permittee must submit any Terms of Reference updates to the director for approval 30 days prior to adopting them.

The Committee must meet at least quarterly to share and receive information about mine activities and the results of monitoring programs with interested members of the public, the Xatśūll First Nation, the Williams Lake First Nation, and regulating agencies.

2.15. **Posting of Security**

The permittee must maintain a Reclamation Security as required by *Mines Act* Permit M-200.

2.16. **Metal Contaminated Soil Milling**

Tailings from the processing of metal contaminated soils in the mill from off mine site sources may be discharged to the tailings storage facility subject to all the following:

(a) The soils must be contaminated only with metals.

(b) The permittee must notify the director 14 days prior to receiving these materials at the mine site and provide results of chemical analysis of the material at the time of notification.

(c) Records of the volumes processed must be maintained and reported as part of the annual reporting requirements.

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

2.17 **Qualified Professionals**

All documents submitted to the director must be signed by the author and where specifically required by this permit, authored, and signed by a Qualified Professional.

A “Qualified Professional", in relation to a duty or function under Ministry legislation, means an individual who:

(a) is registered in British Columbia with a professional association, is acting under that organization’s code of ethics, and

(b) through suitable education, experience, accreditation, and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.

3. MONITORING REQUIREMENTS

3.1. Springer-Cariboo Pit Hydrogeology Work Plan and Assessment

3.1.1 The permittee must submit a summary, when requested by and to the satisfaction of the director, of all hydrogeological work that has been completed downgradient of the Springer Pit and Cariboo Pit relevant to the Springer Pit filling and drawdown. The summary must describe all monitoring, modelling, and drilling investigations, and must provide recommendations by a Qualified Professional for additional hydrogeological investigations required to manage water in the pits during any future refilling and for mine closure. Recommendations must consider ongoing collection of water quality and geology data as the mine advances, review of the groundwater monitoring network, and hydrogeological model refinements, as appropriate.

3.1.2 Based on review of the summary, the director may require additional hydrogeological investigation and assessment of the hydrogeology along the seepage path from the Springer-Cariboo Pit to Bootjack Lake. Any additional monitoring recommended in the summary of hydrogeological work or required by the director must be incorporated into updates of the Comprehensive Environmental Monitoring Plan.

3.1.3 The recommendations of the summary of hydrogeological work required above, and all ongoing hydrogeological data collected must be re-assessed as part of the annual reporting requirements under section 4.2 of this permit. This includes an annual update to the characterization of the groundwater system in the area between the pit and the lake,

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

refinements, and updates to the seepage model near the pit and reporting on the groundwater monitoring network near the pit.

3.1.4 In addition, updated results and interpretations of the Springer-Cariboo Pit Hydrogeology Assessment, including an updated calibration and verification of the seepage model near the pit, must be prepared by a Qualified Professional, and must be submitted to the director prior to any planned refilling of Springer Pit above 1025 masl.

3.2. **Comprehensive Environmental Monitoring Plan**

3.2.1 The permittee must continue to develop, submit, and implement an ongoing Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek, Edney Creek, Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake, Quesnel River, and associated riparian and upland areas.

3.2.2 An updated CEMP must be submitted to the director for approval by March 31, 2020, and every three years thereafter.

3.2.3 The permittee must undertake monitoring in accordance with the approved CEMP immediately following its approval.

3.2.4 The CEMP must meet all the following requirements:

(a) Consolidate and integrate all the monitoring programs that are being conducted in the vicinity of the mine site and include, at minimum, surface water (quality and quantity), groundwater (characterization and interactions with surface water), sediments, soils, periphyton, phytoplankton, benthic invertebrates, zooplankton, fish, floodplain and upland vegetation, and wildlife.
(b) At a minimum address, a three-year time span.
(c) At a minimum include all sampling sites, frequency of sampling, variables to be analysed, method detection limits, sampling methods, sample analysis methods, and data analysis methods.
(d) The updated CEMP must be approved by the director.

3.2.5 The permittee must provide all data and information collected under the CEMP to the director, in electronic format, on a quarterly basis.

3.2.6 The permittee must submit a three-year detailed monitoring program interpretive report to the director by March 31, 2022, and every three years thereafter.

3.2.7 During the period of treated effluent discharge authorized by section 1.2 above, the director may require expedited sampling, testing, and

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

reporting of treated effluent discharged during the spring freshet (March through July annually).

3.2.8 The director may require revisions to the CEMP based on review of monitoring data and/or any other relevant information.

3.3. **Effluent Toxicity Testing**

Acute and chronic toxicity testing of discharges to Quesnel Lake authorized under section 1.2 of this permit must be conducted as follows:

Acute Bioassay	**Frequency**	**Source for Sample Collection**
96-hr LC50 Rainbow Trout	Monthly	HAD-03 - Effluent discharged to Quesnel Lake (E304230)
48-hr LC50 Daphnia magna	Monthly	HAD-03 - Effluent discharged to Quesnel Lake (E304230)
Chronic Bioassay	**Frequency**	**Source for Sample Collection**
7-day Ceriodaphnia dubia survival and reproduction, and 7-day ELS toxicity test with a salmonid fish and/or other tests specified by the director	Quarterly or as required by the approved CEMP	as specified in the approved CEMP when discharging direct to Quesnel Lake

3.4. **Water Flow Measurement**

3.4.1 The permittee must provide and maintain suitable flow measuring devices and record staff gauge measurements, during open water, at surface water stations at W1B (Morehead Creek), W4A (North Dump Creek), W5 (Bootjack Creek) W12 (6K Creek), H1 (continuous, Upper Hazeltine Creek), H3 (Edney Creek), H4 (Polley Lake outlet) and H2 (continuous, Lower Hazeltine Creek), located approximately as shown on the attached Site Plan B, or at alternative monitoring stations satisfactory to the director.

3.4.2 Springer Pit water level elevation must be monitored and recorded on a monthly basis.

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

3.4.3 Staff gauge readings must be taken at the same time as stream flow measurements and/or water quality sampling are collected at the same or associated sites.

3.4.4 A stage discharge curve must be developed for all staff gauges.

3.4.5 All staff gauges and flow measuring devices must be checked and calibrated once per year, after June 15th but prior to August 31st of each calendar year.

3.5. **Outfall and Pipeline Commissioning and Inspection**

3.5.1 The permittee must develop and implement a monthly visual inspection program for the pipeline from the Actiflo treatment plant to the outfall in Quesnel Lake. The monthly visual inspection program must include all of the following:

(a) The pipeline corridor must be visually inspected every month.

(b) Records of the monthly visual inspections must be made available for inspection by the Ministry immediately upon request.

3.5.2 The permittee must conduct a comprehensive annual inspection of the pipeline corridor by October 1st of each year.

3.5.3 The permittee must conduct an underwater inspection of the diffusers every 5 years to ensure they remain in good working order.

3.5.4 An annual inspection report with recommended remedial actions must be prepared by a Qualified Professional and submitted to the director within 60 days of completion of the comprehensive inspection.

3.5.5 The pipeline and outfall must have all the following signage:

(a) A sign must be maintained along the alignment of the outfall facing Quesnel Lake above the high water mark.

(b) Signs must identify the nature of works.

(c) Signs must be posted along the effluent pipeline right-of-way at points of public access to identify the right-of-way.

(d) All signs must include emergency contact information.

3.6. **Climate Monitoring**

The permittee must maintain meteorological stations and measure continuous daily precipitation; daily maximum, minimum and mean temperature; and

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

daily evaporation calculation or suitable alternative as approved by the director. Climate Monitoring sites are as shown in Site Plan C.

3.7. Sampling and Analytical Procedures

3.7.1 The permittee must carry out sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual, (2013 Edition)" or most recent edition, or by alternative procedures as authorized by the director.

3.7.2 The permittee must carry out analyses in accordance with procedures described in the "British Columbia Environmental Laboratory Manual (2020 Edition)", or the most recent edition or by alternative procedures as authorized by the director.

Copies of the above manuals are available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

3.7.3 Bioassays must be conducted using the following methods:

(a) The "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout", Report EPS 1/RM/13 December 2000;

(b) The "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna", Reference Method EPS 1/RM/14 December 2000;

(c) The "Biological Test Method: Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout)", Report EPS 1/RM28, July 1998 -Embryo/Alevin;

(d) The "Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia", Report EPS l/RM/21, February 2007; or,

(e) By suitable alternative procedures as authorized by the director.

3.8. Quality Assurance

3.8.1 The permittee must maintain and implement a "Quality Assurance Manual" consistent with "British Columbia Field Sampling Manual (2013 Edition)", or most recent edition. The permittee must ensure that all data submitted as a requirement of this permit is produced in accordance with the Quality Assurance Manual, that data is handled and

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

reviewed in accordance with protocols established in the Manual and is accompanied by quality assurance data required by the Manual. The permittee must provide the director with any updates to this Manual within 30 days of adoption.

3.8.2 Analysis of samples for parameters designated under the Environmental Data Quality Assurance Regulation must be at a laboratory registered for the designated parameter under the Regulation. In addition, the permittee must participate in quality assurance audits as required by the Regulation.

4. REPORTING

4.1. Routine Reporting

4.1.1 In each month that discharge occurs as authorized by section 1.2 above, the permittee must submit a monthly report, suitably tabulated in a table, and formatted, to the director summarizing:

(a) The volume of treated effluent discharged,

(b) A summary of continuous Turbidity readings of the treated effluent discharged,

(c) The most recently available water quality results for the effluent discharged, including toxicity test results,

(d) Water quality results compared to the applicable permit limits and objectives specified in Table 1 and/or BC WQGs,

(e) Any exceedances of respective permit limits, objectives and/or BC WQGs must be clearly highlighted, and

(f) Any missed sampling events/missing data must be identified with an explanation provided.

4.1.2 Each monthly report must be submitted within seven days of the end of previous month via email to envauthorizationsreporting@gov.bc.ca. Each monthly report must also contain and present all data submitted in the previous 2 monthly reports in a manner that would identify potential trends.

4.1.3 Each monthly report must also be provided to the Williams Lake First Nation and Xatśūll First Nation and be made available to the Public Liaison Committee.

4.1.4 The permittee must cause each data submission required by this Authorization to include a statement outlining the number of

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

exceedances of permitted discharges that occurred during the reporting period, the dates of each such exceedance, an explanation as to the cause of the exceedances, and a description of the measures taken by the permittee to rectify the cause of each such exceedance. If no exceedances occurred over the reporting period, the required statement may instead indicate that no exceedance of permitted discharges occurred during the reporting period.

4.1.5 The permittee must submit all data required to be submitted under this section by email to envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox

4.1.6 The director may require modification to the monitoring program based on the evaluation of the monthly and annual reports and on any other information that pertains to the operations and/or discharges.

4.1.7 The permittee must upload monitoring data associated with this permit to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the three-month period in which the data is collected.

4.2. **Annual Report**

4.2.1 The permittee must also submit by March 31st of each year, a comprehensive annual report of all monitoring via email to the above email address, in a format suitable for public release. The annual report must include:

(a) All monitoring sample results required under the permit,

(b) Evaluation of quality assurance, including collection, sampling, and data handling protocols,

(c) Water quality results from HAD-3 and QUL-58 compared to the applicable permit limits and objectives specified in Table 1, and BC WQGs,

(d) Any exceedances of respective permit limits, objectives and/or BC WQGs must be clearly highlighted,

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(e) Any missed sampling events/missing data must be identified with an explanation provided,

(f) Evaluation of the treatment plant operation and control,

(g) Evaluation of the impacts of the mining operation on the receiving environment from the previous year,

(h) Summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment,

(i) Updates of the water balance, and a calibration assessment of the water balance and water quality models,

(j) Assessment of the outfall dispersion and dispersion modelling for the Quesnel Lake discharge,

(k) Update to any modeling relating to the Springer Pit groundwater seepage and its impacts on Bootjack Lake as described in section 3.1,

(l) Review and update of the assessment of acid rock drainage (ARD) potential and water quality impacts from mine waste management,

(m) Comparison of monitoring data with water quality guidelines, predictions, and targets,

(n) Update on the progress of reclamation and any updates to the reclamation plan that impact on site water quality,

(o) Evaluation of the effectiveness of the Surface Runoff and Mine Drainage Control programs,

(p) Summary of the Public Liaison Committee meetings, including any issues and concerns presented,

(q) Evaluation of the Outfall and Pipeline Inspection program,

(r) Trend analysis (graphs) of water monitoring data at each site for the past 5 years, and,

(s) Assessment of attainment of the NPM target value:

i. Using the HAD-3 monitoring data, evaluate the average annual effluent quality and trends as defined in section 2.11.2 (c),

ii. If the average annual effluent quality exceeds the NPM target value or if trend suggest NPM target value may be

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

exceeded within the next annual review cycle, provide an explanation of the most probable cause(s),

iii. Summary of proposed response action(s), and

iv. Progress update with respect to implementation of any response action(s).

4.2.2 Monitoring data and the analysis of that data, as it will be presented in the annual report, must be reviewed by a third party Qualified Professional.

4.2.3 A groundwater monitoring program review, including but not limited to sampling, well locations, site water balance, interpretation of data trends and possible environmental impacts, and suitable recommendations, must be completed for the entire mine site at least every three years, with the next review required by March 31, 2025.

4.2.4 A copy of the annual report must be provided to the Williams Lake First Nation, Xatśūll First Nation and the Public Liaison Committee within 30 days of the report being submitted to the director.

4.3 Veracity of Data

The permittee must ensure that all information submitted as a requirement of this permit is accurate and free from mistakes or misleading statements. The permittee must include in any submission required under this permit an explanation for any data that:

(a) Is required under the permit but is missing from the submission, and

(b) The permittee considers to be not representative of the actual discharge, conditions, or other circumstances the data is intended to measure.

4.4. Non-compliance Reporting

4.4.1 The permittee must immediately notify the director or designate of any non-compliance with the requirements of this permit and take appropriate remedial action. Written confirmation of all non-compliance events, including available test results is required within 24 hours of the original notification unless otherwise directed by the director.

4.4.2 Both the initial notice and the confirmation must also be emailed to EnvironmentalCompliance@gov.bc.ca.

4.4.3 Within 30 days of any non-compliant event, the permittee must submit a follow-up report to the director and the above mailbox that includes, but not limited to the following:

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

(a) All relevant test results related to the non-compliance instance(s),

(b) An explanation of the most probable cause(s) of the non-compliance(s); and,

(c) Remedial actions taken and planned to prevent similar non-compliance(s).

4.4.4 A copy of the initial compliance notice, written confirmation and follow-up report must also be provided to the Williams Lake First Nation, Xatśūll First Nation, and the Public Liaison Committee.

4.5 **Reporting of Toxicity Failure**

4.5.1 The permittee must immediately notify the director of any toxicity failure according to the Non-Compliance Reporting requirements in section 4.4. For the purpose of this section, a sample is considered to have failed the specific toxicity test if:

(a) 96-hr LC50 Rainbow Trout: Using 100% effluent concentration, more than 50% of the fish die within a 96 hour test period,

(b) 48-hr LC50 Daphnia magna: Using 100% effluent concentration, more than 50% of the organisms die within a 48 hour test period,

(c) 7-day Ceriodaphnia dubia reproduction: The water is determined to cause greater than 25% inhibition of survival and reproduction; or,

(d) 7-day ELS toxicity test with a salmonid fish: The water is determined to cause greater than 25% non-viable embryos.

4.5.2 The permittee must investigate each toxicity failure to determine the cause(s). Reasonable efforts must be made to obtain preliminary and in progress results from the analytical laboratory during the toxicity testing. The permittee must make immediate arrangements to retest in the event of potential and confirmed failures. The director may require additional toxicity testing based on the evaluation of results from toxicity testing and the causes of failure.

4.6. **Other Documents**

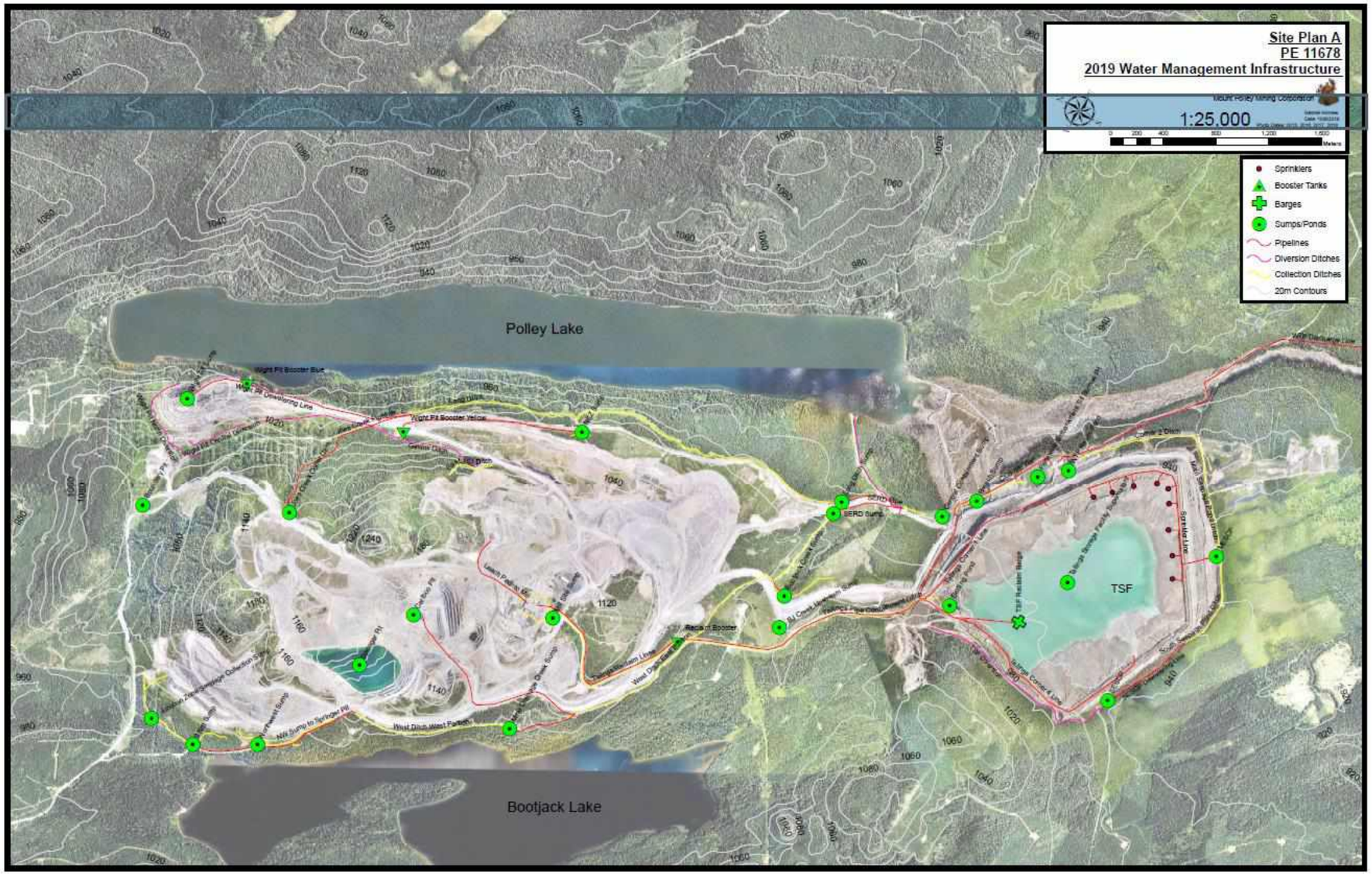
All documents to be submitted to the director must be sent as a separate document and named according to the name listed in this permit. The documents must be submitted to envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the director.

Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)



Luc Lachance, P.Eng
for Director, *Environmental Management Act*

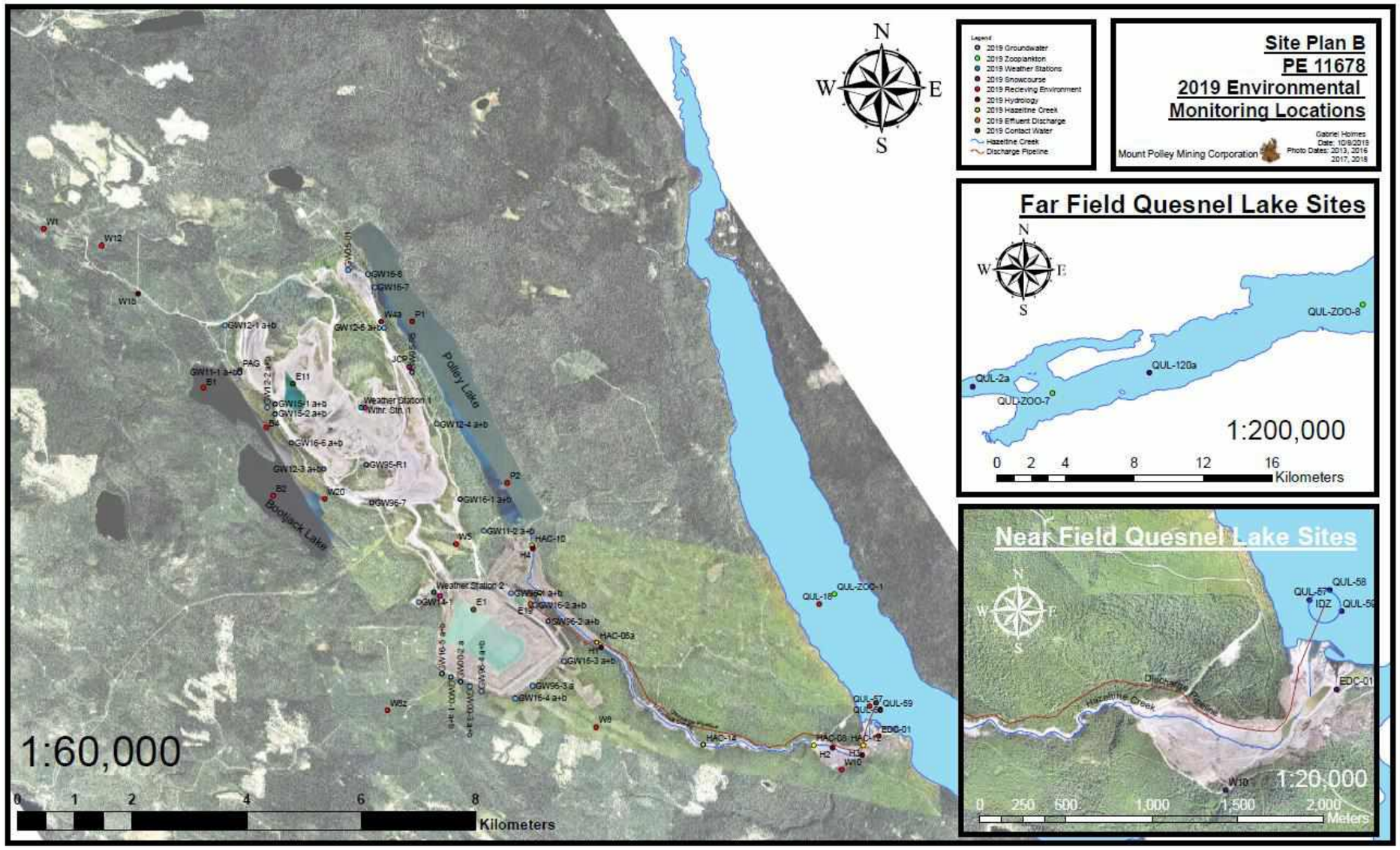
Site Plan A – Water Management Works



Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

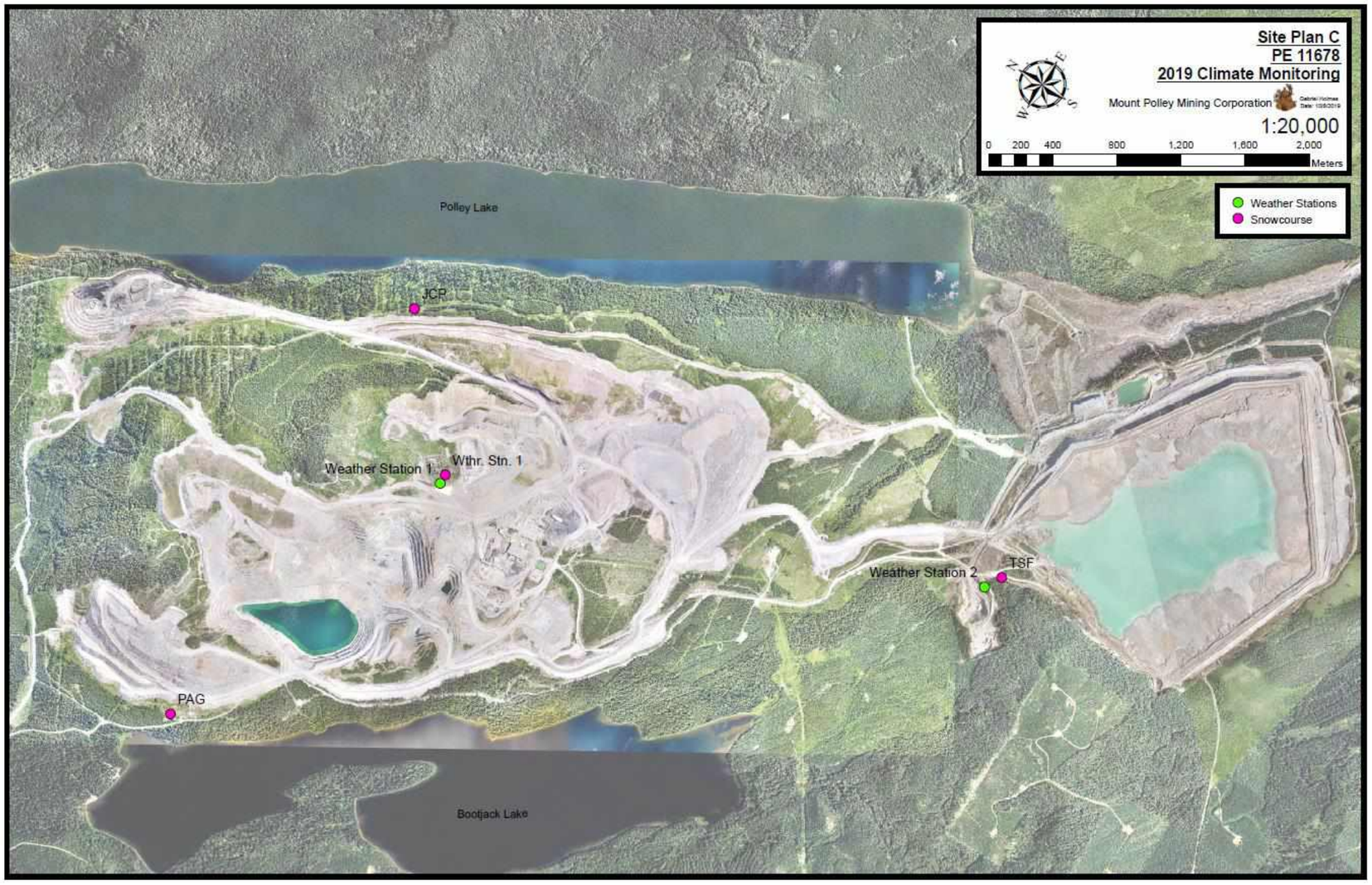
Site Plan B – Monitoring Sites



Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

Site Plan C – Climate Monitoring Locations



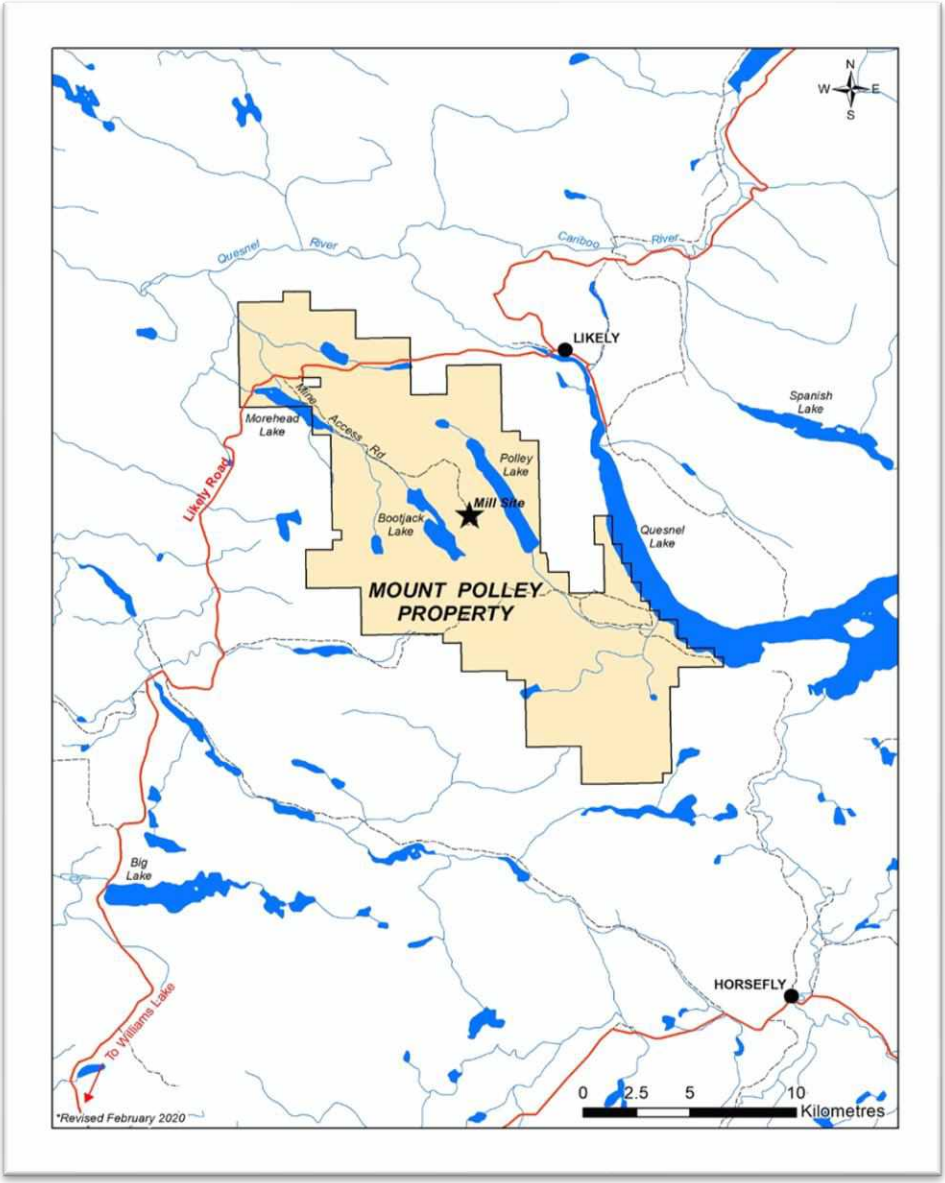
Date issued: May 30, 1997
Date amended: December 1, 2022
(most recent)

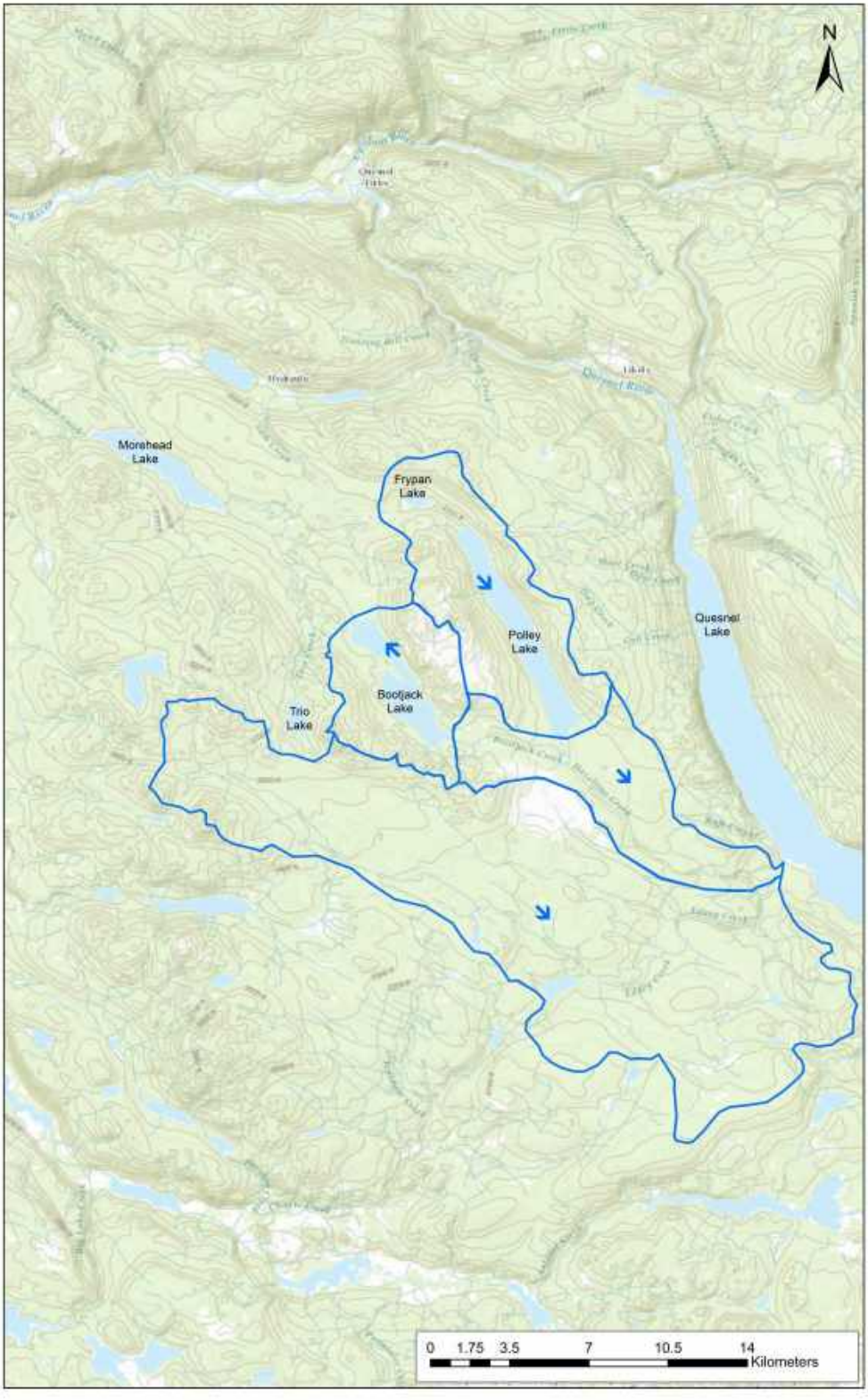
Luc Lachance, P.Eng
for Director, *Environmental Management Act*

Appendix B

Site Locations and Maps

(Electronic format only)




N
Morehead Lake
Frypan Lake
Polley Lake
Quesnel Lake
Trio Lake
Bootjack Lake
0 1.75 3.5 7 10.5 14
Kilometers

Mount Polley Mining Corporation

2023 Authorized Discharge

1:20,000

Gabriel Holmes
Date: 2/27/2024
Photo Dates: 2013, 2023

0 200 400 800 1,200 1,600
Meters

- QUL Discharge Sites
- Water Treatment Plant
- QUL Diffuser Locations
- Discharge pipeline
- 20m Contours

Polley Lake

Water Treatment Plant

TSF

Quesnel Lake

QUL-57

QUL-58

QUL-59

Mount Polley Mining Corporation

2023 Environmental Monitoring Locations

N
W E
S

1:40,000

Gabriel Holmes
Date: 2/27/2024
Photo Dates: 2013, 2023

0 200 400 800 1,200 1,600 2,000
Meters

- Surface Water Permitted
- Surface Water Contact
- Hydrology
- Groundwater Monitoring Wells
- Snowcourses

WTR STN 1 Snowcourse

JCP Snowcourse

PAG Snowcourse

TSF Snowcourse

W1 W12 W12 W1b W1b Boundary Pit WPCW GW16-8 E10 GW05-07 GW16-7 W4a W4a P1 GW12-1 Junction Zone Sump Junction Zone Ditch E17 GavinsDitch GW12-5 JCP SW1 JCP Snowcourse GW95-R5 GW12-4 PAG Snowcourse NW Ditch E13 B1 GW15-1 GW12-2 E11 E8 WTR. STN. 1 Snowcourse B4 GW15-2 GW16-6 E14 GW95-R1 GW12-3 GW96-7 Bootjack Lake B2 W20 GW16-1 P2 E15 SERDS GW11-2 W5 W5 BJDiversion HAC-10 H4 LD E18 POF-5 GW14-1 TSF Snowcourse E1a HAC-13 CSD E19 HAD-3 GW16-2 GW96-2 HAC-05a H1 GW16-3 GW16-5 E22 East MTD West MTD GW96-4 STD GW00-1 GW00-2 GW00-3 GW96-3 GW16-4 W8z W8 Polley Lake Quesnel Lake QUL-18 QUL-ZOO-1 QUL-57 QUL-58 QUL-59 HAC-01c HAC-08 H2 H3a EDC-01a HAC-14 W10

Mount Polley Mining Corporation

2023 Groundwater Monitoring Locations

1:30,000

Gabriel Holmes
Date: 2/27/2024
Photo Dates: 2013, 2023

0 200 400 800 1,200 1,600 2,000
Meters

Groundwater Monitoring Wells
20m Contours

Polley Lake

Bootjack Lake

GW16-8
GW16-7
GW05-01
GW12-5
GW95-R5
GW12-4
GW16-1
GW11-2
GW16-2
GW96-2
GW16-3
GW96-3
GW16-4
GW96-4
GW00-3
GW00-2
GW00-1
GW16-5
GW14-1
GW96-7
GW95-R1
GW12-3
GW15-1
GW15-2
GW16-6
GW12-2
GW11-1
GW12-1

Mount Polley Mining Corporation

2023 Hazeltine Creek Monitoring Locations

N
W E
S

1:20,000

Gabriel Holmes
Date: 2/27/2024
Photo Dates: 2013, 2023

0 100 200 400 600 800 1,000
Meters

- Hazeltine Creek Sites
- Edney Creek
- Hazeltine Creek
- 20m Contours

Polley Lake

HAC-10

POF-1

POF-5

HAC-13

HAC-05A

HAC-14

HAC-08

EDC-01a

Hazeltine Creek

Quesnel Lake

Mount Polley Mining Corporation

2023 Mine Site Facilities

1:25,000

Gabriel Holmes
Date: 2/27/2024
Photo Dates: 2013, 2023

0 150 300 600 900 1,200 1,500 Meters

- Pit Areas
- Dump Areas
- Road Areas
- Stockpile Areas
- TSF Areas
- Misc. Areas
- 20m Contours

Polley Lake

Bootjack Lake

Wight Pit
Boundary/Wight Pit Connector Road
Boundary Pit
Boundary Dump
Wight Pit Haul Road
Old Wrap Around Road
NEZ Soil
NEZ Dump
Wight Pit/TSF Haul Road
Long Ditch
Highway to Heaven
SERDS
SERDS Soil
Old TSF Haul Road
SERDS Ditch
Polley Lake Access Road
Mount Polley Soil
East RDS
New Access Road
North Bell Dump
High Ox Stockpile
Warehouse Area
Pond Zone Soil
Geology Area
#1 Ore Stockpile
Crusher Road
Mill Area
Hydro Line
Springer-Cariboo Pit
Mill/TSF Connector Road
Ore Switchback Road
Cariboo Ore Stockpile
Old Onca Site
Helipad
West Ditch
Temporary NW PAG Stockpile
PAG Stockpile Ditches
West (Waste) Haul Road
Biosolids
TSF Rock Quarry
Corner 4 to Corner 5
Corner 4 to Corner 5 Light Duty Access
Hazeltine Discharge Pipe Grade
Perimeter Embankment (East) Till Borrow Pit
South Till Borrow
Perimeter Embankment
Main Embankment
Tailings Surface
South and Main Ponds
South Embankment

Mount Polley Mining Corporation

2023 M-200 Permit Boundaries

1:25,000

Gabriel Holmes
Date: 2/27/2024
Photo Dates: 2013, 2023

0 150 300 600 900 1,200 1,500
Meters

M-200 Permit Boundary

20m Contours

Polley Lake

Bootjack Lake

Mount Polley Mining Corporation

2023 Quesnel Lake Sample Locations

1:100,000

Gabriel Holmes
Date: 3/6/2024
Photo Dates: 2013, 2023

0 1,000 2,000 4,000 6,000
Meters

- Quesnel Lake Sites
- Zooplankton Sites
- 20m Contours

Likely

Mount Polley Mine Site

P1
B1
P2
B2
QUL-18
QUL-ZOO-1
QUL-58
QUL-57
QUL-59
QUL-2a
QUL-ZOO-7
QUL-120a

Quesnel Lake

Mount Polley Mining Corporation

2023 Reclamation Areas

1:25,000

Gabriel Holmes
Date: 3/6/2024
Photo Dates: 2013, 2023

0 150 300 600 900 1,200 1,500 Meters

Reclamation Areas
Surface Development
20m Contours

Boundary Dump
NBD Wrap Around Toe
NBD Parcel 16
NBD Phase 1
NBD Parcels 1-10
2017 NBD Area 6
2013 Biosolids Research Parcel 6
2013 Biosolids Research Parcel 5
2013 Biosolids Research Parcel 4
2013 Biosolids Research Parcel 3
2013 Biosolids Research Parcel 2
2013 Biosolids Research Parcel 1
NBD Beside Research
NBD Phase 2
NBD South Triangle
NBD Biosolids Parcel 11
NBD Biosolids Parcel 7
NBD Biosolids Parcel 12
Beside Metro Van 2014
NBD Biosolids Parcel 0
NBD Biosolids Parcel 8
NBD Biosolids Parcel 10

NEZ Dump Trials
NEZ Dump
Highway to Heaven
Tree Plots (2000) and adjacent
Tree Plots (1998-1999)
East RDS

Boundary Dump
NBD Wrap Around Toe
NBD Phase 1
NBD Parcel 16
NBD Parcels 1-10
2017 NBD Area 6
2013 Biosolids Research Parcel 5
2013 Biosolids Research Parcel 4
2013 Biosolids Research Parcel 1
NBD Beside Research
NBD South Triangle
NBD Phase 2
NBD Biosolids Parcel 8
Beside Metro Van 2014
NBD Biosolids Parcel 12

NEZ Dump Trials
NEZ Dump
Highway to Heaven
Tree Plots (2000) and adjacent
Tree Plots (1998-1999)
East RDS
East RDS

Above WHR
Below Helipad

South Till Borrow
South Till Borrow

Bootjack Lake

Mount Polley Mining Corporation

2023 Seepage Monitoring Locations

1:20,000

Gabriel Holmes
Date: 3/6/2024
Photo Dates: 2013, 2023

0 100 200 400 600 800 1,000
Meters

Seepage Sites
20m Contours

Polley Lake

Bootjack Lake

NEZ 7
NEZ 14
NEZ 13
NEZ 12
NEZ 11
NEZ 10
NEZ 9
NEZ 8
NEZ 4
NEZ 3
NEZ 2
NEZ 1
East RDS 4
East RDS 3
East RDS 2
East RDS 1
Boundary 4
Boundary 3
SERDS 17
SERDS 14
SERDS 13
SERDS 24
SERDS 23
SERD 25
SERDS 19
SERD 26
TSF Road 16
TSF Road 8
TSF Road 6
TSF ROad 5
TSF Road 1
WHR 22
WHR 29
WHR 11
WHR 2
WHR 4
WHR 27
WHR 24
WHR 9
WHR 8
PAG 4
PAG 5
PAG 7
PAG 8
PAG 15
PAG 10
PAG 13
PAG 14
PAG 9

Mount Polley Mining Corporation

2023 Soil Stockpiles

1:25,000

Gabriel Holmes
Date: 3/6/2024
Photo Dates: 2013, 2023

0 150 300 600 900 1,200 1,500
Meters

20m Contours

Soil Stockpiles

Polley Lake

Bootjack Lake

Wight Pit Till
Wrap Around Road
NEZ Dump Lower
Highway to Heaven - 3
Highway to Heaven - 1
Highway to Heaven - 4
Highway to Heaven - 2
Leach Pad
East RDS
NEZ Dump Top SEZ - 3
Access Road km 11.5
Access Road km 12
North Bell Dump Till - 3
North Bell Dump - 2
North Bell Dump Top
Springer North - 1
Springer North - 2
Springer North - 4
Springer North - 3
PAG Dump
PAG Dump
Northwest Sump Road
SERDS - 2
Lower SERDS - 2
SERDS - 1
Lower SERDS - 3
Lower SERDS - 1
Old TSF Haul Road
SEZ - 2
SEZ - 1
SERD-3
Mill - 3
Mill Site - 2
Mill Site - 1
Mill Site - 1
Upper Caribou Stockpile
Caribou Stockpile
TRR - 6
TAR - 2
TAR - 4
TAR - 3
TAR - 4
TAR - 5
TAR - 6
TAR - 1
TDAR Sand/Soil
TRR - 3
TRR - 2
TRR - 1
TRR - 4
TRR - 3
TRR - 5
Plug - 2
Plug - 1
Till Borrow - 3
Till Borrow - 3
Till Borrow - 3
Perimeter Embankment
Till Borrow - 2
Till Borrow - 2
Till Borrow - 1
Perimeter Pond
Upper PAR
TSF Corner 1
South Till Borrow - 3
South Till Borrow - 1
South Till Borrow - 2
Main Embankment - 2
Main Embankment - 1
Gavin Lake Road - 3
Gavin Lake Road - 2
Gavin Lake Road - 1

Mount Polley Mining Corporation

2023 Surface Development

1:25,000

Gabriel Holmes
Date: 3/6/2024
Photo Dates: 2013, 2023

0 150 300 600 900 1,200 1,500
Meters

20m Contours
Surface Development

Polley Lake

Bootjack Lake

Mount Polley Mining Corporation

2023 Water Management Infrastructure

1:25,000

Gabriel Holmes
Date: 3/6/2024
Photo Dates: 2013, 2023

0 200 400 800 1,200 1,600 Meters

- Sprinklers
- Booster Tanks
- Barges
- Sumps/Ponds
- Pipelines
- Diversion Ditches
- Collection Ditches
- 20m Contours

Polley Lake

Bootjack Lake

TSF

Wight Pit Sump
Wight Pit Booster Blue
Wight Pit Dewatering Line
Wight Pit North Diversion
Wight Pit Central Diversion
NEZ Booster to Mill
NEZ to Wight Pit Gravity Feed
Wight Pit Booster To Mill
NEZ Sump
Long Ditch
Gavins Ditch
East RD Ditch
Joes Creek Collection Dam
Boundary Pit
Caribou Pit
Springer Pit
Leach Pad to Mill
Mill Site Ditch
Mill Site Sump
Caribou Pit to West Ditch
Springer Pit to SERD Ditch
West Ditch West Portion
Jamie Drainage Creek Sump
Junction Zone Seepage Collection Sump
9K Sump
9K Sump to NW Sump
Northwest Sump
NW Sump to Springer Pit
Tailings Pipe Containment Ditch
SERD Ditch
Reclaim Booster
Bootjack Creek Diversion
Bootjack Creek Sump
BJ Creek Upstream Sump
Upper and Lower Long Ditch Sumps
SERD Sump
Long Ditch Pipe
SERD Pipe
Tailings/Reclaim Lines
CCS to TSF
Central Collection Sump
Tailings Corner 1 Line
Breach Sump
Settling Pond
TSF Reclaim Barge
TSF Diversion
Tailings Corner 4 Line
Penmaster Embankment
PERP to TSF
WTP Sludge Pond
WTP Discharge Line
Tailings Storage Facility Superintendent
Corner 2 Ditch
Sprinkler Line
Main Seepage Pond Ditch
MESCP
South Seepage Pond Ditch
SESCP
SESCP Dewatering Line
Embankment Till Borrow Pit

Appendix C

Annual Status Report



Annual Status Form

AUTHORIZATION NUMBER: 11678

AUTHORIZATION TYPE: Effluent, Permit

LEGAL AUTHORIZATION HOLDER NAME: Mount Polley Mining Corporation

AUTHORIZED PERSON NAME: Alicia Lalonde

AUTHORIZED PERSON SIGNATURE: 

SIGNATURE DATE: March 31, 2024

I understand that it is an offense to mislead a government official, and I declare that all of the information presented is accurate and true.
I have been given the authority by the authorization holder to sign this form.

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
1.1.1	The monthly average rate of discharge tailings slurry is 55,500 cubic metres per day.	Yes	N/A
1.1.2	The authorized discharge period is continous.	Yes	N/A
1.1.3	The characteristics of the discharge must be typical concentrator tailings from the milling of ore or metal contaminated soil, mill site runoff, rock disposal site runoff, open pit water, and septic tank effluent from a copper-gold mine and mill complex.	Yes	N/A
1.1.4	The authorized Works are the following: a septic tank, tailings discharge line, open pits, tailings storage facility, water treatment and discharge system, seepage collection and recycle system, surface water collection works, tailings supernatant recycle systems; sediment pond(s); and related appurtenances located approximately as shown on Site Plan A.	Yes	N/A
1.1.5	The location of the facilities from which the discharge originates is within Mineral Leases No. 345731, No. 410495, No. 524068, No. 573346, No.933970, and No.933989 as well as Mineral Claims No. CB16 204475, No. PM5 206540, No. POL2 411010, No. 514039 and No. 514044, Cariboo Mining Division, Cariboo Land District.	Yes	N/A
1.1.6	The location of the point of discharge (tailings storage facility) is on Mineral Claim No. 514039, Cariboo Mining Division, Cariboo Land District.	Yes	N/A
1.2.1	The authorized annual average rate of discharge is 29,000 m^3/day.	Yes	Discharge commenced January 2023; see Section 4.12

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
1.2.2	The maximum rate of discharge is 52,000 m^3/day.	Yes	Discharge commenced January 2023; see Section 4.12
1.2.3	The discharge period is authorized until June 30, 2025.	Yes	N/A
1.2.4	The characteristics of the discharge at the treatment plant outlet must be equivalent to or less than the values specified in column 2 of Table 1.	Yes	There were no exceedances in 2023; see Section 4.12.2.4
1.2.5	The Annual Discharge Plan required under Section 2.8 must show how the concentrations of the parameters meet the objectives for the "Edge of Quesnel Lake Initial Dilution Zone (IDZ)" in Quesnel Lake as specified in column 3 of Table 1.	Yes	N/A
1.2.6	The Permittee must implement the response steps set out in the approved trigger response plan under Section 2.8(e) without delay if either: a) the effluent monitoring at the outlet of the treatment plant indicates that trigger levels set out in the approved trigger response plan are reached for any parameter in Table 1 or; b) An objective set for the Edge of Quesnel Lake IDZ in Table 1 is exceeded, or is predicted to be exceeded, as determined in accordance with procedures in the approved trigger response plan. Where the Permittee must cease discharging, the discharge may resume only in accordance with the approved trigger response plan. The requirement to implement the trigger response plan does not authorize an exceedance of the maximum values specified in Section 1.2.4 for the characteristics of the discharge at the outlet of the treatment plant.	Yes	Trigger response plans are included in the approved Annual Discharge Plan
1.2.7	The discharge is authorized from the Authorized Works, which are the settling pond(s), tailings storage facility, mine contact water collection system, the Veolia Actiflo treatment system, flow control valve(s), continuous flow meter, pipeline and outfall system and associated appurtenances as generally shown in the Site Plans.	Yes	N/A
1.2.8	The location of the facilities from which the discharge originates is the same as in Section 1.1.5.	Yes	N/A
1.2.9	The location of the discharge is the Quesnel Lake outfall at a point within Mineral Claim No. 501479 when discharging to Quesnel Lake.	Yes	N/A
1.3.1	The Permittee must maintain Springer Pit water levels at less than 1,025 meters above sea level (masl) to limit seepage towards Bootjack Lake.	Yes	The Springer Pit did not exceed 1,025 masl in 2023
1.3.2	The characteristics of the discharge must be typical of site runoff and seepage water.	Yes	N/A
1.3.3	The authorized works are Springer Pit, and its associated water management works and related appurtenances.	Yes	See Section 3.3
1.3.4	The location of the facilities from which the discharge originates and the point of discharge are shown in Site Plan A.	Yes	N/A
2.1.1	The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the Permittee which prevents effective operation of the authorized works or leads to an unauthorized discharge, the Permittee must take appropriate remedial action and notify the Director immediately. The Director may require the Permittee to reduce or suspend operations to protect the environment until the authorized works have been restored, and/or corrective steps taken to prevent unauthorized discharges.	Yes	One unauthorized discharged occurred in 2023. See Section 3.7.2.

Authorized Person Initial:_____

Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
2.1.2	All ponds, ditching, and other runoff or seepage collection and diversion works must be inspected at least twice per year, once in the spring after freshet and once in the fall before freeze-up. Records of these inspections must be maintained and made available for inspection by the Ministry immediately upon request.	Yes	See Section 3.3.6
2.1.3	The authorized works must be complete and in operation while discharging.	Yes	N/A
2.2	Any bypass of the authorized works is prohibited unless prior approval of the Director is obtained and confirmed in writing.	Yes	One unauthorized discharged occurred in 2023. See Section 3.7.2.
2.3	The Director must be notified prior to implementing changes to any process that may adversely affect the quality and/or quantity of the authorized discharges. Despite notification under this section, permitted levels must not be exceeded.	Yes	N/A
2.4.1	Unless required for operational purposes, surface runoff from undisturbed areas and groundwater pumped from up gradient of pits or other undisturbed areas, must be diverted so that it does not flow to the tailings storage facility, or to the mine and mill areas.	Yes	N/A
2.4.2	Seepage and runoff from the open pits, rock disposal sites, and from down gradient of the tailings storage facility must be collected and conveyed to treatment works, the tailings storage facility, mill or open pits.	Yes	N/A
2.4.3	Inactive open pits may be used for storage of mine water, tailings storage facility supernatant or mill site runoff, provided records of volumes transferred to any pit are maintained and reported quarterly.	Yes	N/A
2.4.4	Recycling of on-site water and evaporation enhancing techniques must be practiced.	Yes	N/A
2.4.5	Surface water control works must be provided for all areas disturbed by roads, open pits, rock disposal/storage sites, the mill site and ore storage sites. The surface water control works must convey all flows up to a 1 in 10 year 24-hour storm event, and must designed to withstand all flows up to a 1 in 200 year 24-hour storm event, without significant damage.	Yes	See Sections 3.3 and 3.3.6
2.4.6	The tailings storage facility must provide adequate storage, beach width and freeboard as required by Mines Act Permit M-200.	Yes	N/A
2.5.1	In the event that the Permittee reports an incident to the Director that is the result of a storm event that is considered to exceed the 1 in 10 year 24 hour storm event or 1 in 200 year 24 hour storm event, the Permittee must cause a Qualified Professional to complete a flow analysis to demonstrate the estimated magnitude and corresponding return period of the storm event.	Yes	N/A
2.5.2	The flow analysis must be submitted to the Director 60 days following the reporting of the storm event.	Yes	N/A
2.5.3	The Permittee must provide all available supporting information used in the flow analysis, including but not limited to: (a) Date, time and duration of storm event, (b) Total precipitation measured during storm event including source of data, (c) Available measured flow data including source of data (d) Map showing the site watershed location and drainage area (in km2) in proximity to any relevant regional watershed used in the return period flow analysis, and (e) Any other applicabale supporting information.	Yes	N/A

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
2.6.1	The Permittee must maintain and implement the most recent version of the Erosion and Sediment Control Plan (ESCP) dated December 7, 2021. The objective of the ESCP is to outline management practices to prevent erosion and minimize transport of sediment laden water to the receiving environment that could result in exceedances at monitoring stations of water quality guidelines for aquatic life for non-filterable residue (Total Suspended Solids) in British Columbia Approved Water Quality Guidelines (BC WQGs): Aquatic Life, Wildlife & Agricultures (2021 version) or most recent version.	Yes	N/A
2.6.2	The Permittee must cause and Qualified Professional to conduct a review of the ESCP and develop an ESCP Review Report based on the findings of the review. The first review must be conducted in 2023 and then every five years thereafter or earlier if proposed change(s) to the ESCP may affect the quality and/or quantity of the authorized discharges, as stated in section 2.3 of this permit. The Permittee must submit the ESCP Review Report as part of the annual report required by section 4.2 for the year in which the review was required to be conducted.	Yes	The ESCP Review Report is included in Appendix X.
2.6.3	The ESCP Review Report must include, but is not limited to: (a) An assessment of whether the ESCP methods being employed on site are being undertaken in accordance with the most recent ESCP, (b) As assessment of the effectiveness of the ESCP in achieving the objective of the plan, (c) Recommended improvements to the ESCP, and (d) Any comments, recommendations, or observations the Qualified Professional considers would be relevant to achieving the objective of the plan.	Yes	The ESCP Review Report is included in Appendix X.
2.6.4	The Permittee must cause a Qualified Professional to update the ESCP based on the recommended modifications included in the ESCP Review Report and submit the updated ESCP to the Director within 90 days of submissions of the annual report that included the ESCP Review Report. The Permittee must provide justification where any of the recommended modifications have not been included in the updated ESCP as part of a cover letter for the updated ESCP.	Yes	Recommended modifications will be made to the ESCP by the QP within 90 days of annual report submission.
2.6.5	The Permittee must maintain the most recent approved version of the ESCP onsite for inspection by the Ministry.	Yes	N/A
2.6.6	The Permittee must cause a Qualified Professional to modify or amend the ESCP as required by the Director and the Permittee must, within timeframe specified by the Director, resubmit to the Director the ESCP with required modifications or amendments.	Yes	N/A
2.7.1	The Permittee must maintain and implement an up to date Environmental Emergency Response Plan by January 31st of each year. The Environmental Emergency Response Plan must include all of the following: a) adequate procedures for responding to all probable environmental emergencies, including spills, b) permit exceedances associated with the Mount Polley Mine operations and mine site area, c) procedures for the suspension of the effluent discharge to Quesnel Lake and d) a notification protocol for immediate advising the Xatsull First Nation, Williams Lake First Nation, the Cariboo Regional District, and the community of Likely of significant emergency events, and permit exceedances at the mine site.	Yes	Submitted October 18, 2018 and maintained in 2023
2.7.2	The Permittee must ensure mine personnel are trained on the contents of the Emergency Response Plan and it is reviewed annually.	Yes	The Environmental Emergency Response Plan was reviewed in 2023.

Authorized Person Initial:_____

Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
2.8.1	The Permittee must maintain and implement an Annual Discharge Plan approved by the Director for the discharge authorized in section 1.2. The plan must include the following: (a) An outline of the expected volume, timing, and duration of effluent released to Quesnel Lake, (b) Consideration and account of hydrology and snowpack information, mine water balance information, Polley Lake discharge control, and background water quality information, (c) Demonstrate how the objectives, set out in column 3 of Table 1, will be met at the edge of the IDZ in Quesnel Lake, (d) A maximum turbidity target(s), as measured at the outlet of the treatment plant, which requires immediate reporting to the Director should the turbidity target(s), be exceeded for longer than one hour in duration, (e) A trigger response plan for treatment system shutdown(s), and/or for suspension or reduction of discharge, and for the resumption of the discharge, if the effluent discharge limits at the outlet of the treatment plant cannot be met, or if the objectives for the Edge of Quesnel Lake IDZ in Quesnel Lake cannot be met, (f) Identification of the sources of mine water and the percent of each source in the total effluent discharge for each day, (g) Demonstrate how the discharge will be managed to minimize suspended solids deposition into Quesnel Lake, and, (h) Identification of equipment, including calibration and maintenance schedules related to continuous measurements of flow, turbidity, specific conductance and temperature.	Yes	N/A
2.8.2	The Annual Discharge Plan must be reviewed at least once each year, and any necessary updates submitted to the Director for approval at least 30 days prior to adoption.	Yes	The Annual Discharge Plan was reviewed in 2023.
2.9	The Permittee must maintain and implement a Nitrogen Management Plan developed by a Qualified Professional. The plan must describe measures that prevent the loss of nitrogen species into the environment arising from the use of explosives and handling of waste rock. Any update to the plan must be provided to the Director within 30 days of implementation.	Yes	N/A
2.10.1	The Permittee must cause a Qualified Professional to develop a Flocculant Management Plan (FMP) for the Veolia Actiflo treatment system, and the Permittee must submit the FMP to the Director by March 31, 2023. The objective of the FMP is to describe the method for settling of solids while optimizing the use of coagulants and/or flocculants (settling aids) and limiting potential detrimental effects such as toxicity in the receiving environment.	Yes	The FMP was submitted on March 31, 2023.
2.10.2	The FMP must include, but is not limited to: (a) A clear objective statement, (b) A list of settling aids used and safety data sheets for each settling aid, (c) Identification of locations where settling aids are applied, (d) Description of works used for adding settling aids to waste streams, (e) A plan for ensuring that sufficient inventory of settling aids is on site while avoiding excessive quantities of hazardous chemicals being on site and avoiding settling aids from becoming less effective due to age, (f) Application rates at all locations for which settling aids are used and how toxicity in the discharge will be prevented, (g) Justification for choice in settling aids and associated management works, (h) Defined inspection schedule for works used to manage settling aids, (i) Defined monitoring procedures; including inflow rates, outflow rates and dosing applications, (j) Monitoring procedures of the influent and effluent to determine appropriate application rates, and (k) Defined procedures for determining when settling aids will be used and when their use must be terminated, or dosages adjusted.	Yes	N/A
2.10.3	The Permittee must implement the most recent version of the FMP.	Yes	N/A
2.10.4	The Permittee must cause a Qualified Professional to conduct a review of the FMP every 5 years with the first review to be conducted in 2028 and develop an FMP Review Report based on the findings of the FMP review. The Permittee must submit the FMP Review Report as part of the annual report required in section 4.2 for the year in which the review was required to be conducted.	Yes	N/A

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
2.10.5	The FMP Review Report must include, but is not limited to: (a) An assessment of whether the settling aid management methods being employed on site are being undertaken in accordance with the most recent FMP, (b) An assessment of the monitoring data to evaluate whether the objective of the FMP is being met, (c) Recommended improvements to the FMP in achieving the objective of the plan, and (d) Any comments, recommendations, or observations the Qualified Professional considers relevant to achieving the objective of the plan.	Yes	N/A
2.10.6	The Permittee must cause a Qualified Professional to update the FMP based on the recommended updates included in the FMP Review Report and submit to the Director within 90 days of submission of the annual report that included the FMP Report. The Permittee must provide justification where any of the recommended updates have not been included in the updated FMP as part of a cover letter for the FMP.	Yes	N/A
2.10.7	The Permittee must maintain the most recent approved version of the FMP onsite for inspection by the Ministry.	Yes	N/A
2.10.8	The Permittee must cause a Qualified Professional to modify or amend the FMP as required by the Director and the Permittee must, within timeframe specified by the Director, resubmit to the Director the FMP with required modifications or amendments.	Yes	N/A
2.11/2.11.1	The Permittee must undertake a program to investigate new and/or improved treatment technologies and develop a water treatment and discharge program for all mine site water treatment works and source control optimization activities which includes the following: Best Achievable Technology (BAT) Assessment a) The Permittee must undertake a BAT assessment of any treatment technologies identified in the Water Management Plan dated November 27, 2020 or any new and/or improved treatment technologies retained for permitting. The Permittee must submit to the Director for approval by January 31st of each year a study plan that details bench and pilot scale testing that will be undertaken.	Yes	The 2023 BAT Assessment Plan was submitted on January 31, 2023.
2.11.2	The Permittee must operate and optimize the performance of the Veolia Actiflo Water Treatment Plant (WTP) to remove contaminants present in the mine site contact water to meet the discharge requirements of section 1.2.4. (a) "Numeric Performance Metric" (NPM) means a measurable value that quantifies the outcome or result of water treatment and the ability of the treatment to remove specified chemical constituent(s). It forms the basis for a numeric comparison of untreated water, to water that has been treated by the treatment system. b) The Permittee must operate and optimize the design and performance of the WTP to target achievement of any prescribed NPM. The stated NPM target value represents WTP operation that achieves annual average effluent quality that is at or below any specified NPM. Assessment of the attainment of NPM values must be reported in an annual optimization update progress report appended to the annual report required in section 4.2. If the effluent quality does not achieve an NPM value specified by the Director, the Permittee must identify and propose response actions to bring the effluent quality toward meeting the target	Yes	See Section 4.12.1.1 and Progress Reports #12 and #13 included in Appendix W.
2.11.3	The Permittee must undertake ongoing maintenance and surveillance of on-site water management systems and activities undertaken to increase source control of any potential contaminants of concern. a) The Permittee must undertake source control optimization yearly. b) The Permittee must undertake an analysis of the treatment plant effluent to determine selenium species present and at a minimum determine the typical proportion of total selenium that is selenate, selenite and organoselenium. Based on these results the Director may require additional analysis for selenium speciation of mine source waters.	Yes	N/A

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
2.11.4	The Permittee must review discharge alternatives for direct discharge of treated mine water on and around the mine site considering the following mine phases: operations, care and maintenance, closure, and post-closure. The review of discharge alternatives must include consideration of: a) Passive and semi-passive water treatment options for distributed discharges across the mine site informed by the Water Management Plan dated November 27, 2020, and most recent Reclamation and Closure Plan for the site, (b) Physical (geomorphological and hydrological), chemical, and biological characteristics of potential receiving environments, and (c) The capacity of the proposed discharge locations to receive the additional discharges of treated water and meet applicable environmental benchmarks.	Yes	N/A
2.12	The Permittee must report to the Director on all aspects of section 2.11 every 6 months, beginning June 30, 2020, and continuing until such time as the Director deems the reporting no longer required. The report must include, but is not limited to: (a) The results of all BAT assessments, (b) Bench and pilot testing of treatment systems, (c) Progress on implementation of response action(s) for attainment of the NPM target value, (d) Source control optimization studies, (e) Summary and discussion of proposed discharge locations that have the capacity to receive the treated water and changes from the previous progress reports, (f) Documentation that the testing and piloting programs are relevant for the different types of mine influenced water on site, and (g) Any other studies related to the Water Treatment and Discharge Program outlined in section 2.11.	Yes	See Progress Reports #12 and #13 included in Appendix W.
2.13	The Permittee must maintain and implement the Communication Plan dated March 20, 2016. The Communication Plan must demonstrate the sharing of environmental data with the Xatsull First Nation, the Williams Lake First Nation, the Cariboo Regional District, and the community of Likely. Any changes to the plan must be discussed with the Public Liaison Committee and submitted to the Director prior to adoption.	Yes	N/A
2.14	The Permittee must maintain a Public Liaison Committee (PLC), in accordance with the approved Terms of Reference dated November 21, 2018. The Permittee must submit any Terms of Reference updates to the Director for approval 30 days prior to adopting them. The Committee must meet at least quarterly to share and receive information about mine activities and the results of monitoring programs with interested members of the public, Xatsull First Nation, the Williams Lake First Nation, and regulating agencies.	Yes	2023 PLC meeting minutes are included in Appendix C.
2.15	The Permittee must maintain a Reclamation Security as required by Mines Act Permit M-200.	Yes	N/A
2.16	Tailings from the processing of metal contaminated soils in the mill from off mine site sources may be discharged to the tailings storage facility subject to the following: a) The solids must be contaminated only with metals b) The Permittee must notify the Director 14 days prior to receiving these materials at the mine site and and provide results of chemical analysis of the material at the time of notification. c) Records of the volumes processed must be maintained and reported as part of the annual reporting requirements	Yes	N/A
2.17	All documents submitted to the Director must be signed by the author and where specifically required by this permit, authored, and signed by a Qualified Professional. A "Qualified Professional", in relation to a duty or function under Ministry legislation, means an individual who: (a) Is registered in BC with a professional association, is acting under that organization's code of ethics, and (b) through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.	Yes	See Section 1.4

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
3.1.1	The Permittee must submit a summary, when requested by and to the satisfaction of the Director, of all hydrogeological work that has been completed downgradient of the Springer Pit and Cariboo Pit relevant to the Springer Pit filling and drawdown. The summary must describe all monitoring, modelling, and drilling investigations, and must provide recommendations by a Qualified Professional for additional hydrogeological investigations required to manage water in the pits during any future refilling and for mine closure. Recommendations must consider ongoing collection of water quality and geology data as the mine advances, review of the groundwater monitoring network, and hydrogeological model refinements, as appropriate.	Yes	N/A
3.1.2	Based on the review of the summary, the Director may require additional hydrogeological investigation and assessment of the hydrogeology along the seepage path from the Springer-Cariboo Pit to Bootjack Lake. Any additional monitoring recommended in the summary of hydrogeological work, or required by the Director must be incorporated into updates of the Comprehensive Environmental Monitoring Plan.	Yes	N/A
3.1.3	The recommendations of the summary of hydrogeological work required above, and all ongoing hydrogeological data collected must be re-assessed as part of the annual reporting requirements under section 4.2 of this permit. This includes an annual update to the characterization of the groundwater system in the area between the pit and the lake, refinements and updates to the seepage model near the pit, and reporting on the groundwater monitoring network near the pit.	Yes	See Section 4.9 and Appendix G
3.1.4	In addition, updated results and interpretations of the Springer-Cariboo Pit Hydrogeology Assessment, including an updated calibration and verification of the seepage model near the pit, must be prepared by a Qualified Professional, and must be submitted to the Director prior to any planned refilling of Springer Pit above 1,025 masl.	Yes	N/A
3.2.1	The Permittee must continue to develop, submit and implement an ongoing Comprehensive Environmental Monitoring Plan (CEMP) to evaluate the effects of mining-related activities on the physical, chemical, and biological characteristics of Hazeltine Creek, Edney Creek, Bootjack Lake, Morehead Creek, Polley Lake, Quesnel Lake, Quesnel River and associated riparian and upland areas.	Yes	An updated CEMP was submitted on October 31, 2019 and was approved on February 10, 2021. A CEMP update was submitted on March 21, 2023 and is undergoing review.
3.2.2	An updated CEMP must be submitted to the Director for approval by March 31, 2020, and every three years thereafter.	Yes	A CEMP update was submitted on March 21, 2023 and is undergoing review.
3.2.3	The Permittee must undertake monitoring in accordance with the approved CEMP immediately following its approval.	Yes	N/A
3.2.4	The CEMP must meet all the following requirements: a) Consolidate and integrate all of the monitoring programs that are being conducted in the vicinity of the mine site and include, at minimum, surface water (quality and quantity), groundwater (characterization and interactions with surface water), sediments, soils, periphyton, phytoplankton, benthic invertebrates, zooplankton, fish, floodplain and upland vegetation, and wildlife. b) At a minimum address a three year time span. c) At a minimum include all sampling sites, frequency of sampling, variables to be analysed, method detection limits, sampling methods, sample analysis methods, and data analysis methods. d) The updated CEMP must be approved by the Director.	Yes	N/A
3.2.5	The Permittee must provide all data and information collected under the CEMP to the Director, in electronic format, on a quarterly basis.	Yes	N/A
3.2.6	The Permittee must submit a three-year detailed monitoring program interpretive report to the Director by March 31, 2022, and every three years thereafter.	Yes	N/A
3.2.7	During the period of treated effluent discharge authorized by section 1.2 , the Director may require expedited sampling, testing and reporting of treated effluent discharged during the spring freshet (March through July annually).	Yes	N/A

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
3.2.8	The Director may require revisions to the CEMP based on review of monitoring data and/or any other relevant information.	Yes	N/A
3.3	Acute and chronic toxicity testing of discharges to Quesnel Lake authorized under section 1.2 of this permit must be conducted as follows: Acute Bioassay : 96-hr LC50 Rainbow Trout and 48-hr LC50 Daphnia magna at HAD-03 Monthly (when effluent discharged to Quesnel Lake). Chronic Bioassay: 7-day Ceriodaphnia dubia survival and reproduction and 7-day ELS toxicity test with salmonid fish and or other tests specified by the Director Quarterly or as specified in the approved CEMP when discharging directly to Quesnel Lake.	Yes	See Section 4.12.3
3.4.1	The Permittee must provide and maintain suitable flow measuring devices and record staff gauge measurements, during open water, at surface water stations W1b (Morehead Creek), W4A (North Dump Creek), W5 (Bootjack Creek) W12 (6K Creek), H1 (continuous, Upper Hazeltine Creek), H3 (Edney Creek), H4 (Polley Lake outlet) and H2 (continuous, Lower Hazeltine Creek), located approximately as shown on Site Plan B, or at alternative monitoring stations satisfactory to the Director.	Yes	See Section 4.8
3.4.2	Springer Pit water level elevation must be monitored and recorded on a monthly basis.	Yes	See Table 3.3
3.4.3	Staff gauge readings must be taken at the same time as stream flow measurements and/or water quality sampling are collected at the same or associated sites.	Yes	See Section 4.8
3.4.4	A stage discharge curve must be developed for all staff gauges.	Yes	See Section 4.8 and Appendix L
3.4.5	All staff gauges and flow measuring devices must be checked and calibrated once per year, after June 15th but prior to August 31st of each calendar year.	Yes	See Section 4.8
3.5.1	The Permittee must develop and implement a monthly visual inspection program for the pipeline from the Actiflo treatment plant to the outfall in Quesnel Lake. The monthly visual inspection program must include all of the following: a) The pipeline corridor must be visually inspected every month. b) Records of the monthly visual inspections must be made available for inspection by the Ministry immediately upon request.	Yes	See Section 4.12.1.3
3.5.2	The Permittee must conduct a comprehensive annual inspection of the pipe line corridor by October 1st of each year.	Yes	See Section 4.12.1.3
3.5.3	The Permittee must conduct an underwater inspection of the diffusers every 5 years to ensure they remain in good working order.	Yes	The diffusers were inspected on November 2, 2023.
3.5.4	An annual inspection report with recommended remedial actions must be prepared by a Qualified Professional and submitted to the Director within 60 days of completion of the comprehensive inspection.	Yes	See Section 4.12.1.3
3.5.5	The pipeline and outfall must have the following signage: a) A sign must be maintained along the alignment of the outfall facing Quesnel Lake above the high water mark. b) Signs must identify the nature of the works. c) Signs must be posted along the effluent pipeline right-of-way at points of public access to identify the right-of-way. d) All signs must include emergency contact information.	Yes	N/A
3.6	The Permittee must maintain meteorological stations and measure continuous daily precipitation; daily maximum, minimum and mean temperature; and daily evaporation calculation or suitable alternative as approved by the Director. Climate Monitoring sites are shown in Site Plan C.	No	Both weather stations did not run continuously in 2023; see Section 4.6
3.7.1	The Permittee must carry out sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual 2013 Edition", or most recent edition, or by alternative procedures as authorized by the Director.	Yes	See Section 4.3

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
3.7.2	The Permittee must carry out analyses in accordance with procedures described in the "British Columbia Environmental Laboratory Manual (2020 Edition)", or the most recent edition, or by alternative procedures as authorized by the Director.	Yes	N/A
3.7.3	Bioassays must be conducted using the following methods: a) The "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout", Report EPS 1/RM/13 December 2000; b) The "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna", Reference Method EPS 1/RM/14 December 2000; c) The "Biological Test Method: Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout)", Report EPS 1/RM28, July 1998 -Embryo/Alevin; d) The "Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia", Report EPS l/RM/21, February 2007; or e) By suitable alternative procedures as authorized by the Director.	Yes	N/A
3.8.1	The Permittee must maintain and implement a "Quality Assurance Manual" consistent with "British Columbia Field Sampling Manual (2013 Edition)", or most recent edition. The Permittee must ensure that all data submitted as a requirement of this permit is produced in accordance with the Quality Assurance Manual, that data is handled and reviewed in accordance with protocols established in the Manual, and is accompanied by quality assurance data required by the Manual. The Permittee must provide the Director with any updates to this Manual within 30 days of adoption.	Yes	N/A
3.8.2	Analysis of samples for parameters designated under the Environmental Data Quality Assurance Regulation must be at a laboratory registered for the designated parameter under the Regulation. In addition, the Permittee must participate in quality assurance audits as required by the Regulation.	Yes	N/A
4.1.1	In each month that discharge occurs as authorized by section 1.2, the Permittee must submit a monthly report, suitably tabulated in a table and formatted, to the Director summarizing: a) The volume of treated effluent discharged, b) A summary of continuous Turbidity readings of the treated effluent discharged, c) The most recently available water quality results for the effluent discharged, including toxicity test results, d) Water quality results compared to the applicable permit limits and objectives specified in Table 1 and/or BC WQGs, e) Any exceedance of respective permit limits, objectives and/or BC WQGs must be clearly highlighted, and f) Any missed sampling events/missing data must be identified with an explanation provided.	Yes	N/A
4.1.2	Each monthly report must be submitted within seven days of the end of previous month via email to EnvAuthorizationsReporting@gov.bc.ca . Each monthly report must also contain and present all data submitted in the previous 2 monthly reports in a manner that would identify potential trends.	Yes	N/A
4.1.3	Each monthly report must also be provided to the Williams Lake First Nation and Xatsull First Nation, and be made available to the Public Liaison Committee.	Yes	N/A
4.1.4	The Permittee must cause each data submission required by this Authorization to include a statement outlining the number of exceedances of permitted discharges that occurred during the reporting period, the dates of each such exceedance, an explanation as to the cause of the exceedances, and a description of the measures taken by the Permittee to rectify the cause of each exceedance. If no exceedances occurred over the reporting period, the required statement may instead indicate that no exceedance of permitted discharges occurred during the reporting period.	Yes	N/A
4.1.5	The Permittee must submit all data required to be submitted under this section by email to envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the Director.	Yes	N/A

Authorized Person Initial:_____

Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
4.1.6	The Director may require modification to the monitoring program based on the evaluation of the monthly and annual reports and on any other information that pertains to the operations and or discharges.	Yes	N/A
4.1.7	The Permittee must upload monitoring data associated with this permit to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the 3 month period in which the data is collected.	Yes	N/A
4.2.1	The Permittee must also submit by March 31st of each year, a comprehensive annual report of all monitoring via email to the above email address, in a format suitable for public release. The annual report must include: a) all monitoring sample results required under the permit, b) an evaluation of quality assurance, including collection, sampling, and data handling protocols, c) water quality results from HAD-3 and QUL-58 compared to the applicable permit limits and objectives specified in Table 1, and BC WQGs, d) any exceedances of respective permit limits, objectives and/or BC WQGs must be clearly highlighted, e) any missed sampling events/missing data must be identified with an explanation provided, f) evaluation of treatment plant operation and control, g) evaluation of the impacts of the mining operation on the receiving environment from the previous year, h) a summary of any non-compliance with the permit and other incidents that may have led to impacts to the receiving environment, i) updates of the water balance, and a calibration assessments of the water balance and water quality models, j) assessment of the outfall dispersion and dispersion modelling for the Quesnel Lake discharge, k) an update to any modeling relating to the Springer Pit groundwater seepage and its impacts on Bootjack Lake as described in section 3.1, l) a review and update of the assessment of acid rock drainage (ARD) potential and water quality impacts from mine waste management, m) a comparison of monitoring data with water quality guidelines, predictions and targets, n) an update on the progress of reclamation and any updates to the reclamation plan that impact on site water quality, o) an evaluation of the effectiveness of the Surface Runoff and Mine Drainage Control programs, p) a summary of the Public Liaison Committee meetings, including any issues and concerns presented, q) an evaluation of the Outfall and Pipeline Inspection program, r) trend analysis (graphs) of water monitoring data at each site for the past 5 years, and s) assessment of attainment of the NPM target value: i) Using the HAD-3 monitoring data, evaluate the average annual effluent quality and trends as defined in section 2.11.2 (c), ii) if the average annual effluent quality exceeds the NPM target value or if trends suggest NPM target value may be exceeded within the next annual review cycle, provide an explanation of the most probable cause(s), iii) summary of proposed response action(s), and iv) progress update with respect to implementation of any response action(s).	Yes	N/A
4.2.2	Monitoring data and the analysis of that data, as it will be presented in the annual report, must be reviewed by a third party Qualified Professional.	Yes	N/A
4.2.3	A groundwater monitoring program review, including but not limited to sampling, well locations, site water balance, interpretation of data trends and possible environmental impacts, and suitable recommendations, must be completed for the entire mine site at least every three years, with the next review required by March 31, 2025.	No	A groundwater review was completed March 31, 2022.
4.2.4	A copy of the annual report must be provided to the Williams Lake First Nation, Xatsull First Nation and Public Liaison Committee within 30 days of the report being submitted to the Director.	Yes	N/A

Authorized Person Initial:_____ Date:_____

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT? (Yes/No/ND)	ACTION TAKEN
4.3	The Permittee must ensure that all information submitted as a requirement of this permit is accurate and free from mistakes or misleading statements. The Permittee must include in any submission required under this permit an explanation for any data that: a) is required under the permit but is missing from the submission, and b) the Permittee considers to be not representative of the actual discharge, conditions, or other circumstances the data is intended to measure.	Yes	N/A
4.4.1	The Permittee must immediately notify the Director or designate of any noncompliance with the requirements of this Permit and take appropriate remedial action. Written confirmation of all non-compliance events, including available test results is required within 24 hours of the original notification unless otherwise directed by the Director.	Yes	N/A
4.4.2	Both the initial notice and the confirmation must also be emailed to EnvironmentalCompliance@gov.bc.ca	Yes	N/A
4.3.3	Within 30 days of any non-compliant event, the Permittee must submit a follow-up report to the Director that includes, but is not limited to the following: a) all relevant test results related to the non-compliance instance(s), b) an explanation of the most probable cause(s) of the noncompliance(s), and c) remedial actions taken and planned to prevent similar noncompliance(s).	Yes	See Sections 3.7.2 and 14.12.2.4
4.4.4	A copy of the initial compliance notice, written confirmation and follow-up report must also be provided to the Williams Lake First Nation, Xatsull First Nation, and the Public Liaison Committee.	Yes	N/A
4.5.1	The Permittee must immediately notify the Director of any toxicity failure according to the Non-Compliance Reporting requirements in section 4.4. For the purpose of this section , a sample is considered to have failed the specific toxicity test if: a) 96-hr LC50 Rainbow Trout: Using 100% effluent concentration, more than 50% of the fish die within a 96 hour test period, b) 48-hr LC50 Daphnia magna: Using 100% effluent concentration, more than 50% of the organisms die within a 48 hour test period, c) 7-day Ceriodaphnia dubia reproduction: The water is determined to cause greater than 25% inhibition of survival and reproduction, or d) 7-day ELS toxicity test with a salmonid fish: The water is determined to cause greater than 25% non-viable embryos.	Yes	No failures occurred in 2023, See Section 4.12.3
4.5.2	The Permittee must investigate each toxicity failure to determine the cause(s). Reasonable efforts must be made to obtain preliminary and in progress results from the analytical laboratory during the toxicity testing. The Permittee must make immediate arrangements to retest in the event of potential and confirmed failures. The Director may require additional toxicity testing based on the evaluation of results from toxicity testing and the causes of failure.	Yes	No failures occurred in 2023, See Section 4.12.3

Authorized Person Initial:_____ Date:_____

Appendix D

Quality Assurance/Quality Control

(Results in Electronic format only)



MPMC Annual Report 2023
Table 6
QA/QC Blanks

TRAVEL/TRIP BLANKS

GENERAL PARAMETERS

Date	Type of Blank	Lab Ref	Sample Type	Conductivity (µs/cm)	Hardness (as CaCO3) (mg/L)	Hardness (as CaCO3) from total Ca/Mg (mg/L)	pH (pH)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (ntu)	Alkalinity (CaCO3) (mg/L)	Ammonia (as N) (mg/L)	Chloride (Cl) (mg/L)	Nitrate (as N) (mg/L)
10-Jan-23	Travel Blank	VA23A0610	Water	<2.0		<0.50	5.49	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
11-Jan-23	Travel Blank	VA23A0897	Water	<2.0		<0.50	5.35	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
19-Jan-23	Travel Blank	VA23A1780	Water		<0.50							<0.0050		
23-Jan-23	Travel Blank	VA23A1780	Water	<2.0		<0.50	5.51	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
7-Feb-23	Travel Blank	VA23A2874	Water	<2.0		<0.50	5.46	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
16-Feb-23	Travel Blank	VA23A3700	Water	<2.0		<0.50	5.56	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
21-Feb-23	Travel Blank	VA23A4030	Water	<2.0		<0.50	5.44	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
6-Mar-23	Travel Blank	VA23A4928	Water	<2.0		<0.50	5.39	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
7-Mar-23	Travel Blank	VA23A4924	Water	<2.0		<0.50	5.44	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
4-Apr-23	Travel Blank	VA23A7296	Water	<2.0		<0.50	5.45	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
13-Apr-23	Travel Blank	VA23A8073	Water	<2.0		<0.50	5.47	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
2-May-23	Travel Blank	VA23A9530	Water	<2.0		<0.50	5.55				<1.0	<0.0050	<0.50	<0.0050
9-May-23	Travel Blank	VA23B0111	Water	<2.0		<0.50	5.48	<10		<0.10	<1.0	<0.0050	<0.50	<0.0050
10-May-23	Travel Blank	VA23B0453	Water	<2.0		<0.50	5.48	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
15-May-23	Travel Blank	VA23B0787	Water	<2.0		<0.50	6.17	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
15-May-23	Travel Blank	VA23B0789	Water	<2.0		<0.50	5.47	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
16-May-23	Travel Blank	VA23B0784	Water	<2.0		<0.50	5.43	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
17-May-23	Travel Blank	VA23B1175	Water	<2.0		<0.50	5.36	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
23-May-23	Travel Blank	VA23B1432	Water	<2.0		<0.50	5.24	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
25-May-23	Travel Blank	VA23B1774	Water	<2.0		<0.50	5.23	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
29-May-23	Travel Blank	VA23B2096	Water	<2.0		<0.50	5.27	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
30-May-23	Travel Blank	VA23B2099	Water	<2.0		<0.50	5.37	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
12-Jun-23	Travel Blank	VA23B3377	Water	<2.0		<0.50	5.49	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
12-Jun-23	Travel Blank	VA23B3378	Water	<2.0		<0.50	5.29	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
26-Jun-23	Travel Blank	VA23B4773	Water	<2.0		<0.50	5.39	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
27-Jun-23	Travel Blank	VA23B4755	Water	<2.0		<0.50	5.35	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
6-Jul-23	Travel Blank	VA23B5534	Water	<2.0		<0.50	5.19	<10	<1.2	<0.10	<1.0	<0.0050	<0.50	<0.0050
10-Jul-23	Travel Blank	VA23B5741	Water	<2.0		<0.50	5.48	<10	<1.2	<0.10	<1.0	<0.0050	<0.50	<0.0050
25-Jul-23	Travel Blank	VA23B7174	Water	<2.0		<0.50	5.08	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
27-Jul-23	Travel Blank	VA23B7484	Water	<2.0		<0.50	5.43	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
31-Jul-23	Travel Blank	VA23B7775	Water	<2.0		<0.50	5.51	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
2-Aug-23	Travel Blank	VA23B8032	Water	<2.0	<0.50		5.48				<1.0	<0.0050	<0.50	<0.0050
9-Aug-23	Travel Blank	VA23B8561	Water	<2.0		<0.50	5.54	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
15-Aug-23	Travel Blank	VA23B8903	Water	<2.0		<0.50	5.51	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
14-Sep-23	Travel Blank	VA23C1977	Water	<2.0		<0.50	5.41	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
26-Sep-23	Travel Blank	VA23C2939	Water	<2.0		<0.50	5.35	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
28-Sep-23	Travel Blank	VA23C3224	Water	<2.0		<0.50	5.3	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
4-Oct-23	Travel Blank	VA23C3981	Water	<2.0		<0.50	5.28	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
11-Oct-23	Travel Blank	VA23C4517	Water	<2.0		<0.50	5.5	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
16-Oct-23	Travel Blank	VA23C4773	Water	<2.0		<0.50	5.49	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
25-Oct-23	Travel Blank	VA23C5949	Water	<2.0		<0.50	5.51	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
30-Oct-23	Travel Blank	VA23C6268	Water	<2.0		<0.50	5.36	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
31-Oct-23	Travel Blank	VA23C6273	Water	<2.0		<0.50	5.39	<10	<1.1	<0.10	<1.0	<0.0050	<0.50	<0.0050
31-Oct-23	Travel Blank	VA23C6270	Water	<2.0		<0.50	5.38	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
8-Nov-23	Travel Blank	VA23C7187	Water	<2.0		<0.50	5.49	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
15-Nov-23	Travel Blank	VA23C7842	Water	<2.0		<0.50	5.46	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
22-Nov-23	Travel Blank	VA23C8353	Water	<2.0	<0.50		5.31				<1.0	<0.0050	<0.50	<0.0050
12-Dec-23	Travel Blank	VA23C9917	Water	<2.0		<0.50	5.32	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
13-Dec-23	Travel Blank	VA23D0136	Water	<2.0	<0.50		5.85				<1.0	<0.0050	<0.50	<0.0050
19-Dec-23	Travel Blank	VA23D0461	Water	<2.0		<0.50	5.6	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050

MPMC Annual Report 2023
Table 6
QA/QC Blanks

TRAVEL/TRIP BLANKS

TRACE ELEMENTS

Date	Type of Blank	Lab Ref	Sample Type	Aluminum (Al)-Total (mg/L)	Antimony (Sb)-Total (mg/L)	Arsenic (As)-Total (mg/L)	Barium (Ba)-Total (mg/L)	Beryllium (Be)-Total (mg/L)	Bismuth (Bi)-Total (mg/L)	Boron (B)-Total (mg/L)	Cadmium (Cd)-Total (mg/L)	Calcium (Ca)-Total (mg/L)	Chromium (Cr)-Total (mg/L)	Cobalt (Co)-Total (mg/L)
10-Jan-23	Travel Blank	VA23A0610	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
11-Jan-23	Travel Blank	VA23A0897	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
19-Jan-23	Travel Blank	VA23A1780	Water											
23-Jan-23	Travel Blank	VA23A1780	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
7-Feb-23	Travel Blank	VA23A2874	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
16-Feb-23	Travel Blank	VA23A3700	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
21-Feb-23	Travel Blank	VA23A4030	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
6-Mar-23	Travel Blank	VA23A4928	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
7-Mar-23	Travel Blank	VA23A4924	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
4-Apr-23	Travel Blank	VA23A7296	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
13-Apr-23	Travel Blank	VA23A8073	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
2-May-23	Travel Blank	VA23A9530	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
9-May-23	Travel Blank	VA23B0111	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
10-May-23	Travel Blank	VA23B0453	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
15-May-23	Travel Blank	VA23B0787	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
15-May-23	Travel Blank	VA23B0789	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
16-May-23	Travel Blank	VA23B0784	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
17-May-23	Travel Blank	VA23B1175	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
23-May-23	Travel Blank	VA23B1432	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
25-May-23	Travel Blank	VA23B1774	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
29-May-23	Travel Blank	VA23B2096	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
30-May-23	Travel Blank	VA23B2099	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
12-Jun-23	Travel Blank	VA23B3377	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
12-Jun-23	Travel Blank	VA23B3378	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
26-Jun-23	Travel Blank	VA23B4773	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
27-Jun-23	Travel Blank	VA23B4755	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
6-Jul-23	Travel Blank	VA23B5534	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
10-Jul-23	Travel Blank	VA23B5741	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
25-Jul-23	Travel Blank	VA23B7174	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
27-Jul-23	Travel Blank	VA23B7484	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
31-Jul-23	Travel Blank	VA23B7775	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
2-Aug-23	Travel Blank	VA23B8032	Water											
9-Aug-23	Travel Blank	VA23B8561	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
15-Aug-23	Travel Blank	VA23B8903	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
14-Sep-23	Travel Blank	VA23C1977	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
26-Sep-23	Travel Blank	VA23C2939	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
28-Sep-23	Travel Blank	VA23C3224	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
4-Oct-23	Travel Blank	VA23C3981	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
11-Oct-23	Travel Blank	VA23C4517	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
16-Oct-23	Travel Blank	VA23C4773	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
25-Oct-23	Travel Blank	VA23C5949	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
30-Oct-23	Travel Blank	VA23C6268	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
31-Oct-23	Travel Blank	VA23C6273	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
31-Oct-23	Travel Blank	VA23C6270	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
8-Nov-23	Travel Blank	VA23C7187	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
15-Nov-23	Travel Blank	VA23C7842	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
22-Nov-23	Travel Blank	VA23C8353	Water											
12-Dec-23	Travel Blank	VA23C9917	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
13-Dec-23	Travel Blank	VA23D0136	Water											
19-Dec-23	Travel Blank	VA23D0461	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010

MPMC Annual Report 2023
Table 6
QA/QC Blanks

TRAVEL/TRIP BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Strontium (Sr)-Total (mg/L)	Thallium (Tl)-Total (mg/L)	Tin (Sn)-Total (mg/L)	Titanium (Ti)-Total (mg/L)	Uranium (U)-Total (mg/L)	Vanadium (V)-Total (mg/L)	Zinc (Zn)-Total (mg/L)
10-Jan-23	Travel Blank	VA23A0610	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
11-Jan-23	Travel Blank	VA23A0897	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
19-Jan-23	Travel Blank	VA23A1780	Water							
23-Jan-23	Travel Blank	VA23A1780	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
7-Feb-23	Travel Blank	VA23A2874	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
16-Feb-23	Travel Blank	VA23A3700	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
21-Feb-23	Travel Blank	VA23A4030	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
6-Mar-23	Travel Blank	VA23A4928	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
7-Mar-23	Travel Blank	VA23A4924	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
4-Apr-23	Travel Blank	VA23A7296	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
13-Apr-23	Travel Blank	VA23A8073	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
2-May-23	Travel Blank	VA23A9530	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
9-May-23	Travel Blank	VA23B0111	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
10-May-23	Travel Blank	VA23B0453	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
15-May-23	Travel Blank	VA23B0787	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
15-May-23	Travel Blank	VA23B0789	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
16-May-23	Travel Blank	VA23B0784	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
17-May-23	Travel Blank	VA23B1175	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
23-May-23	Travel Blank	VA23B1432	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
25-May-23	Travel Blank	VA23B1774	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
29-May-23	Travel Blank	VA23B2096	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
30-May-23	Travel Blank	VA23B2099	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
12-Jun-23	Travel Blank	VA23B3377	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
12-Jun-23	Travel Blank	VA23B3378	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
26-Jun-23	Travel Blank	VA23B4773	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
27-Jun-23	Travel Blank	VA23B4755	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
6-Jul-23	Travel Blank	VA23B5534	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
10-Jul-23	Travel Blank	VA23B5741	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
25-Jul-23	Travel Blank	VA23B7174	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
27-Jul-23	Travel Blank	VA23B7484	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-Jul-23	Travel Blank	VA23B7775	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
2-Aug-23	Travel Blank	VA23B8032	Water							
9-Aug-23	Travel Blank	VA23B8561	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
15-Aug-23	Travel Blank	VA23B8903	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
14-Sep-23	Travel Blank	VA23C1977	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
26-Sep-23	Travel Blank	VA23C2939	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
28-Sep-23	Travel Blank	VA23C3224	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
4-Oct-23	Travel Blank	VA23C3981	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
11-Oct-23	Travel Blank	VA23C4517	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
16-Oct-23	Travel Blank	VA23C4773	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
25-Oct-23	Travel Blank	VA23C5949	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
30-Oct-23	Travel Blank	VA23C6268	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-Oct-23	Travel Blank	VA23C6273	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-Oct-23	Travel Blank	VA23C6270	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
8-Nov-23	Travel Blank	VA23C7187	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
15-Nov-23	Travel Blank	VA23C7842	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
22-Nov-23	Travel Blank	VA23C8353	Water							
12-Dec-23	Travel Blank	VA23C9917	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
13-Dec-23	Travel Blank	VA23D0136	Water							
19-Dec-23	Travel Blank	VA23D0461	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030

MPMC Annual Report 2023
Table 6
QA/QC Blanks

TRAVEL/TRIP BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Nitrite (as N) (mg/L)	Phosphorus (P) Total (mg/L)	Sulphate (mg/L)	Total Nitrogen (mg/L)
10-Jan-23	Travel Blank	VA23A0610	Water	<0.0010	<0.0020	<0.30	<0.030
11-Jan-23	Travel Blank	VA23A0897	Water	<0.0010	<0.0020	<0.30	<0.030
19-Jan-23	Travel Blank	VA23A1780	Water				<0.030
23-Jan-23	Travel Blank	VA23A1780	Water	<0.0010	<0.0020	<0.30	
7-Feb-23	Travel Blank	VA23A2874	Water	<0.0010	**0.0024**	<0.30	<0.030
16-Feb-23	Travel Blank	VA23A3700	Water	<0.0010	<0.0020	<0.30	<0.030
21-Feb-23	Travel Blank	VA23A4030	Water	<0.0010	<0.0020	<0.30	
6-Mar-23	Travel Blank	VA23A4928	Water	<0.0010	<0.0020	<0.30	<0.030
7-Mar-23	Travel Blank	VA23A4924	Water	<0.0010	<0.0020	<0.30	<0.030
4-Apr-23	Travel Blank	VA23A7296	Water	<0.0010	<0.0020	<0.30	<0.030
13-Apr-23	Travel Blank	VA23A8073	Water	<0.0010	<0.0020	<0.30	<0.030
2-May-23	Travel Blank	VA23A9530	Water	<0.0010	<0.0020	<0.30	<0.030
9-May-23	Travel Blank	VA23B0111	Water	<0.0010	<0.0020	<0.30	<0.030
10-May-23	Travel Blank	VA23B0453	Water	<0.0010	<0.0020	<0.30	<0.030
15-May-23	Travel Blank	VA23B0787	Water	<0.0010	<0.0020	<0.30	
15-May-23	Travel Blank	VA23B0789	Water	<0.0010	<0.0020	<0.30	<0.030
16-May-23	Travel Blank	VA23B0784	Water	<0.0010	<0.0020	<0.30	<0.030
17-May-23	Travel Blank	VA23B1175	Water	<0.0010	<0.0020	<0.30	<0.030
23-May-23	Travel Blank	VA23B1432	Water	<0.0010	<0.0020	<0.30	<0.030
25-May-23	Travel Blank	VA23B1774	Water	<0.0010	<0.0020	<0.30	<0.030
29-May-23	Travel Blank	VA23B2096	Water	<0.0010	<0.0020	<0.30	<0.030
30-May-23	Travel Blank	VA23B2099	Water	<0.0010	<0.0020	<0.30	<0.030
12-Jun-23	Travel Blank	VA23B3377	Water	<0.0010	<0.0020	<0.30	<0.030
12-Jun-23	Travel Blank	VA23B3378	Water	<0.0010	<0.0020	<0.30	<0.030
26-Jun-23	Travel Blank	VA23B4773	Water	<0.0010	<0.0020	<0.30	<0.030
27-Jun-23	Travel Blank	VA23B4755	Water	<0.0010	<0.0020	<0.30	<0.030
6-Jul-23	Travel Blank	VA23B5534	Water	<0.0010	<0.0020	<0.30	<0.030
10-Jul-23	Travel Blank	VA23B5741	Water	<0.0010	<0.0020	<0.30	<0.030
25-Jul-23	Travel Blank	VA23B7174	Water	<0.0010	<0.0020	<0.30	<0.030
27-Jul-23	Travel Blank	VA23B7484	Water	<0.0010	<0.0020	<0.30	<0.030
31-Jul-23	Travel Blank	VA23B7775	Water	<0.0010	<0.0020	<0.30	
2-Aug-23	Travel Blank	VA23B8032	Water	<0.0010	<0.0020	<0.30	<0.030
9-Aug-23	Travel Blank	VA23B8561	Water	<0.0010	<0.0020	<0.30	<0.030
15-Aug-23	Travel Blank	VA23B8903	Water	<0.0010	<0.0020	<0.30	<0.030
14-Sep-23	Travel Blank	VA23C1977	Water	<0.0010	<0.0020	<0.30	<0.030
26-Sep-23	Travel Blank	VA23C2939	Water	<0.0010	<0.0020	<0.30	<0.030
28-Sep-23	Travel Blank	VA23C3224	Water	<0.0010	<0.0020	<0.30	<0.030
4-Oct-23	Travel Blank	VA23C3981	Water	<0.0010	<0.0020	<0.30	<0.030
11-Oct-23	Travel Blank	VA23C4517	Water	<0.0010	<0.0020	<0.30	<0.030
16-Oct-23	Travel Blank	VA23C4773	Water	<0.0010	<0.0020	<0.30	<0.030
25-Oct-23	Travel Blank	VA23C5949	Water	<0.0010	<0.0020	<0.30	<0.030
30-Oct-23	Travel Blank	VA23C6268	Water	<0.0010	<0.0020	<0.30	<0.030
31-Oct-23	Travel Blank	VA23C6273	Water	<0.0010	<0.0020	<0.30	<0.030
31-Oct-23	Travel Blank	VA23C6270	Water	<0.0010	<0.0020	<0.30	<0.030
8-Nov-23	Travel Blank	VA23C7187	Water	<0.0010	<0.0020	<0.30	<0.030
15-Nov-23	Travel Blank	VA23C7842	Water	<0.0010	<0.0020	<0.30	<0.030
22-Nov-23	Travel Blank	VA23C8353	Water	<0.0010	<0.0020	<0.30	<0.030
12-Dec-23	Travel Blank	VA23C9917	Water	<0.0010	<0.0020	<0.30	<0.030
13-Dec-23	Travel Blank	VA23D0136	Water	<0.0010	<0.0020	<0.30	<0.030
19-Dec-23	Travel Blank	VA23D0461	Water	<0.0010	<0.0020	<0.30	<0.030

MPMC Annual Report 2023
Table 6
QA/QC Blanks

TRAVEL/TRIP BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Copper (Cu)-Total (mg/L)	Iron (Fe)-Total (mg/L)	Lead (Pb)-Total (mg/L)	Lithium (Li)-Total (mg/L)	Magnesium (Mg)-Total (mg/L)	Manganese (Mn)-Total (mg/L)	Molybdenum (Mo)-Total (mg/L)	Nickel (Ni)-Total (mg/L)	Potassium (K)-Total (mg/L)	Selenium (Se)-Total (mg/L)
10-Jan-23	Travel Blank	VA23A0610	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
11-Jan-23	Travel Blank	VA23A0897	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
19-Jan-23	Travel Blank	VA23A1780	Water										
23-Jan-23	Travel Blank	VA23A1780	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	**0.000136**	<0.00050	<0.050	<0.000050
7-Feb-23	Travel Blank	VA23A2874	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
16-Feb-23	Travel Blank	VA23A3700	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
21-Feb-23	Travel Blank	VA23A4030	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
6-Mar-23	Travel Blank	VA23A4928	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
7-Mar-23	Travel Blank	VA23A4924	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
4-Apr-23	Travel Blank	VA23A7296	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
13-Apr-23	Travel Blank	VA23A8073	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
2-May-23	Travel Blank	VA23A9530	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
9-May-23	Travel Blank	VA23B0111	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
10-May-23	Travel Blank	VA23B0453	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
15-May-23	Travel Blank	VA23B0787	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
15-May-23	Travel Blank	VA23B0789	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
16-May-23	Travel Blank	VA23B0784	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
17-May-23	Travel Blank	VA23B1175	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
23-May-23	Travel Blank	VA23B1432	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
25-May-23	Travel Blank	VA23B1774	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
29-May-23	Travel Blank	VA23B2096	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
30-May-23	Travel Blank	VA23B2099	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
12-Jun-23	Travel Blank	VA23B3377	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
12-Jun-23	Travel Blank	VA23B3378	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
26-Jun-23	Travel Blank	VA23B4773	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
27-Jun-23	Travel Blank	VA23B4755	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
6-Jul-23	Travel Blank	VA23B5534	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
10-Jul-23	Travel Blank	VA23B5741	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
25-Jul-23	Travel Blank	VA23B7174	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
27-Jul-23	Travel Blank	VA23B7484	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
31-Jul-23	Travel Blank	VA23B7775	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
2-Aug-23	Travel Blank	VA23B8032	Water										
9-Aug-23	Travel Blank	VA23B8561	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
15-Aug-23	Travel Blank	VA23B8903	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
14-Sep-23	Travel Blank	VA23C1977	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
26-Sep-23	Travel Blank	VA23C2939	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
28-Sep-23	Travel Blank	VA23C3224	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
4-Oct-23	Travel Blank	VA23C3981	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
11-Oct-23	Travel Blank	VA23C4517	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
16-Oct-23	Travel Blank	VA23C4773	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
25-Oct-23	Travel Blank	VA23C5949	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
30-Oct-23	Travel Blank	VA23C6268	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
31-Oct-23	Travel Blank	VA23C6273	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
31-Oct-23	Travel Blank	VA23C6270	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
8-Nov-23	Travel Blank	VA23C7187	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
15-Nov-23	Travel Blank	VA23C7842	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
22-Nov-23	Travel Blank	VA23C8353	Water										
12-Dec-23	Travel Blank	VA23C9917	Water	<0.00050	<0.030	**0.000148**	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
13-Dec-23	Travel Blank	VA23D0136	Water										
19-Dec-23	Travel Blank	VA23D0461	Water	**0.00058**	<0.030	**0.000187**	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050

MPMC Annual Report 2023
Table 6
QA/QC Blanks

TRAVEL/TRIP BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Silicon (Si)-Total (mg/L)	Silver (Ag)-Total (mg/L)	Sodium (Na)-Total (mg/L)
10-Jan-23	Travel Blank	VA23A0610	Water	<0.10	<0.000010	<0.050
11-Jan-23	Travel Blank	VA23A0897	Water	<0.10	<0.000010	<0.050
19-Jan-23	Travel Blank	VA23A1780	Water			
23-Jan-23	Travel Blank	VA23A1780	Water	<0.10	<0.000010	<0.050
7-Feb-23	Travel Blank	VA23A2874	Water	<0.10	<0.000010	<0.050
16-Feb-23	Travel Blank	VA23A3700	Water	<0.10	<0.000010	<0.050
21-Feb-23	Travel Blank	VA23A4030	Water	<0.10	<0.000010	<0.050
6-Mar-23	Travel Blank	VA23A4928	Water	<0.10	<0.000010	<0.050
7-Mar-23	Travel Blank	VA23A4924	Water	<0.10	<0.000010	<0.050
4-Apr-23	Travel Blank	VA23A7296	Water	<0.10	<0.000010	<0.050
13-Apr-23	Travel Blank	VA23A8073	Water	<0.10	<0.000010	<0.050
2-May-23	Travel Blank	VA23A9530	Water	<0.10	<0.000010	<0.050
9-May-23	Travel Blank	VA23B0111	Water	<0.10	<0.000010	<0.050
10-May-23	Travel Blank	VA23B0453	Water	<0.10	<0.000010	<0.050
15-May-23	Travel Blank	VA23B0787	Water	<0.10	<0.000010	<0.050
15-May-23	Travel Blank	VA23B0789	Water	<0.10	<0.000010	<0.050
16-May-23	Travel Blank	VA23B0784	Water	<0.10	<0.000010	<0.050
17-May-23	Travel Blank	VA23B1175	Water	<0.10	<0.000010	<0.050
23-May-23	Travel Blank	VA23B1432	Water	<0.10	<0.000010	<0.050
25-May-23	Travel Blank	VA23B1774	Water	<0.10	<0.000010	<0.050
29-May-23	Travel Blank	VA23B2096	Water	<0.10	<0.000010	<0.050
30-May-23	Travel Blank	VA23B2099	Water	<0.10	<0.000010	<0.050
12-Jun-23	Travel Blank	VA23B3377	Water	<0.10	<0.000010	<0.050
12-Jun-23	Travel Blank	VA23B3378	Water	<0.10	<0.000010	<0.050
26-Jun-23	Travel Blank	VA23B4773	Water	<0.10	<0.000010	<0.050
27-Jun-23	Travel Blank	VA23B4755	Water	<0.10	<0.000010	<0.050
6-Jul-23	Travel Blank	VA23B5534	Water	<0.10	<0.000010	<0.050
10-Jul-23	Travel Blank	VA23B5741	Water	<0.10	<0.000010	<0.050
25-Jul-23	Travel Blank	VA23B7174	Water	<0.10	<0.000010	<0.050
27-Jul-23	Travel Blank	VA23B7484	Water	<0.10	<0.000010	<0.050
31-Jul-23	Travel Blank	VA23B7775	Water	<0.10	<0.000010	<0.050
2-Aug-23	Travel Blank	VA23B8032	Water			
9-Aug-23	Travel Blank	VA23B8561	Water	<0.10	<0.000010	<0.050
15-Aug-23	Travel Blank	VA23B8903	Water	<0.10	<0.000010	<0.050
14-Sep-23	Travel Blank	VA23C1977	Water	<0.10	<0.000010	<0.050
26-Sep-23	Travel Blank	VA23C2939	Water	<0.10	<0.000010	<0.050
28-Sep-23	Travel Blank	VA23C3224	Water	<0.10	<0.000010	<0.050
4-Oct-23	Travel Blank	VA23C3981	Water	<0.10	<0.000010	<0.050
11-Oct-23	Travel Blank	VA23C4517	Water	<0.10	<0.000010	<0.050
16-Oct-23	Travel Blank	VA23C4773	Water	<0.10	<0.000010	<0.050
25-Oct-23	Travel Blank	VA23C5949	Water	<0.10	<0.000010	<0.050
30-Oct-23	Travel Blank	VA23C6268	Water	<0.10	<0.000010	<0.050
31-Oct-23	Travel Blank	VA23C6273	Water	<0.10	<0.000010	<0.050
31-Oct-23	Travel Blank	VA23C6270	Water	<0.10	<0.000010	<0.050
8-Nov-23	Travel Blank	VA23C7187	Water	<0.10	<0.000010	<0.050
15-Nov-23	Travel Blank	VA23C7842	Water	<0.10	<0.000010	<0.050
22-Nov-23	Travel Blank	VA23C8353	Water			
12-Dec-23	Travel Blank	VA23C9917	Water	<0.10	<0.000010	<0.050
13-Dec-23	Travel Blank	VA23D0136	Water			
19-Dec-23	Travel Blank	VA23D0461	Water	<0.10	<0.000010	<0.050

MPMC Annual Report 2023
Table 7
QA/QC Blanks

FIELD BLANKS

GENERAL PARAMETERS

Date	Type of Blank	Location	Lab Ref	Sample Type	Conductivity (µs/cm)	Hardness (as CaCO3) (mg/L)	Hardness (as CaCO3) from total Ca/Mg (mg/L)	pH (pH)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (ntu)	Alkalinity (CaCO3) (mg/L)	Ammonia (as N) (mg/L)	Chloride (Cl) (mg/L)
5-Jan-23	Field Blank	Mine Site	VA23A0315	Water	<2.0		<0.50	5.5	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
11-Jan-23	Field Blank	Groundwater	VA23A0902	Water	<2.0	<0.50		5.32				<1.0	<0.0050	<0.50
30-Jan-23	Field Blank	Mine Site	VA23A2395	Water	<2.0	<0.50	<0.50	5.48	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
8-Feb-23	Field Blank	Hazeltine Creek	VA23A3195	Water	<2.0		<0.50	5.36	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
13-Feb-23	Field Blank	Mine Site	VA23A3440	Water	<2.0		<0.50	5.4	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
2-Mar-23	Field Blank	Mine Site	VA23A4692	Water	<2.0		<0.50	5.52	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
6-Mar-23	Field Blank	Mine Site	VA23A4928	Water	<2.0		<0.50	5.37	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
15-Mar-23	Field Blank	Polley Lake	VA23A5799	Water	<2.0		<0.50	5.44	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
21-Mar-23	Field Blank	Mine Site	VA23A6147	Water	<2.0		<0.50	5.46	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
4-Apr-23	Field Blank	Mine Site	VA23A7300	Water	<2.0		<0.50	5.39	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
12-Apr-23	Field Blank	Mine Site	VA23A7867	Water	<2.0		<0.50	5.51	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
26-Apr-23	Field Blank	Mine Site	VA23A9213	Water	<2.0	<0.50	<0.50	5.56	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
1-May-23	Field Blank	Hazeltine Creek	VA23A9519	Water	<2.0		<0.50	5.55	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
23-May-23	Field Blank	Mine Site	VA23B1432	Water	<2.0		<0.50	5.16	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
31-May-23	Field Blank	Groundwater	VA23B2383	Water	<2.0	<0.50		5.76				<1.0	<0.0050	<0.50
6-Jun-23	Field Blank	Quesnel Lake	VA23B2768	Water	<2.0		<0.50	5.49	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
13-Jun-23	Field Blank	Mine Site	VA23B3380	Water	<2.0		<0.50	5.45	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
20-Jun-23	Field Blank	Mine Site	VA23B4085	Water	<2.0		<0.50	5.37	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
29-Jun-23	Field Blank	Mine Site	VA23B5003	Water	<2.0		<0.50	5.15	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
4-Jul-23	Field Blank	Mine Site	VA23B5277	Water	<2.0		<0.50	5.34	<10	<1.2	<0.10	<1.0	<0.0050	<0.50
26-Jul-23	Field Blank	Polley Lake	VA23B7485	Water	<2.0		<0.50	5.49	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
26-Jul-23	Field Blank	Quesnel Lake	VA23B7481	Water	<2.0		<0.50	5.07	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
1-Aug-23	Field Blank	Mine Site	VA23B7781	Water	<2.0		<0.50	5.36	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
2-Aug-23	Field Blank	Hazeltine Creek	VA23B8013	Water	<2.0		<0.50	5.46	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
9-Aug-23	Field Blank	Mine Site	VA23B8561	Water	<2.0		<0.50	5.49	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
23-Aug-23	Field Blank	Bootjack Lake	VA23B9944	Water	<2.0		<0.50	4.95	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
7-Sep-23	Field Blank	Bootjack Lake	VA23C1201	Water	<2.0		<0.50	5.35	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
11-Sep-23	Field Blank	Quesnel Lake	VA23C1541	Water	<2.0		<0.50	5.69	<10	<1.0	<0.10	<1.0	<0.0050	<0.50
20-Sep-23	Field Blank	Groundwater	VA23C2564	Water	<2.0	<0.50		5.5				<1.0	<0.0050	<0.50
5-Oct-23	Field Blank	Mine Site	VA23C3979	Water	<2.0		<0.50	5.32	<10	<1.2	<0.10	<1.0	<0.0050	<0.50
11-Oct-23	Field Blank	Mine Site	VA23C4517	Water	<2.0		<0.50	5.51	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
24-Oct-23	Field Blank	Mine Site	VA23C5590	Water	<2.0		<0.50	5.21	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
26-Oct-23	Field Blank	Mine Site	VA23C5948	Water	<2.0		<0.50	5.35	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
1-Nov-23	Field Blank	Mine Site	VA23C6524	Water	<2.0		<0.50	5.54	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
23-Nov-23	Field Blank	Mine Site	VA23C8357	Water	<2.0		<0.50	5.64	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
7-Dec-23	Field Blank	Mine Site	VA23C9593	Water	<2.0		<0.50	5.29	<10	<1.1	<0.10	<1.0	<0.0050	<0.50
13-Dec-23	Field Blank	Groundwater	VA23D0136	Water	<2.0	<0.50		5.45				<1.0	<0.0050	<0.50

MPMC Annual Report 2023
Table 7
QA/QC Blanks

FIELD BLANKS

TRACE ELEMENTS

Date	Type of Blank	Location	Lab Ref	Sample Type	Aluminum (Al)-Total (mg/L)	Antimony (Sb)-Total (mg/L)	Arsenic (As)-Total (mg/L)	Barium (Ba)-Total (mg/L)	Beryllium (Be)-Total (mg/L)	Bismuth (Bi)-Total (mg/L)	Boron (B)-Total (mg/L)	Cadmium (Cd)-Total (mg/L)	Calcium (Ca)-Total (mg/L)	Chromium (Cr)-Total (mg/L)
5-Jan-23	Field Blank	Mine Site	VA23A0315	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
11-Jan-23	Field Blank	Groundwater	VA23A0902	Water										
30-Jan-23	Field Blank	Mine Site	VA23A2395	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
8-Feb-23	Field Blank	Hazeltine Creek	VA23A3195	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
13-Feb-23	Field Blank	Mine Site	VA23A3440	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
2-Mar-23	Field Blank	Mine Site	VA23A4692	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
6-Mar-23	Field Blank	Mine Site	VA23A4928	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
15-Mar-23	Field Blank	Polley Lake	VA23A5799	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
21-Mar-23	Field Blank	Mine Site	VA23A6147	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
4-Apr-23	Field Blank	Mine Site	VA23A7300	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
12-Apr-23	Field Blank	Mine Site	VA23A7867	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
26-Apr-23	Field Blank	Mine Site	VA23A9213	Water	**0.0077**	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
1-May-23	Field Blank	Hazeltine Creek	VA23A9519	Water	**0.0036**	<0.00010	<0.00010	**0.00018**	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
23-May-23	Field Blank	Mine Site	VA23B1432	Water	**0.0094**	<0.00010	<0.00010	**0.00021**	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
31-May-23	Field Blank	Groundwater	VA23B2383	Water										
6-Jun-23	Field Blank	Quesnel Lake	VA23B2768	Water	**0.0061**	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
13-Jun-23	Field Blank	Mine Site	VA23B3380	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
20-Jun-23	Field Blank	Mine Site	VA23B4085	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
29-Jun-23	Field Blank	Mine Site	VA23B5003	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
4-Jul-23	Field Blank	Mine Site	VA23B5277	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
26-Jul-23	Field Blank	Polley Lake	VA23B7485	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
26-Jul-23	Field Blank	Quesnel Lake	VA23B7481	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
1-Aug-23	Field Blank	Mine Site	VA23B7781	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
2-Aug-23	Field Blank	Hazeltine Creek	VA23B8013	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
9-Aug-23	Field Blank	Mine Site	VA23B8561	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
23-Aug-23	Field Blank	Bootjack Lake	VA23B9944	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
7-Sep-23	Field Blank	Bootjack Lake	VA23C1201	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
11-Sep-23	Field Blank	Quesnel Lake	VA23C1541	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
20-Sep-23	Field Blank	Groundwater	VA23C2564	Water										
5-Oct-23	Field Blank	Mine Site	VA23C3979	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
11-Oct-23	Field Blank	Mine Site	VA23C4517	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
24-Oct-23	Field Blank	Mine Site	VA23C5590	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
26-Oct-23	Field Blank	Mine Site	VA23C5948	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
1-Nov-23	Field Blank	Mine Site	VA23C6524	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
23-Nov-23	Field Blank	Mine Site	VA23C8357	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
7-Dec-23	Field Blank	Mine Site	VA23C9593	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050
13-Dec-23	Field Blank	Groundwater	VA23D0136	Water										

MPMC Annual Report 2023
Table 7
QA/QC Blanks

FIELD BLANKS

Date	Type of Blank	Location	Lab Ref	Sample Type	Strontium (Sr)-Total (mg/L)	Thallium (Tl)-Total (mg/L)	Tin (Sn)-Total (mg/L)	Titanium (Ti)-Total (mg/L)	Uranium (U)-Total (mg/L)	Vanadium (V)-Total (mg/L)	Zinc (Zn)-Total (mg/L)
5-Jan-23	Field Blank	Mine Site	VA23A0315	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
11-Jan-23	Field Blank	Groundwater	VA23A0902	Water							
30-Jan-23	Field Blank	Mine Site	VA23A2395	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
8-Feb-23	Field Blank	Hazeltine Creek	VA23A3195	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
13-Feb-23	Field Blank	Mine Site	VA23A3440	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
2-Mar-23	Field Blank	Mine Site	VA23A4692	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
6-Mar-23	Field Blank	Mine Site	VA23A4928	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
15-Mar-23	Field Blank	Polley Lake	VA23A5799	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
21-Mar-23	Field Blank	Mine Site	VA23A6147	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
4-Apr-23	Field Blank	Mine Site	VA23A7300	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
12-Apr-23	Field Blank	Mine Site	VA23A7867	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
26-Apr-23	Field Blank	Mine Site	VA23A9213	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
1-May-23	Field Blank	Hazeltine Creek	VA23A9519	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
23-May-23	Field Blank	Mine Site	VA23B1432	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-May-23	Field Blank	Groundwater	VA23B2383	Water							
6-Jun-23	Field Blank	Quesnel Lake	VA23B2768	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
13-Jun-23	Field Blank	Mine Site	VA23B3380	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
20-Jun-23	Field Blank	Mine Site	VA23B4085	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
29-Jun-23	Field Blank	Mine Site	VA23B5003	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
4-Jul-23	Field Blank	Mine Site	VA23B5277	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
26-Jul-23	Field Blank	Polley Lake	VA23B7485	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
26-Jul-23	Field Blank	Quesnel Lake	VA23B7481	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
1-Aug-23	Field Blank	Mine Site	VA23B7781	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
2-Aug-23	Field Blank	Hazeltine Creek	VA23B8013	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
9-Aug-23	Field Blank	Mine Site	VA23B8561	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
23-Aug-23	Field Blank	Bootjack Lake	VA23B9944	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
7-Sep-23	Field Blank	Bootjack Lake	VA23C1201	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
11-Sep-23	Field Blank	Quesnel Lake	VA23C1541	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
20-Sep-23	Field Blank	Groundwater	VA23C2564	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
5-Oct-23	Field Blank	Mine Site	VA23C3979	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
11-Oct-23	Field Blank	Mine Site	VA23C4517	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
24-Oct-23	Field Blank	Mine Site	VA23C5590	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
26-Oct-23	Field Blank	Mine Site	VA23C5948	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
1-Nov-23	Field Blank	Mine Site	VA23C6524	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
23-Nov-23	Field Blank	Mine Site	VA23C8357	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
7-Dec-23	Field Blank	Mine Site	VA23C9593	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
13-Dec-23	Field Blank	Groundwater	VA23D0136	Water							

MPMC Annual Report 2023
Table 7
QA/QC Blanks

FIELD BLANKS

Date	Type of Blank	Location	Lab Ref	Sample Type	Nitrate (as N) (mg/L)	Nitrite (as N) (mg/L)	Phosphorus (P) Total (mg/L)	Sulphate (mg/L)	Total Nitrogen (mg/L)	Dissolved Organic Carbon (mg/L)
5-Jan-23	Field Blank	Mine Site	VA23A0315	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
11-Jan-23	Field Blank	Groundwater	VA23A0902	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
30-Jan-23	Field Blank	Mine Site	VA23A2395	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
8-Feb-23	Field Blank	Hazeltine Creek	VA23A3195	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
13-Feb-23	Field Blank	Mine Site	VA23A3440	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
2-Mar-23	Field Blank	Mine Site	VA23A4692	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
6-Mar-23	Field Blank	Mine Site	VA23A4928	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
15-Mar-23	Field Blank	Polley Lake	VA23A5799	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
21-Mar-23	Field Blank	Mine Site	VA23A6147	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
4-Apr-23	Field Blank	Mine Site	VA23A7300	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
12-Apr-23	Field Blank	Mine Site	VA23A7867	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
26-Apr-23	Field Blank	Mine Site	VA23A9213	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
1-May-23	Field Blank	Hazeltine Creek	VA23A9519	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
23-May-23	Field Blank	Mine Site	VA23B1432	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
31-May-23	Field Blank	Groundwater	VA23B2383	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
6-Jun-23	Field Blank	Quesnel Lake	VA23B2768	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
13-Jun-23	Field Blank	Mine Site	VA23B3380	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
20-Jun-23	Field Blank	Mine Site	VA23B4085	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
29-Jun-23	Field Blank	Mine Site	VA23B5003	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
4-Jul-23	Field Blank	Mine Site	VA23B5277	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
26-Jul-23	Field Blank	Polley Lake	VA23B7485	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
26-Jul-23	Field Blank	Quesnel Lake	VA23B7481	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
1-Aug-23	Field Blank	Mine Site	VA23B7781	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
2-Aug-23	Field Blank	Hazeltine Creek	VA23B8013	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
9-Aug-23	Field Blank	Mine Site	VA23B8561	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
23-Aug-23	Field Blank	Bootjack Lake	VA23B9944	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
7-Sep-23	Field Blank	Bootjack Lake	VA23C1201	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
11-Sep-23	Field Blank	Quesnel Lake	VA23C1541	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
20-Sep-23	Field Blank	Groundwater	VA23C2564	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
5-Oct-23	Field Blank	Mine Site	VA23C3979	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50
11-Oct-23	Field Blank	Mine Site	VA23C4517	Water	<0.0050	<0.0010	<0.0020	<0.030	<0.30	<0.50
24-Oct-23	Field Blank	Mine Site	VA23C5590	Water	<0.0050	<0.0010	<0.0020	<0.030	<0.30	<0.50
26-Oct-23	Field Blank	Mine Site	VA23C5948	Water	<0.0050	<0.0010	<0.0020	<0.030	<0.30	<0.50
1-Nov-23	Field Blank	Mine Site	VA23C6524	Water	<0.0050	<0.0010	<0.0020	<0.030	<0.30	<0.50
23-Nov-23	Field Blank	Mine Site	VA23C8357	Water	<0.0050	<0.0010	<0.0020	<0.030	<0.30	<0.50
7-Dec-23	Field Blank	Mine Site	VA23C9593	Water	<0.0050	<0.0010	<0.0020	<0.030	<0.30	<0.50
13-Dec-23	Field Blank	Groundwater	VA23D0136	Water	<0.0050	<0.0010	<0.0020	<0.30	<0.030	<0.50

MPMC Annual Report 2023
Table 7
QA/QC Blanks

FIELD BLANKS

Date	Type of Blank	Location	Lab Ref	Sample Type	Cobalt (Co)-Total (mg/L)	Copper (Cu)-Total (mg/L)	Iron (Fe)-Total (mg/L)	Lead (Pb)-Total (mg/L)	Lithium (Li)-Total (mg/L)	Magnesium (Mg)-Total (mg/L)	Manganese (Mn)-Total (mg/L)	Molybdenum (Mo)-Total (mg/L)	Nickel (Ni)-Total (mg/L)
5-Jan-23	Field Blank	Mine Site	VA23A0315	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
11-Jan-23	Field Blank	Groundwater	VA23A0902	Water									
30-Jan-23	Field Blank	Mine Site	VA23A2395	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
8-Feb-23	Field Blank	Hazeltine Creek	VA23A3195	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
13-Feb-23	Field Blank	Mine Site	VA23A3440	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
2-Mar-23	Field Blank	Mine Site	VA23A4692	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
6-Mar-23	Field Blank	Mine Site	VA23A4928	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
15-Mar-23	Field Blank	Polley Lake	VA23A5799	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
21-Mar-23	Field Blank	Mine Site	VA23A6147	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
4-Apr-23	Field Blank	Mine Site	VA23A7300	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
12-Apr-23	Field Blank	Mine Site	VA23A7867	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
26-Apr-23	Field Blank	Mine Site	VA23A9213	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
1-May-23	Field Blank	Hazeltine Creek	VA23A9519	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
23-May-23	Field Blank	Mine Site	VA23B1432	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00016**	<0.000050	<0.00050
31-May-23	Field Blank	Groundwater	VA23B2383	Water									
6-Jun-23	Field Blank	Quesnel Lake	VA23B2768	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00013**	<0.000050	<0.00050
13-Jun-23	Field Blank	Mine Site	VA23B3380	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
20-Jun-23	Field Blank	Mine Site	VA23B4085	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
29-Jun-23	Field Blank	Mine Site	VA23B5003	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
4-Jul-23	Field Blank	Mine Site	VA23B5277	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
26-Jul-23	Field Blank	Polley Lake	VA23B7485	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
26-Jul-23	Field Blank	Quesnel Lake	VA23B7481	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
1-Aug-23	Field Blank	Mine Site	VA23B7781	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
2-Aug-23	Field Blank	Hazeltine Creek	VA23B8013	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
9-Aug-23	Field Blank	Mine Site	VA23B8561	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
23-Aug-23	Field Blank	Bootjack Lake	VA23B9944	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
7-Sep-23	Field Blank	Bootjack Lake	VA23C1201	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
11-Sep-23	Field Blank	Quesnel Lake	VA23C1541	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
20-Sep-23	Field Blank	Groundwater	VA23C2564	Water									
5-Oct-23	Field Blank	Mine Site	VA23C3979	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
11-Oct-23	Field Blank	Mine Site	VA23C4517	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
24-Oct-23	Field Blank	Mine Site	VA23C5590	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
26-Oct-23	Field Blank	Mine Site	VA23C5948	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
1-Nov-23	Field Blank	Mine Site	VA23C6524	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
23-Nov-23	Field Blank	Mine Site	VA23C8357	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
7-Dec-23	Field Blank	Mine Site	VA23C9593	Water	<0.00010	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050
13-Dec-23	Field Blank	Groundwater	VA23D0136	Water									

MPMC Annual Report 2023
Table 7
QA/QC Blanks

FIELD BLANKS

Date	Type of Blank	Location	Lab Ref	Sample Type	Potassium (K)-Total (mg/L)	Selenium (Se)-Total (mg/L)	Silicon (Si)-Total (mg/L)	Silver (Ag)-Total (mg/L)	Sodium (Na)-Total (mg/L)
5-Jan-23	Field Blank	Mine Site	VA23A0315	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
11-Jan-23	Field Blank	Groundwater	VA23A0902	Water					
30-Jan-23	Field Blank	Mine Site	VA23A2395	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
8-Feb-23	Field Blank	Hazeltine Creek	VA23A3195	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
13-Feb-23	Field Blank	Mine Site	VA23A3440	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
2-Mar-23	Field Blank	Mine Site	VA23A4692	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
6-Mar-23	Field Blank	Mine Site	VA23A4928	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
15-Mar-23	Field Blank	Polley Lake	VA23A5799	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
21-Mar-23	Field Blank	Mine Site	VA23A6147	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
4-Apr-23	Field Blank	Mine Site	VA23A7300	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
12-Apr-23	Field Blank	Mine Site	VA23A7867	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
26-Apr-23	Field Blank	Mine Site	VA23A9213	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
1-May-23	Field Blank	Hazeltine Creek	VA23A9519	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
23-May-23	Field Blank	Mine Site	VA23B1432	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
31-May-23	Field Blank	Groundwater	VA23B2383	Water					
6-Jun-23	Field Blank	Quesnel Lake	VA23B2768	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
13-Jun-23	Field Blank	Mine Site	VA23B3380	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
20-Jun-23	Field Blank	Mine Site	VA23B4085	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
29-Jun-23	Field Blank	Mine Site	VA23B5003	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
4-Jul-23	Field Blank	Mine Site	VA23B5277	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
26-Jul-23	Field Blank	Polley Lake	VA23B7485	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
26-Jul-23	Field Blank	Quesnel Lake	VA23B7481	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
1-Aug-23	Field Blank	Mine Site	VA23B7781	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
2-Aug-23	Field Blank	Hazeltine Creek	VA23B8013	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
9-Aug-23	Field Blank	Mine Site	VA23B8561	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
23-Aug-23	Field Blank	Bootjack Lake	VA23B9944	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
7-Sep-23	Field Blank	Bootjack Lake	VA23C1201	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
11-Sep-23	Field Blank	Quesnel Lake	VA23C1541	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
20-Sep-23	Field Blank	Groundwater	VA23C2564	Water					
5-Oct-23	Field Blank	Mine Site	VA23C3979	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
11-Oct-23	Field Blank	Mine Site	VA23C4517	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
24-Oct-23	Field Blank	Mine Site	VA23C5590	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
26-Oct-23	Field Blank	Mine Site	VA23C5948	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
1-Nov-23	Field Blank	Mine Site	VA23C6524	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
23-Nov-23	Field Blank	Mine Site	VA23C8357	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
7-Dec-23	Field Blank	Mine Site	VA23C9593	Water	<0.050	<0.000050	<0.10	<0.000010	<0.050
13-Dec-23	Field Blank	Groundwater	VA23D0136	Water					

MPMC Annual Report 2023
Table 8
QA/QC Blanks

FILTER BLANKS

GENERAL PARAMETERS

Date	Type of Blank	Lab Ref	Sample	Hardness (as CaCO3) (mg/L)
12-Jan-23	Filter Blank	VA23A0900	Water	<0.50
6-Feb-23	Filter Blank	VA23A2864	Water	<0.50
10-Aug-23	Filter Blank	VA23B8562	Water	<0.50
11-Oct-23	Filter Blank	VA23C4517	Water	<0.50

DISSOLVED METALS

Date	Type of Blank	Lab Ref	Sample	Aluminum (Al)-Dissolved (mg/L)	Antimony (Sb)-Dissolved (mg/L)	Arsenic (As)-Dissolved (mg/L)	Barium (Ba)-Dissolved (mg/L)	Beryllium (Be)-Dissolved (mg/L)	Bismuth (Bi)-Dissolved (mg/L)	Boron (B)-Dissolved (mg/L)	Cadmium (Cd)-Dissolved (mg/L)	Calcium (Ca)-Dissolved (mg/L)	Chromium (Cr)-Dissolved (mg/L)	Cobalt (Co)-Dissolved (mg/L)
12-Jan-23	Filter Blank	VA23A0900	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
6-Feb-23	Filter Blank	VA23A2864	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
10-Aug-23	Filter Blank	VA23B8562	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
11-Oct-23	Filter Blank	VA23C4517	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010

Date	Type of Blank	Lab Ref	Sample	Copper (Cu)-Dissolved (mg/L)	Iron (Fe)-Dissolved (mg/L)	Lead (Pb)-Dissolved (mg/L)	Lithium (Li)-Dissolved (mg/L)	Magnesium (Mg)-Dissolved (mg/L)	Manganese (Mn)-Dissolved (mg/L)	Molybdenum (Mo)-Dissolved (mg/L)	Nickel (Ni)-Dissolved (mg/L)	Potassium (K)-Dissolved (mg/L)	Selenium (Se)-Dissolved (mg/L)	Silicon (Si)-Dissolved (mg/L)
12-Jan-23	Filter Blank	VA23A0900	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
6-Feb-23	Filter Blank	VA23A2864	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	**0.08**	<0.000050	<0.050
10-Aug-23	Filter Blank	VA23B8562	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
11-Oct-23	Filter Blank	VA23C4517	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050

Date	Type of Blank	Lab Ref	Sample	Silver (Ag)-Dissolved (mg/L)	Sodium (Na)-Dissolved (mg/L)	Strontium (Sr)-Dissolved (mg/L)	Thallium (Tl)-Dissolved (mg/L)	Tin (Sn)-Dissolved (mg/L)	Titanium (Ti)-Dissolved (mg/L)	Uranium (U)-Dissolved (mg/L)	Vanadium (V)-Dissolved (mg/L)	Zinc (Zn)-Dissolved (mg/L)
12-Jan-23	Filter Blank	VA23A0900	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
6-Feb-23	Filter Blank	VA23A2864	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
10-Aug-23	Filter Blank	VA23B8562	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
11-Oct-23	Filter Blank	VA23C4517	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030

MPMC Annual Report 2023
Table 9
QA/QC Blanks

DI BLANKS

GENERAL PARAMETERS

Date	Type of Blank	Lab Ref	Sample Type	Conductivity (µs/cm)	Hardness (as CaCO3) (mg/L)	pH (pH)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (ntu)	Alkalinity (CaCO3) (mg/L)	Ammonia (as N) (mg/L)	Chloride (Cl) (mg/L)	Fluoride (F) (mg/L)	Nitrate (as N) (mg/L)	Nitrite (as N) (mg/L)
12-Jan-23	DI-Blank	VA23A0900	Water	<2.0		5.36	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.020	<0.0050	<0.0010

Date	Type of Blank	Lab Ref	Sample Type	Total Nitrogen (mg/L)	Phosphorus (P) Total (mg/L)	Sulphate (mg/L)	Dissolved Organic Carbon (mg/L)
12-Jan-23	DI-Blank	VA23A0900	Water	<0.030	<0.0020	<0.30	<0.50

TRACE ELEMENTS

Date	Type of Blank	Lab Ref	Sample Type	Aluminum (Al)-Total (mg/L)	Antimony (Sb)-Total (mg/L)	Arsenic (As)-Total (mg/L)	Barium (Ba)-Total (mg/L)	Beryllium (Be)-Total (mg/L)	Bismuth (Bi)-Total (mg/L)	Boron (B)-Total (mg/L)	Cadmium (Cd)-Total (mg/L)	Calcium (Ca)-Total (mg/L)	Chromium (Cr)-Total (mg/L)	Cobalt (Co)-Total (mg/L)	Copper (Cu)-Total (mg/L)
12-Jan-23	DI-Blank	VA23A0900	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010	<0.00050

Date	Type of Blank	Lab Ref	Sample Type	Iron (Fe)-Total (mg/L)	Lead (Pb)-Total (mg/L)	Lithium (Li)-Total (mg/L)	Magnesium (Mg)-Total (mg/L)	Manganese (Mn)-Total (mg/L)	Molybdenum (Mo)-Total (mg/L)	Nickel (Ni)-Total (mg/L)	Potassium (K)-Total (mg/L)	Selenium (Se)-Total (mg/L)	Silicon (Si)-Total (mg/L)	Silver (Ag)-Total (mg/L)	Sodium (Na)-Total (mg/L)
12-Jan-23	DI-Blank	VA23A0900	Water	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.10	<0.000010	<0.050

Date	Type of Blank	Lab Ref	Sample Type	Strontium (Sr)-Total (mg/L)	Thallium (Tl)-Total (mg/L)	Tin (Sn)-Total (mg/L)	Titanium (Ti)-Total (mg/L)	Uranium (U)-Total (mg/L)	Vanadium (V)-Total (mg/L)	Zinc (Zn)-Total (mg/L)
12-Jan-23	DI-Blank	VA23A0900	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030

MPMC Annual Report 2023
Table 10
QA/QC Blanks

EQUIPMENT BLANKS

GENERAL PARAMETERS

Date	Type of Blank	Lab Ref	Sample Type	Conductivity (µs/cm)	Hardness (as CaCO3), dissolved (mg/L)	Hardness (as CaCO3, from total Ca/Mg (mg/L)	pH (pH)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (ntu)	Alkalinity (CaCO3) (mg/L)	Ammonia (as N) (mg/L)	Chloride (Cl) (mg/L)	Nitrate (as N) (mg/L)
12-Jan-23	KEM2	VA23A0900	Water	**2.1**		**0.53**	5.42	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
28-Feb-23	KEM2	VA23A4472	Water	**2.7**		**0.61**	6.11	<10	<1.0	<0.10	**1.2**	<0.0050	<0.50	<0.0050
29-Mar-23	KEM2	VA23A6977	Water	**2.6**		**0.58**	5.65	<10	<1.0	<0.10	<1.0	**0.0056**	<0.50	<0.0050
25-Apr-23	KEM2	VA23A9004	Water	**2.4**		**0.52**	5.60	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
24-May-23	KEM2	VA23B1771	Water	<2.0	<0.50	<0.50	5.73	<10	<1.0	**0.4**	<1.0	<0.0050	<0.50	<0.0050
29-Jun-23	KEM2	VA23B5003	Water	<2.0		**1**	5.19	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
25-Jul-23	KEM2	VA23B7174	Water	<2.0		<0.50	5.11	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
24-Aug-23	KEM2	VA23B9948	Water	<2.0		<0.50	5.14	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
19-Sep-23	KEM2	VA23C2247	Water	<2.0		<0.50	5.41	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
19-Oct-23	KEM2	VA23C5161	Water	<2.0		<0.50	5.51	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050
22-Nov-23	KEM2	VA23C8355	Water	<2.0		<0.50	5.33	<10	<1.0	<0.10	<1.0	<0.0050	<0.50	<0.0050

TRACE ELEMENTS

Date	Type of Blank	Lab Ref	Sample Type	Aluminum (Al)-Total (mg/L)	Antimony (Sb)-Total (mg/L)	Arsenic (As)-Total (mg/L)	Barium (Ba)-Total (mg/L)	Beryllium (Be)-Total (mg/L)	Bismuth (Bi)-Total (mg/L)	Boron (B)-Total (mg/L)	Cadmium (Cd)-Total (mg/L)	Calcium (Ca)-Total (mg/L)	Chromium (Cr)-Total (mg/L)	Cobalt (Co)-Total (mg/L)
12-Jan-23	KEM2	VA23A0900	Water	**0.0079**	<0.00010	<0.00010	**0.00022**	<0.000100	<0.000050	<0.010	<0.0000050	**0.212**	<0.00050	<0.00010
28-Feb-23	KEM2	VA23A4472	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	**0.245**	<0.00050	<0.00010
29-Mar-23	KEM2	VA23A6977	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	**0.234**	<0.00050	<0.00010
25-Apr-23	KEM2	VA23A9004	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	**0.207**	<0.00050	<0.00010
24-May-23	KEM2	VA23B1771	Water	**0.0104**	<0.00010	<0.00010	**0.00026**	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
29-Jun-23	KEM2	VA23B5003	Water	**0.169**	<0.00010	**0.00012**	**0.00451**	<0.000100	<0.000050	<0.010	<0.0000050	**0.23**	<0.00050	**0.00012**
25-Jul-23	KEM2	VA23B7174	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
24-Aug-23	KEM2	VA23B9948	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
19-Sep-23	KEM2	VA23C2247	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
19-Oct-23	KEM2	VA23C5161	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
22-Nov-23	KEM2	VA23C8355	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	**0.112**	<0.00050	<0.00010

Date	Type of Blank	Lab Ref	Sample Type	Strontium (Sr)-Total (mg/L)	Thallium (Tl)-Total (mg/L)	Tin (Sn)-Total (mg/L)	Titanium (Ti)-Total (mg/L)	Uranium (U)-Total (mg/L)	Vanadium (V)-Total (mg/L)	Zinc (Zn)-Total (mg/L)
12-Jan-23	KEM2	VA23A0900	Water	**0.00627**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
28-Feb-23	KEM2	VA23A4472	Water	**0.00754**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
29-Mar-23	KEM2	VA23A6977	Water	**0.00722**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
25-Apr-23	KEM2	VA23A9004	Water	**0.00576**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
24-May-23	KEM2	VA23B1771	Water	**0.00037**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
29-Jun-23	KEM2	VA23B5003	Water	**0.00163**	<0.000010	<0.00010	**0.0123**	<0.000010	**0.00057**	<0.0030
25-Jul-23	KEM2	VA23B7174	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
24-Aug-23	KEM2	VA23B9948	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
19-Sep-23	KEM2	VA23C2247	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
19-Oct-23	KEM2	VA23C5161	Water	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
22-Nov-23	KEM2	VA23C8355	Water	**0.00307**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030

MPMC Annual Report 2023
Table 10
QA/QC Blanks

EQUIPMENT BLANKS

GENERAL PARAMETERS

Date	Type of Blank	Lab Ref	Sample Type	Conductivity (µs/cm)	Hardness (as CaCO3) (mg/L)	pH (pH)	Alkalinity (CaCO3) (mg/L)	Ammonia (as N) (mg/L)	Chloride (Cl) (mg/L)	Nitrate (as N) (mg/L)	Nitrite (as N) (mg/L)	Phosphorus (P) Total (mg/L)	Total Nitrogen (mg/L)	Sulphate (mg/L)
12-Jan-23	GW-Low Flow	VA23A0901	Water	<2.0	<0.50	5.43	**1**	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
30-Jan-23	GW-Grundfos	VA23A2397	Water	<2.0	<0.50	5.36	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
31-May-23	GW-Low Flow	VA23B2383	Water	<2.0	<0.50	5.64	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
31-May-23	GW-Grundfos	VA23B2383	Water	<2.0	<0.50	6.11	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
27-Jun-23	GW-Low Flow	VA23B4778	Water	<2.0	<0.50	5.4	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
27-Jun-23	GW-Grundfos	VA23B4778	Water	<2.0	<0.50	5.22	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
25-Jul-23	GW-Low Flow	VA23B7178	Water	<2.0	<0.50	5.28	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
25-Jul-23	GW-Grundfos	VA23B7178	Water	<2.0	<0.50	5.26	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
31-Aug-23	GW-Low Flow	VA23C0598	Water	<2.0	<0.50	5.54	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
31-Aug-23	GW-Grundfos	VA23C0598	Water	<2.0	**1.98**	5.3	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
19-Sep-23	GW-Low Flow	VA23C2244	Water	<2.0	<0.50	5.45	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
19-Sep-23	GW-Grundfos	VA23C2244	Water	<2.0	<0.50	5.37	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
19-Oct-23	GW-Low Flow	VA23C5163	Water	<2.0	<0.50	5.44	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
19-Oct-23	GW-Grundfos	VA23C5163	Water	<2.0	<0.50	5.46	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.030	<0.0020	<0.30
22-Nov-23	GW-Low Flow	VA23C8353	Water	<2.0	<0.50	5.42	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.0020	<0.030	<0.30
22-Nov-23	GW-Grundfos	VA23C8353	Water	<2.0	<0.50	5.40	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.0020	<0.030	<0.30
14-Dec-23	GW-Low Flow	VA23D0138	Water	<2.0	<0.50	5.44	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.0020	<0.030	<0.30
14-Dec-23	GW-Grundfos	VA23D0138	Water	<2.0	<0.50	5.45	<1.0	<0.0050	<0.50	<0.0050	<0.0010	<0.0020	<0.030	<0.30

DISSOLVED METALS

Date	Type of Blank	Lab Ref	Sample Type	Aluminum (Al)-Dissolved (mg/L)	Antimony (Sb)-Dissolved (mg/L)	Arsenic (As)-Dissolved (mg/L)	Barium (Ba)-Dissolved (mg/L)	Beryllium (Be)-Dissolved (mg/L)	Bismuth (Bi)-Dissolved (mg/L)	Boron (B)-Dissolved (mg/L)	Cadmium (Cd)-Dissolved (mg/L)	Calcium (Ca)-Dissolved (mg/L)	Chromium (Cr)-Dissolved (mg/L)	Cobalt (Co)-Dissolved (mg/L)
12-Jan-23	GW-Low Flow	VA23A0901	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
30-Jan-23	GW-Grundfos	VA23A2397	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
31-May-23	GW-Low Flow	VA23B2383	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
31-May-23	GW-Grundfos	VA23B2383	Water	<0.0030	<0.00010	<0.00010	**0.00026**	<0.000100	<0.000050	<0.010	<0.0000050	**0.168**	<0.00050	<0.00010
27-Jun-23	GW-Low Flow	VA23B4778	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
27-Jun-23	GW-Grundfos	VA23B4778	Water	<0.0030	<0.00010	<0.00010	**0.0003**	<0.000100	<0.000050	<0.010	<0.0000050	**0.114**	<0.00050	<0.00010
25-Jul-23	GW-Low Flow	VA23B7178	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
25-Jul-23	GW-Grundfos	VA23B7178	Water	<0.0030	<0.00010	<0.00010	**0.00013**	<0.000100	<0.000050	<0.010	<0.0000050	**0.06**	<0.00050	<0.00010
31-Aug-23	GW-Low Flow	VA23C0598	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
31-Aug-23	GW-Grundfos	VA23C0598	Water	**0.0041**	<0.00010	<0.00010	**0.00146**	<0.000100	<0.000050	<0.010	**0.0000114**	**0.792**	<0.00050	<0.00010
19-Sep-23	GW-Low Flow	VA23C2244	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
19-Sep-23	GW-Grundfos	VA23C2244	Water	<0.0030	<0.00010	<0.00010	**0.00015**	<0.000100	<0.000050	<0.010	<0.0000050	**0.164**	<0.00050	<0.00010
19-Oct-23	GW-Low Flow	VA23C5163	Water	<0.0030	<0.00010	<0.00010	**0.00033**	<0.000100	<0.000050	<0.010	<0.0000050	**0.152**	<0.00050	<0.00010
19-Oct-23	GW-Grundfos	VA23C5163	Water	<0.0030	<0.00010	<0.00010	**0.00014**	<0.000100	<0.000050	<0.010	<0.0000050	**0.082**	<0.00050	<0.00010
22-Nov-23	GW-Low Flow	VA23C8353	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	<0.050	<0.00050	<0.00010
22-Nov-23	GW-Grundfos	VA23C8353	Water	<0.0030	<0.00010	<0.00010	**0.00021**	<0.000100	<0.000050	<0.010	<0.0000050	**0.076**	<0.00050	<0.00010
14-Dec-23	GW-Low Flow	VA23D0138	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	**0.0000558**	<0.050	<0.00050	<0.00010
14-Dec-23	GW-Grundfos	VA23D0138	Water	<0.0030	<0.00010	<0.00010	<0.00010	<0.000100	<0.000050	<0.010	<0.0000050	**0.08**	<0.00050	<0.00010

MPMC Annual Report 2023
Table 10
QA/QC Blanks

EQUIPMENT BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Copper (Cu)-Dissolved (mg/L)	Iron (Fe)-Dissolved (mg/L)	Lead (Pb)-Dissolved (mg/L)	Lithium (Li)-Dissolved (mg/L)	Magnesium (Mg)-Dissolved (mg/L)	Manganese (Mn)-Dissolved (mg/L)	Molybdenum (Mo)-Dissolved (mg/L)	Nickel (Ni)-Dissolved (mg/L)	Potassium (K)-Dissolved (mg/L)	Selenium (Se)-Dissolved (mg/L)	Silicon (Si)-Dissolved (mg/L)
12-Jan-23	GW-Low Flow	VA23A0901	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
30-Jan-23	GW-Grundfos	VA23A2397	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
31-May-23	GW-Low Flow	VA23B2383	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00013**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
31-May-23	GW-Grundfos	VA23B2383	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00464**	**0.00006**	<0.00050	<0.050	<0.000050	<0.050
27-Jun-23	GW-Low Flow	VA23B4778	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00014**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
27-Jun-23	GW-Grundfos	VA23B4778	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00073**	**0.000054**	<0.00050	<0.050	<0.000050	<0.050
25-Jul-23	GW-Low Flow	VA23B7178	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00012**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
25-Jul-23	GW-Grundfos	VA23B7178	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00135**	**0.000053**	<0.00050	<0.050	<0.000050	<0.050
31-Aug-23	GW-Low Flow	VA23C0598	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
31-Aug-23	GW-Grundfos	VA23C0598	Water	**0.00723**	<0.030	**0.000079**	<0.0010	<0.100	**0.00147**	**0.000311**	**0.0036**	**12.2**	<0.000050	<0.050
19-Sep-23	GW-Low Flow	VA23C2244	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
19-Sep-23	GW-Grundfos	VA23C2244	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00049**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
19-Oct-23	GW-Low Flow	VA23C5163	Water	**0.00164**	<0.030	**0.000153**	<0.0010	<0.100	**0.00018**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
19-Oct-23	GW-Grundfos	VA23C5163	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00352**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
22-Nov-23	GW-Low Flow	VA23C8353	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050	<0.050
22-Nov-23	GW-Grundfos	VA23C8353	Water	**0.00064**	<0.030	**0.000103**	<0.0010	<0.100	**0.00053**	<0.000050	<0.00050	**0.204**	<0.000050	<0.050
14-Dec-23	GW-Low Flow	VA23D0138	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00027**	<0.000050	<0.00050	<0.050	<0.000050	<0.050
14-Dec-23	GW-Grundfos	VA23D0138	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00205**	<0.000050	<0.00050	<0.050	<0.000050	<0.050

Date	Type of Blank	Lab Ref	Sample Type	Silver (Ag)-Dissol	Sodium (Na)-Diss	Strontium (Sr)-Dis	Thallium (Tl)-Diss	Tin (Sn)-Dissolvec	Titanium (Ti)-Disso	Uranium (U)-Diss	Vanadium (V)-Dissol	Zinc (Zn)-Dissolved (mg/L)
12-Jan-23	GW-Low Flow	VA23A0901	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
30-Jan-23	GW-Grundfos	VA23A2397	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-May-23	GW-Low Flow	VA23B2383	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-May-23	GW-Grundfos	VA23B2383	Water	<0.000010	<0.050	**0.00087**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
27-Jun-23	GW-Low Flow	VA23B4778	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
27-Jun-23	GW-Grundfos	VA23B4778	Water	<0.000010	<0.050	**0.00056**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	**0.004**
25-Jul-23	GW-Low Flow	VA23B7178	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
25-Jul-23	GW-Grundfos	VA23B7178	Water	<0.000010	<0.050	**0.00068**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-Aug-23	GW-Low Flow	VA23C0598	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
31-Aug-23	GW-Grundfos	VA23C0598	Water	**0.000015**	**0.188**	**0.00576**	<0.000010	**0.00019**	<0.0100	<0.000010	<0.00050	**0.0073**
19-Sep-23	GW-Low Flow	VA23C2244	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
19-Sep-23	GW-Grundfos	VA23C2244	Water	<0.000010	<0.050	**0.00104**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
19-Oct-23	GW-Low Flow	VA23C5163	Water	<0.000010	<0.050	**0.00099**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
19-Oct-23	GW-Grundfos	VA23C5163	Water	<0.000010	<0.050	**0.0008**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
22-Nov-23	GW-Low Flow	VA23C8353	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
22-Nov-23	GW-Grundfos	VA23C8353	Water	<0.000010	<0.050	**0.00032**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
14-Dec-23	GW-Low Flow	VA23D0138	Water	<0.000010	<0.050	<0.00020	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030
14-Dec-23	GW-Grundfos	VA23D0138	Water	<0.000010	<0.050	**0.00029**	<0.000010	<0.00010	<0.0100	<0.000010	<0.00050	<0.0030

MPMC Annual Report 2023
Table 10
QA/QC Blanks

EQUIPMENT BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Nitrite (as N) (mg/L)	Phosphorus (P) Total (mg/L)	Total Nitrogen (mg	Sulphate (mg/L)	Dissolved Organic Carbon (mg/L)
12-Jan-23	KEM2	VA23A0900	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
28-Feb-23	KEM2	VA23A4472	Water	<0.0010	<0.0020	<0.030	**0.62**	<0.50
29-Mar-23	KEM2	VA23A6977	Water	<0.0010	<0.0020	<0.030	**0.53**	<0.50
25-Apr-23	KEM2	VA23A9004	Water	<0.0010	<0.0020	<0.030	**0.43**	<0.50
24-May-23	KEM2	VA23B1771	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
29-Jun-23	KEM2	VA23B5003	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
25-Jul-23	KEM2	VA23B7174	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
24-Aug-23	KEM2	VA23B9948	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
19-Sep-23	KEM2	VA23C2247	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
19-Oct-23	KEM2	VA23C5161	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50
22-Nov-23	KEM2	VA23C8355	Water	<0.0010	<0.0020	<0.030	<0.30	<0.50

Date	Type of Blank	Lab Ref	Sample Type	Copper (Cu)-Total (mg/L)	Iron (Fe)-Total (mg/L)	Lead (Pb)-Total (mg/L)	Lithium (Li)-Total (mg/L)	Magnesium (Mg)-Total (mg/L)	Manganese (Mn)-Total (mg/L)	Molybdenum (Mo)-Total (mg/L)	Nickel (Ni)-Total (mg/L)	Potassium (K)-Total (mg/L)	Selenium (Se)-Total (mg/L)
12-Jan-23	KEM2	VA23A0900	Water	**0.00146**	<0.030	<0.000050	<0.0010	<0.100	**0.00052**	**0.00006**	<0.00050	**0.05**	<0.000050
28-Feb-23	KEM2	VA23A4472	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
29-Mar-23	KEM2	VA23A6977	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00014**	<0.000050	<0.00050	<0.050	<0.000050
25-Apr-23	KEM2	VA23A9004	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
24-May-23	KEM2	VA23B1771	Water	**0.00074**	<0.030	<0.000050	<0.0010	<0.100	**0.00037**	<0.000050	<0.00050	<0.050	<0.000050
29-Jun-23	KEM2	VA23B5003	Water	**0.00753**	**0.165**	**0.000072**	<0.0010	**0.104**	**0.00516**	<0.000050	<0.00050	<0.050	<0.000050
25-Jul-23	KEM2	VA23B7174	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00018**	<0.000050	<0.00050	<0.050	<0.000050
24-Aug-23	KEM2	VA23B9948	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
19-Sep-23	KEM2	VA23C2247	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
19-Oct-23	KEM2	VA23C5161	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	<0.00010	<0.000050	<0.00050	<0.050	<0.000050
22-Nov-23	KEM2	VA23C8355	Water	<0.00050	<0.030	<0.000050	<0.0010	<0.100	**0.00014**	<0.000050	<0.00050	<0.050	<0.000050

MPMC Annual Report 2023
Table 10
QA/QC Blanks

EQUIPMENT BLANKS

Date	Type of Blank	Lab Ref	Sample Type	Silicon (Si)-Total (mg/L)	Silver (Ag)-Total (mg/L)	Sodium (Na)-Total (mg/L)
12-Jan-23	KEM2	VA23A0900	Water	<0.10	<0.000010	<0.050
28-Feb-23	KEM2	VA23A4472	Water	<0.10	<0.000010	<0.050
29-Mar-23	KEM2	VA23A6977	Water	<0.10	<0.000010	<0.050
25-Apr-23	KEM2	VA23A9004	Water	<0.10	<0.000010	<0.050
24-May-23	KEM2	VA23B1771	Water	<0.10	<0.000010	<0.050
29-Jun-23	KEM2	VA23B5003	Water	**0.33**	<0.000010	<0.050
25-Jul-23	KEM2	VA23B7174	Water	<0.10	<0.000010	<0.050
24-Aug-23	KEM2	VA23B9948	Water	<0.10	<0.000010	<0.050
19-Sep-23	KEM2	VA23C2247	Water	<0.10	<0.000010	<0.050
19-Oct-23	KEM2	VA23C5161	Water	<0.10	<0.000010	<0.050
22-Nov-23	KEM2	VA23C8355	Water	<0.10	<0.000010	<0.050

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A0316

Client Sample ID	EDC-01a	EDC-Aa
Date Sampled	04-Jan-23	04-Jan-23
Time Sampled	15:01	15:01
ALS Sample ID	VA23A0316-005	VA23A0316-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	341	342
Conductivity	132	131
Hardness (as CaCO3), Dissolved	155	155
Hardness (as CaCO3), From total Ca/M	148	148
pH	8.3	8.29
Total Dissolved Solids	233	236
Total Suspended Solids	<1.1	<1.0
Turbidity	0.29	0.26
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0081	0.0073
Chloride (Cl)	1.13	1.15
Fluoride (F)	0.08	0.081
Nitrate (as N)	0.126	0.125
Nitrate and Nitrite (as N)	0.126	0.125
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.307	0.32
Orthophosphate-Dissolved (as P)	0.0073	0.0072
Phosphorus (P)-Total	0.011	0.0109
Phosphorus (P)-Total Dissolved	0.0099	0.0097
Sulfate (SO4)	44.4	44.4
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.77	5.95
Total Metals (Water)		
Aluminum (Al)-Total	0.0102	0.0101
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.0011	0.00104
Barium (Ba)-Total	0.0192	0.0191
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.02	0.02
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	43	43.6
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.006	0.00588
Iron (Fe)-Total	0.035	0.034
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	9.82	9.64
Manganese (Mn)-Total	0.039	0.0385

Results Summary VA23A0315

Client Sample ID	E10	EJ
Date Sampled	05-Jan-23	05-Jan-23
Time Sampled	10:46	10:46
ALS Sample ID	VA23A0315-004	VA23A0315-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1240	1240
Conductivity	91.2	91.8
Hardness (as CaCO3), Dissolved	624	625
Hardness (as CaCO3), From total Ca/M	621	612
pH	8.12	8.12
Total Dissolved Solids	973	1000
Total Suspended Solids	1.8	1.5
Turbidity	0.38	0.7
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0056	<0.0050
Chloride (Cl)	5.58	5.45
Fluoride (F)	0.5	0.499
Nitrate (as N)	3.14	3.16
Nitrate and Nitrite (as N)	3.15	3.17
Nitrite (as N)	0.0076	0.0071
Total Nitrogen	3.26	3.2
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.004	0.004
Phosphorus (P)-Total Dissolved	0.0024	0.0024
Sulfate (SO4)	589	587
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.85	1.9
Total Metals (Water)		
Aluminum (Al)-Total	0.0245	0.0249
Antimony (Sb)-Total	0.00099	0.00098
Arsenic (As)-Total	0.00104	0.00097
Barium (Ba)-Total	0.0545	0.0546
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.119	0.118
Cadmium (Cd)-Total	0.000176	0.000175
Calcium (Ca)-Total	199	196
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00020	<0.00020
Copper (Cu)-Total	0.0101	0.0101
Iron (Fe)-Total	0.035	<0.030
Lead (Pb)-Total	0.000815	<0.000100
Lithium (Li)-Total	0.0076	0.0075
Magnesium (Mg)-Total	30.2	29.8
Manganese (Mn)-Total	0.0107	0.0104

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00516	0.0052
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.07	1.03
Selenium (Se)-Total	0.00114	0.00116
Silicon (Si)-Total	4.83	4.75
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	9.07	8.85
Strontium (Sr)-Total	0.308	0.321
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000444	0.000445
Vanadium (V)-Total	0.00078	0.00078
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.162	0.157
Nickel (Ni)-Total	<0.00100	<0.00100
Potassium (K)-Total	2.41	2.42
Selenium (Se)-Total	0.0441	0.0422
Silicon (Si)-Total	4.98	4.9
Silver (Ag)-Total	<0.000020	<0.000020
Sodium (Na)-Total	27.7	26.6
Strontium (Sr)-Total	6.29	6.29
Thallium (Tl)-Total	<0.000020	<0.000020
Tin (Sn)-Total	<0.00020	<0.00020
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00279	0.00267
Vanadium (V)-Total	0.00123	0.00123
Zinc (Zn)-Total	0.0111	0.0115

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00099	0.00107
Barium (Ba)-Dissolved	0.0191	0.0193
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.021	0.021
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	45.6	46
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00558	0.00574
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	9.95	9.69
Manganese (Mn)-Dissolved	0.0383	0.0382
Molybdenum (Mo)-Dissolved	0.00514	0.00515
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.02	1.04
Selenium (Se)-Dissolved	0.00128	0.00131
Silicon (Si)-Dissolved	4.61	4.6
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	8.44	8.53
Strontium (Sr)-Dissolved	0.328	0.328
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000457	0.000452
Vanadium (V)-Dissolved	0.00066	0.00065
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0060	<0.0030
Antimony (Sb)-Dissolved	0.00098	0.00098
Arsenic (As)-Dissolved	0.00095	0.00101
Barium (Ba)-Dissolved	0.0508	0.0517
Beryllium (Be)-Dissolved	<0.000200	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000050
Boron (B)-Dissolved	0.119	0.12
Cadmium (Cd)-Dissolved	<0.000175	<0.000175
Calcium (Ca)-Dissolved	203	203
Chromium (Cr)-Dissolved	<0.00100	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00010
Copper (Cu)-Dissolved	0.00826	0.0082
Iron (Fe)-Dissolved	<0.060	<0.030
Lead (Pb)-Dissolved	<0.000100	<0.000050
Lithium (Li)-Dissolved	0.0076	0.0078
Magnesium (Mg)-Dissolved	28.5	28.8
Manganese (Mn)-Dissolved	0.00898	0.00936
Molybdenum (Mo)-Dissolved	0.16	0.158
Nickel (Ni)-Dissolved	<0.00100	<0.00050
Potassium (K)-Dissolved	2.26	2.35
Selenium (Se)-Dissolved	0.0437	0.0458
Silicon (Si)-Dissolved	4.66	4.57
Silver (Ag)-Dissolved	<0.000020	<0.000010
Sodium (Na)-Dissolved	24.6	25.1
Strontium (Sr)-Dissolved	6.45	6.37
Thallium (Tl)-Dissolved	<0.000020	<0.000010
Tin (Sn)-Dissolved	<0.00020	<0.00010
Titanium (Ti)-Dissolved	<0.0200	<0.0100
Uranium (U)-Dissolved	0.00271	0.00271
Vanadium (V)-Dissolved	0.00108	0.00109
Zinc (Zn)-Dissolved	0.0108	0.0106
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A0611

Client Sample ID	E24	EX
Date Sampled	10-Jan-23	10-Jan-23
Time Sampled	12:55	12:55
ALS Sample ID	VA23A0611-003	VA23A0611-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1720	1700
Conductivity	69.4	69
Hardness (as CaCO3), Dissolved	953	937
Hardness (as CaCO3), From total Ca/Mg	991	1010
pH	1460	1460
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.16	0.19
Turbidity	7.88	7.89
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.008	0.007
Chloride (Cl)	<5.00	<5.00
Fluoride (F)	0.301	0.302
Nitrate (as N)	0.943	0.953
Nitrate and Nitrite (as N)	0.943	0.953
Nitrite (as N)	<0.0100	<0.0100
Total Nitrogen	1.01	1.03
Orthophosphate-Dissolved (as P)	0.0022	0.0025
Phosphorus (P)-Total	0.0043	0.0044
Phosphorus (P)-Total Dissolved	0.0038	0.0039
Sulfate (SO4)	939	953
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.18	3.28
Total Metals (Water)		
Aluminum (Al)-Total	0.031	0.0301
Antimony (Sb)-Total	0.00027	0.00026
Arsenic (As)-Total	<0.00020	<0.00020
Barium (Ba)-Total	0.0378	0.0387
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.068	0.062
Cadmium (Cd)-Total	0.000224	0.00024
Calcium (Ca)-Total	298	303
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00066	0.00068
Copper (Cu)-Total	0.149	0.149
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000100	<0.000100
Lithium (Li)-Total	0.003	0.003
Magnesium (Mg)-Total	59.9	61.2
Manganese (Mn)-Total	0.222	0.225

Results Summary VA23A0902

Client Sample ID	GW16-6a	GW16-Fa
Date Sampled	11-Jan-23	11-Jan-23
Time Sampled	14:55	14:55
ALS Sample ID	VA23A0902-006	VA23A0902-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	420	421
Conductivity	37.3	37.1
Hardness (as CaCO3), Dissolved	119	118
pH	7.87	7.86
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	1	1
Fluoride (F)	0.74	0.743
Nitrate (as N)	0.058	0.0578
Nitrate and Nitrite (as N)	0.058	0.0578
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.059	0.056
Phosphorus (P)-Total	0.0029	0.0027
Phosphorus (P)-Total Dissolved	0.0028	0.0026
Sulfate (SO4)	155	155
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	<0.50	<0.50
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.003	0.0031
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00812	0.00835
Barium (Ba)-Dissolved	0.00131	0.00136
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.558	0.582
Cadmium (Cd)-Dissolved	<0.0000250	<0.0000250
Calcium (Ca)-Dissolved	39.4	38.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0015	0.0015
Magnesium (Mg)-Dissolved	5.05	5.27
Manganese (Mn)-Dissolved	<0.00010	<0.00010
Molybdenum (Mo)-Dissolved	0.0622	0.0611
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.529	0.542
Selenium (Se)-Dissolved	0.00131	0.00129
Silicon (Si)-Dissolved	7.92	8.11

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.163	0.161
Nickel (Ni)-Total	0.00207	0.00211
Potassium (K)-Total	2.15	2.14
Selenium (Se)-Total	0.0939	0.0924
Silicon (Si)-Total	4.03	4.06
Silver (Ag)-Total	<0.000020	<0.000020
Sodium (Na)-Total	20.4	20.7
Strontium (Sr)-Total	3.82	3.8
Thallium (Tl)-Total	<0.000020	<0.000020
Tin (Sn)-Total	<0.00020	<0.00020
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00101	0.001
Vanadium (V)-Total	<0.00100	<0.00100
Zinc (Zn)-Total	0.0115	0.0117

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0071	0.0079
Antimony (Sb)-Dissolved	0.00024	0.00025
Arsenic (As)-Dissolved	<0.00020	<0.00020
Barium (Ba)-Dissolved	0.0362	0.0362
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100
Boron (B)-Dissolved	0.065	0.06
Cadmium (Cd)-Dissolved	0.000243	0.000226
Calcium (Ca)-Dissolved	285	280
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00065	0.00063
Copper (Cu)-Dissolved	0.12	0.118
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000100	<0.000100
Lithium (Li)-Dissolved	0.0028	0.0027
Magnesium (Mg)-Dissolved	58.6	57.7
Manganese (Mn)-Dissolved	0.215	0.212
Molybdenum (Mo)-Dissolved	0.156	0.156
Nickel (Ni)-Dissolved	0.00199	0.00198
Potassium (K)-Dissolved	2.09	2.08
Selenium (Se)-Dissolved	0.0927	0.0913
Silicon (Si)-Dissolved	4.04	3.91
Silver (Ag)-Dissolved	<0.000020	<0.000020
Sodium (Na)-Dissolved	19.8	19.3
Strontium (Sr)-Dissolved	3.73	3.67
Thallium (Tl)-Dissolved	<0.000020	<0.000020
Tin (Sn)-Dissolved	<0.00020	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.001	0.00103
Vanadium (V)-Dissolved	<0.00100	<0.00100
Zinc (Zn)-Dissolved	0.0116	0.0112
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	34.4	34.7
Strontium (Sr)-Dissolved	0.0728	0.0705
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000044	0.00004
Vanadium (V)-Dissolved	0.00172	0.0017
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A0897

Client Sample ID	WIP-30m	23916-30m
Date Sampled	11-Jan-23	11-Jan-23
Time Sampled	11:21	11:21
ALS Sample ID	VA23A0897-004	VA23A0897-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2300	2300
Conductivity	137	138
Hardness (as CaCO3), Dissolved	1410	1440
Hardness (as CaCO3), From total Ca/M	1360	1410
pH	2130	2070
Total Dissolved Solids	<1.1	<1.1
Total Suspended Solids	0.13	0.17
Turbidity	7.85	7.85
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	0.561	0.549
Nitrate (as N)	1.44	1.41
Nitrate and Nitrite (as N)	1.44	1.41
Nitrite (as N)	<0.0200	<0.0200
Total Nitrogen	1.46	1.42
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0022	<0.0020
Phosphorus (P)-Total Dissolved	0.0023	<0.0020
Sulfate (SO4)	1410	1380
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.14	1.21
Total Metals (Water)		
Aluminum (Al)-Total	<0.0150	<0.0150
Antimony (Sb)-Total	0.00084	0.00097
Arsenic (As)-Total	0.00066	0.00069
Barium (Ba)-Total	0.0258	0.0258
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.158	0.162
Cadmium (Cd)-Total	0.00118	0.00124
Calcium (Ca)-Total	449	466
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.0018	0.00176
Copper (Cu)-Total	0.0199	0.0204
Iron (Fe)-Total	<0.050	<0.050
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.0151	0.0158
Magnesium (Mg)-Total	58.4	59.2
Manganese (Mn)-Total	0.438	0.445

Results Summary VA23A1158

Client Sample ID	W4a	WDa
Date Sampled	12-Jan-23	12-Jan-23
Time Sampled	12:40	12:40
ALS Sample ID	VA23A0900-006	VA23A0900-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	398	392
Conductivity	142	142
Hardness (as CaCO3), Dissolved	185	192
Hardness (as CaCO3), From total Ca/M	205	198
pH	261	241
Total Dissolved Solids	7.1	4.6
Total Suspended Solids	0.3	0.38
Turbidity	8.27	8.32
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.73	0.72
Fluoride (F)	0.09	0.087
Nitrate (as N)	0.0566	0.0517
Nitrate and Nitrite (as N)	0.0566	0.0517
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.101	0.098
Orthophosphate-Dissolved (as P)	0.0098	0.0099
Phosphorus (P)-Total	0.0126	0.013
Phosphorus (P)-Total Dissolved	0.0114	0.0111
Sulfate (SO4)	66.9	62.4
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.39	2
Total Metals (Water)		
Aluminum (Al)-Total	0.0305	0.0254
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00036	0.00032
Barium (Ba)-Total	0.0179	0.0171
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.026	0.026
Cadmium (Cd)-Total	<0.0000150	<0.0000150
Calcium (Ca)-Total	66.9	65.2
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.0068	0.00633
Iron (Fe)-Total	0.04	0.032
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	9.22	8.63
Manganese (Mn)-Total	0.00401	0.00374

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.106	0.112
Nickel (Ni)-Total	0.00292	0.00291
Potassium (K)-Total	2.9	2.94
Selenium (Se)-Total	0.0271	0.0269
Silicon (Si)-Total	6.42	6.64
Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	33.3	34.6
Strontium (Sr)-Total	15.5	16.3
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00649	0.00701
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.125	0.13

Molybdenum (Mo)-Total	0.0109	0.0101
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.582	0.556
Selenium (Se)-Total	0.00417	0.00401
Silicon (Si)-Total	6.3	6.16
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	4.19	3.98
Strontium (Sr)-Total	0.346	0.328
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000466	0.00046
Vanadium (V)-Total	0.00066	0.00065
Zinc (Zn)-Total	0.0144	0.015

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0050	<0.0050
Antimony (Sb)-Dissolved	0.0009	0.00091
Arsenic (As)-Dissolved	0.00062	0.00064
Barium (Ba)-Dissolved	0.0265	0.0265
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.175	0.174
Cadmium (Cd)-Dissolved	0.0012	0.00116
Calcium (Ca)-Dissolved	466	473
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00168	0.00166
Copper (Cu)-Dissolved	0.0175	0.0175
Iron (Fe)-Dissolved	<0.050	<0.050
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.0155	0.0154
Magnesium (Mg)-Dissolved	60.2	63.7
Manganese (Mn)-Dissolved	0.442	0.446
Molybdenum (Mo)-Dissolved	0.112	0.113
Nickel (Ni)-Dissolved	0.00293	0.00297
Potassium (K)-Dissolved	3.1	3.04
Selenium (Se)-Dissolved	0.0262	0.0277
Silicon (Si)-Dissolved	6.37	6.39
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	34.1	34.4
Strontium (Sr)-Dissolved	16.6	16.7
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00683	0.00704
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.126	0.13
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00029	0.00029
Barium (Ba)-Dissolved	0.0171	0.0171
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.024	0.025
Cadmium (Cd)-Dissolved	<0.0000150	<0.0000150
Calcium (Ca)-Dissolved	60.8	62.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0052	0.00509
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	8.16	8.38
Manganese (Mn)-Dissolved	0.00237	0.00219
Molybdenum (Mo)-Dissolved	0.00961	0.00973
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.545	0.55
Selenium (Se)-Dissolved	0.00403	0.00363
Silicon (Si)-Dissolved	5.79	5.87
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	3.96	3.98
Strontium (Sr)-Dissolved	0.312	0.323
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00046	0.000476
Vanadium (V)-Dissolved	0.00069	0.00081
Zinc (Zn)-Dissolved	0.0135	0.0143
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A1158

Client Sample ID	HAD-3	HAD-C
Date Sampled	17-Jan-23	17-Jan-23
Time Sampled	11:34	11:34
ALS Sample ID	VA23A1158-001	VA23A1158-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1120	1110
Conductivity	63.4	63.5
Hardness (as CaCO3), Dissolved	443	435
Hardness (as CaCO3), From total Ca/Mg	448	440
pH	851	867
Total Dissolved Solids	11.5	8.7
Total Suspended Solids	1.09	2.63
Turbidity	7.86	7.86
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.155	0.154
Chloride (Cl)	12	12.3
Fluoride (F)	0.51	0.53
Nitrate (as N)	3.61	3.68
Nitrate and Nitrite (as N)	3.67	3.74
Nitrite (as N)	0.0584	0.057
Total Nitrogen	4.16	4.08
Orthophosphate-Dissolved (as P)	0.0015	<0.0010
Phosphorus (P)-Total	0.0138	0.0113
Phosphorus (P)-Total Dissolved	0.0038	0.0044
Sulfate (SO4)	479	486
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.8	4.52
Total Metals (Water)		
Aluminum (Al)-Total	0.835	0.768
Antimony (Sb)-Total	0.00127	0.00117
Arsenic (As)-Total	0.00166	0.00148
Barium (Ba)-Total	0.052	0.0523
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.118	0.119
Cadmium (Cd)-Total	<0.0000600	<0.0000650
Calcium (Ca)-Total	139	137
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00016	0.00016
Copper (Cu)-Total	0.008	0.00736
Iron (Fe)-Total	0.085	0.067
Lead (Pb)-Total	0.000053	<0.000050
Lithium (Li)-Total	0.0075	0.0075
Magnesium (Mg)-Total	24.5	23.8
Manganese (Mn)-Total	0.0718	0.0704

Results Summary VA23A1450

Client Sample ID	E4	ED
Date Sampled	19-Jan-23	19-Jan-23
Time Sampled	11:21	11:21
ALS Sample ID	VA23A1450-002	VA23A1450-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1270	1280
Conductivity	115	118
Hardness (as CaCO3), Dissolved	452	454
Hardness (as CaCO3), From total Ca/M	546	549
pH	986	1020
Total Dissolved Solids	2.4	1.8
Total Suspended Solids	0.34	0.33
Turbidity	8.19	8.21
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0059	0.008
Chloride (Cl)	16	16.1
Fluoride (F)	0.674	0.678
Nitrate (as N)	0.176	0.162
Nitrate and Nitrite (as N)	0.176	0.162
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	0.165	0.223
Orthophosphate-Dissolved (as P)	0.0114	0.0109
Phosphorus (P)-Total	0.0172	0.0168
Phosphorus (P)-Total Dissolved	0.0192	0.0187
Sulfate (SO4)	547	555
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.44	2.45
Total Metals (Water)		
Aluminum (Al)-Total	0.111	0.0598
Antimony (Sb)-Total	0.00015	0.00017
Arsenic (As)-Total	0.00181	0.00173
Barium (Ba)-Total	0.0349	0.0349
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.138	0.141
Cadmium (Cd)-Total	<0.000150	<0.000150
Calcium (Ca)-Total	174	175
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00015	0.0001
Copper (Cu)-Total	0.0111	0.00798
Iron (Fe)-Total	0.146	0.081
Lead (Pb)-Total	0.000054	<0.000050
Lithium (Li)-Total	0.0091	0.0093
Magnesium (Mg)-Total	27.1	27.2
Manganese (Mn)-Total	0.071	0.0674

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.191	0.191
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	8.11	8
Selenium (Se)-Total	0.0379	0.0377
Silicon (Si)-Total	5.86	5.85
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	49.4	49
Strontium (Sr)-Total	2.05	2.04
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.0019	0.00182
Vanadium (V)-Total	0.00206	0.002
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.282	0.283
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	16.9	17
Selenium (Se)-Total	0.00571	0.00575
Silicon (Si)-Total	7.66	7.56
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	95.9	97.3
Strontium (Sr)-Total	2.68	2.68
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00206	0.00206
Vanadium (V)-Total	0.00087	0.00068
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.215	0.173
Antimony (Sb)-Dissolved	0.00112	0.0011
Arsenic (As)-Dissolved	0.00105	0.00104
Barium (Ba)-Dissolved	0.0496	0.0489
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.106	0.107
Cadmium (Cd)-Dissolved	<0.0000600	<0.0000600
Calcium (Ca)-Dissolved	139	137
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00012	0.00011
Copper (Cu)-Dissolved	0.0041	0.00378
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0076	0.0074
Magnesium (Mg)-Dissolved	23.3	22.6
Manganese (Mn)-Dissolved	0.0658	0.0652
Molybdenum (Mo)-Dissolved	0.187	0.187
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	7.78	7.54
Selenium (Se)-Dissolved	0.0356	0.0354
Silicon (Si)-Dissolved	5.32	5.34
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	47.8	47.1
Strontium (Sr)-Dissolved	2	1.96
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00161	0.00162
Vanadium (V)-Dissolved	0.00166	0.00166
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	0.0002	0.00016
Arsenic (As)-Dissolved	0.00165	0.0016
Barium (Ba)-Dissolved	0.0337	0.0331
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.118	0.119
Cadmium (Cd)-Dissolved	0.0000143	0.0000154
Calcium (Ca)-Dissolved	143	144
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00356	0.00356
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0087	0.0087
Magnesium (Mg)-Dissolved	23.1	22.9
Manganese (Mn)-Dissolved	0.0485	0.0476
Molybdenum (Mo)-Dissolved	0.261	0.26
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	15.1	15.2
Selenium (Se)-Dissolved	0.00596	0.00564
Silicon (Si)-Dissolved	6.79	6.46
Silver (Ag)-Dissolved	0.00001	<0.000010
Sodium (Na)-Dissolved	86.2	83.7
Strontium (Sr)-Dissolved	2.74	2.74
Thallium (Tl)-Dissolved	0.00001	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00196	0.00192
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A1443

Client Sample ID	GW12-2a	GW12-Ba
Date Sampled	19-Jan-23	19-Jan-23
Time Sampled	11:45	11:45
ALS Sample ID	VA23A1443-002	VA23A1443-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)		233
Conductivity	48.6	48.1
Hardness (as CaCO3), Dissolved	47.9	47
pH	7.84	7.84
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.96	0.96
Fluoride (F)	0.384	0.401
Nitrate (as N)	0.02	0.0184
Nitrate and Nitrite (as N)	0.021	0.0184
Nitrite (as N)	0.001	<0.0010
Total Nitrogen	<0.030	<0.030
Phosphorus (P)-Total	0.0273	0.0273
Phosphorus (P)-Total Dissolved	0.0276	0.0271
Sulfate (SO4)	60.5	60.3
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.54	<0.50
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0047	0.0048
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.0026	0.00256
Barium (Ba)-Dissolved	0.00403	0.00408
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.304	0.291
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	17.1	16.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.0002	0.0002
Copper (Cu)-Dissolved	0.00067	0.00068
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0036	0.0036
Magnesium (Mg)-Dissolved	1.26	1.24
Manganese (Mn)-Dissolved	0.0246	0.024
Molybdenum (Mo)-Dissolved	0.0405	0.0404
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.187	0.183
Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	8.15	8.01

Results Summary VA23A1780

Client Sample ID	E14	EN
Date Sampled	23-Jan-23	23-Jan-23
Time Sampled	12:12	12:12
ALS Sample ID	VA23A1780-004	VA23A1780-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	771	781
Conductivity	90.2	89.4
Hardness (as CaCO3), Dissolved	384	375
Hardness (as CaCO3), From total Ca/Mg	383	385
pH	614	638
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.67	0.57
Turbidity	7.99	7.99
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	4.66	4.82
Fluoride (F)	0.199	0.213
Nitrate (as N)	1.58	1.64
Nitrate and Nitrite (as N)	1.58	1.64
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	2.28	2.28
Orthophosphate-Dissolved (as P)	0.0077	0.0071
Phosphorus (P)-Total	0.0106	0.0118
Phosphorus (P)-Total Dissolved	0.011	0.0111
Sulfate (SO4)	288	300
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.38	3.29
Total Metals (Water)		
Aluminum (Al)-Total	0.0498	0.0426
Antimony (Sb)-Total	0.00072	0.00074
Arsenic (As)-Total	0.00161	0.00156
Barium (Ba)-Total	0.0326	0.032
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.177	0.18
Cadmium (Cd)-Total	<0.0000450	<0.0000450
Calcium (Ca)-Total	113	115
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00639	0.00593
Iron (Fe)-Total	0.054	0.042
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0037	0.0038
Magnesium (Mg)-Total	24.5	23.8
Manganese (Mn)-Total	0.00579	0.00534

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	27.6	27.7
Strontium (Sr)-Dissolved	0.058	0.0576
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000102	0.000103
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0068	0.0072
Dissolved Metals Filtration Location	Field	Field

Molybdenum (Mo)-Total	0.146	0.148
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.32	1.3
Selenium (Se)-Total	0.016	0.0161
Silicon (Si)-Total	6.55	6.38
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	23.8	23.6
Strontium (Sr)-Total	0.747	0.737
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00341	0.0035
Vanadium (V)-Total	0.0012	0.00114
Zinc (Zn)-Total	0.0046	0.0042

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	0.00058	0.00056
Arsenic (As)-Dissolved	0.00132	0.00132
Barium (Ba)-Dissolved	0.0276	0.0272
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.168	0.163
Cadmium (Cd)-Dissolved	<0.0000250	<0.0000250
Calcium (Ca)-Dissolved	115	111
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00569	0.00568
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0032	0.0032
Magnesium (Mg)-Dissolved	23.4	23.7
Manganese (Mn)-Dissolved	0.00592	0.0058
Molybdenum (Mo)-Dissolved	0.125	0.126
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.33	1.35
Selenium (Se)-Dissolved	0.0153	0.0157
Silicon (Si)-Dissolved	7.2	7.3
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	22.3	22.4
Strontium (Sr)-Dissolved	0.682	0.687
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00259	0.00257
Vanadium (V)-Dissolved	0.00099	0.00102
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A1777

Client Sample ID	W12	WL
Date Sampled	24-Jan-23	24-Jan-23
Time Sampled	11:47	11:47
ALS Sample ID	VA23A1777-002	VA23A1777-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	223	223
Conductivity	98.2	97.5
Hardness (as CaCO3), Dissolved	99.8	98
Hardness (as CaCO3), From total Ca/Mg	97.5	95.9
pH	155	166
Total Dissolved Solids	1.3	1.6
Total Suspended Solids	2.37	2.21
Turbidity	8.16	8.15
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.173	0.186
Chloride (Cl)	1.29	1.28
Fluoride (F)	0.06	0.059
Nitrate (as N)	0.0536	0.0521
Nitrate and Nitrite (as N)	0.0547	0.0533
Nitrite (as N)	0.0011	0.0012
Total Nitrogen	0.561	0.56
Orthophosphate-Dissolved (as P)	0.007	0.0068
Phosphorus (P)-Total	0.0187	0.0191
Phosphorus (P)-Total Dissolved	0.0132	0.0126
Sulfate (SO4)	16.5	16.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	10.6	10.8
Total Metals (Water)		
Aluminum (Al)-Total	0.0157	0.0166
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00036	0.00042
Barium (Ba)-Total	0.0143	0.0138
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.093	0.094
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	29.4	28.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00264	0.00266
Iron (Fe)-Total	0.72	0.727
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.86	5.82
Manganese (Mn)-Total	0.222	0.221

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.000306	0.000319
Nickel (Ni)-Total	<0.00050	0.00052
Potassium (K)-Total	0.514	0.51
Selenium (Se)-Total	0.000054	0.00007
Silicon (Si)-Total	7.2	7.22
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	5.32	5.41
Strontium (Sr)-Total	0.161	0.16
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000018	0.000018
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0077	0.0081
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00033	0.00034
Barium (Ba)-Dissolved	0.0128	0.0129
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.091	0.089
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	30.2	29.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0023	0.00232
Iron (Fe)-Dissolved	0.45	0.467
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.92	5.92
Manganese (Mn)-Dissolved	0.207	0.208
Molybdenum (Mo)-Dissolved	0.000311	0.000313
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.523	0.532
Selenium (Se)-Dissolved	0.000052	0.000083
Silicon (Si)-Dissolved	7.62	7.65
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	5.14	5.24
Strontium (Sr)-Dissolved	0.161	0.164
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000016	0.000017
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A2609

Client Sample ID	E8	EH
Date Sampled	01-Feb-23	01-Feb-23
Time Sampled	11:40	11:40
ALS Sample ID	VA23A2609-001	VA23A2609-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1050	998
Conductivity	74	74.2
Hardness (as CaCO3), Dissolved	484	479
Hardness (as CaCO3), From total Ca/M	471	496
pH	752	766
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.47	0.47
Turbidity	7.91	7.91
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.046	0.0152
Chloride (Cl)	7.85	6.78
Fluoride (F)	0.434	0.433
Nitrate (as N)	5.78	5.8
Nitrate and Nitrite (as N)	5.79	5.81
Nitrite (as N)	0.0144	0.0142
Total Nitrogen	6.01	5.99
Orthophosphate-Dissolved (as P)	0.0017	0.0016
Phosphorus (P)-Total	0.0066	0.0066
Phosphorus (P)-Total Dissolved	0.0039	0.004
Sulfate (SO4)	434	437
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.04	2.27
Total Metals (Water)		
Aluminum (Al)-Total	0.0399	0.0478
Antimony (Sb)-Total	0.00128	0.00132
Arsenic (As)-Total	0.00153	0.0015
Barium (Ba)-Total	0.0499	0.052
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.159	0.162
Cadmium (Cd)-Total	<0.0000800	<0.0000800
Calcium (Ca)-Total	141	149
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00022	0.00023
Copper (Cu)-Total	0.0208	0.0214
Iron (Fe)-Total	0.037	0.039
Lead (Pb)-Total	0.00009	0.000098
Lithium (Li)-Total	0.0074	0.0077
Magnesium (Mg)-Total	28.8	30.1
Manganese (Mn)-Total	0.0571	0.0601
Molybdenum (Mo)-Total	0.16	0.17
Nickel (Ni)-Total	<0.00050	0.00051
Potassium (K)-Total	2.11	2.24
Selenium (Se)-Total	0.0529	0.0541
Silicon (Si)-Total	6.6	6.69

Results Summary VA23A2874

Client Sample ID	E19	ES
Date Sampled	07-Feb-23	07-Feb-23
Time Sampled	11:51	11:51
ALS Sample ID	VA23A2874-001	VA23A2874-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1070	1070
Conductivity	66.7	66.7
Hardness (as CaCO3), Dissolved	473	485
Hardness (as CaCO3), From total Ca/M	466	466
pH	832	798
Total Dissolved Solids	1.4	1.6
Total Suspended Solids	4.12	3.76
Turbidity	7.91	7.91
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.181	0.201
Chloride (Cl)	11	11
Fluoride (F)	0.528	0.53
Nitrate (as N)	3.63	3.64
Nitrate and Nitrite (as N)	3.7	3.71
Nitrite (as N)	0.0754	0.0723
Total Nitrogen	3.96	3.94
Orthophosphate-Dissolved (as P)	0.0014	0.0017
Phosphorus (P)-Total	0.011	0.0112
Phosphorus (P)-Total Dissolved	0.0037	0.0035
Sulfate (SO4)	500	502
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.78	4.06
Total Metals (Water)		
Aluminum (Al)-Total	0.129	0.122
Antimony (Sb)-Total	0.00104	0.00103
Arsenic (As)-Total	0.00165	0.00162
Barium (Ba)-Total	0.053	0.0517
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.116	0.118
Cadmium (Cd)-Total	<0.0000500	<0.0000500
Calcium (Ca)-Total	149	149
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.0002	0.0002
Copper (Cu)-Total	0.00868	0.00832
Iron (Fe)-Total	0.096	0.094
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0072	0.0072
Magnesium (Mg)-Total	22.8	22.9
Manganese (Mn)-Total	0.079	0.0783
Molybdenum (Mo)-Total	0.176	0.17
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	8.28	8.24
Selenium (Se)-Total	0.0357	0.0355
Silicon (Si)-Total	5.4	5.22

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	28	28.8
Strontium (Sr)-Total	1.32	1.37
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00272	0.00285
Vanadium (V)-Total	0.00201	0.00217
Zinc (Zn)-Total	<0.0030	0.0034
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	0.00134	0.0013
Arsenic (As)-Dissolved	0.00139	0.00141
Barium (Ba)-Dissolved	0.0462	0.0461
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.156	0.155
Cadmium (Cd)-Dissolved	<0.0000650	<0.0000700
Calcium (Ca)-Dissolved	147	145
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00019	0.00018
Copper (Cu)-Dissolved	0.0173	0.0172
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	0.000051	0.000051
Lithium (Li)-Dissolved	0.0073	0.0071
Magnesium (Mg)-Dissolved	28.5	28.5
Manganese (Mn)-Dissolved	0.0549	0.0545
Molybdenum (Mo)-Dissolved	0.17	0.166
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	2.08	2.05
Selenium (Se)-Dissolved	0.053	0.0533
Silicon (Si)-Dissolved	6.54	6.52
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	27.4	27.1
Strontium (Sr)-Dissolved	1.34	1.31
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00272	0.00272
Vanadium (V)-Dissolved	0.00181	0.00184
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	52.6	52.3
Strontium (Sr)-Total	2.33	2.22
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00188	0.00187
Vanadium (V)-Total	0.00191	0.00183
Zinc (Zn)-Total	<0.0030	<0.0030
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0085	0.0092
Antimony (Sb)-Dissolved	0.00109	0.00106
Arsenic (As)-Dissolved	0.0016	0.00157
Barium (Ba)-Dissolved	0.0509	0.0536
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.12	0.123
Cadmium (Cd)-Dissolved	<0.0000650	<0.0000650
Calcium (Ca)-Dissolved	149	154
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00012	0.00011
Copper (Cu)-Dissolved	0.00334	0.00324
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0076	0.0079
Magnesium (Mg)-Dissolved	24.6	24.5
Manganese (Mn)-Dissolved	0.0729	0.072
Molybdenum (Mo)-Dissolved	0.177	0.175
Nickel (Ni)-Dissolved	0.0009	0.00086
Potassium (K)-Dissolved	8.61	8.25
Selenium (Se)-Dissolved	0.0355	0.0356
Silicon (Si)-Dissolved	5.07	5.01
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	52.9	51.6
Strontium (Sr)-Dissolved	2.33	2.29
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.0018	0.00182
Vanadium (V)-Dissolved	0.00165	0.00161
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A3195

Client Sample ID	HAC-10	HAC-J
Date Sampled	08-Feb-23	08-Feb-23
Time Sampled	10:11	10:11
ALS Sample ID	VA23A3195-001	VA23A3195-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	266	264
Conductivity	97.2	95.3
Hardness (as CaCO3), Dissolved	111	112
Hardness (as CaCO3), From total Ca/M	118	117
pH	160	166
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.18	0.18
Turbidity	8.11	8.11
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0355	0.01
Chloride (Cl)	0.88	0.88
Fluoride (F)	0.077	0.075
Nitrate (as N)	0.0528	0.0539
Nitrate and Nitrite (as N)	0.0528	0.0553
Nitrite (as N)	<0.0010	0.0014
Total Nitrogen	0.3	0.312
Orthophosphate-Dissolved (as P)	0.0087	0.0082
Phosphorus (P)-Total	0.0128	0.0128
Phosphorus (P)-Total Dissolved	0.0116	0.012
Sulfate (SO4)	38	38
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.63	6.74
Total Metals (Water)		
Aluminum (Al)-Total	0.007	0.0068
Antimony (Sb)-Total	0.0001	0.00011
Arsenic (As)-Total	0.00054	0.00055
Barium (Ba)-Total	0.0105	0.0105
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.022	0.022
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	38	37.7
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00396	0.0044
Iron (Fe)-Total	<0.030	0.037
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.66	5.57
Manganese (Mn)-Total	0.0024	0.00268
Molybdenum (Mo)-Total	0.00687	0.00707
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.06	1.05
Selenium (Se)-Total	0.00058	0.000537
Silicon (Si)-Total	3.58	3.57

Results Summary VA23A3700

Client Sample ID	WIP-20m	23916-20m
Date Sampled	16-Feb-23	16-Feb-23
Time Sampled	10:49	10:49
ALS Sample ID	VA23A3700-003	VA23A3700-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2230	2220
Conductivity	126	126
Hardness (as CaCO3), Dissolved	1440	1420
Hardness (as CaCO3), From total Ca/M	1480	1480
pH	2020	2060
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.11	0.12
Turbidity	7.88	7.87
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0053	0.0099
Chloride (Cl)	<5.00	<5.00
Fluoride (F)	0.693	0.712
Nitrate (as N)	1.85	1.81
Nitrate and Nitrite (as N)	1.85	1.81
Nitrite (as N)	<0.0100	<0.0100
Total Nitrogen	1.85	1.91
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	1340	1320
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.31	1.33
Total Metals (Water)		
Aluminum (Al)-Total	<0.0150	<0.0150
Antimony (Sb)-Total	0.00064	0.00064
Arsenic (As)-Total	0.00058	0.00064
Barium (Ba)-Total	0.0327	0.0323
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.183	0.177
Cadmium (Cd)-Total	0.00105	0.000961
Calcium (Ca)-Total	491	492
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00112	0.00118
Copper (Cu)-Total	0.0199	0.02
Iron (Fe)-Total	<0.050	<0.050
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.0139	0.0139
Magnesium (Mg)-Total	60.6	60.6
Manganese (Mn)-Total	0.268	0.275
Molybdenum (Mo)-Total	0.107	0.108
Nickel (Ni)-Total	<0.00250	<0.00250
Potassium (K)-Total	2.61	2.6
Selenium (Se)-Total	0.0363	0.0342
Silicon (Si)-Total	6.46	6.33

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.67	7.53
Strontium (Sr)-Total	0.265	0.271
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000205	0.000201
Vanadium (V)-Total	0.0014	0.00139
Zinc (Zn)-Total	<0.0030	<0.0030
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00054	0.00056
Barium (Ba)-Dissolved	0.0106	0.0106
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.019	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	35.3	36.1
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00372	0.00375
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.56	5.39
Manganese (Mn)-Dissolved	0.00174	0.0017
Molybdenum (Mo)-Dissolved	0.00652	0.0065
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.04	1.04
Selenium (Se)-Dissolved	0.000568	0.00054
Silicon (Si)-Dissolved	3.61	3.5
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.56	7.53
Strontium (Sr)-Dissolved	0.244	0.244
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000207	0.000206
Vanadium (V)-Dissolved	0.00133	0.00133
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	32.5	33
Strontium (Sr)-Total	15.4	15.6
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00549	0.00563
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.108	0.109
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	0.00071	0.00069
Arsenic (As)-Dissolved	0.00058	0.00062
Barium (Ba)-Dissolved	0.0321	0.032
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000100
Boron (B)-Dissolved	0.16	0.164
Cadmium (Cd)-Dissolved	0.000989	0.00101
Calcium (Ca)-Dissolved	482	469
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00099	0.00103
Copper (Cu)-Dissolved	0.0182	0.0184
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000100
Lithium (Li)-Dissolved	0.0135	0.0136
Magnesium (Mg)-Dissolved	58.4	59.6
Manganese (Mn)-Dissolved	0.267	0.263
Molybdenum (Mo)-Dissolved	0.11	0.106
Nickel (Ni)-Dissolved	0.00232	0.00233
Potassium (K)-Dissolved	2.68	2.6
Selenium (Se)-Dissolved	0.0378	0.0341
Silicon (Si)-Dissolved	6.17	6.04
Silver (Ag)-Dissolved	0.000013	<0.000020
Sodium (Na)-Dissolved	30.3	30.5
Strontium (Sr)-Dissolved	15	15.1
Thallium (Tl)-Dissolved	0.000016	<0.000020
Tin (Sn)-Dissolved	<0.00010	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.0056	0.00544
Vanadium (V)-Dissolved	0.00081	<0.00100
Zinc (Zn)-Dissolved	0.104	0.105
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A4030

Client Sample ID	E1a	EAa
Date Sampled	21-Feb-23	21-Feb-23
Time Sampled	10:48	10:48
ALS Sample ID	VA23A4030-002	VA23A4030-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1140	1140
Conductivity	17.5	18.5
Hardness (as CaCO3), Dissolved	335	330
Hardness (as CaCO3), From total Ca/M	351	348
pH	805	814
Total Dissolved Solids	6.7	7.3
Total Suspended Solids	5.6	5.25
Turbidity	7.45	7.45
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.452	0.456
Chloride (Cl)	20	19.9
Fluoride (F)	0.678	0.672
Nitrate (as N)	3.04	3.24
Nitrate and Nitrite (as N)	3.29	3.48
Nitrite (as N)	0.246	0.245
Total Nitrogen	4.1	4.07
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0164	0.0162
Phosphorus (P)-Total Dissolved	0.0043	0.0042
Sulfate (SO4)	505	503
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.68	7.06
Total Metals (Water)		
Aluminum (Al)-Total	0.282	0.27
Antimony (Sb)-Total	0.00165	0.00166
Arsenic (As)-Total	0.00282	0.00279
Barium (Ba)-Total	0.0655	0.0646
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.124	0.123
Cadmium (Cd)-Total	<0.0000400	<0.0000450
Calcium (Ca)-Total	116	115
Chromium (Cr)-Total	0.00061	<0.00050
Cobalt (Co)-Total	0.00019	0.00015
Copper (Cu)-Total	0.00242	0.0023
Iron (Fe)-Total	0.142	0.114
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0112	0.0112
Magnesium (Mg)-Total	15	14.9
Manganese (Mn)-Total	0.0134	0.0127
Molybdenum (Mo)-Total	0.211	0.213
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	16.7	16.5
Selenium (Se)-Total	0.0269	0.0267
Silicon (Si)-Total	4.8	4.59

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	93	92
Strontium (Sr)-Total	1.25	1.24
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.0101	<0.0100
Uranium (U)-Total	0.00049	0.000493
Vanadium (V)-Total	0.00308	0.00285
Zinc (Zn)-Total	<0.0030	<0.0030
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0218	0.0188
Antimony (Sb)-Dissolved	0.00162	0.00166
Arsenic (As)-Dissolved	0.00252	0.00259
Barium (Ba)-Dissolved	0.0596	0.0589
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.116	0.11
Cadmium (Cd)-Dissolved	<0.0000300	<0.0000250
Calcium (Ca)-Dissolved	110	108
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00096	0.00085
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0104	0.0102
Magnesium (Mg)-Dissolved	14.6	14.6
Manganese (Mn)-Dissolved	0.00934	0.00925
Molybdenum (Mo)-Dissolved	0.21	0.217
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	16.1	16
Selenium (Se)-Dissolved	0.0246	0.0244
Silicon (Si)-Dissolved	4.13	4.14
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	89.1	90
Strontium (Sr)-Dissolved	1.3	1.31
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000477	0.00047
Vanadium (V)-Dissolved	0.00241	0.00244
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A4694

Client Sample ID	WIP-S	23916-S
Date Sampled	02-Mar-23	02-Mar-23
Time Sampled	11:10	11:10
ALS Sample ID	VA23A4694-001	VA23A4694-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1130	1130
Conductivity	94.2	94.4
Hardness (as CaCO3), Dissolved	580	590
Hardness (as CaCO3), From total Ca/M	563	555
pH	904	897
Total Dissolved Solids	1.6	1.4
Total Suspended Solids	0.46	0.46
Turbidity	7.92	7.92
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0181	0.0169
Chloride (Cl)	5.1	5.05
Fluoride (F)	0.538	0.53
Nitrate (as N)	2.86	2.84
Nitrate and Nitrite (as N)	2.87	2.85
Nitrite (as N)	0.0083	0.008
Total Nitrogen	3.06	3.09
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0046	0.0116
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	548	543
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.54	1.47
Total Metals (Water)		
Aluminum (Al)-Total	0.0199	0.0306
Antimony (Sb)-Total	0.00085	0.00082
Arsenic (As)-Total	0.00096	0.00092
Barium (Ba)-Total	0.051	0.0511
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.109	0.108
Cadmium (Cd)-Total	0.000152	0.000146
Calcium (Ca)-Total	180	177
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00020	<0.00020
Copper (Cu)-Total	0.00958	0.00964
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000100	<0.000100
Lithium (Li)-Total	0.0066	0.0066
Magnesium (Mg)-Total	27.6	27.4
Manganese (Mn)-Total	0.0117	0.0114
Molybdenum (Mo)-Total	0.149	0.149
Nickel (Ni)-Total	<0.00100	<0.00100
Potassium (K)-Total	2.11	2.08

Results Summary VA23A4928

Client Sample ID	E21	EU
Date Sampled	06-Mar-23	06-Mar-23
Time Sampled	11:21	11:21
ALS Sample ID	VA23A4928-001	VA23A4928-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1120	1030
Conductivity	22.5	23.1
Hardness (as CaCO3), Dissolved	360	352
Hardness (as CaCO3), From total Ca/M	388	334
pH	776	817
Total Dissolved Solids	12	10.8
Total Suspended Solids	7.38	9.08
Turbidity	7.54	8.02
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.42	0.424
Chloride (Cl)	21.4	21
Fluoride (F)	0.733	0.692
Nitrate (as N)	3.25	3.27
Nitrate and Nitrite (as N)	3.5	3.52
Nitrite (as N)	0.247	0.25
Total Nitrogen	4.29	3.9
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0174	0.0196
Phosphorus (P)-Total Dissolved	<0.0020	0.0024
Sulfate (SO4)	496	500
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.69	7.97
Total Metals (Water)		
Aluminum (Al)-Total	0.481	0.403
Antimony (Sb)-Total	0.00161	0.00161
Arsenic (As)-Total	0.00283	0.00286
Barium (Ba)-Total	0.0674	0.0683
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.118	0.11
Cadmium (Cd)-Total	<0.0000450	<0.0000100
Calcium (Ca)-Total	130	110
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00045	0.00031
Copper (Cu)-Total	0.0172	0.00329
Iron (Fe)-Total	0.327	0.217
Lead (Pb)-Total	0.000212	0.000061
Lithium (Li)-Total	0.0106	0.0109
Magnesium (Mg)-Total	15.4	14.3
Manganese (Mn)-Total	0.0209	0.0182
Molybdenum (Mo)-Total	0.239	0.221
Nickel (Ni)-Total	0.00054	<0.00050
Potassium (K)-Total	16.2	15.1

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.0392	0.038
Silicon (Si)-Total	4.75	4.69
Silver (Ag)-Total	<0.000020	<0.000020
Sodium (Na)-Total	24.7	25
Strontium (Sr)-Total	5.98	5.94
Thallium (Tl)-Total	<0.000020	<0.000020
Tin (Sn)-Total	<0.00020	<0.00020
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.0027	0.0027
Vanadium (V)-Total	0.00112	0.00107
Zinc (Zn)-Total	0.0086	0.0096

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.003	<0.0030
Antimony (Sb)-Dissolved	0.00082	0.0008
Arsenic (As)-Dissolved	0.0009	0.00086
Barium (Ba)-Dissolved	0.0513	0.0506
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100
Boron (B)-Dissolved	0.111	0.115
Cadmium (Cd)-Dissolved	0.000156	0.000159
Calcium (Ca)-Dissolved	186	190
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00020
Copper (Cu)-Dissolved	0.00829	0.00828
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000100	<0.000100
Lithium (Li)-Dissolved	0.0072	0.0074
Magnesium (Mg)-Dissolved	28.1	28
Manganese (Mn)-Dissolved	0.0106	0.0103
Molybdenum (Mo)-Dissolved	0.146	0.148
Nickel (Ni)-Dissolved	<0.00100	<0.00100
Potassium (K)-Dissolved	2.16	2.12
Selenium (Se)-Dissolved	0.0369	0.0375
Silicon (Si)-Dissolved	4.7	4.65
Silver (Ag)-Dissolved	<0.000020	<0.000020
Sodium (Na)-Dissolved	24.6	24.4
Strontium (Sr)-Dissolved	5.92	5.82
Thallium (Tl)-Dissolved	<0.000020	<0.000020
Tin (Sn)-Dissolved	<0.00020	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00245	0.00251
Vanadium (V)-Dissolved	0.00105	0.00104
Zinc (Zn)-Dissolved	0.0084	0.0083
Dissolved Metals Filtration Location	Field	Field

Selenium (Se)-Total	0.027	0.0262
Silicon (Si)-Total	4.98	4.94
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	99.8	91.7
Strontium (Sr)-Total	1.49	1.32
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.027	0.0201
Uranium (U)-Total	0.00053	0.00054
Vanadium (V)-Total	0.00304	0.00284
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0164	0.0172
Antimony (Sb)-Dissolved	0.00149	0.00151
Arsenic (As)-Dissolved	0.0024	0.00238
Barium (Ba)-Dissolved	0.0608	0.0591
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.1	0.097
Cadmium (Cd)-Dissolved	<0.0000350	<0.0000350
Calcium (Ca)-Dissolved	120	117
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00106	0.00109
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0096	0.0092
Magnesium (Mg)-Dissolved	14.7	14.6
Manganese (Mn)-Dissolved	0.0114	0.011
Molybdenum (Mo)-Dissolved	0.218	0.219
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	14.9	15.1
Selenium (Se)-Dissolved	0.0248	0.0242
Silicon (Si)-Dissolved	3.79	3.81
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	90	94.7
Strontium (Sr)-Dissolved	1.39	1.41
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000506	0.000513
Vanadium (V)-Dissolved	0.00191	0.00191
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A4924

Client Sample ID	EDC-01a	EDC-Aa
Date Sampled	07-Mar-23	07-Mar-23
Time Sampled	11:24	11:24
ALS Sample ID	VA23A4924-005	VA23A4924-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	311	315
Conductivity	121	121
Hardness (as CaCO3), Dissolved	145	144
Hardness (as CaCO3), From total Ca/M	135	136
pH	211	204
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.22	0.26
Turbidity	8.25	8.26
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0061	0.0107
Chloride (Cl)	0.99	0.98
Fluoride (F)	0.082	0.082
Nitrate (as N)	0.0902	0.0895
Nitrate and Nitrite (as N)	0.0902	0.0895
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.299	0.3
Orthophosphate-Dissolved (as P)	0.0068	0.0066
Phosphorus (P)-Total	0.0089	0.0095
Phosphorus (P)-Total Dissolved	0.0079	0.0075
Sulfate (SO4)	41.6	41.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.16	6.13
Total Metals (Water)		
Aluminum (Al)-Total	0.0115	0.0106
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00087	0.0009
Barium (Ba)-Total	0.0169	0.0167
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.02	0.02
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	40.4	40.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00628	0.00606
Iron (Fe)-Total	0.031	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	8.34	8.38
Manganese (Mn)-Total	0.033	0.0323
Molybdenum (Mo)-Total	0.00568	0.00538
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.05	1.03

Results Summary VA23A5234

Client Sample ID	W4a	WDa
Date Sampled	08-Mar-23	08-Mar-23
Time Sampled	11:23	11:23
ALS Sample ID	VA23A5234-002	VA23A5234-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	344	344
Conductivity	146	146
Hardness (as CaCO3), Dissolved	183	181
Hardness (as CaCO3), From total Ca/M	174	172
pH	249	208
Total Dissolved Solids	<1.2	<1.0
Total Suspended Solids	<0.10	0.1
Turbidity	8.3	8.3
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	0.0062
Chloride (Cl)	0.64	0.64
Fluoride (F)	0.084	0.082
Nitrate (as N)	0.0261	0.0212
Nitrate and Nitrite (as N)	0.0261	0.0212
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.07	0.069
Orthophosphate-Dissolved (as P)	0.0104	0.0113
Phosphorus (P)-Total	0.014	0.015
Phosphorus (P)-Total Dissolved	0.0131	0.0132
Sulfate (SO4)	41.2	41.1
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.29	2.36
Total Metals (Water)		
Aluminum (Al)-Total	0.023	0.0125
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00033	0.0003
Barium (Ba)-Total	0.0156	0.0154
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.026	0.026
Cadmium (Cd)-Total	<0.0000100	<0.0000100
Calcium (Ca)-Total	58	57.3
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00654	0.00411
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	7.07	7.08
Manganese (Mn)-Total	0.00232	0.00118
Molybdenum (Mo)-Total	0.00664	0.00672
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.462	0.471

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.000952	0.000967
Silicon (Si)-Total	4.34	4.2
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	8.09	8.01
Strontium (Sr)-Total	0.292	0.284
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000386	0.000382
Vanadium (V)-Total	0.00091	0.00089
Zinc (Zn)-Total	<0.0030	<0.0030

Selenium (Se)-Total	0.00168	0.00143
Silicon (Si)-Total	6.13	6.12
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	3.46	3.58
Strontium (Sr)-Total	0.237	0.233
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000411	0.000404
Vanadium (V)-Total	0.00076	0.0007
Zinc (Zn)-Total	0.0104	0.0106

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00083	0.0008
Barium (Ba)-Dissolved	0.0161	0.0169
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.019	0.018
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	43.5	43.1
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0057	0.00565
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	8.83	8.75
Manganese (Mn)-Dissolved	0.0311	0.0306
Molybdenum (Mo)-Dissolved	0.00525	0.00538
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1	0.996
Selenium (Se)-Dissolved	0.000974	0.000937
Silicon (Si)-Dissolved	4.2	4.17
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	8.58	8.56
Strontium (Sr)-Dissolved	0.312	0.308
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000365	0.00036
Vanadium (V)-Dissolved	0.00074	0.00075
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00028	0.00028
Barium (Ba)-Dissolved	0.015	0.0147
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.024	0.025
Cadmium (Cd)-Dissolved	0.0000076	<0.0000100
Calcium (Ca)-Dissolved	61.5	60.7
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00333	0.00325
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	7.15	7.06
Manganese (Mn)-Dissolved	0.00017	0.00018
Molybdenum (Mo)-Dissolved	0.0064	0.00634
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.46	0.461
Selenium (Se)-Dissolved	0.00163	0.00162
Silicon (Si)-Dissolved	5.51	5.57
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	3.68	3.62
Strontium (Sr)-Dissolved	0.266	0.26
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00038	0.000386
Vanadium (V)-Dissolved	<0.00050	0.0005
Zinc (Zn)-Dissolved	0.009	0.009
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A5233

Client Sample ID	WIP-10m	23916-10m
Date Sampled	09-Mar-23	09-Mar-23
Time Sampled	10:10	10:10
ALS Sample ID	VA23A5233-002	VA23A5233-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1840	1860
Conductivity	106	107
Hardness (as CaCO3), Dissolved	1100	1100
Hardness (as CaCO3), From total Ca/M	1100	1070
pH	1700	1670
Total Dissolved Solids	<1.0	1
Total Suspended Solids	0.45	0.52
Turbidity	8.09	8.09
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0098	0.0097
Chloride (Cl)	5.14	5.1
Fluoride (F)	0.582	0.577
Nitrate (as N)	2.34	2.35
Nitrate and Nitrite (as N)	2.34	2.35
Nitrite (as N)	<0.0100	<0.0100
Total Nitrogen	2.14	2.13
Orthophosphate-Dissolved (as P)	0.0019	0.0019
Phosphorus (P)-Total	0.0037	0.0026
Phosphorus (P)-Total Dissolved	0.0034	0.0028
Sulfate (SO4)	1090	1090
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.47	1.43
Total Metals (Water)		
Aluminum (Al)-Total	0.01	<0.0150
Antimony (Sb)-Total	0.00084	0.00086
Arsenic (As)-Total	0.00078	0.00075
Barium (Ba)-Total	0.0433	0.0446
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000250
Boron (B)-Total	0.175	0.169
Cadmium (Cd)-Total	0.00069	0.000722
Calcium (Ca)-Total	370	358
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00020	<0.00050
Copper (Cu)-Total	0.0142	0.0148
Iron (Fe)-Total	<0.030	<0.050
Lead (Pb)-Total	<0.000100	<0.000250
Lithium (Li)-Total	0.0112	0.0111
Magnesium (Mg)-Total	43	42.6
Manganese (Mn)-Total	0.0693	0.0696
Molybdenum (Mo)-Total	0.161	0.15
Nickel (Ni)-Total	0.00132	<0.00250
Potassium (K)-Total	2.58	2.55

Results Summary VA23A5502

Client Sample ID	E10	EJ
Date Sampled	14-Mar-23	14-Mar-23
Time Sampled	9:50	9:50
ALS Sample ID	VA23A5502-003	VA23A5502-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1110	1110
Conductivity	108	107
Hardness (as CaCO3), Dissolved	528	524
Hardness (as CaCO3), From total Ca/Mg	547	542
pH	924	936
Total Dissolved Solids	25.8	25.6
Total Suspended Solids	17.2	12.6
Turbidity	8.07	8.07
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	4.97	4.86
Fluoride (F)	0.454	0.43
Nitrate (as N)	2.66	2.63
Nitrate and Nitrite (as N)	2.66	2.63
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	3	2.96
Orthophosphate-Dissolved (as P)	0.0024	0.0014
Phosphorus (P)-Total	0.056	0.0568
Phosphorus (P)-Total Dissolved	0.0032	<0.0020
Sulfate (SO4)	522	515
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.75	1.58
Total Metals (Water)		
Aluminum (Al)-Total	0.934	0.808
Antimony (Sb)-Total	0.0008	0.00082
Arsenic (As)-Total	0.00165	0.00148
Barium (Ba)-Total	0.0688	0.0659
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.104	0.103
Cadmium (Cd)-Total	0.000183	0.000197
Calcium (Ca)-Total	176	174
Chromium (Cr)-Total	0.00086	0.00063
Cobalt (Co)-Total	0.00082	0.00072
Copper (Cu)-Total	0.0711	0.0664
Iron (Fe)-Total	1.09	0.911
Lead (Pb)-Total	0.000627	0.000558
Lithium (Li)-Total	0.0076	0.0074
Magnesium (Mg)-Total	26.2	26.1
Manganese (Mn)-Total	0.0747	0.0686
Molybdenum (Mo)-Total	0.14	0.14
Nickel (Ni)-Total	0.00136	0.00113
Potassium (K)-Total	2.18	2.18

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.0377	0.0364
Silicon (Si)-Total	5.12	5.09
Silver (Ag)-Total	<0.000020	<0.000050
Sodium (Na)-Total	33.8	33
Strontium (Sr)-Total	10.4	10
Thallium (Tl)-Total	0.000026	<0.000050
Tin (Sn)-Total	<0.00020	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00462	0.00462
Vanadium (V)-Total	<0.00100	<0.00250
Zinc (Zn)-Total	0.0714	0.0752

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0057	0.0066
Antimony (Sb)-Dissolved	0.00083	0.00087
Arsenic (As)-Dissolved	0.00068	0.00071
Barium (Ba)-Dissolved	0.0427	0.0433
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.168	0.166
Cadmium (Cd)-Dissolved	0.000652	0.000654
Calcium (Ca)-Dissolved	375	370
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00050	<0.00050
Copper (Cu)-Dissolved	0.0121	0.0125
Iron (Fe)-Dissolved	<0.050	<0.050
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.0103	0.0104
Magnesium (Mg)-Dissolved	40.9	41.7
Manganese (Mn)-Dissolved	0.059	0.0621
Molybdenum (Mo)-Dissolved	0.151	0.156
Nickel (Ni)-Dissolved	<0.00250	<0.00250
Potassium (K)-Dissolved	2.4	2.4
Selenium (Se)-Dissolved	0.0386	0.036
Silicon (Si)-Dissolved	4.88	4.85
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	29.7	29.9
Strontium (Sr)-Dissolved	10.9	11.2
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00435	0.00446
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.0726	0.0757
Dissolved Metals Filtration Location	Field	Field

Selenium (Se)-Total	0.0359	0.0351
Silicon (Si)-Total	7.12	6.65
Silver (Ag)-Total	0.000026	0.000021
Sodium (Na)-Total	23	23.4
Strontium (Sr)-Total	5.45	5.51
Thallium (Tl)-Total	<0.000020	<0.000020
Tin (Sn)-Total	<0.00020	<0.00020
Titanium (Ti)-Total	0.0482	0.0397
Uranium (U)-Total	0.00273	0.00274
Vanadium (V)-Total	0.00449	0.00384
Zinc (Zn)-Total	0.0223	0.0209

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0052	0.0069
Antimony (Sb)-Dissolved	0.00077	0.00075
Arsenic (As)-Dissolved	0.0008	0.00075
Barium (Ba)-Dissolved	0.0469	0.0467
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100
Boron (B)-Dissolved	0.102	0.1
Cadmium (Cd)-Dissolved	0.00015	0.000154
Calcium (Ca)-Dissolved	171	170
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00020
Copper (Cu)-Dissolved	0.0102	0.01
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000100	<0.000100
Lithium (Li)-Dissolved	0.0065	0.0064
Magnesium (Mg)-Dissolved	24.6	24.3
Manganese (Mn)-Dissolved	0.0254	0.0249
Molybdenum (Mo)-Dissolved	0.137	0.133
Nickel (Ni)-Dissolved	<0.00100	<0.00100
Potassium (K)-Dissolved	1.97	1.94
Selenium (Se)-Dissolved	0.0328	0.0322
Silicon (Si)-Dissolved	4.81	4.75
Silver (Ag)-Dissolved	<0.000020	<0.000020
Sodium (Na)-Dissolved	22.3	21.6
Strontium (Sr)-Dissolved	5.23	5.17
Thallium (Tl)-Dissolved	<0.000020	<0.000020
Tin (Sn)-Dissolved	<0.00020	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00253	0.00255
Vanadium (V)-Dissolved	<0.00100	<0.00100
Zinc (Zn)-Dissolved	0.0133	0.0135
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A6148

Client Sample ID	WIP-20m	23916-20m
Date Sampled	20-Mar-23	20-Mar-23
Time Sampled	14:15	14:15
ALS Sample ID	VA23A6148-003	VA23A6148-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2230	2240
Conductivity	133	133
Hardness (as CaCO3), Dissolved	1390	1350
Hardness (as CaCO3), From total Ca/Mg	1340	1380
pH	2290	2170
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.11	0.11
Turbidity	7.91	7.93
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	0.724	0.774
Nitrate (as N)	1.73	1.76
Nitrate and Nitrite (as N)	1.73	1.78
Nitrite (as N)	<0.0200	0.021
Total Nitrogen	1.81	1.78
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	1430	1410
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.17	1.14
Total Metals (Water)		
Aluminum (Al)-Total	<0.0150	<0.0150
Antimony (Sb)-Total	0.00077	0.00104
Arsenic (As)-Total	0.00057	0.00064
Barium (Ba)-Total	0.0267	0.0268
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.167	0.166
Cadmium (Cd)-Total	0.00104	0.00106
Calcium (Ca)-Total	443	456
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.0015	0.0016
Copper (Cu)-Total	0.017	0.0178
Iron (Fe)-Total	<0.050	<0.050
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.0147	0.0151
Magnesium (Mg)-Total	56.8	58.2
Manganese (Mn)-Total	0.34	0.342
Molybdenum (Mo)-Total	0.1	0.103
Nickel (Ni)-Total	0.00263	0.0026
Potassium (K)-Total	2.58	2.64

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.03	0.0302
Silicon (Si)-Total	6.01	6.07
Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	29.4	30
Strontium (Sr)-Total	16	16.5
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.0059	0.006
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.112	0.112

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0050	<0.0050
Antimony (Sb)-Dissolved	0.00102	0.0009
Arsenic (As)-Dissolved	0.00066	0.00053
Barium (Ba)-Dissolved	0.028	0.0282
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.158	0.162
Cadmium (Cd)-Dissolved	0.00106	0.00102
Calcium (Ca)-Dissolved	460	442
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.0016	0.00155
Copper (Cu)-Dissolved	0.0174	0.0175
Iron (Fe)-Dissolved	<0.050	<0.050
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.0151	0.0148
Magnesium (Mg)-Dissolved	58.2	60.1
Manganese (Mn)-Dissolved	0.36	0.361
Molybdenum (Mo)-Dissolved	0.105	0.104
Nickel (Ni)-Dissolved	0.00276	0.00265
Potassium (K)-Dissolved	2.72	2.69
Selenium (Se)-Dissolved	0.0309	0.0321
Silicon (Si)-Dissolved	6.29	6.24
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	31	31.5
Strontium (Sr)-Dissolved	16.6	16.3
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00591	0.00589
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.12	0.119
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A7298

Client Sample ID	HAC-10	HAC-J
Date Sampled	03-Apr-23	03-Apr-23
Time Sampled	11:14	11:14
ALS Sample ID	VA23A7298-001	VA23A7298-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	257	257
Conductivity	96.6	97
Hardness (as CaCO3), Dissolved	112	114
Hardness (as CaCO3), From total Ca/M	110	112
pH	202	159
Total Dissolved Solids	1.3	<1.0
Total Suspended Solids	0.56	0.25
Turbidity	8.17	8.16
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0055	0.0055
Chloride (Cl)	0.84	0.85
Fluoride (F)	0.074	0.071
Nitrate (as N)	0.0509	0.0511
Nitrate and Nitrite (as N)	0.0509	0.0511
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.28	0.285
Orthophosphate-Dissolved (as P)	0.0059	0.0058
Phosphorus (P)-Total	0.0134	0.0135
Phosphorus (P)-Total Dissolved	0.0104	0.0098
Sulfate (SO4)	35.9	36.1
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.29	6.81
Total Metals (Water)		
Aluminum (Al)-Total	0.0117	0.0093
Antimony (Sb)-Total	<0.00010	0.00011
Arsenic (As)-Total	0.00055	0.00059
Barium (Ba)-Total	0.0108	0.0104
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.019	0.021
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	35.1	35.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00404	0.00391
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.49	5.59
Manganese (Mn)-Total	0.01	0.00978
Molybdenum (Mo)-Total	0.00644	0.00635
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.06	1.05

Results Summary VA23A7564

Client Sample ID	WIP-30m	23916-30m
Date Sampled	05-Apr-23	05-Apr-23
Time Sampled	12:27	12:27
ALS Sample ID	VA23A7564-004	VA23A7564-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2880	2450
Conductivity	145	145
Hardness (as CaCO3), Dissolved	1390	1400
Hardness (as CaCO3), From total Ca/M	1430	1450
pH	2280	2260
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.23	0.23
Turbidity	8.06	8.09
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	0.701	0.715
Nitrate (as N)	0.589	0.579
Nitrate and Nitrite (as N)	0.589	0.579
Nitrite (as N)	<0.0200	<0.0200
Total Nitrogen	0.588	0.627
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	0.0024
Phosphorus (P)-Total Dissolved	0.0035	<0.0020
Sulfate (SO4)	1400	1420
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.65	1.32
Total Metals (Water)		
Aluminum (Al)-Total	<0.0150	<0.0150
Antimony (Sb)-Total	0.00087	0.00087
Arsenic (As)-Total	0.00065	0.00065
Barium (Ba)-Total	0.0222	0.0225
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.165	0.168
Cadmium (Cd)-Total	0.00117	0.00117
Calcium (Ca)-Total	465	472
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00253	0.00249
Copper (Cu)-Total	0.0212	0.0214
Iron (Fe)-Total	<0.050	<0.050
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.0147	0.0151
Magnesium (Mg)-Total	65.9	66.5
Manganese (Mn)-Total	0.584	0.589
Molybdenum (Mo)-Total	0.115	0.115
Nickel (Ni)-Total	0.00292	0.00298
Potassium (K)-Total	3.18	3.16

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.000527	0.000536
Silicon (Si)-Total	3.51	3.51
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.38	7.52
Strontium (Sr)-Total	0.248	0.245
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00019	0.000194
Vanadium (V)-Total	0.00135	0.00134
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	0.0037
Antimony (Sb)-Dissolved	<0.00010	0.00011
Arsenic (As)-Dissolved	0.00053	0.00054
Barium (Ba)-Dissolved	0.00998	0.00972
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.02	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	35.3	36.4
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00392	0.00427
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	0.000069
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.82	5.66
Manganese (Mn)-Dissolved	0.00912	0.00919
Molybdenum (Mo)-Dissolved	0.00605	0.00617
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.02	1.07
Selenium (Se)-Dissolved	0.000479	0.000555
Silicon (Si)-Dissolved	3.39	3.38
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.44	7.68
Strontium (Sr)-Dissolved	0.24	0.238
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000203	0.000205
Vanadium (V)-Dissolved	0.00124	0.00125
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Selenium (Se)-Total	0.0122	0.0123
Silicon (Si)-Total	6.52	6.5
Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	36	36.8
Strontium (Sr)-Total	15.4	15.4
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00782	0.00808
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.144	0.147

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0150	<0.0150
Antimony (Sb)-Dissolved	0.00082	0.00083
Arsenic (As)-Dissolved	<0.00050	<0.00050
Barium (Ba)-Dissolved	0.0213	0.0212
Beryllium (Be)-Dissolved	<0.000500	<0.000500
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.16	0.16
Cadmium (Cd)-Dissolved	0.00107	0.00106
Calcium (Ca)-Dissolved	453	458
Chromium (Cr)-Dissolved	<0.00250	<0.00250
Cobalt (Co)-Dissolved	0.00232	0.00234
Copper (Cu)-Dissolved	0.0111	0.0114
Iron (Fe)-Dissolved	<0.150	<0.150
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.0145	0.0144
Magnesium (Mg)-Dissolved	62.6	61.3
Manganese (Mn)-Dissolved	0.543	0.54
Molybdenum (Mo)-Dissolved	0.108	0.107
Nickel (Ni)-Dissolved	0.00267	0.0028
Potassium (K)-Dissolved	3.01	2.99
Selenium (Se)-Dissolved	0.0108	0.0109
Silicon (Si)-Dissolved	5.96	5.86
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	34.2	34.1
Strontium (Sr)-Dissolved	15	14.8
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0500	<0.0500
Uranium (U)-Dissolved	0.00697	0.00704
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.138	0.135
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A7873

Client Sample ID	W4a	WDa
Date Sampled	12-Apr-23	12-Apr-23
Time Sampled	10:31	10:31
ALS Sample ID	VA23A7873-002	VA23A7873-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	331	330
Conductivity	106	106
Hardness (as CaCO3), Dissolved	157	160
Hardness (as CaCO3), From total Ca/Mg	173	169
pH	242	252
Total Dissolved Solids	1.3	1.2
Total Suspended Solids	6.24	6.06
Turbidity	8.22	8.21
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.79	0.79
Fluoride (F)	0.086	0.086
Nitrate (as N)	0.0215	0.0187
Nitrate and Nitrite (as N)	0.0215	0.0187
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.17	0.191
Orthophosphate-Dissolved (as P)	0.0099	0.0101
Phosphorus (P)-Total	0.027	0.0283
Phosphorus (P)-Total Dissolved	0.0166	0.0165
Sulfate (SO4)	66.7	66.6
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	8.1	7.59
Total Metals (Water)		
Aluminum (Al)-Total	0.666	0.646
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00049	0.0005
Barium (Ba)-Total	0.0193	0.0195
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.023	0.023
Cadmium (Cd)-Total	0.000009	0.0000077
Calcium (Ca)-Total	57.5	56
Chromium (Cr)-Total	0.00117	0.0012
Cobalt (Co)-Total	0.00028	0.00026
Copper (Cu)-Total	0.0135	0.0136
Iron (Fe)-Total	0.55	0.55
Lead (Pb)-Total	0.00012	0.000117
Lithium (Li)-Total	0.001	<0.0010
Magnesium (Mg)-Total	7.06	7
Manganese (Mn)-Total	0.0114	0.0113
Molybdenum (Mo)-Total	0.005	0.00493
Nickel (Ni)-Total	0.00095	0.00092
Potassium (K)-Total	0.555	0.559

Results Summary VA23A8073

Client Sample ID	E13	EM
Date Sampled	13-Apr-23	13-Apr-23
Time Sampled	11:25	11:25
ALS Sample ID	VA23A8073-002	VA23A8073-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1280	1270
Conductivity	79.3	79.4
Hardness (as CaCO3), Dissolved	678	667
Hardness (as CaCO3), From total Ca/Mg	682	680
pH	1120	1090
Total Dissolved Solids	2.7	2.6
Total Suspended Solids	1.44	1.6
Turbidity	7.95	7.94
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0062	0.008
Chloride (Cl)	<2.50	<2.50
Fluoride (F)	0.102	0.102
Nitrate (as N)	8.08	8.09
Nitrate and Nitrite (as N)	8.09	8.1
Nitrite (as N)	0.0104	0.0102
Total Nitrogen	8.25	8.15
Orthophosphate-Dissolved (as P)	0.0022	0.002
Phosphorus (P)-Total	0.0161	0.0157
Phosphorus (P)-Total Dissolved	0.0122	0.0113
Sulfate (SO4)	657	656
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.79	6.28
Total Metals (Water)		
Aluminum (Al)-Total	0.158	0.173
Antimony (Sb)-Total	0.00017	0.00015
Arsenic (As)-Total	0.00042	0.00043
Barium (Ba)-Total	0.0476	0.0496
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.066	0.061
Cadmium (Cd)-Total	<0.0000600	<0.0000650
Calcium (Ca)-Total	211	209
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00018	0.00018
Copper (Cu)-Total	0.0133	0.0136
Iron (Fe)-Total	0.182	0.198
Lead (Pb)-Total	0.000059	0.000063
Lithium (Li)-Total	0.0018	0.0017
Magnesium (Mg)-Total	37.6	38.5
Manganese (Mn)-Total	0.0361	0.0372
Molybdenum (Mo)-Total	0.119	0.116
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.95	1.98

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.00173	0.00201
Silicon (Si)-Total	7.31	7.25
Silver (Ag)-Total	0.000011	<0.000010
Sodium (Na)-Total	3.07	3.02
Strontium (Sr)-Total	0.245	0.242
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.0205	0.0196
Uranium (U)-Total	0.000323	0.000319
Vanadium (V)-Total	0.00207	0.00202
Zinc (Zn)-Total	0.0075	0.0072

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0641	0.0581
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00033	0.00034
Barium (Ba)-Dissolved	0.0147	0.0142
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.027	0.027
Cadmium (Cd)-Dissolved	0.0000101	0.0000058
Calcium (Ca)-Dissolved	52.6	53.6
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00948	0.0094
Iron (Fe)-Dissolved	0.08	0.074
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	6.28	6.35
Manganese (Mn)-Dissolved	0.00353	0.00306
Molybdenum (Mo)-Dissolved	0.00464	0.0048
Nickel (Ni)-Dissolved	<0.00050	0.00051
Potassium (K)-Dissolved	0.473	0.472
Selenium (Se)-Dissolved	0.00192	0.00177
Silicon (Si)-Dissolved	5.47	5.45
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	2.85	2.9
Strontium (Sr)-Dissolved	0.22	0.22
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000302	0.000309
Vanadium (V)-Dissolved	0.00084	0.00084
Zinc (Zn)-Dissolved	0.006	0.0059
Dissolved Metals Filtration Location	Field	Field

Selenium (Se)-Total	0.0503	0.0532
Silicon (Si)-Total	6.64	6.67
Silver (Ag)-Total	0.000011	0.00001
Sodium (Na)-Total	19.6	19.2
Strontium (Sr)-Total	0.799	0.813
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000476	0.000471
Vanadium (V)-Total	0.00092	0.00113
Zinc (Zn)-Total	0.0042	0.004

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0092	0.0102
Antimony (Sb)-Dissolved	0.00019	0.00015
Arsenic (As)-Dissolved	0.00035	0.00035
Barium (Ba)-Dissolved	0.0482	0.0474
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.059	0.057
Cadmium (Cd)-Dissolved	<0.0000600	<0.0000550
Calcium (Ca)-Dissolved	209	205
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00838	0.00834
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0015	0.0015
Magnesium (Mg)-Dissolved	38	37.7
Manganese (Mn)-Dissolved	0.0287	0.0283
Molybdenum (Mo)-Dissolved	0.109	0.112
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	2.02	1.95
Selenium (Se)-Dissolved	0.0534	0.0519
Silicon (Si)-Dissolved	6.64	6.25
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	19	18.7
Strontium (Sr)-Dissolved	0.799	0.821
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000457	0.000471
Vanadium (V)-Dissolved	<0.00050	0.0005
Zinc (Zn)-Dissolved	0.0043	0.0036
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A8579

Client Sample ID	E11c	EKc
Date Sampled	20-Apr-23	20-Apr-23
Time Sampled	10:10	10:10
ALS Sample ID	VA23A8579-001	VA23A8579-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	796	785
Conductivity	70.9	71
Hardness (as CaCO3), Dissolved	344	344
Hardness (as CaCO3), From total Ca/M	342	342
pH	594	590
Total Dissolved Solids	<1.0	1.5
Total Suspended Solids	0.47	0.66
Turbidity	7.95	7.96
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.227	0.224
Chloride (Cl)	3.74	3.65
Fluoride (F)	0.396	0.383
Nitrate (as N)	7.74	7.7
Nitrate and Nitrite (as N)	8.2	8.15
Nitrite (as N)	0.459	0.447
Total Nitrogen	8.27	8.01
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0075	0.0074
Phosphorus (P)-Total Dissolved	0.006	0.0101
Sulfate (SO4)	326	325
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.74	1.55
Total Metals (Water)		
Aluminum (Al)-Total	0.0488	0.0364
Antimony (Sb)-Total	0.00252	0.00255
Arsenic (As)-Total	0.003	0.00306
Barium (Ba)-Total	0.0215	0.0211
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.251	0.247
Cadmium (Cd)-Total	0.000039	0.0000258
Calcium (Ca)-Total	104	104
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00019	0.00018
Copper (Cu)-Total	0.0105	0.00983
Iron (Fe)-Total	0.065	0.047
Lead (Pb)-Total	<0.000050	0.000102
Lithium (Li)-Total	0.0067	0.0067
Magnesium (Mg)-Total	20.1	20.1
Manganese (Mn)-Total	0.0911	0.0901
Molybdenum (Mo)-Total	0.244	0.246
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.931	0.907

Results Summary VA23A8999

Client Sample ID	E14	EN
Date Sampled	24-Apr-23	24-Apr-23
Time Sampled	10:25	10:25
ALS Sample ID	VA23A8999-001	VA23A8999-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	690	686
Conductivity	79.7	80.5
Hardness (as CaCO3), Dissolved	273	274
Hardness (as CaCO3), From total Ca/Mg	341	330
pH	452	477
Total Dissolved Solids	6.7	6.5
Total Suspended Solids	5.25	5.22
Turbidity	8.03	8.05
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0139	0.0123
Chloride (Cl)	2.28	2.26
Fluoride (F)	0.147	0.147
Nitrate (as N)	3.89	3.9
Nitrate and Nitrite (as N)	3.91	3.92
Nitrite (as N)	0.0203	0.0209
Total Nitrogen	4.13	4.28
Orthophosphate-Dissolved (as P)	0.004	0.0046
Phosphorus (P)-Total	0.0218	0.0222
Phosphorus (P)-Total Dissolved	0.0127	0.0125
Sulfate (SO4)	247	248
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	8.5	8.43
Total Metals (Water)		
Aluminum (Al)-Total	0.33	0.354
Antimony (Sb)-Total	0.00049	0.00048
Arsenic (As)-Total	0.00107	0.00101
Barium (Ba)-Total	0.0321	0.0321
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.078	0.074
Cadmium (Cd)-Total	<0.0000550	<0.0000550
Calcium (Ca)-Total	103	100
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00027	0.00029
Copper (Cu)-Total	0.0235	0.0243
Iron (Fe)-Total	0.32	0.335
Lead (Pb)-Total	0.000106	0.000112
Lithium (Li)-Total	0.0024	0.0024
Magnesium (Mg)-Total	20.3	19.4
Manganese (Mn)-Total	0.0263	0.0269
Molybdenum (Mo)-Total	0.108	0.108
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.52	1.48

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.0385	0.0382	Selenium (Se)-Total	0.0265	0.026
Silicon (Si)-Total	7.03	7.08	Silicon (Si)-Total	6.68	6.71
Silver (Ag)-Total	<0.000010	<0.000010	Silver (Ag)-Total	<0.000010	0.000013
Sodium (Na)-Total	34	33.5	Sodium (Na)-Total	13.5	13
Strontium (Sr)-Total	0.854	0.883	Strontium (Sr)-Total	0.5	0.484
Thallium (Tl)-Total	<0.000010	<0.000010	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100	Titanium (Ti)-Total	0.0139	0.015
Uranium (U)-Total	0.00545	0.00532	Uranium (U)-Total	0.00106	0.001
Vanadium (V)-Total	0.00221	0.00217	Vanadium (V)-Total	0.00188	0.00199
Zinc (Zn)-Total	<0.0030	<0.0030	Zinc (Zn)-Total	0.0058	0.0063

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0058	0.0035	Aluminum (Al)-Dissolved	0.0178	0.0175
Antimony (Sb)-Dissolved	0.00238	0.00244	Antimony (Sb)-Dissolved	0.00034	0.00035
Arsenic (As)-Dissolved	0.00284	0.003	Arsenic (As)-Dissolved	0.00067	0.00065
Barium (Ba)-Dissolved	0.0201	0.02	Barium (Ba)-Dissolved	0.023	0.0236
Beryllium (Be)-Dissolved	<0.000100	<0.000100	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.236	0.231	Boron (B)-Dissolved	0.066	0.065
Cadmium (Cd)-Dissolved	<0.0000600	<0.0000700	Cadmium (Cd)-Dissolved	<0.0000400	<0.0000400
Calcium (Ca)-Dissolved	104	104	Calcium (Ca)-Dissolved	82.2	83
Chromium (Cr)-Dissolved	<0.00050	<0.00050	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00016	0.00015	Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00815	0.00816	Copper (Cu)-Dissolved	0.0139	0.0138
Iron (Fe)-Dissolved	<0.030	<0.030	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0066	0.0066	Lithium (Li)-Dissolved	0.0017	0.0017
Magnesium (Mg)-Dissolved	20.4	20.6	Magnesium (Mg)-Dissolved	16.4	16.2
Manganese (Mn)-Dissolved	0.0885	0.0883	Manganese (Mn)-Dissolved	0.0145	0.0142
Molybdenum (Mo)-Dissolved	0.242	0.247	Molybdenum (Mo)-Dissolved	0.0812	0.0847
Nickel (Ni)-Dissolved	<0.00050	<0.00050	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.927	0.93	Potassium (K)-Dissolved	1.35	1.33
Selenium (Se)-Dissolved	0.0341	0.0337	Selenium (Se)-Dissolved	0.0226	0.0217
Silicon (Si)-Dissolved	6.98	6.93	Silicon (Si)-Dissolved	5.96	5.86
Silver (Ag)-Dissolved	<0.000010	<0.000010	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	32	32.2	Sodium (Na)-Dissolved	10.2	10.2
Strontium (Sr)-Dissolved	0.841	0.851	Strontium (Sr)-Dissolved	0.396	0.411
Thallium (Tl)-Dissolved	<0.000010	<0.000010	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00524	0.00518	Uranium (U)-Dissolved	0.000727	0.000746
Vanadium (V)-Dissolved	0.00196	0.00198	Vanadium (V)-Dissolved	0.00082	0.0008
Zinc (Zn)-Dissolved	<0.0030	<0.0030	Zinc (Zn)-Dissolved	0.005	0.0048
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A9213

Client Sample ID	E24	EX
Date Sampled	26-Apr-23	26-Apr-23
Time Sampled	11:25	11:25
ALS Sample ID	VA23A9213-003	VA23A9213-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1180	1160
Conductivity	61	61.5
Hardness (as CaCO3), Dissolved	584	594
Hardness (as CaCO3), From total Ca/Mg	583	588
pH	744	896
Total Dissolved Solids	5.8	5.6
Total Suspended Solids	2.82	2.92
Turbidity	8	8.01
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<2.50	<2.50
Fluoride (F)	0.406	0.402
Nitrate (as N)	1.02	1.01
Nitrate and Nitrite (as N)	1.02	1.01
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	1.11	1.1
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0109	0.0098
Phosphorus (P)-Total Dissolved	0.0039	0.0037
Sulfate (SO4)	568	571
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.48	2.3
Total Metals (Water)		
Aluminum (Al)-Total	0.397	0.409
Antimony (Sb)-Total	0.00039	0.00039
Arsenic (As)-Total	0.0003	0.0003
Barium (Ba)-Total	0.0213	0.0212
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.06	0.059
Cadmium (Cd)-Total	0.000185	0.000195
Calcium (Ca)-Total	176	178
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00203	0.002
Copper (Cu)-Total	0.345	0.367
Iron (Fe)-Total	0.12	0.124
Lead (Pb)-Total	0.000057	0.000057
Lithium (Li)-Total	0.0039	0.0038
Magnesium (Mg)-Total	34.9	34.9
Manganese (Mn)-Total	0.209	0.207
Molybdenum (Mo)-Total	0.228	0.224
Nickel (Ni)-Total	0.00165	0.00175
Potassium (K)-Total	1.51	1.51

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.0866	0.0882
Silicon (Si)-Total	4.37	4.25
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	12.8	12.8
Strontium (Sr)-Total	3.01	2.92
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00102	0.00102
Vanadium (V)-Total	0.00059	0.0006
Zinc (Zn)-Total	0.0088	0.0092

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0115	0.012
Antimony (Sb)-Dissolved	0.00036	0.00035
Arsenic (As)-Dissolved	0.00014	0.00017
Barium (Ba)-Dissolved	0.0202	0.0205
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.052	0.054
Cadmium (Cd)-Dissolved	0.000149	0.000121
Calcium (Ca)-Dissolved	179	182
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00172	0.00179
Copper (Cu)-Dissolved	0.0903	0.0916
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0039	0.0041
Magnesium (Mg)-Dissolved	33.2	34
Manganese (Mn)-Dissolved	0.181	0.184
Molybdenum (Mo)-Dissolved	0.226	0.224
Nickel (Ni)-Dissolved	0.0014	0.00139
Potassium (K)-Dissolved	1.46	1.48
Selenium (Se)-Dissolved	0.0827	0.0847
Silicon (Si)-Dissolved	3.76	3.79
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	12.3	12.7
Strontium (Sr)-Dissolved	2.98	2.97
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000911	0.000919
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0068	0.0069
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A9524

Client Sample ID	GW96-4b	GW96-Db
Date Sampled	01-May-23	01-May-23
Time Sampled	13:23	13:23
ALS Sample ID	VA23A9524-006	VA23A9524-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1250	1260
Conductivity	221	221
Hardness (as CaCO3), Dissolved	607	610
pH	8.23	8.19
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0241	0.0246
Chloride (Cl)	14.1	14.1
Fluoride (F)	<0.100	<0.100
Nitrate (as N)	<0.0250	<0.0250
Nitrate and Nitrite (as N)	<0.0255	<0.0255
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	0.064	0.065
Phosphorus (P)-Total	0.0166	0.0152
Phosphorus (P)-Total Dissolved	0.0147	0.0152
Sulfate (SO4)	476	474
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.15	4.21
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00164	0.00165
Barium (Ba)-Dissolved	0.0718	0.0728
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.092	0.092
Cadmium (Cd)-Dissolved	0.0000334	0.0000339
Calcium (Ca)-Dissolved	166	168
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00015	0.00017
Copper (Cu)-Dissolved	0.00063	0.00066
Iron (Fe)-Dissolved	0.818	0.808
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0127	0.0129
Magnesium (Mg)-Dissolved	46.8	46.4
Manganese (Mn)-Dissolved	0.251	0.252
Molybdenum (Mo)-Dissolved	0.000645	0.000616
Nickel (Ni)-Dissolved	0.00054	0.00054
Potassium (K)-Dissolved	0.713	0.713

Results Summary VA23A9519

Client Sample ID	HAC-05a	HAC-Ea
Date Sampled	01-May-23	01-May-23
Time Sampled	10:55	10:55
ALS Sample ID	VA23A9519-006	VA23A9519-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	256	258
Conductivity	77.2	76.8
Hardness (as CaCO3), Dissolved	120	123
Hardness (as CaCO3), From total Ca/M	124	125
pH	179	182
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	2.28	1.9
Turbidity	8	8.01
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0121	0.0115
Chloride (Cl)	0.54	0.54
Fluoride (F)	0.096	0.094
Nitrate (as N)	0.0356	0.0353
Nitrate and Nitrite (as N)	0.0377	0.0366
Nitrite (as N)	0.0021	0.0013
Total Nitrogen	0.476	0.486
Orthophosphate-Dissolved (as P)	<0.0010	0.0011
Phosphorus (P)-Total	0.0206	0.0201
Phosphorus (P)-Total Dissolved	0.0162	0.0159
Sulfate (SO4)	54.1	53.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	21.6	18.9
Total Metals (Water)		
Aluminum (Al)-Total	0.18	0.174
Antimony (Sb)-Total	0.0001	0.00011
Arsenic (As)-Total	0.00048	0.00048
Barium (Ba)-Total	0.0181	0.0181
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.011	0.011
Cadmium (Cd)-Total	0.0000106	0.0000086
Calcium (Ca)-Total	39.9	40.3
Chromium (Cr)-Total	0.00064	0.00061
Cobalt (Co)-Total	0.0001	<0.00010
Copper (Cu)-Total	0.0318	0.0324
Iron (Fe)-Total	0.196	0.197
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Dissolved	0.000061	<0.000050
Silicon (Si)-Dissolved	10.4	10.4
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	43.9	43.9
Strontium (Sr)-Dissolved	2.78	2.67
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000721	0.000729
Vanadium (V)-Dissolved	0.00066	0.00067
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Magnesium (Mg)-Total	5.96	5.96
Manganese (Mn)-Total	0.0325	0.0333
Molybdenum (Mo)-Total	0.0053	0.00539
Nickel (Ni)-Total	0.00059	0.00062
Potassium (K)-Total	1.11	1.13
Selenium (Se)-Total	0.0017	0.00172
Silicon (Si)-Total	3.95	3.9
Silver (Ag)-Total	0.000026	0.000027
Sodium (Na)-Total	4.02	4.06
Strontium (Sr)-Total	0.237	0.245
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000361	0.000351
Vanadium (V)-Total	0.0011	0.00111
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.103	0.098
Antimony (Sb)-Dissolved	0.00011	0.0001
Arsenic (As)-Dissolved	0.00043	0.00043
Barium (Ba)-Dissolved	0.017	0.0165
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.01	0.01
Cadmium (Cd)-Dissolved	0.0000062	0.0000064
Calcium (Ca)-Dissolved	38.9	39.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0294	0.0289
Iron (Fe)-Dissolved	0.124	0.119
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.66	5.65
Manganese (Mn)-Dissolved	0.0246	0.0244
Molybdenum (Mo)-Dissolved	0.00499	0.0051
Nickel (Ni)-Dissolved	0.00051	0.00051
Potassium (K)-Dissolved	1.09	1.09
Selenium (Se)-Dissolved	0.00179	0.0018
Silicon (Si)-Dissolved	3.85	3.84
Silver (Ag)-Dissolved	0.000019	0.00002
Sodium (Na)-Dissolved	3.91	3.88
Strontium (Sr)-Dissolved	0.235	0.23
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000348	0.000332
Vanadium (V)-Dissolved	0.00092	0.00086
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A9793

Client Sample ID	GW96-2a	GW96-Ba
Date Sampled	03-May-23	03-May-23
Time Sampled	10:54	10:54
ALS Sample ID	VA23A9793-004	VA23A9793-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	450	445
Conductivity	218	220
Hardness (as CaCO3), Dissolved	162	161
pH	8.34	8.34
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0904	0.0914
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.18	0.18
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.108	0.098
Phosphorus (P)-Total	0.027	0.0274
Phosphorus (P)-Total Dissolved	0.0105	0.0106
Sulfate (SO4)	27.3	27.2
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.58	0.58
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0064	0.0038
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00787	0.00787
Barium (Ba)-Dissolved	0.0617	0.0625
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.05	0.051
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	32.5	31.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00026	0.00025
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	0.118	0.117
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0338	0.0346
Magnesium (Mg)-Dissolved	19.7	19.8
Manganese (Mn)-Dissolved	0.00393	0.00388
Molybdenum (Mo)-Dissolved	0.00234	0.00239
Nickel (Ni)-Dissolved	0.00084	0.00087
Potassium (K)-Dissolved	2.1	2.14

Results Summary VA23A9793

Client Sample ID	GW16-2a	GW16-Ba
Date Sampled	03-May-23	03-May-23
Time Sampled	12:40	12:40
ALS Sample ID	VA23A9793-007	VA23A9793-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	541	543
Conductivity	222	222
Hardness (as CaCO3), Dissolved	196	198
pH	8.42	8.42
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0165	0.0151
Chloride (Cl)	1.81	1.77
Fluoride (F)	0.192	0.196
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.038	0.044
Phosphorus (P)-Total	0.0267	0.0271
Phosphorus (P)-Total Dissolved	0.0268	0.0266
Sulfate (SO4)	72.7	72.7
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.41	1.41
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00233	0.00233
Barium (Ba)-Dissolved	0.0896	0.0896
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.1	0.098
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	44.6	44.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00018	0.00018
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	20.6	21.1
Manganese (Mn)-Dissolved	0.0518	0.0525
Molybdenum (Mo)-Dissolved	0.0064	0.00635
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	2.13	2.16

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	2.95	2.98
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	23.3	23.3
Strontium (Sr)-Dissolved	0.458	0.462
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000072	0.000074
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0036	0.0036
Dissolved Metals Filtration Location	Field	Field

Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	9.26	9.36
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	39.9	40.6
Strontium (Sr)-Dissolved	0.445	0.458
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00241	0.00245
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0033	0.0039
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23A9794

Client Sample ID	E11c	EKc
Date Sampled	03-May-23	03-May-23
Time Sampled	11:20	11:20
ALS Sample ID	VA23A9794-002	VA23A9794-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	853	852
Conductivity	93.4	93.3
Hardness (as CaCO3), Dissolved	343	345
Hardness (as CaCO3), From total Ca/M	353	358
pH	628	624
Total Dissolved Solids	1.5	<1.0
Total Suspended Solids	0.48	1.11
Turbidity	8.14	8.14
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.276	0.275
Chloride (Cl)	3.72	3.56
Fluoride (F)	0.359	0.353
Nitrate (as N)	11.3	10.7
Nitrate and Nitrite (as N)	11.7	11.1
Nitrite (as N)	0.444	0.419
Total Nitrogen	11.6	14.2
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0087	0.0082
Phosphorus (P)-Total Dissolved	0.0051	0.0059
Sulfate (SO4)	312	296
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.48	1.48
Total Metals (Water)		
Aluminum (Al)-Total	0.0501	0.0524
Antimony (Sb)-Total	0.00323	0.00326
Arsenic (As)-Total	0.00379	0.00383
Barium (Ba)-Total	0.021	0.0216
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.272	0.276
Cadmium (Cd)-Total	<0.0000950	<0.0000900
Calcium (Ca)-Total	109	111
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00031	0.00031
Copper (Cu)-Total	0.0343	0.0348
Iron (Fe)-Total	0.052	0.055
Lead (Pb)-Total	0.000053	0.000054
Lithium (Li)-Total	0.0072	0.0071

Results Summary VA23B0109

Client Sample ID	E21	EU
Date Sampled	08-May-23	08-May-23
Time Sampled	11:15	11:15
ALS Sample ID	VA23B0109-001	VA23B0109-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	832	826
Conductivity	33.7	33.7
Hardness (as CaCO3), Dissolved	285	282
Hardness (as CaCO3), From total Ca/Mg	285	284
pH	634	645
Total Dissolved Solids	1.5	5.6
Total Suspended Solids	5.39	5.18
Turbidity	7.56	7.58
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0196	0.0232
Chloride (Cl)	12.8	12.9
Fluoride (F)	0.58	0.559
Nitrate (as N)	2.61	2.63
Nitrate and Nitrite (as N)	2.74	2.76
Nitrite (as N)	0.125	0.127
Total Nitrogen	3.04	3.04
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0261	0.0288
Phosphorus (P)-Total Dissolved	<0.0020	0.0084
Sulfate (SO4)	370	371
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.32	6.04
Total Metals (Water)		
Aluminum (Al)-Total	0.397	0.396
Antimony (Sb)-Total	0.00116	0.00115
Arsenic (As)-Total	0.00185	0.00181
Barium (Ba)-Total	0.05	0.0488
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.086	0.088
Cadmium (Cd)-Total	<0.0000400	<0.0000500
Calcium (Ca)-Total	93.1	93
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.0003	0.0003
Copper (Cu)-Total	0.015	0.0151
Iron (Fe)-Total	0.226	0.228
Lead (Pb)-Total	0.000141	0.000149
Lithium (Li)-Total	0.0088	0.0085

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	19.7	19.6	Magnesium (Mg)-Total	12.8	12.6
Manganese (Mn)-Total	0.102	0.102	Manganese (Mn)-Total	0.0292	0.0284
Molybdenum (Mo)-Total	0.296	0.302	Molybdenum (Mo)-Total	0.157	0.147
Nickel (Ni)-Total	<0.00050	<0.00050	Nickel (Ni)-Total	0.00065	0.00066
Potassium (K)-Total	0.98	0.973	Potassium (K)-Total	8.79	8.92
Selenium (Se)-Total	0.0283	0.0281	Selenium (Se)-Total	0.0259	0.026
Silicon (Si)-Total	7.66	7.86	Silicon (Si)-Total	4.71	4.5
Silver (Ag)-Total	<0.000010	<0.000010	Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	36.8	36.9	Sodium (Na)-Total	60.2	62.1
Strontium (Sr)-Total	0.836	0.854	Strontium (Sr)-Total	1.1	1.1
Thallium (Tl)-Total	<0.000010	<0.000010	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100	Titanium (Ti)-Total	0.0146	0.0141
Uranium (U)-Total	0.00686	0.00692	Uranium (U)-Total	0.000573	0.000621
Vanadium (V)-Total	0.0025	0.00255	Vanadium (V)-Total	0.00214	0.00215
Zinc (Zn)-Total	<0.0030	<0.0030	Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0062	0.0036	Aluminum (Al)-Dissolved	0.0399	0.0402
Antimony (Sb)-Dissolved	0.00316	0.00315	Antimony (Sb)-Dissolved	0.00116	0.00114
Arsenic (As)-Dissolved	0.00351	0.00373	Arsenic (As)-Dissolved	0.00158	0.00163
Barium (Ba)-Dissolved	0.0218	0.0216	Barium (Ba)-Dissolved	0.0447	0.0445
Beryllium (Be)-Dissolved	<0.000100	<0.000100	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.248	0.251	Boron (B)-Dissolved	0.085	0.084
Cadmium (Cd)-Dissolved	<0.0000950	<0.0000850	Cadmium (Cd)-Dissolved	0.0000095	0.0000145
Calcium (Ca)-Dissolved	106	107	Calcium (Ca)-Dissolved	92.8	91
Chromium (Cr)-Dissolved	<0.00050	<0.00050	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00027	0.00028	Cobalt (Co)-Dissolved	0.00013	0.00012
Copper (Cu)-Dissolved	0.0263	0.0268	Copper (Cu)-Dissolved	0.0074	0.00753
Iron (Fe)-Dissolved	<0.030	<0.030	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0069	0.0069	Lithium (Li)-Dissolved	0.0084	0.0083
Magnesium (Mg)-Dissolved	19	19	Magnesium (Mg)-Dissolved	12.9	13.2
Manganese (Mn)-Dissolved	0.1	0.101	Manganese (Mn)-Dissolved	0.0177	0.0178
Molybdenum (Mo)-Dissolved	0.287	0.283	Molybdenum (Mo)-Dissolved	0.156	0.155
Nickel (Ni)-Dissolved	<0.00050	<0.00050	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.972	0.979	Potassium (K)-Dissolved	8.59	8.96
Selenium (Se)-Dissolved	0.0284	0.0293	Selenium (Se)-Dissolved	0.0269	0.0267
Silicon (Si)-Dissolved	7.52	7.56	Silicon (Si)-Dissolved	3.71	3.74
Silver (Ag)-Dissolved	<0.000010	<0.000010	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	35.4	36.1	Sodium (Na)-Dissolved	59.5	60.8
Strontium (Sr)-Dissolved	0.83	0.814	Strontium (Sr)-Dissolved	1.12	1.12
Thallium (Tl)-Dissolved	<0.000010	<0.000010	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00672	0.00676	Uranium (U)-Dissolved	0.000582	0.000577
Vanadium (V)-Dissolved	0.0022	0.00224	Vanadium (V)-Dissolved	0.00146	0.00149
Zinc (Zn)-Dissolved	<0.0030	<0.0030	Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B0453

Client Sample ID	QUL-58-MID	QUL-EH-MID
Date Sampled	10-May-23	10-May-23
Time Sampled	10:58	10:58
ALS Sample ID	VA23B0453-002	VA23B0453-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	115	115
Conductivity	50.5	50.1
Hardness (as CaCO3), Dissolved	52.7	49.9
Hardness (as CaCO3), From total Ca/M	57.3	57.5
pH	77	90
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.25	0.26
Turbidity	7.9	7.89
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.036	0.035
Nitrate (as N)	0.142	0.142
Nitrate and Nitrite (as N)	0.142	0.142
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.19	0.192
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.003	0.0025
Phosphorus (P)-Total Dissolved	0.0039	<0.0020
Sulfate (SO4)	7.94	7.85
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.69	2.53
Total Metals (Water)		
Aluminum (Al)-Total	0.0287	0.0259
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00015	0.00013
Barium (Ba)-Total	0.00548	0.00508
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	19.2	19.3
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00119	0.0009
Iron (Fe)-Total	0.03	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0015	0.0014

Results Summary VA23B0453

Client Sample ID	QUL-120a-120m	QUL-ATa-120m
Date Sampled	10-May-23	10-May-23
Time Sampled	13:47	13:47
ALS Sample ID	VA23B0453-014	VA23B0453-015
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	112	113
Conductivity	49.8	50.7
Hardness (as CaCO3), Dissolved	52.4	50.8
Hardness (as CaCO3), From total Ca/M	51.8	51
pH	78	71
Total Dissolved Solids	<1.1	<1.0
Total Suspended Solids	0.14	0.13
Turbidity	7.92	7.92
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.033	0.034
Nitrate (as N)	0.142	0.148
Nitrate and Nitrite (as N)	0.142	0.148
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.184	0.187
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	6.31	6.3
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.01	1.95
Total Metals (Water)		
Aluminum (Al)-Total	0.0107	0.011
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	<0.00010	<0.00010
Barium (Ba)-Total	0.00504	0.00523
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	17.3	16.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00053	0.00059
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	2.28	2.27
Manganese (Mn)-Total	0.00172	0.00164
Molybdenum (Mo)-Total	0.000934	0.00101
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.514	0.514
Selenium (Se)-Total	0.00028	0.000238
Silicon (Si)-Total	1.94	1.89
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	1.17	1.17
Strontium (Sr)-Total	0.149	0.149
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000151	0.000153
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0118	0.0095
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00011	<0.00010
Barium (Ba)-Dissolved	0.00558	0.00521
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	17.5	16.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00091	0.00074
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.18	2.11
Manganese (Mn)-Dissolved	0.00058	0.00043
Molybdenum (Mo)-Dissolved	0.000964	0.000952
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.508	0.486
Selenium (Se)-Dissolved	0.000252	0.000218
Silicon (Si)-Dissolved	1.89	1.89
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	1.12	1.08
Strontium (Sr)-Dissolved	0.135	0.131
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000159	0.000156
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Magnesium (Mg)-Total	2.09	2.15
Manganese (Mn)-Total	0.00117	0.00117
Molybdenum (Mo)-Total	0.000357	0.000355
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.483	0.494
Selenium (Se)-Total	0.00012	0.000104
Silicon (Si)-Total	1.85	1.83
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	0.942	0.973
Strontium (Sr)-Total	0.134	0.137
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000167	0.000174
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.006	0.0045
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	<0.00010	<0.00010
Barium (Ba)-Dissolved	0.00496	0.00506
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	17.6	17
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0005	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.05	2.03
Manganese (Mn)-Dissolved	0.00034	0.00034
Molybdenum (Mo)-Dissolved	0.000352	0.000347
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.482	0.478
Selenium (Se)-Dissolved	0.000082	0.000084
Silicon (Si)-Dissolved	1.86	1.82
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.929	0.925
Strontium (Sr)-Dissolved	0.136	0.136
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000162	0.000158
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B0446

Client Sample ID	QUL-2a-0m	QUL-Ba-0m
Date Sampled	11-May-23	11-May-23
Time Sampled	10:33	10:33
ALS Sample ID	VA23B0446-001	VA23B0446-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	111	110
Conductivity	49.9	49.5
Hardness (as CaCO3), Dissolved	56.7	55.8
Hardness (as CaCO3), From total Ca/M	49.9	50.8
pH	72	66
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.26	0.24
Turbidity	7.91	7.91
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.035	0.034
Nitrate (as N)	0.144	0.147
Nitrate and Nitrite (as N)	0.144	0.147
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.188	0.188
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0032	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	0.0033
Sulfate (SO4)	7.11	7.08
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.01	2.1
Total Metals (Water)		
Aluminum (Al)-Total	0.013	0.0123
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.0001	0.00012
Barium (Ba)-Total	0.00515	0.00526
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	16.6	16.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00063	0.0006
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

Results Summary VA23B0446

Client Sample ID	QUL-18-20m	QUL-R-20m
Date Sampled	11-May-23	11-May-23
Time Sampled	11:55	11:55
ALS Sample ID	VA23B0446-007	VA23B0446-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	112	113
Conductivity	49.7	49.9
Hardness (as CaCO3), Dissolved	60.4	57.2
Hardness (as CaCO3), From total Ca/M	52.2	50.9
pH	75	70
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.25	0.24
Turbidity	7.91	7.9
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.036	0.036
Nitrate (as N)	0.146	0.15
Nitrate and Nitrite (as N)	0.146	0.15
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.193	0.191
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0027	0.0093
Phosphorus (P)-Total Dissolved	0.0025	<0.0020
Sulfate (SO4)	8.06	8.2
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.28	2.22
Total Metals (Water)		
Aluminum (Al)-Total	0.0163	0.016
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00013	0.0001
Barium (Ba)-Total	0.00538	0.00527
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	17.4	16.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00075	0.00079
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	2.05	2.09
Manganese (Mn)-Total	0.00136	0.00138
Molybdenum (Mo)-Total	0.000591	0.000604
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.475	0.489
Selenium (Se)-Total	0.000185	0.000149
Silicon (Si)-Total	1.84	1.82
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	0.99	1
Strontium (Sr)-Total	0.134	0.136
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000157	0.000164
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0062	0.0068
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	<0.00010	<0.00010
Barium (Ba)-Dissolved	0.00511	0.00508
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	19	18.7
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00056	0.00057
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.24	2.22
Manganese (Mn)-Dissolved	0.00042	0.00046
Molybdenum (Mo)-Dissolved	0.000653	0.000594
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.488	0.488
Selenium (Se)-Dissolved	0.000146	0.000153
Silicon (Si)-Dissolved	1.79	1.81
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	1.07	1.07
Strontium (Sr)-Dissolved	0.143	0.141
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000154	0.000152
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Magnesium (Mg)-Total	2.12	2.12
Manganese (Mn)-Total	0.00118	0.00116
Molybdenum (Mo)-Total	0.000956	0.000929
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.501	0.5
Selenium (Se)-Total	0.000258	0.000214
Silicon (Si)-Total	1.82	1.83
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	1.1	1.09
Strontium (Sr)-Total	0.135	0.14
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00016	0.000162
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.01	0.0094
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00012	0.0001
Barium (Ba)-Dissolved	0.00529	0.00506
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	20.5	19.3
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00069	0.00065
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.001	0.001
Magnesium (Mg)-Dissolved	2.23	2.19
Manganese (Mn)-Dissolved	0.00039	0.00031
Molybdenum (Mo)-Dissolved	0.000972	0.000904
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.508	0.504
Selenium (Se)-Dissolved	0.000238	0.000207
Silicon (Si)-Dissolved	1.77	1.76
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	1.15	1.14
Strontium (Sr)-Dissolved	0.153	0.149
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000153	0.000169
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B0789

Client Sample ID	E1a	EAa
Date Sampled	15-May-23	15-May-23
Time Sampled	12:17	12:17
ALS Sample ID	VA23B0789-004	VA23B0789-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	859	866
Conductivity	32.6	32.5
Hardness (as CaCO3), Dissolved	272	276
Hardness (as CaCO3), From total Ca/Mg	280	283
pH	643	658
Total Dissolved Solids	9.1	10.7
Total Suspended Solids	5.81	4.55
Turbidity	7.61	7.6
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0129	0.0125
Chloride (Cl)	14.4	14.4
Fluoride (F)	0.597	0.6
Nitrate (as N)	2.58	2.59
Nitrate and Nitrite (as N)	2.68	2.69
Nitrite (as N)	0.0967	0.0972
Total Nitrogen	3.04	3.09
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0161	0.0155
Phosphorus (P)-Total Dissolved	0.0064	0.0035
Sulfate (SO4)	374	375
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.56	6.98
Total Metals (Water)		
Aluminum (Al)-Total	0.433	0.315
Antimony (Sb)-Total	0.00133	0.0013
Arsenic (As)-Total	0.00233	0.00223
Barium (Ba)-Total	0.0587	0.0577
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.1	0.102
Cadmium (Cd)-Total	<0.0000500	<0.0000450
Calcium (Ca)-Total	93.2	93.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00028	0.00021
Copper (Cu)-Total	0.0122	0.0104
Iron (Fe)-Total	0.273	0.145
Lead (Pb)-Total	0.000095	0.000063
Lithium (Li)-Total	0.0096	0.0096

Results Summary VA23B0783

Client Sample ID	SERDS 22	SERDSV
Date Sampled	16-May-23	16-May-23
Time Sampled	11:55	11:55
ALS Sample ID	VA23B0783-006	VA23B0783-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	817	817
Conductivity	118	118
Hardness (as CaCO3), Dissolved	392	384
Hardness (as CaCO3), From total Ca/M	430	421
pH	549	540
Total Dissolved Solids	1.6	2.9
Total Suspended Solids	0.94	1.13
Turbidity	8.21	8.2
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0488	0.0515
Chloride (Cl)	<2.50	<2.50
Fluoride (F)	0.216	0.216
Nitrate (as N)	8.83	8.83
Nitrate and Nitrite (as N)	8.86	8.86
Nitrite (as N)	0.0347	0.0344
Total Nitrogen	13.7	9.6
Orthophosphate-Dissolved (as P)	0.0281	0.0234
Phosphorus (P)-Total	0.0494	0.049
Phosphorus (P)-Total Dissolved	0.0379	0.0402
Sulfate (SO4)	292	292
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.02	4.28
Total Metals (Water)		
Aluminum (Al)-Total	0.244	0.193
Antimony (Sb)-Total	0.00051	0.00051
Arsenic (As)-Total	0.00115	0.00115
Barium (Ba)-Total	0.0482	0.0479
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.053	0.052
Cadmium (Cd)-Total	<0.0000550	<0.0000550
Calcium (Ca)-Total	132	128
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00019	0.00016
Copper (Cu)-Total	0.0138	0.0133
Iron (Fe)-Total	0.229	0.182
Lead (Pb)-Total	0.000117	0.000095
Lithium (Li)-Total	0.0023	0.0022

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	11.6	11.8	Magnesium (Mg)-Total	24.4	24.6
Manganese (Mn)-Total	0.0185	0.016	Manganese (Mn)-Total	0.0184	0.0166
Molybdenum (Mo)-Total	0.161	0.158	Molybdenum (Mo)-Total	0.198	0.201
Nickel (Ni)-Total	<0.00050	<0.00050	Nickel (Ni)-Total	0.00067	0.0006
Potassium (K)-Total	11.5	11.2	Potassium (K)-Total	1.54	1.49
Selenium (Se)-Total	0.0269	0.0273	Selenium (Se)-Total	0.0638	0.0652
Silicon (Si)-Total	5.04	4.76	Silicon (Si)-Total	6.88	6.9
Silver (Ag)-Total	<0.000010	<0.000010	Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	67.8	69	Sodium (Na)-Total	13	12.9
Strontium (Sr)-Total	1.03	1.04	Strontium (Sr)-Total	1.26	1.25
Thallium (Tl)-Total	<0.000010	<0.000010	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.017	0.0108	Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000558	0.000562	Uranium (U)-Total	0.00165	0.00163
Vanadium (V)-Total	0.00328	0.00309	Vanadium (V)-Total	0.00179	0.00172
Zinc (Zn)-Total	0.003	<0.0030	Zinc (Zn)-Total	0.0061	0.0054

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0528	0.0481	Aluminum (Al)-Dissolved	0.0226	0.0092
Antimony (Sb)-Dissolved	0.00123	0.00126	Antimony (Sb)-Dissolved	0.00049	0.0005
Arsenic (As)-Dissolved	0.00201	0.00213	Arsenic (As)-Dissolved	0.00102	0.00098
Barium (Ba)-Dissolved	0.0496	0.05	Barium (Ba)-Dissolved	0.0428	0.0435
Beryllium (Be)-Dissolved	<0.000100	<0.000100	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.093	0.094	Boron (B)-Dissolved	0.047	0.047
Cadmium (Cd)-Dissolved	<0.0000200	<0.0000200	Cadmium (Cd)-Dissolved	<0.0000450	<0.0000500
Calcium (Ca)-Dissolved	89.7	91.6	Calcium (Ca)-Dissolved	121	118
Chromium (Cr)-Dissolved	<0.00050	<0.00050	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010	Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00401	0.00376	Copper (Cu)-Dissolved	0.0109	0.0108
Iron (Fe)-Dissolved	<0.030	<0.030	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0087	0.0088	Lithium (Li)-Dissolved	0.0019	0.0019
Magnesium (Mg)-Dissolved	11.6	11.5	Magnesium (Mg)-Dissolved	21.8	21.7
Manganese (Mn)-Dissolved	0.00273	0.00245	Manganese (Mn)-Dissolved	0.0115	0.0111
Molybdenum (Mo)-Dissolved	0.153	0.155	Molybdenum (Mo)-Dissolved	0.191	0.192
Nickel (Ni)-Dissolved	<0.00050	<0.00050	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	10.8	10.9	Potassium (K)-Dissolved	1.34	1.33
Selenium (Se)-Dissolved	0.0266	0.0268	Selenium (Se)-Dissolved	0.0632	0.0628
Silicon (Si)-Dissolved	4.08	4.04	Silicon (Si)-Dissolved	5.76	5.95
Silver (Ag)-Dissolved	<0.000010	<0.000010	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	68.2	66.8	Sodium (Na)-Dissolved	11.5	11.7
Strontium (Sr)-Dissolved	1.02	1.02	Strontium (Sr)-Dissolved	1.19	1.24
Thallium (Tl)-Dissolved	<0.000010	<0.000010	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000516	0.000529	Uranium (U)-Dissolved	0.00157	0.00161
Vanadium (V)-Dissolved	0.00236	0.00238	Vanadium (V)-Dissolved	0.00101	0.00102
Zinc (Zn)-Dissolved	<0.0030	<0.0030	Zinc (Zn)-Dissolved	0.0033	<0.0030
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B1179

Client Sample ID	NEZ 2	NEZ B
Date Sampled	17-May-23	17-May-23
Time Sampled	9:20	9:20
ALS Sample ID	VA23B1179-003	VA23B1179-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1380	1400
Conductivity	59.7	60.3
Hardness (as CaCO3), Dissolved	790	776
Hardness (as CaCO3), From total Ca/M	856	836
pH	1230	1350
Total Dissolved Solids	7.2	10.8
Total Suspended Solids	1.51	3.01
Turbidity	7.89	7.89
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.005	<0.0050
Chloride (Cl)	<2.50	<2.50
Fluoride (F)	0.454	0.446
Nitrate (as N)	0.963	0.938
Nitrate and Nitrite (as N)	0.963	0.938
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	1.03	1.04
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0132	0.0063
Phosphorus (P)-Total Dissolved	0.004	0.0045
Sulfate (SO4)	812	818
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.24	2.56
Total Metals (Water)		
Aluminum (Al)-Total	0.182	0.162
Antimony (Sb)-Total	0.00034	0.00034
Arsenic (As)-Total	0.00024	0.00024
Barium (Ba)-Total	0.028	0.0265
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.066	0.063
Cadmium (Cd)-Total	<0.000180	<0.000175
Calcium (Ca)-Total	259	252
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00082	0.00088
Copper (Cu)-Total	0.167	0.164
Iron (Fe)-Total	0.142	0.117
Lead (Pb)-Total	0.000065	0.000063
Lithium (Li)-Total	0.0042	0.004

Results Summary VA23B1175

Client Sample ID	QUL-57-S	QUL-EG-S
Date Sampled	17-May-23	17-May-23
Time Sampled	11:33	11:33
ALS Sample ID	VA23B1175-005	VA23B1175-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	115	113
Conductivity	50.7	49.9
Hardness (as CaCO3), Dissolved	52.9	53.2
Hardness (as CaCO3), From total Ca/M	53.5	54.8
pH	81	80
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.36	0.28
Turbidity	7.88	7.88
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.04	0.036
Nitrate (as N)	0.136	0.134
Nitrate and Nitrite (as N)	0.136	0.134
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.199	0.21
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0025	0.004
Phosphorus (P)-Total Dissolved	<0.0020	0.002
Sulfate (SO4)	7.55	7.54
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.82	3.14
Total Metals (Water)		
Aluminum (Al)-Total	0.149	0.0194
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00024	0.00012
Barium (Ba)-Total	0.00932	0.00556
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	0.000006	<0.0000050
Calcium (Ca)-Total	17.6	18.3
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00012	<0.00010
Copper (Cu)-Total	0.00801	0.00094
Iron (Fe)-Total	0.137	<0.030
Lead (Pb)-Total	0.000074	<0.000050
Lithium (Li)-Total	<0.0010	0.001

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	50.9	50.2	Magnesium (Mg)-Total	2.32	2.21
Manganese (Mn)-Total	0.105	0.105	Manganese (Mn)-Total	0.00572	0.0017
Molybdenum (Mo)-Total	0.231	0.244	Molybdenum (Mo)-Total	0.000754	0.000715
Nickel (Ni)-Total	0.00158	0.00151	Nickel (Ni)-Total	0.00052	<0.00050
Potassium (K)-Total	1.84	1.81	Potassium (K)-Total	0.601	0.504
Selenium (Se)-Total	0.107	0.11	Selenium (Se)-Total	0.000188	0.000149
Silicon (Si)-Total	4.44	4.36	Silicon (Si)-Total	2.15	1.96
Silver (Ag)-Total	<0.000010	<0.000010	Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	18.7	19	Sodium (Na)-Total	1.12	1.08
Strontium (Sr)-Total	3.93	3.97	Strontium (Sr)-Total	0.142	0.148
Thallium (Tl)-Total	<0.000010	<0.000010	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100	Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00117	0.00115	Uranium (U)-Total	0.000172	0.000152
Vanadium (V)-Total	0.00054	<0.00050	Vanadium (V)-Total	0.00053	<0.00050
Zinc (Zn)-Total	0.0089	0.009	Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0093	0.0091	Aluminum (Al)-Dissolved	0.009	0.0085
Antimony (Sb)-Dissolved	0.00034	0.00032	Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00014	0.00014	Arsenic (As)-Dissolved	<0.00010	<0.00010
Barium (Ba)-Dissolved	0.0256	0.0259	Barium (Ba)-Dissolved	0.00524	0.00525
Beryllium (Be)-Dissolved	<0.000100	<0.000100	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.059	0.058	Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	0.00013	0.000121	Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	238	233	Calcium (Ca)-Dissolved	17.8	17.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00073	0.00069	Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0853	0.0855	Copper (Cu)-Dissolved	0.00063	0.00064
Iron (Fe)-Dissolved	<0.030	<0.030	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0039	0.0039	Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	47.6	47.1	Magnesium (Mg)-Dissolved	2.05	2.07
Manganese (Mn)-Dissolved	0.0993	0.0994	Manganese (Mn)-Dissolved	0.00081	0.00082
Molybdenum (Mo)-Dissolved	0.237	0.235	Molybdenum (Mo)-Dissolved	0.000688	0.000627
Nickel (Ni)-Dissolved	0.00136	0.00137	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.86	1.87	Potassium (K)-Dissolved	0.518	0.52
Selenium (Se)-Dissolved	0.0995	0.0985	Selenium (Se)-Dissolved	0.00019	0.000174
Silicon (Si)-Dissolved	4.06	4.01	Silicon (Si)-Dissolved	1.92	1.9
Silver (Ag)-Dissolved	<0.000010	<0.000010	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	17.6	17.3	Sodium (Na)-Dissolved	1.03	1.04
Strontium (Sr)-Dissolved	3.7	3.7	Strontium (Sr)-Dissolved	0.139	0.134
Thallium (Tl)-Dissolved	<0.000010	<0.000010	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00119	0.00118	Uranium (U)-Dissolved	0.000155	0.00016
Vanadium (V)-Dissolved	<0.00050	<0.00050	Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.008	0.0077	Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B1771

Client Sample ID	B1-B	BA-B
Date Sampled	24-May-23	24-May-23
Time Sampled	13:35	13:35
ALS Sample ID	VA23B1771-003	VA23B1771-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	102	102
Conductivity	41.3	41.5
Hardness (as CaCO3), Dissolved	46.1	45
Hardness (as CaCO3), From total Ca/Mg	45.4	44.7
pH	74	75
Total Dissolved Solids	3.7	1.2
Total Suspended Solids	0.6	0.43
Turbidity	7.7	7.69
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.58	0.56
Fluoride (F)	0.053	0.052
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.265	0.256
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.013	0.011
Phosphorus (P)-Total Dissolved	0.0055	0.005
Sulfate (SO4)	8.64	8.29
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	7.42	7.28
Total Metals (Water)		
Aluminum (Al)-Total	0.014	0.0158
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00032	0.00029
Barium (Ba)-Total	0.0162	0.0159
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.044	0.043
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	14	13.7
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00244	0.00196
Iron (Fe)-Total	0.04	0.043
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

Results Summary VA23B1773

Client Sample ID	QUL-58-B	QUL-EH-B
Date Sampled	25-May-23	25-May-23
Time Sampled	11:45	11:45
ALS Sample ID	VA23B1773-004	VA23B1773-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	125	125
Conductivity	49.8	49.5
Hardness (as CaCO3), Dissolved	58.1	60.5
Hardness (as CaCO3), From total Ca/M	57	57.6
pH	96	96
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.2	0.25
Turbidity	7.8	7.8
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.036	0.042
Nitrate (as N)	0.173	0.174
Nitrate and Nitrite (as N)	0.173	0.174
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.214	0.227
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0024	0.0022
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	11.4	11.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.67	2.75
Total Metals (Water)		
Aluminum (Al)-Total	0.0234	0.0233
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00012	0.00014
Barium (Ba)-Total	0.00574	0.00576
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	18.9	19.2
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00108	0.00121
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	2.55	2.55	Magnesium (Mg)-Total	2.38	2.35
Manganese (Mn)-Total	0.0164	0.0173	Manganese (Mn)-Total	0.00158	0.00149
Molybdenum (Mo)-Total	0.000802	0.000813	Molybdenum (Mo)-Total	0.00196	0.00198
Nickel (Ni)-Total	<0.00050	<0.00050	Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.464	0.469	Potassium (K)-Total	0.533	0.52
Selenium (Se)-Total	0.000194	0.000221	Selenium (Se)-Total	0.000443	0.000595
Silicon (Si)-Total	3.07	2.99	Silicon (Si)-Total	1.95	1.94
Silver (Ag)-Total	<0.000010	<0.000010	Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	2.46	2.54	Sodium (Na)-Total	1.3	1.29
Strontium (Sr)-Total	0.131	0.132	Strontium (Sr)-Total	0.166	0.169
Thallium (Tl)-Total	<0.000010	<0.000010	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100	Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000035	0.000038	Uranium (U)-Total	0.000171	0.000174
Vanadium (V)-Total	<0.00050	<0.00050	Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030	Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0068	0.0052	Aluminum (Al)-Dissolved	0.0103	0.0111
Antimony (Sb)-Dissolved	<0.00010	<0.00010	Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00028	0.00028	Arsenic (As)-Dissolved	0.0001	0.00011
Barium (Ba)-Dissolved	0.0156	0.0148	Barium (Ba)-Dissolved	0.00543	0.00538
Beryllium (Be)-Dissolved	<0.000100	<0.000100	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.044	0.043	Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050	Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	14.2	13.8	Calcium (Ca)-Dissolved	19.4	20.4
Chromium (Cr)-Dissolved	<0.00050	<0.00050	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010	Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00178	0.00175	Copper (Cu)-Dissolved	0.00083	0.00087
Iron (Fe)-Dissolved	<0.030	<0.030	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010	Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.58	2.56	Magnesium (Mg)-Dissolved	2.34	2.32
Manganese (Mn)-Dissolved	0.001	0.00083	Manganese (Mn)-Dissolved	0.00034	0.00043
Molybdenum (Mo)-Dissolved	0.00075	0.000775	Molybdenum (Mo)-Dissolved	0.00189	0.00191
Nickel (Ni)-Dissolved	<0.00050	<0.00050	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.472	0.461	Potassium (K)-Dissolved	0.538	0.525
Selenium (Se)-Dissolved	0.000158	0.000175	Selenium (Se)-Dissolved	0.000469	0.000502
Silicon (Si)-Dissolved	2.8	2.76	Silicon (Si)-Dissolved	1.76	1.77
Silver (Ag)-Dissolved	<0.000010	<0.000010	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	2.41	2.41	Sodium (Na)-Dissolved	1.29	1.28
Strontium (Sr)-Dissolved	0.124	0.123	Strontium (Sr)-Dissolved	0.153	0.151
Thallium (Tl)-Dissolved	<0.000010	<0.000010	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000031	0.00003	Uranium (U)-Dissolved	0.000159	0.00016
Vanadium (V)-Dissolved	<0.00050	<0.00050	Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030	Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B2103

Client Sample ID	HAD-3	HAD-C
Date Sampled	30-May-23	30-May-23
Time Sampled	9:23	9:23
ALS Sample ID	VA23B2103-001	VA23B2103-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1030	1040
Conductivity	96.7	95.7
Hardness (as CaCO3), Dissolved	492	503
Hardness (as CaCO3), From total Ca/M	508	508
pH	774	830
Total Dissolved Solids	2.6	<1.0
Total Suspended Solids	0.75	1.02
Turbidity	8.13	8.14
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0062	0.0071
Chloride (Cl)	4.2	4.22
Fluoride (F)	0.401	0.326
Nitrate (as N)	3.47	3.46
Nitrate and Nitrite (as N)	3.48	3.47
Nitrite (as N)	0.0118	0.014
Total Nitrogen	3.83	3.82
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0069	0.0065
Phosphorus (P)-Total Dissolved	0.0037	0.0024
Sulfate (SO4)	458	458
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.02	3.32
Total Metals (Water)		
Aluminum (Al)-Total	0.268	0.285
Antimony (Sb)-Total	0.00083	0.00084
Arsenic (As)-Total	0.0011	0.00111
Barium (Ba)-Total	0.0421	0.0421
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.111	0.11
Cadmium (Cd)-Total	<0.000110	<0.000100
Calcium (Ca)-Total	157	158
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00017	0.00018
Copper (Cu)-Total	0.00908	0.00937
Iron (Fe)-Total	0.034	0.05
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.006	0.0059

Results Summary VA23B2099

Client Sample ID	QUL-58-MP	QUL-EH-MP
Date Sampled	30-May-23	30-May-23
Time Sampled	11:11	11:11
ALS Sample ID	VA23B2099-003	VA23B2099-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	118	118
Conductivity	49.6	49.8
Hardness (as CaCO3), Dissolved	55.2	55.1
Hardness (as CaCO3), From total Ca/M	56.6	56.9
pH	84	95
Total Dissolved Solids	<1.0	1
Total Suspended Solids	0.15	0.18
Turbidity	7.77	7.78
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.033	0.033
Nitrate (as N)	0.155	0.154
Nitrate and Nitrite (as N)	0.155	0.154
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.227	0.222
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0025	0.0026
Phosphorus (P)-Total Dissolved	0.0028	<0.0020
Sulfate (SO4)	8.41	8.43
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.3	2.58
Total Metals (Water)		
Aluminum (Al)-Total	0.0199	0.0712
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00016	0.00019
Barium (Ba)-Total	0.00577	0.00734
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	18.7	18.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00096	0.0032
Iron (Fe)-Total	<0.030	0.072
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Magnesium (Mg)-Total	28.1	27.7
Manganese (Mn)-Total	0.084	0.085
Molybdenum (Mo)-Total	0.156	0.154
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	2.38	2.37
Selenium (Se)-Total	0.0457	0.0444
Silicon (Si)-Total	4.87	4.91
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	23	22.5
Strontium (Sr)-Total	3.47	3.42
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00249	0.00245
Vanadium (V)-Total	0.00134	0.00137
Zinc (Zn)-Total	<0.0030	<0.0030

Magnesium (Mg)-Total	2.42	2.42
Manganese (Mn)-Total	0.00129	0.0028
Molybdenum (Mo)-Total	0.0014	0.00144
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.561	0.559
Selenium (Se)-Total	0.000388	0.000406
Silicon (Si)-Total	1.91	2.02
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	1.27	1.26
Strontium (Sr)-Total	0.147	0.148
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000179	0.000178
Vanadium (V)-Total	<0.00050	0.00053
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.187	0.191
Antimony (Sb)-Dissolved	0.0008	0.00082
Arsenic (As)-Dissolved	0.00092	0.00101
Barium (Ba)-Dissolved	0.0402	0.0403
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.107	0.108
Cadmium (Cd)-Dissolved	<0.000100	<0.000100
Calcium (Ca)-Dissolved	152	156
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00011	0.00012
Copper (Cu)-Dissolved	0.00612	0.00633
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0058	0.0059
Magnesium (Mg)-Dissolved	27.3	27.5
Manganese (Mn)-Dissolved	0.0685	0.07
Molybdenum (Mo)-Dissolved	0.152	0.152
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	2.36	2.38
Selenium (Se)-Dissolved	0.0444	0.0438
Silicon (Si)-Dissolved	4.67	4.74
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	22.5	22.7
Strontium (Sr)-Dissolved	3.39	3.36
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.0024	0.00238
Vanadium (V)-Dissolved	0.00108	0.00105
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0102	0.0116
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00012	0.0001
Barium (Ba)-Dissolved	0.00532	0.00536
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	18.2	18.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00074	0.00077
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.36	2.34
Manganese (Mn)-Dissolved	0.0002	0.00021
Molybdenum (Mo)-Dissolved	0.00136	0.00138
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.542	0.539
Selenium (Se)-Dissolved	0.000352	0.000344
Silicon (Si)-Dissolved	1.85	1.85
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	1.25	1.24
Strontium (Sr)-Dissolved	0.14	0.148
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000166	0.000164
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B2101

Client Sample ID	GW16-6a	GW16-Fa
Date Sampled	30-May-23	30-May-23
Time Sampled	12:12	12:12
ALS Sample ID	VA23B2101-003	VA23B2101-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	415	412
Conductivity	37.6	38.1
Hardness (as CaCO3), Dissolved	116	117
pH	7.95	7.96
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.93	0.93
Fluoride (F)	0.694	0.694
Nitrate (as N)	0.0635	0.063
Nitrate and Nitrite (as N)	0.0635	0.063
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.072	0.071
Phosphorus (P)-Total	0.0024	0.0022
Phosphorus (P)-Total Dissolved	0.0033	0.0023
Sulfate (SO4)	151	151
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.84	0.87
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0038	0.0036
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00801	0.00793
Barium (Ba)-Dissolved	0.0014	0.00138
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.57	0.578
Cadmium (Cd)-Dissolved	<0.0000200	<0.0000150
Calcium (Ca)-Dissolved	37.6	37.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0015	0.0015
Magnesium (Mg)-Dissolved	5.42	5.5
Manganese (Mn)-Dissolved	0.00523	0.0051
Molybdenum (Mo)-Dissolved	0.0553	0.0554
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.531	0.53

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Dissolved	0.00169	0.00177
Silicon (Si)-Dissolved	8.12	8.11
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	33.6	34.2
Strontium (Sr)-Dissolved	0.0691	0.0687
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000049	0.000047
Vanadium (V)-Dissolved	0.00171	0.00166
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B2759

Client Sample ID	HAC-14	HAC-N
Date Sampled	05-Jun-23	05-Jun-23
Time Sampled	12:18	12:18
ALS Sample ID	VA23B2759-005	VA23B2759-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	298	297
Conductivity	105	106
Hardness (as CaCO3), Dissolved	134	135
Hardness (as CaCO3), From total Ca/M	146	141
pH	221	209
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.36	0.32
Turbidity	8.28	8.26
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	0.0055
Chloride (Cl)	1.02	1.03
Fluoride (F)	0.086	0.083
Nitrate (as N)	0.0553	0.0558
Nitrate and Nitrite (as N)	0.0553	0.0558
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.262	0.254
Orthophosphate-Dissolved (as P)	0.0045	0.0045
Phosphorus (P)-Total	0.0115	0.011
Phosphorus (P)-Total Dissolved	0.0096	0.0098
Sulfate (SO4)	49.2	49.1
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.77	5.85
Total Metals (Water)		
Aluminum (Al)-Total	0.0213	0.0209
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00068	0.0007
Barium (Ba)-Total	0.0159	0.0158
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.023	0.022
Cadmium (Cd)-Total	<0.0000050	0.0000056
Calcium (Ca)-Total	46.1	44.1
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00806	0.00811
Iron (Fe)-Total	0.037	0.039
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	7.57	7.59

Results Summary VA23B3012

Client Sample ID	B1-S	BA-S
Date Sampled	08-Jun-23	08-Jun-23
Time Sampled	10:56	10:56
ALS Sample ID	VA23B3012-001	VA23B3012-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	97.4	97.6
Conductivity	40.1	40.2
Hardness (as CaCO3), Dissolved	44.2	45
Hardness (as CaCO3), From total Ca/Mg	46	45.8
pH	77	58
Total Dissolved Solids	3.2	3.6
Total Suspended Solids	1.55	1.62
Turbidity	7.44	7.45
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.58	0.58
Fluoride (F)	0.059	0.062
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.298	0.459
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0121	0.0109
Phosphorus (P)-Total Dissolved	0.006	0.006
Sulfate (SO4)	7.94	7.91
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.74	7.02
Total Metals (Water)		
Aluminum (Al)-Total	0.055	0.0461
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00042	0.00039
Barium (Ba)-Total	0.0166	0.0167
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.046	0.046
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	14.3	14.3
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00293	0.00281
Iron (Fe)-Total	0.057	0.046
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.51	2.46

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Manganese (Mn)-Total	0.0116	0.0118
Molybdenum (Mo)-Total	0.00622	0.00632
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.1	1.08
Selenium (Se)-Total	0.00141	0.00145
Silicon (Si)-Total	3.78	3.74
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	8.16	7.94
Strontium (Sr)-Total	0.293	0.297
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000305	0.000317
Vanadium (V)-Total	0.0012	0.00126
Zinc (Zn)-Total	<0.0030	<0.0030

Manganese (Mn)-Total	0.00928	0.00868
Molybdenum (Mo)-Total	0.000879	0.000831
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.517	0.49
Selenium (Se)-Total	0.000224	0.000222
Silicon (Si)-Total	2.62	2.52
Silver (Ag)-Total	<0.000010	0.000029
Sodium (Na)-Total	2.47	2.47
Strontium (Sr)-Total	0.133	0.132
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	0.0001
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000045	0.000044
Vanadium (V)-Total	0.0005	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0095	0.0187
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00061	0.00066
Barium (Ba)-Dissolved	0.0155	0.0164
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.021	0.021
Cadmium (Cd)-Dissolved	0.000008	0.0000075
Calcium (Ca)-Dissolved	42	42
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00701	0.00765
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	7.1	7.29
Manganese (Mn)-Dissolved	0.00501	0.00535
Molybdenum (Mo)-Dissolved	0.00625	0.00635
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.04	1.06
Selenium (Se)-Dissolved	0.00135	0.00133
Silicon (Si)-Dissolved	3.43	3.49
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.35	7.53
Strontium (Sr)-Dissolved	0.304	0.309
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000292	0.000287
Vanadium (V)-Dissolved	0.00109	0.00111
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0109	0.0189
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00032	0.00034
Barium (Ba)-Dissolved	0.0162	0.0156
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.043	0.043
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	13.5	13.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00215	0.00278
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.54	2.57
Manganese (Mn)-Dissolved	0.00596	0.00615
Molybdenum (Mo)-Dissolved	0.000766	0.000778
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.441	0.452
Selenium (Se)-Dissolved	0.000163	0.000193
Silicon (Si)-Dissolved	2.57	2.6
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	2.45	2.5
Strontium (Sr)-Dissolved	0.127	0.125
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000037	0.000042
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B3377

Client Sample ID	W5	WE
Date Sampled	12-Jun-23	12-Jun-23
Time Sampled	11:07	11:07
ALS Sample ID	VA23B3377-003	VA23B3377-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	188	188
Conductivity	93.3	91
Hardness (as CaCO3), Dissolved	87.1	84.9
Hardness (as CaCO3), From total Ca/M	86.2	85.7
pH	136	138
Total Dissolved Solids	1.2	1.2
Total Suspended Solids	0.84	0.83
Turbidity	8.03	8.04
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0117	0.0116
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.077	0.076
Nitrate (as N)	0.0229	0.0154
Nitrate and Nitrite (as N)	0.0229	0.0154
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.5	0.42
Orthophosphate-Dissolved (as P)	0.003	0.0022
Phosphorus (P)-Total	0.045	0.0291
Phosphorus (P)-Total Dissolved	0.0115	0.0113
Sulfate (SO4)	9.02	8.94
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	9.91	10.3
Total Metals (Water)		
Aluminum (Al)-Total	0.0894	0.113
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00036	0.00038
Barium (Ba)-Total	0.019	0.0185
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.036	0.036
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	24.9	24.7
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00589	0.00564
Iron (Fe)-Total	0.083	0.067
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.84	5.83

Results Summary VA23B4408

Client Sample ID	QUL-ZOO-	QUL-ZOO-
Date Sampled	21-Jun-2023	21-Jun-2023
Time Sampled	07:30	07:30
ALS Sample ID	VA23B4408-004	VA23B4408-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
	Water	Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	107	107
Conductivity	47.6	47.2
Hardness (as CaCO3), Dissolved	55	54.6
Hardness (as CaCO3), From total Ca/M	53.7	53.5
pH	72	72
Total Dissolved Solids	6.6	9
Total Suspended Solids	2.22	2.55
Turbidity	7.92	7.91
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.041	0.041
Nitrate (as N)	0.104	0.104
Nitrate and Nitrite (as N)	0.104	0.104
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.158	0.168
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0169	0.0161
Phosphorus (P)-Total Dissolved	<0.0020	0.0027
Sulfate (SO4)	6.15	6.16
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.71	2.7
Total Metals (Water)		
Aluminum (Al)-Total	0.144	0.159
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.0003	0.00034
Barium (Ba)-Total	0.0094	0.00966
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	0.0000938	0.000168
Calcium (Ca)-Total	17.9	17.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	0.00013
Copper (Cu)-Total	0.0066	0.0067
Iron (Fe)-Total	0.119	0.145
Lead (Pb)-Total	0.000142	0.000218
Lithium (Li)-Total	0.0011	0.0011
Magnesium (Mg)-Total	2.18	2.19

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Manganese (Mn)-Total	0.00877	0.00978
Molybdenum (Mo)-Total	0.0023	0.00215
Nickel (Ni)-Total	0.00052	<0.00050
Potassium (K)-Total	0.984	0.975
Selenium (Se)-Total	0.000195	0.000202
Silicon (Si)-Total	5.94	6.18
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	5.79	6.05
Strontium (Sr)-Total	0.223	0.22
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00013	0.000125
Vanadium (V)-Total	0.00059	0.00055
Zinc (Zn)-Total	0.0031	0.003

Manganese (Mn)-Total	0.00565	0.0064
Molybdenum (Mo)-Total	0.000422	0.00042
Nickel (Ni)-Total	0.00055	0.0006
Potassium (K)-Total	0.582	0.592
Selenium (Se)-Total	0.000168	0.000186
Silicon (Si)-Total	2.07	2.09
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	1	1.02
Strontium (Sr)-Total	0.139	0.136
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000159	0.00015
Vanadium (V)-Total	0.0005	0.00056
Zinc (Zn)-Total	0.0044	0.0064

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0345	0.0318
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00038	0.00035
Barium (Ba)-Dissolved	0.0179	0.0181
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.034	0.032
Cadmium (Cd)-Dissolved	0.0000055	<0.0000050
Calcium (Ca)-Dissolved	25.5	24.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0052	0.00504
Iron (Fe)-Dissolved	0.038	0.038
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.69	5.52
Manganese (Mn)-Dissolved	0.015	0.0145
Molybdenum (Mo)-Dissolved	0.00234	0.00228
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.96	0.935
Selenium (Se)-Dissolved	0.000174	0.00019
Silicon (Si)-Dissolved	5.96	5.93
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	5.6	5.41
Strontium (Sr)-Dissolved	0.234	0.233
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000127	0.000123
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0135	0.0119
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00013	0.00012
Barium (Ba)-Dissolved	0.00569	0.00594
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	0.000205	0.000207
Calcium (Ca)-Dissolved	18.4	18.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00128	0.00143
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.19	2.23
Manganese (Mn)-Dissolved	0.00106	0.00126
Molybdenum (Mo)-Dissolved	0.000393	0.0004
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.552	0.582
Selenium (Se)-Dissolved	0.000142	0.000223
Silicon (Si)-Dissolved	1.71	1.75
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	1.03	1.06
Strontium (Sr)-Dissolved	0.135	0.137
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000149	0.000154
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B4773

Client Sample ID	QUL-2a-20m	QUL-Ba-20m
Date Sampled	26-Jun-23	26-Jun-23
Time Sampled	13:08	13:08
ALS Sample ID	VA23B4773-007	VA23B4773-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	106	104
Conductivity	50.4	49.3
Hardness (as CaCO3), Dissolved	52.1	52.9
Hardness (as CaCO3), From total Ca/M	52.8	52.4
pH	68	71
Total Dissolved Solids	<1.0	<1.1
Total Suspended Solids	0.16	0.32
Turbidity	7.87	7.86
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.035	0.031
Nitrate (as N)	0.116	0.116
Nitrate and Nitrite (as N)	0.116	0.116
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.164	0.168
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0028	0.0042
Phosphorus (P)-Total Dissolved	<0.0020	0.0033
Sulfate (SO4)	5.7	5.78
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.43	2.46
Total Metals (Water)		
Aluminum (Al)-Total	0.0222	0.012
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00013	0.00012
Barium (Ba)-Total	0.00602	0.00566
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	17.6	17.4
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00135	0.00057
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.14	2.17

Results Summary VA23B4755

Client Sample ID	QUL-58-AP	QUL-EH-AP
Date Sampled	27-Jun-23	27-Jun-23
Time Sampled	10:05	10:05
ALS Sample ID	VA23B4755-002	VA23B4755-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	112	111
Conductivity	48.3	48.1
Hardness (as CaCO3), Dissolved	52.3	52.2
Hardness (as CaCO3), From total Ca/Mg	54.1	53
pH	78	73
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.2	0.14
Turbidity	7.92	7.92
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.036	0.036
Nitrate (as N)	0.142	0.142
Nitrate and Nitrite (as N)	0.142	0.142
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.193	0.187
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0029	0.0029
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	6.53	6.56
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.29	2.41
Total Metals (Water)		
Aluminum (Al)-Total	0.0125	0.0145
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.0001	0.00014
Barium (Ba)-Total	0.00539	0.00565
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	18.3	17.7
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00064	0.00077
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.05	2.14

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Manganese (Mn)-Total	0.00166	0.00131
Molybdenum (Mo)-Total	0.000393	0.000398
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.502	0.514
Selenium (Se)-Total	0.000139	0.000095
Silicon (Si)-Total	1.77	1.82
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	0.928	0.94
Strontium (Sr)-Total	0.137	0.139
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000148	0.000138
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Manganese (Mn)-Total	0.00141	0.00133
Molybdenum (Mo)-Total	0.000521	0.000495
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.499	0.527
Selenium (Se)-Total	0.000155	0.000129
Silicon (Si)-Total	1.84	1.89
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	0.968	1.01
Strontium (Sr)-Total	0.144	0.139
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000163	0.000165
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0101	0.0068
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00012	0.00011
Barium (Ba)-Dissolved	0.00531	0.00522
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	17.5	17.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00084	0.0007
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.05	2.06
Manganese (Mn)-Dissolved	0.00025	0.00018
Molybdenum (Mo)-Dissolved	0.000391	0.000398
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.531	0.534
Selenium (Se)-Dissolved	0.000098	0.000074
Silicon (Si)-Dissolved	1.88	1.86
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	1.01	1.01
Strontium (Sr)-Dissolved	0.13	0.131
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000154	0.000156
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0071	0.008
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	<0.00010	0.0001
Barium (Ba)-Dissolved	0.00539	0.00533
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	17.6	17.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00059	0.00067
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.03	2.07
Manganese (Mn)-Dissolved	0.00018	0.00023
Molybdenum (Mo)-Dissolved	0.000478	0.000476
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.504	0.517
Selenium (Se)-Dissolved	0.000159	0.000155
Silicon (Si)-Dissolved	1.76	1.75
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.966	0.975
Strontium (Sr)-Dissolved	0.134	0.135
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000158	0.00016
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B5005

Client Sample ID	GW12-5a	GW12-Ea
Date Sampled	28-Jun-23	28-Jun-23
Time Sampled	8:14	8:14
ALS Sample ID	VA23B5005-001	VA23B5005-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	320	318
Conductivity	152	153
Hardness (as CaCO3), Dissolved	164	160
pH	7.89	7.93
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.007	0.0083
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.169	0.169
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	<0.030	<0.030
Phosphorus (P)-Total	0.005	0.0048
Phosphorus (P)-Total Dissolved	0.0038	0.0038
Sulfate (SO4)	18.9	18.8
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.63	0.66
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00121	0.0012
Barium (Ba)-Dissolved	0.0288	0.0277
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.016	0.015
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	55.8	54.4
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	0.252	0.248
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0025	0.0024
Magnesium (Mg)-Dissolved	6.05	5.82
Manganese (Mn)-Dissolved	0.0414	0.0405
Molybdenum (Mo)-Dissolved	0.00979	0.01
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.468	0.45
Selenium (Se)-Dissolved	<0.000050	<0.000050

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Silicon (Si)-Dissolved	8.52	8.39
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	4.36	4.23
Strontium (Sr)-Dissolved	0.204	0.208
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000813	0.00084
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0042	0.0042
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B5534

Client Sample ID	HAC-10	HAC-J
Date Sampled	06-Jul-23	06-Jul-23
Time Sampled	9:35	9:35
ALS Sample ID	VA23B5534-001	VA23B5534-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	249	248
Conductivity	89.7	89.1
Hardness (as CaCO3), Dissolved	107	112
Hardness (as CaCO3), From total Ca/M	110	111
pH	166	172
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.62	0.64
Turbidity	8.12	8.14
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0092	0.0085
Chloride (Cl)	0.82	0.78
Fluoride (F)	0.068	0.069
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.336	0.338
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0104	0.0107
Phosphorus (P)-Total Dissolved	0.0097	0.0091
Sulfate (SO4)	33.3	33.3
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	7.87	7.62
Total Metals (Water)		
Aluminum (Al)-Total	0.0165	0.0186
Antimony (Sb)-Total	<0.00010	0.00014
Arsenic (As)-Total	0.00053	0.00054
Barium (Ba)-Total	0.0102	0.0104
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.02	0.02
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	35.7	36
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00433	0.00447
Iron (Fe)-Total	0.038	0.042
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.13	5.12
Manganese (Mn)-Total	0.0144	0.015

Results Summary VA23B5741

Client Sample ID	E19	ES
Date Sampled	10-Jul-23	10-Jul-23
Time Sampled	9:56	9:56
ALS Sample ID	VA23B5741-002	VA23B5741-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1500	1500
Conductivity	99.7	98.6
Hardness (as CaCO3), Dissolved	797	803
Hardness (as CaCO3), From total Ca/M	824	842
pH	1230	1280
Total Dissolved Solids	7.6	8.3
Total Suspended Solids	3.28	2.76
Turbidity	8.2	8.18
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0208	0.0194
Chloride (Cl)	4.95	5.04
Fluoride (F)	0.502	0.503
Nitrate (as N)	3.24	3.26
Nitrate and Nitrite (as N)	3.26	3.27
Nitrite (as N)	0.0178	0.013
Total Nitrogen	3.44	3.37
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0173	0.02
Phosphorus (P)-Total Dissolved	0.004	0.0049
Sulfate (SO4)	758	768
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.54	2.72
Total Metals (Water)		
Aluminum (Al)-Total	0.302	0.299
Antimony (Sb)-Total	0.00066	0.00064
Arsenic (As)-Total	0.0011	0.00111
Barium (Ba)-Total	0.05	0.0498
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.134	0.136
Cadmium (Cd)-Total	<0.000185	<0.000185
Calcium (Ca)-Total	267	274
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.0005	0.0005
Copper (Cu)-Total	0.0182	0.018
Iron (Fe)-Total	0.328	0.344
Lead (Pb)-Total	0.000133	0.000132
Lithium (Li)-Total	0.0088	0.009
Magnesium (Mg)-Total	38.1	38.4
Manganese (Mn)-Total	0.182	0.181

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00601	0.00617
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.927	0.929
Selenium (Se)-Total	0.00052	0.000545
Silicon (Si)-Total	2.95	2.92
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.22	6.92
Strontium (Sr)-Total	0.234	0.239
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000175	0.000178
Vanadium (V)-Total	0.00156	0.00158
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.18	0.173
Nickel (Ni)-Total	0.00102	0.00106
Potassium (K)-Total	3.31	3.35
Selenium (Se)-Total	0.0421	0.0433
Silicon (Si)-Total	5.97	6.2
Silver (Ag)-Total	<0.000020	<0.000020
Sodium (Na)-Total	33.3	33.4
Strontium (Sr)-Total	6.6	6.64
Thallium (Tl)-Total	<0.000020	<0.000020
Tin (Sn)-Total	<0.00020	<0.00020
Titanium (Ti)-Total	0.013	0.0134
Uranium (U)-Total	0.00322	0.00322
Vanadium (V)-Total	0.00178	0.00182
Zinc (Zn)-Total	0.0175	0.0176

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0046	0.0046
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00053	0.00049
Barium (Ba)-Dissolved	0.0105	0.0105
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.02	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	34.3	36.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00405	0.00416
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.25	5.28
Manganese (Mn)-Dissolved	0.0112	0.0113
Molybdenum (Mo)-Dissolved	0.00605	0.00625
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.985	0.995
Selenium (Se)-Dissolved	0.000541	0.000563
Silicon (Si)-Dissolved	2.77	2.88
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.27	7.31
Strontium (Sr)-Dissolved	0.248	0.251
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000191	0.000189
Vanadium (V)-Dissolved	0.0014	0.0014
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0168	0.0086
Antimony (Sb)-Dissolved	0.00057	0.00058
Arsenic (As)-Dissolved	0.00096	0.00092
Barium (Ba)-Dissolved	0.045	0.044
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100
Boron (B)-Dissolved	0.123	0.125
Cadmium (Cd)-Dissolved	<0.000135	<0.000145
Calcium (Ca)-Dissolved	258	261
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00020
Copper (Cu)-Dissolved	0.00826	0.00695
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	0.000108	<0.000100
Lithium (Li)-Dissolved	0.008	0.0081
Magnesium (Mg)-Dissolved	37.1	36.8
Manganese (Mn)-Dissolved	0.089	0.0874
Molybdenum (Mo)-Dissolved	0.169	0.176
Nickel (Ni)-Dissolved	<0.00100	<0.00100
Potassium (K)-Dissolved	3.29	3.12
Selenium (Se)-Dissolved	0.042	0.043
Silicon (Si)-Dissolved	5.58	5.52
Silver (Ag)-Dissolved	<0.000020	<0.000020
Sodium (Na)-Dissolved	30.9	30.7
Strontium (Sr)-Dissolved	6.06	6.42
Thallium (Tl)-Dissolved	<0.000020	<0.000020
Tin (Sn)-Dissolved	<0.00020	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00292	0.00296
Vanadium (V)-Dissolved	<0.00100	<0.00100
Zinc (Zn)-Dissolved	0.0139	0.0108
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B6172

Client Sample ID	B1-S	BA-S
Date Sampled	12-Jul-23	12-Jul-23
Time Sampled	11:00	11:00
ALS Sample ID	VA23B6172-005	VA23B6172-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	100	102
Conductivity	41.4	41.2
Hardness (as CaCO3), Dissolved	45.5	44.4
Hardness (as CaCO3), From total Ca/Mg	46.9	47
pH	73	77
Total Dissolved Solids	<1.0	1.1
Total Suspended Solids	0.43	0.55
Turbidity	8	8
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.53	0.55
Fluoride (F)	0.059	0.065
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.298	0.293
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0066	0.0065
Phosphorus (P)-Total Dissolved	0.0054	0.0055
Sulfate (SO4)	7.97	7.99
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	7.85	8.12
Total Metals (Water)		
Aluminum (Al)-Total	0.0112	0.0122
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00033	0.00035
Barium (Ba)-Total	0.0163	0.0165
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.043	0.043
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	14.4	14.4
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00228	0.00242
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.65	2.67
Manganese (Mn)-Total	0.011	0.0109

Results Summary VA23B7481

Client Sample ID	P1-B	PA-B
Date Sampled	26-Jul-23	26-Jul-23
Time Sampled	11:55	11:55
ALS Sample ID	VA23B7481-004	VA23B7481-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	256	255
Conductivity	94.2	94.2
Hardness (as CaCO3), Dissolved	110	110
Hardness (as CaCO3), From total Ca/M	118	119
pH	187	191
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.33	0.35
Turbidity	7.97	7.98
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0066	0.0067
Chloride (Cl)	0.83	0.83
Fluoride (F)	0.071	0.07
Nitrate (as N)	0.0454	0.0478
Nitrate and Nitrite (as N)	0.0454	0.0478
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.262	0.261
Orthophosphate-Dissolved (as P)	0.0212	0.018
Phosphorus (P)-Total	0.0257	0.0268
Phosphorus (P)-Total Dissolved	0.0238	0.024
Sulfate (SO4)	35.5	35.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.03	6.03
Total Metals (Water)		
Aluminum (Al)-Total	0.0124	0.013
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00064	0.00062
Barium (Ba)-Total	0.00954	0.00992
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.021	0.02
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	38.7	38.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00385	0.00388
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.3	5.39
Manganese (Mn)-Total	0.0177	0.0183

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.0009	0.000876
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.474	0.475
Selenium (Se)-Total	0.000279	0.000209
Silicon (Si)-Total	2.31	2.21
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	2.51	2.52
Strontium (Sr)-Total	0.138	0.139
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000042	0.00004
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.00628	0.00618
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.975	0.99
Selenium (Se)-Total	0.0005	0.000487
Silicon (Si)-Total	3.85	4.52
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.21	7.31
Strontium (Sr)-Total	0.262	0.262
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000197	0.000202
Vanadium (V)-Total	0.00139	0.00141
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0168	0.0145
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00037	0.00033
Barium (Ba)-Dissolved	0.0168	0.016
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.042	0.042
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	13.8	13.4
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00298	0.00268
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.69	2.67
Manganese (Mn)-Dissolved	0.00287	0.00234
Molybdenum (Mo)-Dissolved	0.000854	0.000851
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.497	0.49
Selenium (Se)-Dissolved	0.000263	0.000168
Silicon (Si)-Dissolved	2.05	2.03
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	2.63	2.61
Strontium (Sr)-Dissolved	0.136	0.13
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000036	0.000037
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	0.0058
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00057	0.00053
Barium (Ba)-Dissolved	0.00984	0.00983
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.019	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	35.8	35.6
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00357	0.00358
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	4.97	5.11
Manganese (Mn)-Dissolved	0.00485	0.00491
Molybdenum (Mo)-Dissolved	0.00624	0.00624
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.12	1.14
Selenium (Se)-Dissolved	0.000626	0.000527
Silicon (Si)-Dissolved	3.8	3.78
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.54	7.61
Strontium (Sr)-Dissolved	0.253	0.256
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000197	0.000201
Vanadium (V)-Dissolved	0.00123	0.00127
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B7485

Client Sample ID	QUL-ZOO-	QUL-ZOO-
Date Sampled	26-Jul-2023	26-Jul-2023
Time Sampled	07:55	07:55
ALS Sample ID	VA23B7485-002	VA23B7485-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	111	110
Conductivity	48.3	48.5
Hardness (as CaCO3), Dissolved	50.1	51.1
Hardness (as CaCO3), From total Ca/M	53.6	53.8
pH	80	72
Total Dissolved Solids	2.6	1.6
Total Suspended Solids	0.97	1.06
Turbidity	7.9	7.87
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.035	0.036
Nitrate (as N)	0.0618	0.0617
Nitrate and Nitrite (as N)	0.0618	0.0617
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.145	0.144
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0049	0.0047
Phosphorus (P)-Total Dissolved	<0.0020	0.0021
Sulfate (SO4)	5.73	5.66
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.8	2.58
Total Metals (Water)		
Aluminum (Al)-Total	0.0426	0.0394
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00019	0.00021
Barium (Ba)-Total	0.0065	0.00647
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	0.0000703	0.0000662
Calcium (Ca)-Total	18.2	18.2
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00314	0.00308
Iron (Fe)-Total	0.037	0.035
Lead (Pb)-Total	0.00009	0.00009
Lithium (Li)-Total	0.001	<0.0010
Magnesium (Mg)-Total	1.97	2.04
Manganese (Mn)-Total	0.00258	0.00247

Results Summary VA23B7483

Client Sample ID	95-R-5	95-R-E
Date Sampled	27-Jul-23	27-Jul-23
Time Sampled	11:13	11:13
ALS Sample ID	VA23B7483-005	VA23B7483-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1020	1020
Conductivity	443	445
Hardness (as CaCO3), Dissolved	535	555
pH	7.38	7.41
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<2.50	<2.50
Fluoride (F)	0.109	<0.100
Nitrate (as N)	<0.0250	<0.0250
Nitrate and Nitrite (as N)	<0.0255	<0.0255
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	<0.030	<0.030
Phosphorus (P)-Total	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	147	133
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.71	2.39
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0043	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00599	0.00568
Barium (Ba)-Dissolved	0.0193	0.0188
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.06	0.06
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	177	185
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00058	0.00061
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	4.11	4.1
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0072	0.0075
Magnesium (Mg)-Dissolved	22.5	22.7
Manganese (Mn)-Dissolved	1.91	1.93
Molybdenum (Mo)-Dissolved	0.00706	0.00707
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.02	1.02
Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	12.6	12.5

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00036	0.000415
Nickel (Ni)-Total	0.00056	0.00053
Potassium (K)-Total	0.513	0.532
Selenium (Se)-Total	0.000133	0.000152
Silicon (Si)-Total	1.46	1.49
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	0.92	0.945
Strontium (Sr)-Total	0.135	0.139
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000157	0.000158
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0105	0.0136
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00011	0.00012
Barium (Ba)-Dissolved	0.00566	0.00616
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	0.0000518	0.0000559
Calcium (Ca)-Dissolved	16.8	17.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00103	0.00113
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	0.000069	0.000091
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	1.99	1.97
Manganese (Mn)-Dissolved	0.00089	0.00132
Molybdenum (Mo)-Dissolved	0.000386	0.000401
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.586	0.578
Selenium (Se)-Dissolved	0.000157	0.000107
Silicon (Si)-Dissolved	1.29	1.33
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.99	0.982
Strontium (Sr)-Dissolved	0.141	0.144
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000155	0.000155
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	0.003
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.28	7.28
Strontium (Sr)-Dissolved	0.485	0.5
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000582	0.000586
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0133	0.013
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B7775

Client Sample ID	E22	EV
Date Sampled	31-Jul-23	31-Jul-23
Time Sampled	12:36	12:36
ALS Sample ID	VA23B7775-003	VA23B7775-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1510	1520
Conductivity	238	239
Hardness (as CaCO3), Dissolved	897	915
Hardness (as CaCO3), From total Ca/M(	916	896
pH	1320	1290
Total Dissolved Solids	1.3	1.6
Total Suspended Solids	0.44	0.4
Turbidity	8.2	8.21
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0271	0.0273
Chloride (Cl)	8.32	8.35
Fluoride (F)	0.36	0.366
Nitrate (as N)	1.11	1.12
Nitrate and Nitrite (as N)	1.12	1.13
Nitrite (as N)	0.0101	0.0097
Total Nitrogen	1.32	1.32
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0095	0.0088
Phosphorus (P)-Total Dissolved	0.0052	0.005
Sulfate (SO4)	649	648
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.74	3.79
Total Metals (Water)		
Aluminum (Al)-Total	0.0167	0.0177
Antimony (Sb)-Total	0.00021	0.0002
Arsenic (As)-Total	0.00053	0.00055
Barium (Ba)-Total	0.0294	0.0305
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.043	0.042
Cadmium (Cd)-Total	<0.000145	<0.000150
Calcium (Ca)-Total	268	263
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.0223	0.0222
Iron (Fe)-Total	0.043	0.046
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.013	0.0128
Magnesium (Mg)-Total	59.9	58.2
Manganese (Mn)-Total	0.0129	0.0139

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.281	0.278
Nickel (Ni)-Total	0.00051	<0.00050
Potassium (K)-Total	1.82	1.79
Selenium (Se)-Total	0.112	0.11
Silicon (Si)-Total	5.21	5.15
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	20.8	20.6
Strontium (Sr)-Total	5.75	5.65
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00504	0.00491
Vanadium (V)-Total	0.00063	0.00062
Zinc (Zn)-Total	0.0037	0.004

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	0.00019	0.0002
Arsenic (As)-Dissolved	0.00051	0.0005
Barium (Ba)-Dissolved	0.0295	0.0286
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.04	0.039
Cadmium (Cd)-Dissolved	<0.000130	<0.000135
Calcium (Ca)-Dissolved	261	269
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0203	0.0204
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0115	0.0116
Magnesium (Mg)-Dissolved	59.6	59
Manganese (Mn)-Dissolved	0.0102	0.0104
Molybdenum (Mo)-Dissolved	0.271	0.268
Nickel (Ni)-Dissolved	0.00057	0.00058
Potassium (K)-Dissolved	1.81	1.82
Selenium (Se)-Dissolved	0.114	0.116
Silicon (Si)-Dissolved	4.93	4.93
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	21.2	21
Strontium (Sr)-Dissolved	5.58	5.6
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00461	0.00479
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0034	0.0036
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B7781

Client Sample ID	W4a	WDa
Date Sampled	01-Aug-23	01-Aug-23
Time Sampled	11:52	11:52
ALS Sample ID	VA23B7781-006	VA23B7781-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	371	374
Conductivity	160	159
Hardness (as CaCO3), Dissolved	185	188
Hardness (as CaCO3), From total Ca/Mg	191	196
pH	253	236
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.13	0.13
Turbidity	8.33	8.38
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.085	0.084
Nitrate (as N)	0.0064	<0.0050
Nitrate and Nitrite (as N)	0.0064	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.058	0.059
Orthophosphate-Dissolved (as P)	0.012	0.0117
Phosphorus (P)-Total	0.0156	0.0149
Phosphorus (P)-Total Dissolved	0.0145	0.0139
Sulfate (SO4)	37.5	37.8
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.6	3.42
Total Metals (Water)		
Aluminum (Al)-Total	0.0144	0.0143
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00033	0.00033
Barium (Ba)-Total	0.0197	0.0213
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.034	0.035
Cadmium (Cd)-Total	0.0000086	0.0000065
Calcium (Ca)-Total	64.4	65.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00489	0.00489
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	7.41	7.74
Manganese (Mn)-Total	0.00389	0.00356

Results Summary VA23B8013

Client Sample ID	HAC-13	HAC-M
Date Sampled	02-Aug-23	02-Aug-23
Time Sampled	10:17	10:17
ALS Sample ID	VA23B8013-002	VA23B8013-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	247	251
Conductivity	92.4	92.4
Hardness (as CaCO3), Dissolved	126	126
Hardness (as CaCO3), From total Ca/Mg	112	111
pH	175	174
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.74	0.73
Turbidity	8.23	8.25
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0103	0.0086
Chloride (Cl)	0.75	0.74
Fluoride (F)	0.065	0.062
Nitrate (as N)	0.0067	0.0076
Nitrate and Nitrite (as N)	0.0067	0.0076
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.283	0.27
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0131	0.0127
Phosphorus (P)-Total Dissolved	0.0068	0.006
Sulfate (SO4)	32.6	32.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.37	6.76
Total Metals (Water)		
Aluminum (Al)-Total	0.0353	0.0375
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00057	0.00056
Barium (Ba)-Total	0.011	0.0109
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.02	0.02
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	36.3	36.2
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00463	0.00449
Iron (Fe)-Total	0.047	0.046
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.21	5.12
Manganese (Mn)-Total	0.0195	0.0189

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00583	0.00605
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.504	0.5
Selenium (Se)-Total	0.000597	0.000662
Silicon (Si)-Total	7.37	7.59
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	3.7	3.83
Strontium (Sr)-Total	0.277	0.288
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000275	0.000278
Vanadium (V)-Total	0.00094	0.0009
Zinc (Zn)-Total	0.0082	0.009

Molybdenum (Mo)-Total	0.00638	0.00619
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.985	0.94
Selenium (Se)-Total	0.000536	0.000529
Silicon (Si)-Total	3.28	3.22
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.14	6.92
Strontium (Sr)-Total	0.249	0.24
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000197	0.000185
Vanadium (V)-Total	0.00155	0.00153
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0037	0.0036
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.0003	0.00028
Barium (Ba)-Dissolved	0.0187	0.0194
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.031	0.032
Cadmium (Cd)-Dissolved	0.0000075	0.0000076
Calcium (Ca)-Dissolved	62.8	63.8
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00453	0.00442
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	6.84	7
Manganese (Mn)-Dissolved	0.00246	0.00228
Molybdenum (Mo)-Dissolved	0.0056	0.00574
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.487	0.492
Selenium (Se)-Dissolved	0.000706	0.00068
Silicon (Si)-Dissolved	7.09	7.25
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	3.68	3.58
Strontium (Sr)-Dissolved	0.271	0.274
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000257	0.00026
Vanadium (V)-Dissolved	0.00073	0.00072
Zinc (Zn)-Dissolved	0.008	0.008
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.004	0.0053
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00058	0.00053
Barium (Ba)-Dissolved	0.0111	0.0108
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.018	0.018
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	40.6	40.6
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00365	0.0036
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.91	5.89
Manganese (Mn)-Dissolved	0.0105	0.00995
Molybdenum (Mo)-Dissolved	0.00622	0.00609
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.02	0.996
Selenium (Se)-Dissolved	0.000467	0.000494
Silicon (Si)-Dissolved	3.19	3.11
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.88	7.51
Strontium (Sr)-Dissolved	0.274	0.267
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000184	0.000192
Vanadium (V)-Dissolved	0.00155	0.00146
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B8278

Client Sample ID	HAC-D_WS-1_2023-08	HAC-D_WS-1X_2023-08
Date Sampled	07-Aug-2023	07-Aug-2023
Time Sampled	10:10	10:10
ALS Sample ID	VA23B8278-004	VA23B8278-009
Parameter	Sub-Matrix Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	285	285
Conductivity	108	108
Hardness (as CaCO3), Dissolved	130	127
Hardness (as CaCO3), From total Ca/M	128	130
pH	203	200
Total Dissolved Solids	1.4	<1.0
Total Suspended Solids	0.44	0.34
Turbidity	8.3	8.28
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.006	0.0074
Chloride (Cl)	0.93	0.94
Fluoride (F)	0.089	0.088
Nitrate (as N)	0.007	<0.0050
Nitrate and Nitrite (as N)	0.007	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.228	0.241
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0103	0.0092
Phosphorus (P)-Total Dissolved	0.0086	0.0075
Sulfate (SO4)	42.3	42.6
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.66	5.67
Total Metals (Water)		
Aluminum (Al)-Total	0.0289	0.0288
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00074	0.00076
Barium (Ba)-Total	0.0162	0.0168
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.022	0.022
Cadmium (Cd)-Total	<0.0000050	0.0000074
Calcium (Ca)-Total	40.1	40.4
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00693	0.00706
Iron (Fe)-Total	0.037	0.041
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	6.81	6.98
Manganese (Mn)-Total	0.0112	0.0114

Results Summary VA23B8561

Client Sample ID	MDC	1343
Date Sampled	09-Aug-23	09-Aug-23
Time Sampled	13:25	13:25
ALS Sample ID	VA23B8561-005	VA23B8561-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	917	912
Conductivity	151	150
Hardness (as CaCO3), Dissolved	420	420
Hardness (as CaCO3), From total Ca/M	422	430
pH	718	703
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.47	0.46
Turbidity	8.36	8.36
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	16.8	16.7
Fluoride (F)	0.23	0.241
Nitrate (as N)	7.01	7.01
Nitrate and Nitrite (as N)	7.01	7.01
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	6.99	7.07
Orthophosphate-Dissolved (as P)	0.0222	0.022
Phosphorus (P)-Total	0.0272	0.0269
Phosphorus (P)-Total Dissolved	0.0261	0.0259
Sulfate (SO4)	280	280
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.58	5.72
Total Metals (Water)		
Aluminum (Al)-Total	0.0202	0.0211
Antimony (Sb)-Total	0.00038	0.00039
Arsenic (As)-Total	0.00054	0.00053
Barium (Ba)-Total	0.0413	0.0419
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.051	0.05
Cadmium (Cd)-Total	<0.0000600	<0.0000550
Calcium (Ca)-Total	124	125
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	0.00011
Copper (Cu)-Total	0.0185	0.0194
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0035	0.0035
Magnesium (Mg)-Total	27.2	28.6
Manganese (Mn)-Total	0.00942	0.0107

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00629	0.00628
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.07	1.11
Selenium (Se)-Total	0.000875	0.000958
Silicon (Si)-Total	3.47	3.64
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	8.22	8.13
Strontium (Sr)-Total	0.273	0.27
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000258	0.000268
Vanadium (V)-Total	0.00147	0.0015
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.146	0.153
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.95	2.01
Selenium (Se)-Total	0.0232	0.023
Silicon (Si)-Total	9.38	9.39
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	16.4	16.8
Strontium (Sr)-Total	0.715	0.746
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000924	0.00096
Vanadium (V)-Total	0.00081	0.00078
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.004	0.0039
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.0007	0.00073
Barium (Ba)-Dissolved	0.0161	0.0158
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.022	0.021
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	40.9	39.4
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00609	0.00616
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	6.74	7.04
Manganese (Mn)-Dissolved	0.00275	0.00258
Molybdenum (Mo)-Dissolved	0.00629	0.00613
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.03	1.04
Selenium (Se)-Dissolved	0.000954	0.000853
Silicon (Si)-Dissolved	3.59	3.57
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.93	7.9
Strontium (Sr)-Dissolved	0.288	0.287
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000246	0.000246
Vanadium (V)-Dissolved	0.00131	0.00136
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.004	0.0038
Antimony (Sb)-Dissolved	0.00037	0.00037
Arsenic (As)-Dissolved	0.00054	0.0005
Barium (Ba)-Dissolved	0.044	0.0427
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.049	0.049
Cadmium (Cd)-Dissolved	<0.0000500	<0.0000500
Calcium (Ca)-Dissolved	123	123
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0172	0.0172
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0032	0.0031
Magnesium (Mg)-Dissolved	27.4	27.4
Manganese (Mn)-Dissolved	0.00315	0.00312
Molybdenum (Mo)-Dissolved	0.144	0.15
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.98	1.98
Selenium (Se)-Dissolved	0.0242	0.0236
Silicon (Si)-Dissolved	9.24	9.26
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	16.6	16.3
Strontium (Sr)-Dissolved	0.71	0.737
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00092	0.000906
Vanadium (V)-Dissolved	0.00065	0.00066
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B8563

Client Sample ID	GW11-1a	GW11-Aa
Date Sampled	10-Aug-23	10-Aug-23
Time Sampled	10:03	10:03
ALS Sample ID	VA23B8563-001	VA23B8563-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	522	525
Conductivity	142	142
Hardness (as CaCO3), Dissolved	206	212
pH	8.02	8.05
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.74	0.74
Fluoride (F)	0.171	0.17
Nitrate (as N)	0.204	0.203
Nitrate and Nitrite (as N)	0.204	0.203
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.241	0.212
Phosphorus (P)-Total	0.0219	0.0223
Phosphorus (P)-Total Dissolved	0.0214	0.0218
Sulfate (SO4)	135	135
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.8	0.65
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	0.00036	0.00035
Arsenic (As)-Dissolved	0.0026	0.0027
Barium (Ba)-Dissolved	0.00234	0.00243
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.322	0.335
Cadmium (Cd)-Dissolved	<0.0000250	<0.0000250
Calcium (Ca)-Dissolved	62.8	64.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00086	0.00083
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0021	0.0021
Magnesium (Mg)-Dissolved	12	12.4
Manganese (Mn)-Dissolved	<0.00010	<0.00010
Molybdenum (Mo)-Dissolved	0.0388	0.0389
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.392	0.397
Selenium (Se)-Dissolved	0.00505	0.005
Silicon (Si)-Dissolved	8.06	8.26

Results Summary VA23B9236

Client Sample ID	E26	EZ
Date Sampled	17-Aug-23	17-Aug-23
Time Sampled	7:46	7:46
ALS Sample ID	VA23B9236-002	VA23B9236-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1180	1170
Conductivity	14.1	14
Hardness (as CaCO3), Dissolved	344	352
Hardness (as CaCO3), From total Ca/M	333	333
pH	914	936
Total Dissolved Solids	4.2	5.3
Total Suspended Solids	4.82	4.48
Turbidity	6.69	6.7
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.78	0.933
Chloride (Cl)	28.1	27.3
Fluoride (F)	0.822	0.815
Nitrate (as N)	6.06	5.87
Nitrate and Nitrite (as N)	6.34	6.14
Nitrite (as N)	0.277	0.273
Total Nitrogen	7.62	7.32
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0238	0.0244
Phosphorus (P)-Total Dissolved	0.0138	0.0133
Sulfate (SO4)	504	486
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	9.32	10.1
Total Metals (Water)		
Aluminum (Al)-Total	0.407	0.37
Antimony (Sb)-Total	0.00606	0.0061
Arsenic (As)-Total	0.00331	0.00329
Barium (Ba)-Total	0.0647	0.0625
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.162	0.167
Cadmium (Cd)-Total	<0.0000550	<0.0000500
Calcium (Ca)-Total	112	112
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00046	0.00042
Copper (Cu)-Total	0.161	0.154
Iron (Fe)-Total	0.464	0.452
Lead (Pb)-Total	0.000151	0.000167
Lithium (Li)-Total	0.0146	0.0145
Magnesium (Mg)-Total	12.9	12.9
Manganese (Mn)-Total	0.0193	0.0189

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	22.5	23.1
Strontium (Sr)-Dissolved	0.368	0.37
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00132	0.00138
Vanadium (V)-Dissolved	0.00314	0.00317
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Molybdenum (Mo)-Total	0.247	0.253
Nickel (Ni)-Total	0.00165	0.00159
Potassium (K)-Total	17.4	17.2
Selenium (Se)-Total	0.0396	0.0388
Silicon (Si)-Total	8.05	7.72
Silver (Ag)-Total	0.000036	0.000035
Sodium (Na)-Total	116	114
Strontium (Sr)-Total	1.39	1.41
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.0128	0.0126
Uranium (U)-Total	0.00041	0.000411
Vanadium (V)-Total	0.00523	0.00497
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.031	0.0314
Antimony (Sb)-Dissolved	0.00586	0.00563
Arsenic (As)-Dissolved	0.00314	0.00316
Barium (Ba)-Dissolved	0.0578	0.0593
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.16	0.161
Cadmium (Cd)-Dissolved	<0.0000550	<0.0000500
Calcium (Ca)-Dissolved	117	120
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00073	0.00079
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.013	0.0134
Magnesium (Mg)-Dissolved	12.7	12.6
Manganese (Mn)-Dissolved	0.0115	0.0119
Molybdenum (Mo)-Dissolved	0.241	0.236
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	17.4	17.8
Selenium (Se)-Dissolved	0.0422	0.0412
Silicon (Si)-Dissolved	6.73	6.65
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	122	123
Strontium (Sr)-Dissolved	1.38	1.33
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000388	0.000395
Vanadium (V)-Dissolved	0.0038	0.00392
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B9236

Client Sample ID	E1a	EAa
Date Sampled	16-Aug-23	16-Aug-23
Time Sampled	11:11	11:11
ALS Sample ID	VA23B9236-006	VA23B9236-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1160	1160
Conductivity	30	30.2
Hardness (as CaCO3), Dissolved	322	338
Hardness (as CaCO3), From total Ca/M	309	304
pH	882	922
Total Dissolved Solids	2	1.7
Total Suspended Solids	3.46	2.28
Turbidity	7.02	7.01
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.231	0.229
Chloride (Cl)	24.1	24.1
Fluoride (F)	0.878	0.876
Nitrate (as N)	3.6	3.6
Nitrate and Nitrite (as N)	3.68	3.68
Nitrite (as N)	0.0789	0.0813
Total Nitrogen	4.09	4.08
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0087	0.0088
Phosphorus (P)-Total Dissolved	0.0038	0.0034
Sulfate (SO4)	499	496
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.32	4.52
Total Metals (Water)		
Aluminum (Al)-Total	0.371	0.36
Antimony (Sb)-Total	0.00242	0.00242
Arsenic (As)-Total	0.00342	0.00345
Barium (Ba)-Total	0.0828	0.0812
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.181	0.171
Cadmium (Cd)-Total	<0.0000500	<0.0000400
Calcium (Ca)-Total	108	106
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00024	0.00024
Copper (Cu)-Total	0.00494	0.00514
Iron (Fe)-Total	0.18	0.184
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0146	0.0141
Magnesium (Mg)-Total	9.47	9.47
Manganese (Mn)-Total	0.0158	0.0162

Results Summary VA23B9675

Client Sample ID	GW11-2b	GW11-Bb
Date Sampled	21-Aug-23	21-Aug-23
Time Sampled	13:33	13:33
ALS Sample ID	VA23B9675-003	VA23B9675-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	553	551
Conductivity	316	317
Hardness (as CaCO3), Dissolved	230	228
pH	7.81	7.77
Anions and Nutrients (Water)		
Ammonia, Total (as N)	1.03	1.05
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.274	0.251
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	1.5	1.55
Phosphorus (P)-Total	0.621	0.61
Phosphorus (P)-Total Dissolved	0.638	0.626
Sulfate (SO4)	<0.30	<0.30
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.38	4.43
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00751	0.00759
Barium (Ba)-Dissolved	0.0652	0.067
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.047	0.046
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	61.7	61.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	2.72	2.73
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	18.4	18.3
Manganese (Mn)-Dissolved	1.14	1.12
Molybdenum (Mo)-Dissolved	0.00157	0.00155
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.35	1.33
Selenium (Se)-Dissolved	0.000089	0.00008
Silicon (Si)-Dissolved	11	11.2

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.237	0.235
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	18.8	18.8
Selenium (Se)-Total	0.0285	0.0288
Silicon (Si)-Total	6.64	6.6
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	119	118
Strontium (Sr)-Total	1.49	1.51
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.0181	0.0187
Uranium (U)-Total	0.000631	0.00062
Vanadium (V)-Total	0.00408	0.00408
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0383	0.0357
Antimony (Sb)-Dissolved	0.0025	0.0023
Arsenic (As)-Dissolved	0.00327	0.00342
Barium (Ba)-Dissolved	0.081	0.0744
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.175	0.18
Cadmium (Cd)-Dissolved	<0.0000500	<0.0000550
Calcium (Ca)-Dissolved	114	120
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00163	0.00169
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0143	0.0137
Magnesium (Mg)-Dissolved	9.15	9.28
Manganese (Mn)-Dissolved	0.0103	0.0106
Molybdenum (Mo)-Dissolved	0.218	0.225
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	18.1	19
Selenium (Se)-Dissolved	0.0287	0.0301
Silicon (Si)-Dissolved	5.74	5.67
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	125	124
Strontium (Sr)-Dissolved	1.49	1.45
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000626	0.000622
Vanadium (V)-Dissolved	0.0032	0.00336
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	22.1	21.9
Strontium (Sr)-Dissolved	0.516	0.524
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	0.00011
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000028	0.000029
Vanadium (V)-Dissolved	0.00067	0.00071
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B9673

Client Sample ID	E10	EJ
Date Sampled	21-Aug-23	21-Aug-23
Time Sampled	13:37	13:37
ALS Sample ID	VA23B9673-003	VA23B9673-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2100	2110
Conductivity	132	133
Hardness (as CaCO3), Dissolved	1230	1360
Hardness (as CaCO3), From total Ca/M	1220	1340
pH	2000	2060
Total Dissolved Solids	<1.1	<1.1
Total Suspended Solids	0.55	0.51
Turbidity	7.89	7.89
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	0.584	0.618
Nitrate (as N)	1.17	1.16
Nitrate and Nitrite (as N)	1.17	1.16
Nitrite (as N)	<0.0200	<0.0200
Total Nitrogen	1.36	1.38
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0028	0.0026
Phosphorus (P)-Total Dissolved	0.0037	<0.0020
Sulfate (SO4)	1200	1200
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.02	1.9
Total Metals (Water)		
Aluminum (Al)-Total	0.0153	<0.0150
Antimony (Sb)-Total	0.00086	0.00081
Arsenic (As)-Total	0.00064	0.00067
Barium (Ba)-Total	0.0282	0.0302
Beryllium (Be)-Total	<0.000500	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.159	0.182
Cadmium (Cd)-Total	0.000756	0.000845
Calcium (Ca)-Total	403	446
Chromium (Cr)-Total	<0.00250	<0.00050
Cobalt (Co)-Total	0.00059	0.00062
Copper (Cu)-Total	0.0123	0.0135
Iron (Fe)-Total	<0.150	<0.050
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.0139	0.0146
Magnesium (Mg)-Total	52.4	55.2
Manganese (Mn)-Total	0.175	0.183

Results Summary VA23B9677

Client Sample ID	E19	ES
Date Sampled	22-Aug-23	22-Aug-23
Time Sampled	11:25	11:25
ALS Sample ID	VA23B9677-002	VA23B9677-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1720	1730
Conductivity	99.1	99.5
Hardness (as CaCO3), Dissolved	944	944
Hardness (as CaCO3), From total Ca/M	938	936
pH	1440	1580
Total Dissolved Solids	1.9	1.4
Total Suspended Solids	0.63	0.78
Turbidity	8.07	8.08
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.028	0.0275
Chloride (Cl)	7.62	7.63
Fluoride (F)	0.548	0.554
Nitrate (as N)	3.89	3.91
Nitrate and Nitrite (as N)	3.91	3.93
Nitrite (as N)	0.0236	0.0232
Total Nitrogen	4.21	4.19
Orthophosphate-Dissolved (as P)	<0.200	<0.0010
Phosphorus (P)-Total	0.0068	0.0067
Phosphorus (P)-Total Dissolved	0.0039	0.0039
Sulfate (SO4)	891	894
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.75	2.59
Total Metals (Water)		
Aluminum (Al)-Total	0.0473	0.0474
Antimony (Sb)-Total	0.0008	0.00081
Arsenic (As)-Total	0.00114	0.0011
Barium (Ba)-Total	0.0417	0.0425
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.176	0.176
Cadmium (Cd)-Total	<0.000135	<0.000145
Calcium (Ca)-Total	306	305
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00020	<0.00020
Copper (Cu)-Total	0.00607	0.006
Iron (Fe)-Total	0.049	0.045
Lead (Pb)-Total	<0.000100	<0.000100
Lithium (Li)-Total	0.0112	0.0112
Magnesium (Mg)-Total	42.3	42.4
Manganese (Mn)-Total	0.0842	0.0834

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.141	0.148
Nickel (Ni)-Total	<0.00250	<0.00250
Potassium (K)-Total	2.57	2.71
Selenium (Se)-Total	0.0235	0.0236
Silicon (Si)-Total	6.11	6.43
Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	30.7	33.1
Strontium (Sr)-Total	13.8	13.9
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0500	<0.0100
Uranium (U)-Total	0.00631	0.00668
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.0864	0.0963

Molybdenum (Mo)-Total	0.184	0.182
Nickel (Ni)-Total	<0.00100	<0.00100
Potassium (K)-Total	4.9	4.87
Selenium (Se)-Total	0.0355	0.0351
Silicon (Si)-Total	6.95	7.06
Silver (Ag)-Total	<0.000020	<0.000020
Sodium (Na)-Total	44.6	44.6
Strontium (Sr)-Total	7.83	7.75
Thallium (Tl)-Total	<0.000020	<0.000020
Tin (Sn)-Total	<0.00020	<0.00020
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00417	0.00426
Vanadium (V)-Total	0.00127	0.00119
Zinc (Zn)-Total	0.0086	0.0085

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0301	0.0074
Antimony (Sb)-Dissolved	0.00079	0.00086
Arsenic (As)-Dissolved	0.00054	0.0006
Barium (Ba)-Dissolved	0.029	0.0311
Beryllium (Be)-Dissolved	<0.000500	<0.000100
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.158	0.166
Cadmium (Cd)-Dissolved	<0.000760	0.000837
Calcium (Ca)-Dissolved	404	453
Chromium (Cr)-Dissolved	<0.00250	<0.00050
Cobalt (Co)-Dissolved	<0.00050	0.0005
Copper (Cu)-Dissolved	0.0106	0.0114
Iron (Fe)-Dissolved	<0.050	<0.050
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.0138	0.0139
Magnesium (Mg)-Dissolved	53.4	54.4
Manganese (Mn)-Dissolved	0.159	0.169
Molybdenum (Mo)-Dissolved	0.142	0.152
Nickel (Ni)-Dissolved	<0.00250	<0.00250
Potassium (K)-Dissolved	2.65	2.68
Selenium (Se)-Dissolved	0.0229	0.0246
Silicon (Si)-Dissolved	5.93	5.78
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	30.9	31.4
Strontium (Sr)-Dissolved	14	14.3
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0500	<0.0100
Uranium (U)-Dissolved	0.00638	0.00664
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.0878	0.0878
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.006	0.0061
Antimony (Sb)-Dissolved	0.00086	0.00082
Arsenic (As)-Dissolved	0.00101	0.00103
Barium (Ba)-Dissolved	0.0413	0.042
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100
Boron (B)-Dissolved	0.152	0.15
Cadmium (Cd)-Dissolved	<0.000120	<0.000130
Calcium (Ca)-Dissolved	311	310
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00020
Copper (Cu)-Dissolved	0.0052	0.00523
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000100	<0.000100
Lithium (Li)-Dissolved	0.0105	0.0104
Magnesium (Mg)-Dissolved	40.6	41.4
Manganese (Mn)-Dissolved	0.0807	0.0808
Molybdenum (Mo)-Dissolved	0.188	0.185
Nickel (Ni)-Dissolved	<0.00100	<0.00100
Potassium (K)-Dissolved	4.83	4.84
Selenium (Se)-Dissolved	0.0372	0.0355
Silicon (Si)-Dissolved	6.33	6.28
Silver (Ag)-Dissolved	<0.000020	<0.000020
Sodium (Na)-Dissolved	44.2	44.4
Strontium (Sr)-Dissolved	7.88	7.71
Thallium (Tl)-Dissolved	<0.000020	<0.000020
Tin (Sn)-Dissolved	<0.00020	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00417	0.00423
Vanadium (V)-Dissolved	<0.00100	<0.00100
Zinc (Zn)-Dissolved	0.0075	0.0075
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23B9946

Client Sample ID	P2-B	PB-B
Date Sampled	24-Aug-23	24-Aug-23
Time Sampled	10:53	10:53
ALS Sample ID	VA23B9946-008	VA23B9946-009
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	259	259
Conductivity	96.2	95.6
Hardness (as CaCO3), Dissolved	110	108
Hardness (as CaCO3), From total Ca/Mg	111	113
pH	178	167
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.99	1.09
Turbidity	8.13	8.11
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0067	0.0062
Chloride (Cl)	0.84	0.84
Fluoride (F)	0.07	0.07
Nitrate (as N)	0.0674	0.0623
Nitrate and Nitrite (as N)	0.0674	0.0623
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.283	0.28
Orthophosphate-Dissolved (as P)	0.0186	0.0187
Phosphorus (P)-Total	0.0292	0.0302
Phosphorus (P)-Total Dissolved	0.0245	0.0239
Sulfate (SO4)	34.7	34.5
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.81	5.81
Total Metals (Water)		
Aluminum (Al)-Total	0.0346	0.0322
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00057	0.00061
Barium (Ba)-Total	0.0101	0.0104
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.021	0.021
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	36.1	36.5
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00419	0.00423
Iron (Fe)-Total	0.033	0.03
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.09	5.36
Manganese (Mn)-Total	0.0372	0.0388

Results Summary VA23B9946

Client Sample ID	E24	EX
Date Sampled	31-Aug-23	31-Aug-23
Time Sampled	11:26	11:26
ALS Sample ID	VA23C0595-003	VA23C0595-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1500	1500
Conductivity	69	69.6
Hardness (as CaCO3), Dissolved	810	831
Hardness (as CaCO3), From total Ca/Mg	849	858
pH	1230	1280
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.13	0.14
Turbidity	7.91	7.91
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	2.73	2.75
Fluoride (F)	0.34	0.347
Nitrate (as N)	0.836	0.847
Nitrate and Nitrite (as N)	0.836	0.847
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	0.898	0.909
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0034	0.0036
Phosphorus (P)-Total Dissolved	0.0048	0.003
Sulfate (SO4)	759	772
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.65	3.5
Total Metals (Water)		
Aluminum (Al)-Total	0.0111	0.0107
Antimony (Sb)-Total	0.0003	0.00028
Arsenic (As)-Total	0.00016	0.00016
Barium (Ba)-Total	0.0322	0.0315
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.06	0.063
Cadmium (Cd)-Total	<0.000175	0.000174
Calcium (Ca)-Total	257	261
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00032	0.00032
Copper (Cu)-Total	0.0922	0.0916
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.003	0.0032
Magnesium (Mg)-Total	50.4	50.2
Manganese (Mn)-Total	0.0748	0.0734

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00647	0.00651
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.06	1.1
Selenium (Se)-Total	0.000511	0.00047
Silicon (Si)-Total	3.81	3.86
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.33	7.8
Strontium (Sr)-Total	0.252	0.253
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000193	0.000197
Vanadium (V)-Total	0.00141	0.00144
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.178	0.174
Nickel (Ni)-Total	0.00152	0.00156
Potassium (K)-Total	1.97	1.94
Selenium (Se)-Total	0.0948	0.0974
Silicon (Si)-Total	4.17	4.28
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	17.7	18.6
Strontium (Sr)-Total	3.5	3.34
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00102	0.00106
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	0.0081	0.0081

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00059	0.00054
Barium (Ba)-Dissolved	0.00957	0.00947
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.02	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	35.6	34.4
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.0035	0.00346
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.22	5.29
Manganese (Mn)-Dissolved	0.00466	0.00468
Molybdenum (Mo)-Dissolved	0.006	0.00601
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.05	1.03
Selenium (Se)-Dissolved	0.000506	0.000502
Silicon (Si)-Dissolved	3.82	3.8
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.12	7.15
Strontium (Sr)-Dissolved	0.234	0.239
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000203	0.000198
Vanadium (V)-Dissolved	0.00121	0.00121
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0077	0.0318
Antimony (Sb)-Dissolved	0.00026	0.00028
Arsenic (As)-Dissolved	0.00013	0.00016
Barium (Ba)-Dissolved	0.0318	0.031
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.058	0.063
Cadmium (Cd)-Dissolved	<0.000160	0.000163
Calcium (Ca)-Dissolved	244	253
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.0003	0.00035
Copper (Cu)-Dissolved	0.0861	0.087
Iron (Fe)-Dissolved	<0.030	0.041
Lead (Pb)-Dissolved	<0.000050	0.000055
Lithium (Li)-Dissolved	0.0028	0.0032
Magnesium (Mg)-Dissolved	48.8	48.3
Manganese (Mn)-Dissolved	0.0712	0.0738
Molybdenum (Mo)-Dissolved	0.172	0.164
Nickel (Ni)-Dissolved	0.00146	0.00155
Potassium (K)-Dissolved	1.94	1.97
Selenium (Se)-Dissolved	0.0881	0.0893
Silicon (Si)-Dissolved	4.1	4.15
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	17.2	18.1
Strontium (Sr)-Dissolved	3.34	3.23
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000994	0.00103
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0078	0.0086
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C0877

Client Sample ID	W5	WE
Date Sampled	05-Sep-23	05-Sep-23
Time Sampled	11:58	11:58
ALS Sample ID	VA23C0877-001	VA23C0877-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	295	328
Conductivity	147	145
Hardness (as CaCO3), Dissolved	136	136
Hardness (as CaCO3), From total Ca/M	136	138
pH	196	204
Total Dissolved Solids	8.5	7.9
Total Suspended Solids	4.7	3.37
Turbidity	8.1	8.08
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	1.23	0.62
Fluoride (F)	0.118	0.112
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.198	0.198
Orthophosphate-Dissolved (as P)	0.0053	0.0052
Phosphorus (P)-Total	0.0228	0.0243
Phosphorus (P)-Total Dissolved	0.0129	0.0126
Sulfate (SO4)	13.6	13.6
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.6	6.56
Total Metals (Water)		
Aluminum (Al)-Total	0.365	0.176
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00052	0.00047
Barium (Ba)-Total	0.0294	0.027
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.066	0.066
Cadmium (Cd)-Total	0.0000191	0.0000103
Calcium (Ca)-Total	39.1	39.6
Chromium (Cr)-Total	0.00055	<0.00050
Cobalt (Co)-Total	0.00026	0.00013
Copper (Cu)-Total	0.00852	0.00628
Iron (Fe)-Total	0.42	0.211
Lead (Pb)-Total	0.000229	0.000078
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	9.38	9.38
Manganese (Mn)-Total	0.116	0.078
Molybdenum (Mo)-Total	0.00353	0.0034

Results Summary VA23C1204

Client Sample ID	HAC-05a	HAC-Ea
Date Sampled	06-Sep-23	06-Sep-23
Time Sampled	9:44	9:44
ALS Sample ID	VA23C1204-003	VA23C1204-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	276	277
Conductivity	98.9	97.2
Hardness (as CaCO3), Dissolved	122	122
Hardness (as CaCO3), From total Ca/M	123	122
pH	192	188
Total Dissolved Solids	<1.0	1.5
Total Suspended Solids	0.52	0.47
Turbidity	8.2	8.21
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0062	0.0071
Chloride (Cl)	0.98	0.98
Fluoride (F)	0.075	0.072
Nitrate (as N)	0.0128	0.0172
Nitrate and Nitrite (as N)	0.0128	0.0172
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.241	0.238
Orthophosphate-Dissolved (as P)	<0.0010	0.0012
Phosphorus (P)-Total	0.011	0.0109
Phosphorus (P)-Total Dissolved	0.0073	0.0075
Sulfate (SO4)	42.2	41.9
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.1	6.29
Total Metals (Water)		
Aluminum (Al)-Total	0.0165	0.0154
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00058	0.00056
Barium (Ba)-Total	0.0114	0.0112
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.021	0.021
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	39.1	38.6
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00446	0.00436
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	6.22	6.23
Manganese (Mn)-Total	0.0269	0.0256
Molybdenum (Mo)-Total	0.00629	0.00627

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Nickel (Ni)-Total	0.00096	0.00057	Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.26	1.26	Potassium (K)-Total	0.961	0.938
Selenium (Se)-Total	0.000148	0.000118	Selenium (Se)-Total	0.00108	0.00105
Silicon (Si)-Total	7.38	7.14	Silicon (Si)-Total	3.33	3.33
Silver (Ag)-Total	<0.000010	<0.000010	Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	10.1	10.3	Sodium (Na)-Total	7.33	7.15
Strontium (Sr)-Total	0.38	0.373	Strontium (Sr)-Total	0.255	0.248
Thallium (Tl)-Total	<0.000010	<0.000010	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.0119	<0.0100	Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000494	0.000482	Uranium (U)-Total	0.000241	0.00023
Vanadium (V)-Total	0.00147	0.00074	Vanadium (V)-Total	0.00139	0.00136
Zinc (Zn)-Total	0.0098	0.0062	Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0117	0.0116	Aluminum (Al)-Dissolved	0.0035	0.0036
Antimony (Sb)-Dissolved	<0.00010	<0.00010	Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00033	0.00032	Arsenic (As)-Dissolved	0.00052	0.00052
Barium (Ba)-Dissolved	0.0221	0.0221	Barium (Ba)-Dissolved	0.0116	0.0116
Beryllium (Be)-Dissolved	<0.000100	<0.000100	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.06	0.06	Boron (B)-Dissolved	0.019	0.019
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050	Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	39.1	39.5	Calcium (Ca)-Dissolved	37.9	38
Chromium (Cr)-Dissolved	<0.00050	<0.00050	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010	Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00234	0.00233	Copper (Cu)-Dissolved	0.00394	0.00391
Iron (Fe)-Dissolved	<0.030	<0.030	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010	Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	9.3	9.12	Magnesium (Mg)-Dissolved	6.53	6.67
Manganese (Mn)-Dissolved	0.0212	0.021	Manganese (Mn)-Dissolved	0.0178	0.0178
Molybdenum (Mo)-Dissolved	0.00317	0.00328	Molybdenum (Mo)-Dissolved	0.00604	0.00604
Nickel (Ni)-Dissolved	<0.00050	<0.00050	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.25	1.23	Potassium (K)-Dissolved	0.986	0.975
Selenium (Se)-Dissolved	0.000103	0.000103	Selenium (Se)-Dissolved	0.000962	0.000975
Silicon (Si)-Dissolved	6.86	6.71	Silicon (Si)-Dissolved	3.16	3.16
Silver (Ag)-Dissolved	<0.000010	<0.000010	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	10.1	10.1	Sodium (Na)-Dissolved	8.17	8.13
Strontium (Sr)-Dissolved	0.357	0.363	Strontium (Sr)-Dissolved	0.275	0.28
Thallium (Tl)-Dissolved	<0.000010	<0.000010	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000496	0.000479	Uranium (U)-Dissolved	0.000246	0.00025
Vanadium (V)-Dissolved	<0.00050	<0.00050	Vanadium (V)-Dissolved	0.00123	0.00122
Zinc (Zn)-Dissolved	<0.0030	<0.0030	Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C1201

Client Sample ID	B2-AT	BB-AT
Date Sampled	07-Sep-23	07-Sep-23
Time Sampled	11:21	11:21
ALS Sample ID	VA23C1201-006	VA23C1201-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	104	105
Conductivity	44	43.4
Hardness (as CaCO3), Dissolved	45.9	46.8
Hardness (as CaCO3), From total Ca/M	47.7	45.3
pH	75	71
Total Dissolved Solids	<1.1	<1.0
Total Suspended Solids	0.63	0.67
Turbidity	7.74	7.73
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.52	0.52
Fluoride (F)	0.056	0.055
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.265	0.268
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0102	0.0108
Phosphorus (P)-Total Dissolved	0.0051	0.0062
Sulfate (SO4)	7.17	7.1
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	7.2	7.18
Total Metals (Water)		
Aluminum (Al)-Total	0.0077	0.0077
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.0004	0.00038
Barium (Ba)-Total	0.0167	0.0163
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.047	0.046
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	14.7	13.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00198	0.00196
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.67	2.64
Manganese (Mn)-Total	0.0113	0.0114
Molybdenum (Mo)-Total	0.000906	0.000937

Results Summary VA23C1541

Client Sample ID	QUL-2a-0m	QUL-Ba-0m
Date Sampled	11-Sep-23	11-Sep-23
Time Sampled	13:13	13:13
ALS Sample ID	VA23C1541-010	VA23C1541-011
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	109	109
Conductivity	49.9	50
Hardness (as CaCO3), Dissolved	50	50.9
Hardness (as CaCO3), From total Ca/M	53.6	53.1
pH	72	69
Total Dissolved Solids	1.5	1.6
Total Suspended Solids	0.57	0.56
Turbidity	7.98	7.99
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.037	0.036
Nitrate (as N)	0.0072	0.0074
Nitrate and Nitrite (as N)	0.0072	0.0074
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.107	0.108
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0028	0.003
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	6.5	6.52
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.38	2.22
Total Metals (Water)		
Aluminum (Al)-Total	0.0128	0.0145
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00011	0.00012
Barium (Ba)-Total	0.0052	0.00536
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	18	17.7
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00056	0.00072
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.001	<0.0010
Magnesium (Mg)-Total	2.11	2.16
Manganese (Mn)-Total	0.00084	0.00096
Molybdenum (Mo)-Total	0.000354	0.000357

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.46	0.453
Selenium (Se)-Total	0.000208	0.000206
Silicon (Si)-Total	2.1	2.06
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	2.67	2.7
Strontium (Sr)-Total	0.14	0.141
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000044	0.000042
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.496	0.491
Selenium (Se)-Total	0.000121	0.000111
Silicon (Si)-Total	0.8	0.78
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	0.98	0.996
Strontium (Sr)-Total	0.141	0.137
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000168	0.000171
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0039	0.0041
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00036	0.00034
Barium (Ba)-Dissolved	0.0158	0.0154
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.046	0.046
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	14.1	14.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00188	0.00208
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.59	2.58
Manganese (Mn)-Dissolved	0.00167	0.00161
Molybdenum (Mo)-Dissolved	0.000923	0.000904
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.45	0.441
Selenium (Se)-Dissolved	0.000171	0.000183
Silicon (Si)-Dissolved	2.05	2.08
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	2.73	2.7
Strontium (Sr)-Dissolved	0.14	0.141
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000042	0.000042
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0151	0.0094
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00011	0.0001
Barium (Ba)-Dissolved	0.00539	0.00526
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	16.6	16.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00085	0.00065
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.09	2.11
Manganese (Mn)-Dissolved	0.00055	0.00034
Molybdenum (Mo)-Dissolved	0.000343	0.00036
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.483	0.489
Selenium (Se)-Dissolved	0.000093	0.000086
Silicon (Si)-Dissolved	0.758	0.749
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.947	0.942
Strontium (Sr)-Dissolved	0.137	0.137
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000163	0.00016
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C2247

Client Sample ID	W12	WL
Date Sampled	19-Sep-23	19-Sep-23
Time Sampled	12:15	12:15
ALS Sample ID	VA23C2247-004	VA23C2247-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	235	238
Conductivity	131	132
Hardness (as CaCO3), Dissolved	117	113
Hardness (as CaCO3), From total Ca/M	116	114
pH	184	194
Total Dissolved Solids	3.8	1.6
Total Suspended Solids	0.94	0.93
Turbidity	8.33	8.31
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0696	0.062
Chloride (Cl)	0.54	<0.50
Fluoride (F)	0.074	0.075
Nitrate (as N)	0.0475	0.0454
Nitrate and Nitrite (as N)	0.0518	0.0492
Nitrite (as N)	0.0043	0.0038
Total Nitrogen	0.616	0.6
Orthophosphate-Dissolved (as P)	0.0024	0.0025
Phosphorus (P)-Total	0.0241	0.0215
Phosphorus (P)-Total Dissolved	0.0152	0.015
Sulfate (SO4)	0.35	0.32
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	15.4	16
Total Metals (Water)		
Aluminum (Al)-Total	0.0181	0.0193
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00112	0.00112
Barium (Ba)-Total	0.0171	0.0172
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.1	0.095
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	34.9	33.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00024	0.00023
Copper (Cu)-Total	0.00112	0.0011
Iron (Fe)-Total	0.645	0.661
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	7.01	7.12
Manganese (Mn)-Total	1.49	1.5
Molybdenum (Mo)-Total	0.00112	0.0011

Results Summary VA23B2564

Client Sample ID	GW12-2a	GW12-Ba
Date Sampled	20-Sep-23	20-Sep-23
Time Sampled	11:37	11:37
ALS Sample ID	VA23C2564-007	VA23C2564-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	243	243
Conductivity	49.9	48.7
Hardness (as CaCO3), Dissolved	63.9	71
pH	7.94	7.95
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0056	0.008
Chloride (Cl)	1.04	0.96
Fluoride (F)	0.405	0.367
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	<0.030	<0.030
Phosphorus (P)-Total	0.0252	0.0252
Phosphorus (P)-Total Dissolved	0.0244	0.0244
Sulfate (SO4)	65.5	65.1
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.59	0.76
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0056	0.0084
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00258	0.00252
Barium (Ba)-Dissolved	0.00729	0.00765
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.304	0.291
Cadmium (Cd)-Dissolved	<0.0000200	<0.0000200
Calcium (Ca)-Dissolved	21.6	23.3
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0039	0.0038
Magnesium (Mg)-Dissolved	2.42	3.11
Manganese (Mn)-Dissolved	0.306	0.294
Molybdenum (Mo)-Dissolved	0.0422	0.0408
Nickel (Ni)-Dissolved	0.00052	<0.00050
Potassium (K)-Dissolved	0.17	0.192
Selenium (Se)-Dissolved	0.00016	0.000274
Silicon (Si)-Dissolved	8.9	8.95
Silver (Ag)-Dissolved	<0.000010	<0.000010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.17	1.14
Selenium (Se)-Total	0.000094	0.000085
Silicon (Si)-Total	6.49	6.39
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	5.28	5.16
Strontium (Sr)-Total	0.206	0.21
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000027	0.000026
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0084	0.0085
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00094	0.00098
Barium (Ba)-Dissolved	0.0168	0.0163
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.104	0.102
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	35.2	33.6
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.0002	0.00021
Copper (Cu)-Dissolved	0.00075	0.0008
Iron (Fe)-Dissolved	0.35	0.35
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	7.01	7.15
Manganese (Mn)-Dissolved	1.34	1.38
Molybdenum (Mo)-Dissolved	0.00103	0.00101
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.2	1.2
Selenium (Se)-Dissolved	0.000089	0.000083
Silicon (Si)-Dissolved	6.32	6.33
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	5.44	5.52
Strontium (Sr)-Dissolved	0.2	0.196
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000025	0.000023
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Sodium (Na)-Dissolved	28.6	27.6
Strontium (Sr)-Dissolved	0.0743	0.0828
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000143	0.000163
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0036	0.0039
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C2564

Client Sample ID	GW12-1a	GW12-Aa
Date Sampled	20-Sep-23	20-Sep-23
Time Sampled	13:02	13:02
ALS Sample ID	VA23C2564-012	VA23C2564-013
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	521	520
Conductivity	47.3	46.9
Hardness (as CaCO3), Dissolved	109	106
pH	7.85	7.85
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.029	0.0288
Chloride (Cl)	3.07	3.07
Fluoride (F)	1.2	1.2
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.064	0.062
Phosphorus (P)-Total	0.112	0.112
Phosphorus (P)-Total Dissolved	0.095	0.0968
Sulfate (SO4)	196	197
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.45	1.56
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0063	0.0051
Antimony (Sb)-Dissolved	<0.00020	<0.00020
Arsenic (As)-Dissolved	0.0044	0.00438
Barium (Ba)-Dissolved	0.0234	0.0236
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100
Boron (B)-Dissolved	3.25	3.38
Cadmium (Cd)-Dissolved	<0.0000100	<0.0000100
Calcium (Ca)-Dissolved	34.9	34
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00020
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	0.275	0.273
Lead (Pb)-Dissolved	<0.000100	<0.000100
Lithium (Li)-Dissolved	0.0066	0.0065
Magnesium (Mg)-Dissolved	5.3	5.18
Manganese (Mn)-Dissolved	0.279	0.274
Molybdenum (Mo)-Dissolved	0.0287	0.0281
Nickel (Ni)-Dissolved	<0.00100	<0.00100
Potassium (K)-Dissolved	0.374	0.368
Selenium (Se)-Dissolved	<0.000100	<0.000100
Silicon (Si)-Dissolved	6.18	6
Silver (Ag)-Dissolved	<0.000020	<0.000020

Results Summary VA23C3220

Client Sample ID	WIP-10m	23916-10m
Date Sampled	27-Sep-23	27-Sep-23
Time Sampled	9:51	9:51
ALS Sample ID	VA23C3220-002	VA23C3220-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2300	2300
Conductivity	162	159
Hardness (as CaCO3), Dissolved	1410	1440
Hardness (as CaCO3), From total Ca/M	1500	1510
pH	2290	2210
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.59	0.63
Turbidity	8.27	8.27
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	0.559	0.633
Nitrate (as N)	0.216	0.232
Nitrate and Nitrite (as N)	0.216	0.232
Nitrite (as N)	<0.0200	<0.0200
Total Nitrogen	0.274	0.271
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	0.0033
Phosphorus (P)-Total Dissolved	0.0046	0.0027
Sulfate (SO4)	1350	1320
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.78	1.42
Total Metals (Water)		
Aluminum (Al)-Total	<0.0150	<0.0150
Antimony (Sb)-Total	0.00075	0.00077
Arsenic (As)-Total	<0.00050	<0.00050
Barium (Ba)-Total	0.022	0.0227
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.179	0.181
Cadmium (Cd)-Total	0.00112	0.00118
Calcium (Ca)-Total	501	498
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00191	0.002
Copper (Cu)-Total	0.0136	0.0135
Iron (Fe)-Total	<0.050	<0.050
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.016	0.0158
Magnesium (Mg)-Total	60.8	64
Manganese (Mn)-Total	0.64	0.646
Molybdenum (Mo)-Total	0.119	0.118

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Sodium (Na)-Dissolved	67.3	66.2
Strontium (Sr)-Dissolved	1.12	1.1
Thallium (Tl)-Dissolved	<0.000020	<0.000020
Tin (Sn)-Dissolved	<0.00020	<0.00020
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000116	0.000118
Vanadium (V)-Dissolved	<0.00100	<0.00100
Zinc (Zn)-Dissolved	0.0035	0.004
Dissolved Metals Filtration Location	Field	Field

Nickel (Ni)-Total	0.00298	0.00301
Potassium (K)-Total	2.83	2.9
Selenium (Se)-Total	0.00469	0.005
Silicon (Si)-Total	6.76	6.89
Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	33	34.1
Strontium (Sr)-Total	14	13.8
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00786	0.00786
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.167	0.167

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0050	<0.0050
Antimony (Sb)-Dissolved	0.00068	0.00069
Arsenic (As)-Dissolved	<0.00050	<0.00050
Barium (Ba)-Dissolved	0.0225	0.023
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.152	0.155
Cadmium (Cd)-Dissolved	0.00117	0.00122
Calcium (Ca)-Dissolved	464	469
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.0008	0.00087
Copper (Cu)-Dissolved	0.011	0.0114
Iron (Fe)-Dissolved	<0.050	<0.050
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.014	0.0143
Magnesium (Mg)-Dissolved	61.4	65.6
Manganese (Mn)-Dissolved	0.601	0.64
Molybdenum (Mo)-Dissolved	0.108	0.11
Nickel (Ni)-Dissolved	0.00298	0.00312
Potassium (K)-Dissolved	2.77	3.02
Selenium (Se)-Dissolved	0.0049	0.005
Silicon (Si)-Dissolved	6.38	6.67
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	33.4	34.8
Strontium (Sr)-Dissolved	13.1	13
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00746	0.00749
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.172	0.183
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C3224

Client Sample ID	P2-BT	PB-BT
Date Sampled	28-Sep-23	28-Sep-23
Time Sampled	10:32	10:32
ALS Sample ID	VA23C3224-007	VA23C3224-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	253	252
Conductivity	94.8	95.7
Hardness (as CaCO3), Dissolved	106	107
Hardness (as CaCO3), From total Ca/M	108	109
pH	153	167
Total Dissolved Solids	1	<1.0
Total Suspended Solids	0.44	0.42
Turbidity	8.25	8.25
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.82	0.82
Fluoride (F)	0.076	0.076
Nitrate (as N)	0.0233	0.0213
Nitrate and Nitrite (as N)	0.0233	0.0213
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.231	0.234
Orthophosphate-Dissolved (as P)	0.0016	0.0015
Phosphorus (P)-Total	0.0092	0.0096
Phosphorus (P)-Total Dissolved	0.0066	0.0076
Sulfate (SO4)	35.3	35.3
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.07	6.04
Total Metals (Water)		
Aluminum (Al)-Total	0.0159	0.0128
Antimony (Sb)-Total	0.0001	<0.00010
Arsenic (As)-Total	0.00056	0.00054
Barium (Ba)-Total	0.0101	0.0104
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.02	0.02
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	34.5	35.2
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00372	0.00361
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.19	5.07
Manganese (Mn)-Total	0.0105	0.0103
Molybdenum (Mo)-Total	0.00656	0.00659

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1	1.01
Selenium (Se)-Total	0.000482	0.00057
Silicon (Si)-Total	3.54	3.59
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.17	7.27
Strontium (Sr)-Total	0.254	0.252
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000203	0.000205
Vanadium (V)-Total	0.00138	0.00138
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0049	0.003
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00049	0.00049
Barium (Ba)-Dissolved	0.0101	0.00986
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.019	0.019
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	34.2	34.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00352	0.00332
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5	5.31
Manganese (Mn)-Dissolved	0.00231	0.00199
Molybdenum (Mo)-Dissolved	0.00621	0.00573
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.01	0.981
Selenium (Se)-Dissolved	0.000516	0.00047
Silicon (Si)-Dissolved	3.43	3.52
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	6.9	6.71
Strontium (Sr)-Dissolved	0.247	0.226
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000194	0.000183
Vanadium (V)-Dissolved	0.0012	0.00118
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C3731

Client Sample ID	HAC-08	HAC-H
Date Sampled	03-Oct-23	03-Oct-23
Time Sampled	12:05	12:05
ALS Sample ID	VA23C3731-005	VA23C3731-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	312	319
Conductivity	115	114
Hardness (as CaCO3), Dissolved	138	143
Hardness (as CaCO3), From total Ca/M	142	145
pH	204	209
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.17	0.2
Turbidity	8.3	8.3
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0054	<0.0050
Chloride (Cl)	0.98	1
Fluoride (F)	0.067	0.077
Nitrate (as N)	0.0051	<0.0050
Nitrate and Nitrite (as N)	0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.191	0.193
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0052	0.0056
Phosphorus (P)-Total Dissolved	0.005	0.0043
Sulfate (SO4)	45.2	45.3
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.74	4.74
Total Metals (Water)		
Aluminum (Al)-Total	0.0144	0.0187
Antimony (Sb)-Total	0.00014	0.0001
Arsenic (As)-Total	0.00072	0.00075
Barium (Ba)-Total	0.0161	0.0162
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.021	0.022
Cadmium (Cd)-Total	<0.0000050	<0.0000100
Calcium (Ca)-Total	43	44.6
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00624	0.00655
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	8.52	8.28
Manganese (Mn)-Total	0.00593	0.0062

Results Summary VA23C3981

Client Sample ID	E4	ED
Date Sampled	04-Oct-23	04-Oct-23
Time Sampled	10:50	10:50
ALS Sample ID	VA23C3981-004	VA23C3981-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1300	1300
Conductivity	131	132
Hardness (as CaCO3), Dissolved	529	524
Hardness (as CaCO3), From total Ca/M	547	546
pH	939	996
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.38	0.42
Turbidity	8.11	8.11
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0107	0.01
Chloride (Cl)	15.3	15.3
Fluoride (F)	0.664	0.661
Nitrate (as N)	0.256	0.254
Nitrate and Nitrite (as N)	0.256	0.254
Nitrite (as N)	<0.0050	<0.0050
Total Nitrogen	0.339	0.346
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0077	0.0081
Phosphorus (P)-Total Dissolved	0.0061	0.0061
Sulfate (SO4)	590	587
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.37	2.49
Total Metals (Water)		
Aluminum (Al)-Total	0.0338	0.0094
Antimony (Sb)-Total	0.00018	0.00017
Arsenic (As)-Total	0.00143	0.00147
Barium (Ba)-Total	0.0269	0.0273
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.149	0.15
Cadmium (Cd)-Total	<0.0000900	<0.000970
Calcium (Ca)-Total	177	177
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00665	0.00611
Iron (Fe)-Total	0.041	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0114	0.0114
Magnesium (Mg)-Total	25.6	25.3
Manganese (Mn)-Total	0.0463	0.0436

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00641	0.00637
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.07	1.06
Selenium (Se)-Total	0.00125	0.0012
Silicon (Si)-Total	3.71	3.75
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	8.5	8.58
Strontium (Sr)-Total	0.328	0.324
Thallium (Tl)-Total	0.000016	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000334	0.000334
Vanadium (V)-Total	0.00115	0.00118
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.325	0.331
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	13.4	13.5
Selenium (Se)-Total	0.01	0.01
Silicon (Si)-Total	6.92	6.93
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	83.8	84.1
Strontium (Sr)-Total	2.78	2.85
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00218	0.00216
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0043	0.0037
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00064	0.00064
Barium (Ba)-Dissolved	0.0153	0.0158
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.02	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	42.4	44
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00555	0.00579
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	7.78	8.1
Manganese (Mn)-Dissolved	0.00233	0.00245
Molybdenum (Mo)-Dissolved	0.0062	0.00617
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.04	1.08
Selenium (Se)-Dissolved	0.00126	0.00117
Silicon (Si)-Dissolved	3.54	3.6
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	8.22	8.52
Strontium (Sr)-Dissolved	0.299	0.306
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000319	0.000326
Vanadium (V)-Dissolved	0.00097	0.00098
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0075	0.0049
Antimony (Sb)-Dissolved	0.00015	0.00015
Arsenic (As)-Dissolved	0.0014	0.0014
Barium (Ba)-Dissolved	0.0265	0.0274
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.14	0.136
Cadmium (Cd)-Dissolved	<0.0000850	<0.0000800
Calcium (Ca)-Dissolved	169	168
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00534	0.00526
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0098	0.0097
Magnesium (Mg)-Dissolved	25.9	25.4
Manganese (Mn)-Dissolved	0.0404	0.0403
Molybdenum (Mo)-Dissolved	0.311	0.321
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	13.7	13.5
Selenium (Se)-Dissolved	0.0101	0.0102
Silicon (Si)-Dissolved	7.25	7.25
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	88.5	88.5
Strontium (Sr)-Dissolved	2.71	2.79
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00208	0.00209
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C3979

Client Sample ID	Pag Seep 15	Pag Seep O
Date Sampled	05-Oct-23	05-Oct-23
Time Sampled	12:04	12:04
ALS Sample ID	VA23C3979-006	VA23C3979-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1840	1820
Conductivity	131	129
Hardness (as CaCO3), Dissolved	1070	1070
Hardness (as CaCO3), From total Ca/Mg	1160	1140
pH	1620	1640
Total Dissolved Solids	5.5	5.2
Total Suspended Solids	1.25	1.04
Turbidity	8.14	8.14
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0051	0.0094
Chloride (Cl)	<5.00	<5.00
Fluoride (F)	0.251	0.25
Nitrate (as N)	10.4	10.5
Nitrate and Nitrite (as N)	10.4	10.5
Nitrite (as N)	<0.0100	<0.0100
Total Nitrogen	10.4	10
Orthophosphate-Dissolved (as P)	0.0037	0.0032
Phosphorus (P)-Total	0.022	0.0156
Phosphorus (P)-Total Dissolved	0.015	0.0259
Sulfate (SO4)	1020	1020
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.12	5.05
Total Metals (Water)		
Aluminum (Al)-Total	0.0228	0.0396
Antimony (Sb)-Total	0.00043	0.00044
Arsenic (As)-Total	0.00053	0.0005
Barium (Ba)-Total	0.0329	0.0334
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.139	0.137
Cadmium (Cd)-Total	<0.0000550	<0.0000550
Calcium (Ca)-Total	358	354
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	0.00012
Copper (Cu)-Total	0.00778	0.00824
Iron (Fe)-Total	0.032	0.054
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0048	0.0048
Magnesium (Mg)-Total	63.4	63.1
Manganese (Mn)-Total	0.0478	0.0504

Results Summary VA23C4168

Client Sample ID	B1-B	BA-B
Date Sampled	10-Oct-23	10-Oct-23
Time Sampled	10:48	10:48
ALS Sample ID	VA23C4168-003	VA23C4168-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	104	104
Conductivity	44.2	43.7
Hardness (as CaCO3), Dissolved	49	51.7
Hardness (as CaCO3), From total Ca/M	48.2	45.7
pH	75	81
Total Dissolved Solids	2	2
Total Suspended Solids	1.21	1.6
Turbidity	7.81	7.81
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0066	0.0065
Chloride (Cl)	0.55	0.55
Fluoride (F)	0.059	0.059
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.322	0.317
Orthophosphate-Dissolved (as P)	0.0015	0.0014
Phosphorus (P)-Total	0.0201	0.0214
Phosphorus (P)-Total Dissolved	0.0088	0.007
Sulfate (SO4)	7.77	7.84
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	7.36	7.34
Total Metals (Water)		
Aluminum (Al)-Total	0.0167	0.0168
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00044	0.00048
Barium (Ba)-Total	0.0172	0.0172
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.046	0.045
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	14.9	13.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.002	0.00198
Iron (Fe)-Total	0.092	0.09
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.66	2.66
Manganese (Mn)-Total	0.0519	0.0512

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.282	0.295
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	2.47	2.51
Selenium (Se)-Total	0.0805	0.0799
Silicon (Si)-Total	7.43	7.49
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	33.5	32
Strontium (Sr)-Total	1.37	1.42
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00185	0.00183
Vanadium (V)-Total	0.00061	0.00064
Zinc (Zn)-Total	<0.0030	<0.0030

Molybdenum (Mo)-Total	0.000992	0.00103
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.458	0.454
Selenium (Se)-Total	0.000178	0.000229
Silicon (Si)-Total	2	1.98
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	2.62	2.5
Strontium (Sr)-Total	0.139	0.139
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000038	0.000053
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0053	0.0483
Antimony (Sb)-Dissolved	0.00042	0.00046
Arsenic (As)-Dissolved	0.00042	0.0004
Barium (Ba)-Dissolved	0.0307	0.0306
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.121	0.118
Cadmium (Cd)-Dissolved	<0.0000700	<0.0000750
Calcium (Ca)-Dissolved	334	337
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00014	0.00014
Copper (Cu)-Dissolved	0.00681	0.0068
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0049	0.0049
Magnesium (Mg)-Dissolved	56.6	56.4
Manganese (Mn)-Dissolved	0.182	0.179
Molybdenum (Mo)-Dissolved	0.272	0.267
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	2.33	2.33
Selenium (Se)-Dissolved	0.0659	0.066
Silicon (Si)-Dissolved	6.49	6.41
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	30.3	30.5
Strontium (Sr)-Dissolved	1.31	1.28
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00184	0.00187
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0030	0.0052
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00042	0.00043
Barium (Ba)-Dissolved	0.017	0.0177
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.054	0.055
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	14.9	16
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00185	0.00194
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.87	2.86
Manganese (Mn)-Dissolved	0.0148	0.015
Molybdenum (Mo)-Dissolved	0.00099	0.000995
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.496	0.487
Selenium (Se)-Dissolved	0.000175	0.000181
Silicon (Si)-Dissolved	1.96	2.02
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	2.73	2.72
Strontium (Sr)-Dissolved	0.138	0.138
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00004	0.000042
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C4773

Client Sample ID	E24	EX
Date Sampled	16-Oct-23	16-Oct-23
Time Sampled	12:30	12:30
ALS Sample ID	VA23C4773-003	VA23C4773-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1500	1500
Conductivity	70.8	70.7
Hardness (as CaCO3), Dissolved	937	924
Hardness (as CaCO3), From total Ca/M	877	871
pH	1300	1320
Total Dissolved Solids	1	<1.0
Total Suspended Solids	0.12	0.16
Turbidity	7.93	7.93
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<5.00	2.98
Fluoride (F)	0.37	0.346
Nitrate (as N)	0.811	0.81
Nitrate and Nitrite (as N)	0.811	0.81
Nitrite (as N)	<0.0100	<0.0050
Total Nitrogen	0.885	0.894
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0044	0.0049
Phosphorus (P)-Total Dissolved	0.0038	0.0039
Sulfate (SO4)	814	813
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.51	3.38
Total Metals (Water)		
Aluminum (Al)-Total	0.0273	0.0279
Antimony (Sb)-Total	0.00028	0.00028
Arsenic (As)-Total	0.00021	0.00021
Barium (Ba)-Total	0.034	0.0339
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.067	0.064
Cadmium (Cd)-Total	<0.000185	<0.000175
Calcium (Ca)-Total	263	261
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00025	0.00025
Copper (Cu)-Total	0.0919	0.0916
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0028	0.0027
Magnesium (Mg)-Total	53.5	53.2
Manganese (Mn)-Total	0.0687	0.0679

Results Summary VA23C4915

Client Sample ID	GW16-6a	GW16-Fa
Date Sampled	17-Oct-23	17-Oct-23
Time Sampled	12:19	12:19
ALS Sample ID	VA23C4915-002	VA23C4915-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	420	420
Conductivity	38.8	38.5
Hardness (as CaCO3), Dissolved	134	132
pH	7.87	7.87
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.97	0.99
Fluoride (F)	0.72	0.729
Nitrate (as N)	0.0585	0.0582
Nitrate and Nitrite (as N)	0.0585	0.0582
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.066	0.067
Phosphorus (P)-Total	0.0026	0.0023
Phosphorus (P)-Total Dissolved	0.0021	0.0026
Sulfate (SO4)	157	156
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	<0.50	<0.50
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	0.0032
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00814	0.00806
Barium (Ba)-Dissolved	0.00128	0.00129
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.7	0.651
Cadmium (Cd)-Dissolved	<0.0000250	<0.0000200
Calcium (Ca)-Dissolved	44.2	43.6
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0015	0.0015
Magnesium (Mg)-Dissolved	5.76	5.52
Manganese (Mn)-Dissolved	<0.00010	<0.00010
Molybdenum (Mo)-Dissolved	0.0599	0.0576
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.512	0.514
Selenium (Se)-Dissolved	0.00177	0.00176
Silicon (Si)-Dissolved	8.15	7.96

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.154	0.154
Nickel (Ni)-Total	0.00141	0.00148
Potassium (K)-Total	2.05	2.04
Selenium (Se)-Total	0.0826	0.0822
Silicon (Si)-Total	4.14	4.14
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	18.7	18.6
Strontium (Sr)-Total	3.51	3.49
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00113	0.00114
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	0.0079	0.0077

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0086	0.008
Antimony (Sb)-Dissolved	0.00024	0.00024
Arsenic (As)-Dissolved	0.00014	0.00014
Barium (Ba)-Dissolved	0.0362	0.0342
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.065	0.059
Cadmium (Cd)-Dissolved	<0.000210	<0.000210
Calcium (Ca)-Dissolved	286	283
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00023	0.00022
Copper (Cu)-Dissolved	0.089	0.0871
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0022	0.0023
Magnesium (Mg)-Dissolved	54.1	52.9
Manganese (Mn)-Dissolved	0.0687	0.0662
Molybdenum (Mo)-Dissolved	0.154	0.149
Nickel (Ni)-Dissolved	0.00155	0.00153
Potassium (K)-Dissolved	2.04	2.01
Selenium (Se)-Dissolved	0.0937	0.0922
Silicon (Si)-Dissolved	3.98	4.02
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	18.4	18.1
Strontium (Sr)-Dissolved	3.39	3.39
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00101	0.001
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0082	0.008
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	31.9	32.8
Strontium (Sr)-Dissolved	0.0707	0.07
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000046	0.000048
Vanadium (V)-Dissolved	0.00156	0.00158
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C5174

Client Sample ID	P1-S	PA-S
Date Sampled	18-Oct-23	18-Oct-23
Time Sampled	11:13	11:13
ALS Sample ID	VA23C5174-001	VA23C5174-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	248	249
Conductivity	95.4	94.6
Hardness (as CaCO3), Dissolved	111	111
Hardness (as CaCO3), From total Ca/Mg	117	115
pH	169	159
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.34	0.42
Turbidity	8.21	8.21
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.8	0.8
Fluoride (F)	0.075	0.076
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.254	0.24
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0068	0.009
Phosphorus (P)-Total Dissolved	0.0043	0.0047
Sulfate (SO4)	34.9	34.7
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.33	5.98
Total Metals (Water)		
Aluminum (Al)-Total	0.0182	0.0169
Antimony (Sb)-Total	0.0001	<0.00010
Arsenic (As)-Total	0.00058	0.00059
Barium (Ba)-Total	0.0105	0.0108
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.02	0.021
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	37.3	36.3
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00377	0.00382
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	5.8	5.86
Manganese (Mn)-Total	0.00402	0.00409

Results Summary VA23C6153

Client Sample ID	GW12-4a	GW12-Da
Date Sampled	19-Oct-23	19-Oct-23
Time Sampled	10:46	10:46
ALS Sample ID	VA23C5163-002	VA23C5163-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	313	312
Conductivity	139	140
Hardness (as CaCO3), Dissolved	134	136
pH	7.97	7.97
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0996	0.102
Chloride (Cl)	1.51	1.51
Fluoride (F)	0.424	0.423
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.172	0.159
Phosphorus (P)-Total	0.205	0.209
Phosphorus (P)-Total Dissolved	0.13	0.129
Sulfate (SO4)	23.7	23.6
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.24	2.2
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.0096	0.0088
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.0027	0.00271
Barium (Ba)-Dissolved	0.0314	0.0308
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.338	0.349
Cadmium (Cd)-Dissolved	<0.0000200	<0.0000200
Calcium (Ca)-Dissolved	32.3	32.1
Chromium (Cr)-Dissolved	0.001	0.00099
Cobalt (Co)-Dissolved	0.00032	0.00032
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	0.331	0.325
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0018	0.0017
Magnesium (Mg)-Dissolved	13	13.5
Manganese (Mn)-Dissolved	0.755	0.753
Molybdenum (Mo)-Dissolved	0.0659	0.0674
Nickel (Ni)-Dissolved	0.00072	0.00074
Potassium (K)-Dissolved	1.56	1.57
Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	14	13.9

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.00646	0.0066
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.972	1.01
Selenium (Se)-Total	0.000507	0.000532
Silicon (Si)-Total	3.12	3.05
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	7.66	7.98
Strontium (Sr)-Total	0.254	0.259
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000194	0.000198
Vanadium (V)-Total	0.00156	0.00157
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0059	0.0047
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00054	0.00053
Barium (Ba)-Dissolved	0.0107	0.0106
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.018	0.02
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	35.3	35.2
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00346	0.00341
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	5.67	5.59
Manganese (Mn)-Dissolved	0.00188	0.0019
Molybdenum (Mo)-Dissolved	0.00631	0.00624
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.03	1.01
Selenium (Se)-Dissolved	0.000504	0.00049
Silicon (Si)-Dissolved	3.21	3.13
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	7.48	7.55
Strontium (Sr)-Dissolved	0.246	0.248
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00021	0.000212
Vanadium (V)-Dissolved	0.00145	0.00144
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	13.8	13.9
Strontium (Sr)-Dissolved	0.337	0.343
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000481	0.000469
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0036	0.0036
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C6272

Client Sample ID	SERDS23	SERDSW
Date Sampled	30-Oct-23	30-Oct-23
Time Sampled	12:20	12:20
ALS Sample ID	VA23C6272-005	VA23C6272-006
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2820	2870
Conductivity	96.9	97.9
Hardness (as CaCO3), Dissolved	1740	1720
Hardness (as CaCO3), From total Ca/Mg	1760	1790
pH	2710	2830
Total Dissolved Solids	33.8	23.4
Total Suspended Solids	1.87	6.48
Turbidity	8	7.97
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0079	0.0073
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	<0.400	<0.400
Nitrate (as N)	61.5	63.8
Nitrate and Nitrite (as N)	61.5	63.8
Nitrite (as N)	<0.0200	<0.0200
Total Nitrogen	66.4	65.6
Orthophosphate-Dissolved (as P)	0.0266	0.0338
Phosphorus (P)-Total	0.176	0.117
Phosphorus (P)-Total Dissolved	0.0476	0.0483
Sulfate (SO4)	1430	1500
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	6.6	7.37
Total Metals (Water)		
Aluminum (Al)-Total	0.471	0.457
Antimony (Sb)-Total	0.00051	0.00051
Arsenic (As)-Total	0.00105	0.00099
Barium (Ba)-Total	0.0548	0.0577
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000100	<0.000100
Boron (B)-Total	0.103	0.104
Cadmium (Cd)-Total	<0.000200	<0.000200
Calcium (Ca)-Total	520	536
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00043	0.00037
Copper (Cu)-Total	0.0209	0.0189
Iron (Fe)-Total	0.514	0.425
Lead (Pb)-Total	0.000284	0.000243
Lithium (Li)-Total	0.0082	0.0083
Magnesium (Mg)-Total	111	110
Manganese (Mn)-Total	0.0396	0.0342

Results Summary VA22C6268

Client Sample ID	QUL-18-20m	QUL-R-20m
Date Sampled	30-Oct-23	30-Oct-23
Time Sampled	12:07	12:07
ALS Sample ID	VA23C6268-002	VA23C6268-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	113	113
Conductivity	51.2	50.9
Hardness (as CaCO3), Dissolved	55	54.8
Hardness (as CaCO3), From total Ca/Mg	54	53.4
pH	66	69
Total Dissolved Solids	<1.2	<1.1
Total Suspended Solids	0.14	0.17
Turbidity	7.78	7.82
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.029	0.028
Nitrate (as N)	0.128	0.128
Nitrate and Nitrite (as N)	0.128	0.128
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.176	0.175
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	6.47	6.47
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.99	1.96
Total Metals (Water)		
Aluminum (Al)-Total	0.0098	0.0107
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00012	0.00011
Barium (Ba)-Total	0.00505	0.00536
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	18.1	17.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00056	0.00059
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	<0.0010
Magnesium (Mg)-Total	2.13	2.12
Manganese (Mn)-Total	0.00069	0.0007

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.361	0.363	Molybdenum (Mo)-Total	0.000512	0.000497
Nickel (Ni)-Total	<0.00100	<0.00100	Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	2.85	2.84	Potassium (K)-Total	0.497	0.492
Selenium (Se)-Total	0.341	0.342	Selenium (Se)-Total	0.000135	0.000124
Silicon (Si)-Total	5.94	6.39	Silicon (Si)-Total	1.58	1.56
Silver (Ag)-Total	<0.000020	<0.000020	Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	31.5	31.5	Sodium (Na)-Total	0.979	0.979
Strontium (Sr)-Total	6.84	6.87	Strontium (Sr)-Total	0.138	0.139
Thallium (Tl)-Total	<0.000020	<0.000020	Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00020	<0.00020	Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	0.0278	0.0269	Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00299	0.003	Uranium (U)-Total	0.00016	0.000172
Vanadium (V)-Total	0.00198	0.00226	Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	0.007	0.0063	Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0115	0.0098	Aluminum (Al)-Dissolved	0.0053	0.0072
Antimony (Sb)-Dissolved	0.00048	0.00047	Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00071	0.00062	Arsenic (As)-Dissolved	<0.00010	<0.00010
Barium (Ba)-Dissolved	0.037	0.0346	Barium (Ba)-Dissolved	0.00478	0.00481
Beryllium (Be)-Dissolved	<0.000100	<0.000200	Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000100	<0.000100	Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.097	0.098	Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.000180	0.000113	Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	526	519	Calcium (Ca)-Dissolved	18.8	18.7
Chromium (Cr)-Dissolved	<0.00050	<0.00100	Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00020	<0.00020	Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00598	0.00562	Copper (Cu)-Dissolved	0.0005	0.00054
Iron (Fe)-Dissolved	<0.030	<0.060	Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000100	<0.000100	Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0079	0.0078	Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	105	103	Magnesium (Mg)-Dissolved	1.95	1.97
Manganese (Mn)-Dissolved	0.0139	0.0124	Manganese (Mn)-Dissolved	0.0002	0.00022
Molybdenum (Mo)-Dissolved	0.344	0.363	Molybdenum (Mo)-Dissolved	0.000523	0.000523
Nickel (Ni)-Dissolved	<0.00100	<0.00100	Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	2.77	2.66	Potassium (K)-Dissolved	0.487	0.495
Selenium (Se)-Dissolved	0.324	0.328	Selenium (Se)-Dissolved	0.000124	0.00011
Silicon (Si)-Dissolved	5.56	5.54	Silicon (Si)-Dissolved	1.55	1.56
Silver (Ag)-Dissolved	<0.000020	<0.000020	Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	30.3	30.4	Sodium (Na)-Dissolved	0.972	0.968
Strontium (Sr)-Dissolved	6.78	6.54	Strontium (Sr)-Dissolved	0.146	0.144
Thallium (Tl)-Dissolved	<0.000020	<0.000020	Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00020	<0.00020	Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0200	Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00293	0.00251	Uranium (U)-Dissolved	0.000165	0.000165
Vanadium (V)-Dissolved	<0.00100	<0.00100	Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0034	<0.0060	Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field	Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C6270

Client Sample ID	QUL-59-B	QUL-EI-B
Date Sampled	31-Oct-23	31-Oct-23
Time Sampled	12:09	12:09
ALS Sample ID	VA23C6270-008	VA23C6270-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	114	115
Conductivity	51.1	51.1
Hardness (as CaCO3), Dissolved	53	53.3
Hardness (as CaCO3), From total Ca/Mg	52.9	54
pH	66	68
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.19	0.19
Turbidity	7.82	7.82
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	<0.50	<0.50
Fluoride (F)	0.032	0.032
Nitrate (as N)	0.147	0.147
Nitrate and Nitrite (as N)	0.147	0.147
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.183	0.184
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0023	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	6.71	6.72
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.11	2.05
Total Metals (Water)		
Aluminum (Al)-Total	0.012	0.0109
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00012	0.00013
Barium (Ba)-Total	0.00535	0.00521
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	<0.010	<0.010
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	17.4	18
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00067	0.00062
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	<0.0010	0.001
Magnesium (Mg)-Total	2.3	2.19
Manganese (Mn)-Total	0.0008	0.00076

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Molybdenum (Mo)-Total	0.000577	0.000563
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.54	0.514
Selenium (Se)-Total	0.000163	0.00017
Silicon (Si)-Total	1.85	1.75
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	1.1	1.03
Strontium (Sr)-Total	0.143	0.148
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000175	0.000187
Vanadium (V)-Total	<0.00050	<0.00050
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0073	0.0051
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	<0.00010	<0.00010
Barium (Ba)-Dissolved	0.00503	0.00497
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	<0.010	<0.010
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	17.9	17.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00064	0.00051
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	2.03	2.09
Manganese (Mn)-Dissolved	0.00023	0.00014
Molybdenum (Mo)-Dissolved	0.0005	0.000523
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.494	0.503
Selenium (Se)-Dissolved	0.000141	0.000131
Silicon (Si)-Dissolved	1.64	1.63
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.991	0.957
Strontium (Sr)-Dissolved	0.136	0.138
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000159	0.000162
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C6514

Client Sample ID	WIP-20m	23916-20m
Date Sampled	01-Nov-2023	01-Nov-2023
Time Sampled	10:30	10:30
ALS Sample ID	VA23C6514-003	VA23C6514-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	2360	2360
Conductivity	162	162
Hardness (as CaCO3), Dissolved	1470	1460
Hardness (as CaCO3), From total Ca/M	1580	1480
pH	2040	2180
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.67	0.7
Turbidity	8.15	8.15
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0079	0.0077
Chloride (Cl)	<10.0	<10.0
Fluoride (F)	0.596	0.596
Nitrate (as N)	0.13	0.128
Nitrate and Nitrite (as N)	0.13	0.128
Nitrite (as N)	<0.0200	<0.0200
Total Nitrogen	0.185	0.182
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	<0.0020	<0.0020
Phosphorus (P)-Total Dissolved	<0.0020	<0.0020
Sulfate (SO4)	1280	1260
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	1.22	1.28
Total Metals (Water)		
Aluminum (Al)-Total	<0.0150	<0.0150
Antimony (Sb)-Total	0.00079	0.00074
Arsenic (As)-Total	<0.00050	<0.00050
Barium (Ba)-Total	0.0234	0.0227
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000250	<0.000250
Boron (B)-Total	0.188	0.186
Cadmium (Cd)-Total	0.00127	0.00111
Calcium (Ca)-Total	522	490
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00393	0.00384
Copper (Cu)-Total	0.0108	0.0102
Iron (Fe)-Total	0.133	0.13
Lead (Pb)-Total	<0.000250	<0.000250
Lithium (Li)-Total	0.0158	0.0153
Magnesium (Mg)-Total	66.2	63.4
Manganese (Mn)-Total	0.892	0.869
Molybdenum (Mo)-Total	0.122	0.117
Nickel (Ni)-Total	0.00328	0.0033
Potassium (K)-Total	3.11	3

Results Summary VA23C6526

Client Sample ID	EDC-01a	EDC-Aa
Date Sampled	02-Nov-2023	02-Nov-2023
Time Sampled	11:45	11:45
ALS Sample ID	VA23C6526-006	VA23C6526-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	368	366
Conductivity	142	141
Hardness (as CaCO3), Dissolved	163	165
Hardness (as CaCO3), From total Ca/M	162	164
pH	226	232
Total Dissolved Solids	<1.0	<1.0
Total Suspended Solids	0.33	0.21
Turbidity	8.31	8.31
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0056	<0.0050
Chloride (Cl)	1.21	1.21
Fluoride (F)	0.083	0.082
Nitrate (as N)	0.0533	0.0543
Nitrate and Nitrite (as N)	0.0533	0.0543
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.207	0.196
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0064	0.0054
Phosphorus (P)-Total Dissolved	0.0046	0.0045
Sulfate (SO4)	49.8	49.8
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.38	4.23
Total Metals (Water)		
Aluminum (Al)-Total	0.0069	0.0066
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.0008	0.00079
Barium (Ba)-Total	0.0195	0.0198
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.024	0.024
Cadmium (Cd)-Total	<0.0000050	0.0000056
Calcium (Ca)-Total	48.3	48.9
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00517	0.00515
Iron (Fe)-Total	<0.030	<0.030
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0011	0.0011
Magnesium (Mg)-Total	10	10.1
Manganese (Mn)-Total	0.047	0.0474
Molybdenum (Mo)-Total	0.0057	0.00573
Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	0.988	0.986

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.00335	0.00314
Silicon (Si)-Total	7.35	7.21
Silver (Ag)-Total	<0.000050	<0.000050
Sodium (Na)-Total	35.4	35.1
Strontium (Sr)-Total	13.5	13.2
Thallium (Tl)-Total	<0.000050	<0.000050
Tin (Sn)-Total	<0.00050	<0.00050
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00859	0.00841
Vanadium (V)-Total	<0.00250	<0.00250
Zinc (Zn)-Total	0.134	0.133

Selenium (Se)-Total	0.00138	0.00133
Silicon (Si)-Total	4.18	4.15
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	8.96	8.93
Strontium (Sr)-Total	0.349	0.353
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.0006	0.000595
Vanadium (V)-Total	0.00065	0.00067
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	<0.0050	<0.0050
Antimony (Sb)-Dissolved	0.00066	0.00066
Arsenic (As)-Dissolved	<0.00050	<0.00050
Barium (Ba)-Dissolved	0.022	0.021
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000250	<0.000250
Boron (B)-Dissolved	0.179	0.176
Cadmium (Cd)-Dissolved	0.00108	0.00105
Calcium (Ca)-Dissolved	484	486
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00357	0.00343
Copper (Cu)-Dissolved	0.00534	0.00548
Iron (Fe)-Dissolved	<0.050	<0.050
Lead (Pb)-Dissolved	<0.000250	<0.000250
Lithium (Li)-Dissolved	0.0156	0.0151
Magnesium (Mg)-Dissolved	63.5	60.6
Manganese (Mn)-Dissolved	0.841	0.811
Molybdenum (Mo)-Dissolved	0.114	0.112
Nickel (Ni)-Dissolved	0.00314	0.00305
Potassium (K)-Dissolved	3.07	2.94
Selenium (Se)-Dissolved	0.00302	0.00319
Silicon (Si)-Dissolved	6.69	6.92
Silver (Ag)-Dissolved	<0.000050	<0.000050
Sodium (Na)-Dissolved	34.2	32.9
Strontium (Sr)-Dissolved	12.7	12.5
Thallium (Tl)-Dissolved	<0.000050	<0.000050
Tin (Sn)-Dissolved	<0.00050	<0.00050
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00791	0.00799
Vanadium (V)-Dissolved	<0.00250	<0.00250
Zinc (Zn)-Dissolved	0.128	0.127
Dissolved Metals Filtration Location	Field	Field

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0038	<0.0030
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00076	0.00077
Barium (Ba)-Dissolved	0.0198	0.0198
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.023	0.023
Cadmium (Cd)-Dissolved	0.0000056	<0.0000050
Calcium (Ca)-Dissolved	48.2	48.9
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00503	0.00505
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0012	0.0012
Magnesium (Mg)-Dissolved	10.3	10.4
Manganese (Mn)-Dissolved	0.0466	0.0463
Molybdenum (Mo)-Dissolved	0.0056	0.00548
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	1.05	1.07
Selenium (Se)-Dissolved	0.00134	0.00132
Silicon (Si)-Dissolved	4.24	4.31
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	9.53	9.62
Strontium (Sr)-Dissolved	0.341	0.346
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000601	0.000588
Vanadium (V)-Dissolved	0.00063	0.00064
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C7187

Client Sample ID	E1a	EAa
Date Sampled	08-Nov-2023	08-Nov-2023
Time Sampled	10:14	10:14
ALS Sample ID	VA23C7187-001	VA23C7187-002
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1730	1730
Conductivity	39.3	39.5
Hardness (as CaCO3), Dissolved	657	657
Hardness (as CaCO3), From total Ca/M(	650	659
pH	1390	1390
Total Dissolved Solids	2.9	2.7
Total Suspended Solids	0.86	1.07
Turbidity	7.59	7.59
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.262	0.24
Chloride (Cl)	26.5	26.7
Fluoride (F)	0.67	0.723
Nitrate (as N)	3.93	3.94
Nitrate and Nitrite (as N)	4.06	4.08
Nitrite (as N)	0.131	0.143
Total Nitrogen	4.13	4.26
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.007	0.0075
Phosphorus (P)-Total Dissolved	0.0033	0.0027
Sulfate (SO4)	844	839
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.69	5.12
Total Metals (Water)		
Aluminum (Al)-Total	0.144	0.13
Antimony (Sb)-Total	0.00205	0.00207
Arsenic (As)-Total	0.00172	0.0017
Barium (Ba)-Total	0.063	0.0633
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.167	0.17
Cadmium (Cd)-Total	<0.0000600	<0.0000550
Calcium (Ca)-Total	208	212
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00027	0.00025
Copper (Cu)-Total	0.00716	0.00633
Iron (Fe)-Total	0.105	0.096
Lead (Pb)-Total	<0.000050	<0.000050
Lithium (Li)-Total	0.0259	0.0261
Magnesium (Mg)-Total	31.6	31.5
Manganese (Mn)-Total	0.0681	0.0679
Molybdenum (Mo)-Total	0.215	0.22
Nickel (Ni)-Total	0.00113	0.00109
Potassium (K)-Total	18.9	18.8

Results Summary VA23C7556

Client Sample ID	GW12-4a	GW12-Da
Date Sampled	14-Nov-2023	14-Nov-2023
Time Sampled	10:51	10:51
ALS Sample ID	VA23C7556-002	VA23C7556-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	311	313
Conductivity	139	138
Hardness (as CaCO3), Dissolved	131	131
pH	8.17	8.19
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0851	0.0882
Chloride (Cl)	1.61	1.61
Fluoride (F)	0.463	0.462
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.172	0.146
Phosphorus (P)-Total	0.179	0.179
Phosphorus (P)-Total Dissolved	0.154	0.157
Sulfate (SO4)	25.1	25.1
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.22	2.15
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.003	0.0036
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.0032	0.0032
Barium (Ba)-Dissolved	0.0303	0.0308
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.25	0.254
Cadmium (Cd)-Dissolved	<0.0000150	<0.0000150
Calcium (Ca)-Dissolved	31.6	31.8
Chromium (Cr)-Dissolved	0.00108	0.00108
Cobalt (Co)-Dissolved	0.00028	0.00026
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	0.303	0.316
Lead (Pb)-Dissolved	0.000096	<0.000050
Lithium (Li)-Dissolved	0.0015	0.0015
Magnesium (Mg)-Dissolved	12.6	12.6
Manganese (Mn)-Dissolved	0.682	0.689
Molybdenum (Mo)-Dissolved	0.0651	0.0641
Nickel (Ni)-Dissolved	0.00056	0.00056
Potassium (K)-Dissolved	1.52	1.52
Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	13.5	13.2
Silver (Ag)-Dissolved	<0.000020	<0.000010
Sodium (Na)-Dissolved	14.8	14.9
Strontium (Sr)-Dissolved	0.325	0.324

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.0284	0.0284
Silicon (Si)-Total	4.67	4.6
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	127	126
Strontium (Sr)-Total	2.82	2.88
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00167	0.0017
Vanadium (V)-Total	0.00148	0.00146
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0274	0.0155
Antimony (Sb)-Dissolved	0.00191	0.00186
Arsenic (As)-Dissolved	0.00158	0.00162
Barium (Ba)-Dissolved	0.0597	0.0646
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.168	0.168
Cadmium (Cd)-Dissolved	<0.0000750	<0.0000700
Calcium (Ca)-Dissolved	211	209
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00018	0.00016
Copper (Cu)-Dissolved	0.00382	0.00271
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0266	0.0262
Magnesium (Mg)-Dissolved	31.7	32.9
Manganese (Mn)-Dissolved	0.0648	0.0688
Molybdenum (Mo)-Dissolved	0.217	0.215
Nickel (Ni)-Dissolved	0.00097	0.00105
Potassium (K)-Dissolved	18.9	20.4
Selenium (Se)-Dissolved	0.0266	0.0257
Silicon (Si)-Dissolved	4.42	4.35
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	129	134
Strontium (Sr)-Dissolved	2.7	2.73
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00149	0.00145
Vanadium (V)-Dissolved	0.00115	0.00119
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000504	0.000497
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C7556

Client Sample ID	GW15-2a	GW15-Ba
Date Sampled	14-Nov-2023	14-Nov-2023
Time Sampled	12:21	12:21
ALS Sample ID	VA23C7556-007	VA23C7556-008
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	201	201
Conductivity	63.4	63.5
Hardness (as CaCO3), Dissolved	61.8	61.9
pH	8.06	8.06
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	0.51	0.5
Fluoride (F)	0.375	0.377
Nitrate (as N)	0.0192	0.0194
Nitrate and Nitrite (as N)	0.0192	0.0194
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.035	0.052
Phosphorus (P)-Total	0.04	0.0402
Phosphorus (P)-Total Dissolved	0.0394	0.0398
Sulfate (SO4)	34.9	34.9
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	<0.50	<0.50
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	<0.0030	0.0038
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00304	0.00314
Barium (Ba)-Dissolved	0.0164	0.0162
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.501	0.515
Cadmium (Cd)-Dissolved	<0.0000100	<0.0000150
Calcium (Ca)-Dissolved	19.6	19.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	<0.00050	<0.00050
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0027	0.0028
Magnesium (Mg)-Dissolved	3.12	3.21
Manganese (Mn)-Dissolved	0.0062	0.00601
Molybdenum (Mo)-Dissolved	0.0445	0.0441
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.47	0.476
Selenium (Se)-Dissolved	<0.000050	<0.000050
Silicon (Si)-Dissolved	8.25	8.38
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	18.3	18.7
Strontium (Sr)-Dissolved	0.0425	0.0418

Results Summary VA23C8353

Client Sample ID	GW16-1a	GW16-Aa
Date Sampled	22-Nov-2023	22-Nov-2023
Time Sampled	11:36	11:36
ALS Sample ID	VA23C8353-004	VA23C8353-005
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	623	622
Conductivity	261	256
Hardness (as CaCO3), Dissolved	13.2	13.3
pH	8.57	8.57
Anions and Nutrients (Water)		
Ammonia, Total (as N)	0.0536	0.054
Chloride (Cl)	1.83	1.81
Fluoride (F)	0.411	0.404
Nitrate (as N)	<0.0050	<0.0050
Nitrate and Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.165	0.168
Phosphorus (P)-Total	0.18	0.176
Phosphorus (P)-Total Dissolved	0.165	0.162
Sulfate (SO4)	76.6	76.6
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	5.8	6.43
Dissolved Metals (Water)		
Aluminum (Al)-Dissolved	0.023	0.0223
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00403	0.00407
Barium (Ba)-Dissolved	0.01	0.0101
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.402	0.41
Cadmium (Cd)-Dissolved	<0.0000200	<0.0000200
Calcium (Ca)-Dissolved	3.28	3.28
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00056	0.00053
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	0.000137	0.0001
Lithium (Li)-Dissolved	0.0229	0.0229
Magnesium (Mg)-Dissolved	1.23	1.24
Manganese (Mn)-Dissolved	0.00653	0.00658
Molybdenum (Mo)-Dissolved	0.0315	0.0313
Nickel (Ni)-Dissolved	0.00077	0.00077
Potassium (K)-Dissolved	0.629	0.644
Selenium (Se)-Dissolved	0.000091	0.000077
Silicon (Si)-Dissolved	3.15	3.18
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	142	144
Strontium (Sr)-Dissolved	0.0798	0.0794

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000148	0.000153
Vanadium (V)-Dissolved	<0.00050	<0.00050
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.000437	0.000433
Vanadium (V)-Dissolved	0.00053	0.00054
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C8707

Client Sample ID	E19a	ESa
Date Sampled	28-Nov-23	28-Nov-23
Time Sampled	10:32	10:32
ALS Sample ID	VA23C8707-002	VA23C8707-003
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	1450	1450
Conductivity	128	126
Hardness (as CaCO3), Dissolved	693	676
Hardness (as CaCO3), From total Ca/M	665	681
pH	1210	1140
Total Dissolved Solids	4.8	4.9
Total Suspended Solids	3.47	3
Turbidity	8.26	8.25
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	10	10
Fluoride (F)	0.536	0.538
Nitrate (as N)	4.71	4.73
Nitrate and Nitrite (as N)	4.72	4.74
Nitrite (as N)	0.0072	0.0062
Total Nitrogen	5.04	4.77
Orthophosphate-Dissolved (as P)	<0.0010	<0.0010
Phosphorus (P)-Total	0.0332	0.0327
Phosphorus (P)-Total Dissolved	0.0042	0.0056
Sulfate (SO4)	680	679
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	3.25	3.23
Total Metals (Water)		
Aluminum (Al)-Total	0.149	0.142
Antimony (Sb)-Total	0.00038	0.00038
Arsenic (As)-Total	0.00115	0.00115
Barium (Ba)-Total	0.0437	0.0439
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.128	0.132
Cadmium (Cd)-Total	<0.000105	<0.0000950
Calcium (Ca)-Total	204	210
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	0.00064	0.00063
Copper (Cu)-Total	0.0112	0.0118
Iron (Fe)-Total	0.132	0.134
Lead (Pb)-Total	<0.000050	0.000058
Lithium (Li)-Total	0.0073	0.0074
Magnesium (Mg)-Total	37.9	38
Manganese (Mn)-Total	0.448	0.451
Molybdenum (Mo)-Total	0.218	0.219
Nickel (Ni)-Total	0.00066	0.00069
Potassium (K)-Total	6.76	6.58

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Selenium (Se)-Total	0.0355	0.0353
Silicon (Si)-Total	7.34	7.24
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	52	52.1
Strontium (Sr)-Total	2.34	2.4
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.00243	0.00242
Vanadium (V)-Total	0.00104	0.001
Zinc (Zn)-Total	0.004	0.0043

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0059	0.0036
Antimony (Sb)-Dissolved	0.00034	0.00034
Arsenic (As)-Dissolved	0.00104	0.00097
Barium (Ba)-Dissolved	0.0411	0.0401
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.127	0.124
Cadmium (Cd)-Dissolved	<0.0000900	<0.0000900
Calcium (Ca)-Dissolved	212	208
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	0.00052	0.00052
Copper (Cu)-Dissolved	0.00672	0.00644
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0071	0.0069
Magnesium (Mg)-Dissolved	39.8	38.1
Manganese (Mn)-Dissolved	0.437	0.424
Molybdenum (Mo)-Dissolved	0.225	0.223
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	6.91	6.27
Selenium (Se)-Dissolved	0.0337	0.0342
Silicon (Si)-Dissolved	7.1	6.92
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	53.1	50.9
Strontium (Sr)-Dissolved	2.34	2.3
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00245	0.0025
Vanadium (V)-Dissolved	0.00066	0.00061
Zinc (Zn)-Dissolved	0.0035	0.0032
Dissolved Metals Filtration Location	Field	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23C9590

Client Sample ID	HAC-08	HAC-H
Date Sampled	06-Dec-23	06-Dec-23
Time Sampled	14:08	14:08
ALS Sample ID	VA23C9590-006	VA23C9590-007
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Alkalinity, Total (as CaCO3)	350	352
Conductivity	121	122
Hardness (as CaCO3), Dissolved	154	154
Hardness (as CaCO3), From total Ca/M	158	158
pH	216	226
Total Dissolved Solids	2.5	2.1
Total Suspended Solids	0.73	0.5
Turbidity	8.36	8.36
Anions and Nutrients (Water)		
Ammonia, Total (as N)	<0.0050	<0.0050
Chloride (Cl)	1.18	1.18
Fluoride (F)	0.079	0.079
Nitrate (as N)	0.0695	0.0694
Nitrate and Nitrite (as N)	0.0695	0.0694
Nitrite (as N)	<0.0010	<0.0010
Total Nitrogen	0.221	0.226
Orthophosphate-Dissolved (as P)	0.001	<0.0010
Phosphorus (P)-Total	0.0083	0.0076
Phosphorus (P)-Total Dissolved	0.0054	0.0055
Sulfate (SO4)	57.4	57.4
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	4.54	4.57
Total Metals (Water)		
Aluminum (Al)-Total	0.0669	0.0558
Antimony (Sb)-Total	<0.00010	<0.00010
Arsenic (As)-Total	0.00091	0.00087
Barium (Ba)-Total	0.0191	0.019
Beryllium (Be)-Total	<0.000100	<0.000100
Bismuth (Bi)-Total	<0.000050	<0.000050
Boron (B)-Total	0.023	0.022
Cadmium (Cd)-Total	<0.0000050	<0.0000050
Calcium (Ca)-Total	46.9	46.8
Chromium (Cr)-Total	<0.00050	<0.00050
Cobalt (Co)-Total	<0.00010	<0.00010
Copper (Cu)-Total	0.00741	0.00697
Iron (Fe)-Total	0.119	0.096
Lead (Pb)-Total	0.000069	0.000052
Lithium (Li)-Total	0.0014	0.0014
Magnesium (Mg)-Total	9.9	9.92
Manganese (Mn)-Total	0.0177	0.0139
Molybdenum (Mo)-Total	0.00614	0.00624

Results Summary VA23D0136

Client Sample ID	95-R-5	95-R-E
Date Sampled	13-Dec-23	13-Dec-23
Time Sampled	13:17	13:17
ALS Sample ID	VA23D0136-003	VA23D0136-004
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Conductivity	990	989
Alkalinity, total (as CaCO3)	443	447
Hardness (as CaCO3), dissolved		522
pH	7.47	7.33
Anions and Nutrients (Water)		
Ammonia, total (as N)	0.0064	0.0051
Chloride	<2.50	<2.50
Fluoride	0.1	<0.100
Nitrate (as N)	<0.0250	<0.0250
Nitrate + Nitrite (as N)	<0.0255	<0.0255
Nitrite (as N)	<0.0050	<0.0050
Nitrogen, total	<0.030	<0.030
Phosphorus, total	0.0059	0.0065
Phosphorus, total dissolved	0.0024	<0.0020
Sulfate (as SO4)	130	130
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	2.17	2.2
Dissolved Metals (Water)		
Aluminum, dissolved		<0.0030
Antimony, dissolved		<0.00010
Arsenic, dissolved		0.00434
Barium, dissolved		0.0185
Beryllium, dissolved		<0.000100
Bismuth, dissolved		<0.000050
Boron, dissolved		0.062
Cadmium, dissolved		<0.0000050
Calcium, dissolved		173
Chromium, dissolved		<0.00050
Cobalt, dissolved		0.00044
Copper, dissolved		<0.00050
Iron, dissolved		6.37
Lead, dissolved		<0.000050
Lithium, dissolved		0.0068
Magnesium, dissolved		22
Manganese, dissolved		1.81
Molybdenum, dissolved		0.00733
Nickel, dissolved		<0.00050
Potassium, dissolved		0.869
Selenium, dissolved		<0.000050
Silicon, dissolved		12.3
Silver, dissolved		<0.000010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Nickel (Ni)-Total	<0.00050	<0.00050
Potassium (K)-Total	1.02	1.04
Selenium (Se)-Total	0.00176	0.00171
Silicon (Si)-Total	4.39	4.35
Silver (Ag)-Total	<0.000010	<0.000010
Sodium (Na)-Total	8.97	9.11
Strontium (Sr)-Total	0.355	0.36
Thallium (Tl)-Total	<0.000010	<0.000010
Tin (Sn)-Total	<0.00010	<0.00010
Titanium (Ti)-Total	<0.0100	<0.0100
Uranium (U)-Total	0.000517	0.000525
Vanadium (V)-Total	0.00094	0.00089
Zinc (Zn)-Total	<0.0030	<0.0030

Dissolved Metals (Water)

Aluminum (Al)-Dissolved	0.0041	0.0044
Antimony (Sb)-Dissolved	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00071	0.00069
Barium (Ba)-Dissolved	0.017	0.0176
Beryllium (Be)-Dissolved	<0.000100	<0.000100
Bismuth (Bi)-Dissolved	<0.000050	<0.000050
Boron (B)-Dissolved	0.022	0.022
Cadmium (Cd)-Dissolved	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	46	45.5
Chromium (Cr)-Dissolved	<0.00050	<0.00050
Cobalt (Co)-Dissolved	<0.00010	<0.00010
Copper (Cu)-Dissolved	0.00538	0.00555
Iron (Fe)-Dissolved	<0.030	<0.030
Lead (Pb)-Dissolved	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0013	0.0013
Magnesium (Mg)-Dissolved	9.52	9.83
Manganese (Mn)-Dissolved	0.00444	0.00454
Molybdenum (Mo)-Dissolved	0.0061	0.00599
Nickel (Ni)-Dissolved	<0.00050	<0.00050
Potassium (K)-Dissolved	0.98	1.02
Selenium (Se)-Dissolved	0.00155	0.00167
Silicon (Si)-Dissolved	4.08	4.15
Silver (Ag)-Dissolved	<0.000010	<0.000010
Sodium (Na)-Dissolved	8.7	9.02
Strontium (Sr)-Dissolved	0.35	0.345
Thallium (Tl)-Dissolved	<0.000010	<0.000010
Tin (Sn)-Dissolved	<0.00010	<0.00010
Titanium (Ti)-Dissolved	<0.0100	<0.0100
Uranium (U)-Dissolved	0.00051	0.000514
Vanadium (V)-Dissolved	0.00063	0.00064
Zinc (Zn)-Dissolved	<0.0030	<0.0030
Dissolved Metals Filtration Location	Field	Field

Sodium, dissolved	6.78
Strontium, dissolved	0.472
Thallium, dissolved	<0.000010
Tin, dissolved	<0.00010
Titanium, dissolved	<0.0100
Uranium, dissolved	0.000612
Vanadium, dissolved	<0.00050
Zinc, dissolved	0.0088
Dissolved metals filtration location	Field

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Results Summary VA23D0136

Client Sample ID	GW96-7	GW96-G
Date Sampled	13-Dec-23	13-Dec-23
Time Sampled	12:36	12:36
ALS Sample ID	VA23D0136-008	VA23D0136-009
Parameter	Sub-Matrix: Water	Sub-Matrix: Water
Physical Tests (Water)		
Conductivity	466	466
Alkalinity, total (as CaCO3)	186	184
Hardness (as CaCO3), dissolved	215	213
pH	8.12	8.14
Anions and Nutrients (Water)		
Ammonia, total (as N)	<0.0050	<0.0050
Chloride	0.59	0.58
Fluoride	0.168	0.164
Nitrate (as N)	<0.0050	<0.0050
Nitrate + Nitrite (as N)	<0.0051	<0.0051
Nitrite (as N)	<0.0010	<0.0010
Nitrogen, total	<0.030	<0.030
Phosphorus, total	0.0147	0.0139
Phosphorus, total dissolved	0.0131	0.0133
Sulfate (as SO4)	65	64.7
Organic / Inorganic Carbon (Water)		
Dissolved Organic Carbon	0.75	0.68
Dissolved Metals (Water)		
Aluminum, dissolved	<0.0030	<0.0030
Antimony, dissolved	<0.00010	<0.00010
Arsenic, dissolved	0.00173	0.0017
Barium, dissolved	0.0271	0.0269
Beryllium, dissolved	<0.000100	<0.000100
Bismuth, dissolved	<0.000050	<0.000050
Boron, dissolved	0.021	0.018
Cadmium, dissolved	<0.0000050	<0.0000050
Calcium, dissolved	64	63.5
Chromium, dissolved	<0.00050	<0.00050
Cobalt, dissolved	<0.00010	<0.00010
Copper, dissolved	<0.00050	<0.00050
Iron, dissolved	0.267	0.264
Lead, dissolved	<0.000050	<0.000050
Lithium, dissolved	0.0074	0.0072
Magnesium, dissolved	13.5	13.2
Manganese, dissolved	0.233	0.23
Molybdenum, dissolved	0.0058	0.00589
Nickel, dissolved	<0.00050	<0.00050
Potassium, dissolved	1.38	1.35
Selenium, dissolved	<0.000050	<0.000050
Silicon, dissolved	13.9	13.7
Silver, dissolved	<0.000010	<0.000010

MPMC Annual Report 2023
QA/QC Field Replicate Comparison

RAW DATA

Sodium, dissolved	9.65	9.48
Strontium, dissolved	0.192	0.189
Thallium, dissolved	<0.000010	<0.000010
Tin, dissolved	<0.00010	<0.00010
Titanium, dissolved	<0.0100	<0.0100
Uranium, dissolved	0.000195	0.000194
Vanadium, dissolved	<0.00050	<0.00050
Zinc, dissolved	<0.0030	<0.0030
Dissolved metals filtration location	Field	Field

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

		Al-T DL = 0.0030						Ba-T DL = 0.0010					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	0.01020	0.01010	No	n/a	0.0001	FALSE	0.01920	0.01910	Yes	1%	n/a	FALSE
05-Jan-23	E10	0.02450	0.02490	Yes	2%	n/a	FALSE	0.05450	0.05460	Yes	0%	n/a	FALSE
10-Jan-23	E24	0.03100	0.03010	Yes	3%	n/a	FALSE	0.03780	0.03870	Yes	2%	n/a	FALSE
11-Jan-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
11-Jan-23	WIP-30m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.02580	0.02580	Yes	0%	n/a	FALSE
12-Jan-23	W4a	0.03050	0.02540	Yes	18%	n/a	FALSE	0.01790	0.01710	Yes	5%	n/a	FALSE
17-Jan-23	HAD-3	0.83500	0.76800	Yes	8%	n/a	FALSE	0.05200	0.05230	Yes	1%	n/a	FALSE
19-Jan-23	E4	0.11100	0.05980	Yes	60%	n/a	TRUE	0.03490	0.03490	Yes	0%	n/a	FALSE
19-Jan-23	GW12-2a	-	-	-	-	-	-	-	-	-	-	-	-
23-Jan-23	E14	0.04980	0.04260	Yes	16%	n/a	FALSE	0.03260	0.03200	Yes	2%	n/a	FALSE
24-Jan-23	W12	0.01570	0.01660	Yes	6%	n/a	FALSE	0.01430	0.01380	No	n/a	0.0005	FALSE
01-Feb-23	E8	0.03990	0.04780	Yes	18%	n/a	FALSE	0.04990	0.05200	Yes	4%	n/a	FALSE
07-Feb-23	E19	0.12900	0.12200	Yes	6%	n/a	FALSE	0.05300	0.05170	Yes	2%	n/a	FALSE
08-Feb-23	HAC-10	0.00700	0.00680	No	n/a	0.0002	FALSE	0.01050	0.01050	No	n/a	0.0000	FALSE
16-Feb-23	WIP-20m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.03270	0.03230	Yes	1%	n/a	FALSE
21-Feb-23	E1a	0.28200	0.27000	Yes	4%	n/a	FALSE	0.06550	0.06460	Yes	1%	n/a	FALSE
02-Mar-23	WIP-S	0.01990	0.03060	Yes	42%	n/a	TRUE	0.05100	0.05110	Yes	0%	n/a	FALSE
06-Mar-23	E21	0.48100	0.40300	Yes	18%	n/a	FALSE	0.06740	0.06830	Yes	1%	n/a	FALSE
07-Mar-23	EDC-01a	0.01150	0.01060	No	n/a	0.0009	FALSE	0.01690	0.01670	Yes	1%	n/a	FALSE
08-Mar-23	W4a	0.02300	0.01250	No	n/a	0.0105	TRUE	0.01560	0.01540	Yes	1%	n/a	FALSE
09-Mar-23	WIP-10m	0.01000	<0.0150	No	n/a	n/a	FALSE	0.04330	0.04460	Yes	3%	n/a	FALSE
14-Mar-23	E10	0.93400	0.80800	Yes	14%	n/a	FALSE	0.06880	0.06590	Yes	4%	n/a	FALSE
20-Mar-23	WIP-20m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.02670	0.02680	Yes	0%	n/a	FALSE
03-Apr-23	HAC-10	0.01170	0.00930	No	n/a	0.0024	FALSE	0.01080	0.01040	No	n/a	0.0004	FALSE
05-Apr-23	WIP-30m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.02220	0.02250	Yes	1%	n/a	FALSE
12-Apr-23	W4a	0.66600	0.64600	Yes	3%	n/a	FALSE	0.01930	0.01950	Yes	1%	n/a	FALSE
13-Apr-23	E13	0.15800	0.17300	Yes	9%	n/a	FALSE	0.04760	0.04960	Yes	4%	n/a	FALSE
20-Apr-23	E11c	0.04880	0.03640	Yes	29%	n/a	FALSE	0.02150	0.02110	Yes	2%	n/a	FALSE
24-Apr-23	E14	0.33000	0.35400	Yes	7%	n/a	FALSE	0.03210	0.03210	Yes	0%	n/a	FALSE
26-Apr-23	E24	0.39700	0.40900	Yes	3%	n/a	FALSE	0.02130	0.02120	Yes	0%	n/a	FALSE
01-May-23	GW96-4b	-	-	-	-	-	-	-	-	-	-	-	-
01-May-23	HAC-05a	0.18000	0.17400	Yes	3%	n/a	FALSE	0.01810	0.01810	Yes	0%	n/a	FALSE
03-May-23	GW96-2a	-	-	-	-	-	-	-	-	-	-	-	-
03-May-23	GW16-2a	-	-	-	-	-	-	-	-	-	-	-	-
03-May-23	E11c	0.05010	0.05240	Yes	4%	n/a	FALSE	0.02100	0.02160	Yes	3%	n/a	FALSE
08-May-23	E21	0.39700	0.39600	Yes	0%	n/a	FALSE	0.05000	0.04880	Yes	2%	n/a	FALSE
10-May-23	QUL-58-MID	0.02870	0.02590	Yes	10%	n/a	FALSE	0.00548	0.00508	No	n/a	0.0004	FALSE
10-May-23	QUL-120a-120m	0.01070	0.01100	No	n/a	0.0003	FALSE	0.00504	0.00523	No	n/a	0.0002	FALSE
11-May-23	QUL-2a-0m	0.01300	0.01230	No	n/a	0.0007	FALSE	0.00515	0.00526	No	n/a	0.0001	FALSE
11-May-23	QUL-18-20m	0.01630	0.01600	Yes	2%	n/a	FALSE	0.00538	0.00527	No	n/a	0.0001	FALSE
15-May-23	E1a	0.43300	0.31500	Yes	32%	n/a	TRUE	0.05870	0.05770	Yes	2%	n/a	FALSE
16-May-23	SERDS 22	0.24400	0.19300	Yes	23%	n/a	FALSE	0.04820	0.04790	Yes	1%	n/a	FALSE
16-May-23	NEZ 2	0.18200	0.16200	Yes	12%	n/a	FALSE	0.02800	0.02650	Yes	6%	n/a	FALSE
17-May-23	QUL-57-S	0.14900	0.01940	Yes	154%	n/a	TRUE	0.00932	0.00556	No	n/a	0.0038	FALSE
24-May-23	B1-B	0.01400	0.01580	No	n/a	0.0018	FALSE	0.01620	0.01590	Yes	2%	n/a	FALSE
25-May-23	QUL-58-B	0.02340	0.02330	Yes	0%	n/a	FALSE	0.00574	0.00576	No	n/a	0.0000	FALSE
30-May-23	HAD-3	0.26800	0.28500	Yes	6%	n/a	FALSE	0.04210	0.04210	Yes	0%	n/a	FALSE
30-May-23	QUL-58-MP	0.01990	0.07120	Yes	113%	n/a	TRUE	0.00577	0.00734	No	n/a	0.0016	FALSE
30-May-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
05-Jun-23	HAC-14	0.02130	0.02090	Yes	2%	n/a	FALSE	0.01590	0.01580	Yes	1%	n/a	FALSE
08-Jun-23	B1-S	0.05500	0.04610	Yes	18%	n/a	FALSE	0.01660	0.01670	Yes	1%	n/a	FALSE
12-Jun-23	W5	0.08940	0.11300	Yes	23%	n/a	FALSE	0.01900	0.01850	Yes	3%	n/a	FALSE
21-Jun-23	QUL-ZOO-7	0.14400	0.15900	Yes	10%	n/a	FALSE	0.00940	0.00966	No	n/a	0.0003	FALSE
26-Jun-23	QUL-2a-20m	0.02220	0.01200	No	n/a	0.0102	TRUE	0.00602	0.00566	No	n/a	0.0004	FALSE
27-Jun-23	QUL-58-AP	0.01250	0.01450	No	n/a	0.0020	FALSE	0.00539	0.00565	No	n/a	0.0003	FALSE
28-Jun-23	GW12-5a	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-23	HAC-10	0.01650	0.01860	Yes	12%	n/a	FALSE	0.01020	0.01040	No	n/a	0.0002	FALSE
10-Jul-23	E19	0.30200	0.29900	Yes	1%	n/a	FALSE	0.05000	0.04980	Yes	0%	n/a	FALSE
12-Jul-23	B1-S	0.01120	0.01220	No	n/a	0.0010	FALSE	0.01630	0.01650	Yes	1%	n/a	FALSE
26-Jul-23	P1-B	0.01240	0.01300	No	n/a	0.0006	FALSE	0.00954	0.00992	No	n/a	0.0004	FALSE
26-Jul-23	QUL-ZOO-7	0.04260	0.03940	Yes	8%	n/a	FALSE	0.00650	0.00647	No	n/a	0.0000	FALSE
27-Jul-23	95-R-5	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-23	E22	0.01670	0.01770	Yes	6%	n/a	FALSE	0.02940	0.03050	Yes	4%	n/a	FALSE
01-Aug-23	W4a	0.01440	0.01430	No	n/a	0.0001	FALSE	0.01970	0.02130	Yes	8%	n/a	FALSE
02-Aug-23	HAC-13	0.03530	0.03750	Yes	6%	n/a	FALSE	0.01100	0.01090	No	n/a	0.0001	FALSE
07-Aug-23	HAC-D	0.02890	0.02880	Yes	0%	n/a	FALSE	0.01620	0.01680	Yes	4%	n/a	FALSE
09-Aug-23	MDC	0.02020	0.02110	Yes	4%	n/a	FALSE	0.04130	0.04190	Yes	1%	n/a	FALSE
10-Aug-23	GW11-1a	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-23	E26	0.40700	0.37000	Yes	10%	n/a	FALSE	0.06470	0.06250	Yes	3%	n/a	FALSE

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

		Al-T						Ba-T					
		DL = 0.0030						DL = 0.0010					
Date	Site	Sample	Duplicate Sa	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sa	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	0.37100	0.36000	Yes	3%	n/a	FALSE	0.08280	0.08120	Yes	2%	n/a	FALSE
21-Aug-23	GW11-2b	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-23	E10	0.01530	<0.0150	No	n/a	n/a	FALSE	0.02820	0.03020	Yes	7%	n/a	FALSE
22-Aug-23	E19	0.04730	0.04740	Yes	0%	n/a	FALSE	0.04170	0.04250	Yes	2%	n/a	FALSE
24-Aug-23	P2-B	0.03460	0.03220	Yes	7%	n/a	FALSE	0.01010	0.01040	No	n/a	0.0003	FALSE
31-Aug-23	E24	0.01110	0.01070	No	n/a	0.0004	FALSE	0.03220	0.03150	Yes	2%	n/a	FALSE
05-Sep-23	W5	0.36500	0.17600	Yes	70%	n/a	TRUE	0.02940	0.02700	Yes	9%	n/a	FALSE
06-Sep-23	HAC-05a	0.01650	0.01540	Yes	7%	n/a	FALSE	0.01140	0.01120	No	n/a	0.0002	FALSE
07-Sep-23	B2-AT	0.00770	0.00770	No	n/a	0.0000	FALSE	0.01670	0.01630	Yes	2%	n/a	FALSE
11-Sep-23	QUL-2a-0m	0.01280	0.01450	No	n/a	0.0017	FALSE	0.00520	0.00536	No	n/a	0.0002	FALSE
19-Sep-23	W12	0.01810	0.01930	Yes	6%	n/a	FALSE	0.01710	0.01720	Yes	1%	n/a	FALSE
20-Sep-23	GW12-2a	-	-	-	-	-	-	-	-	-	-	-	-
20-Sep-23	GW12-1a	-	-	-	-	-	-	-	-	-	-	-	-
27-Sep-23	WIP-10m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.02200	0.02270	Yes	3%	n/a	FALSE
28-Sep-23	P2-BT	0.01590	0.01280	No	n/a	0.0031	FALSE	0.01010	0.01040	No	n/a	0.0003	FALSE
03-Oct-23	HAC-08	0.01440	0.01870	No	n/a	0.0043	FALSE	0.01610	0.01620	Yes	1%	n/a	FALSE
05-Oct-23	E4	0.03380	0.00940	No	n/a	0.0244	TRUE	0.02690	0.02730	Yes	1%	n/a	FALSE
05-Oct-23	PAG Seep 15	0.02280	0.03960	Yes	54%	n/a	TRUE	0.03290	0.03340	Yes	2%	n/a	FALSE
10-Oct-23	B1-B	0.01670	0.01680	Yes	1%	n/a	FALSE	0.01720	0.01720	Yes	0%	n/a	FALSE
16-Oct-23	E24	0.02730	0.02790	Yes	2%	n/a	FALSE	0.03400	0.03390	Yes	0%	n/a	FALSE
17-Oct-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
18-Oct-23	P1-S	0.01820	0.01690	Yes	7%	n/a	FALSE	0.01050	0.01080	No	n/a	0.0003	FALSE
19-Oct-23	GW12-4a	-	-	-	-	-	-	-	-	-	-	-	-
30-Oct-23	SERDS23	0.47100	0.45700	Yes	3%	n/a	FALSE	0.05480	0.05770	Yes	5%	n/a	FALSE
30-Oct-23	QUL-18-20m	0.00980	0.01070	No	n/a	0.0009	FALSE	0.00505	0.00536	No	n/a	0.0003	FALSE
31-Oct-23	QUL-59-B	0.01200	0.01090	No	n/a	0.0011	FALSE	0.00535	0.00521	No	n/a	0.0001	FALSE
01-Nov-23	WIP-20m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.02340	0.02270	Yes	3%	n/a	FALSE
02-Nov-23	EDC-01a	0.00690	0.00660	No	n/a	0.0003	FALSE	0.01950	0.01980	Yes	2%	n/a	FALSE
08-Nov-23	E1a	0.14400	0.13000	Yes	10%	n/a	FALSE	0.06300	0.06330	Yes	0%	n/a	FALSE
14-Nov-23	GW12-4a	-	-	-	-	-	-	-	-	-	-	-	-
14-Nov-23	GW15-2a	-	-	-	-	-	-	-	-	-	-	-	-
22-Nov-23	GW16-1a	-	-	-	-	-	-	-	-	-	-	-	-
28-Nov-23	E19a	0.14900	0.14200	Yes	5%	n/a	FALSE	0.04370	0.04390	Yes	0%	n/a	FALSE
06-Dec-23	HAC-08	0.06690	0.05580	Yes	18%	n/a	FALSE	0.01910	0.01900	Yes	1%	n/a	FALSE
13-Dec-23	95-R-5	-	-	-	-	-	-	-	-	-	-	-	-
13-Dec-23	GW96-7	-	-	-	-	-	-	-	-	-	-	-	-

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

		Cd-T DL = 0.00001						Cu-T DL = 0.0005					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0060	0.0059	Yes	2%	n/a	FALSE
05-Jan-23	E10	0.0001760	0.0001750	Yes	1%	n/a	FALSE	0.0101	0.0101	Yes	0%	n/a	FALSE
10-Jan-23	E24	0.0002240	0.0002400	Yes	7%	n/a	FALSE	0.1490	0.1490	Yes	0%	n/a	FALSE
11-Jan-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
11-Jan-23	WIP-30m	0.0011800	0.0012400	Yes	5%	n/a	FALSE	0.0199	0.0204	Yes	2%	n/a	FALSE
12-Jan-23	W4a	<0.0000150	<0.0000150	No	n/a	n/a	FALSE	0.0068	0.0063	Yes	7%	n/a	FALSE
17-Jan-23	HAD-3	<0.0000600	<0.0000650	No	n/a	n/a	FALSE	0.0080	0.0074	Yes	8%	n/a	FALSE
19-Jan-23	E4	<0.000150	<0.000150	No	n/a	n/a	FALSE	0.0111	0.0080	Yes	33%	n/a	TRUE
19-Jan-23	GW12-2a	-	-	-	-	-	-	-	-	-	-	-	-
23-Jan-23	E14	<0.0000450	<0.0000450	No	n/a	n/a	FALSE	0.0064	0.0059	Yes	7%	n/a	FALSE
24-Jan-23	W12	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0026	0.0027	Yes	1%	n/a	FALSE
01-Feb-23	E8	<0.0000800	<0.0000800	No	n/a	n/a	FALSE	0.0208	0.0214	Yes	3%	n/a	FALSE
07-Feb-23	E19	<0.0000500	<0.0000500	No	n/a	n/a	FALSE	0.0087	0.0083	Yes	4%	n/a	FALSE
08-Feb-23	HAC-10	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0040	0.0044	Yes	11%	n/a	FALSE
16-Feb-23	WIP-20m	0.0010500	0.0009610	Yes	9%	n/a	FALSE	0.0199	0.0200	Yes	1%	n/a	FALSE
21-Feb-23	E1a	<0.0000400	<0.0000450	No	n/a	n/a	FALSE	0.0024	0.0023	No	n/a	0.00	FALSE
02-Mar-23	WIP-S	0.0001520	0.0001460	Yes	4%	n/a	FALSE	0.0096	0.0096	Yes	1%	n/a	FALSE
06-Mar-23	E21	<0.0000450	<0.0000100	No	n/a	n/a	FALSE	0.0172	0.0033	Yes	136%	n/a	TRUE
07-Mar-23	EDC-01a	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0063	0.0061	Yes	4%	n/a	FALSE
08-Mar-23	W4a	<0.0000100	<0.0000100	No	n/a	n/a	FALSE	0.0065	0.0041	Yes	46%	n/a	TRUE
09-Mar-23	WIP-10m	0.0006900	0.0007220	Yes	5%	n/a	FALSE	0.0142	0.0148	Yes	4%	n/a	FALSE
14-Mar-23	E10	0.0001830	0.0001970	Yes	7%	n/a	FALSE	0.0711	0.0664	Yes	7%	n/a	FALSE
20-Mar-23	WIP-20m	0.0010400	0.0010600	Yes	2%	n/a	FALSE	0.0170	0.0178	Yes	5%	n/a	FALSE
03-Apr-23	HAC-10	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0040	0.0039	Yes	3%	n/a	FALSE
05-Apr-23	WIP-30m	0.0011700	0.0011700	Yes	0%	n/a	FALSE	0.0212	0.0214	Yes	1%	n/a	FALSE
12-Apr-23	W4a	0.0000090	0.0000077	No	n/a	0.000001	FALSE	0.0135	0.0136	Yes	1%	n/a	FALSE
13-Apr-23	E13	<0.0000600	<0.0000650	No	n/a	n/a	FALSE	0.0133	0.0136	Yes	2%	n/a	FALSE
20-Apr-23	E11c	0.0000390	0.0000258	No	n/a	0.000013	FALSE	0.0105	0.0098	Yes	7%	n/a	FALSE
24-Apr-23	E14	<0.0000550	<0.0000550	No	n/a	n/a	FALSE	0.0235	0.0243	Yes	3%	n/a	FALSE
26-Apr-23	E24	0.0001850	0.0001950	Yes	5%	n/a	FALSE	0.3450	0.3670	Yes	6%	n/a	FALSE
01-May-23	GW96-4b	-	-	-	-	-	-	-	-	-	-	-	-
01-May-23	HAC-05a	0.0000106	0.0000086	No	n/a	0.000002	FALSE	0.0318	0.0324	Yes	2%	n/a	FALSE
03-May-23	GW96-2a	-	-	-	-	-	-	-	-	-	-	-	-
03-May-23	GW16-2a	-	-	-	-	-	-	-	-	-	-	-	-
03-May-23	E11c	<0.0000950	<0.0000900	No	n/a	n/a	FALSE	0.0343	0.0348	Yes	1%	n/a	FALSE
08-May-23	E21	<0.0000400	<0.0000500	No	n/a	n/a	FALSE	0.0150	0.0151	Yes	1%	n/a	FALSE
10-May-23	QUL-58-MID	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0012	0.0009	No	n/a	0.00	FALSE
10-May-23	QUL-120a-120m	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0005	0.0006	No	n/a	0.00	FALSE
11-May-23	QUL-2a-0m	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0006	0.0006	No	n/a	0.00	FALSE
11-May-23	QUL-18-20m	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0008	0.0008	No	n/a	0.00	FALSE
15-May-23	E1a	<0.0000500	<0.0000450	No	n/a	n/a	FALSE	0.0122	0.0104	Yes	16%	n/a	FALSE
16-May-23	SERDS 22	<0.0000550	<0.0000550	No	n/a	n/a	FALSE	0.0138	0.0133	Yes	4%	n/a	FALSE
16-May-23	NEZ 2	<0.000180	<0.000175	No	n/a	n/a	FALSE	0.1670	0.1640	Yes	2%	n/a	FALSE
17-May-23	QUL-57-S	0.0000060	<0.0000050	No	n/a	n/a	FALSE	0.0080	0.0009	No	n/a	0.0071	TRUE
24-May-23	B1-B	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0024	0.0020	No	n/a	0.00	FALSE
25-May-23	QUL-58-B	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0011	0.0012	No	n/a	0.00	FALSE
30-May-23	HAD-3	<0.000110	<0.000100	No	n/a	n/a	FALSE	0.0091	0.0094	Yes	3%	n/a	FALSE
30-May-23	QUL-58-MP	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0010	0.0032	No	n/a	0.0022	TRUE
30-May-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
05-Jun-23	HAC-14	<0.0000050	0.0000056	No	n/a	n/a	FALSE	0.0081	0.0081	Yes	1%	n/a	FALSE
08-Jun-23	B1-S	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0029	0.0028	Yes	4%	n/a	FALSE
12-Jun-23	W5	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0059	0.0056	Yes	4%	n/a	FALSE
21-Jun-23	QUL-ZOO-7	0.0000938	0.0001680	Yes	57%	n/a	TRUE	0.0066	0.0067	Yes	2%	n/a	FALSE
26-Jun-23	QUL-2a-20m	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0014	0.0006	No	n/a	0.00	FALSE
27-Jun-23	QUL-58-AP	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0006	0.0008	No	n/a	0.00	FALSE
28-Jun-23	GW12-5a	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-23	HAC-10	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0043	0.0045	Yes	3%	n/a	FALSE
10-Jul-23	E19	<0.000185	<0.000185	No	n/a	n/a	FALSE	0.0182	0.0180	Yes	1%	n/a	FALSE
12-Jul-23	B1-S	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0023	0.0024	No	n/a	0.00	FALSE
26-Jul-23	P1-B	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0039	0.0039	Yes	1%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	0.0000703	0.0000662	Yes	6%	n/a	FALSE	0.0031	0.0031	Yes	2%	n/a	FALSE
27-Jul-23	95-R-5	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-23	E22	-	-	-	-	-	-	-	-	-	-	-	-
01-Aug-23	W4a	0.0000086	0.0000065	No	n/a	0.000002	FALSE	0.0049	0.0049	Yes	0%	n/a	FALSE
02-Aug-23	HAC-13	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0046	0.0045	Yes	3%	n/a	FALSE
07-Aug-23	HAC-D	<0.0000050	0.0000074	No	n/a	n/a	FALSE	0.0069	0.0071	Yes	2%	n/a	FALSE
09-Aug-23	MDC	<0.0000600	<0.0000550	No	n/a	n/a	FALSE	0.0185	0.0194	Yes	5%	n/a	FALSE
10-Aug-23	GW11-1a	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-23	E26	<0.0000550	<0.0000500	No	n/a	n/a	FALSE	0.1610	0.1540	Yes	4%	n/a	FALSE

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

Date	Site	Cd-T DL = 0.00001						Cu-T DL = 0.0005					
		Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	<0.0000500	<0.0000400	No	n/a	n/a	FALSE	0.0049	0.0051	Yes	4%	n/a	FALSE
21-Aug-23	GW11-2b	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-23	E10	0.0007560	0.0008450	Yes	11%	n/a	FALSE	0.0123	0.0135	Yes	9%	n/a	FALSE
22-Aug-23	E19	<0.000135	<0.000145	No	n/a	n/a	FALSE	0.0061	0.0060	Yes	1%	n/a	FALSE
24-Aug-23	P2-B	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0042	0.0042	Yes	1%	n/a	FALSE
31-Aug-23	E24	<0.000175	0.0001740	No	n/a	n/a	FALSE	0.0922	0.0916	Yes	1%	n/a	FALSE
05-Sep-23	W5	0.0000191	0.0000103	No	n/a	0.000009	FALSE	0.0085	0.0063	Yes	30%	n/a	TRUE
06-Sep-23	HAC-05a	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0045	0.0044	Yes	2%	n/a	FALSE
07-Sep-23	B2-AT	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0020	0.0020	No	n/a	0.00	FALSE
11-Sep-23	QUL-2a-0m	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0006	0.0007	No	n/a	0.00	FALSE
19-Sep-23	W12	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0011	0.0011	No	n/a	0.00	FALSE
20-Sep-23	GW12-2a	-	-	-	-	-	-	-	-	-	-	-	-
20-Sep-23	GW12-1a	-	-	-	-	-	-	-	-	-	-	-	-
27-Sep-23	WIP-10m	0.0011200	0.0011800	Yes	5%	n/a	FALSE	0.0136	0.0135	Yes	1%	n/a	FALSE
28-Sep-23	P2-BT	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0037	0.0036	Yes	3%	n/a	FALSE
03-Oct-23	HAC-08	<0.0000050	<0.0000100	No	n/a	n/a	FALSE	0.0062	0.0066	Yes	5%	n/a	FALSE
05-Oct-23	E4	<0.0000900	<0.000970	No	n/a	n/a	FALSE	0.0067	0.0061	Yes	8%	n/a	FALSE
05-Oct-23	PAG Seep 15	<0.0000550	<0.0000550	No	n/a	n/a	FALSE	0.0078	0.0082	Yes	6%	n/a	FALSE
10-Oct-23	B1-B	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0020	0.0020	No	n/a	0.00	FALSE
16-Oct-23	E24	<0.000185	<0.000175	No	n/a	n/a	FALSE	0.0919	0.0916	Yes	0%	n/a	FALSE
17-Oct-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
18-Oct-23	P1-S	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0038	0.0038	Yes	1%	n/a	FALSE
19-Oct-23	GW12-4a	-	-	-	-	-	-	-	-	-	-	-	-
30-Oct-23	SERDS23	<0.000200	<0.000200	No	n/a	n/a	FALSE	0.0209	0.0189	Yes	10%	n/a	FALSE
30-Oct-23	QUL-18-20m	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0006	0.0006	No	n/a	0.00	FALSE
31-Oct-23	QUL-59-B	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0007	0.0006	No	n/a	0.00	FALSE
01-Nov-23	WIP-20m	0.0012700	0.0011100	Yes	13%	n/a	FALSE	0.0108	0.0102	Yes	6%	n/a	FALSE
02-Nov-23	EDC-01a	<0.0000050	0.0000056	No	n/a	n/a	FALSE	0.0052	0.0052	Yes	0%	n/a	FALSE
08-Nov-23	E1a	<0.0000600	<0.0000550	No	n/a	n/a	FALSE	0.0072	0.0063	Yes	12%	n/a	FALSE
14-Nov-23	GW12-4a	-	-	-	-	-	-	-	-	-	-	-	-
14-Nov-23	GW15-2a	-	-	-	-	-	-	-	-	-	-	-	-
22-Nov-23	GW16-1a	-	-	-	-	-	-	-	-	-	-	-	-
28-Nov-23	E19a	<0.000105	<0.0000950	No	n/a	n/a	FALSE	0.0112	0.0118	Yes	5%	n/a	FALSE
06-Dec-23	HAC-08	<0.0000050	<0.0000050	No	n/a	n/a	FALSE	0.0074	0.0070	Yes	6%	n/a	FALSE
13-Dec-23	95-R-5	-	-	-	-	-	-	-	-	-	-	-	-
13-Dec-23	GW96-7	-	-	-	-	-	-	-	-	-	-	-	-

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

		Fe-T DL = 0.030						Mn-T DL = 0.00010					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	0.035	0.034	No	n/a	0.00	FALSE	0.03900	0.03850	Yes	1%	n/a	FALSE
05-Jan-23	E10	0.035	<0.030	No	n/a	n/a	FALSE	0.01070	0.01040	Yes	3%	n/a	FALSE
10-Jan-23	E24	<0.030	<0.030	No	n/a	n/a	FALSE	0.22200	0.22500	Yes	1%	n/a	FALSE
11-Jan-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
11-Jan-23	WIP-30m	<0.050	<0.050	No	n/a	n/a	FALSE	0.43800	0.44500	Yes	2%	n/a	FALSE
12-Jan-23	W4a	0.040	0.032	No	n/a	0.01	FALSE	0.00401	0.00374	Yes	7%	n/a	FALSE
17-Jan-23	HAD-3	0.085	0.067	No	n/a	0.02	FALSE	0.07180	0.07040	Yes	2%	n/a	FALSE
19-Jan-23	E4	0.146	0.081	No	n/a	0.0650	TRUE	0.07100	0.06740	Yes	5%	n/a	FALSE
19-Jan-23	GW12-2a	-	-	-	-	-	-	-	-	-	-	-	-
23-Jan-23	E14	0.054	0.042	No	n/a	0.01	FALSE	0.00579	0.00534	Yes	8%	n/a	FALSE
24-Jan-23	W12	0.720	0.727	Yes	1%	n/a	FALSE	0.22200	0.22100	Yes	0%	n/a	FALSE
01-Feb-23	E8	0.037	0.039	No	n/a	0.00	FALSE	0.05710	0.06010	Yes	5%	n/a	FALSE
07-Feb-23	E19	0.096	0.094	No	n/a	0.00	FALSE	0.07900	0.07830	Yes	1%	n/a	FALSE
08-Feb-23	HAC-10	<0.030	0.037	No	n/a	n/a	FALSE	0.00240	0.00268	Yes	11%	n/a	FALSE
16-Feb-23	WIP-20m	<0.050	<0.050	No	n/a	n/a	FALSE	0.26800	0.27500	Yes	3%	n/a	FALSE
21-Feb-23	E1a	0.142	0.114	No	n/a	0.03	FALSE	0.01340	0.01270	Yes	5%	n/a	FALSE
02-Mar-23	WIP-S	<0.030	<0.030	No	n/a	n/a	FALSE	0.01170	0.01140	Yes	3%	n/a	FALSE
06-Mar-23	E21	0.327	0.217	Yes	40%	n/a	TRUE	0.02090	0.01820	Yes	14%	n/a	FALSE
07-Mar-23	EDC-01a	0.031	<0.030	No	n/a	n/a	FALSE	0.03300	0.03230	Yes	2%	n/a	FALSE
08-Mar-23	W4a	<0.030	<0.030	No	n/a	n/a	FALSE	0.00232	0.00118	Yes	65%	n/a	TRUE
09-Mar-23	WIP-10m	<0.030	<0.050	No	n/a	n/a	FALSE	0.06930	0.06960	Yes	0%	n/a	FALSE
14-Mar-23	E10	1.090	0.911	Yes	18%	n/a	FALSE	0.07470	0.06860	Yes	9%	n/a	FALSE
20-Mar-23	WIP-20m	<0.050	<0.050	No	n/a	n/a	FALSE	0.34000	0.34200	Yes	1%	n/a	FALSE
03-Apr-23	HAC-10	<0.030	<0.030	No	n/a	n/a	FALSE	0.01000	0.00978	Yes	2%	n/a	FALSE
05-Apr-23	WIP-30m	<0.050	<0.050	No	n/a	n/a	FALSE	0.58400	0.58900	Yes	1%	n/a	FALSE
12-Apr-23	W4a	0.550	0.550	Yes	0%	n/a	FALSE	0.01140	0.01130	Yes	1%	n/a	FALSE
13-Apr-23	E13	0.182	0.198	Yes	8%	n/a	FALSE	0.03610	0.03720	Yes	3%	n/a	FALSE
20-Apr-23	E11c	0.065	0.047	No	n/a	0.02	FALSE	0.09110	0.09010	Yes	1%	n/a	FALSE
24-Apr-23	E14	0.320	0.335	Yes	5%	n/a	FALSE	0.02630	0.02690	Yes	2%	n/a	FALSE
26-Apr-23	E24	0.120	0.124	No	n/a	0.00	FALSE	0.20900	0.20700	Yes	1%	n/a	FALSE
01-May-23	GW96-4b	-	-	-	-	-	-	-	-	-	-	-	-
01-May-23	HAC-05a	<0.050	<0.050	No	n/a	n/a	FALSE	0.03250	0.03330	Yes	2%	n/a	FALSE
03-May-23	GW96-2a	-	-	-	-	-	-	-	-	-	-	-	-
03-May-23	GW16-2a	-	-	-	-	-	-	-	-	-	-	-	-
03-May-23	E11c	0.052	0.055	No	n/a	0.00	FALSE	0.10200	0.10200	Yes	0%	n/a	FALSE
08-May-23	E21	0.226	0.228	Yes	1%	n/a	FALSE	0.02920	0.02840	Yes	3%	n/a	FALSE
10-May-23	QUL-58-MID	0.030	<0.030	No	n/a	n/a	FALSE	0.00172	0.00164	Yes	5%	n/a	FALSE
10-May-23	QUL-120a-120m	<0.030	<0.030	No	n/a	n/a	FALSE	0.00117	0.00117	Yes	0%	n/a	FALSE
11-May-23	QUL-2a-0m	<0.030	<0.030	No	n/a	n/a	FALSE	0.00136	0.00138	Yes	1%	n/a	FALSE
11-May-23	QUL-18-20m	<0.030	<0.030	No	n/a	n/a	FALSE	0.00118	0.00116	Yes	2%	n/a	FALSE
15-May-23	E1a	0.273	0.145	No	n/a	0.1280	TRUE	0.01850	0.01600	Yes	14%	n/a	FALSE
16-May-23	SERDS 22	0.229	0.182	Yes	23%	n/a	FALSE	0.01840	0.01660	Yes	10%	n/a	FALSE
16-May-23	NEZ 2	0.142	0.117	No	n/a	0.03	FALSE	0.10500	0.10500	Yes	0%	n/a	FALSE
17-May-23	QUL-57-S	0.137	<0.030	No	n/a	n/a	FALSE	0.00572	0.00170	Yes	108%	n/a	TRUE
24-May-23	B1-B	0.040	0.043	No	n/a	0.00	FALSE	0.01640	0.01730	Yes	5%	n/a	FALSE
25-May-23	QUL-58-B	<0.030	<0.030	No	n/a	n/a	FALSE	0.00158	0.00149	Yes	6%	n/a	FALSE
30-May-23	HAD-3	0.034	0.050	No	n/a	0.02	FALSE	0.08400	0.08500	Yes	1%	n/a	FALSE
30-May-23	QUL-58-MP	<0.030	0.072	No	n/a	n/a	FALSE	0.00129	0.00280	Yes	74%	n/a	TRUE
30-May-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
05-Jun-23	HAC-14	0.037	0.039	No	n/a	0.00	FALSE	0.01160	0.01180	Yes	2%	n/a	FALSE
08-Jun-23	B1-S	0.057	0.046	No	n/a	0.01	FALSE	0.00928	0.00868	Yes	7%	n/a	FALSE
12-Jun-23	W5	0.083	0.067	No	n/a	0.02	FALSE	0.00877	0.00978	Yes	11%	n/a	FALSE
21-Jun-23	QUL-ZOO-7	0.119	0.145	No	n/a	0.03	FALSE	0.00565	0.00640	Yes	12%	n/a	FALSE
26-Jun-23	QUL-2a-20m	<0.030	<0.030	No	n/a	n/a	FALSE	0.00166	0.00131	Yes	24%	n/a	FALSE
27-Jun-23	QUL-58-AP	<0.030	<0.030	No	n/a	n/a	FALSE	0.00141	0.00133	Yes	6%	n/a	FALSE
28-Jun-23	GW12-5a	-	-	-	-	-	-	-	-	-	-	-	-
06-Jul-23	HAC-10	0.038	0.042	No	n/a	0.00	FALSE	0.01440	0.01500	Yes	4%	n/a	FALSE
10-Jul-23	E19	0.328	0.344	Yes	5%	n/a	FALSE	0.18200	0.18100	Yes	1%	n/a	FALSE
12-Jul-23	B1-S	<0.030	<0.030	No	n/a	n/a	FALSE	0.01100	0.01090	Yes	1%	n/a	FALSE
26-Jul-23	P1-B	<0.030	<0.030	No	n/a	n/a	FALSE	0.01770	0.01830	Yes	3%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	0.037	0.035	No	n/a	0.00	FALSE	0.00258	0.00247	Yes	4%	n/a	FALSE
27-Jul-23	95-R-5	-	-	-	-	-	-	-	-	-	-	-	-
31-Jul-23	E22	0.043	0.046	No	n/a	0.00	FALSE	0.01290	0.01390	Yes	7%	n/a	FALSE
01-Aug-23	W4a	<0.030	<0.030	No	n/a	n/a	FALSE	0.00389	0.00356	Yes	9%	n/a	FALSE
02-Aug-23	HAC-13	0.047	0.046	No	n/a	0.00	FALSE	0.01950	0.01890	Yes	3%	n/a	FALSE
07-Aug-23	HAC-D	0.037	0.041	No	n/a	0.00	FALSE	0.01120	0.01140	Yes	2%	n/a	FALSE
09-Aug-23	MDC	<0.030	<0.030	No	n/a	n/a	FALSE	0.00942	0.01070	Yes	13%	n/a	FALSE
10-Aug-23	GW11-1a	-	-	-	-	-	-	-	-	-	-	-	-
16-Aug-23	E26	0.464	0.452	Yes	3%	n/a	FALSE	0.01930	0.01890	Yes	2%	n/a	FALSE

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

		Fe-T DL = 0.030						Mn-T DL = 0.0001					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	0.180	0.184	Yes	2%	n/a	FALSE	0.01580	0.01620	Yes	2%	n/a	FALSE
21-Aug-23	GW11-2b	-	-	-	-	-	-	-	-	-	-	-	-
21-Aug-23	E10	<0.150	<0.050	No	n/a	n/a	FALSE	0.17500	0.18300	Yes	4%	n/a	FALSE
22-Aug-23	E19	0.049	0.045	No	n/a	0.00	FALSE	0.08420	0.08340	Yes	1%	n/a	FALSE
24-Aug-23	P2-B	0.033	0.030	No	n/a	0.00	FALSE	0.03720	0.03880	Yes	4%	n/a	FALSE
31-Aug-23	E24	<0.030	<0.030	No	n/a	n/a	FALSE	0.07480	0.07340	Yes	2%	n/a	FALSE
05-Sep-23	W5	0.420	0.211	Yes	66%	n/a	TRUE	0.11600	0.07800	Yes	39%	n/a	TRUE
06-Sep-23	HAC-05a	<0.030	<0.030	No	n/a	n/a	FALSE	0.02690	0.02560	Yes	5%	n/a	FALSE
07-Sep-23	B2-AT	<0.030	<0.030	No	n/a	n/a	FALSE	0.01130	0.01140	Yes	1%	n/a	FALSE
11-Sep-23	QUL-2a-0m	<0.030	<0.030	No	n/a	n/a	FALSE	0.00084	0.00096	Yes	13%	n/a	FALSE
19-Sep-23	W12	0.645	0.661	Yes	2%	n/a	FALSE	1.49000	1.50000	Yes	1%	n/a	FALSE
20-Sep-23	GW12-2a	-	-	-	-	-	-	-	-	-	-	-	-
20-Sep-23	GW12-1a	-	-	-	-	-	-	-	-	-	-	-	-
27-Sep-23	WIP-10m	<0.050	<0.050	No	n/a	n/a	FALSE	0.64000	0.64600	Yes	1%	n/a	FALSE
28-Sep-23	P2-BT	<0.030	<0.030	No	n/a	n/a	FALSE	0.01050	0.01030	Yes	2%	n/a	FALSE
03-Oct-23	HAC-08	<0.030	<0.030	No	n/a	n/a	FALSE	0.00593	0.00620	Yes	4%	n/a	FALSE
05-Oct-23	E4	0.041	<0.030	No	n/a	n/a	FALSE	0.04630	0.04360	Yes	6%	n/a	FALSE
05-Oct-23	PAG Seep 15	0.032	0.054	No	n/a	0.02	FALSE	0.04780	0.05040	Yes	5%	n/a	FALSE
10-Oct-23	B1-B	0.092	0.090	No	n/a	0.00	FALSE	0.05190	0.05120	Yes	1%	n/a	FALSE
16-Oct-23	E24	<0.030	<0.030	No	n/a	n/a	FALSE	0.06870	0.06790	Yes	1%	n/a	FALSE
17-Oct-23	GW16-6a	-	-	-	-	-	-	-	-	-	-	-	-
18-Oct-23	P1-S	<0.030	<0.030	No	n/a	n/a	FALSE	0.00402	0.00409	Yes	2%	n/a	FALSE
19-Oct-23	GW12-4a	-	-	-	-	-	-	-	-	-	-	-	-
30-Oct-23	SERDS23	0.514	0.425	Yes	19%	n/a	FALSE	0.03960	0.03420	Yes	15%	n/a	FALSE
30-Oct-23	QUL-18-20m	<0.030	<0.030	No	n/a	n/a	FALSE	0.00069	0.00070	Yes	1%	n/a	FALSE
31-Oct-23	QUL-59-B	<0.030	<0.030	No	n/a	n/a	FALSE	0.00080	0.00076	Yes	5%	n/a	FALSE
01-Nov-23	WIP-20m	0.133	0.130	No	n/a	0.00	FALSE	0.89200	0.86900	Yes	3%	n/a	FALSE
02-Nov-23	EDC-01a	<0.030	<0.030	No	n/a	n/a	FALSE	0.04700	0.04740	Yes	1%	n/a	FALSE
08-Nov-23	E1a	0.105	0.096	No	n/a	0.01	FALSE	0.06810	0.06790	Yes	0%	n/a	FALSE
14-Nov-23	GW12-4a	-	-	-	-	-	-	-	-	-	-	-	-
14-Nov-23	GW15-2a	-	-	-	-	-	-	-	-	-	-	-	-
22-Nov-23	GW16-1a	-	-	-	-	-	-	-	-	-	-	-	-
28-Nov-23	E19a	0.132	0.134	No	n/a	0.00	FALSE	0.44800	0.45100	Yes	1%	n/a	FALSE
06-Dec-23	HAC-08	0.119	0.096	No	n/a	0.02	FALSE	0.01770	0.01390	Yes	24%	n/a	FALSE
13-Dec-23	95-R-5	-	-	-	-	-	-	-	-	-	-	-	-
13-Dec-23	GW96-7	-	-	-	-	-	-	-	-	-	-	-	-

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

Se-T
DL = 0.00005

Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	0.001140	0.001160	Yes	2%	n/a	FALSE
05-Jan-23	E10	0.044100	0.042200	Yes	4%	n/a	FALSE
10-Jan-23	E24	0.093900	0.092400	Yes	2%	n/a	FALSE
11-Jan-23	GW16-6a	-	-	-	-	-	-
11-Jan-23	WIP-30m	0.027100	0.026900	Yes	1%	n/a	FALSE
12-Jan-23	W4a	0.004170	0.004010	Yes	4%	n/a	FALSE
17-Jan-23	HAD-3	0.037900	0.037700	Yes	1%	n/a	FALSE
19-Jan-23	E4	0.005710	0.005750	Yes	1%	n/a	FALSE
19-Jan-23	GW12-2a	-	-	-	-	-	-
23-Jan-23	E14	0.016000	0.016100	Yes	1%	n/a	FALSE
24-Jan-23	W12	0.000054	0.000070	No	n/a	0.00	FALSE
01-Feb-23	E8	0.052900	0.054100	Yes	2%	n/a	FALSE
07-Feb-23	E19	0.035700	0.035500	Yes	1%	n/a	FALSE
08-Feb-23	HAC-10	0.000580	0.000537	Yes	8%	n/a	FALSE
16-Feb-23	WIP-20m	0.036300	0.034200	Yes	6%	n/a	FALSE
21-Feb-23	E1a	0.026900	0.026700	Yes	1%	n/a	FALSE
02-Mar-23	WIP-S	0.039200	0.038000	Yes	3%	n/a	FALSE
06-Mar-23	E21	0.027000	0.026200	Yes	3%	n/a	FALSE
07-Mar-23	EDC-01a	0.000952	0.000967	Yes	2%	n/a	FALSE
08-Mar-23	W4a	0.001680	0.001430	Yes	16%	n/a	FALSE
09-Mar-23	WIP-10m	0.037700	0.036400	Yes	4%	n/a	FALSE
14-Mar-23	E10	0.035900	0.035100	Yes	2%	n/a	FALSE
20-Mar-23	WIP-20m	0.030000	0.030200	Yes	1%	n/a	FALSE
03-Apr-23	HAC-10	0.000527	0.000536	Yes	2%	n/a	FALSE
05-Apr-23	WIP-30m	0.012200	0.012300	Yes	1%	n/a	FALSE
12-Apr-23	W4a	0.001730	0.002010	Yes	15%	n/a	FALSE
13-Apr-23	E13	0.050300	0.053200	Yes	6%	n/a	FALSE
20-Apr-23	E11c	0.038500	0.038200	Yes	1%	n/a	FALSE
24-Apr-23	E14	0.026500	0.026000	Yes	2%	n/a	FALSE
26-Apr-23	E24	0.086600	0.088200	Yes	2%	n/a	FALSE
01-May-23	GW96-4b	-	-	-	-	-	-
01-May-23	HAC-05a	0.001700	0.001720	Yes	1%	n/a	FALSE
03-May-23	GW96-2a	-	-	-	-	-	-
03-May-23	GW16-2a	-	-	-	-	-	-
03-May-23	E11c	0.028300	0.028100	Yes	1%	n/a	FALSE
08-May-23	E21	0.025900	0.026000	Yes	0%	n/a	FALSE
10-May-23	QUL-58-MID	0.000280	0.000238	No	n/a	0.00	FALSE
10-May-23	QUL-120a-120m	0.000120	0.000104	No	n/a	0.00	FALSE
11-May-23	QUL-2a-0m	0.000185	0.000149	No	n/a	0.00	FALSE
11-May-23	QUL-18-20m	0.000258	0.000214	No	n/a	0.00	FALSE
15-May-23	E1a	0.026900	0.027300	Yes	1%	n/a	FALSE
16-May-23	SERDS 22	0.063800	0.065200	Yes	2%	n/a	FALSE
16-May-23	NEZ 2	0.107000	0.110000	Yes	3%	n/a	FALSE
17-May-23	QUL-57-S	0.000188	0.000149	No	n/a	0.00	FALSE
24-May-23	B1-B	0.000194	0.000221	No	n/a	0.00	FALSE
25-May-23	QUL-58-B	0.000443	0.000595	Yes	29%	n/a	FALSE
30-May-23	HAD-3	0.045700	0.044400	Yes	3%	n/a	FALSE
30-May-23	QUL-58-MP	0.000388	0.000406	Yes	5%	n/a	FALSE
30-May-23	GW16-6a	-	-	-	-	-	-
05-Jun-23	HAC-14	0.001410	0.001450	Yes	3%	n/a	FALSE
08-Jun-23	B1-S	0.000224	0.000222	No	n/a	0.00	FALSE
12-Jun-23	W5	0.000195	0.000202	No	n/a	0.00	FALSE
21-Jun-23	QUL-ZOO-7	0.000168	0.000186	No	n/a	0.00	FALSE
26-Jun-23	QUL-2a-20m	0.000139	0.000095	No	n/a	0.00	FALSE
27-Jun-23	QUL-58-AP	0.000155	0.000129	No	n/a	0.00	FALSE
28-Jun-23	GW12-5a	-	-	-	-	-	-
06-Jul-23	HAC-10	0.000520	0.000545	Yes	5%	n/a	FALSE
10-Jul-23	E19	0.042100	0.043300	Yes	3%	n/a	FALSE
12-Jul-23	B1-S	0.000279	0.000209	No	n/a	0.00	FALSE
26-Jul-23	P1-B	0.000500	0.000487	Yes	3%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	0.000133	0.000152	No	n/a	0.00	FALSE
27-Jul-23	95-R-5	-	-	-	-	-	-
31-Jul-23	E22	0.112000	0.110000	Yes	2%	n/a	FALSE
01-Aug-23	W4a	0.000597	0.000662	Yes	10%	n/a	FALSE
02-Aug-23	HAC-13	0.000536	0.000529	Yes	1%	n/a	FALSE
07-Aug-23	HAC-D	0.000875	0.000958	Yes	9%	n/a	FALSE
09-Aug-23	MDC	0.023200	0.023000	Yes	1%	n/a	FALSE
10-Aug-23	GW11-1a	-	-	-	-	-	-
16-Aug-23	E26	0.039600	0.038800	Yes	2%	n/a	FALSE

MPMC Annual Report 2023
Table 1
QA/QC Field Replicate Comparison

TOTAL METALS

Se-T

DL = 0.00005

Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	0.028500	0.028800	Yes	1%	n/a	FALSE
21-Aug-23	GW11-2b	-	-	-	-	-	-
21-Aug-23	E10	0.023500	0.023600	Yes	0%	n/a	FALSE
22-Aug-23	E19	0.035500	0.035100	Yes	1%	n/a	FALSE
24-Aug-23	P2-B	0.000511	0.000470	Yes	8%	n/a	FALSE
31-Aug-23	E24	0.094800	0.097400	Yes	3%	n/a	FALSE
05-Sep-23	W5	0.000148	0.000118	No	n/a	0.00	FALSE
06-Sep-23	HAC-05a	0.001080	0.001050	Yes	3%	n/a	FALSE
07-Sep-23	B2-AT	0.000208	0.000206	No	n/a	0.00	FALSE
11-Sep-23	QUL-2a-0m	0.000121	0.000111	No	n/a	0.00	FALSE
19-Sep-23	W12	0.000094	0.000085	No	n/a	0.00	FALSE
20-Sep-23	GW12-2a	-	-	-	-	-	-
20-Sep-23	GW12-1a	-	-	-	-	-	-
27-Sep-23	WIP-10m	0.004690	0.005000	Yes	6%	n/a	FALSE
28-Sep-23	P2-BT	0.000482	0.000570	Yes	17%	n/a	FALSE
03-Oct-23	HAC-08	0.001250	0.001200	Yes	4%	n/a	FALSE
05-Oct-23	E4	0.010000	0.010000	Yes	0%	n/a	FALSE
05-Oct-23	PAG Seep 15	0.080500	0.079900	Yes	1%	n/a	FALSE
10-Oct-23	B1-B	0.000178	0.000229	No	n/a	0.00	FALSE
16-Oct-23	E24	0.082600	0.082200	Yes	0%	n/a	FALSE
17-Oct-23	GW16-6a	-	-	-	-	-	-
18-Oct-23	P1-S	0.000507	0.000532	Yes	5%	n/a	FALSE
19-Oct-23	GW12-4a	-	-	-	-	-	-
30-Oct-23	SERDS23	0.341000	0.342000	Yes	0%	n/a	FALSE
30-Oct-23	QUL-18-20m	0.000135	0.000124	No	n/a	0.00	FALSE
31-Oct-23	QUL-59-B	0.000163	0.000170	No	n/a	0.00	FALSE
01-Nov-23	WIP-20m	0.003350	0.003140	Yes	6%	n/a	FALSE
02-Nov-23	EDC-01a	0.001380	0.001330	Yes	4%	n/a	FALSE
08-Nov-23	E1a	0.028400	0.028400	Yes	0%	n/a	FALSE
14-Nov-23	GW12-4a	-	-	-	-	-	-
14-Nov-23	GW15-2a	-	-	-	-	-	-
22-Nov-23	GW16-1a	-	-	-	-	-	-
28-Nov-23	E19a	0.035500	0.035300	Yes	1%	n/a	FALSE
06-Dec-23	HAC-08	0.001760	0.001710	Yes	3%	n/a	FALSE
13-Dec-23	95-R-5	-	-	-	-	-	-
13-Dec-23	GW96-7	-	-	-	-	-	-

MPMC Annual Report 2023
Table 2
QA/QC Field Replicate Comparison

DISSOLVED METALS

		Al-D DL = 0.003						Cu-D DL = 0.0005					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0056	0.0057	Yes	2.8%	n/a	FALSE
05-Jan-23	E10	<0.0060	<0.0030	No	n/a	n/a	FALSE	0.0083	0.0082	Yes	0.7%	n/a	FALSE
10-Jan-23	E24	0.0071	0.0079	No	n/a	0.0008	FALSE	0.1200	0.1180	Yes	1.7%	n/a	FALSE
11-Jan-23	GW16-6a	0.0030	0.0031	No	n/a	1E-04	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
11-Jan-23	WIP-30m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.0175	0.0175	Yes	0.0%	n/a	FALSE
12-Jan-23	W4a	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0052	0.0051	Yes	2.1%	n/a	FALSE
17-Jan-23	HAD-3	0.2150	0.1730	Yes	21.6%	n/a	FALSE	0.0041	0.0038	Yes	8.1%	n/a	FALSE
19-Jan-23	E4	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0036	0.0036	Yes	0.0%	n/a	FALSE
19-Jan-23	GW12-2a	0.0047	0.0048	No	n/a	1E-04	FALSE	0.0007	0.0007	No	n/a	0.00001	FALSE
23-Jan-23	E14	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0057	0.0057	Yes	0.2%	n/a	FALSE
24-Jan-23	W12	0.0077	0.0081	No	n/a	0.0004	FALSE	0.0023	0.0023	No	n/a	2E-05	FALSE
01-Feb-23	E8	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0173	0.0172	Yes	0.6%	n/a	FALSE
07-Feb-23	E19	0.0085	0.0092	No	n/a	0.0007	FALSE	0.0033	0.0032	Yes	3.0%	n/a	FALSE
08-Feb-23	HAC-10	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0037	0.0038	Yes	0.8%	n/a	FALSE
16-Feb-23	WIP-20m	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0182	0.0184	Yes	1.1%	n/a	FALSE
21-Feb-23	E1a	0.0218	0.0188	Yes	14.8%	n/a	FALSE	0.0010	0.0009	No	n/a	0.00011	FALSE
02-Mar-23	WIP-S	0.0030	<0.0030	No	n/a	n/a	FALSE	0.0083	0.0083	Yes	0.1%	n/a	FALSE
06-Mar-23	E21	0.0164	0.0172	Yes	4.8%	n/a	FALSE	0.0011	0.0011	No	n/a	3E-05	FALSE
07-Mar-23	EDC-01a	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0057	0.0057	Yes	0.9%	n/a	FALSE
08-Mar-23	W4a	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0033	0.0033	Yes	2.4%	n/a	FALSE
09-Mar-23	WIP-10m	0.0057	0.0066	No	n/a	0.0009	FALSE	0.0121	0.0125	Yes	3.3%	n/a	FALSE
14-Mar-23	E10	0.0052	0.0069	No	n/a	0.0017	FALSE	0.0102	0.0100	Yes	2.0%	n/a	FALSE
20-Mar-23	WIP-20m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.0174	0.0175	Yes	0.6%	n/a	FALSE
03-Apr-23	HAC-10	<0.0030	0.0037	No	n/a	n/a	FALSE	0.0039	0.0043	Yes	8.5%	n/a	FALSE
05-Apr-23	WIP-30m	<0.0150	<0.0150	No	n/a	n/a	FALSE	0.0111	0.0114	Yes	2.7%	n/a	FALSE
12-Apr-23	W4a	0.0641	0.0581	Yes	9.8%	n/a	FALSE	0.0095	0.0094	Yes	0.8%	n/a	FALSE
13-Apr-23	E13	0.0092	0.0102	No	n/a	0.001	FALSE	0.0084	0.0083	Yes	0.5%	n/a	FALSE
20-Apr-23	E11c	0.0058	0.0035	No	n/a	0.0023	FALSE	0.0082	0.0082	Yes	0.1%	n/a	FALSE
24-Apr-23	E14	0.0178	0.0175	Yes	1.7%	n/a	FALSE	0.0139	0.0138	Yes	0.7%	n/a	FALSE
26-Apr-23	E24	0.0115	0.0120	No	n/a	0.0005	FALSE	0.0903	0.0916	Yes	1.4%	n/a	FALSE
01-May-23	GW96-4b	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0006	0.0007	No	n/a	0.00003	FALSE
01-May-23	HAC-05a	0.1030	0.0980	Yes	5.0%	n/a	FALSE	0.0294	0.0289	Yes	1.7%	n/a	FALSE
03-May-23	GW96-2a	0.0064	0.0038	No	n/a	0.0026	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
03-May-23	GW16-2a	<0.0030	<0.0030	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
03-May-23	E11c	0.0062	0.0036	No	n/a	0.0026	FALSE	0.0263	0.0268	Yes	1.9%	n/a	FALSE
08-May-23	E21	0.0399	0.0402	Yes	0.7%	n/a	FALSE	0.0074	0.0075	Yes	1.7%	n/a	FALSE
10-May-23	QUL-58-MID	0.0118	0.0095	No	n/a	0.0023	FALSE	0.0009	0.0007	No	n/a	0.00017	FALSE
10-May-23	QUL-120a-120m	0.0060	0.0045	No	n/a	0.0015	FALSE	0.0005	<0.00050	No	n/a	n/a	FALSE
11-May-23	QUL-2a-0m	0.0062	0.0068	No	n/a	0.0006	FALSE	0.0006	0.0006	No	n/a	0.00001	FALSE
11-May-23	QUL-18-20m	0.0100	0.0094	No	n/a	0.0006	FALSE	0.0007	0.0007	No	n/a	0.00004	FALSE
15-May-23	E1a	0.0528	0.0481	Yes	9.3%	n/a	FALSE	0.0040	0.0038	Yes	6.4%	n/a	FALSE
16-May-23	SERDS 22	0.0226	0.0092	No	n/a	0.0134	TRUE	0.0109	0.0108	Yes	0.9%	n/a	FALSE
16-May-23	NEZ 2	0.0093	0.0091	No	n/a	0.0002	FALSE	0.0853	0.0855	Yes	0.2%	n/a	FALSE
17-May-23	QUL-57-S	0.0090	0.0085	No	n/a	0.0005	FALSE	0.0006	0.0006	No	n/a	0.00001	FALSE
24-May-23	B1-B	0.0068	0.0052	No	n/a	0.0016	FALSE	0.0018	0.0018	No	n/a	3E-05	FALSE
25-May-23	QUL-58-B	0.0103	0.0111	No	n/a	0.0008	FALSE	0.0008	0.0009	No	n/a	0.00004	FALSE
30-May-23	HAD-3	0.1870	0.1910	Yes	2.1%	n/a	FALSE	0.0061	0.0063	Yes	3.4%	n/a	FALSE
30-May-23	QUL-58-MP	0.0102	0.0116	No	n/a	0.0014	FALSE	0.0007	0.0008	No	n/a	0.00003	FALSE
30-May-23	GW16-6a	0.0038	0.0036	No	n/a	0.0002	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
05-Jun-23	HAC-14	0.0095	0.0187	No	n/a	0.0092	TRUE	0.0070	0.0077	Yes	8.7%	n/a	FALSE
08-Jun-23	B1-S	0.0109	0.0189	No	n/a	0.0080	TRUE	0.0022	0.0028	No	n/a	0.00063	FALSE
12-Jun-23	W5	0.0345	0.0318	Yes	8.1%	n/a	FALSE	0.0052	0.0050	Yes	3.1%	n/a	FALSE
21-Jun-23	QUL-ZOO-7	0.0135	0.0119	No	n/a	0.0016	FALSE	0.0013	0.0014	No	n/a	0.00015	FALSE
26-Jun-23	QUL-2a-20m	0.0101	0.0068	No	n/a	0.0033	FALSE	0.0008	0.0007	No	n/a	0.00014	FALSE
27-Jun-23	QUL-58-AP	0.0071	0.0080	No	n/a	0.0009	FALSE	0.0006	0.0007	No	n/a	0.00008	FALSE
28-Jun-23	GW12-5a	<0.0030	<0.0030	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
06-Jul-23	HAC-10	0.0046	0.0046	No	n/a	0	FALSE	0.0041	0.0042	Yes	2.7%	n/a	FALSE
10-Jul-23	E19	0.0168	0.0086	No	n/a	0.0082	TRUE	0.0083	0.0070	Yes	17.2%	n/a	FALSE
12-Jul-23	B1-S	0.0168	0.0145	No	n/a	0.0023	FALSE	0.0030	0.0027	Yes	10.6%	n/a	FALSE
26-Jul-23	P1-B	<0.0030	0.0058	No	n/a	n/a	FALSE	0.0036	0.0036	Yes	0.3%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	0.0105	0.0136	No	n/a	0.0031	FALSE	0.0010	0.0011	No	n/a	1E-04	FALSE
27-Jul-23	95-R-5	0.0043	<0.0030	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
31-Jul-23	E22	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0203	0.0204	Yes	0.5%	n/a	FALSE
01-Aug-23	W4a	0.0037	0.0036	No	n/a	0.0001	FALSE	0.0045	0.0044	Yes	2.5%	n/a	FALSE
02-Aug-23	HAC-13	0.0040	0.0053	No	n/a	0.0013	FALSE	0.0037	0.0036	Yes	1.4%	n/a	FALSE
07-Aug-23	HAC-D	0.0040	0.0039	No	n/a	0.0001	FALSE	0.0061	0.0062	Yes	1.1%	n/a	FALSE
09-Aug-23	MDC	0.0040	0.0038	No	n/a	0.0002	FALSE	0.0172	0.0172	Yes	0.0%	n/a	FALSE
10-Aug-23	GW11-1a	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0009	0.0008	No	n/a	0.00003	FALSE
16-Aug-23	E26	0.0310	0.0314	Yes	1.3%	n/a	FALSE	0.0007	0.0008	No	n/a	0.00006	FALSE

MPMC Annual Report 2023
Table 2
QA/QC Field Replicate Comparison

DISSOLVED METALS

		Al-D DL = 0.003						Cu-D DL = 0.0005					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	0.0383	0.0357	Yes	7.0%	n/a	FALSE	0.0016	0.0017	No	n/a	6E-05	FALSE
21-Aug-23	GW11-2b	<0.0030	<0.0030	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
21-Aug-23	E10	0.0301	0.0074	No	n/a	0.0227	TRUE	0.0106	0.0114	Yes	7.3%	n/a	FALSE
22-Aug-23	E19	0.0060	0.0061	No	n/a	0.0001	FALSE	0.0052	0.0052	Yes	0.6%	n/a	FALSE
24-Aug-23	P2-B	<0.0030	<0.0030	No	n/a	n/a	FALSE	0.0035	0.0035	Yes	1.1%	n/a	FALSE
31-Aug-23	E24	0.0077	0.0318	No	n/a	0.0241	TRUE	0.0861	0.0870	Yes	1.0%	n/a	FALSE
05-Sep-23	W5	0.0117	0.0117	No	n/a	0	FALSE	0.0023	0.0023	No	n/a	0.00001	FALSE
06-Sep-23	HAC-05a	0.0035	0.0036	No	n/a	1E-04	FALSE	0.0039	0.0039	Yes	0.8%	n/a	FALSE
07-Sep-23	B2-AT	0.0039	0.0041	No	n/a	0.0002	FALSE	0.0019	0.0021	No	n/a	0.0002	FALSE
11-Sep-23	QUL-2a-0m	0.0151	0.0094	No	n/a	0.0057	FALSE	0.0009	0.0007	No	n/a	0.0002	FALSE
19-Sep-23	W12	0.0084	0.0085	No	n/a	0.0001	FALSE	0.0008	0.0008	No	n/a	0.00005	FALSE
20-Sep-23	GW12-2a	0.0056	0.0084	No	n/a	0.0028	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
20-Sep-23	GW12-1a	0.0063	0.0051	No	n/a	0.0012	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
27-Sep-23	WIP-10m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.0110	0.0114	Yes	3.6%	n/a	FALSE
28-Sep-23	P2-BT	0.0049	0.0030	No	n/a	0.0019	FALSE	0.0035	0.0033	Yes	5.8%	n/a	FALSE
03-Oct-23	HAC-08	0.0043	0.0037	No	n/a	0.0006	FALSE	0.0056	0.0058	Yes	4.2%	n/a	FALSE
05-Oct-23	E4	0.0075	0.0049	No	n/a	0.0026	FALSE	0.0053	0.0053	Yes	1.5%	n/a	FALSE
05-Oct-23	PAG Seep 15	0.0053	0.0483	No	n/a	0.0430	TRUE	0.0068	0.0068	Yes	0.1%	n/a	FALSE
10-Oct-23	B1-B	<0.0030	0.0052	No	n/a	n/a	FALSE	0.0019	0.0019	No	n/a	0.00009	FALSE
16-Oct-23	E24	0.0086	0.0080	No	n/a	0.0006	FALSE	0.0890	0.0871	Yes	2.2%	n/a	FALSE
17-Oct-23	GW16-6a	<0.0030	0.0032	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
18-Oct-23	P1-S	0.0059	0.0047	No	n/a	0.0012	FALSE	0.0035	0.0034	Yes	1.5%	n/a	FALSE
19-Oct-23	GW12-4a	0.0096	0.0088	No	n/a	0.0008	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
30-Oct-23	SERDS23	0.0115	0.0098	No	n/a	0.0017	FALSE	0.0060	0.0056	Yes	6.2%	n/a	FALSE
30-Oct-23	QUL-18-20m	0.0053	0.0072	No	n/a	0.0019	FALSE	0.0005	0.0056	No	n/a	0.00512	TRUE
31-Oct-23	QUL-59-B	0.0073	0.0051	No	n/a	0.0022	FALSE	0.0006	0.0005	No	n/a	0.00013	FALSE
01-Nov-23	WIP-20m	<0.0050	<0.0050	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
02-Nov-23	EDC-01a	0.0038	<0.0030	No	n/a	n/a	FALSE	0.0008	0.0008	No	n/a	1E-05	FALSE
08-Nov-23	E1a	0.0274	0.0155	Yes	55.5%	n/a	TRUE	0.0016	0.0016	No	n/a	4E-05	FALSE
14-Nov-23	GW12-4a	0.0030	0.0036	No	n/a	0.0006	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
14-Nov-23	GW15-2a	<0.0030	0.0038	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE
22-Nov-23	GW16-1a	0.0230	0.0223	Yes	3.1%	n/a	FALSE	0.0006	0.0005	No	n/a	0.00003	FALSE
28-Nov-23	E19a	0.0059	0.0036	No	n/a	0.0023	FALSE	0.0010	0.0010	No	n/a	7E-05	FALSE
06-Dec-23	HAC-08	0.0041	0.0044	No	n/a	0.0003	FALSE	0.0007	0.0007	No	n/a	2E-05	FALSE
13-Dec-23	95-R-5	0.0000	<0.0030	No	n/a	n/a	FALSE	0.0000	<0.00050	No	n/a	n/a	FALSE
13-Dec-23	GW96-7	<0.0030	<0.0030	No	n/a	n/a	FALSE	<0.00050	<0.00050	No	n/a	n/a	FALSE

MPMC Annual Report 2023
Table 2
QA/QC Field Replicate Comparison

DISSOLVED METALS

		K-D DL = 0.05						Mg-D DL = 0.1					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	1.020	1.040	Yes	1.9%	n/a	FALSE	9.95	9.69	Yes	2.6%	n/a	FALSE
05-Jan-23	E10	2.260	2.350	Yes	3.9%	n/a	FALSE	28.50	28.80	Yes	1.0%	n/a	FALSE
10-Jan-23	E24	2.090	2.080	Yes	0.5%	n/a	FALSE	58.60	57.70	Yes	1.5%	n/a	FALSE
11-Jan-23	GW16-6a	0.529	0.542	Yes	2.4%	n/a	FALSE	5.05	5.27	Yes	4.3%	n/a	FALSE
11-Jan-23	WIP-30m	3.100	3.040	Yes	2.0%	n/a	FALSE	60.20	63.70	Yes	5.6%	n/a	FALSE
12-Jan-23	W4a	0.545	0.550	Yes	0.9%	n/a	FALSE	8.16	8.38	Yes	2.7%	n/a	FALSE
17-Jan-23	HAD-3	7.780	7.540	Yes	3.1%	n/a	FALSE	23.30	22.60	Yes	3.1%	n/a	FALSE
19-Jan-23	E4	15.100	15.200	Yes	0.7%	n/a	FALSE	23.10	22.90	Yes	0.9%	n/a	FALSE
19-Jan-23	GW12-2a	0.187	0.183	No	n/a	0.004	FALSE	1.26	1.24	Yes	1.6%	n/a	FALSE
23-Jan-23	E14	1.330	1.350	Yes	1.5%	n/a	FALSE	23.40	23.70	Yes	1.3%	n/a	FALSE
24-Jan-23	W12	0.523	0.532	Yes	1.7%	n/a	FALSE	5.92	5.92	Yes	0.0%	n/a	FALSE
01-Feb-23	E8	2.080	2.050	Yes	1.5%	n/a	FALSE	28.50	28.50	Yes	0.0%	n/a	FALSE
07-Feb-23	E19	8.610	8.250	Yes	4.3%	n/a	FALSE	24.60	24.50	Yes	0.4%	n/a	FALSE
08-Feb-23	HAC-10	1.040	1.040	Yes	0.0%	n/a	FALSE	5.56	5.39	Yes	3.1%	n/a	FALSE
16-Feb-23	WIP-20m	2.680	2.600	Yes	3.0%	n/a	FALSE	58.40	59.60	Yes	2.0%	n/a	FALSE
21-Feb-23	E1a	16.100	16.000	Yes	0.6%	n/a	FALSE	14.60	14.60	Yes	0.0%	n/a	FALSE
02-Mar-23	WIP-S	2.160	2.120	Yes	1.9%	n/a	FALSE	28.10	28.00	Yes	0.4%	n/a	FALSE
06-Mar-23	E21	14.900	15.100	Yes	1.3%	n/a	FALSE	14.70	14.60	Yes	0.7%	n/a	FALSE
07-Mar-23	EDC-01a	1.000	0.996	Yes	0.4%	n/a	FALSE	8.83	8.75	Yes	0.9%	n/a	FALSE
08-Mar-23	W4a	0.460	0.461	Yes	0.2%	n/a	FALSE	7.15	7.06	Yes	1.3%	n/a	FALSE
09-Mar-23	WIP-10m	2.400	2.400	Yes	0.0%	n/a	FALSE	40.90	41.70	Yes	1.9%	n/a	FALSE
14-Mar-23	E10	1.970	1.940	Yes	1.5%	n/a	FALSE	24.60	24.30	Yes	1.2%	n/a	FALSE
20-Mar-23	WIP-20m	2.720	2.690	Yes	1.1%	n/a	FALSE	58.20	60.10	Yes	3.2%	n/a	FALSE
03-Apr-23	HAC-10	1.020	1.070	Yes	4.8%	n/a	FALSE	5.82	5.66	Yes	2.8%	n/a	FALSE
05-Apr-23	WIP-30m	3.010	2.990	Yes	0.7%	n/a	FALSE	62.60	61.30	Yes	2.1%	n/a	FALSE
12-Apr-23	W4a	0.473	0.472	Yes	0.2%	n/a	FALSE	6.28	6.35	Yes	1.1%	n/a	FALSE
13-Apr-23	E13	2.020	1.950	Yes	3.5%	n/a	FALSE	38.00	37.70	Yes	0.8%	n/a	FALSE
20-Apr-23	E11c	0.927	0.930	Yes	0.3%	n/a	FALSE	20.40	20.60	Yes	1.0%	n/a	FALSE
24-Apr-23	E14	1.350	1.330	Yes	1.5%	n/a	FALSE	16.40	16.20	Yes	1.2%	n/a	FALSE
26-Apr-23	E24	1.460	1.480	Yes	1.4%	n/a	FALSE	33.20	34.00	Yes	2.4%	n/a	FALSE
01-May-23	GW96-4b	0.713	0.713	Yes	0.0%	n/a	FALSE	46.80	46.40	Yes	0.9%	n/a	FALSE
01-May-23	HAC-05a	1.090	1.090	Yes	0.0%	n/a	FALSE	5.66	5.65	Yes	0.2%	n/a	FALSE
03-May-23	GW96-2a	2.100	2.140	Yes	1.9%	n/a	FALSE	19.70	19.80	Yes	0.5%	n/a	FALSE
03-May-23	GW16-2a	2.130	2.160	Yes	1.4%	n/a	FALSE	20.60	21.10	Yes	2.4%	n/a	FALSE
03-May-23	E11c	0.972	0.979	Yes	0.7%	n/a	FALSE	19.00	19.00	Yes	0.0%	n/a	FALSE
08-May-23	E21	8.590	8.960	Yes	4.2%	n/a	FALSE	12.90	13.20	Yes	2.3%	n/a	FALSE
10-May-23	QUL-58-MID	0.508	0.486	Yes	4.4%	n/a	FALSE	2.18	2.11	Yes	3.3%	n/a	FALSE
10-May-23	QUL-120a-120m	0.482	0.478	Yes	0.8%	n/a	FALSE	2.05	2.03	Yes	1.0%	n/a	FALSE
11-May-23	QUL-2a-0m	0.488	0.488	Yes	0.0%	n/a	FALSE	2.24	2.22	Yes	0.9%	n/a	FALSE
11-May-23	QUL-18-20m	0.508	0.504	Yes	0.8%	n/a	FALSE	2.23	2.19	Yes	1.8%	n/a	FALSE
15-May-23	E1a	10.800	10.900	Yes	0.9%	n/a	FALSE	11.60	11.50	Yes	0.9%	n/a	FALSE
16-May-23	SERDS 22	1.340	1.330	Yes	0.7%	n/a	FALSE	21.80	21.70	Yes	0.5%	n/a	FALSE
16-May-23	NEZ 2	1.860	1.870	Yes	0.5%	n/a	FALSE	47.60	47.10	Yes	1.1%	n/a	FALSE
17-May-23	QUL-57-S	0.518	0.520	Yes	0.4%	n/a	FALSE	2.05	2.07	Yes	1.0%	n/a	FALSE
24-May-23	B1-B	0.472	0.461	Yes	2.4%	n/a	FALSE	2.58	2.56	Yes	0.8%	n/a	FALSE
25-May-23	QUL-58-B	0.538	0.525	Yes	2.4%	n/a	FALSE	2.34	2.32	Yes	0.9%	n/a	FALSE
30-May-23	HAD-3	2.360	2.380	Yes	0.8%	n/a	FALSE	27.30	27.50	Yes	0.7%	n/a	FALSE
30-May-23	QUL-58-MP	0.542	0.539	Yes	0.6%	n/a	FALSE	2.36	2.34	Yes	0.9%	n/a	FALSE
30-May-23	GW16-6a	0.531	0.530	Yes	0.2%	n/a	FALSE	5.42	5.50	Yes	1.5%	n/a	FALSE
05-Jun-23	HAC-14	1.040	1.060	Yes	1.9%	n/a	FALSE	7.10	7.29	Yes	2.6%	n/a	FALSE
08-Jun-23	B1-S	0.441	0.452	Yes	2.5%	n/a	FALSE	2.54	2.57	Yes	1.2%	n/a	FALSE
12-Jun-23	W5	0.960	0.935	Yes	2.6%	n/a	FALSE	5.69	5.52	Yes	3.0%	n/a	FALSE
21-Jun-23	QUL-ZOO-7	0.552	0.582	Yes	5.3%	n/a	FALSE	2.19	2.23	Yes	1.8%	n/a	FALSE
26-Jun-23	QUL-2a-20m	0.531	0.534	Yes	0.6%	n/a	FALSE	2.05	2.06	Yes	0.5%	n/a	FALSE
27-Jun-23	QUL-58-AP	0.504	0.517	Yes	2.5%	n/a	FALSE	2.03	2.07	Yes	2.0%	n/a	FALSE
28-Jun-23	GW12-5a	0.468	0.450	Yes	3.9%	n/a	FALSE	6.05	5.82	Yes	3.9%	n/a	FALSE
06-Jul-23	HAC-10	0.985	0.995	Yes	1.0%	n/a	FALSE	5.25	5.28	Yes	0.6%	n/a	FALSE
10-Jul-23	E19	3.290	3.120	Yes	5.3%	n/a	FALSE	37.10	36.80	Yes	0.8%	n/a	FALSE
12-Jul-23	B1-S	0.497	0.490	Yes	1.4%	n/a	FALSE	2.69	2.67	Yes	0.7%	n/a	FALSE
26-Jul-23	P1-B	1.120	1.140	Yes	1.8%	n/a	FALSE	4.97	5.11	Yes	2.8%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	0.586	0.578	Yes	1.4%	n/a	FALSE	1.99	1.97	Yes	1.0%	n/a	FALSE
27-Jul-23	95-R-5	1.020	1.020	Yes	0.0%	n/a	FALSE	22.50	22.70	Yes	0.9%	n/a	FALSE
31-Jul-23	E22	1.810	1.820	Yes	0.6%	n/a	FALSE	59.60	59.00	Yes	1.0%	n/a	FALSE
01-Aug-23	W4a	0.487	0.492	Yes	1.0%	n/a	FALSE	6.84	7.00	Yes	2.3%	n/a	FALSE
02-Aug-23	HAC-13	1.020	0.996	Yes	2.4%	n/a	FALSE	5.91	5.89	Yes	0.3%	n/a	FALSE
07-Aug-23	HAC-D	1.030	1.040	Yes	1.0%	n/a	FALSE	6.74	7.04	Yes	4.4%	n/a	FALSE
09-Aug-23	MDC	1.980	1.980	Yes	0.0%	n/a	FALSE	27.40	27.40	Yes	0.0%	n/a	FALSE
10-Aug-23	GW11-1a	0.392	0.397	Yes	1.3%	n/a	FALSE	12.00	12.40	Yes	3.3%	n/a	FALSE
16-Aug-23	E26	17.400	17.800	Yes	2.3%	n/a	FALSE	12.70	12.60	Yes	0.8%	n/a	FALSE

MPMC Annual Report 2023
Table 2
QA/QC Field Replicate Comparison

DISSOLVED METALS

		K-D DL = 0.05						Mg-D DL = 0.1					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	18.100	19.000	Yes	4.9%	n/a	FALSE	9.15	9.28	Yes	1.4%	n/a	FALSE
21-Aug-23	GW11-2b	1.350	1.330	Yes	1.5%	n/a	FALSE	18.40	18.30	Yes	0.5%	n/a	FALSE
21-Aug-23	E10	2.650	2.680	Yes	1.1%	n/a	FALSE	53.40	54.40	Yes	1.9%	n/a	FALSE
22-Aug-23	E19	4.830	4.840	Yes	0.2%	n/a	FALSE	40.60	41.40	Yes	2.0%	n/a	FALSE
24-Aug-23	P2-B	1.050	1.030	Yes	1.9%	n/a	FALSE	5.22	5.29	Yes	1.3%	n/a	FALSE
31-Aug-23	E24	1.940	1.970	Yes	1.5%	n/a	FALSE	48.80	48.30	Yes	1.0%	n/a	FALSE
05-Sep-23	W5	1.250	1.230	Yes	1.6%	n/a	FALSE	9.30	9.12	Yes	2.0%	n/a	FALSE
06-Sep-23	HAC-05a	0.986	0.975	Yes	1.1%	n/a	FALSE	6.53	6.67	Yes	2.1%	n/a	FALSE
07-Sep-23	B2-AT	0.450	0.441	Yes	2.0%	n/a	FALSE	2.59	2.58	Yes	0.4%	n/a	FALSE
11-Sep-23	QUL-2a-0m	0.483	0.489	Yes	1.2%	n/a	FALSE	2.09	2.11	Yes	1.0%	n/a	FALSE
19-Sep-23	W12	1.200	1.200	Yes	0.0%	n/a	FALSE	7.01	7.15	Yes	2.0%	n/a	FALSE
20-Sep-23	GW12-2a	0.170	0.192	No	n/a	0.022	FALSE	2.42	3.11	Yes	25.0%	n/a	FALSE
20-Sep-23	GW12-1a	0.374	0.368	Yes	1.6%	n/a	FALSE	5.30	5.18	Yes	2.3%	n/a	FALSE
27-Sep-23	WIP-10m	2.770	3.020	Yes	8.6%	n/a	FALSE	61.40	65.60	Yes	6.6%	n/a	FALSE
28-Sep-23	P2-BT	1.010	0.981	Yes	2.9%	n/a	FALSE	5.00	5.31	Yes	6.0%	n/a	FALSE
03-Oct-23	HAC-08	1.040	1.080	Yes	3.8%	n/a	FALSE	7.78	8.10	Yes	4.0%	n/a	FALSE
05-Oct-23	E4	13.700	13.500	Yes	1.5%	n/a	FALSE	25.90	25.40	Yes	1.9%	n/a	FALSE
05-Oct-23	PAG Seep 15	2.330	2.330	Yes	0.0%	n/a	FALSE	56.60	56.40	Yes	0.4%	n/a	FALSE
10-Oct-23	B1-B	0.496	0.487	Yes	1.8%	n/a	FALSE	2.87	2.86	Yes	0.3%	n/a	FALSE
16-Oct-23	E24	2.040	2.010	Yes	1.5%	n/a	FALSE	54.10	52.90	Yes	2.2%	n/a	FALSE
17-Oct-23	GW16-6a	0.512	0.514	Yes	0.4%	n/a	FALSE	5.76	5.52	Yes	4.3%	n/a	FALSE
18-Oct-23	P1-S	1.030	1.010	Yes	2.0%	n/a	FALSE	5.67	5.59	Yes	1.4%	n/a	FALSE
19-Oct-23	GW12-4a	1.560	1.570	Yes	0.6%	n/a	FALSE	13.00	13.50	Yes	3.8%	n/a	FALSE
30-Oct-23	SERDS23	2.770	2.660	Yes	4.1%	n/a	FALSE	105.00	103.00	Yes	1.9%	n/a	FALSE
30-Oct-23	QUL-18-20m	0.487	0.495	Yes	1.6%	n/a	FALSE	1.95	1.97	Yes	1.0%	n/a	FALSE
31-Oct-23	QUL-59-B	0.494	0.503	Yes	1.8%	n/a	FALSE	2.03	2.09	Yes	2.9%	n/a	FALSE
01-Nov-23	WIP-20m	3.070	2.940	Yes	4.3%	n/a	FALSE	63.50	60.60	Yes	4.7%	n/a	FALSE
02-Nov-23	EDC-01a	1.050	1.070	Yes	1.9%	n/a	FALSE	10.30	10.40	Yes	1.0%	n/a	FALSE
08-Nov-23	E1a	18.900	20.400	Yes	7.6%	n/a	FALSE	31.70	32.90	Yes	3.7%	n/a	FALSE
14-Nov-23	GW12-4a	1.520	1.520	Yes	0.0%	n/a	FALSE	12.60	12.60	Yes	0.0%	n/a	FALSE
14-Nov-23	GW15-2a	0.470	0.476	Yes	1.3%	n/a	FALSE	3.12	3.21	Yes	2.8%	n/a	FALSE
22-Nov-23	GW16-1a	0.629	0.644	Yes	2.4%	n/a	FALSE	1.23	1.24	Yes	0.8%	n/a	FALSE
28-Nov-23	E19a	6.910	6.270	Yes	9.7%	n/a	FALSE	39.80	38.10	Yes	4.4%	n/a	FALSE
06-Dec-23	HAC-08	0.980	1.020	Yes	4.0%	n/a	FALSE	9.52	9.83	Yes	3.2%	n/a	FALSE
13-Dec-23	95-R-5	0.000	0.869	No	n/a	0.8690	TRUE	0.00	22.00	No	n/a	22	TRUE
13-Dec-23	GW96-7	1.380	1.350	Yes	2.2%	n/a	FALSE	13.5000	22.0000	Yes	47.9%	n/a	TRUE

MPMC Annual Report 2023
Table 2
QA/QC Field Replicate Comparison

DISSOLVED METALS

		Mn-D DL = 0.0001						Se-D DL = 0.00005					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	0.0383	0.0382	No	n/a	0.0001	FALSE	0.001280	0.001310	Yes	2.3%	n/a	FALSE
05-Jan-23	E10	0.0090	0.0094	No	n/a	0.00038	FALSE	0.043700	0.045800	Yes	4.7%	n/a	FALSE
10-Jan-23	E24	0.2150	0.2120	No	n/a	0.003	FALSE	0.092700	0.091300	Yes	1.5%	n/a	FALSE
11-Jan-23	GW16-6a	<0.00010	<0.00010	No	n/a	n/a	FALSE	0.001310	0.001290	Yes	1.5%	n/a	FALSE
11-Jan-23	WIP-30m	0.4420	0.4460	No	n/a	0.004	FALSE	0.026200	0.027700	Yes	5.6%	n/a	FALSE
12-Jan-23	W4a	0.0024	0.0022	No	n/a	0.00018	FALSE	0.004030	0.003630	Yes	10.4%	n/a	FALSE
17-Jan-23	HAD-3	0.0658	0.0652	No	n/a	0.0006	FALSE	0.035600	0.035400	Yes	0.6%	n/a	FALSE
19-Jan-23	E4	0.0485	0.0476	No	n/a	0.0009	FALSE	0.005960	0.005640	Yes	5.5%	n/a	FALSE
19-Jan-23	GW12-2a	0.0246	0.0240	No	n/a	0.0006	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
23-Jan-23	E14	0.0059	0.0058	No	n/a	0.00012	FALSE	0.015300	0.015700	Yes	2.6%	n/a	FALSE
24-Jan-23	W12	0.2080	0.2070	No	n/a	0.001	FALSE	0.000052	0.000083	No	n/a	0.000031	FALSE
01-Feb-23	E8	0.0549	0.0545	No	n/a	0.0004	FALSE	0.053000	0.053300	Yes	0.6%	n/a	FALSE
07-Feb-23	E19	0.0729	0.0720	No	n/a	0.0009	FALSE	0.035500	0.035600	Yes	0.3%	n/a	FALSE
08-Feb-23	HAC-10	0.0017	0.0017	No	n/a	4E-05	FALSE	0.000568	0.000540	Yes	5.1%	n/a	FALSE
16-Feb-23	WIP-20m	0.2670	0.2630	No	n/a	0.004	FALSE	0.037800	0.034100	Yes	10.3%	n/a	FALSE
21-Feb-23	E1a	0.0093	0.0093	No	n/a	9E-05	FALSE	0.024600	0.024400	Yes	0.8%	n/a	FALSE
02-Mar-23	WIP-S	0.0106	0.0103	No	n/a	0.0003	FALSE	0.036900	0.037500	Yes	1.6%	n/a	FALSE
06-Mar-23	E21	0.0114	0.0110	No	n/a	0.0004	FALSE	0.024800	0.024200	Yes	2.4%	n/a	FALSE
07-Mar-23	EDC-01a	0.0311	0.0306	No	n/a	0.0005	FALSE	0.000974	0.000937	Yes	3.9%	n/a	FALSE
08-Mar-23	W4a	0.0002	0.0002	No	n/a	0.00001	FALSE	0.001630	0.001620	Yes	0.6%	n/a	FALSE
09-Mar-23	WIP-10m	0.0590	0.0621	No	n/a	0.0031	FALSE	0.038600	0.036000	Yes	7.0%	n/a	FALSE
14-Mar-23	E10	0.0254	0.0249	No	n/a	0.0005	FALSE	0.032800	0.032200	Yes	1.8%	n/a	FALSE
20-Mar-23	WIP-20m	0.3600	0.3610	No	n/a	0.001	FALSE	0.030900	0.032100	Yes	3.8%	n/a	FALSE
03-Apr-23	HAC-10	0.0091	0.0092	No	n/a	7E-05	FALSE	0.000479	0.000555	Yes	14.7%	n/a	FALSE
05-Apr-23	WIP-30m	0.5430	0.5400	Yes	0.6%	n/a	FALSE	0.010800	0.010900	Yes	0.9%	n/a	FALSE
12-Apr-23	W4a	0.0035	0.0031	No	n/a	0.00047	FALSE	0.001920	0.001770	Yes	8.1%	n/a	FALSE
13-Apr-23	E13	0.0287	0.0283	No	n/a	0.0004	FALSE	0.053400	0.051900	Yes	2.8%	n/a	FALSE
20-Apr-23	E11c	0.0885	0.0883	No	n/a	0.0002	FALSE	0.034100	0.033700	Yes	1.2%	n/a	FALSE
24-Apr-23	E14	0.0145	0.0142	No	n/a	0.0003	FALSE	0.022600	0.021700	Yes	4.1%	n/a	FALSE
26-Apr-23	E24	0.1810	0.1840	No	n/a	0.003	FALSE	0.082700	0.084700	Yes	2.4%	n/a	FALSE
01-May-23	GW96-4b	0.2510	0.2520	No	n/a	0.001	FALSE	0.000061	<0.000050	No	n/a	n/a	FALSE
01-May-23	HAC-05a	0.0246	0.0244	No	n/a	0.0002	FALSE	0.001790	0.001800	Yes	0.6%	n/a	FALSE
03-May-23	GW96-2a	0.0039	0.0039	No	n/a	5E-05	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
03-May-23	GW16-2a	0.0518	0.0525	No	n/a	0.0007	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
03-May-23	E11c	0.1000	0.1010	No	n/a	0.001	FALSE	0.028400	0.029300	Yes	3.1%	n/a	FALSE
08-May-23	E21	0.0177	0.0178	No	n/a	1E-04	FALSE	0.026900	0.026700	Yes	0.7%	n/a	FALSE
10-May-23	QUL-58-MID	0.0006	0.0004	No	n/a	0.00015	FALSE	0.000252	0.000218	No	n/a	0.000034	FALSE
10-May-23	QUL-120a-120m	0.0003	0.0003	No	n/a	0	FALSE	0.000082	0.000084	No	n/a	2E-06	FALSE
11-May-23	QUL-2a-0m	0.0004	0.0005	No	n/a	0.00004	FALSE	0.000146	0.000153	No	n/a	7E-06	FALSE
11-May-23	QUL-18-20m	0.0004	0.0003	No	n/a	0.00008	FALSE	0.000238	0.000207	No	n/a	0.000031	FALSE
15-May-23	E1a	0.0027	0.0025	No	n/a	0.00028	FALSE	0.026600	0.026800	Yes	0.7%	n/a	FALSE
16-May-23	SERDS 22	0.0115	0.0111	No	n/a	0.0004	FALSE	0.063200	0.062800	Yes	0.6%	n/a	FALSE
16-May-23	NEZ 2	0.0993	0.0994	No	n/a	0.0001	FALSE	0.099500	0.098500	Yes	1.0%	n/a	FALSE
17-May-23	QUL-57-S	0.0008	0.0008	No	n/a	0.00001	FALSE	0.000190	0.000174	No	n/a	0.000016	FALSE
24-May-23	B1-B	0.0010	0.0008	No	n/a	0.00017	FALSE	0.000158	0.000175	No	n/a	0.000017	FALSE
25-May-23	QUL-58-B	0.0003	0.0004	No	n/a	0.00009	FALSE	0.000469	0.000502	Yes	6.8%	n/a	FALSE
30-May-23	HAD-3	0.0685	0.0700	No	n/a	0.0015	FALSE	0.044400	0.043800	Yes	1.4%	n/a	FALSE
30-May-23	QUL-58-MP	0.0002	0.0002	No	n/a	0.00001	FALSE	0.000352	0.000344	Yes	2.3%	n/a	FALSE
30-May-23	GW16-6a	0.0052	0.0051	No	n/a	0.00013	FALSE	0.001690	0.001770	Yes	4.6%	n/a	FALSE
05-Jun-23	HAC-14	0.0050	0.0054	No	n/a	0.00034	FALSE	0.001350	0.001330	Yes	1.5%	n/a	FALSE
08-Jun-23	B1-S	0.0060	0.0062	No	n/a	0.00019	FALSE	0.000163	0.000193	No	n/a	0.00003	FALSE
12-Jun-23	W5	0.0150	0.0145	No	n/a	0.0005	FALSE	0.000174	0.000190	No	n/a	0.000016	FALSE
21-Jun-23	QUL-ZOO-7	0.0011	0.0013	No	n/a	0.0002	FALSE	0.000142	0.000223	No	n/a	0.000081	FALSE
26-Jun-23	QUL-2a-20m	0.0003	0.0002	No	n/a	0.00007	FALSE	0.000098	0.000074	No	n/a	0.000024	FALSE
27-Jun-23	QUL-58-AP	0.0002	0.0002	No	n/a	0.00005	FALSE	0.000159	0.000155	No	n/a	4E-06	FALSE
28-Jun-23	GW12-5a	0.0414	0.0405	No	n/a	0.0009	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
06-Jul-23	HAC-10	0.0112	0.0113	No	n/a	1E-04	FALSE	0.000541	0.000563	Yes	4.0%	n/a	FALSE
10-Jul-23	E19	0.0890	0.0874	No	n/a	0.0016	FALSE	0.042000	0.043000	Yes	2.4%	n/a	FALSE
12-Jul-23	B1-S	0.0029	0.0023	No	n/a	0.00053	FALSE	0.000263	0.000168	No	n/a	0.000095	FALSE
26-Jul-23	P1-B	0.0049	0.0049	No	n/a	6E-05	FALSE	0.000626	0.000527	Yes	17.2%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	0.0009	0.0013	No	n/a	0.00043	FALSE	0.000157	0.000107	No	n/a	0.00005	FALSE
27-Jul-23	95-R-5	1.9100	1.9300	Yes	1.0%	n/a	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
31-Jul-23	E22	0.0102	0.0104	No	n/a	0.0002	FALSE	0.114000	0.116000	Yes	1.7%	n/a	FALSE
01-Aug-23	W4a	0.0025	0.0023	No	n/a	0.00018	FALSE	0.000706	0.000680	Yes	3.8%	n/a	FALSE
02-Aug-23	HAC-13	0.0105	0.0100	No	n/a	0.00055	FALSE	0.000467	0.000494	Yes	5.6%	n/a	FALSE
07-Aug-23	HAC-D	0.0028	0.0026	No	n/a	0.00017	FALSE	0.000954	0.000853	Yes	11.2%	n/a	FALSE
09-Aug-23	MDC	0.0032	0.0031	No	n/a	3E-05	FALSE	0.024200	0.023600	Yes	2.5%	n/a	FALSE
10-Aug-23	GW11-1a	<0.00010	<0.00010	No	n/a	n/a	FALSE	0.005050	0.005000	Yes	1.0%	n/a	FALSE
16-Aug-23	E26	0.0115	0.0119	No	n/a	0.0004	FALSE	0.042200	0.041200	Yes	2.4%	n/a	FALSE

MPMC Annual Report 2023
Table 2
QA/QC Field Replicate Comparison

DISSOLVED METALS

		Mn-D DL = 0.0001						Se-D DL = 0.00005					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
16-Aug-23	E1a	0.0103	0.0106	No	n/a	0.0003	FALSE	0.028700	0.030100	Yes	4.8%	n/a	FALSE
21-Aug-23	GW11-2b	1.1400	1.1200	Yes	1.8%	n/a	FALSE	0.000089	0.000080	No	n/a	9E-06	FALSE
21-Aug-23	E10	0.1590	0.1690	No	n/a	0.01	FALSE	0.022900	0.024600	Yes	7.2%	n/a	FALSE
22-Aug-23	E19	0.0807	0.0808	No	n/a	0.0001	FALSE	0.037200	0.035500	Yes	4.7%	n/a	FALSE
24-Aug-23	P2-B	0.0047	0.0047	No	n/a	2E-05	FALSE	0.000506	0.000502	Yes	0.8%	n/a	FALSE
31-Aug-23	E24	0.0712	0.0738	No	n/a	0.0026	FALSE	0.088100	0.089300	Yes	1.4%	n/a	FALSE
05-Sep-23	W5	0.0212	0.0210	No	n/a	0.0002	FALSE	0.000103	0.000103	No	n/a	0	FALSE
06-Sep-23	HAC-05a	0.0178	0.0178	No	n/a	0	FALSE	0.000962	0.000975	Yes	1.3%	n/a	FALSE
07-Sep-23	B2-AT	0.0017	0.0016	No	n/a	6E-05	FALSE	0.000171	0.000183	No	n/a	0.000012	FALSE
11-Sep-23	QUL-2a-0m	0.0006	0.0003	No	n/a	0.00021	FALSE	0.000093	0.000086	No	n/a	7E-06	FALSE
19-Sep-23	W12	1.3400	1.3800	Yes	2.9%	n/a	FALSE	0.000089	0.000083	No	n/a	0.000006	FALSE
20-Sep-23	GW12-2a	0.3060	0.2940	No	n/a	0.012	FALSE	0.000160	0.000274	No	n/a	0.000114	TRUE
20-Sep-23	GW12-1a	0.2790	0.2740	No	n/a	0.005	FALSE	<0.000100	<0.000100	No	n/a	n/a	FALSE
27-Sep-23	WIP-10m	0.6010	0.6400	Yes	6.3%	n/a	FALSE	0.004900	0.005000	Yes	2.0%	n/a	FALSE
28-Sep-23	P2-BT	0.0023	0.0020	No	n/a	0.00032	FALSE	0.000516	0.000470	Yes	9.3%	n/a	FALSE
03-Oct-23	HAC-08	0.0023	0.0025	No	n/a	0.00012	FALSE	0.00126	0.00117	Yes	7.4%	n/a	FALSE
05-Oct-23	E4	0.0404	0.0403	No	n/a	1E-04	FALSE	0.01010	0.01020	Yes	1.0%	n/a	FALSE
05-Oct-23	PAG Seep 15	0.1820	0.1790	No	n/a	0.003	FALSE	0.06590	0.06600	Yes	0.2%	n/a	FALSE
10-Oct-23	B1-B	0.0148	0.0150	No	n/a	0.0002	FALSE	0.00018	0.00018	No	n/a	6E-06	FALSE
16-Oct-23	E24	0.0687	0.0662	No	n/a	0.0025	FALSE	0.09370	0.09220	Yes	1.6%	n/a	FALSE
17-Oct-23	GW16-6a	<0.00010	<0.00010	No	n/a	n/a	FALSE	0.00177	0.00176	Yes	0.6%	n/a	FALSE
18-Oct-23	P1-S	0.0019	0.0019	No	n/a	2E-05	FALSE	0.00050	0.00049	Yes	2.8%	n/a	FALSE
19-Oct-23	GW12-4a	0.7550	0.7530	Yes	0.3%	n/a	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
30-Oct-23	SERDS23	0.0139	0.0124	No	n/a	0.0015	FALSE	0.32400	0.32800	Yes	1.2%	n/a	FALSE
30-Oct-23	QUL-18-20m	0.0002	0.0002	No	n/a	0.00002	FALSE	0.00012	0.00011	No	n/a	0.000014	FALSE
31-Oct-23	QUL-59-B	0.0002	0.0001	No	n/a	0.00009	FALSE	0.00014	0.00013	No	n/a	0.00001	FALSE
01-Nov-23	WIP-20m	0.8410	0.8110	Yes	3.6%	n/a	FALSE	0.00302	0.00319	Yes	5.5%	n/a	FALSE
02-Nov-23	EDC-01a	0.0466	0.0463	No	n/a	0.0003	FALSE	0.00134	0.00132	Yes	1.5%	n/a	FALSE
08-Nov-23	E1a	0.0648	0.0688	No	n/a	0.004	FALSE	0.02660	0.02570	Yes	3.4%	n/a	FALSE
14-Nov-23	GW12-4a	0.6820	0.6890	Yes	1.0%	n/a	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
14-Nov-23	GW15-2a	0.0062	0.0060	No	n/a	0.00019	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE
22-Nov-23	GW16-1a	0.0065	0.0066	No	n/a	5E-05	FALSE	0.00009	0.00008	No	n/a	0.000014	FALSE
28-Nov-23	E19a	0.4370	0.4240	No	n/a	0.013	FALSE	0.03370	0.03420	Yes	1.5%	n/a	FALSE
06-Dec-23	HAC-08	0.0044	0.0045	No	n/a	1E-04	FALSE	0.00155	0.00167	Yes	7.5%	n/a	FALSE
13-Dec-23	95-R-5	0.0000	1.8100	No	n/a	1.81	TRUE	0.00000	<0.000050	No	n/a	n/a	FALSE
13-Dec-23	GW96-7	0.2330	0.2300	No	n/a	0.003	FALSE	<0.000050	<0.000050	No	n/a	n/a	FALSE

MPMC Annual Report 2023
Table 3
QA/QC Field Replicate Comparison

General Parameters

		Ammonia DL = 0.005						Total Nitrogen DL = 0.03					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	0.0081	0.0073	No	n/a	0.0008	FALSE	0.31	0.32	Yes	4.1%	n/a	FALSE
05-Jan-23	E10	0.0056	<0.0050	No	n/a	n/a	FALSE	3.26	3.20	Yes	1.9%	n/a	FALSE
10-Jan-23	E24	0.0080	0.0070	No	n/a	0.001	FALSE	1.01	1.03	Yes	2.0%	n/a	FALSE
11-Jan-23	GW16-6a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.06	0.06	No	n/a	0.003	FALSE
11-Jan-23	WIP-30m	<0.0050	<0.0050	No	n/a	n/a	FALSE	1.46	1.42	Yes	2.8%	n/a	FALSE
12-Jan-23	W4a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.10	0.10	No	n/a	0.003	FALSE
17-Jan-23	HAD-3	0.1550	0.1540	Yes	0.6%	n/a	FALSE	4.16	4.08	Yes	1.9%	n/a	FALSE
19-Jan-23	E4	0.0059	0.0080	No	n/a	0.0021	FALSE	0.17	0.22	Yes	29.9%	n/a	FALSE
19-Jan-23	GW12-2a	<0.0050	<0.0050	No	n/a	n/a	FALSE	<0.030	<0.030	No	n/a	n/a	FALSE
23-Jan-23	E14	0.6700	0.5700	Yes	16.1%	n/a	FALSE	2.28	2.28	Yes	0.0%	n/a	FALSE
24-Jan-23	W12	0.1730	0.1860	Yes	7.2%	n/a	FALSE	0.56	0.56	Yes	0.2%	n/a	FALSE
01-Feb-23	E8	0.0460	0.0152	No	n/a	0.0308	TRUE	6.01	5.99	Yes	0.3%	n/a	FALSE
07-Feb-23	E19	0.1810	0.2010	Yes	10.5%	n/a	FALSE	3.96	3.94	Yes	0.5%	n/a	FALSE
08-Feb-23	HAC-10	0.0355	0.0100	No	n/a	0.0255	TRUE	0.30	0.31	Yes	3.9%	n/a	FALSE
16-Feb-23	WIP-20m	0.0053	0.0099	No	n/a	0.0046	FALSE	1.85	1.91	Yes	3.2%	n/a	FALSE
21-Feb-23	E1a	0.4520	0.4560	Yes	0.9%	n/a	FALSE	4.10	4.07	Yes	0.7%	n/a	FALSE
02-Mar-23	WIP-S	0.0181	0.0169	No	n/a	0.0012	FALSE	3.06	3.09	Yes	1.0%	n/a	FALSE
06-Mar-23	E21	0.4200	0.4240	Yes	0.9%	n/a	FALSE	4.29	3.90	Yes	9.5%	n/a	FALSE
07-Mar-23	EDC-01a	0.0061	0.0107	No	n/a	0.0046	FALSE	0.30	0.30	Yes	0.3%	n/a	FALSE
08-Mar-23	W4a	<0.0050	0.0062	No	n/a	n/a	FALSE	0.07	0.07	No	n/a	0.001	FALSE
09-Mar-23	WIP-10m	0.0098	0.0097	No	n/a	1E-04	FALSE	2.14	2.13	Yes	0.5%	n/a	FALSE
14-Mar-23	E10	<0.0050	<0.0050	No	n/a	n/a	FALSE	3.00	2.96	Yes	1.3%	n/a	FALSE
20-Mar-23	WIP-20m	<0.0050	<0.0050	No	n/a	n/a	FALSE	1.81	1.78	Yes	1.7%	n/a	FALSE
03-Apr-23	HAC-10	0.0055	0.0055	No	n/a	0	FALSE	0.28	0.29	Yes	1.8%	n/a	FALSE
05-Apr-23	WIP-30m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.59	0.63	Yes	6.4%	n/a	FALSE
12-Apr-23	W4a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.17	0.19	Yes	11.6%	n/a	FALSE
13-Apr-23	E13	0.0062	0.0080	No	n/a	0.0018	FALSE	8.25	8.15	Yes	1.2%	n/a	FALSE
20-Apr-23	E11c	0.2270	0.2240	Yes	1.3%	n/a	FALSE	8.27	8.01	Yes	3.2%	n/a	FALSE
24-Apr-23	E14	0.0139	0.0123	No	n/a	0.0016	FALSE	4.13	4.28	Yes	3.6%	n/a	FALSE
26-Apr-23	E24	<0.0050	<0.0050	No	n/a	n/a	FALSE	1.11	1.10	Yes	0.9%	n/a	FALSE
01-May-23	GW96-4b	0.0241	0.0246	No	n/a	0.0005	FALSE	0.06	0.07	No	n/a	0.001	FALSE
01-May-23	HAC-05a	0.0121	0.0115	No	n/a	0.0006	FALSE	0.48	0.49	Yes	2.1%	n/a	FALSE
03-May-23	GW96-2a	0.0904	0.0914	Yes	1.1%	n/a	FALSE	0.11	0.10	No	n/a	0.010	TRUE
03-May-23	GW16-2a	0.0165	0.0151	No	n/a	0.0014	FALSE	0.04	0.04	No	n/a	0.006	TRUE
03-May-23	E11c	0.2760	0.2750	Yes	0.4%	n/a	FALSE	11.60	14.20	Yes	20.2%	n/a	FALSE
08-May-23	E21	0.0196	0.0232	No	n/a	0.0036	FALSE	3.04	3.04	Yes	0.0%	n/a	FALSE
10-May-23	QUL-58-MID	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.19	0.19	Yes	1.0%	n/a	FALSE
10-May-23	QUL-120a-120m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.18	0.19	Yes	1.6%	n/a	FALSE
11-May-23	QUL-2a-0m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.19	0.19	Yes	0.0%	n/a	FALSE
11-May-23	QUL-18-20m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.19	0.19	Yes	1.0%	n/a	FALSE
15-May-23	E1a	0.0129	0.0125	No	n/a	0.0004	FALSE	3.04	3.09	Yes	1.6%	n/a	FALSE
16-May-23	SERDS 22	0.0488	0.0515	Yes	5.4%	n/a	FALSE	13.70	9.60	Yes	35.2%	n/a	FALSE
16-May-23	NEZ 2	0.0050	<0.0050	No	n/a	n/a	FALSE	1.03	1.04	Yes	1.0%	n/a	FALSE
17-May-23	QUL-57-S	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.20	0.21	Yes	5.4%	n/a	FALSE
24-May-23	B1-B	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.27	0.26	Yes	3.5%	n/a	FALSE
25-May-23	QUL-58-B	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.21	0.23	Yes	5.9%	n/a	FALSE
30-May-23	HAD-3	0.0062	0.0071	No	n/a	0.0009	FALSE	3.83	3.82	Yes	0.3%	n/a	FALSE
30-May-23	QUL-58-MP	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.23	0.22	Yes	2.2%	n/a	FALSE
30-May-23	GW16-6a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.07	0.07	No	n/a	0.001	FALSE
05-Jun-23	HAC-14	<0.0050	0.0055	No	n/a	n/a	FALSE	0.26	0.25	Yes	3.1%	n/a	FALSE
08-Jun-23	B1-S	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.30	0.46	Yes	42.5%	n/a	FALSE
12-Jun-23	W5	0.0117	0.0116	No	n/a	0.0001	FALSE	0.50	0.42	Yes	17.4%	n/a	FALSE
21-Jun-23	QUL-ZOO-7	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.16	0.17	Yes	6.1%	n/a	FALSE
26-Jun-23	QUL-2a-20m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.16	0.17	Yes	2.4%	n/a	FALSE
27-Jun-23	QUL-58-AP	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.19	0.19	Yes	3.2%	n/a	FALSE
28-Jun-23	GW12-5a	0.0070	0.0083	No	n/a	0.0013	FALSE	<0.030	<0.030	No	n/a	n/a	FALSE
06-Jul-23	HAC-10	0.0092	0.0085	No	n/a	0.0007	FALSE	0.34	0.34	Yes	0.6%	n/a	FALSE
10-Jul-23	E19	0.0208	0.0194	No	n/a	0.0014	FALSE	3.44	3.37	Yes	2.1%	n/a	FALSE
12-Jul-23	B1-S	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.30	0.29	Yes	1.7%	n/a	FALSE
26-Jul-23	P1-B	0.0066	0.0067	No	n/a	0.0001	FALSE	0.26	0.26	Yes	0.4%	n/a	FALSE
26-Jul-23	QUL-ZOO-7	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.15	0.14	No	n/a	0.001	FALSE
27-Jul-23	95-R-5	<0.0050	<0.0050	No	n/a	n/a	FALSE	<0.030	<0.030	No	n/a	n/a	FALSE
31-Jul-23	E22	0.0271	0.0273	Yes	0.7%	n/a	FALSE	1.32	1.32	Yes	0.0%	n/a	FALSE
01-Aug-23	W4a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.06	0.06	No	n/a	0.001	FALSE
02-Aug-23	HAC-13	0.0103	0.0086	No	n/a	0.0017	FALSE	0.28	0.27	Yes	4.7%	n/a	FALSE

MPMC Annual Report 2023
Table 3
QA/QC Field Replicate Comparison

General Parameters

		Ammonia DL = 0.005						Total Nitrogen DL = 0.03					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
07-Aug-23	HAC-D	0.0060	0.0074	No	n/a	0.0014	FALSE	0.23	0.24	Yes	5.5%	n/a	FALSE
09-Aug-23	MDC	<0.0050	<0.0050	No	n/a	n/a	FALSE	6.99	7.07	Yes	1.1%	n/a	FALSE
10-Aug-23	GW11-1a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.24	0.21	Yes	12.8%	n/a	FALSE
16-Aug-23	E26	0.7800	0.9330	Yes	17.9%	n/a	FALSE	7.62	7.32	Yes	4.0%	n/a	FALSE
16-Aug-23	E1a	0.2310	0.2290	Yes	0.9%	n/a	FALSE	4.09	4.08	Yes	0.2%	n/a	FALSE
21-Aug-23	GW11-2b	1.0300	1.0500	Yes	1.9%	n/a	FALSE	1.50	1.55	Yes	3.3%	n/a	FALSE
21-Aug-23	E10	<0.0050	<0.0050	No	n/a	n/a	FALSE	1.36	1.38	Yes	1.5%	n/a	FALSE
22-Aug-23	E19	0.0280	0.0275	Yes	1.8%	n/a	FALSE	4.21	4.19	Yes	0.5%	n/a	FALSE
24-Aug-23	P2-B	0.0067	0.0062	No	n/a	0.0005	FALSE	0.28	0.28	Yes	1.1%	n/a	FALSE
31-Aug-23	E24	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.90	0.91	Yes	1.2%	n/a	FALSE
05-Sep-23	W5	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.20	0.20	Yes	0.0%	n/a	FALSE
06-Sep-23	HAC-05a	0.0062	0.0071	No	n/a	0.0009	FALSE	0.24	0.24	Yes	1.3%	n/a	FALSE
07-Sep-23	B2-AT	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.27	0.27	Yes	1.1%	n/a	FALSE
11-Sep-23	QUL-2a-0m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.11	0.11	No	n/a	0.001	FALSE
19-Sep-23	W12	0.0696	0.0620	Yes	11.55%	n/a	FALSE	0.62	0.60	Yes	2.6%	n/a	FALSE
20-Sep-23	GW12-2a	0.0056	0.0080	No	n/a	0.0024	FALSE	<0.030	<0.030	No	n/a	n/a	FALSE
20-Sep-23	GW12-1a	0.0290	0.0288	Yes	0.69%	n/a	FALSE	0.06	0.06	No	n/a	0.002	FALSE
27-Sep-23	WIP-10m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.27	0.27	Yes	1.1%	n/a	FALSE
28-Sep-23	P2-BT	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.23	0.23	Yes	1.3%	n/a	FALSE
03-Oct-23	HAC-08	0.0054	<0.0050	No	n/a	n/a	FALSE	0.19	0.19	Yes	1.0%	n/a	FALSE
05-Oct-23	E4	0.0107	0.0100	No	n/a	0.0007	FALSE	0.34	0.35	Yes	2.0%	n/a	FALSE
05-Oct-23	PAG Seep 15	0.0051	0.0094	No	n/a	0.0043	FALSE	10.40	10.00	Yes	3.9%	n/a	FALSE
10-Oct-23	B1-B	0.0066	0.0065	No	n/a	0.0001	FALSE	0.32	0.32	Yes	1.6%	n/a	FALSE
16-Oct-23	E24	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.89	0.89	Yes	1.0%	n/a	FALSE
17-Oct-23	GW16-6a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.07	0.07	No	n/a	0.001	FALSE
18-Oct-23	P1-S	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.25	0.24	Yes	5.7%	n/a	FALSE
19-Oct-23	GW12-4a	0.0996	0.1020	Yes	2.38%	n/a	FALSE	0.17	0.16	Yes	7.9%	n/a	FALSE
30-Oct-23	SERDS23	0.0079	0.0073	No	n/a	0.0006	FALSE	66.40	65.60	Yes	1.2%	n/a	FALSE
30-Oct-23	QUL-18-20m	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.18	0.18	Yes	0.6%	n/a	FALSE
31-Oct-23	QUL-59-B	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.18	0.18	Yes	0.5%	n/a	FALSE
01-Nov-23	WIP-20m	0.0079	0.0077	No	n/a	0.0002	FALSE	0.19	0.18	Yes	1.6%	n/a	FALSE
02-Nov-23	EDC-01a	0.0056	<0.0050	No	n/a	n/a	FALSE	0.21	0.20	Yes	5.5%	n/a	FALSE
08-Nov-23	E1a	0.2620	0.2400	Yes	8.76%	n/a	FALSE	4.13	4.26	Yes	3.1%	n/a	FALSE
14-Nov-23	GW12-4a	0.0851	0.0882	Yes	3.58%	n/a	FALSE	0.17	0.15	No	n/a	0.026	TRUE
14-Nov-23	GW15-2a	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.04	0.05	No	n/a	0.017	TRUE
22-Nov-23	GW16-1a	0.0536	0.0540	Yes	0.74%	n/a	FALSE	0.17	0.17	Yes	1.8%	n/a	FALSE
28-Nov-23	E19a	<0.0050	<0.0050	No	n/a	n/a	FALSE	5.04	4.77	Yes	5.5%	n/a	FALSE
06-Dec-23	HAC-08	<0.0050	<0.0050	No	n/a	n/a	FALSE	0.22	0.23	Yes	2.2%	n/a	FALSE
13-Dec-23	95-R-5	0.0064	0.0051	No	n/a	0.0013	FALSE	<0.030	<0.030	No	n/a	n/a	FALSE
13-Dec-23	GW96-7	<0.0050	<0.0050	No	n/a	n/a	FALSE	<0.030	<0.030	No	n/a	n/a	FALSE

MPMC Annual Report 2023
Table 3
QA/QC Field Replicate Comparison

General Parameters

		Total Phosphorus DL = 0.002						Total Suspended Solids DL = 1					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
04-Jan-23	EDC-01a	0.011	0.011	No	n/a	1E-04	FALSE	<1.1	<1.0	No	n/a	n/a	FALSE
05-Jan-23	E10	0.004	0.004	No	n/a	0	FALSE	1.80	1.50	No	n/a	0.3	FALSE
10-Jan-23	E24	0.004	0.004	No	n/a	0.0001	FALSE	0.16	0.19	No	n/a	0.03	FALSE
11-Jan-23	GW16-6a	0.003	0.003	No	n/a	0.0002	FALSE	<0.0050	<0.0050	No	n/a	n/a	FALSE
11-Jan-23	WIP-30m	0.002	<0.0020	No	n/a	n/a	FALSE	0.13	0.17	No	n/a	0.04	FALSE
12-Jan-23	W4a	0.013	0.013	No	n/a	0.0004	FALSE	0.30	0.38	No	n/a	0.08	FALSE
17-Jan-23	HAD-3	0.014	0.011	No	n/a	0.0025	FALSE	1.09	2.63	No	n/a	1.54	FALSE
19-Jan-23	E4	0.017	0.017	No	n/a	0.0004	FALSE	0.34	0.33	No	n/a	0.01	FALSE
19-Jan-23	GW12-2a	0.027	0.027	No	n/a	0	FALSE	-	-	-	-	-	-
23-Jan-23	E14	0.011	0.012	No	n/a	0.0012	FALSE	0.67	0.57	No	n/a	0.1	FALSE
24-Jan-23	W12	0.019	0.019	No	n/a	0.0004	FALSE	2.37	2.21	No	n/a	0.16	FALSE
01-Feb-23	E8	0.007	0.007	No	n/a	0	FALSE	0.47	0.47	No	n/a	0	FALSE
07-Feb-23	E19	0.011	0.011	No	n/a	0.0002	FALSE	4.12	3.76	No	n/a	0.36	FALSE
08-Feb-23	HAC-10	0.013	0.013	No	n/a	0	FALSE	0.18	0.18	No	n/a	0	FALSE
16-Feb-23	WIP-20m	<0.0020	<0.0020	No	n/a	n/a	FALSE	0.11	0.12	No	n/a	0.01	FALSE
21-Feb-23	E1a	0.016	0.016	No	n/a	0.0002	FALSE	5.60	5.25	Yes	6.5%	n/a	FALSE
02-Mar-23	WIP-S	0.005	0.012	No	n/a	0.0070	TRUE	0.46	0.46	No	n/a	0	FALSE
06-Mar-23	E21	0.017	0.020	No	n/a	0.0022	FALSE	7.38	9.08	Yes	20.7%	n/a	FALSE
07-Mar-23	EDC-01a	0.009	0.010	No	n/a	0.0006	FALSE	0.22	0.26	No	n/a	0.04	FALSE
08-Mar-23	W4a	0.014	0.015	No	n/a	0.001	FALSE	<0.10	0.10	No	n/a	n/a	FALSE
09-Mar-23	WIP-10m	0.004	0.003	No	n/a	0.0011	FALSE	0.45	0.52	No	n/a	0.07	FALSE
14-Mar-23	E10	0.056	0.057	No	n/a	0.0008	FALSE	17.20	12.60	Yes	30.9%	n/a	FALSE
20-Mar-23	WIP-20m	<0.0020	<0.0020	No	n/a	n/a	FALSE	0.11	0.11	No	n/a	0	FALSE
03-Apr-23	HAC-10	0.013	0.014	No	n/a	1E-04	FALSE	0.56	0.25	No	n/a	0.31	FALSE
05-Apr-23	WIP-30m	<0.0020	0.002	No	n/a	n/a	FALSE	0.23	0.23	No	n/a	0	FALSE
12-Apr-23	W4a	0.027	0.028	No	n/a	0.0013	FALSE	6.24	6.06	Yes	2.9%	n/a	FALSE
13-Apr-23	E13	0.016	0.016	No	n/a	0.0004	FALSE	1.44	1.60	No	n/a	0.16	FALSE
20-Apr-23	E11c	0.008	0.007	No	n/a	1E-04	FALSE	0.47	0.66	No	n/a	0.19	FALSE
24-Apr-23	E14	0.022	0.022	No	n/a	0.0004	FALSE	5.25	5.22	Yes	0.6%	n/a	FALSE
26-Apr-23	E24	0.011	0.010	No	n/a	0.0011	FALSE	2.82	2.92	No	n/a	0.1	FALSE
01-May-23	GW96-4b	0.017	0.015	No	n/a	0.0014	FALSE	-	-	-	-	-	-
01-May-23	HAC-05a	0.021	0.020	No	n/a	0.0005	FALSE	2.28	1.90	No	n/a	0.38	FALSE
03-May-23	GW96-2a	0.027	0.027	No	n/a	0.0004	FALSE	-	-	-	-	-	-
03-May-23	GW16-2a	0.027	0.027	No	n/a	0.0004	FALSE	-	-	-	-	-	-
03-May-23	E11c	0.009	0.008	No	n/a	0.0005	FALSE	0.48	1.11	No	n/a	0.63	FALSE
08-May-23	E21	0.026	0.029	No	n/a	0.0027	FALSE	5.39	5.18	Yes	4.0%	n/a	FALSE
10-May-23	QUL-58-MID	0.003	0.003	No	n/a	0.0005	FALSE	0.25	0.26	No	n/a	0.01	FALSE
10-May-23	QUL-120a-120m	<0.0020	<0.0020	No	n/a	n/a	FALSE	0.14	0.13	No	n/a	0.01	FALSE
11-May-23	QUL-2a-0m	0.003	<0.0020	No	n/a	n/a	FALSE	0.26	0.24	No	n/a	0.02	FALSE
11-May-23	QUL-18-20m	0.003	0.009	No	n/a	0.0066	TRUE	0.25	0.24	No	n/a	0.01	FALSE
15-May-23	E1a	0.016	0.016	No	n/a	0.0006	FALSE	5.81	4.55	No	n/a	1.26	FALSE
16-May-23	SERDS 22	0.049	0.049	No	n/a	0.0004	FALSE	0.94	1.13	No	n/a	0.19	FALSE
16-May-23	NEZ 2	0.013	0.006	No	n/a	0.0069	TRUE	1.51	3.01	No	n/a	1.5	FALSE
17-May-23	QUL-57-S	0.003	0.004	No	n/a	0.0015	FALSE	0.36	0.28	No	n/a	0.08	FALSE
24-May-23	B1-B	0.013	0.011	No	n/a	0.002	FALSE	0.60	0.43	No	n/a	0.17	FALSE
25-May-23	QUL-58-B	0.002	0.002	No	n/a	0.0002	FALSE	0.20	0.25	No	n/a	0.05	FALSE
30-May-23	HAD-3	0.007	0.007	No	n/a	0.0004	FALSE	0.75	1.02	No	n/a	0.27	FALSE
30-May-23	QUL-58-MP	0.003	0.003	No	n/a	1E-04	FALSE	0.15	0.18	No	n/a	0.03	FALSE
30-May-23	GW16-6a	0.002	0.002	No	n/a	0.0002	FALSE	-	-	-	-	-	-
05-Jun-23	HAC-14	0.012	0.011	No	n/a	0.0005	FALSE	0.36	0.32	No	n/a	0.04	FALSE
08-Jun-23	B1-S	0.012	0.011	No	n/a	0.0012	FALSE	1.55	1.62	No	n/a	0.07	FALSE
12-Jun-23	W5	0.045	0.029	No	n/a	0.0159	TRUE	0.84	0.83	No	n/a	0.01	FALSE
21-Jun-23	QUL-ZOO-7	0.017	0.016	No	n/a	0.0008	FALSE	2.22	2.55	No	n/a	0.33	FALSE
26-Jun-23	QUL-2a-20m	0.003	0.004	No	n/a	0.0014	FALSE	0.16	0.32	No	n/a	0.16	FALSE
27-Jun-23	QUL-58-AP	0.003	0.003	No	n/a	0	FALSE	0.20	0.14	No	n/a	0.06	FALSE
28-Jun-23	GW12-5a	0.005	0.005	No	n/a	0.0002	FALSE	-	-	-	-	-	-
06-Jul-23	HAC-10	0.010	0.011	No	n/a	0.0003	FALSE	0.62	0.64	No	n/a	0.02	FALSE
10-Jul-23	E19	0.017	0.020	No	n/a	0.0027	FALSE	3.28	2.76	No	n/a	0.52	FALSE
12-Jul-23	B1-S	0.007	0.007	No	n/a	0.0001	FALSE	0.43	0.55	No	n/a	0.12	FALSE
26-Jul-23	P1-B	0.026	0.027	No	n/a	0.0011	FALSE	0.33	0.35	No	n/a	0.02	FALSE
26-Jul-23	QUL-ZOO-7	0.005	0.005	No	n/a	0.0002	FALSE	0.97	1.06	No	n/a	0.09	FALSE
27-Jul-23	95-R-5	<0.0020	<0.0020	No	n/a	n/a	FALSE	-	-	-	-	-	-
31-Jul-23	E22	0.010	0.009	No	n/a	0.0007	FALSE	0.44	0.40	No	n/a	0.04	FALSE
01-Aug-23	W4a	0.016	0.015	No	n/a	0.0007	FALSE	0.13	0.13	No	n/a	0	FALSE
02-Aug-23	HAC-13	0.013	0.013	No	n/a	0.0004	FALSE	0.74	0.73	No	n/a	0.01	FALSE

MPMC Annual Report 2023
Table 3
QA/QC Field Replicate Comparison

General Parameters

		Total Phosphorus DL = 0.002						Total Suspended Solids DL = 1					
Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
07-Aug-23	HAC-D	0.010	0.009	No	n/a	0.0011	FALSE	0.44	0.34	No	n/a	0.1	FALSE
09-Aug-23	MDC	0.027	0.027	No	n/a	0.0003	FALSE	0.47	0.46	No	n/a	0.01	FALSE
10-Aug-23	GW11-1a	0.022	0.022	No	n/a	0.0004	FALSE	-	-	-	-	-	-
16-Aug-23	E26	0.024	0.024	No	n/a	0.0006	FALSE	4.82	4.48	No	n/a	0.34	FALSE
16-Aug-23	E1a	0.009	0.009	No	n/a	0.0001	FALSE	3.46	2.28	No	n/a	1.18	FALSE
21-Aug-23	GW11-2b	0.621	0.610	Yes	1.8%	n/a	FALSE	-	-	-	-	-	-
21-Aug-23	E10	0.003	0.003	No	n/a	0.0002	FALSE	0.55	0.51	No	n/a	0.04	FALSE
22-Aug-23	E19	0.007	0.007	No	n/a	1E-04	FALSE	0.63	0.78	No	n/a	0.15	FALSE
24-Aug-23	P2-B	0.029	0.030	No	n/a	0.001	FALSE	0.99	1.09	No	n/a	0.1	FALSE
31-Aug-23	E24	0.003	0.004	No	n/a	0.0002	FALSE	0.13	0.14	No	n/a	0.01	FALSE
05-Sep-23	W5	0.023	0.024	No	n/a	0.0015	FALSE	4.70	3.37	No	n/a	1.33	FALSE
06-Sep-23	HAC-05a	0.011	0.011	No	n/a	1E-04	FALSE	0.52	0.47	No	n/a	0.05	FALSE
07-Sep-23	B2-AT	0.010	0.011	No	n/a	0.0006	FALSE	0.63	0.67	No	n/a	0.04	FALSE
11-Sep-23	QUL-2a-0m	0.003	0.003	No	n/a	0.0002	FALSE	0.57	0.56	No	n/a	0.01	FALSE
19-Sep-23	W12	0.024	0.022	No	n/a	0.0026	FALSE	0.94	0.93	No	n/a	0.01	FALSE
20-Sep-23	GW12-2a	0.025	0.025	No	n/a	0	FALSE	-	-	-	-	-	-
20-Sep-23	GW12-1a	0.112	0.112	No	n/a	0	FALSE	-	-	-	-	-	-
27-Sep-23	WIP-10m	<0.0020	0.003	No	n/a	n/a	FALSE	0.59	0.63	No	n/a	0.04	FALSE
28-Sep-23	P2-BT	0.009	0.010	No	n/a	0.0004	FALSE	0.44	0.42	No	n/a	0.02	FALSE
03-Oct-23	HAC-08	0.01	0.01	No	n/a	0.0004	FALSE	0.17	0.20	No	n/a	0.03	FALSE
05-Oct-23	E4	0.01	0.01	No	n/a	0.0004	FALSE	0.38	0.42	No	n/a	0.04	FALSE
05-Oct-23	PAG Seep 15	0.02	0.02	No	n/a	0.0064	TRUE	1.25	1.04	No	n/a	0.21	FALSE
10-Oct-23	B1-B	0.02	0.02	No	n/a	0.0013	FALSE	1.21	1.60	No	n/a	0.39	FALSE
16-Oct-23	E24	0.00	0.00	No	n/a	0.0005	FALSE	0.12	0.16	No	n/a	0.04	FALSE
17-Oct-23	GW16-6a	0.00	0.00	No	n/a	0.0003	FALSE	-	-	-	-	-	-
18-Oct-23	P1-S	0.01	0.01	No	n/a	0.0022	FALSE	0.34	0.42	No	n/a	0.08	FALSE
19-Oct-23	GW12-4a	0.21	0.21	Yes	1.9%	n/a	FALSE	-	-	-	-	-	-
30-Oct-23	SERDS23	0.18	0.12	No	n/a	0.0590	TRUE	1.87	6.48	No	n/a	4.61	TRUE
30-Oct-23	QUL-18-20m	<0.0020	<0.0020	No	n/a	n/a	FALSE	0.14	0.17	No	n/a	0.03	FALSE
31-Oct-23	QUL-59-B	0.00	<0.0020	No	n/a	n/a	FALSE	0.19	0.19	No	n/a	0	FALSE
01-Nov-23	WIP-20m	<0.0020	<0.0020	No	n/a	n/a	FALSE	0.67	0.70	No	n/a	0.03	FALSE
02-Nov-23	EDC-01a	0.01	0.01	No	n/a	0.001	FALSE	0.33	0.21	No	n/a	0.12	FALSE
08-Nov-23	E1a	0.01	0.01	No	n/a	0.0005	FALSE	0.86	1.07	No	n/a	0.21	FALSE
14-Nov-23	GW12-4a	0.18	0.18	Yes	0.0%	n/a	FALSE	-	-	-	-	-	-
14-Nov-23	GW15-2a	0.04	0.04	No	n/a	0.0002	FALSE	-	-	-	-	-	-
22-Nov-23	GW16-1a	0.18	0.18	Yes	2.2%	n/a	FALSE	-	-	-	-	-	-
28-Nov-23	E19a	0.03	0.03	No	n/a	0.0005	FALSE	3.47	3.00	No	n/a	0.47	FALSE
06-Dec-23	HAC-08	0.01	0.01	No	n/a	0.0007	FALSE	0.73	0.50	No	n/a	0.23	FALSE
13-Dec-23	95-R-5	0.01	0.01	No	n/a	0.0006	FALSE	-	-	-	-	-	-
13-Dec-23	GW96-7	0.01	0.01	No	n/a	0.0008	FALSE	-	-	-	-	-	-

MPMC Annual Report 2023
Table 4
QA/QC Field Replicate Comparison

E-COLI AND TOTAL COLIFORM

E.coli

DL = 1 MPN/100ml

Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
10-Jan-23	BAC-02	<1	<1	No	n/a	n/a	FALSE
14-Feb-23	BAC-03	<1	<1	No	n/a	n/a	FALSE
21-Mar-23	BAC-04	<1	<1	No	n/a	n/a	FALSE
04-Apr-23	BAC-01	<1	<1	No	n/a	n/a	FALSE
09-May-23	BAC-02	<1	<1	No	n/a	n/a	FALSE
20-Jun-23	BAC-03	<1	<1	No	n/a	n/a	FALSE
25-Jul-23	BAC-04	<1	<1	No	n/a	n/a	FALSE
01-Aug-23	BAC-01	<1	<1	No	n/a	n/a	FALSE
16-Oct-23	BAC-03	<1	<1	No	n/a	n/a	FALSE
07-Dec-23	BAC-01	<1	<1	No	n/a	n/a	FALSE

Coliform Bacteria - Total

DL = 1 MPN/100ml

Date	Site	Sample	Duplicate Sample	Values >5x DL?	RPD	Difference	Criteria Exceeded
10-Jan-23	BAC-02	<1	<1	No	n/a	n/a	FALSE
14-Feb-23	BAC-03	<1	<1	No	n/a	n/a	FALSE
21-Mar-23	BAC-04	<1	<1	No	n/a	n/a	FALSE
04-Apr-23	BAC-01	<1	<1	No	n/a	n/a	FALSE
09-May-23	BAC-02	<1	**1**	No	n/a	n/a	FALSE
20-Jun-23	BAC-03	<1	<1	No	n/a	n/a	FALSE
25-Jul-23	BAC-04	<1	<1	No	n/a	n/a	FALSE
01-Aug-23	BAC-01	<1	<1	No	n/a	n/a	FALSE
16-Oct-23	BAC-03	<1	<1	No	n/a	n/a	FALSE
07-Dec-23	BAC-01	<1	<1	No	n/a	n/a	FALSE

Grid Format Report : DI-Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: DI-Blank
	12-Jan-23
Hardness (as CaCO3), (mg/L)	<0.50
Anions and Nutrients	
Alkalinity (CaCO3) (mg/L)	<1.0
Ammonia (as N) (mg/L)	<0.0050
Chloride (mg/L)	<0.50
Diss-Orthophosphate (mg/L)	<0.0010
Diss-Phosphorus (mg/L)	<0.0020
Floride (mg/L)	<0.020
Nitrate (N) (mg/L)	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051
Nitrite (N) (mg/L)	<0.0010
Sulphate (mg/L)	<0.30
Total Nitrogen (mg/L)	<0.030
Total Phosphorus (mg/L)	<0.0020
Dissolved Metals	
TDS (mg/L)	<10
Organic / Inorganic	
DOC (mg/L)	<0.50
Physical Test	
Conductivity (µs/cm)	<2.0
NTU (ntu)	<0.10
pH (pH)	5.36
TDS (mg/L)	<10
TSS (mg/L)	<1.0
Total Metals	
Aluminum (Al)-Total (mg/L)	<0.0030
Antimony (Sb)-Total (mg/L)	<0.00010
Arsenic (As)-Total (mg/L)	<0.00010
Barium (Ba)-Total (mg/L)	<0.00010
Beryllium (Be)-Total (mg/L)	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050
Boron (B)-Total (mg/L)	<0.010
Cadmium (Cd)-Total (mg/L)	<0.0000050
Calcium (Ca)-Total (mg/L)	<0.050

Grid Format Report : DI-Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: DI-Blank
	12-Jan-23
Chromium (Cr)-Total (mg/L)	<0.00050
Cobalt (Co)-Total (mg/L)	<0.00010
Copper (Cu)-Total (mg/L)	<0.00050
Iron (Fe)-Total (mg/L)	<0.030
Lead (Pb)-Total (mg/L)	<0.000050
Lithium (Li)-Total (mg/L)	<0.0010
Magnesium (Mg)-Total (mg/L)	<0.100
Manganese (Mn)-Total (mg/L)	<0.00010
Molybdenum (Mo)-Tota (mg/L)	<0.000050
Nickel (Ni)-Total (mg/L)	<0.00050
Potassium (K)-Total (mg/L)	<0.050
Selenium (Se)-Total (mg/L)	<0.000050
Silicon (Si)-Total (mg/L)	<0.10
Silver (Ag)-Total (mg/L)	<0.000010
Sodium (Na)-Total (mg/L)	<0.050
Strontium (Sr)-Total (mg/L)	<0.00020
Thallium (Tl)-Total (mg/L)	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100
Uranium (U)-Total (mg/L)	<0.000010
Vanadium (V)-Total (mg/L)	<0.00050
Zinc (Zn)-Total (mg/L)	<0.0030

Grid Format Report : DI-Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: DI-Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Hardness (as CaCO3), (mg/L)	1	0	0.25000	0.25000	0.25000	0.29500	
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	1	0	0.50000	0.50000	0.50000	0.62500	
Ammonia (as N) (mg/L)	1	0	0.00250	0.00250	0.00250	0.00250	
Chloride (mg/L)	1	0	0.25000	0.25000	0.25000	0.25000	
Diss-Orthophosphate (mg/L)	1	0	0.00050	0.00050	0.00050	0.00050	
Diss-Phosphorus (mg/L)	1	0	0.00100	0.00100	0.00100	0.00100	
Floride (mg/L)	1	0	0.01000	0.01000	0.01000	0.01000	
Nitrate (N) (mg/L)	1	0	0.00250	0.00250	0.00250	0.00250	
Nitrate and Nitrite (mg/L)	1	0	0.00255	0.00255	0.00255	0.01377	
Nitrite (N) (mg/L)	1	0	0.00050	0.00050	0.00050	0.00050	
Sulphate (mg/L)	1	0	0.15000	0.15000	0.15000	0.25000	
Total Nitrogen (mg/L)	1	0	0.01500	0.01500	0.01500	0.02500	
Total Phosphorus (mg/L)	1	0	0.00100	0.00100	0.00100	0.00100	
Dissolved Metals							
TDS (mg/L)	1	0	5.00000	5.00000	5.00000	5.00000	
Organic / Inorganic							
DOC (mg/L)	1	0	0.25000	0.25000	0.25000	0.32750	
Physical Test							
Conductivity (µs/cm)	1	0	1.00000	1.00000	1.00000	1.00000	
NTU (ntu)	1	0	0.05000	0.05000	0.05000	0.06500	
pH (pH)	1	1	5.36000	5.36000	5.36000	5.81250	
TDS (mg/L)	1	0	5.00000	5.00000	5.00000	5.00000	
TSS (mg/L)	1	0	0.50000	0.50000	0.50000	1.50000	
Total Metals							
Aluminum (Al)-Total (mg/L)	1	0	0.00150	0.00150	0.00150	0.00150	
Antimony (Sb)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Arsenic (As)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Barium (Ba)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Beryllium (Be)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Bismuth (Bi)-Total (mg/L)	1	0	0.00003	0.00003	0.00003	0.00025	
Boron (B)-Total (mg/L)	1	0	0.00500	0.00500	0.00500	0.00500	
Cadmium (Cd)-Total (mg/L)	1	0	0.00000	0.00000	0.00000	0.00001	

Grid Format Report : DI-Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: DI-Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Calcium (Ca)-Total (mg/L)	1	0	0.02500	0.02500	0.02500	0.02500	
Chromium (Cr)-Total (mg/L)	1	0	0.00025	0.00025	0.00025	0.00025	
Cobalt (Co)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Copper (Cu)-Total (mg/L)	1	0	0.00025	0.00025	0.00025	0.00025	
Iron (Fe)-Total (mg/L)	1	0	0.01500	0.01500	0.01500	0.01500	
Lead (Pb)-Total (mg/L)	1	0	0.00003	0.00003	0.00003	0.00003	
Lithium (Li)-Total (mg/L)	1	0	0.00050	0.00050	0.00050	0.00050	
Magnesium (Mg)-Total (mg/L)	1	0	0.05000	0.05000	0.05000	0.05000	
Manganese (Mn)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Molybdenum (Mo)-Tota (mg/L)	1	0	0.00003	0.00003	0.00003	0.00003	
Nickel (Ni)-Total (mg/L)	1	0	0.00025	0.00025	0.00025	0.00025	
Potassium (K)-Total (mg/L)	1	0	0.02500	0.02500	0.02500	0.02500	
Selenium (Se)-Total (mg/L)	1	0	0.00003	0.00003	0.00003	0.00025	
Silicon (Si)-Total (mg/L)	1	0	0.05000	0.05000	0.05000	0.05000	
Silver (Ag)-Total (mg/L)	1	0	0.00001	0.00001	0.00001	0.00001	
Sodium (Na)-Total (mg/L)	1	0	0.02500	0.02500	0.02500	0.02500	
Strontium (Sr)-Total (mg/L)	1	0	0.00010	0.00010	0.00010	0.00010	
Thallium (Tl)-Total (mg/L)	1	0	0.00001	0.00001	0.00001	0.00001	
Tin (Sn)-Total (mg/L)	1	0	0.00005	0.00005	0.00005	0.00005	
Titanium (Ti)-Total (mg/L)	1	0	0.00500	0.00500	0.00500	0.00500	
Uranium (U)-Total (mg/L)	1	0	0.00001	0.00001	0.00001	0.00001	
Vanadium (V)-Total (mg/L)	1	0	0.00025	0.00025	0.00025	0.00050	
Zinc (Zn)-Total (mg/L)	1	0	0.00150	0.00150	0.00150	0.00150	

Grid Format Report : Field Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Field Blank														
	5-Jan-23	11-Jan-23	30-Jan-23	8-Feb-23	13-Feb-23	2-Mar-23	6-Mar-23	15-Mar-23	21-Mar-23	4-Apr-23	12-Apr-23	26-Apr-23	1-May-23	23-May-23	31-May-23
Hardness (as CaCO3), (mg/L)	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Diss-Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0029	<0.0020
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		<0.0030	<0.0030									<0.0030			<0.0030
Diss-Antimony (Sb) (mg/L)		<0.00010	<0.00010									<0.00010			<0.00010
Diss-Arsenic (As) (mg/L)		<0.00010	<0.00010									<0.00010			<0.00010
Diss-Barium (Ba) (mg/L)		<0.00010	<0.00010									<0.00010			<0.00010
Diss-Beryllium (Be) (mg/L)		<0.000100	<0.000100									<0.000100			<0.000100
Diss-Bismuth (Bi) (mg/L)		<0.000050	<0.000050									<0.000050			<0.000050
Diss-Boron (B) (mg/L)		<0.010	<0.010									<0.010			<0.010
Diss-Cadmium (Cd) (mg/L)		<0.0000050	<0.0000050									<0.0000050			<0.0000050
Diss-Calcium (Ca) (mg/L)		<0.050	<0.050									<0.050			<0.050
Diss-Chromium (Cr) (mg/L)		<0.00050	<0.00050									<0.00050			<0.00050
Diss-Cobalt (Co) (mg/L)		<0.00010	<0.00010									<0.00010			<0.00010
Diss-Copper (Cu) (mg/L)		<0.00050	<0.00050									<0.00050			<0.00050
Diss-Iron (Fe) (mg/L)		<0.030	<0.030									<0.030			<0.030
Diss-Lead (Pb) (mg/L)		<0.000050	<0.000050									<0.000050			<0.000050
Diss-Lithium (Li) (mg/L)		<0.0010	<0.0010									<0.0010			<0.0010
Diss-Magnesium (Mg) (mg/L)		<0.100	<0.100									<0.100			<0.100
Diss-Manganese (Mn) (mg/L)		<0.00010	<0.00010									<0.00010			<0.00010
Diss-Molybdenum (Mo) (mg/L)		<0.000050	<0.000050									<0.000050			<0.000050
Diss-Nickel (Ni) (mg/L)		<0.00050	<0.00050									<0.00050			<0.00050

	: Field Blank														
	6-Jun-23	13-Jun-23	20-Jun-23	29-Jun-23	4-Jul-23	26-Jul-23	1-Aug-23	2-Aug-23	9-Aug-23	23-Aug-23	7-Sep-23	11-Sep-23	20-Sep-23	5-Oct-23	11-Oct-23
Hardness (as CaCO3), (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50	<0.50
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		0.0024	<0.0010
Diss-Phosphorus (mg/L)	<0.0020	0.0035	0.0026	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0026
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)													<0.0030		
Diss-Antimony (Sb) (mg/L)													<0.00010		
Diss-Arsenic (As) (mg/L)													<0.00010		
Diss-Barium (Ba) (mg/L)													<0.00010		
Diss-Beryllium (Be) (mg/L)													<0.000100		
Diss-Bismuth (Bi) (mg/L)													<0.000050		
Diss-Boron (B) (mg/L)													<0.010		
Diss-Cadmium (Cd) (mg/L)													<0.0000050		
Diss-Calcium (Ca) (mg/L)													<0.050		
Diss-Chromium (Cr) (mg/L)													<0.00050		
Diss-Cobalt (Co) (mg/L)													<0.00010		
Diss-Copper (Cu) (mg/L)													<0.00050		
Diss-Iron (Fe) (mg/L)													<0.030		
Diss-Lead (Pb) (mg/L)													<0.000050		
Diss-Lithium (Li) (mg/L)													<0.0010		
Diss-Magnesium (Mg) (mg/L)													<0.100		
Diss-Manganese (Mn) (mg/L)													<0.00010		
Diss-Molybdenum (Mo) (mg/L)													<0.000050		
Diss-Nickel (Ni) (mg/L)													<0.00050		

	: Field Blank					
	24-Oct-23	26-Oct-23	1-Nov-23	23-Nov-23	7-Dec-23	13-Dec-23
Hardness (as CaCO3), (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	
Anions and Nutrients						
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Diss-Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals						
Aluminum (Al)-Diss (mg/L)						<0.0030
Diss-Antimony (Sb) (mg/L)						<0.00010
Diss-Arsenic (As) (mg/L)						<0.00010
Diss-Barium (Ba) (mg/L)						<0.00010
Diss-Beryllium (Be) (mg/L)						<0.000100
Diss-Bismuth (Bi) (mg/L)						<0.000050
Diss-Boron (B) (mg/L)						<0.010
Diss-Cadmium (Cd) (mg/L)						<0.0000050
Diss-Calcium (Ca) (mg/L)						<0.050
Diss-Chromium (Cr) (mg/L)						<0.00050
Diss-Cobalt (Co) (mg/L)						<0.00010
Diss-Copper (Cu) (mg/L)						<0.00050
Diss-Iron (Fe) (mg/L)						<0.030
Diss-Lead (Pb) (mg/L)						<0.000050
Diss-Lithium (Li) (mg/L)						<0.0010
Diss-Magnesium (Mg) (mg/L)						<0.100
Diss-Manganese (Mn) (mg/L)						<0.00010
Diss-Molybdenum (Mo) (mg/L)						<0.000050
Diss-Nickel (Ni) (mg/L)						<0.00050

Grid Format Report : Field Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Field Blank														
	5-Jan-23	11-Jan-23	30-Jan-23	8-Feb-23	13-Feb-23	2-Mar-23	6-Mar-23	15-Mar-23	21-Mar-23	4-Apr-23	12-Apr-23	26-Apr-23	1-May-23	23-May-23	31-May-23
Diss-Potassium (K) (mg/L)		<0.050	<0.050									<0.050			<0.050
Diss-Selenium (mg/L)		<0.000050	<0.000050									<0.000050			<0.000050
Diss-Silicon (Si) (mg/L)		<0.050	<0.050									<0.050			<0.050
Diss-Silver (Ag) (mg/L)		<0.000010	<0.000010									<0.000010			<0.000010
Diss-Sodium (Na) (mg/L)		<0.050	<0.050									<0.050			<0.050
Diss-Strontium (Sr) (mg/L)		<0.00020	<0.00020									<0.00020			<0.00020
Diss-Thallium (Tl) (mg/L)		<0.000010	<0.000010									<0.000010			<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010	<0.00010									<0.00010			<0.00010
Diss-Titanium (Ti) (mg/L)		<0.0100	<0.0100									<0.0100			<0.0100
Diss-Uranium (U) (mg/L)		<0.000010	<0.000010									<0.000010			<0.000010
Diss-Vanadium (V) (mg/L)		<0.00050	<0.00050									<0.00050			<0.00050
Diss-Zinc (Zn) (mg/L)		<0.0030	<0.0030									<0.0030			<0.0030
TDS (mg/L)	<10		<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Organic / Inorganic															
DOC (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Physical Test															
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)		<0.50	<0.50									<0.50			<0.50
NTU (ntu)	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
pH (pH)	5.50	5.32	5.48	5.36	5.40	5.52	5.37	5.44	5.46	5.39	5.51	5.56	5.55	5.16	5.76
TDS (mg/L)	<10		<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
TSS (mg/L)	<1.1		<1.0	<1.1	<1.1	<1.0	<1.0	<1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0077	0.0036	0.0094	
Antimony (Sb)-Total (mg/L)	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Arsenic (As)-Total (mg/L)	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Barium (Ba)-Total (mg/L)	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00018	0.00021	
Beryllium (Be)-Total (mg/L)	<0.000100		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	
Bismuth (Bi)-Total (mg/L)	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Boron (B)-Total (mg/L)	<0.010		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	
Cadmium (Cd)-Total (mg/L)	<0.0000050		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Calcium (Ca)-Total (mg/L)	<0.050		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Chromium (Cr)-Total (mg/L)	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Cobalt (Co)-Total (mg/L)	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Copper (Cu)-Total (mg/L)	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	

	: Field Blank														
	6-Jun-23	13-Jun-23	20-Jun-23	29-Jun-23	4-Jul-23	26-Jul-23	1-Aug-23	2-Aug-23	9-Aug-23	23-Aug-23	7-Sep-23	11-Sep-23	20-Sep-23	5-Oct-23	11-Oct-23
Diss-Potassium (K) (mg/L)													<0.050		
Diss-Selenium (mg/L)													<0.000050		
Diss-Silicon (Si) (mg/L)													<0.050		
Diss-Silver (Ag) (mg/L)													<0.000010		
Diss-Sodium (Na) (mg/L)													<0.050		
Diss-Strontium (Sr) (mg/L)													<0.00020		
Diss-Thallium (Tl) (mg/L)													<0.000010		
Diss-Tin (Sn) (mg/L)													<0.00010		
Diss-Titanium (Ti) (mg/L)													<0.0100		
Diss-Uranium (U) (mg/L)													<0.000010		
Diss-Vanadium (V) (mg/L)													<0.00050		
Diss-Zinc (Zn) (mg/L)													<0.0030		
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10	<10
Organic / Inorganic															
DOC (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Physical Test															
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)													<0.50		
NTU (ntu)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
pH (pH)	5.49	5.45	5.37	5.15	5.34	5.49	5.36	5.46	5.49	4.95	5.35	5.69	5.50	5.32	5.51
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10	<10
TSS (mg/L)	<1.1	<1.1	<1.0	<1.0	<1.2	<1.1	<1.1	<1.1	<1.1	<1.1	<1.0	<1.0		<1.2	<1.1
Total Metals															
Aluminum (Al)-Total (mg/L)	0.0061	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		<0.0030	<0.0030
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Arsenic (As)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Barium (Ba)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		<0.010	<0.010
Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		<0.0000050	<0.0000050
Calcium (Ca)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		<0.050	<0.050
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050

	: Field Blank					
	24-Oct-23	26-Oct-23	1-Nov-23	23-Nov-23	7-Dec-23	13-Dec-23
Diss-Potassium (K) (mg/L)						<0.050
Diss-Selenium (mg/L)						<0.000050
Diss-Silicon (Si) (mg/L)						<0.050
Diss-Silver (Ag) (mg/L)						<0.000010
Diss-Sodium (Na) (mg/L)						<0.050
Diss-Strontium (Sr) (mg/L)						<0.00020
Diss-Thallium (Tl) (mg/L)						<0.000010
Diss-Tin (Sn) (mg/L)						<0.00010
Diss-Titanium (Ti) (mg/L)						<0.0100
Diss-Uranium (U) (mg/L)						<0.000010
Diss-Vanadium (V) (mg/L)						<0.00050
Diss-Zinc (Zn) (mg/L)						<0.0030
TDS (mg/L)	<10	<10	<10	<10	<10	
Organic / Inorganic						
DOC (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Physical Test						
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)						<0.50
NTU (ntu)	<0.10	<0.10	<0.10	<0.10	<0.10	
pH (pH)	5.21	5.35	5.54	5.64	5.29	5.45
TDS (mg/L)	<10	<10	<10	<10	<10	
TSS (mg/L)	<1.1	<1.1	<1.1	<1.1	<1.1	
Total Metals						
Aluminum (Al)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Arsenic (As)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Barium (Ba)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	
Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Calcium (Ca)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	

Grid Format Report : Field Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Field Blank														
	5-Jan-23	11-Jan-23	30-Jan-23	8-Feb-23	13-Feb-23	2-Mar-23	6-Mar-23	15-Mar-23	21-Mar-23	4-Apr-23	12-Apr-23	26-Apr-23	1-May-23	23-May-23	31-May-23
Iron (Fe)-Total (mg/L)	<0.030		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	
Lead (Pb)-Total (mg/L)	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Lithium (Li)-Total (mg/L)	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Magnesium (Mg)-Total (mg/L)	<0.100		<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	
Manganese (Mn)-Total (mg/L)	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00016	
Molybdenum (Mo)-Tota (mg/L)	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Nickel (Ni)-Total (mg/L)	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Potassium (K)-Total (mg/L)	<0.050		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Selenium (Se)-Total (mg/L)	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Silicon (Si)-Total (mg/L)	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Silver (Ag)-Total (mg/L)	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Sodium (Na)-Total (mg/L)	<0.050		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Strontium (Sr)-Total (mg/L)	<0.00020		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Thallium (Tl)-Total (mg/L)	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Tin (Sn)-Total (mg/L)	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Titanium (Ti)-Total (mg/L)	<0.0100		<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	
Uranium (U)-Total (mg/L)	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Vanadium (V)-Total (mg/L)	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Zinc (Zn)-Total (mg/L)	<0.0030		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	

	: Field Blank														
	6-Jun-23	13-Jun-23	20-Jun-23	29-Jun-23	4-Jul-23	26-Jul-23	1-Aug-23	2-Aug-23	9-Aug-23	23-Aug-23	7-Sep-23	11-Sep-23	20-Sep-23	5-Oct-23	11-Oct-23
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Magnesium (Mg)-Total (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100		<0.100	<0.100
Manganese (Mn)-Total (mg/L)	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Molybdenum (Mo)-Tota (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Potassium (K)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		<0.050	<0.050
Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Silicon (Si)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	<0.000010
Sodium (Na)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		<0.050	<0.050
Strontium (Sr)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100		<0.0100	<0.0100
Uranium (U)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	<0.000010
Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		<0.0030	<0.0030

	: Field Blank					
	24-Oct-23	26-Oct-23	1-Nov-23	23-Nov-23	7-Dec-23	13-Dec-23
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Magnesium (Mg)-Total (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	
Manganese (Mn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Molybdenum (Mo)-Tota (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Potassium (K)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	
Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Silicon (Si)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Sodium (Na)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	
Strontium (Sr)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	
Uranium (U)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	

Grid Format Report : Field Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Field Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Hardness (as CaCO3), (mg/L)	33	0	0.25000	0.25000	0.25000	0.30000	0.00000
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	37	0	0.50000	0.50000	0.50000	0.50000	0.00000
Ammonia (as N) (mg/L)	37	0	0.00250	0.00250	0.00250	0.00250	0.00000
Chloride (mg/L)	37	0	0.25000	0.25000	0.25000	0.25000	0.00000
Diss-Orthophosphate (mg/L)	33	1	0.00050	0.00240	0.00056	0.00050	0.00033
Diss-Phosphorus (mg/L)	36	4	0.00100	0.00350	0.00121	0.00100	0.00062
Floride (mg/L)	37	0	0.01000	0.01000	0.01000	0.01000	0.00000
Nitrate (N) (mg/L)	37	0	0.00250	0.00250	0.00250	0.00250	0.00000
Nitrate and Nitrite (mg/L)	37	0	0.00255	0.00255	0.00255	0.00255	0.00000
Nitrite (N) (mg/L)	37	0	0.00050	0.00050	0.00050	0.00050	0.00000
Sulphate (mg/L)	37	0	0.15000	0.15000	0.15000	0.25000	0.00000
Total Nitrogen (mg/L)	37	0	0.01500	0.01500	0.01500	0.02500	0.00000
Total Phosphorus (mg/L)	37	0	0.00100	0.00100	0.00100	0.00567	0.00000
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	6	0	0.00150	0.00150	0.00150	0.00150	0.00000
Diss-Antimony (Sb) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Arsenic (As) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Barium (Ba) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Beryllium (Be) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Bismuth (Bi) (mg/L)	6	0	0.00003	0.00003	0.00003	0.00018	0.00000
Diss-Boron (B) (mg/L)	6	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Cadmium (Cd) (mg/L)	6	0	0.00000	0.00000	0.00000	0.00000	0.00000
Diss-Calcium (Ca) (mg/L)	6	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Chromium (Cr) (mg/L)	6	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Copper (Cu) (mg/L)	6	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Iron (Fe) (mg/L)	6	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	6	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Lithium (Li) (mg/L)	6	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Magnesium (Mg) (mg/L)	6	0	0.05000	0.05000	0.05000	0.05000	0.00000
Diss-Manganese (Mn) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Molybdenum (Mo) (mg/L)	6	0	0.00003	0.00003	0.00003	0.00003	0.00000

Grid Format Report : Field Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Field Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Nickel (Ni) (mg/L)	6	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Potassium (K) (mg/L)	6	0	0.02500	0.02500	0.02500	0.05930	0.00000
Diss-Selenium (mg/L)	6	0	0.00003	0.00003	0.00003	0.00018	0.00000
Diss-Silicon (Si) (mg/L)	6	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Silver (Ag) (mg/L)	6	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	6	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Strontium (Sr) (mg/L)	6	0	0.00010	0.00010	0.00010	0.00010	0.00000
Diss-Thallium (Tl) (mg/L)	6	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	6	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	6	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Uranium (U) (mg/L)	6	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Vanadium (V) (mg/L)	6	0	0.00025	0.00025	0.00025	0.00043	0.00000
Diss-Zinc (Zn) (mg/L)	6	0	0.00150	0.00150	0.00150	0.00150	0.00000
TDS (mg/L)	33	0	5.00000	5.00000	5.00000	5.00000	0.00000
Organic / Inorganic							
DOC (mg/L)	36	0	0.25000	0.25000	0.25000	0.25000	0.00000
Physical Test							
Conductivity (µs/cm)	37	0	1.00000	1.00000	1.00000	1.00000	0.00000
Hardness (mg/L)	6	0	0.25000	0.25000	0.25000	0.25000	0.00000
NTU (ntu)	33	0	0.05000	0.05000	0.05000	0.05000	0.00000
pH (pH)	37	37	4.95000	5.76000	5.41216	5.77450	0.16183
TDS (mg/L)	33	0	5.00000	5.00000	5.00000	5.00000	0.00000
TSS (mg/L)	33	0	0.50000	0.60000	0.53182	1.50000	0.03015
Total Metals							
Aluminum (Al)-Total (mg/L)	33	4	0.00150	0.00940	0.00213	0.00150	0.00188
Antimony (Sb)-Total (mg/L)	33	0	0.00005	0.00005	0.00005	0.00005	0.00000
Arsenic (As)-Total (mg/L)	33	0	0.00005	0.00005	0.00005	0.00005	0.00000
Barium (Ba)-Total (mg/L)	33	2	0.00005	0.00021	0.00006	0.00005	0.00004
Beryllium (Be)-Total (mg/L)	33	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	33	0	0.00003	0.00003	0.00002	0.00025	0.00000
Boron (B)-Total (mg/L)	33	0	0.00500	0.00500	0.00500	0.00500	0.00000
Cadmium (Cd)-Total (mg/L)	33	0	0.00000	0.00000	0.00000	0.00001	0.00000
Calcium (Ca)-Total (mg/L)	33	0	0.02500	0.02500	0.02500	0.02500	0.00000
Chromium (Cr)-Total (mg/L)	33	0	0.00025	0.00025	0.00025	0.00025	0.00000
Cobalt (Co)-Total (mg/L)	33	0	0.00005	0.00005	0.00005	0.00005	0.00000

Grid Format Report : Field Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Field Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Copper (Cu)-Total (mg/L)	33	0	0.00025	0.00025	0.00025	0.00025	0.00000
Iron (Fe)-Total (mg/L)	33	0	0.01500	0.01500	0.01500	0.01500	0.00000
Lead (Pb)-Total (mg/L)	33	0	0.00003	0.00003	0.00002	0.00003	0.00000
Lithium (Li)-Total (mg/L)	33	0	0.00050	0.00050	0.00050	0.00050	0.00000
Magnesium (Mg)-Total (mg/L)	33	0	0.05000	0.05000	0.05000	0.05000	0.00000
Manganese (Mn)-Total (mg/L)	33	2	0.00005	0.00016	0.00006	0.00005	0.00002
Molybdenum (Mo)-Tota (mg/L)	33	0	0.00003	0.00003	0.00002	0.00003	0.00000
Nickel (Ni)-Total (mg/L)	33	0	0.00025	0.00025	0.00025	0.00025	0.00000
Potassium (K)-Total (mg/L)	33	0	0.02500	0.02500	0.02500	0.02500	0.00000
Selenium (Se)-Total (mg/L)	33	0	0.00003	0.00003	0.00002	0.00025	0.00000
Silicon (Si)-Total (mg/L)	33	0	0.05000	0.05000	0.05000	0.05000	0.00000
Silver (Ag)-Total (mg/L)	33	0	0.00001	0.00001	0.00001	0.00001	0.00000
Sodium (Na)-Total (mg/L)	33	0	0.02500	0.02500	0.02500	0.02500	0.00000
Strontium (Sr)-Total (mg/L)	33	0	0.00010	0.00010	0.00010	0.00010	0.00000
Thallium (Tl)-Total (mg/L)	33	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	33	0	0.00005	0.00005	0.00005	0.00005	0.00000
Titanium (Ti)-Total (mg/L)	33	0	0.00500	0.00500	0.00500	0.00500	0.00000
Uranium (U)-Total (mg/L)	33	0	0.00001	0.00001	0.00001	0.00001	0.00000
Vanadium (V)-Total (mg/L)	33	0	0.00025	0.00025	0.00025	0.00050	0.00000
Zinc (Zn)-Total (mg/L)	33	0	0.00150	0.00150	0.00150	0.00150	0.00000

Grid Format Report : Filter Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Filter Blank			
	12-Jan-23	6-Feb-23	10-Aug-23	11-Oct-23
Dissolved Metals				
Aluminum (Al)-Diss (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030
Diss-Antimony (Sb) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Arsenic (As) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Barium (Ba) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Beryllium (Be) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Boron (B) (mg/L)	<0.010	<0.010	<0.010	<0.010
Diss-Cadmium (Cd) (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Diss-Calcium (Ca) (mg/L)	<0.050	<0.050	<0.050	<0.050
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Copper (Cu) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
Diss-Magnesium (Mg) (mg/L)	<0.100	<0.100	<0.100	<0.100
Diss-Manganese (Mn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Molybdenum (Mo) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Nickel (Ni) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Potassium (K) (mg/L)	<0.050	0.080	<0.050	<0.050
Diss-Selenium (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Silicon (Si) (mg/L)	<0.050	<0.050	<0.050	<0.050
Diss-Silver (Ag) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	<0.050	<0.050	<0.050	<0.050
Diss-Strontium (Sr) (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030
Physical Test				
Hardness (mg/L)	<0.50	<0.50	<0.50	<0.50

Grid Format Report : Filter Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Filter Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	4	0	0.00150	0.00150	0.00150	0.00150	0.00000
Diss-Antimony (Sb) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Arsenic (As) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Barium (Ba) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Beryllium (Be) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Bismuth (Bi) (mg/L)	4	0	0.00003	0.00003	0.00003	0.00025	0.00000
Diss-Boron (B) (mg/L)	4	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Cadmium (Cd) (mg/L)	4	0	0.00000	0.00000	0.00000	0.00001	0.00000
Diss-Calcium (Ca) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Chromium (Cr) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Copper (Cu) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Iron (Fe) (mg/L)	4	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	4	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Lithium (Li) (mg/L)	4	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Magnesium (Mg) (mg/L)	4	0	0.05000	0.05000	0.05000	0.05000	0.00000
Diss-Manganese (Mn) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Molybdenum (Mo) (mg/L)	4	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Nickel (Ni) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Potassium (K) (mg/L)	4	1	0.02500	0.08000	0.03875	0.02500	0.02750
Diss-Selenium (mg/L)	4	0	0.00003	0.00003	0.00003	0.00025	0.00000
Diss-Silicon (Si) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Silver (Ag) (mg/L)	4	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Strontium (Sr) (mg/L)	4	0	0.00010	0.00010	0.00010	0.00010	0.00000
Diss-Thallium (Tl) (mg/L)	4	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	4	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Uranium (U) (mg/L)	4	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Vanadium (V) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00050	0.00000
Diss-Zinc (Zn) (mg/L)	4	0	0.00150	0.00150	0.00150	0.00150	0.00000
Physical Test							
Hardness (mg/L)	4	0	0.25000	0.25000	0.25000	0.30000	0.00000

Grid Format Report : GW-Grundfos

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Grundfos								
	30-Jan-23	31-May-23	27-Jun-23	25-Jul-23	31-Aug-23	19-Sep-23	19-Oct-23	22-Nov-23	14-Dec-23
Anions and Nutrients									
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Phosphorus (mg/L)	<0.0020	<0.0020	0.0020	<0.0020	0.0036	<0.0020	<0.0020	<0.0020	<0.0020
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals									
Aluminum (Al)-Diss (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	0.0041	<0.0030	<0.0030	<0.0030	<0.0030
Diss-Antimony (Sb) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Arsenic (As) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Barium (Ba) (mg/L)	<0.00010	0.00026	0.00030	0.00013	0.00146	0.00015	0.00014	0.00021	<0.00010
Diss-Beryllium (Be) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Boron (B) (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Diss-Cadmium (Cd) (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000114	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Diss-Calcium (Ca) (mg/L)	<0.050	0.168	0.114	0.060	0.792	0.164	0.082	0.076	0.080
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Copper (Cu) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	0.00723	<0.00050	<0.00050	0.00064	<0.00050
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	0.000079	<0.000050	<0.000050	0.000103	<0.000050
Diss-Lithium (Li) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Diss-Magnesium (Mg) (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Diss-Manganese (Mn) (mg/L)	<0.00010	0.00464	0.00073	0.00135	0.00147	0.00049	0.00352	0.00053	0.00205
Diss-Molybdenum (Mo) (mg/L)	<0.000050	0.000060	0.000054	0.000053	0.000311	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Nickel (Ni) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	0.00360	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Potassium (K) (mg/L)	<0.050	<0.050	<0.050	<0.050	12.2	<0.050	<0.050	0.204	<0.050
Diss-Selenium (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Silicon (Si) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Grid Format Report : GW-Grundfos

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Grundfos								
	30-Jan-23	**31-May-23**	**27-Jun-23**	**25-Jul-23**	**31-Aug-23**	**19-Sep-23**	**19-Oct-23**	**22-Nov-23**	**14-Dec-23**
Diss-Silver (Ag) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000015	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	<0.050	<0.050	<0.050	<0.050	0.188	<0.050	<0.050	<0.050	<0.050
Diss-Strontium (Sr) (mg/L)	<0.00020	0.00087	0.00056	0.00068	0.00576	0.00104	0.00080	0.00032	0.00029
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00019	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030	0.0040	<0.0030	0.0073	<0.0030	<0.0030	<0.0030	<0.0030
Organic / Inorganic									
DOC (mg/L)	<0.50	<0.50	<0.50	0.54	1.10	<0.50	<0.50	<0.50	<0.50
Physical Test									
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)	<0.50	<0.50	<0.50	<0.50	1.98	<0.50	<0.50	<0.50	<0.50
pH (pH)	5.36	6.11	5.22	5.26	5.30	5.37	5.46	5.40	5.45

Grid Format Report : GW-Grundfos

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Grundfos						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	9	0	0.50000	0.50000	0.50000	2.04000	0.00000
Ammonia (as N) (mg/L)	9	0	0.00250	0.00250	0.00250	0.00292	0.00000
Chloride (mg/L)	9	0	0.25000	0.25000	0.25000	0.25000	0.00000
Diss-Phosphorus (mg/L)	9	2	0.00100	0.00360	0.00140	0.00807	0.00089
Floride (mg/L)	9	0	0.01000	0.01000	0.01000	0.01000	0.00000
Nitrate (N) (mg/L)	9	0	0.00250	0.00250	0.00250	0.00998	0.00000
Nitrate and Nitrite (mg/L)	9	0	0.00255	0.00255	0.00255	0.01455	0.00000
Nitrite (N) (mg/L)	9	0	0.00050	0.00050	0.00050	0.00050	0.00000
Sulphate (mg/L)	9	0	0.15000	0.15000	0.15000	0.61250	0.00000
Total Nitrogen (mg/L)	9	0	0.01500	0.01500	0.01500	0.04950	0.00000
Total Phosphorus (mg/L)	9	0	0.00100	0.00100	0.00100	0.01416	0.00000
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	9	1	0.00150	0.00410	0.00179	0.00556	0.00087
Diss-Antimony (Sb) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Arsenic (As) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00007	0.00000
Diss-Barium (Ba) (mg/L)	9	7	0.00005	0.00146	0.00031	0.00063	0.00044
Diss-Beryllium (Be) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00050	0.00000
Diss-Bismuth (Bi) (mg/L)	9	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Boron (B) (mg/L)	9	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Cadmium (Cd) (mg/L)	9	1	0.00000	0.00001	0.00000	0.00000	0.00000
Diss-Calcium (Ca) (mg/L)	9	8	0.02500	0.79200	0.17344	0.57455	0.23658
Diss-Chromium (Cr) (mg/L)	9	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Copper (Cu) (mg/L)	9	2	0.00025	0.00723	0.00107	0.00152	0.00231
Diss-Iron (Fe) (mg/L)	9	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	9	2	0.00003	0.00010	0.00004	0.00003	0.00003
Diss-Lithium (Li) (mg/L)	9	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Magnesium (Mg) (mg/L)	9	0	0.05000	0.05000	0.05000	0.14600	0.00000
Diss-Manganese (Mn) (mg/L)	9	8	0.00005	0.00464	0.00165	0.00275	0.00153
Diss-Molybdenum (Mo) (mg/L)	9	4	0.00003	0.00031	0.00007	0.00014	0.00009
Diss-Nickel (Ni) (mg/L)	9	1	0.00025	0.00360	0.00062	0.00025	0.00112
Diss-Potassium (K) (mg/L)	9	2	0.02500	12.20000	1.39767	0.18660	4.05131
Diss-Selenium (mg/L)	9	0	0.00003	0.00003	0.00003	0.00003	0.00000

Grid Format Report : GW-Grundfos

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Grundfos						
	Sample (n)	**Count >MDL**	**Min**	**Max**	**Mean**	**95th Percentile**	**St Dev**
Diss-Silicon (Si) (mg/L)	9	0	0.02500	0.02500	0.02500	0.06650	0.00000
Diss-Silver (Ag) (mg/L)	9	1	0.00001	0.00002	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	9	1	0.02500	0.18800	0.04311	0.09315	0.05433
Diss-Strontium (Sr) (mg/L)	9	8	0.00010	0.00576	0.00116	0.00536	0.00175
Diss-Thallium (Tl) (mg/L)	9	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	9	1	0.00005	0.00019	0.00007	0.00007	0.00005
Diss-Titanium (Ti) (mg/L)	9	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Uranium (U) (mg/L)	9	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Vanadium (V) (mg/L)	9	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Zinc (Zn) (mg/L)	9	2	0.00150	0.00730	0.00242	0.00746	0.00201
Organic / Inorganic							
DOC (mg/L)	9	2	0.25000	1.10000	0.37667	0.77200	0.28771
Physical Test							
Conductivity (µs/cm)	9	0	1.00000	1.00000	1.00000	3.70500	0.00000
Hardness (mg/L)	9	1	0.25000	1.98000	0.44222	1.99150	0.57667
pH (pH)	9	9	5.22000	6.11000	5.43667	6.47100	0.26519

Grid Format Report : GW-Low Flow

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Low Flow								
	12-Jan-23	31-May-23	27-Jun-23	25-Jul-23	31-Aug-23	19-Sep-23	19-Oct-23	22-Nov-23	14-Dec-23
Anions and Nutrients									
Alkalinity (CaCO3) (mg/L)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals									
Aluminum (Al)-Diss (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Diss-Antimony (Sb) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Arsenic (As) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Barium (Ba) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00033	<0.00010	<0.00010
Diss-Beryllium (Be) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Boron (B) (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Diss-Cadmium (Cd) (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000558
Diss-Calcium (Ca) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.152	<0.050	<0.050
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Copper (Cu) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00164	<0.00050	<0.00050
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000153	<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Diss-Magnesium (Mg) (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Diss-Manganese (Mn) (mg/L)	<0.00010	0.00013	0.00014	0.00012	<0.00010	<0.00010	0.00018	<0.00010	0.00027
Diss-Molybdenum (Mo) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Nickel (Ni) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Potassium (K) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Diss-Selenium (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Silicon (Si) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Grid Format Report : GW-Low Flow

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Low Flow								
	12-Jan-23	**31-May-23**	**27-Jun-23**	**25-Jul-23**	**31-Aug-23**	**19-Sep-23**	**19-Oct-23**	**22-Nov-23**	**14-Dec-23**
Diss-Silver (Ag) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Diss-Strontium (Sr) (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00099	<0.00020	<0.00020
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Organic / Inorganic									
DOC (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	0.63	<0.50	<0.50	<0.50
Physical Test									
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
pH (pH)	5.43	5.64	5.40	5.28	5.54	5.45	5.44	5.42	5.44

Grid Format Report : GW-Low Flow

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Low Flow						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	9	1	0.50000	1.00000	0.55556	29.03000	0.16667
Ammonia (as N) (mg/L)	9	0	0.00250	0.00250	0.00250	0.00722	0.00000
Chloride (mg/L)	9	0	0.25000	0.25000	0.25000	0.45700	0.00000
Diss-Phosphorus (mg/L)	9	0	0.00100	0.00100	0.00100	0.00100	0.00000
Floride (mg/L)	9	0	0.01000	0.01000	0.01000	0.02950	0.00000
Nitrate (N) (mg/L)	9	0	0.00250	0.00250	0.00250	0.00250	0.00000
Nitrate and Nitrite (mg/L)	9	0	0.00255	0.00255	0.00255	0.00929	0.00000
Nitrite (N) (mg/L)	9	0	0.00050	0.00050	0.00050	0.00050	0.00000
Sulphate (mg/L)	9	0	0.15000	0.15000	0.15000	11.11500	0.00000
Total Nitrogen (mg/L)	9	0	0.01500	0.01500	0.01500	0.03840	0.00000
Total Phosphorus (mg/L)	9	0	0.00100	0.00100	0.00100	0.00616	0.00000
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	9	0	0.00150	0.00150	0.00150	0.00426	0.00000
Diss-Antimony (Sb) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Arsenic (As) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Barium (Ba) (mg/L)	9	1	0.00005	0.00033	0.00008	0.00013	0.00009
Diss-Beryllium (Be) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00050	0.00000
Diss-Bismuth (Bi) (mg/L)	9	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Boron (B) (mg/L)	9	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Cadmium (Cd) (mg/L)	9	1	0.00000	0.00006	0.00001	0.00000	0.00002
Diss-Calcium (Ca) (mg/L)	9	1	0.02500	0.15200	0.03911	0.19890	0.04233
Diss-Chromium (Cr) (mg/L)	9	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Copper (Cu) (mg/L)	9	1	0.00025	0.00164	0.00040	0.00025	0.00046
Diss-Iron (Fe) (mg/L)	9	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	9	1	0.00003	0.00015	0.00004	0.00003	0.00004
Diss-Lithium (Li) (mg/L)	9	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Magnesium (Mg) (mg/L)	9	0	0.05000	0.05000	0.05000	0.05000	0.00000
Diss-Manganese (Mn) (mg/L)	9	5	0.00005	0.00027	0.00012	0.00061	0.00008
Diss-Molybdenum (Mo) (mg/L)	9	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Nickel (Ni) (mg/L)	9	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Potassium (K) (mg/L)	9	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Selenium (mg/L)	9	0	0.00003	0.00003	0.00003	0.00003	0.00000

Grid Format Report : GW-Low Flow

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: GW-Low Flow						
	Sample (n)	**Count >MDL**	**Min**	**Max**	**Mean**	**95th Percentile**	**St Dev**
Diss-Silicon (Si) (mg/L)	9	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Silver (Ag) (mg/L)	9	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	9	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Strontium (Sr) (mg/L)	9	1	0.00010	0.00099	0.00020	0.00130	0.00030
Diss-Thallium (Tl) (mg/L)	9	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	9	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	9	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Uranium (U) (mg/L)	9	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Vanadium (V) (mg/L)	9	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Zinc (Zn) (mg/L)	9	0	0.00150	0.00150	0.00150	0.00150	0.00000
Organic / Inorganic							
DOC (mg/L)	9	1	0.25000	0.63000	0.29222	0.25000	0.12667
Physical Test							
Conductivity (µs/cm)	9	0	1.00000	1.00000	1.00000	77.50000	0.00000
Hardness (mg/L)	9	0	0.25000	0.25000	0.25000	0.65400	0.00000
pH (pH)	9	9	5.28000	5.64000	5.44889	6.34000	0.09816

Grid Format Report : KEM2

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: KEM2										
	12-Jan-23	28-Feb-23	29-Mar-23	25-Apr-23	24-May-23	29-Jun-23	25-Jul-23	24-Aug-23	19-Sep-23	19-Oct-23	22-Nov-23
Hardness (as CaCO3), (mg/L)	0.53	0.61	0.58	0.52	<0.50	1.00	<0.50	<0.50	<0.50	<0.50	<0.50
Anions and Nutrients											
Alkalinity (CaCO3) (mg/L)	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	0.0056	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Diss-Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	0.0021	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	0.62	0.53	0.43	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals											
Aluminum (Al)-Diss (mg/L)					0.0042						
Diss-Antimony (Sb) (mg/L)					<0.00010						
Diss-Arsenic (As) (mg/L)					<0.00010						
Diss-Barium (Ba) (mg/L)					0.00027						
Diss-Beryllium (Be) (mg/L)					<0.000100						
Diss-Bismuth (Bi) (mg/L)					<0.000050						
Diss-Boron (B) (mg/L)					<0.010						
Diss-Cadmium (Cd) (mg/L)					<0.0000050						
Diss-Calcium (Ca) (mg/L)					0.066						
Diss-Chromium (Cr) (mg/L)					<0.00050						
Diss-Cobalt (Co) (mg/L)					<0.00010						
Diss-Copper (Cu) (mg/L)					<0.00050						
Diss-Iron (Fe) (mg/L)					<0.030						
Diss-Lead (Pb) (mg/L)					<0.000050						
Diss-Lithium (Li) (mg/L)					<0.0010						
Diss-Magnesium (Mg) (mg/L)					<0.100						
Diss-Manganese (Mn) (mg/L)					0.00024						
Diss-Molybdenum (Mo) (mg/L)					<0.000050						
Diss-Nickel (Ni) (mg/L)					<0.00050						

Grid Format Report : KEM2

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: KEM2										
	12-Jan-23	28-Feb-23	29-Mar-23	25-Apr-23	24-May-23	29-Jun-23	25-Jul-23	24-Aug-23	19-Sep-23	19-Oct-23	22-Nov-23
Diss-Potassium (K) (mg/L)					<0.050						
Diss-Selenium (mg/L)					<0.000050						
Diss-Silicon (Si) (mg/L)					<0.050						
Diss-Silver (Ag) (mg/L)					<0.000010						
Diss-Sodium (Na) (mg/L)					<0.050						
Diss-Strontium (Sr) (mg/L)					0.00051						
Diss-Thallium (Tl) (mg/L)					<0.000010						
Diss-Tin (Sn) (mg/L)					<0.00010						
Diss-Titanium (Ti) (mg/L)					<0.0100						
Diss-Uranium (U) (mg/L)					<0.000010						
Diss-Vanadium (V) (mg/L)					<0.00050						
Diss-Zinc (Zn) (mg/L)					<0.0030						
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Organic / Inorganic											
DOC (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Physical Test											
Conductivity (µs/cm)	2.1	2.7	2.6	2.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)					<0.50						
NTU (ntu)	<0.10	<0.10	<0.10	<0.10	0.40	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
pH (pH)	5.42	6.11	5.65	5.60	5.73	5.19	5.11	5.14	5.41	5.51	5.33
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
TSS (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Metals											
Aluminum (Al)-Total (mg/L)	0.0079	<0.0030	<0.0030	<0.0030	0.0104	0.169	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00012	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Barium (Ba)-Total (mg/L)	0.00022	<0.00010	<0.00010	<0.00010	0.00026	0.00451	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Total (mg/L)	0.212	0.245	0.234	0.207	<0.050	0.230	<0.050	<0.050	<0.050	<0.050	0.112
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00012	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Total (mg/L)	0.00146	<0.00050	<0.00050	<0.00050	0.00074	0.00753	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050

Grid Format Report : KEM2

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: KEM2										
	12-Jan-23	28-Feb-23	29-Mar-23	25-Apr-23	24-May-23	29-Jun-23	25-Jul-23	24-Aug-23	19-Sep-23	19-Oct-23	22-Nov-23
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	0.165	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000072	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Total (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	0.104	<0.100	<0.100	<0.100	<0.100	<0.100
Manganese (Mn)-Total (mg/L)	0.00052	<0.00010	0.00014	<0.00010	0.00037	0.00516	0.00018	<0.00010	<0.00010	<0.00010	0.00014
Molybdenum (Mo)-Tota (mg/L)	0.000060	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Potassium (K)-Total (mg/L)	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Silicon (Si)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	0.33	<0.10	<0.10	<0.10	<0.10	<0.10
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Strontium (Sr)-Total (mg/L)	0.00627	0.00754	0.00722	0.00576	0.00037	0.00163	<0.00020	<0.00020	<0.00020	<0.00020	0.00307
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0123	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Uranium (U)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00057	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

Grid Format Report : KEM2

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: KEM2						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Hardness (as CaCO3), (mg/L)	11	5	0.25000	1.00000	0.43091	0.30000	0.24337
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	11	1	0.50000	1.20000	0.56364	0.50000	0.21106
Ammonia (as N) (mg/L)	11	1	0.00250	0.00560	0.00278	0.00250	0.00093
Chloride (mg/L)	11	0	0.25000	0.25000	0.25000	0.25000	0.00000
Diss-Orthophosphate (mg/L)	11	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Phosphorus (mg/L)	11	1	0.00100	0.00210	0.00110	0.00210	0.00033
Floride (mg/L)	11	0	0.01000	0.01000	0.01000	0.01000	0.00000
Nitrate (N) (mg/L)	11	0	0.00250	0.00250	0.00250	0.00250	0.00000
Nitrate and Nitrite (mg/L)	11	0	0.00255	0.00255	0.00255	0.01794	0.00000
Nitrite (N) (mg/L)	11	0	0.00050	0.00050	0.00050	0.00050	0.00000
Sulphate (mg/L)	11	3	0.15000	0.62000	0.25273	0.15000	0.18100
Total Nitrogen (mg/L)	11	0	0.01500	0.01500	0.01500	0.01500	0.00000
Total Phosphorus (mg/L)	11	0	0.00100	0.00100	0.00100	0.00595	0.00000
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	1	1	0.00420	0.00420	0.00420		
Diss-Antimony (Sb) (mg/L)	1	0	0.00005	0.00005	0.00005		
Diss-Arsenic (As) (mg/L)	1	0	0.00005	0.00005	0.00005		
Diss-Barium (Ba) (mg/L)	1	1	0.00027	0.00027	0.00027		
Diss-Beryllium (Be) (mg/L)	1	0	0.00005	0.00005	0.00005		
Diss-Bismuth (Bi) (mg/L)	1	0	0.00003	0.00003	0.00003		
Diss-Boron (B) (mg/L)	1	0	0.00500	0.00500	0.00500		
Diss-Cadmium (Cd) (mg/L)	1	0	0.00000	0.00000	0.00000		
Diss-Calcium (Ca) (mg/L)	1	1	0.06600	0.06600	0.06600		
Diss-Chromium (Cr) (mg/L)	1	0	0.00025	0.00025	0.00025		
Diss-Cobalt (Co) (mg/L)	1	0	0.00005	0.00005	0.00005		
Diss-Copper (Cu) (mg/L)	1	0	0.00025	0.00025	0.00025		
Diss-Iron (Fe) (mg/L)	1	0	0.01500	0.01500	0.01500		
Diss-Lead (Pb) (mg/L)	1	0	0.00003	0.00003	0.00003		
Diss-Lithium (Li) (mg/L)	1	0	0.00050	0.00050	0.00050		
Diss-Magnesium (Mg) (mg/L)	1	0	0.05000	0.05000	0.05000		
Diss-Manganese (Mn) (mg/L)	1	1	0.00024	0.00024	0.00024		
Diss-Molybdenum (Mo) (mg/L)	1	0	0.00003	0.00003	0.00003		

Grid Format Report : KEM2

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: KEM2						
	Sample (n)	**Count >MDL**	**Min**	**Max**	**Mean**	**95th Percentile**	**St Dev**
Diss-Nickel (Ni) (mg/L)	1	0	0.00025	0.00025	0.00025		
Diss-Potassium (K) (mg/L)	1	0	0.02500	0.02500	0.02500		
Diss-Selenium (mg/L)	1	0	0.00003	0.00003	0.00003		
Diss-Silicon (Si) (mg/L)	1	0	0.02500	0.02500	0.02500		
Diss-Silver (Ag) (mg/L)	1	0	0.00001	0.00001	0.00001		
Diss-Sodium (Na) (mg/L)	1	0	0.02500	0.02500	0.02500		
Diss-Strontium (Sr) (mg/L)	1	1	0.00051	0.00051	0.00051		
Diss-Thallium (Tl) (mg/L)	1	0	0.00001	0.00001	0.00001		
Diss-Tin (Sn) (mg/L)	1	0	0.00005	0.00005	0.00005		
Diss-Titanium (Ti) (mg/L)	1	0	0.00500	0.00500	0.00500		
Diss-Uranium (U) (mg/L)	1	0	0.00001	0.00001	0.00001		
Diss-Vanadium (V) (mg/L)	1	0	0.00025	0.00025	0.00025		
Diss-Zinc (Zn) (mg/L)	1	0	0.00150	0.00150	0.00150		
TDS (mg/L)	11	0	5.00000	5.00000	5.00000	5.00000	0.00000
Organic / Inorganic							
DOC (mg/L)	11	0	0.25000	0.25000	0.25000	0.90700	0.00000
Physical Test							
Conductivity (µs/cm)	11	4	1.00000	2.70000	1.52727	1.00000	0.74578
Hardness (mg/L)	1	0	0.25000	0.25000	0.25000	0.25000	
NTU (ntu)	11	1	0.05000	0.40000	0.08182	0.08850	0.10553
pH (pH)	11	11	5.11000	6.11000	5.47273	5.78200	0.29506
TDS (mg/L)	11	0	5.00000	5.00000	5.00000	5.00000	0.00000
TSS (mg/L)	11	0	0.50000	0.50000	0.50000	1.05000	0.00000
Total Metals							
Aluminum (Al)-Total (mg/L)	11	3	0.00150	0.16900	0.01812	0.00499	0.05014
Antimony (Sb)-Total (mg/L)	11	0	0.00005	0.00005	0.00005	0.00005	0.00000
Arsenic (As)-Total (mg/L)	11	1	0.00005	0.00012	0.00006	0.00005	0.00002
Barium (Ba)-Total (mg/L)	11	3	0.00005	0.00451	0.00049	0.00008	0.00134
Beryllium (Be)-Total (mg/L)	11	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	11	0	0.00003	0.00003	0.00003	0.00003	0.00000
Boron (B)-Total (mg/L)	11	0	0.00500	0.00500	0.00500	0.00500	0.00000
Cadmium (Cd)-Total (mg/L)	11	0	0.00000	0.00000	0.00000	0.00000	0.00000
Calcium (Ca)-Total (mg/L)	11	6	0.02500	0.24500	0.12409	0.08840	0.10088
Chromium (Cr)-Total (mg/L)	11	0	0.00025	0.00025	0.00025	0.00025	0.00000
Cobalt (Co)-Total (mg/L)	11	1	0.00005	0.00012	0.00006	0.00005	0.00002

Grid Format Report : KEM2

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: KEM2						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Copper (Cu)-Total (mg/L)	11	3	0.00025	0.00753	0.00107	0.00025	0.00218
Iron (Fe)-Total (mg/L)	11	1	0.01500	0.16500	0.02864	0.01500	0.04523
Lead (Pb)-Total (mg/L)	11	1	0.00003	0.00007	0.00003	0.00003	0.00001
Lithium (Li)-Total (mg/L)	11	0	0.00050	0.00050	0.00050	0.00050	0.00000
Magnesium (Mg)-Total (mg/L)	11	1	0.05000	0.10400	0.05491	0.05000	0.01628
Manganese (Mn)-Total (mg/L)	11	6	0.00005	0.00516	0.00061	0.00027	0.00152
Molybdenum (Mo)-Tota (mg/L)	11	1	0.00003	0.00006	0.00003	0.00003	0.00001
Nickel (Ni)-Total (mg/L)	11	0	0.00025	0.00025	0.00025	0.00025	0.00000
Potassium (K)-Total (mg/L)	11	1	0.02500	0.05000	0.02727	0.02500	0.00754
Selenium (Se)-Total (mg/L)	11	0	0.00003	0.00003	0.00003	0.00003	0.00000
Silicon (Si)-Total (mg/L)	11	1	0.05000	0.33000	0.07545	0.05000	0.08442
Silver (Ag)-Total (mg/L)	11	0	0.00001	0.00001	0.00001	0.00001	0.00000
Sodium (Na)-Total (mg/L)	11	0	0.02500	0.02500	0.02500	0.02500	0.00000
Strontium (Sr)-Total (mg/L)	11	7	0.00010	0.00754	0.00293	0.00047	0.00315
Thallium (Tl)-Total (mg/L)	11	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	11	0	0.00005	0.00005	0.00005	0.00005	0.00000
Titanium (Ti)-Total (mg/L)	11	1	0.00500	0.01230	0.00566	0.00500	0.00220
Uranium (U)-Total (mg/L)	11	0	0.00001	0.00001	0.00001	0.00001	0.00000
Vanadium (V)-Total (mg/L)	11	1	0.00025	0.00057	0.00028	0.00025	0.00010
Zinc (Zn)-Total (mg/L)	11	0	0.00150	0.00150	0.00150	0.00150	0.00000

Grid Format Report : Travel Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Travel Blank														
	10-Jan-23	11-Jan-23	19-Jan-23	23-Jan-23	7-Feb-23	16-Feb-23	21-Feb-23	6-Mar-23	7-Mar-23	4-Apr-23	13-Apr-23	2-May-23	9-May-23	10-May-23	15-May-23
Hardness (as CaCO3), (mg/L)	<0.50	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010
Diss-Phosphorus (mg/L)			<0.0020			<0.0020									
Floride (mg/L)	<0.020	<0.020		<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051		<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030		<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020		<0.0020	0.0024	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)			<0.0030												
Diss-Antimony (Sb) (mg/L)			<0.00010												
Diss-Arsenic (As) (mg/L)			<0.00010												
Diss-Barium (Ba) (mg/L)			<0.00010												
Diss-Beryllium (Be) (mg/L)			<0.000100												
Diss-Bismuth (Bi) (mg/L)			<0.000050												
Diss-Boron (B) (mg/L)			<0.010												
Diss-Cadmium (Cd) (mg/L)			<0.0000050												
Diss-Calcium (Ca) (mg/L)			<0.050												
Diss-Chromium (Cr) (mg/L)			<0.00050												
Diss-Cobalt (Co) (mg/L)			<0.00010												
Diss-Copper (Cu) (mg/L)			<0.00050												
Diss-Iron (Fe) (mg/L)			<0.030												
Diss-Lead (Pb) (mg/L)			<0.000050												
Diss-Lithium (Li) (mg/L)			<0.0010												
Diss-Magnesium (Mg) (mg/L)			<0.100												
Diss-Manganese (Mn) (mg/L)			<0.00010												
Diss-Molybdenum (Mo) (mg/L)			0.000143												
Diss-Nickel (Ni) (mg/L)			<0.00050												

	: Travel Blank														
	16-May-23	17-May-23	23-May-23	25-May-23	29-May-23	30-May-23	12-Jun-23	26-Jun-23	27-Jun-23	6-Jul-23	10-Jul-23	25-Jul-23	27-Jul-23	31-Jul-23	2-Aug-23
Hardness (as CaCO3), (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Diss-Phosphorus (mg/L)															<0.0020
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)															<0.0030
Diss-Antimony (Sb) (mg/L)															<0.00010
Diss-Arsenic (As) (mg/L)															<0.00010
Diss-Barium (Ba) (mg/L)															<0.00010
Diss-Beryllium (Be) (mg/L)															<0.000100
Diss-Bismuth (Bi) (mg/L)															<0.000050
Diss-Boron (B) (mg/L)															<0.010
Diss-Cadmium (Cd) (mg/L)															<0.0000050
Diss-Calcium (Ca) (mg/L)															<0.050
Diss-Chromium (Cr) (mg/L)															<0.00050
Diss-Cobalt (Co) (mg/L)															<0.00010
Diss-Copper (Cu) (mg/L)															<0.00050
Diss-Iron (Fe) (mg/L)															<0.030
Diss-Lead (Pb) (mg/L)															<0.000050
Diss-Lithium (Li) (mg/L)															<0.0010
Diss-Magnesium (Mg) (mg/L)															<0.100
Diss-Manganese (Mn) (mg/L)															<0.00010
Diss-Molybdenum (Mo) (mg/L)															<0.000050
Diss-Nickel (Ni) (mg/L)															<0.00050

	: Travel Blank														
	9-Aug-23	15-Aug-23	14-Sep-23	26-Sep-23	28-Sep-23	4-Oct-23	11-Oct-23	16-Oct-23	25-Oct-23	30-Oct-23	31-Oct-23	8-Nov-23	15-Nov-23	22-Nov-23	12-Dec-23
Hardness (as CaCO3), (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010
Diss-Phosphorus (mg/L)														<0.0020	
Floride (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)														<0.0030	
Diss-Antimony (Sb) (mg/L)														<0.00010	
Diss-Arsenic (As) (mg/L)														<0.00010	
Diss-Barium (Ba) (mg/L)														<0.00010	
Diss-Beryllium (Be) (mg/L)														<0.000100	
Diss-Bismuth (Bi) (mg/L)														<0.000050	
Diss-Boron (B) (mg/L)														<0.010	
Diss-Cadmium (Cd) (mg/L)														<0.0000050	
Diss-Calcium (Ca) (mg/L)														<0.050	
Diss-Chromium (Cr) (mg/L)														<0.00050	
Diss-Cobalt (Co) (mg/L)														<0.00010	
Diss-Copper (Cu) (mg/L)														<0.00050	
Diss-Iron (Fe) (mg/L)														<0.030	
Diss-Lead (Pb) (mg/L)														<0.000050	
Diss-Lithium (Li) (mg/L)														<0.0010	
Diss-Magnesium (Mg) (mg/L)														<0.100	
Diss-Manganese (Mn) (mg/L)														<0.00010	
Diss-Molybdenum (Mo) (mg/L)														<0.000050	
Diss-Nickel (Ni) (mg/L)														<0.00050	

	: Travel Blank	
	13-Dec-23	19-Dec-23
Hardness (as CaCO3), (mg/L)		<0.50
Anions and Nutrients		
Alkalinity (CaCO3) (mg/L)	<1.0	<1.0
Ammonia (as N) (mg/L)	<0.0050	<0.0050
Chloride (mg/L)	<0.50	<0.50
Diss-Orthophosphate (mg/L)		<0.0010
Diss-Phosphorus (mg/L)	<0.0020	
Floride (mg/L)	<0.020	<0.020
Nitrate (N) (mg/L)	<0.0050	<0.0050
Nitrate and Nitrite (mg/L)	<0.0051	<0.0051
Nitrite (N) (mg/L)	<0.0010	<0.0010
Sulphate (mg/L)	<0.30	<0.30
Total Nitrogen (mg/L)	<0.030	<0.030
Total Phosphorus (mg/L)	<0.0020	<0.0020
Dissolved Metals		
Aluminum (Al)-Diss (mg/L)	<0.0030	
Diss-Antimony (Sb) (mg/L)	<0.00010	
Diss-Arsenic (As) (mg/L)	<0.00010	
Diss-Barium (Ba) (mg/L)	<0.00010	
Diss-Beryllium (Be) (mg/L)	<0.000100	
Diss-Bismuth (Bi) (mg/L)	<0.000050	
Diss-Boron (B) (mg/L)	<0.010	
Diss-Cadmium (Cd) (mg/L)	<0.0000050	
Diss-Calcium (Ca) (mg/L)	<0.050	
Diss-Chromium (Cr) (mg/L)	<0.00050	
Diss-Cobalt (Co) (mg/L)	<0.00010	
Diss-Copper (Cu) (mg/L)	<0.00050	
Diss-Iron (Fe) (mg/L)	<0.030	
Diss-Lead (Pb) (mg/L)	0.000157	
Diss-Lithium (Li) (mg/L)	<0.0010	
Diss-Magnesium (Mg) (mg/L)	<0.100	
Diss-Manganese (Mn) (mg/L)	<0.00010	
Diss-Molybdenum (Mo) (mg/L)	<0.000050	
Diss-Nickel (Ni) (mg/L)	<0.00050	

Grid Format Report : Travel Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Travel Blank														
	10-Jan-23	11-Jan-23	19-Jan-23	23-Jan-23	7-Feb-23	16-Feb-23	21-Feb-23	6-Mar-23	7-Mar-23	4-Apr-23	13-Apr-23	2-May-23	9-May-23	10-May-23	15-May-23
Diss-Potassium (K) (mg/L)			<0.050												
Diss-Selenium (mg/L)			<0.000050												
Diss-Silicon (Si) (mg/L)			<0.050												
Diss-Silver (Ag) (mg/L)			<0.000010												
Diss-Sodium (Na) (mg/L)			<0.050												
Diss-Strontium (Sr) (mg/L)			<0.00020												
Diss-Thallium (Tl) (mg/L)			<0.000010												
Diss-Tin (Sn) (mg/L)			<0.00010												
Diss-Titanium (Ti) (mg/L)			<0.0100												
Diss-Uranium (U) (mg/L)			<0.000010												
Diss-Vanadium (V) (mg/L)			<0.00050												
Diss-Zinc (Zn) (mg/L)			<0.0030												
TDS (mg/L)	<10	<10		<10	<10	<10	<10	<10	<10	<10	<10		<10	<10	<10
Organic / Inorganic															
DOC (mg/L)			<0.50			<0.50									
Physical Test															
Conductivity (µs/cm)	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)			<0.50												
NTU (ntu)	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
pH (pH)	5.49	5.35		5.51	5.46	5.56	5.44	5.39	5.44	5.45	5.47	5.55	5.48	5.48	6.17
TDS (mg/L)	<10	<10		<10	<10	<10	<10	<10	<10	<10	<10		<10	<10	<10
TSS (mg/L)	<1.0	<1.0		<1.1	<1.1	<1.1	<1.0	<1.1	<1.1	<1.0	<1.0			<1.0	<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030	<0.0030		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Barium (Ba)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total (mg/L)	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Total (mg/L)	<0.050	<0.050		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Total (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050

	: Travel Blank														
	16-May-23	17-May-23	23-May-23	25-May-23	29-May-23	30-May-23	12-Jun-23	26-Jun-23	27-Jun-23	6-Jul-23	10-Jul-23	25-Jul-23	27-Jul-23	31-Jul-23	2-Aug-23
Diss-Potassium (K) (mg/L)															<0.050
Diss-Selenium (mg/L)															<0.000050
Diss-Silicon (Si) (mg/L)															<0.050
Diss-Silver (Ag) (mg/L)															<0.000010
Diss-Sodium (Na) (mg/L)															<0.050
Diss-Strontium (Sr) (mg/L)															<0.00020
Diss-Thallium (Tl) (mg/L)															<0.000010
Diss-Tin (Sn) (mg/L)															<0.00010
Diss-Titanium (Ti) (mg/L)															<0.0100
Diss-Uranium (U) (mg/L)															<0.000010
Diss-Vanadium (V) (mg/L)															<0.00050
Diss-Zinc (Zn) (mg/L)															<0.0030
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
Organic / Inorganic															
DOC (mg/L)															<0.50
Physical Test															
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)															<0.50
NTU (ntu)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
pH (pH)	5.43	5.36	5.24	5.23	5.27	5.37	5.49	5.39	5.35	5.19	5.48	5.08	5.43	5.51	5.48
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	
TSS (mg/L)	<1.1	<1.0	<1.0	<1.0	<1.0	<1.1	<1.1	<1.1	<1.0	<1.2	<1.2	<1.0	<1.1	<1.1	
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Arsenic (As)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Barium (Ba)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	
Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Calcium (Ca)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	

	: Travel Blank														
	9-Aug-23	15-Aug-23	14-Sep-23	26-Sep-23	28-Sep-23	4-Oct-23	11-Oct-23	16-Oct-23	25-Oct-23	30-Oct-23	31-Oct-23	8-Nov-23	15-Nov-23	22-Nov-23	12-Dec-23
Diss-Potassium (K) (mg/L)														<0.050	
Diss-Selenium (mg/L)														<0.000050	
Diss-Silicon (Si) (mg/L)														<0.050	
Diss-Silver (Ag) (mg/L)														<0.000010	
Diss-Sodium (Na) (mg/L)														<0.050	
Diss-Strontium (Sr) (mg/L)														<0.00020	
Diss-Thallium (Tl) (mg/L)														<0.000010	
Diss-Tin (Sn) (mg/L)														<0.00010	
Diss-Titanium (Ti) (mg/L)														<0.0100	
Diss-Uranium (U) (mg/L)														<0.000010	
Diss-Vanadium (V) (mg/L)														<0.00050	
Diss-Zinc (Zn) (mg/L)														<0.0030	
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10
Organic / Inorganic															
DOC (mg/L)														<0.50	
Physical Test															
Conductivity (µs/cm)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Hardness (mg/L)														<0.50	
NTU (ntu)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10
pH (pH)	5.54	5.51	5.41	5.35	5.30	5.28	5.50	5.49	5.51	5.36	5.39	5.49	5.46	5.31	5.32
TDS (mg/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10		<10
TSS (mg/L)	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.0	<1.1	<1.1	<1.0	<1.0		<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		<0.0030
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010
Arsenic (As)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010
Barium (Ba)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050
Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		<0.010
Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		<0.0000050
Calcium (Ca)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		<0.050
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050
Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010
Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050

	: Travel Blank	
	13-Dec-23	19-Dec-23
Diss-Potassium (K) (mg/L)	<0.050	
Diss-Selenium (mg/L)	<0.000050	
Diss-Silicon (Si) (mg/L)	<0.050	
Diss-Silver (Ag) (mg/L)	<0.000010	
Diss-Sodium (Na) (mg/L)	<0.050	
Diss-Strontium (Sr) (mg/L)	<0.00020	
Diss-Thallium (Tl) (mg/L)	<0.000010	
Diss-Tin (Sn) (mg/L)	<0.00010	
Diss-Titanium (Ti) (mg/L)	<0.0100	
Diss-Uranium (U) (mg/L)	<0.000010	
Diss-Vanadium (V) (mg/L)	<0.00050	
Diss-Zinc (Zn) (mg/L)	<0.0030	
TDS (mg/L)		<10
Organic / Inorganic		
DOC (mg/L)	<0.50	
Physical Test		
Conductivity (µs/cm)	<2.0	<2.0
Hardness (mg/L)	<0.50	
NTU (ntu)		<0.10
pH (pH)	5.85	5.60
TDS (mg/L)		<10
TSS (mg/L)		<1.0
Total Metals		
Aluminum (Al)-Total (mg/L)		<0.0030
Antimony (Sb)-Total (mg/L)		<0.00010
Arsenic (As)-Total (mg/L)		<0.00010
Barium (Ba)-Total (mg/L)		<0.00010
Beryllium (Be)-Total (mg/L)		<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050
Boron (B)-Total (mg/L)		<0.010
Cadmium (Cd)-Total (mg/L)		<0.0000050
Calcium (Ca)-Total (mg/L)		<0.050
Chromium (Cr)-Total (mg/L)		<0.00050
Cobalt (Co)-Total (mg/L)		<0.00010
Copper (Cu)-Total (mg/L)		0.00058

Grid Format Report : Travel Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Travel Blank														
	10-Jan-23	11-Jan-23	19-Jan-23	23-Jan-23	7-Feb-23	16-Feb-23	21-Feb-23	6-Mar-23	7-Mar-23	4-Apr-23	13-Apr-23	2-May-23	9-May-23	10-May-23	15-May-23
Iron (Fe)-Total (mg/L)	<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Total (mg/L)	<0.100	<0.100		<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Manganese (Mn)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Molybdenum (Mo)-Tota (mg/L)	<0.000050	<0.000050		0.000136	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Potassium (K)-Total (mg/L)	<0.050	<0.050		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Selenium (Se)-Total (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Silicon (Si)-Total (mg/L)	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Total (mg/L)	<0.050	<0.050		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Strontium (Sr)-Total (mg/L)	<0.00020	<0.00020		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100		<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Uranium (U)-Total (mg/L)	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Vanadium (V)-Total (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

	: Travel Blank														
	16-May-23	17-May-23	23-May-23	25-May-23	29-May-23	30-May-23	12-Jun-23	26-Jun-23	27-Jun-23	6-Jul-23	10-Jul-23	25-Jul-23	27-Jul-23	31-Jul-23	2-Aug-23
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Magnesium (Mg)-Total (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	
Manganese (Mn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Molybdenum (Mo)-Tota (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Potassium (K)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Silicon (Si)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Sodium (Na)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Strontium (Sr)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	
Uranium (U)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	

	: Travel Blank														
	9-Aug-23	15-Aug-23	14-Sep-23	26-Sep-23	28-Sep-23	4-Oct-23	11-Oct-23	16-Oct-23	25-Oct-23	30-Oct-23	31-Oct-23	8-Nov-23	15-Nov-23	22-Nov-23	12-Dec-23
Iron (Fe)-Total (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		0.000148
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010
Magnesium (Mg)-Total (mg/L)	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100		<0.100
Manganese (Mn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010
Molybdenum (Mo)-Tota (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050
Potassium (K)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		<0.050
Selenium (Se)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050
Silicon (Si)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010
Sodium (Na)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		<0.050
Strontium (Sr)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100		<0.0100
Uranium (U)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010
Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		<0.0030

	: Travel Blank	
	13-Dec-23	19-Dec-23
Iron (Fe)-Total (mg/L)		<0.030
Lead (Pb)-Total (mg/L)		0.000187
Lithium (Li)-Total (mg/L)		<0.0010
Magnesium (Mg)-Total (mg/L)		<0.100
Manganese (Mn)-Total (mg/L)		<0.00010
Molybdenum (Mo)-Tota (mg/L)		<0.000050
Nickel (Ni)-Total (mg/L)		<0.00050
Potassium (K)-Total (mg/L)		<0.050
Selenium (Se)-Total (mg/L)		<0.000050
Silicon (Si)-Total (mg/L)		<0.10
Silver (Ag)-Total (mg/L)		<0.000010
Sodium (Na)-Total (mg/L)		<0.050
Strontium (Sr)-Total (mg/L)		<0.00020
Thallium (Tl)-Total (mg/L)		<0.000010
Tin (Sn)-Total (mg/L)		<0.00010
Titanium (Ti)-Total (mg/L)		<0.0100
Uranium (U)-Total (mg/L)		<0.000010
Vanadium (V)-Total (mg/L)		<0.00050
Zinc (Zn)-Total (mg/L)		<0.0030

Grid Format Report : Travel Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Travel Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Hardness (as CaCO3), (mg/L)	46	0	0.25000	0.25000	0.25000	0.30000	0.00000
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	49	0	0.50000	0.50000	0.50000	1.30000	0.00000
Ammonia (as N) (mg/L)	50	0	0.00250	0.00250	0.00250	0.00614	0.00000
Chloride (mg/L)	49	0	0.25000	0.25000	0.25000	0.25000	0.00000
Diss-Orthophosphate (mg/L)	44	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Phosphorus (mg/L)	5	0	0.00100	0.00100	0.00100	0.00100	0.00000
Floride (mg/L)	49	0	0.01000	0.01000	0.01000	0.01000	0.00000
Nitrate (N) (mg/L)	49	0	0.00250	0.00250	0.00250	0.00250	0.00000
Nitrate and Nitrite (mg/L)	49	0	0.00255	0.00255	0.00255	0.00255	0.00000
Nitrite (N) (mg/L)	49	0	0.00050	0.00050	0.00050	0.00050	0.00000
Sulphate (mg/L)	49	0	0.15000	0.15000	0.15000	0.25000	0.00000
Total Nitrogen (mg/L)	46	0	0.01500	0.01500	0.01500	0.02500	0.00000
Total Phosphorus (mg/L)	49	1	0.00100	0.00240	0.00103	0.00100	0.00020
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	4	0	0.00150	0.00150	0.00150	0.00150	0.00000
Diss-Antimony (Sb) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Arsenic (As) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Barium (Ba) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Beryllium (Be) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Bismuth (Bi) (mg/L)	4	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Boron (B) (mg/L)	4	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Cadmium (Cd) (mg/L)	4	0	0.00000	0.00000	0.00000	0.00000	0.00000
Diss-Calcium (Ca) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Chromium (Cr) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Copper (Cu) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Iron (Fe) (mg/L)	4	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	4	1	0.00003	0.00016	0.00006	0.00003	0.00007
Diss-Lithium (Li) (mg/L)	4	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Magnesium (Mg) (mg/L)	4	0	0.05000	0.05000	0.05000	0.05000	0.00000
Diss-Manganese (Mn) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Molybdenum (Mo) (mg/L)	4	1	0.00003	0.00014	0.00005	0.00005	0.00006

Grid Format Report : Travel Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Travel Blank						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Nickel (Ni) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Potassium (K) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Selenium (mg/L)	4	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Silicon (Si) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Silver (Ag) (mg/L)	4	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	4	0	0.02500	0.02500	0.02500	0.02500	0.00000
Diss-Strontium (Sr) (mg/L)	4	0	0.00010	0.00010	0.00010	0.00010	0.00000
Diss-Thallium (Tl) (mg/L)	4	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	4	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	4	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Uranium (U) (mg/L)	4	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Vanadium (V) (mg/L)	4	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Zinc (Zn) (mg/L)	4	0	0.00150	0.00150	0.00150	0.00150	0.00000
TDS (mg/L)	45	0	5.00000	5.00000	5.00000	5.00000	0.00000
Organic / Inorganic							
DOC (mg/L)	5	0	0.25000	0.25000	0.25000	0.25000	0.00000
Physical Test							
Conductivity (µs/cm)	49	0	1.00000	1.00000	1.00000	1.00000	0.00000
Hardness (mg/L)	4	0	0.25000	0.25000	0.25000	0.25000	0.00000
NTU (ntu)	45	0	0.05000	0.05000	0.05000	0.05000	0.00000
pH (pH)	49	49	5.08000	6.17000	5.43571	5.83400	0.16220
TDS (mg/L)	45	0	5.00000	5.00000	5.00000	5.00000	0.00000
TSS (mg/L)	44	0	0.50000	0.60000	0.52955	1.50000	0.02917
Total Metals							
Aluminum (Al)-Total (mg/L)	46	0	0.00150	0.00150	0.00150	0.00150	0.00000
Antimony (Sb)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000
Arsenic (As)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000
Barium (Ba)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000
Beryllium (Be)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	46	0	0.00003	0.00003	0.00003	0.00025	0.00000
Boron (B)-Total (mg/L)	46	0	0.00500	0.00500	0.00500	0.00500	0.00000
Cadmium (Cd)-Total (mg/L)	46	0	0.00000	0.00000	0.00000	0.00001	0.00000
Calcium (Ca)-Total (mg/L)	46	0	0.02500	0.02500	0.02500	0.02500	0.00000
Chromium (Cr)-Total (mg/L)	46	0	0.00025	0.00025	0.00025	0.00025	0.00000
Cobalt (Co)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000

Grid Format Report : Travel Blank

From 1 Jan 2023 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Travel Blank						
	Sample (n)	**Count >MDL**	**Min**	**Max**	**Mean**	**95th Percentile**	**St Dev**
Copper (Cu)-Total (mg/L)	46	1	0.00025	0.00058	0.00026	0.00025	0.00005
Iron (Fe)-Total (mg/L)	46	0	0.01500	0.01500	0.01500	0.01500	0.00000
Lead (Pb)-Total (mg/L)	46	2	0.00003	0.00019	0.00003	0.00003	0.00003
Lithium (Li)-Total (mg/L)	46	0	0.00050	0.00050	0.00050	0.00050	0.00000
Magnesium (Mg)-Total (mg/L)	46	0	0.05000	0.05000	0.05000	0.05000	0.00000
Manganese (Mn)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000
Molybdenum (Mo)-Tota (mg/L)	46	1	0.00003	0.00014	0.00003	0.00003	0.00002
Nickel (Ni)-Total (mg/L)	46	0	0.00025	0.00025	0.00025	0.00025	0.00000
Potassium (K)-Total (mg/L)	46	0	0.02500	0.02500	0.02500	0.02500	0.00000
Selenium (Se)-Total (mg/L)	46	0	0.00003	0.00003	0.00003	0.00025	0.00000
Silicon (Si)-Total (mg/L)	46	0	0.05000	0.05000	0.05000	0.05000	0.00000
Silver (Ag)-Total (mg/L)	46	0	0.00001	0.00001	0.00001	0.00001	0.00000
Sodium (Na)-Total (mg/L)	46	0	0.02500	0.02500	0.02500	0.02500	0.00000
Strontium (Sr)-Total (mg/L)	46	0	0.00010	0.00010	0.00010	0.00010	0.00000
Thallium (Tl)-Total (mg/L)	46	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	46	0	0.00005	0.00005	0.00005	0.00005	0.00000
Titanium (Ti)-Total (mg/L)	46	0	0.00500	0.00500	0.00500	0.00500	0.00000
Uranium (U)-Total (mg/L)	46	0	0.00001	0.00001	0.00001	0.00001	0.00000
Vanadium (V)-Total (mg/L)	46	0	0.00025	0.00025	0.00025	0.00050	0.00000
Zinc (Zn)-Total (mg/L)	46	0	0.00150	0.00150	0.00150	0.00150	0.00000

ALS Quality Management System Summary

ALS is a global diversified testing services organization with a presence on every continent, offering a broad range of services to leading global companies.

The following report summarizes standard practices routinely employed by the ALS Environmental Division in Canada. Our practices exceed accreditation requirements and have been built to meet the needs of our customers and to give them confidence in the reliability of our test data.

Additional information is available on request from the Quality Department. Customers are invited to audit or tour ALS facilities at their convenience.

Services to Customers

ALS cooperates closely with its customers to ensure their testing needs are understood, and allows them reasonable access to relevant work areas of the laboratories to audit the management system or to witness test work undertaken on their behalf.

All client issues are logged into our tracking system to ensure each issue is addressed completely and appropriately. Local and national oversight and initiatives ensure that identified improvements are incorporated in the Canadian laboratories so that customers receive the same level of service regardless of which location performs the testing.

Documentation and Document Control

Test methods and support procedures are documented in detail to ensure consistency of application, repeatability of test results and traceability of analyses.

Test method requirements include but are not limited to sample handling, sample storage, minimizing interference, sample preparation, reagent and standard specifications, equipment, supplies, calibration requirements, instrumental measurement procedures, quality control requirements, data quality objectives and corrective actions, calculations, reporting requirements, reference information, hazards and their preventive measures.

Administrative support procedures are also documented where needed to ensure quality system procedures and customer services are provided in a controlled, approved manner consistent with ALS policies and client needs.

All procedures are authorized prior to use by the signing authority, ensuring adequate technical and quality oversight.

Distribution of documents is controlled to ensure only the most recent version is available for use. Authorized documents are reviewed periodically by the signing authority to ensure they continue to meet ALS requirements and customer needs.

Test methods and support procedures are available for client viewing on-site.

Internal Audits

Internal audits are scheduled and performed by qualified Quality and Technical staff for all routine analytical procedures and Quality System elements. Such audits ensure that procedures are implemented as intended, that test methods are scientifically defensible and technically sound, and that policies, procedures and records continue to meet the Quality System objectives.

Quality staff may periodically initiate unscheduled audits in response to proficiency testing program results, client feedback, requests from managers or any other circumstance that warrants investigation.

Quality Control (QC)

ALS has established QC procedures for monitoring the validity of tests performed by its laboratories. Individual test methods specify quality control requirements, frequency of use, and Data Quality Objectives (DQOs).

The type of quality control elements used for process monitoring is dependent on the test performed, but typically includes (as appropriate): Calibration Verification Standards, Continuing Calibration Verifications, Instrument Blanks, Method Blanks, Laboratory Control Samples, Reference Materials, Matrix Spikes, Surrogate Spikes, and Internal Standards.

DQOs are established for each QC sample, based on a combination of reference method objectives, customer requirements and historical test method performance. Where applicable, prescriptive elements of reference methods take precedence over internal DQOs.

Test results for selected QC samples are available on test reports. Please contact your Account Manager for more information.

Control Charts

Control charts are used to provide a graphical representation of QC results and test method performance over time. Control charts graphically display DQOs as well as the statistically derived mean and ± 2 and 3 standard deviations ("sigma") around the mean, calculated from recent historical QC results. ALS applies advanced trend monitoring algorithms to identify outliers and non-random data distributions (trends) that may indicate undesirable changes in test method performance. The trend monitoring process has been automated within our LIMS. Upon data entry, each QC result is checked against programmed limits and trends. If a trend is identified, a notification is e-mailed to the analyst and their supervisor, so that it can be investigated and corrected.

Continuous Improvement

ALS is committed to continuously improving its processes and services. The Quality System feeds into a continuous cycle of review, implementation, and monitoring so that improvements are actively sought and adopted where needed.

Data Validation

ALS analytical data proceeds through several reviews prior to the release of final reports. The ALS data validation process includes test result validation, inter-parameter validation and report validation. Test result validation involves an independent peer review of raw and calculated test results. Inter-parameter validation occurs when all department specific parameters for a sample are completed, and involves an overall review of test results within each sample for consistency among any related test parameters. Report validation occurs when all the requested test results for a work order are completed, and involves a review of the final report before it is sent to the customer.

ALS maintains laboratory records in a traceable manner for five years.

Method Validation

Customers rely on ALS to select test methods that are appropriate to meet their needs. Wherever possible, ALS references the latest versions of published standard methods developed by organizations such as American Public Health Association, United States Environmental Protection Agency, NIOSH, Environment Canada, and other international, regional or regulatory organizations, or equipment manufacturers.

Method validations are conducted to confirm that our test methods are fit for their intended use. The validations are as extensive as necessary to meet the needs of the given application. The extent depends on the source of the method. Test methods are revalidated periodically to ensure continued suitability and fitness for purpose.

Method Detection Limits and Limits of Reporting

ALS Limits of Reporting (LORs) are established using rigorous experimental and statistical procedures that begin with the determination of the Method Detection Limit (MDL) at 99% confidence. The MDL takes into account several factors, like long term Method Blanks, low level Sample Duplicates, and low level Spiked Samples. When detected at or above the MDL, ALS test results are considered to be qualitatively accurate, and a parameter can be reported with 99% confidence as being present in the sample.

$$MDL = (s_0 \times t_{n-1}) + |MBlk|$$

Where:
- s_0 = the standard deviation derived from the analysis of blank or low level samples, whichever gives a higher standard deviation,
- t_{n-1} = the Student's t-distribution with n-1 degrees of freedom for the one-sided 99% confidence interval.
- |MBlk|= the absolute value of the mean method blank.

ALS takes a conservative approach to detection limits. Our goal is to minimize false positives, because we recognize that any false positive results can be damaging for our clients. Where possible, we establish LORs at levels well-above the statistical MDL, and ideally at the LOQ_5. This improves the accuracy and precision of results near the detection limit, and reduces the chance of false positives due to sample-specific issues. At or above the LOQ_5, test results are considered to be quantitatively accurate. A reported parameter at the LOQ_5 is considered to be within 40% of the true value 95% of the time.

$$LOQ_5 = 5s_0 + |MBlk|$$

Where:
- s_0 = the standard deviation used in the MDL calculation,
- |MBlk| = the absolute value of the mean method blank.

The D. L. column on ALS analytical reports contains the LOR. The LOR may be the MDL as calculated above, or a higher value. ALS does not report LORs that are less than the calculated MDL.

Measurement Uncertainty (MU)

ALS procedures for calculating measurement uncertainty are based on accepted practices of identifying components contributing to uncertainty, compiling data that represents or includes these components, evaluating the data using appropriate statistical calculations, and reporting in a manner that prevents misunderstanding of the result. The Type A method of calculating measurement uncertainty is followed, however additional factors are considered to ensure the best and most complete information is derived from our evaluation of test method performance.

The ALS model describes the dependency of uncertainty on three factors. The first is a constant contribution to uncertainty attributable to s_0, the standard deviation of the method for concentrations that approach zero. The second is a constant relative uncertainty associated with higher parameter concentrations. The third is a constant contribution to uncertainty attributable to the mean long-term method blank value where it is significant. The following is the ALS equation for measurement uncertainty, using an expansion factor of k=2:

Expanded 95% Uncertainty as a Function of Concentration

$$U(c) = 2 * [\sqrt{ \{ s_0^2 + (\Theta c)^2 \} }] + |MBlk_{LT}|$$

Where:
- **U(c)** = The expanded uncertainty at concentration c. The range c ± U(c) represents approximately the 95% confidence interval (two standard deviations).
- **c** = Measured concentration of parameter in the sample.
- s_0 = A constant contribution to standard uncertainty represented by the standard deviation at zero concentration, which is related to the method detection limit.
- **Θ** = Combined relative standard uncertainty, excluding MDL and Method Blank contributions. Theta has no units.
- $|MBlk_{LT}|$ = Absolute value of the mean long-term Method Blank value, where significant (i.e. if > 1/5 s_0). [Note that the Method Blank term is not expanded because it represents a constant bias, not a variance.]

Uncertainty values obtained from this procedure must be regarded as estimates. Primarily, this is because all environmental samples are different, especially with regard to matrix effects and heterogeneity. It is our intent with this procedure to arrive at an estimate of a 95% confidence level uncertainty value that can be assumed to apply to 95% (or more) of the samples that a laboratory receives for a given test. It follows that for samples where undetected matrix effects or interferences occur, or for samples that are atypically heterogeneous, uncertainty estimates may be low.

Another aspect of reporting MU is the reporting of test method bias. Bias occurs in a small number of test methods that cannot recover 100% of a parameter from a sample. In these cases ALS reports bias along with the MU to aid with the interpretation of the test result.

Participation in Interlaboratory Proficiency Testing (PT) Programs

ALS locations participate in an extensive variety of proficiency testing programs. Where available, formal programs operated by outside agencies are used. When not available, ALS utilizes less formal proficiency testing studies. Root cause analysis is initiated and corrective action plans are developed when PT program results indicate a decline in test method performance.

Staff Training

Formal training procedures are in place to ensure all staff are trained in ALS polices and analytical procedures prior to performing analyses. A staff orientation program communicates ALS polices to newly hired staff. Task specific training is performed, and analyst proficiency is demonstrated and documented before staff are authorized to work independently. On-going analyst proficiency is monitored using proficiency testing programs. Records are maintained in training logs issued to staff upon hiring.

As well, ALS Canada promotes continuing education and learning by offering advanced courses covering technical and quality functions.

Employee Agreements

ALS protects its customers' confidential information and proprietary rights. We require all employees to review and sign a Code of Conduct policy that communicates the ALS confidentiality policy. It is ALS practice to never disclose information about a client's analysis to a third party without prior consent of the client, or unless compelled to by law. If we are obligated by law to disclose such information, we will inform the client prior to doing so.

Our employees avoid involvement in activities that would diminish confidence in their competence, impartiality, judgment, or integrity by complying with the ALS Code of Conduct and Data Integrity Policy.

Sample Tracking

Procedures are in place to track samples from receipt at the lab through to final reporting. A data management system (LIMS – Laboratory Information Management System) is used to generate a work order number for each sample submission, and a unique identification number is generated for each sample within the work order. The system is then used to assign specific analyses for the samples, to identify methods to be used, and to assign due dates for the results. The system is used to manage analytical workloads and track the status of all samples in-house. LIMS is a secure system that can only be accessed using login passwords. Controlling the level of access according to staff needs provides additional security.

When requested by the client, legal sample protocols are implemented to ensure chain of custody defensibility in a court of law. Contact the lab for legal sampling and transportation instructions if this service is needed.

Equipment Calibration

Measuring and testing equipment used by ALS laboratories that can have a significant effect on the accuracy or validity of test results is calibrated using established procedures. The procedures ensure traceability through an unbroken chain of calibrations or comparisons to national measurement standards. Where traceability of measurements to SI units is not possible and/or not relevant, traceability is provided by the use of certified reference materials and/or consensus standards.

Management Reviews (MR)

Management conducts a review at least annually to ensure the management system is effective, and continues to be suitable for its operations, and to identify necessary changes or improvements. Senior management is included in the review process for all locations.

Freshwater Phytoplankton Enumeration and Identification Methods
Client: Minnow Environmental
Project: Mount Polley 2020

Sample Inventory

Sample arrival: 25-Jun-2020, 2-Sep-2020
Number of samples:
Number of jars:
Biologica project number: fp20-092

Upon arrival, samples were examined, and Lugol's preservative was added to ensure adequate preservation of samples. An inventory form was created and verified with the chain of custody (COC) to ensure (1) all samples are accounted for, (2) each sample has the appropriate number of jars as indicated on the COC. Any discrepancies were reported to the client and were resolved before further sample handling.

Sample Processing

Samples were thoroughly mixed by shaking, and sub-samples (25-100) were dispensed into Utermohl settling chambers, and allowed to settle for 24-48 hours (depending on sub-sample volume). Sub-samples were then systematically scanned using a Zeiss Axio Vert A.1 inverted phase-contrast microscope at 400x magnification. All algal units were counted in a series of randomly located fields of view (FOV) until a minimum of 300 units were enumerated. Algal units represent single cells of all algal groups, as well as colonies or filaments of blue-green algae. Given that blue-green algal colonies/filaments may contain hundreds of cells, enumerating units, rather than individual cells, allows for a more equal representation of algal groups. The mean number of cells per unit (= 1 for single cells, >1 for all other algal forms) were estimated for all taxa and used to calculate total densities. Only "viable" cells (those that appeared to be alive at the time of collection) were identified and enumerated. Chrysophyte loricas were also counted (EPA, 2003).

Algae were identified to genus, where possible, following the most up-to-date taxonomic references and collaborations with international and local algal taxonomic experts. Species-level identifications were only given to identifiable taxa for which there are reliable taxonomic references available that encompass the species-level morphological diversity in North America. This approach ensures long-term consistency of data sets and is in accordance with the trend in algal taxonomic practice to be more conservative with delineation of species. Species-level identifications for some taxa are problematic due to widespread phenotypic plasticity that can artificially inflate species richness (Wehr *et al.* 2015). When applicable, terms "cf." (*confertim*, possibly for species) and "sp.1" (a single undetermined species) were employed to distinguish between different species in the same genus.

Table 1. Summary of phytoplankton samples processed for Minnow Environmental, Mount Polley 2020.

Client Sample ID	Date Sampled	Biologica Sample ID	Subsample Volume (mL)	Fields of View Counted	Sum of Units Counted
POL-P2	22-Jun-20	fp20-092-001	100	15	319
BOL-B2	22-Jun-20	fp20-092-002	25	23	319
QUL-ZOO-1	23-Jun-20	fp20-092-004	50	23	326
QUL-ZOO-7	23-Jun-20	fp20-092-005	50	23	364
POL-P2-1	27-Jul-20	fp20-092-011	50	13	334
POL-P2-2	27-Jul-20	fp20-092-012	50	10	312
POL-P2-3	27-Jul-20	fp20-092-013	25	27	332
POL-P2-4	27-Jul-20	fp20-092-014	50	13	347
POL-P2-5	27-Jul-20	fp20-092-015	50	15	330
QUL-ZOO-1-1	28-Jul-20	fp20-092-016	50	23	320
QUL-ZOO-1-2	28-Jul-20	fp20-092-017	50	13	307
QUL-ZOO-1-3	28-Jul-20	fp20-092-018	50	17	321
QUL-ZOO-1-4	28-Jul-20	fp20-092-019	50	13	357
QUL-ZOO-1-5	28-Jul-20	fp20-092-020	50	15	341
QUL-ZOO-A-1	28-Jul-20	fp20-092-021	50	20	334
QUL-ZOO-G-1	28-Jul-20	fp20-092-022	50	20	311
QUL-ZOO-7-1	28-Jul-20	fp20-092-023	50	17	334
QUL-ZOO-7-2	28-Jul-20	fp20-092-024	50	17	328
QUL-ZOO-7-3	28-Jul-20	fp20-092-025	50	20	327
QUL-ZOO-7-4	28-Jul-20	fp20-092-026	50	15	329
QUL-ZOO-7-5	28-Jul-20	fp20-092-027	50	13	307
B2-1	29-Jul-20	fp20-092-028	50	20	328
B2-2	29-Jul-20	fp20-092-029	50	23	317
B2-3	29-Jul-20	fp20-092-030	50	17	322
B2-4	29-Jul-20	fp20-092-031	50	17	334
B2-5	29-Jul-20	fp20-092-032	50	17	300
BOL-B2	30-Aug-20	fp20-092-070	50	13	305
POL-P2	30-Aug-20	fp20-092-071	50	15	329
QUL-ZOO-1	27-Aug-20	fp20-092-072	50	13	324
QUL-ZOO-7	27-Aug-20	fp20-092-073	50	13	324

*Algal units represent single cells, colonies, coenobia or filaments.

Data Analysis

Algal densities expressed as the number of cells per litre (cells/L) were derived for each sample from the sub-sample volume, number of FOV assessed, number of units counted, and number of cells per unit.

QA/QC

Three samples (=10% of samples) were reanalyzed to assess sub-sampling and enumeration precision (Table 2). Samples were randomly selected and processed at different times to reduce counting and identification bias.

Table 2. Summary of taxonomic QA/QC results for Minnow Environmental, Mount Polley, 2020. project.

Client Sample #	Biologica Sample #	Original Density (cells/L)	QA Density (cells/L)	% Agreement
QUL-ZOO-1	20-092-004	622,075	679,739	**90.73**
QUL-ZOO-7	20-092-005	793,321	714,687	**90.09**
QUL-ZOO-7-4	20-092-026	886,865	961,887	**91.54**
			Average:	**90.79**

* Percent Agreement: [100- (difference in abundance between samples) / total abundance of the original sample)] %

Results were provided to the Minnow Environmental project manager in Excel spreadsheets via email.

Methodological and Taxonomic References

Coesel, P. F., & Meesters, K. 2007. Desmids of the lowlands: Mesotaeniaceae and Desmidiaceae of the European lowlands (Vol. 200, pp. 3-83). Zeist: KNNV Publishing.

Cox, E. J. 1996. Identification of freshwater diatoms from live material. Chapman & Hall.

Environmental Protection Agency. 2003. Standard operating procedure for phytoplankton analysis. Online report number LG401, 41 pp. http://www.epa.gov/glnpo/monitoring/sop/Chapter_4/LG401.pdf.

John, D. M., Whitton, B. A., & Brook, A. J. 2002. The freshwater algal flora of the British Isles: an identification guide to freshwater and terrestrial Algae (Vol. 1). Cambridge University Press.

Guiry, M.D. & Guiry, G.M. 2017. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. http://www.algaebase.org.

Hillebrand, H., Dürselen, C. D., Kirschtel, D., Pollingher, U., & Zohary, T. 1999 Biovolume calculation for pelagic and benthic microalgae. Journal of Phycology 35(2): 403-424.

Kelly, M. 2000. Identification of common benthic diatoms in rivers. Field Stud, 9, 583-700

Komárek, J., & Anagnostidis, K. 2000. Cyanoprokaryota Teil-1: Chroococcales. Berlin: Spektrum Akademischer Verlag Heidelberg; ISBN 3-8274-0890-3.

Komárek, J., & Anagnostidis, K. 2000. Cyanoprokaryota Teil-2: Oscillatoriales. Berlin: Spektrum Akademischer Verlag Heidelberg; ISBN 3-8274-0890-3.

Komárek, J., & Anagnostidis, K. 2000. Cyanoprokaryota Teil-3: Heterocytous Genera. Berlin: Spektrum Akademischer Verlag Heidelberg; ISBN 3-8274-0890-3.

Krammer, K., & Lange-Bertalot, H. 1986. Bacillariophyceae, Part 2, Volume 1: Naviculaceae. Freshwater Flora of Middle Europe. Gustav Fischer Publisher, New York.

Krammer, K., & Lange-Bertalot, H. 1988. Bacillariophyceae, Part 2, Volume 2: Bacillariaceae, Epithemiaceae, Surirellaceae. Freshwater Flora of Middle Europe. Gustav Fischer Publisher, New York.

Krammer, K., & Lange-Bertalot, H. 1991. Bacillariophyceae, Part 2, Volume 3: Centrales, Fragilariaceae, Eunotiaceae. Freshwater Flora of Middle Europe. Gustav Fischer Publisher, Stuttgart.

Krammer, K., & Lange-Bertalot, H. 1991. Bacillariophyceae, Part 2, Volume 4: Achnanthaceae, Critical Supplement to Navicula (Lineolatae) and Gomphonema, Complete List of Literature for Volumes 1-4. Freshwater Flora of Middle Europe. Gustav Fischer Publisher, Stuttgart.

Spaulding, S., & Edlund, M. 2020. Diatoms of North America. https://diatoms.org

Taylor, J. C., Harding, W. R., & Archibald, C. G. M. 2007. An illustrated guide to some common diatom species from South Africa. Pretoria: Water Research Commission.

Wehr, J. D., Sheath, R. G., & Kociolek, J. P. (Eds.). 2015. Freshwater Algae of North America: ecology and classification. Elsevier.

Freshwater Zooplankton Enumeration and Identification Methods
Client: Minnow Environmental Inc.
Project: Mount Polley Lakes

Sample Inventory

Sample arrival: 25-Jun-20, 21-Aug-20 & 2-Sep-20
Number of samples: 31 (28 processed)
Number of jars: 31
Screen size: 45 µm
Biologica project number: fz20-092

Upon arrival, the samples were examined and double-checked against the chain of custody to ensure that (1) all samples were accounted for, and (2) each sample had the appropriate number of jars as indicated on the COC. Any discrepancies were reported to the client and were resolved before further sample handling. Samples were transferred from formalin into 70% ethanol and assigned a unique identification number.

Sample Processing

Freshwater zooplankton samples were analyzed in two fractions as follows:

(1) A "Coarse" fraction comprised of cladocerans, adult copepods, and copepodids, in which a minimum count of 200 organisms was obtained, and

(2) A "Fine" or "Micro" fraction, in which only copepod nauplii and rotifers were identified and enumerated. Processing of the micro fraction was completed to either a 100-count or a minimum of three sub-samples. The Micro fraction was analyzed using a 1-mL Sedgewick-Rafter counting chamber.

The Coarse fraction was analyzed in a Bogorov tray through a stereo microscope at 10-40x magnification. All organisms were identified by taxonomic experts to the lowest taxonomic level using a compound microscope (100–400x magnification), appropriate dissection tools, and standard taxonomic references. For copepods, the stage of development was also recorded (copepodite stages I-V) as is the sex for mature individuals (copepod stage VI).

Sub-sampling for all fractions was performed using Hensen-Stempel pipettes. Generally sub-samples are 1/10 of total sample volume for the "Coarse" fraction and 1/100 for the "Micro" fraction.

Zooplankton were identified to species wherever possible, although immature copepods lack differentiating features required for identification beyond order (e.g., Calanoida, Cyclopoida, or Harpacticoida). All identifications were performed using taxonomic references and collaborations with external experts, where necessary.

Table 1. Summary of zooplankton samples processed for Minnow Environmental Mount Polley Lakes, 2020.

Lake	Client Sample ID	Date Sampled	Biologica Sample ID	Fraction	Split	Specimens Counted
Polley	POL-P2	22-Jun-20	fz20-092-006	Coarse	10/1000	383
				Fine	1/1000	196
Bootjack	BOL-B2	22-Jun-20	fz20-092-007	Coarse	6/1000	267
				Fine	1/1000	158
Quesnel	QUL-ZOO-DUP	23-Jun-20	fz20-092-008	n/a	n/a	Not processed
Quesnel	QUL-ZOO-1	23-Jun-20	fz20-092-009	Coarse	5/1000	204
				Fine	3/1000	76
Quesnel	QUL-ZOO-7	23-Jun-20	fz20-092-010	Coarse	4/500	250
				Fine	3/500	131
Polley	P2-1	27-Jul-20	fz20-092-033	Coarse	5/1000	208
				Fine	1/1000	120
Polley	POL-P2-2	27-Jul-20	fz20-092-034	Coarse	8/1000	208
				Fine	2/1000	137
Polley	POL-P2-3	27-Jul-20	fz20-092-035	Coarse	5/1000	204
				Fine	1/1000	104
Polley	P2-4	27-Jul-20	fz20-092-036	Coarse	7/1000	230
				Fine	1/1000	117
Polley	P2-5	27-Jul-20	fz20-092-037	Coarse	5/1000	201
				Fine	1/1000	125
Quesnel	QUL-ZOO-1-1	28-Jul-20	fz20-092-038	Coarse	14/1000	218
				Fine	2/1000	130
Quesnel	QUL-ZOO-1-2	28-Jul-20	fz20-092-039	Coarse	7/300	209
				Fine	1/300	99
Quesnel	QUL-ZOO-1-3	28-Jul-20	fz20-092-040	Coarse	8/300	211
				Fine	1/300	213
Quesnel	QUL-ZOO-1-4	28-Jul-20	fz20-092-041	Coarse	10/300	257
				Fine	1/300	121
Quesnel	QUL-ZOO-1-5	28-Jul-20	fz20-092-042	Coarse	20/600	310
				Fine	1/600	148
Quesnel	QUL-ZOO-7-1	28-Jul-20	fz20-092-043	Coarse	6/300	277
				Fine	1/300	154
Quesnel	QUL-ZOO-7-2	28-Jul-20	fz20-092-044	Coarse	20/600	243
				Fine	1/600	103
Quesnel	QUL-ZOO-7-3	28-Jul-20	fz20-092-045	Coarse	10/300	281
				Fine	1/300	130
Quesnel	QUL-ZOO-7-4	28-Jul-20	fz20-092-046	Coarse	5/300	199
				Fine	1/300	191
Quesnel	QUL-ZOO-7-5	28-Jul-20	fz20-092-047	Coarse	20/1000	225
				Fine	1/1000	141
Bootjack	B2-1	29-Jul-20	fz20-092-048	Coarse	8/500	212
					Whole	8
				Fine	1/500	99

Lake	Client Sample ID	Date Sampled	Biologica Sample ID	Fraction	Split	Specimens Counted
Bootjack	B2-2	29-Jul-20	fz20-092-049	Coarse	8/500	199
					Whole	4
				Fine	1/500	127
Bootjack	B2-3	29-Jul-20	fz20-092-050	Coarse	11/500	204
					Whole	4
				Fine	1/500	97
Bootjack	B2-4	29-Jul-20	fz20-092-051	Coarse	16/500	228
					Whole	1
				Fine	1/500	130
Bootjack	B2-5	29-Jul-20	fz20-092-052	Coarse	10/500	229
					Whole	8
				Fine	1/500	112
Bootjack	B2-2X	29-Jul-20	fz20-092-053	n/a	n/a	Not processed
Bootjack	B2-3X	29-Jul-20	fz20-092-054	n/a	n/a	Not processed
Bootjack	BOL-B2	30-Aug-20	fz20-092-074	Coarse	10/300	273
				Fine	2/300	99
Polley	POL-P2	30-Aug-20	fz20-092-075	Coarse	5/500	224
				Fine	1/500	102
Quesnel	QUL-ZOO-1	27-Aug-20	fz20-092-076	Coarse	8/300	202
				Fine	2/300	167
Quesnel	QUL-ZOO-7	27-Aug-20	fz20-092-077	Coarse	1/300	102
				Fine	2/300	108

QA/QC

Ten percent (10%) of samples were reanalyzed to assess sub-sampling accuracy and consistency of enumeration. The sample(s) were chosen at random and processed at different times to reduce counting and identification bias. The percent agreement between QA samples is reported in Table 3. No QA samples were performed on the 150 µm fraction.

Table 2. Summary of taxonomic QA/QC results for Minnow Environmental Mount Polley Lakes, 2020.

Client Sample ID	Biologica Sample ID	Abundance (Original Replicate)	Abundance (QA Replicate)	Percent Agreement
POL-P2-3	fz20-092-035	144,800	150,200	96.27
QUL-ZOO-7-1	fz20-092-043	60,050	55,900	93.09
B2-2	fz20-092-049	75,942	68,129	89.71
			Average:	**93.02%**

Percent Agreement:
{100 – [(difference in abundance between samples/total abundance of original sample) x 100]} %

Data Analysis

Biomass calculations were also performed for the 6 dominant zooplankton taxa by measuring at least 5-10 specimens of each taxon and applying length/weight regression formulae (EPA, 2003).

Biomass estimates were presented as total per-sample wet-weight and dry-weight values derived from per-sample abundances.

Taxonomic data were recorded in Biologica's custom database. Results were provided to the Minnow Environmental project manager in Excel spreadsheets via email.

Methodological and Taxonomic References

Anderson RS. 1967. Diaptomid copepods from two mountain ponds in Alberta. Can. J. Zool., 45: 1043–1047.

Anderson RS. 1970. Diaptomus (Leptodiaptomus) connexus Light 1938 in Alberta and Saskatchewan. Can. J. Zool. 48: 4147.

Chapman, M.A. 1982. A study of the mouthparts of some Diaptomus species (Copepoda, Caianoida). J. Nat. Hist. 16: 561–576.

Dumont HJ, van de Velde I, Dumont S. 1975. The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the plankton, periphyton and benthos of continental waters. Oecologia. 19:75–97.

EPA Great Lakes National Program Office. 2003. Standard operating procedure for zooplankton analysis. LG403, Revision 03 February 2003.

Haney JF, et al. "An-Image-based Key to the Zooplankton of North America" version 5.0 released 2013. University of New Hampshire Center for Freshwater Biology. http//cfb.unh.edu. Accessed December 2017.

McCauley E. 1984. Chapter 7. The estimation of the abundance and biomass of zooplankton in samples. In: Downing, J.A. and Rigler, F.H. (eds.) A manual on methods for the assessment of secondary production in fresh waters.-2nd edition. IBP Handbook 17. Blackwell Scientific Publications. Smith, D.G. 2001. *Pennak's Freshwater Invertebrates of the United States*, 4th ed. John Wiley and Sons. 664 p.

Rowe C, et al. Three new cryptic species of the freshwater zooplankton genus Holopedium (Crustacea: Branchiopoda: Ctenopoda), revealed by genetic methods. Zootaxa. 1656: 1-49. 2007

Thorp JH, Covich AP. 2000. *Ecology and Classification of Freshwater Invertebrates*. Academic Press, San Diego and New York. 936 p.

Watkins J, Rudstam L, Holeck K. 2011. Length-weight regressions for zooplankton biomass calculations – A review and a suggestion for standard equations. Cornell Biological Field Station, Cornell University, New York. http://ecommons.cornell.edu/bitstream/1813/24566/2/LengthWeight_Oct24.pdf Accessed December 2017.

Wilson MS. 1951. Some significant points in the distribution of Alaskan fresh-water Copepod Crustacea. Proc. 2nd Alaskan Sci. Conf. 1951: 315–318.

Wilson MS. 1953. New and inadequately known North American species of the copepod genus *Diaptomus*. Smithsonian Misc. Coll. 122(2): 1–30.

Wilson MS. 1959. Calanoida, pp. 738–794. In: W.T. Edmondson (ed.). Fresh-Water Biology, 2nd ed. John Wiley & Sons, New York.

QAQC Objectives

The Nautilus Environmental laboratory is accredited by the Canadian Association for Laboratory Accreditation (CALA) to ISO/IEC 17025:2017 standards and by the State of Washington Department of Ecology (WDOE) laboratory accreditation program for the suite of tests listed in their respective Scopes of Testing.

Nautilus Environmental is committed to providing scientifically defensible data produced according to sound professional practice. Provision of high quality data is integral to the company's commitment to provision of high quality service to our clients within a framework of scientific integrity. The combination of good science and good client service ensures that client expectations are met and that data produced by the laboratory meet a high technical standard.

Our QA program is designed with the overall objectives of:

1) Ensuring that all tests are performed in accordance with approved protocols and ISO/IEC 17025: 2017 standards, while accommodating the needs of the client, regulatory authority, CALA (Canadian Association for Laboratory Accreditation) and WDOE (Washington State Department of Ecology), where applicable;
2) Increasing test performance and precision; and
3) Striving for continual improvement in our quality systems.

To ensure that high quality data are generated to meet a client's specific needs, we ensure that tests are conducted according to established test methods and that staff are adequately trained to perform the tests. In order to do this, Nautilus Environmental has the following quality objectives:

1) To implement a quality assurance program to ensure quality control;
2) To ensure that SOPs, equipment and resources are readily available to staff;
3) To provide adequate supervision and training of staff;
4) To ensure that all aspects of testing are properly documented to allow traceability; and
5) To ensure that data are reviewed prior to releasing to a client.

In order to achieve these objectives, the program is broken down into several systems, which are monitored by the QA Manager. These QA systems include:

1) Management of Change (MOC);
2) Corrective Action Records (CAR);
3) Development of Quality Documents and control;
4) Technical Staff Training;
5) Laboratory Audits; and
6) Procedures for documentation and handling variations.

QC practices address all activities that affect the final quality of the toxicity test data including: sample/material handling, water quality and test conditions, source and condition of test organisms, condition of equipment, instrument calibration and maintenance, measurement of test precision, record keeping, problem identification and corrective actions, data evaluation, and personnel training.

All staff involved in conducting, interpreting and reporting toxicity tests are required to read and become familiar with the Quality Assurance procedures described in the QA Manual. Furthermore, staff are expected to implement the procedures to the extent that is outlined in the Manual and in other related quality assurance documents, such as Standard Operating Procedures.

Nautilus follows a comprehensive QA/QC program to ensure that the data generated are of high quality and scientifically defensible. To meet these objectives, quality control procedures include the following:

- Negative controls to ensure that appropriate testing performance criteria are met;
- Positive controls to assess the health and sensitivity of the test organisms;
- Use of appropriate species and life stages to meet the study objectives;
- Use of appropriate test methodology and protocols;
- Appropriate number of replicates to allow proper statistical analyses;
- Calibration and proper maintenance of instruments to ensure accurate measurements;
- Proper documentation and record keeping to allow traceability of performance;
- Adequate supervision and training of staff to ensure that methods are followed;
- Proper handling and storage of samples to ensure their integrity;

- Procedures that are in place to address issues that may arise during testing and ensure the implementation of appropriate corrective actions; and
- Rigorous review of the data and report by a Registered Professional Biologist to ensure they are of acceptable quality and are scientifically defensible prior to finalizing the report.

Appendix E

Climate Monitoring Results

(Results in Electronic format only)



Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-01-01	-1.36	-2.909236111	-4.32	99.99861111	0	15.25	0.2
2023-01-02	-3.3	-4.518159722	-6.96	99.75208333	0	13.625	0.3
2023-01-03	-4.68	-6.999444444	-8.9	98.23159722	0	31.03472222	0.5
2023-01-04	-5.05	-6.904375	-8.26	98.29513889	0	32.71875	0.6
2023-01-05	2.82	-1.556319444	-8.46	95.48194444	5.425	20.60416667	0.7
2023-01-06	2.8	1.604930556	-0.31	79.79340278	5.661458333	37.08333333	1.4
2023-01-07	2.02	0.92375	-0.2	87.05381944	5.067708333	15.07986111	0.9
2023-01-08	0.13	-0.176909722	-0.79	100	1.972222222	14.08680556	0.5
2023-01-09	0	-0.932916667	-1.73	99.74618056	4.03125	45.82986111	0.8
2023-01-10	1.07	-0.641354167	-1.67	94.49652778	3.569444444	49.05208333	0.8
2023-01-11	0.41	-1.495138889	-3.48	88.88263889	3.767361111	54.70486111	0.6
2023-01-12	2.45	0.793576389	-0.76	92.52256944	6.136458333	17	0.4
2023-01-13	5.49	3.463993056	1.45	89.44965278	4.986111111	19.86458333	0.5
2023-01-14	2.93	1.448993056	-0.14	97.12395833	2.557291667	37.84722222	0.1
2023-01-15	2.42	0.775243056	-1.24	88.97951389	1.611111111	27.33680556	0.3
2023-01-16	1.67	-0.007326389	-1.04	94.19652778	2.592013889	26.27777778	0.2
2023-01-17	0.88	-0.713680556	-1.99	94.746875	4.228125	41.50694444	0.2
2023-01-18	1.34	-0.981944444	-4.44	89.57743056	5.290625	15.69097222	0.6
2023-01-19	-3.48	-5.131805556	-8.53	97.01770833	1.713541667	36.59375	0.1
2023-01-20	-3.09	-3.8365625	-4.56	99.36111111	2.984375	26.08680556	0.2
2023-01-21	-1.18	-2.639548611	-5.17	99.96527778	2.967013889	12.60416667	0.3
2023-01-22	-3.18	-6.037743056	-7.9	98.74131944	2.307291667	38.11805556	0.2
2023-01-23	-3.42	-4.879444444	-6.29	99.27743056	1.307291667	31.17361111	0.2
2023-01-24	0.63	-1.0096875	-4.17	98.32395833	0.381944444	28.57638889	0.2
2023-01-25	4.48	2.385069444	-0.12	92.64479167	0.809027778	37.03819444	0.2
2023-01-26	4.53	2.249791667	-0.54	93.49375	1.302083333	20.78819444	0.3
2023-01-27	-0.06	-1.569236111	-4.74	98.64166667	1.125	39.50347222	0.2
2023-01-28	-4.41	-11.52680556	-19.51	79.60625	3.09375	89.80555556	0.3
2023-01-29	-14.2	-18.15125	-21.52	81.89131944	1.144097222	58.82638889	0.3
2023-01-30	-11.72	-14.75854167	-18.7	91.04236111	2.258680556	28.81597222	0.4

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-01-31	-7.9	-9.800486111	-11.72	95.55486111	3.387152778	28.94444444	0.4
2023-02-01	-5.64	-6.984352941	-7.93	97.50294118	4.023529412	32.6	0
2023-02-02	---	---	---	---	---	---	---
2023-02-03	---	---	---	---	---	---	---
2023-02-04	---	---	---	---	---	---	---
2023-02-05	---	---	---	---	---	---	---
2023-02-06	---	---	---	---	---	---	---
2023-02-07	---	---	---	---	---	---	---
2023-02-08	-2.13	-3.32896	-4.11	86.9616	3.584	54	1.2
2023-02-09	0.88	-2.136840278	-4.59	94.32986111	7.190972222	28.92361111	0.8
2023-02-10	1.37	-0.486527778	-1.84	86.60416667	3.115277778	41.08333333	0.9
2023-02-11	-1.07	-2.648576389	-3.96	91.440625	2.078125	42.62847222	0.4
2023-02-12	2.98	-0.741979167	-3.04	99.90243056	5.434722222	66.09027778	-0.4
2023-02-13	-0.48	-2.796770833	-6.33	94.51701389	2.706597222	69.72222222	0.5
2023-02-14	-2.95	-6.733680556	-9.68	84.621875	3.232638889	105.96875	0.7
2023-02-15	-4.71	-6.954722222	-9.37	93.21076389	3.40625	44.71527778	0.6
2023-02-16	-3.15	-4.178819444	-5.14	96.75277778	3.9375	41.40625	0.5
2023-02-17	-3.78	-5.656319444	-9.13	98.12569444	1.791666667	89.03472222	0.5
2023-02-18	-1.7	-3.146979167	-4.68	99.78368056	1.480902778	82.22222222	0.5
2023-02-19	-0.12	-1.358020833	-3.57	100	2.222222222	20	0.4
2023-02-20	-1.96	-3.842256944	-4.56	99.98020833	2.668402778	27.81597222	0.4
2023-02-21	-2.51	-12.55263889	-19.75	94.89861111	3.493055556	40.26736111	0.6
2023-02-22	-19.38	-21.60027778	-24.43	89.21840278	1.911458333	101.2222222	0.8
2023-02-23	-18.16	-21.61236111	-24.32	89.06979167	2.840277778	116.1145833	0.9
2023-02-24	-15.59	-20.49875	-26.19	89.58402778	2.029513889	75.35416667	0.7
2023-02-25	-7.93	-11.62833333	-15.63	95.18888889	5.795138889	31.23611111	0.6
2023-02-26	-4.35	-7.215416667	-9.24	98.13055556	1.553819444	78.00694444	0.7
2023-02-27	-5.7	-7.952604167	-10.2	97.69270833	2.190972222	121.1145833	0.9
2023-02-28	-4.08	-7.845069444	-10.9	97.80520833	1.696180556	99.32291667	0.8
2023-03-01	-5.39	-8.375555556	-11.25	97.34652778	3.713541667	69.06597222	-0.4

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-03-02	-3.36	-5.074166667	-6.64	98.346875	3.832291667	91.64236111	0.2
2023-03-03	-2.51	-5.836076389	-8.46	75.25486111	2.043402778	110.9965278	1.2
2023-03-04	-0.7	-5.421180556	-9.64	70.996875	0.847222222	139.5069444	1.7
2023-03-05	-5.92	-11.23770833	-14.83	79.58993056	3.40625	132.8333333	2
2023-03-06	-7.64	-12.60777778	-17.68	86.50486111	0.897569444	109.40625	1.6
2023-03-07	-0.99	-7.114444444	-12.94	84.21944444	0.59375	124.7430556	1.8
2023-03-08	2.64	-2.591493056	-6.01	61.28402778	0.095486111	167.21875	2.1
2023-03-09	2.16	-4.873055556	-11	64.25486111	1.411458333	152.2951389	2
2023-03-10	1.37	-3.767708333	-8	62.04305556	2.527777778	158.4930556	1.7
2023-03-11	-2.39	-6.803055556	-11.04	90.20277778	0.866319444	107.0173611	0.3
2023-03-12	0.6	-3.100798611	-6.67	85.20729167	3.460416667	109.1388889	-0.7
2023-03-13	1.78	-1.800208333	-4.99	86.73923611	3.064236111	94.95138889	1.2
2023-03-14	0.27	-3.628854167	-6.9	76.59027778	1.256944444	131.75	1.4
2023-03-15	1.78	-2.396180556	-5.92	69.33541667	1.611111111	138.0069444	1.5
2023-03-16	3.27	-2.002083333	-6.42	62.18020833	0.378472222	176.03125	1.6
2023-03-17	4.35	-0.202083333	-5.14	55.79270833	1.5	174.375	1.9
2023-03-18	6.74	1.892951389	-2.07	54.62673611	0.607638889	162.8472222	1.7
2023-03-19	7.57	3.193263889	-1.18	51.91493056	0.348958333	181.8090278	1.7
2023-03-20	10.59	4.399305556	-0.96	37.11006944	0	194.6770833	1.8
2023-03-21	11.27	4.199131944	-1.18	33.41805556	0.001736111	198.5902778	1.8
2023-03-22	8.12	3.123194444	-2.68	41.27569444	0.342013889	200.1145833	1.9
2023-03-23	5.72	1.993541667	-1.64	53.98229167	2	176.5694444	2.1
2023-03-24	3.85	0.563576389	-2.33	72.05798611	0.835069444	120.7708333	1.4
2023-03-25	4.04	-0.430520833	-2.8	87.75	0.102430556	145.5069444	1.5
2023-03-26	3.8	-0.691770833	-2.57	87.39791667	0.017361111	138.9270833	1.4
2023-03-27	2.58	-1.970451389	-6.67	67.18576389	1.668402778	209.7222222	2.2
2023-03-28	4.66	-0.987326389	-7.03	45.70069444	1.109375	214.0486111	2.3
2023-03-29	6.91	0.955625	-4.2	38.93611111	0.994791667	188.6111111	2.2
2023-03-30	7.42	2.183715278	-4.14	38.340625	0.682291667	218.0173611	2.3
2023-03-31	1.26	-0.782137681	-1.96	72.84166667	3.326449275	84.39855072	1.5

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-04-01	3.33	-0.600694444	-3.01	69.67465278	1.482638889	172.8055556	-1.8
2023-04-02	0.49	-2.405381944	-5.14	80.18194444	0.006944444	126.3993056	0.1
2023-04-03	3.19	-1.717256944	-6.23	57.12048611	0.010416667	194.0902778	1.3
2023-04-04	2.53	-1.444340278	-5.95	50.15590278	0.138888889	224.625	2.3
2023-04-05	5.13	-0.171006944	-6.2	49.68402778	0.546875	228.6354167	2.8
2023-04-06	6.15	2.609201389	-1.04	60.92534722	6.889930556	152.7673611	3.3
2023-04-07	8.12	5.093784722	1.91	66.22951389	4.037847222	149.3506944	2.6
2023-04-08	7.62	3.103263889	0.19	64.13923611	6.316666667	129.8611111	2.8
2023-04-09	8.77	4.659826389	1.13	69.12743056	8.305902778	92.62152778	2.4
2023-04-10	6.31	2.3940625	-1.33	51.65034722	1.870833333	172.7638889	1.7
2023-04-11	5.67	1.223472222	-1.87	69.81840278	0	172.4791667	0
2023-04-12	4.3	-0.227986111	-2.98	88.921875	0.291666667	200.5972222	-2.1
2023-04-13	3.22	-0.804548611	-3.18	81.45694444	0.0625	144.0590278	1.7
2023-04-14	5.44	0.6534375	-4.29	63.50555556	0.862847222	211.625	2.4
2023-04-15	5.54	2.805902778	0.25	60.47569444	6.16875	146.46875	2.9
2023-04-16	6.61	3.472465278	0.58	75.71701389	5.144097222	92.36111111	1.9
2023-04-17	5.69	1.417673611	-2.42	57.40381944	0.491319444	241.7534722	2.7
2023-04-18	2.07	-0.413645833	-1.96	81.46736111	2.583333333	114.1875	1.7
2023-04-19	6.81	1.703958333	-3.3	60.87361111	1.864583333	233.8333333	2.9
2023-04-20	6.43	1.511354167	-2.95	62.54201389	2.835763889	196.9270833	2.7
2023-04-21	5.57	1.731805556	-1.61	78.96145833	0.015625	154.53125	1.9
2023-04-22	7.77	3.509930556	-0.73	65.68576389	2.269097222	158.9444444	2.3
2023-04-23	7.34	4.202326389	1.67	86.978125	1.442708333	123.4236111	1.6
2023-04-24	7.37	3.842569444	1.23	90.22256944	0	141.8680556	1.7
2023-04-25	9.56	5.938541667	2.74	52.61458333	0	227.0104167	2.6
2023-04-26	12.61	5.938854167	2.02	56.27326389	0.999652778	200.3090278	2.6
2023-04-27	12.41	5.918958333	-0.2	43.30277778	0	266.0833333	3
2023-04-28	19.32	12.56274306	5.15	36.42118056	0	279.6805556	3.1
2023-04-29	22.13	15.08739583	8	37.08576389	0	278.6215278	3.1
2023-04-30	21.44	14.59371528	9.04	43.11979167	0	205.4479167	2.5

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-05-01	13.86	10.21826389	6.23	76.32083333	0	159.4618056	-1.7
2023-05-02	20.15	13.70590278	6.84	61.3375	0	276.2638889	-0.3
2023-05-03	21.7	14.3578125	8.29	61.32152778	0.45	245.5868056	1.6
2023-05-04	23.04	15.85170139	8.69	58.72222222	1.086805556	263.2361111	2.8
2023-05-05	23.83	16.40350694	11.15	49.58715278	3.467708333	200.4097222	3.2
2023-05-06	11.37	7.839548611	5.33	92.90069444	1.828125	79.19097222	1.3
2023-05-07	10.49	7.027222222	5.33	86.321875	1.373263889	166.5694444	2.2
2023-05-08	14	8.525659722	3.62	70.67361111	1.578125	198.8298611	2.6
2023-05-09	15.89	9.946215278	3.93	60.91979167	0.987847222	276.3854167	2.8
2023-05-10	15.1	10.47597222	5.59	66.32152778	1.140625	191.9340278	1.5
2023-05-11	16.94	11.85506944	6.05	58.45625	2.092013889	257.1736111	0
2023-05-12	21.94	15.26045139	7.24	42.35138889	2.833333333	304.1944444	-3.6
2023-05-13	25.16	18.36791667	10.91	34.85798611	1.772569444	300.46875	3.9
2023-05-14	27.41	21.14211806	14.39	27.91875	1.569444444	317.5486111	4.1
2023-05-15	27.95	22.05385417	15.2	24.753125	1.401041667	317.0277778	4.1
2023-05-16	26.26	20.17402778	14.94	37.02708333	2.684027778	299.5347222	4.2
2023-05-17	23.16	16.73947917	10.2	47.13993056	2.737847222	274.6666667	3.9
2023-05-18	22.44	16.21177083	10.83	46.67881944	2.051041667	219.9861111	3.2
2023-05-19	23.59	17.52420139	10.37	54.28680556	0.475694444	281.3263889	3.4
2023-05-20	24.24	18.53128472	13.21	43.47256944	0.545138889	290	3.5
2023-05-21	20.27	13.93725694	8.02	55.17291667	1.571180556	197.4027778	2.8
2023-05-22	8	6.657673611	5.74	93.53159722	0	85.04513889	1.3
2023-05-23	6.71	5.785520833	4.77	99.6375	0	37.97222222	0.8
2023-05-24	14.72	8.714201389	4.06	86.12256944	0.112847222	205.6180556	2.5
2023-05-25	20.7	14.06677083	7.57	63.90625	0	301.5069444	3.5
2023-05-26	22.82	16.37180556	9.46	50.24548611	0	309.0763889	3.6
2023-05-27	22.08	15.60715278	10.93	57.34097222	0	300.1944444	3.5
2023-05-28	19.86	14.76083333	10.22	50.38159722	0	299.0451389	3.5
2023-05-29	16.58	12.85861111	8.27	47.21423611	0.076388889	275.2638889	3.3
2023-05-30	15.89	11.42524306	7.04	50.59375	0.548611111	229.9756944	3

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-05-31	14.17	9.136666667	3.51	47.57430556	1.520833333	304.0381944	3.9
2023-06-01	18.01	12.00288194	5.95	38.57673611	0.861111111	331.0104167	-4.5
2023-06-02	21.49	15.30725694	8.32	38.42916667	0	230.0208333	-0.3
2023-06-03	22.99	17.66319444	12.1	31.084375	0	334.5	1.7
2023-06-04	16.99	12.18107639	7.17	40.553125	0	272.8506944	2.7
2023-06-05	14.96	8.911736111	3.3	43.74340278	0	292.7291667	3.3
2023-06-06	20.51	13.77090278	6.08	32.22013889	0	343.8298611	4
2023-06-07	26.28	19.37645833	10.08	22.5125	0	341.4409722	3.9
2023-06-08	29.34	22.81496528	14.27	23.19618056	0	340.7569444	3.7
2023-06-09	24.34	19.8434375	16.7	37.55868056	0	215.3506944	2.2
2023-06-10	17.75	12.53944444	9.85	85.696875	0	43.75347222	0.7
2023-06-11	21.29	15.54368056	10.05	62.05034722	0	326.2256944	-0.8
2023-06-12	25.19	19.52934028	12.36	33.95763889	0.901041667	309.4895833	-4.5
2023-06-13	20.58	11.82260417	7.29	76.50694444	0.071180556	65.26388889	1.2
2023-06-14	13.21	8.887777778	6.15	87.09826389	0	125.2847222	1.7
2023-06-15	19.96	13.073125	4.95	61.84479167	0	297.7395833	3.5
2023-06-16	19.29	13.28152778	9.44	67.35416667	0.105902778	230.3819444	2.9
2023-06-17	12.56	7.521180556	2.4	63.58229167	0.006944444	203.9722222	2.6
2023-06-18	7.92	4.639861111	2.4	94.52048611	1.614583333	140.8402778	1.9
2023-06-19	11.18	7.5940625	4.19	81.91597222	1.392361111	145.0451389	2.1
2023-06-20	17.7	12.25204861	7.14	52.50625	0	295.5347222	3.5
2023-06-21	15.34	10.78253472	7.32	79.51736111	0.423611111	184.6180556	2.4
2023-06-22	18.7	12.64368056	6.81	75.596875	0.546875	286.8506944	3.4
2023-06-23	20.84	14.65565972	11.27	68.57743056	0	244.1145833	3
2023-06-24	22.44	15.39547009	10.54	66.84957265	0	310.8803419	3.6
2023-06-25	---	---	---	---	---	---	---
2023-06-26	---	---	---	---	---	---	---
2023-06-27	---	---	---	---	---	---	---
2023-06-28	26.89	21.99201681	14.82	50.09243697	0	306.1680672	3.6
2023-06-29	22.75	17.04288194	13.45	72.64548611	0	242.5416667	2.9

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-06-30	22.66	16.04614583	11.35	64.68645833	0.284722222	314.1388889	3.7
2023-07-01	17.87	11.55059028	5.62	64.06006944	3.381944444	259.2604167	-2.5
2023-07-02	17.25	10.85892361	5.15	54.74444444	1.760416667	341.6736111	-0.1
2023-07-03	19.03	13.76670139	8.92	54.484375	2.404513889	236.1875	2
2023-07-04	23.35	16.91444444	10.69	50.83888889	2.071180556	289.8819444	3.3
2023-07-05	25.02	19.46590278	13.5	41.48333333	1.059027778	263.78125	3.3
2023-07-06	26.16	19.58173611	14.12	44.85555556	1.128472222	236.2916667	3.2
2023-07-07	26.45	19.75427083	14.34	48.87118056	1.534722222	236.9444444	3.3
2023-07-08	27.95	21.17170139	14.72	47.89270833	1.362847222	293.6354167	3.6
2023-07-09	28.69	20.47868056	15.77	51.33402778	1.970833333	263.6180556	3
2023-07-10	25.31	19.25111111	15.32	54.43923611	2.387152778	283.6319444	2.1
2023-07-11	23.76	18.43232639	13.74	51.62013889	2.506944444	267.5972222	-0.2
2023-07-12	24.94	18.76659722	13.28	40.74756944	2.177083333	280.1979167	-3.6
2023-07-13	19.7	15.61482639	11.98	61.56909722	0.815972222	149.96875	2.2
2023-07-14	22.73	17.15854167	12.34	63.57986111	0.815972222	201.34375	2.7
2023-07-15	22.01	17.60979167	14.17	64.32118056	1.28125	171.2256944	2.4
2023-07-16	25.16	17.91663194	12.17	61.678125	2.092013889	239.2430556	3.2
2023-07-17	15.7	12.8546875	10.54	74.60104167	2.571180556	165.7083333	2.4
2023-07-18	19.53	14.75006944	10.57	57.50243056	1.128472222	232.4375	3
2023-07-19	25.99	19.74774306	12.8	46.57430556	1.180555556	295.5347222	3.7
2023-07-20	29.02	23.12309028	16.77	38.91527778	1.671875	277.3576389	3.7
2023-07-21	26.18	20.39756944	14.39	47.18368056	2.038194444	222.9097222	3.2
2023-07-22	24.68	16.82510417	12.27	59.44027778	2.90625	229.3298611	3.3
2023-07-23	19.79	15.38319444	10.3	54.39652778	1.550347222	161.6423611	2.5
2023-07-24	16.99	13.68034722	10.61	76.09583333	1.515625	128.2395833	1.9
2023-07-25	16.03	10.71826389	8.54	82.33125	1.546875	168.1111111	2.2
2023-07-26	13.45	10.28986111	7.47	88.36284722	0	117.2569444	1.6
2023-07-27	14.6	11.82263889	10.12	91.46145833	0.097222222	111.4097222	1.5
2023-07-28	19.96	14.60427083	10.61	80.47951389	0.104166667	163.3611111	2.1
2023-07-29	24.63	16.35920139	11.05	64.93229167	0	212.9166667	2.6

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-07-30	22.32	16.391875	11.88	66.09236111	0.222222222	243.2951389	2.9
2023-07-31	19.15	14.68208333	9.9	64.03541667	1.868055556	227.7256944	3
2023-08-01	21.06	15.88423611	11.22	54.49305556	1.435763889	248.6111111	-2.7
2023-08-02	16.63	12.65670139	9.71	74.93125	1.920138889	105.1909722	0.5
2023-08-03	21.06	13.74569444	6.03	67.65138889	1.210069444	278.0451389	2
2023-08-04	24.46	18.14774306	11.15	48.015625	2.149305556	292.6284722	3.3
2023-08-05	27.16	20.73684028	13.88	40.15833333	2.227430556	289.9027778	3.9
2023-08-06	26.55	21.17111111	15.77	40.571875	2.243055556	235.4722222	3.5
2023-08-07	24.82	20.00354167	15.63	50.12430556	0.671875	229.4444444	3
2023-08-08	19.86	15.36381944	12.19	75.74270833	0	122.4409722	1.6
2023-08-09	16.87	12.99236111	11.05	92.96701389	0	115.0590278	1.3
2023-08-10	17.51	12.97090278	9.04	73.35868056	0.015625	167.3125	1.2
2023-08-11	15.51	12.85982639	10.05	79.14826389	0	118.4027778	0
2023-08-12	21.99	16.244375	11.39	66.778125	0	209.0868056	-2.6
2023-08-13	25.57	19.65777778	13.52	56.76979167	0.210069444	250.2048611	2.8
2023-08-14	26.55	21.44315972	17.7	52.46388889	0.020833333	231.84375	2.7
2023-08-15	26.79	20.82951389	15.34	54.45034722	0	200.1423611	2.4
2023-08-16	26.08	19.72572917	13.91	44.30138889	0	257.7743056	2.9
2023-08-17	25.6	20.0959375	16.11	48.92534722	0	193.5625	2.3
2023-08-18	16.06	11.30909722	7.22	57.42256944	1.967013889	187.3472222	2.6
2023-08-19	19.17	12.06850694	4.95	56.86145833	0	256.9826389	2.8
2023-08-20	21.27	14.94753472	8.42	41.95902778	0	254.1006944	2.8
2023-08-21	22.23	17.46503472	12.9	36.99930556	0	174.2291667	2.1
2023-08-22	18.15	14.64819444	11.39	65.92847222	0.487847222	90.24652778	1.4
2023-08-23	12.05	9.225729167	7.87	97.80486111	2.376736111	35.23263889	0.7
2023-08-24	16.99	12.13572917	8.07	84.55659722	0.026041667	220.6736111	2.4
2023-08-25	20.01	14.96315972	10.03	69.84027778	0	210.84375	2.3
2023-08-26	23.16	17.08114583	11.35	62.28159722	0	210.1145833	2.3
2023-08-27	25.02	19.34420139	12.03	47.64166667	0.067708333	231.0590278	2.5
2023-08-28	28.12	21.76329861	14.7	38.025	0	234.8055556	2.5

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-08-29	22.2	18.450625	15.32	53.49583333	0	159.15625	1.9
2023-08-30	17.63	14.12729167	11.61	75.11770833	2.838541667	147.8784722	2
2023-08-31	16.84	13.34875	9.71	67.05520833	3.001736111	171.7256944	2.4
2023-09-01	20.63	15.2165625	9.39	57.05659722	1.434027778	214.5208333	-2.1
2023-09-02	21.84	16.51503472	11.08	52.67256944	1.447916667	192.3229167	0.5
2023-09-03	18.51	13.56142361	9.61	57.34791667	1.875694444	136.7569444	1.6
2023-09-04	14.91	11.65694444	7.72	57.20451389	1.65625	176.0694444	2.3
2023-09-05	12.53	8.858993056	5.74	85.65347222	0.611111111	102.6736111	1.5
2023-09-06	11.66	8.563090278	5.9	85.81631944	0.001736111	114.3368056	1.6
2023-09-07	15.41	9.355034722	4.19	79.0125	0	147.5451389	2
2023-09-08	19.1	13.07666667	6.56	53.76631944	0	217.4236111	2.6
2023-09-09	22.66	16.47909722	9.71	43.84444444	0	212.0069444	2.1
2023-09-10	24.22	18.39461806	12.99	41.12361111	0	194.1180556	1.2
2023-09-11	18.01	15.42347222	11.98	59.41145833	0	103.6284722	0
2023-09-12	14.19	11.99427083	10.17	80.771875	0	89.64583333	-0.8
2023-09-13	15.63	11.33944444	8.22	65.76840278	0	189.1597222	1.9
2023-09-14	19.53	12.69555556	5.67	55.96041667	0	197.6319444	1.9
2023-09-15	25.19	17.08277778	10.37	38.82152778	0	190.8090278	1.9
2023-09-16	23.28	16.15149306	9.31	34.53854167	0	167.5381944	1.7
2023-09-17	17.8	13.96770833	9.8	45.23541667	0	117.7916667	1.4
2023-09-18	10.76	7.057291667	2.56	70.70347222	0	149.2013889	1.5
2023-09-19	7.27	5.549652778	3.8	90.66076389	0	55.51736111	0.8
2023-09-20	10.61	6.141770833	2.26	88.04097222	0	129.6006944	1.3
2023-09-21	15.17	8.790486111	1.56	70.24861111	0	172.5451389	1.6
2023-09-22	19.7	12.71409722	5.15	55.33923611	0.059027778	180.5173611	1.7
2023-09-23	15.08	11.36881944	8.27	62.48333333	0	85.48263889	1.1
2023-09-24	14.1	9.020104167	4.04	60.12083333	0	165.3715278	1.5
2023-09-25	11.93	10.75909722	8.77	70.60659722	0	20.02777778	0.7
2023-09-26	13.4	9.979479167	7.59	65.21458333	0	88.3125	1.1
2023-09-27	11.18	7.677916667	5.18	73.02847222	0	107.5173611	1.1

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-09-28	9.26	5.160833333	3.62	93.98784722	0	83.41319444	0.9
2023-09-29	7.72	5.188020833	3.46	91.98020833	0	95.88541667	1
2023-09-30	11.3	5.132256944	1.4	87.44236111	0	141.2986111	1.2
2023-10-01	10.79	6.385416667	1.13	91.29270833	0	95.03819444	-0.6
2023-10-02	12.77	8.600763889	5.77	82.54270833	0	100.0902778	0.4
2023-10-03	11.15	7.260416667	5.46	85.03993056	0	70.36111111	0.8
2023-10-04	10.12	7.602569444	5.59	83.87256944	0	95.07986111	1.3
2023-10-05	8.27	5.835590278	4.09	96.49548611	0	58.85416667	1
2023-10-06	15.65	9.168194444	4.32	97.15520833	0	130.0069444	1.7
2023-10-07	20.13	13.55128472	7.67	69.72881944	0.963541667	147.0381944	2.1
2023-10-08	19.34	15.54986111	11.39	52.00069444	2.701736111	101.4861111	2.1
2023-10-09	16.25	14.26402778	9.53	54.57430556	4.901041667	53.91319444	2
2023-10-10	10.12	8.1196875	6.1	91.375	0	42.90277778	0.6
2023-10-11	12.7	8.014861111	4.66	78.59965278	0	122.5	-0.1
2023-10-12	13.93	8.036597222	3.33	75.27291667	0	133.3194444	-1.5
2023-10-13	14.53	9.639479167	5.46	64.88715278	0	117.0381944	0.9
2023-10-14	12.39	9.696909722	6.96	70.51215278	0	91.30208333	0.8
2023-10-15	13.09	9.1996875	6.41	74.30416667	0	106.5277778	0.8
2023-10-16	11.95	9.414548611	6.94	79.71180556	0	35.12152778	0.6
2023-10-17	8	6.0090625	3.49	85.04201389	2.178472222	72.05555556	0.8
2023-10-18	13.79	8.868506944	5.59	81.925	2.520833333	97.20138889	0.9
2023-10-19	15.1	9.096840278	6.43	82.06111111	0	93.56597222	0.6
2023-10-20	9.61	5.954097222	3.14	68.08854167	0	115.2951389	0.7
2023-10-21	9.83	5.308090278	3.06	69.98576389	0	97.18055556	0.6
2023-10-22	6.18	2.326076389	-1.07	78.11875	0	112.21875	0.6
2023-10-23	-0.9	-2.810416667	-6.87	87.928125	0	58.87152778	0.5
2023-10-24	-3.6	-7.101770833	-9.85	76.85763889	0	50.30555556	0.5
2023-10-25	-4.02	-7.977881944	-13.13	68.27986111	0	107.3020833	0.5
2023-10-26	-0.51	-4.853645833	-7.97	61.15416667	1.361111111	103.3923611	0.8
2023-10-27	-0.48	-4.104791667	-7.22	51.57743056	1.380208333	101.6944444	0.8

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-10-28	2.32	-2.613958333	-6.42	58.31180556	0.576388889	98.16319444	0.6
2023-10-29	3.46	-1.302673611	-5.54	64.94236111	1.053819444	90.96527778	0.6
2023-10-30	5.36	0.348715278	-3.04	64.81319444	2.149305556	87.37152778	0.8
2023-10-31	6.1	1.257118056	-2.48	62.97951389	1.303819444	91.11805556	0.6
2023-11-01	4.01	1.332638889	-1.87	65.23784722	0.157986111	52.75	-0.1
2023-11-02	3.04	1.783125	-0.34	88.11736111	0	17.85763889	0.4
2023-11-03	4.01	2.7134375	2.05	100	0.638888889	33.18402778	0.6
2023-11-04	7.9	4.773055556	2.42	94.54861111	5.609375	33.30555556	0.8
2023-11-05	6.33	4.338263889	1.94	85.0875	3.461805556	50.20138889	1.2
2023-11-06	3.59	2.627743056	1.64	95.23958333	2.352430556	21.87152778	0.7
2023-11-07	2.8	0.840868056	-1.27	85.23888889	0.720486111	58.52430556	1.1
2023-11-08	0.19	-0.732395833	-2.1	97.71215278	1.064236111	26.98611111	0.7
2023-11-09	3.35	0.9775	-0.85	96.49965278	4.489236111	32.12152778	0.7
2023-11-10	4.35	1.600798611	-0.68	82.86458333	5.140625	68.8125	1.1
2023-11-11	4.3	2.183472222	-1.41	73.06041667	4.438541667	31.49305556	0.9
2023-11-12	2.24	-0.727465278	-2.74	89.28090278	3.508680556	30.45138889	0.2
2023-11-13	0.88	-1.159444444	-2.51	99.50902778	2.510416667	39.89930556	0.2
2023-11-14	-1.61	-2.746145833	-4.26	96.33819444	1.777777778	17.45833333	0.3
2023-11-15	-1.78	-4.255868056	-5.79	90.28645833	0.401041667	49.40972222	0.2
2023-11-16	-2.19	-4.375798611	-7.09	94.465625	2.777777778	19.86458333	0.4
2023-11-17	1.15	-0.607604167	-2.22	99.64375	2.538194444	46.21180556	0.1
2023-11-18	4.71	2.103159722	0.52	87.18576389	3.815972222	55.59722222	0.3
2023-11-19	4.48	1.7709375	-2.45	72.15347222	3.104513889	43.21875	0.6
2023-11-20	1.86	-1.539340278	-4.8	74.57708333	0.764236111	26.89583333	0.4
2023-11-21	4.82	2.689027778	-0.56	62.221875	3.834027778	27.90625	1
2023-11-22	-0.51	-1.445277778	-2.77	96.10138889	0.935763889	28.60069444	0.2
2023-11-23	-1.01	-2.638993056	-4.29	86.14236111	0.144097222	32.17708333	0.2
2023-11-24	1.34	-2.341770833	-4.59	85.12986111	0.005208333	47.375	0
2023-11-25	-0.7	-1.715833333	-2.6	97.22222222	0	22.81944444	0.2
2023-11-26	-1.76	-2.132881944	-2.74	99.19722222	0	20.30208333	0.2

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-11-27	-0.42	-2.578229167	-4.02	94.20034722	0	43.15277778	0
2023-11-28	-3.72	-4.679027778	-6.26	93.3125	0	40.32291667	0
2023-11-29	-3.72	-4.726527778	-5.73	91.98715278	0	29.71527778	0.1
2023-11-30	-4.68	-5.904201389	-7.22	87.67673611	0	31.73611111	0.1
2023-12-01	-4.02	-5.012326389	-6.93	97.20972222	0.006944444	22.99305556	0.2
2023-12-02	-2.28	-3.2359375	-4.65	98.57951389	0.104166667	30.56944444	0.4
2023-12-03	-2.19	-2.901493056	-3.69	99.85694444	2.321875	14.80902778	0.5
2023-12-04	1.56	-1.369409722	-2.74	100	4.996875	8.604166667	0.5
2023-12-05	4.92	2.9875	0.93	98.21076389	3.600347222	36.67361111	0.8
2023-12-06	2.02	-0.739131944	-4.35	96.81180556	1.703125	6.409722222	0.5
2023-12-07	-3.63	-5.352430556	-6.67	98.70381944	0.314236111	13.10069444	0.5
2023-12-08	-5.33	-6.07125	-6.74	98.44027778	0	9.0625	0.5
2023-12-09	-3.15	-4.612604167	-6.04	99.10069444	4.936111111	4.107638889	0.4
2023-12-10	-1.53	-2.273368056	-3.9	100	1.59375	8.65625	0.4
2023-12-11	-3.48	-4.233402778	-5.14	99.875	0	12.84027778	0.3
2023-12-12	-2.77	-5.194409722	-7.12	99.23263889	3.003472222	28.28472222	0
2023-12-13	2.24	0.082673611	-2.89	80.34652778	4.992708333	9.253472222	0.8
2023-12-14	-0.85	-1.467013889	-1.93	99.95520833	0.345486111	8.944444444	0.3
2023-12-15	1.32	-1.075659722	-3.63	98.57777778	2.345486111	10.78819444	0.3
2023-12-16	0.74	-0.352604167	-2.45	99.54791667	0.602430556	22.61458333	0.1
2023-12-17	-0.42	-1.270972222	-2.95	99.80729167	2.232638889	19.57986111	0.1
2023-12-18	1.02	-0.369444444	-2.02	100	1.880208333	19.28472222	0.1
2023-12-19	2.02	1.435902778	0.85	100	4.751736111	14.36805556	0.2
2023-12-20	2.45	1.48125	0.3	100	2.470486111	12.09027778	0.2
2023-12-21	3.27	1.690348432	0.13	100	4.62543554	17.37630662	0.1
2023-12-22	4.25	0.716631944	-3.78	91.35555556	3.713541667	8.975694444	0.4
2023-12-23	-3.21	-4.602916667	-6.1	83.78368056	0.517361111	47.32291667	-0.2
2023-12-24	-1.99	-4.199131944	-6.07	78.44201389	0.012152778	24.46180556	0.1
2023-12-25	3.35	-0.635104167	-3.81	82.99097222	5.409375	14.37847222	0.7
2023-12-26	4.04	2.047916667	-0.59	75.10486111	6.319097222	47.97569444	0.5

Date	Temperature Daily Max (°C) Wth Stn 1	Temperature Daily Mean (°C) Wth Stn 1	Temperature Daily Min (°C) Wth Stn 1	Relative Humidity Daily Mean (%) Wth Stn 1	Wind Speed Daily Mean (m/s) Wth Stn 1	Solar Radiation Daily Mean (W/m2) Wth Stn 1	Evaporation Total (mm) Wth Stn 1
2023-12-27	4.95	2.955381944	-0.73	70.64548611	7.33125	14.94444444	1.3
2023-12-28	4.19	3.796909722	3.14	74.68159722	6.639236111	24.56944444	0.9
2023-12-29	6.53	4.215659722	1.91	79.5375	4.772569444	27.69444444	0.5
2023-12-30	7.29	5.916840278	3.19	69.21076389	4.690972222	19.92013889	0.9
2023-12-31	4.35	1.969479167	-1.01	85.43090278	0.454861111	43.48263889	-0.1

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-01-01	---	---	---	---	---	---	---
2023-01-02	---	---	---	---	---	---	---
2023-01-03	---	---	---	---	---	---	---
2023-01-04	---	---	---	---	---	---	---
2023-01-05	---	---	---	---	---	---	---
2023-01-06	---	---	---	---	---	---	---
2023-01-07	---	---	---	---	---	---	---
2023-01-08	---	---	---	---	---	---	---
2023-01-09	---	---	---	---	---	---	---
2023-01-10	---	---	---	---	---	---	---
2023-01-11	---	---	---	---	---	---	---
2023-01-12	---	---	---	---	---	---	---
2023-01-13	---	---	---	---	---	---	---
2023-01-14	---	---	---	---	---	---	---
2023-01-15	---	---	---	---	---	---	---
2023-01-16	---	---	---	---	---	---	---
2023-01-17	---	---	---	---	---	---	---
2023-01-18	---	---	---	---	---	---	---
2023-01-19	---	---	---	---	---	---	---
2023-01-20	---	---	---	---	---	---	---
2023-01-21	---	---	---	---	---	---	---
2023-01-22	---	---	---	---	---	---	---
2023-01-23	---	---	---	---	---	---	---
2023-01-24	---	---	---	---	---	---	---
2023-01-25	---	---	---	---	---	---	---
2023-01-26	---	---	---	---	---	---	---
2023-01-27	---	---	---	---	---	---	---
2023-01-28	---	---	---	---	---	---	---
2023-01-29	---	---	---	---	---	---	---
2023-01-30	---	---	---	---	---	---	---

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-01-31	---	---	---	---	---	---	---
2023-02-01	---	---	---	---	---	---	---
2023-02-02	---	---	---	---	---	---	---
2023-02-03	0.77	0.026730769	-0.82	91.59519231	1.201923077	5.644230769	0.5
2023-02-04	1.99	0.3453125	-0.87	96.00555556	0.940972222	51.41666667	0.8
2023-02-05	3.27	0.732473498	-3.51	89.64452297	0.685512367	45.32508834	0.9
2023-02-06	1.4	0.11012987	-1.36	87.71818182	1.149350649	100.5714286	1.5
2023-02-07	2.1	1.6	0.44	90.66229508	0.581967213	127.1803279	1.7
2023-02-08	-0.4	-2.548392857	-3.72	88.26130952	0.514880952	82.00595238	1.3
2023-02-09	2.02	-1.080763889	-3.6	91.68159722	2.651041667	28.93055556	0.8
2023-02-10	3.19	0.359618056	-2.39	84.83090278	0.680555556	40.57291667	0.7
2023-02-11	-0.62	-1.886527778	-5.02	92.02013889	0.119791667	40.57638889	0.4
2023-02-12	3.33	0.067916667	-2.13	95.52361111	1.592013889	57.34722222	-0.2
2023-02-13	0.66	-1.920546218	-5.05	89.46722689	1.636554622	63.69327731	0.5
2023-02-14	-2.1	-6.0159375	-8.66	81.86701389	2.109375	92.53819444	0.7
2023-02-15	-3.18	-5.656041667	-8.5	88.89618056	1.131944444	45.30902778	0.5
2023-02-16	-2.1	-3.104444444	-5.92	93.47222222	0.980902778	34.83333333	0.5
2023-02-17	-2.33	-5.090034722	-8.33	95.19722222	0.1875	60.55208333	0.5
2023-02-18	0.19	-2.012430556	-3.9	96.33854167	0.465277778	56.00694444	0.5
2023-02-19	1.45	-0.509201389	-2.04	98.50381944	0.703125	22.22222222	0.4
2023-02-20	-1.1	-2.861284722	-3.72	97.49826389	1.130208333	23.06597222	0.5
2023-02-21	-1.47	-11.15972222	-18.74	93.13645833	4.913194444	37.85763889	0.7
2023-02-22	-18.3	-20.40302083	-22.83	85.13263889	2.678819444	107.1423611	0.9
2023-02-23	-16.74	-21.09951389	-25.33	82.89756944	3.571180556	110.8125	1
2023-02-24	-14.59	-19.50576389	-26.02	86.11701389	1.020833333	76.19097222	0.7
2023-02-25	-6.93	-10.58684028	-14.63	95.23333333	1.859375	26.60763889	0.5
2023-02-26	-4.08	-6.407777778	-9.51	95.80277778	0.564236111	79.66666667	0.7
2023-02-27	-2.98	-6.982881944	-10.65	89.915625	0.425347222	120.4131944	0.9
2023-02-28	-3.33	-6.846006944	-9.82	89.65034722	1.602430556	86.28472222	0.8
2023-03-01	-3.54	-7.288472222	-11.83	93.53125	1.095486111	71.78125	-0.5

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-03-02	0.13	-3.503958333	-6.42	81.06944444	0.881944444	81.40277778	0.3
2023-03-03	-0.4	-5.210729167	-9.07	77.259375	0.446180556	114.6006944	1
2023-03-04	0.52	-5.221354167	-10.23	75.61354167	0.305555556	132.3680556	1.6
2023-03-05	-4.9	-10.41253472	-13.77	78.88645833	3.618055556	127.8645833	2
2023-03-06	-6.71	-12.2028125	-16.08	83.06736111	2.3125	99.80902778	1.6
2023-03-07	0.25	-7.080208333	-14.2	81.32256944	0.664930556	120.9722222	1.7
2023-03-08	3.33	-2.543819444	-7.25	66.85208333	0.532986111	157.0104167	2.1
2023-03-09	1.94	-5.412326389	-12.86	68.40347222	1.743055556	147.2916667	1.9
2023-03-10	2.26	-3.1509375	-7.71	61.81944444	1.815972222	159.0347222	1.6
2023-03-11	-2.39	-6.791979167	-10.51	86.675	2.611111111	97.86805556	0.4
2023-03-12	2.64	-2.570798611	-7.67	84.65798611	1.135416667	105.3854167	-0.8
2023-03-13	2.37	-1.169069767	-2.19	97.29069767	1.321705426	56.05426357	0.7
2023-03-14							
2023-03-15	1.86	-1.868085106	-5.54	65.60851064	0.861702128	28.96808511	0.9
2023-03-16	4.32	-2.107673611	-8.43	65.97361111	0.333333333	169.4930556	1.6
2023-03-17	6.28	0.230416667	-5.23	57.43229167	0.831597222	169.2916667	1.7
2023-03-18	8.34	2.158436364	-2.16	57.31854545	0.456363636	171.3054545	1.7
2023-03-19	---	---	---	---	---	---	---
2023-03-20	---	---	---	---	---	---	---
2023-03-21	---	---	---	---	---	---	---
2023-03-22	---	---	---	---	---	---	---
2023-03-23	---	---	---	---	---	---	---
2023-03-24	---	---	---	---	---	---	---
2023-03-25	---	---	---	---	---	---	---
2023-03-26	---	---	---	---	---	---	---
2023-03-27	---	---	---	---	---	---	---
2023-03-28	---	---	---	---	---	---	---
2023-03-29	---	---	---	---	---	---	---
2023-03-30	---	---	---	---	---	---	---
2023-03-31	---	---	---	---	---	---	---

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-04-01	---	---	---	---	---	---	---
2023-04-02	---	---	---	---	---	---	---
2023-04-03	---	---	---	---	---	---	---
2023-04-04	---	---	---	---	---	---	---
2023-04-05	---	---	---	---	---	---	---
2023-04-06	---	---	---	---	---	---	---
2023-04-07	---	---	---	---	---	---	---
2023-04-08	---	---	---	---	---	---	---
2023-04-09	---	---	---	---	---	---	---
2023-04-10	---	---	---	---	---	---	---
2023-04-11	---	---	---	---	---	---	---
2023-04-12	---	---	---	---	---	---	---
2023-04-13	---	---	---	---	---	---	---
2023-04-14	---	---	---	---	---	---	---
2023-04-15	---	---	---	---	---	---	---
2023-04-16	---	---	---	---	---	---	---
2023-04-17	---	---	---	---	---	---	---
2023-04-18	---	---	---	---	---	---	---
2023-04-19	---	---	---	---	---	---	---
2023-04-20	---	---	---	---	---	---	---
2023-04-21	---	---	---	---	---	---	---
2023-04-22	---	---	---	---	---	---	---
2023-04-23	---	---	---	---	---	---	---
2023-04-24	---	---	---	---	---	---	---
2023-04-25	---	---	---	---	---	---	---
2023-04-26	---	---	---	---	---	---	---
2023-04-27	---	---	---	---	---	---	---
2023-04-28	---	---	---	---	---	---	---
2023-04-29	---	---	---	---	---	---	---
2023-04-30	---	---	---	---	---	---	---

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-05-01	---	---	---	---	---	---	---
2023-05-02	---	---	---	---	---	---	---
2023-05-03	---	---	---	---	---	---	---
2023-05-04	---	---	---	---	---	---	---
2023-05-05	---	---	---	---	---	---	---
2023-05-06	---	---	---	---	---	---	---
2023-05-07	---	---	---	---	---	---	---
2023-05-08	---	---	---	---	---	---	---
2023-05-09	---	---	---	---	---	---	---
2023-05-10	---	---	---	---	---	---	---
2023-05-11	---	---	---	---	---	---	---
2023-05-12	---	---	---	---	---	---	---
2023-05-13	---	---	---	---	---	---	---
2023-05-14	---	---	---	---	---	---	---
2023-05-15	---	---	---	---	---	---	---
2023-05-16	---	---	---	---	---	---	---
2023-05-17	---	---	---	---	---	---	---
2023-05-18	---	---	---	---	---	---	---
2023-05-19	---	---	---	---	---	---	---
2023-05-20	25.67	21.73195531	15.41	35.41117318	0.687150838	417.7988827	4.7
2023-05-21	23.06	14.66142361	9.11	56.82569444	0.873263889	196.0902778	2.6
2023-05-22	9.04	7.886979167	7.02	89.375	1.602430556	85.51736111	1.3
2023-05-23	7.64	7.004404145	6.61	96.94145078	1.787564767	48.34196891	0.9
2023-05-24	15.82	12.96766667	9.66	73.31066667	0.27	312.3333333	3.6
2023-05-25	21.96	14.61177083	7.57	65.28472222	0.592013889	307.4652778	3.6
2023-05-26	24.56	16.5275	8.07	53.09513889	0.550347222	308.2708333	3.6
2023-05-27	24.1	16.37385417	11.56	57.68229167	1.387152778	274.3368056	3.5
2023-05-28	21.34	15.50138889	11.03	51.93229167	1.170138889	297.34375	3.7
2023-05-29	19.39	13.90503472	9.63	48.89444444	1.642361111	319.75	4
2023-05-30	17.7	12.45222222	8	52.67222222	1.154513889	255.96875	3.3

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-05-31	16.44	10.27555556	4.82	46.71180556	2.404513889	280.4548611	3.9
2023-06-01	20.01	12.72711806	5.02	41.84444444	1.519097222	333.6180556	-4.3
2023-06-02	22.85	15.80059028	7.39	41.00416667	0.475694444	229.25	-0.1
2023-06-03	24.53	18.34159722	11.15	33.26770833	0.84375	335.28125	2
2023-06-04	17.91	13.33375	8.57	39.73993056	1.453125	299.2152778	3.2
2023-06-05	16.96	10.22638889	4.77	42.29444444	2.534722222	286.9097222	3.9
2023-06-06	22.7	14.035	4.9	35.95833333	0.430555556	347.3472222	4.1
2023-06-07	27.73	18.64447917	8.05	28.79895833	0.314236111	343.9236111	4.1
2023-06-08	30.8	22.49628472	12.68	27.63923611	0.34375	341.8402778	3.8
2023-06-09	24.94	19.71697917	15.96	42.13368056	0.998263889	203.6840278	2.4
2023-06-10	18.75	13.42423611	11.15	86.23333333	1.098958333	62.44097222	0.8
2023-06-11	22.75	16.31618056	10.74	62.25694444	1.604166667	327.7361111	-0.5
2023-06-12	27.09	19.91666667	12.17	37.49131944	0.569444444	323.5659722	-4.7
2023-06-13	19.08	12.63194444	8.47	74.75034722	2.098958333	74.31597222	1.5
2023-06-14	14.48	10.05565972	7.42	83.12951389	2.208333333	134.1076389	2
2023-06-15	22.44	13.50888889	5.23	64.77465278	0.581597222	271.1284722	3.3
2023-06-16	20.91	14.17315972	10.47	70.43958333	1.097222222	219.0347222	2.9
2023-06-17	13.88	8.915104167	3.14	61.00694444	1.675347222	194.15625	2.8
2023-06-18	10.64	6.015590278	3.04	90.12326389	2.291666667	203.7881944	2.6
2023-06-19	12.44	8.869895833	5.41	77.58993056	3.527777778	153	2.4
2023-06-20	19.13	13.04618056	7.39	53.58159722	1.204861111	280.3229167	3.6
2023-06-21	16.65	11.85267361	8.07	77.89027778	0.684027778	181.1180556	2.4
2023-06-22	20.1	13.39857639	7.34	75.16736111	0.175347222	269.8958333	3.2
2023-06-23	22.06	14.4909375	9.53	74.26701389	0.234375	214.3402778	2.7
2023-06-24	23.16	15.42121528	10.2	72.47465278	0.447916667	269.3506944	3.3
2023-06-25	24.24	17.21864583	10.81	67.86041667	0.328125	319.7465278	3.8
2023-06-26	26.92	19.79461806	11.3	54.35902778	0.526041667	303.3125	3.7
2023-06-27	27.09	21.1890625	14.22	44.67083333	1.303819444	299.4895833	3.9
2023-06-28	28.84	20.76621528	14.86	54.47291667	0.763888889	324.2673611	3.9
2023-06-29	24.6	17.93986111	14	73.24444444	0.701388889	225.7152778	2.9

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-06-30	23.59	16.81975694	12.03	65.76006944	0.975694444	290.4583333	3.6
2023-07-01	18.72	12.54517361	6.61	63.97291667	2.10625	226.2916667	-2.3
2023-07-02	19.15	11.93784722	4.97	54.50972222	0.748263889	299.9548611	-0.1
2023-07-03	20.32	14.27385417	8.44	56.89548611	1.880208333	239.3784722	1.9
2023-07-04	24.7	17.77482639	10.54	51.02708333	1.342013889	314.4965278	3.3
2023-07-05	26.57	19.63364583	11.81	45.09861111	0.491319444	286.9340278	3.4
2023-07-06	27.33	19.43107639	13.06	49.84583333	0.479166667	233.1805556	3
2023-07-07	27.63	20.11024306	15.06	53.67326389	0.430555556	219.0069444	2.8
2023-07-08	29.31	21.39350694	13.91	50.14652778	0.602430556	290.0138889	3.4
2023-07-09	29.36	20.60142361	15.68	56.15486111	0.880208333	252.6527778	2.6
2023-07-10	26.48	19.82118056	15.03	57.09444444	1.489583333	269.9722222	1.8
2023-07-11	25.72	19.26152778	14.24	53.16944444	1.293402778	267.5694444	-0.4
2023-07-12	26.16	19.25604167	13.16	43.46354167	1.333333333	267.5486111	-3.5
2023-07-13	21.03	15.51097222	11.76	66.23125	0.154513889	144.5347222	2
2023-07-14	23.47	16.99336806	10.74	66.82743056	0.336805556	190.8854167	2.5
2023-07-15	23.09	18.17270833	14.39	66.44930556	0.75	154.8923611	2.2
2023-07-16	26.52	19.04347222	12.29	60.54409722	0.791666667	233.7222222	3
2023-07-17	17.99	13.80020833	10.22	73.10590278	1.729166667	174.5902778	2.4
2023-07-18	20.75	15.38326389	9.98	60.69618056	0.491319444	219.2013889	2.8
2023-07-19	27.46	20.38767361	13.38	48.42916667	0.779513889	295.3194444	3.6
2023-07-20	30.42	23.30055556	16.06	42.04583333	0.394097222	268.1840278	3.3
2023-07-21	28.64	21.77125	15.6	47.30240385	1.668269231	261.3557692	3.5
2023-07-22	26.21	18.01534722	12.92	57.98368056	1.84375	228.90625	3.1
2023-07-23	21.44	16.1665625	10.34	55.43958333	1.131944444	159.2951389	2.3
2023-07-24	16.75	15.93791667	15.1	57.59166667	1.802083333	1	1
2023-07-25	---	---	---	---	---	---	---
2023-07-26	---	---	---	---	---	---	---
2023-07-27	16.27	15.385	14.82	83.68333333	1.083333333	552	5.9
2023-07-28	19.2	16.745	15.7	77.50416667	0.333333333	469.25	5
2023-07-29	---	---	---	---	---	---	---

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-07-30	---	---	---	---	---	---	---
2023-07-31	---	---	---	---	---	---	---
2023-08-01	---	---	---	---	---	---	---
2023-08-02	---	---	---	---	---	---	---
2023-08-03	---	---	---	---	---	---	---
2023-08-04	---	---	---	---	---	---	---
2023-08-05	---	---	---	---	---	---	---
2023-08-06	---	---	---	---	---	---	---
2023-08-07	---	---	---	---	---	---	---
2023-08-08	18.25	16.48958333	14.29	81.46736111	0.34375	151.5833333	1.9
2023-08-09	18.84	13.97697917	11.56	93.10659722	0.364583333	146.6805556	1.6
2023-08-10	18.68	13.75739583	9.8	77.22430556	0.253472222	160.4201389	1.2
2023-08-11	17.01	13.30194444	10.66	85.12326389	0.154513889	128.5347222	0
2023-08-12	23.66	16.87	11.93	70.32604167	0.447916667	202.0451389	-2.4
2023-08-13	28.07	19.33350694	11.93	62.59201389	0.159722222	240.3576389	2.7
2023-08-14	28.99	21.50670139	14.34	56.54548611	0.697916667	223.65625	2.7
2023-08-15	28.52	21.13256944	14.89	56.93888889	0.640625	197.4826389	2.5
2023-08-16	27.43	20.53482639	14.62	44.63541667	0.947916667	252.0763889	3
2023-08-17	27.46	20.21381944	15.25	53	0.954861111	193.625	2.5
2023-08-18	17.46	12.59545139	8.84	54.00138889	3.086805556	182.6354167	2.8
2023-08-19	21.46	12.9834375	5.72	57.68993056	0.75	243.5243056	2.8
2023-08-20	22.82	14.92447917	7.39	47.12465278	0.213541667	248.1666667	2.8
2023-08-21	23.5	17.2234375	12.07	42.53229167	0.279513889	168.4965278	2.1
2023-08-22	19.08	14.63663194	12.22	69.85486111	0.413194444	91.45833333	1.4
2023-08-23	12.53	10.30677083	9.09	96.384375	0.385416667	36.85069444	0.7
2023-08-24	18.37	12.91201389	8.42	84.7	0.348958333	197.8194444	2.2
2023-08-25	21.8	15.21649306	9.01	73.56145833	0.373263889	206.9618056	2.3
2023-08-26	23.95	16.85034722	10.96	67.515625	0.185763889	210.4722222	2.3
2023-08-27	27.55	18.46954861	11.08	55.08125	0.118055556	223.7604167	2.4
2023-08-28	30.09	20.26857639	11.93	46.29131944	0.166666667	226.7222222	2.5

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-08-29	23.23	18.37958333	14.07	57.29652778	0.805555556	152.5486111	2
2023-08-30	19.96	15.16336806	12.92	72.63472222	2.602430556	139.4236111	2
2023-08-31	17.77	14.4628125	11.03	64.07777778	2.510416667	153.1354167	2.2
2023-09-01	22.94	15.73902778	9.16	59.78263889	0.404513889	207.6979167	-2.2
2023-09-02	23.35	16.36708333	9.88	58.72916667	0.265625	183.3090278	0.3
2023-09-03	18.37	14.33760417	10.98	58.03333333	1.125	129.8819444	1.4
2023-09-04	16.87	12.51180556	8.82	58.646875	0.869791667	168.5659722	2.1
2023-09-05	14.39	10.04628472	6.94	85.05833333	0.256944444	118.3229167	1.6
2023-09-06	13.55	9.345555556	6.61	88.33263889	0.576388889	121.2256944	1.7
2023-09-07	17.39	9.987152778	5.08	79.18229167	0.102430556	153.96875	2
2023-09-08	21.63	12.70013889	5.72	60.21388889	0.197916667	208.3993056	2.5
2023-09-09	23.83	15.69201389	7.95	51.17013889	0.286458333	204.8368056	2.1
2023-09-10	25.38	17.88857639	10.86	48.42604167	0.824652778	182.1076389	1.4
2023-09-11	19.22	15.73614583	12.39	62.828125	0.135416667	95.23263889	0.1
2023-09-12	15.87	12.62059028	9.44	81.48333333	0.189236111	86.65972222	-0.8
2023-09-13	17.99	11.91809028	8.02	66.66840278	0.6875	183.4513889	1.9
2023-09-14	21.06	12.42486111	5.36	62.41666667	0.237847222	189.6319444	1.9
2023-09-15	27.11	17.42413194	10.91	42.02847222	1.039930556	187.6041667	2.1
2023-09-16	24.8	16.19083333	8.52	38.61493056	0.701388889	168.3854167	1.9
2023-09-17	18.72	14.56118056	9.34	45.61458333	0.71875	100.7013889	1.5
2023-09-18	12.22	8.006423611	2.37	70.62916667	0.779861111	127.3854167	1.5
2023-09-19	8.47	6.570208333	4.9	88.28368056	0.272569444	55.68055556	0.8
2023-09-20	11.9	7.122847222	3.25	85.51111111	1.767361111	139.8020833	1.5
2023-09-21	9.9	4.442483221	2.45	92.38120805	0.127516779	114.0939597	1.2
2023-09-22	---	---	---	---	---	---	---
2023-09-23	---	---	---	---	---	---	---
2023-09-24	---	---	---	---	---	---	---
2023-09-25	---	---	---	---	---	---	---
2023-09-26	---	---	---	---	---	---	---
2023-09-27	---	---	---	---	---	---	---

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-09-28	---	---	---	---	---	---	---
2023-09-29	---	---	---	---	---	---	---
2023-09-30	---	---	---	---	---	---	---
2023-10-01	11.88	6.847604167	1.37	83.08784722	0.180555556	85.88888889	-0.5
2023-10-02	15.37	9.108298611	6.56	86.24583333	0.210069444	107.0381944	0.4
2023-10-03	12.53	8.012673611	5.8	87.82361111	0.326388889	88.61111111	0.9
2023-10-04	11.39	8.207569444	6.53	84.003125	0.369791667	89.29166667	1.2
2023-10-05	9.51	6.865347222	5.31	95.74409722	0.003472222	45.13194444	0.8
2023-10-06	17.18	9.899583333	5.57	86.76180556	0.157986111	117.8576389	1.6
2023-10-07	21.2	13.78635417	7.74	67.90729167	0.595486111	134.53125	1.9
2023-10-08	20.72	15.44142361	9.53	55.44791667	0.803819444	89.48958333	1.6
2023-10-09	17.68	15.00600694	10.39	54.87743056	1.223958333	47.71180556	1.2
2023-10-10	11.3	9.224861111	7.32	91.01909722	0.833333333	36.95138889	0.6
2023-10-11	14.6	8.696215278	5.57	79.32430556	0.423611111	125.1944444	0
2023-10-12	14.67	7.326909722	2.32	83.35972222	0.097222222	112.0173611	-1.1
2023-10-13	15.56	9.378645833	3.72	72.21597222	1.293402778	103.6145833	1
2023-10-14	13.14	10.60607639	8.02	69.73993056	1.069444444	83.69097222	0.9
2023-10-15	13.76	10.10520833	6.53	73.76840278	1.105902778	90.63541667	0.9
2023-10-16	12.75	10.04659722	7.64	80.49756944	1.256944444	30.37847222	0.7
2023-10-17	9.39	7.044305556	4.14	84.43958333	1.432291667	68.08333333	0.70
2023-10-18	14.96	9.721527778	6.43	79.46597222	1.326388889	92.5	0.80
2023-10-19	17.22	9.946076389	7.22	80.37048611	1.435763889	85.90972222	0.80
2023-10-20	11.03	6.559201389	3.59	68.60520833	1.192708333	98.94791667	0.80
2023-10-21	11.30	5.656319444	3.17	72.19826389	1.140625	85.45138889	0.80
2023-10-22	7.62	1.858055556	-2.74	82.43263889	1.114583333	93.51736111	0.70
2023-10-23	0.77	-1.667291667	-5.20	85.83090278	2.758680556	55.51736111	0.70
2023-10-24	-2.51	-5.651944444	-8.30	71.95243056	2.522569444	59.78819444	0.90
2023-10-25	-2.39	-6.814548611	-11.61	64.63090278	2.621527778	93.23263889	1.00
2023-10-26	1.04	-3.511701389	-6.48	56.93020833	2.741319444	90.09375	1.10
2023-10-27	1.07	-3.519652778	-7.25	51.9	1.586805556	89.84375	0.90

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-10-28	2.72	-3.280798611	-7.80	61.76354167	0.118055556	87.53472222	0.50
2023-10-29	4.30	-1.332013889	-5.08	70.87326389	0.175347222	84.55902778	0.50
2023-10-30	6.51	0.540694444	-3.06	68.690625	0.407986111	77.40972222	0.50
2023-10-31	7.12	0.912986111	-3.93	67.09131944	0.243055556	82.51041667	0.40
2023-11-01	4.56	1.355208333	-1.78	72.93854167	0.234375	54.13888889	-0.10
2023-11-02	3.75	2.253832753	0.33	90.0554007	0.726480836	16.28571429	0.50
2023-11-03	4.84	3.374965278	2.45	99.71875	0.324652778	30.82986111	0.60
2023-11-04	8.49	5.431736111	3.17	91.74027778	1.857638889	23.46527778	0.70
2023-11-05	7.49	5.052048611	2.82	83.36006944	0.467013889	44.91666667	0.90
2023-11-06	4.09	3.185486111	1.72	97.26423611	0.164930556	17.45486111	0.60
2023-11-07	3.77	1.254652778	-0.54	87.93784722	0.685763889	51.41319444	1.00
2023-11-08	1.23	0.140277778	-1.38	98.72326389	0.130208333	24.53472222	0.60
2023-11-09	4.64	2.156180556	0.11	87.74826389	1.427083333	31.85763889	0.80
2023-11-10	5.54	2.870069444	-0.42	75.64513889	1.675347222	62.56597222	0.90
2023-11-11	5.85	3.450208333	-0.17	68.17638889	1.086805556	28.68055556	0.60
2023-11-12	3.09	0.377534722	-2.02	89.70659722	1.140625	29.88888889	0.10
2023-11-13	2.93	-0.095277778	-1.56	96.29826389	0.4375	37.84722222	0.20
2023-11-14	-0.59	-2.009895833	-4.29	93.79270833	0	17.65972222	0.30
2023-11-15	-0.20	-3.427430556	-5.39	91.42118056	0.171875	43.39236111	0.20
2023-11-16	-1.33	-3.609791667	-6.71	94.62395833	0	20.625	0.30
2023-11-17	2.53	0.300694444	-1.47	97.23229167	0.583333333	44.09027778	0.10
2023-11-18	5.62	2.653784722	0.27	84.43576389	0.732638889	49.72916667	0.20
2023-11-19	6.00	2.667222222	-1.73	71.10729167	1.09375	38.30902778	0.40
2023-11-20	2.48	-0.706006944	-3.84	75.10763889	1.243055556	26.59722222	0.40
2023-11-21	6.76	3.593333333	0.38	59.80694444	1.258680556	26.98263889	0.60
2023-11-22	1.18	-0.338125	-2.07	91.57777778	0.970486111	28.07638889	0.20
2023-11-23	0.36	-1.521398601	-3.72	82.47937063	0.702797203	27.40909091	0.30
2023-11-24	0.82	-2.266736111	-3.84	85.92604167	0.097222222	43.80555556	0.10
2023-11-25	0.08	-1.298923611	-2.57	95.17916667	0.131944444	21.36458333	0.20
2023-11-26	-0.17	-0.852222222	-1.24	94.66909722	0.392361111	20.00694444	0.20

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-11-27	0.80	-1.331672474	-2.95	88.18327526	0.806620209	39.29616725	0.10
2023-11-28	-2.10	-3.482906574	-5.29	87.64532872	0.788927336	38.69896194	0.10
2023-11-29	-2.36	-3.334201389	-4.44	86.04479167	0.069444444	29.46527778	0.10
2023-11-30	-3.33	-4.529583333	-6.04	81.33090278	0.810763889	29.53472222	0.20
2023-12-01	-2.68	-3.9859375	-6.14	94.37951389	1.185763889	20.20833333	0.20
2023-12-02	-1.21	-2.189444444	-3.27	97.321875	0.670138889	19.03819444	0.40
2023-12-03	-1.21	-2.026840278	-2.77	99.86736111	0.883680556	9.239583333	0.40
2023-12-04	2.13	-0.630451389	-2.42	99.95868056	1.75	7.020833333	0.40
2023-12-05	5.46	2.722048611	-0.28	96.46840278	0.272569444	31.8125	0.70
2023-12-06	0.71	-0.788541667	-4.29	99.540625	0.217013889	11.96180556	0.50
2023-12-07	-3.27	-4.380833333	-5.33	98.23159722	0	26.56944444	0.70
2023-12-08	-4.41	-5.176388889	-6.20	97.35833333	0	21.43402778	0.60
2023-12-09	-2.42	-3.743819444	-5.39	98.271875	0	4.930555556	0.40
2023-12-10	-0.68	-1.426145833	-2.51	100	0	13.11111111	0.40
2023-12-11	-2.16	-3.102534722	-4.11	99.67881944	0	25.71180556	0.30
2023-12-12	-1.84	-4.185659722	-6.71	95.00486111	0.585069444	36.05208333	-0.10
2023-12-13	2.69	0.428784722	-1.93	82.51006944	0.979166667	9.635416667	0.40
2023-12-14	0.22	-0.533819444	-1.18	99.43506944	0.038194444	12.84722222	0.20
2023-12-15	2.10	-0.277152778	-3.45	96.09166667	0.939236111	17.59722222	0.20
2023-12-16	1.29	0.406458333	-0.45	99.61076389	0.463541667	23.74305556	0.10
2023-12-17	1.18	-0.279097222	-1.47	99.53611111	0.390625	19.36805556	0.10
2023-12-18	1.75	0.355034722	-0.96	99.96388889	0.604166667	16.68055556	0.10
2023-12-19	2.85	2.205069444	1.67	99.87152778	0.71875	11.10416667	0.20
2023-12-20	3.54	2.195972222	1.07	99.98680556	0.269097222	11.89236111	0.20
2023-12-21	3.56	2.289721254	0.85	99.36167247	0.804878049	17.00696864	0.10
2023-12-22	5.15	1.412256944	-4.38	86.065625	0.744791667	8.642361111	0.40
2023-12-23	-2.33	-4.380381944	-6.77	88.81111111	0	38.39583333	-0.10
2023-12-24	-0.79	-3.192152778	-5.39	75.18819444	0.387152778	23.35763889	0.20
2023-12-25	4.40	0.432256944	-3.24	78.21319444	2.907986111	13.79861111	0.60
2023-12-26	5.02	3.103993056	0.33	70.64027778	2.034722222	37.88888889	0.20

Date	Temperature Daily Max (°C) Wth Stn 2	Temperature Daily Mean (°C) Wth Stn 2	Temperature Daily Min (°C) Wth Stn 2	Relative Humidity Daily Mean (%) Wth Stn 2	Wind Speed Daily Mean (m/s) Wth Stn 2	Solar Radiation Daily Mean (W/m2) Wth Stn 2	Evaporation Total (mm) Wth Stn 2
2023-12-27	6.20	4.068159722	0.60	66.48020833	2.366319444	14.29513889	0.70
2023-12-28	5.59	4.743923611	3.80	70.80034722	1.673611111	22.63541667	0.40
2023-12-29	7.62	4.972361111	2.56	76.89722222	1.201388889	26.05902778	0.2
2023-12-30	8.54	6.525	2.66	66.73368056	0.723958333	18.70138889	0.4
2023-12-31	4.53	1.340069444	-1.41	89.47951389	0.046875	35.22916667	0

SNOW PACK DATA SHEET

DATE: **09-Jan-23** **Samplers:** **KI AN**

Blue in-situ measurements

Black calculations

Site: **PAG** **Time:** 12:20

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	43	35	1	29	39	10	1.27	34	0.23
2	10	47	40	1	29	39	10	1.21	39	0.21
3	20	45	34	1	29	38	9	1.38	33	0.20
4	30	49	38	1	29	40	11	1.33	37	0.22
5	40	46	40	1	29	39	10	1.18	39	0.22
6	50	55	42	1	29	42	13	1.35	41	0.24
7	60	27	24	3	29	34	5	1.33	21	0.19
8	70	34	26	3	29	35	6	1.55	23	0.18
9	80	48	41	3	29	36	7	1.29	38	0.15
10	90	45	45	1	29	46	17	1.02	44	0.38
Average		**43.9**	**36.5**	**1.6**	**29**	**38.8**	**9.8**	**1.29**	**34.9**	**0.22**
COMMENTS:		#2, #3, #5, #6, location approx, stakes missing. Animals track throughout snowcourse. #7 multiple attempls								

Site: **TSF** **Time:** 13:40

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	52	39	1	29	38	9	1.34	38	0.17
2	10	38	36	4	29	38	9	1.06	32	0.24
3	20	35	33	3	29	35	6	1.07	30	0.17
4	30	32	27	2	29	34	5	1.20	25	0.16
5	40	42	39	5	29	38	9	1.09	34	0.21
6	50	27	23	1	29	37	8	1.18	22	0.30
7	60	42	39	3	29	36	7	1.08	36	0.17
8	70	49	44	5	29	38	9	1.13	39	0.18
9	80	26	22	3	29	36	7	1.21	19	0.27
10	90	45	34	4	29	37	8	1.37	30	0.18
Average		**38.8**	**33.6**	**3.1**	**29**	**36.7**	**7.7**	**1.17**	**30.5**	**0.20**
COMMENTS:										

Site: **JCP** **Time:** 14:26

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	39	24	1	29	37	8	1.65	23	0.21
2	10	49	38	4	29	41	12	1.32	34	0.24
3	20	47	39	1	29	40	11	1.21	38	0.23
4	30	53	40	1	29	41	12	1.33	39	0.23
5	40	53	32	1	29	41	12	1.68	31	0.23
6	50	54	41	1	29	42	13	1.33	40	0.24
7	60	44	37	1	29	40	11	1.19	36	0.25
8	70	62	55	4	29	42	13	1.14	51	0.21
9	80	47	33	1	29	40	11	1.44	32	0.23
10	90	45	36	1	29	40	11	1.26	35	0.24
Average		**49.3**	**37.5**	**1.6**	**29**	**40.4**	**11.4**	**1.35**	**35.9**	**0.23**
COMMENTS:		*multiple attempt w/ similar values								

Site: **WTH STN #1** **Time:** 15:16

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	39	32	1	29	36	7	1.23	31	0.18
2	10	65	53	1	29	44	15	1.23	52	0.23
3	20	65	45	1	29	42	13	1.45	44	0.20
4	30	68	53	2	29	42	13	1.29	51	0.19
5	40	64	58	3	29	42	13	1.11	55	0.20
6	50	66	59	1	29	42	13	1.12	58	0.20
7	60	63	34	3	29	40	11	1.94	31	0.17
8	70	45	39	3	29	39	10	1.17	36	0.22
9	80	50	41	2	29	40	11	1.23	39	0.22
10	90	50	36	1	29	38	9	1.40	35	0.18
Average		**57.5**	**45**	**1.8**	**29**	**40.5**	**11.5**	**1.32**	**43.2**	**0.20**
COMMENTS:										

Total Average	**47.4**	**38.2**	**2.0**	**29.0**	**39.1**	**10.1**	**1.3**	**36.1**	**0.2**

Total Average (mm) 101

DATE: 31-Jan-23 **Samplers:** AN DS KA

Blue in-situ measurements

Black calculations

Site: TSF **Time:** 10:47

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	77	59	1	29	42	13	1.33	58	0.17
2	10	53	46	4	29	42	13	1.29	42	0.25
3	20	53	47	1	29	40	11	1.16	46	0.21
4	30	47	40	1	29	36	7	1.21	39	0.15
5	40	60	51	5	29	40	11	1.34	46	0.18
6	50	41	34	1	29	36	7	1.25	33	0.17
7	60	73	61	4	29	44	15	1.30	57	0.21
8	70	63	49	5	29	41	12	1.49	44	0.19
9	80	62	46	3	29	39	10	1.48	43	0.16
10	90	65	48	4	29	40	11	1.53	44	0.17
Average		**59.4**	**48.1**	**2.9**	**29**	**40**	**11**	**1.34**	**45.2**	**0.19**
COMMENTS:		*multiple attempt with similar values @Stations 2, 9								

Site: JCP **Time:** 11:43

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	51	44	1	29	40	11	1.16	43	0.22
2	10	73	53	3	29	40	11	1.40	50	0.15
3	20	63	54	1	29	42	13	1.17	53	0.21
4	30	75	48	1	29	42	13	1.57	47	0.17
5	40	78	49	1	29	40	11	1.60	48	0.14
6	50	80	40	1	29	42	13	2.03	39	0.16
7	60	64	57	2	29	42	13	1.13	55	0.20
8	70	77	66	3	29	44	15	1.17	63	0.19
9	80	65	45	1	29	40	11	1.45	44	0.17
10	90	59	52	2	29	40	11	1.14	50	0.19
Average		**68.5**	**50.8**	**1.6**	**29**	**41.2**	**12.2**	**1.38**	**49.2**	**0.18**
COMMENTS:		*multiple attempt with similar values @Stations 2, 3, 4, 5, 6, 7								

Site: **PAG** **Time:** 12:34

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	55	43	1	29	40	11	1.29	42	0.20
2	10	64	50	1	29	42	13	1.29	49	0.20
3	20	49	42	1	29	38	9	1.17	41	0.18
4	30	57	52	2	29	40	11	1.10	50	0.19
5	40	52	45	3	29	40	11	1.17	42	0.21
6	50	58	48	3	29	40	11	1.22	45	0.19
7	60	27	27	3	29	31	2	1.00	24	0.07
8	70	44	39	2	29	40	11	1.14	37	0.25
9	80	62	55	3	29	40	11	1.13	52	0.18
10	90	46	43	1	29	40	11	1.07	42	0.24
Average		**51.4**	**44.4**	**2.0**	**29**	**39.1**	**10.1**	**1.16**	**42.4**	**0.19**
COMMENTS:		*multiple attempt with similar values @Stations 2, 3, 9, 10								

Site: **WTH STN #1** **Time:**

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0									
2	10									
3	20									
4	30									
5	40									
6	50									
7	60									
8	70									
9	80									
10	90									
Average		**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**
COMMENTS:		Site not accessible via road and not adequate enough time to snowshow into location. Will make sure enough time for next measurements.								

Total Average	**59.8**	**47.8**	**2.2**	**29.0**	**40.1**	**11.10**	**1.3**	**45.6**	**0.2**

Total Average (mm) 111

SNOW PACK DATA SHEET

DATE: **15-Feb-23** **Samplers:** **AN/DS/KA**

Blue in-situ measurements

Black calculations

Site: **PAG** **Time:** 10:45

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	51	48	1	29	42	13	1.09	47	0.25
2	10	79	73	2	29	50	21	1.12	71	0.27
3	20	62	50	3	29	48	19	1.34	47	0.31
4	30	82	68	1	29	51	22	1.23	67	0.27
5	40	64	52	3	29	43	14	1.33	49	0.22
6	50	96	83	2	29	54	25	1.19	81	0.26
7	60	35	30	1	29	40	11	1.21	29	0.31
8	70	48	41	1	29	41	12	1.21	40	0.25
9	80	62	56	1	29	45	16	1.13	55	0.26
10	90	45	43	3	29	41	12	1.14	40	0.27
Average		**62.4**	**54.4**	**1.8**	**29**	**45.5**	**16.5**	**1.20**	**52.6**	**0.27**
COMMENTS:		#2, 6, Approx location, stakes covered in snow. #4 multiple attempts								

Site: **WTH STN #1** **Time:** 11:33

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	69	65	3	29	48	19	1.06	62	0.28
2	10	89	76	4	29	50	21	1.18	72	0.24
3	20	91	72	2	29	50	21	1.27	70	0.23
4	30	98	86	5	29	53	24	1.15	81	0.24
5	40	88	79	5	29	50	21	1.12	74	0.24
6	50	95	81	1	29	52	23	1.18	80	0.24
7	60	93	71	3	29	50	21	1.32	68	0.23
8	70	76	62	2	29	45	16	1.23	60	0.21
9	80	79	62	1	29	46	17	1.28	61	0.22
10	90	89	70	1	29	51	22	1.28	69	0.25
Average		**86.7**	**72.4**	**2.7**	**29**	**49.5**	**20.5**	**1.21**	**69.7**	**0.24**
COMMENTS:										

Site: **TSF** **Time:** 12:15

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	86	65	4	29	47	18	1.34	61	0.21
2	10	60	51	4	29	43	14	1.19	47	0.23
3	20	53	51	3	29	42	13	1.04	48	0.25
4	30	61	56	3	29	42	13	1.09	53	0.21
5	40	79	71	1	29	42	13	1.11	70	0.16
6	50	51	50	6	29	42	13	1.02	44	0.25
7	60	72	61	1	29	45	16	1.18	60	0.22
8	70	86	83	6	29	50	21	1.04	77	0.24
9	80	106	86	2	29	51	22	1.24	84	0.21
10	90	98	74	1	29	53	24	1.33	73	0.24
Average		**75.2**	**64.8**	**3.1**	**29**	**45.7**	**16.7**	**1.16**	**61.7**	**0.22**
COMMENTS:		# 1 Multiple attempts, #2,5 Locations approx, stakes covered in snow								

Site: **JCP** **Time:** 13:00

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	61	53	1	29	42	13	1.15	52	0.21
2	10	83	70	2	29	49	20	1.19	68	0.24
3	20	86	65	5	29	46	17	1.35	60	0.20
4	30	92	78	1	29	50	21	1.18	77	0.23
5	40	92	79	4	29	52	23	1.17	75	0.25
6	50	91	53	1	29	47	18	1.73	52	0.20
7	60	81	66	1	29	44	15	1.23	65	0.19
8	70	91	78	6	29	51	22	1.18	72	0.24
9	80	74	58	6	29	45	16	1.31	52	0.22
10	90	71	61	1	29	46	17	1.17	60	0.24
Average		**82.2**	**66.1**	**2.8**	**29**	**47.2**	**18.2**	**1.27**	**63.3**	**0.22**
COMMENTS:		#4,6,7,10 Multiple Attempts. Hollow sections with grass								

Total Average	**76.6**	**64.4**	**2.6**	**29.0**	**47.0**	**17.98**	**1.2**	**61.8**	**0.2**

Total Average (mm)	179.8

DATE: **27-Feb-23** **Samplers:** **AN/MJ**

Blue in-situ measurements

Black calculations

Site: **TSF** **Time:** 11:25

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	59	59	1	29	42	13	1.02	58	0.22
2	10	96	91	1	29	51	22	1.07	90	0.23
3	20	101	100	3	29	52	23	1.04	97	0.23
4	30	98	97	1	29	50	21	1.02	96	0.21
5	40	88	85	1	29	50	21	1.05	84	0.24
6	50	122	117	1	29	60	31	1.05	116	0.25
7	60	100	90	6	29	50	21	1.21	84	0.21
8	70	135	126	3	29	59	30	1.10	123	0.22
9	80	148	139	1	29	67	38	1.07	138	0.26
10	90	116	90	5	29	56	27	1.39	85	0.23
Average		**106.3**	**99.4**	**2.3**	**29**	**53.7**	**24.7**	**1.10**	**97.1**	**0.23**
COMMENTS:		Locations Approx. Deep snow covered most stakes #2,3,4,5,6,7,8,9								

Site: **JCP** **Time:** 12:15

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	103	95	1	29	53	24	1.09	94	0.23
2	10	120	105	1	29	56	27	1.14	104	0.23
3	20	117	112	1	29	57	28	1.05	111	0.24
4	30	125	115	1	29	57	28	1.09	114	0.22
5	40	130	115	1	29	56	27	1.13	114	0.21
6	50	132	112	1	29	61	32	1.18	111	0.24
7	60	126	116	1	29	56	27	1.09	115	0.21
8	70	133	120	1	29	60	31	1.11	119	0.23
9	80	111	103	1	29	55	26	1.08	102	0.23
10	90	113	104	3	29	54	25	1.09	101	0.22
Average		**121**	**109.7**	**1.2**	**29**	**56.5**	**27.5**	**1.10**	**108.5**	**0.23**
COMMENTS:		#2, #3 approx location, stakes covered in snow								

Site: **PAG** **Time:** 13:20

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	114	66	1	29	50	21	1.74	65	0.18
2	10	118	85	1	29	57	28	1.39	84	0.24
3	20	98	73	1	29	51	22	1.35	72	0.22
4	30	113	87	1	29	54	25	1.30	86	0.22
5	40	100	65	1	29	51	22	1.55	64	0.22
6	50	131	108	1	29	60	31	1.21	107	0.24
7	60	85	72	1	29	50	21	1.18	71	0.25
8	70	99	89	1	29	52	23	1.11	88	0.23
9	80	112	98	1	29	55	26	1.14	97	0.23
10	90	85	74	1	29	50	21	1.15	73	0.25
Average		**105.5**	**81.7**	**1.0**	**29**	**53**	**24**	**1.31**	**80.7**	**0.23**
COMMENTS:		#1, #2, multiple attempts. Tube Freezing. #2,3,6,7,8 Approx location stakes covered in deep snow. Snow drifts throughout snow course								

Site: **WTH STN#1** **Time:** 14:15

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	98	69	1	29	46	17	1.43	68	0.17
2	10	119	113	1	29	60	31	1.05	112	0.26
3	20	126	91	1	29	54	25	1.39	90	0.20
4	30	143	139	1	29	64	35	1.03	138	0.24
5	40	128	125	1	29	60	31	1.02	124	0.24
6	50	128	125	1	29	62	33	1.02	124	0.26
7	60	129	126	1	29	62	33	1.02	125	0.26
8	70	119	114	1	29	56	27	1.04	113	0.23
9	80	117	102	1	29	54	25	1.15	101	0.21
10	90	132	125	1	29	62	33	1.06	124	0.25
Average		**123.9**	**112.9**	**1.0**	**29**	**58**	**29**	**1.12**	**111.9**	**0.23**
COMMENTS:		#1,7 multiple attempts, #7 Stake missing covered under deep snow								

Total Average	**114.2**	**100.9**	**1.4**	**29.0**	**55.3**	**26.3**	**1.2**	**99.6**	**0.2**

Total Average (mm) 263

SNOW PACK DATA SHEET

DATE: **08-Mar-23** **Samplers** DS/KA

Blue in-situ measurements

Black calculations

Site: **TSF** **Time:** 10:00

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	80	74	1	29	50	21	1.10	73	0.26
2	10	83	82	6	29	50	21	1.10	76	0.25
3	20	84	75	2	29	51	22	1.15	73	0.26
4	30	85	82	2	29	51	22	1.06	80	0.26
5	40	74	68	4	29	46	17	1.17	64	0.23
6	50	103	90	1	29	56	27	1.16	89	0.26
7	60	89	82	7	29	50	21	1.21	75	0.24
8	70	132	110	2	29	66	37	1.23	108	0.28
9	80	125	112	3	29	62	33	1.15	109	0.26
10	90	104	94	2	29	60	31	1.13	92	0.30
Average		**95.9**	**86.9**	**3.0**	**29**	**54.2**	**25.2**	**1.15**	**83.9**	**0.26**
COMMENTS:		#7 & #8 Multiple attempts								

Site: **JCP** **Time:** 11:00

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	93	84	1	29	41	12	1.11	83	0.13
2	10	109	97	1	29	58	29	1.13	96	0.27
3	20	105	97	2	29	57	28	1.08	95	0.27
4	30	112	103	3	29	60	31	1.09	100	0.28
5	40	118	96	3	29	58	29	1.24	93	0.25
6	50	118	103	1	29	60	31	1.15	102	0.26
7	60	107	100	1	29	58	29	1.07	99	0.27
8	70	118	111	2	29	62	33	1.06	109	0.28
9	80	96	87	3	29	52	23	1.11	84	0.24
10	90	100	87	1	29	54	25	1.15	86	0.25
Average		**107.6**	**96.5**	**1.8**	**29**	**56**	**27**	**1.12**	**94.7**	**0.25**
COMMENTS:		#2 Multiple attempts								

Site: **PAG** **Time:** 12:53

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	84	77	3	29	50	21	1.09	74	0.25
2	10	96	91	3	29	50	21	1.06	88	0.22
3	20	86	78	2	29	52	23	1.11	76	0.27
4	30	99	78	1	29	55	26	1.27	77	0.26
5	40	90	77	1	29	43	14	1.17	76	0.16
6	50	112	103	1	29	59	30	1.09	102	0.27
7	60	74	68	1	29	49	20	1.09	67	0.27
8	70	82	72	2	29	53	24	1.14	70	0.29
9	80	93	82	1	29	54	25	1.14	81	0.27
10	90	71	65	2	29	50	21	1.10	63	0.30
Average		**88.7**	**79.1**	**1.7**	**29**	**51.5**	**22.5**	**1.13**	**77.4**	**0.25**
COMMENTS:										

Site: **WTH STN #1** **Time:** 11:40

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	89	87	1	29	55	26	1.02	86	0.29
2	10	104	87	1	29	58	29	1.20	86	0.28
3	20	111	95	1	29	60	31	1.17	94	0.28
4	30	119	112	2	29	60	31	1.06	110	0.26
5	40	110	99	1	29	59	30	1.11	98	0.27
6	50	110	107	2	29	60	31	1.03	105	0.28
7	60	111	89	1	29	60	31	1.25	88	0.28
8	70	100	89	1	29	56	27	1.13	88	0.27
9	80	101	97	3	29	60	31	1.04	94	0.31
10	90	113	89	1	29	58	29	1.27	88	0.26
Average		**106.8**	**95.1**	**1.4**	**29**	**58.6**	**29.6**	**1.13**	**93.7**	**0.28**
COMMENTS:		#1 Multiple Attempts								

Total Average	**99.8**	**89.4**	**2.0**	**29.0**	**55.1**	**26.1**	**1.1**	**87.4**	**0.3**

Total Average (mm) 260.75

DATE: **22-Mar-23** **Samplers:** DS/KA Blue in-situ measurements

Black calculations

Site: **TSF** **Time:** 9:20

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	86	64	1	29	52	23	1.37	63	0.27
2	10	73	69	4	29	49	20	1.13	65	0.27
3	20	73	71	5	29	50	21	1.11	66	0.29
4	30	72	70	2	29	50	21	1.06	68	0.29
5	40	70	65	3	29	50	21	1.14	62	0.30
6	50	103	94	1	29	60	31	1.11	93	0.30
7	60	92	85	1	29	60	31	1.10	84	0.34
8	70	125	114	1	29	70	41	1.11	113	0.33
9	80	117	109	2	29	69	40	1.10	107	0.34
10	90	79	67	3	29	50	21	1.25	64	0.27
Average		**89**	**80.8**	**2.3**	**29**	**56**	**27**	**1.15**	**78.5**	**0.30**
COMMENTS:										

Site: **JCP** **Time:** 10:37

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	69	59	4	29	46	17	1.18	55	0.25
2	10	85	70	1	29	51	22	1.22	69	0.26
3	20	84	75	2	29	55	26	1.12	73	0.31
4	30	94	77	1	29	51	22	1.22	76	0.23
5	40	93	87	1	29	60	31	1.07	86	0.33
6	50	95	76	1	29	54	25	1.25	75	0.26
7	60	95	87	2	29	57	28	1.09	85	0.29
8	70	97	84	2	29	59	30	1.16	82	0.31
9	80	79	67	2	29	52	23	1.18	65	0.29
10	90	81	71	1	29	53	24	1.14	70	0.30
Average		**87.2**	**75.3**	**1.7**	**29**	**53.8**	**24.8**	**1.16**	**73.6**	**0.28**
COMMENTS:										

Site: **PAG** **Time:** 12:21

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	54	47	3	29	46	17	1.16	44	0.31
2	10	62	54	4	29	51	22	1.16	50	0.35
3	20	45	39	3	29	45	16	1.17	36	0.36
4	30	66	50	2	29	51	22	1.33	48	0.33
5	40	55	39	3	29	47	18	1.44	36	0.33
6	50	97	78	3	29	54	25	1.25	75	0.26
7	60	22	20	1	29	37	8	1.11	19	0.36
8	70	51	42	4	29	49	20	1.24	38	0.39
9	80	62	45	3	29	52	23	1.40	42	0.37
10	90	30	26	1	29	41	12	1.16	25	0.40
Average		**54.4**	**44**	**2.7**	**29**	**47.3**	**18.3**	**1.24**	**41.3**	**0.35**
COMMENTS:										

Site: **WTH STN** **Time:** 11:23

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	70	69	2	29	51	22	1.01	67	0.31
2	10	87	69	1	29	52	23	1.26	68	0.26
3	20	90	86	2	29	57	28	1.05	84	0.31
4	30	94	91	1	29	60	31	1.03	90	0.33
5	40	90	89	2	29	57	28	1.01	87	0.31
6	50	89	87	1	29	57	28	1.02	86	0.31
7	60	97	95	3	29	61	32	1.02	92	0.33
8	70	77	71	1	29	55	26	1.09	70	0.34
9	80	78	75	3	29	54	25	1.04	72	0.32
10	90	92	88	2	29	57	28	1.05	86	0.30
Average		**86.4**	**82**	**1.8**	**29**	**56.1**	**27.1**	**1.06**	**80.2**	**0.31**
COMMENTS:										

Total Average	**79.3**	**70.5**	**2.1**	**29.0**	**53.3**	**24.3**	**1.2**	**68.4**	**0.3**

Total Average (mm)	243

SNOW PACK DATA SHEET

DATE: **05-Apr-23** **Samplers:** **AN/MJ**

Blue in-situ measurements

Black calculations

Site: **PAG** **Time:** 8:54

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	23	23	1	29	46	17	1.05	22	0.74
2	10	20	20	4	29	50	21	1.33	16	1.05
3	20	0	0	0	0	0	0	0.00	0	0.00
4	30	30	29	1	29	54	25	1.07	28	0.83
5	40	24	23	3	29	52	23	1.24	20	0.96
6	50	73	57	1	29	50	21	1.31	56	0.29
7	60	0	0	0	0	0	0	0.00	0	0.00
8	70	15	15	3	29	50	21	1.33	12	1.40
9	80	19	19	1	29	50	21	1.06	18	1.11
10	90	0	0	0	0	0	0	0.00	0	0.00
Average		**20.4**	**18.6**	**1.4**	**20.3**	**35.2**	**14.9**	**0.84**	**17.2**	**0.64**
COMMENTS:		Station 1- 70% Snowfree, 2-20% Snowfree, 3-100% Snowfree in 1 meter radius around stake, #6 -Multiple attempts, #7-100% Snowfree, #8- 70% Snowfree, #9-50% snowfree, #10- 100% Snowfree								

Site: **WTH STN 1** **Time:** 9:50

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	43	43	1	29	46	17	1.00	42	0.40
2	10	59	49	1	29	50	21	1.21	48	0.36
3	20	80	73	1	29	56	27	1.10	72	0.34
4	30	73	71	3	29	54	25	1.03	68	0.34
5	40	65	65	3	29	52	23	1.00	62	0.35
6	50	68	65	1	29	50	21	1.05	64	0.31
7	60	68	61	1	29	54	25	1.12	60	0.37
8	70	56	53	1	29	50	21	1.06	52	0.38
9	80	5	49	1	29	50	21	0.08	48	4.20
10	90	73	65	1	29	56	27	1.13	64	0.37
Average		**59**	**59.4**	**1.4**	**29**	**51.8**	**22.8**	**0.98**	**58**	**0.74**
COMMENTS:										

Site: **JCP** **Time:** 10:33

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	44	42	1	29	42	13	1.05	41	0.30
2	10	63	56	2	29	50	21	1.13	54	0.33
3	20	68	56	1	29	50	21	1.22	55	0.31
4	30	74	70	1	29	56	27	1.06	69	0.36
5	40	78	73	1	29	56	27	1.07	72	0.35
6	50	80	73	1	29	56	27	1.10	72	0.34
7	60	84	75	1	29	54	25	1.12	74	0.30
8	70	83	74	1	29	54	25	1.12	73	0.30
9	80	65	59	4	29	52	23	1.11	55	0.35
10	90	74	69	1	29	52	23	1.07	68	0.31
Average		**71.3**	**64.7**	**1.4**	**29**	**52.2**	**23.2**	**1.10**	**63.3**	**0.32**
COMMENTS:		#3 had grass layers throughout core								

Site: **TSF** **Time:** 11:50

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	69	62	1	29	52	23	1.11	61	0.33
2	10	60	58	4	29	50	21	1.04	54	0.35
3	20	63	62	3	29	50	21	1.02	59	0.33
4	30	63	62	1	29	51	22	1.02	61	0.35
5	40	61	58	1	29	48	19	1.05	57	0.31
6	50	95	84	1	29	61	32	1.13	83	0.34
7	60	80	78	1	29	54	25	1.03	77	0.31
8	70	97	88	2	29	62	33	1.10	86	0.34
9	80	98	80	2	29	60	31	1.23	78	0.32
10	90	82	74	4	29	56	27	1.11	70	0.33
Average		**76.8**	**70.6**	**2.0**	**29**	**54.4**	**25.4**	**1.08**	**68.6**	**0.33**
COMMENTS:										

Total Average	**56.9**	**53.3**	**1.6**	**26.8**	**48.4**	**21.6**	**1.0**	**51.8**	**0.5**

Total Average (mm) 215.8

DATE: **13-Apr-23** **Samplers:** **AN/MJ**

Blue in-situ measurements

Black calculations

Site: **PAG** **Time:** 9:40

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	0	0	0	0	0	0	0.00	0	0.00
2	10	0	0	0	0	0	0	0.00	0	0.00
3	20	0	0	0	0	0	0	0.00	0	0.00
4	30	0	0	0	0	0	0	0.00	0	0.00
5	40	0	0	0	0	0	0	0.00	0	0.00
6	50	23	21	4	29	33	4	1.12	17	0.17
7	60	0	0	0	0	0	0	0.00	0	0.00
8	70	0	0	0	0	0	0	0.00	0	0.00
9	80	0	0	0	0	0	0	0.00	0	0.00
10	90	0	0	0	0	0	0	0.00	0	0.00
Average		**2.3**	**2.1**	**0.4**	**2.9**	**3.3**	**0.4**	**0.11**	**1.7**	**0.02**
COMMENTS:		Stations 1-5 & 7-10 are 100% snowfree								

Site: **WTH STN#1** **Time:** 10:25

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	12	11	1	29	33	4	1.10	10	0.33
2	10	27	24	1	29	39	10	1.13	23	0.37
3	20	52	49	4	29	48	19	1.07	45	0.37
4	30	46	46	3	29	46	17	1.00	43	0.37
5	40	46	45	3	29	46	17	1.02	42	0.37
6	50	41	38	2	29	45	16	1.08	36	0.39
7	60	42	40	4	29	45	16	1.06	36	0.38
8	70	21	20	1	29	36	7	1.05	19	0.33
9	80	29	28	1	29	41	12	1.04	27	0.41
10	90	42	40	2	29	45	16	1.05	38	0.38
Average		**35.8**	**34.1**	**2.2**	**29**	**42.4**	**13.4**	**1.06**	**31.9**	**0.37**
COMMENTS:										

Site: **JCP** **Time:** 11:25

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	30	25	3	29	36	7	1.23	22	0.23
2	10	43	35	1	29	42	13	1.24	34	0.30
3	20	46	32	1	29	42	13	1.45	31	0.28
4	30	55	40	1	29	46	17	1.38	39	0.31
5	40	54	43	1	29	46	17	1.26	42	0.31
6	50	53	30	1	29	40	11	1.79	29	0.21
7	60	63	60	1	29	54	25	1.05	59	0.40
8	70	64	53	1	29	48	19	1.21	52	0.30
9	80	42	36	3	29	42	13	1.18	33	0.31
10	90	53	48	4	29	46	17	1.11	44	0.32
Average		**50.3**	**40.2**	**1.7**	**29**	**44.2**	**15.2**	**1.29**	**38.5**	**0.30**
COMMENTS:		Multiple Attempts at #2, 3, 6. #3 had grass layers throughout core								

Site: **TSF** **Time:** 12:30

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	41	33	5	29	40	11	1.29	28	0.27
2	10	29	27	1	29	36	7	1.08	26	0.24
3	20	33	28	1	29	36	7	1.19	27	0.21
4	30	35	34	5	29	41	12	1.03	29	0.34
5	40	37	33	5	29	36	7	1.14	28	0.19
6	50	61	54	4	29	50	21	1.14	50	0.34
7	60	60	53	1	29	51	22	1.13	52	0.37
8	70	77	63	1	29	54	25	1.23	62	0.32
9	80	66	63	5	29	50	21	1.05	58	0.32
10	90	52	45	7	29	42	13	1.18	38	0.25
Average		**49.1**	**43.3**	**3.5**	**36.3**	**43.6**	**14.6**	**1.15**	**39.8**	**0.29**
COMMENTS:		#6 Multiple Attempts								

Total Average	**34.4**	**29.9**	**2.0**	**22.5**	**33.4**	**10.9**	**0.9**	**28.0**	**0.2**

Total Average (mm) 109

SNOW PACK DATA SHEET

DATE: **Dec 4 2023** **Samplers** **AN/DS**

Blue in-situ measurements

Black calculations

Site: TSF **Time:** 11:29

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	18	11	1	29	31	2	1.70	10	0.11
2	10	9	9	1	29	31	2	1.00	8	0.22
3	20	18	18	1	29	31	2	1.00	17	0.11
4	30	15	14	1	29	31	2	1.08	13	0.13
5	40	22	17	1	29	32	3	1.31	16	0.14
6	50	17	16	1	29	30	1	1.07	15	0.06
7	60	12	10	1	29	31	2	1.22	9	0.17
8	70	20	19	1	29	32	3	1.06	18	0.15
9	80	18	17	1	29	31	2	1.06	16	0.11
10	90	15	14	1	29	31	2	1.08	13	0.13
Average		**16.4**	**14.5**	**1.0**	**29**	**31.1**	**2.1**	**1.16**	**13.5**	**0.13**
COMMENTS:										

Site: **JCP** **Time:** 12:21

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	18	14	1	29	30	1	1.31	13	0.06
2	10	20	10	1	29	30	1	2.11	9	0.05
3	20	18	13	1	29	31	2	1.42	12	0.11
4	30	17	14	2	29	30	1	1.25	12	0.06
5	40	19	18	1	29	31	2	1.06	17	0.11
6	50	20	13	1	29	30	1	1.58	12	0.05
7	60	15	12	1	29	30	1	1.27	11	0.07
8	70	20	15	1	29	30	1	1.36	14	0.05
9	80	21	17	2	29	31	2	1.27	15	0.10
10	90	16	11	1	29	30	1	1.50	10	0.06
Average		**18.4**	**13.7**	**1.2**	**29**	**30.3**	**1.3**	**1.41**	**12.5**	**0.07**
COMMENTS:		**Voids in core from tall grass throughout whole course**								

Site: **WTH STN #1** **Time:** 14:04

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	21	19	1	29	31	2	1.11	18	0.10
2	10	20	19	1	29	31	0	1.06	18	0.00
3	20	20	20	1	29	31	2	1.00	19	0.10
4	30	19	14	2	29	31	2	1.42	12	0.11
5	40	20	19	2	29	32	3	1.06	17	0.15
6	50	21	20	2	29	32	3	1.06	18	0.14
7	60	22	22	3	29	32	3	1.00	19	0.14
8	70	21	18	2	29	32	3	1.19	16	0.14
9	80	21	18	1	29	31	2	1.18	17	0.10
10	90	21	15	1	29	30	0	1.43	14	0.00
Average		**20.6**	**18.4**	**1.6**	**29**	**31.3**	**2**	**1.15**	**16.8**	**0.10**
COMMENTS:										

Site: **PAG** **Time:** 14:42

Sample #	Dist.	HS (cm)	Core Length (cm)	Plug (cm)	TARE Weight	Weight Tube + Core	SWE (cm)	Core/HS Ratio	Core Length - Plug (cm)	Density
1	0	16	15	1	29	30	1	1.07	14	0.06
2	10	18	14	1	29	31	2	1.31	13	0.11
3	20	15	13	1	29	31	2	1.17	12	0.13
4	30	22	21	2	29	32	3	1.05	19	0.14
5	40	23	22	2	29	33	4	1.05	20	0.17
6	50	24	19	1	29	32	3	1.28	18	0.13
7	60	14	13	1	29	30	1	1.08	12	0.07
8	70	10	8	1	29	30	1	1.29	7	0.10
9	80	10	7	1	29	30	1	1.50	6	0.10
10	90	16	10	1	29	30	1	1.67	9	0.06
Average		**16.8**	**14.2**	**1.2**	**29**	**30.9**	**1.9**	**1.25**	**13**	**0.11**
COMMENTS:										

Total Average	**18.1**	**15.2**	**1.3**	**29.0**	**30.9**	**1.8**	**1.2**	**14.0**	**0.1**

Total Average (mm) 18.3

Appendix F

Surface, Contact, and Drainage Water Quality

(Results in Electronic format only)



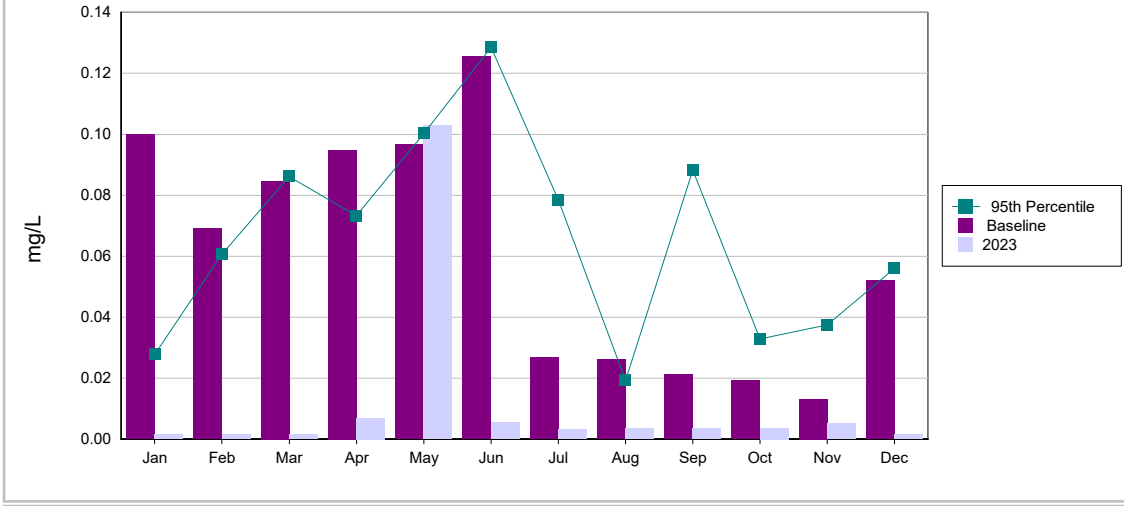
Water Quality Report

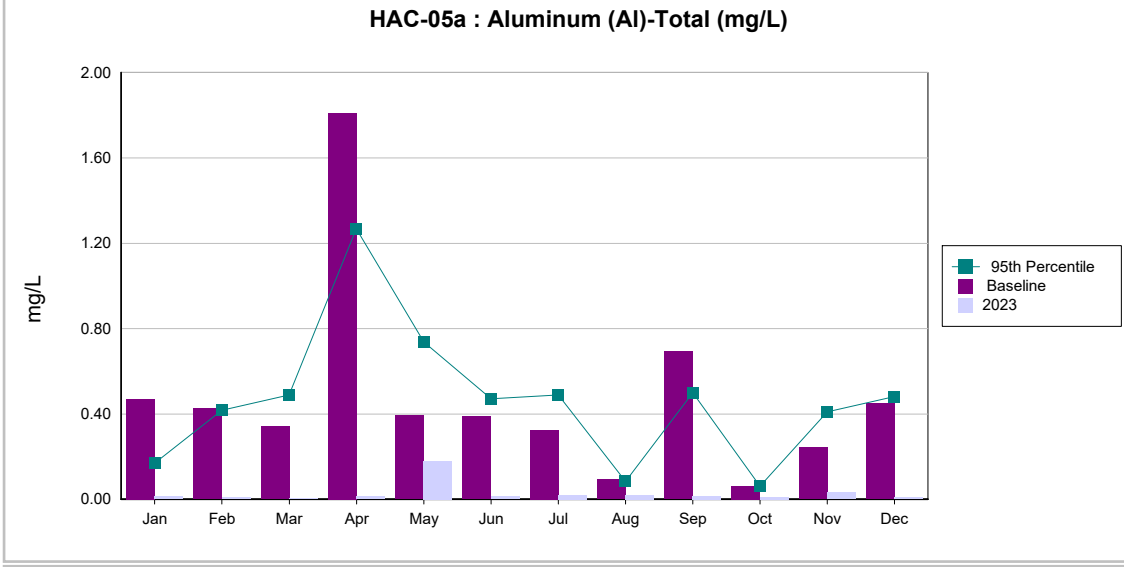
Annual Report HAC vs BCWQG

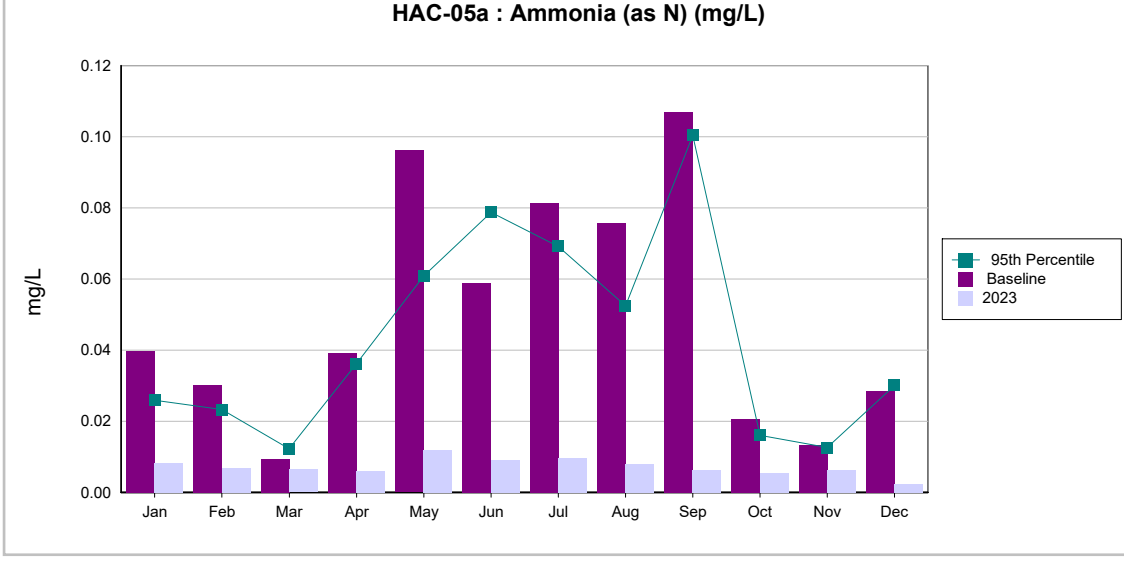
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







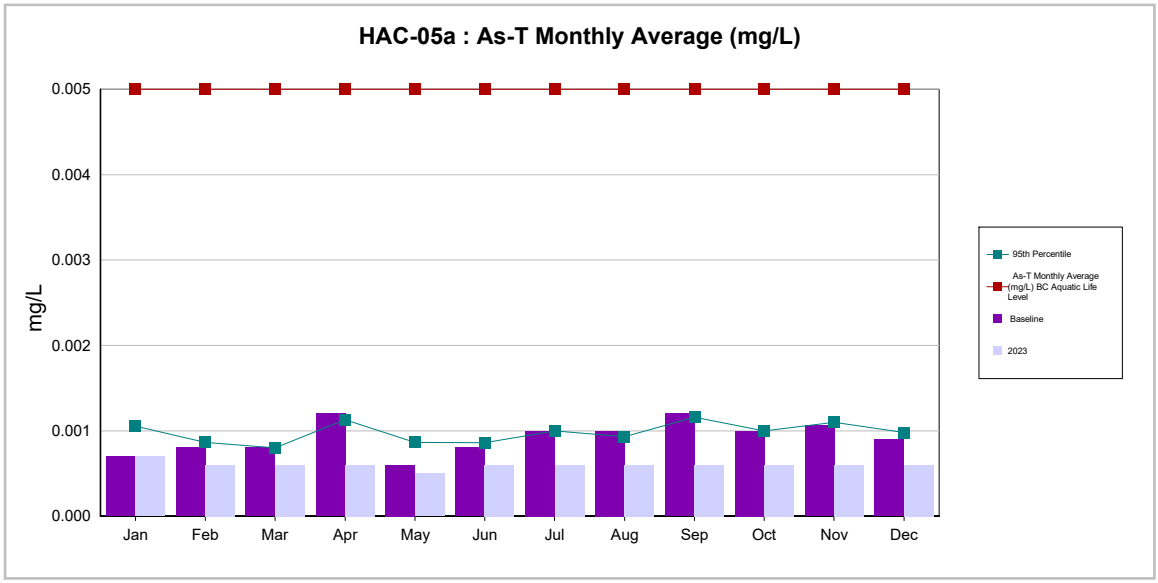
Water Quality Report

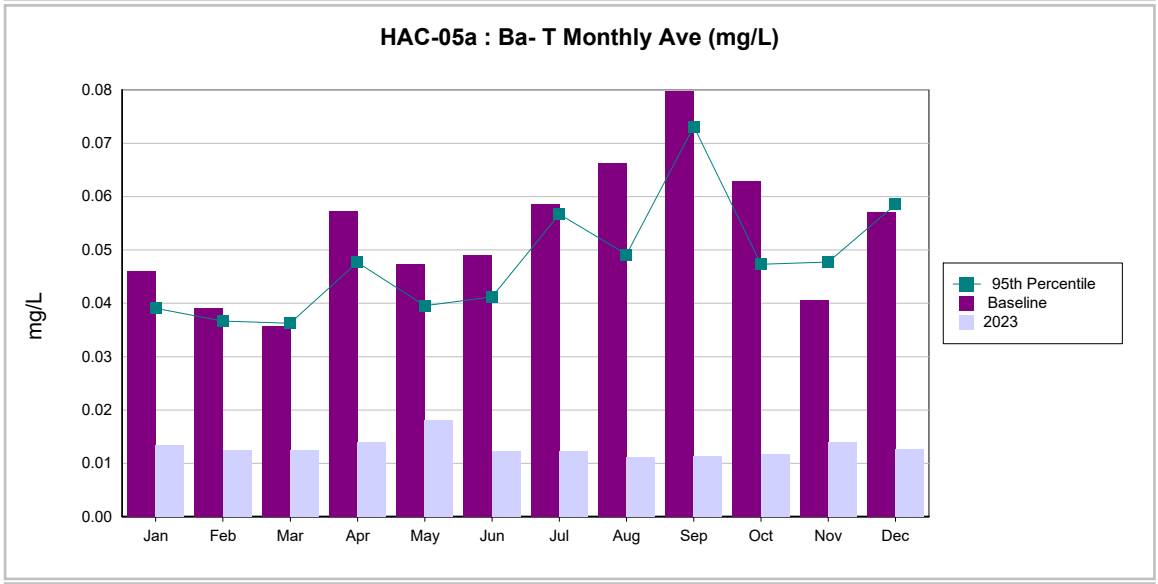
Annual Report HAC vs BCWQG

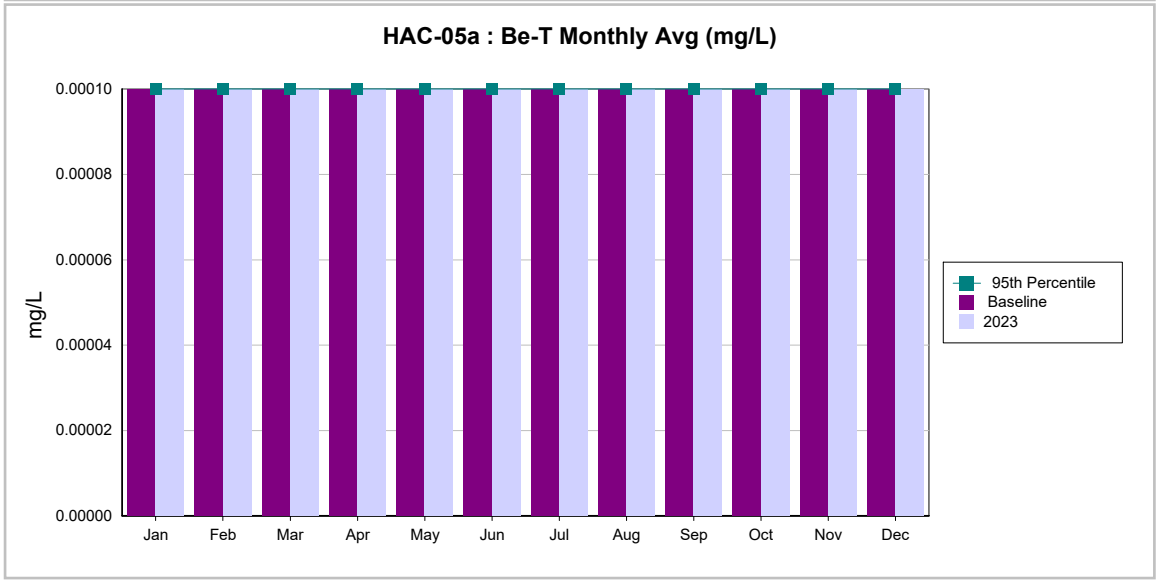
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







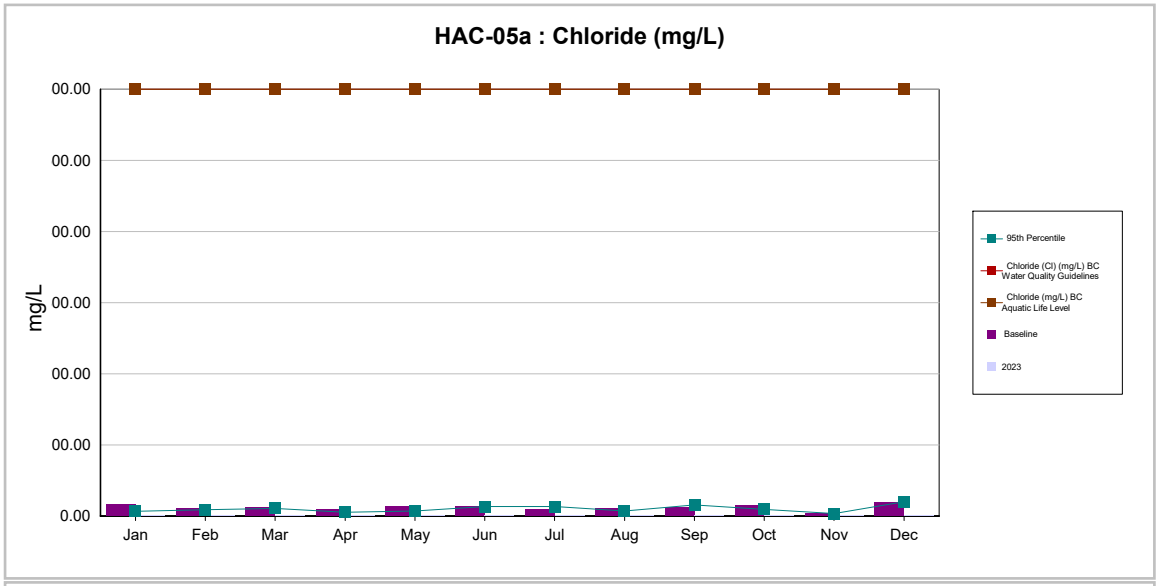
Water Quality Report

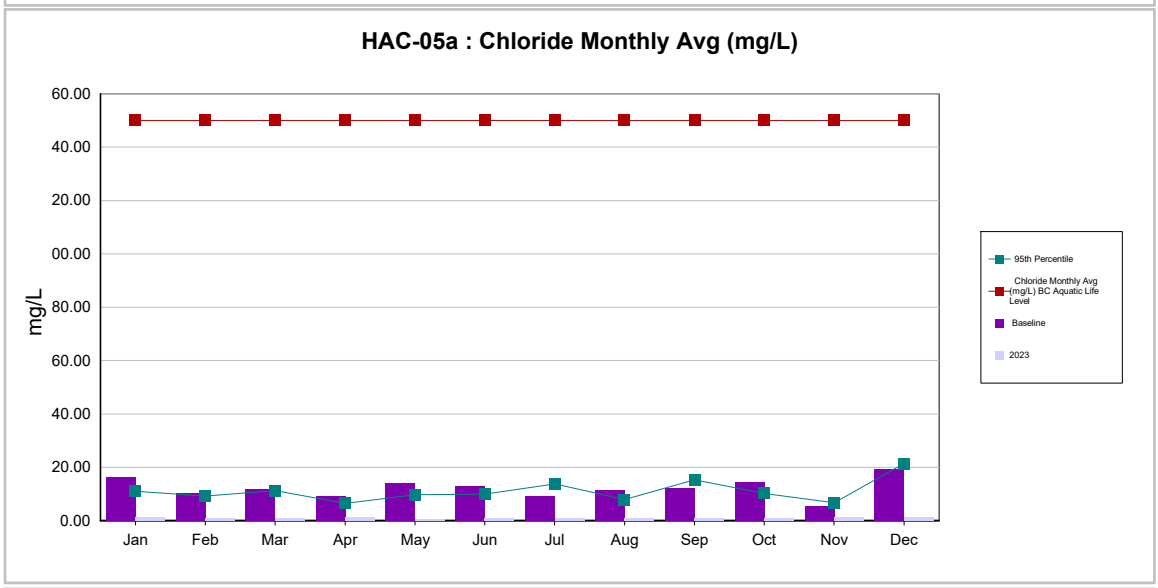
Annual Report HAC vs BCWQG

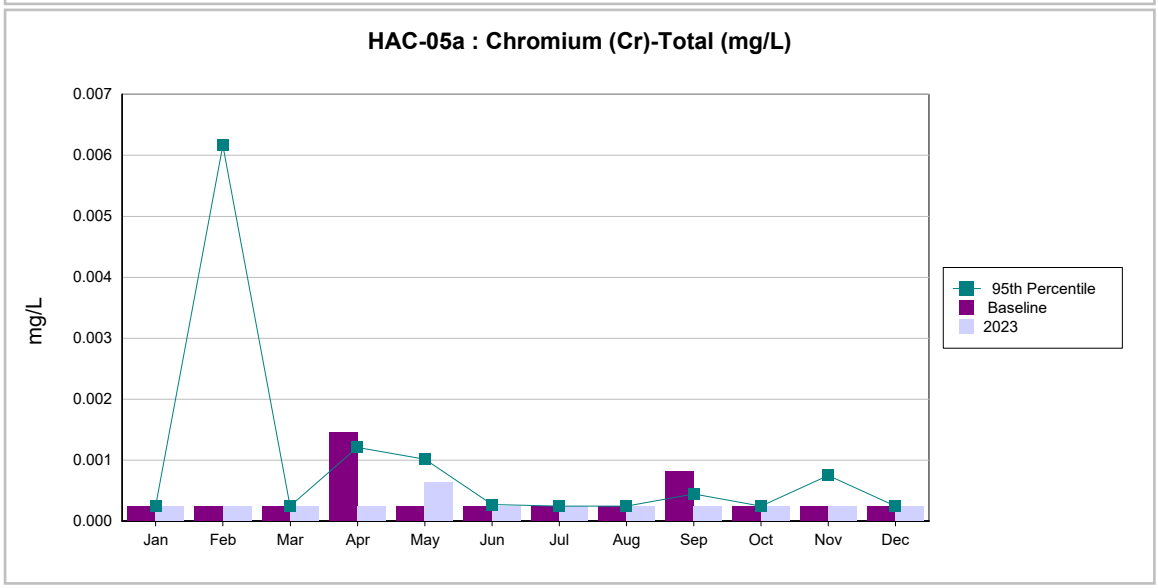
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







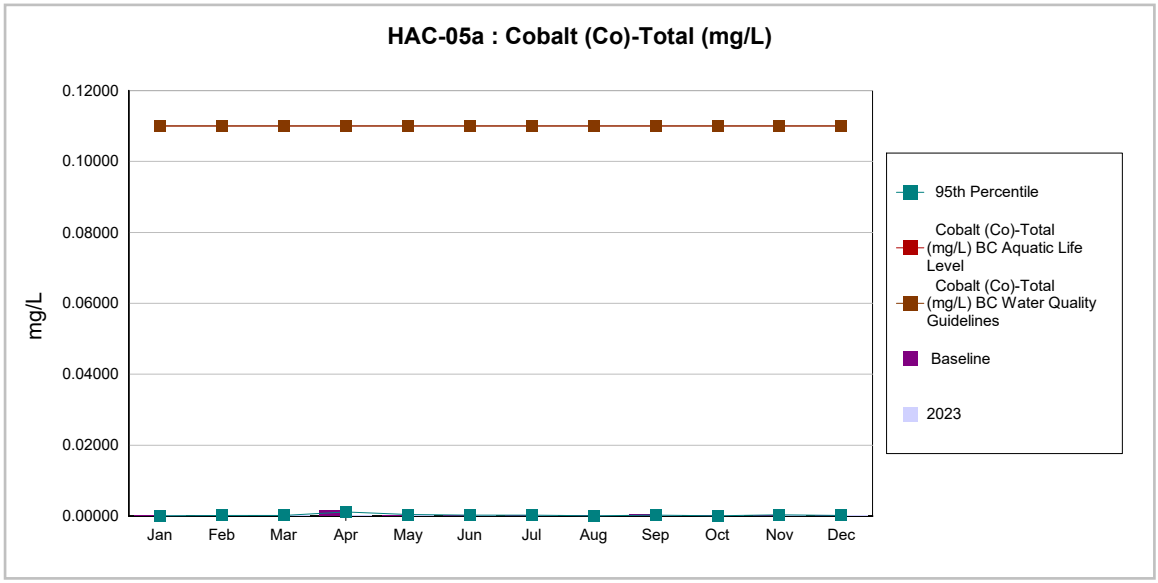
Water Quality Report

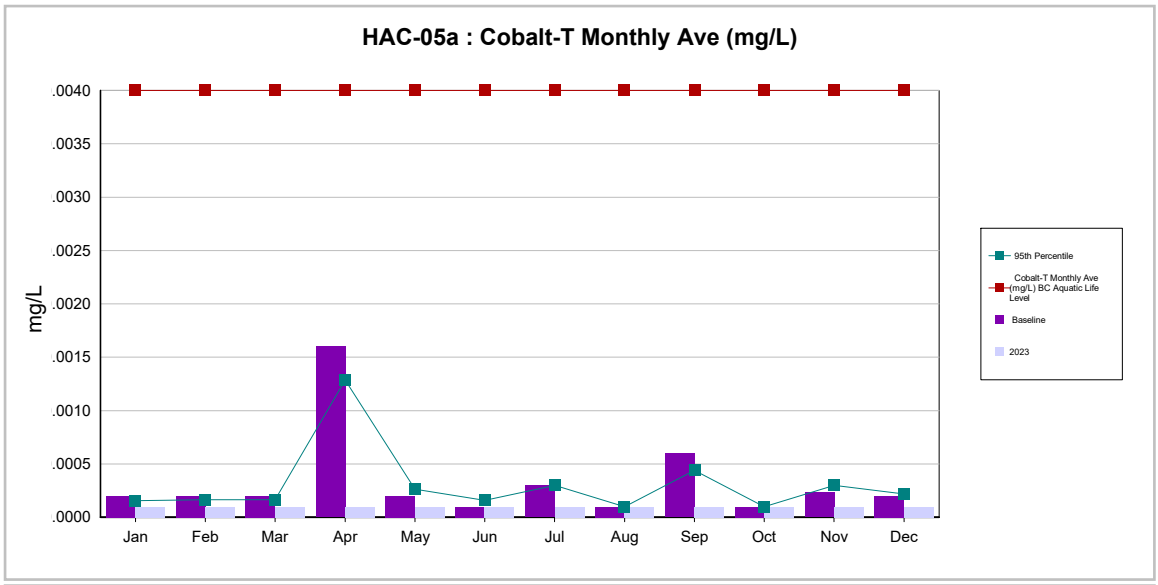
Annual Report HAC vs BCWQG

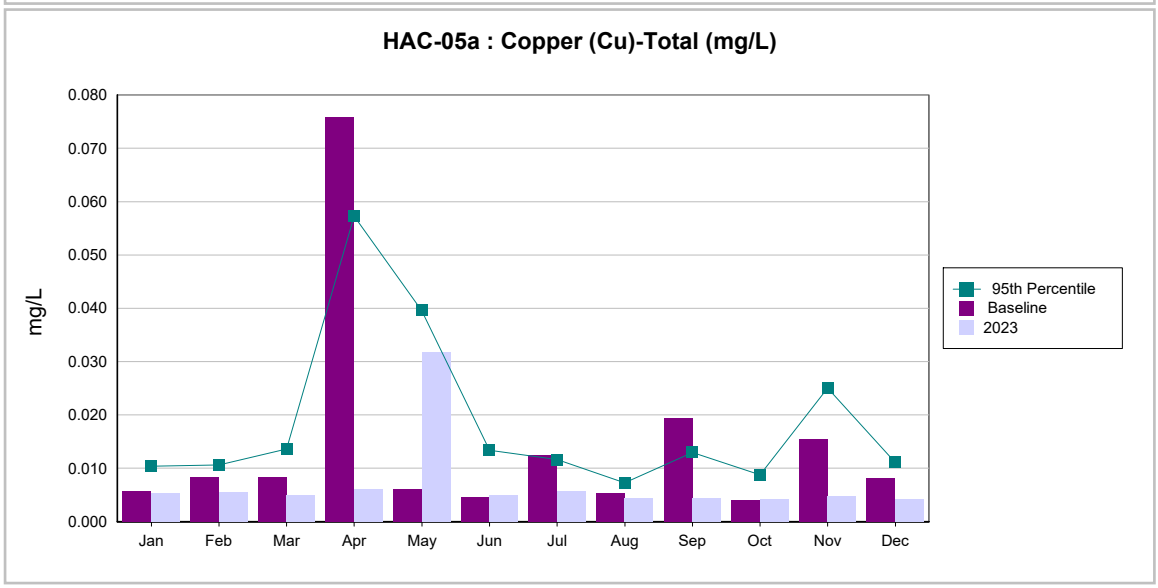
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







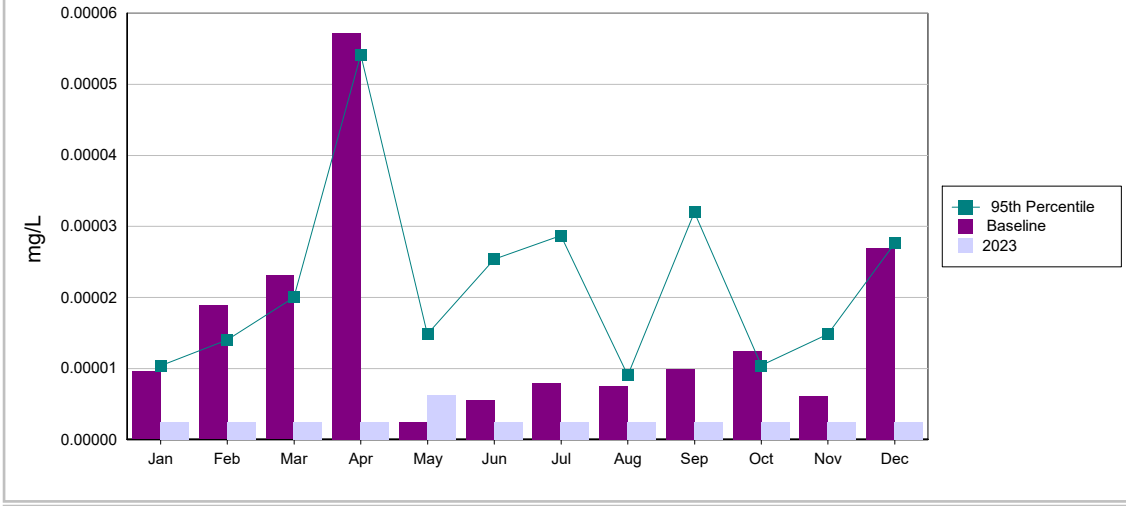
Water Quality Report

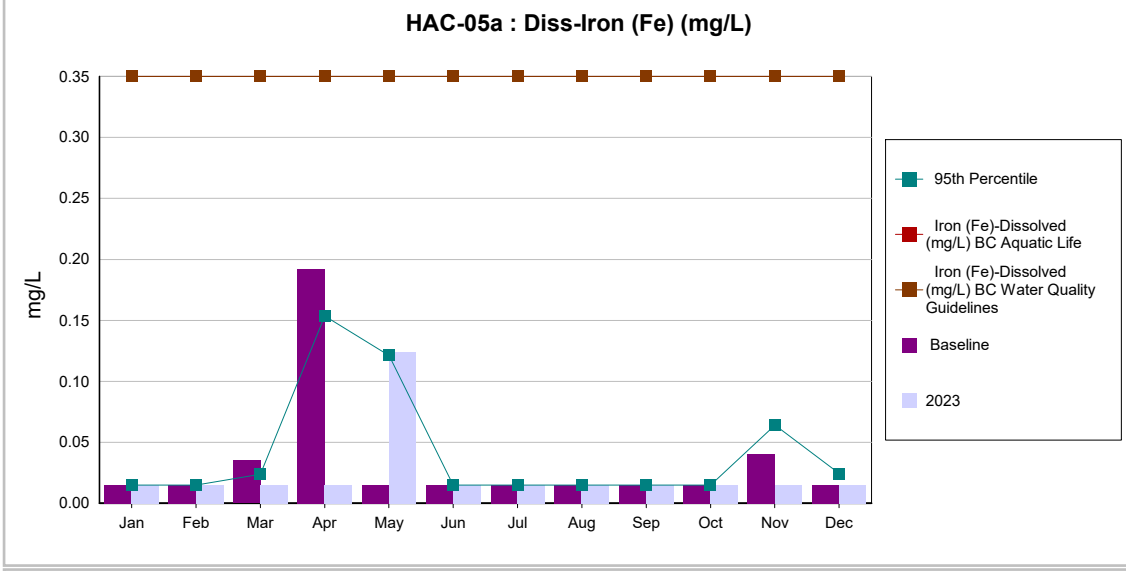
Annual Report HAC vs BCWQG

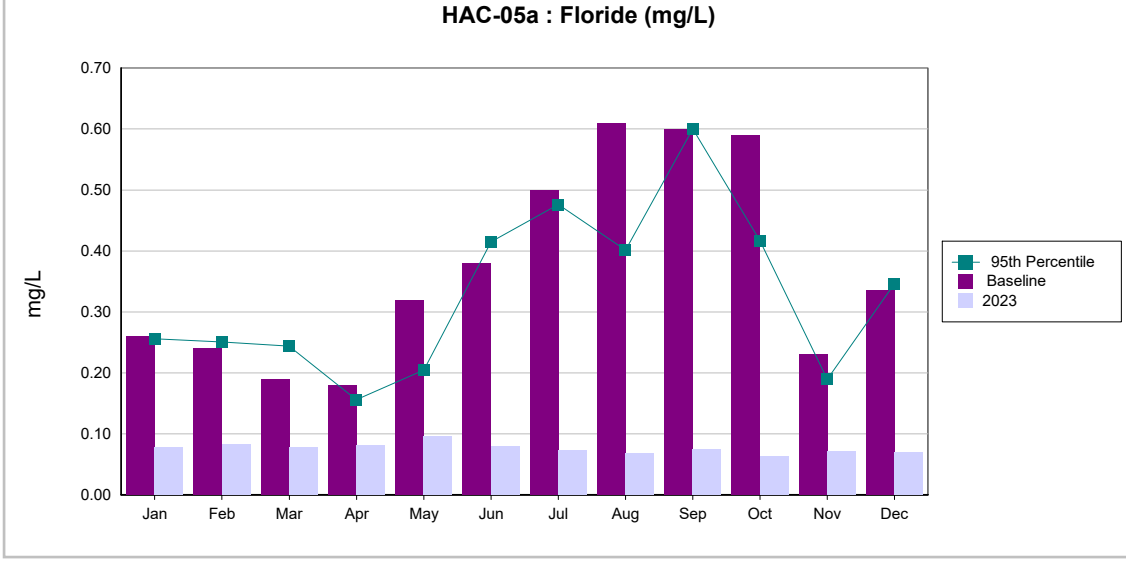
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







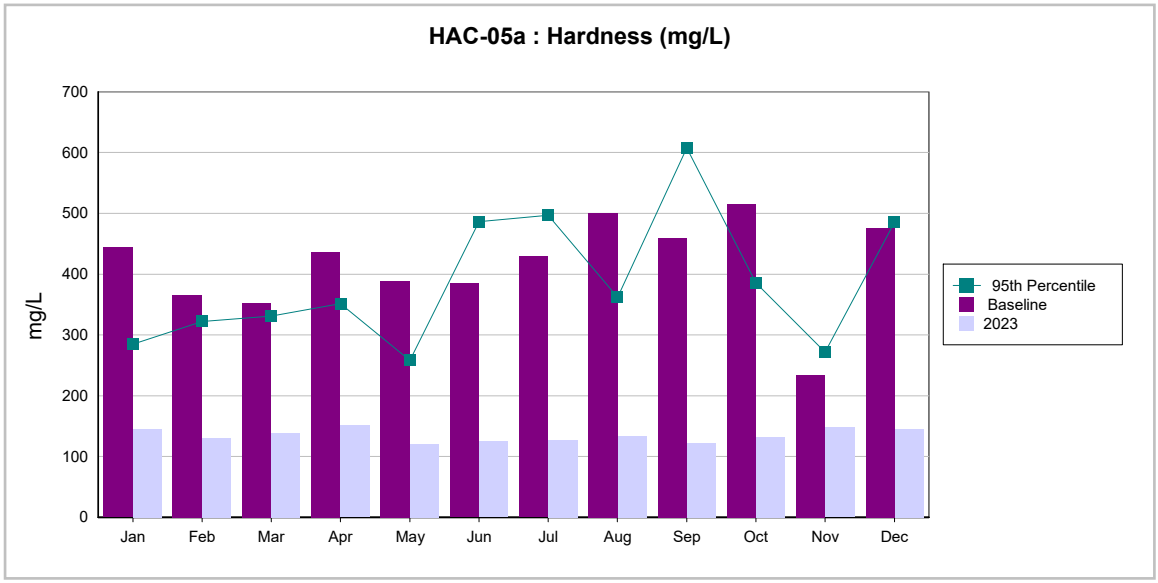
Water Quality Report

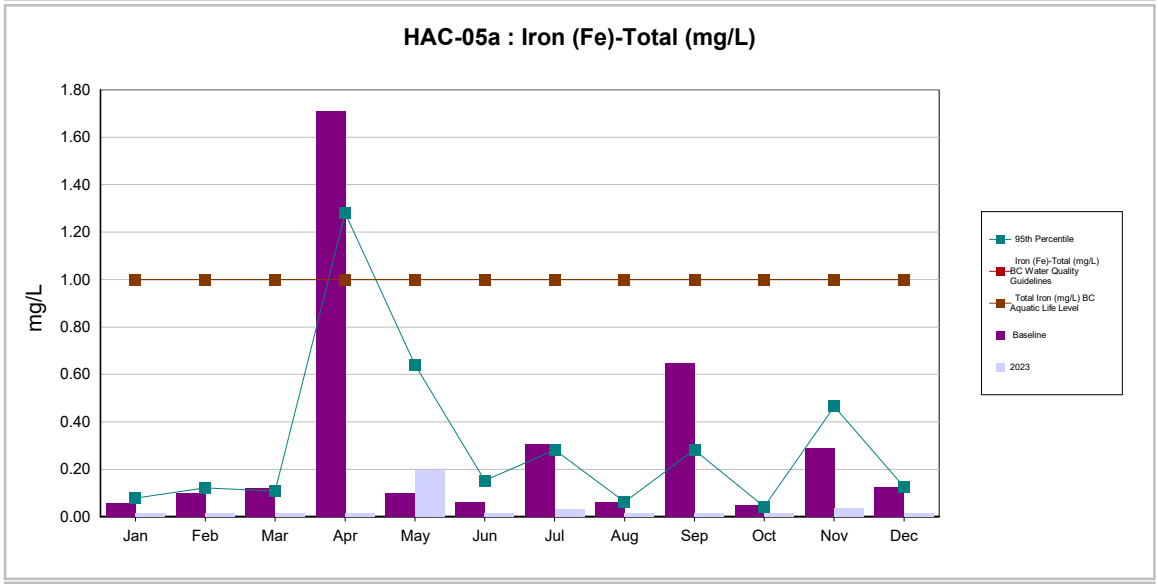
Annual Report HAC vs BCWQG

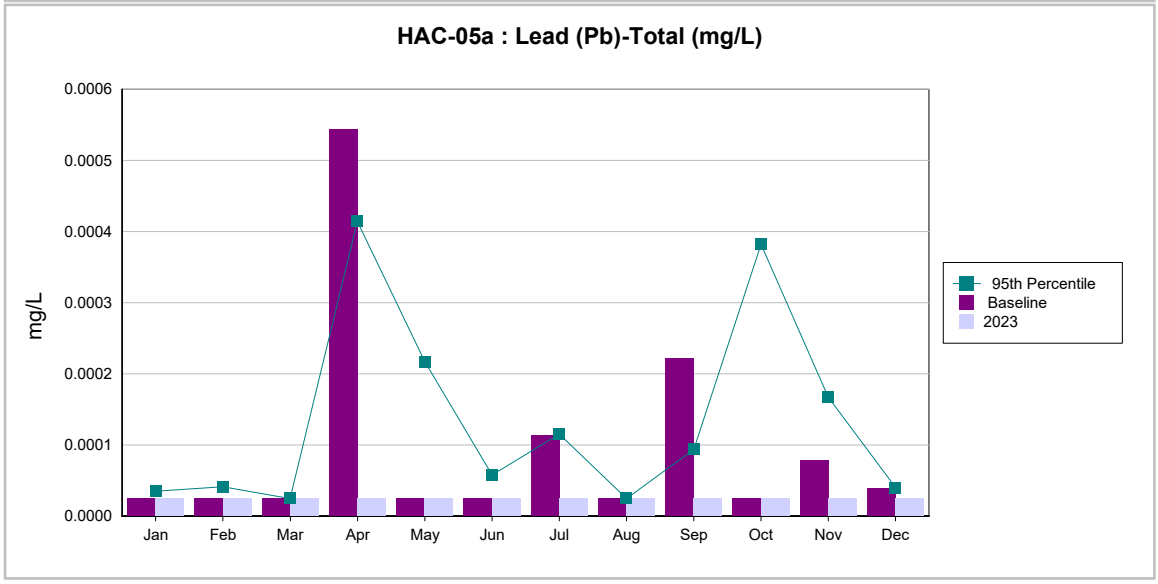
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







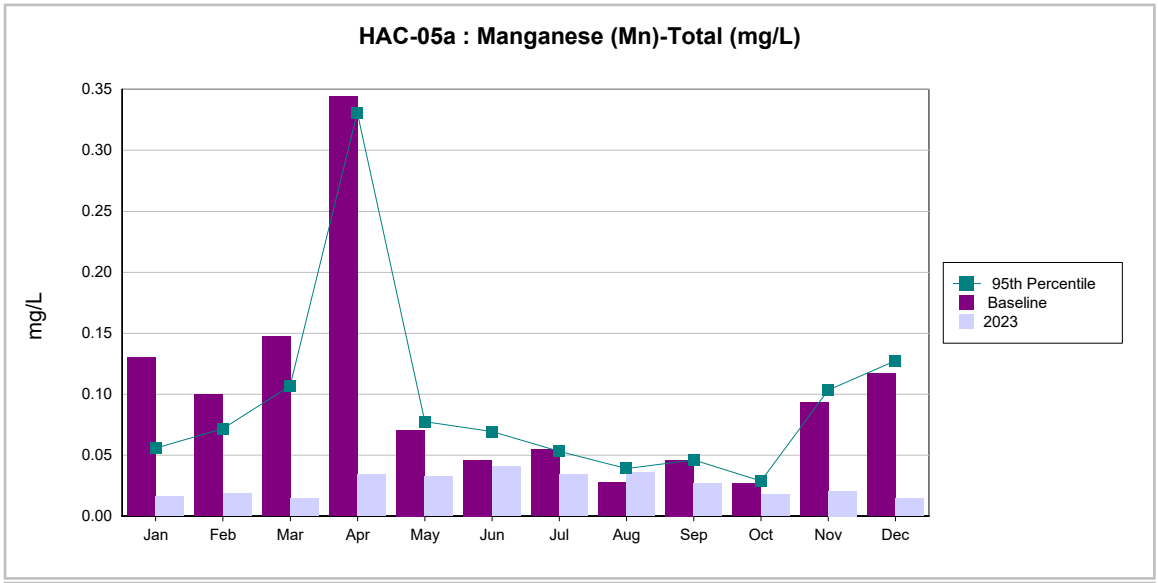
Water Quality Report

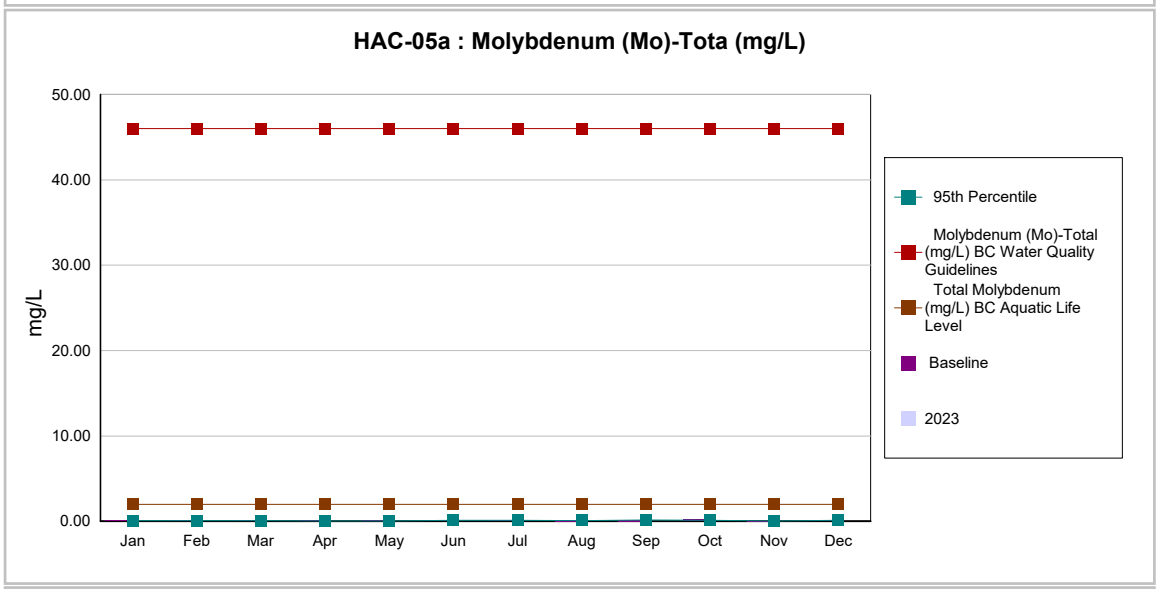
Annual Report HAC vs BCWQG

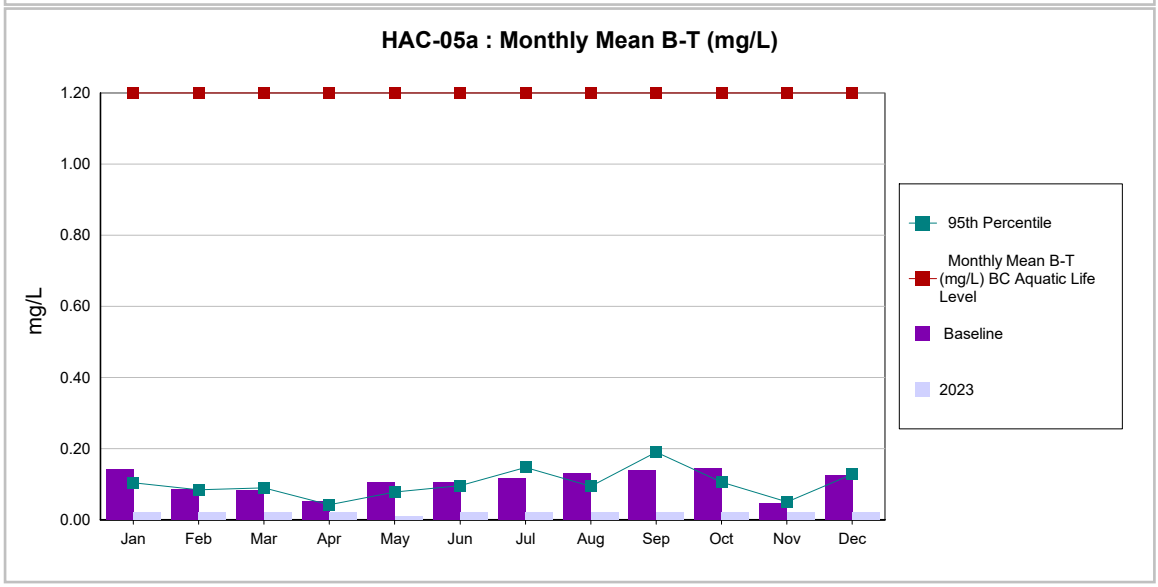
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







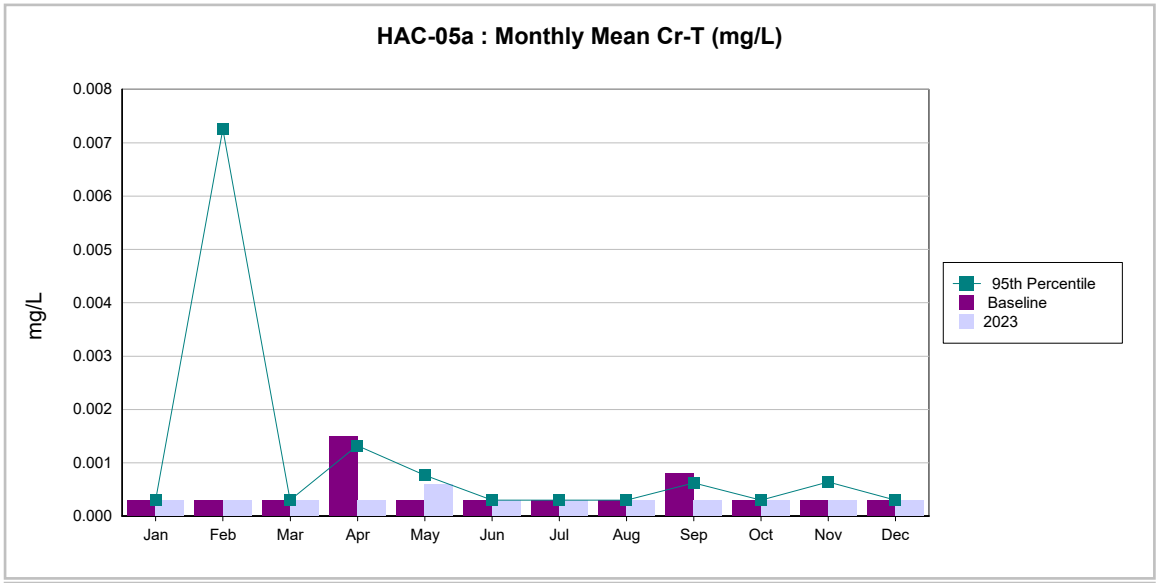
Water Quality Report

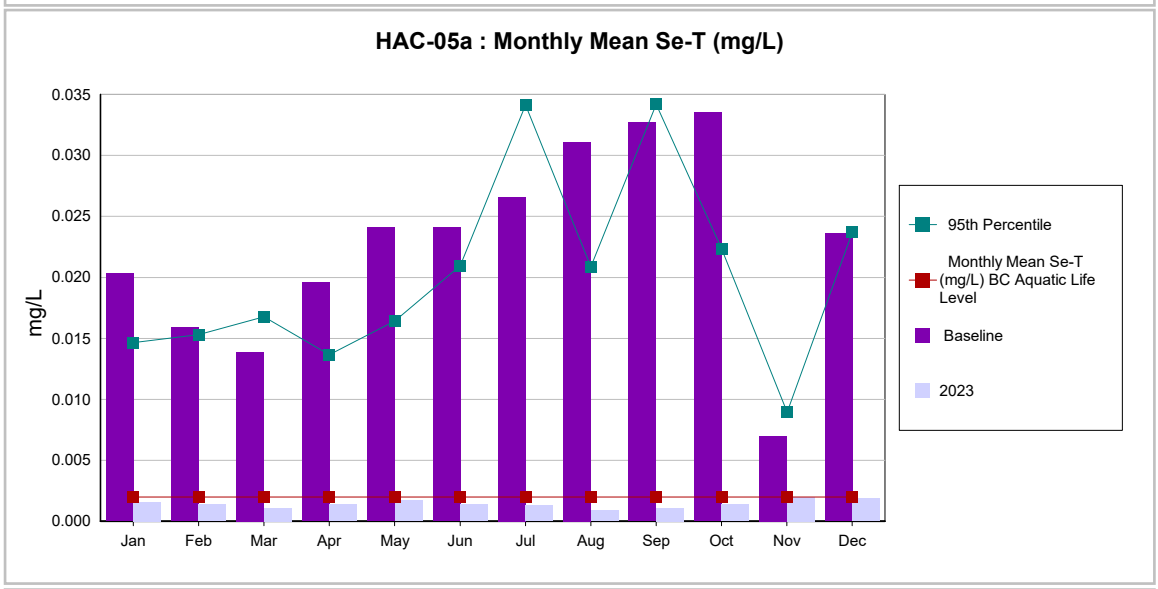
Annual Report HAC vs BCWQG

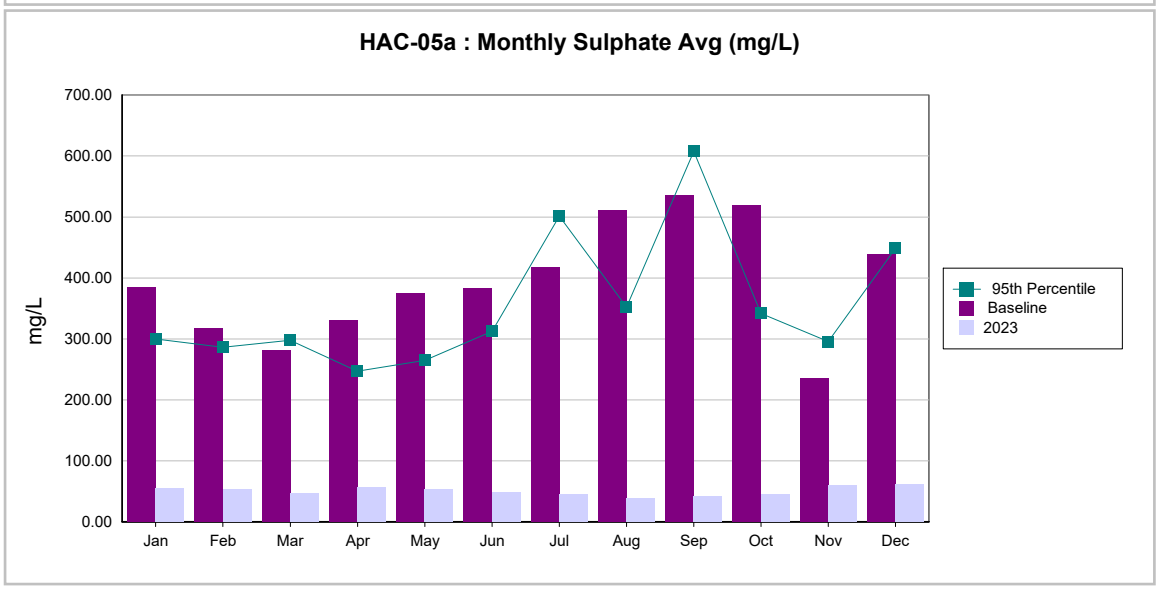
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







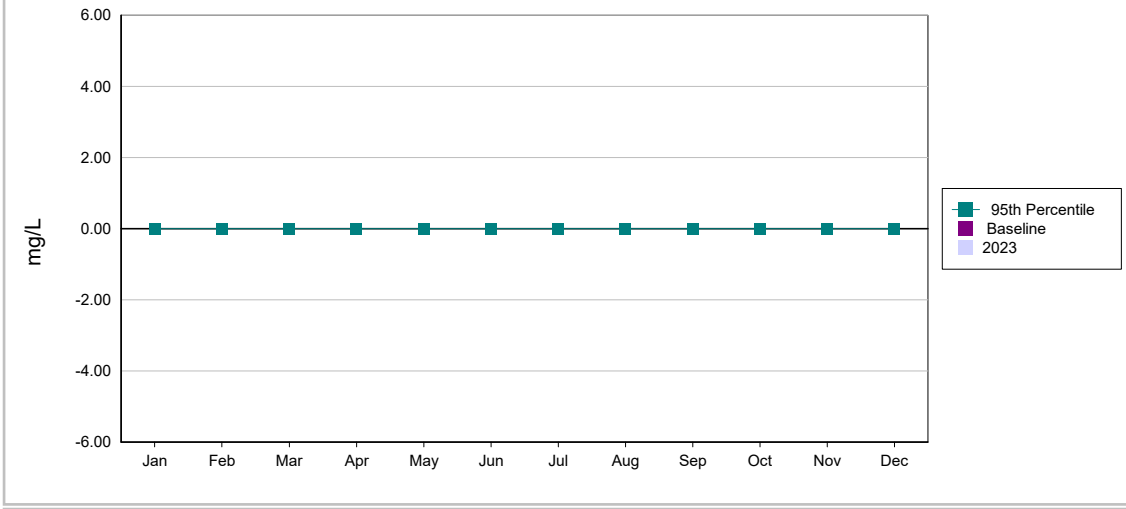
Water Quality Report

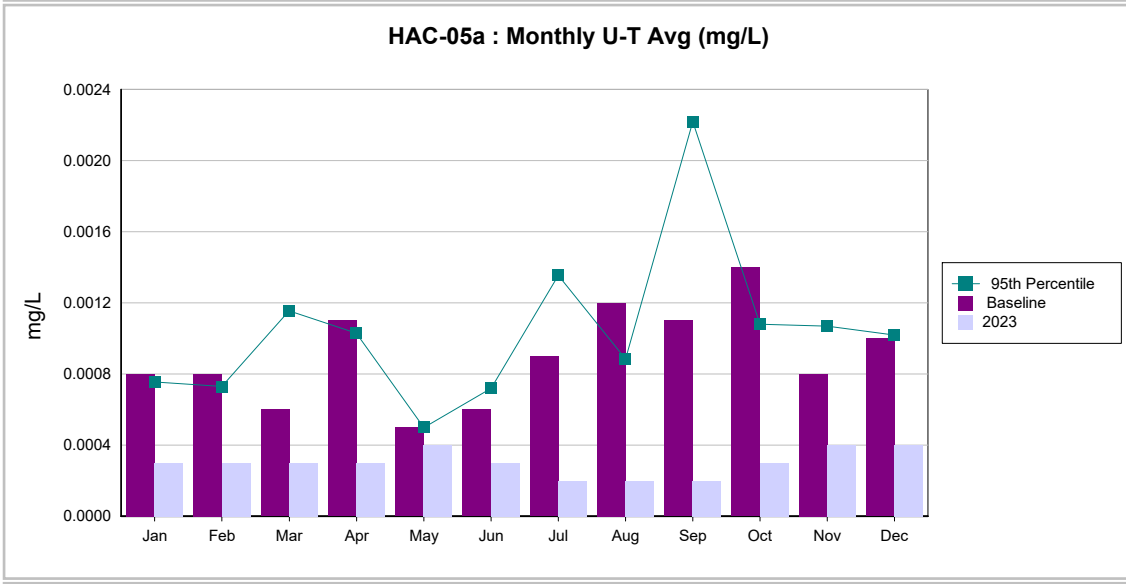
Annual Report HAC vs BCWQG

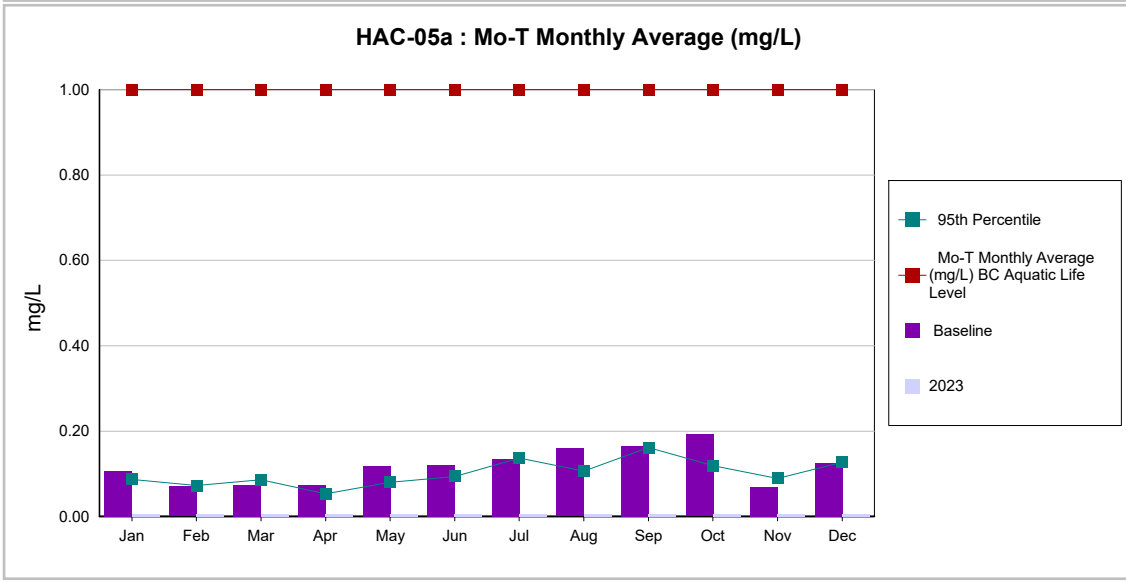
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







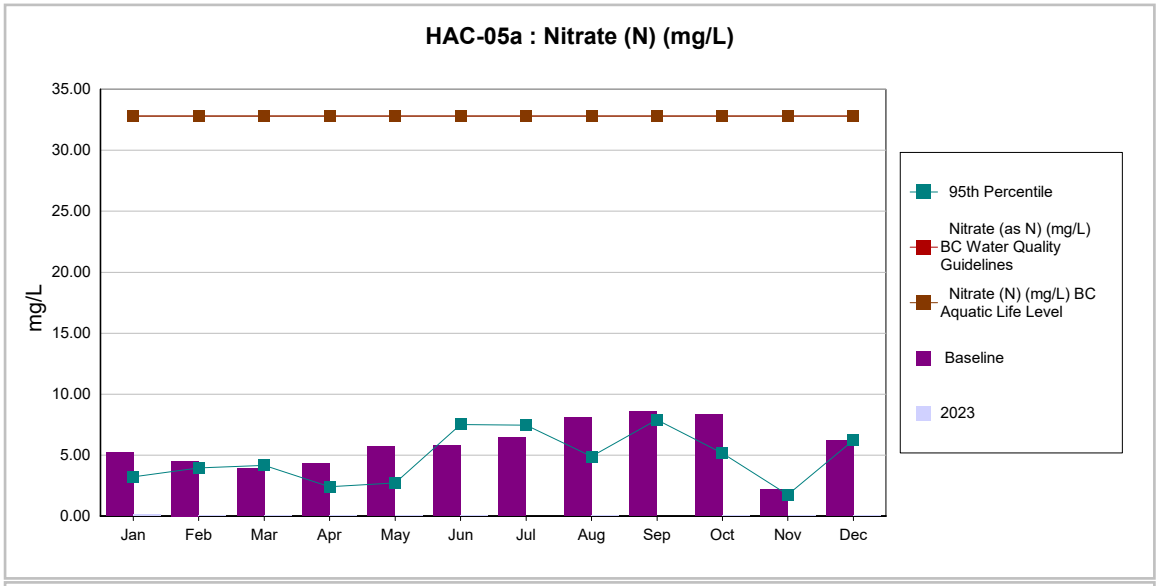
Water Quality Report

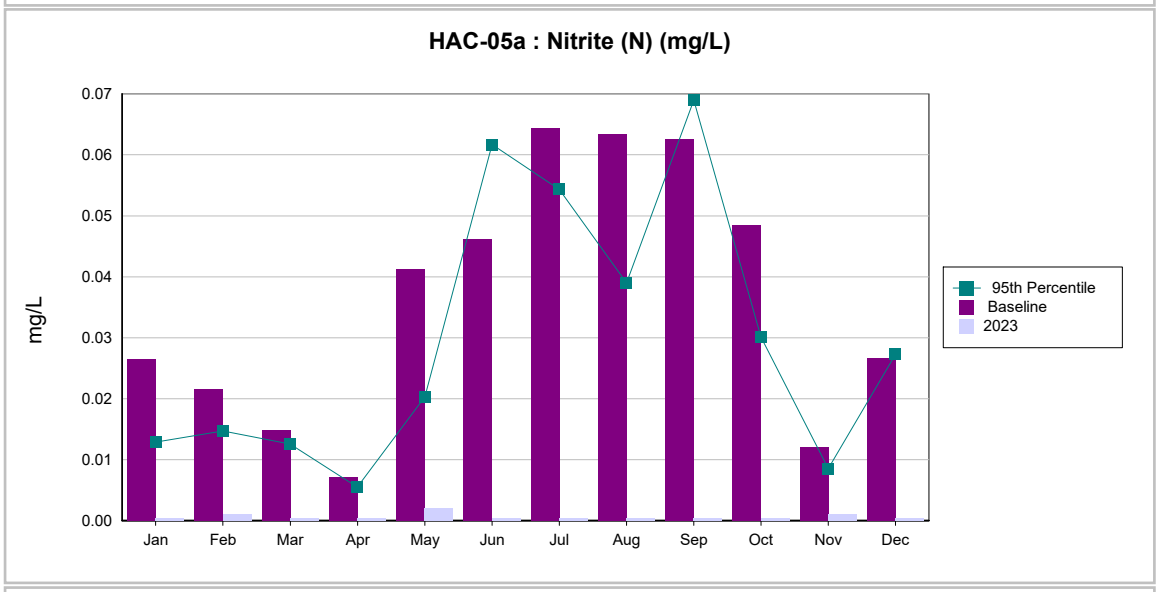
Annual Report HAC vs BCWQG

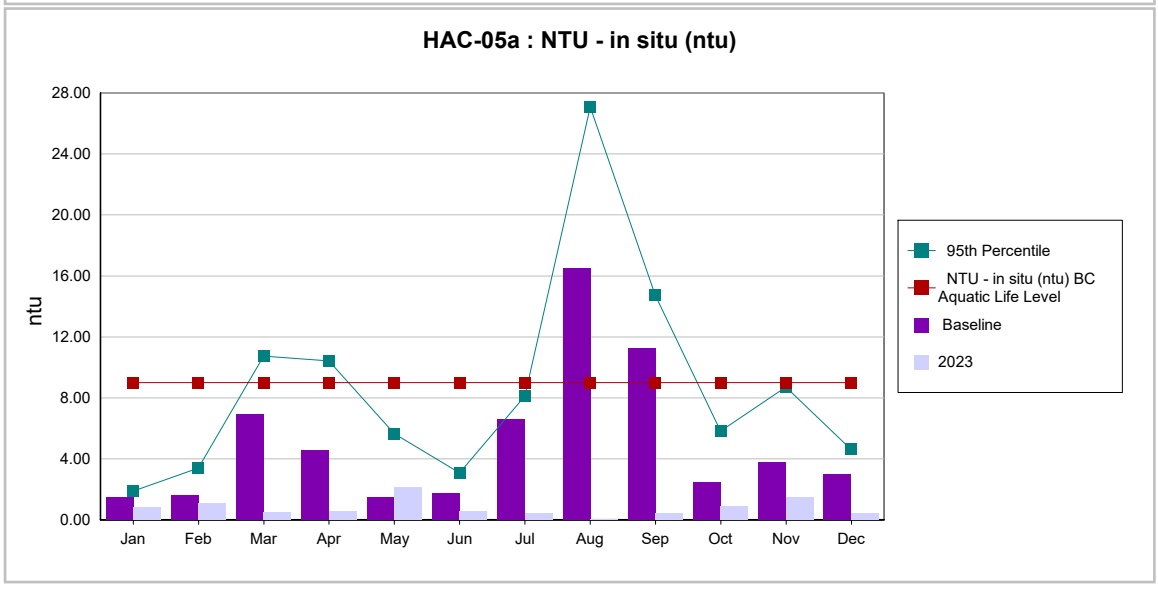
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







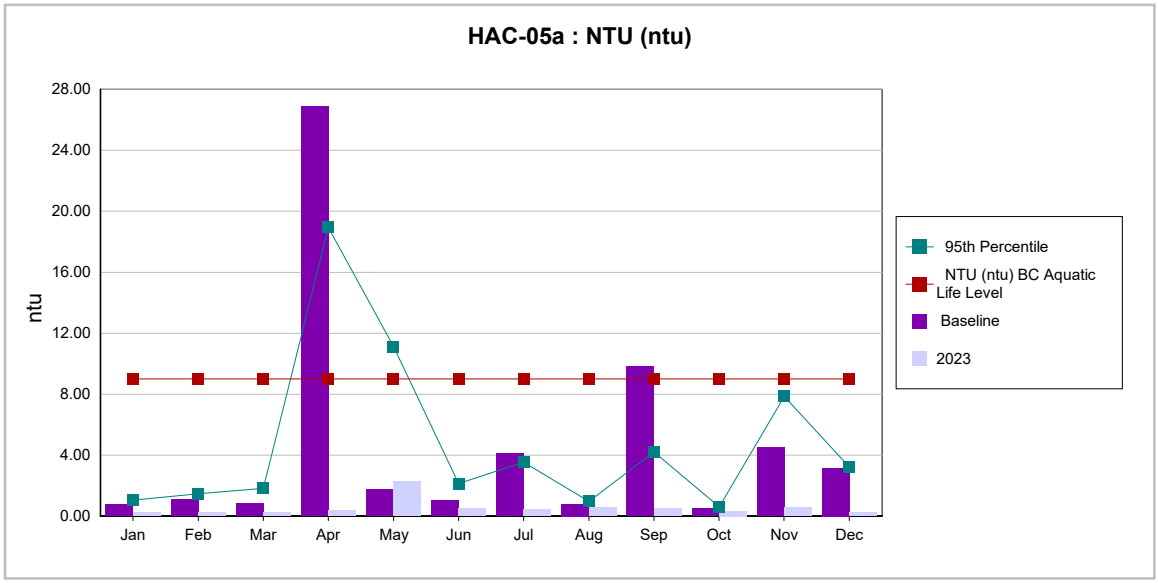
Water Quality Report

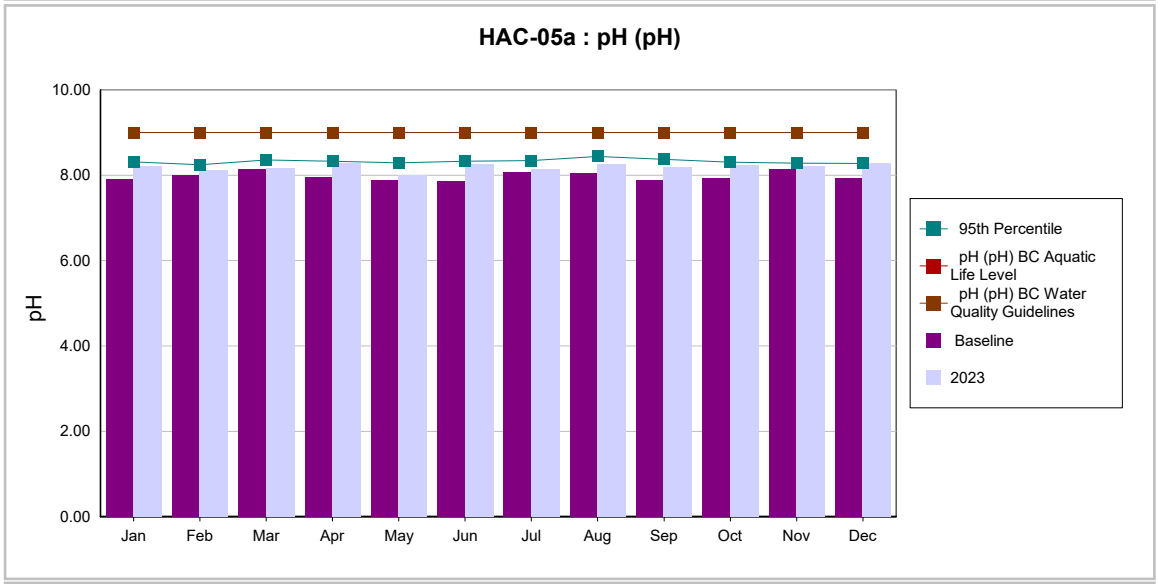
Annual Report HAC vs BCWQG

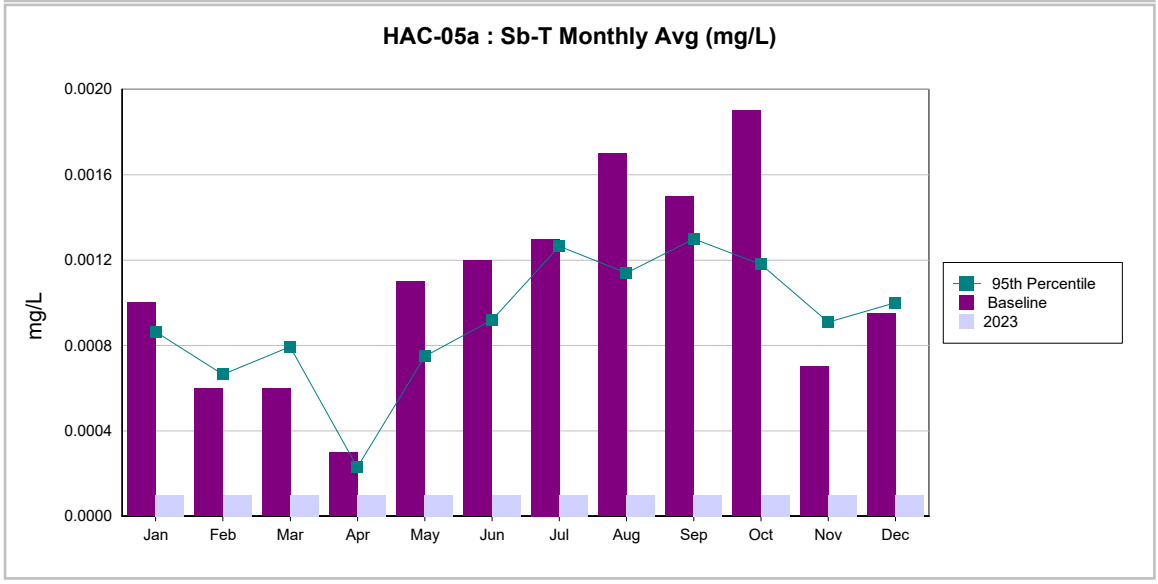
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







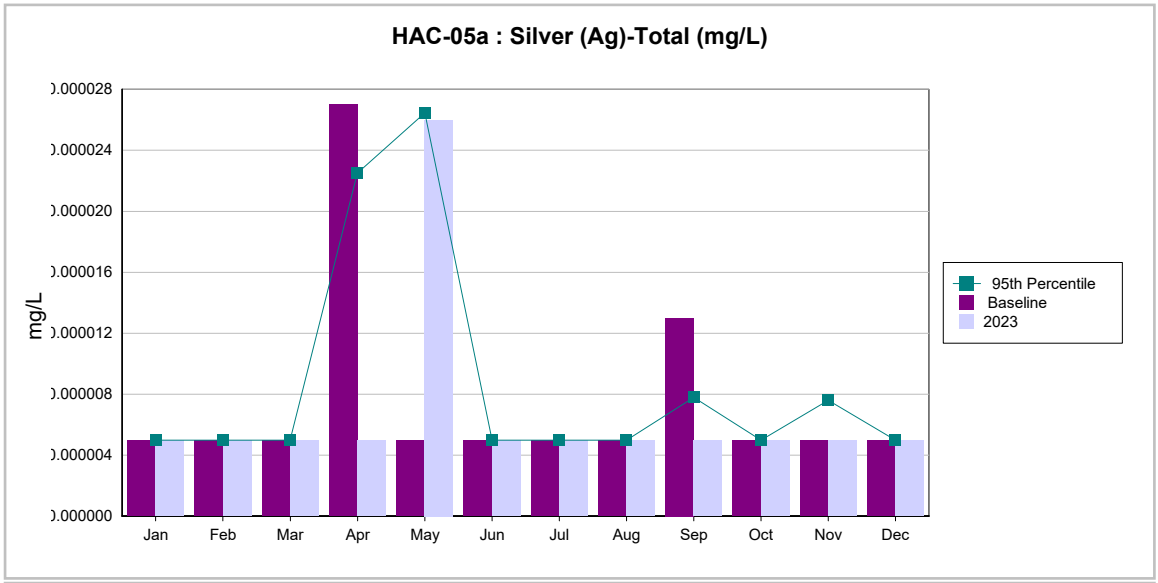
Water Quality Report

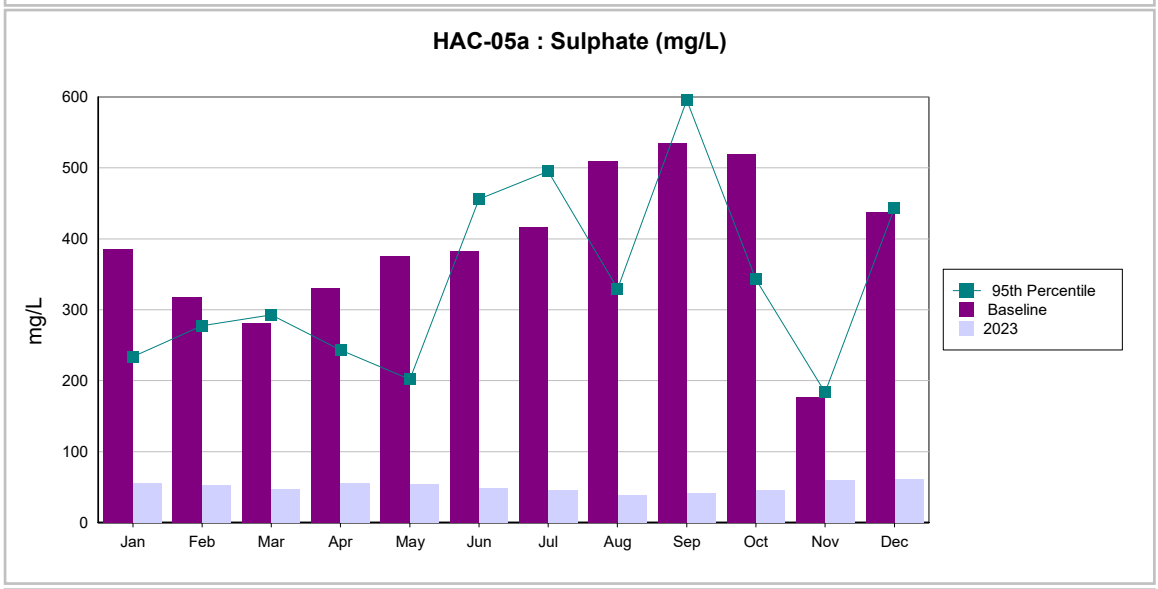
Annual Report HAC vs BCWQG

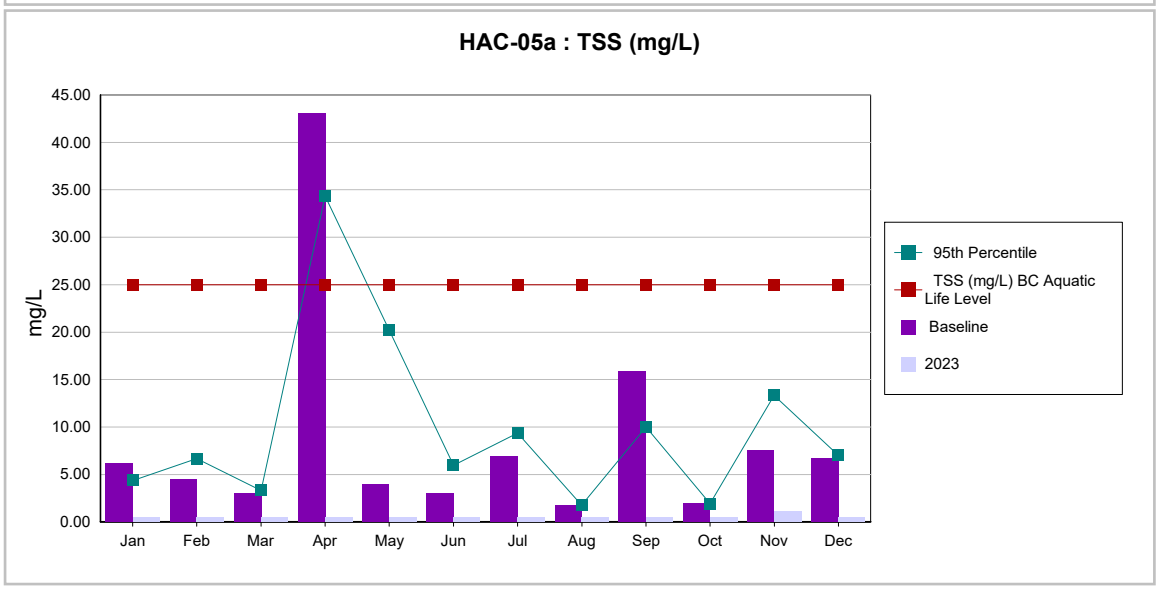
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

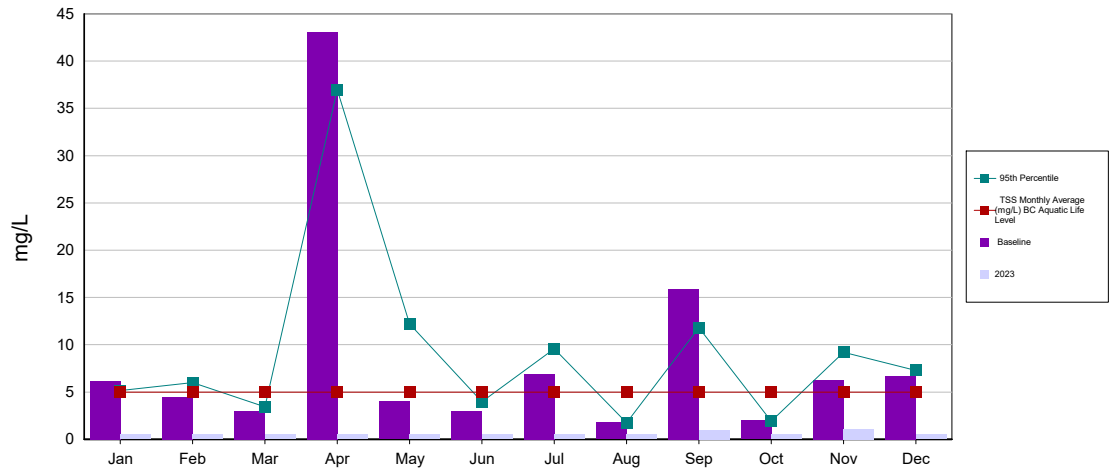
Annual Report HAC vs BCWQG

Mount Polley

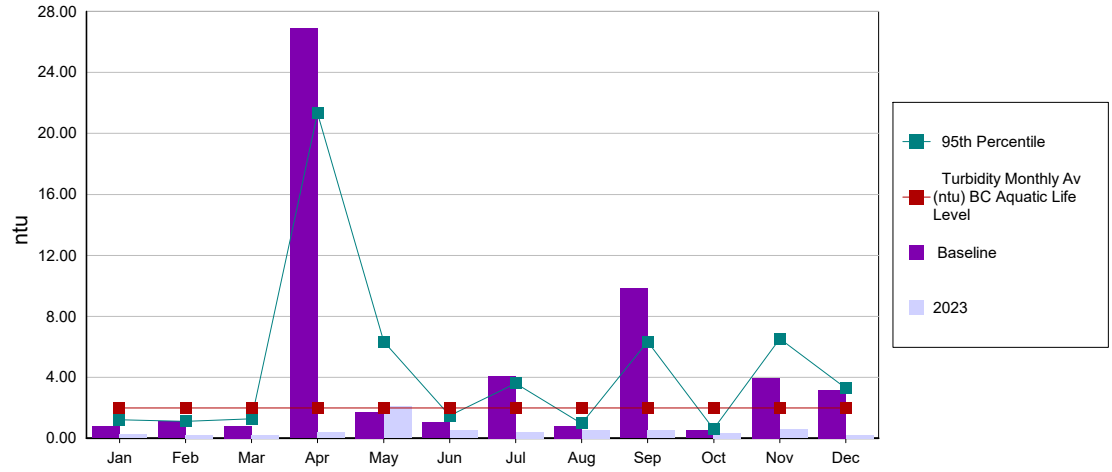
Mining Corporation

IMPERIAL METALS CORPORATION

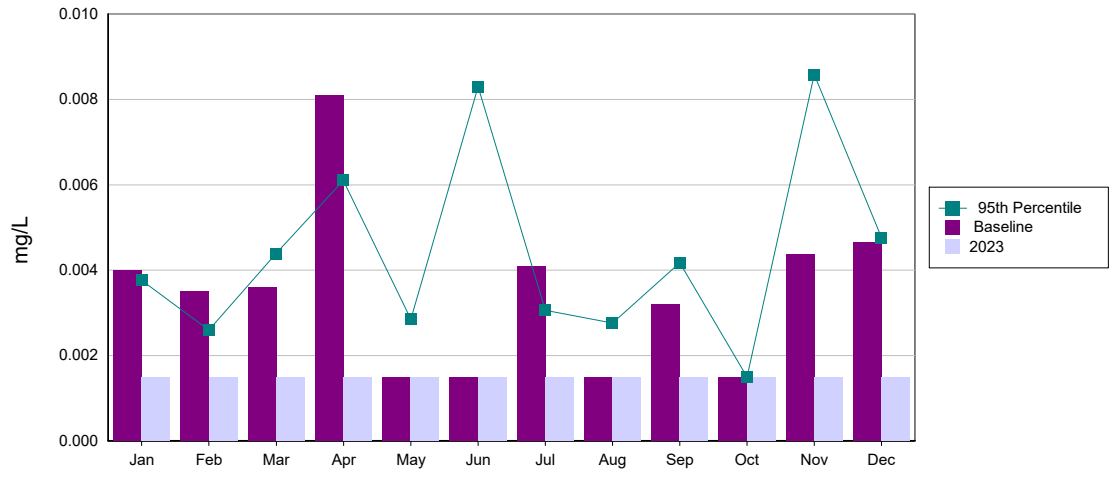
HAC-05a : TSS Monthly Average (mg/L)



HAC-05a : Turbidity Monthly Av (ntu)



HAC-05a : Zinc (Zn)-Total (mg/L)



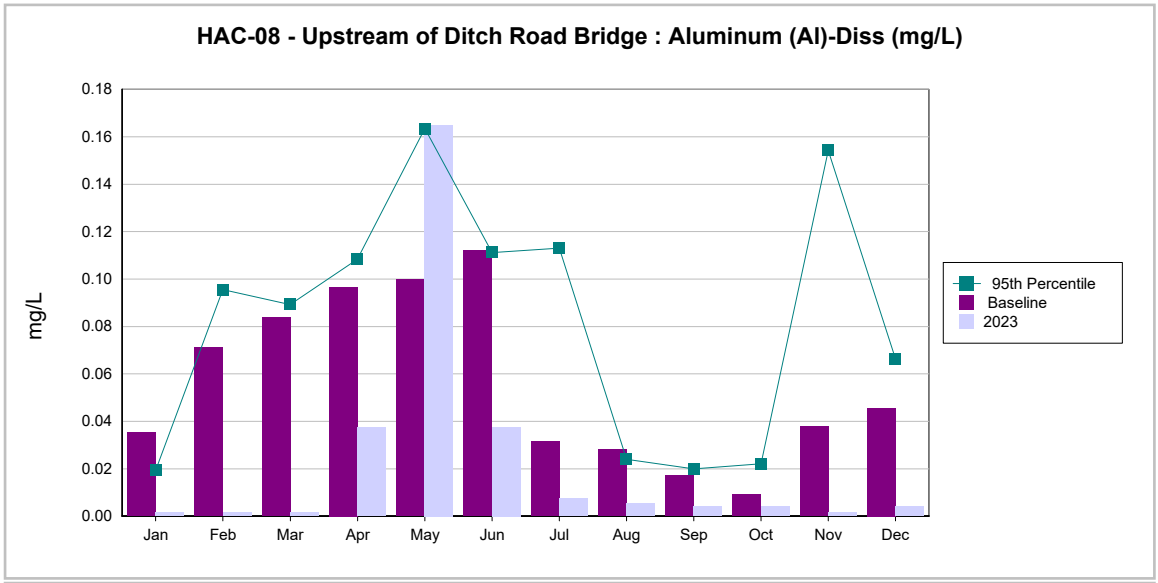
Water Quality Report

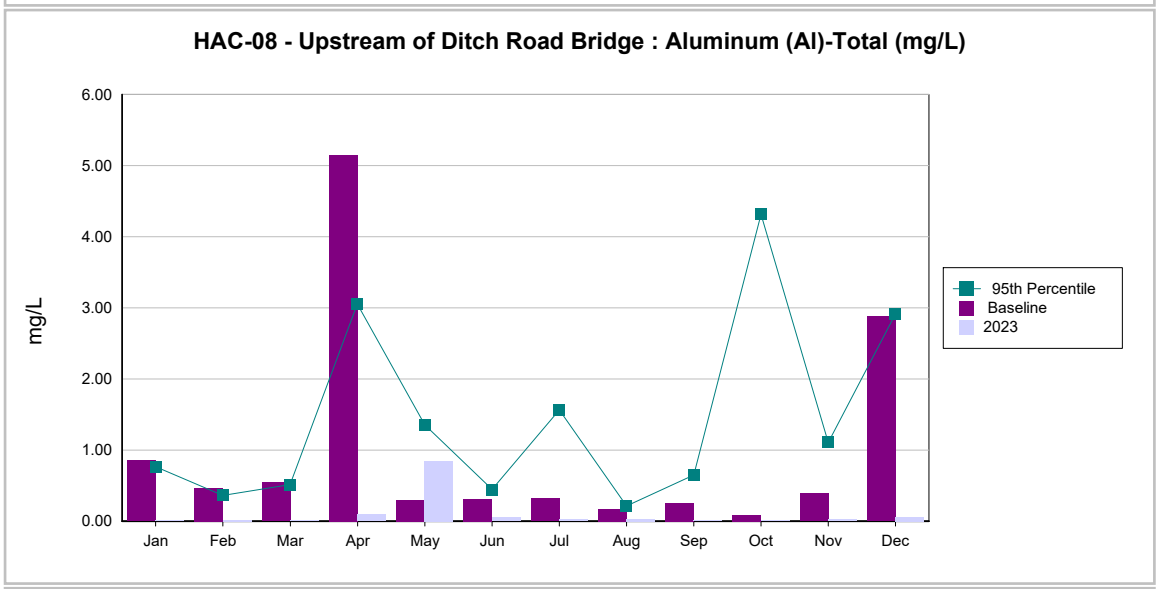
Annual Report HAC vs BCWQG

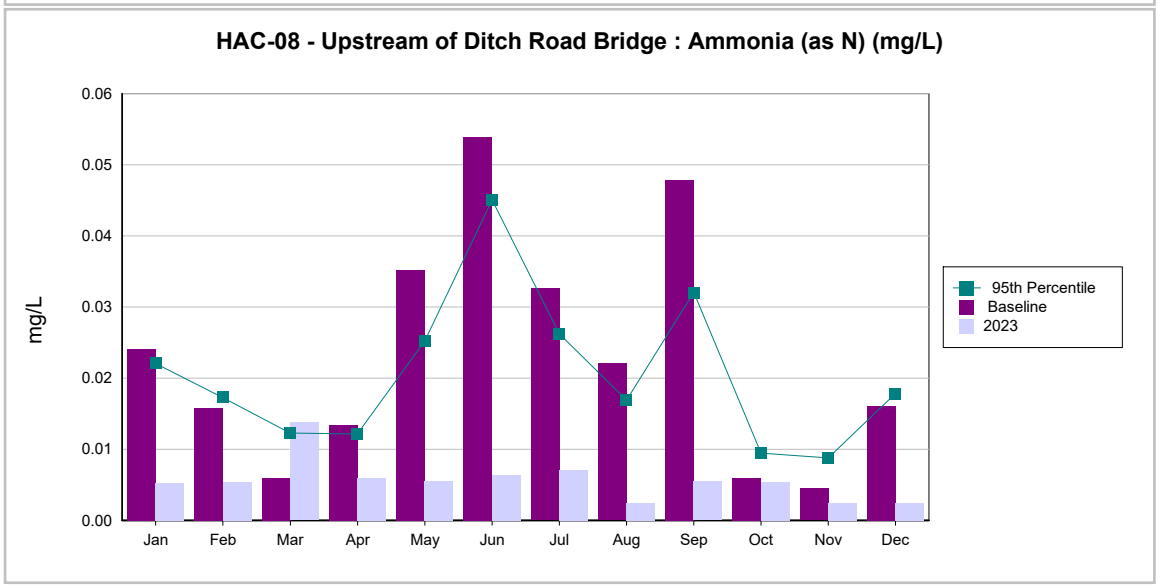
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







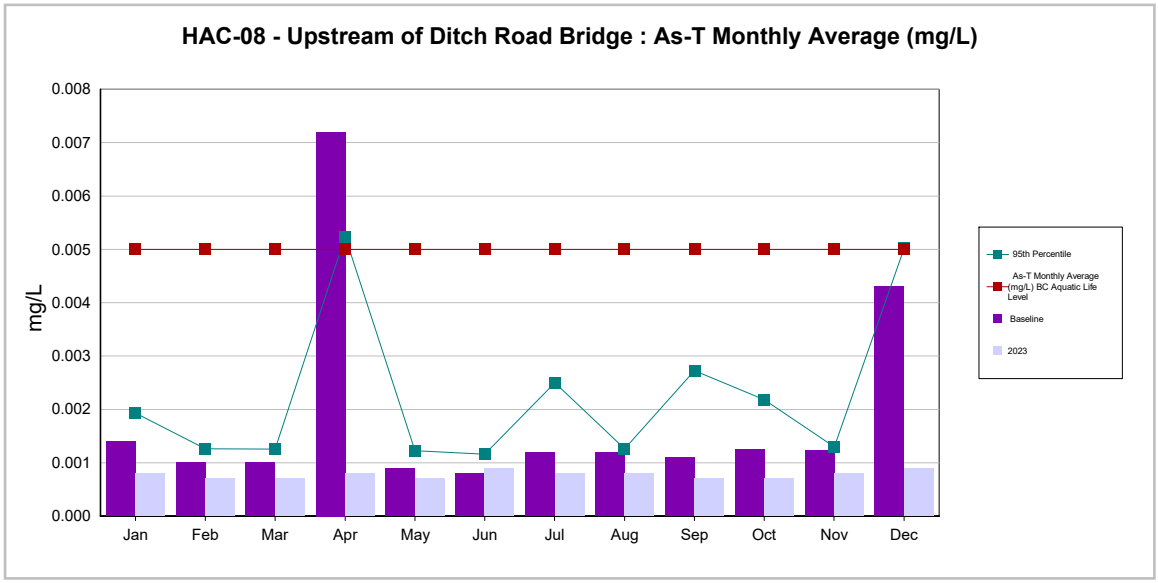
Water Quality Report

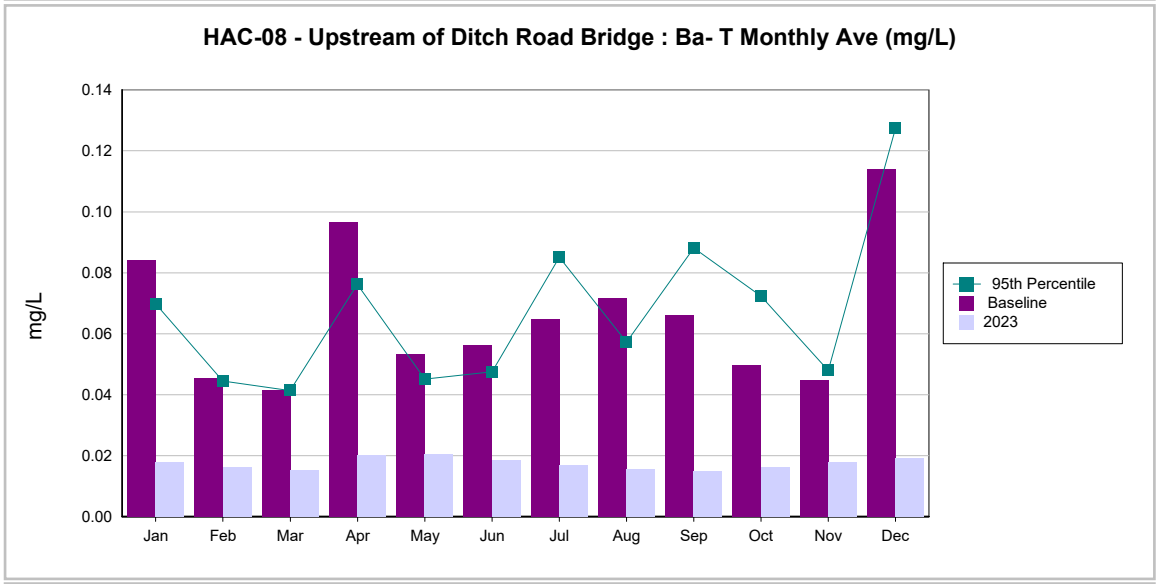
Annual Report HAC vs BCWQG

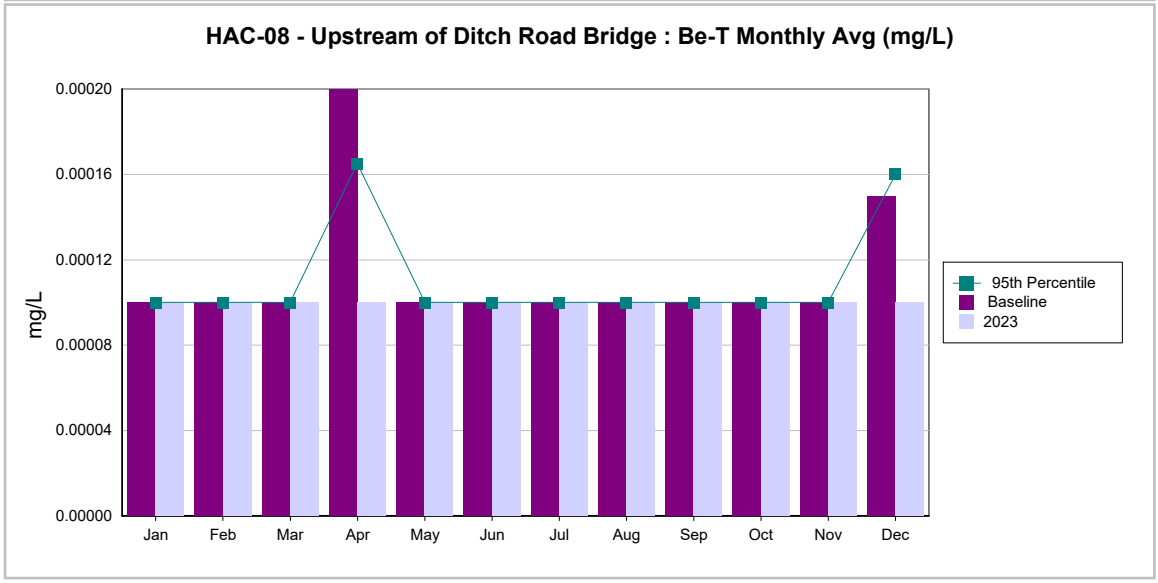
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







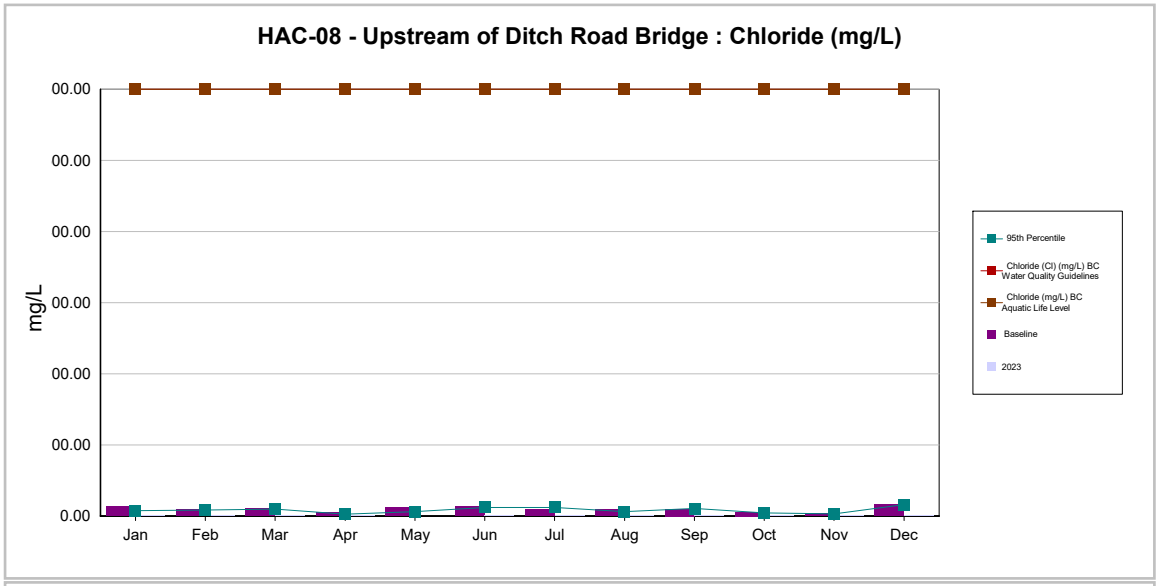
Water Quality Report

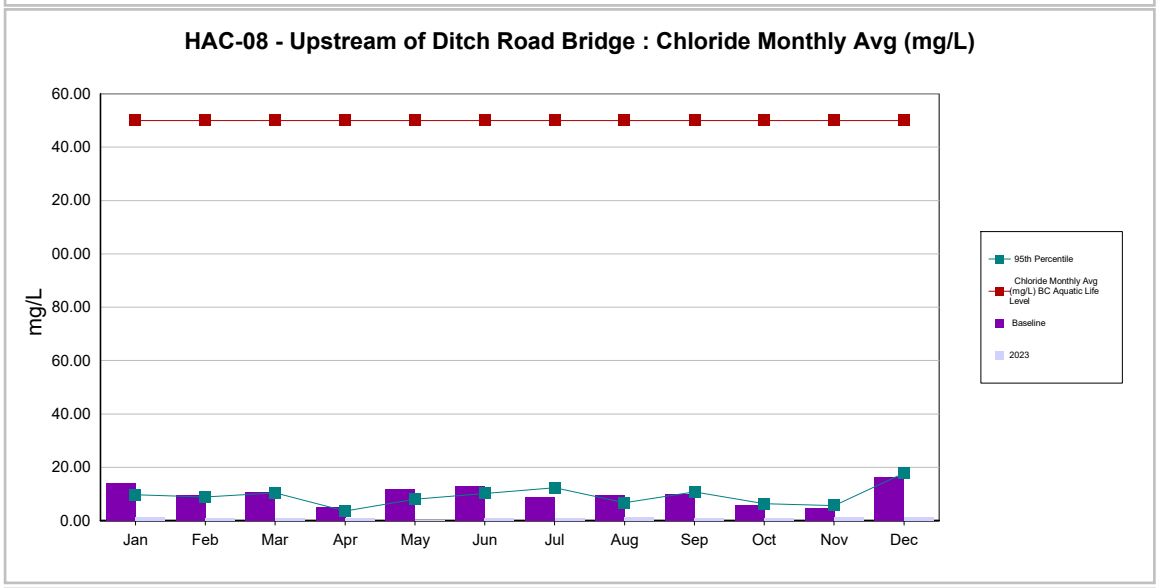
Annual Report HAC vs BCWQG

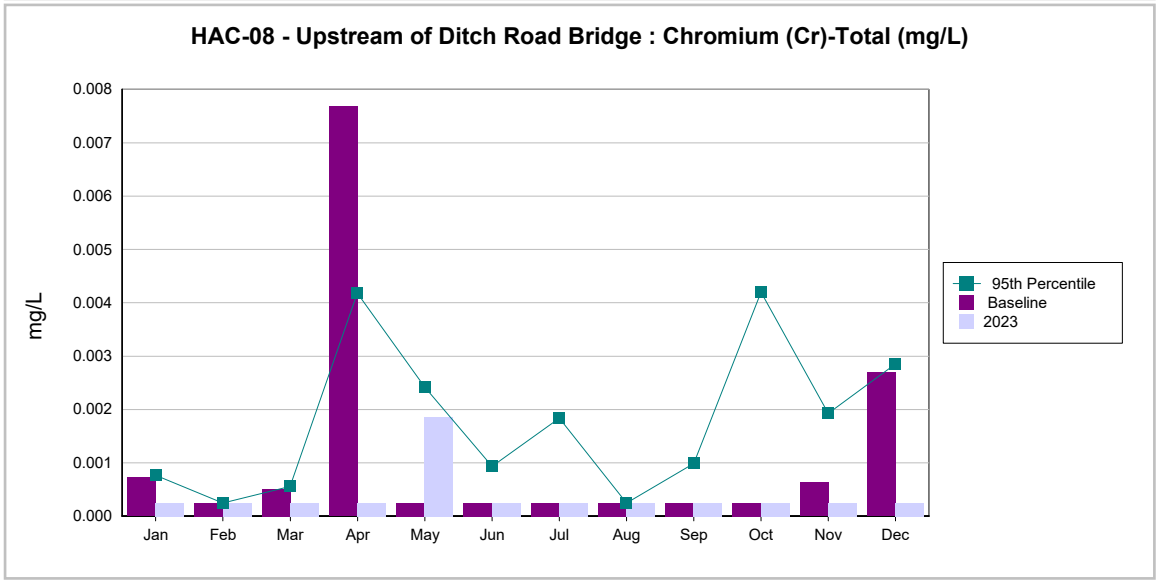
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

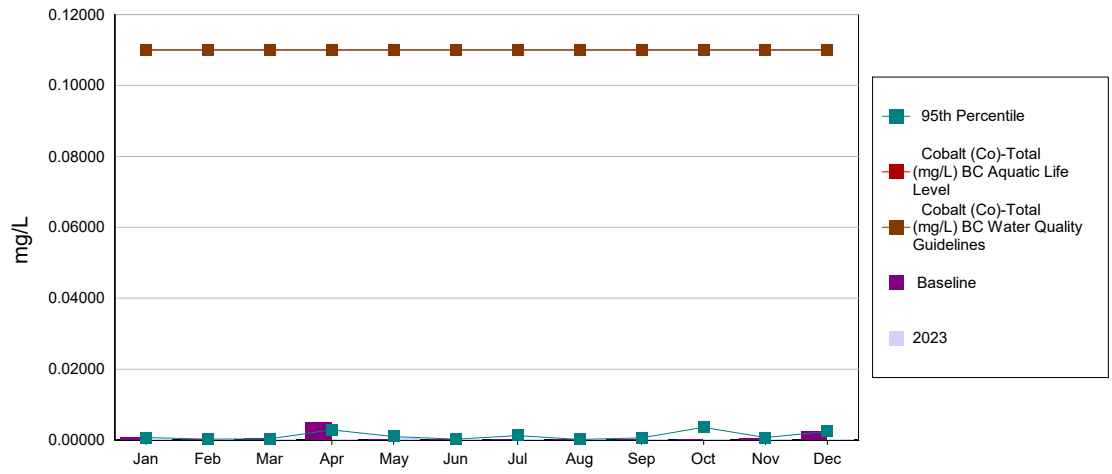
Annual Report HAC vs BCWQG

Mount Polley

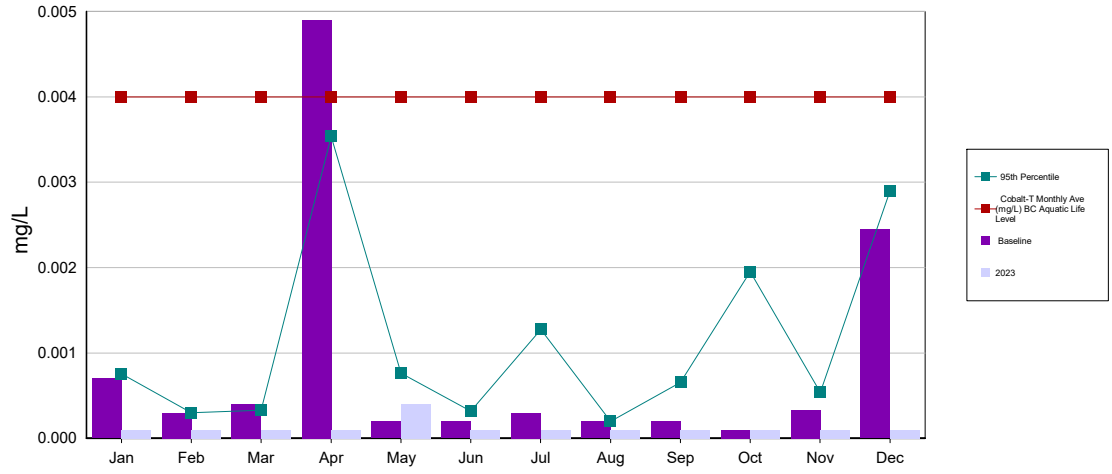
Mining Corporation

IMPERIAL METALS CORPORATION

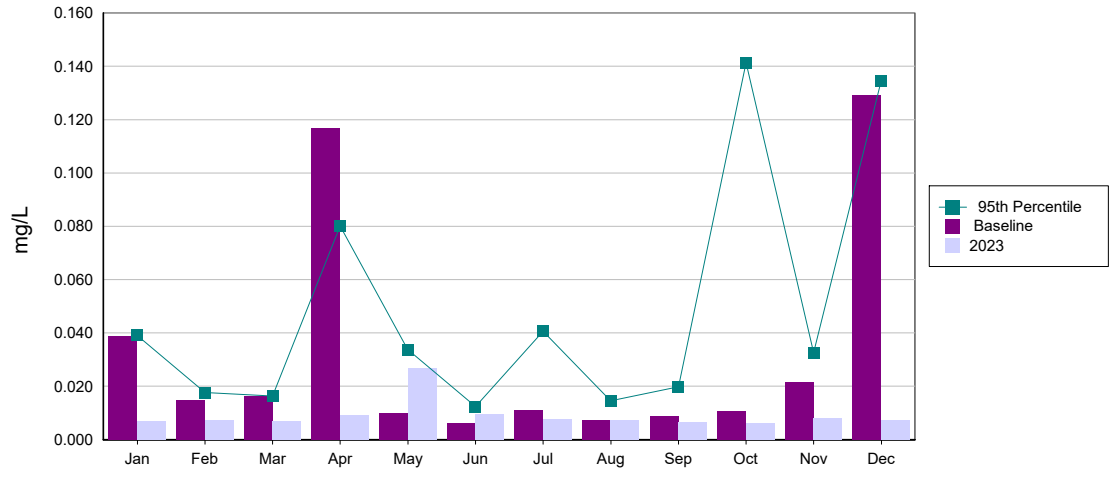
HAC-08 - Upstream of Ditch Road Bridge : Cobalt (Co)-Total (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Cobalt-T Monthly Ave (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Copper (Cu)-Total (mg/L)



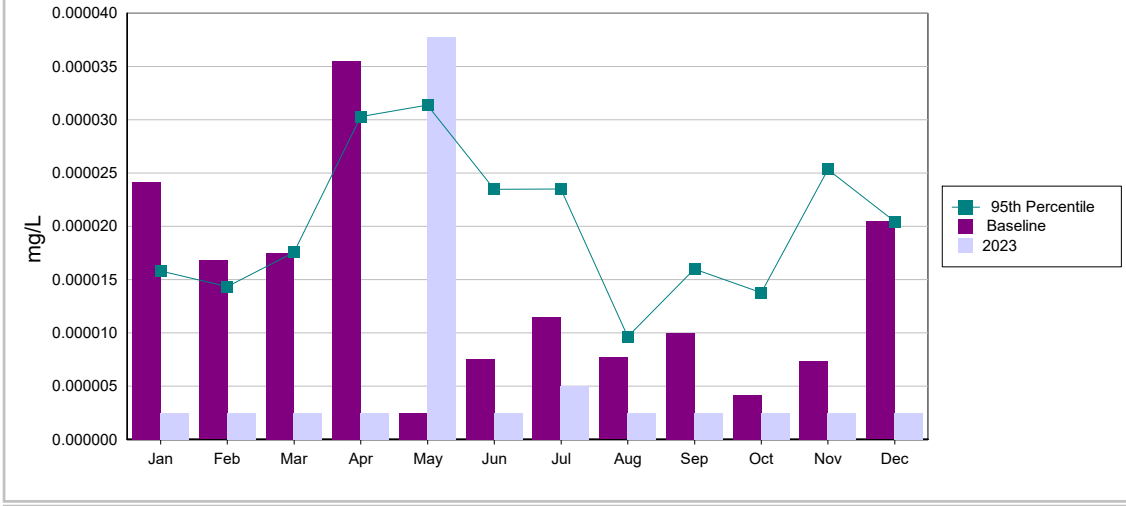
Water Quality Report

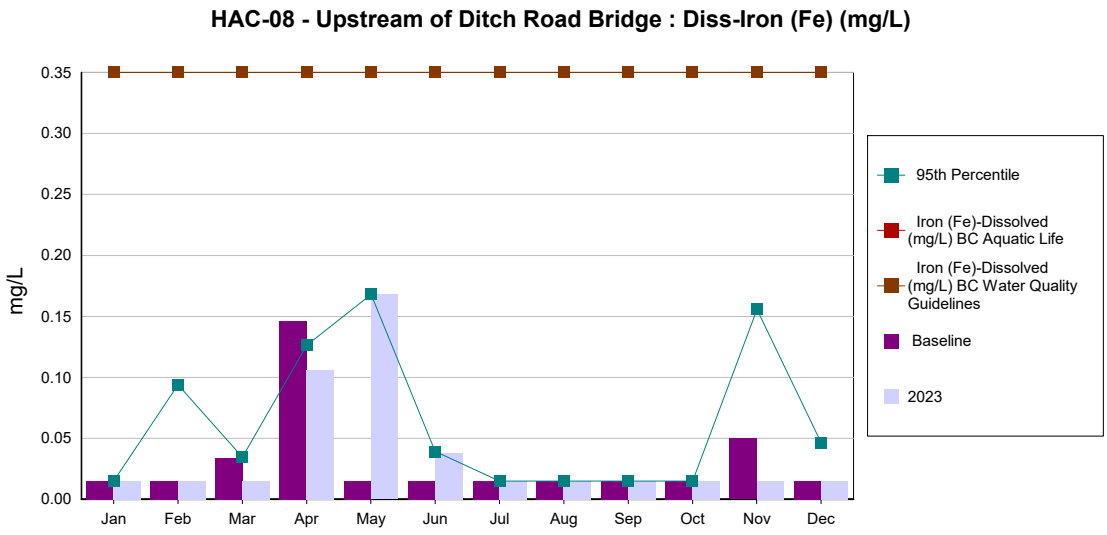
Annual Report HAC vs BCWQG

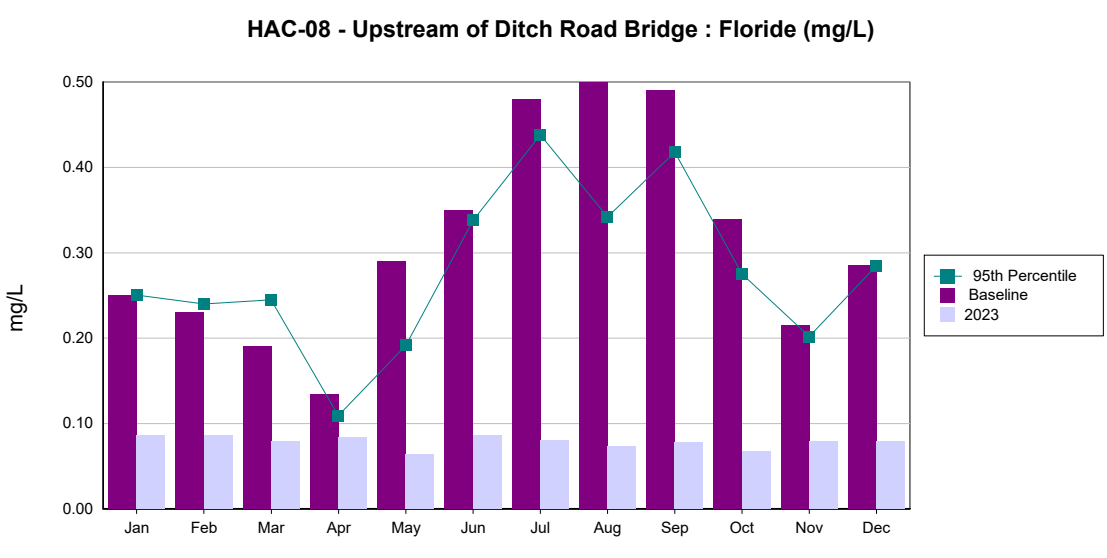
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

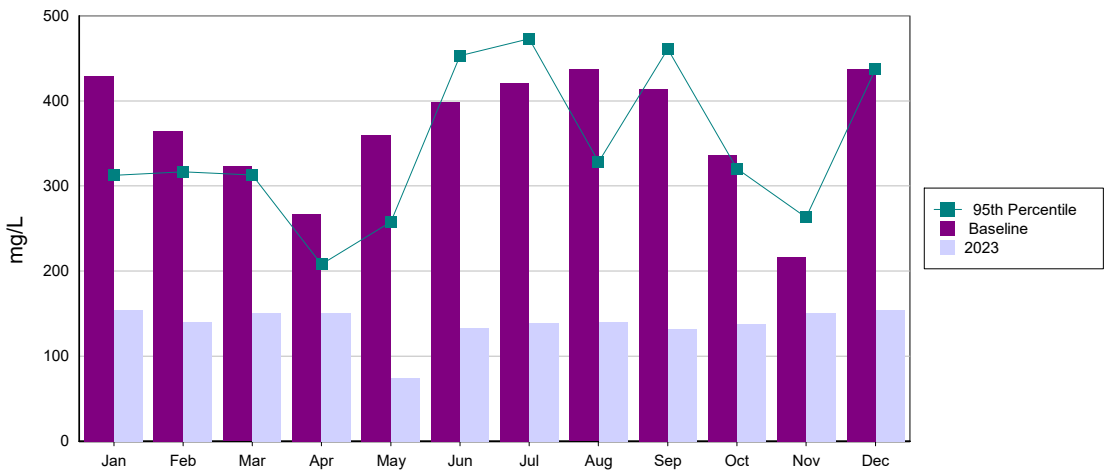
Annual Report HAC vs BCWQG

Mount Polley

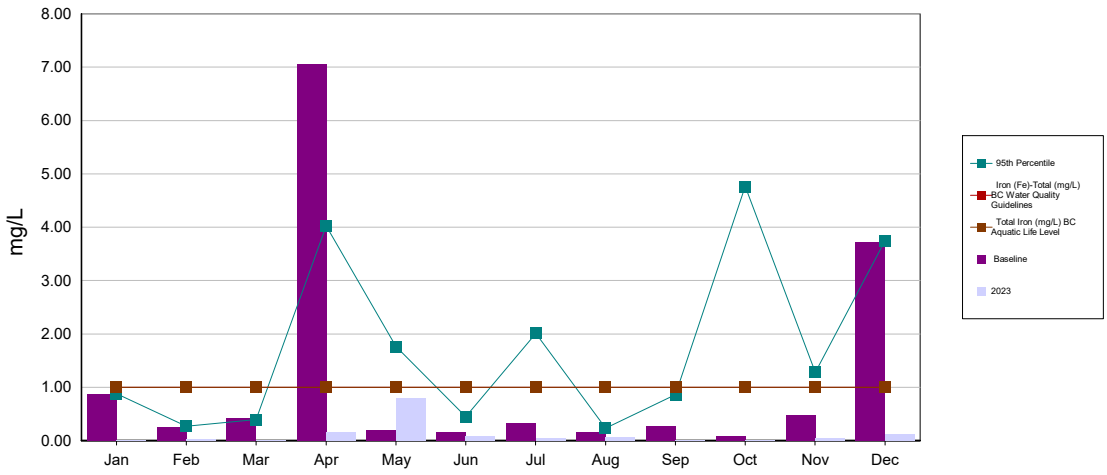
Mining Corporation

IMPERIAL METALS CORPORATION

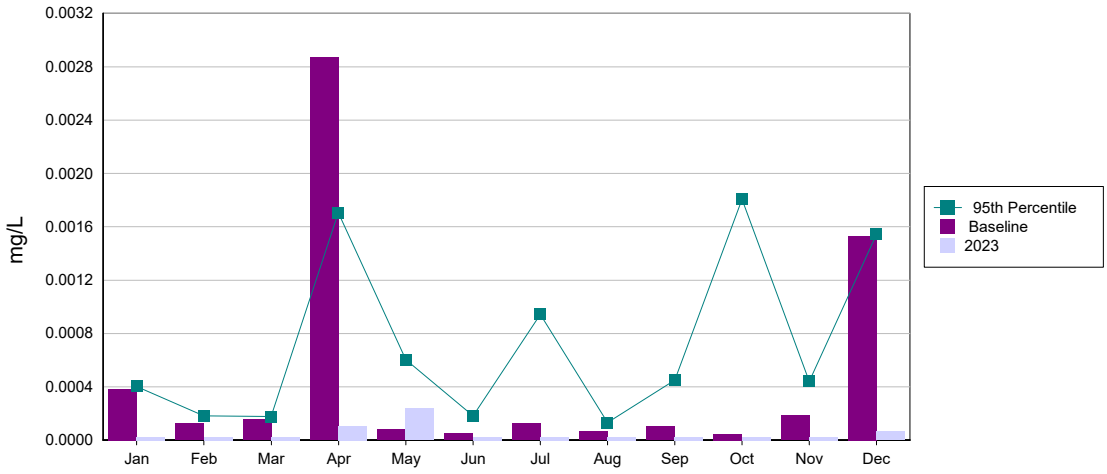
HAC-08 - Upstream of Ditch Road Bridge : Hardness (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Iron (Fe)-Total (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Lead (Pb)-Total (mg/L)



Water Quality Report

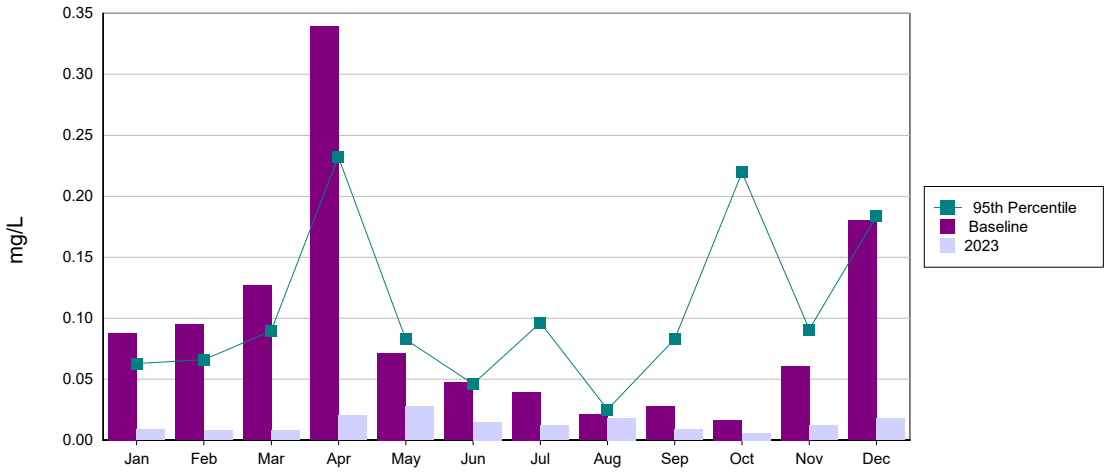
Annual Report HAC vs BCWQG

Mount Polley

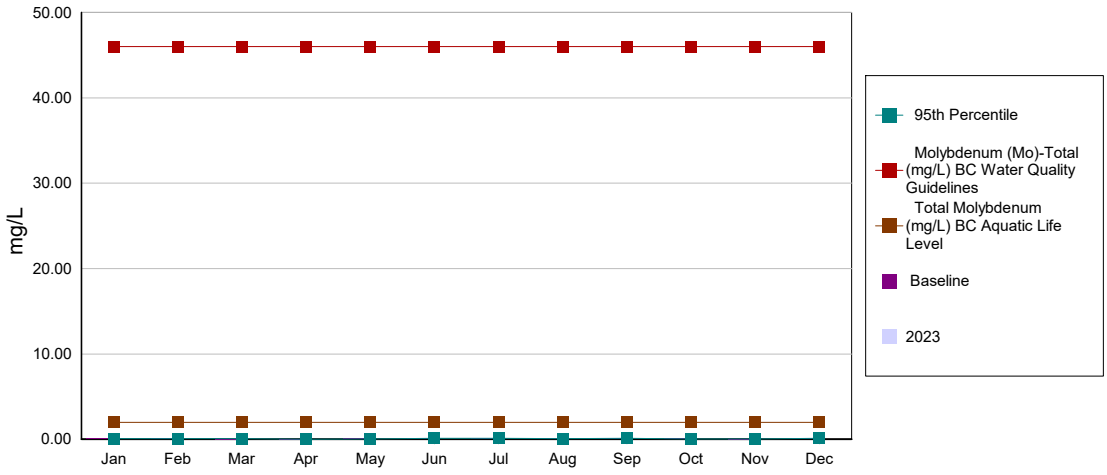
Mining Corporation

IMPERIAL METALS CORPORATION

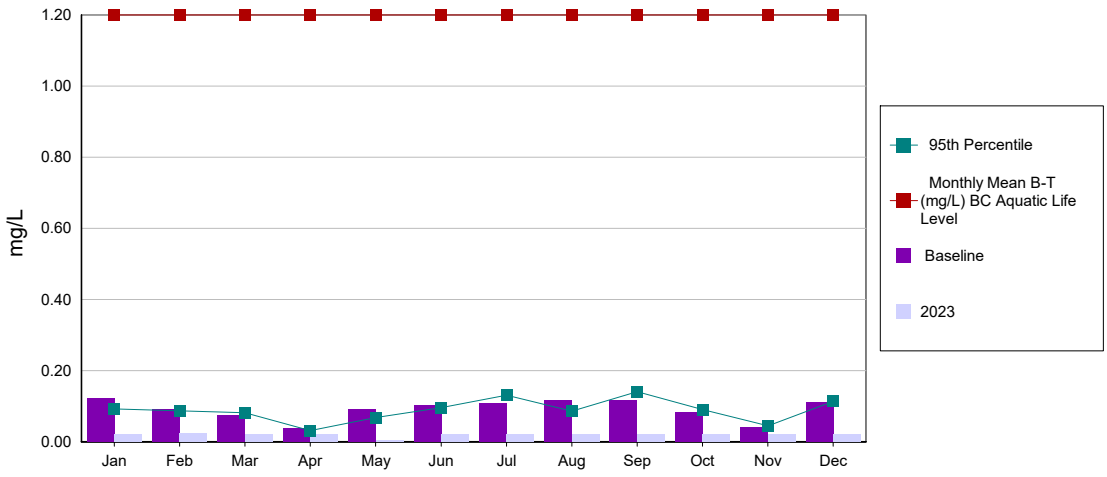
HAC-08 - Upstream of Ditch Road Bridge : Manganese (Mn)-Total (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Molybdenum (Mo)-Tota (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Monthly Mean B-T (mg/L)



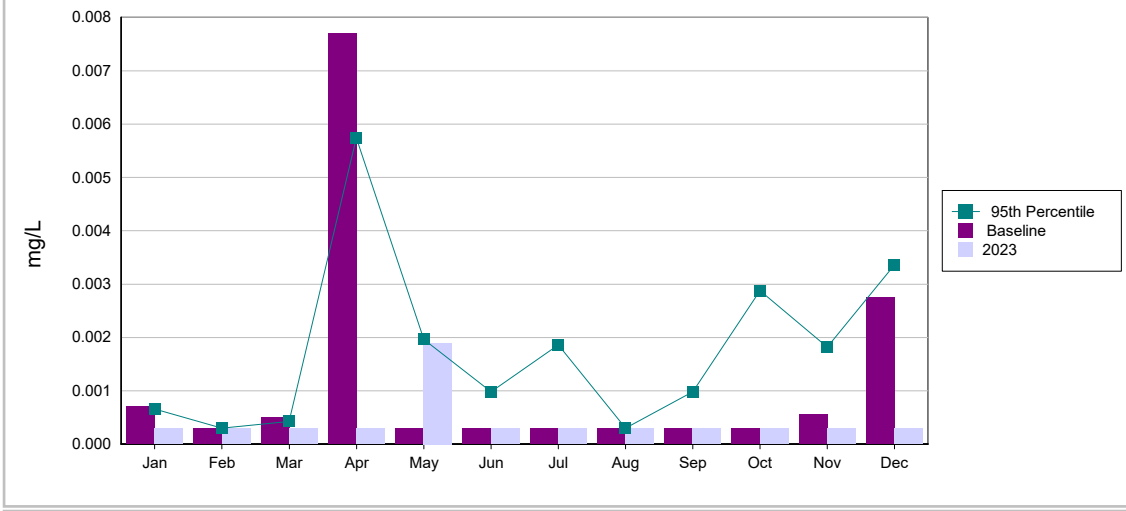
Water Quality Report

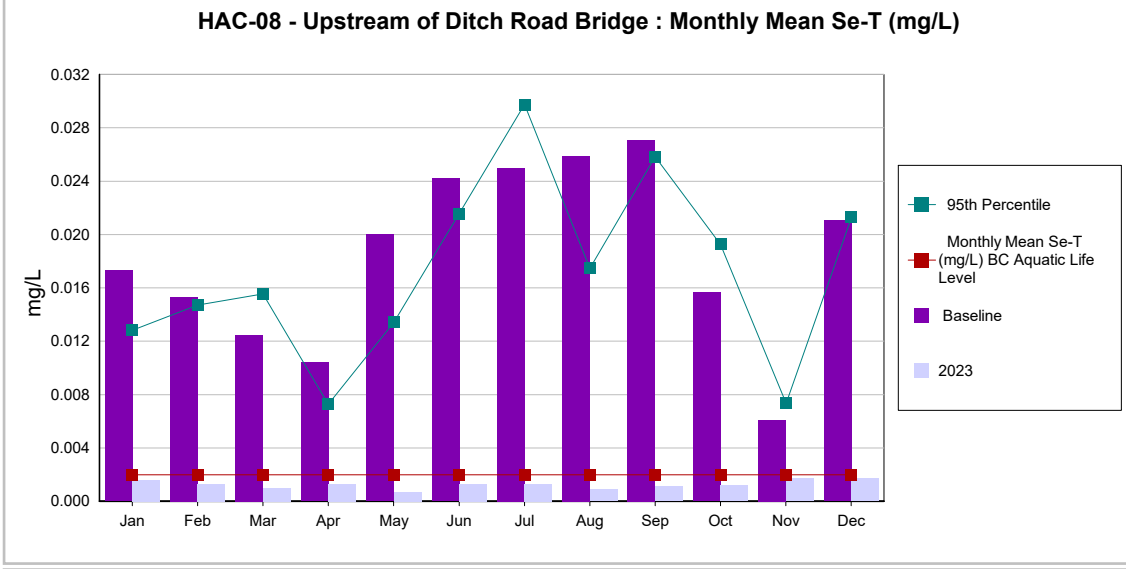
Annual Report HAC vs BCWQG

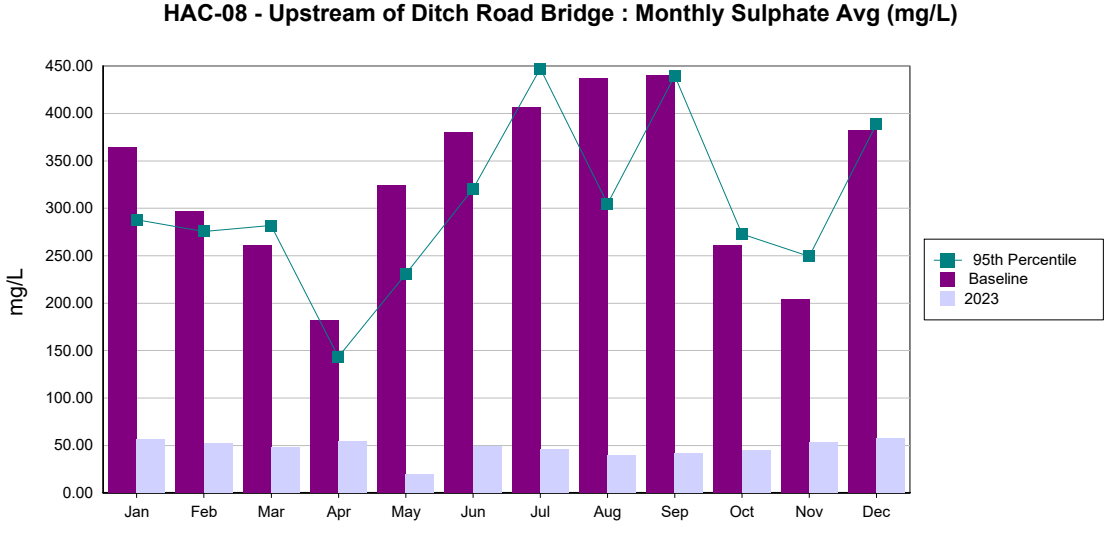
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







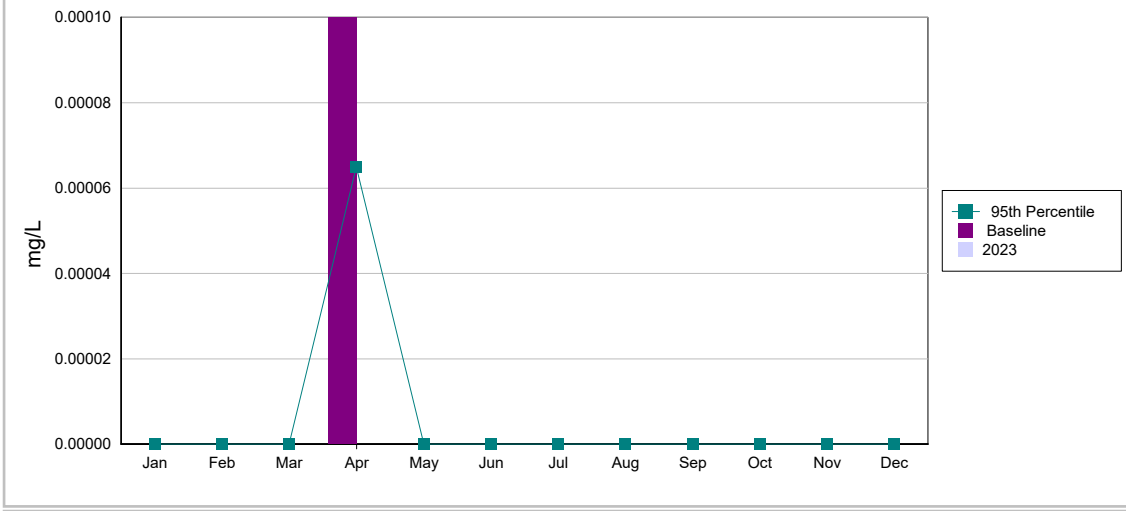
Water Quality Report

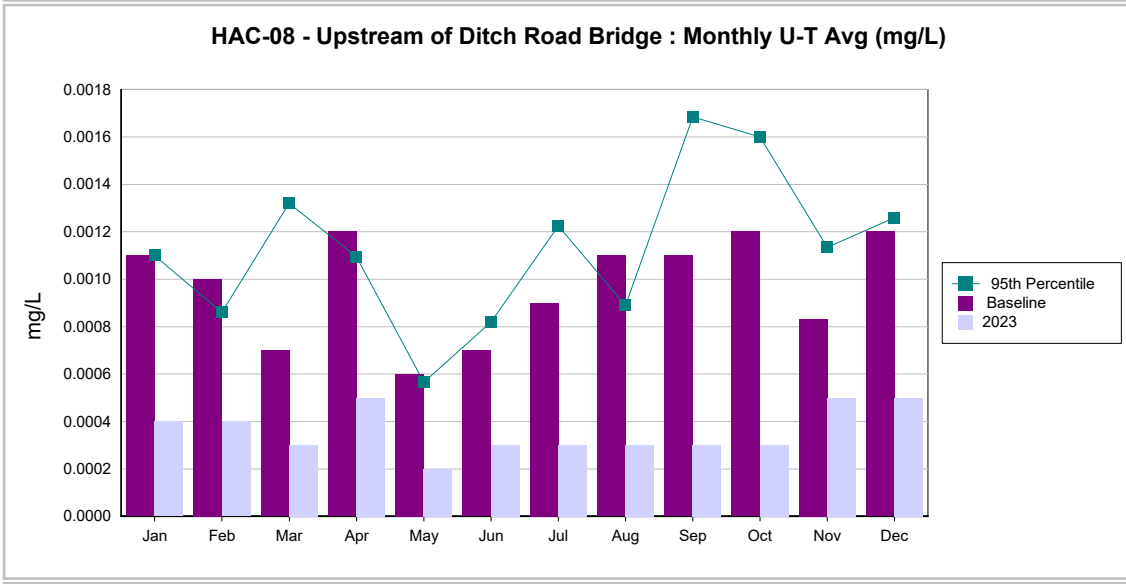
Annual Report HAC vs BCWQG

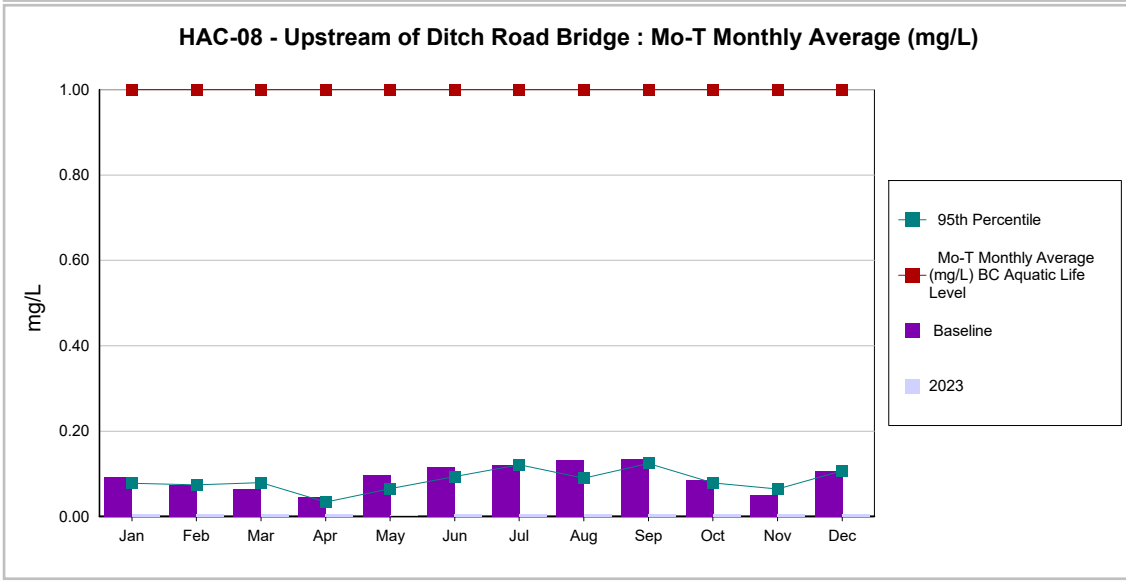
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







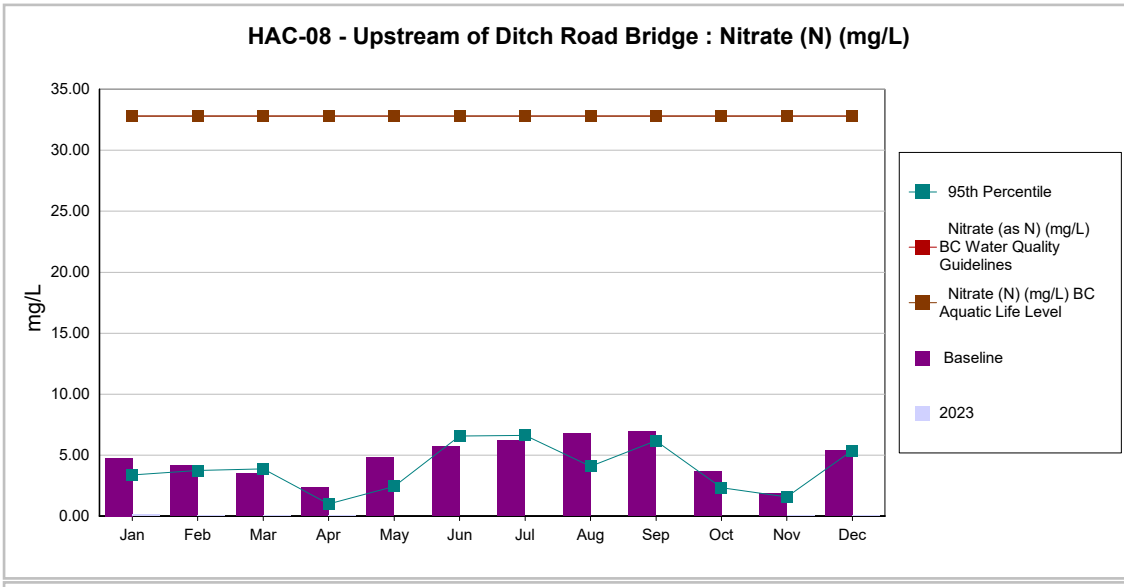
Water Quality Report

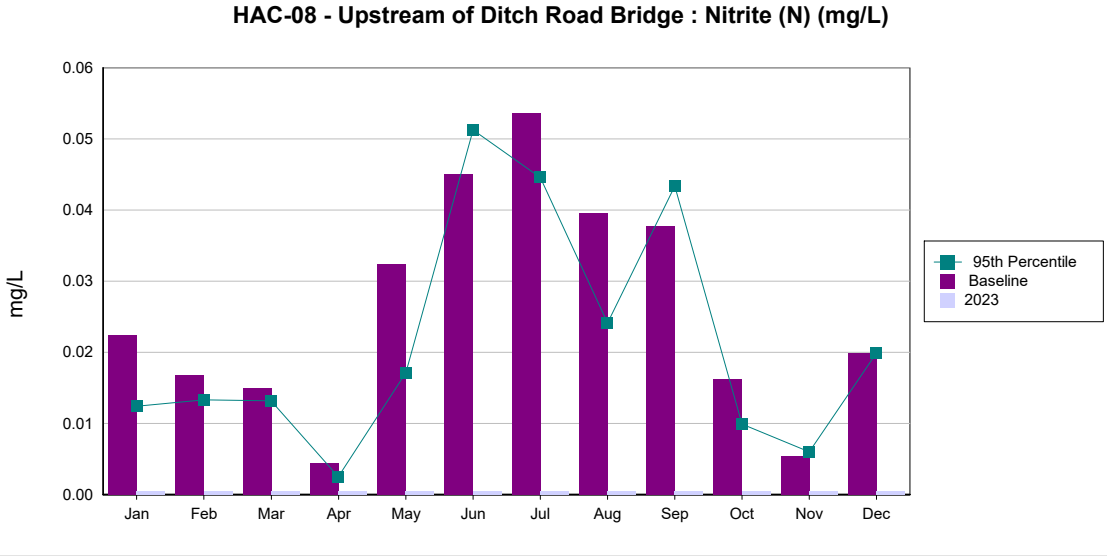
Annual Report HAC vs BCWQG

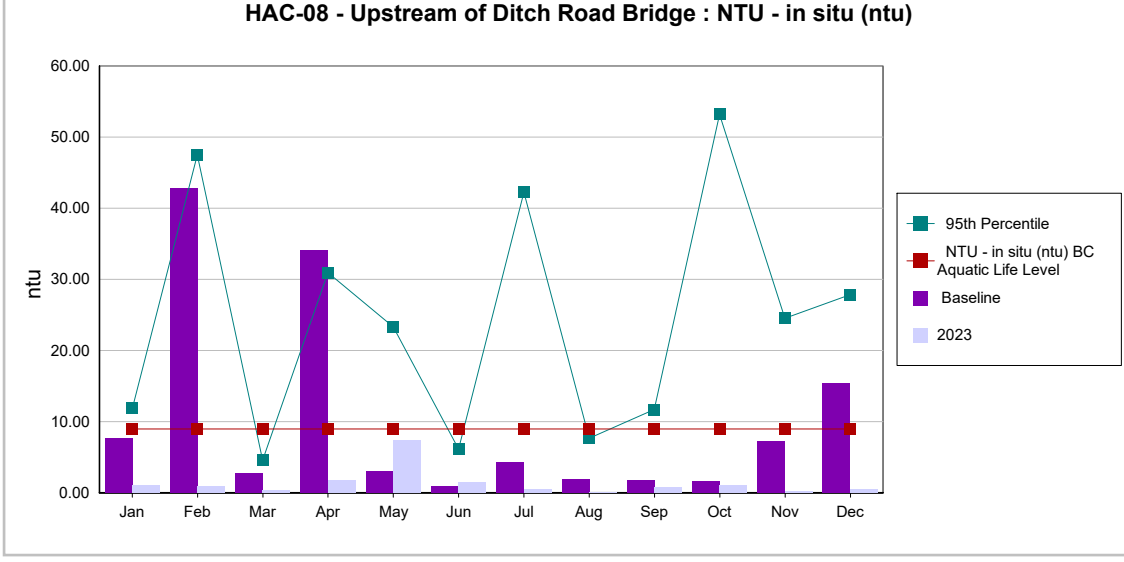
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







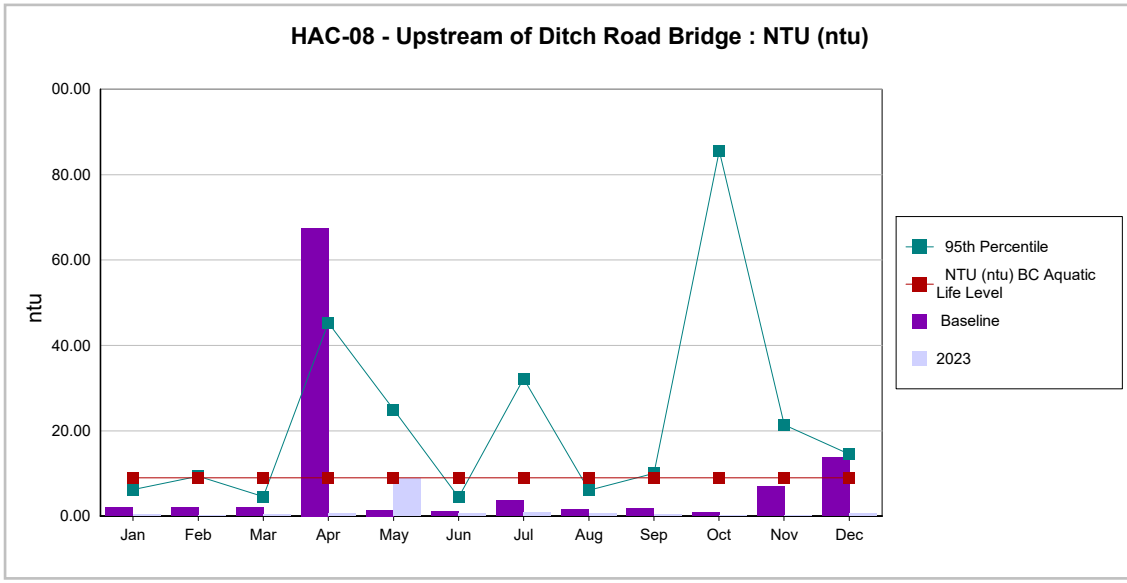
Water Quality Report

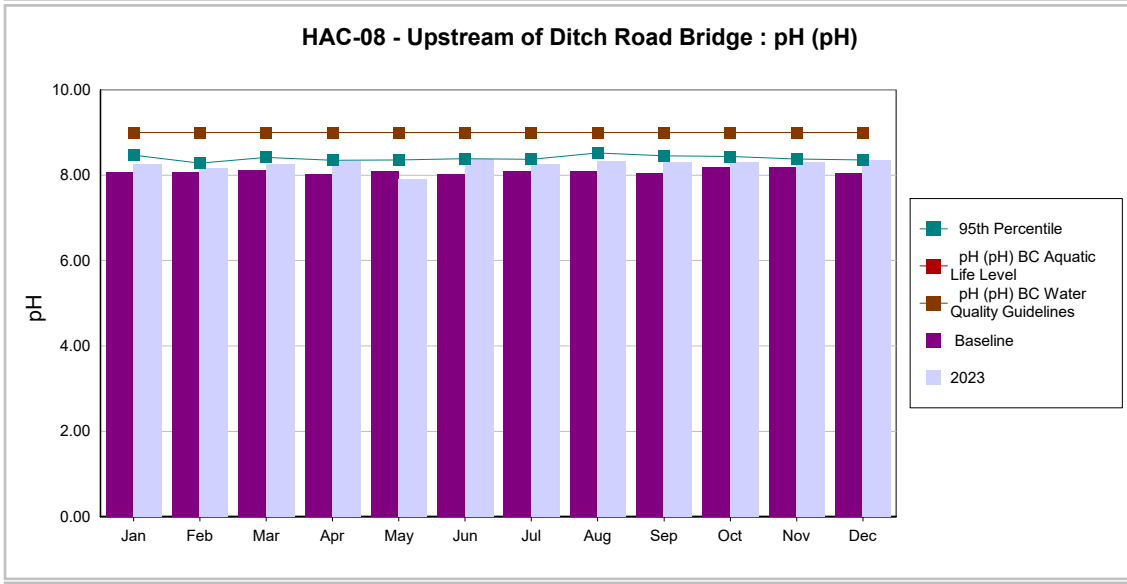
Annual Report HAC vs BCWQG

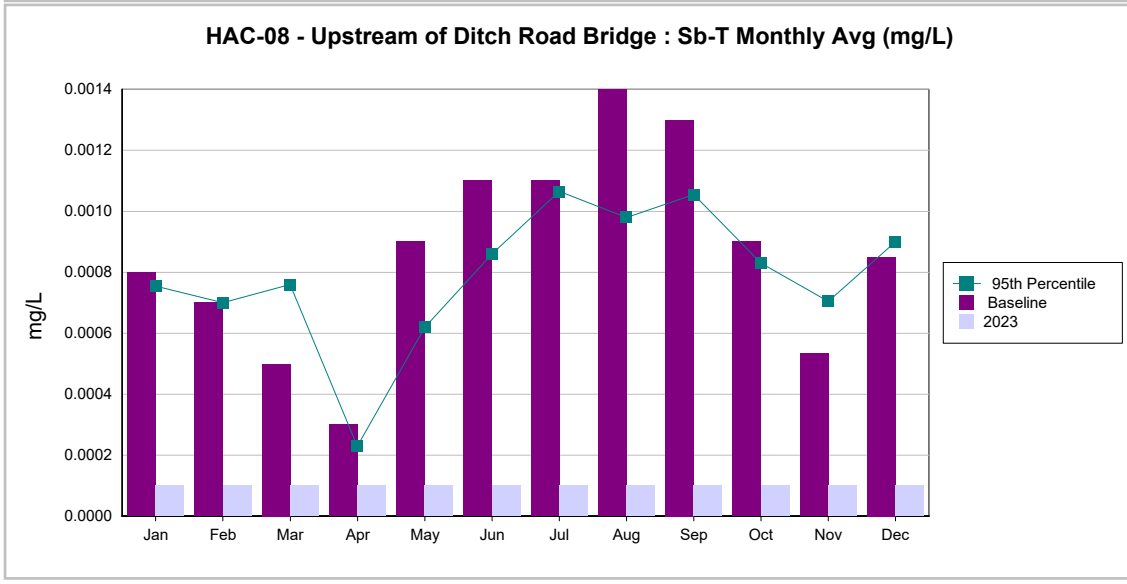
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







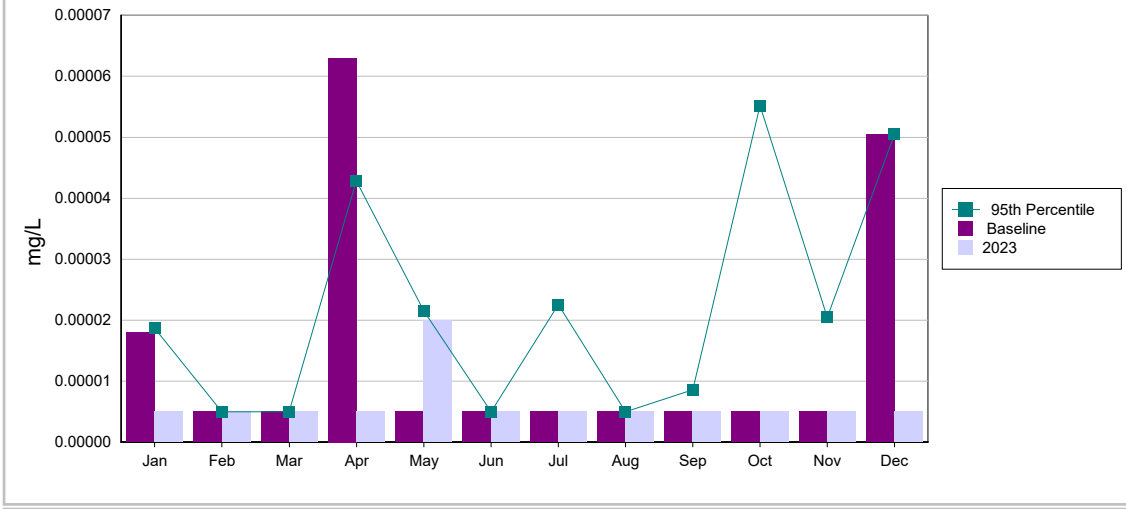
Water Quality Report

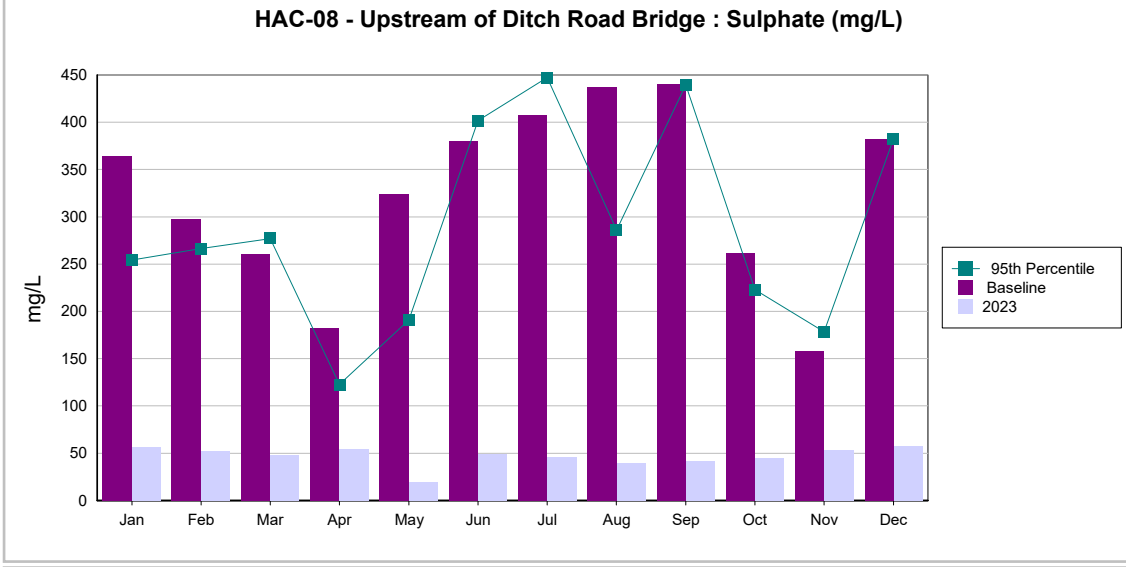
Annual Report HAC vs BCWQG

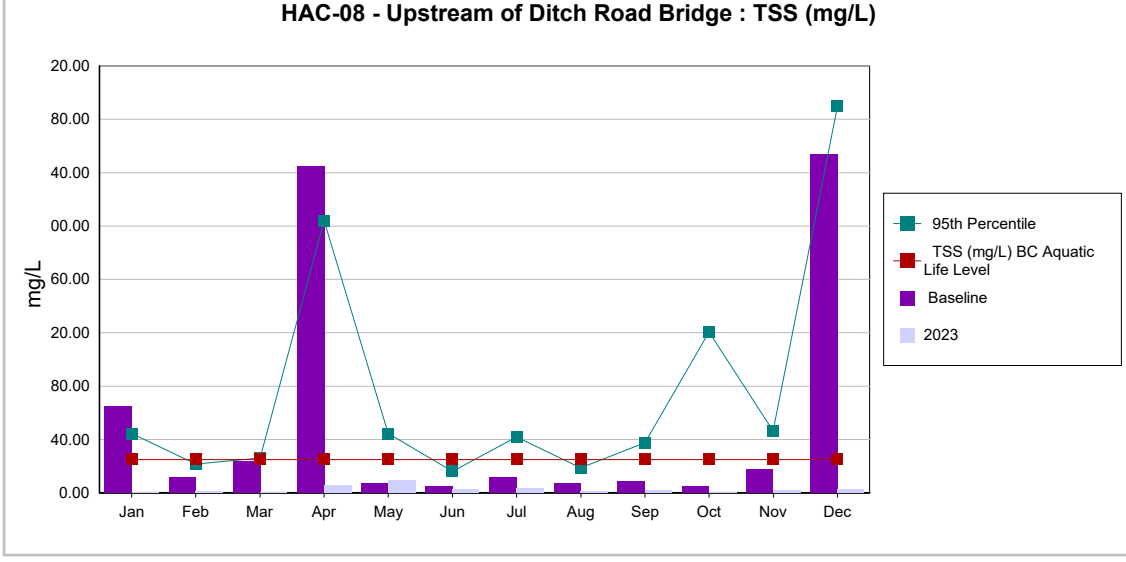
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

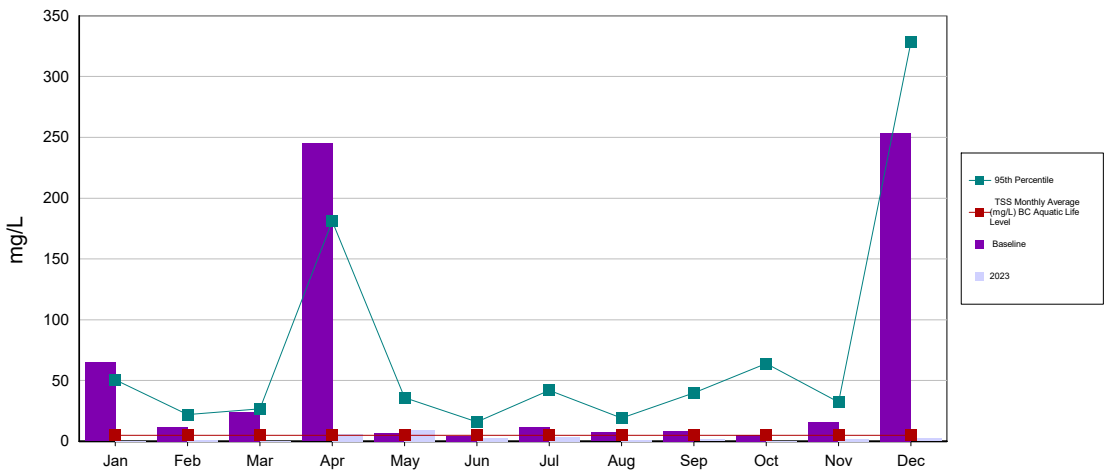
Annual Report HAC vs BCWQG

Mount Polley

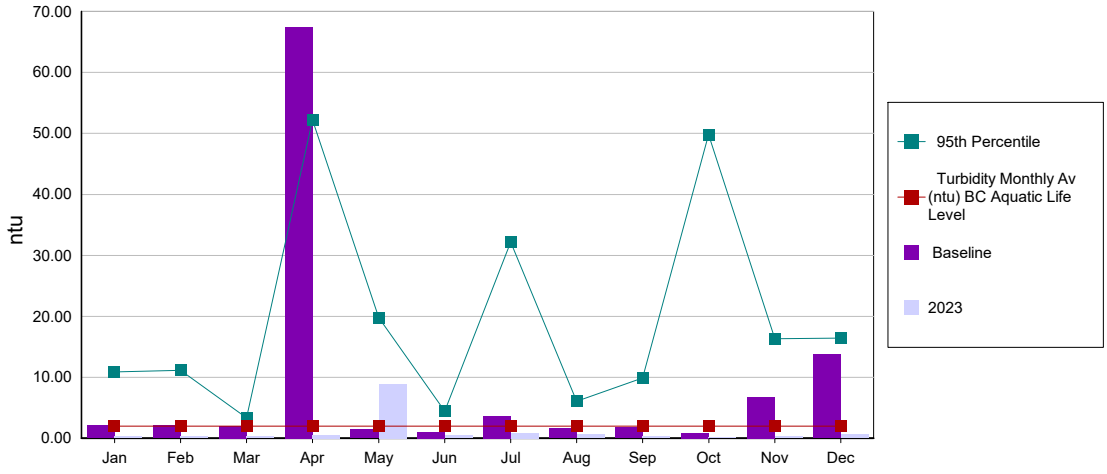
Mining Corporation

IMPERIAL METALS CORPORATION

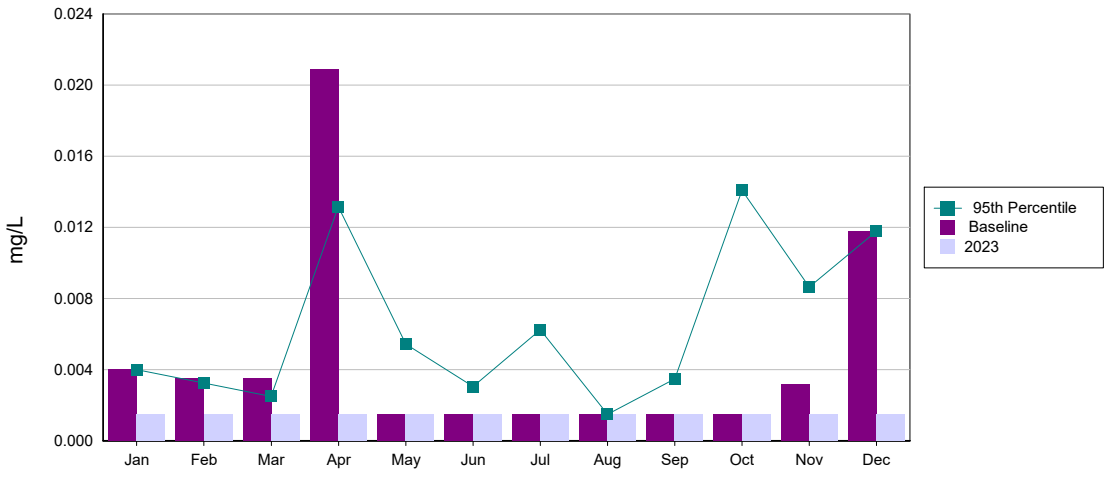
HAC-08 - Upstream of Ditch Road Bridge : TSS Monthly Average (mg/L)



HAC-08 - Upstream of Ditch Road Bridge : Turbidity Monthly Av (ntu)



HAC-08 - Upstream of Ditch Road Bridge : Zinc (Zn)-Total (mg/L)



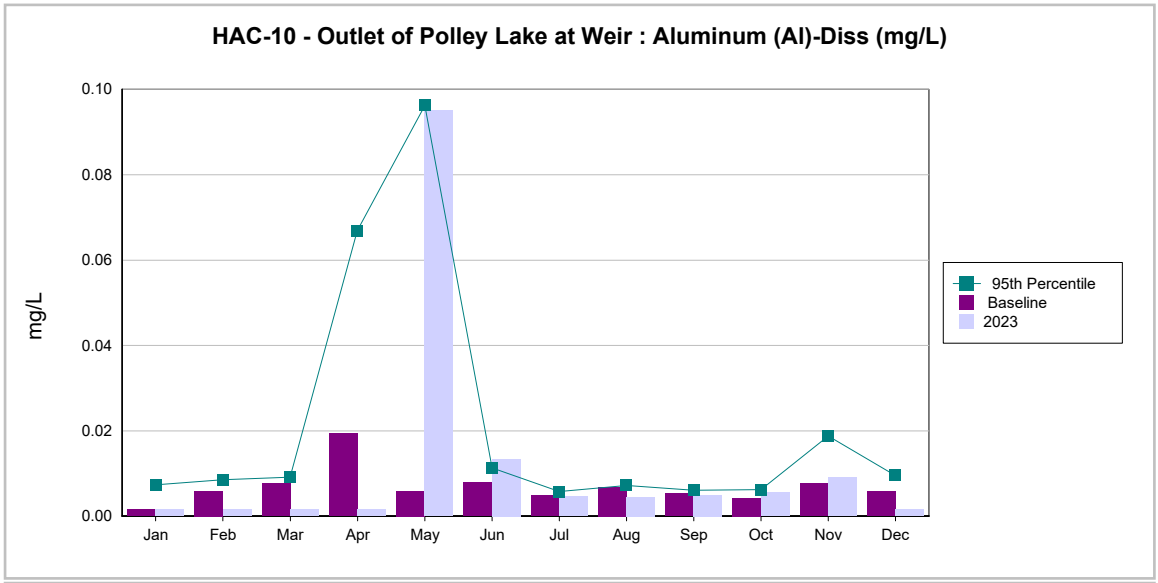
Water Quality Report

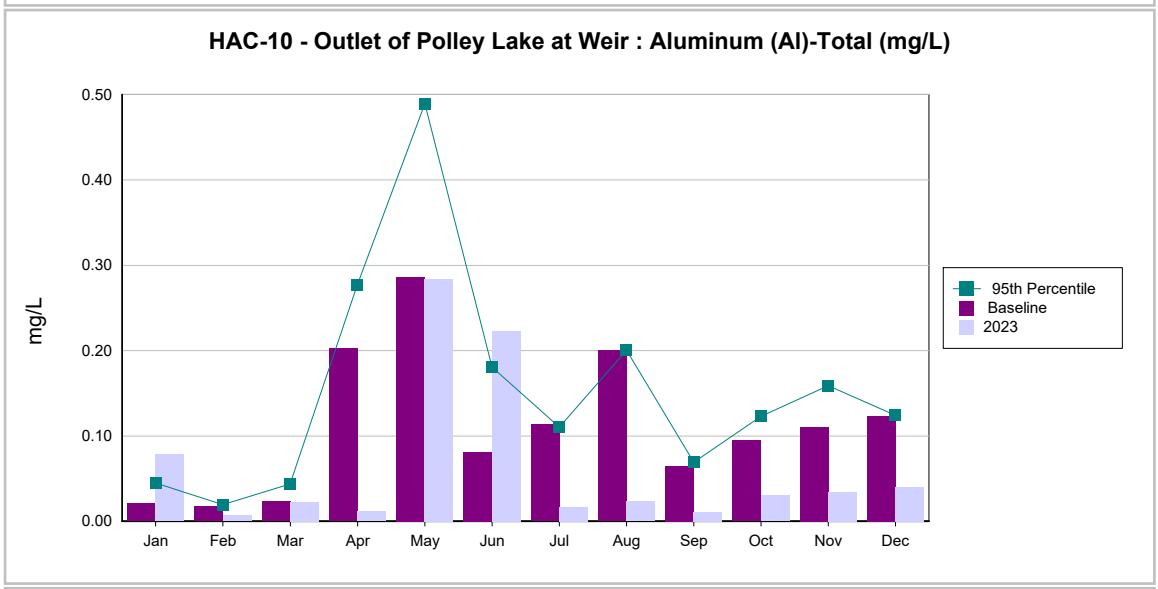
Annual Report HAC vs BCWQG

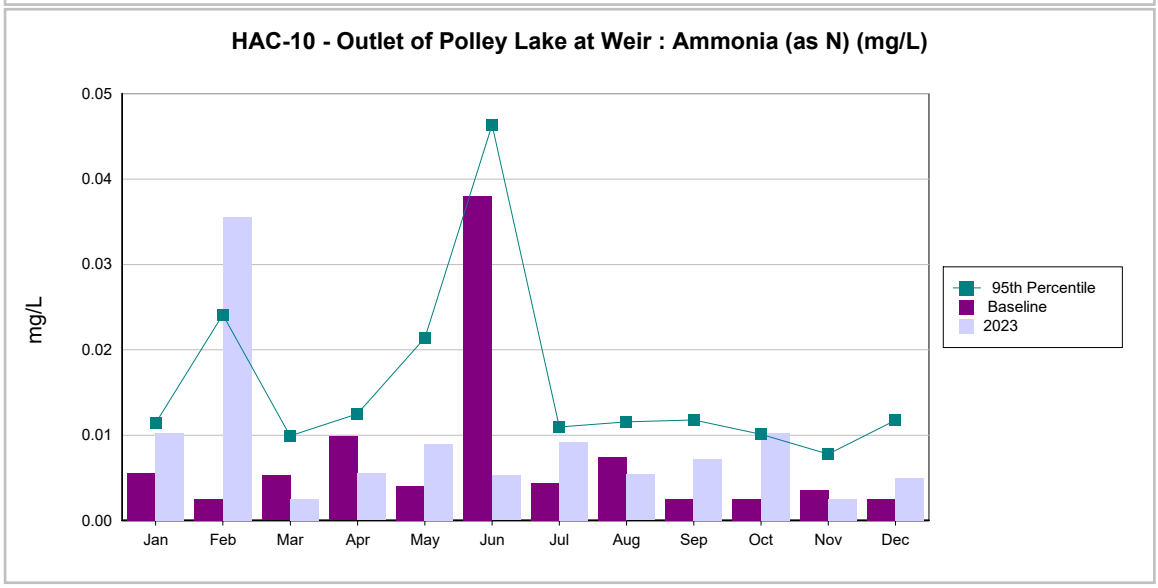
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







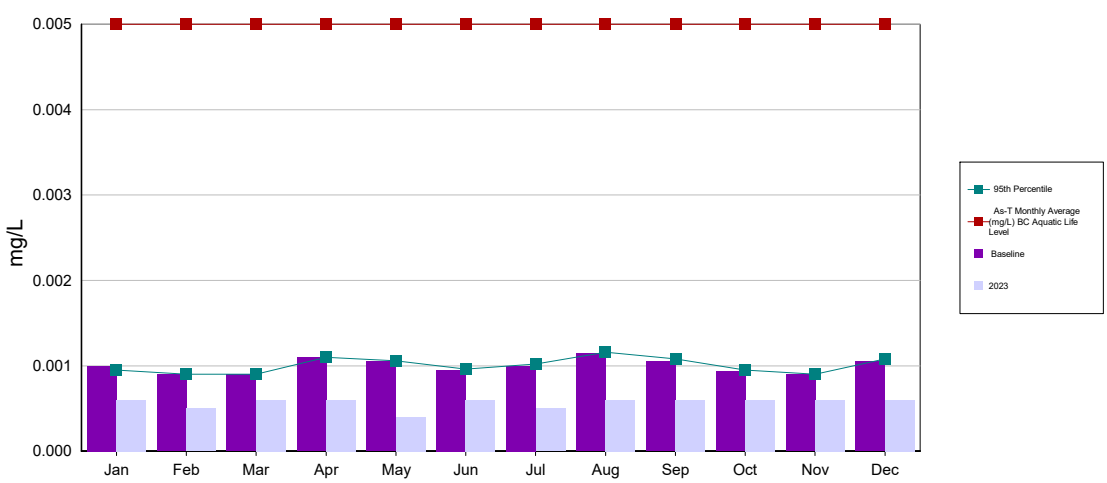
Water Quality Report

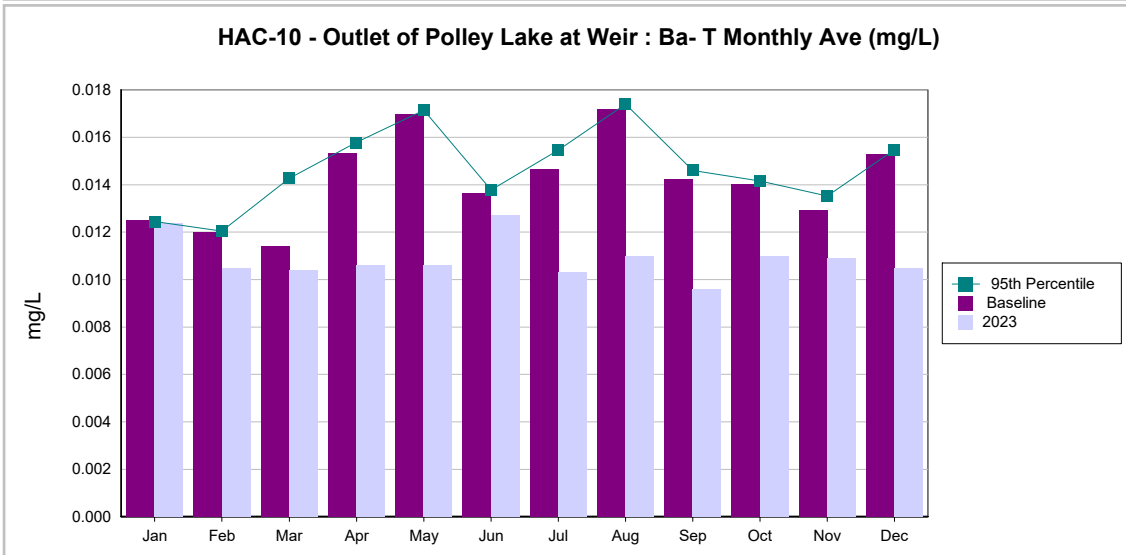
Annual Report HAC vs BCWQG

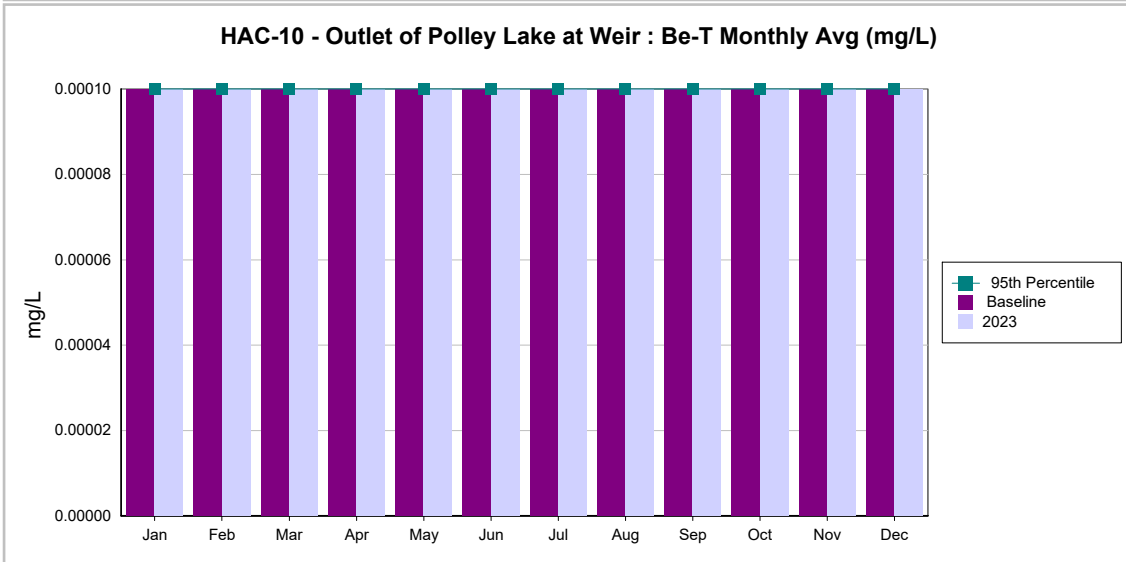
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







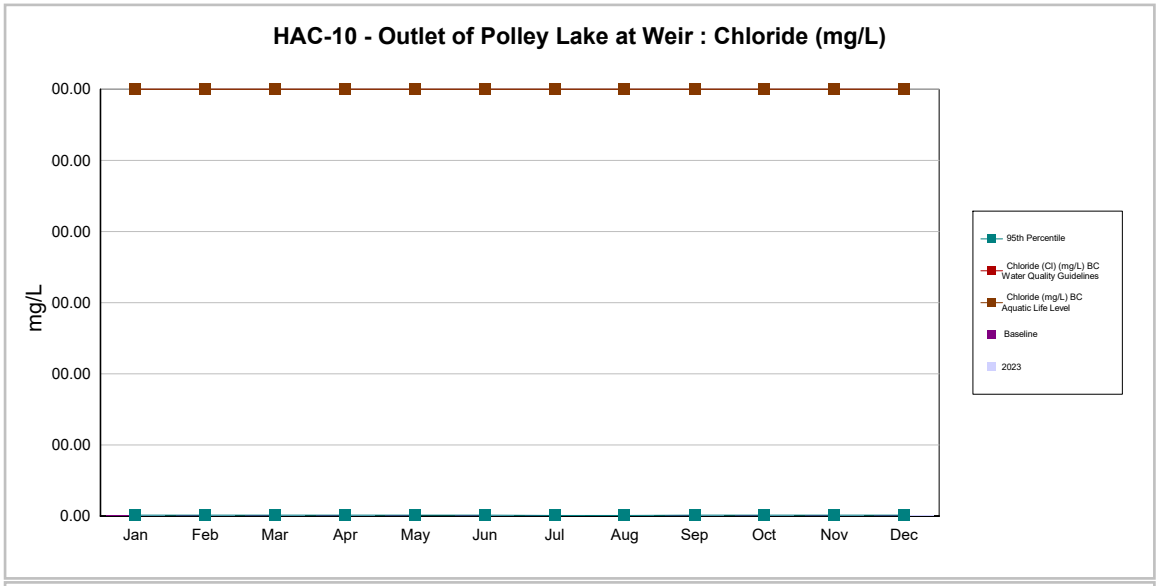
Water Quality Report

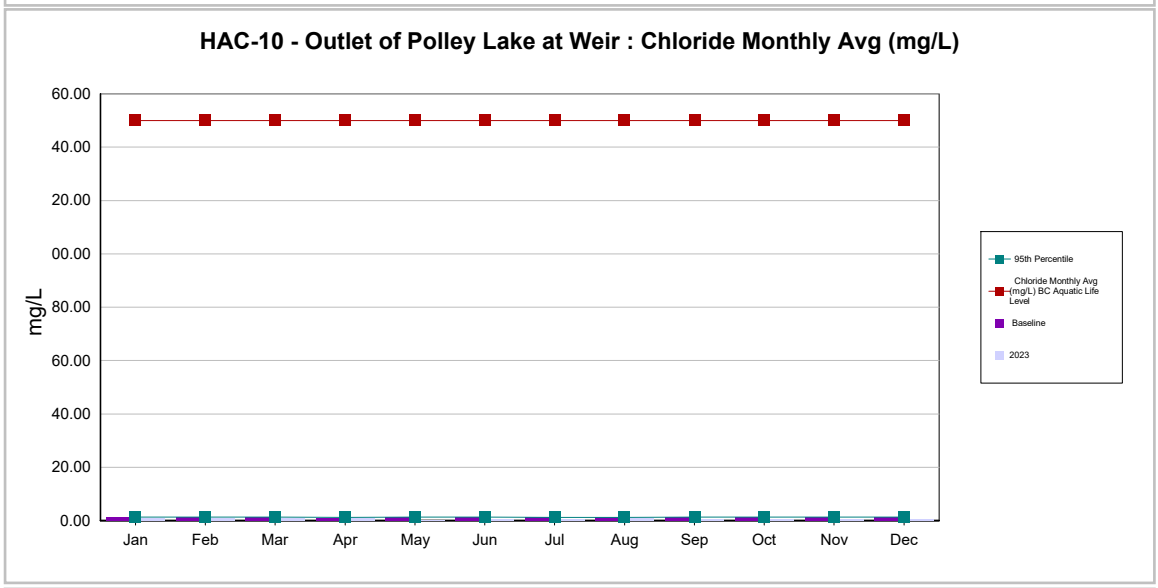
Annual Report HAC vs BCWQG

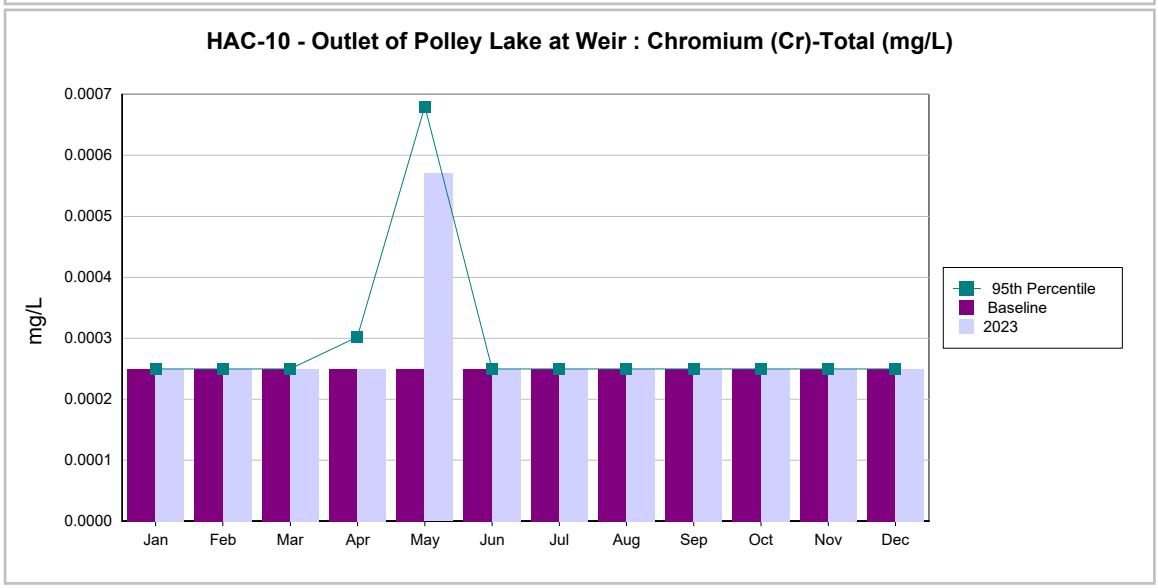
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







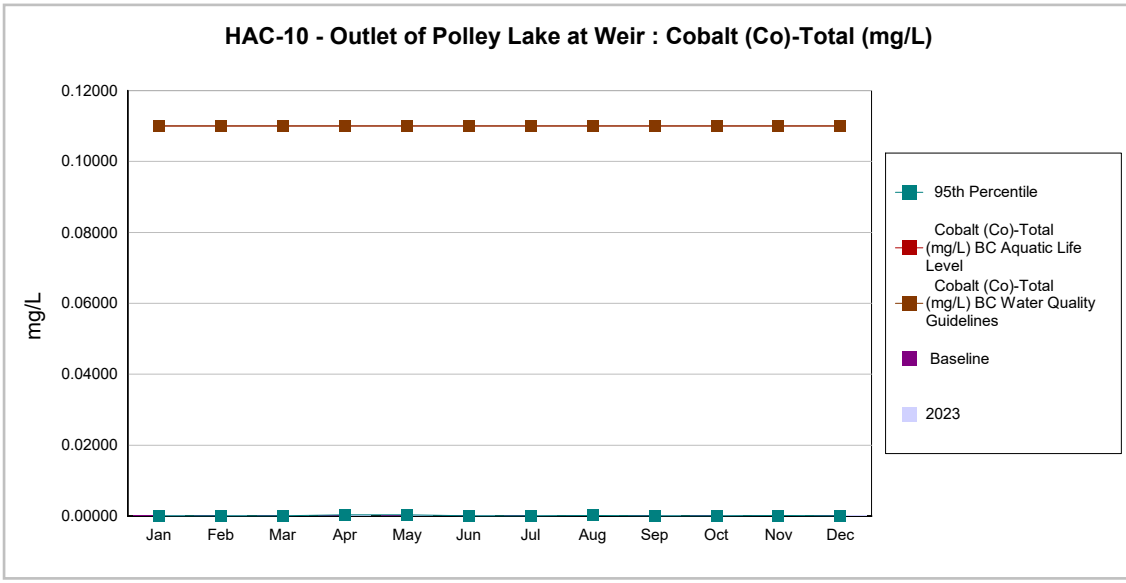
Water Quality Report

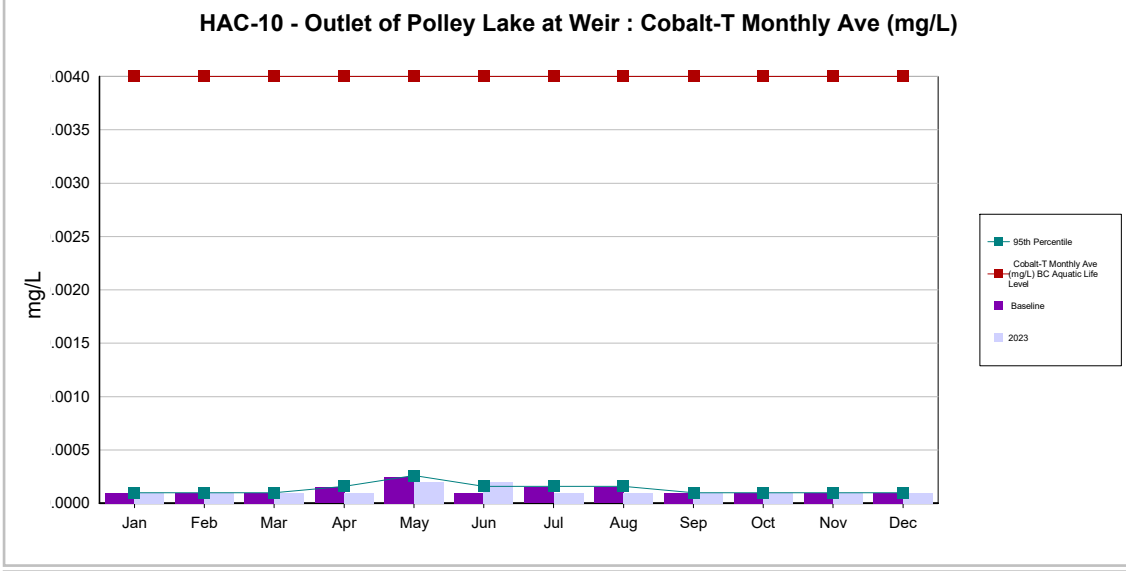
Annual Report HAC vs BCWQG

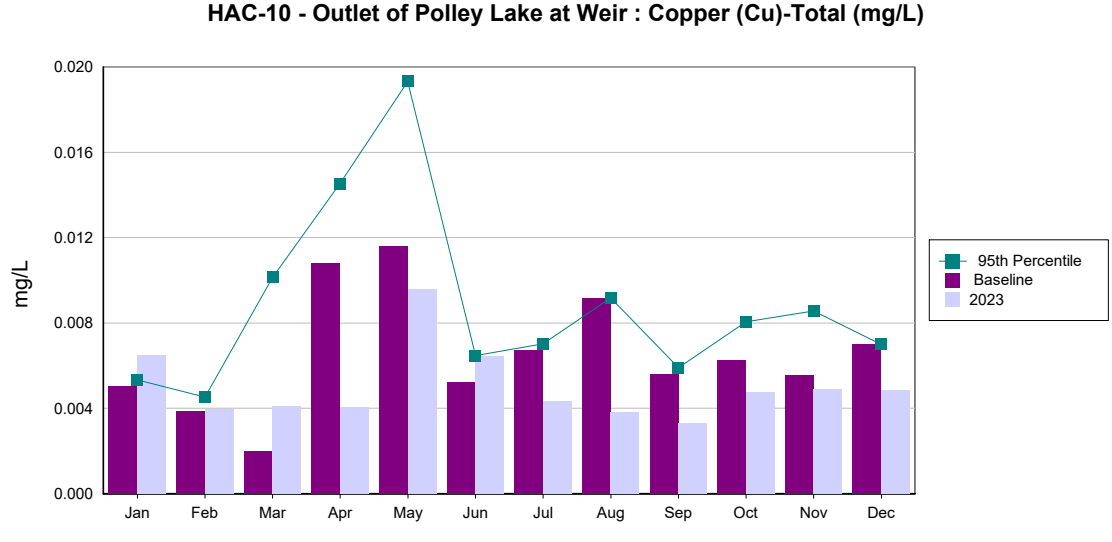
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







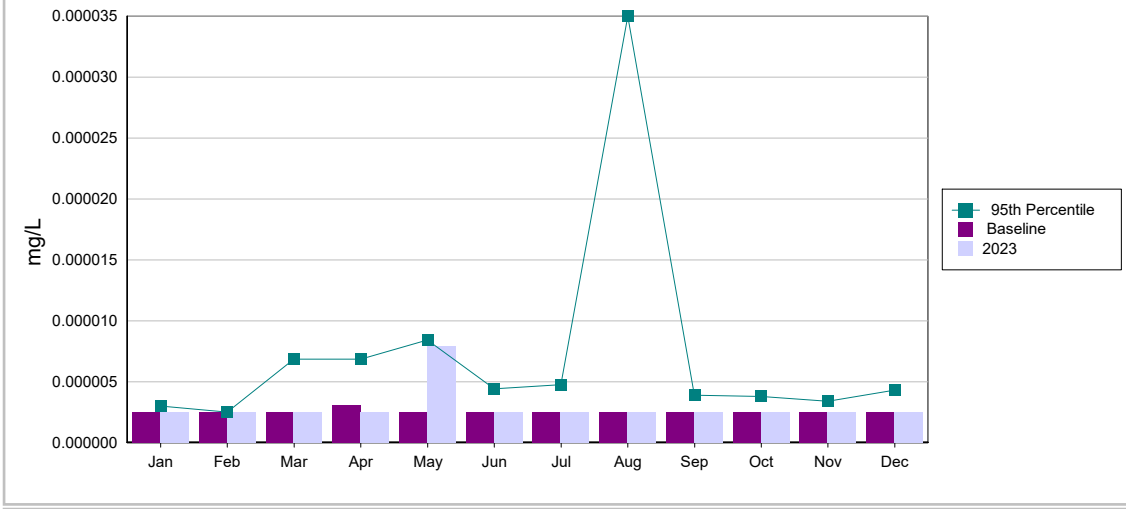
Water Quality Report

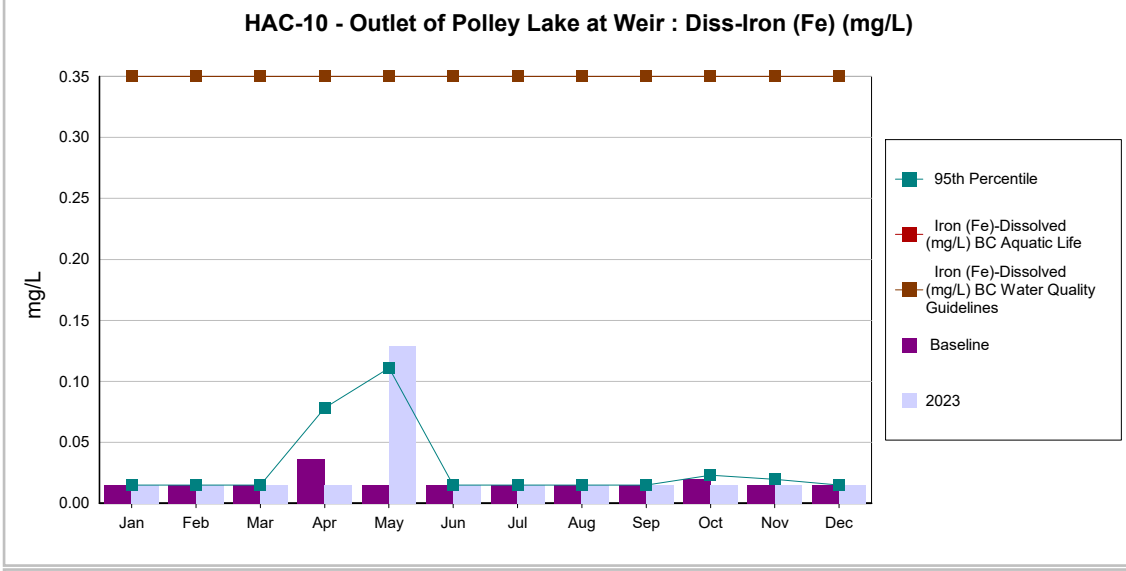
Annual Report HAC vs BCWQG

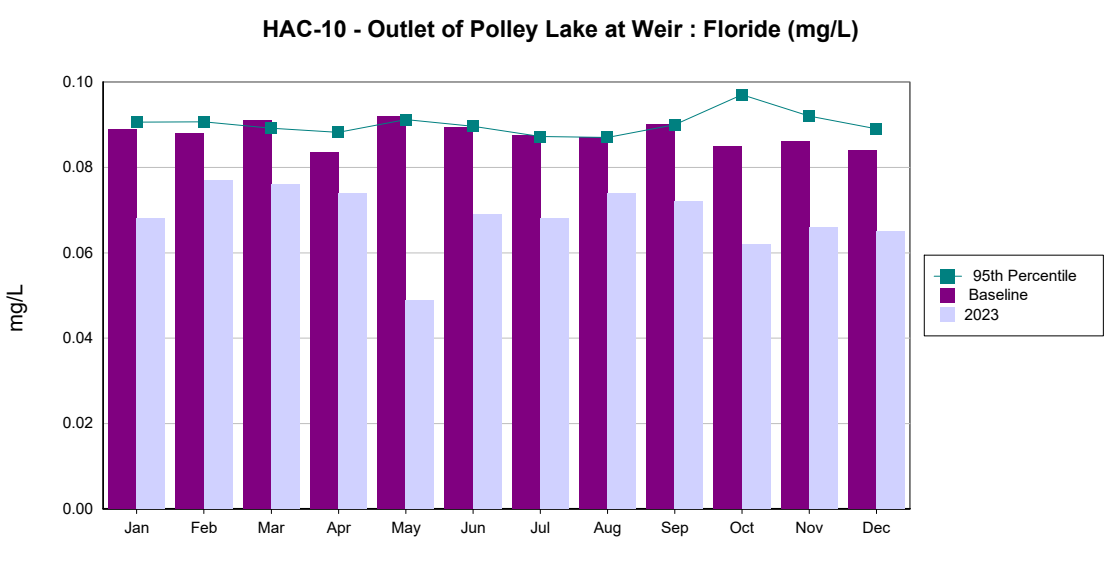
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







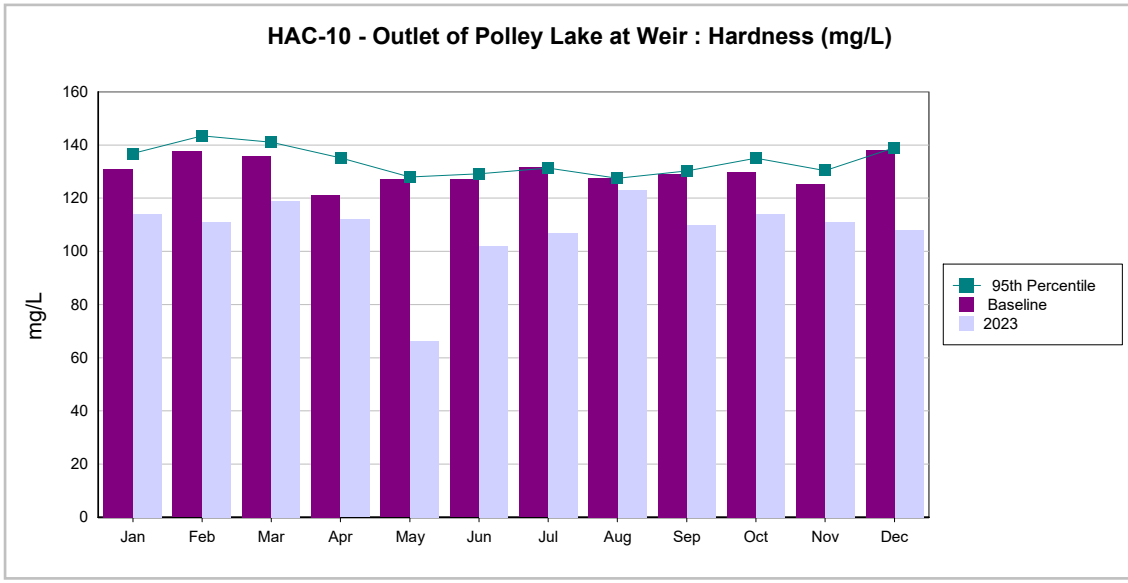
Water Quality Report

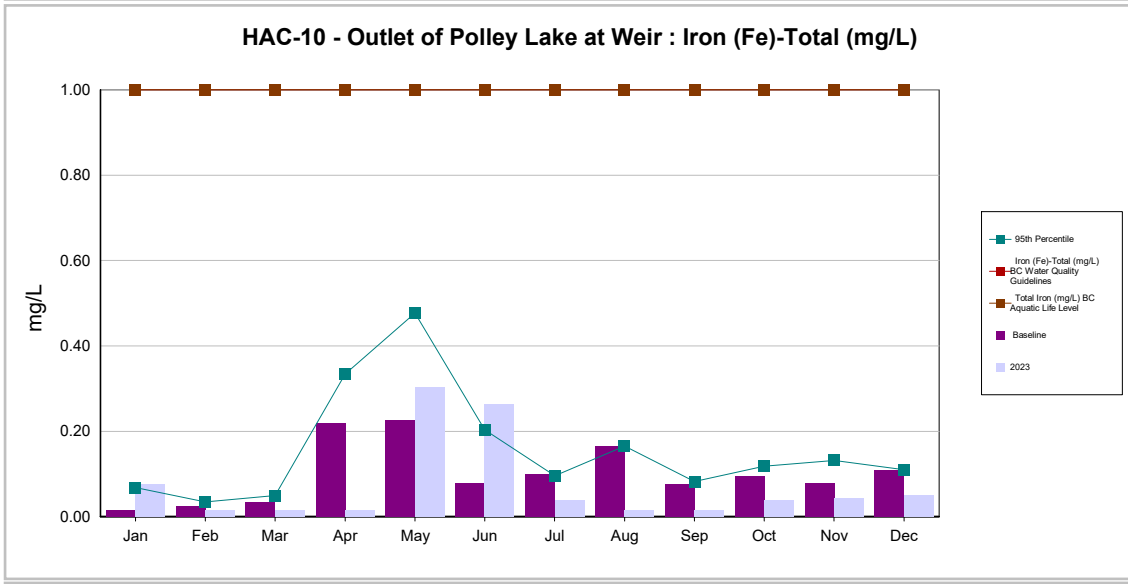
Annual Report HAC vs BCWQG

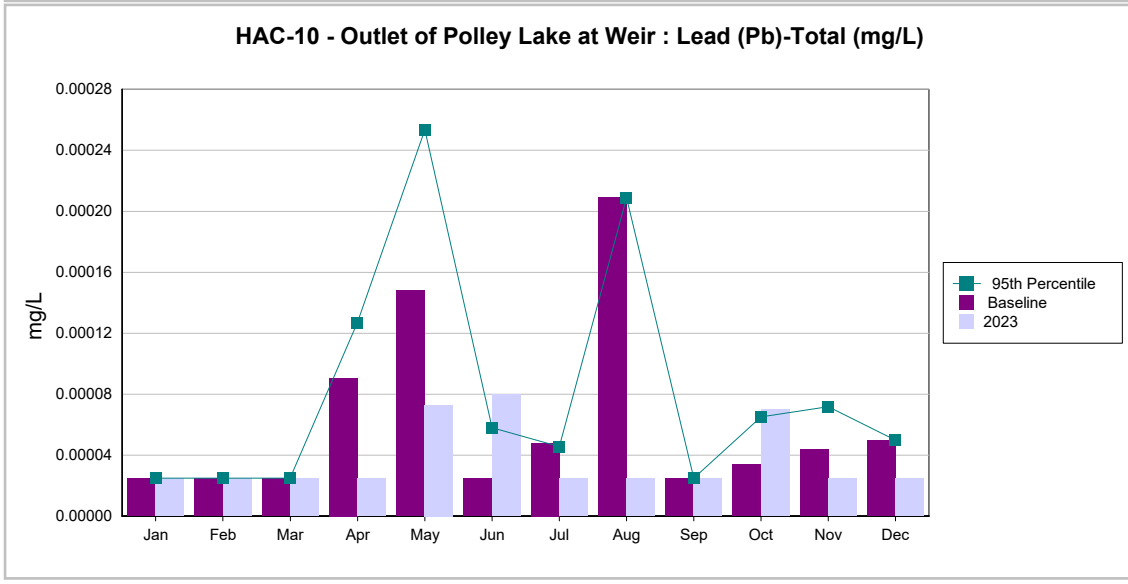
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







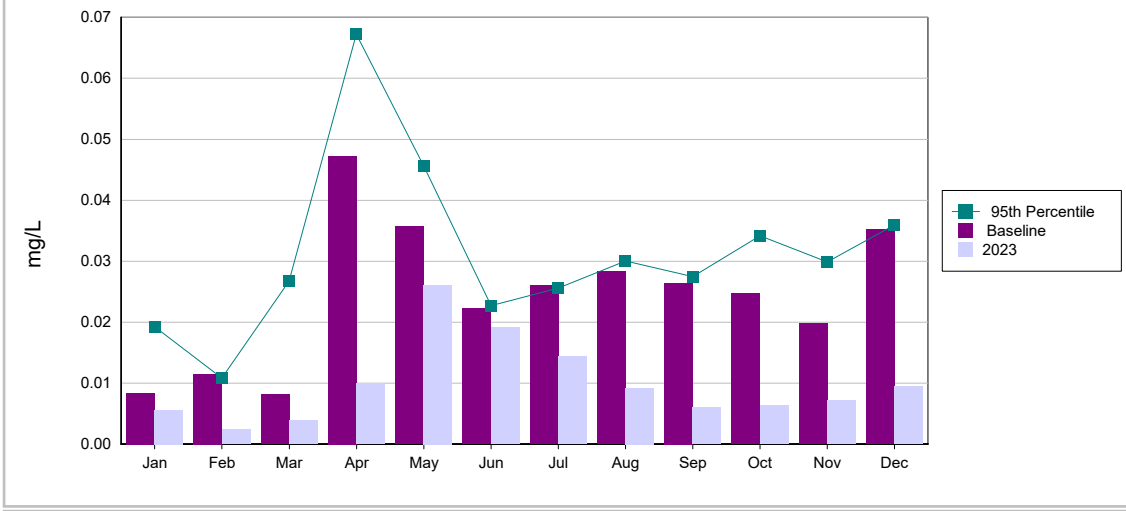
Water Quality Report

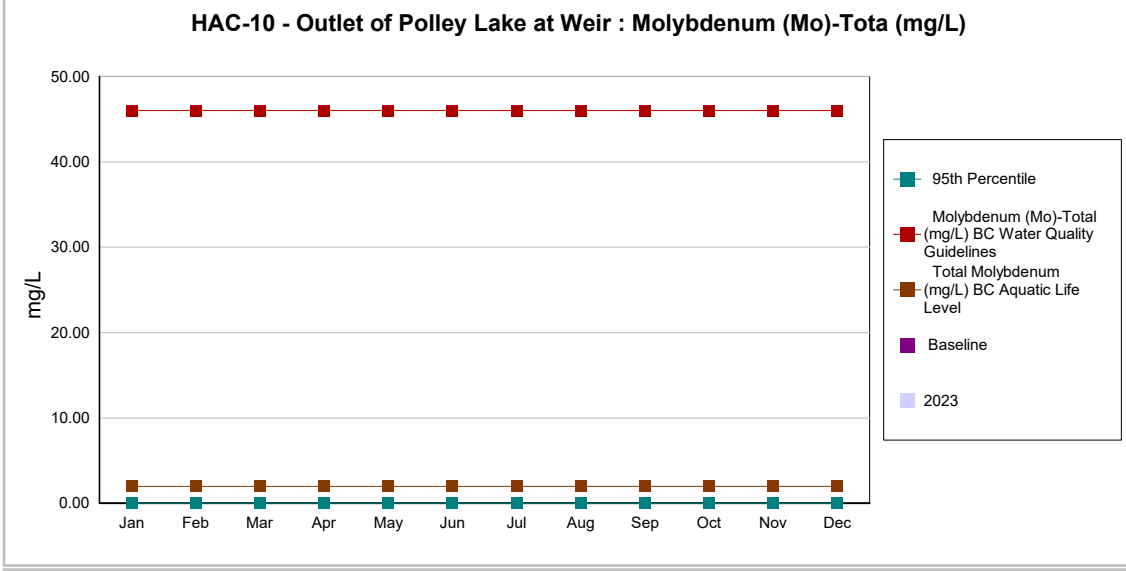
Annual Report HAC vs BCWQG

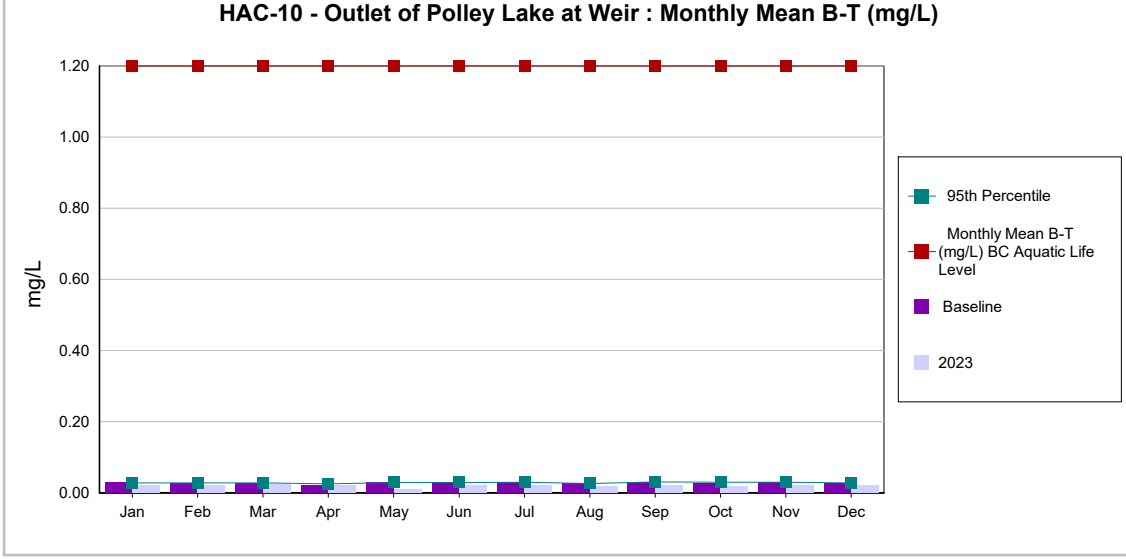
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







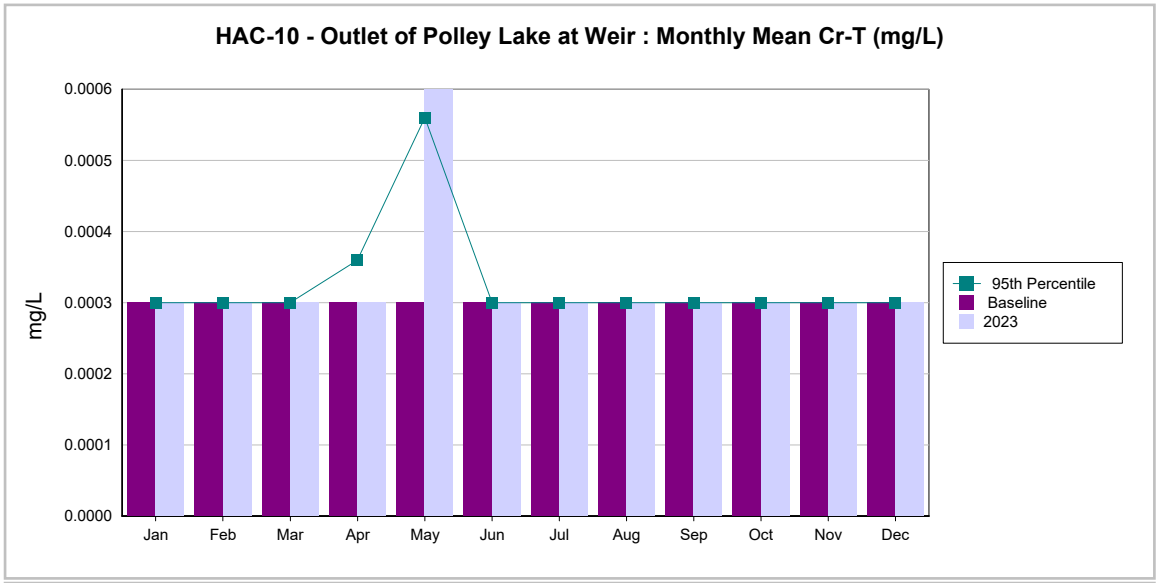
Water Quality Report

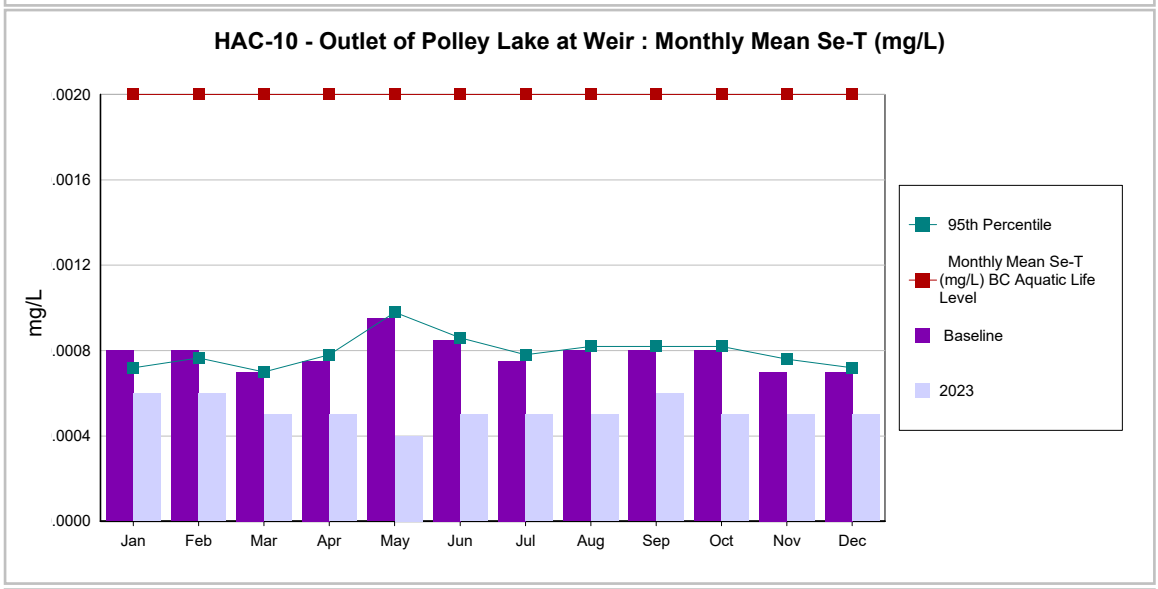
Annual Report HAC vs BCWQG

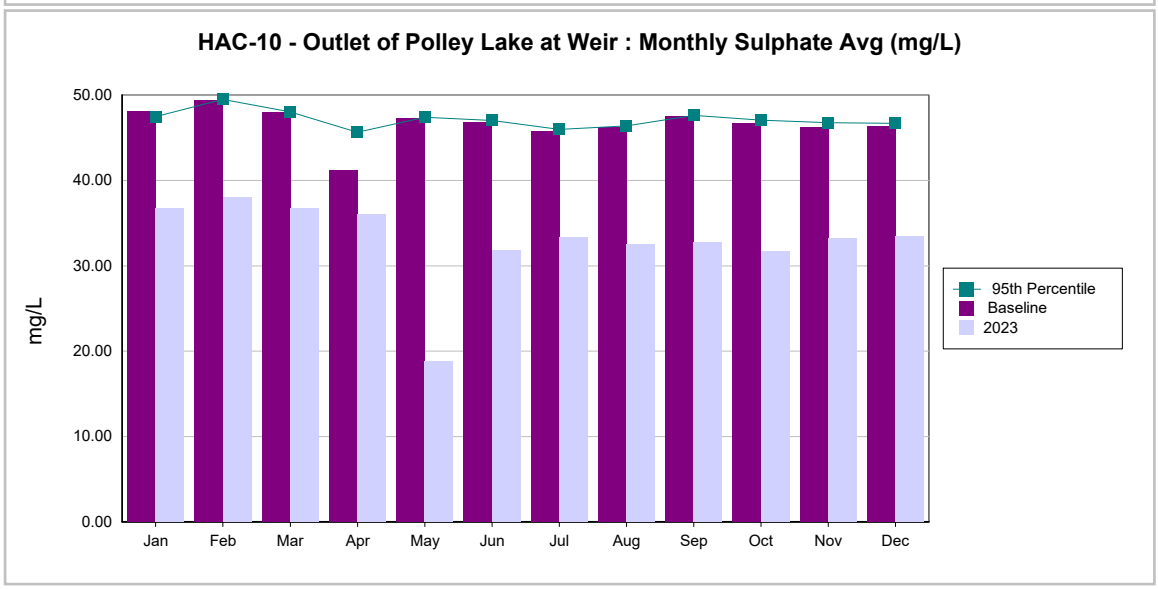
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







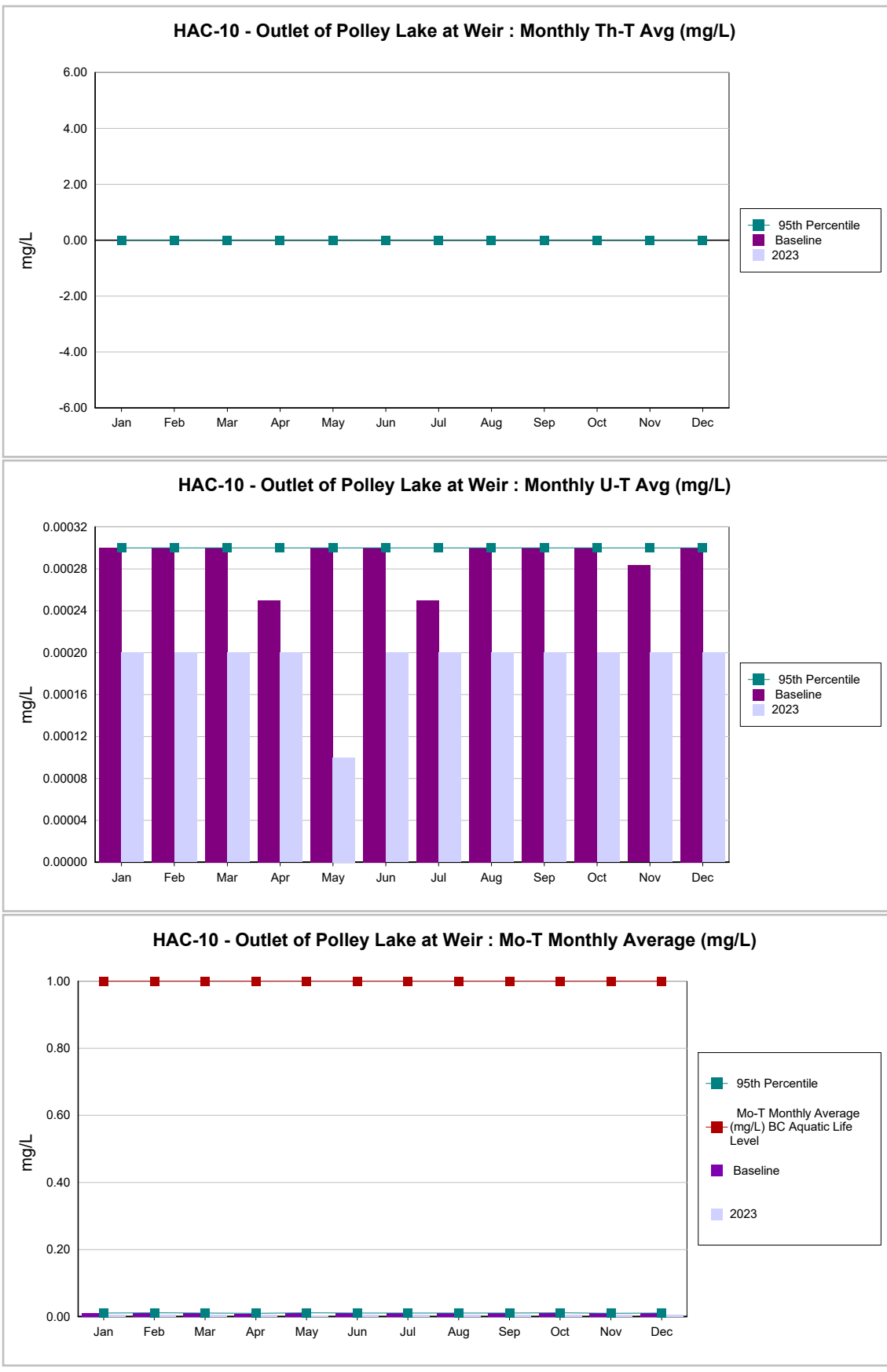
Water Quality Report

Annual Report HAC vs BCWQG

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



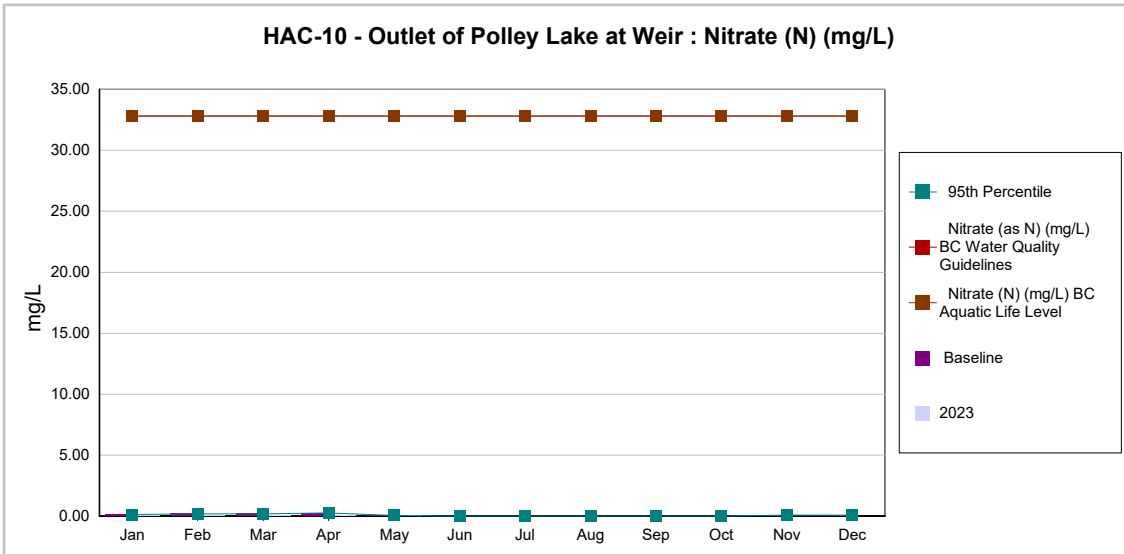
Water Quality Report

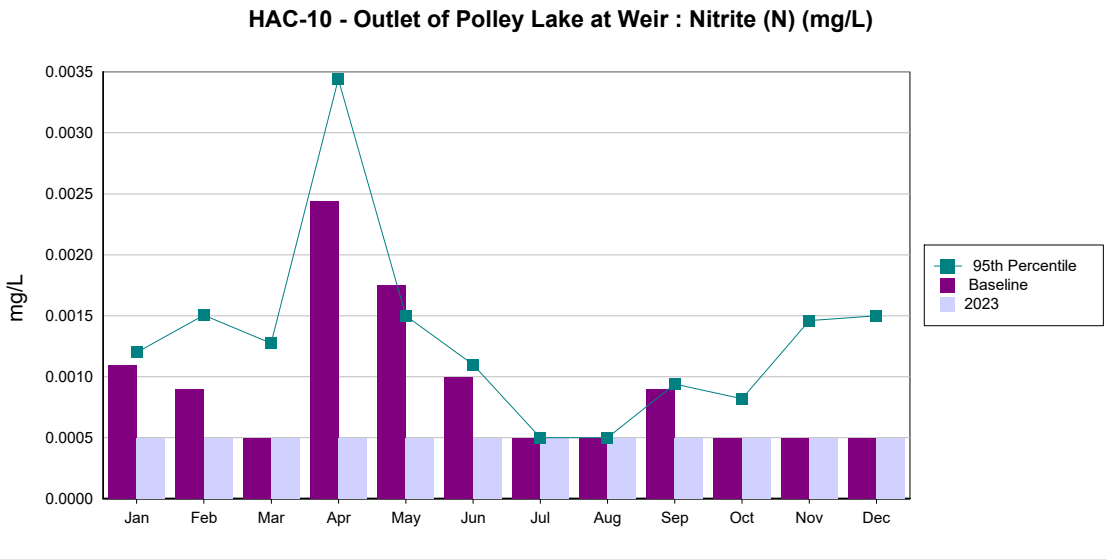
Annual Report HAC vs BCWQG

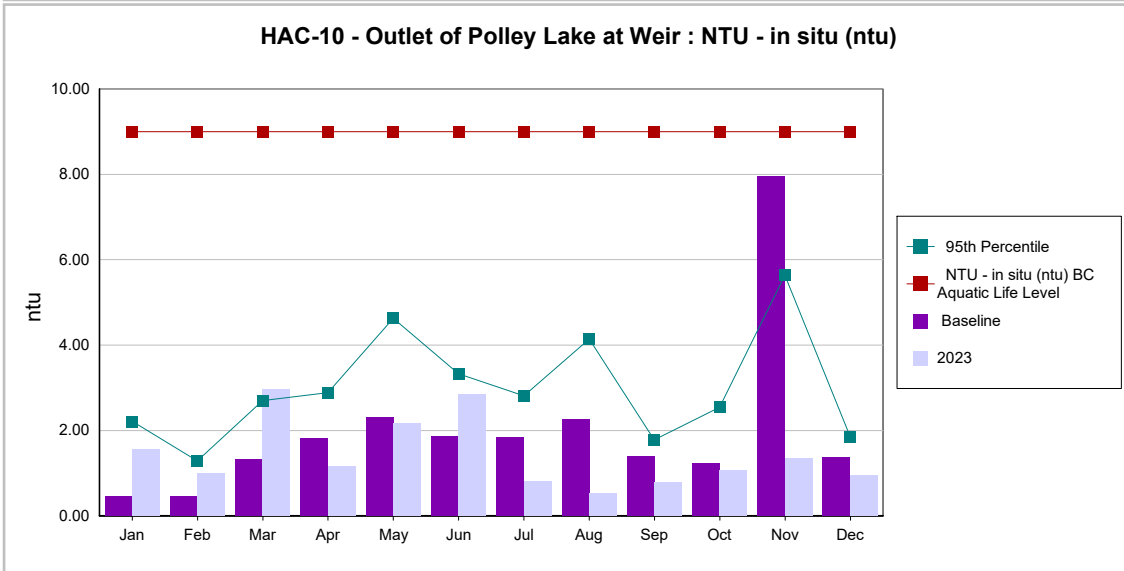
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







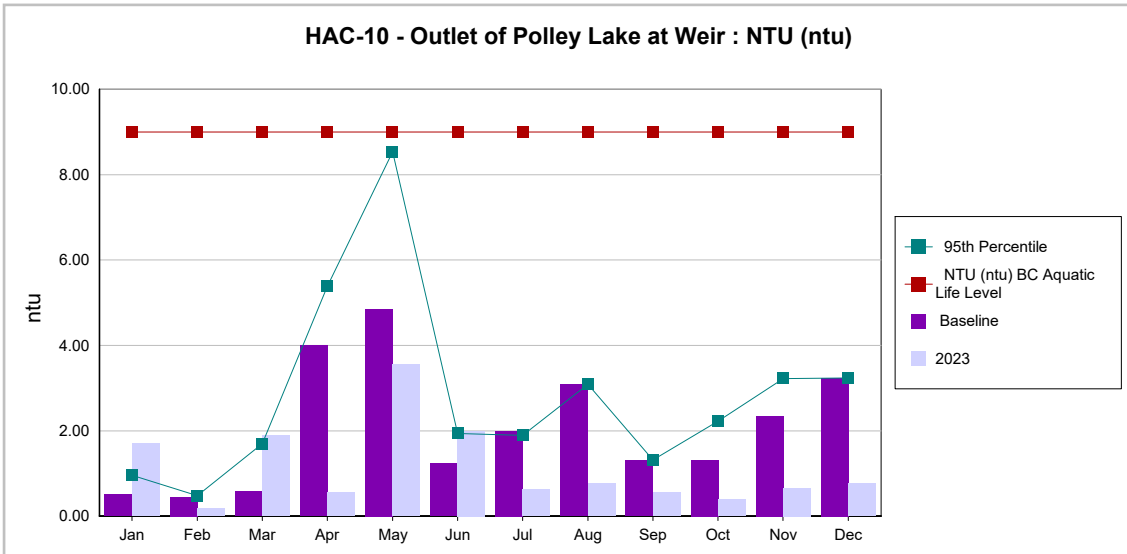
Water Quality Report

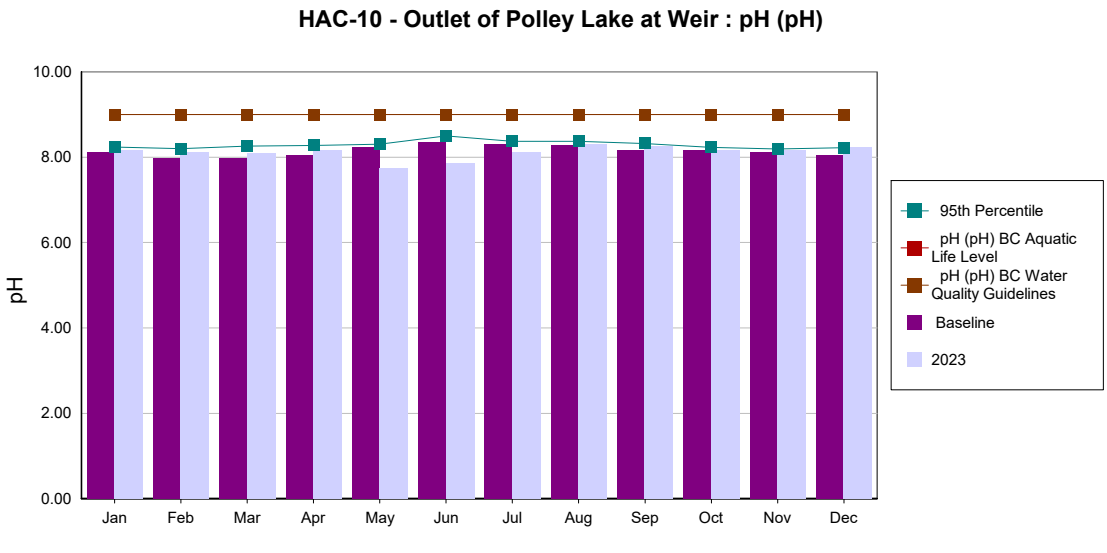
Annual Report HAC vs BCWQG

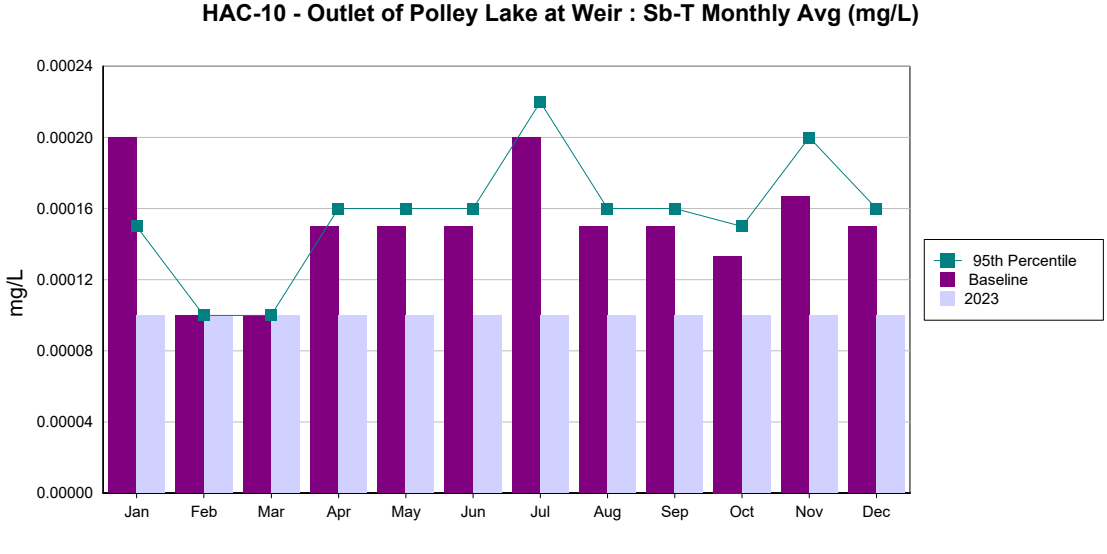
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







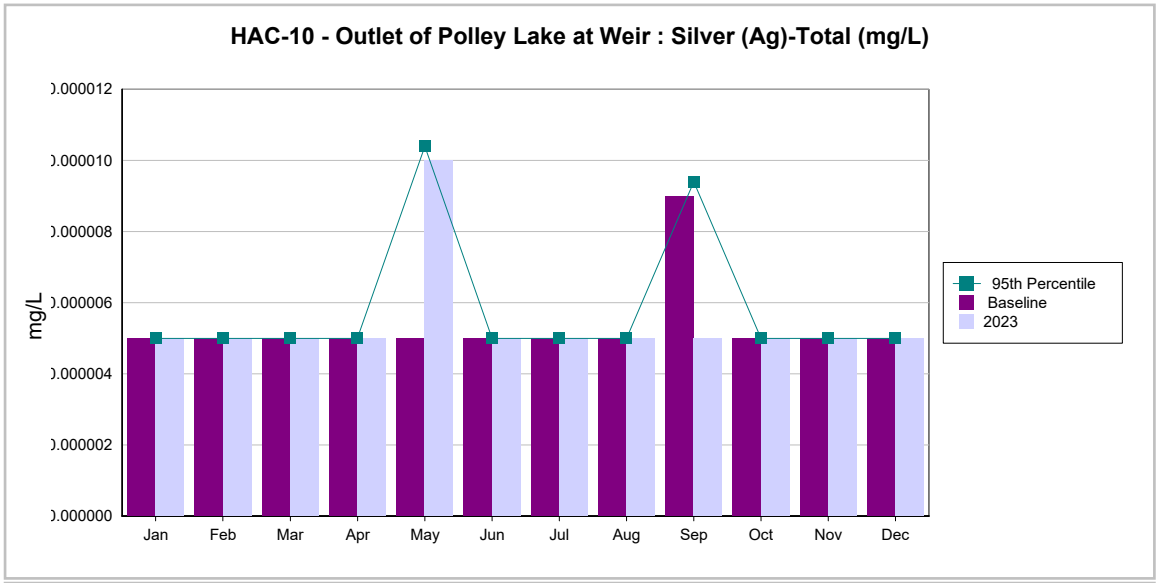
Water Quality Report

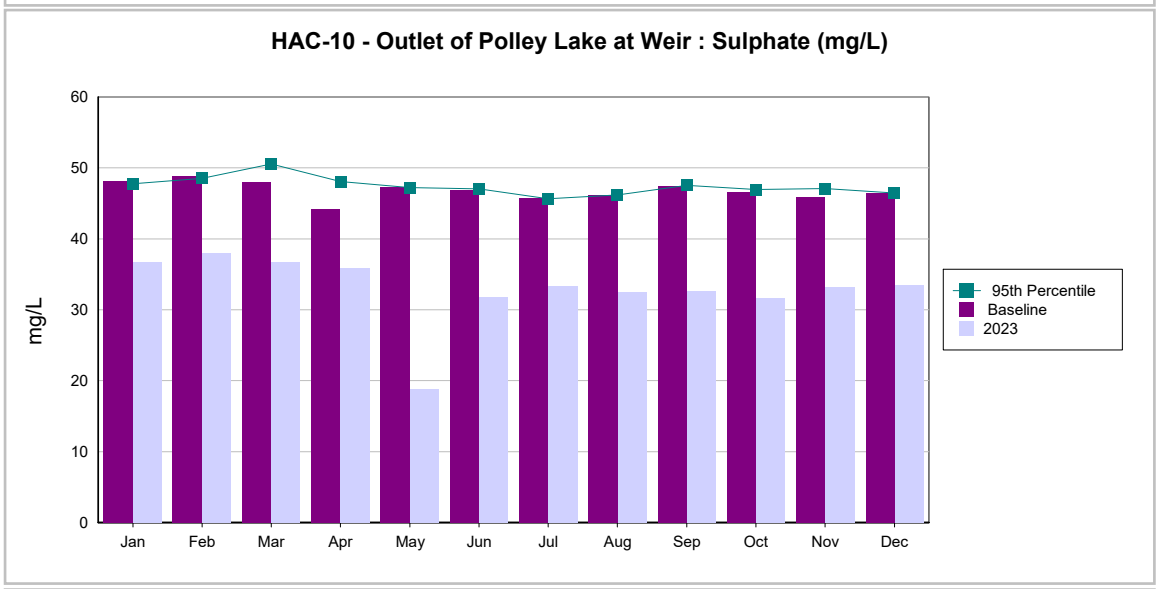
Annual Report HAC vs BCWQG

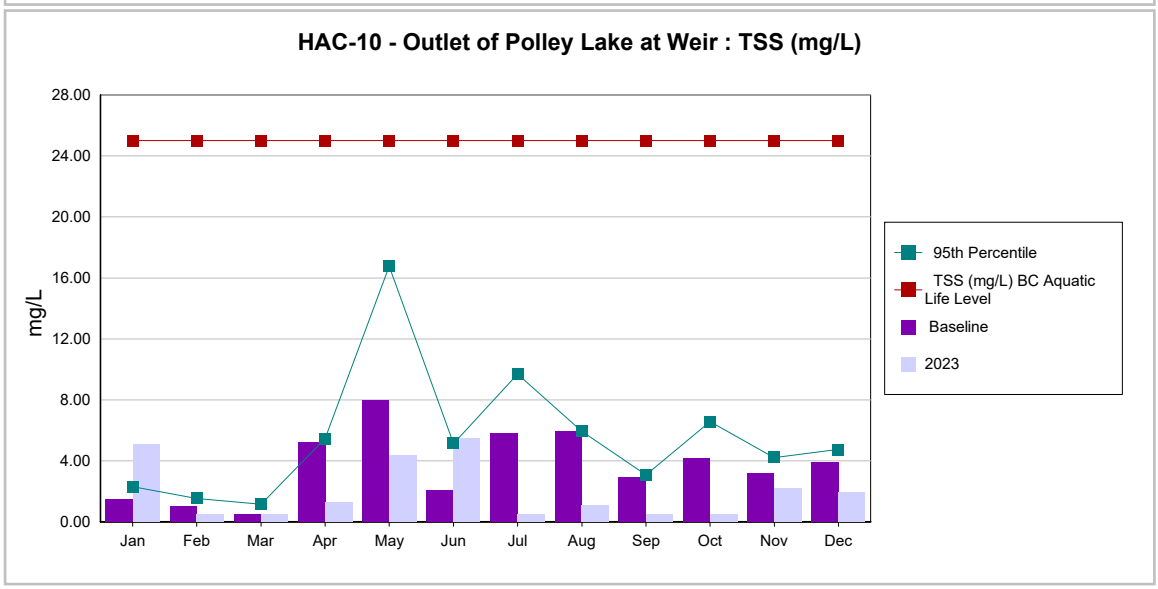
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







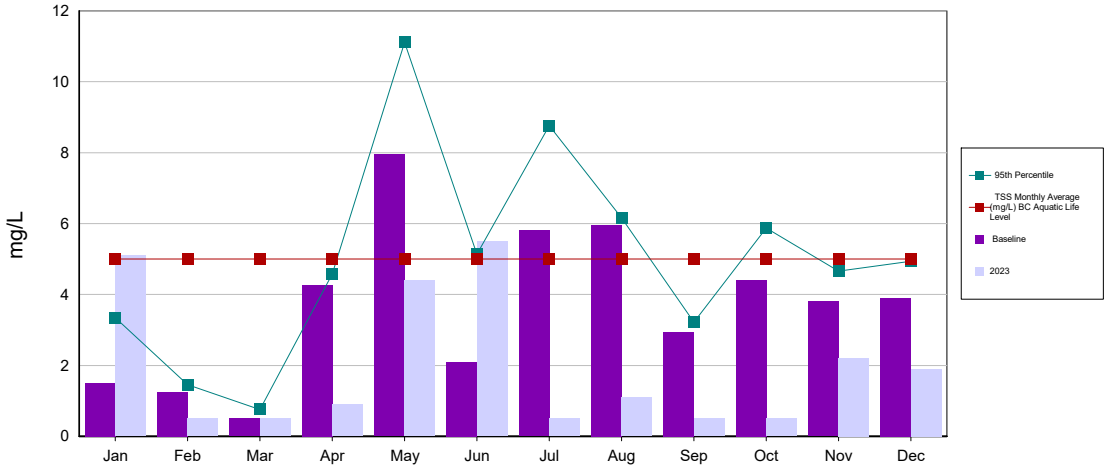
Water Quality Report

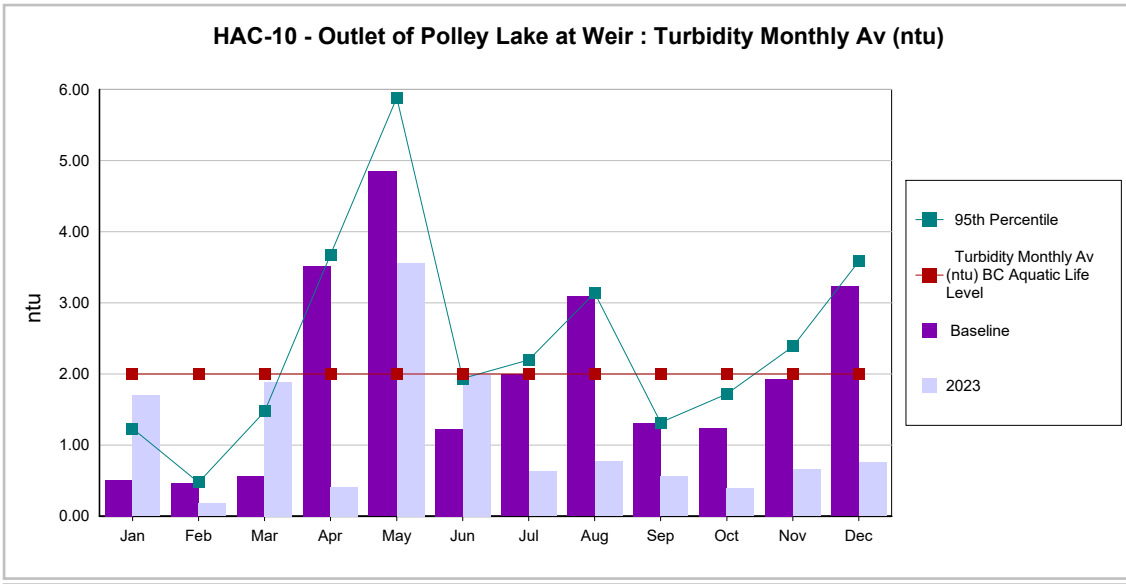
Annual Report HAC vs BCWQG

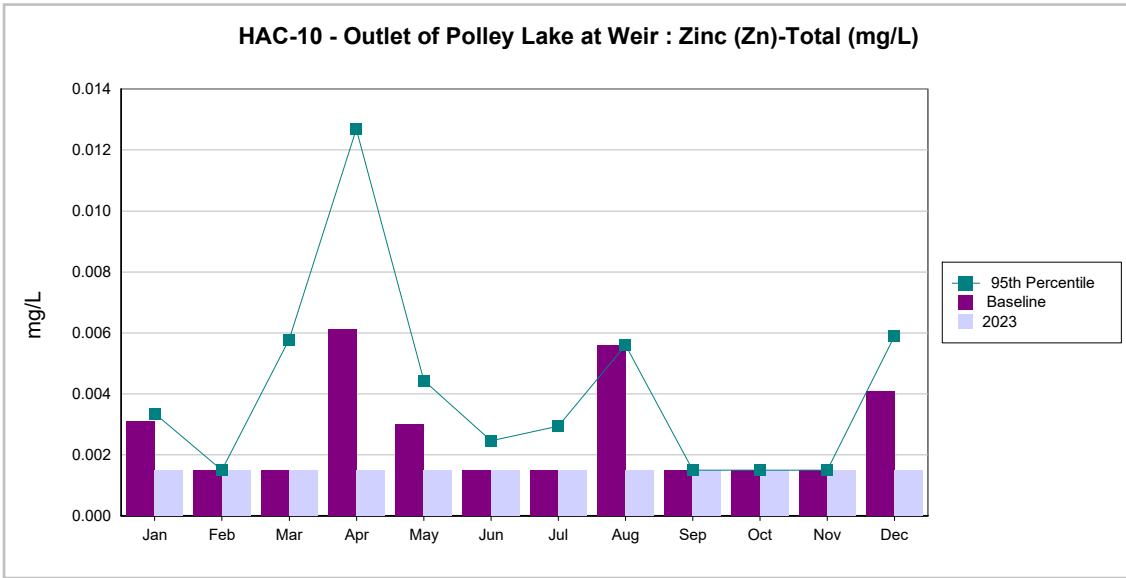
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







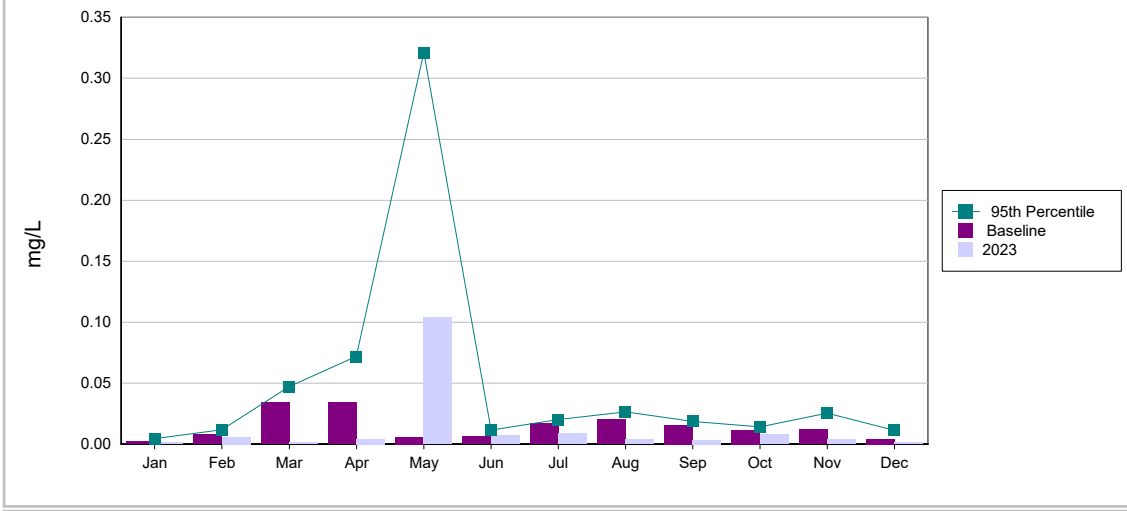
Water Quality Report

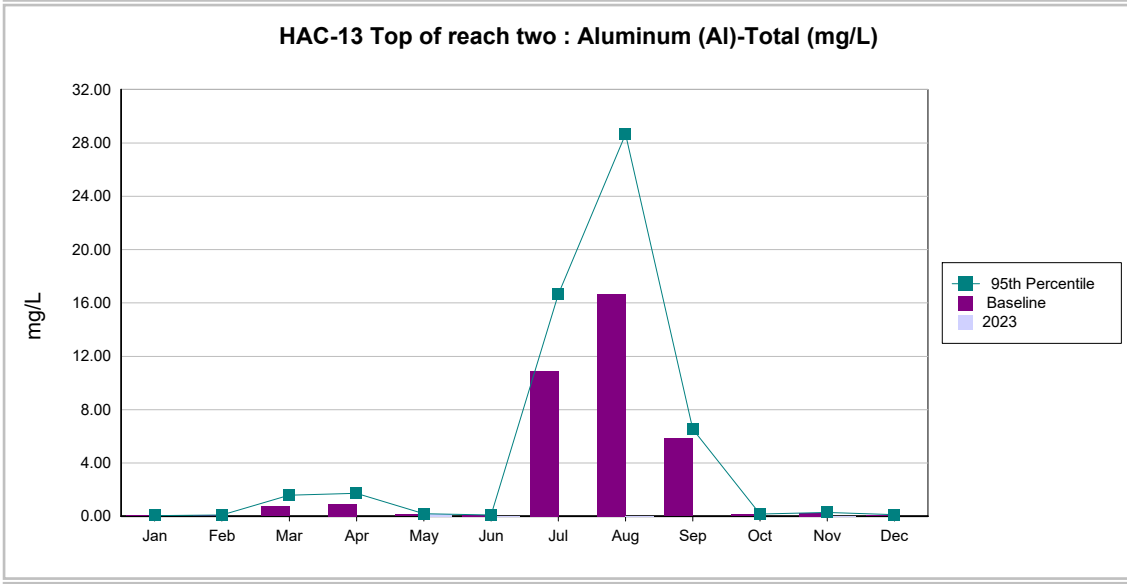
Annual Report HAC vs BCWQG

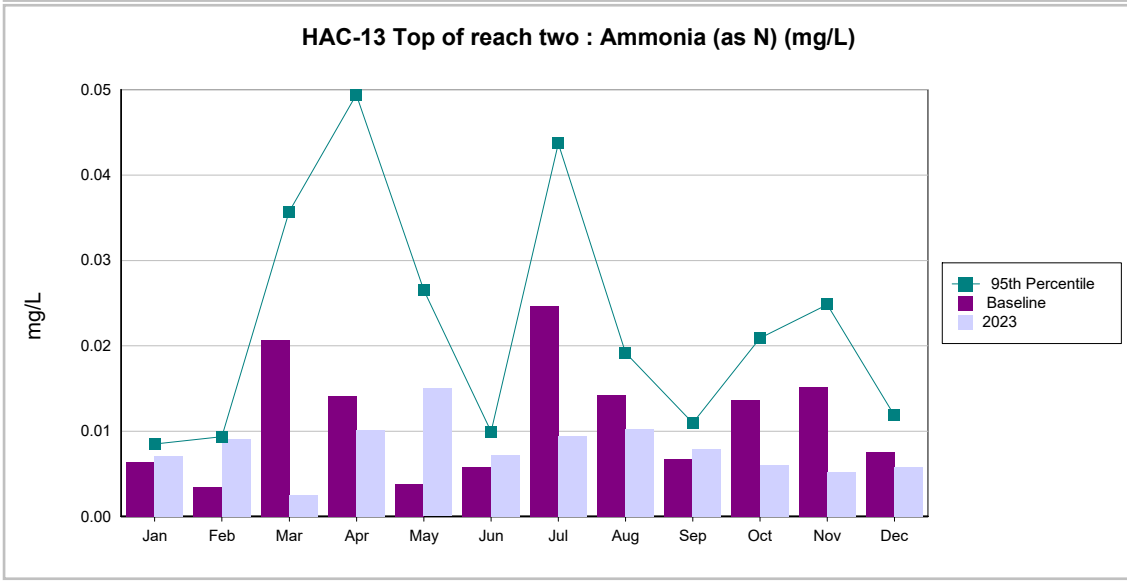
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







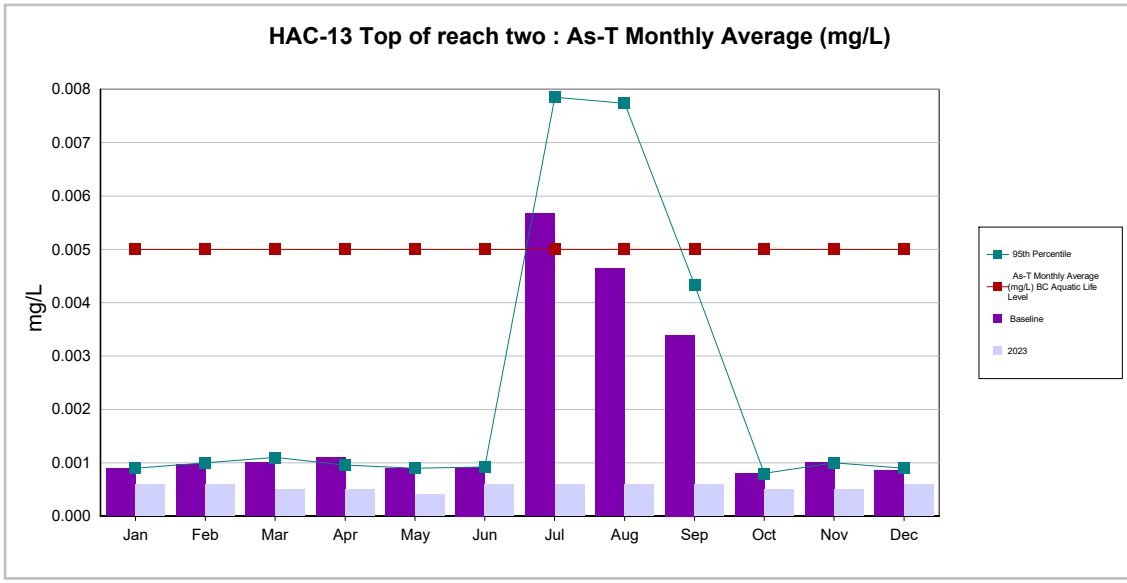
Water Quality Report

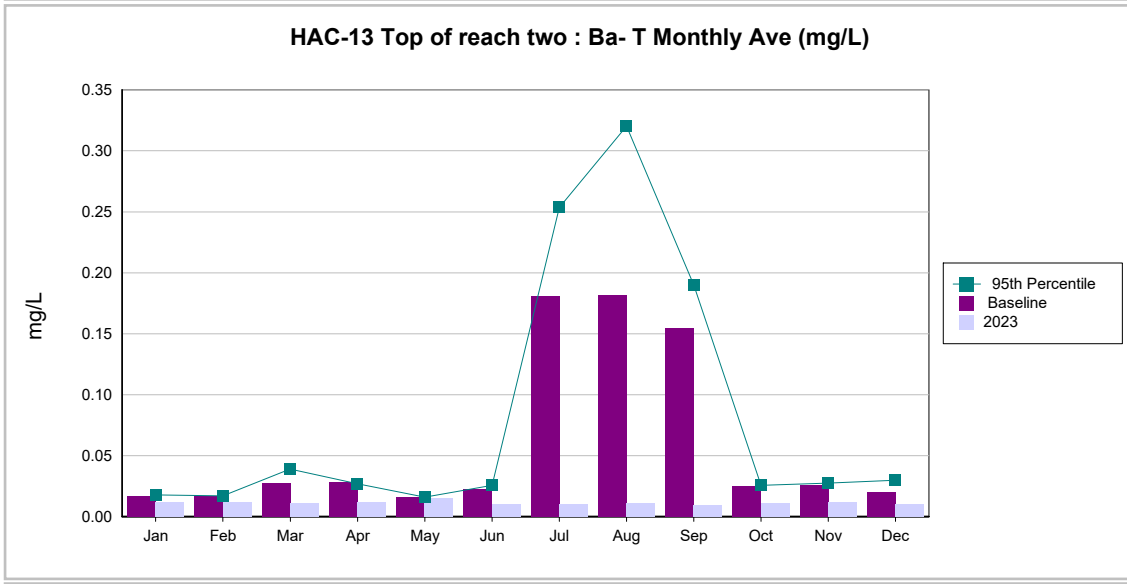
Annual Report HAC vs BCWQG

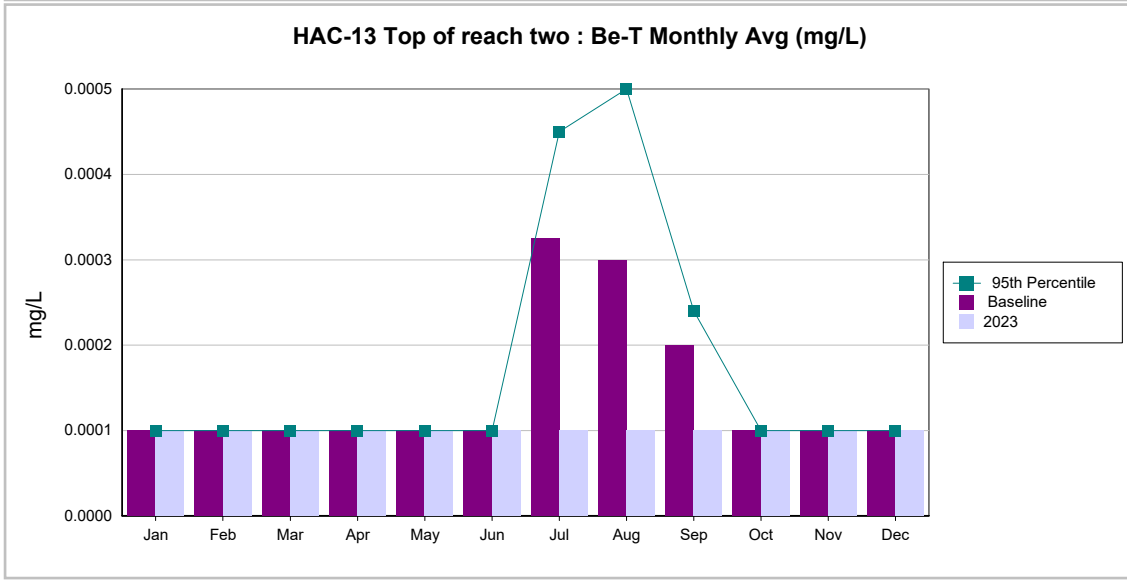
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







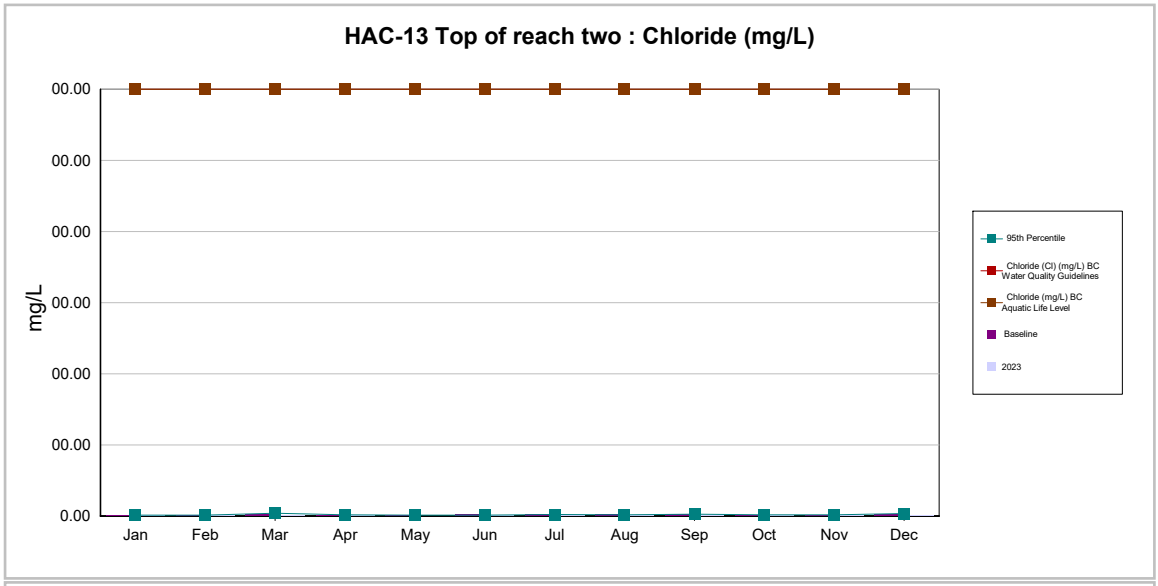
Water Quality Report

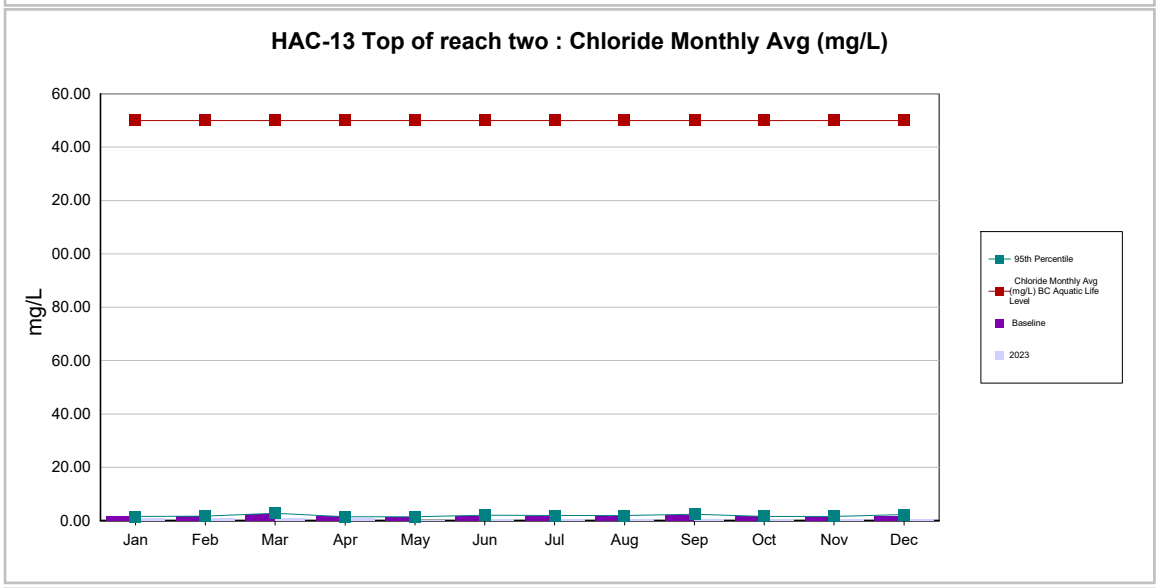
Annual Report HAC vs BCWQG

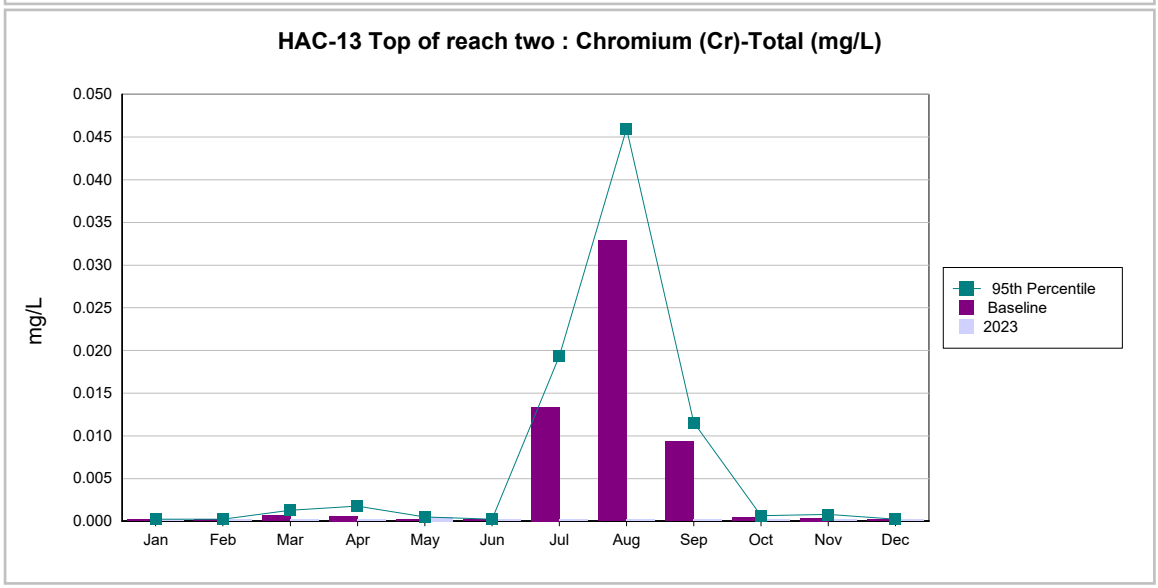
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







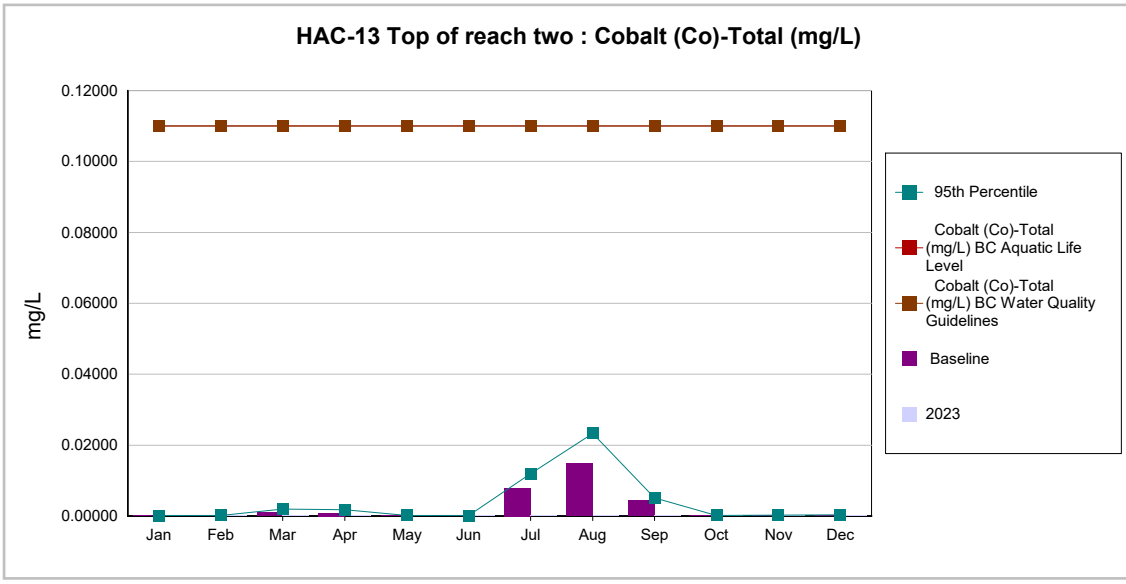
Water Quality Report

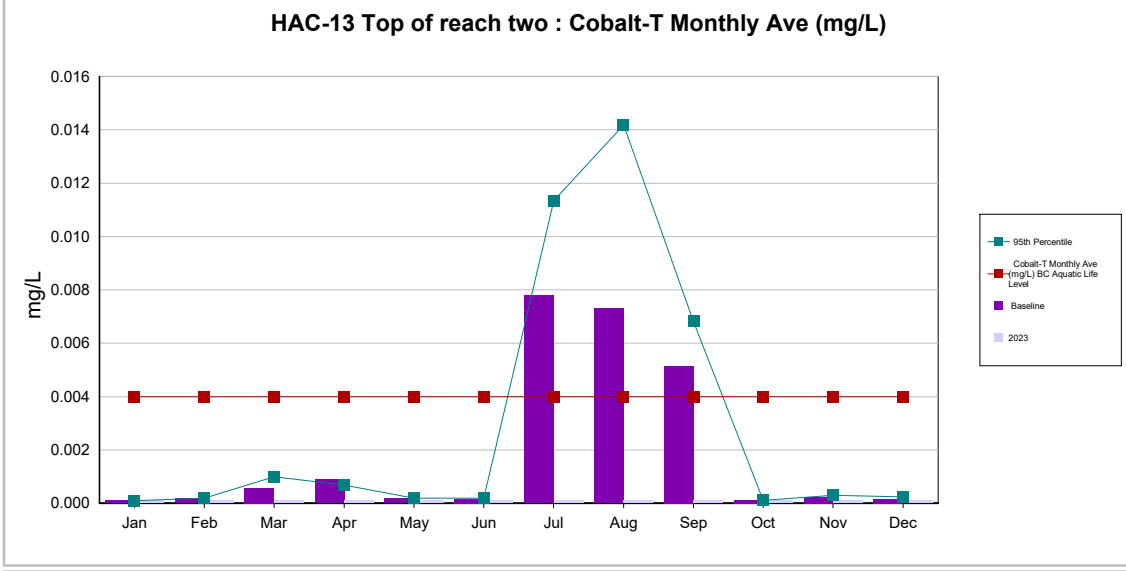
Annual Report HAC vs BCWQG

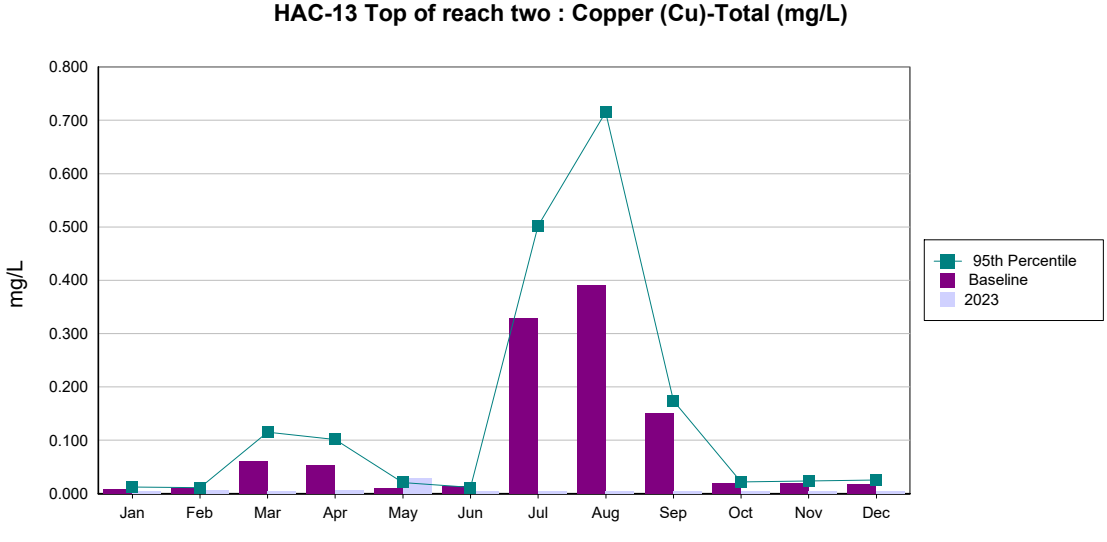
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







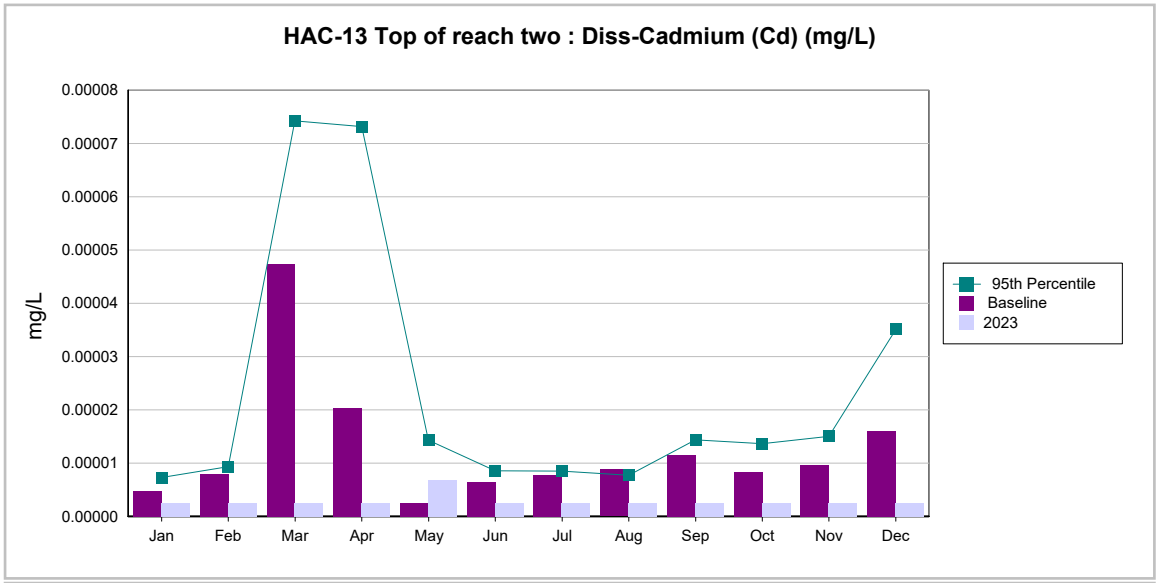
Water Quality Report

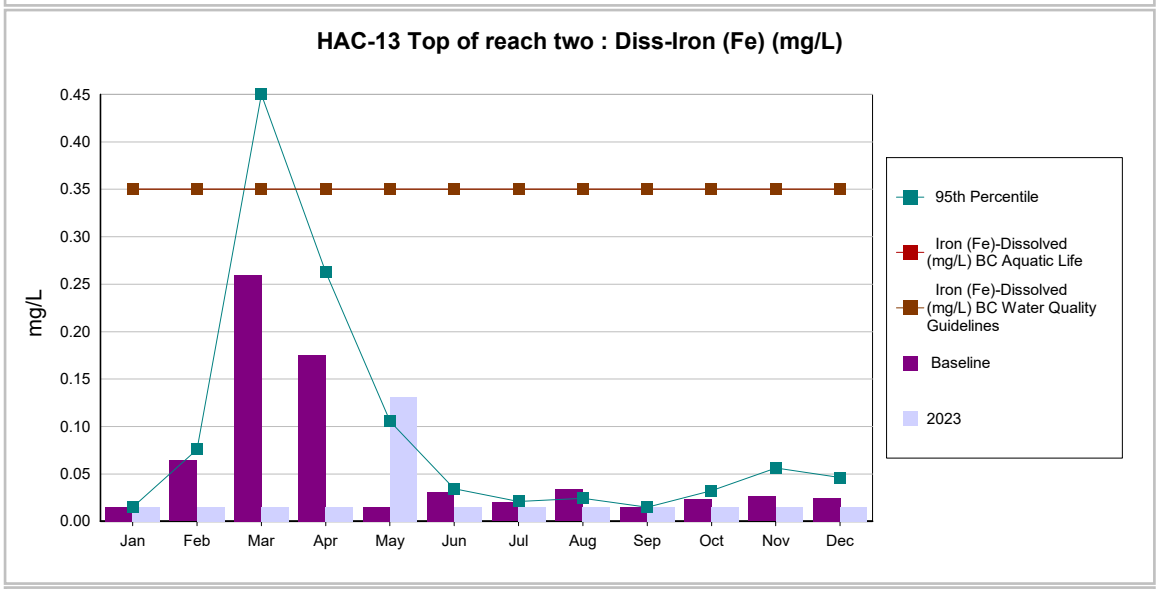
Annual Report HAC vs BCWQG

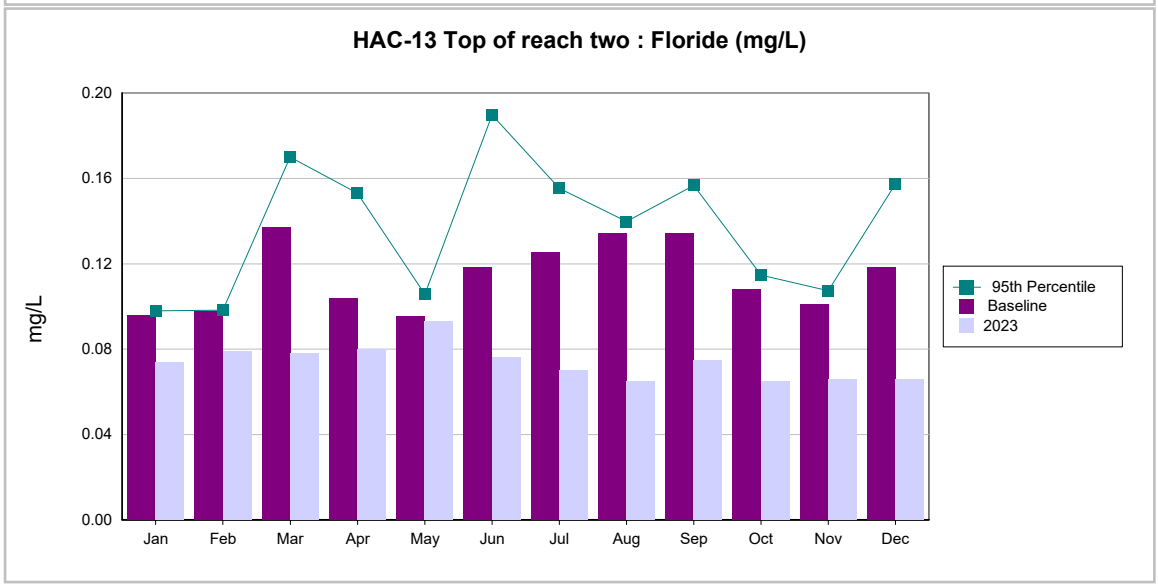
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







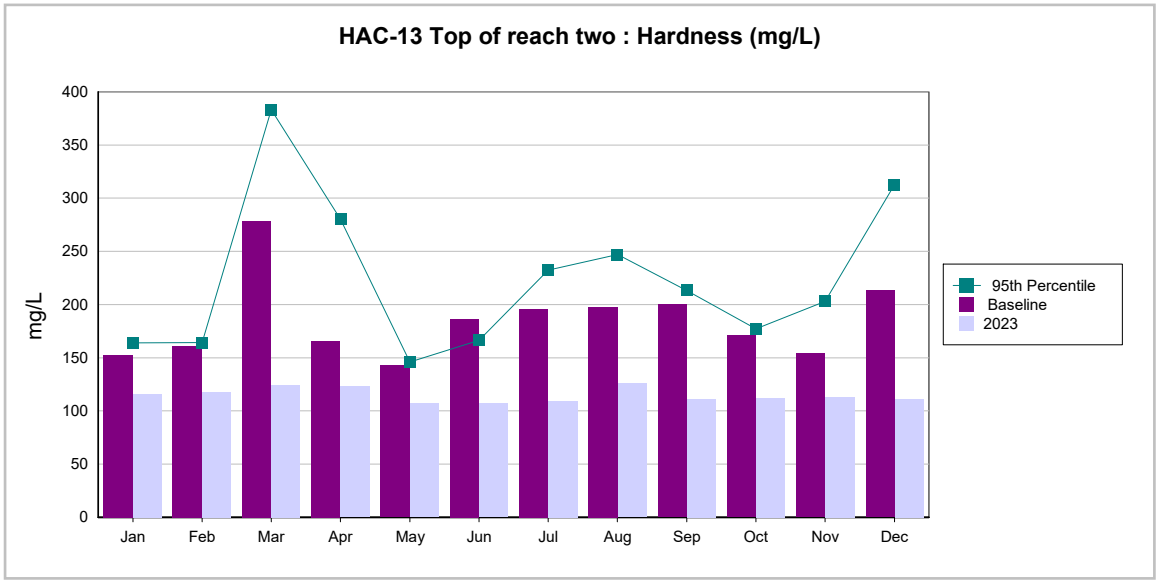
Water Quality Report

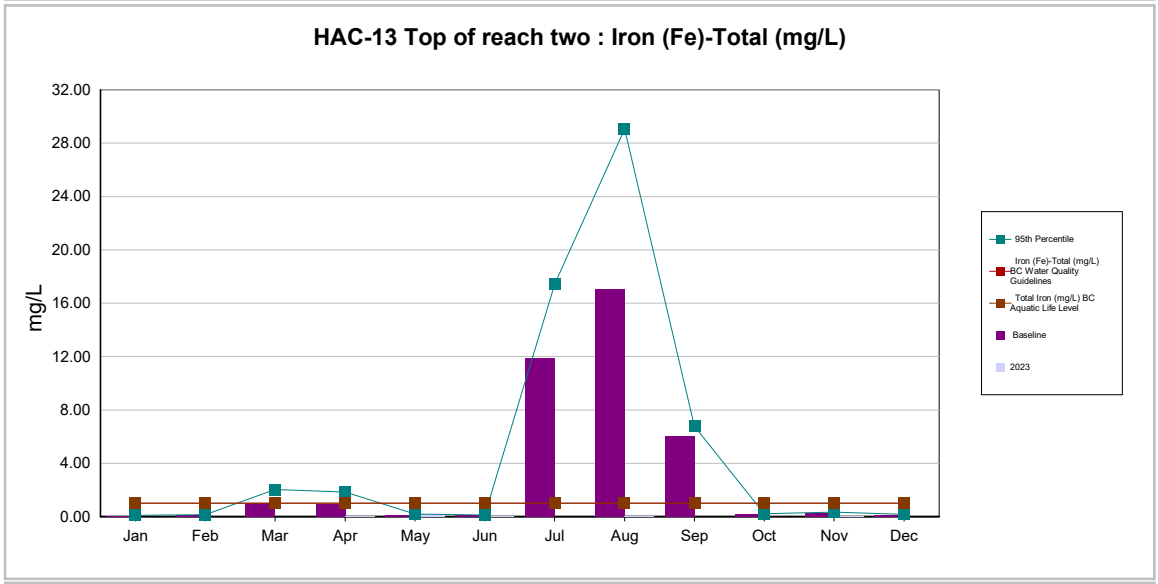
Annual Report HAC vs BCWQG

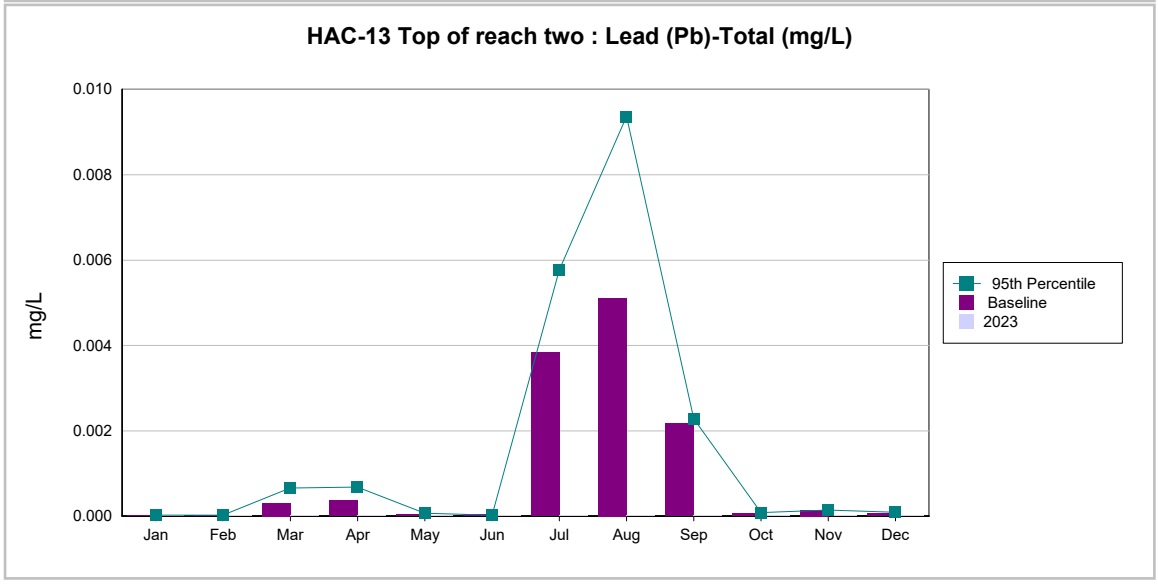
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







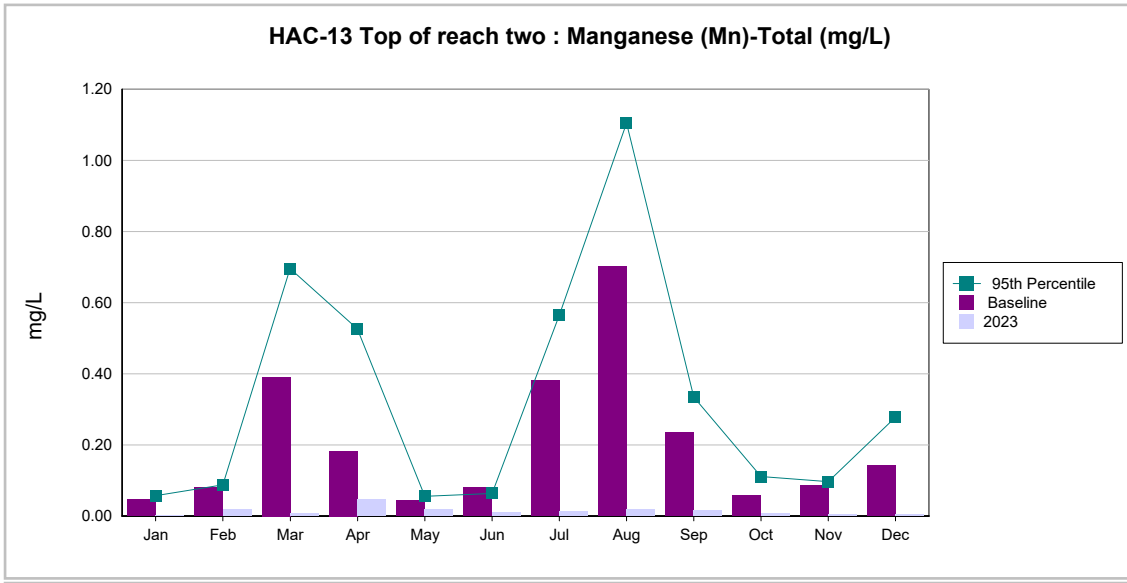
Water Quality Report

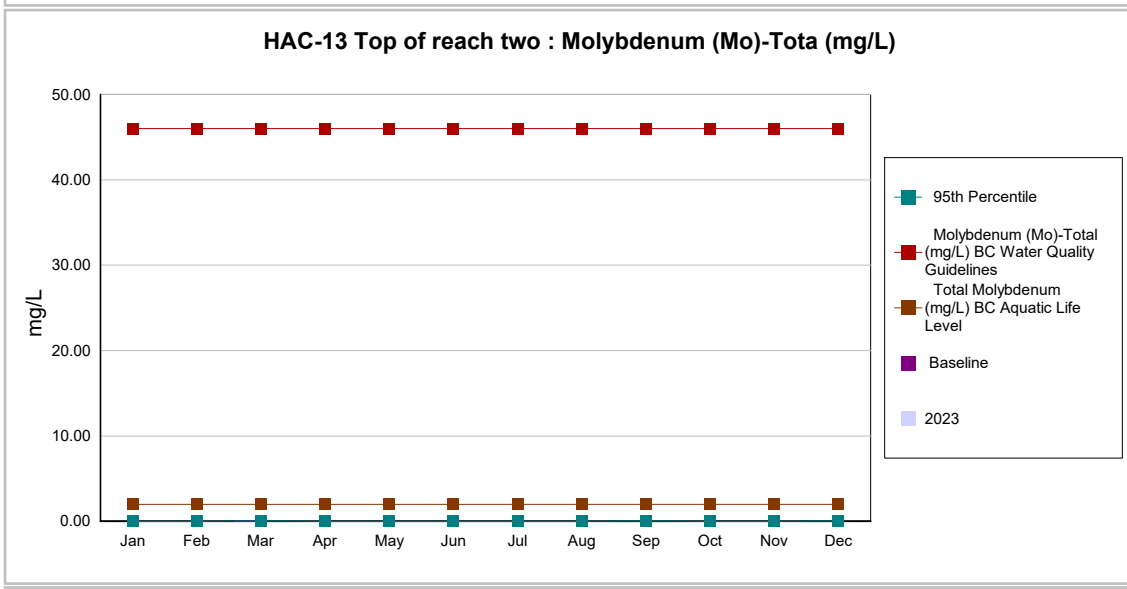
Annual Report HAC vs BCWQG

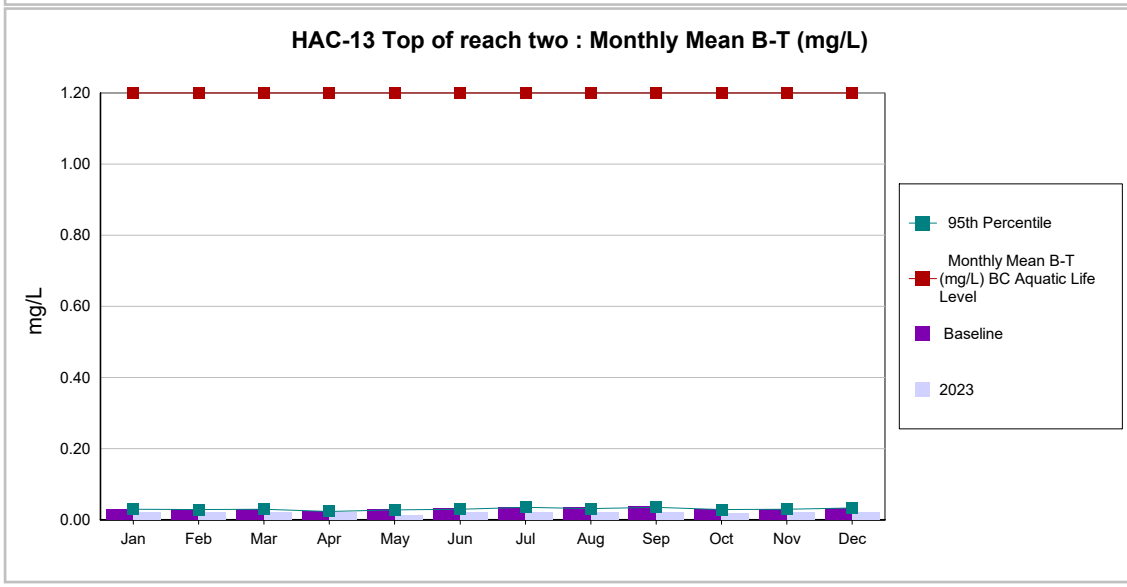
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







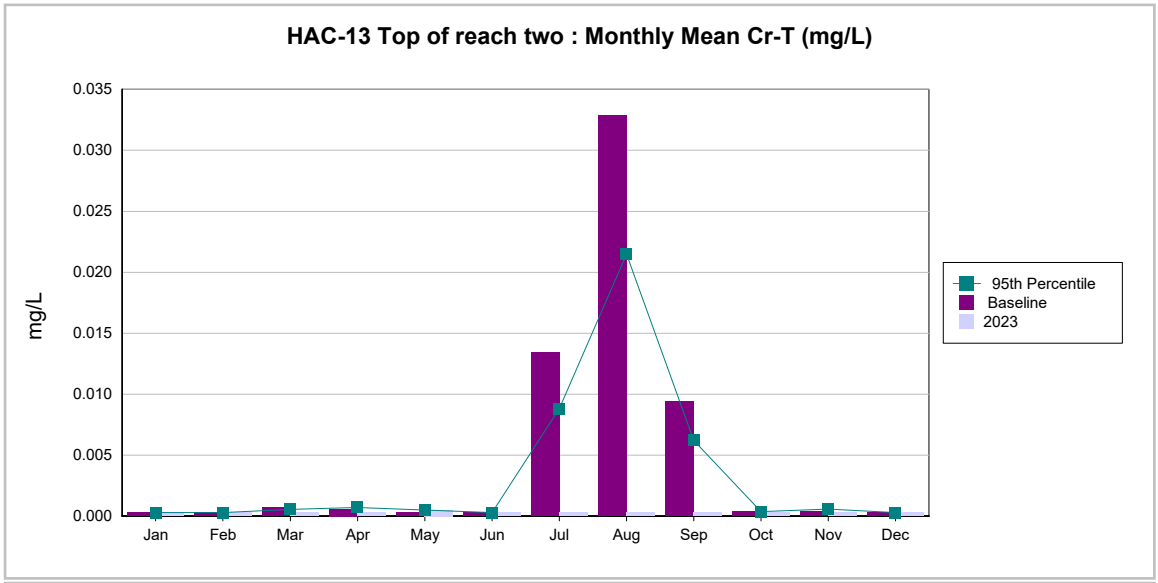
Water Quality Report

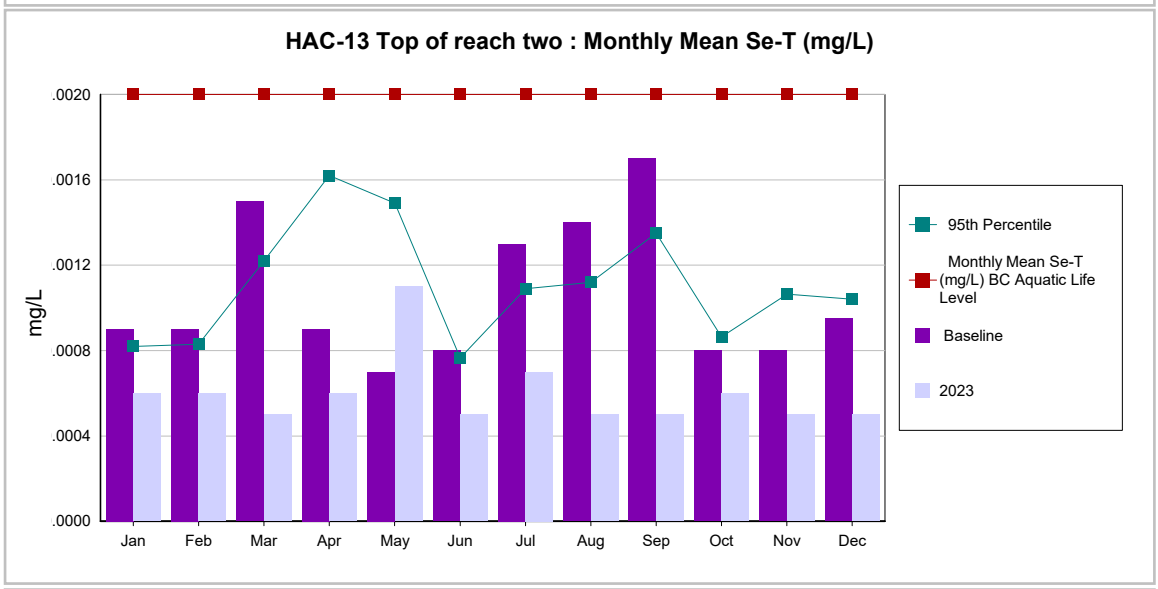
Annual Report HAC vs BCWQG

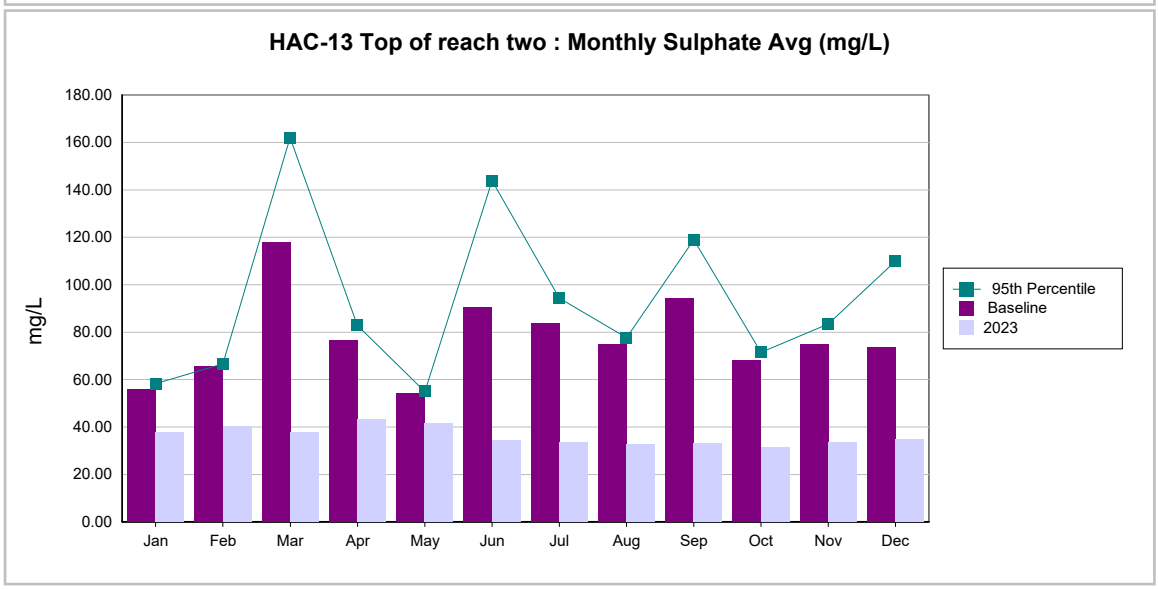
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







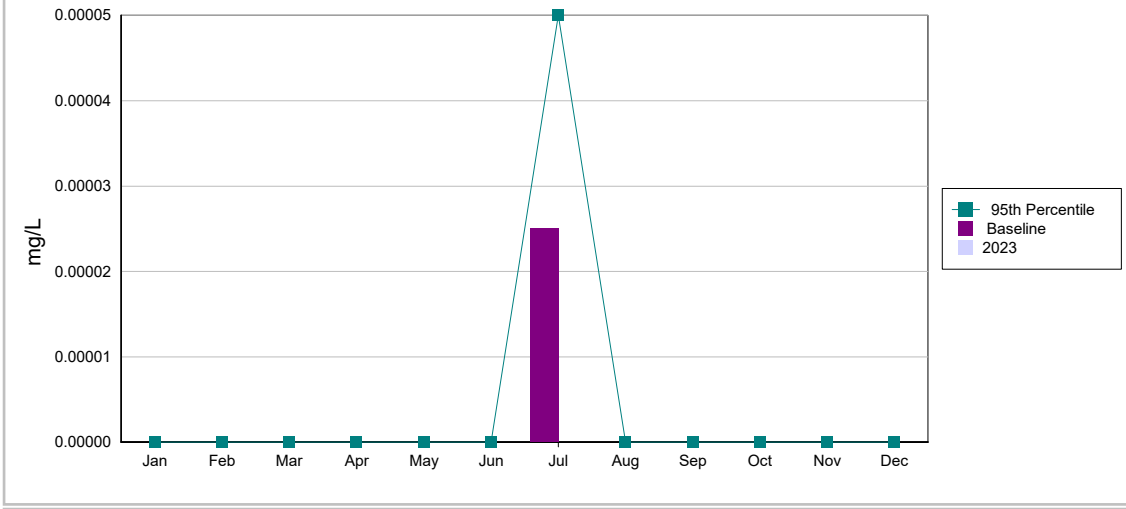
Water Quality Report

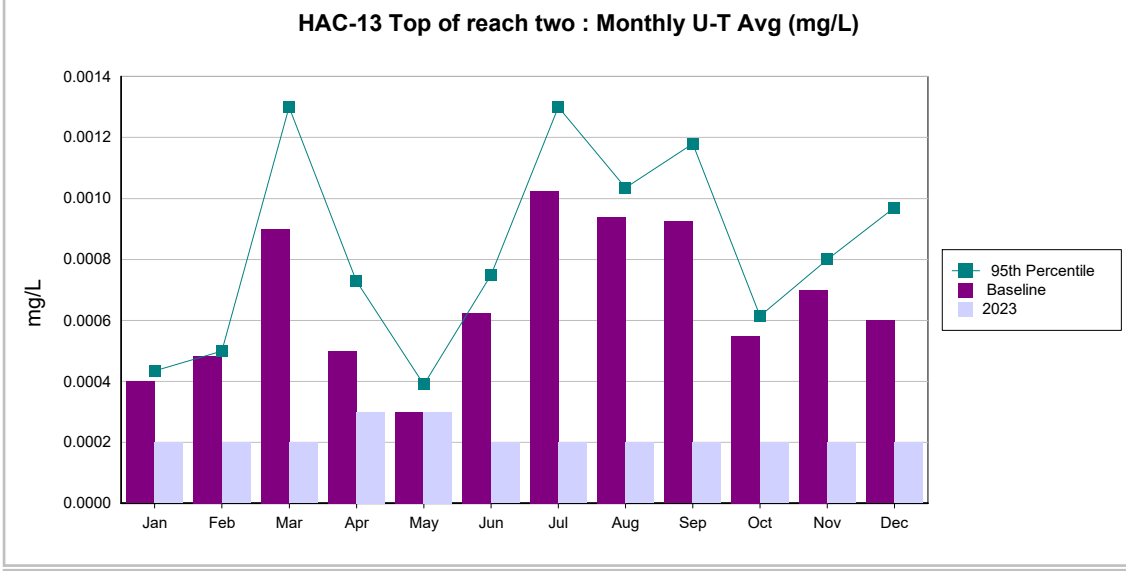
Annual Report HAC vs BCWQG

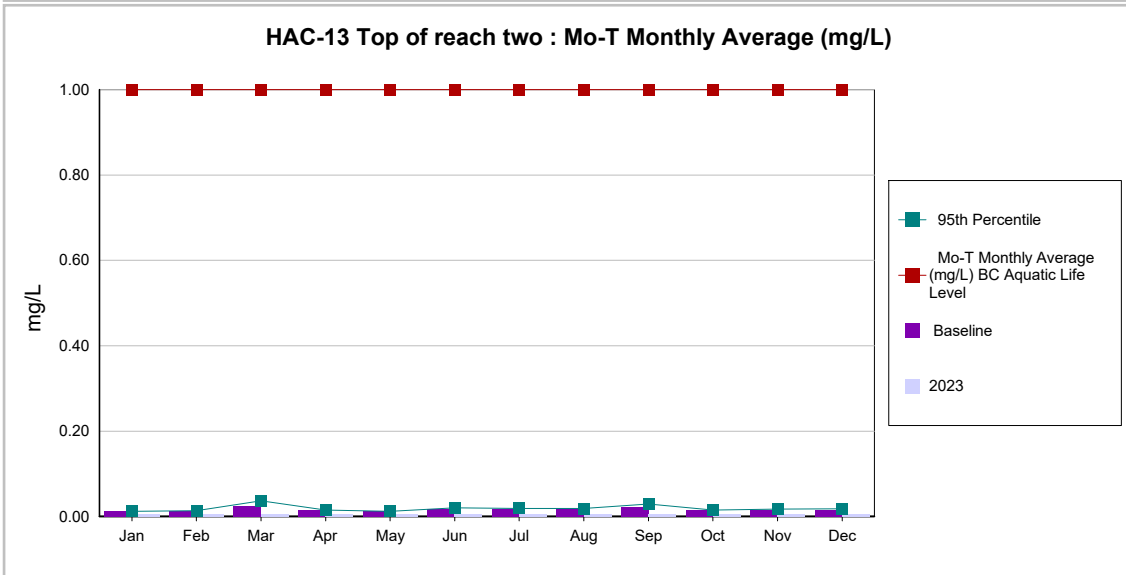
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







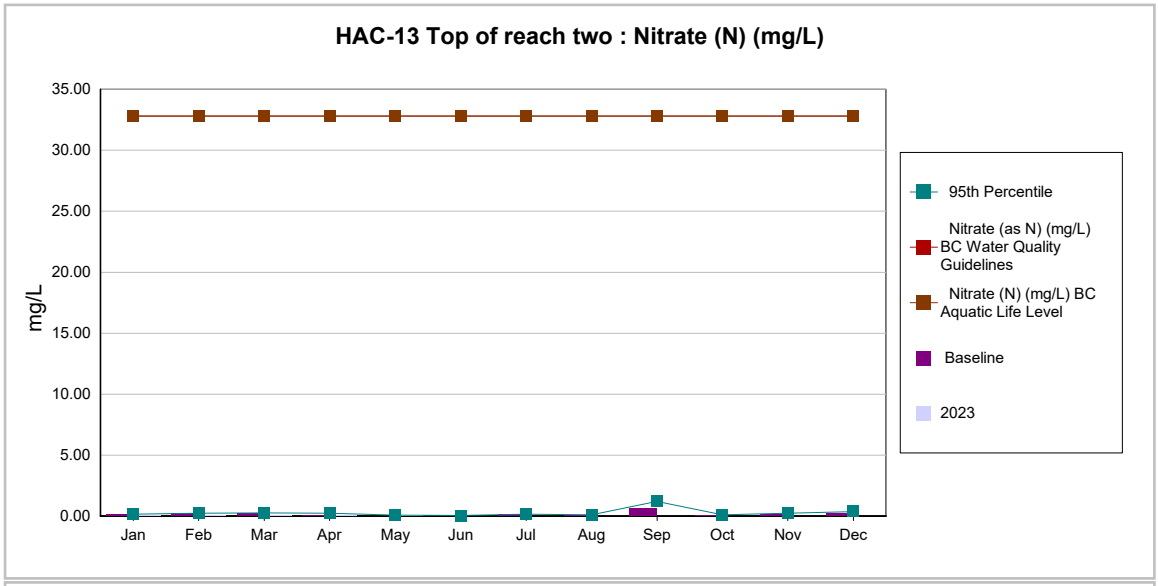
Water Quality Report

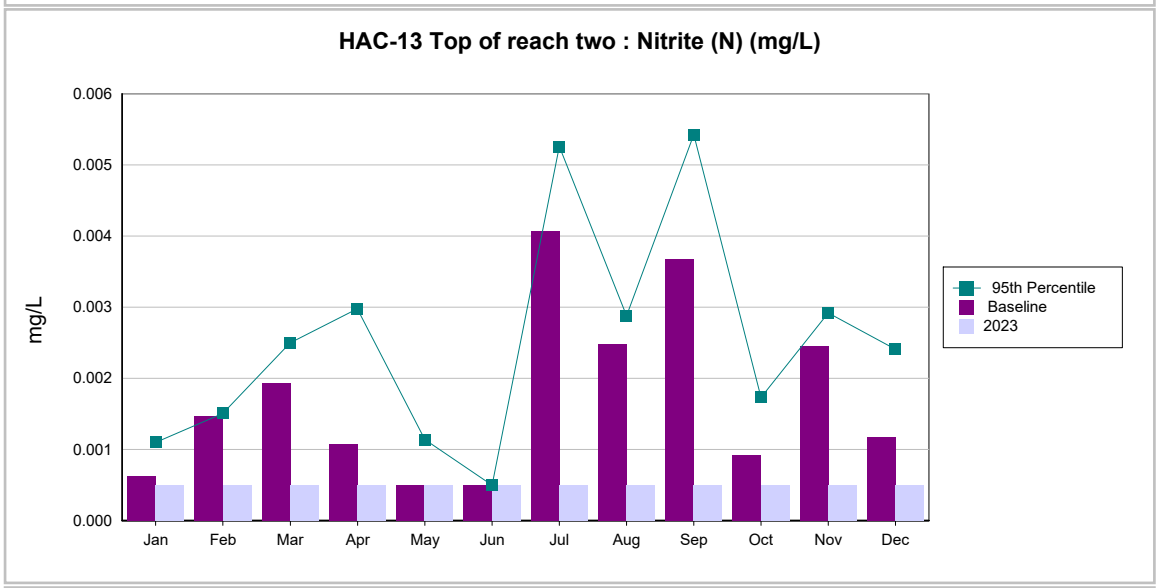
Annual Report HAC vs BCWQG

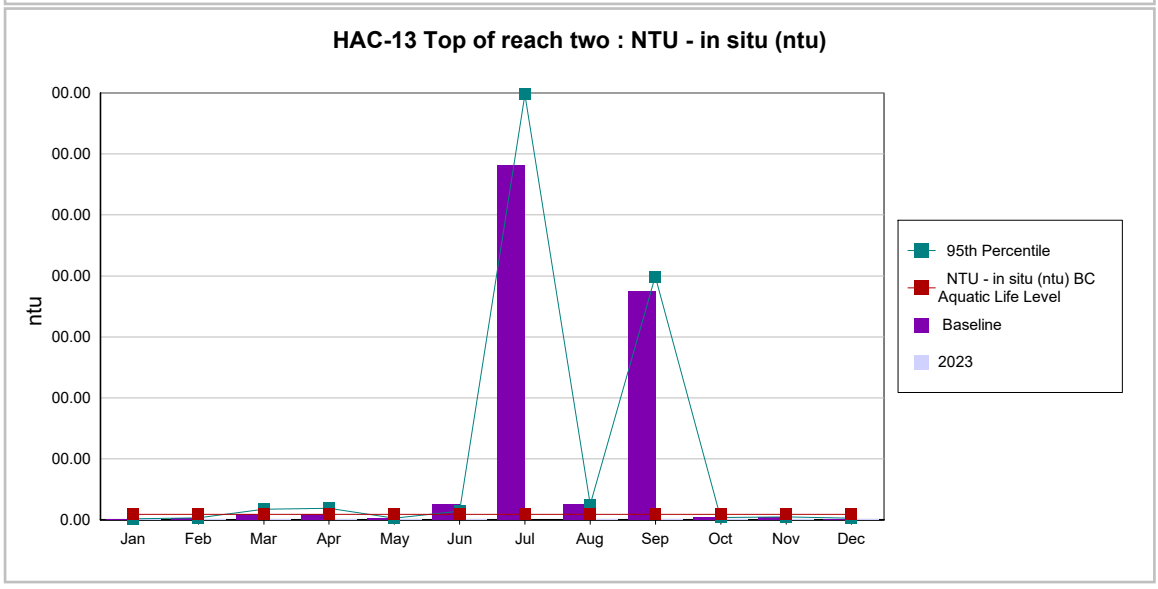
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







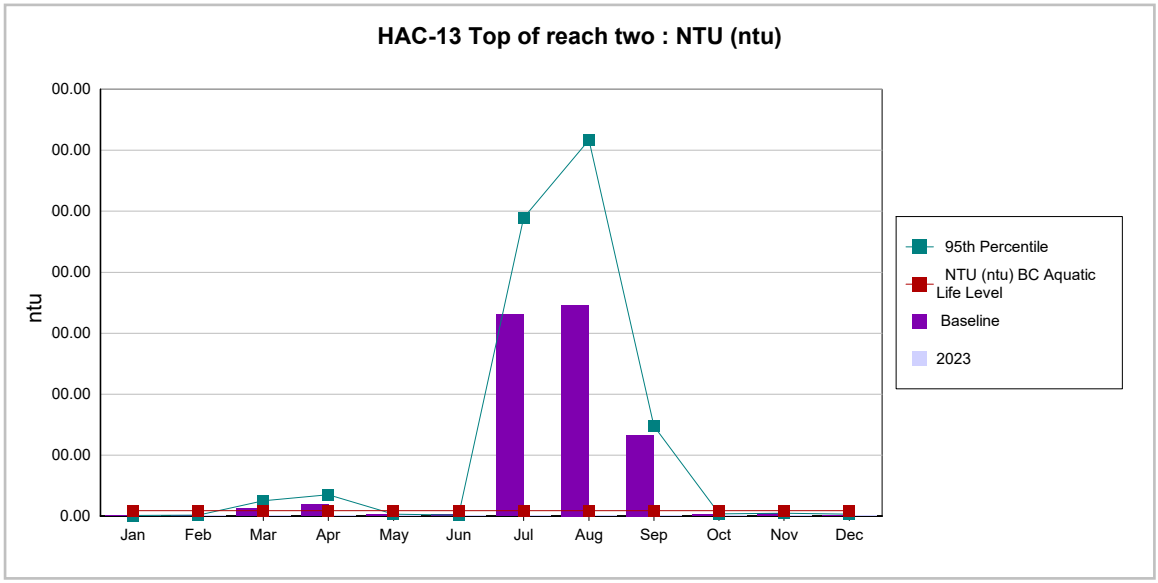
Water Quality Report

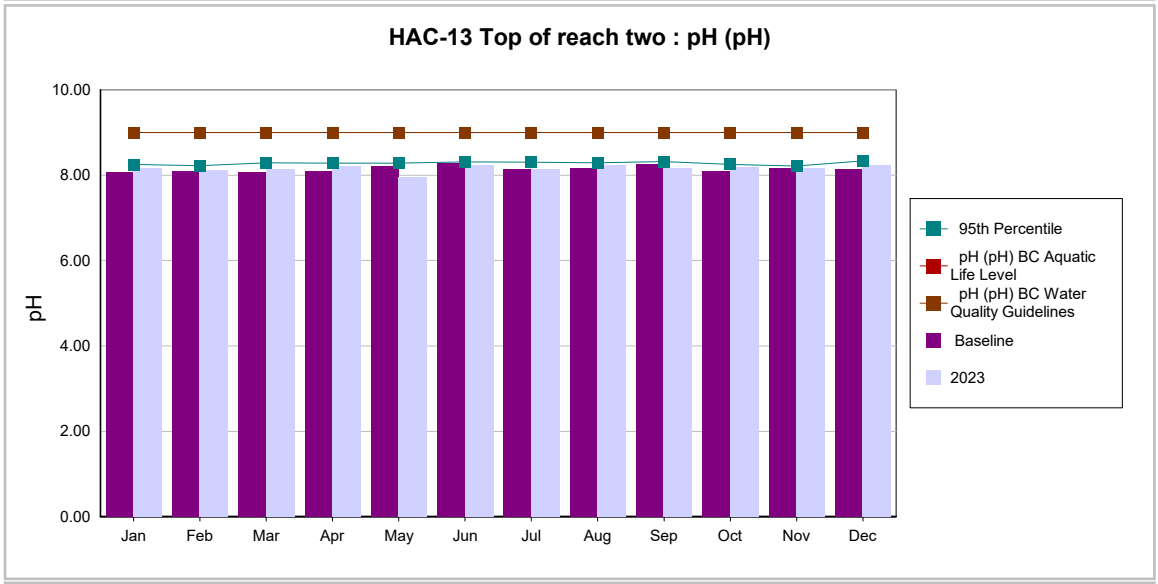
Annual Report HAC vs BCWQG

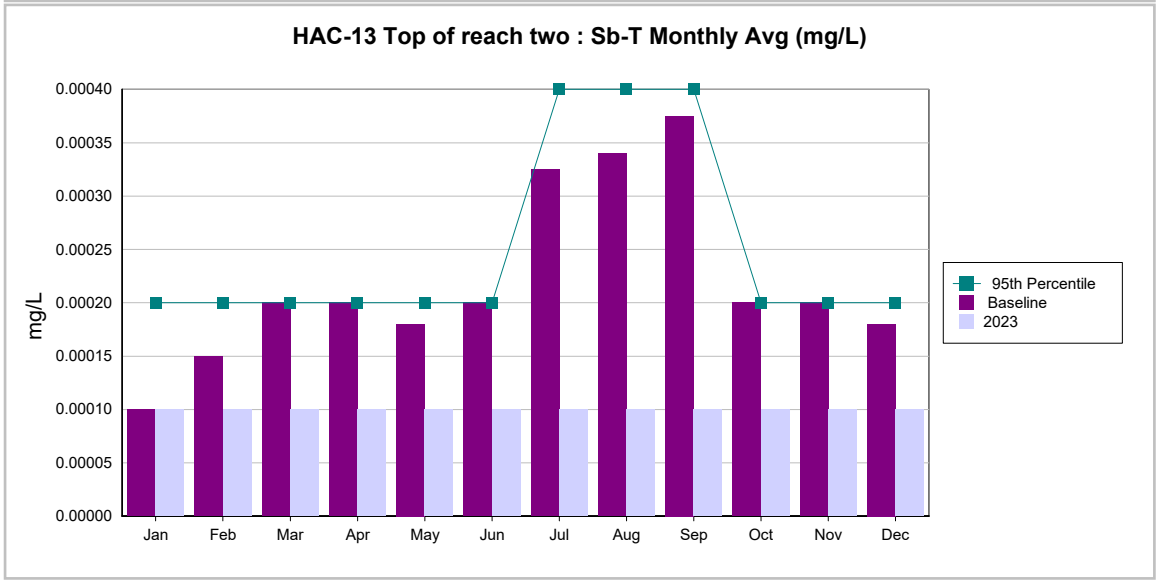
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







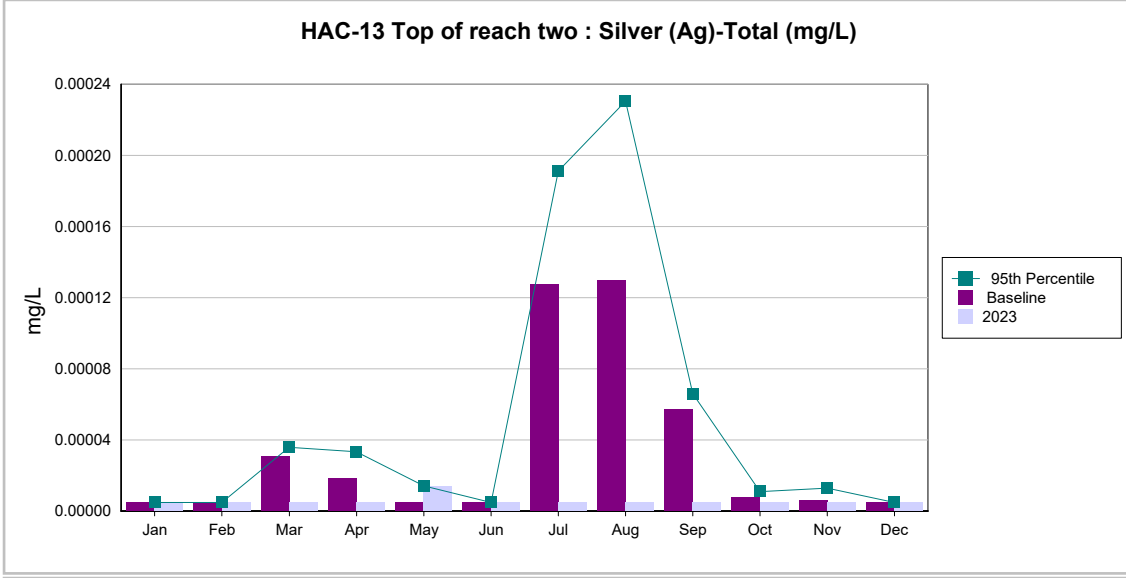
Water Quality Report

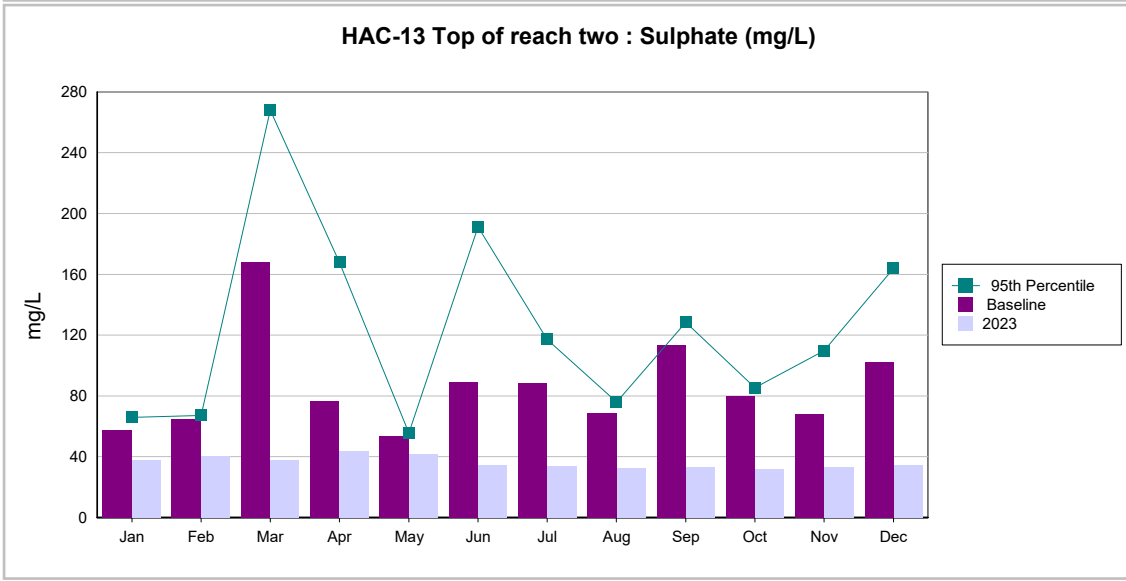
Annual Report HAC vs BCWQG

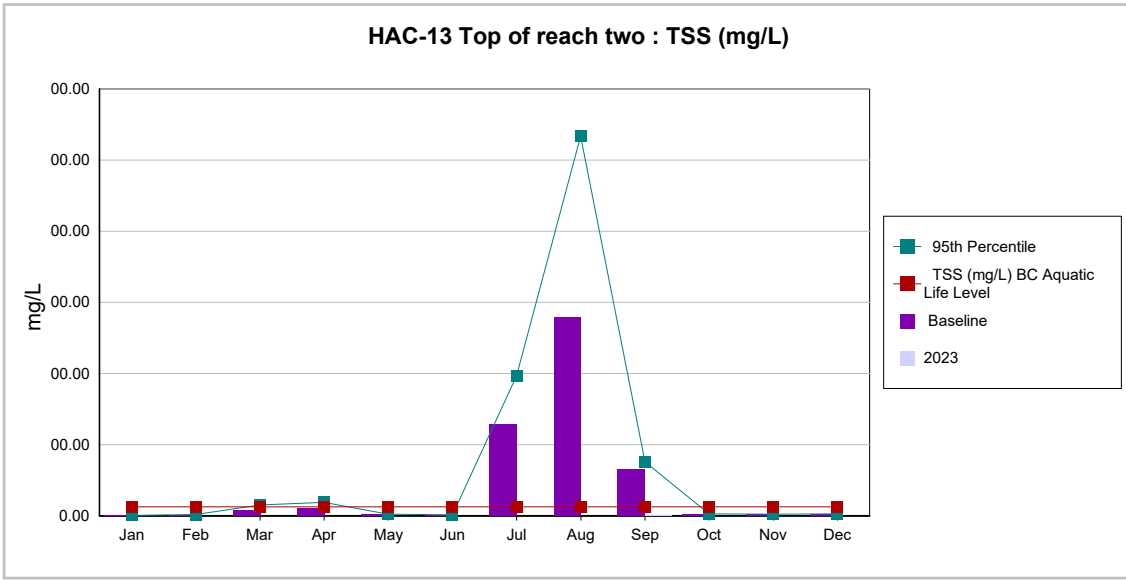
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







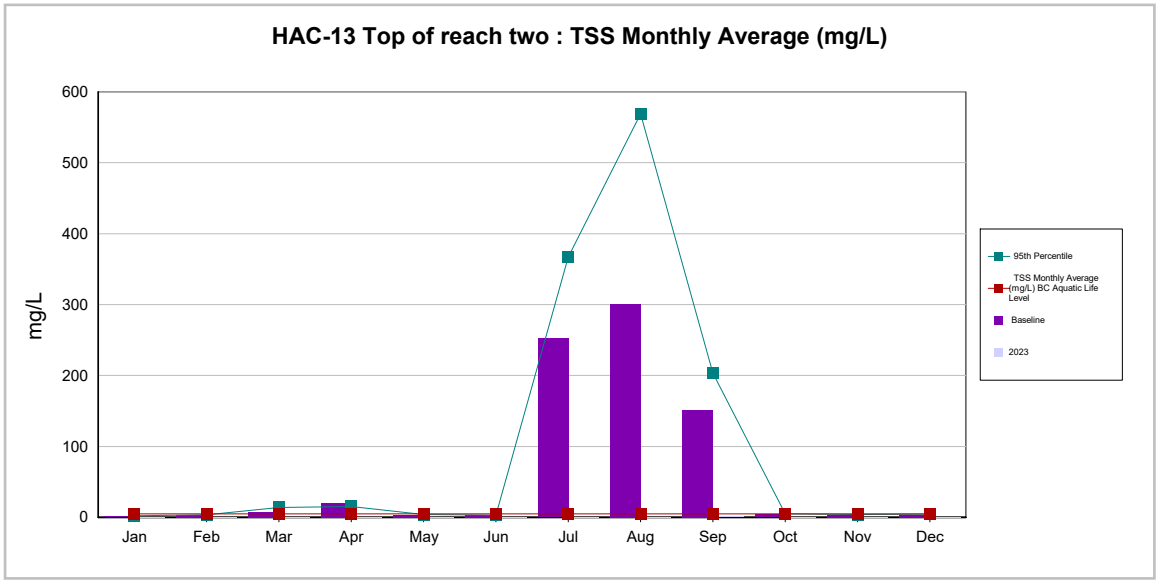
Water Quality Report

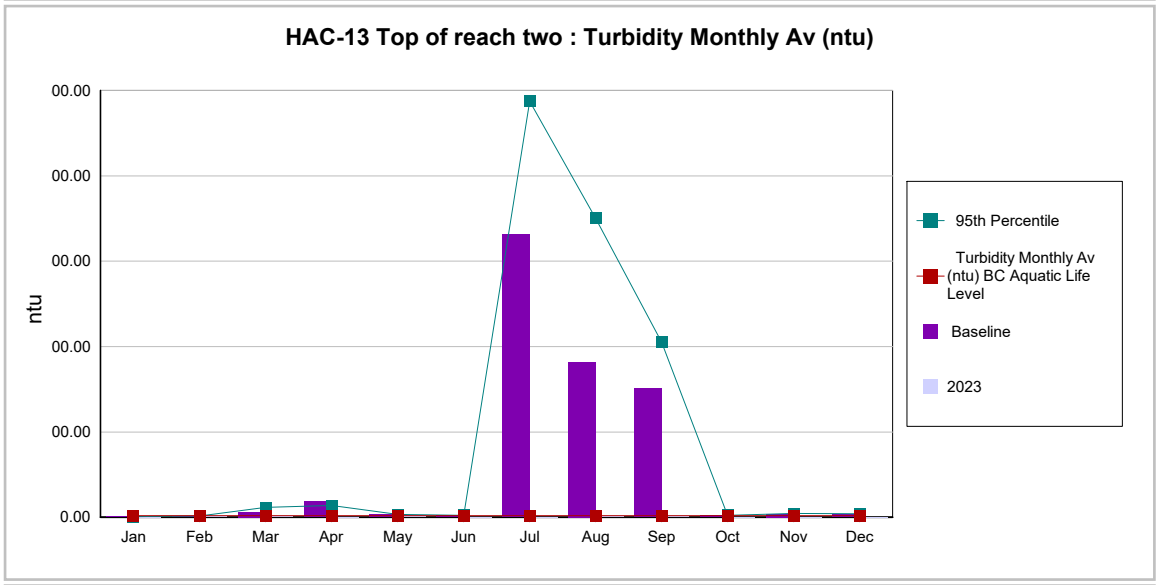
Annual Report HAC vs BCWQG

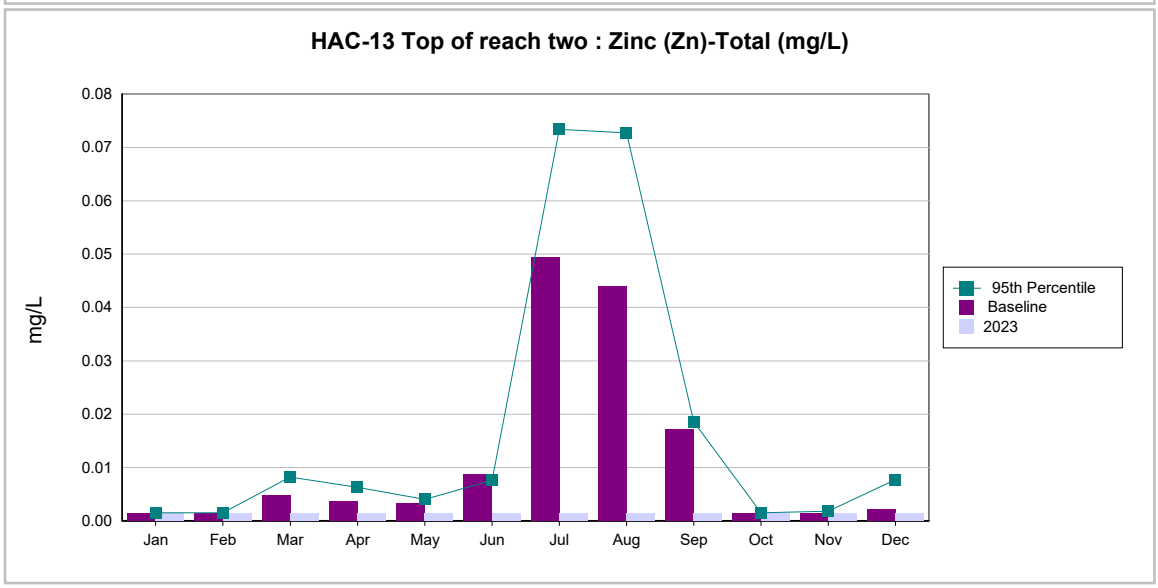
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







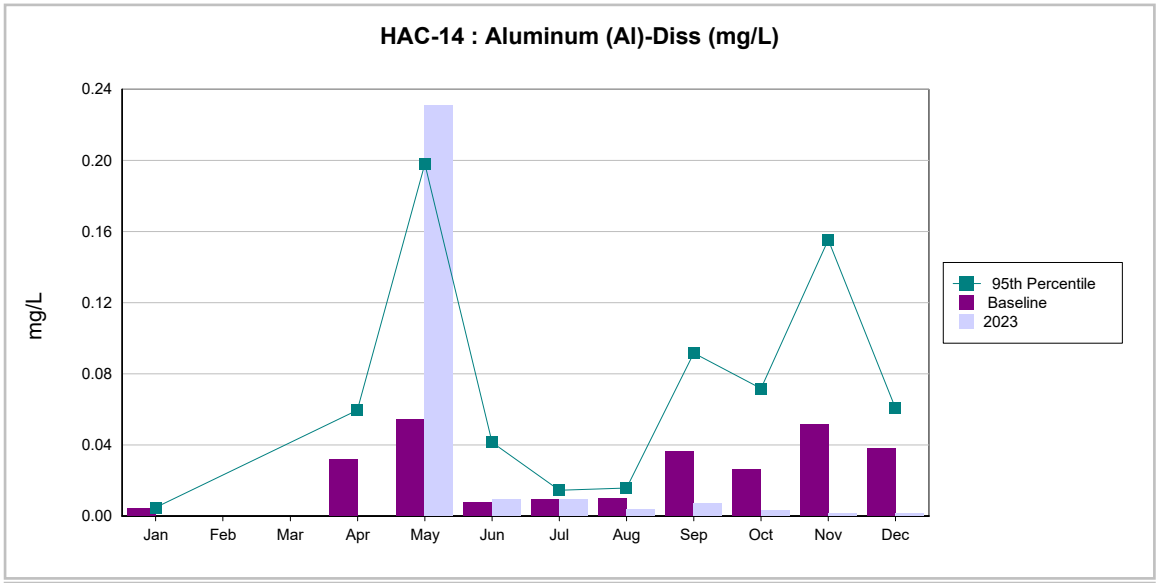
Water Quality Report

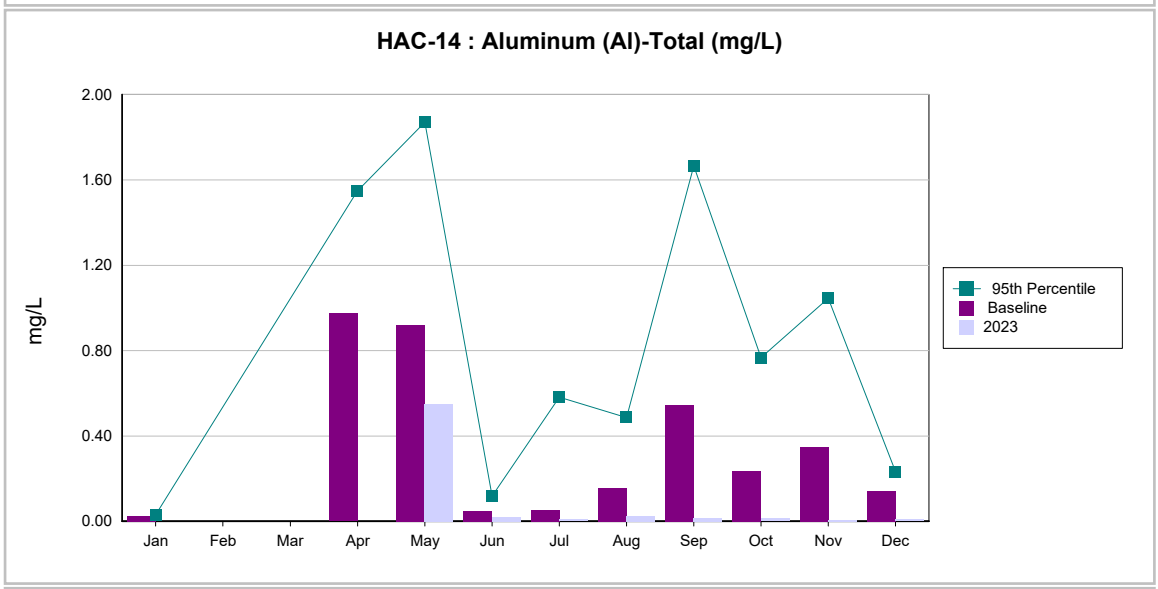
Annual Report HAC vs BCWQG

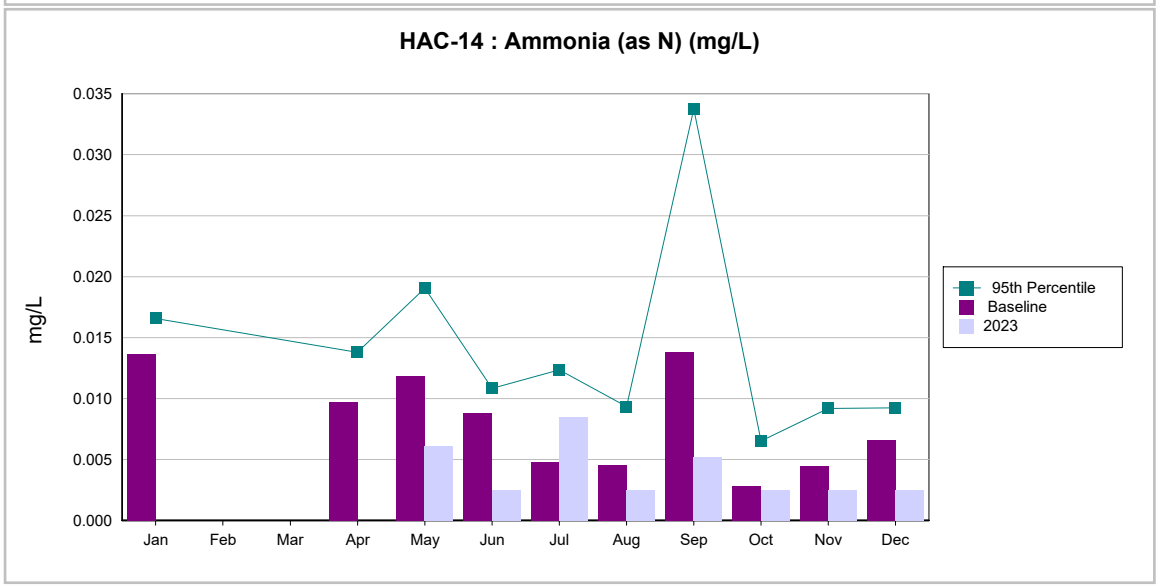
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







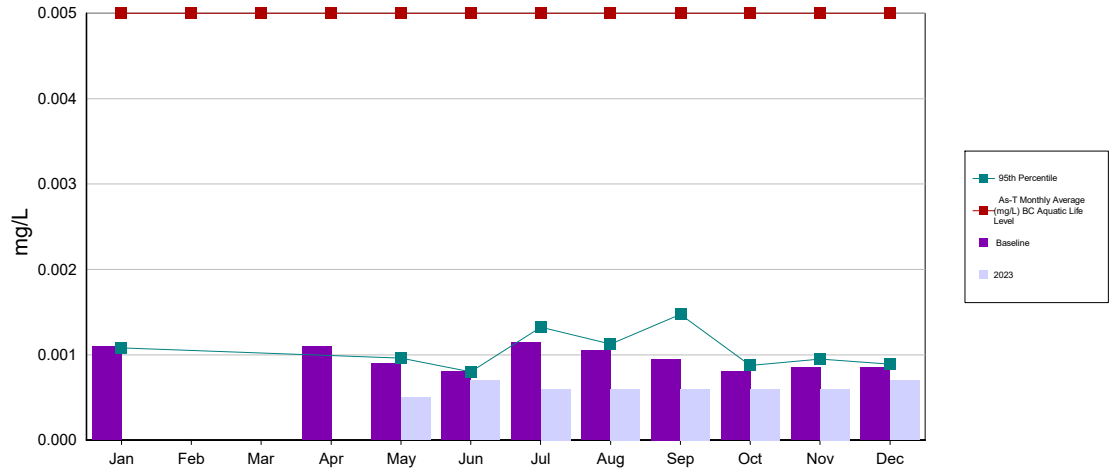
Water Quality Report

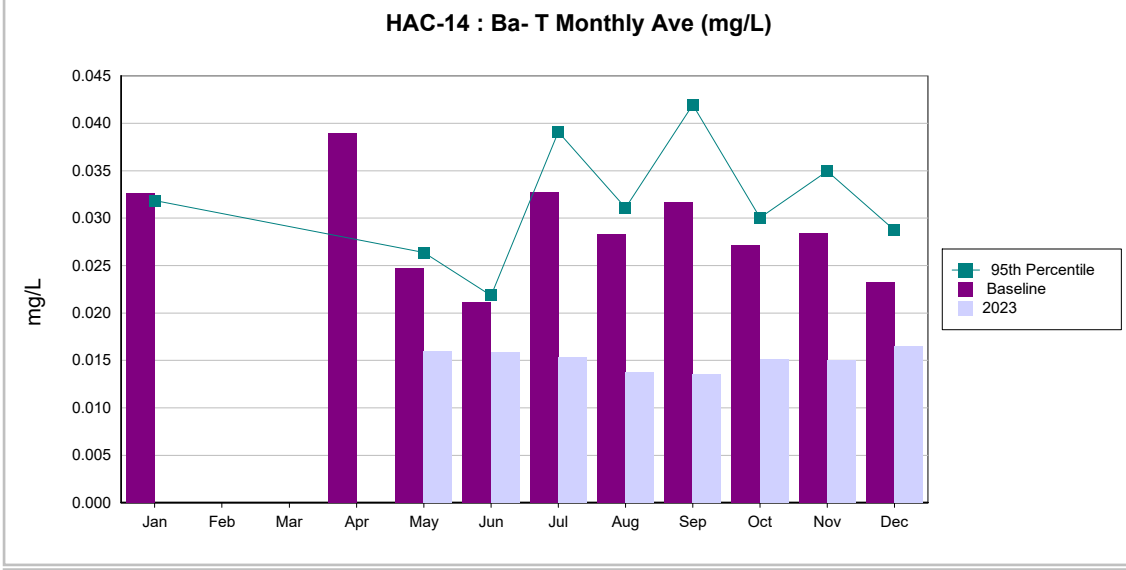
Annual Report HAC vs BCWQG

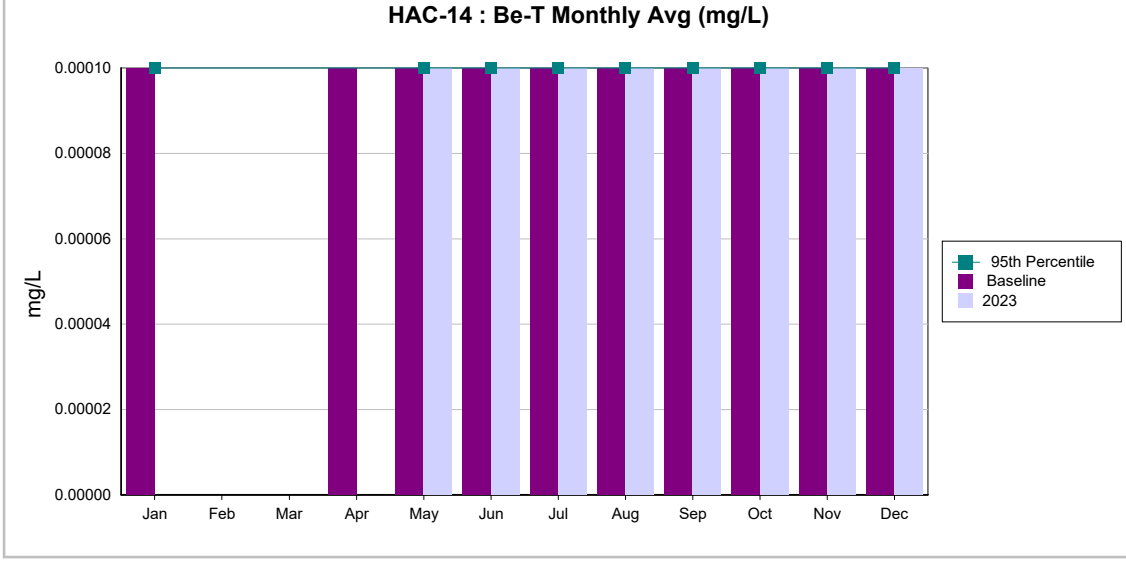
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







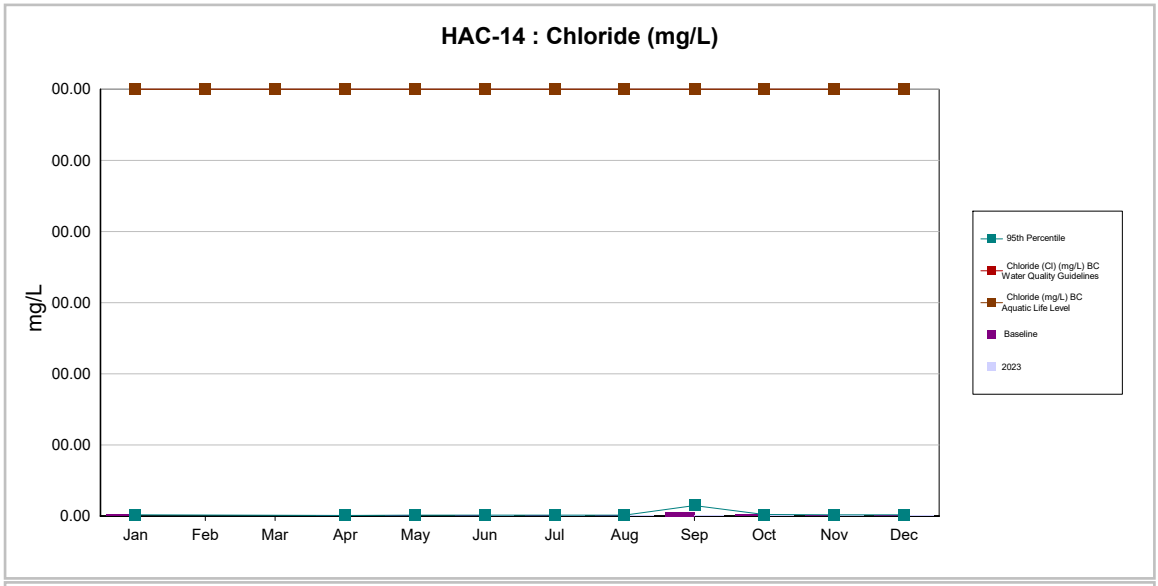
Water Quality Report

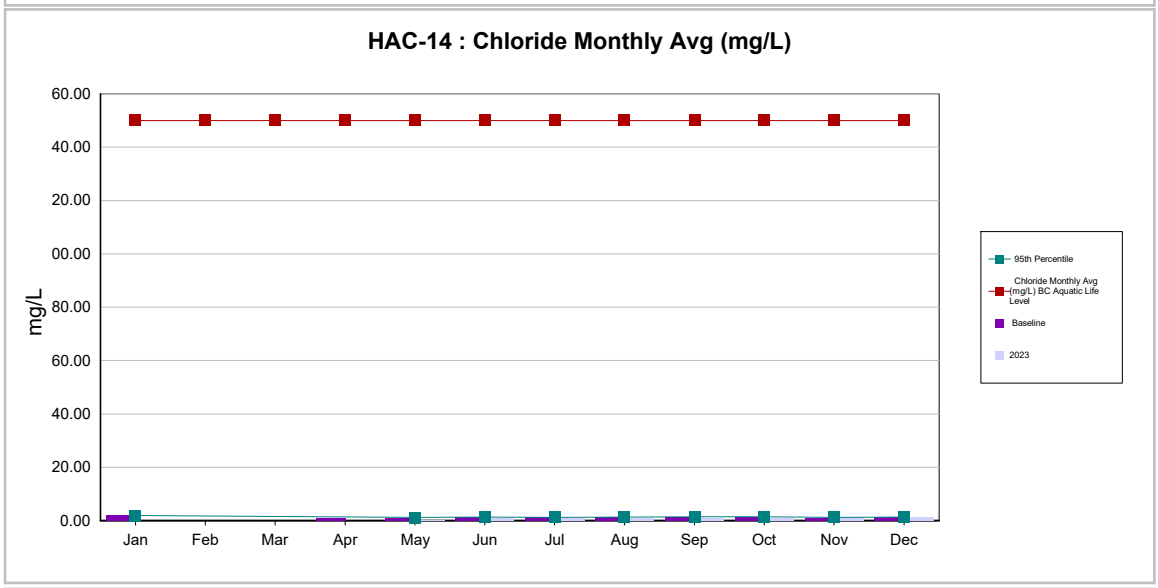
Annual Report HAC vs BCWQG

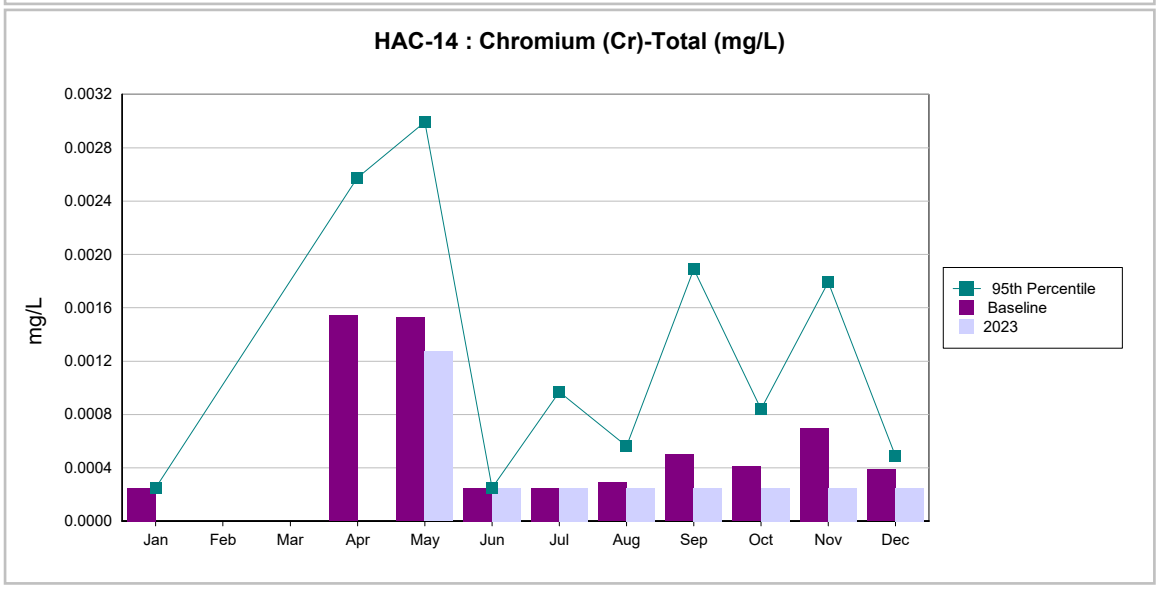
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







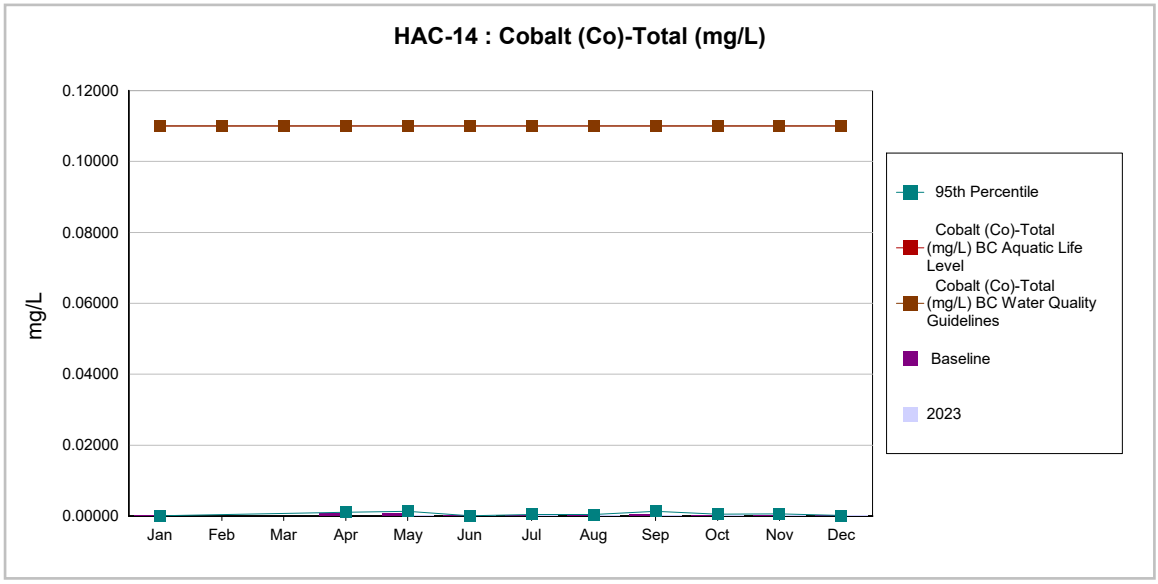
Water Quality Report

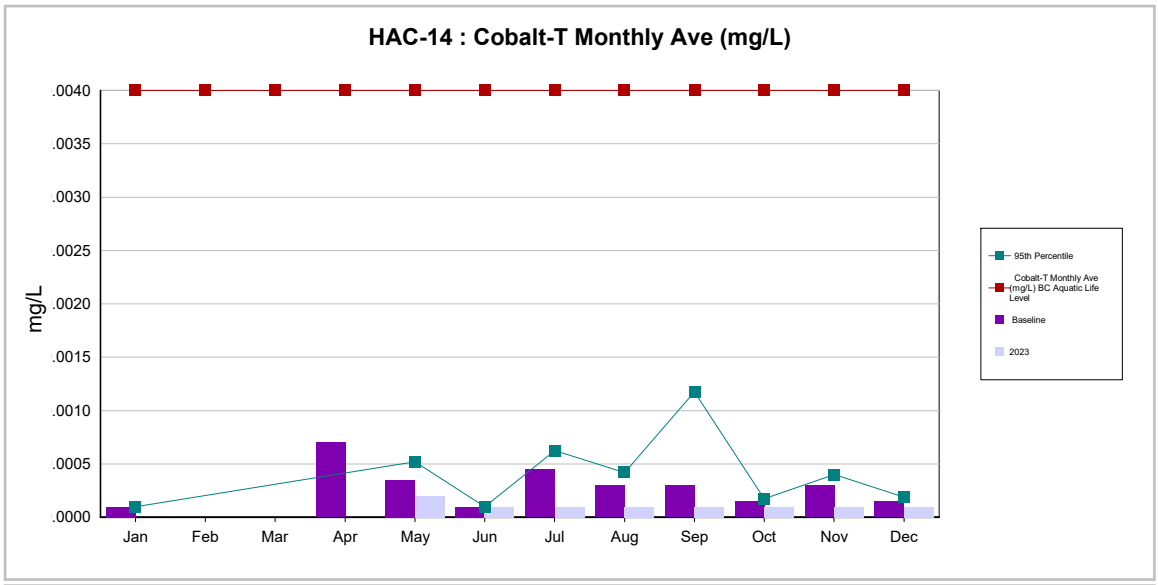
Annual Report HAC vs BCWQG

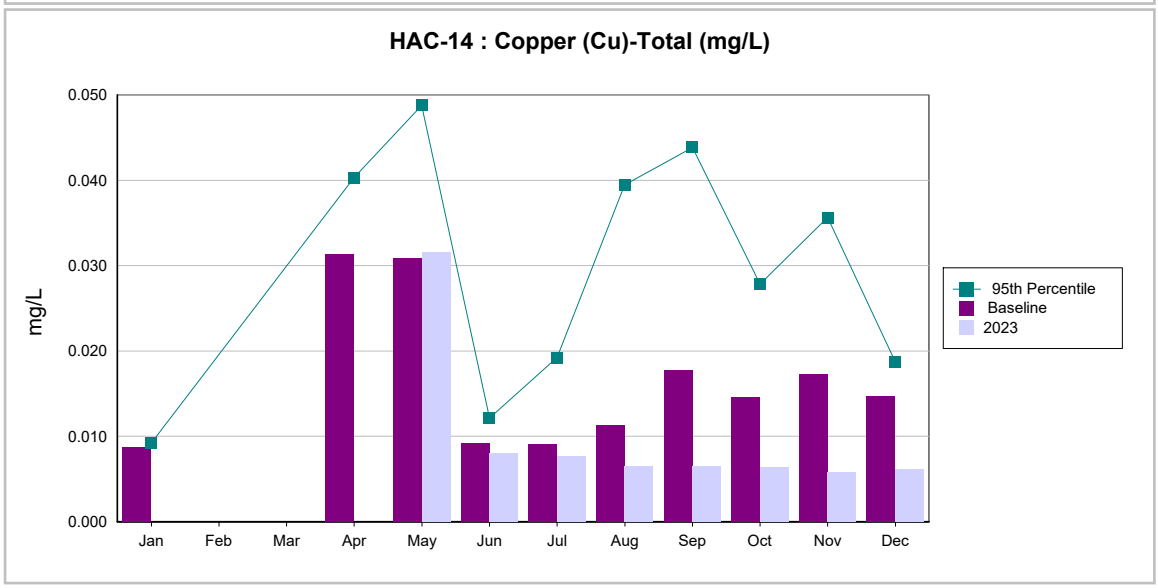
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







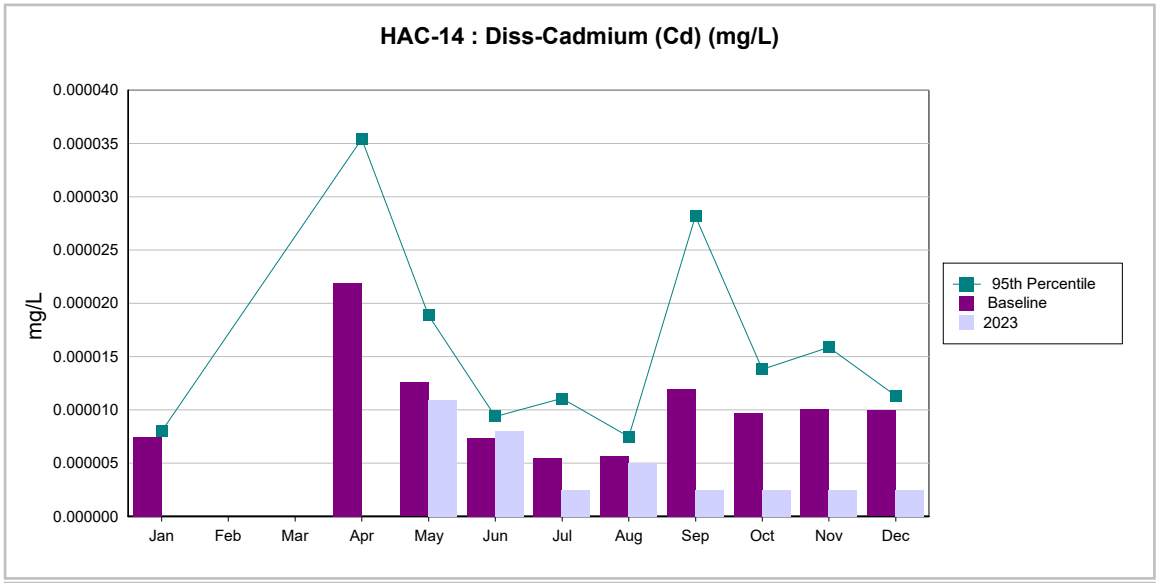
Water Quality Report

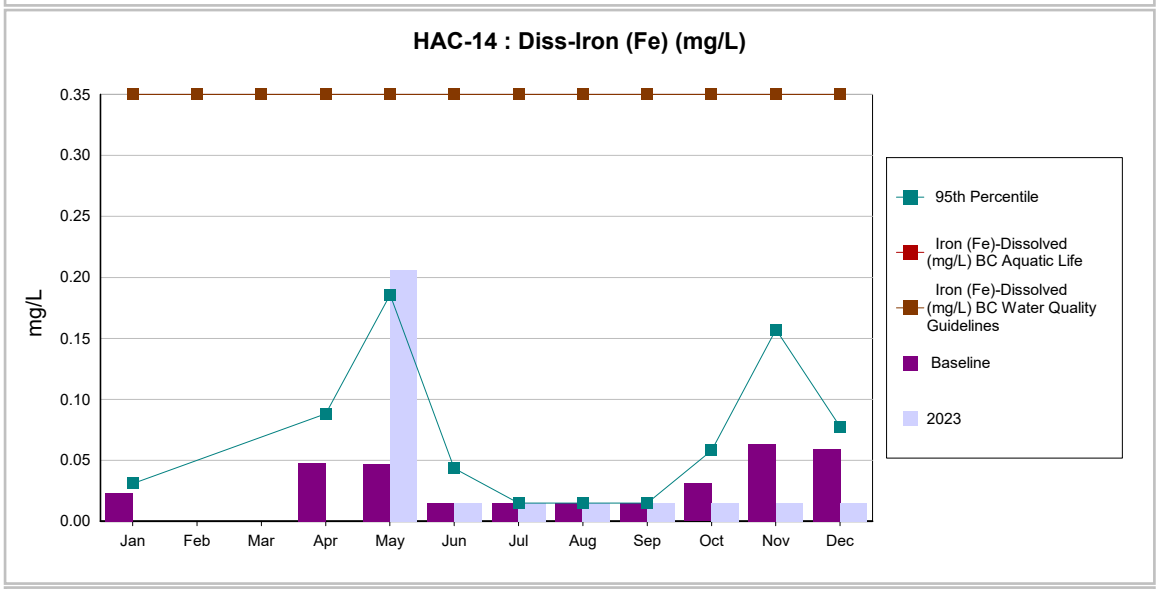
Annual Report HAC vs BCWQG

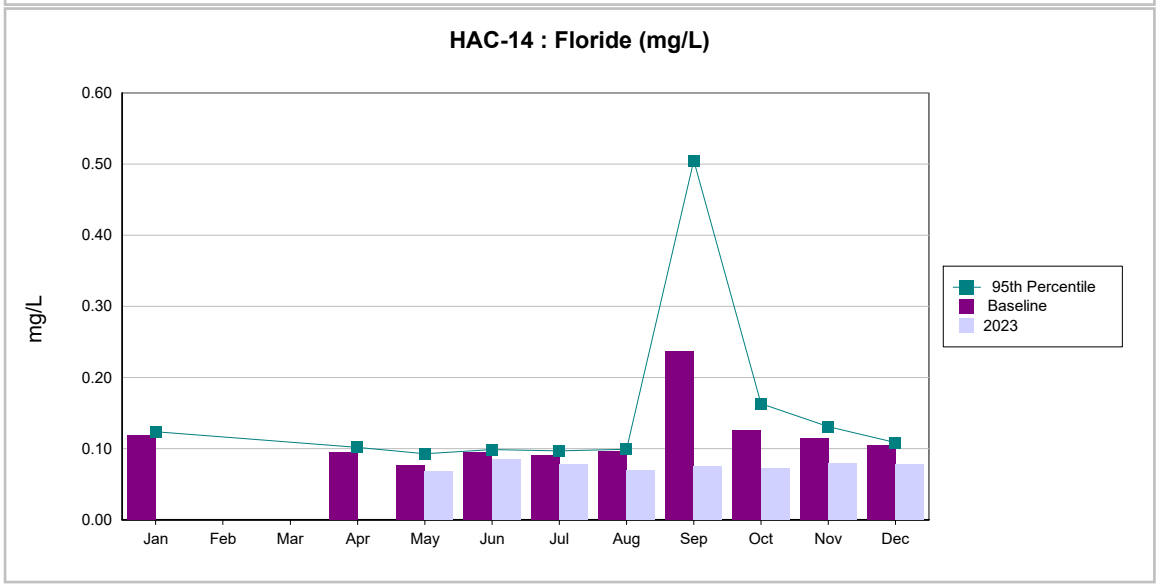
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







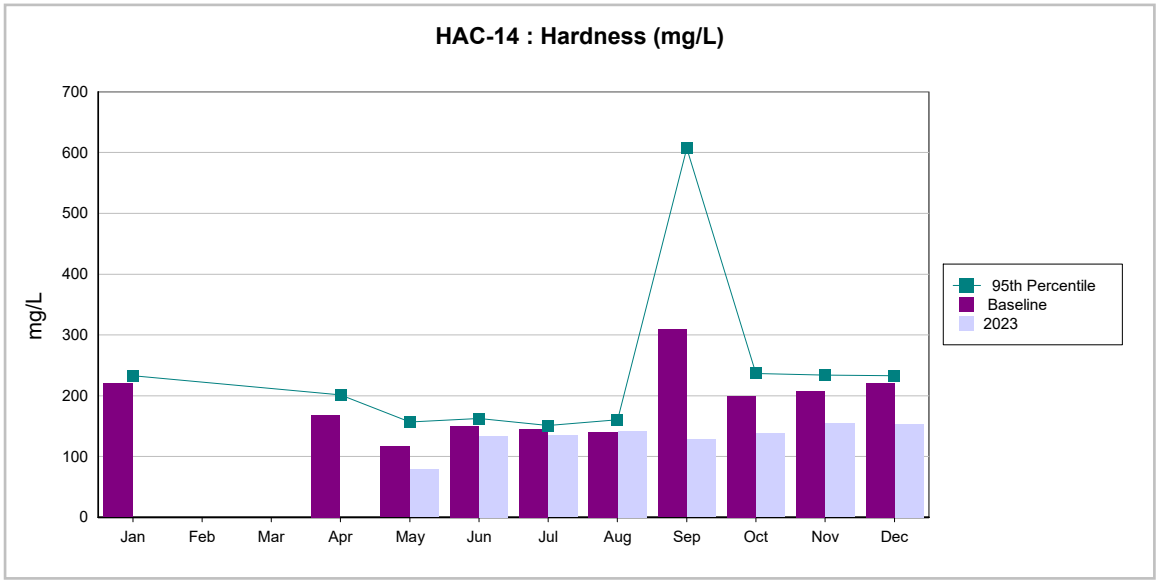
Water Quality Report

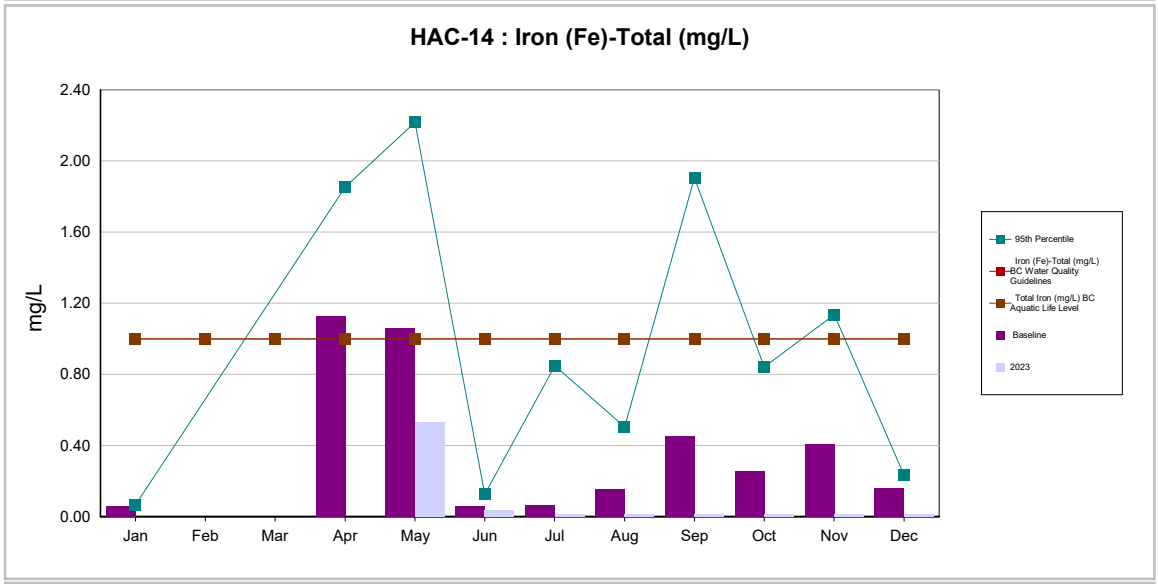
Annual Report HAC vs BCWQG

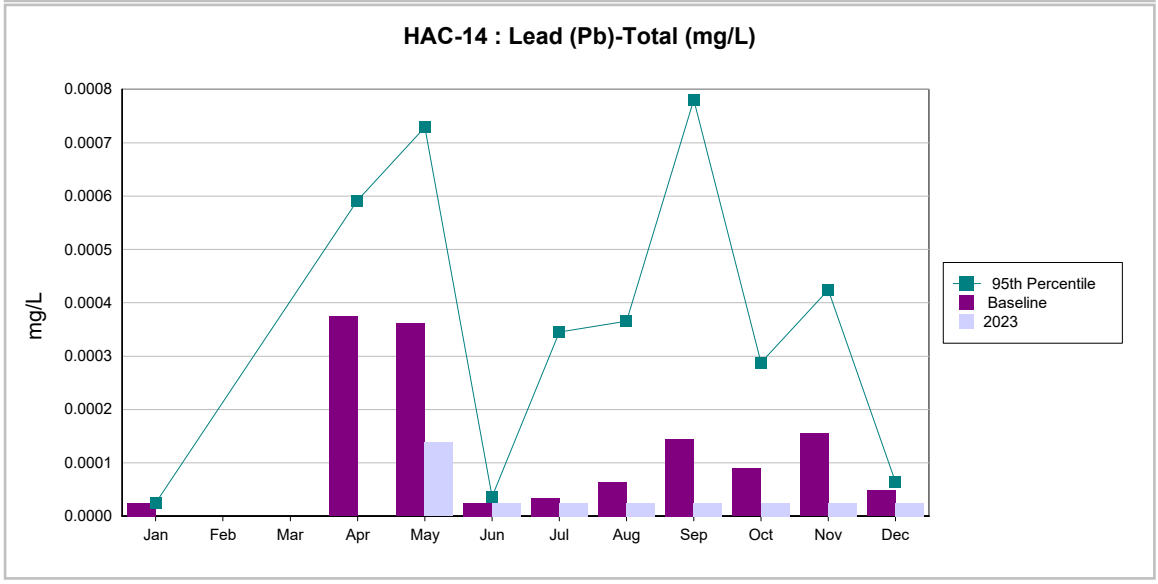
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







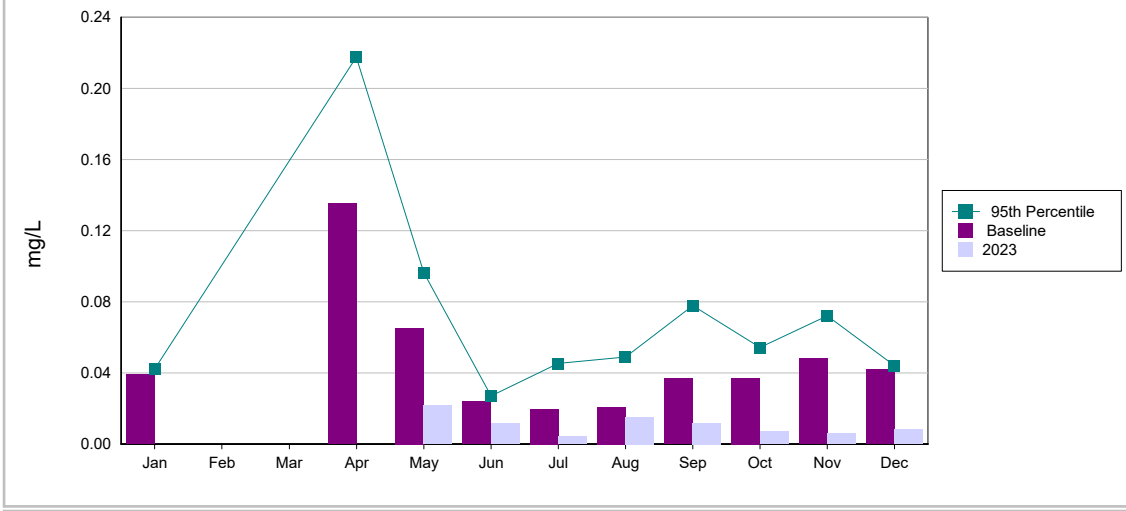
Water Quality Report

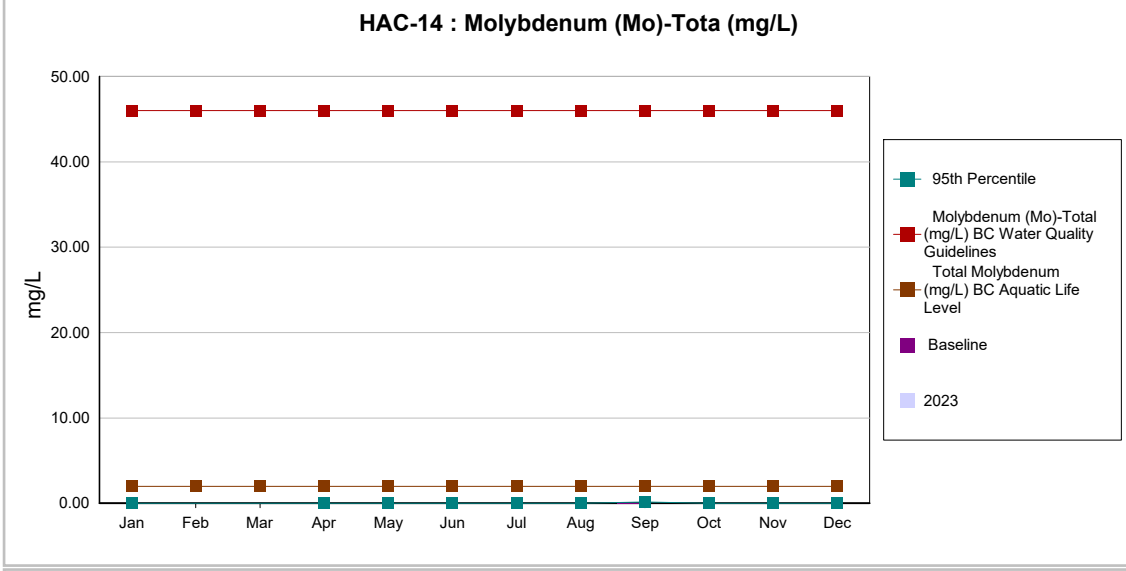
Annual Report HAC vs BCWQG

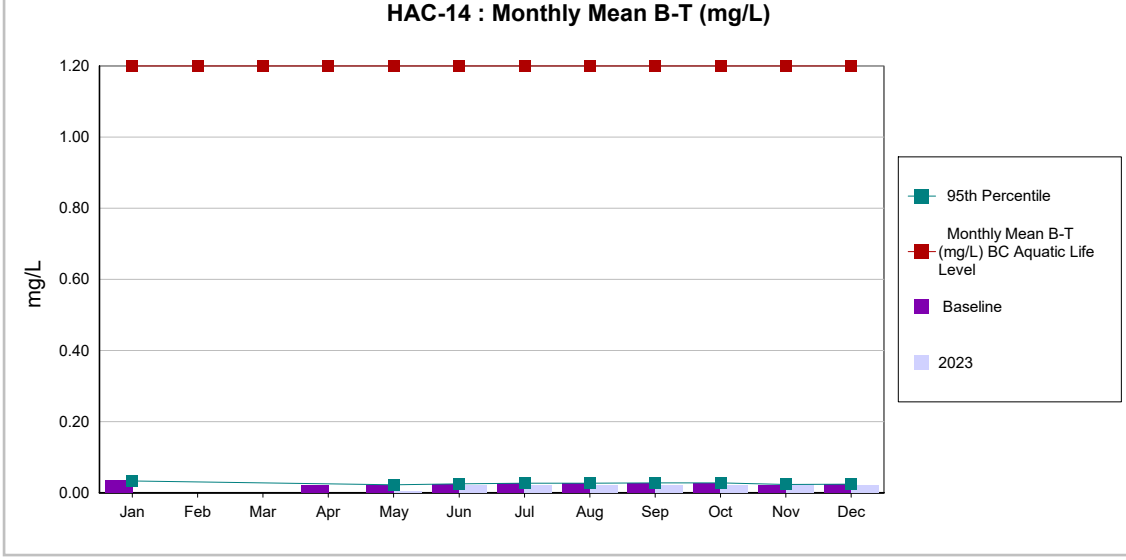
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







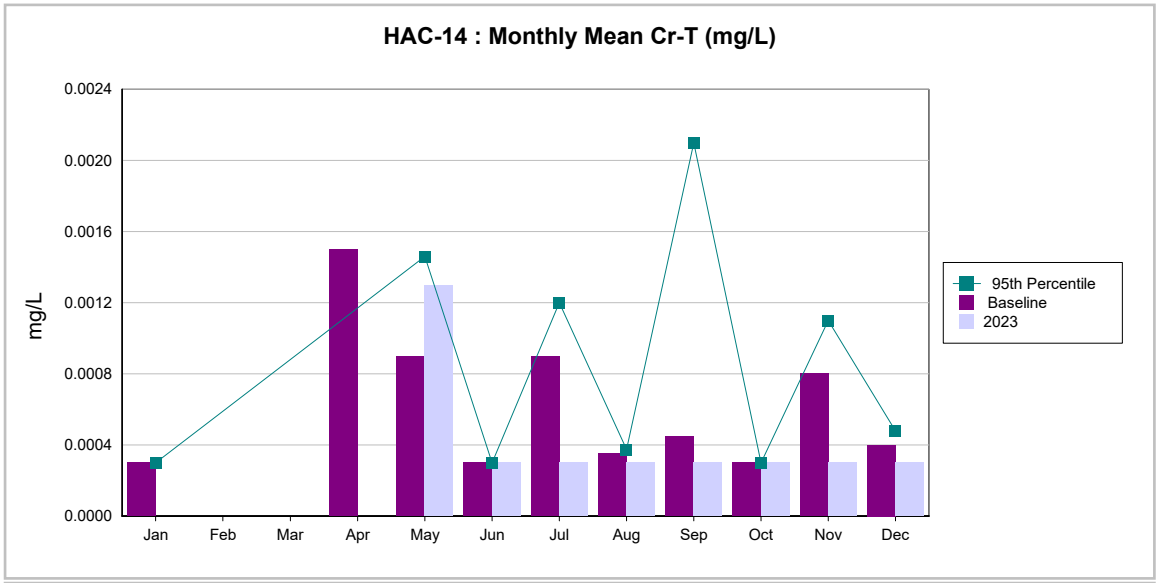
Water Quality Report

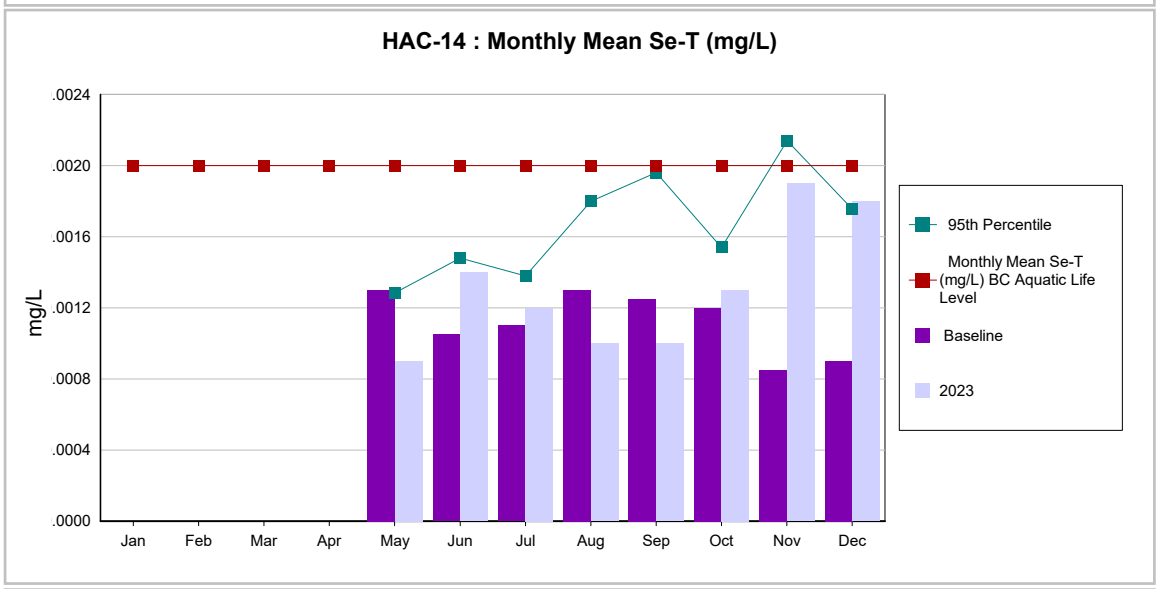
Annual Report HAC vs BCWQG

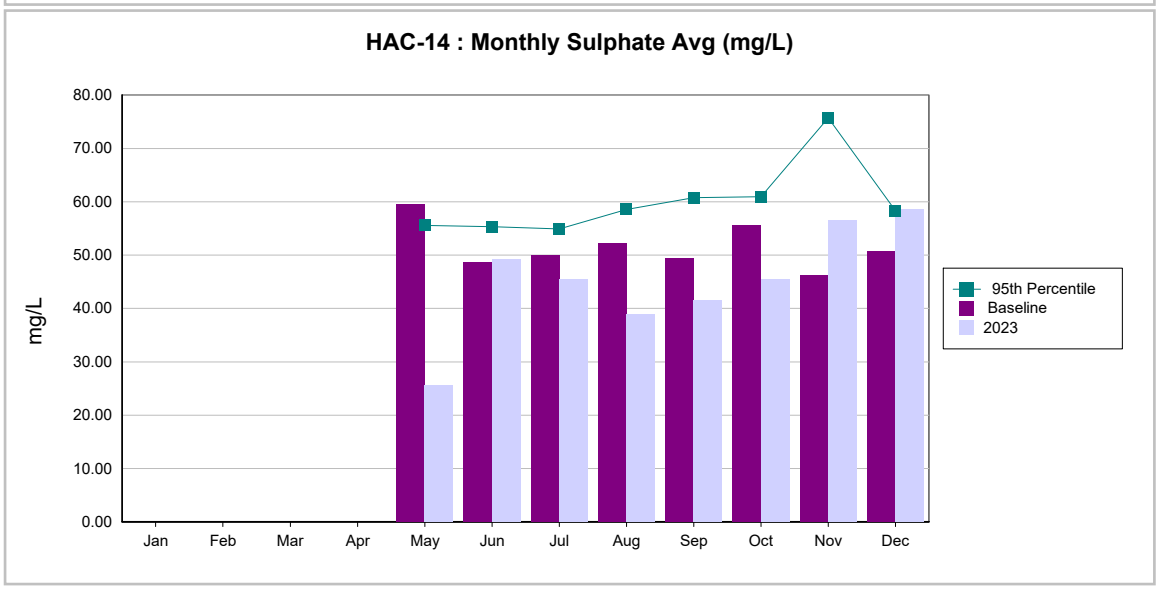
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







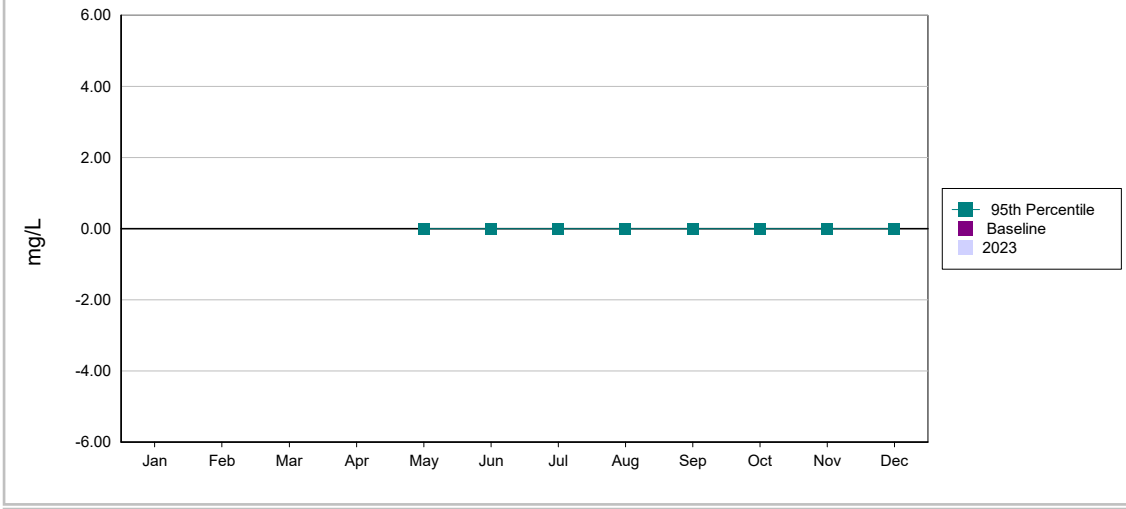
Water Quality Report

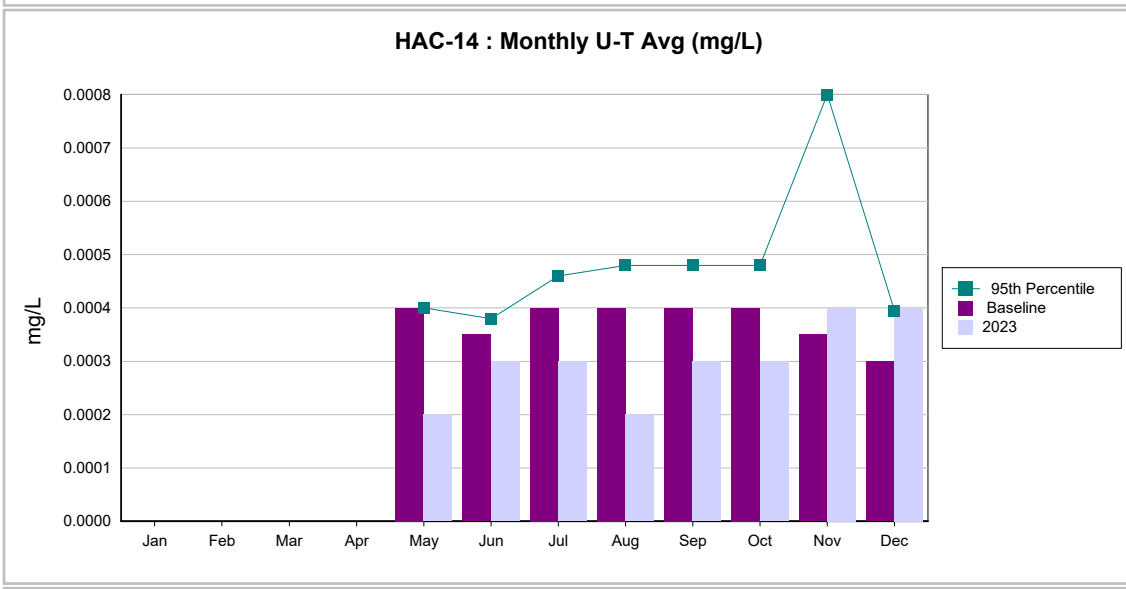
Annual Report HAC vs BCWQG

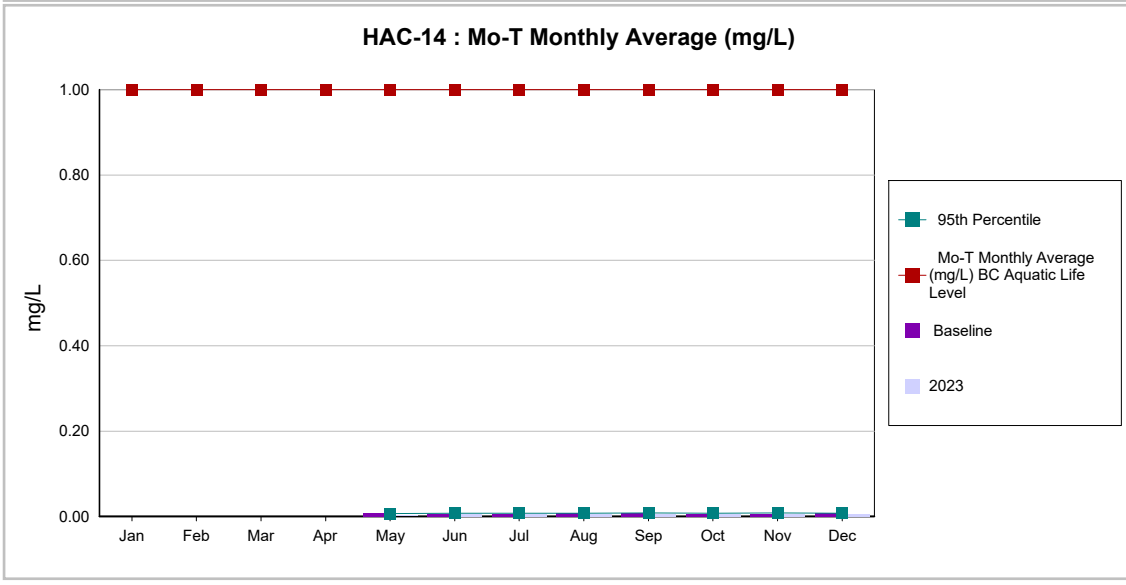
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



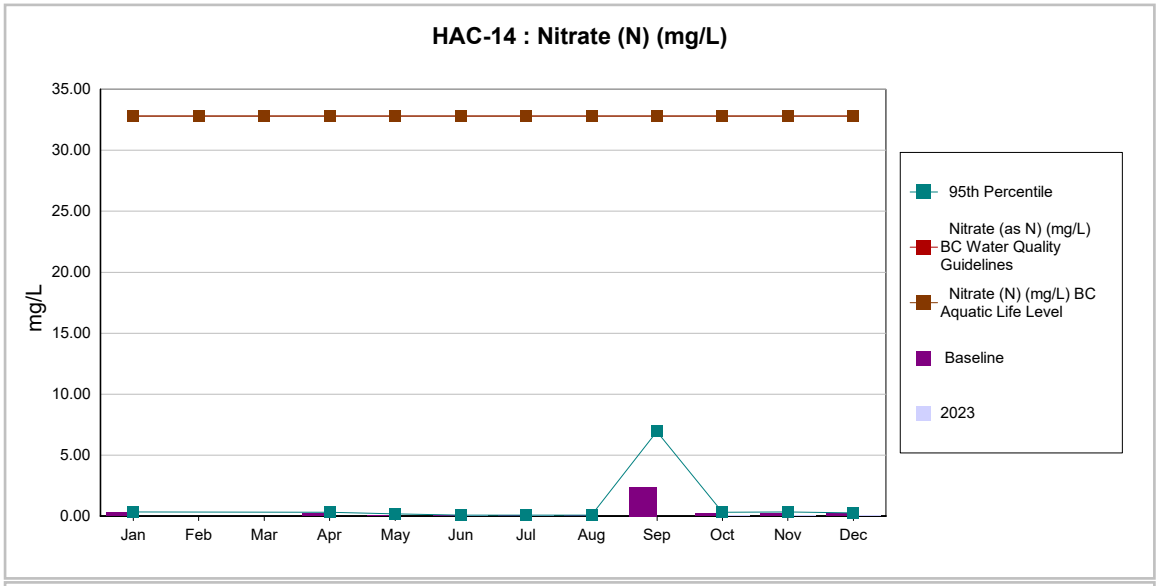


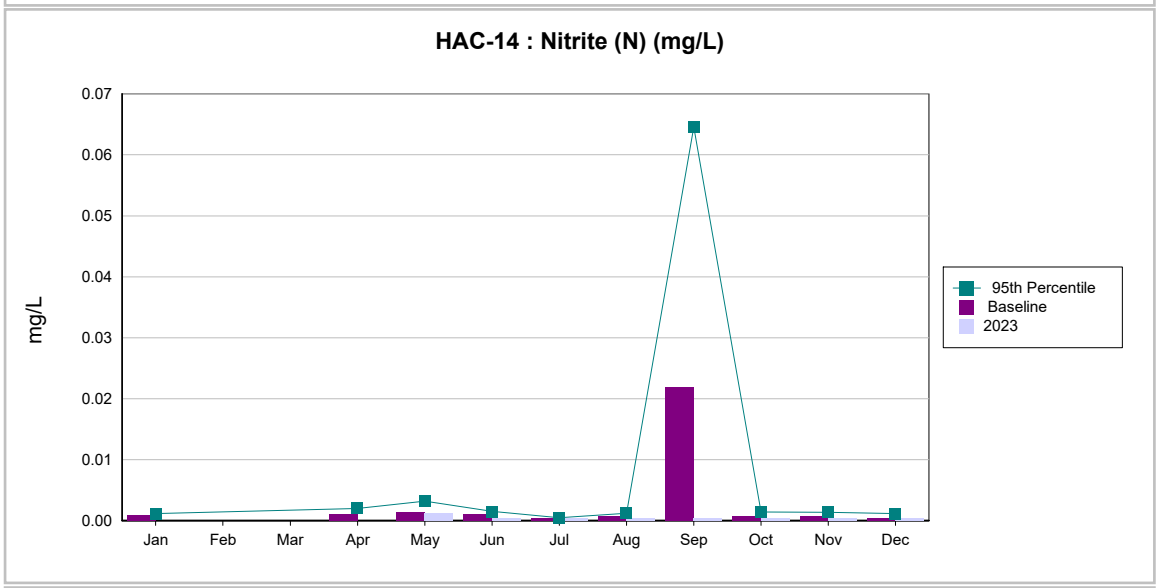


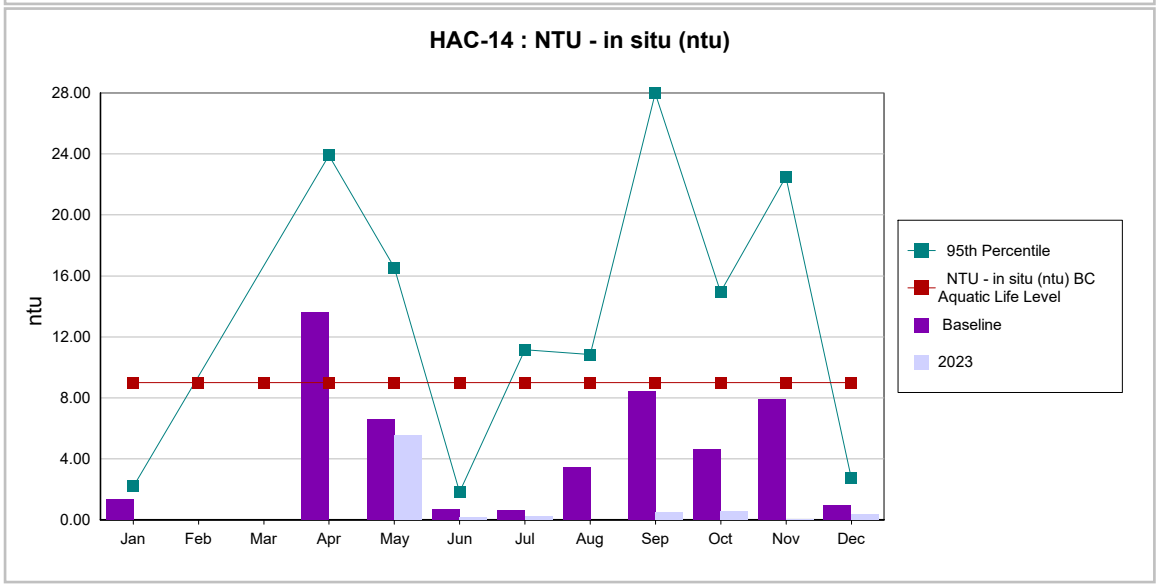
Water Quality Report

Annual Report HAC vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







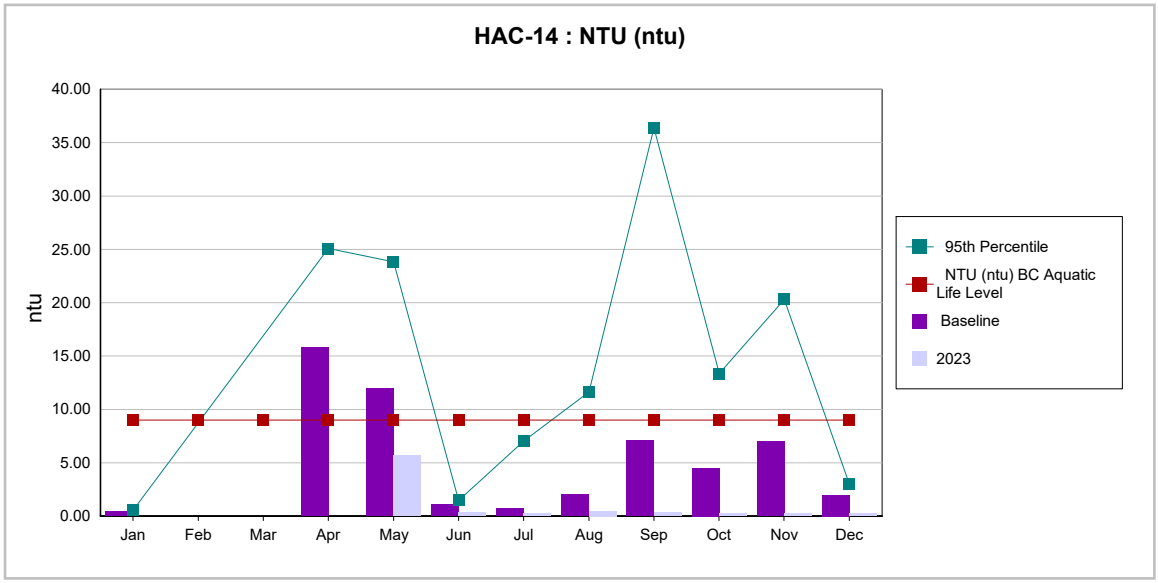
Water Quality Report

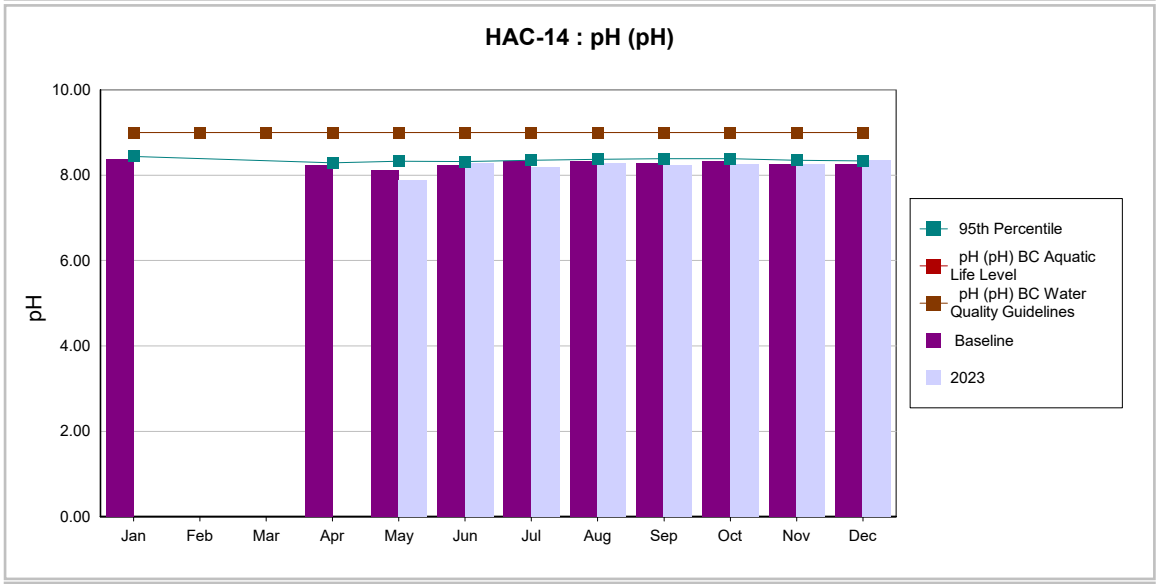
Annual Report HAC vs BCWQG

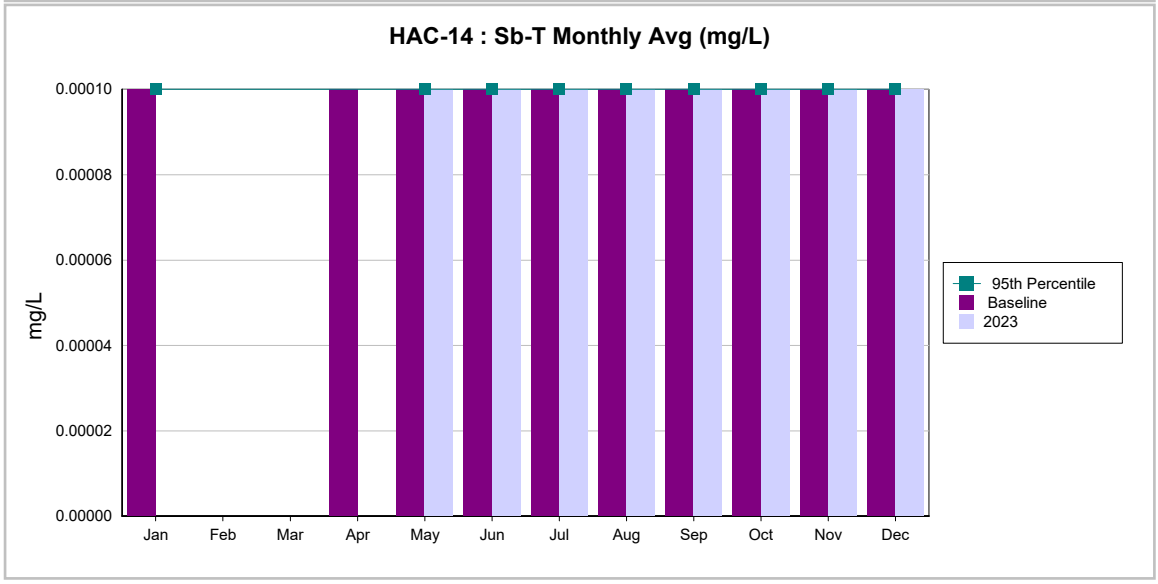
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







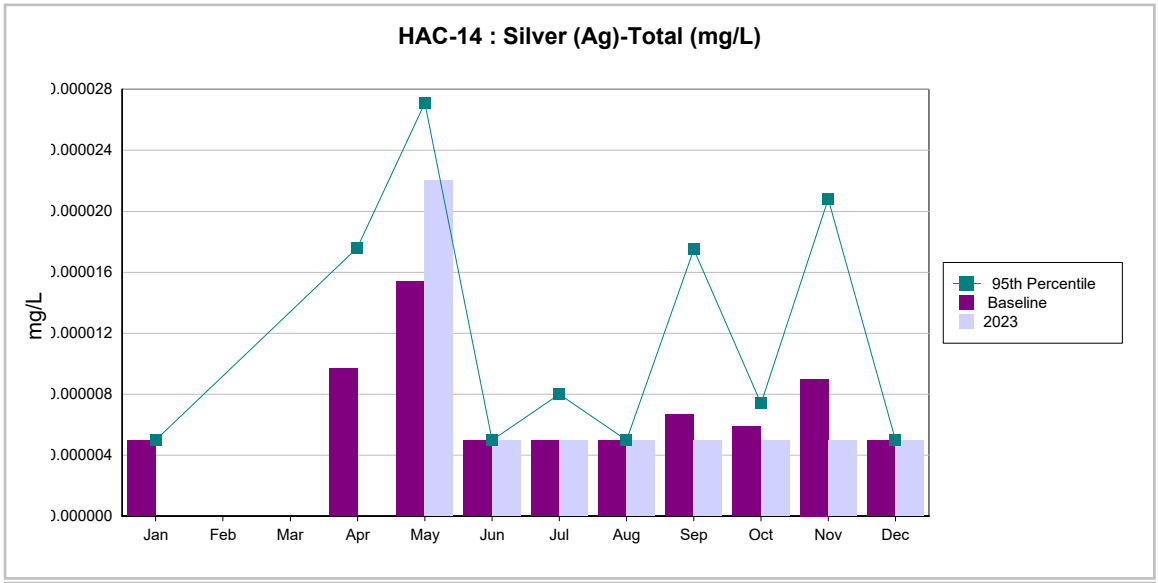
Water Quality Report

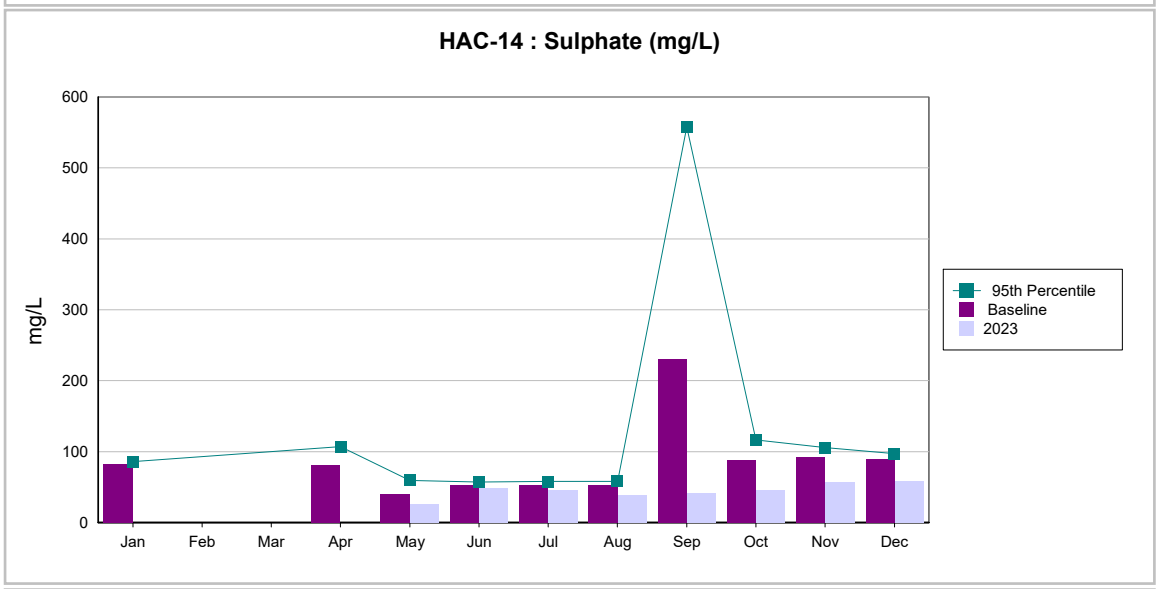
Annual Report HAC vs BCWQG

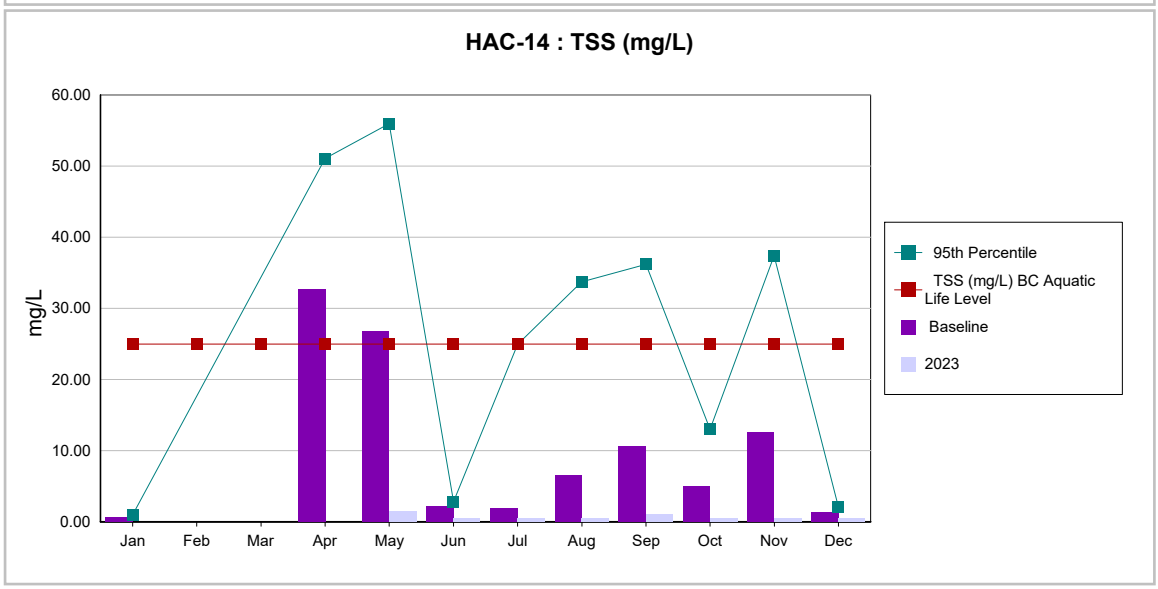
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

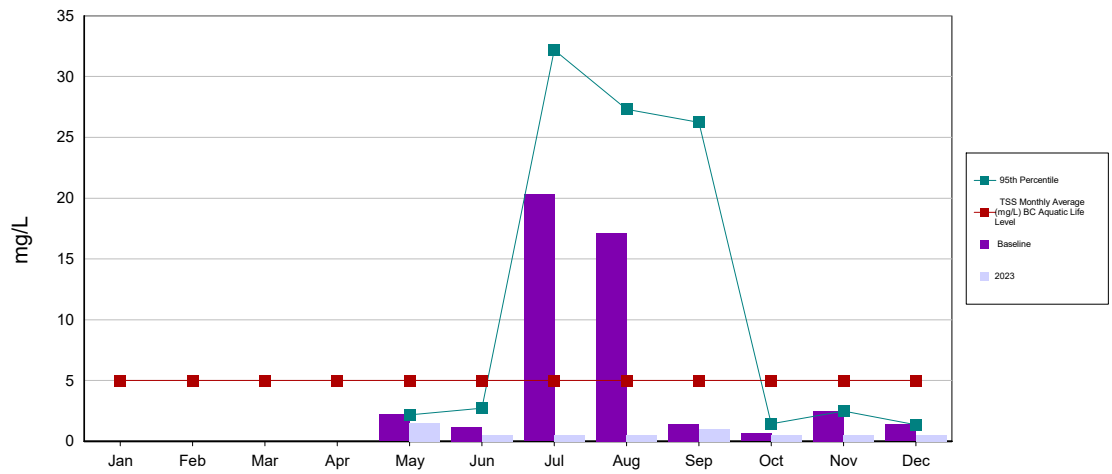
Annual Report HAC vs BCWQG

Mount Polley

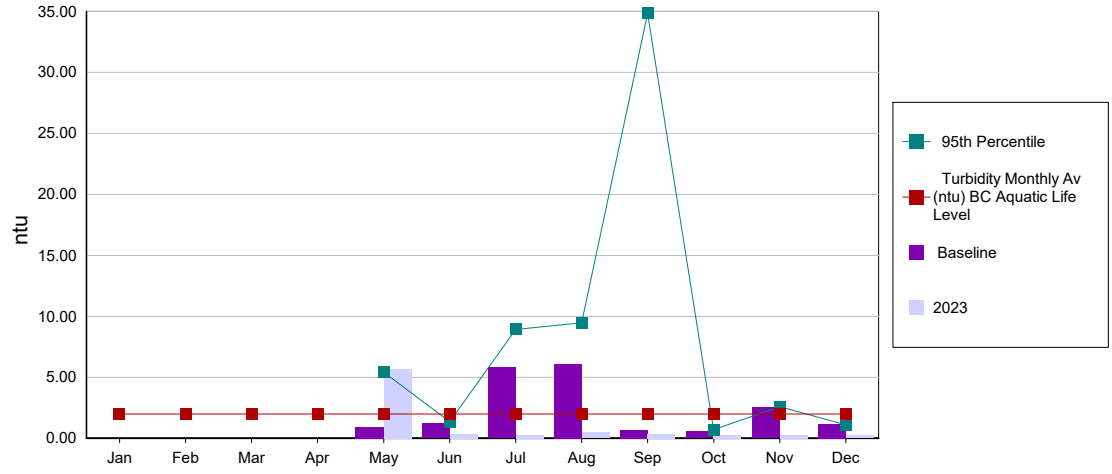
Mining Corporation

IMPERIAL METALS CORPORATION

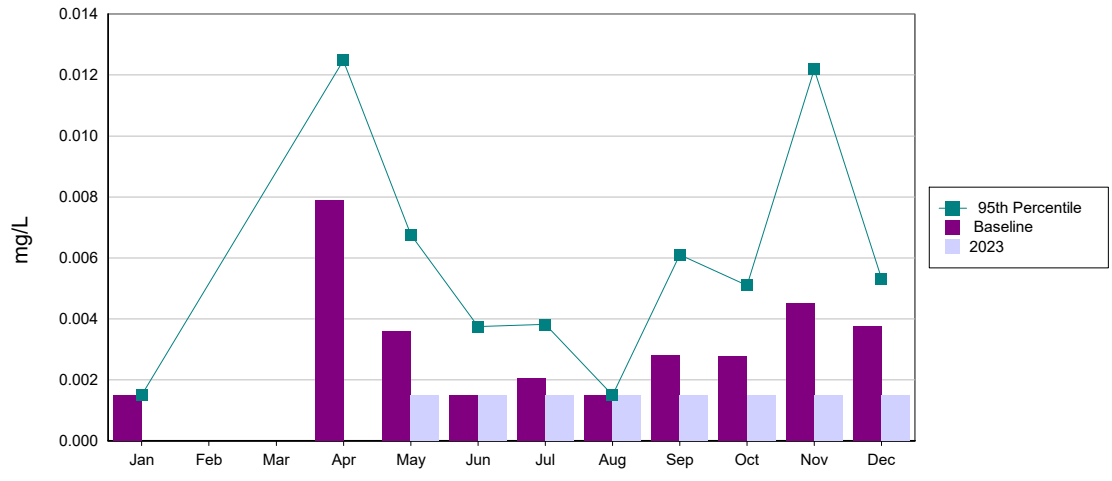
HAC-14 : TSS Monthly Average (mg/L)



HAC-14 : Turbidity Monthly Av (ntu)



HAC-14 : Zinc (Zn)-Total (mg/L)



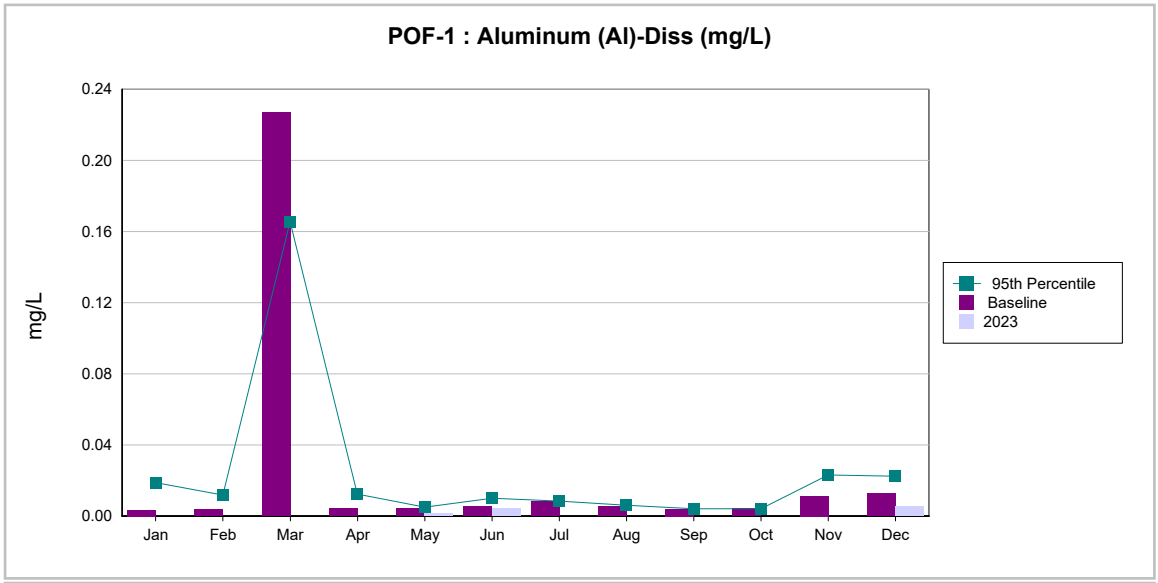
Water Quality Report

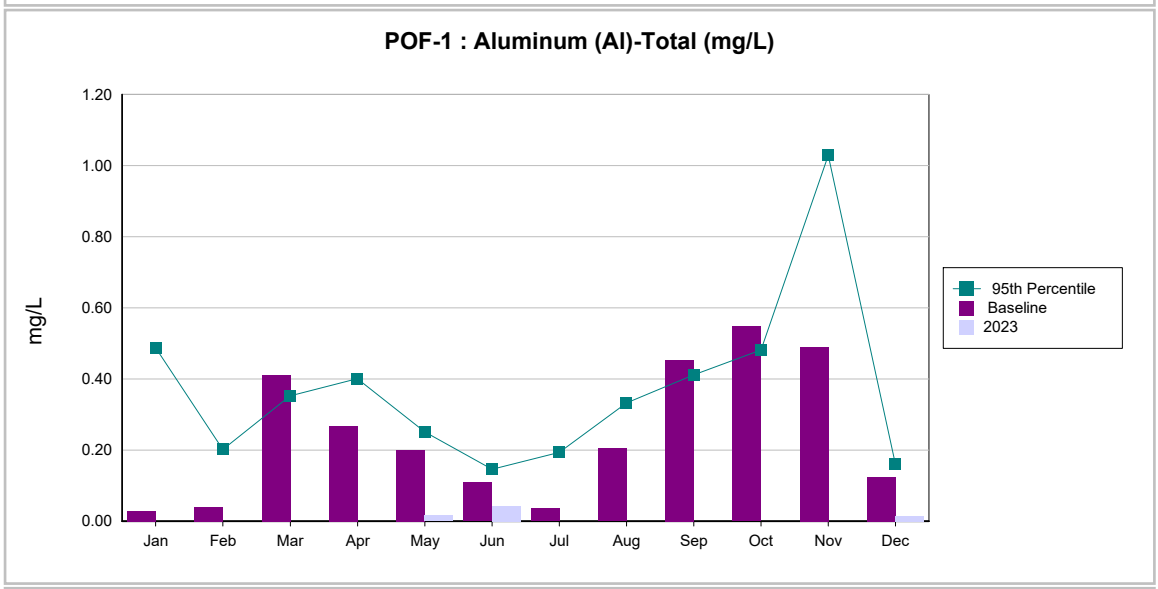
Annual Report HAC vs BCWQG

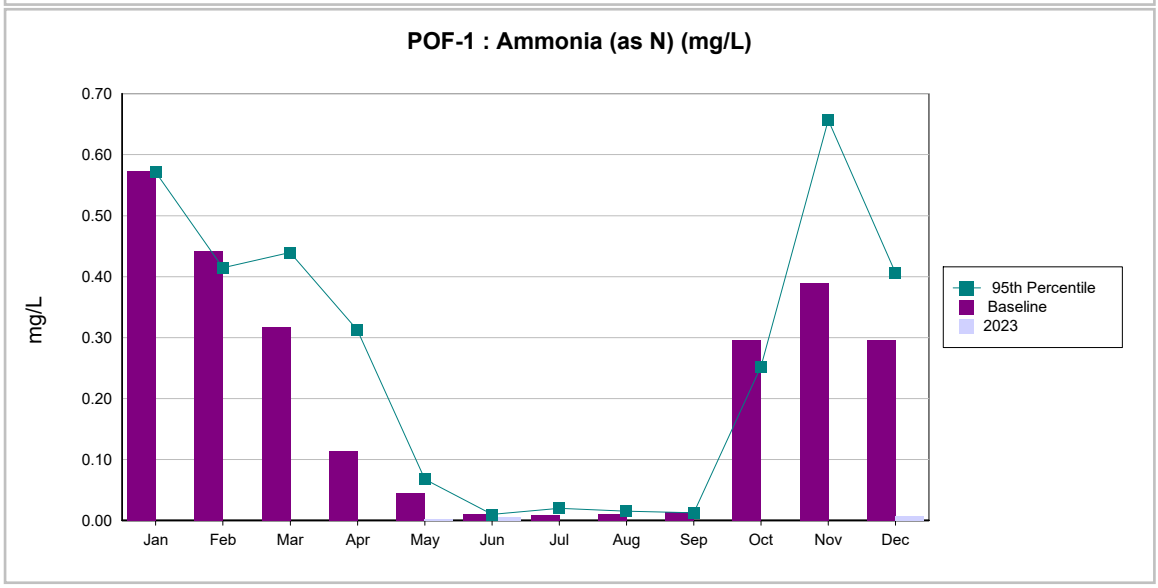
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







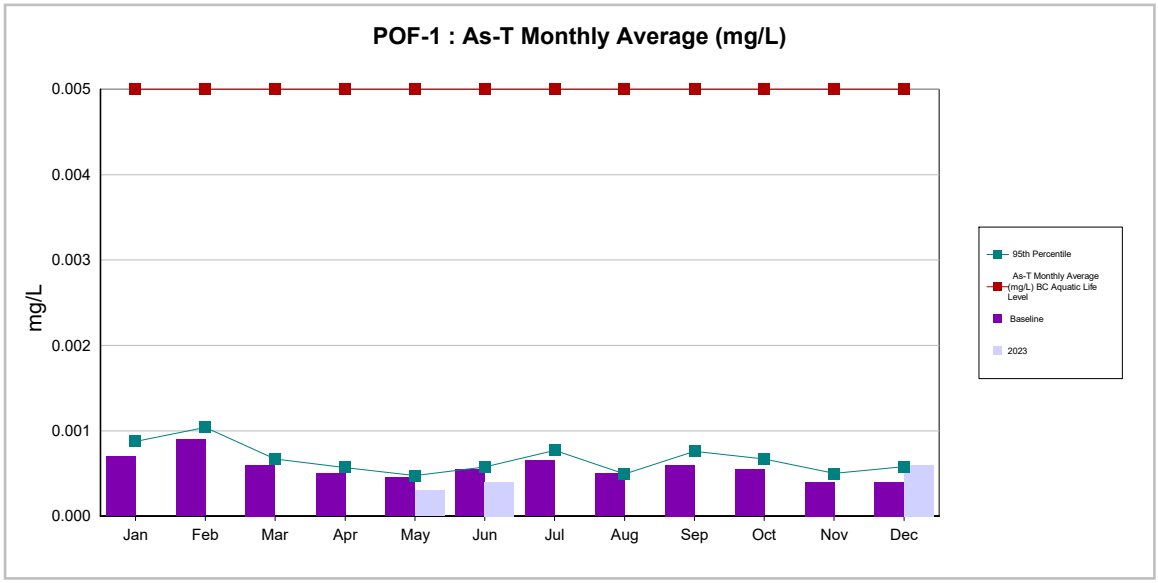
Water Quality Report

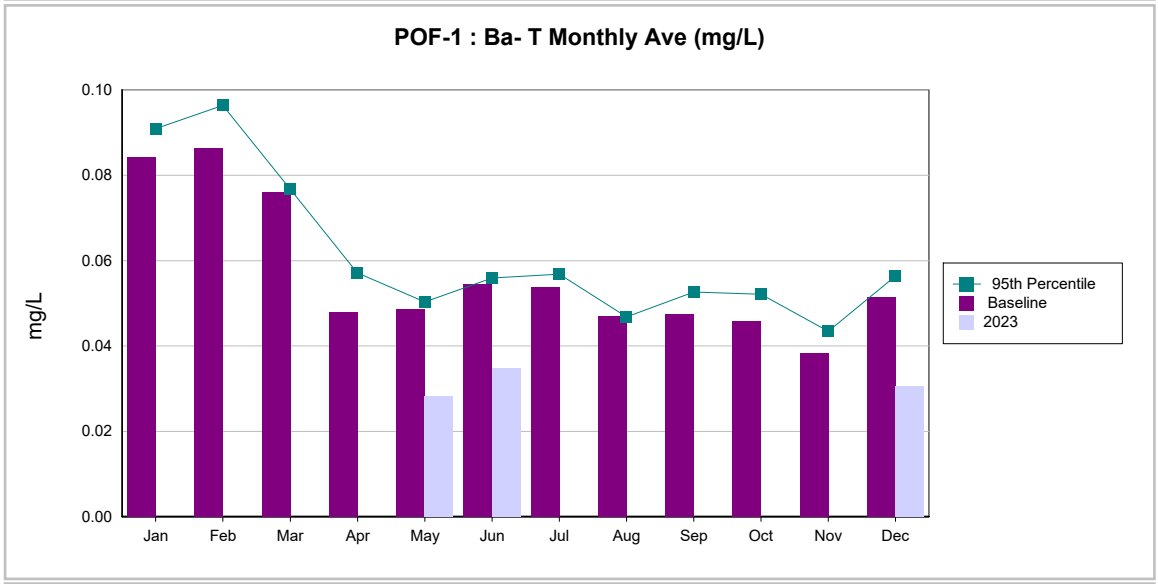
Annual Report HAC vs BCWQG

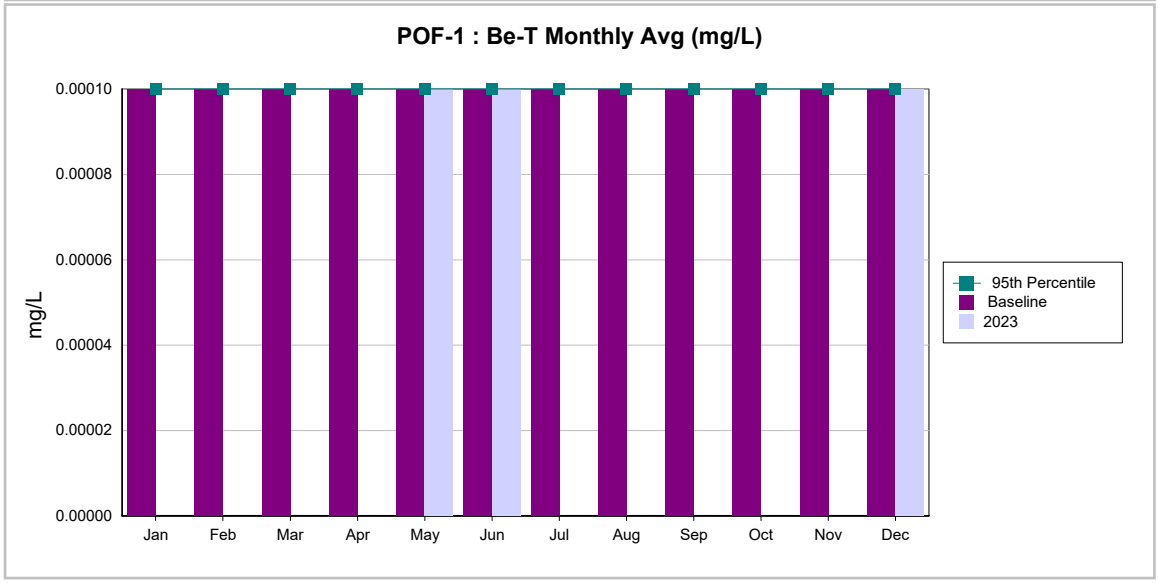
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







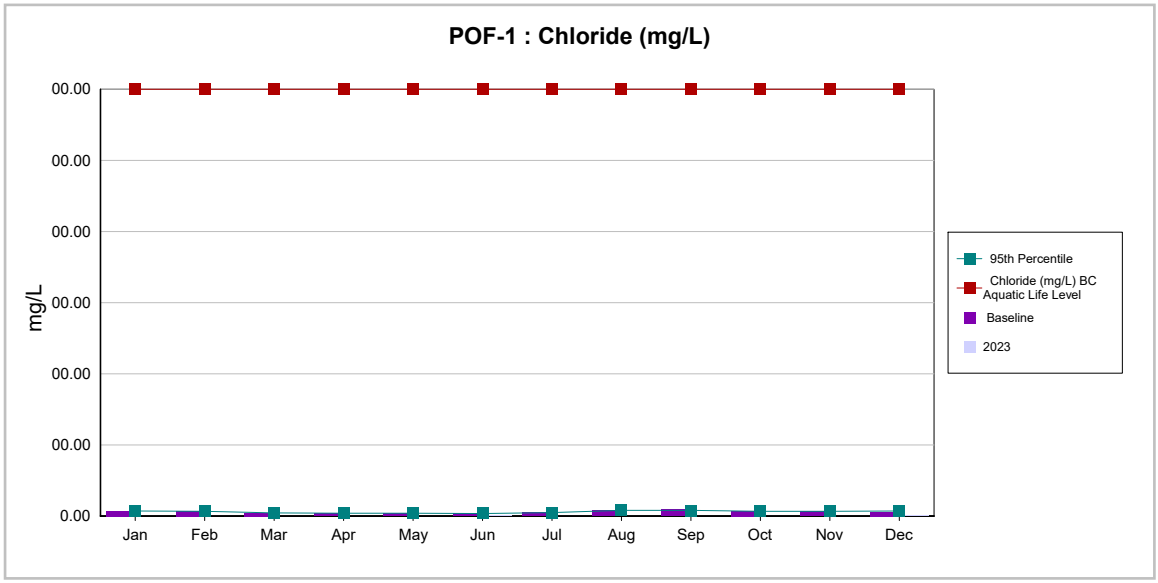
Water Quality Report

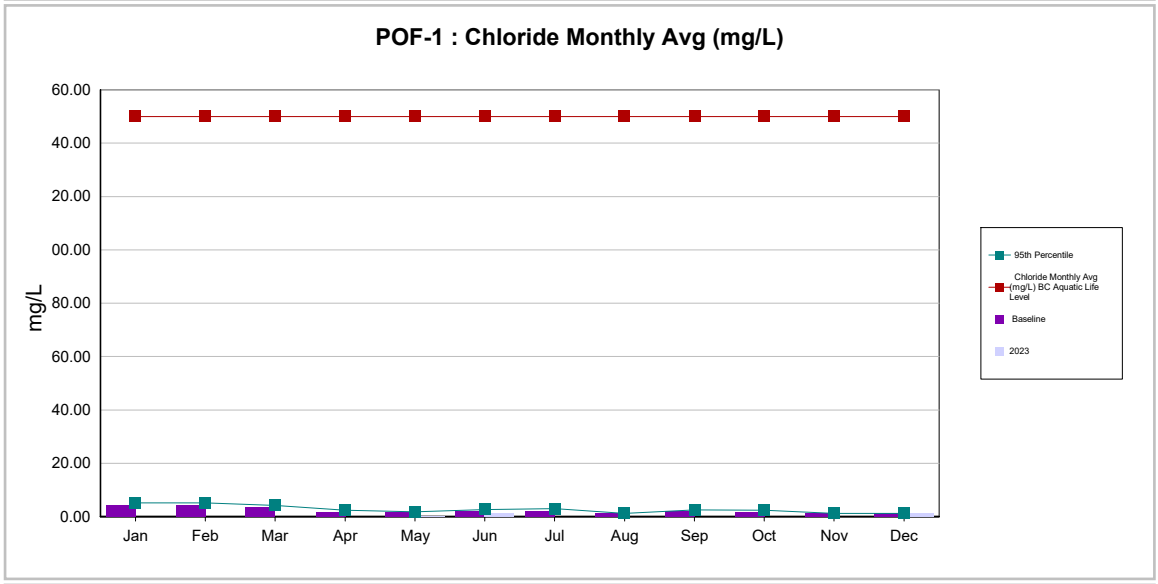
Annual Report HAC vs BCWQG

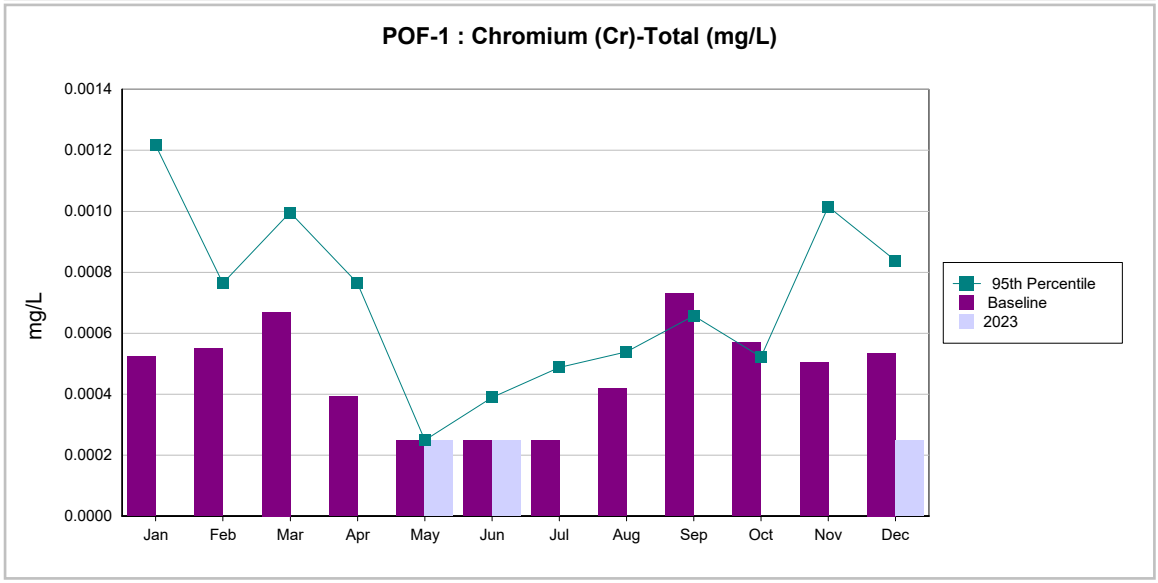
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







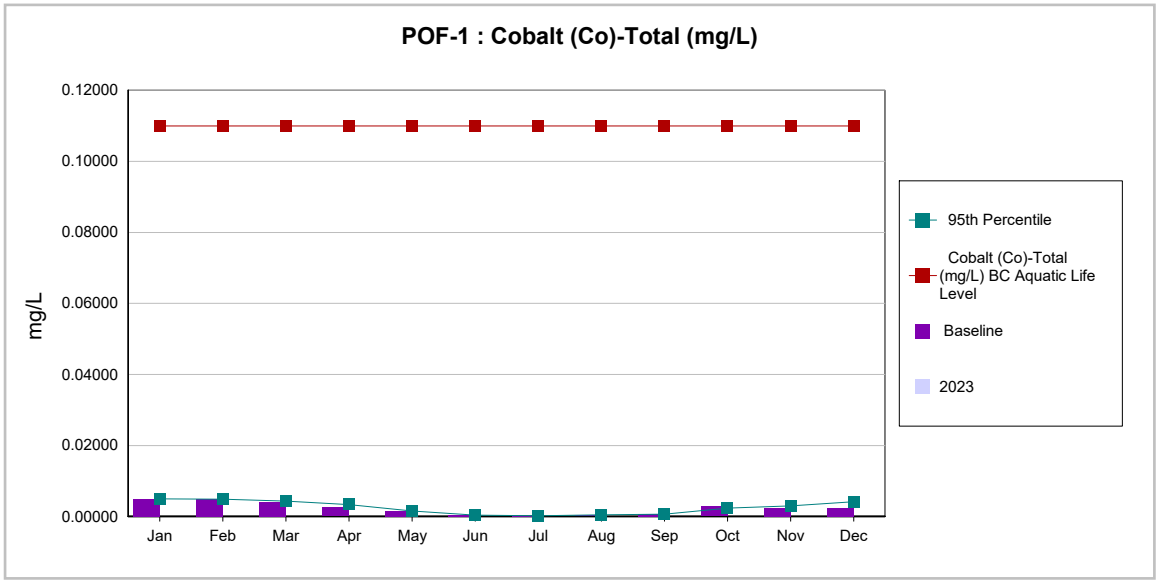
Water Quality Report

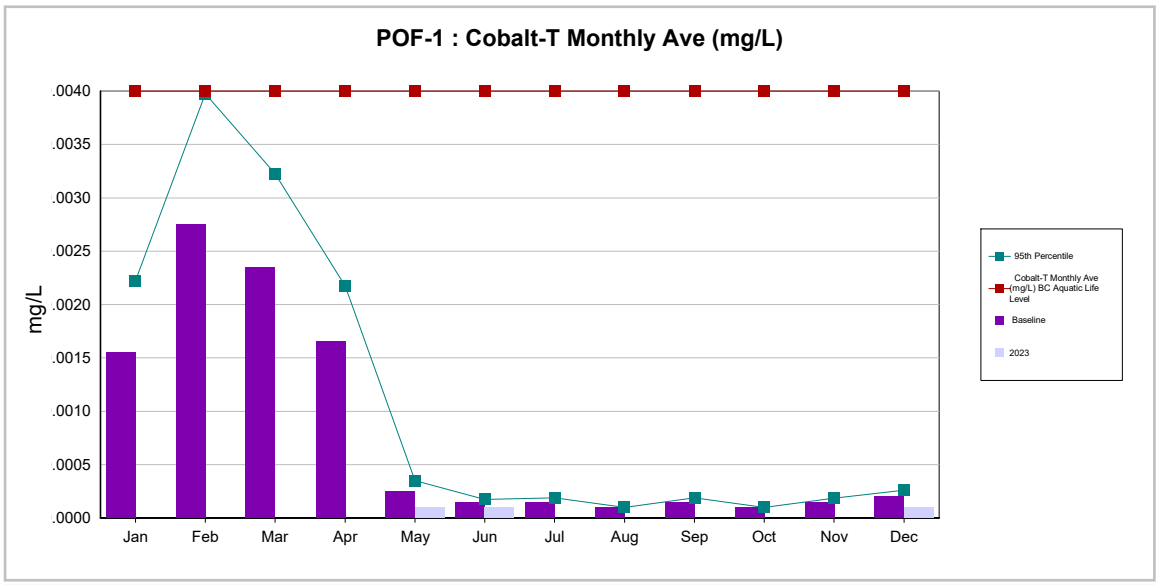
Annual Report HAC vs BCWQG

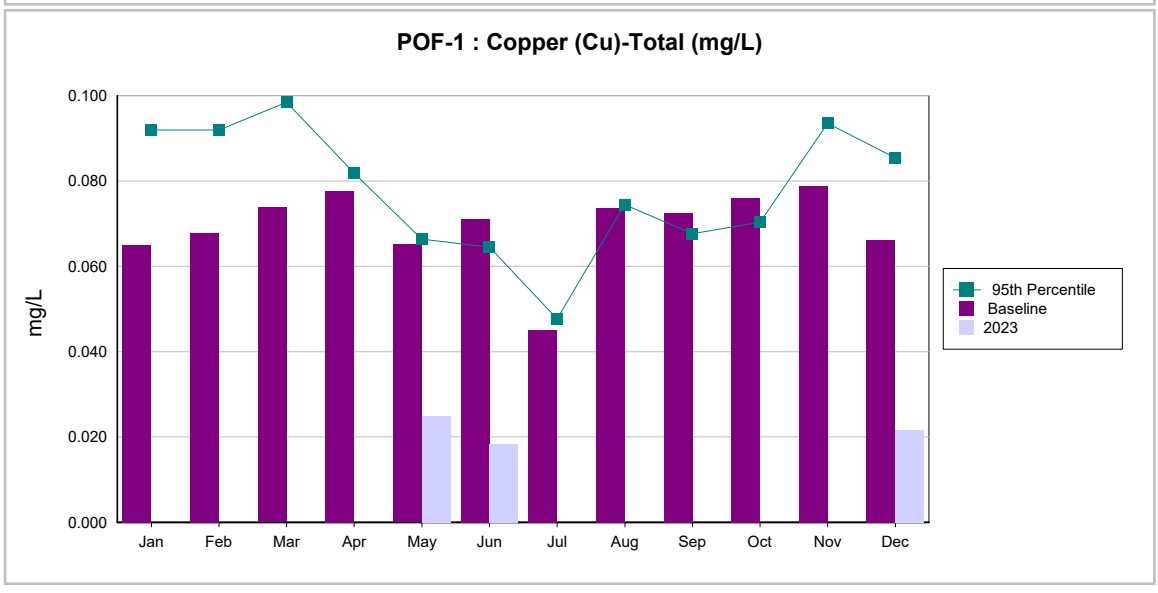
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







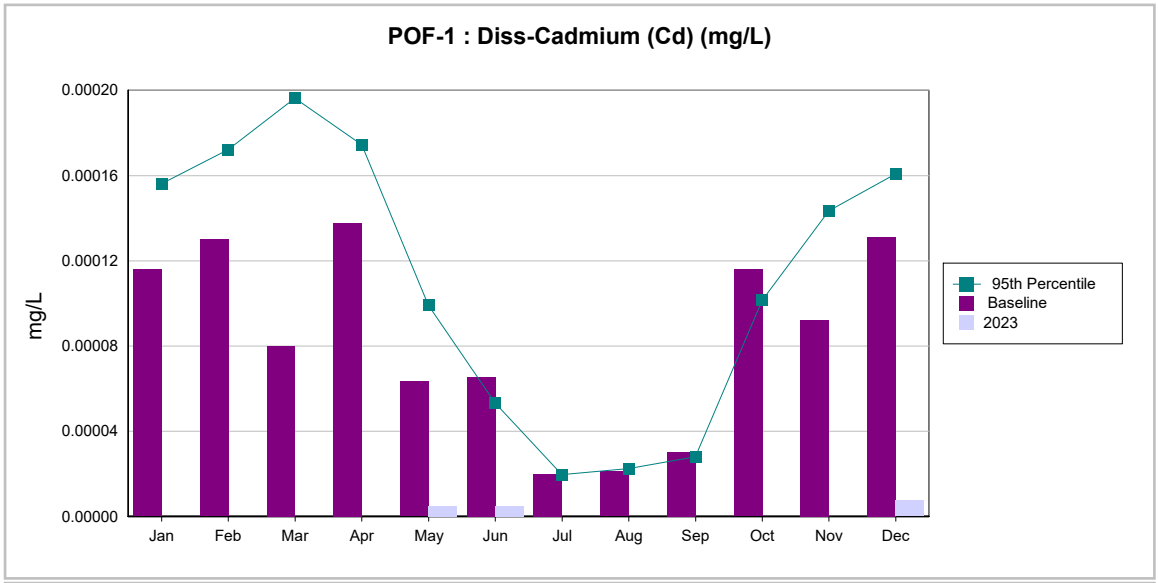
Water Quality Report

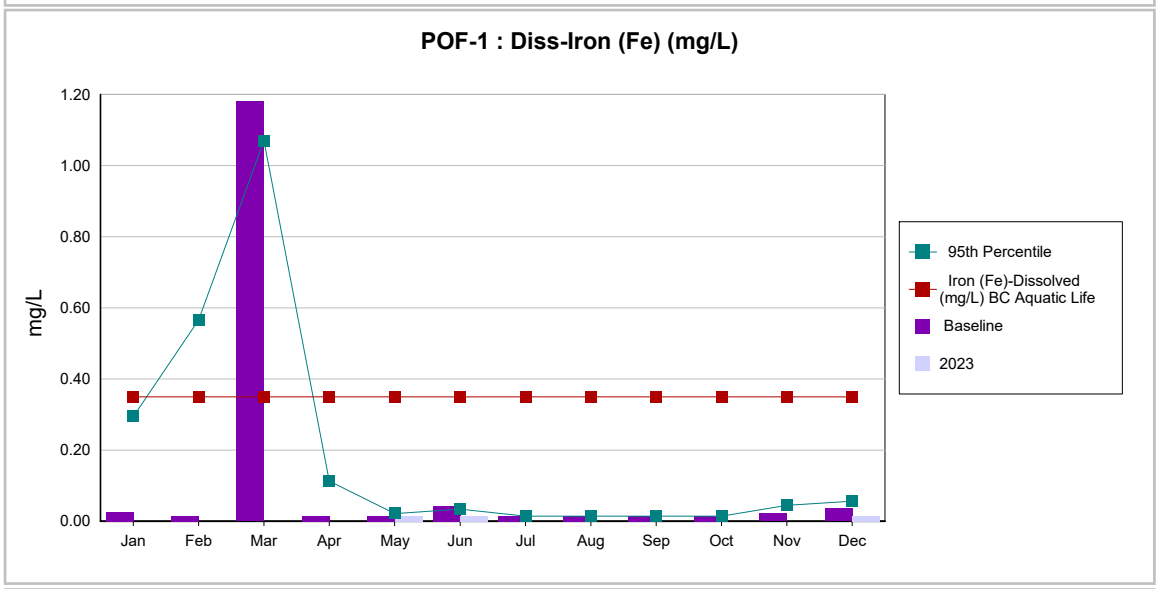
Annual Report HAC vs BCWQG

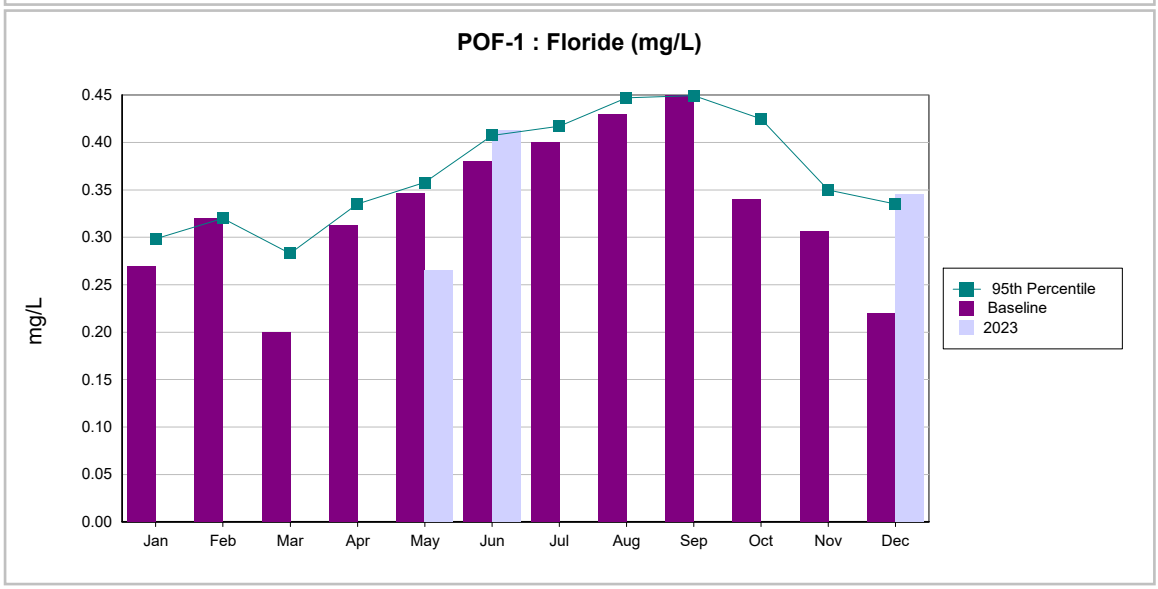
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







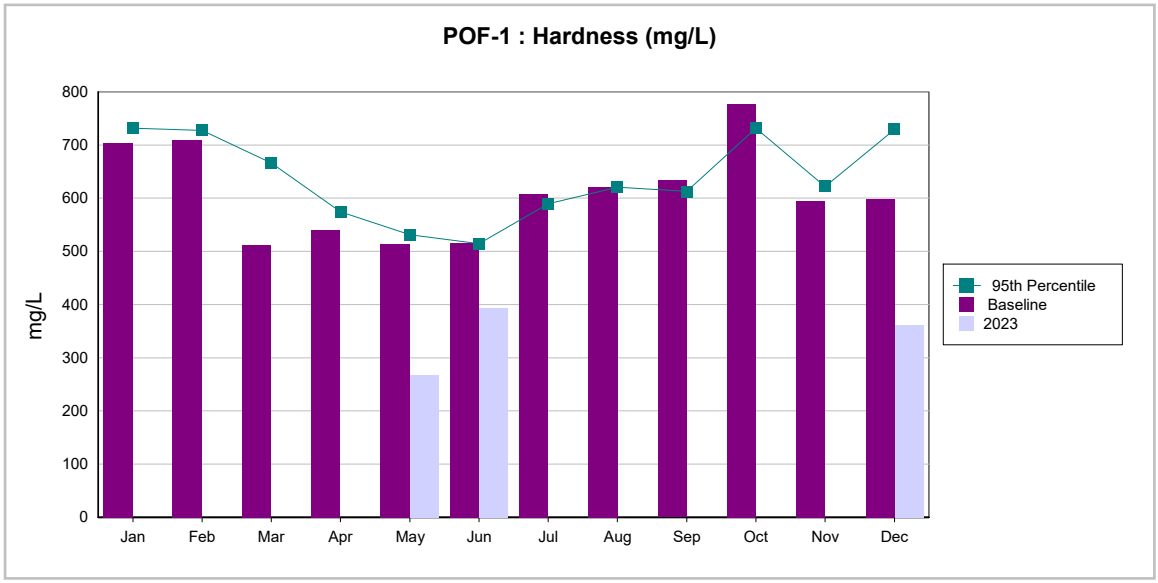
Water Quality Report

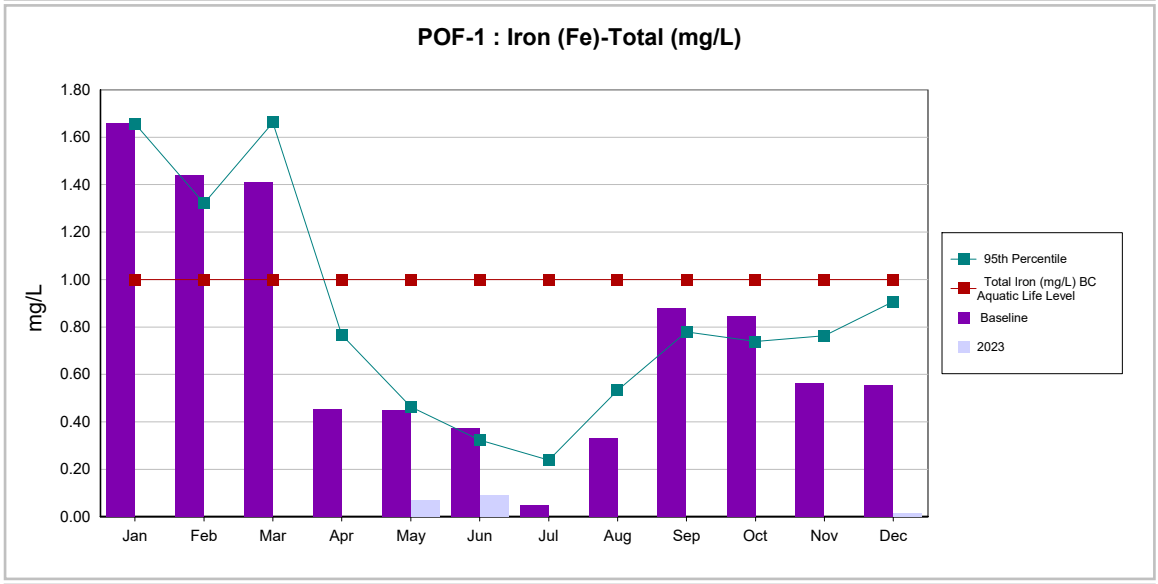
Annual Report HAC vs BCWQG

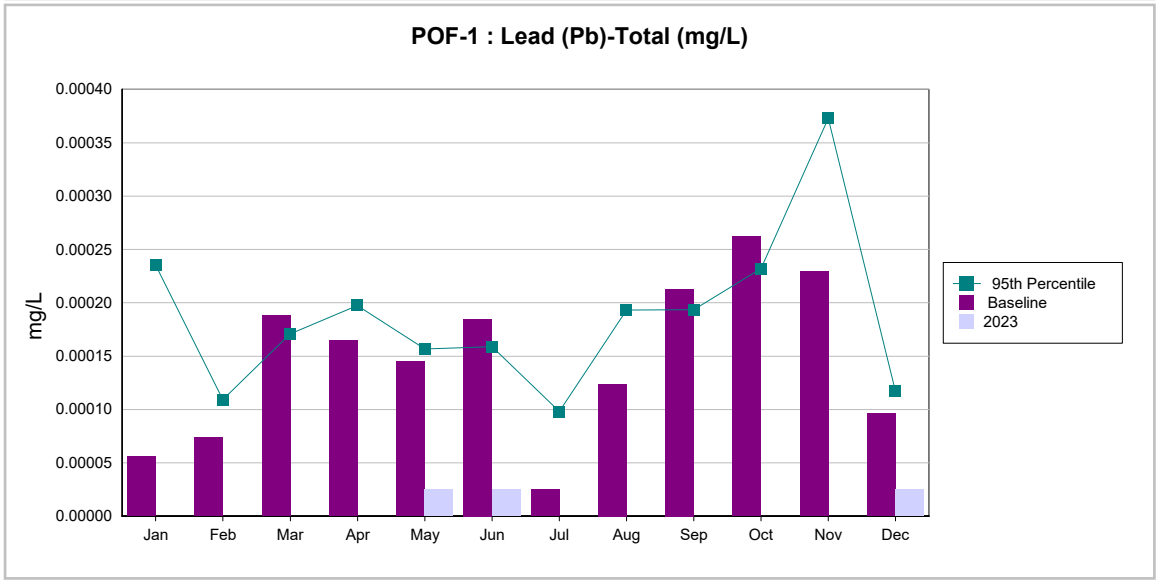
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







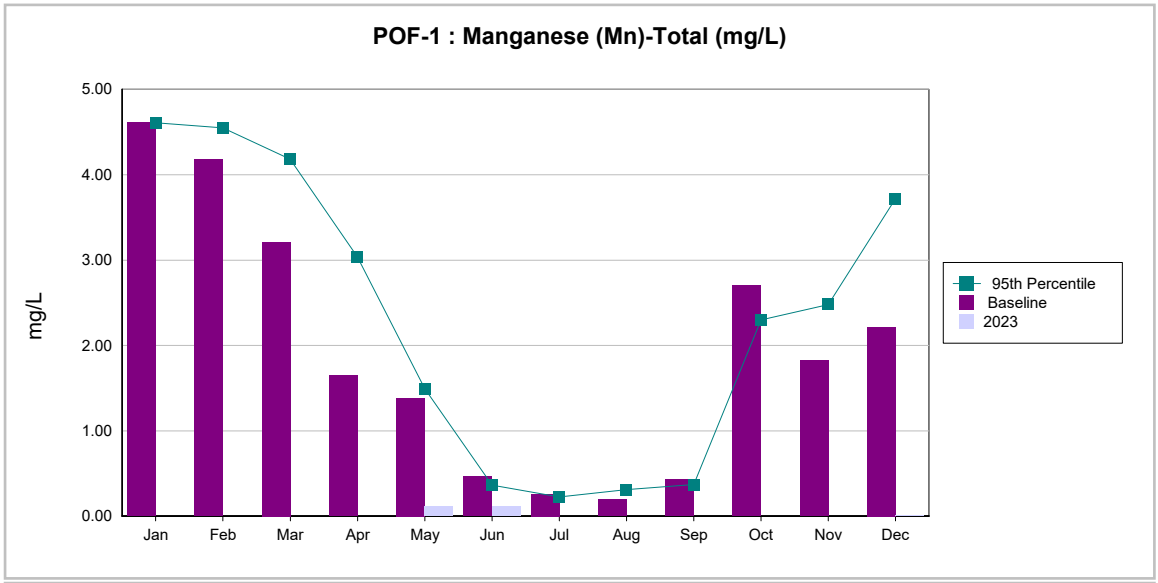
Water Quality Report

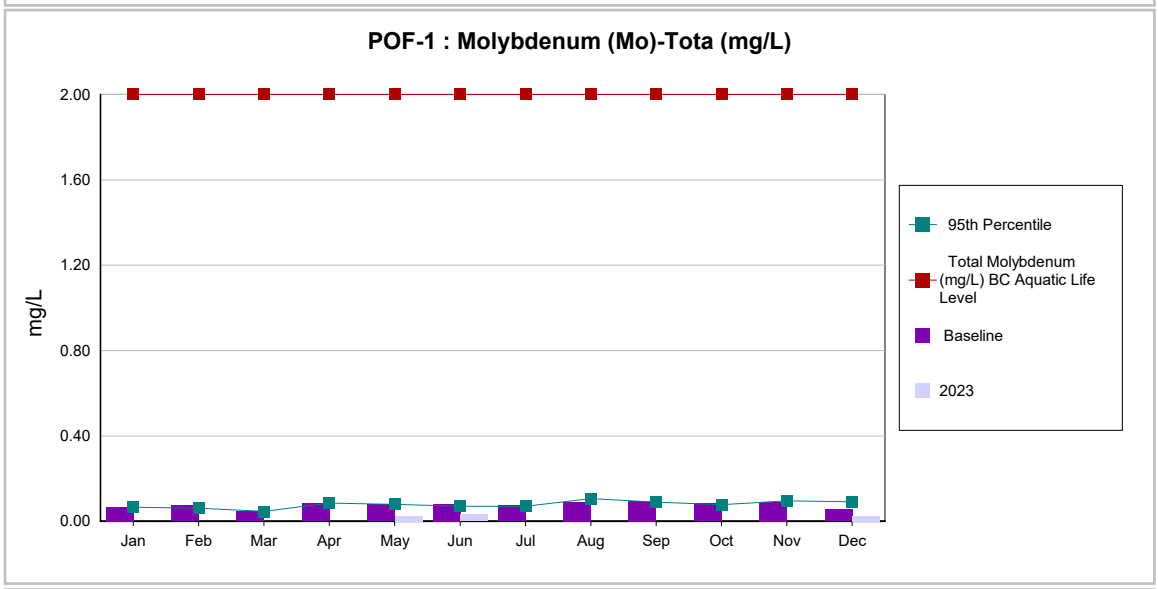
Annual Report HAC vs BCWQG

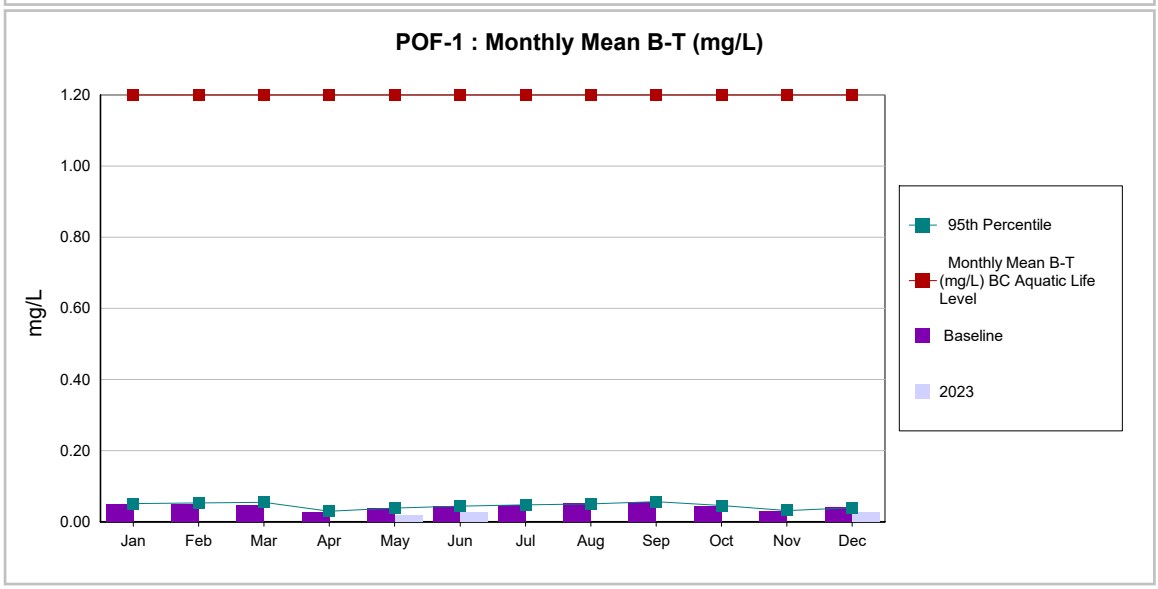
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







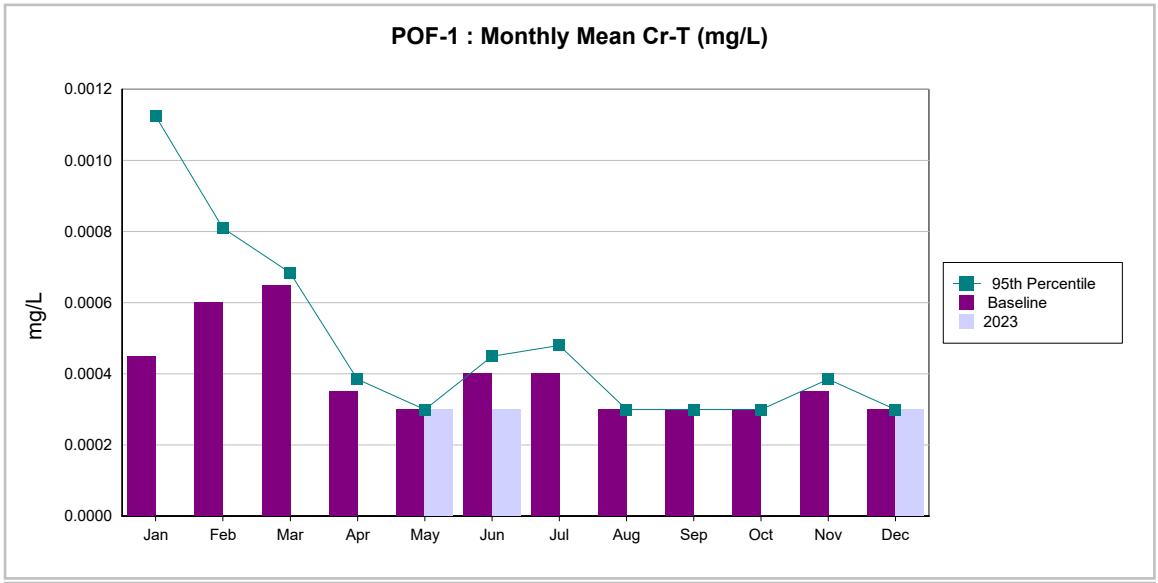
Water Quality Report

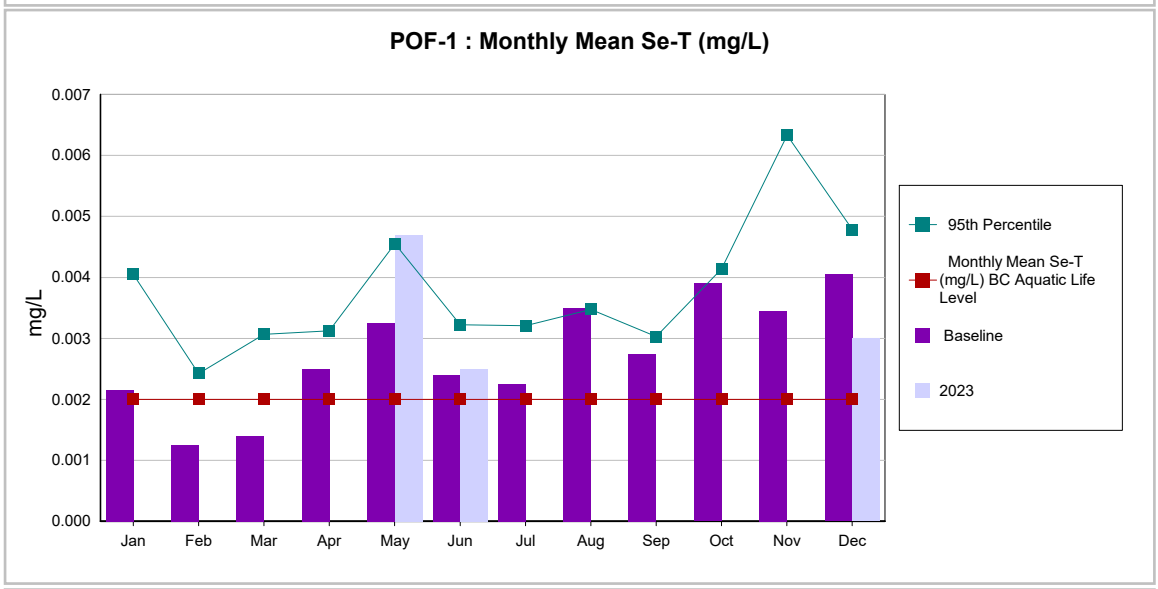
Annual Report HAC vs BCWQG

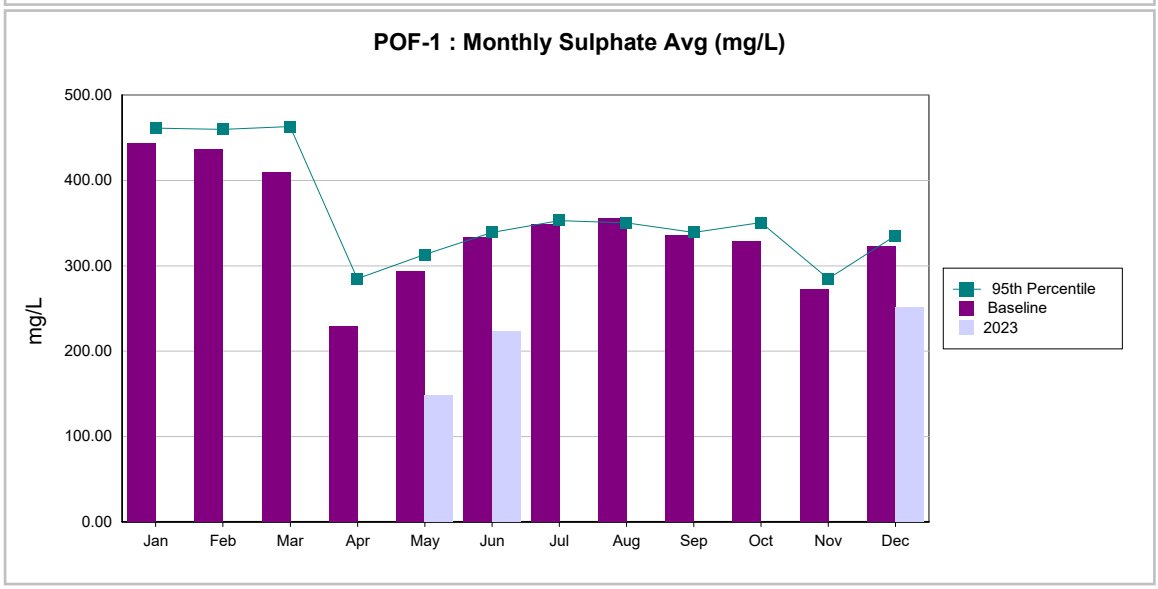
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







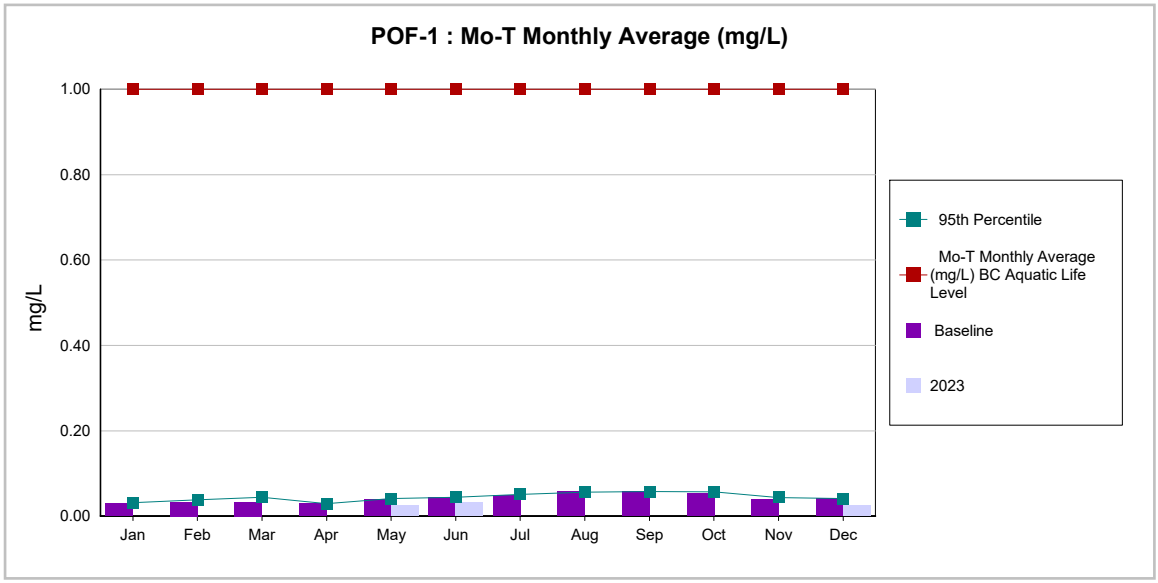
Water Quality Report

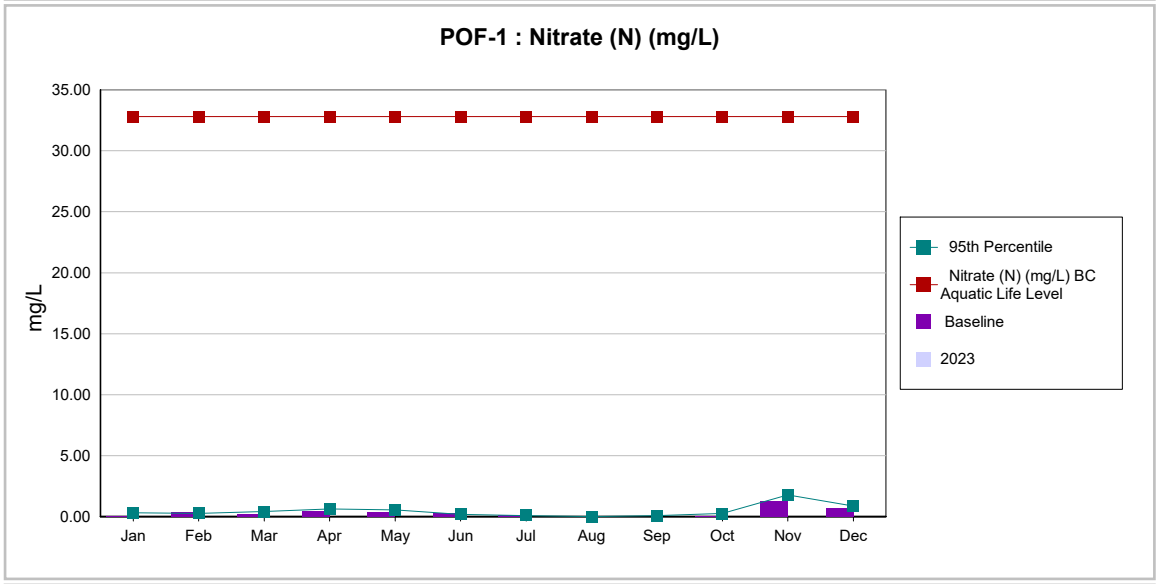
Annual Report HAC vs BCWQG

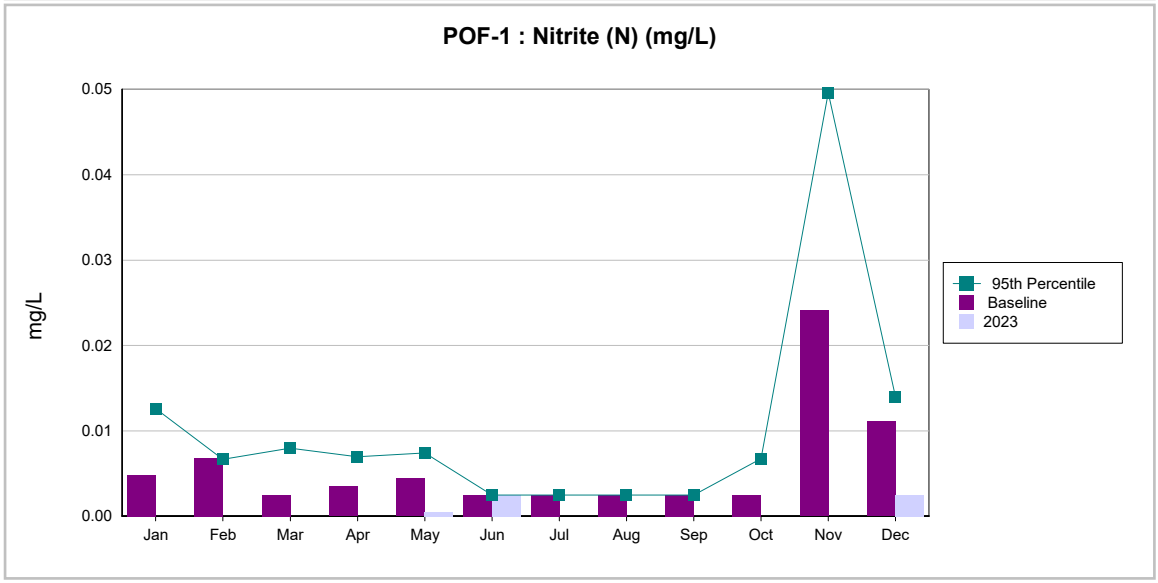
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







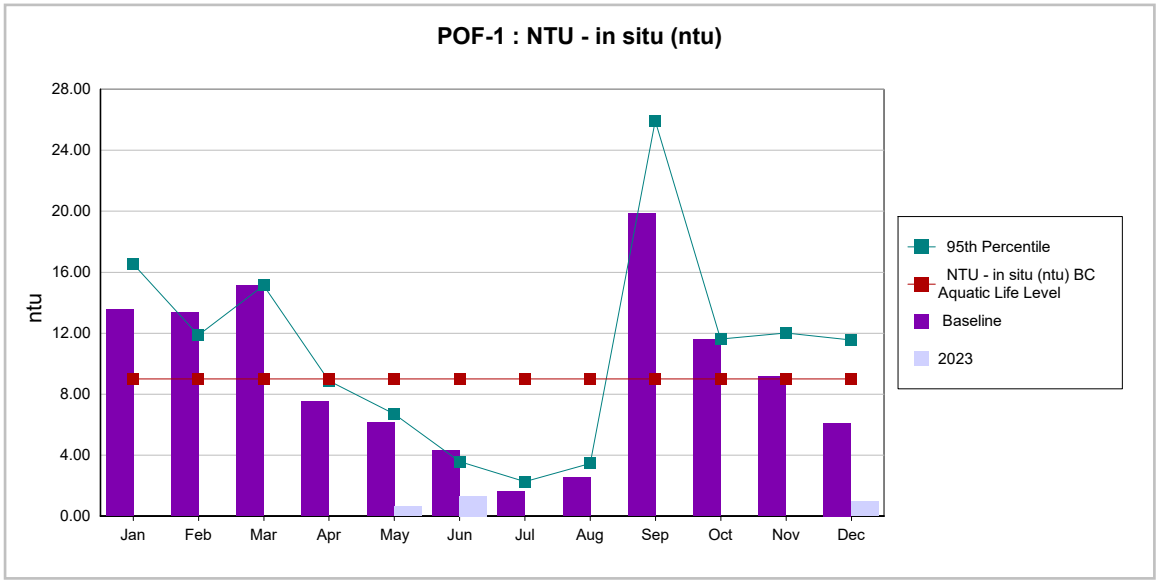
Water Quality Report

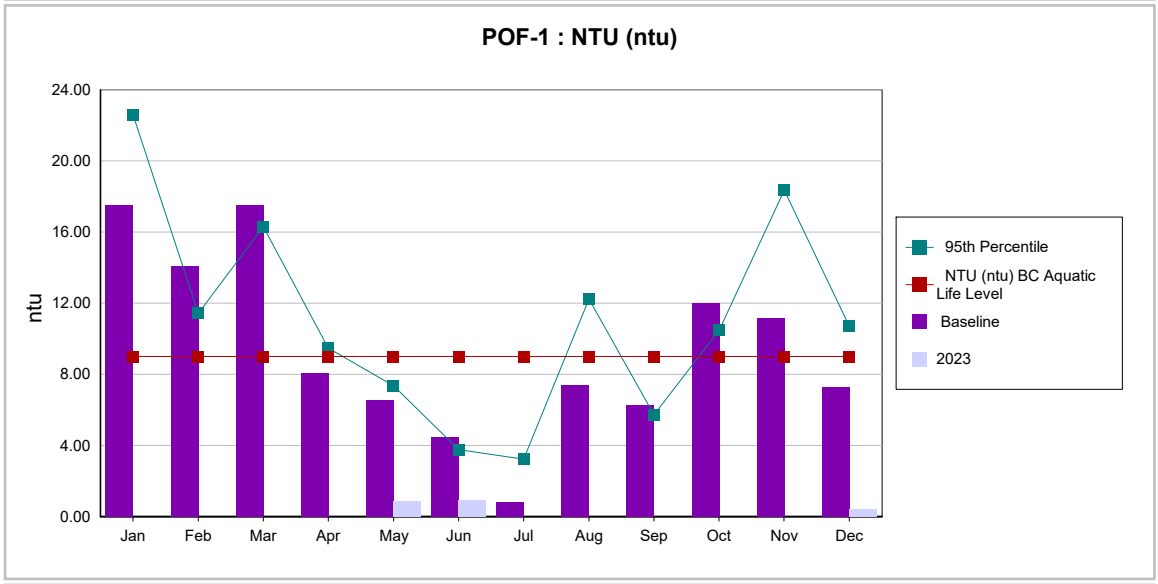
Annual Report HAC vs BCWQG

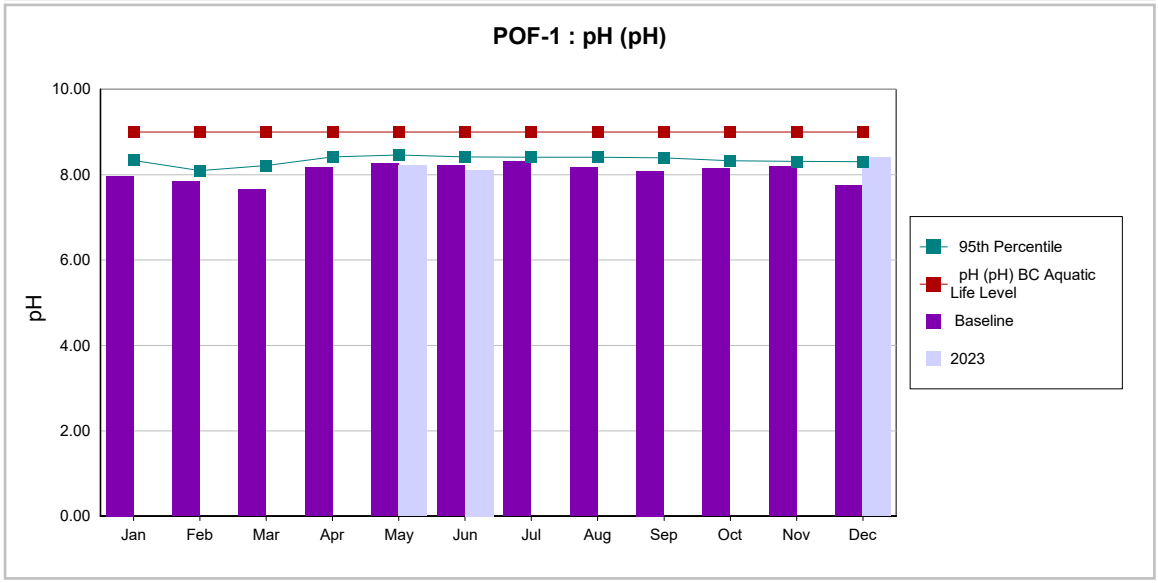
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







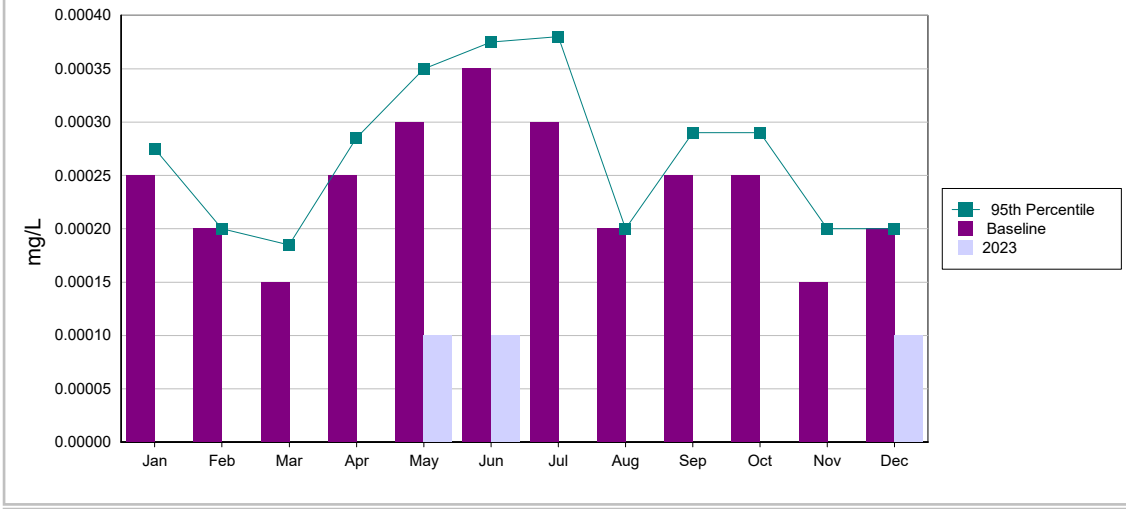
Water Quality Report

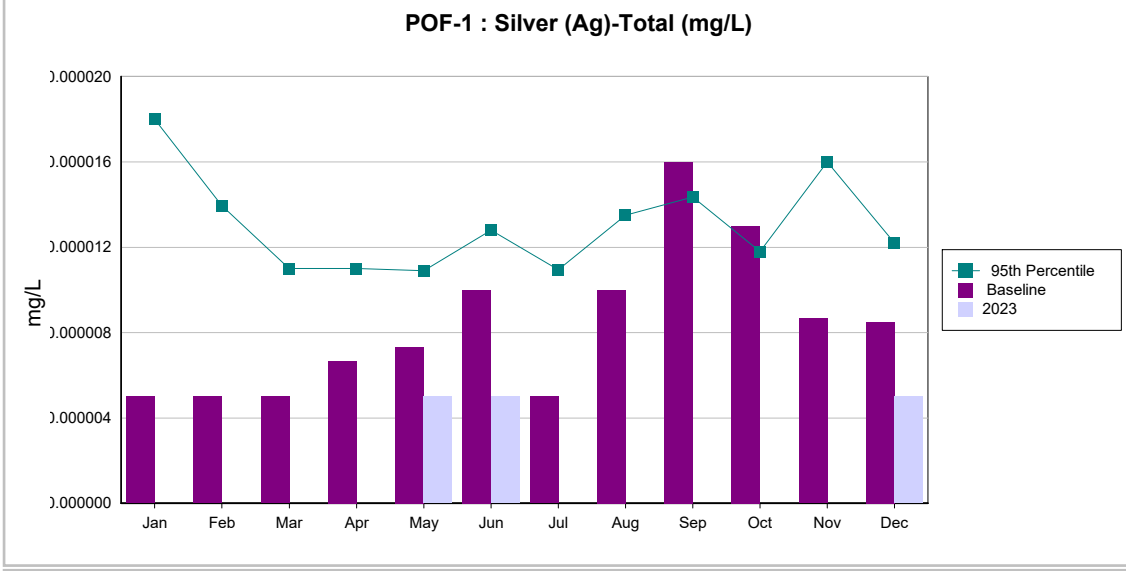
Annual Report HAC vs BCWQG

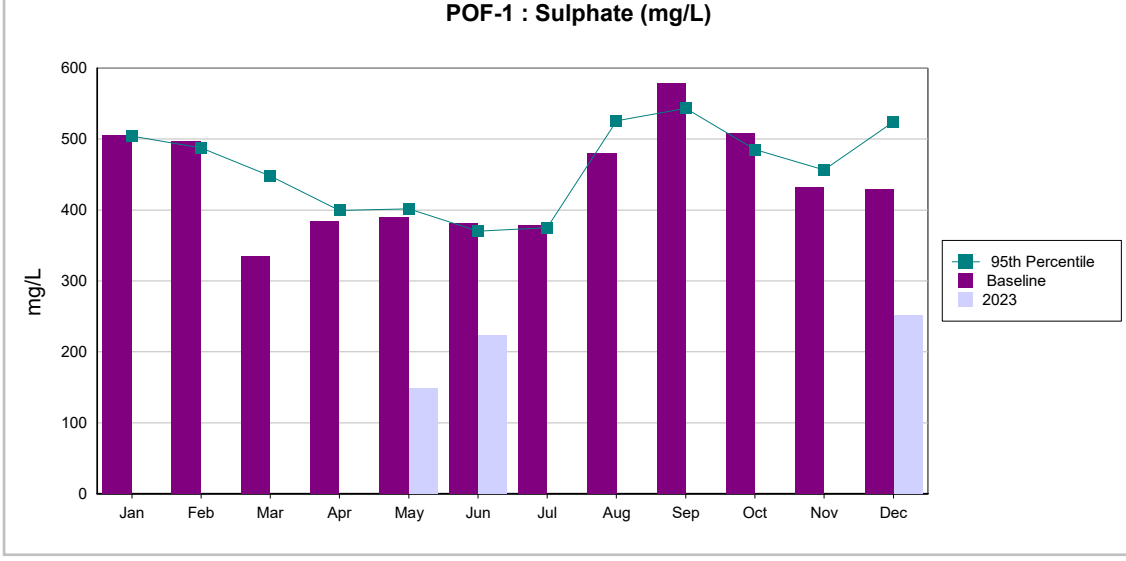
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







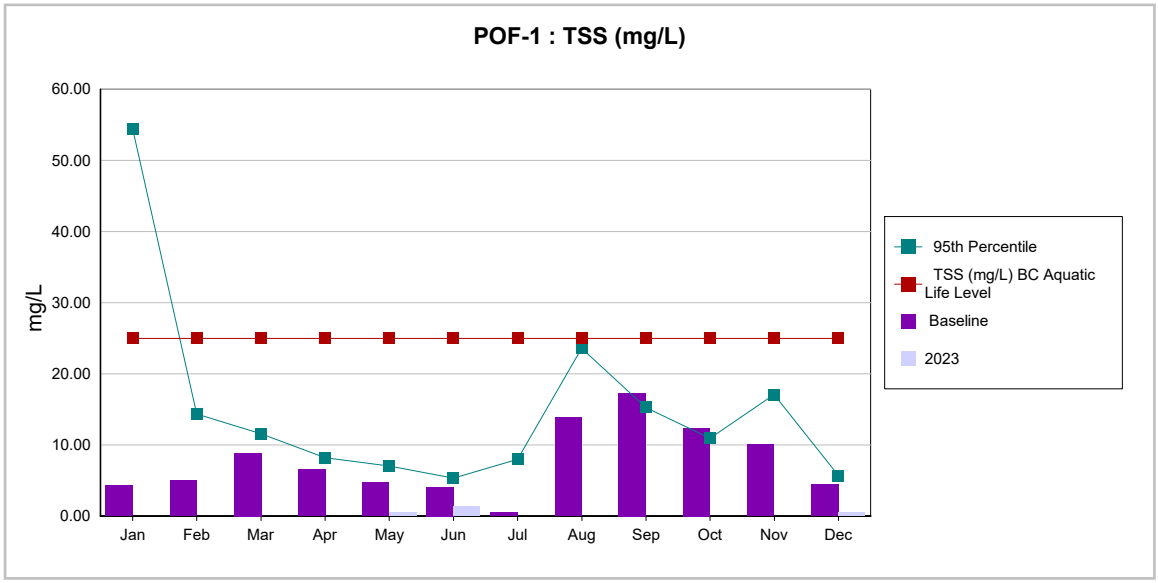
Water Quality Report

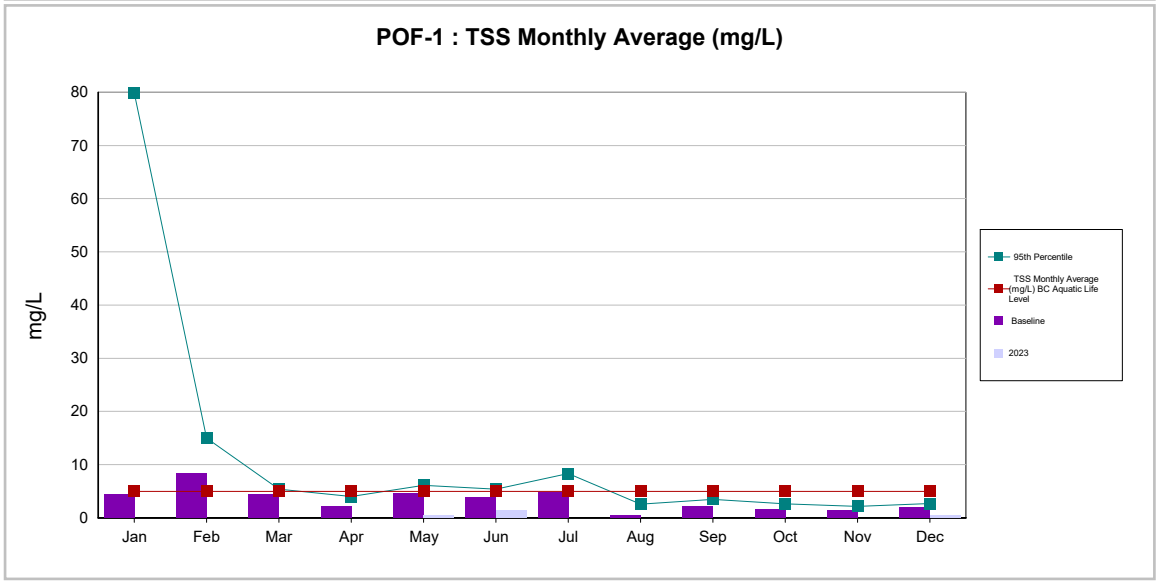
Annual Report HAC vs BCWQG

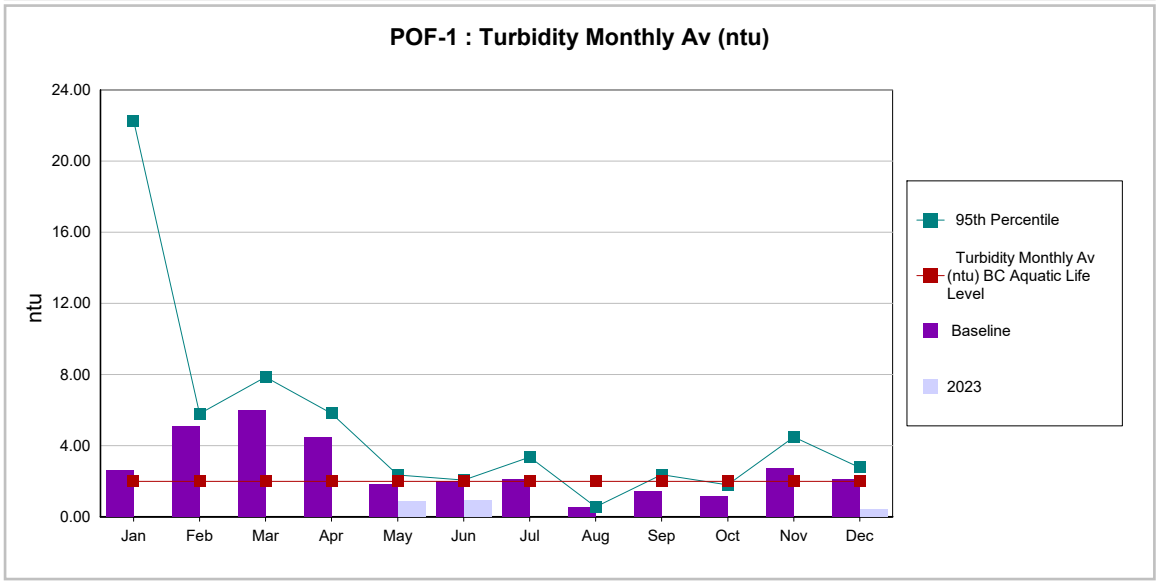
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







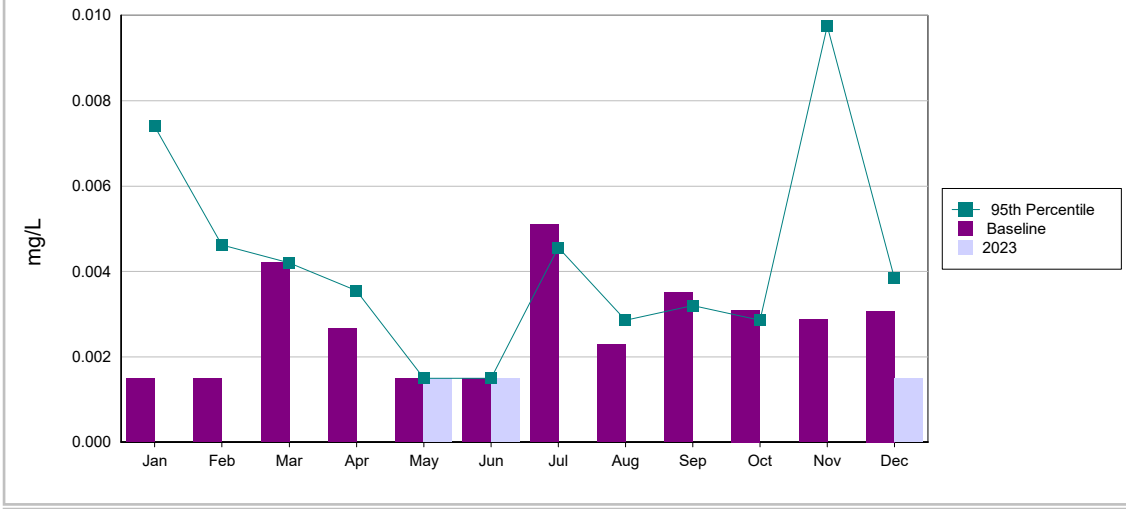
Water Quality Report

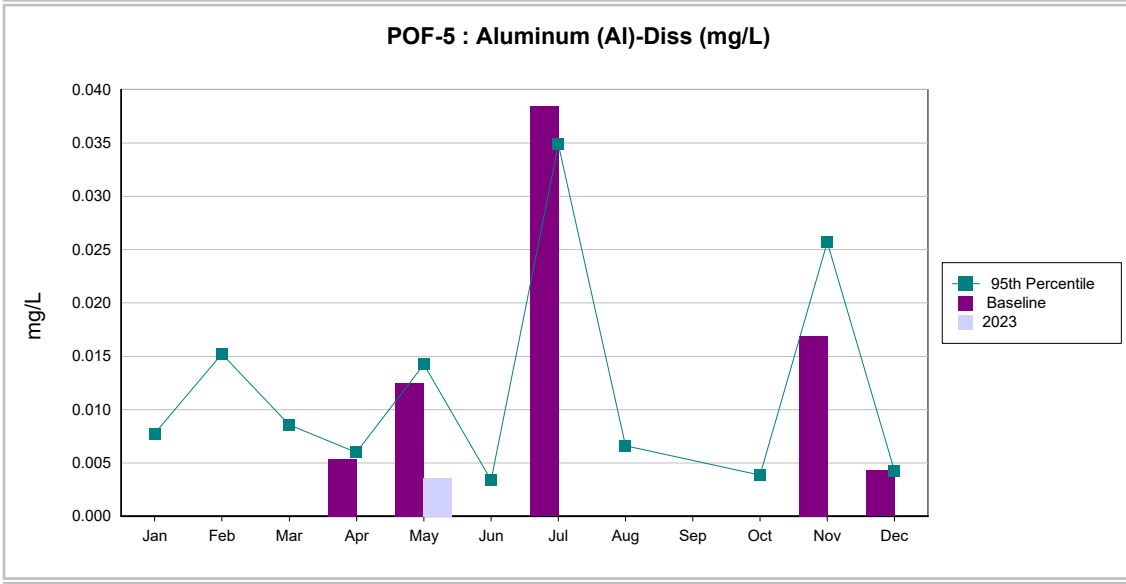
Annual Report HAC vs BCWQG

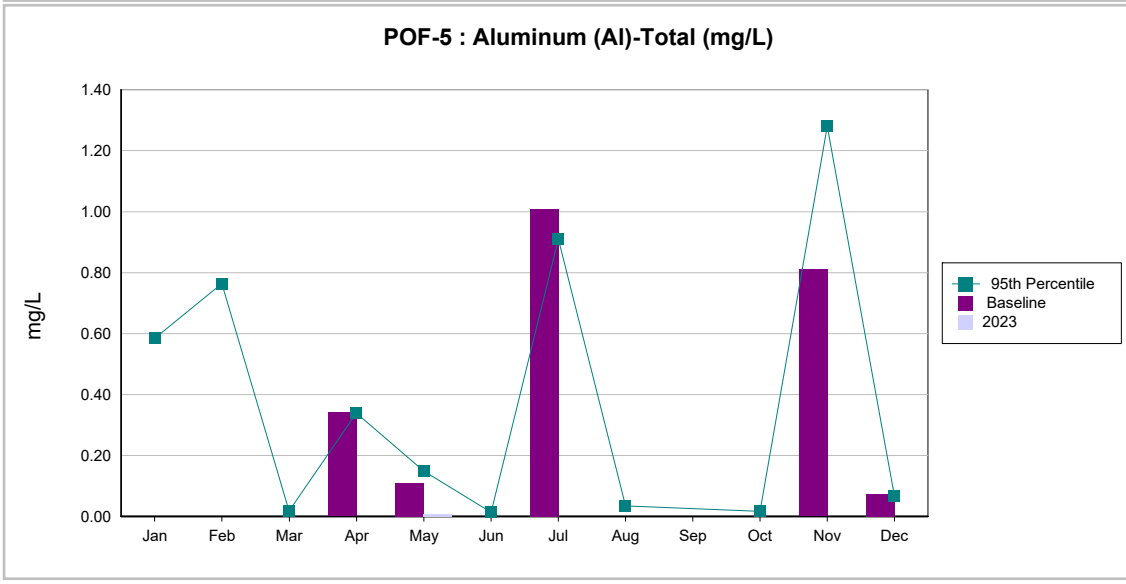
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







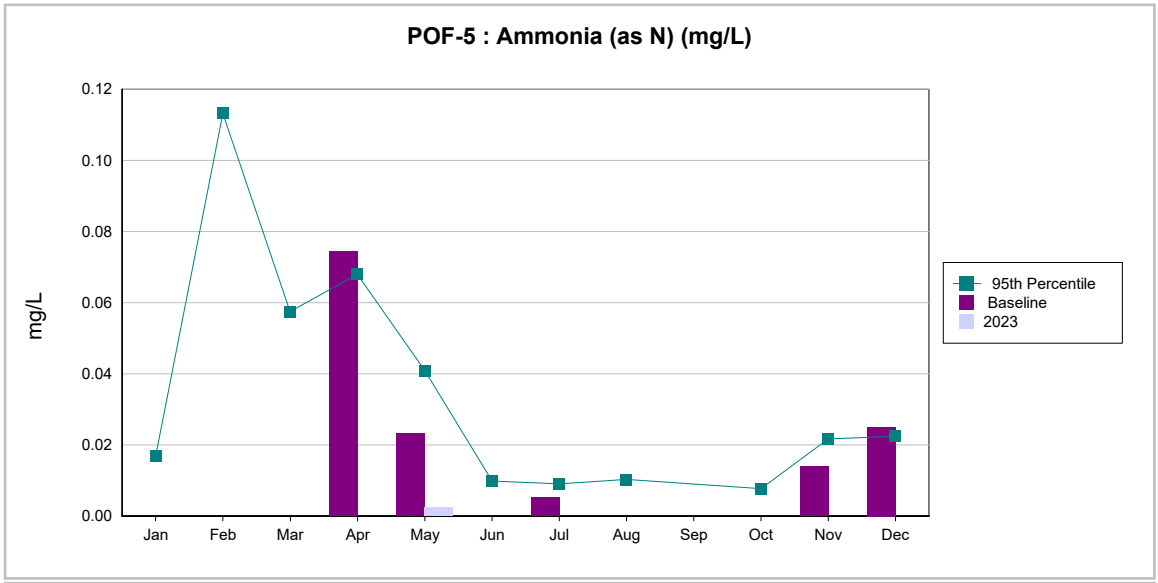
Water Quality Report

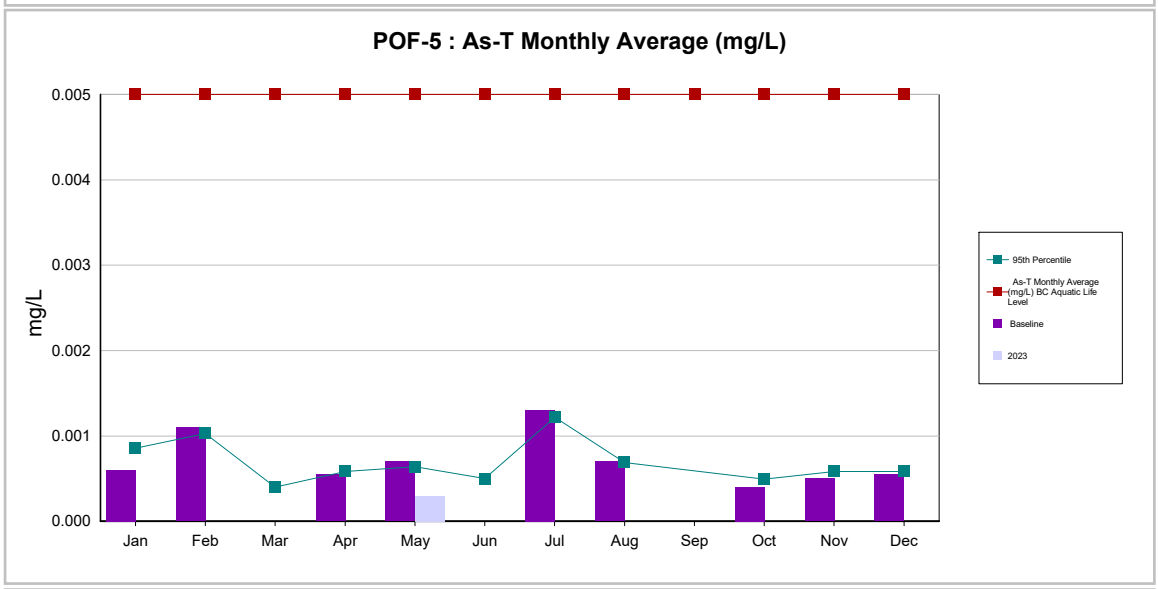
Annual Report HAC vs BCWQG

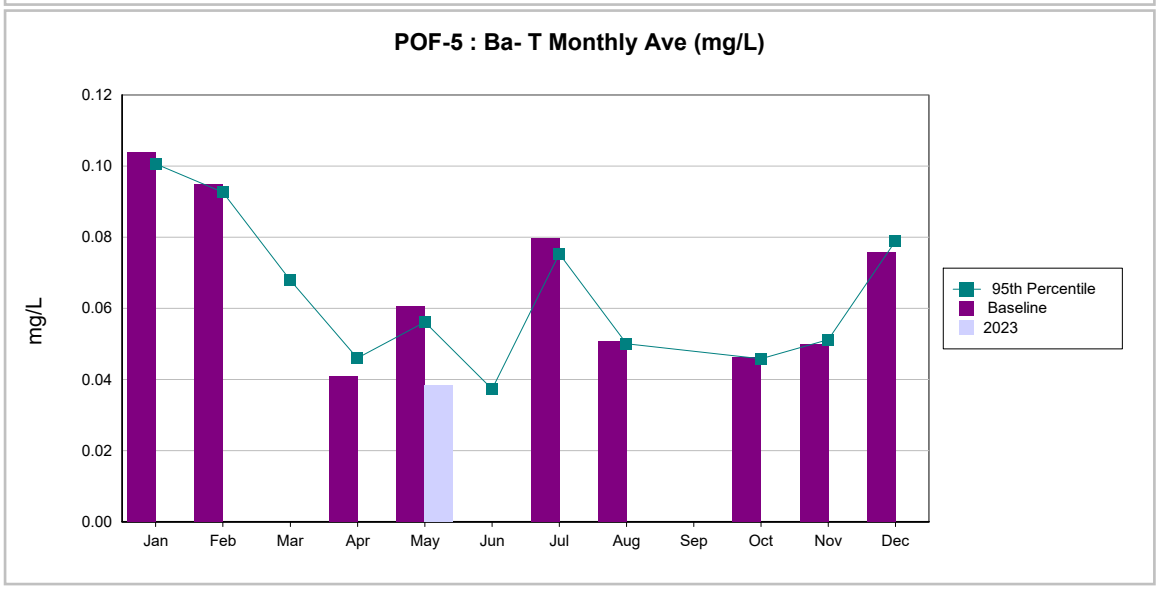
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







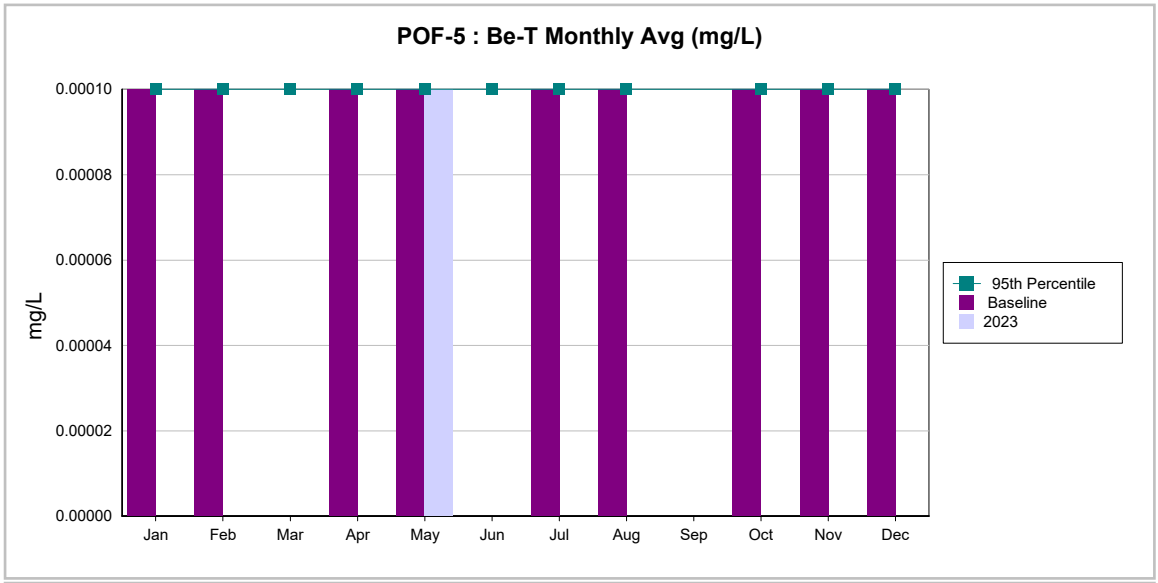
Water Quality Report

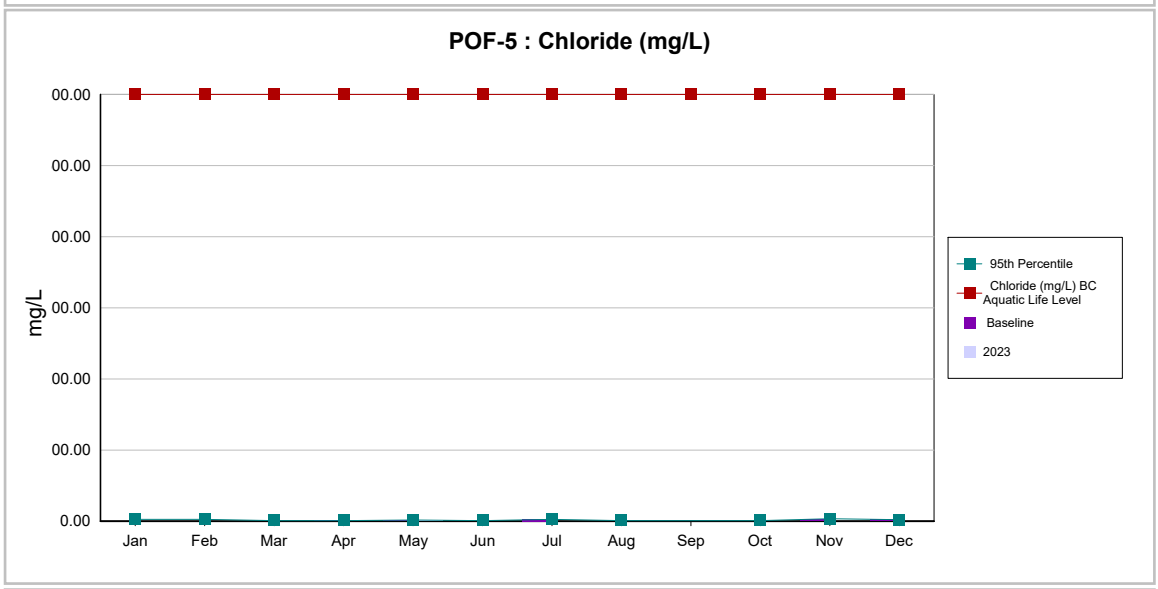
Annual Report HAC vs BCWQG

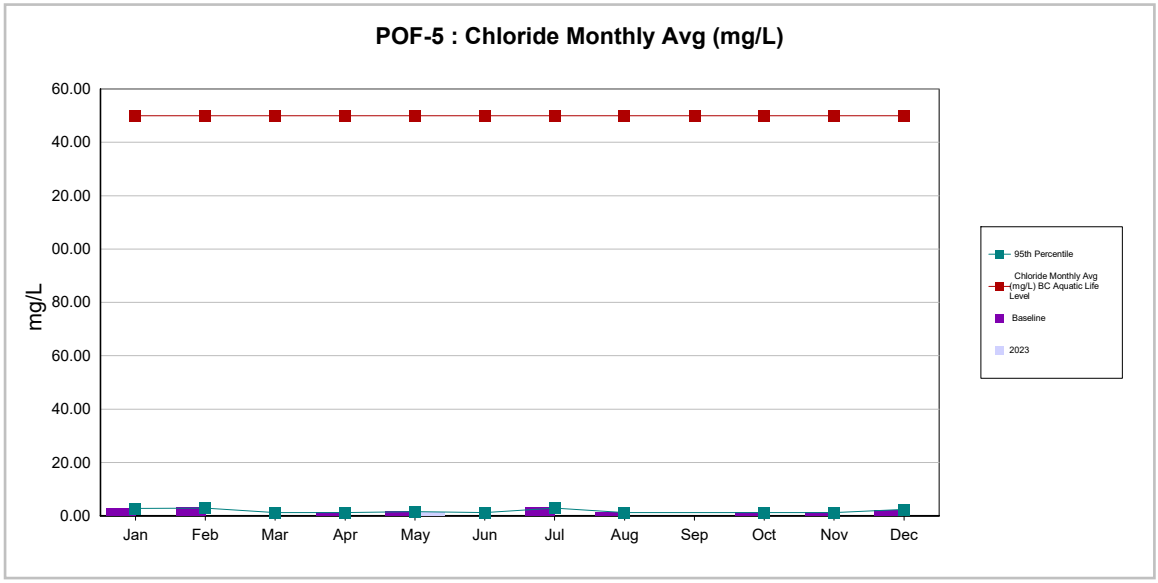
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







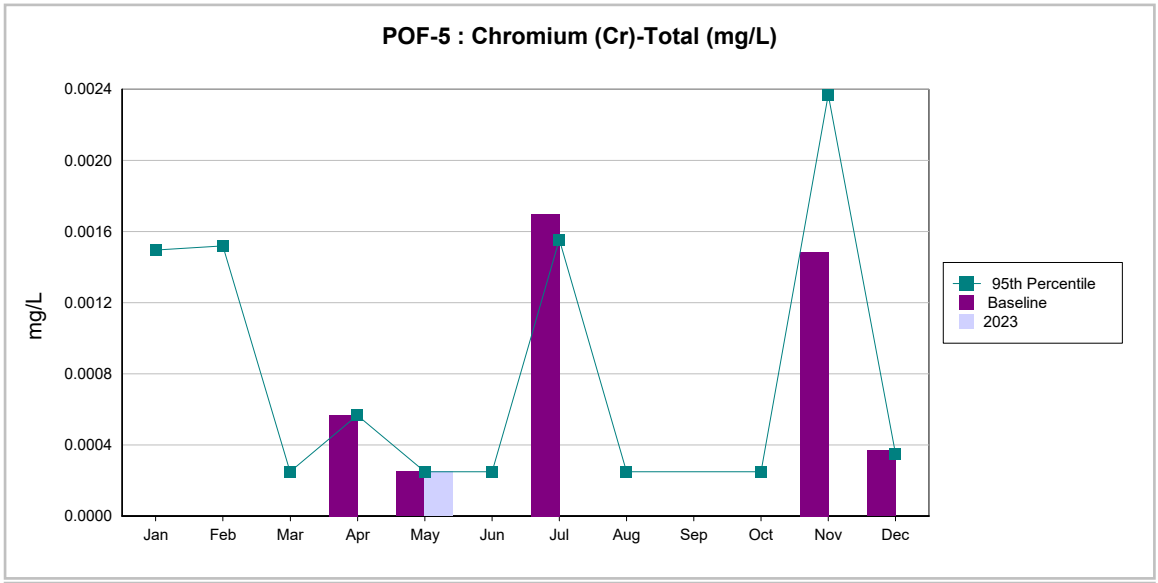
Water Quality Report

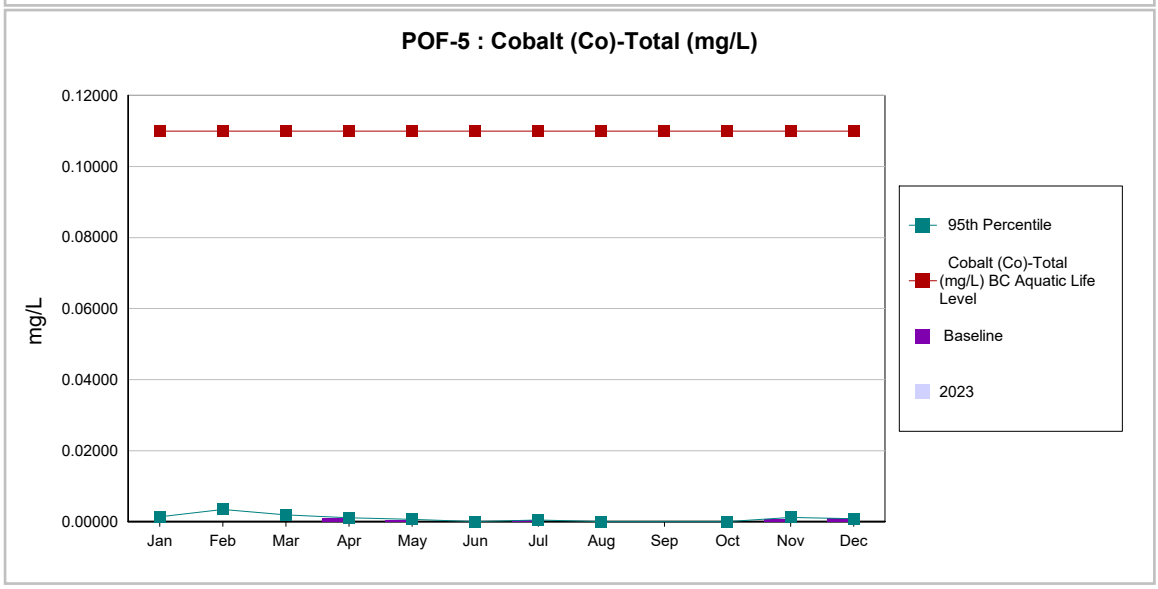
Annual Report HAC vs BCWQG

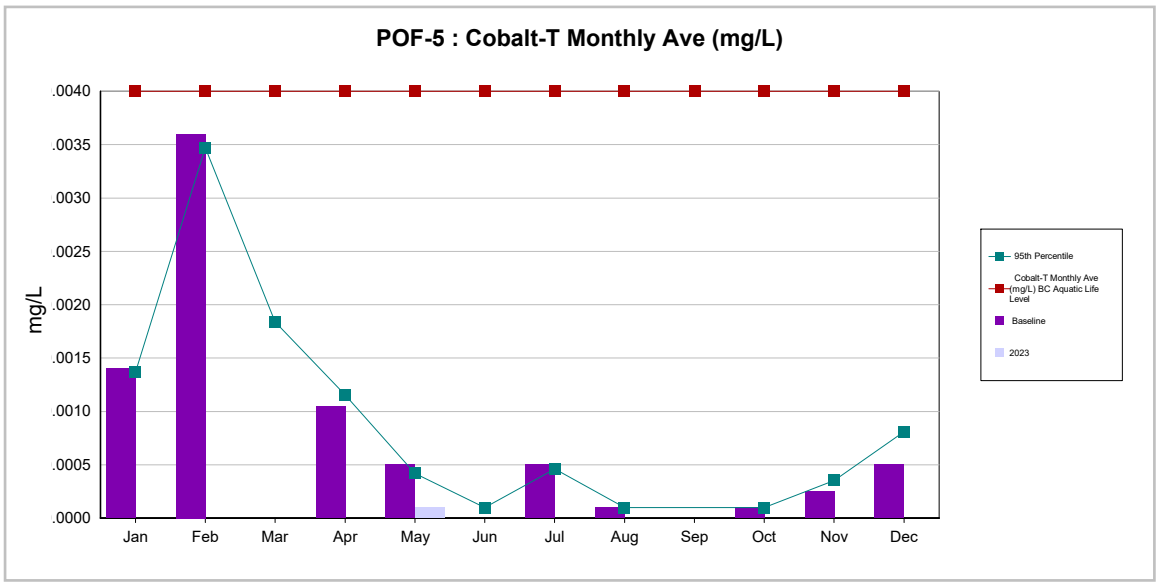
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







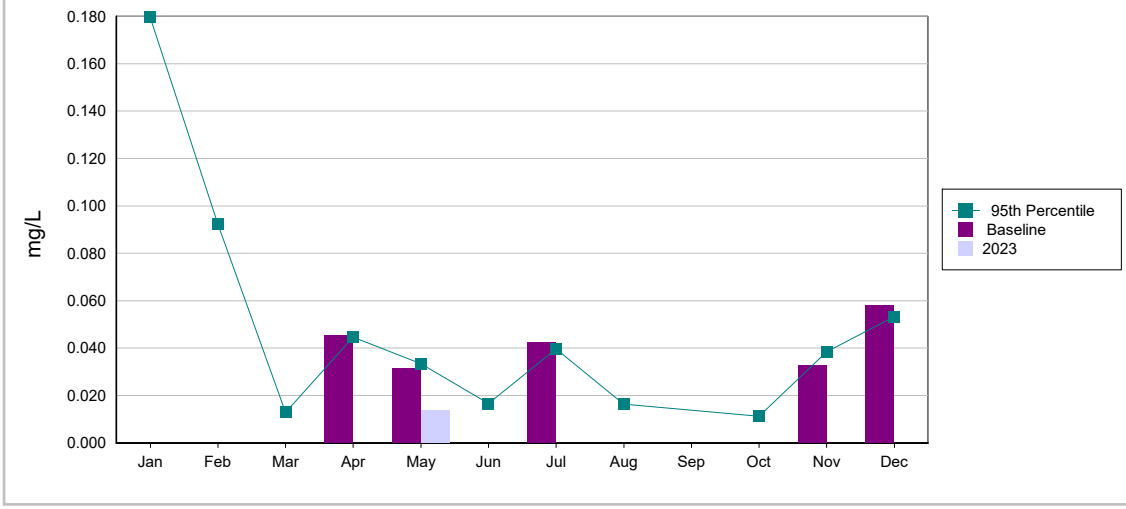
Water Quality Report

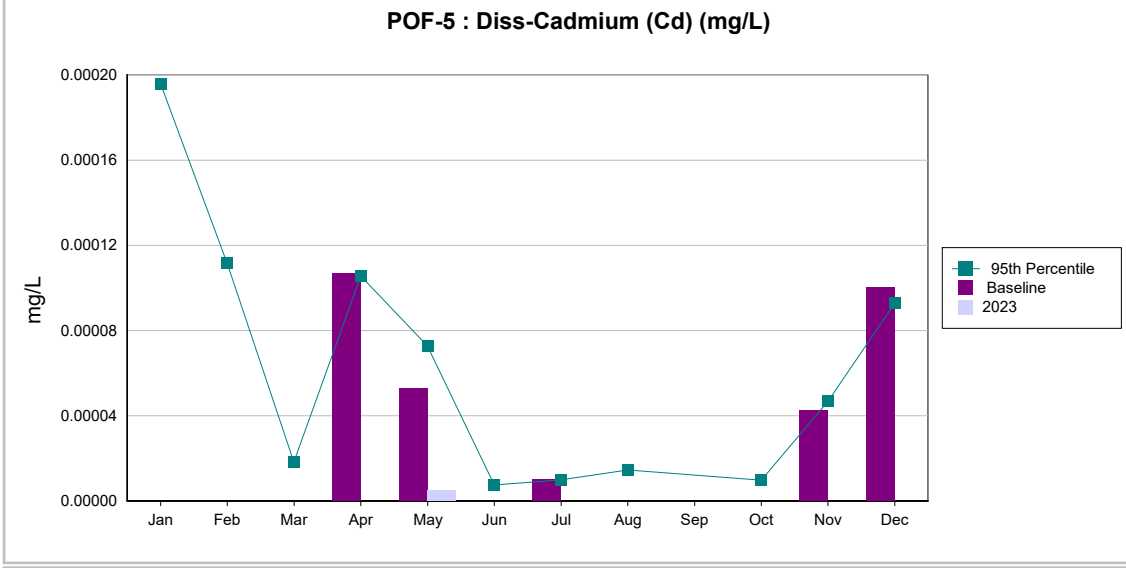
Annual Report HAC vs BCWQG

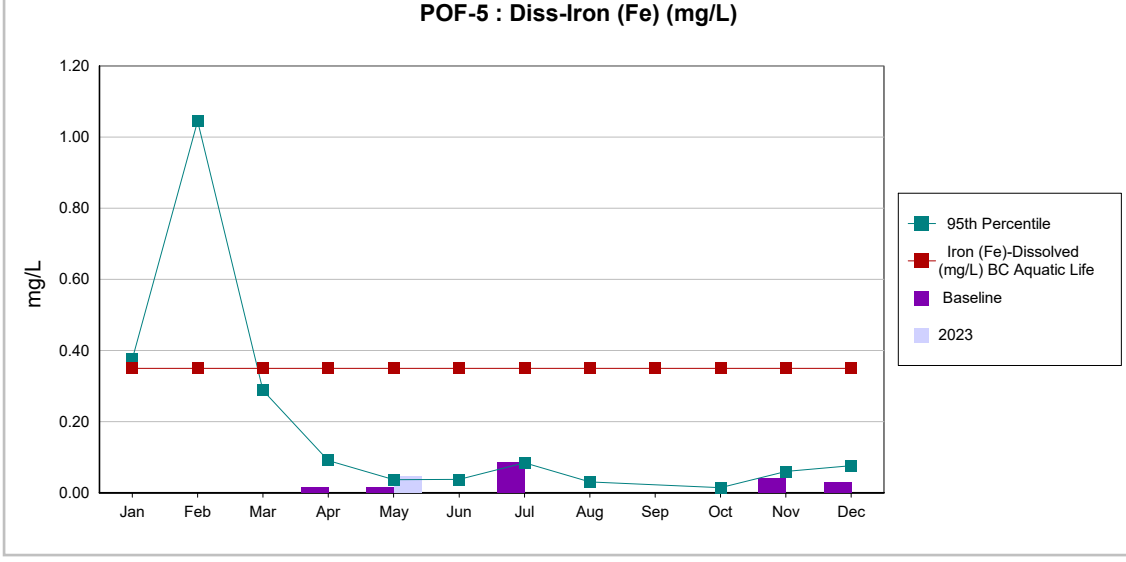
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







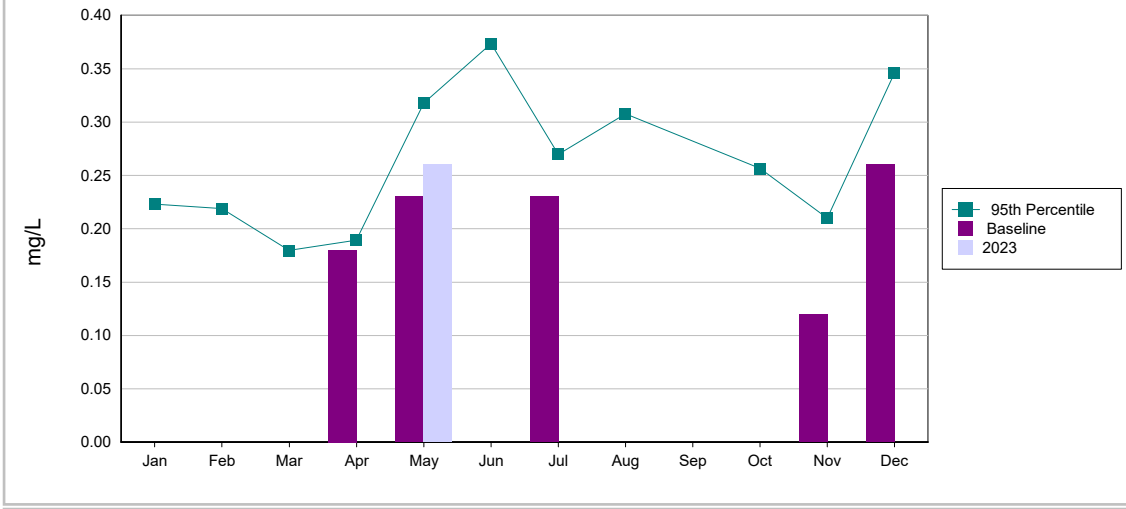
Water Quality Report

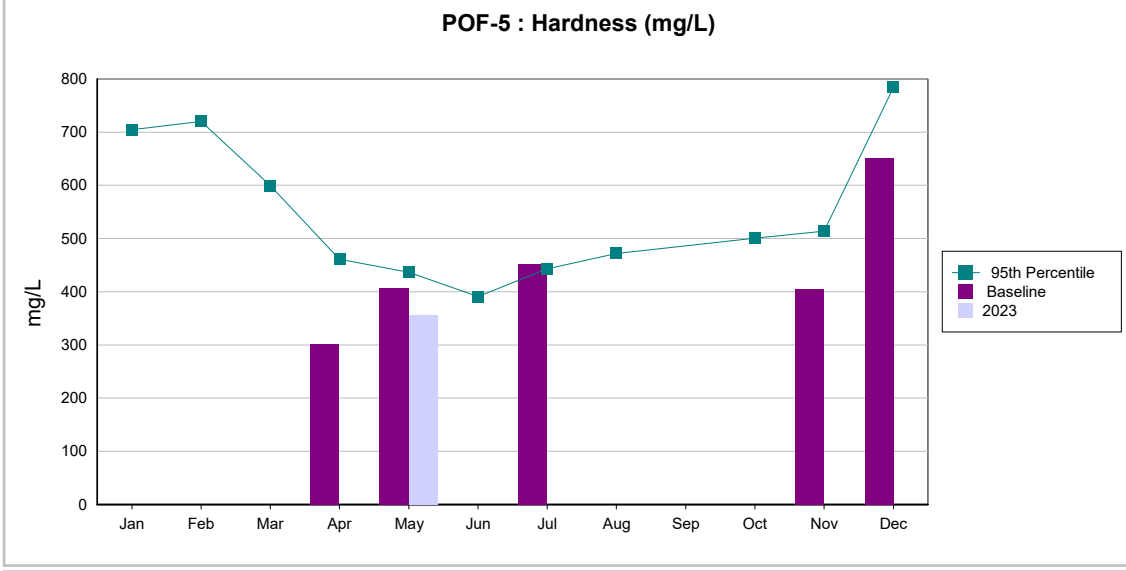
Annual Report HAC vs BCWQG

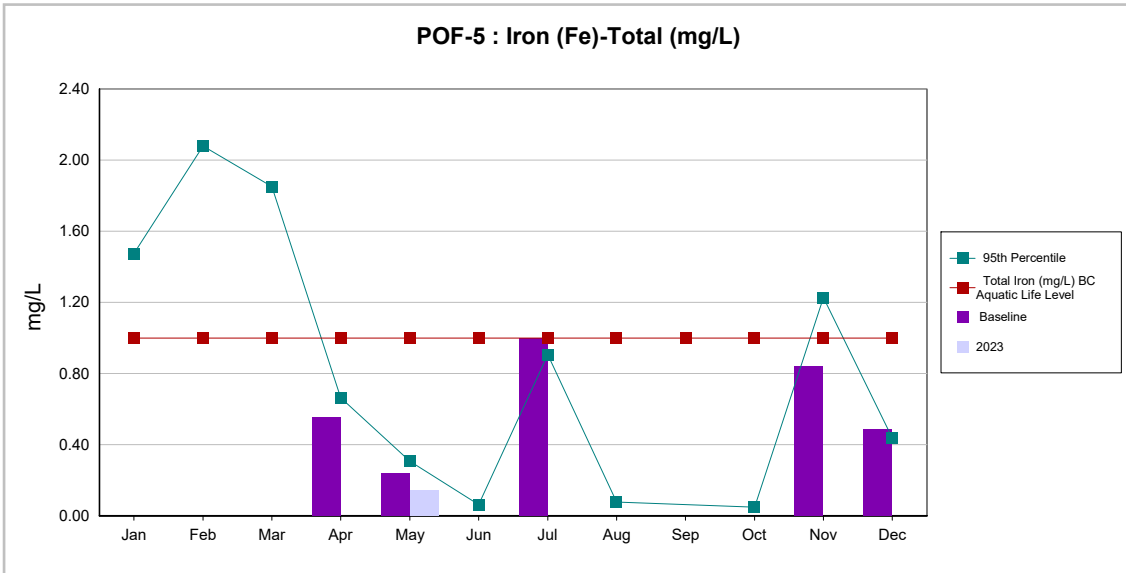
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







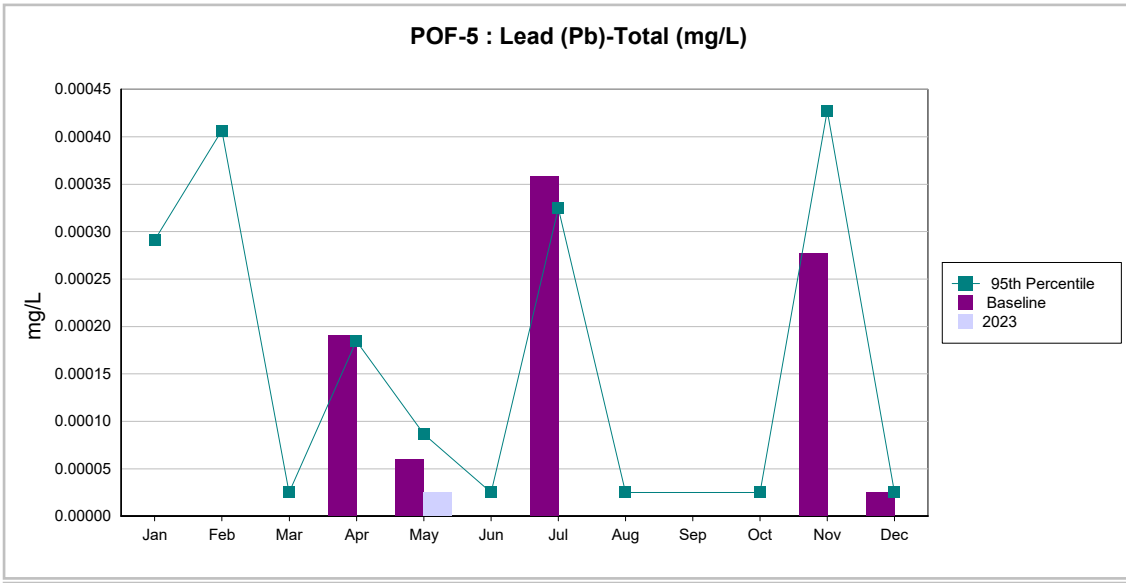
Water Quality Report

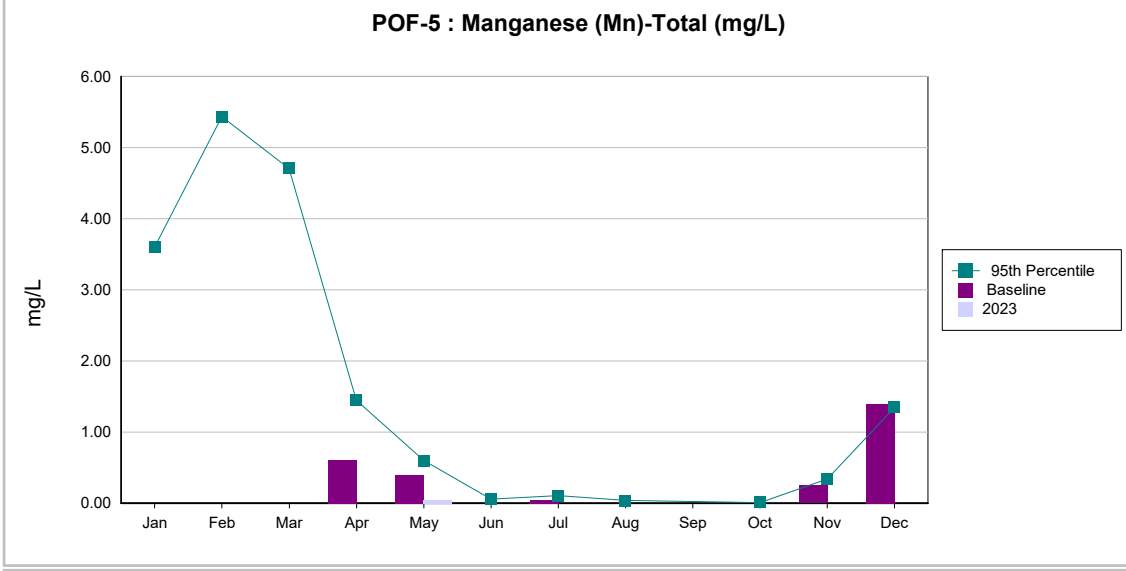
Annual Report HAC vs BCWQG

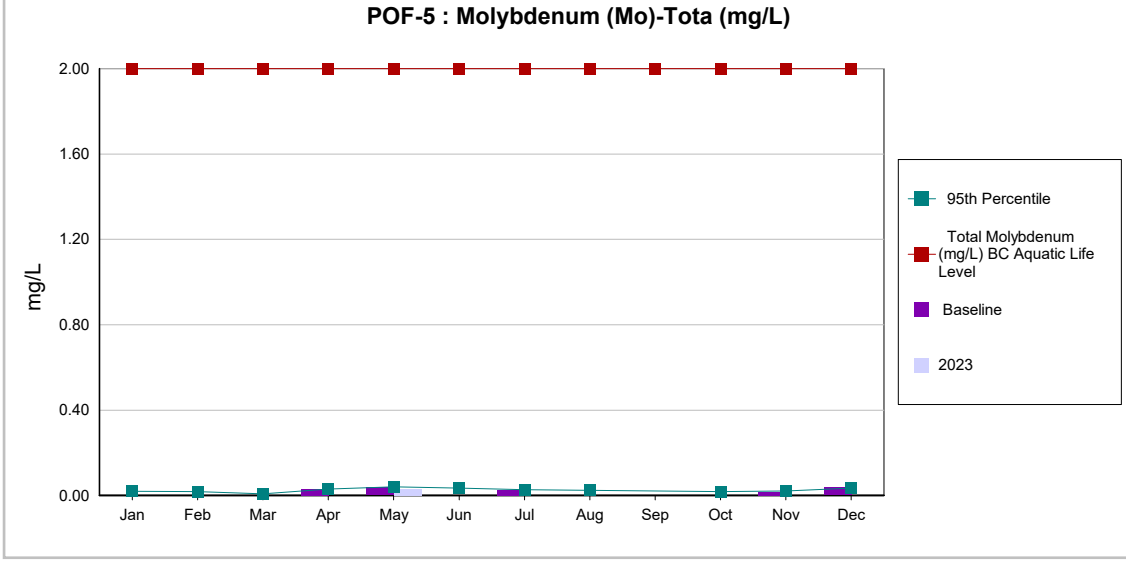
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







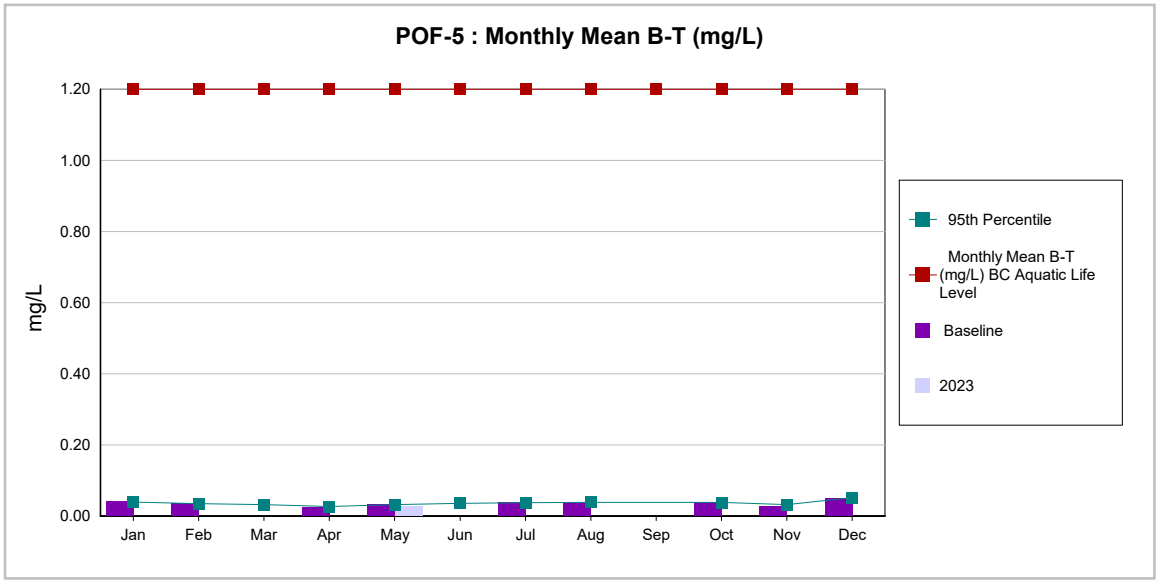
Water Quality Report

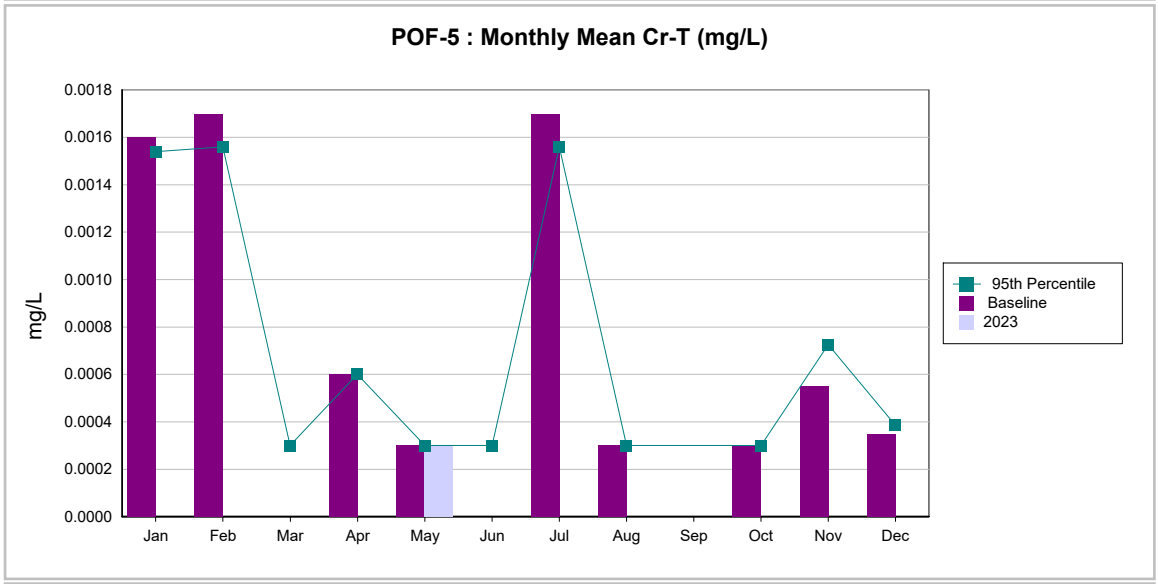
Annual Report HAC vs BCWQG

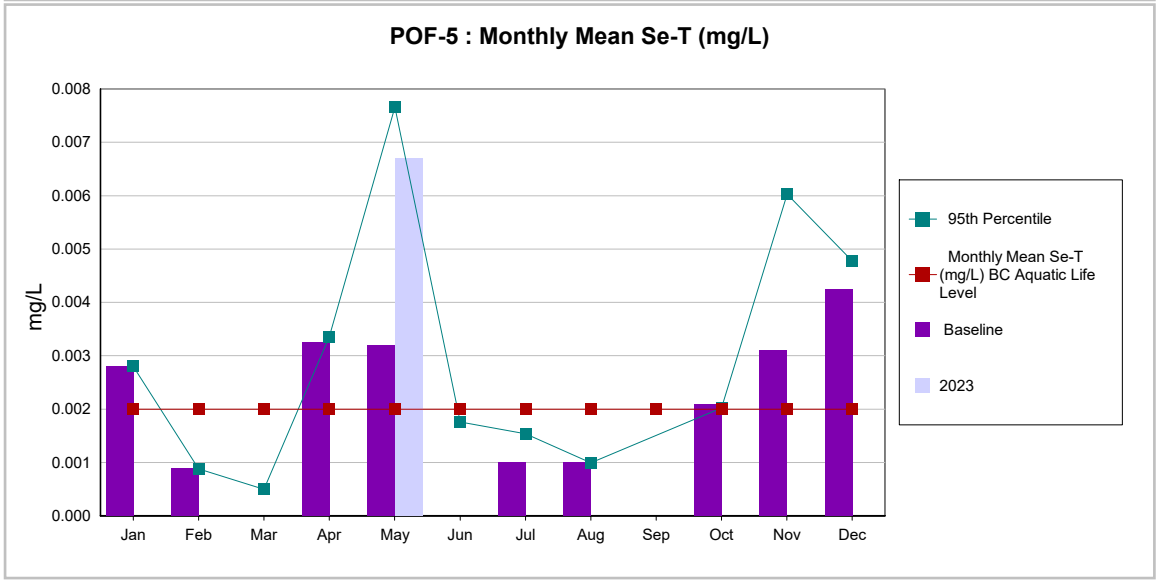
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







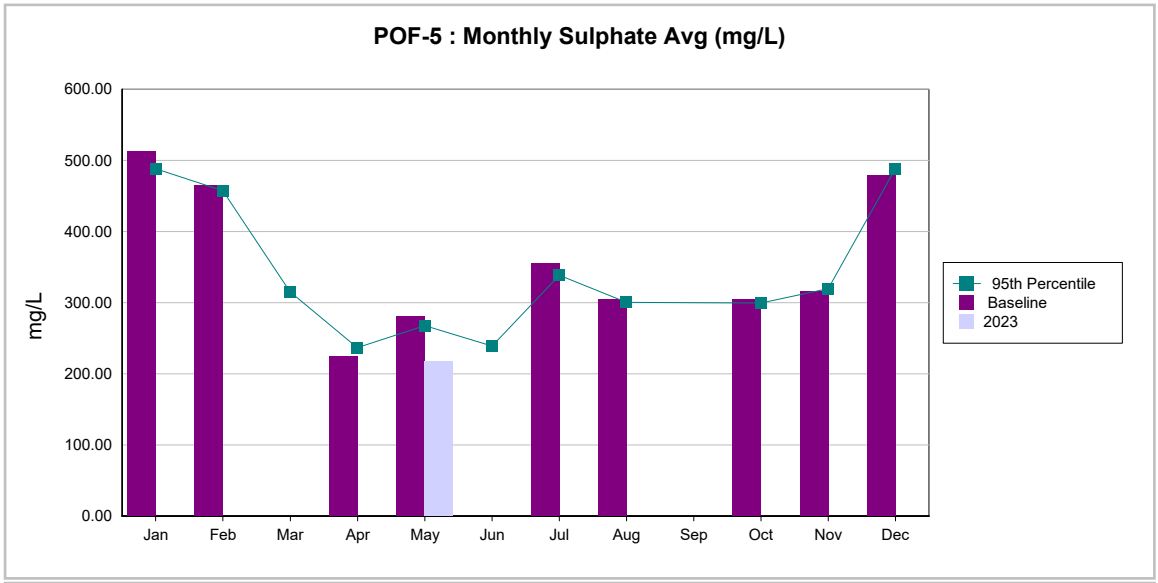
Water Quality Report

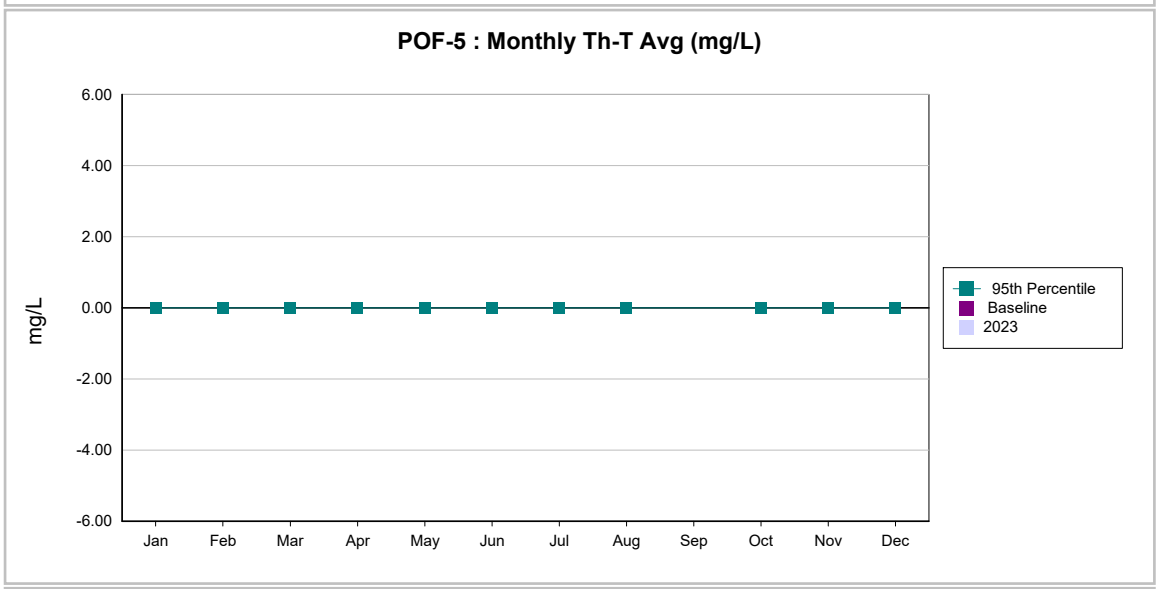
Annual Report HAC vs BCWQG

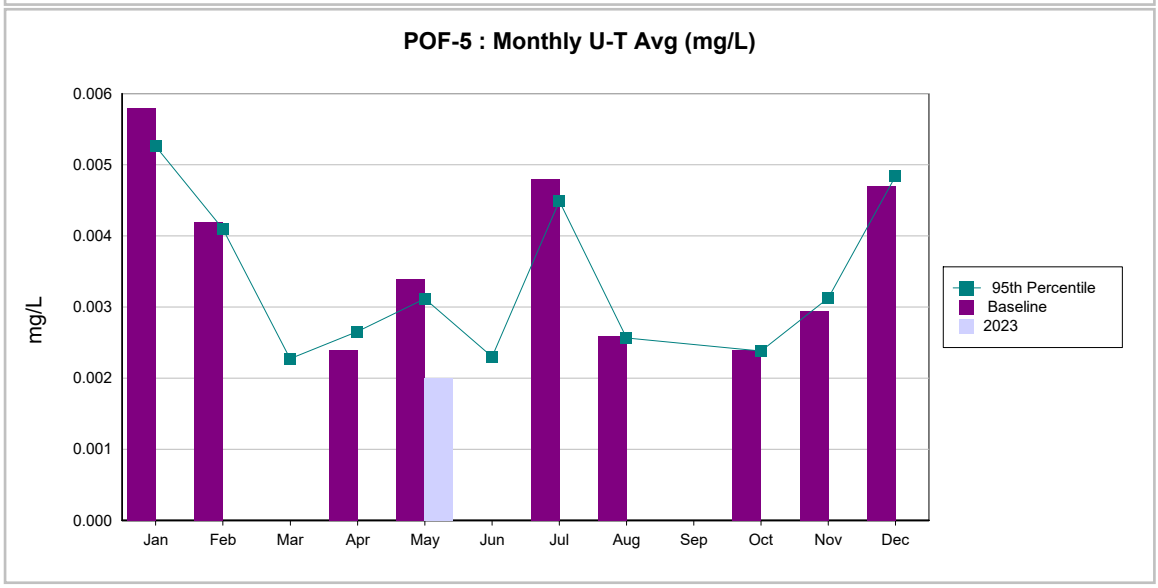
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







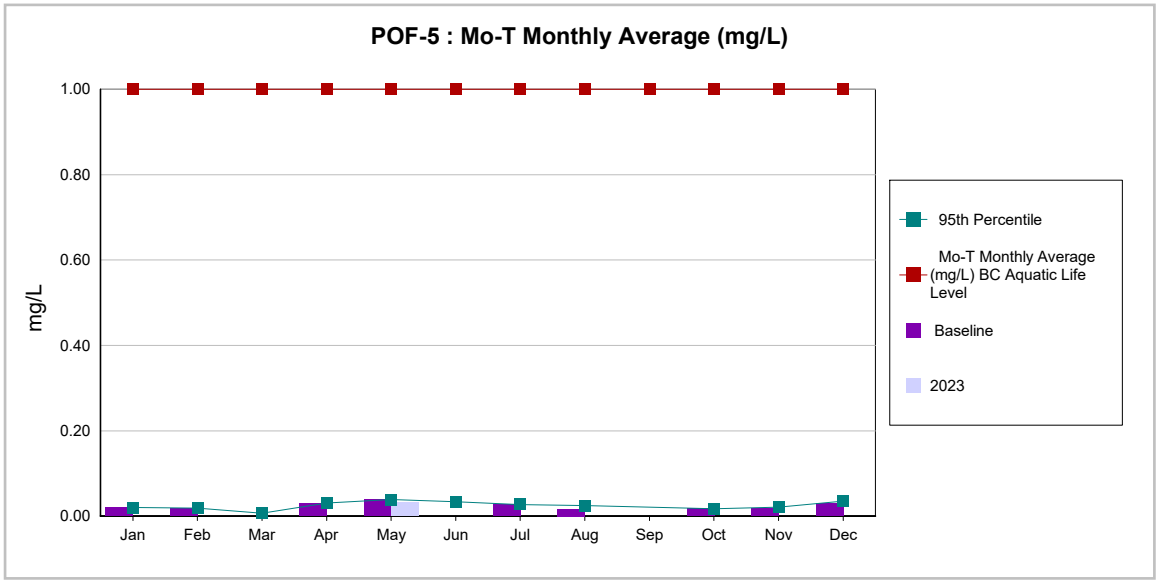
Water Quality Report

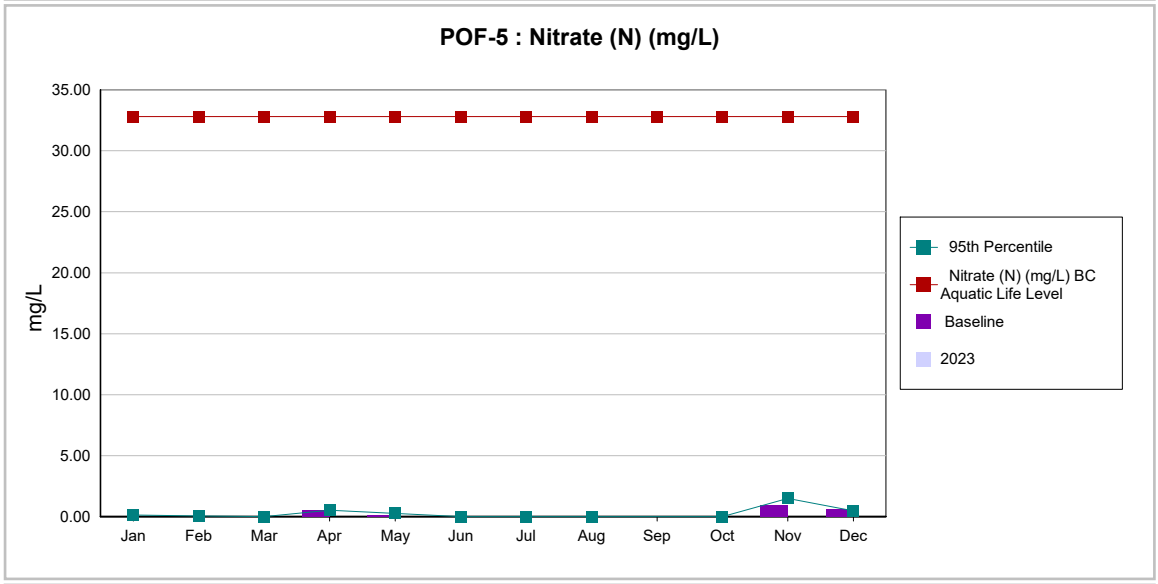
Annual Report HAC vs BCWQG

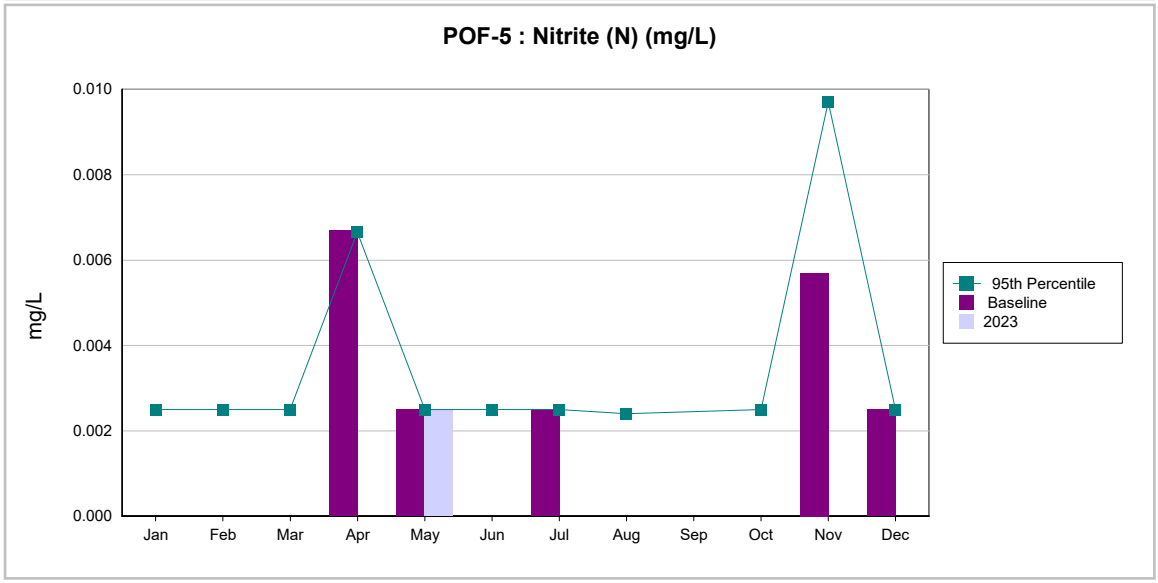
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



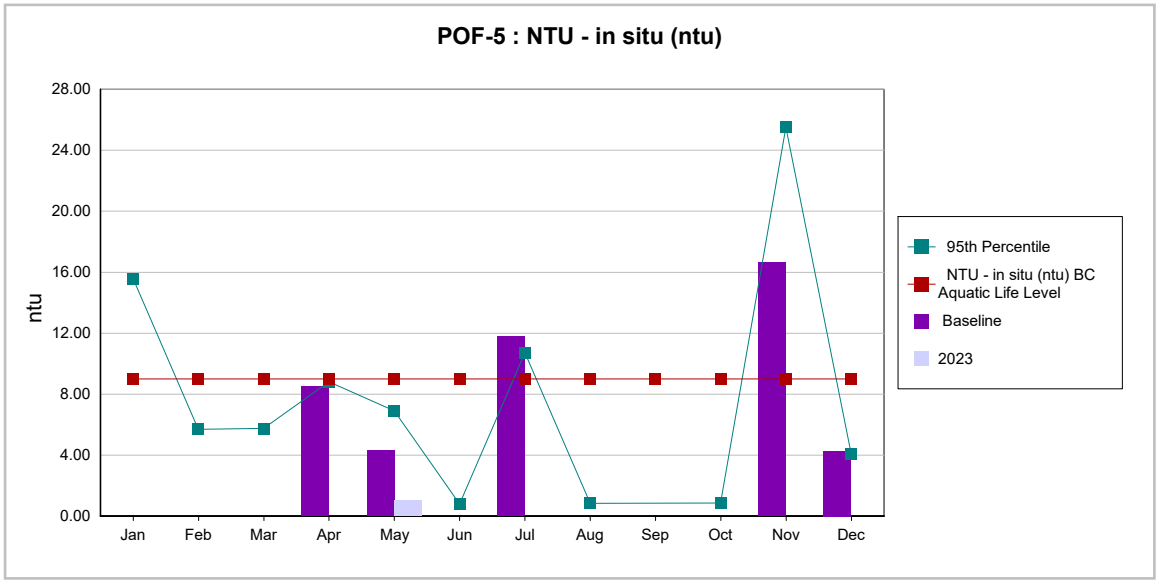


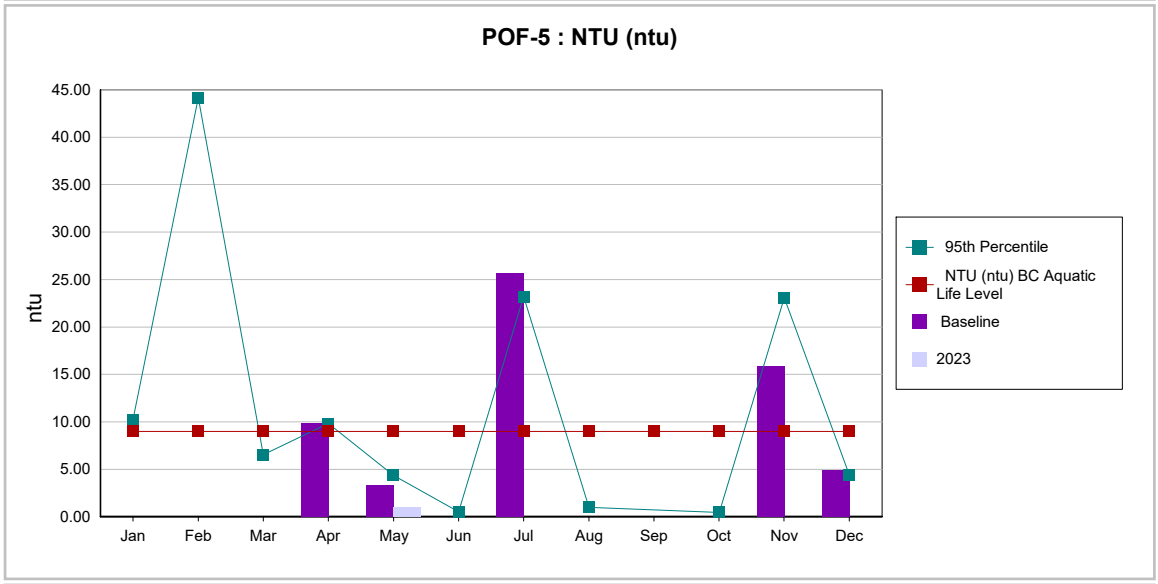


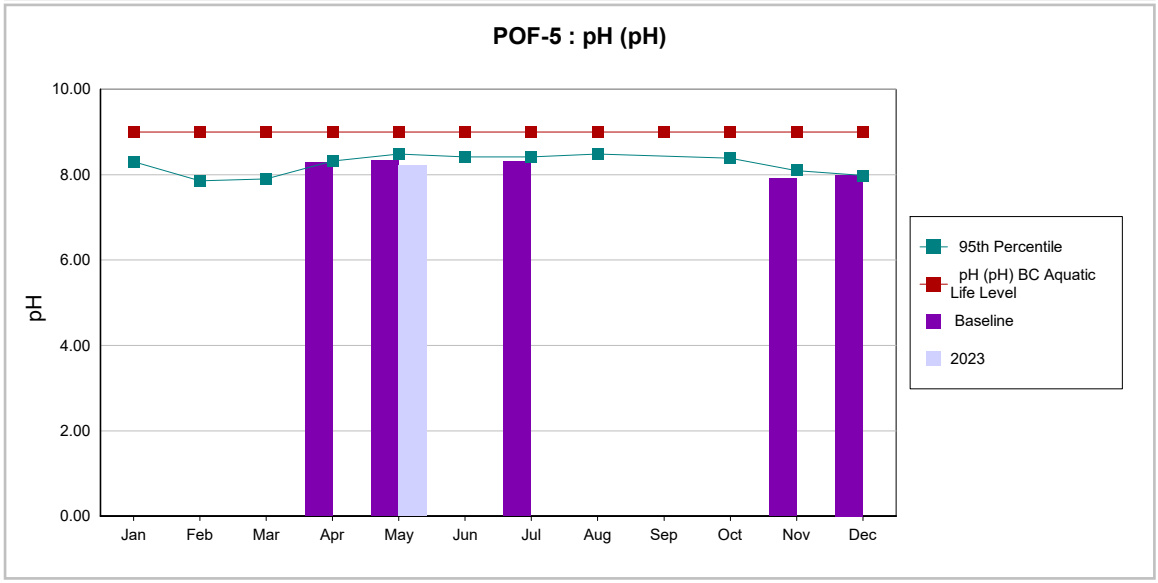
Water Quality Report

Annual Report HAC vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







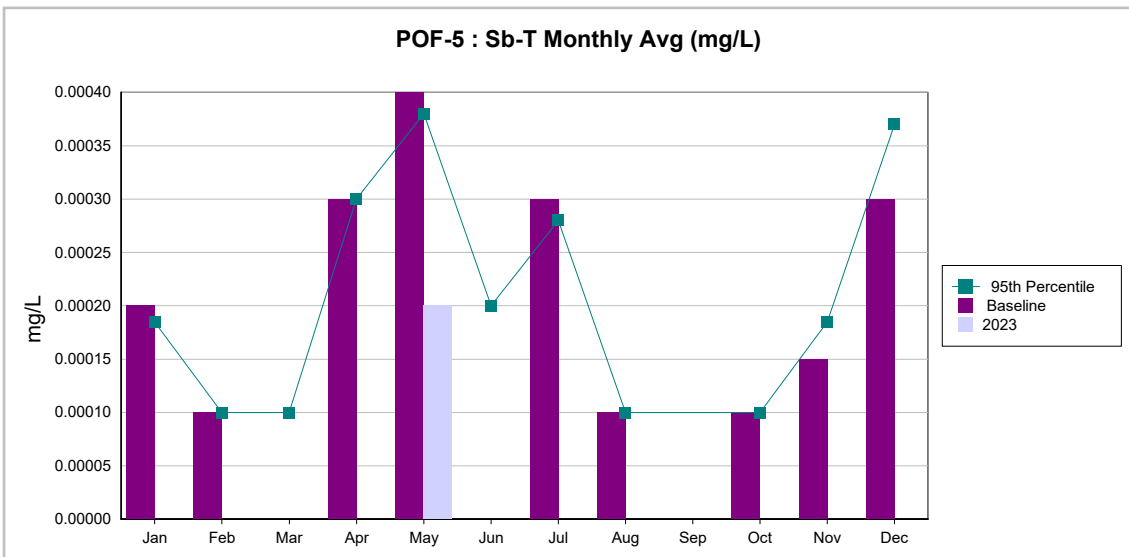
Water Quality Report

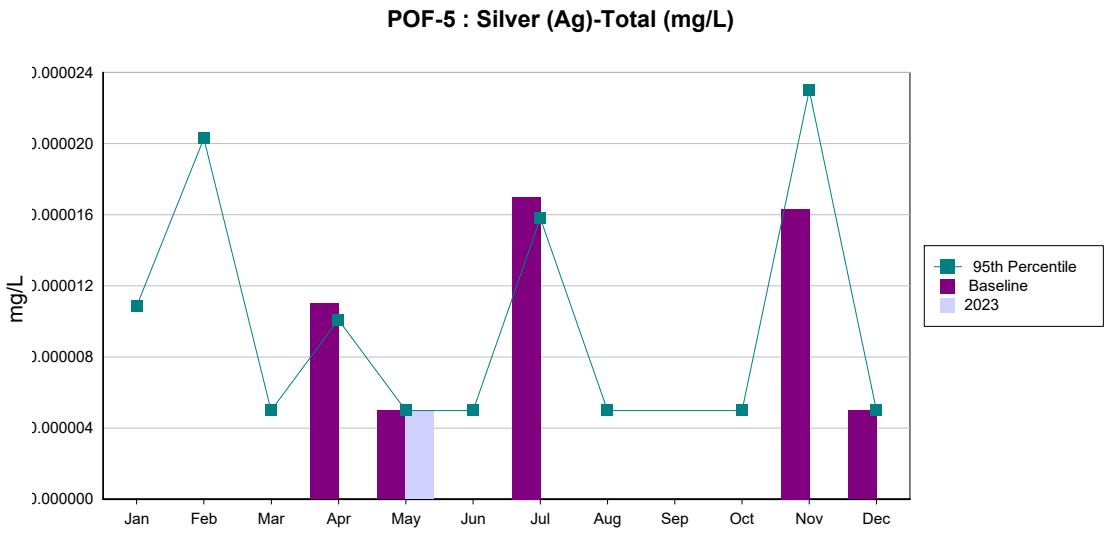
Annual Report HAC vs BCWQG

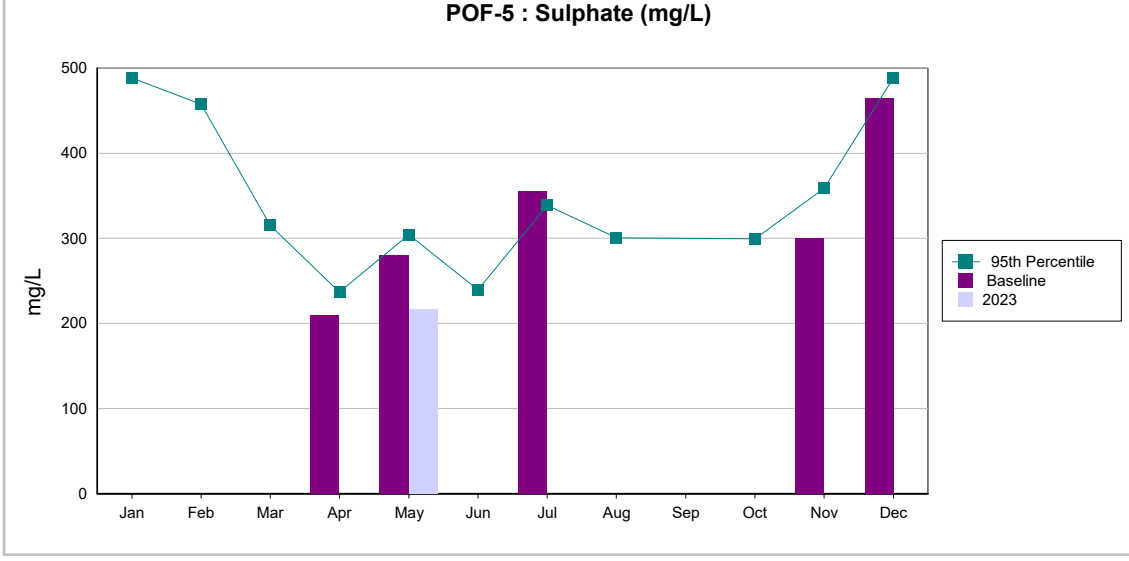
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







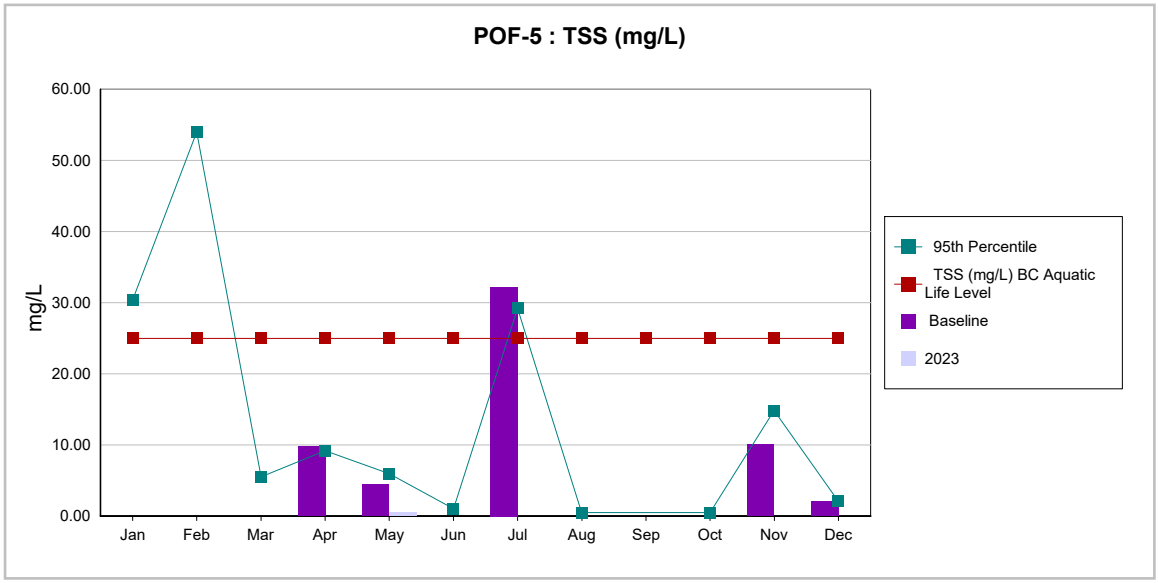
Water Quality Report

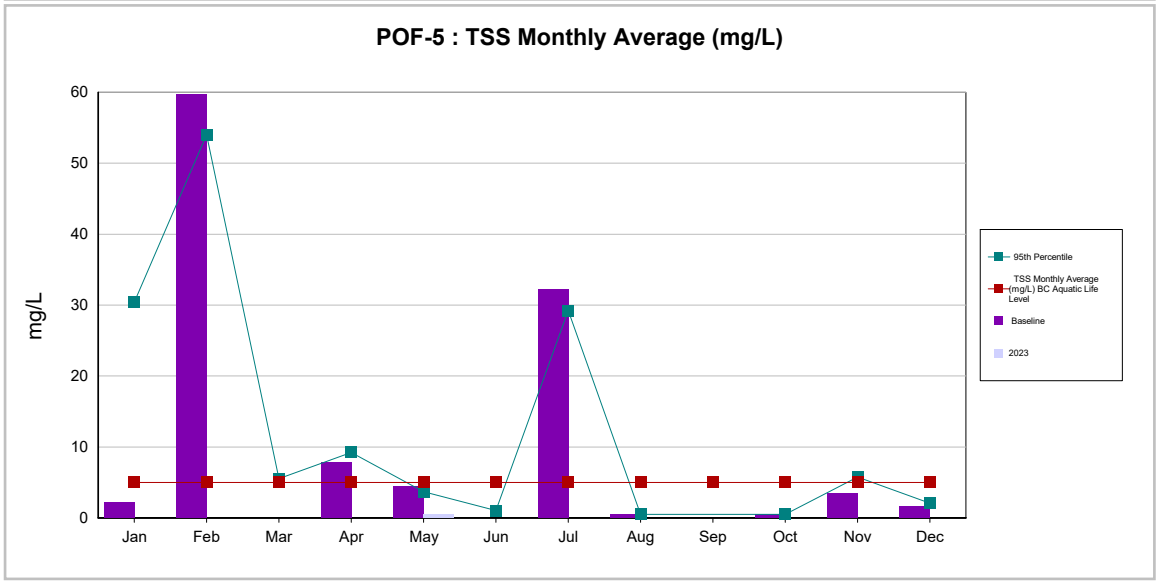
Annual Report HAC vs BCWQG

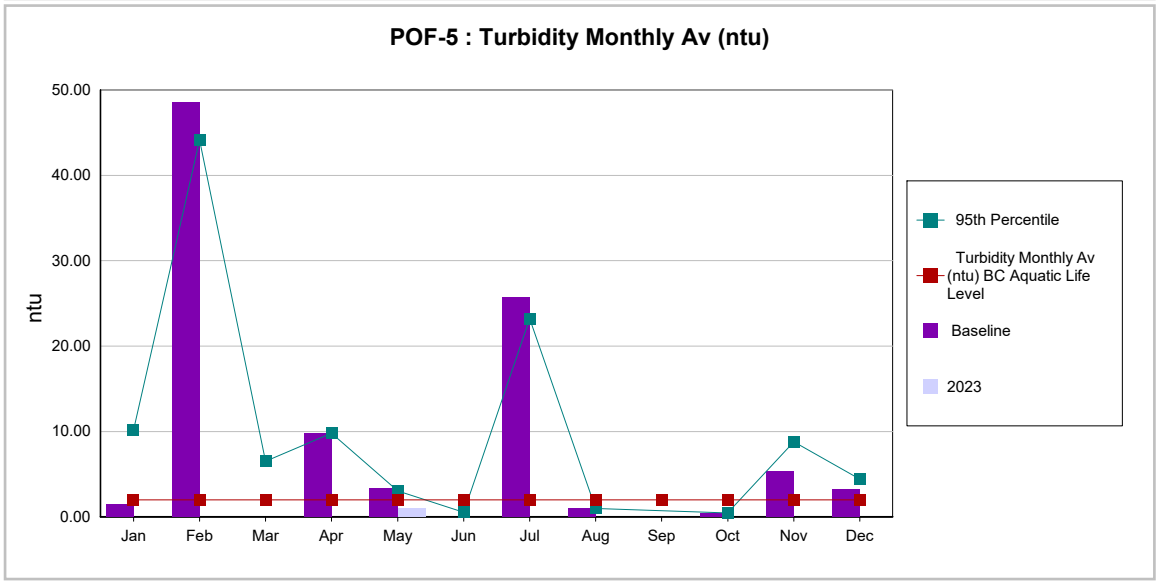
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







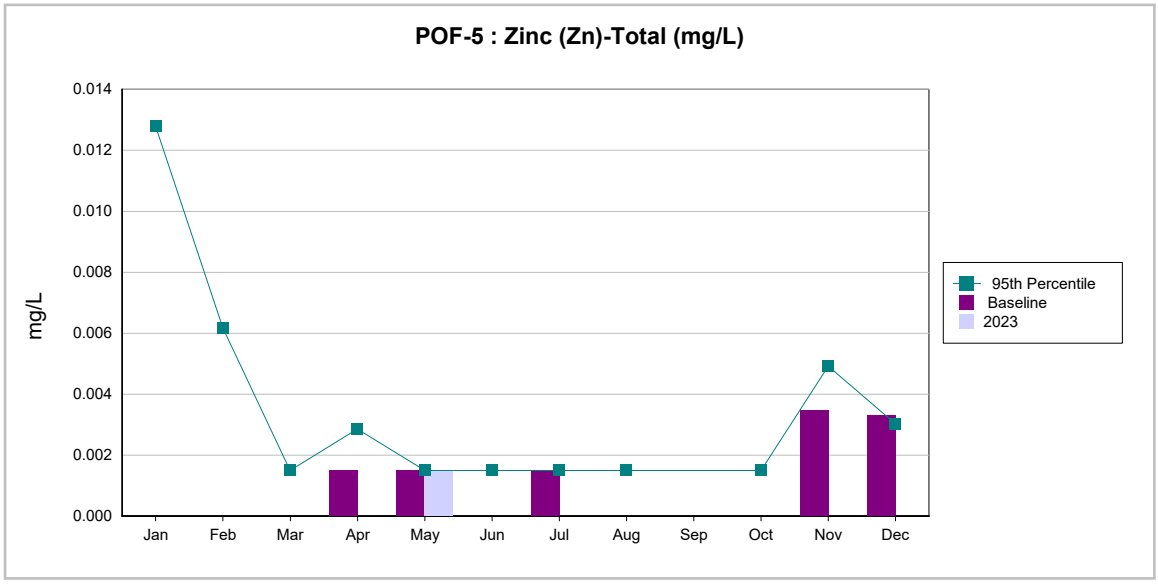
Water Quality Report

Annual Report HAC vs BCWQG

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



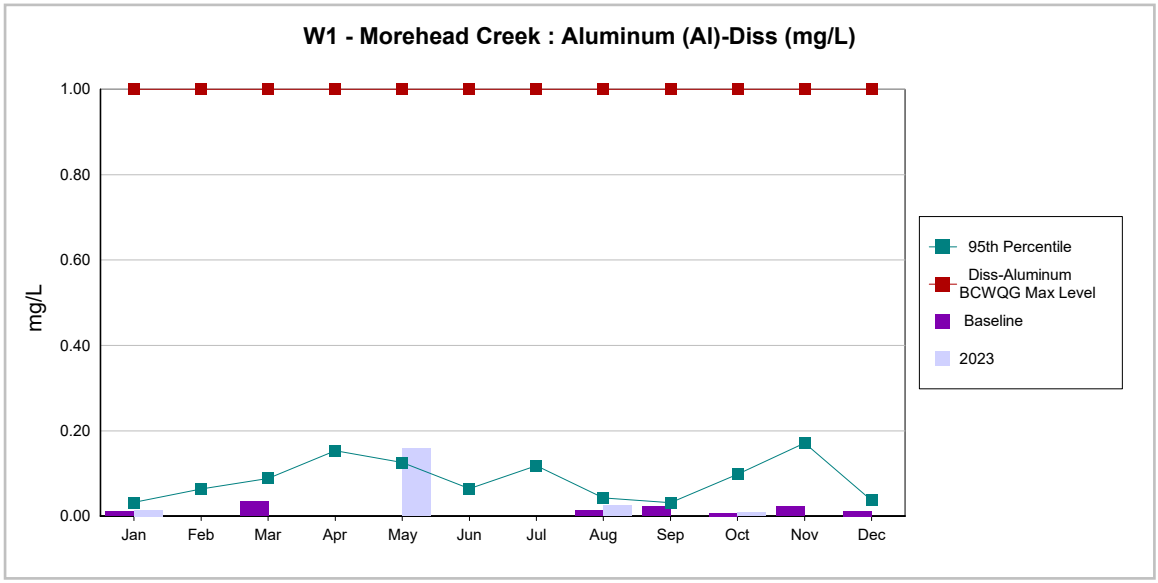
Water Quality Report

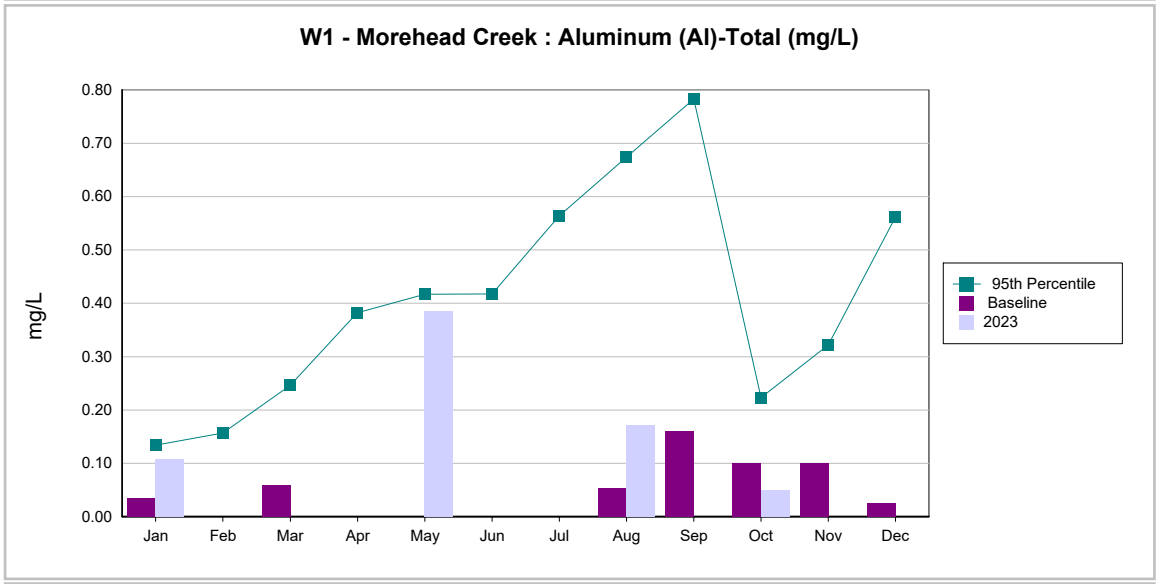
Annual Report SW vs BCWQG

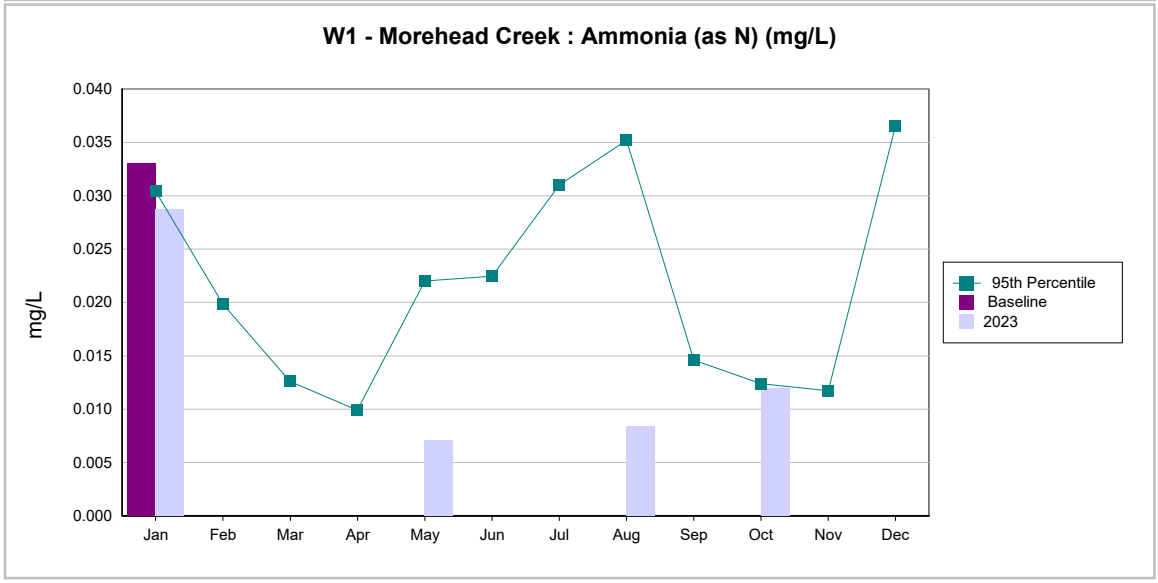
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







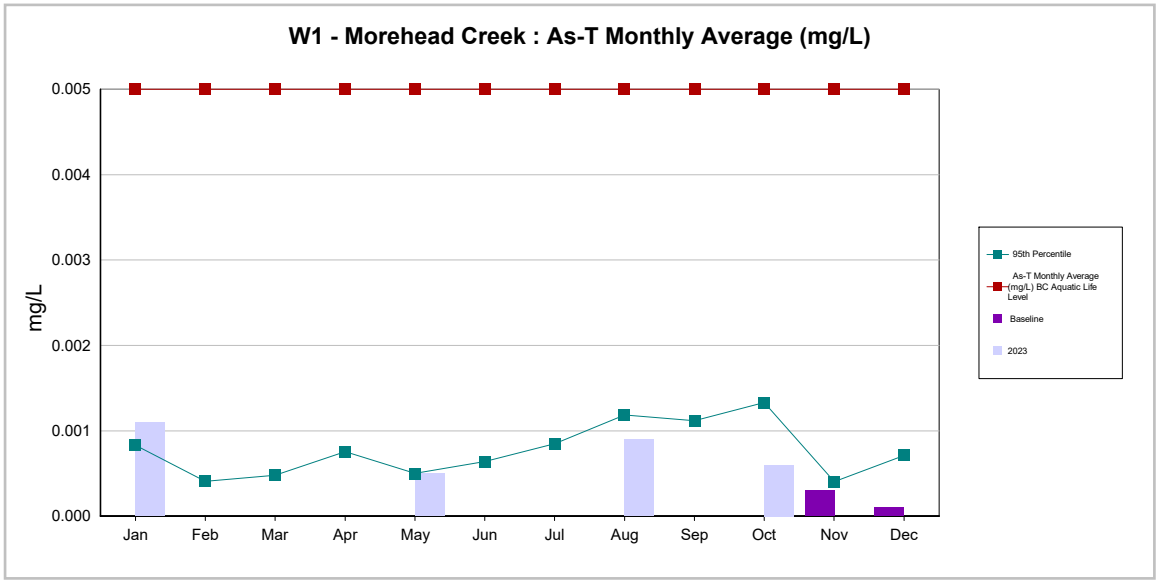
Water Quality Report

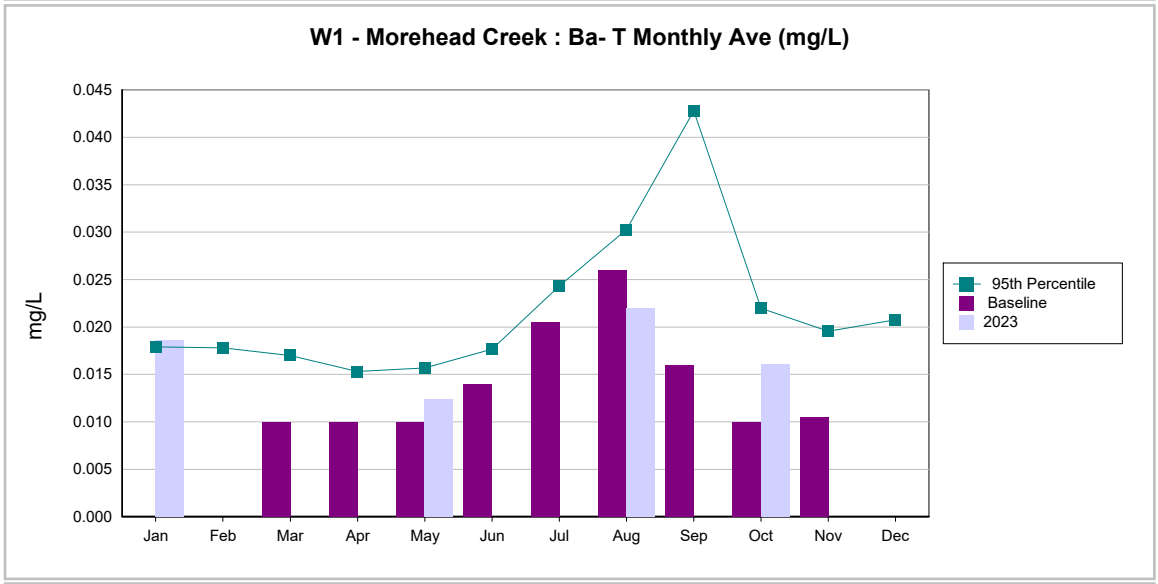
Annual Report SW vs BCWQG

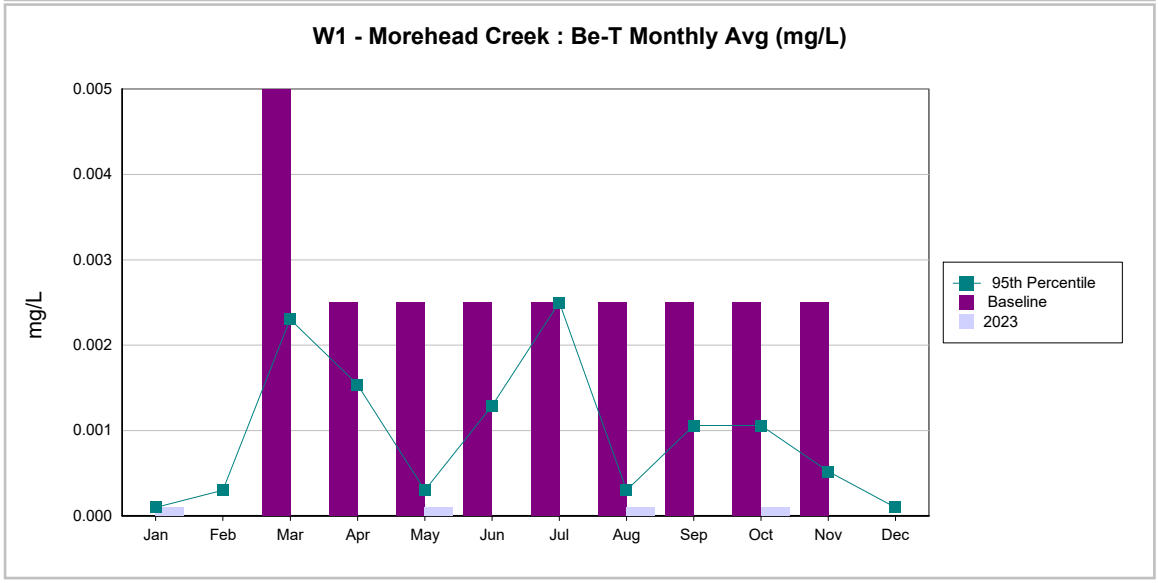
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







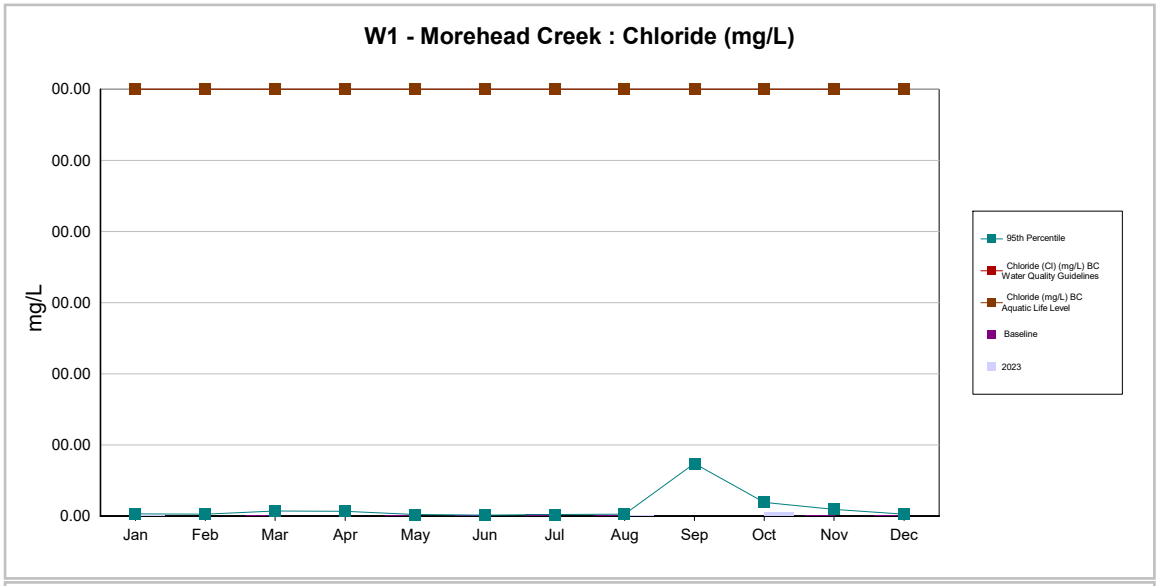
Water Quality Report

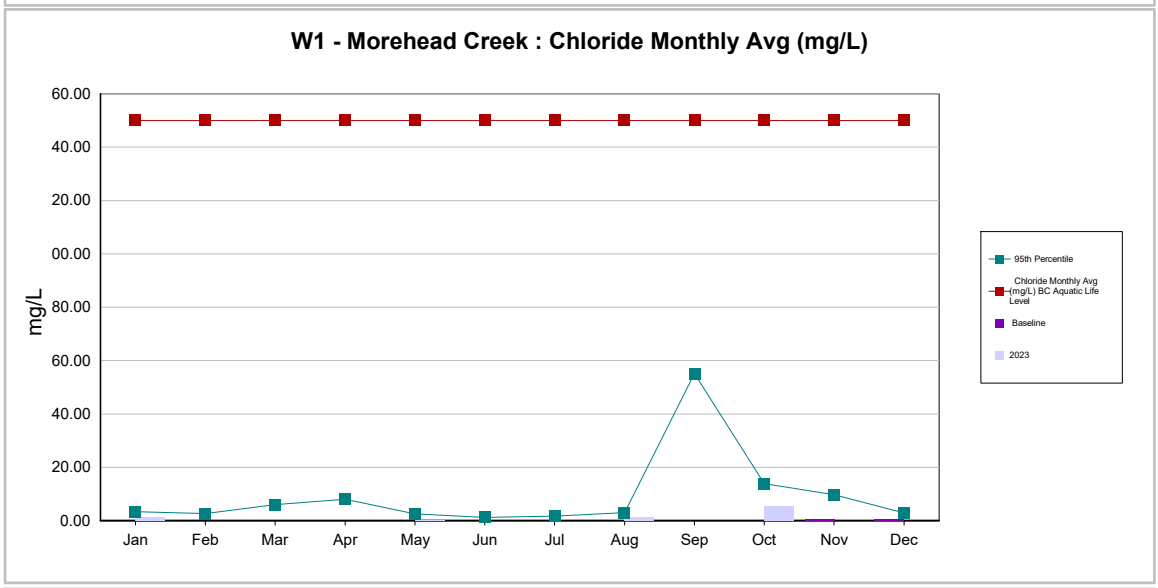
Annual Report SW vs BCWQG

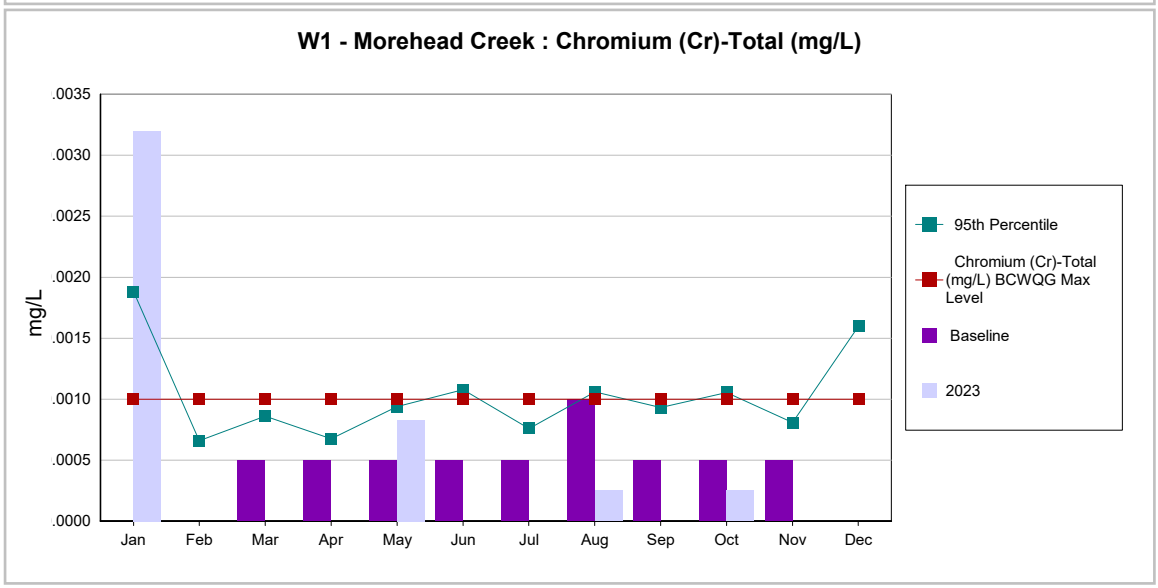
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







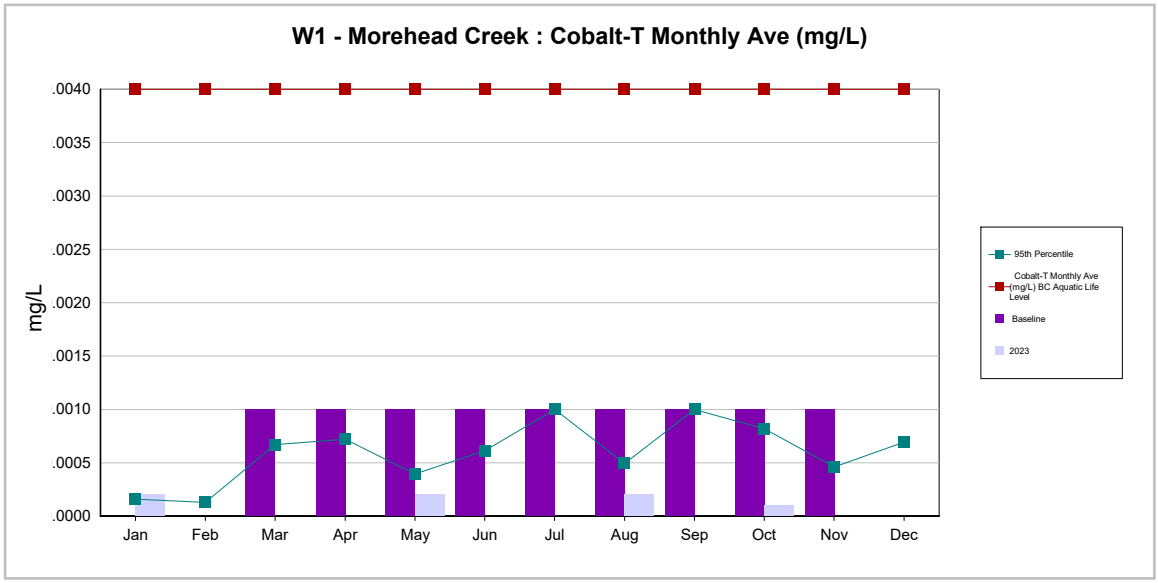
Water Quality Report

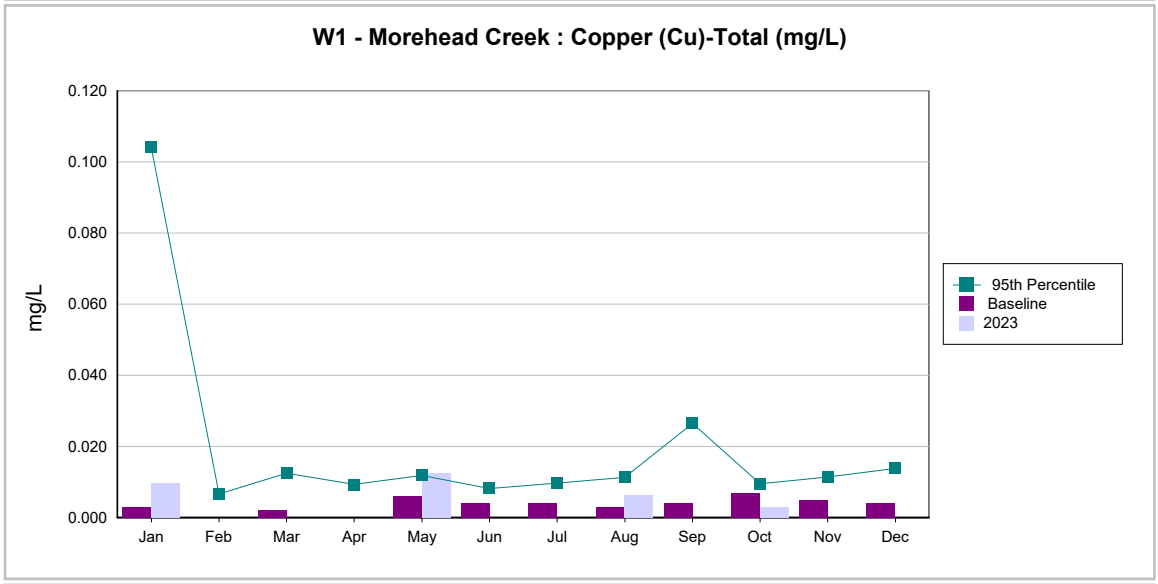
Annual Report SW vs BCWQG

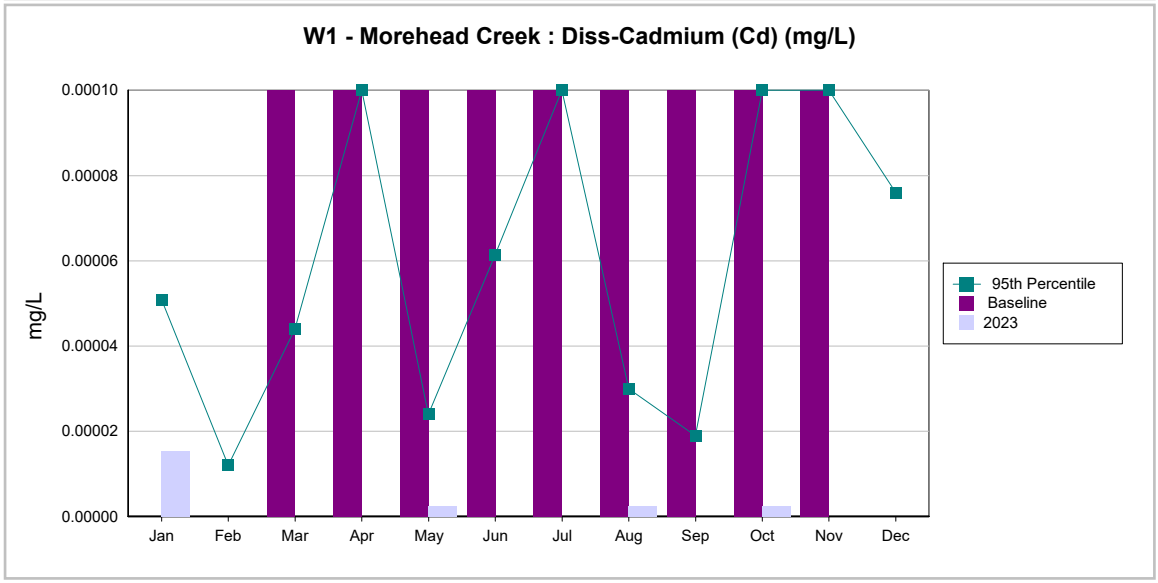
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







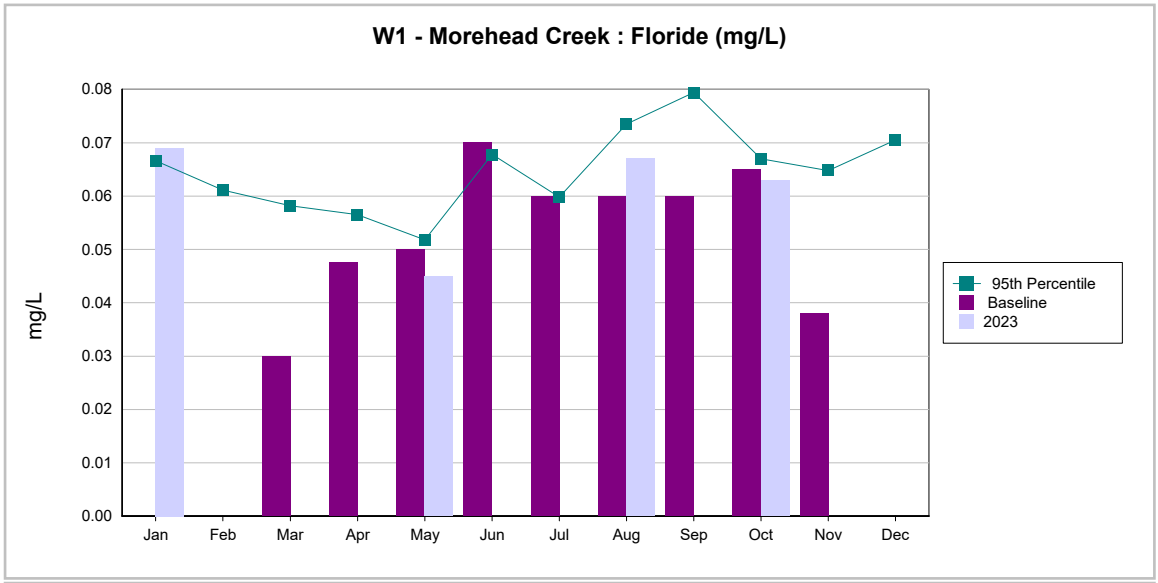
Water Quality Report

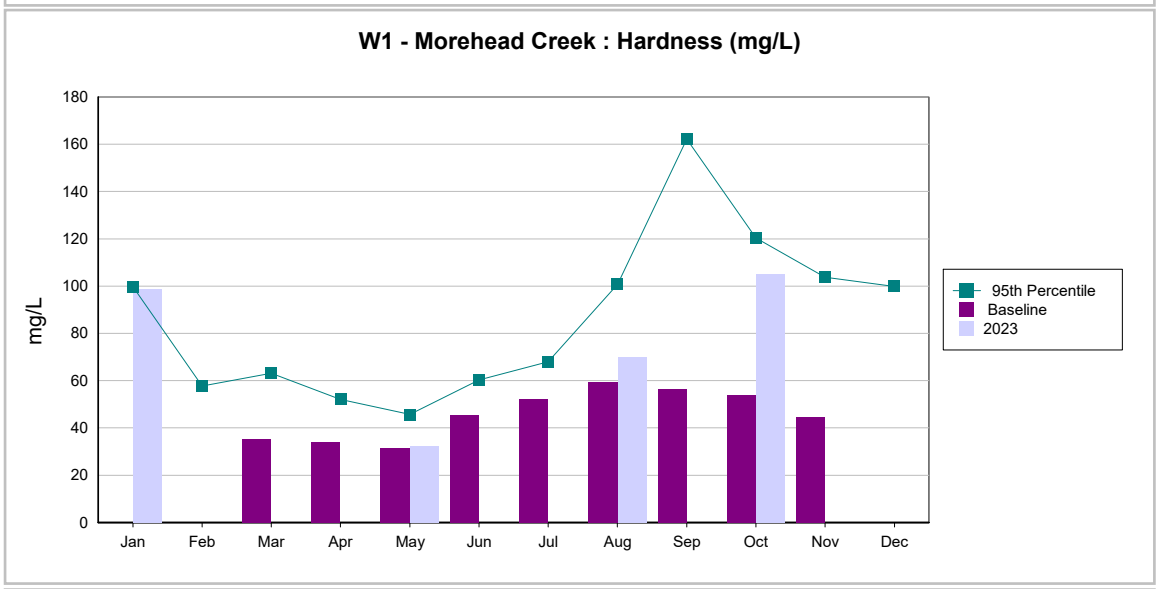
Annual Report SW vs BCWQG

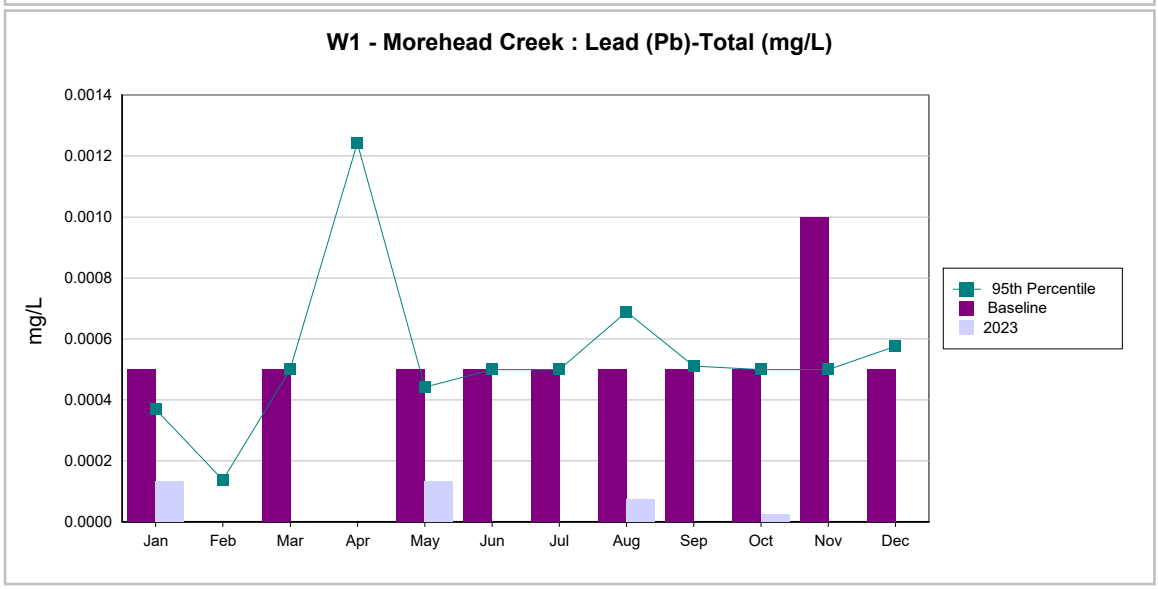
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







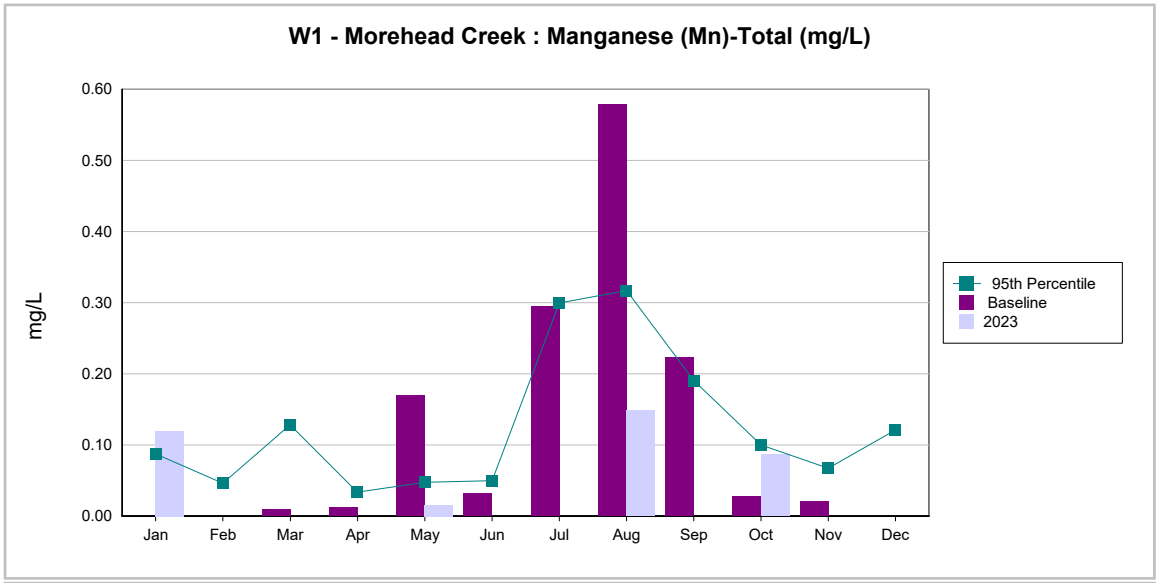
Water Quality Report

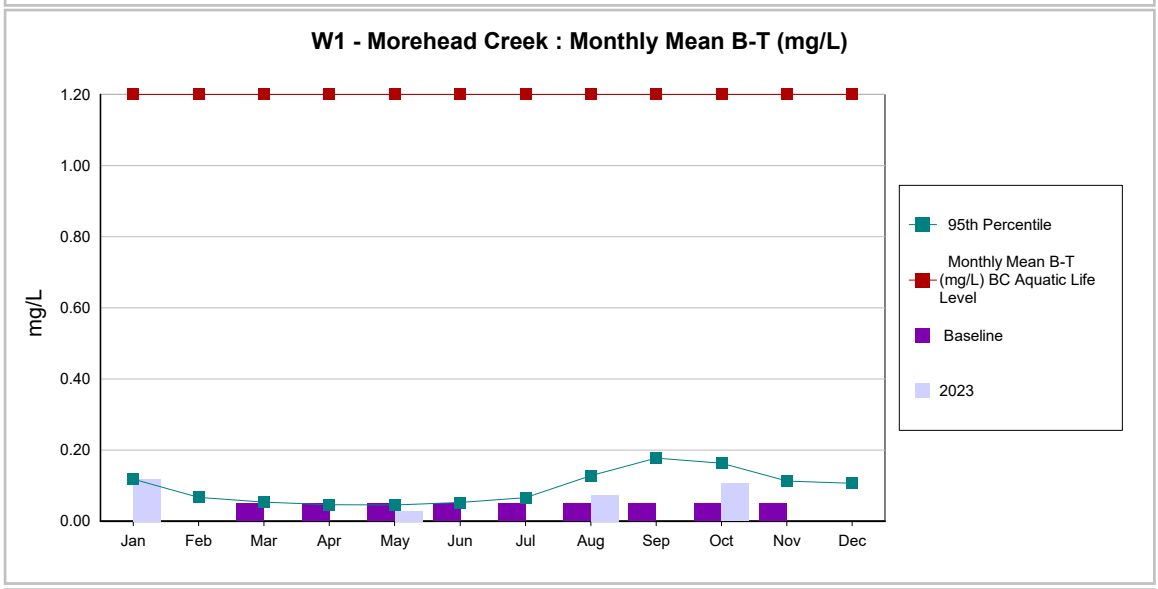
Annual Report SW vs BCWQG

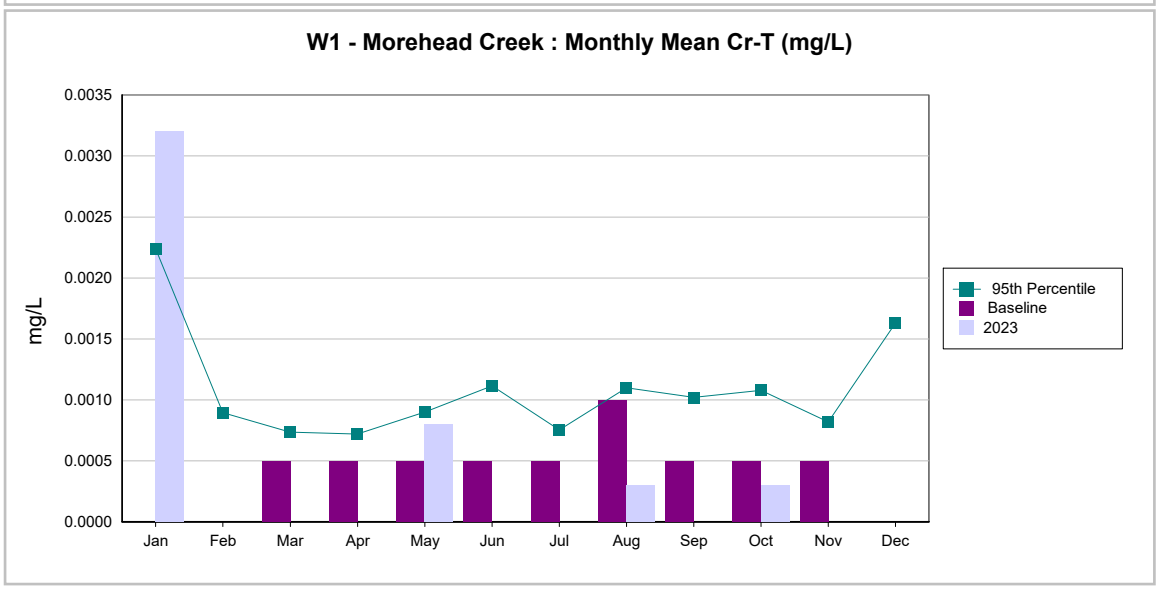
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







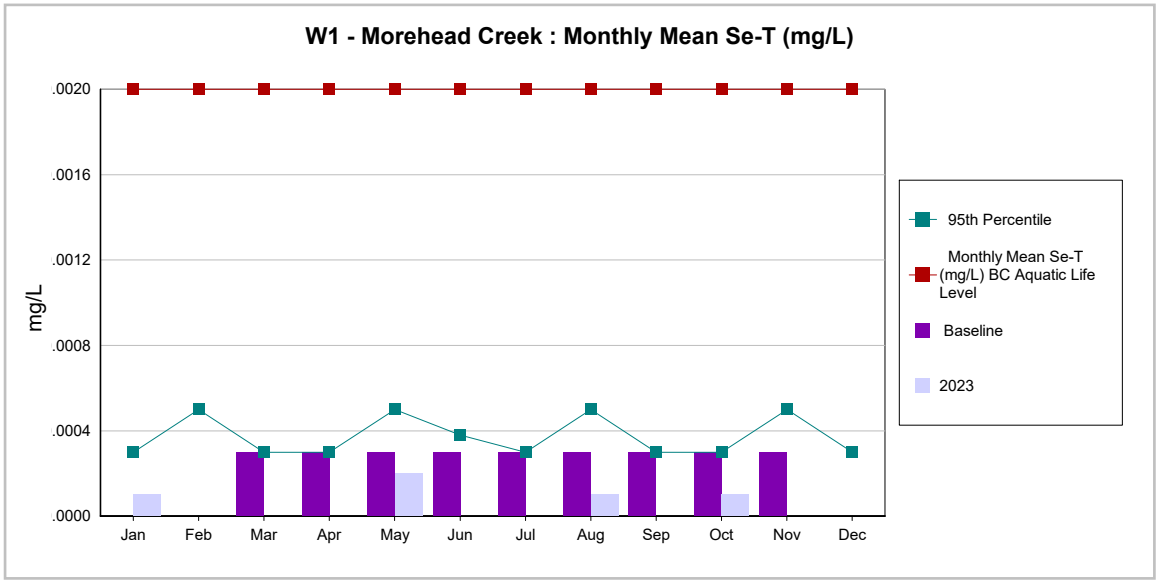
Water Quality Report

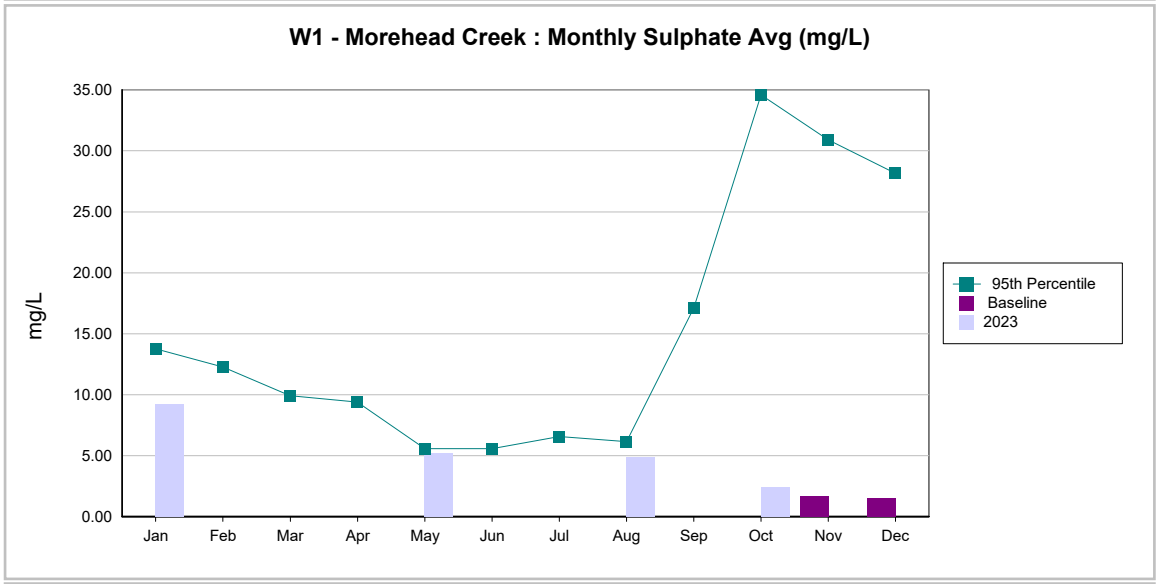
Annual Report SW vs BCWQG

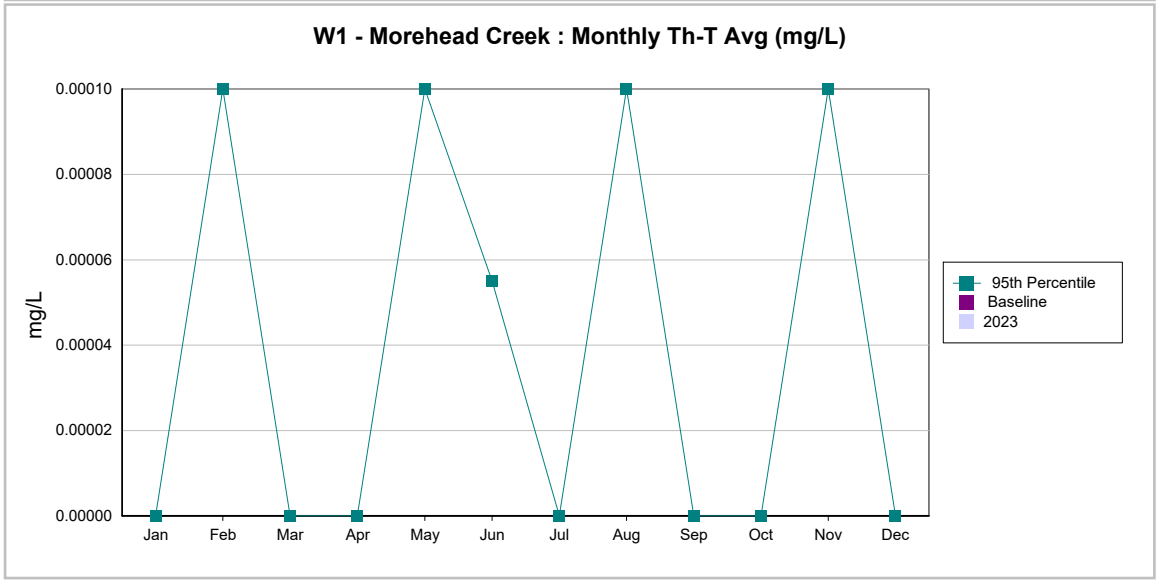
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







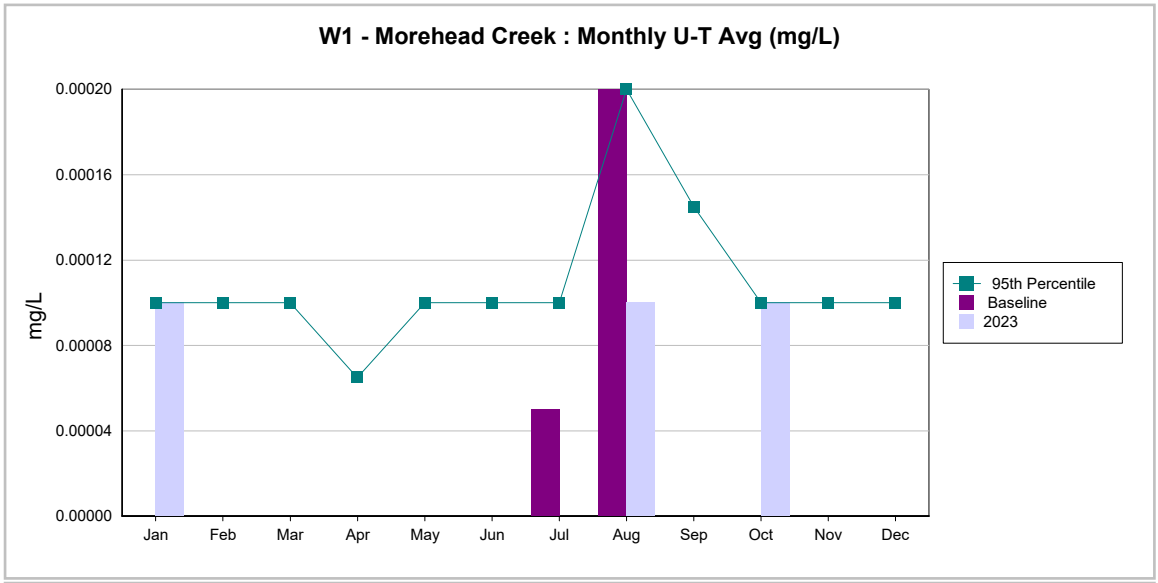
Water Quality Report

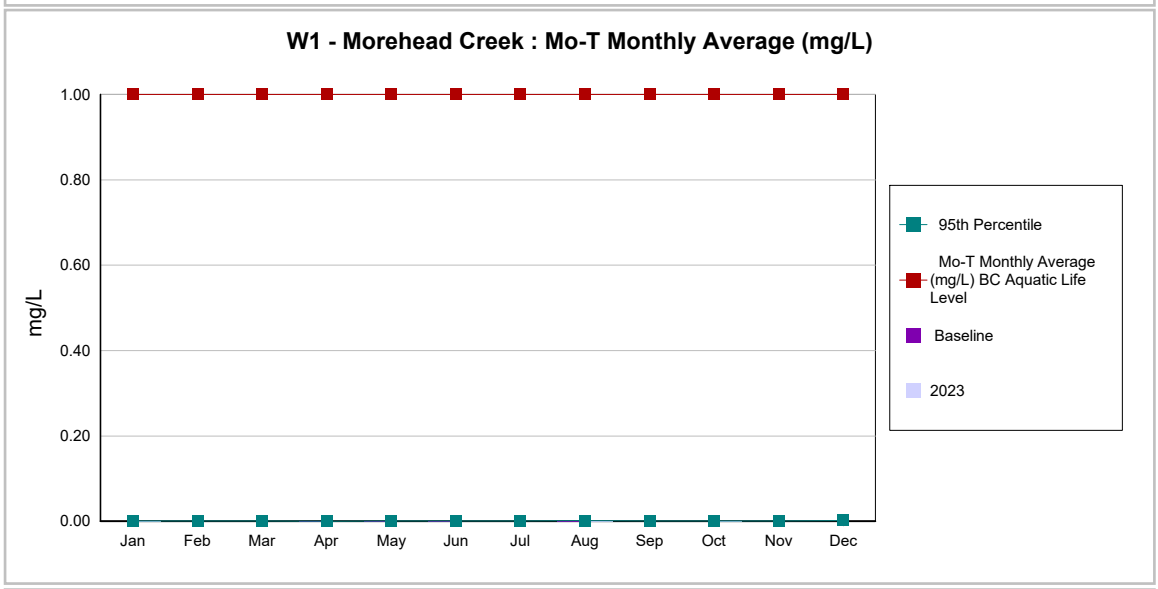
Annual Report SW vs BCWQG

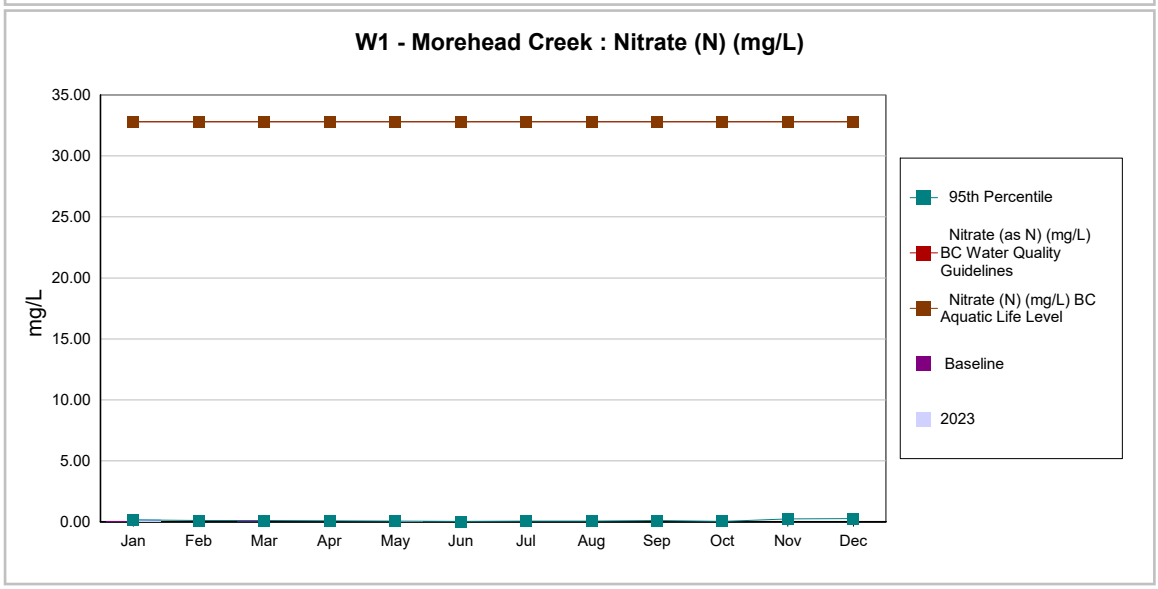
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



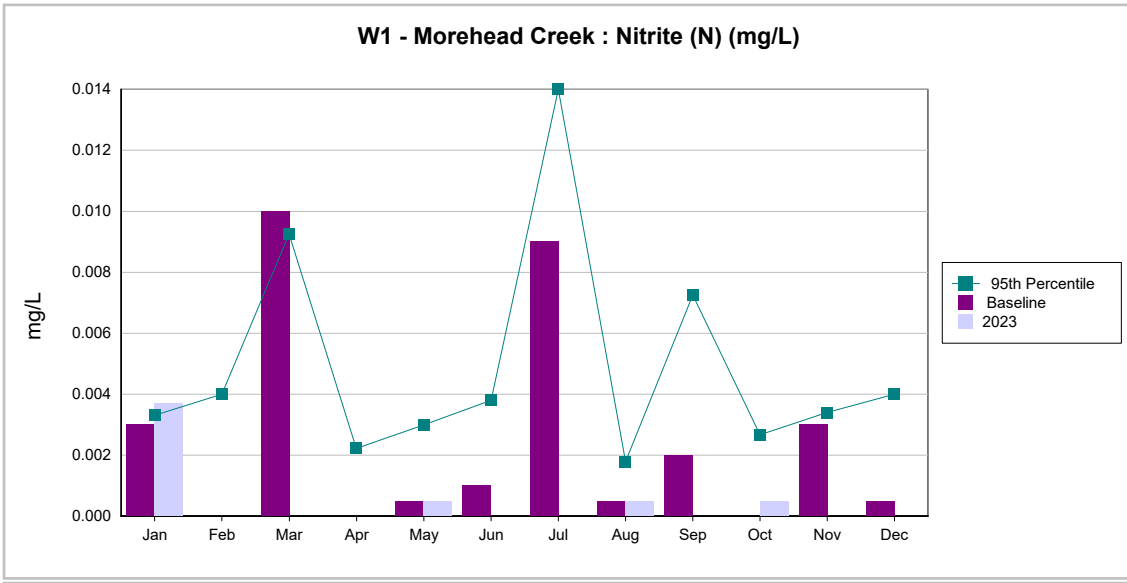


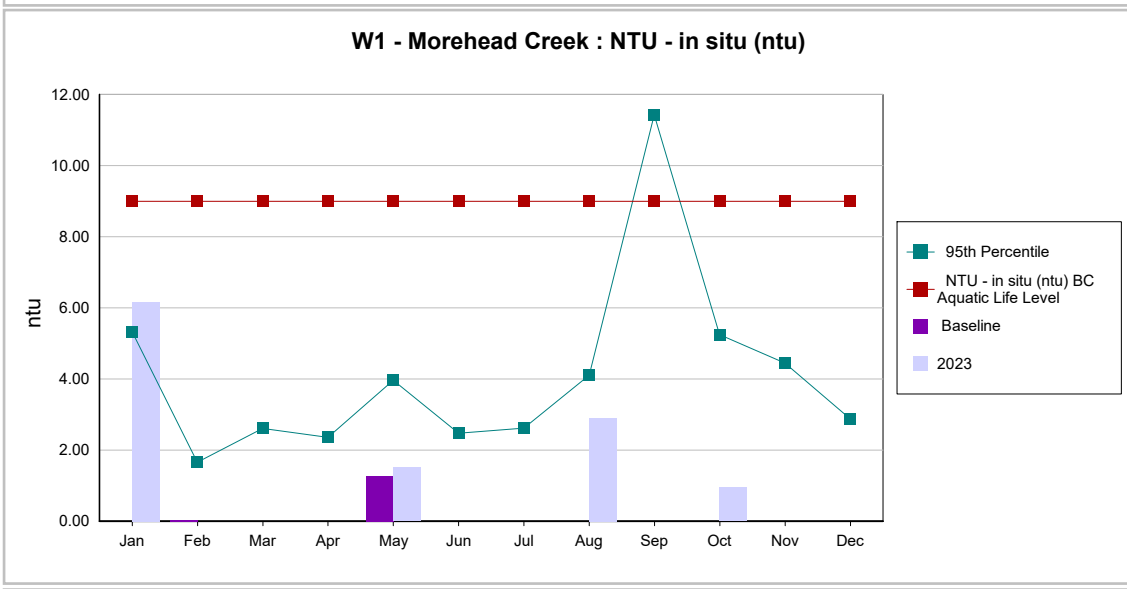


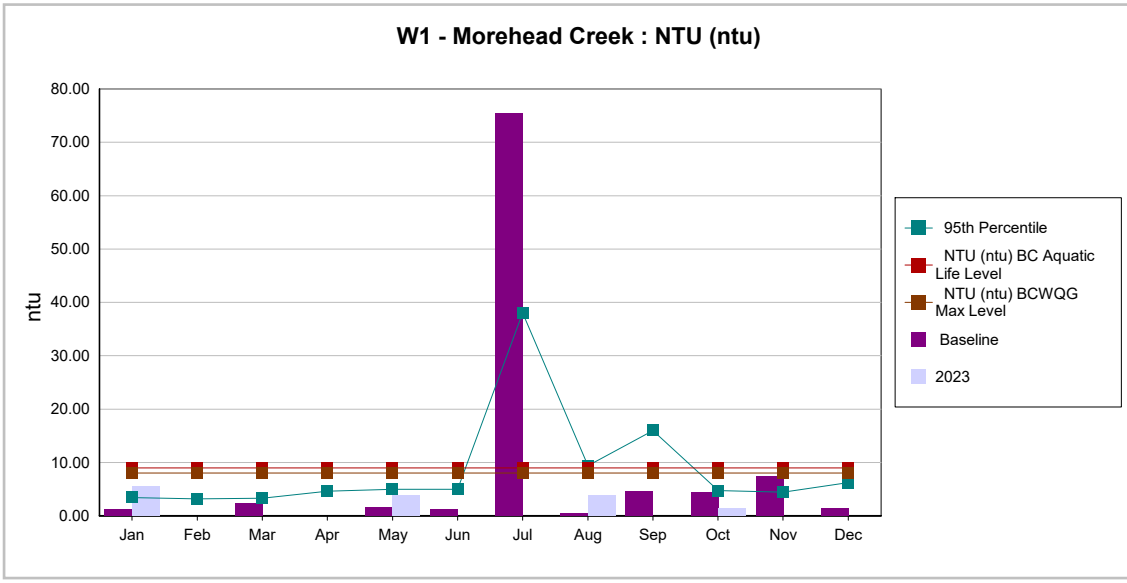
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







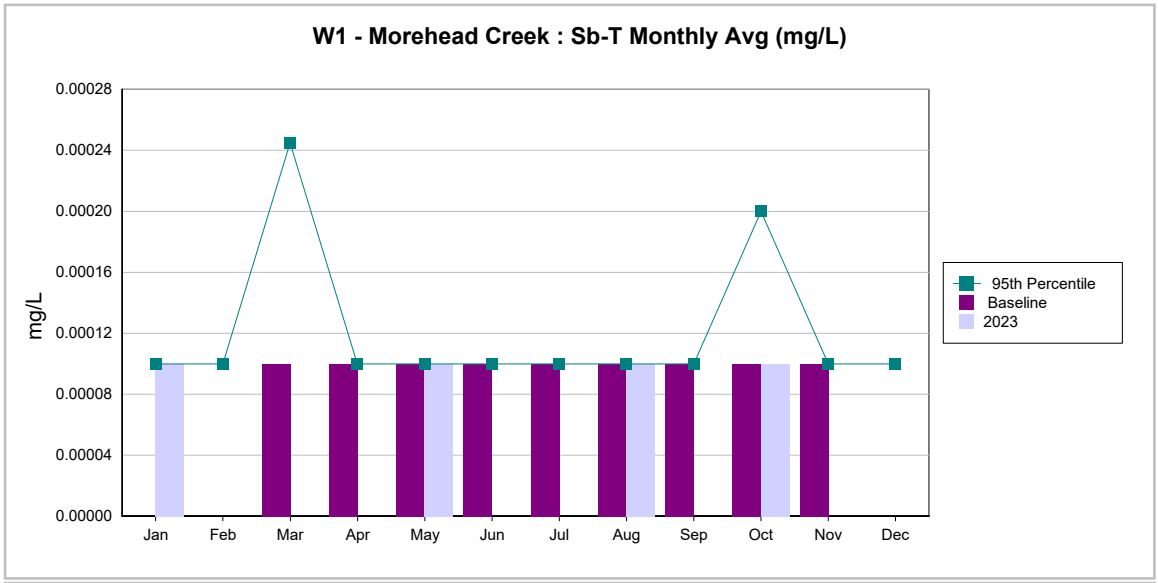
Water Quality Report

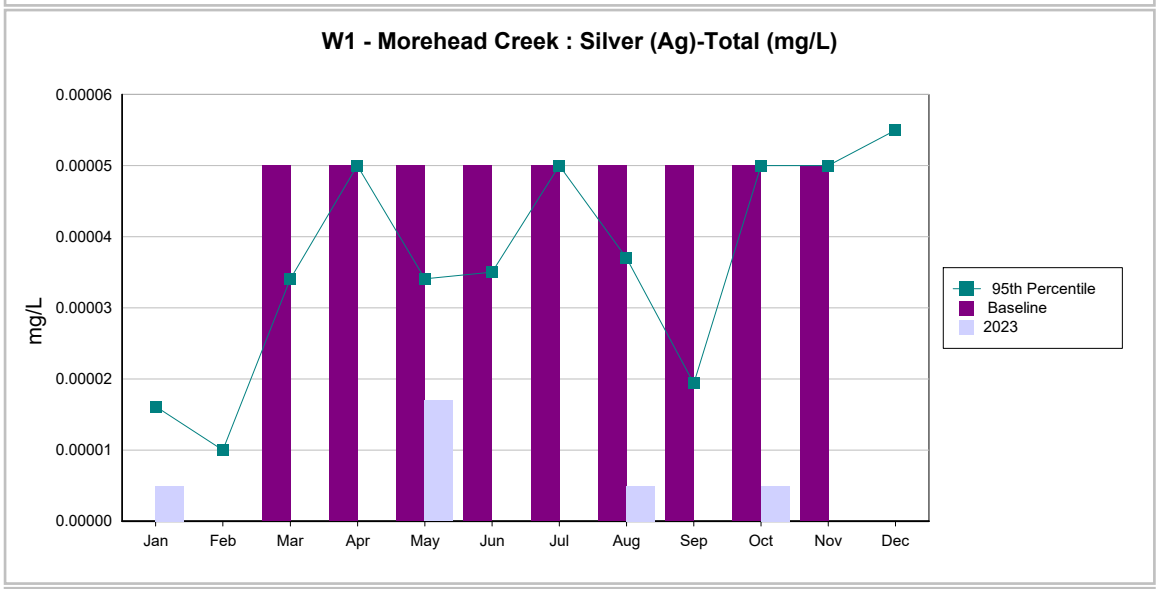
Annual Report SW vs BCWQG

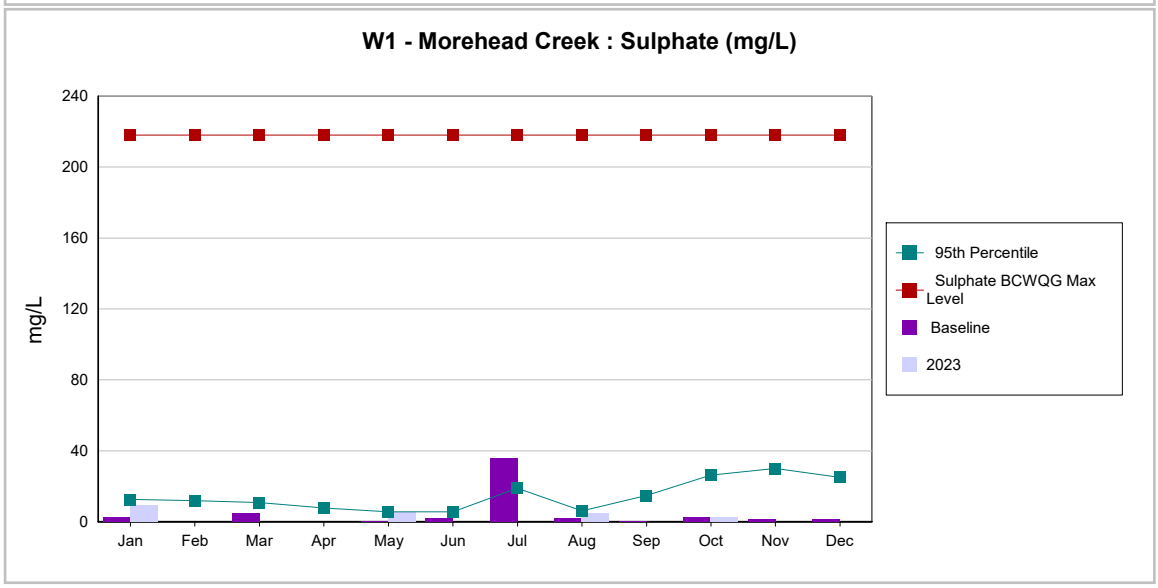
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







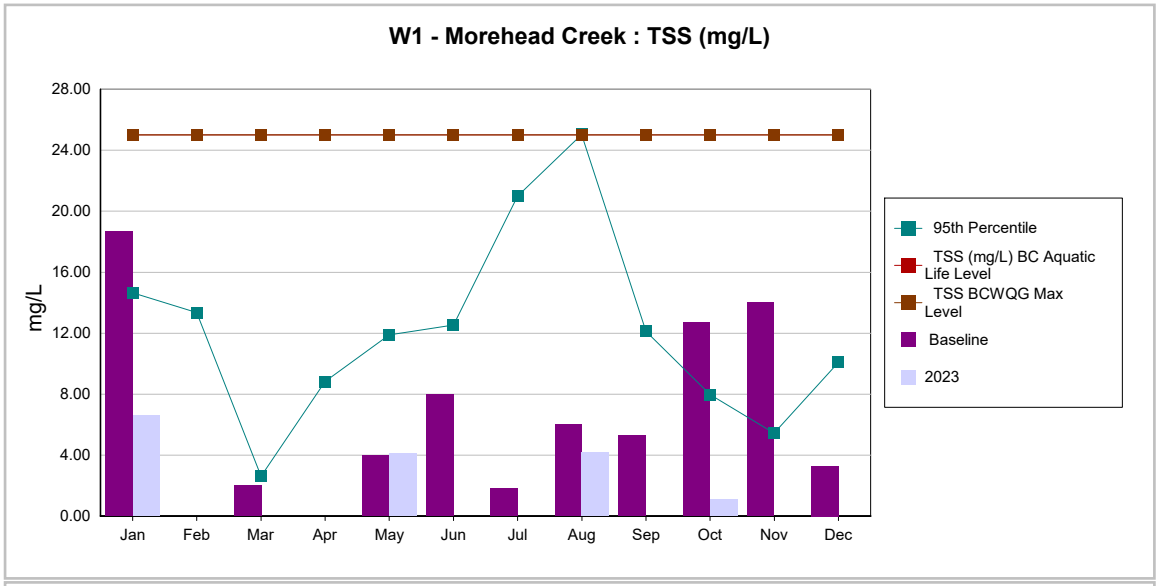
Water Quality Report

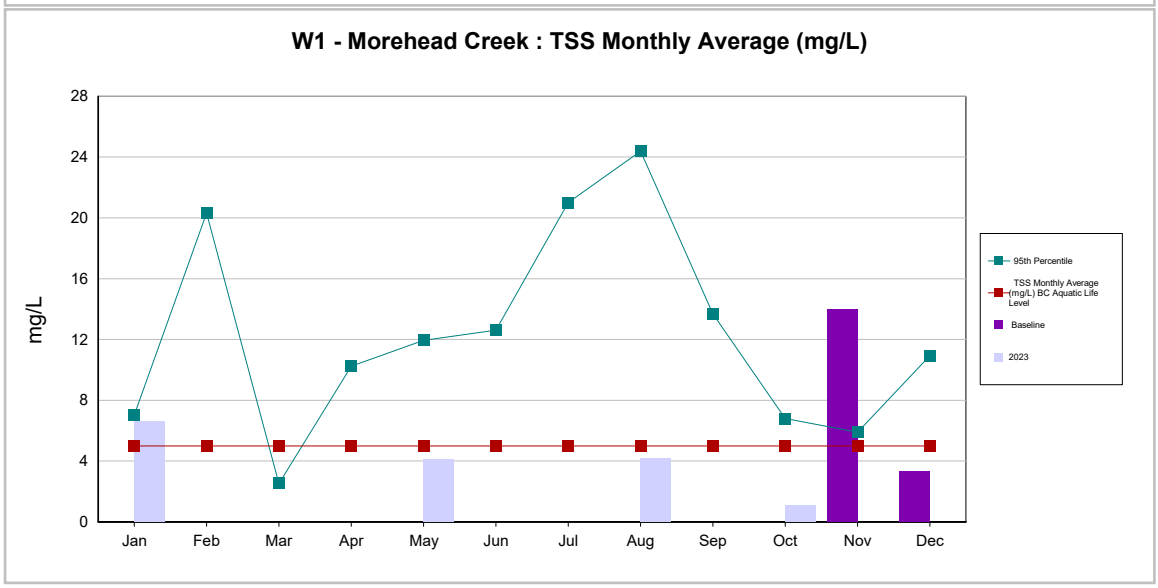
Annual Report SW vs BCWQG

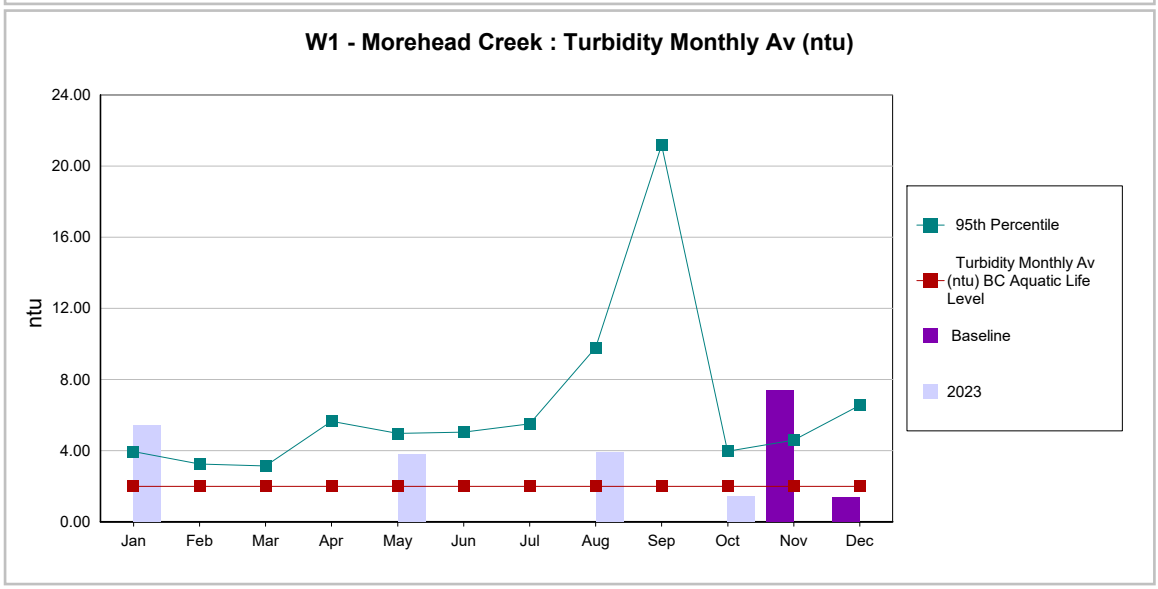
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







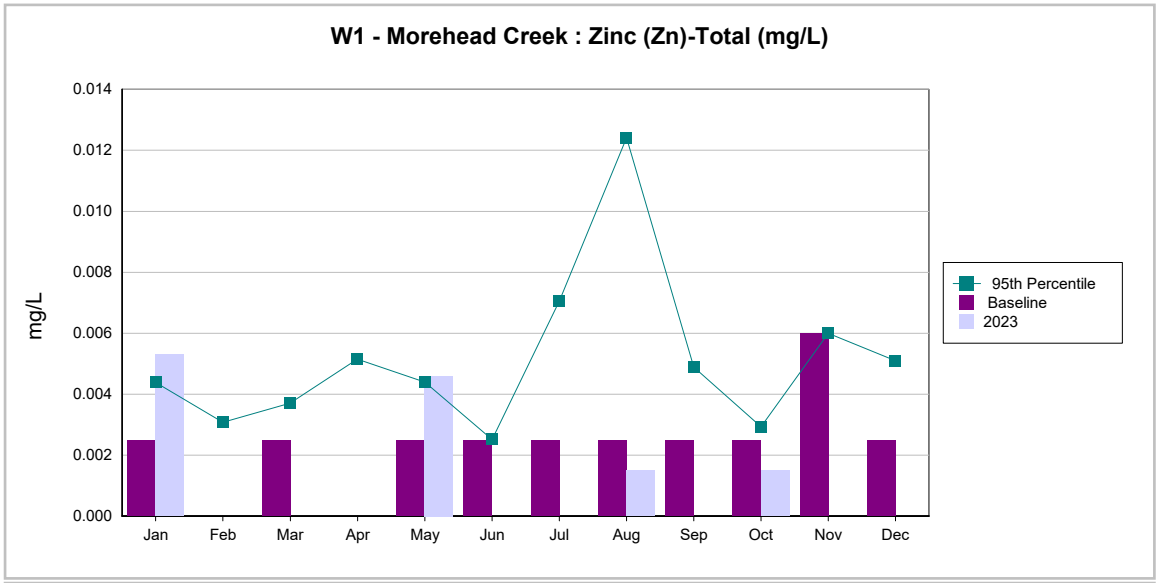
Water Quality Report

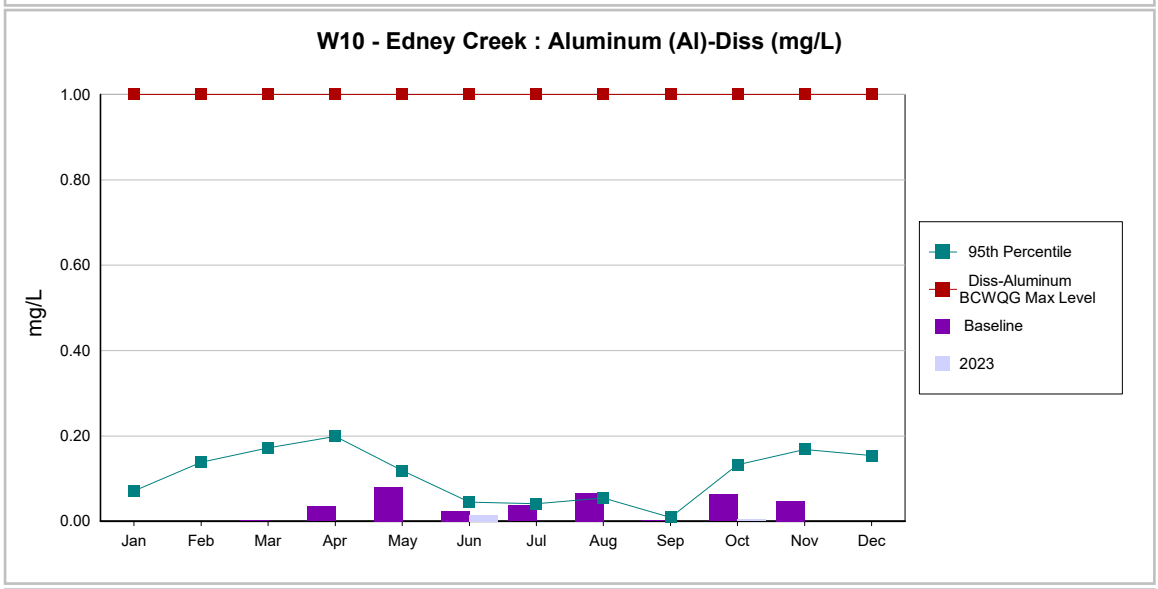
Annual Report SW vs BCWQG

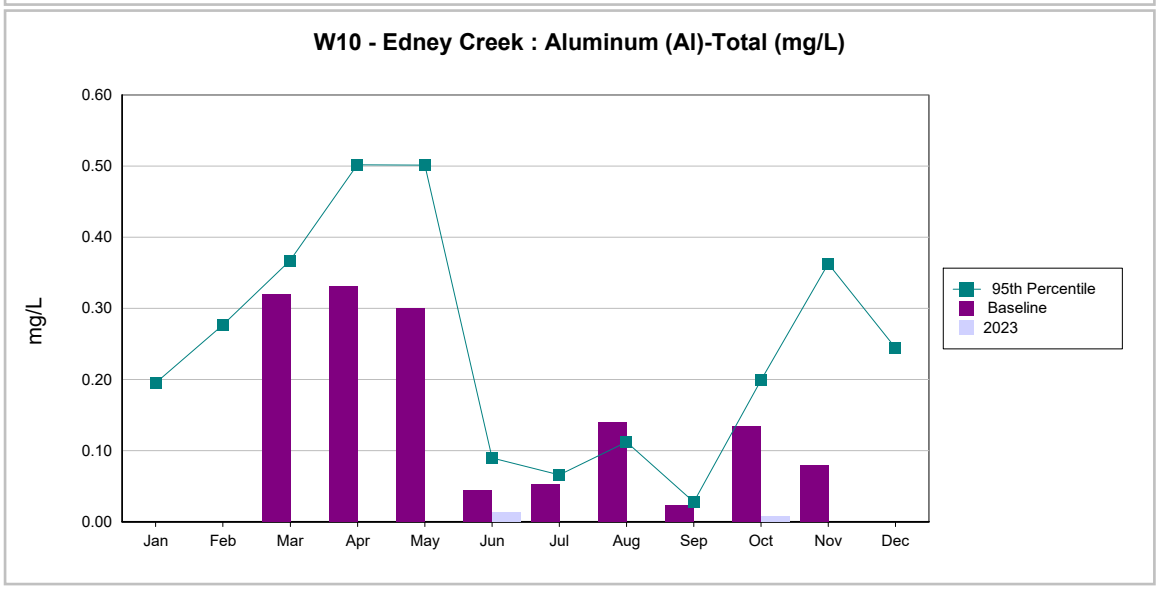
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







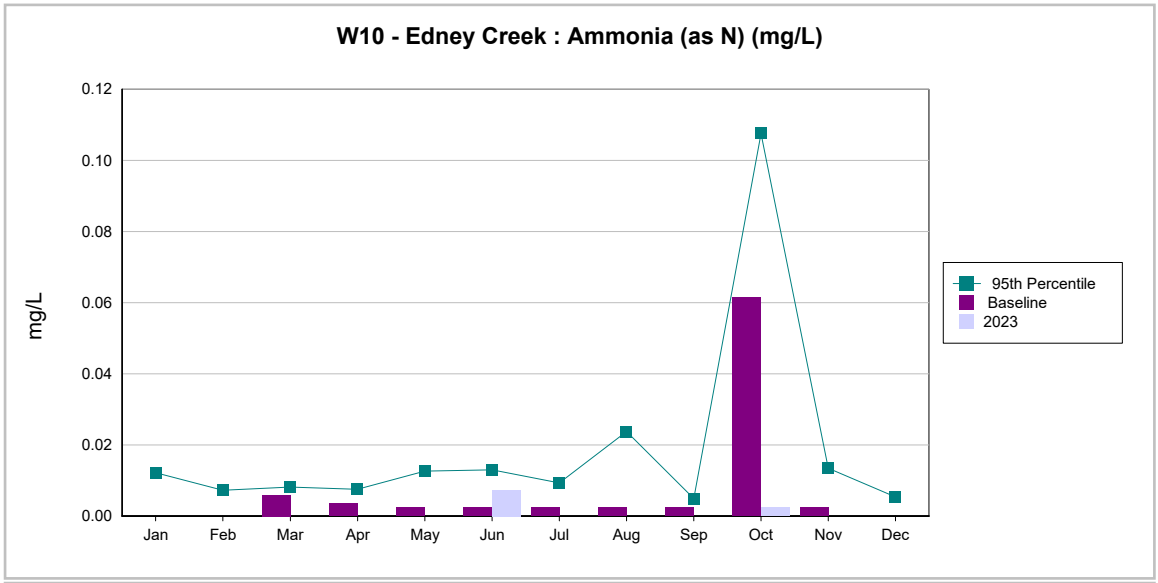
Water Quality Report

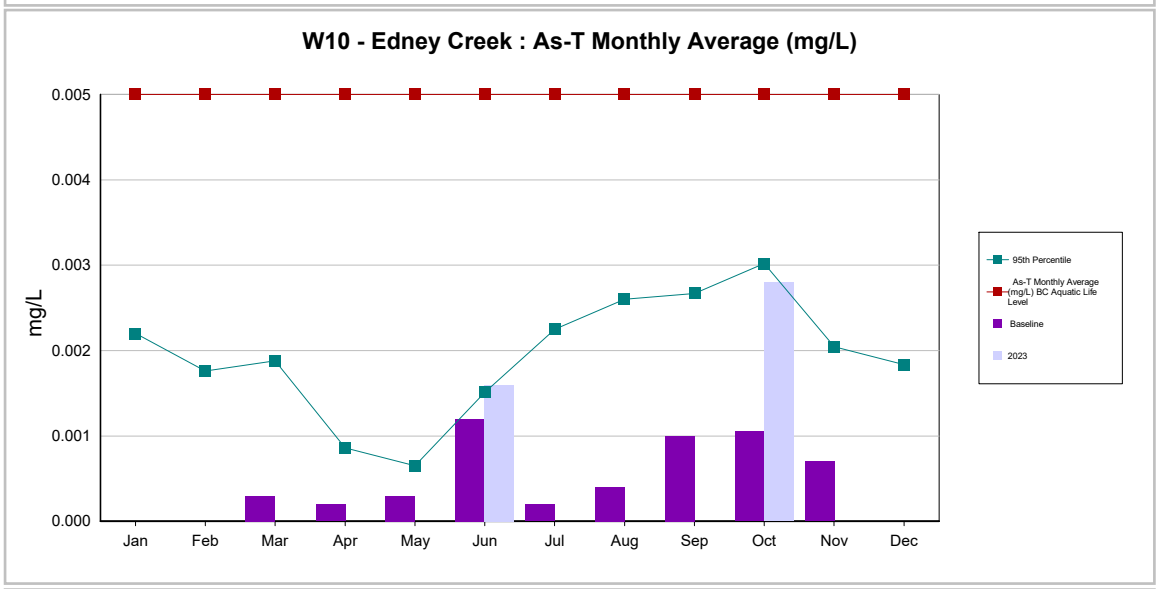
Annual Report SW vs BCWQG

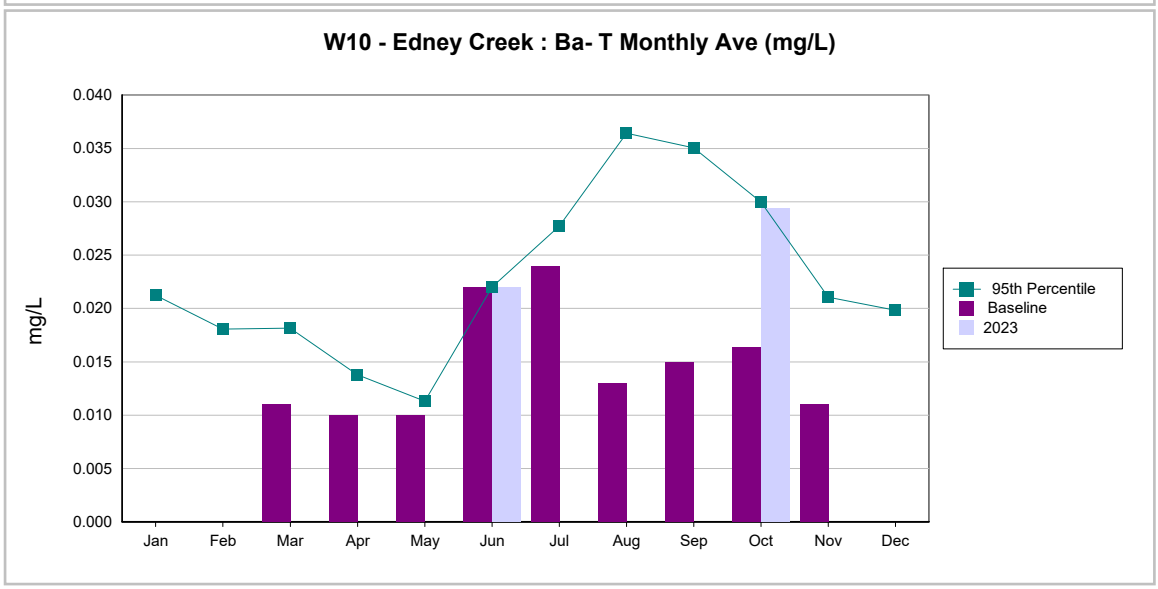
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







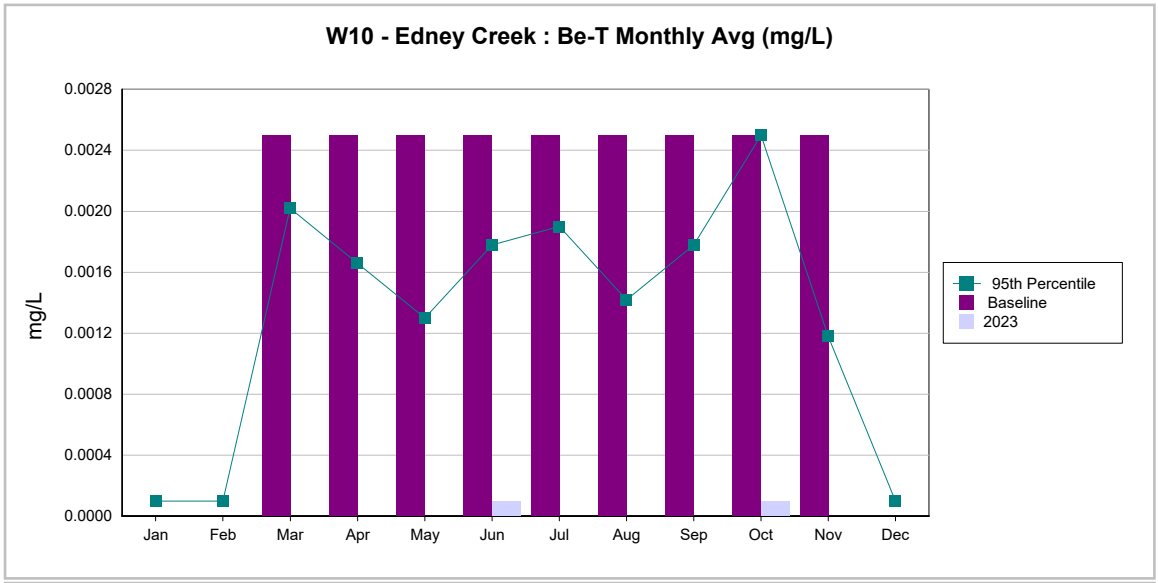
Water Quality Report

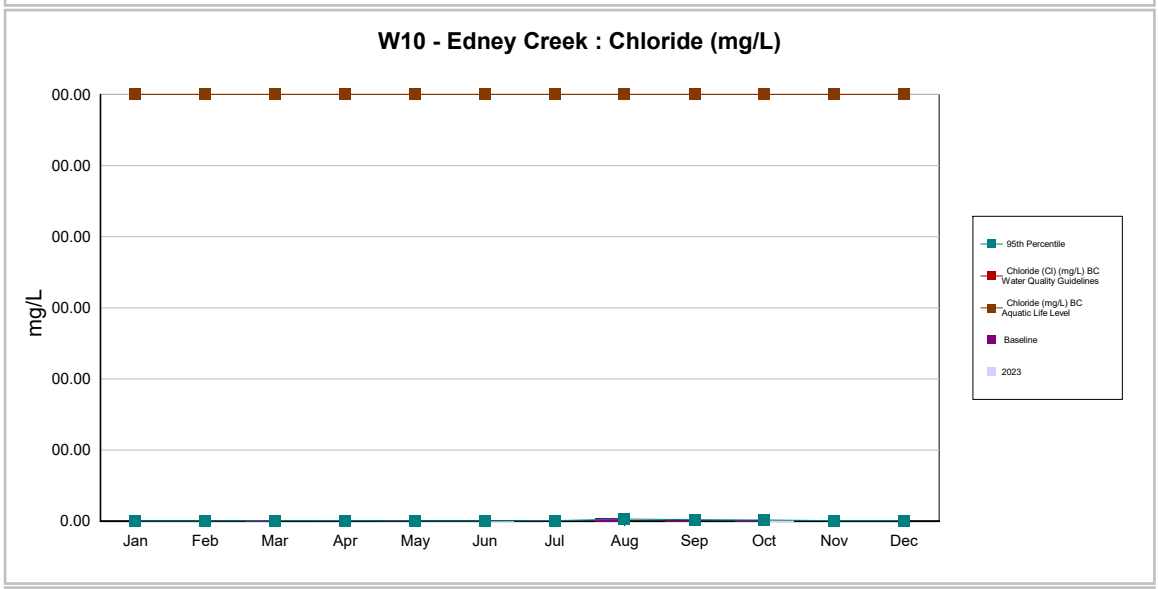
Annual Report SW vs BCWQG

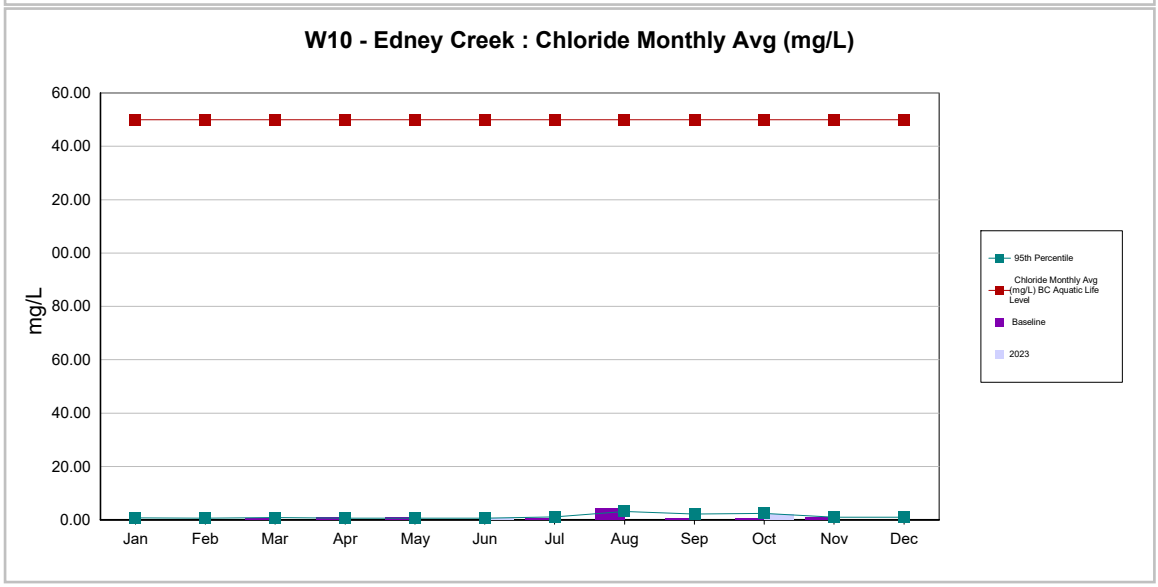
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







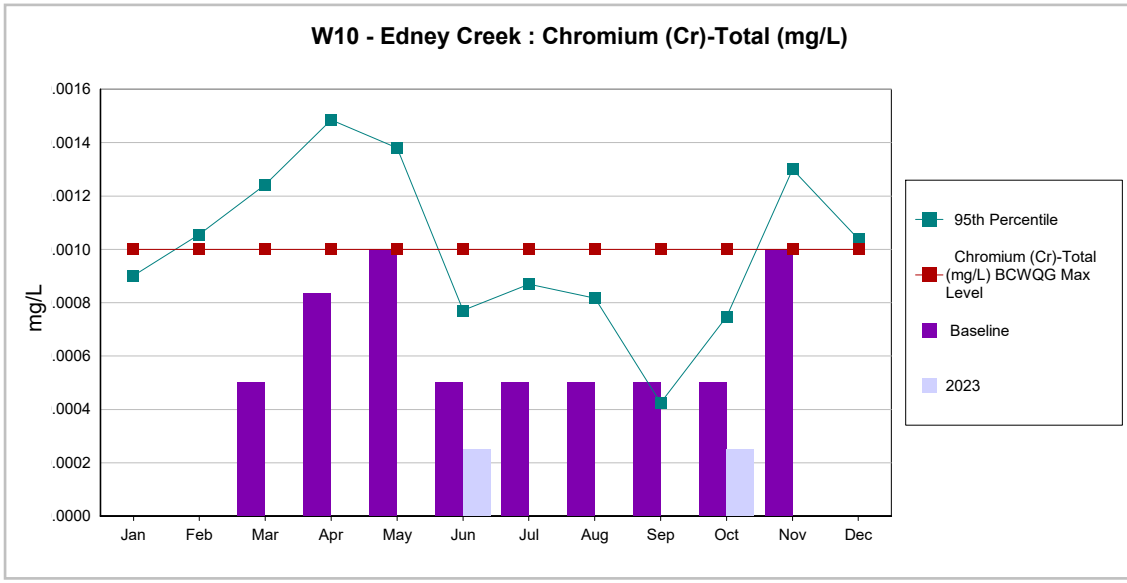
Water Quality Report

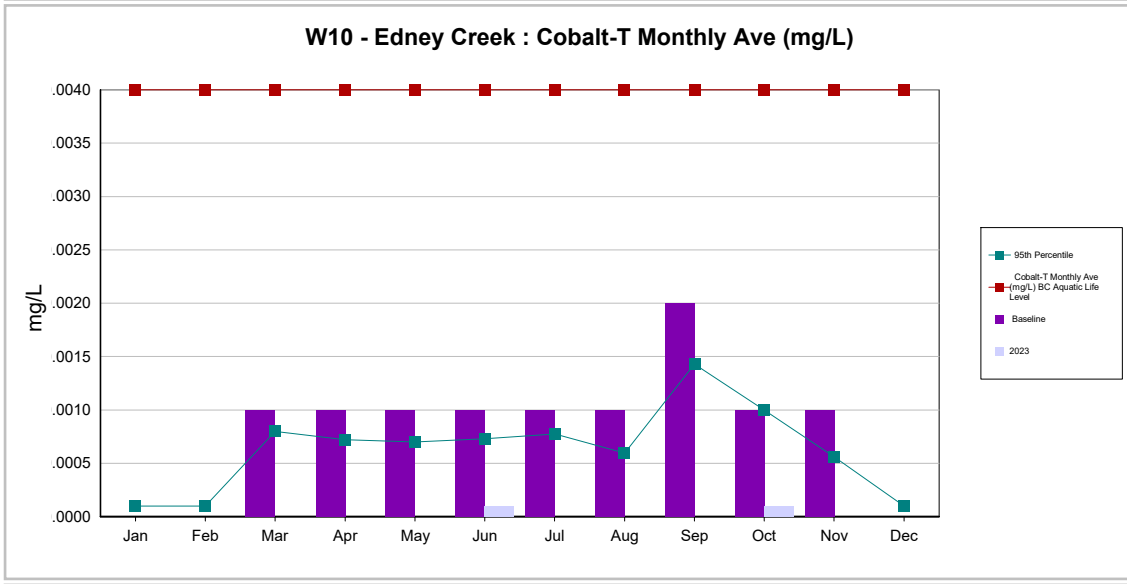
Annual Report SW vs BCWQG

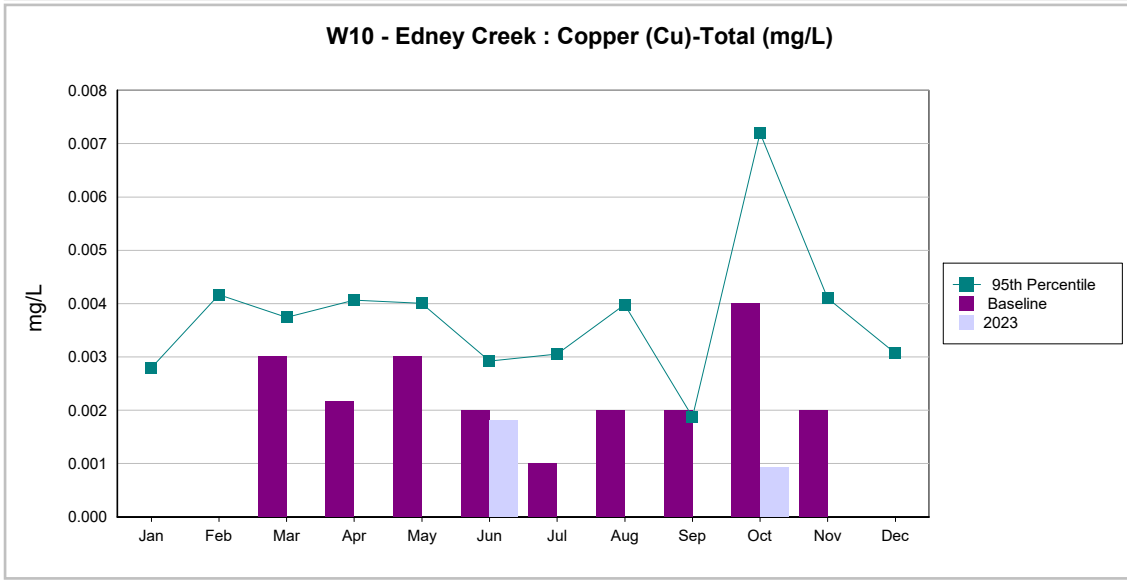
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







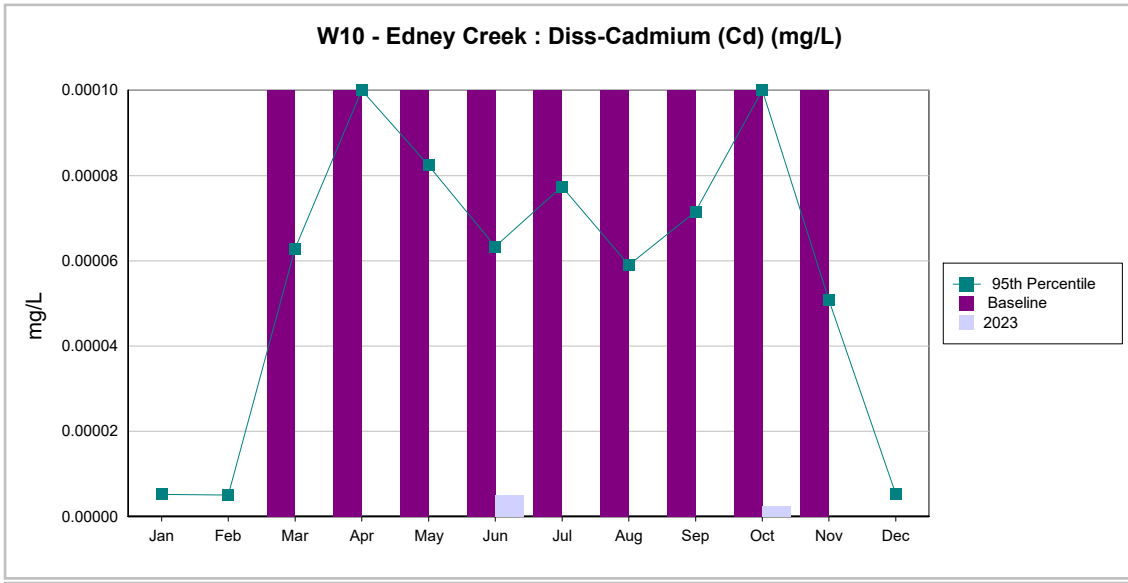
Water Quality Report

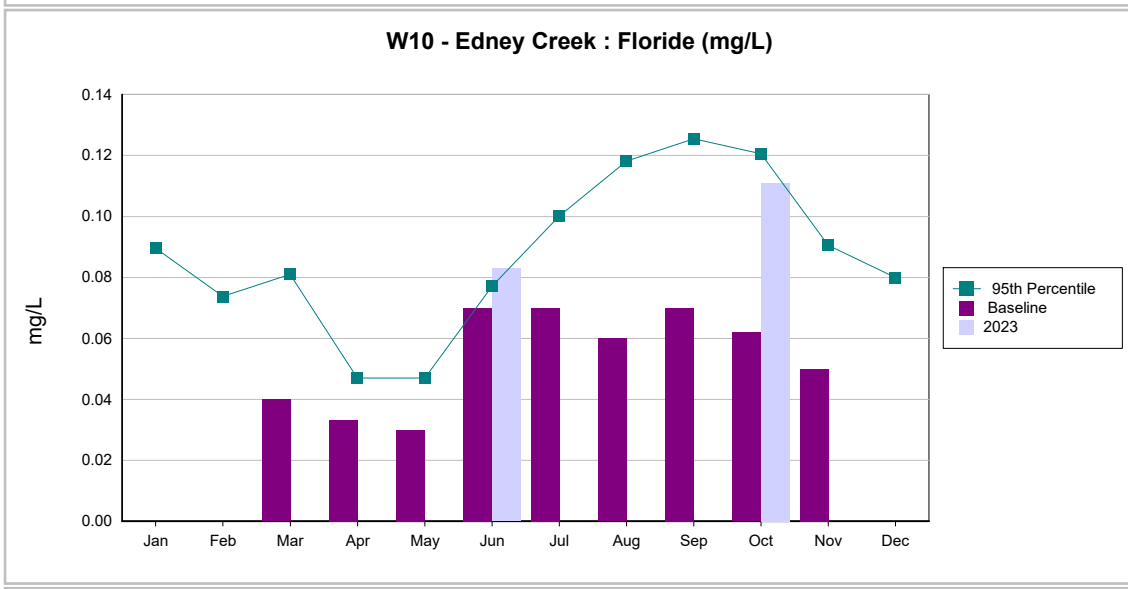
Annual Report SW vs BCWQG

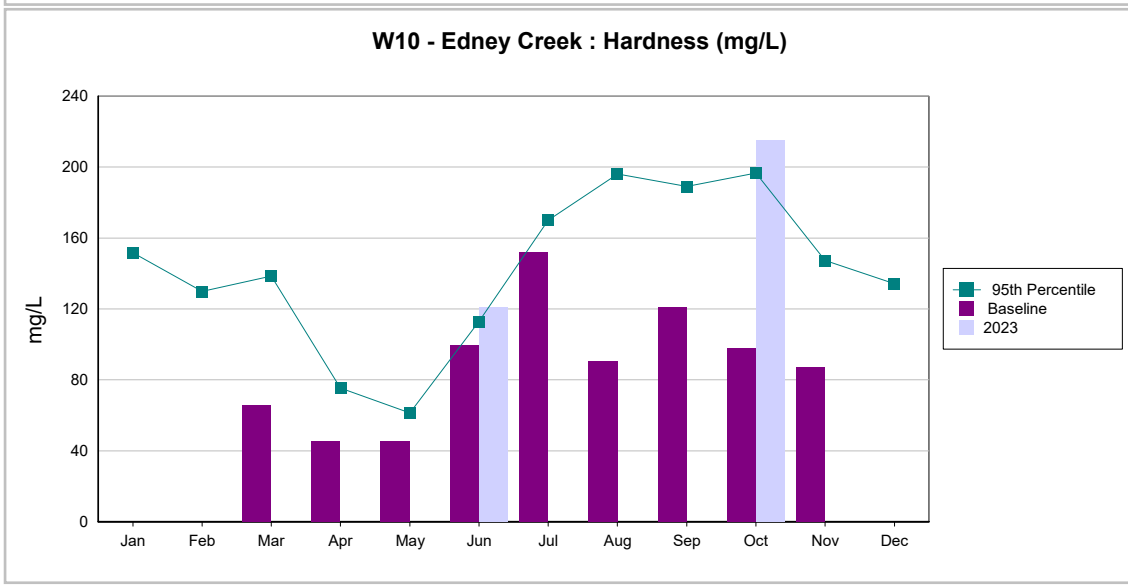
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







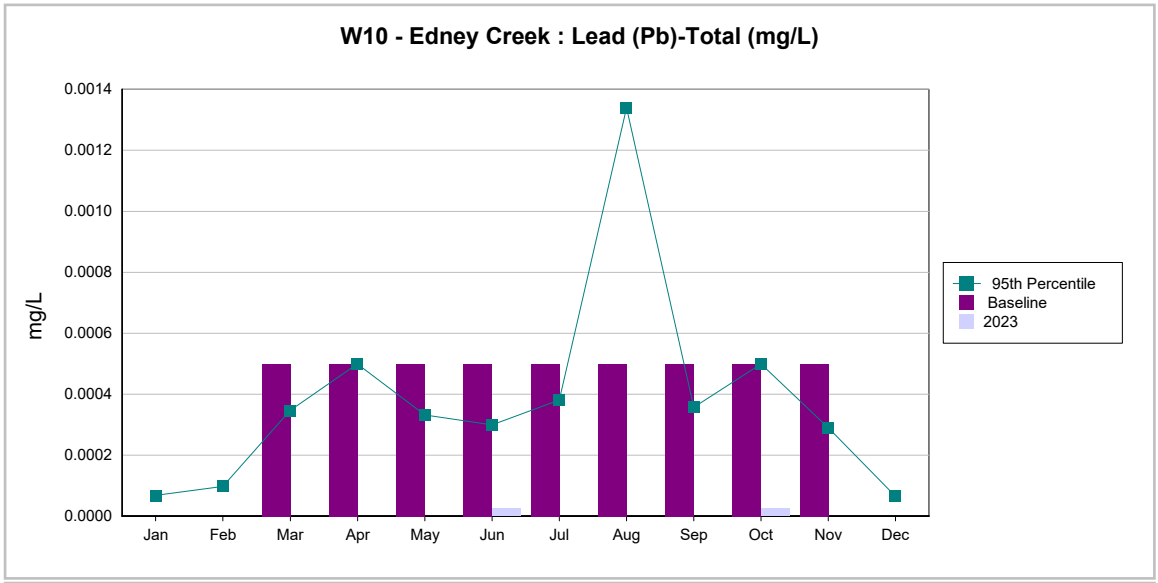
Water Quality Report

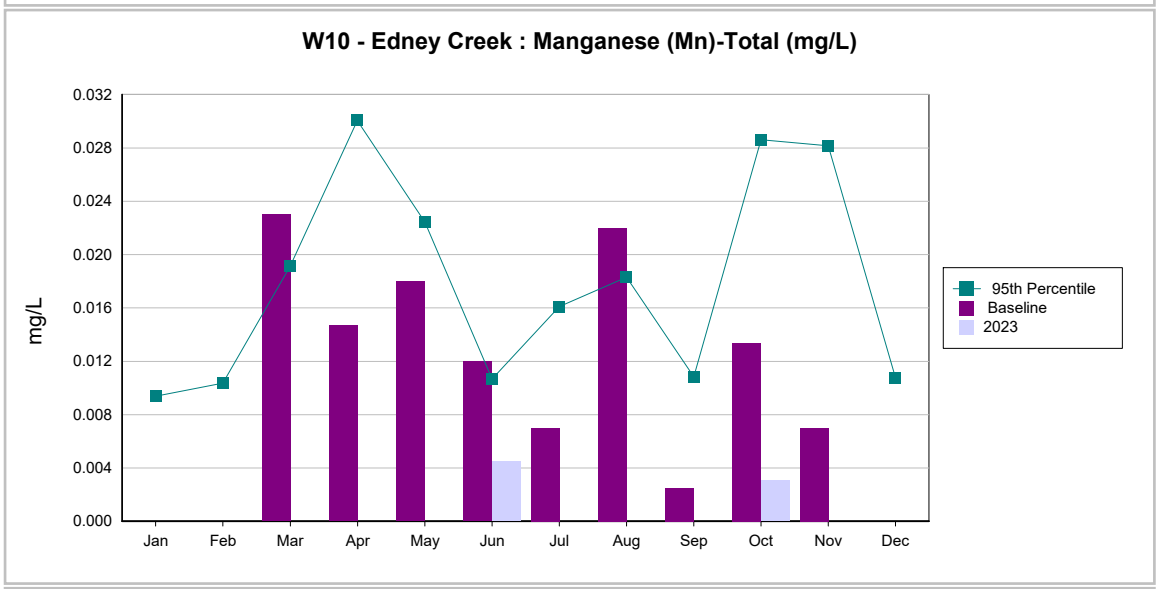
Annual Report SW vs BCWQG

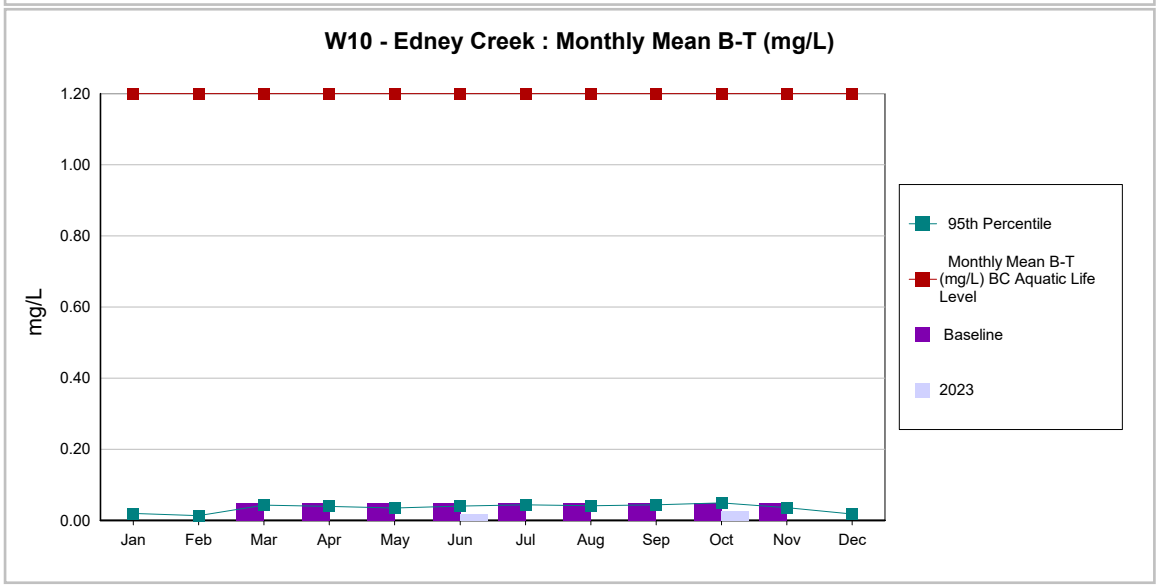
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







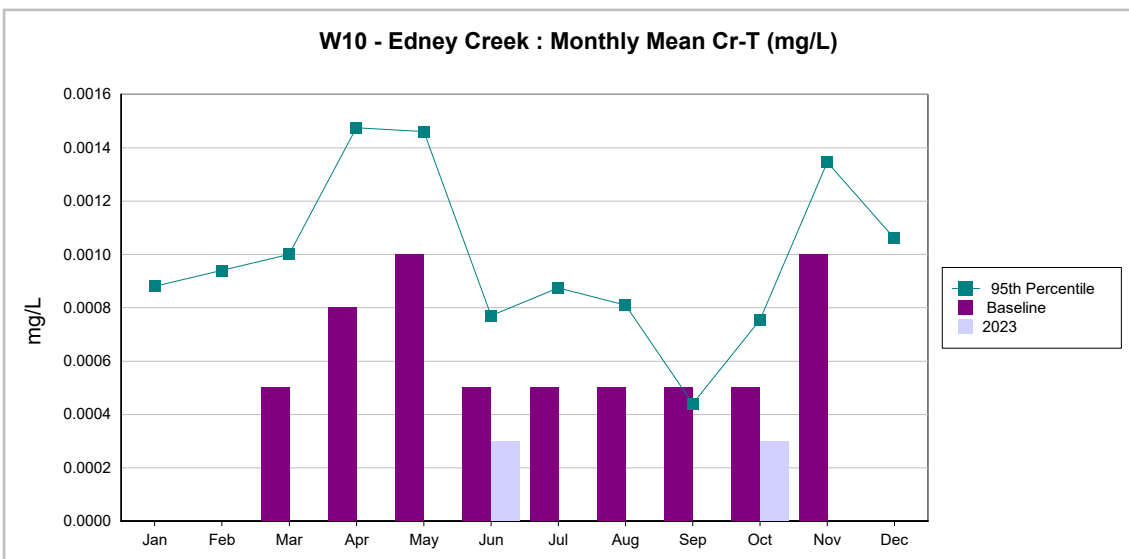
Water Quality Report

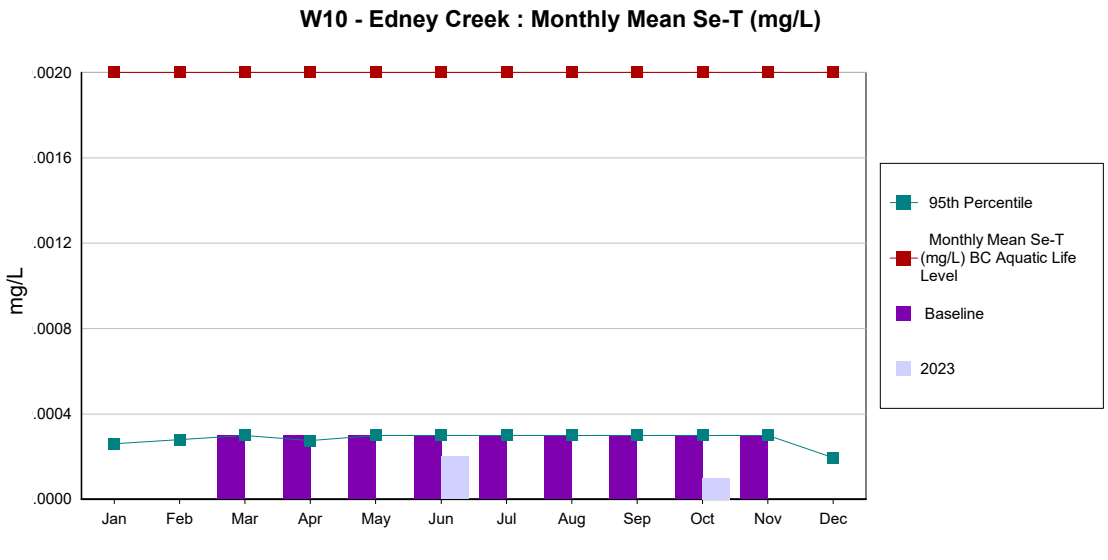
Annual Report SW vs BCWQG

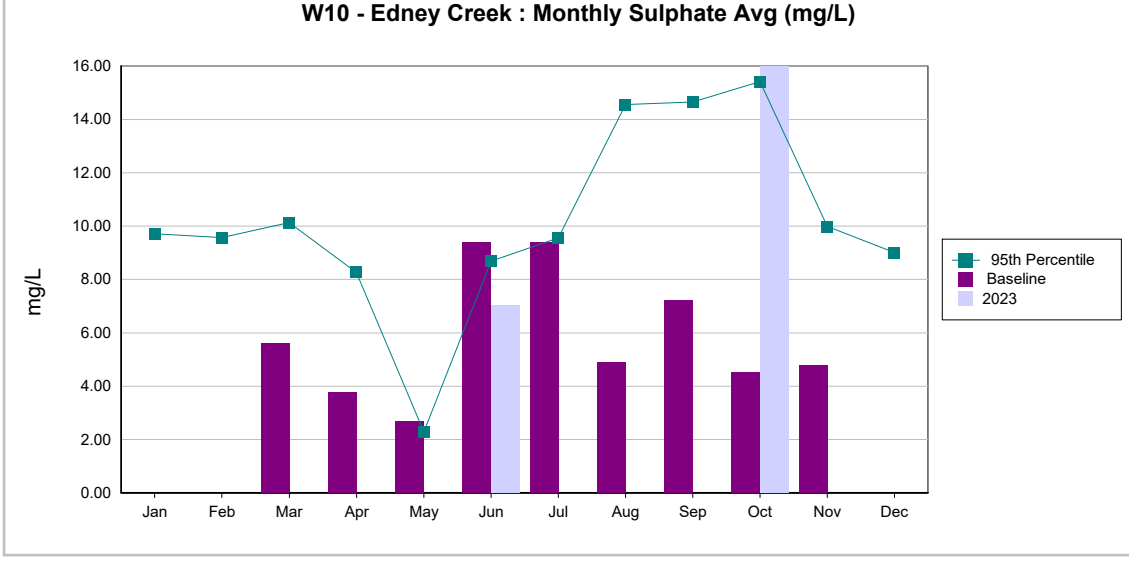
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







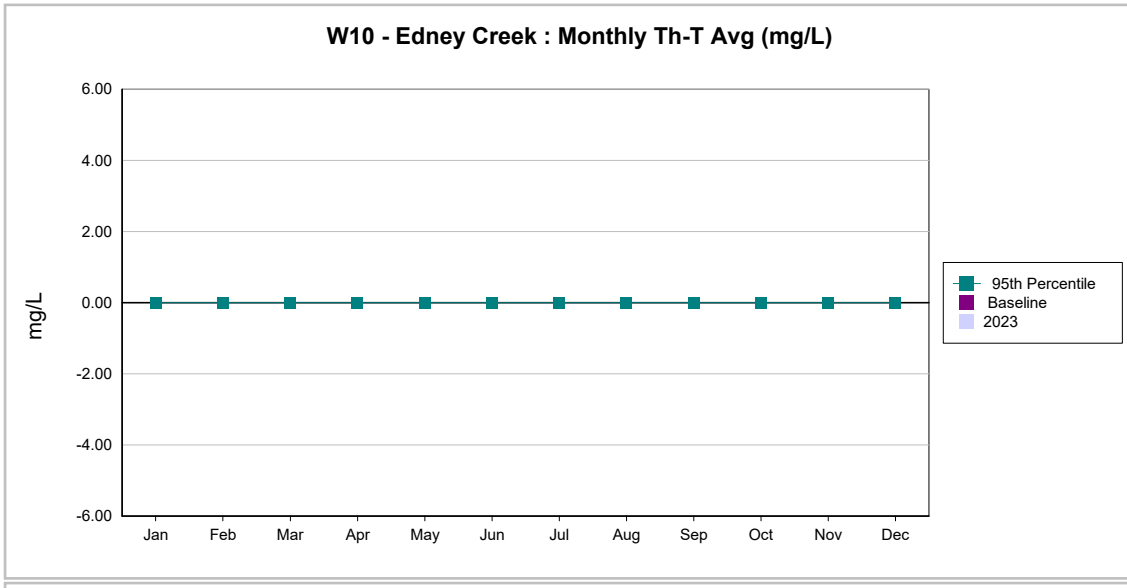
Water Quality Report

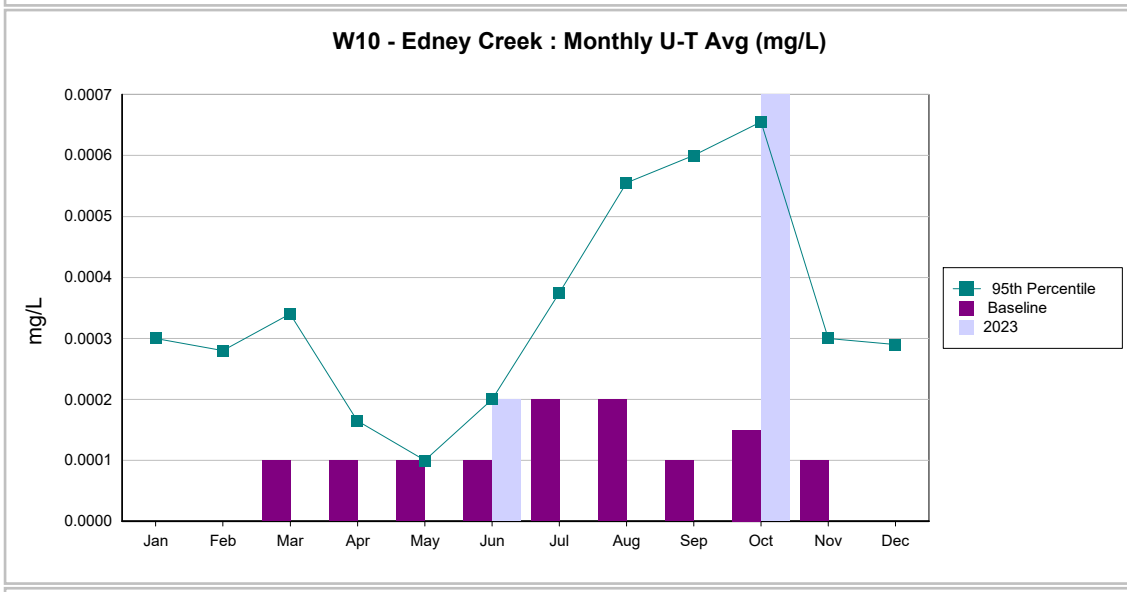
Annual Report SW vs BCWQG

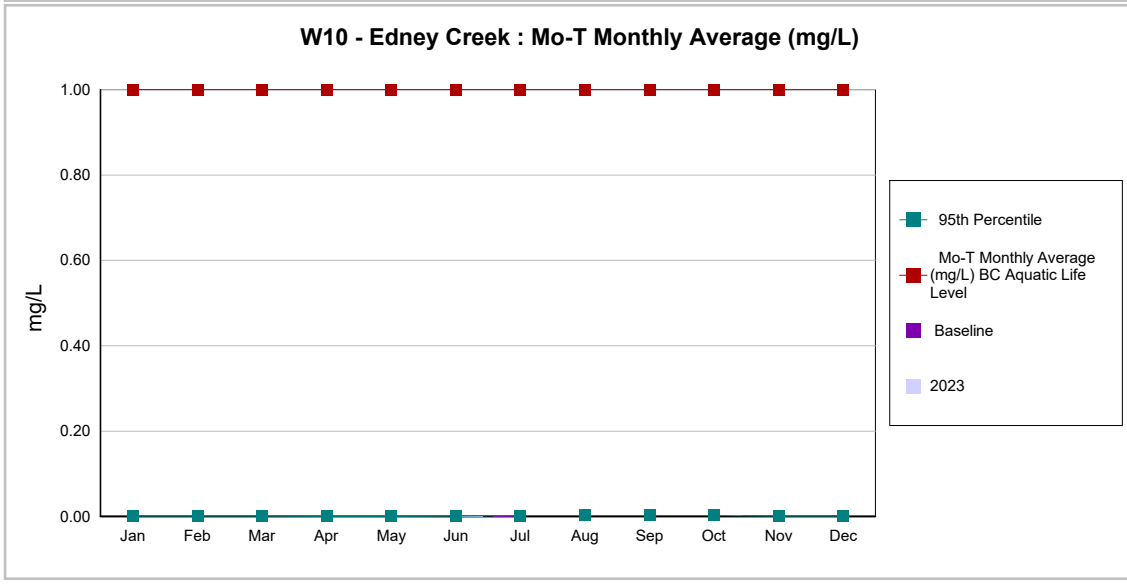
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







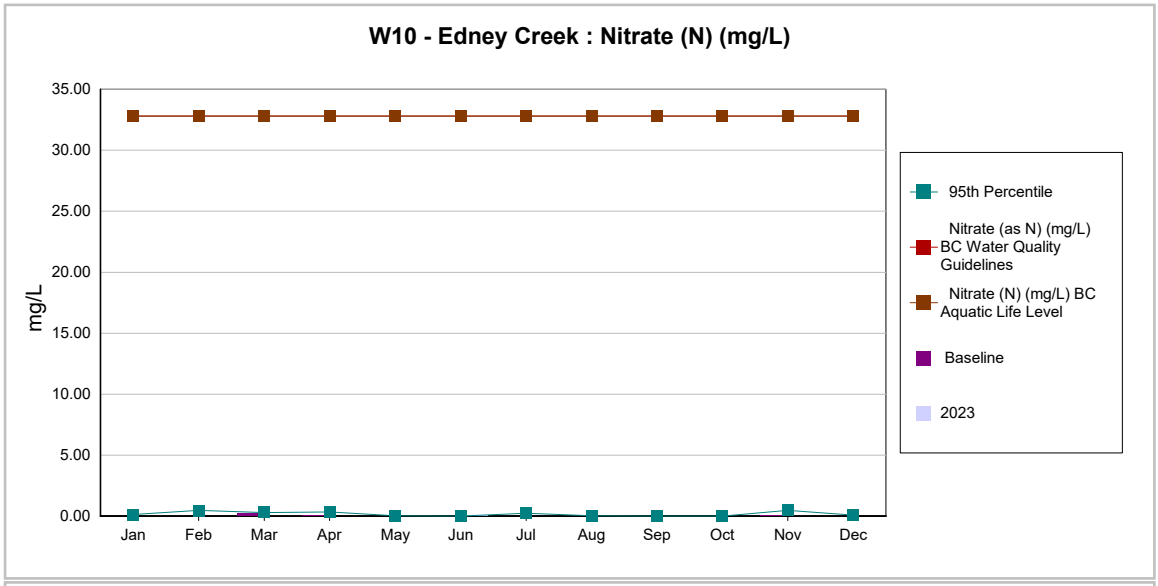
Water Quality Report

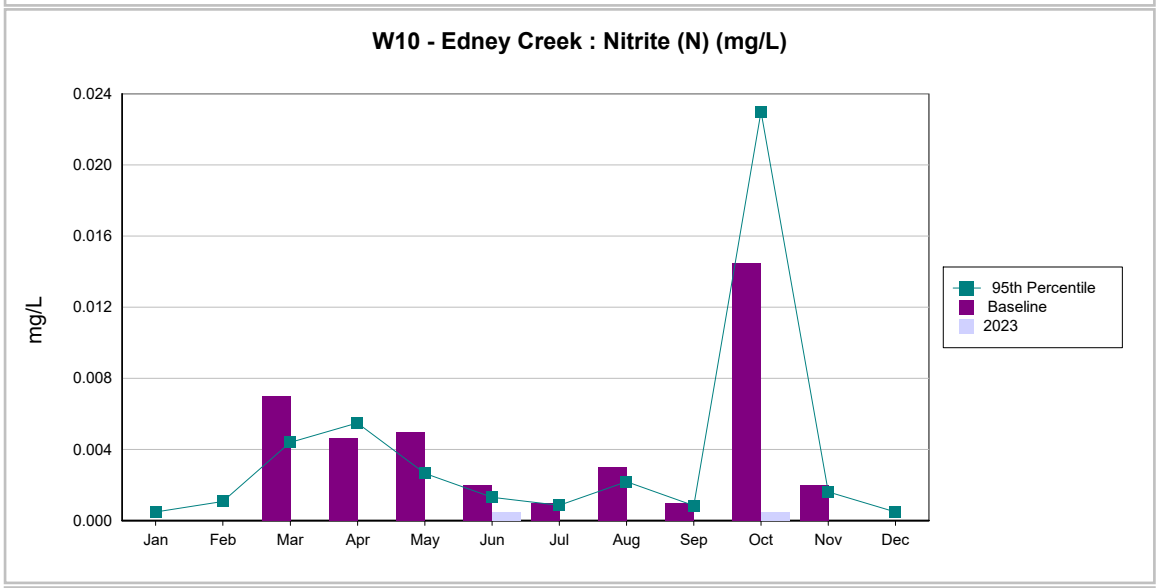
Annual Report SW vs BCWQG

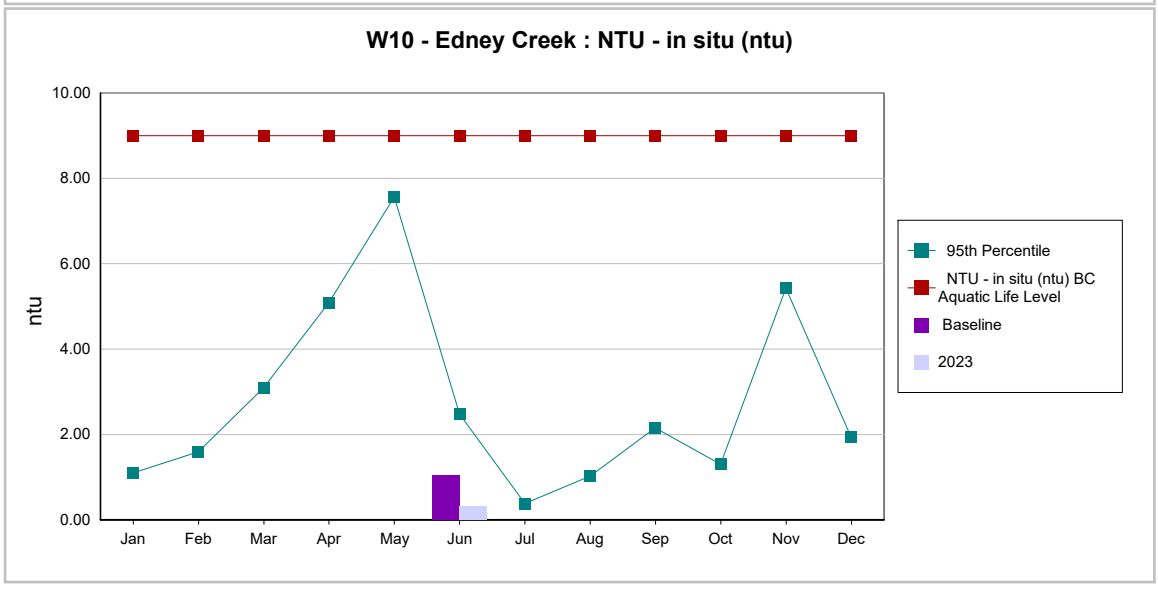
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







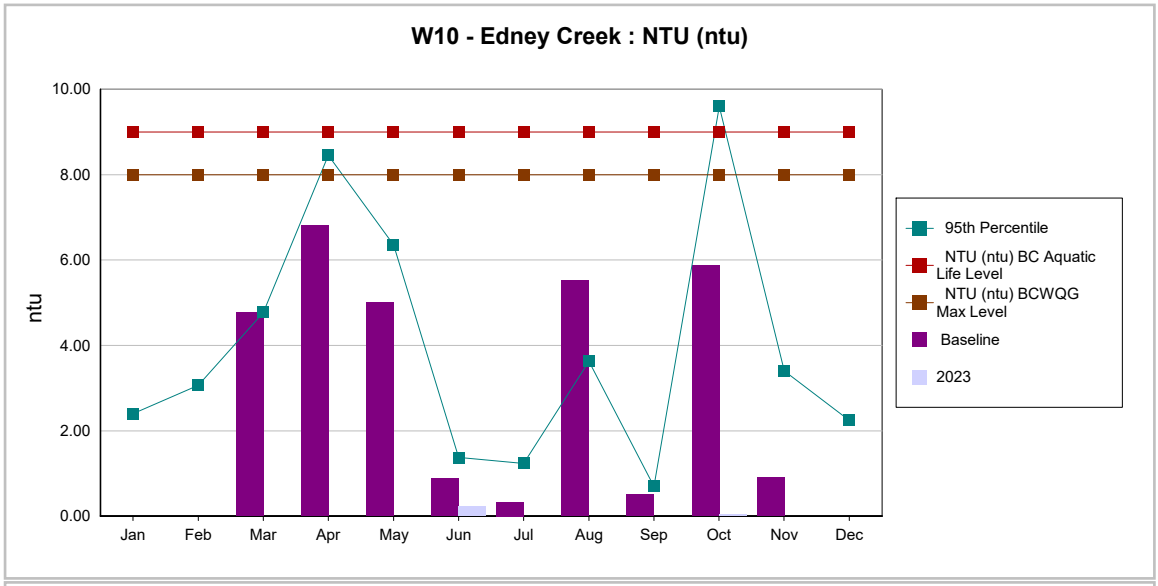
Water Quality Report

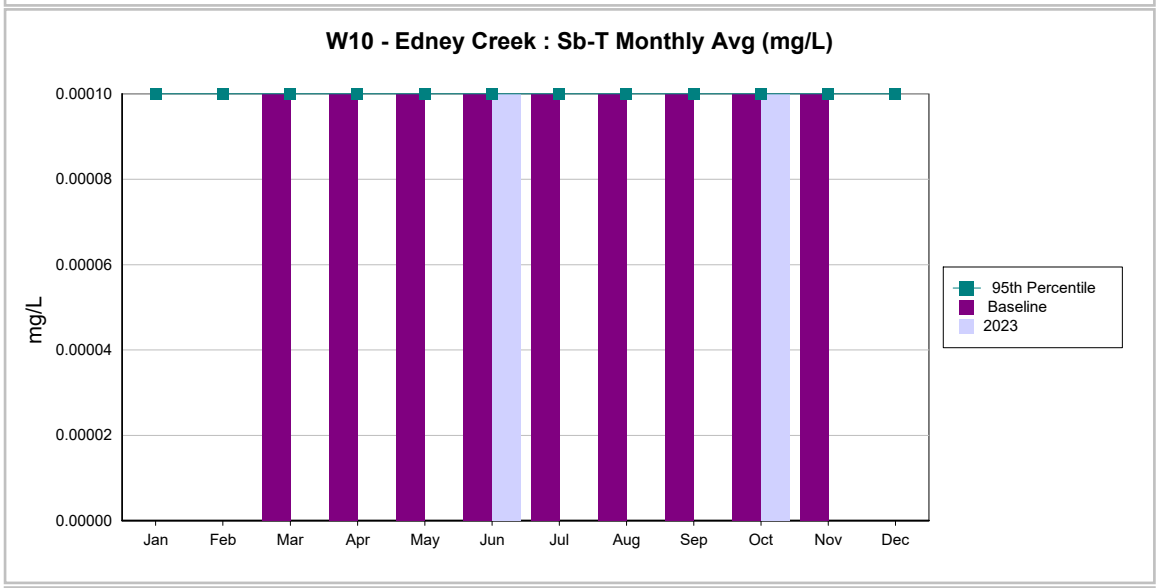
Annual Report SW vs BCWQG

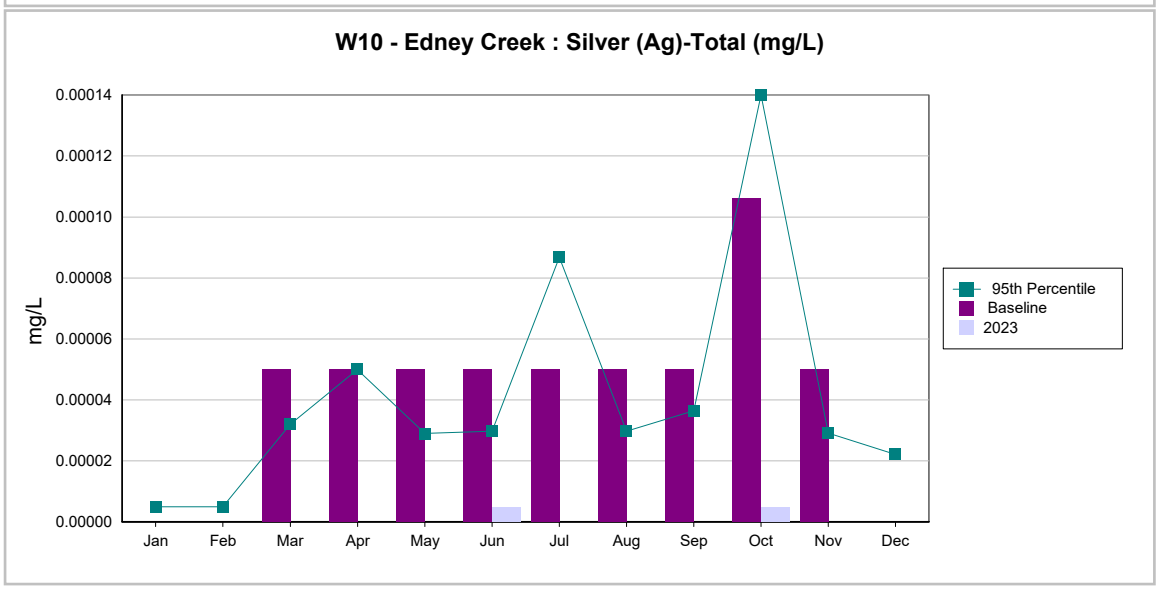
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







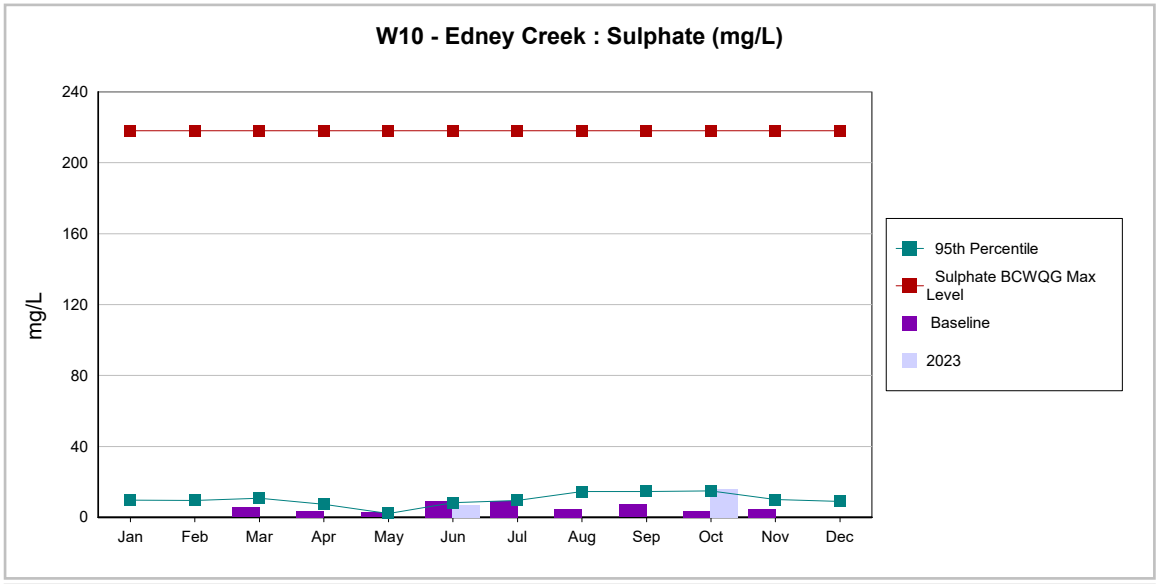
Water Quality Report

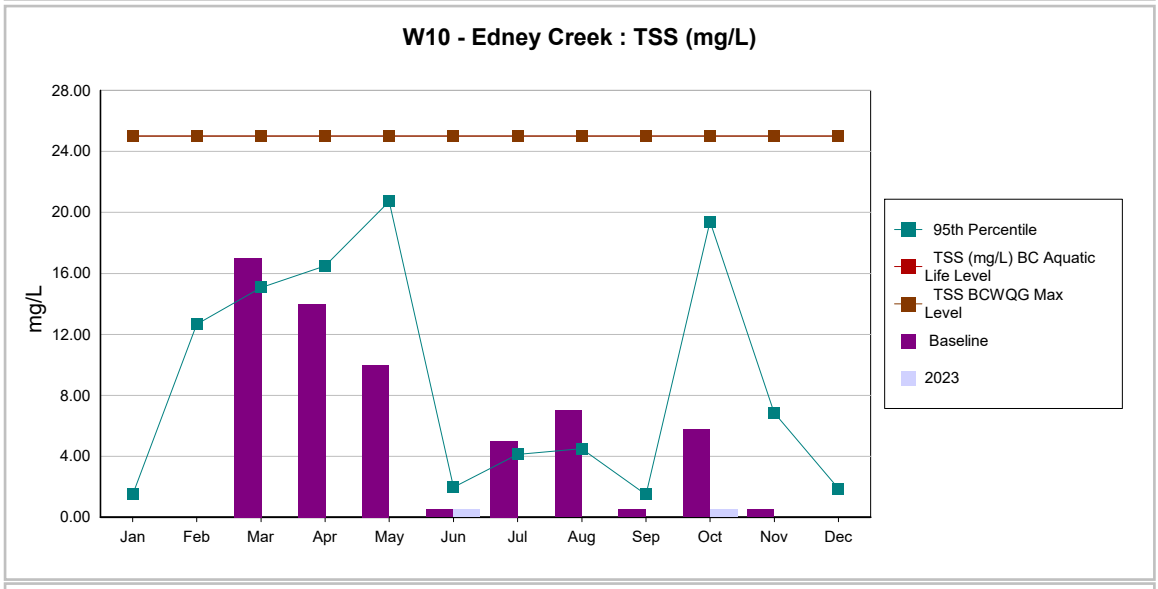
Annual Report SW vs BCWQG

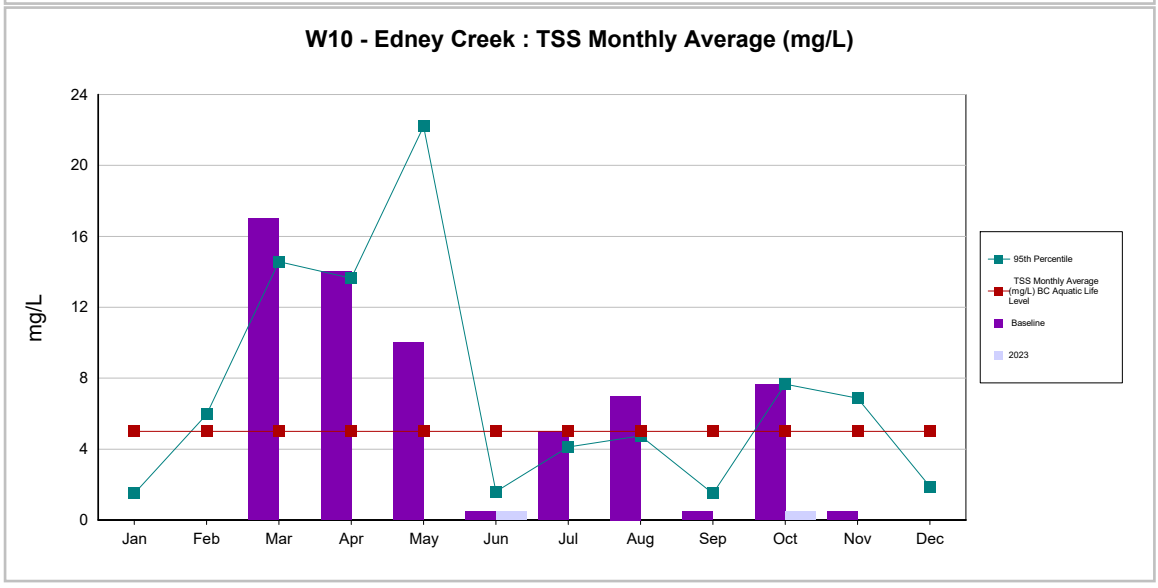
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



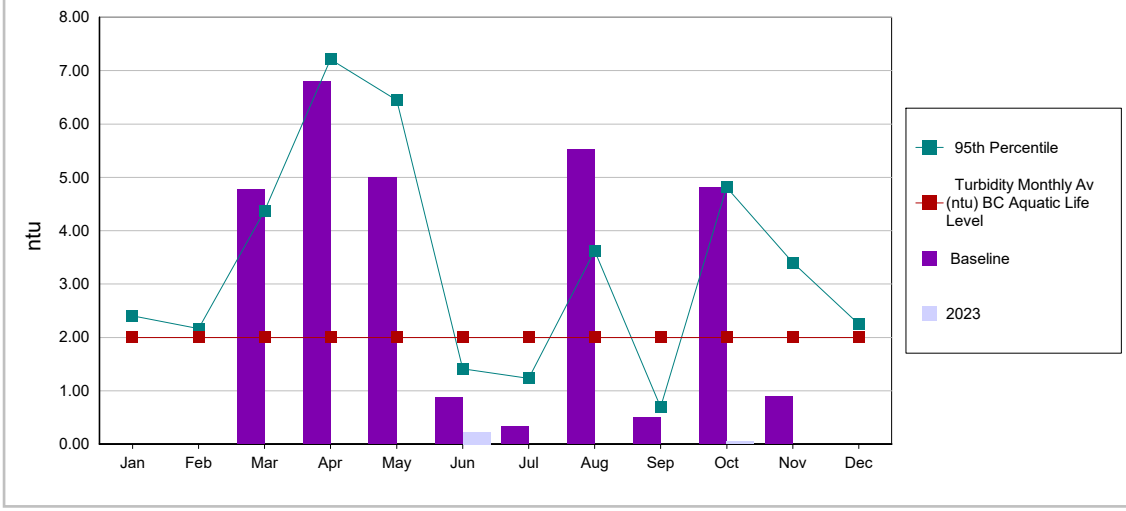


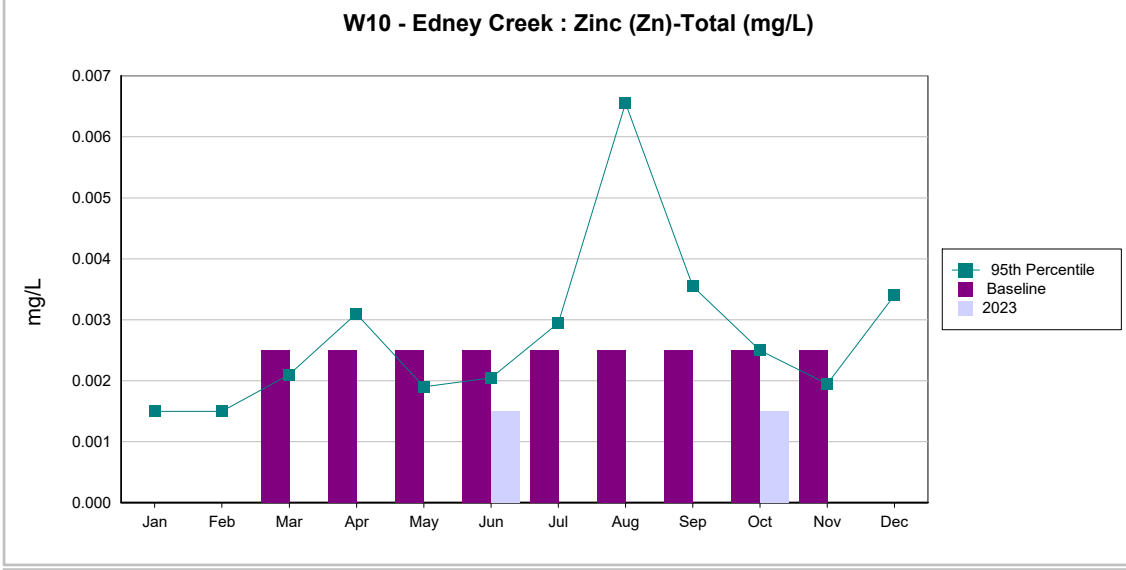


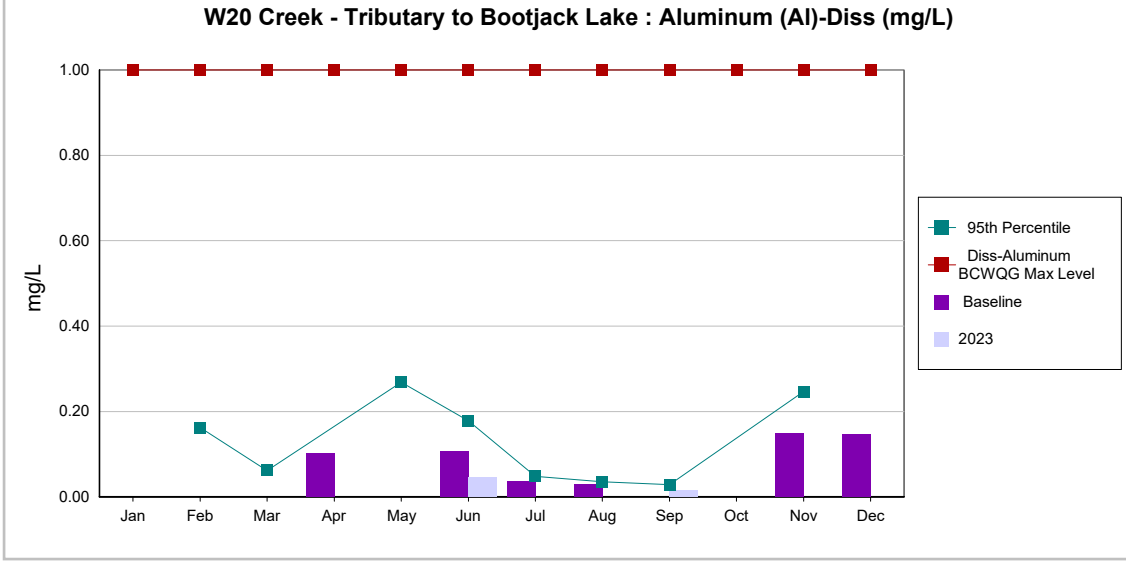
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







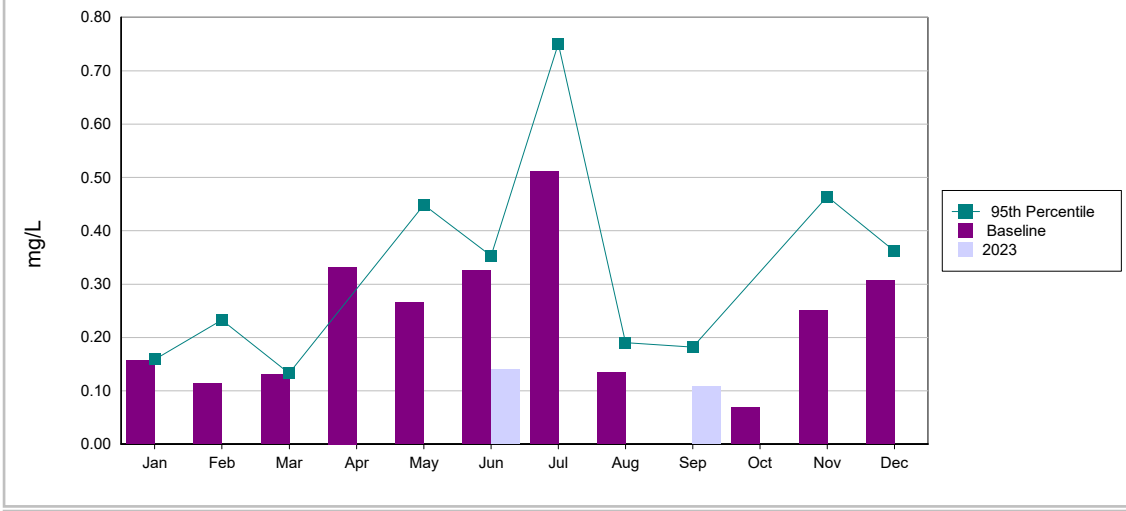
Water Quality Report

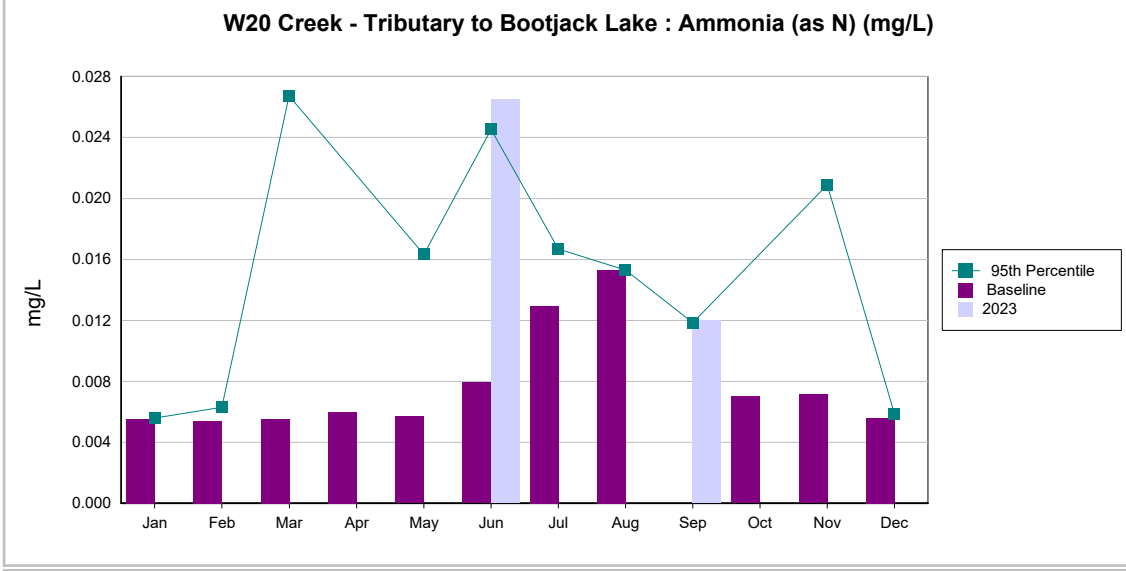
Annual Report SW vs BCWQG

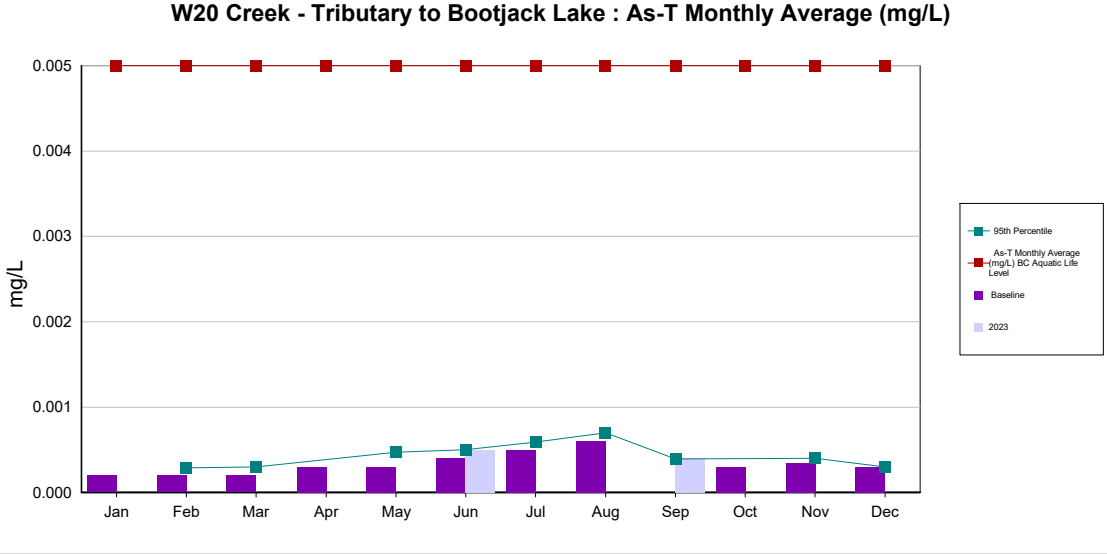
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







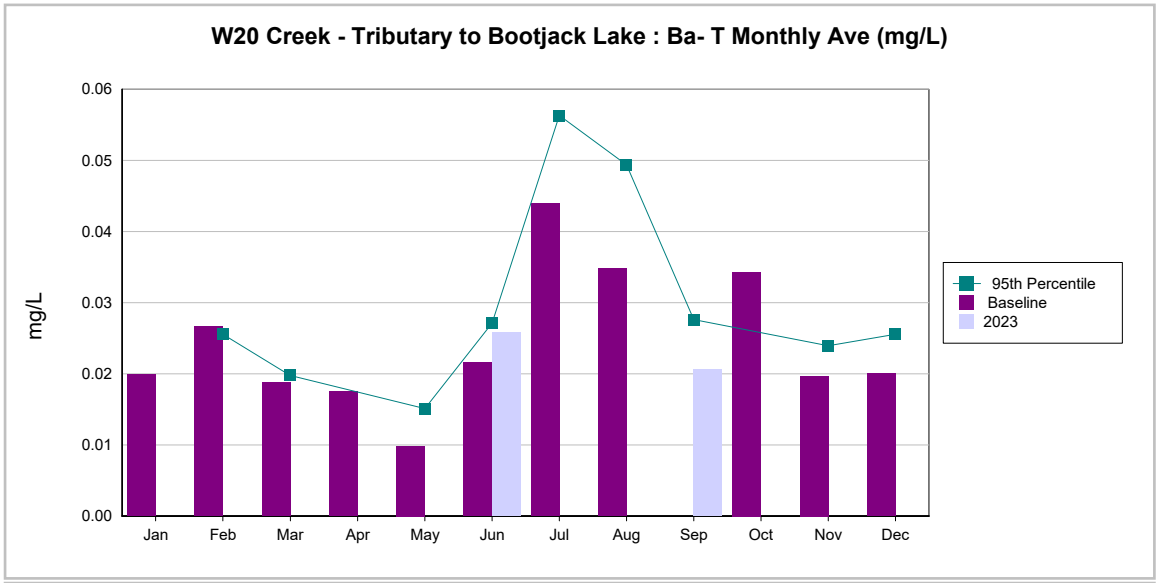
Water Quality Report

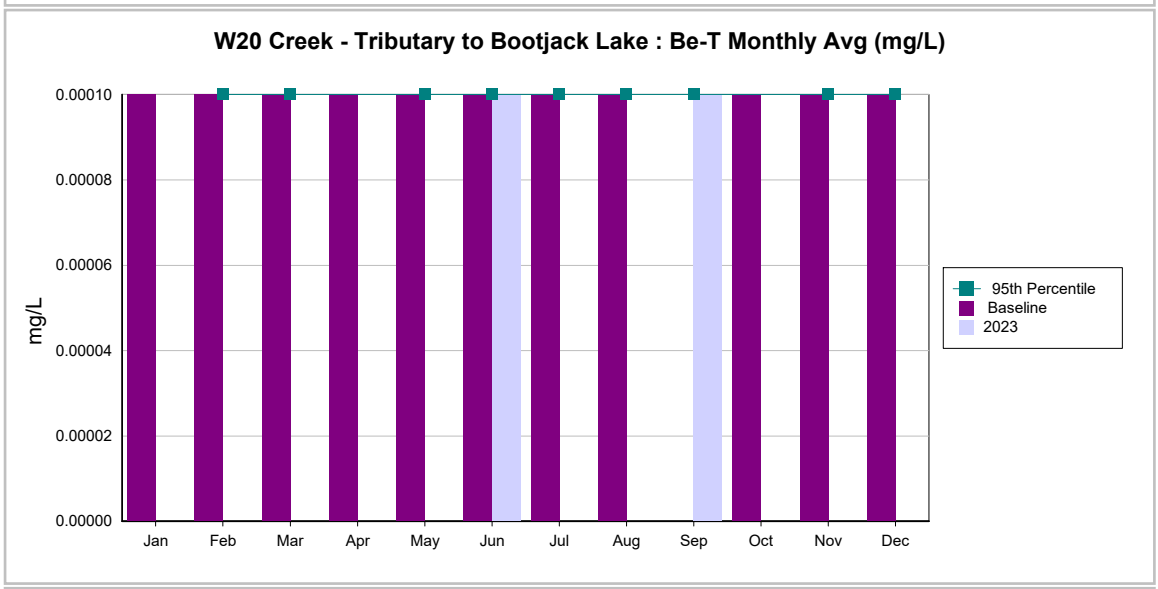
Annual Report SW vs BCWQG

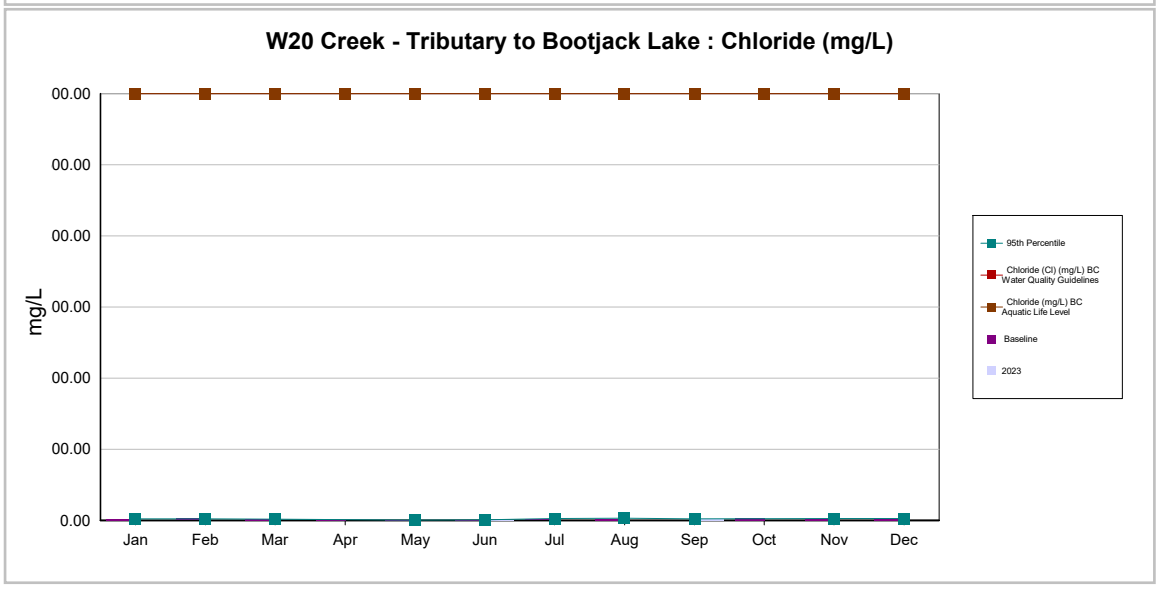
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







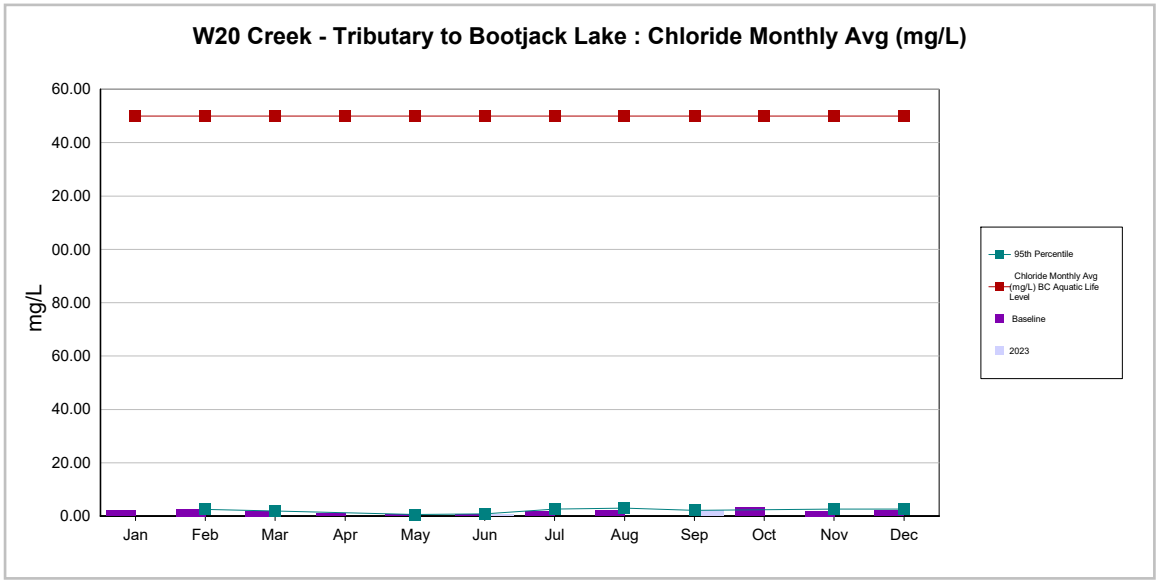
Water Quality Report

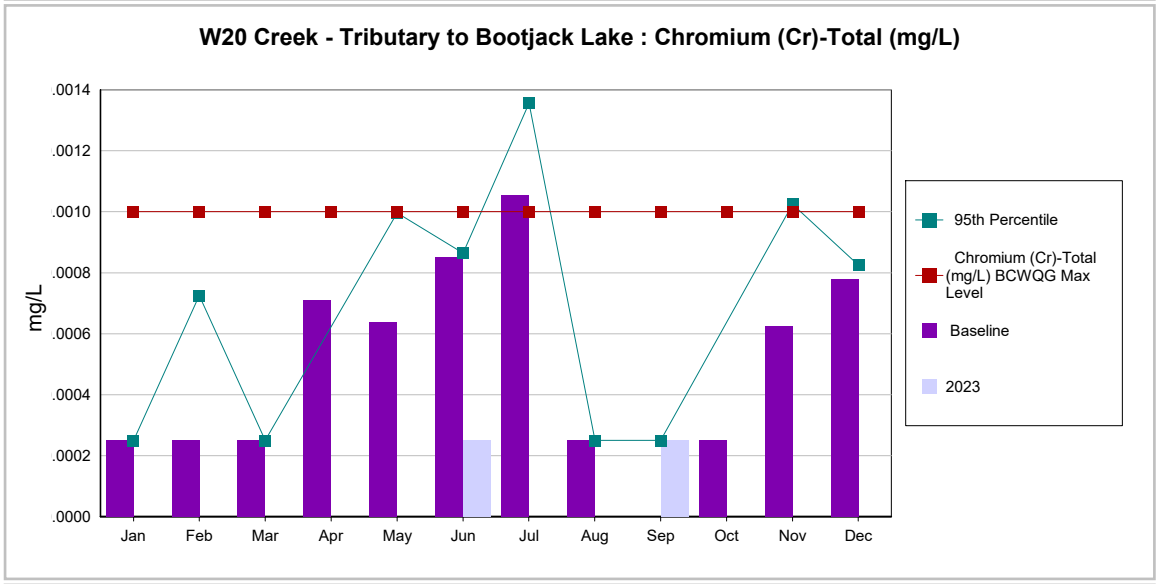
Annual Report SW vs BCWQG

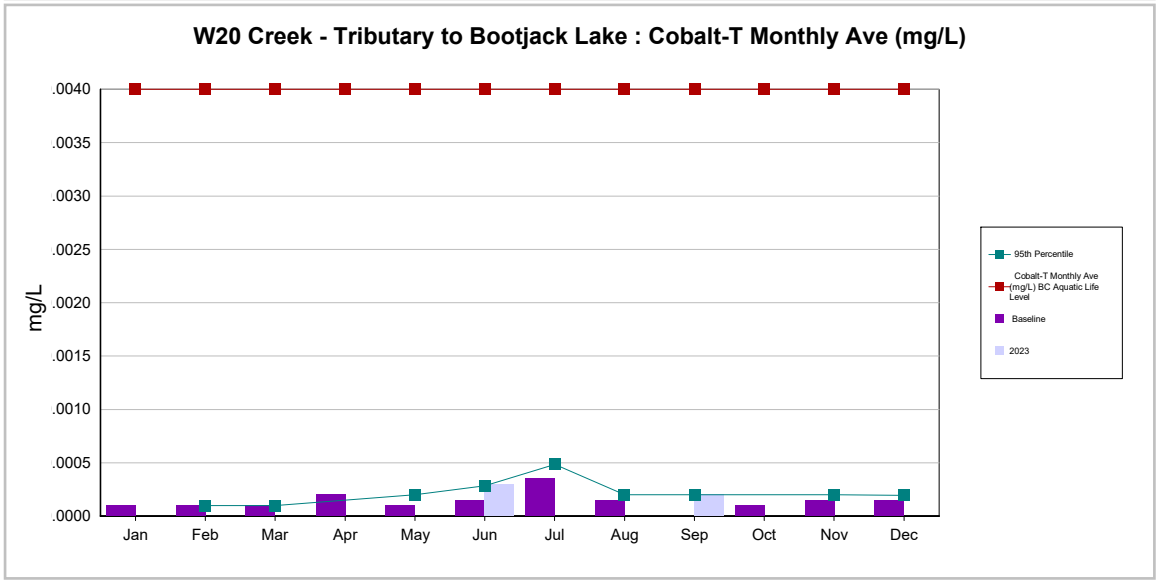
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







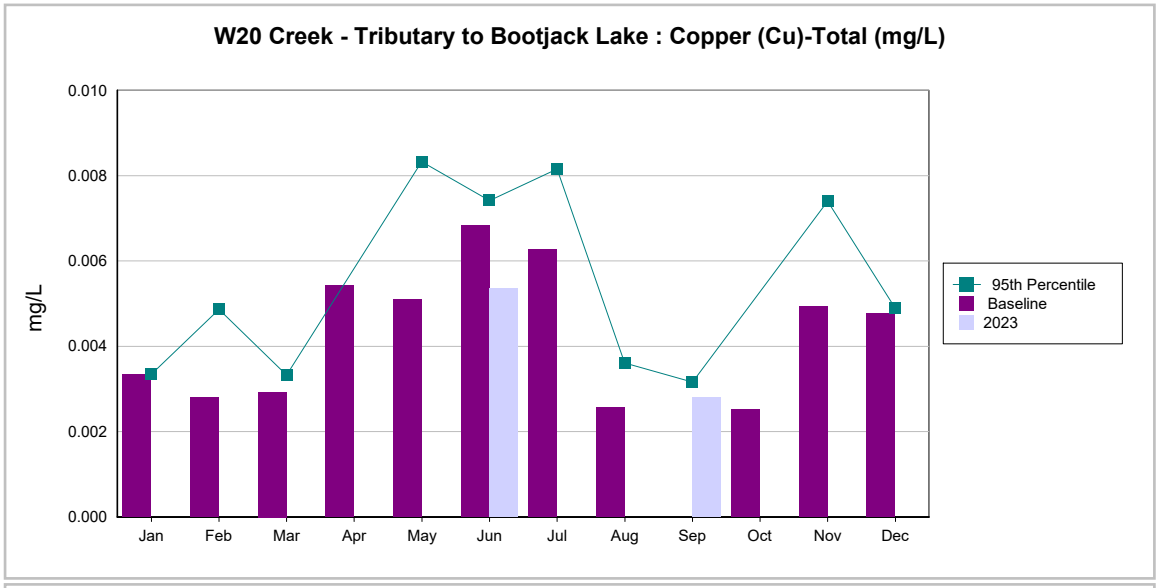
Water Quality Report

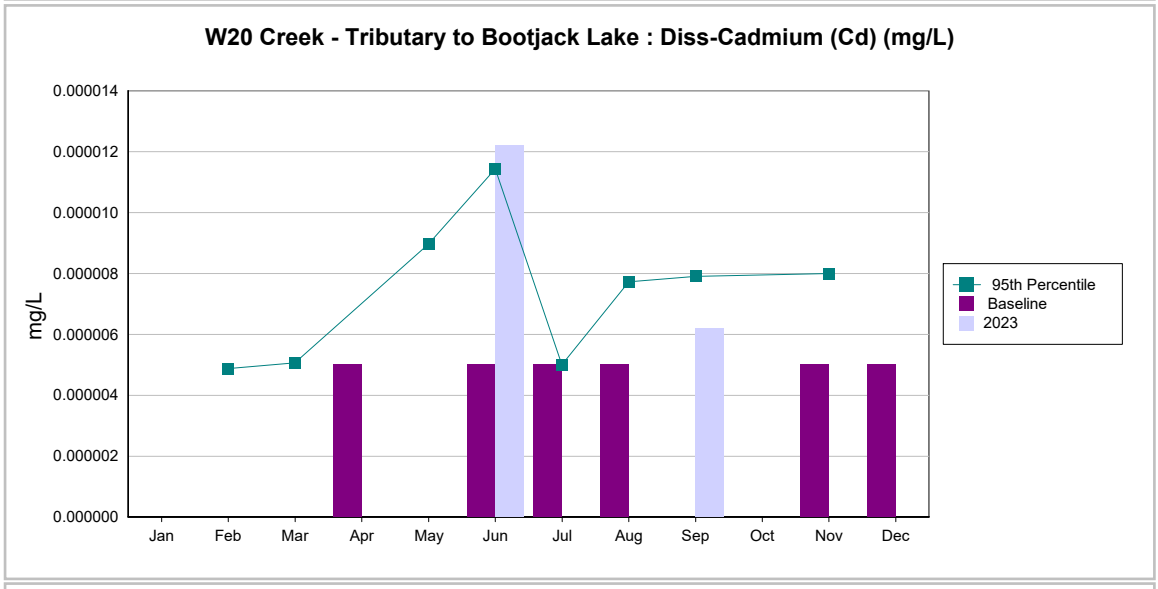
Annual Report SW vs BCWQG

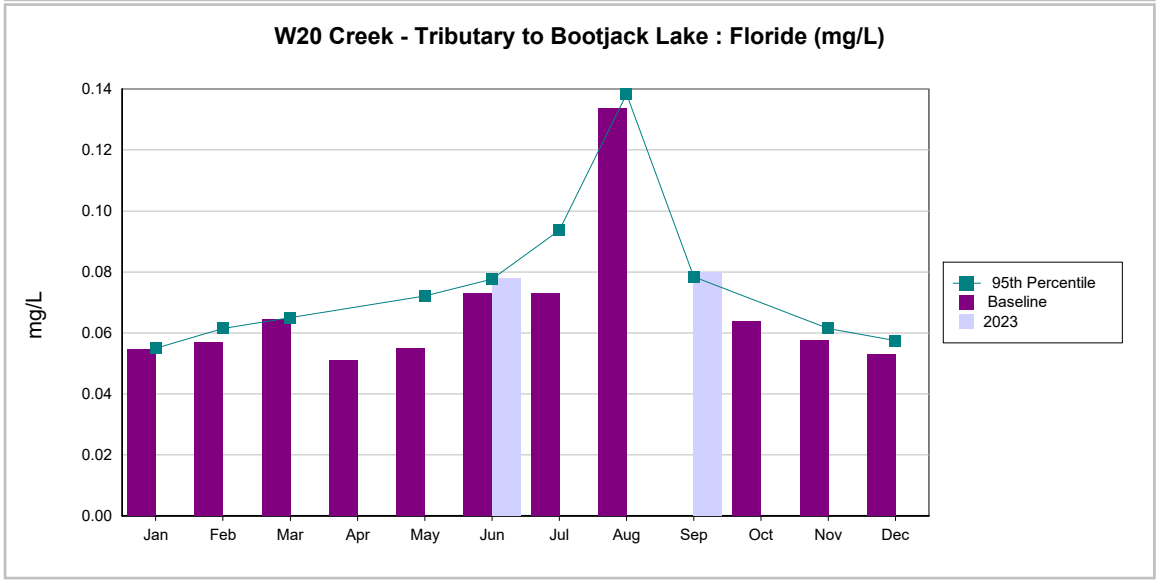
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







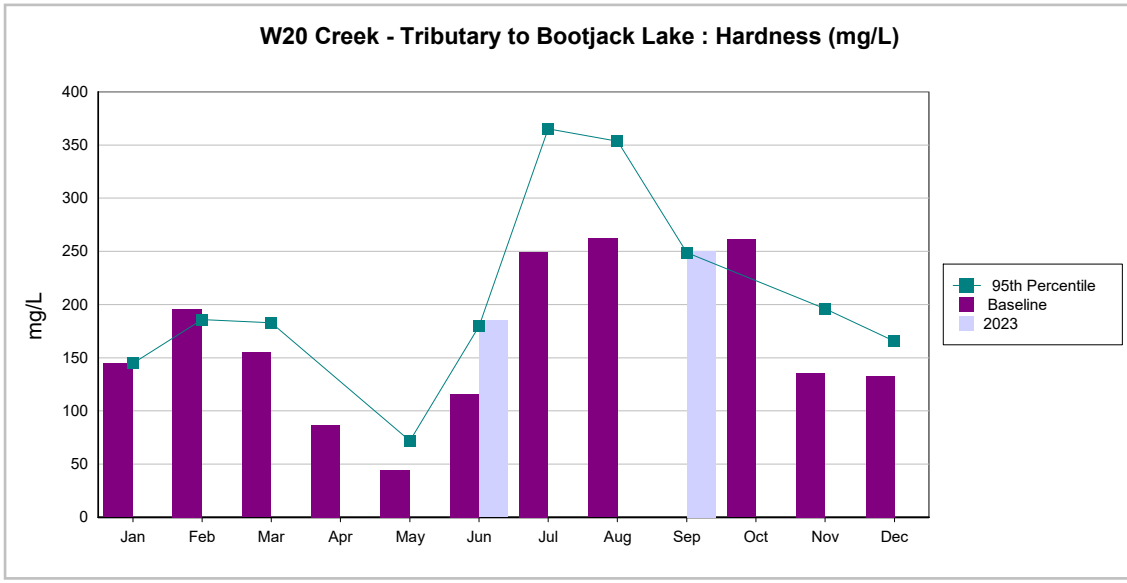
Water Quality Report

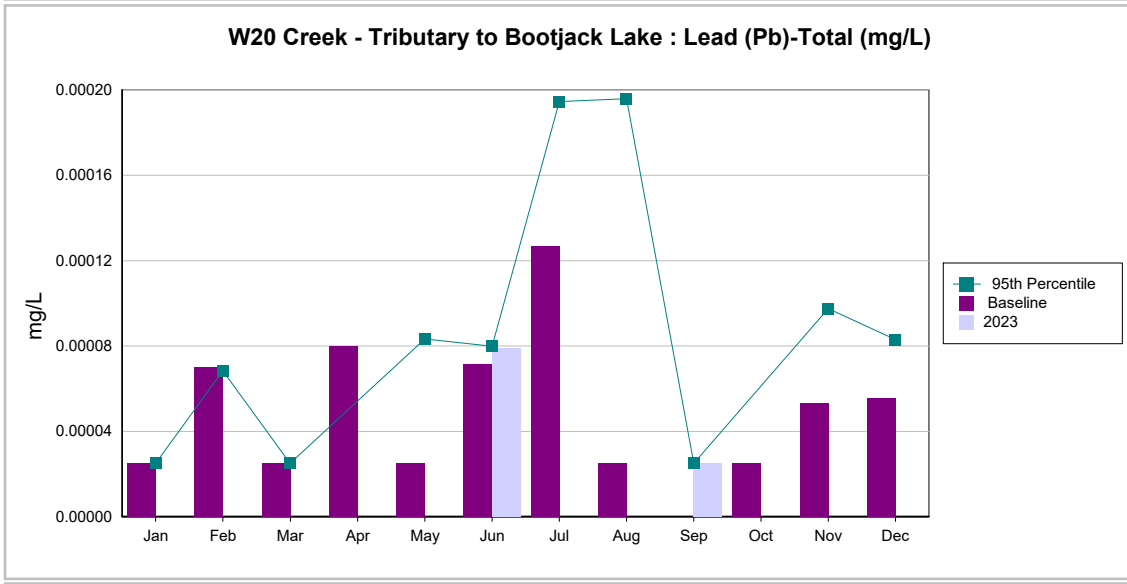
Annual Report SW vs BCWQG

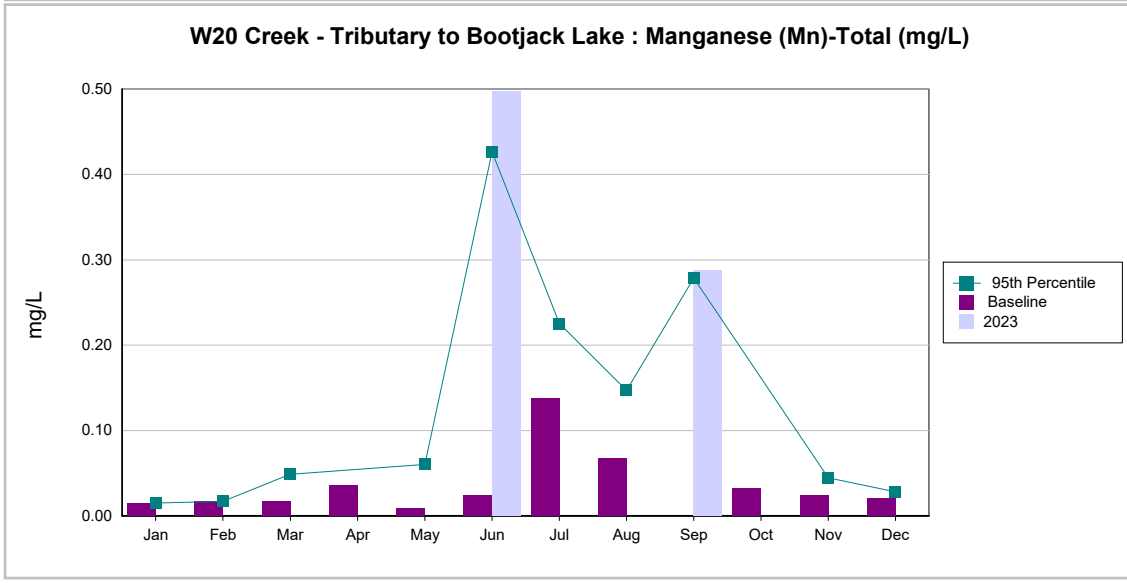
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







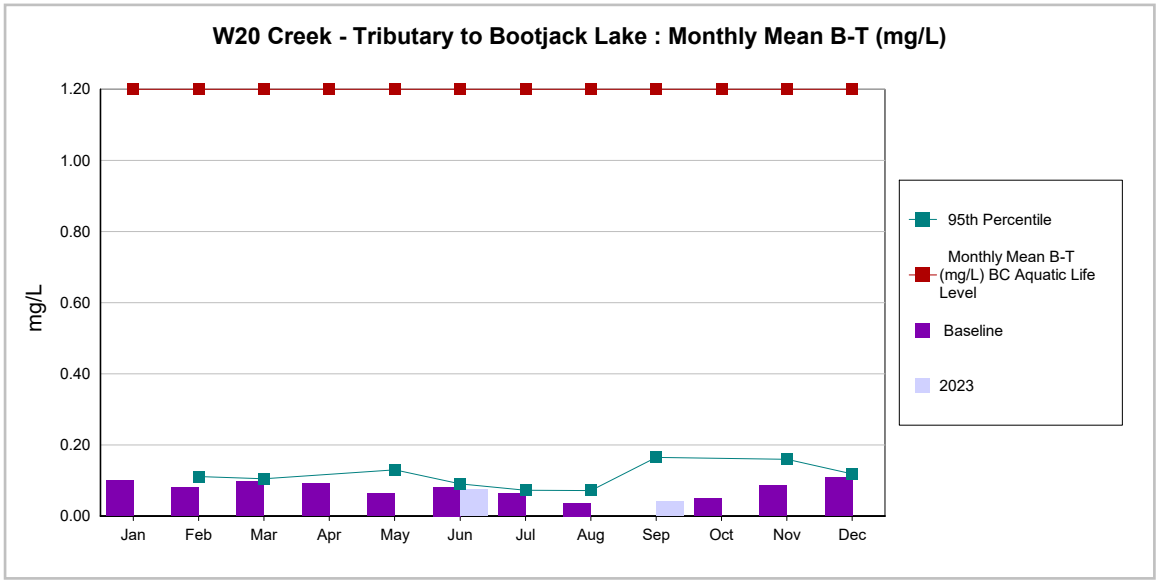
Water Quality Report

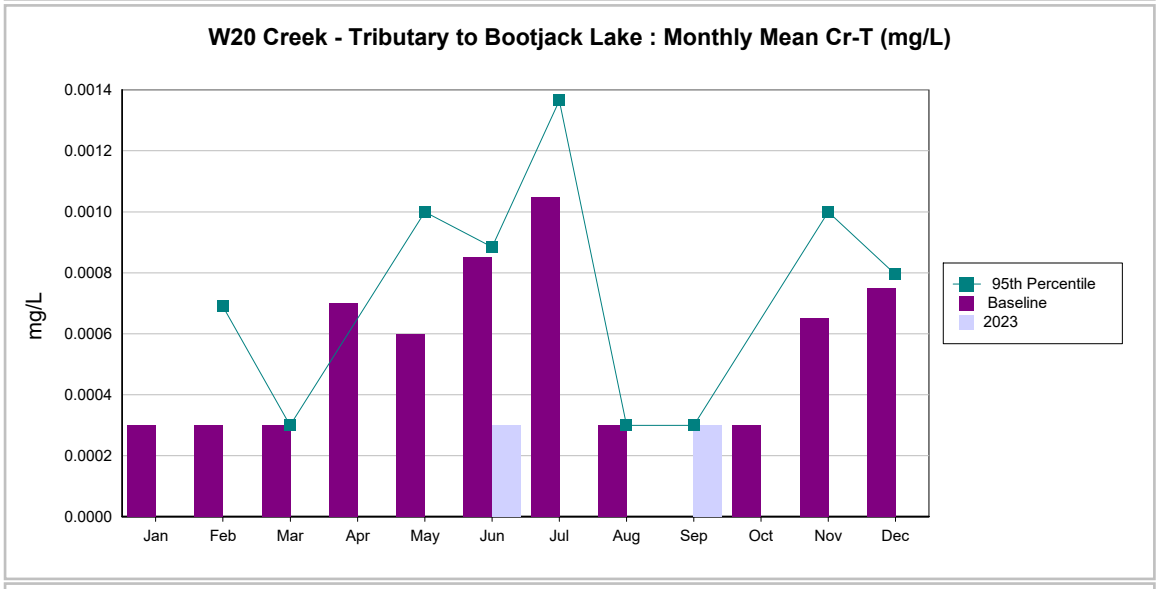
Annual Report SW vs BCWQG

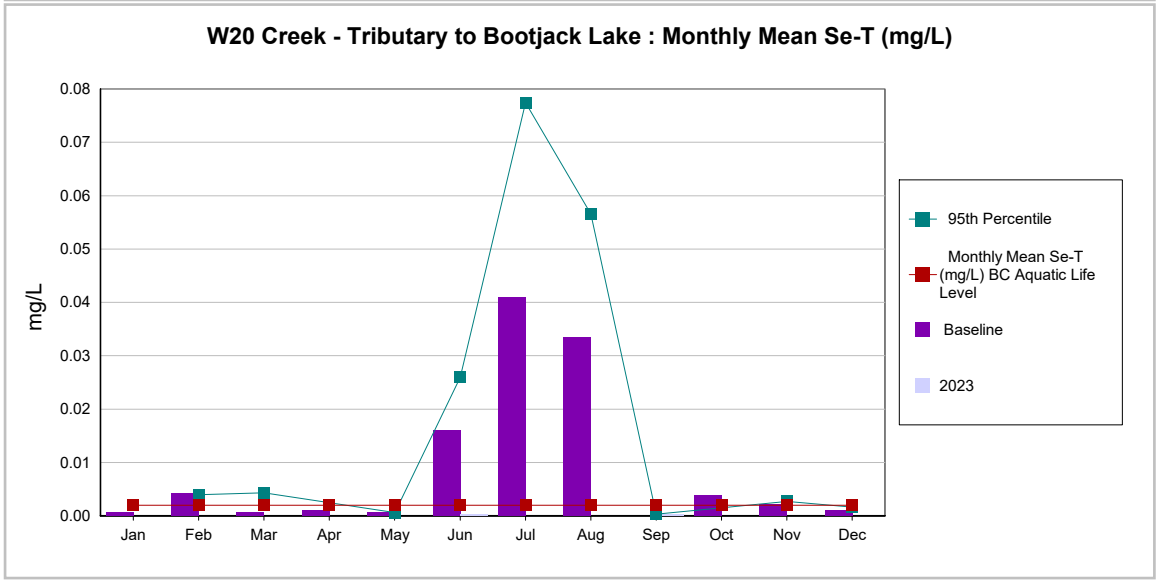
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







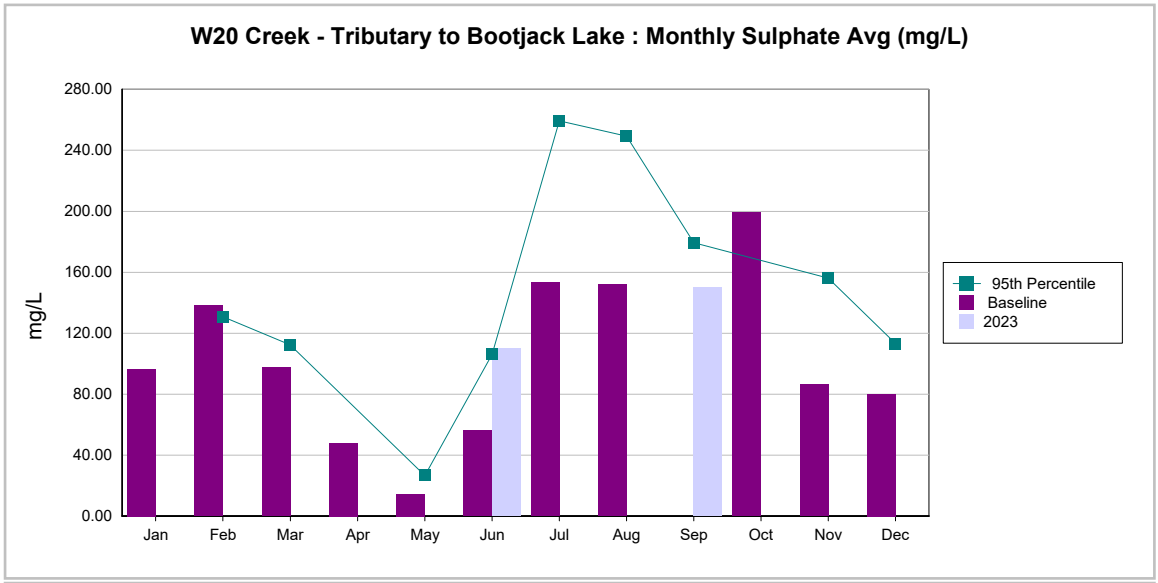
Water Quality Report

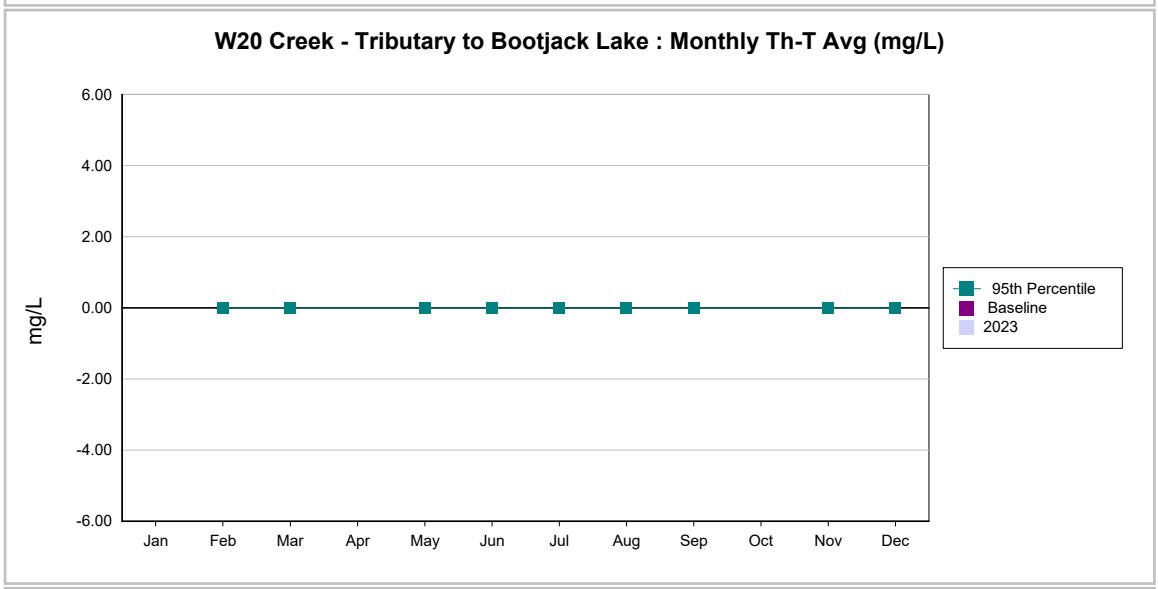
Annual Report SW vs BCWQG

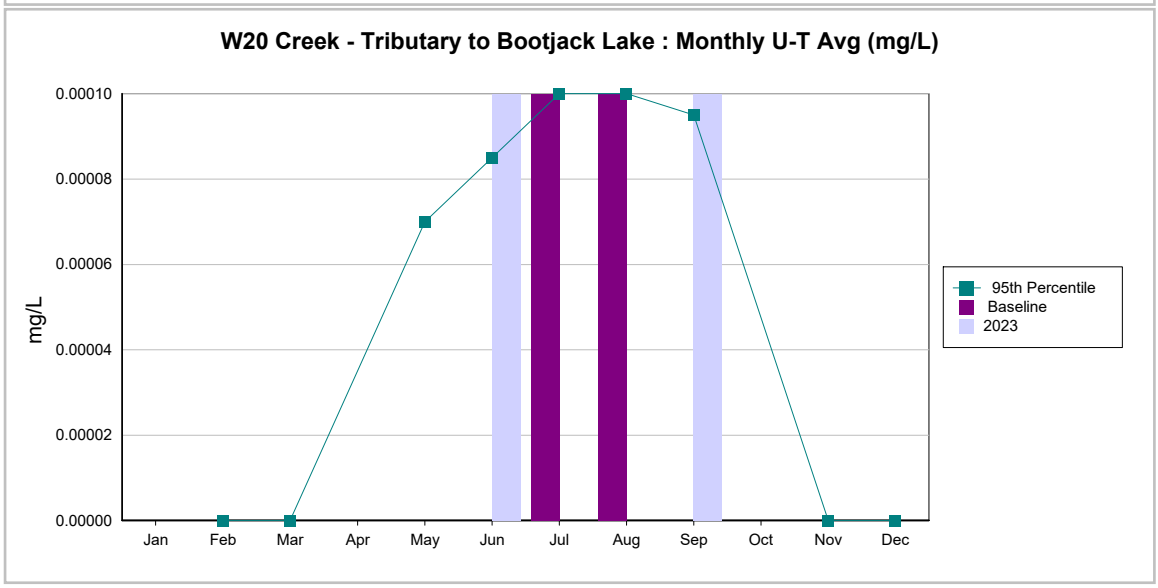
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







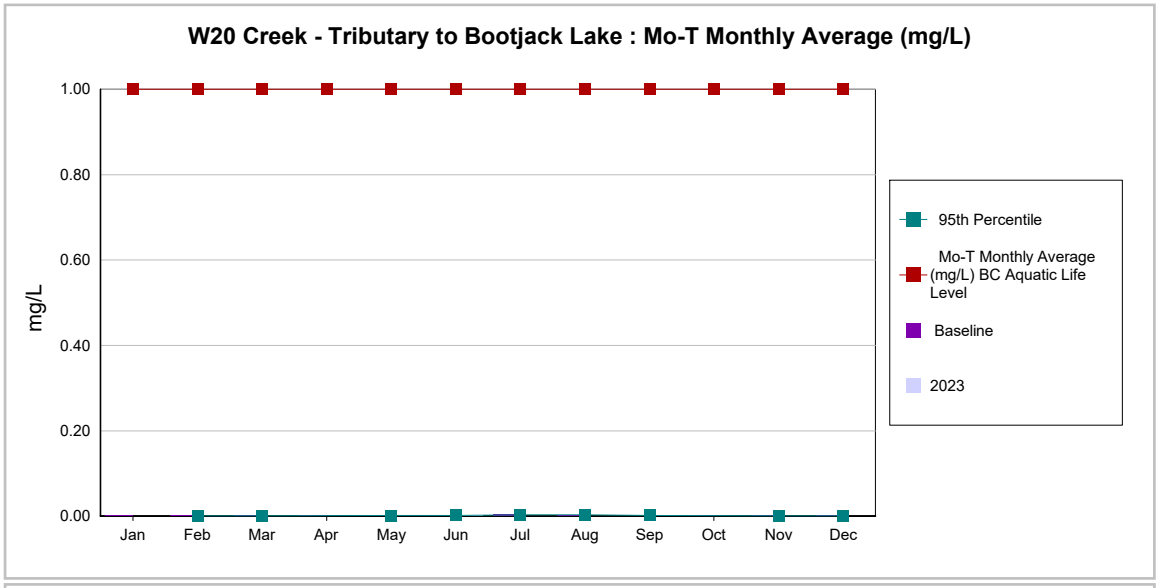
Water Quality Report

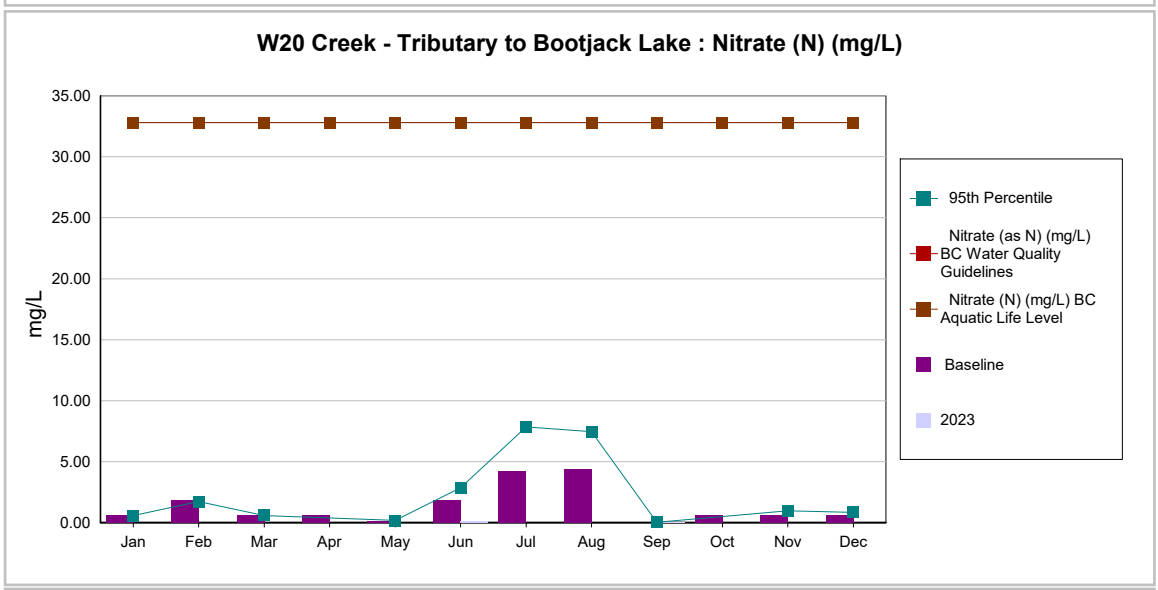
Annual Report SW vs BCWQG

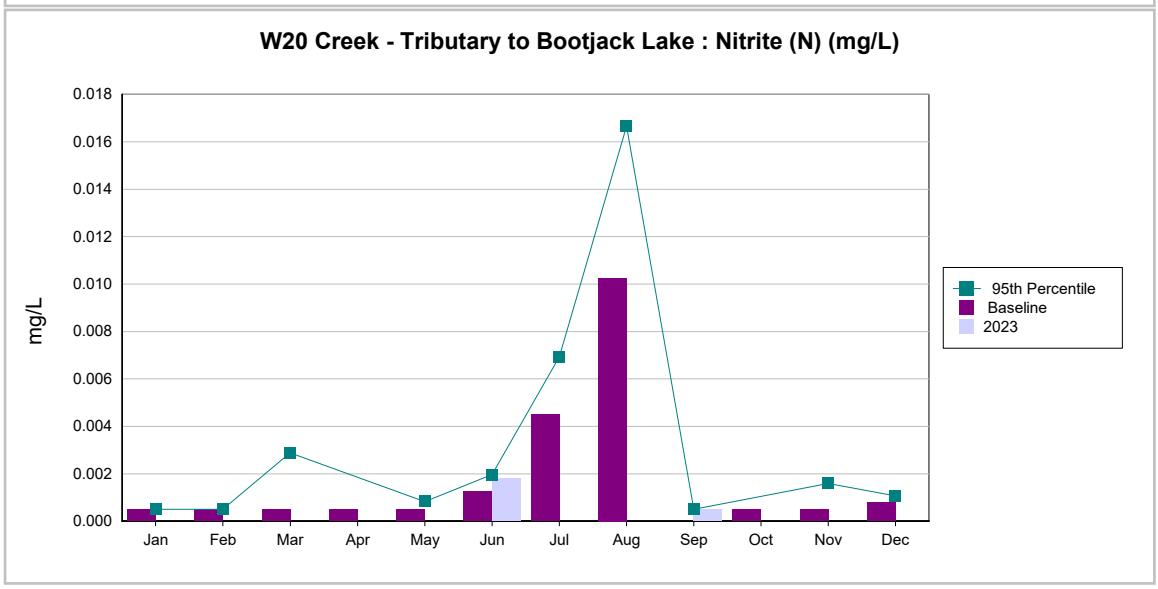
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







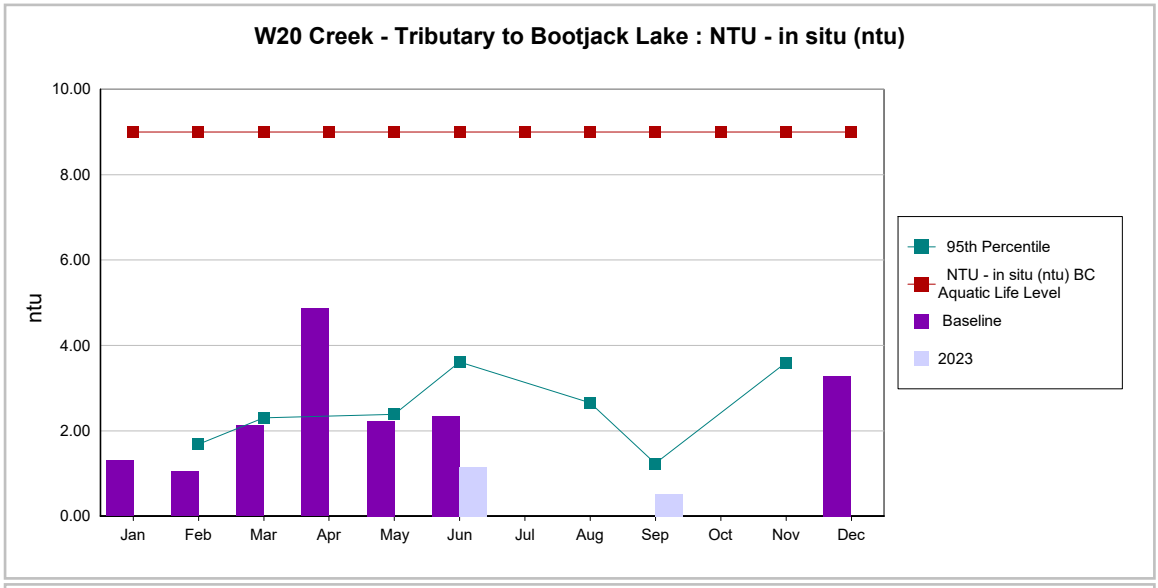
Water Quality Report

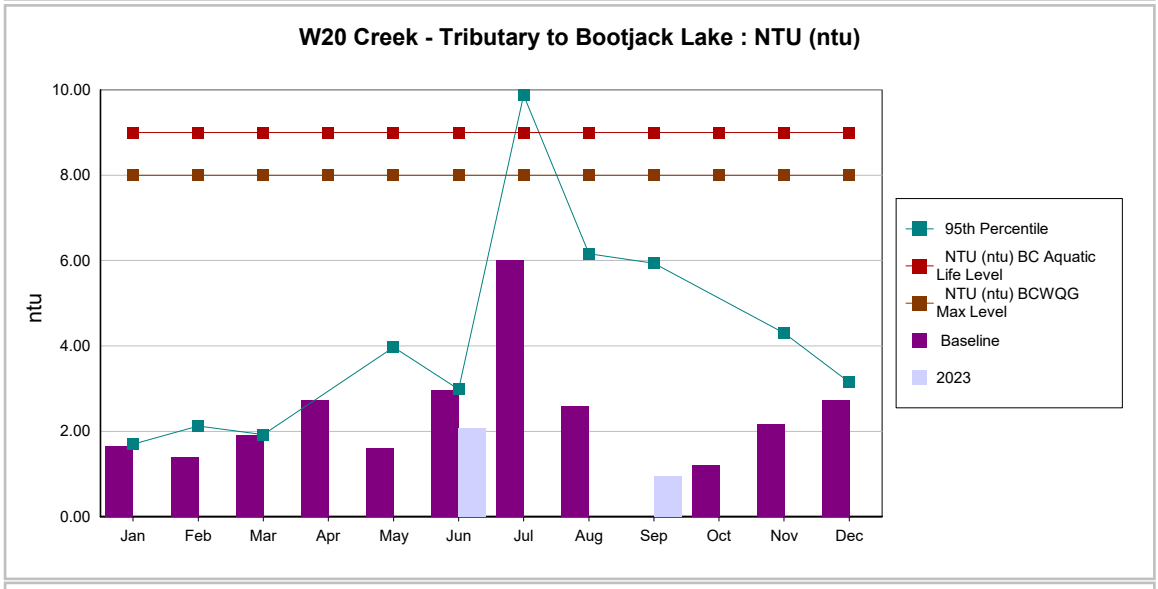
Annual Report SW vs BCWQG

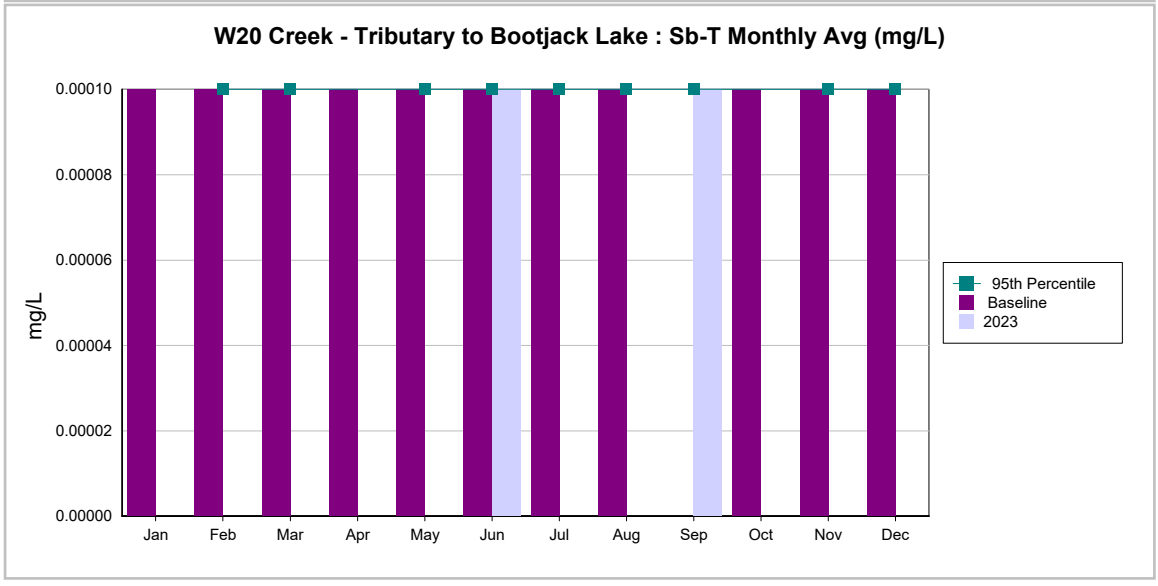
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







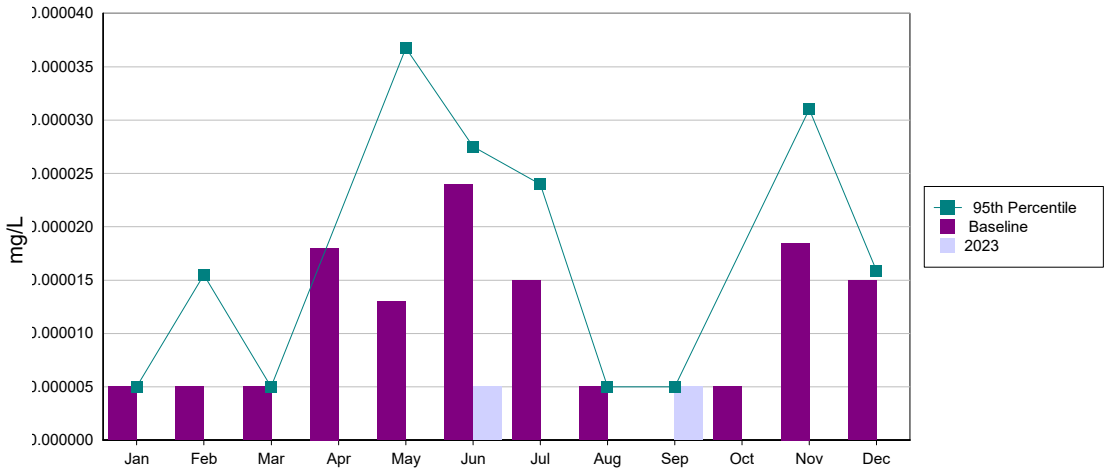
Water Quality Report

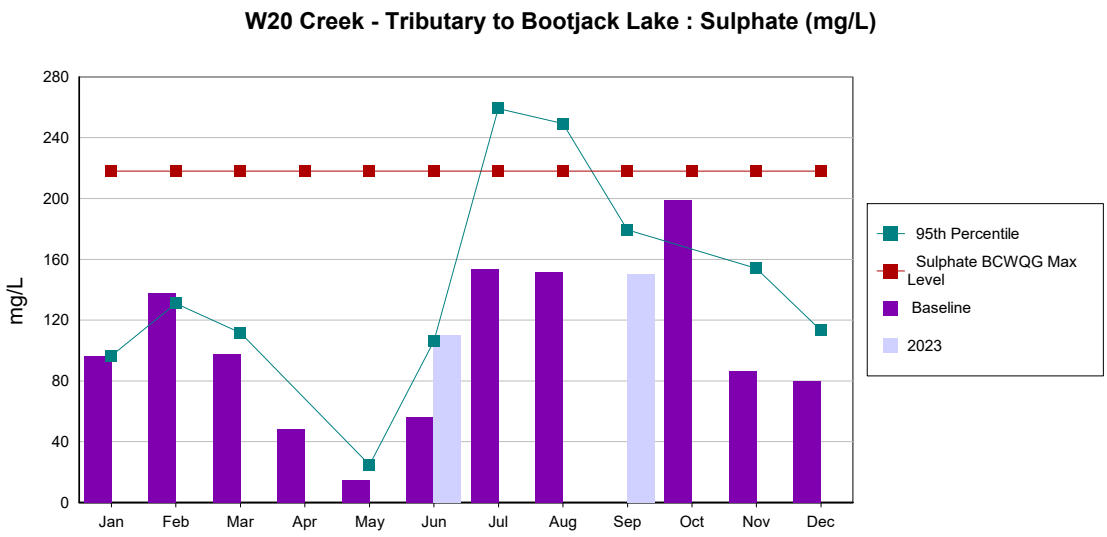
Annual Report SW vs BCWQG

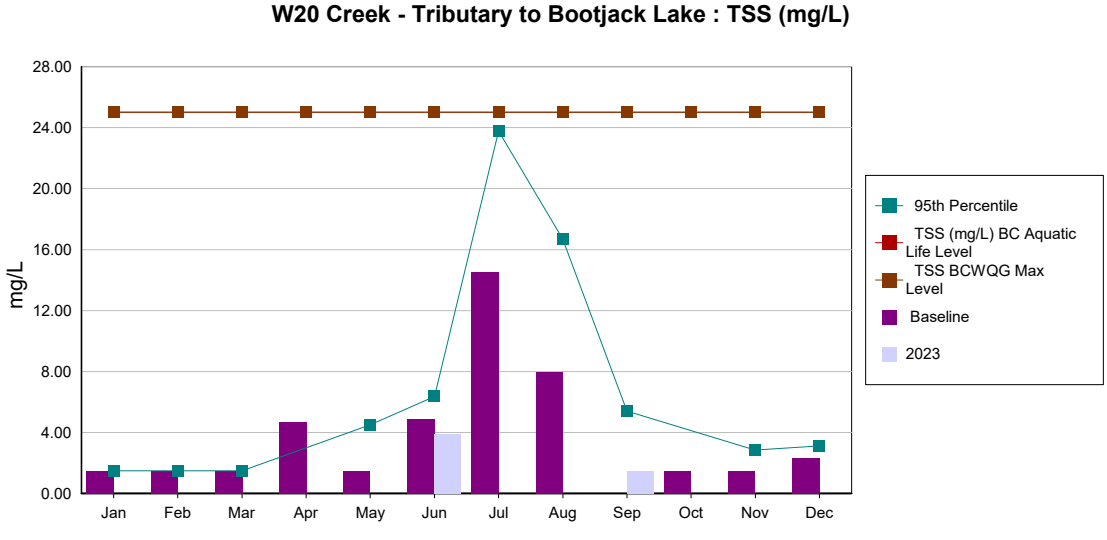
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







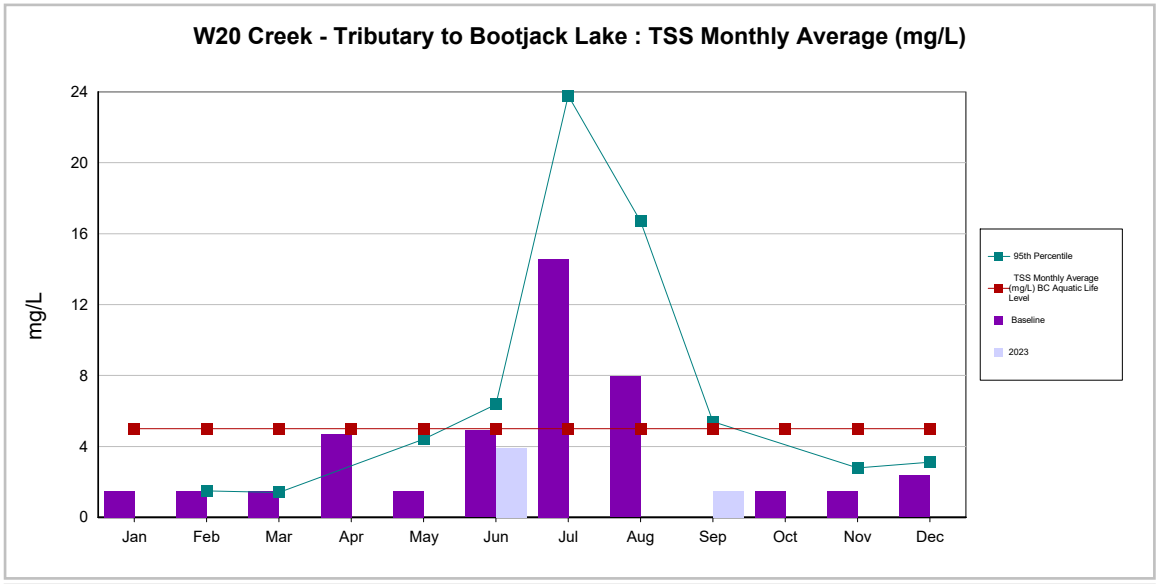
Water Quality Report

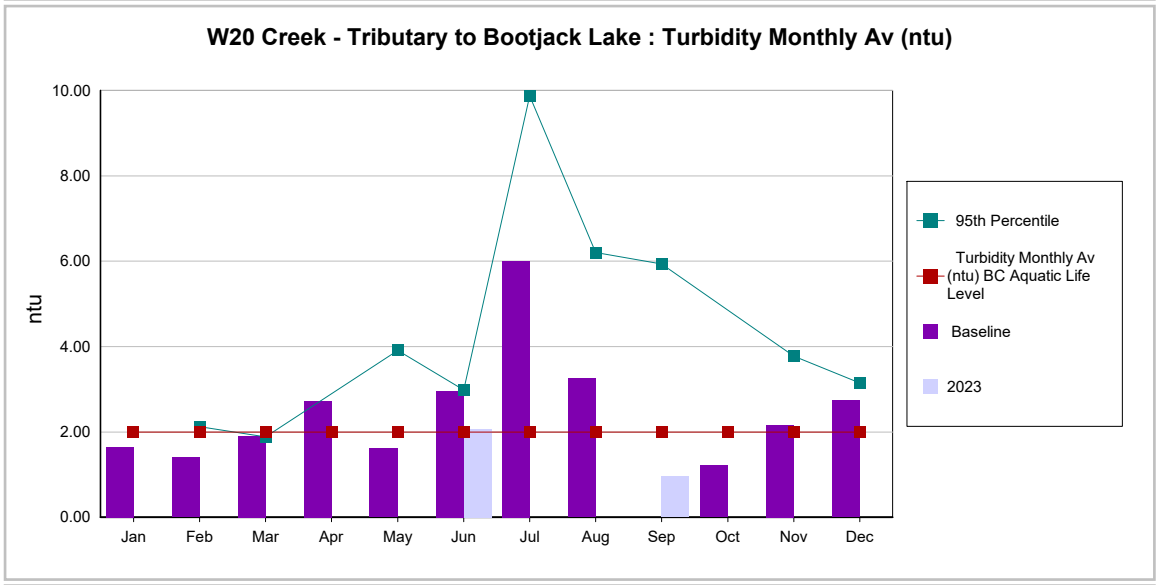
Annual Report SW vs BCWQG

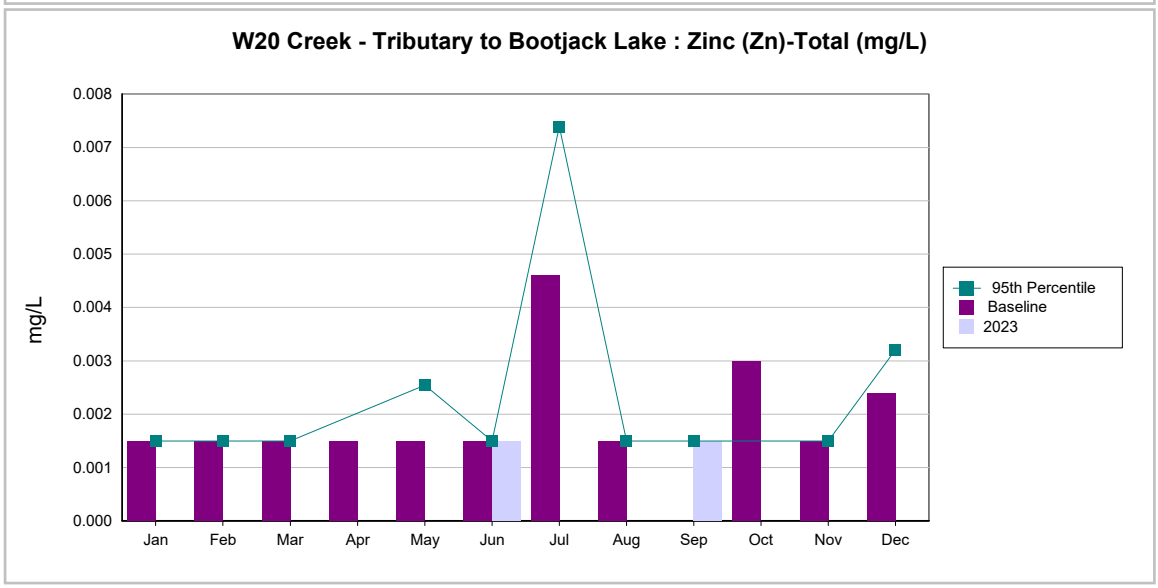
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







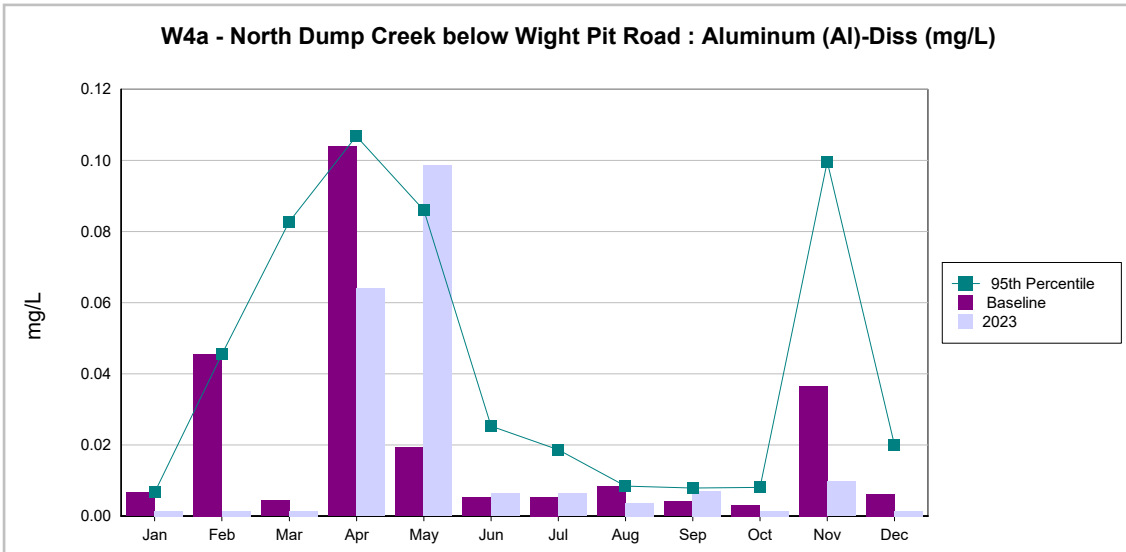
Water Quality Report

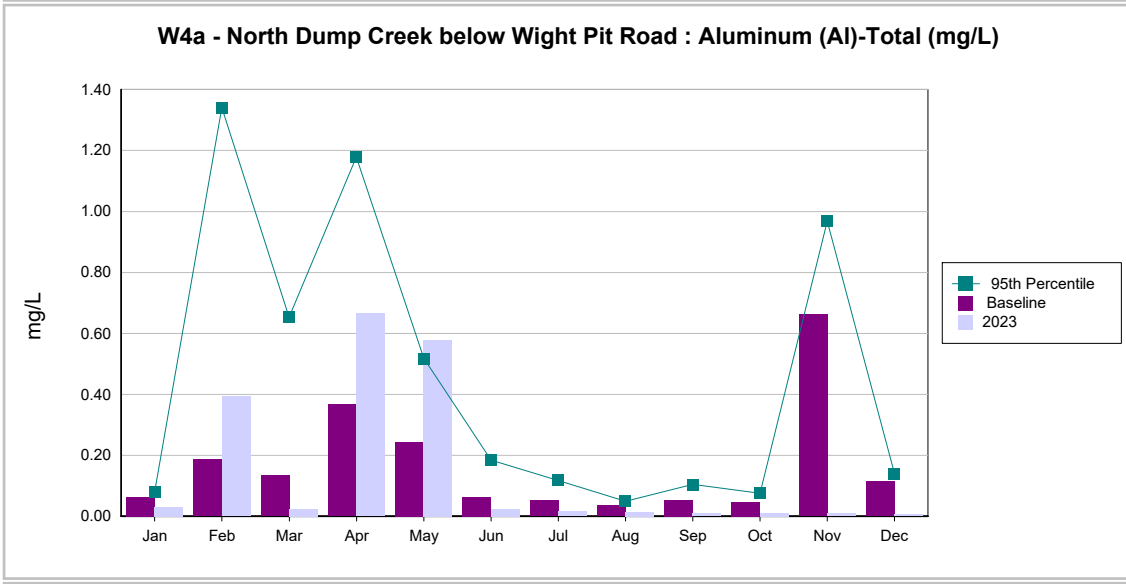
Annual Report SW vs BCWQG

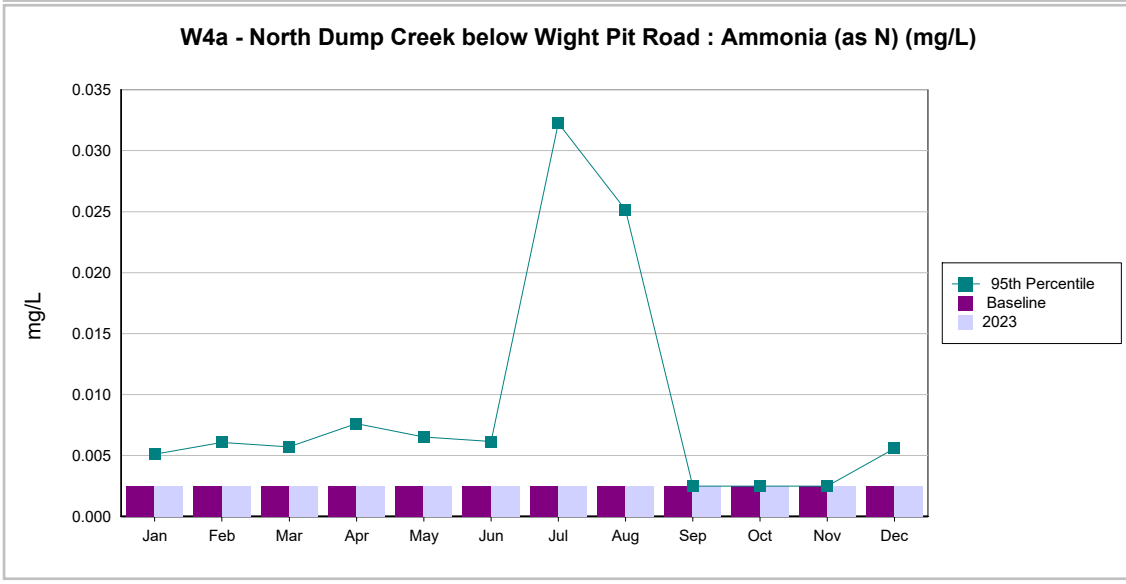
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







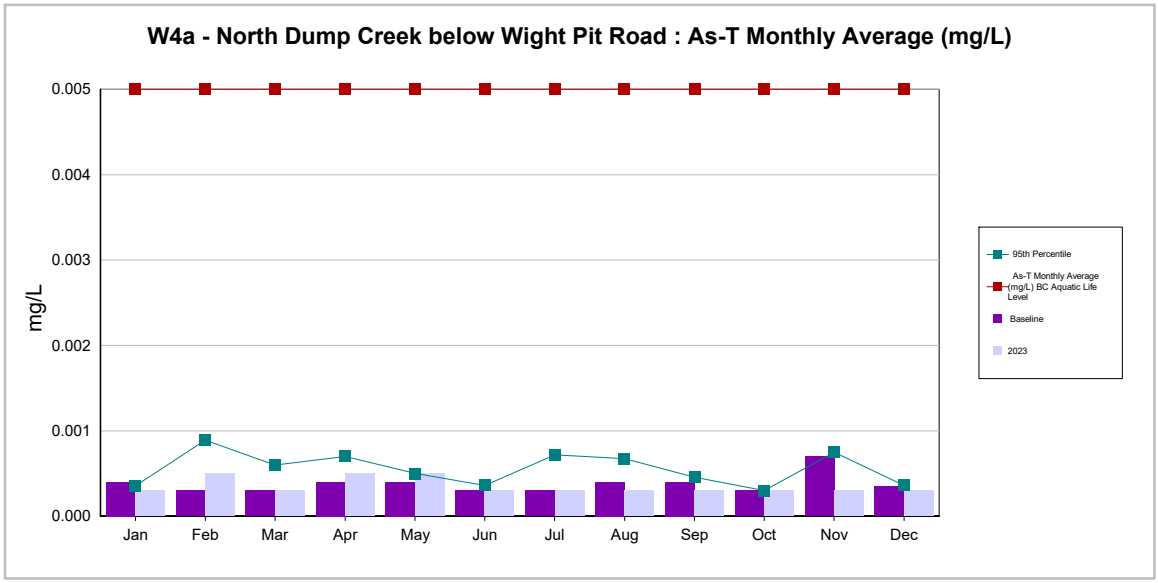
Water Quality Report

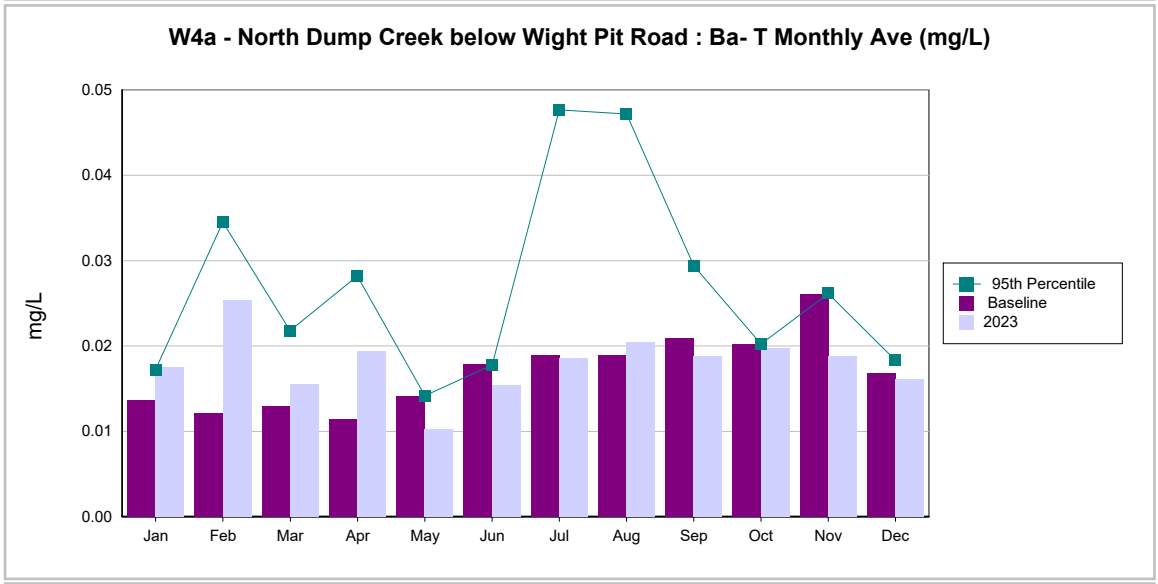
Annual Report SW vs BCWQG

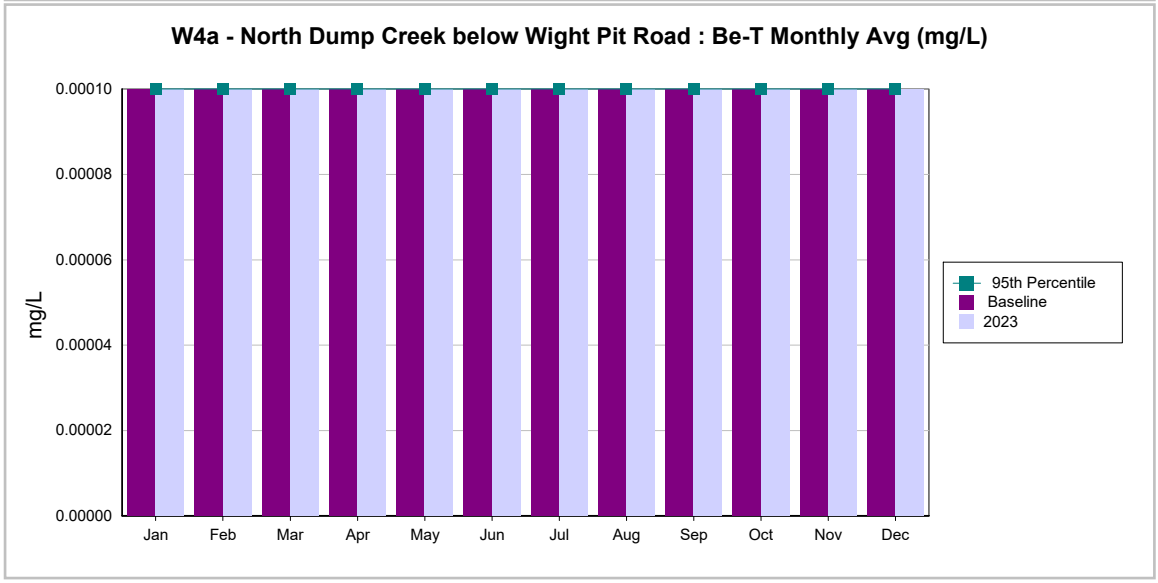
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

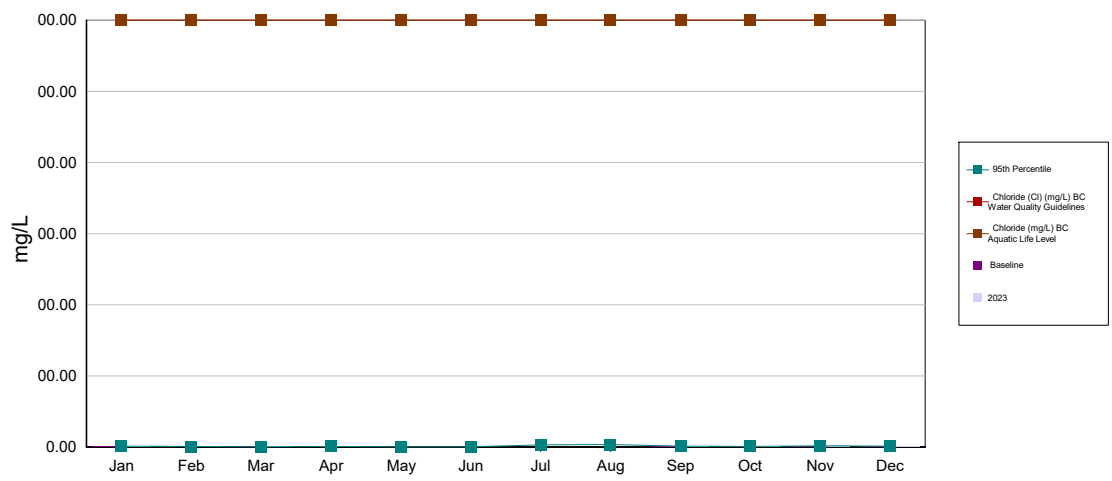
Annual Report SW vs BCWQG

Mount Polley

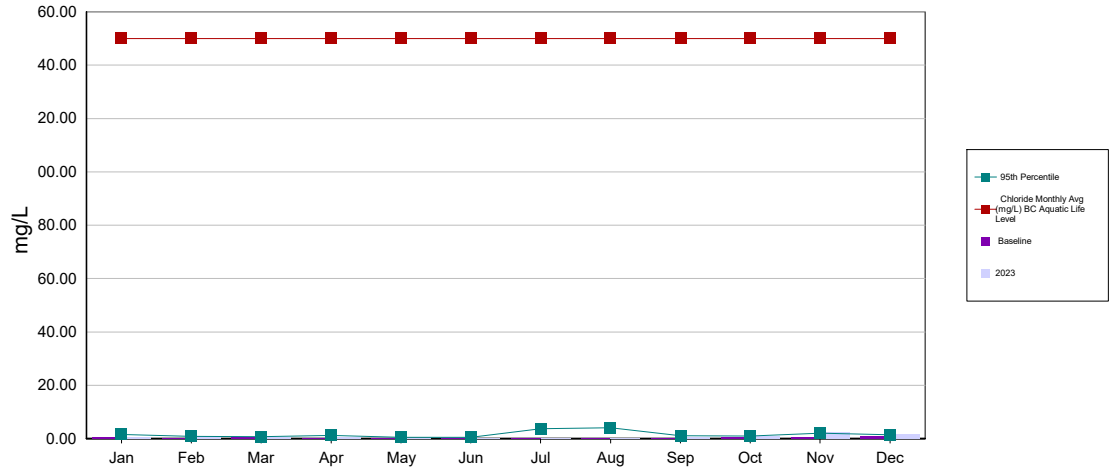
Mining Corporation

IMPERIAL METALS CORPORATION

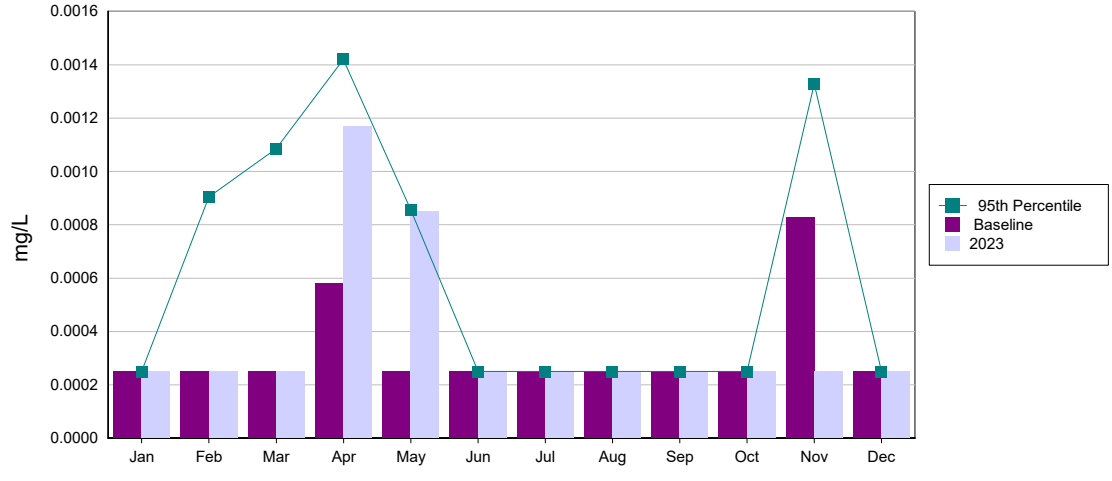
W4a - North Dump Creek below Wight Pit Road : Chloride (mg/L)



W4a - North Dump Creek below Wight Pit Road : Chloride Monthly Avg (mg/L)



W4a - North Dump Creek below Wight Pit Road : Chromium (Cr)-Total (mg/L)



Water Quality Report

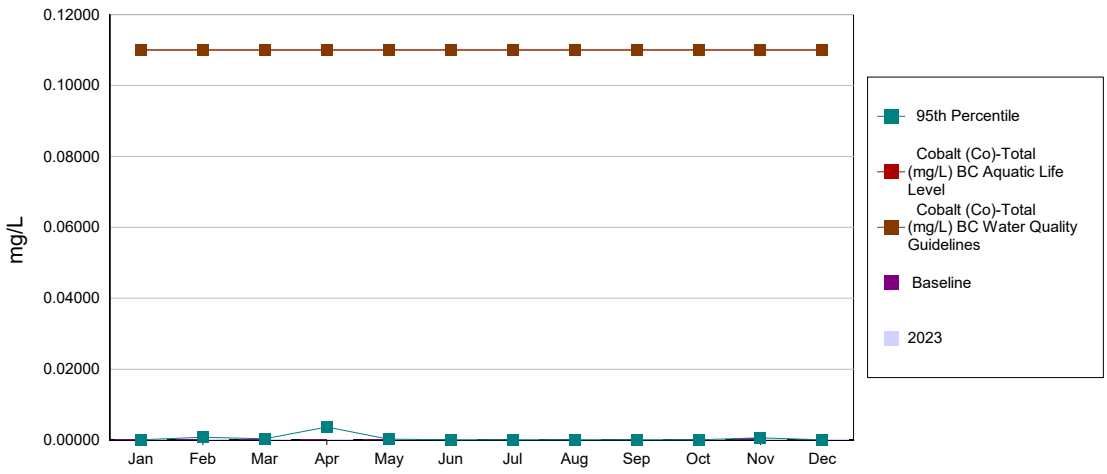
Annual Report SW vs BCWQG

Mount Polley

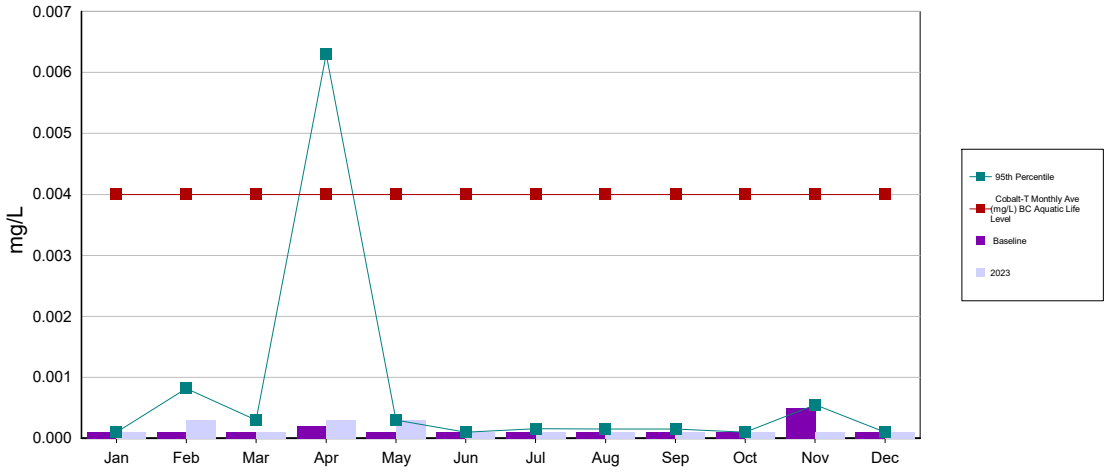
Mining Corporation

IMPERIAL METALS CORPORATION

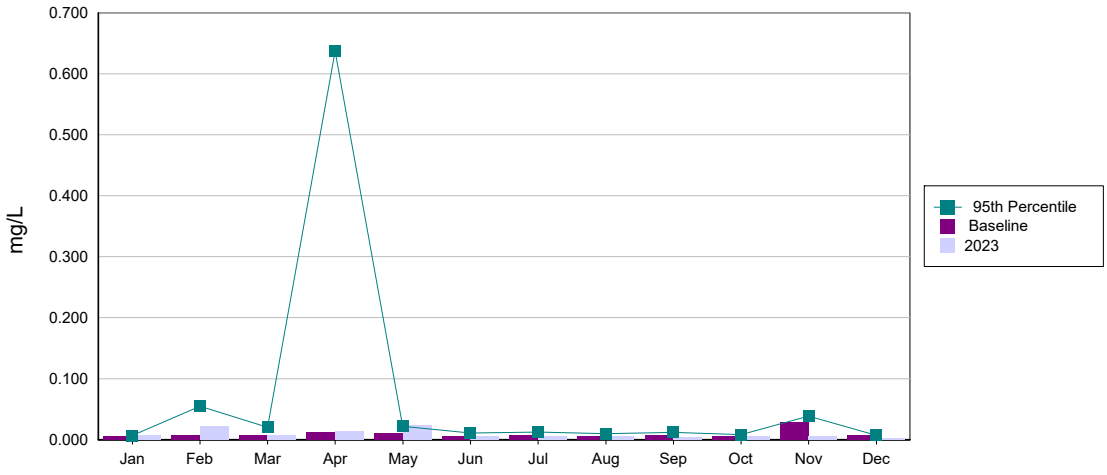
W4a - North Dump Creek below Wight Pit Road : Cobalt (Co)-Total (mg/L)



W4a - North Dump Creek below Wight Pit Road : Cobalt-T Monthly Ave (mg/L)



W4a - North Dump Creek below Wight Pit Road : Copper (Cu)-Total (mg/L)



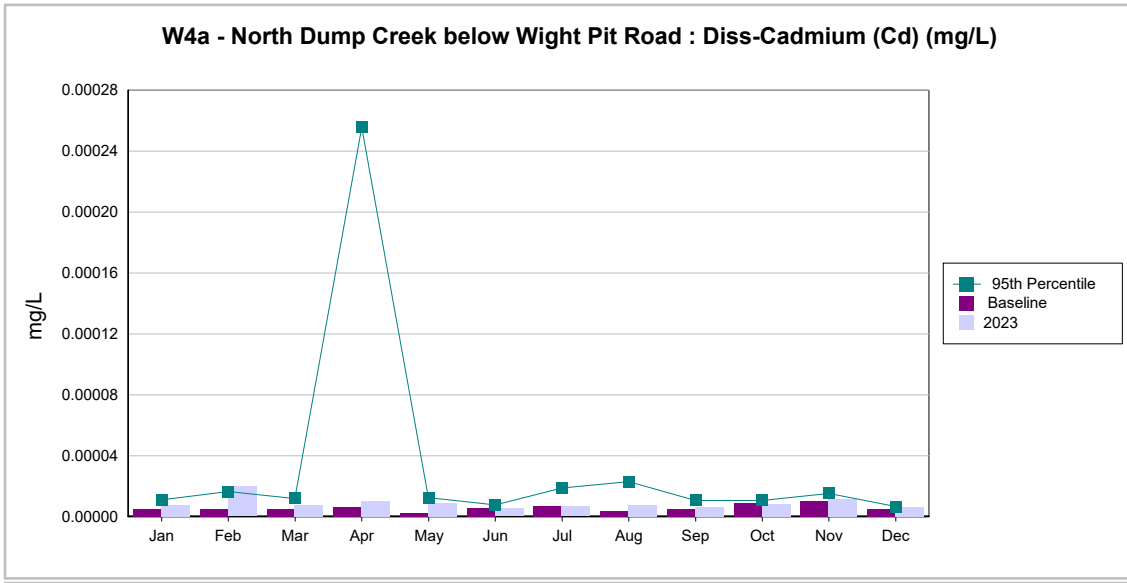
Water Quality Report

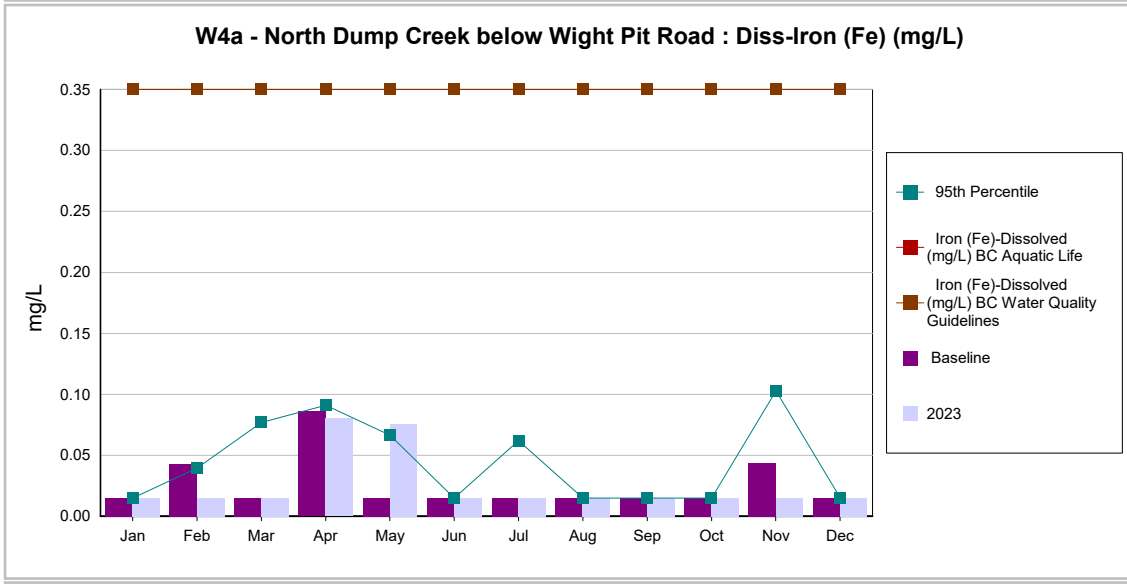
Annual Report SW vs BCWQG

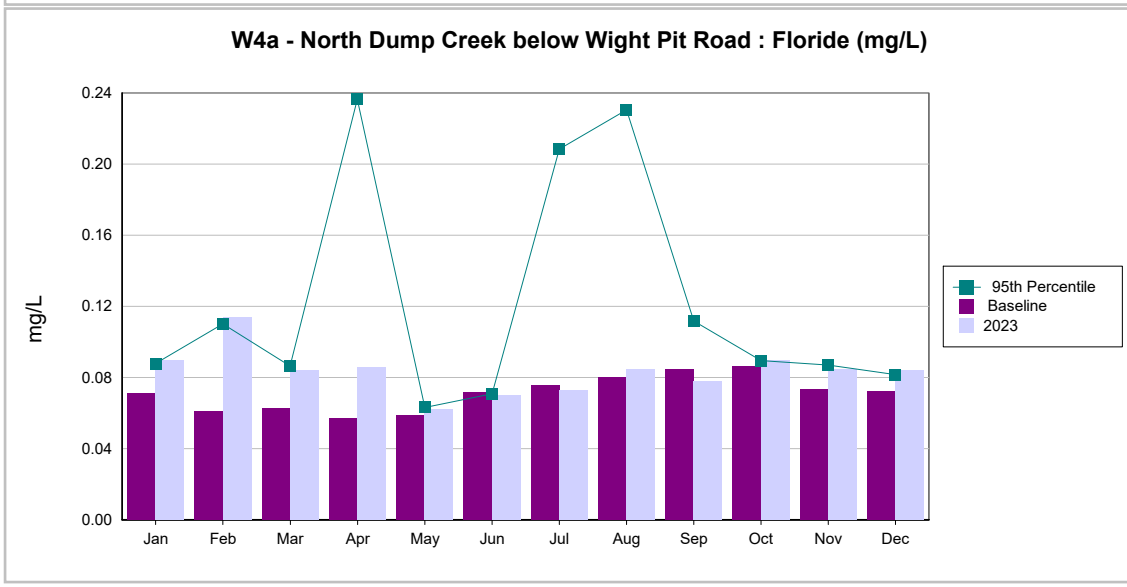
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

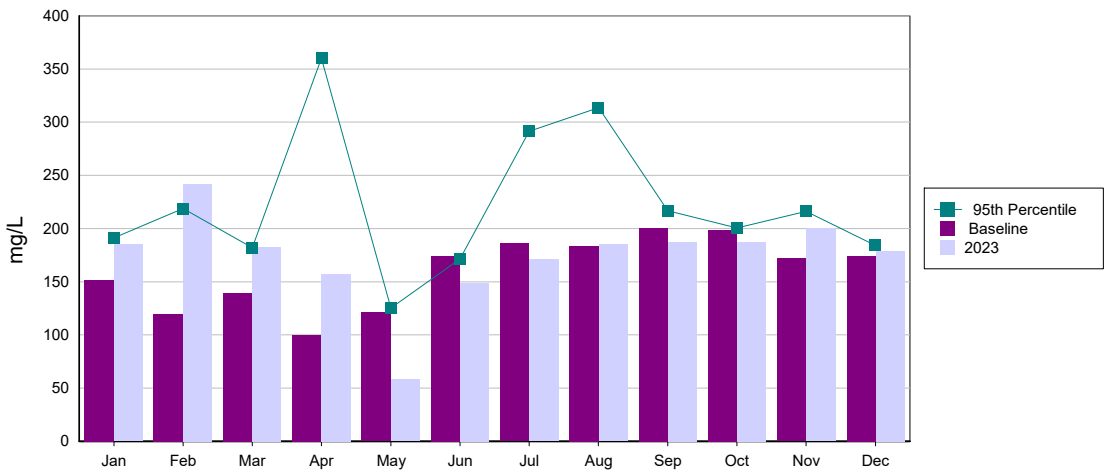
Annual Report SW vs BCWQG

Mount Polley

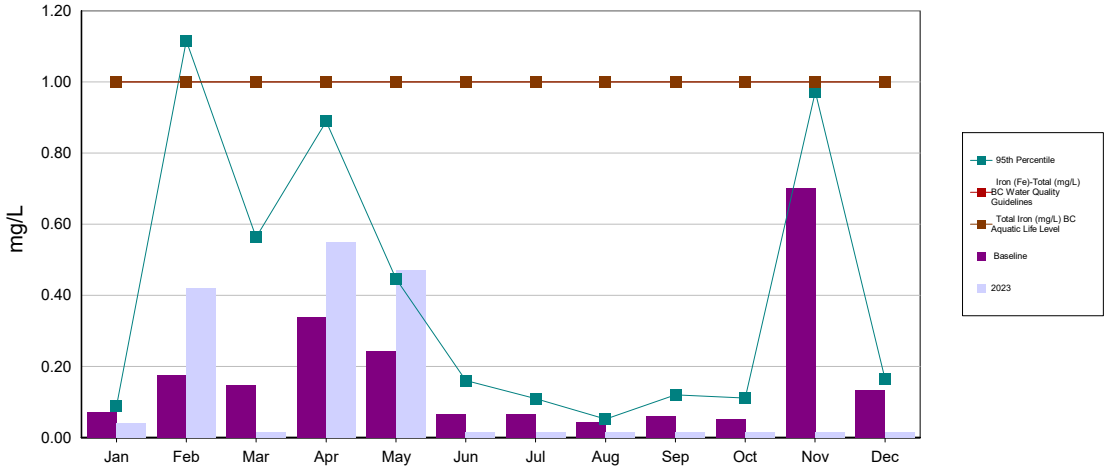
Mining Corporation

IMPERIAL METALS CORPORATION

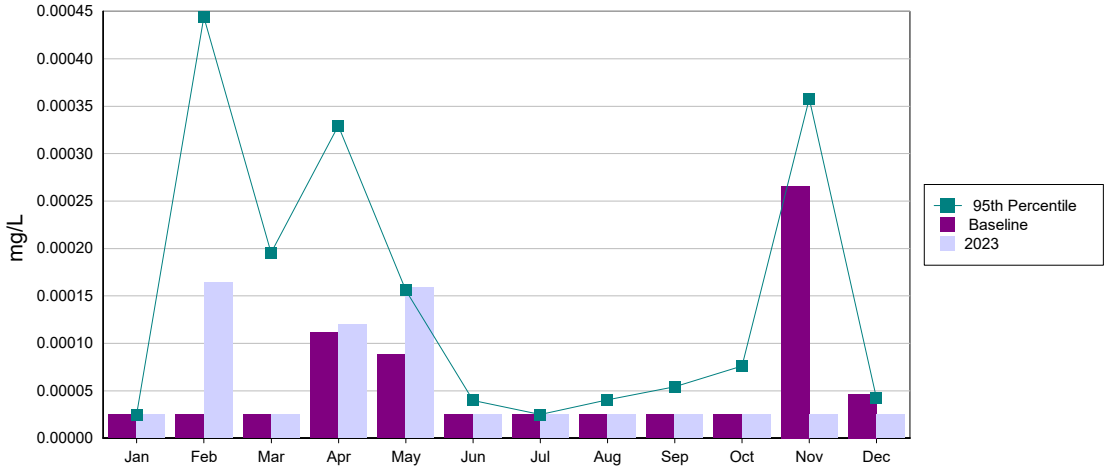
W4a - North Dump Creek below Wight Pit Road : Hardness (mg/L)



W4a - North Dump Creek below Wight Pit Road : Iron (Fe)-Total (mg/L)



W4a - North Dump Creek below Wight Pit Road : Lead (Pb)-Total (mg/L)



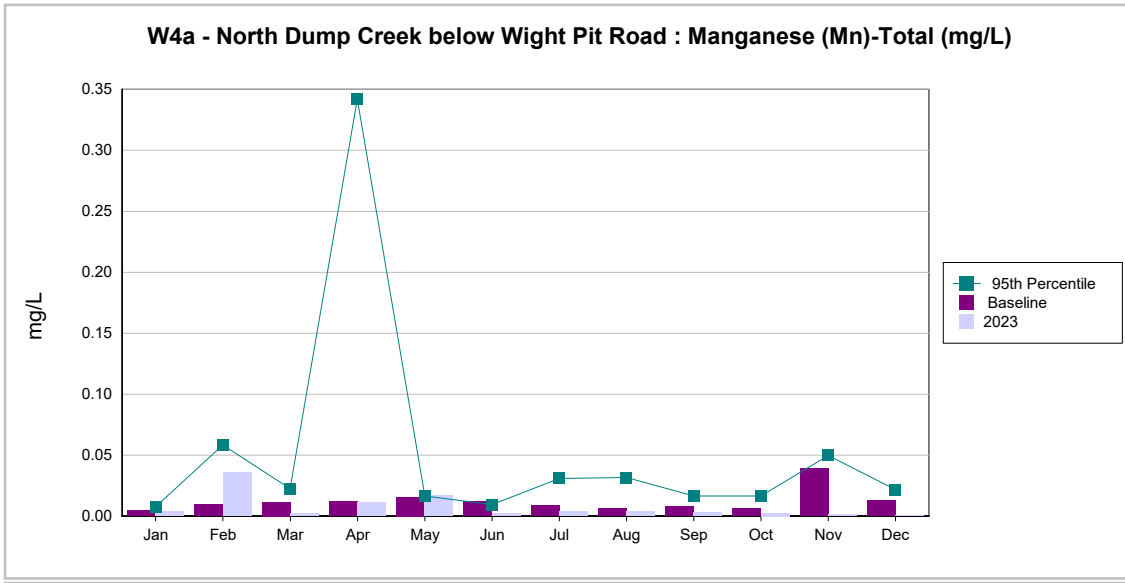
Water Quality Report

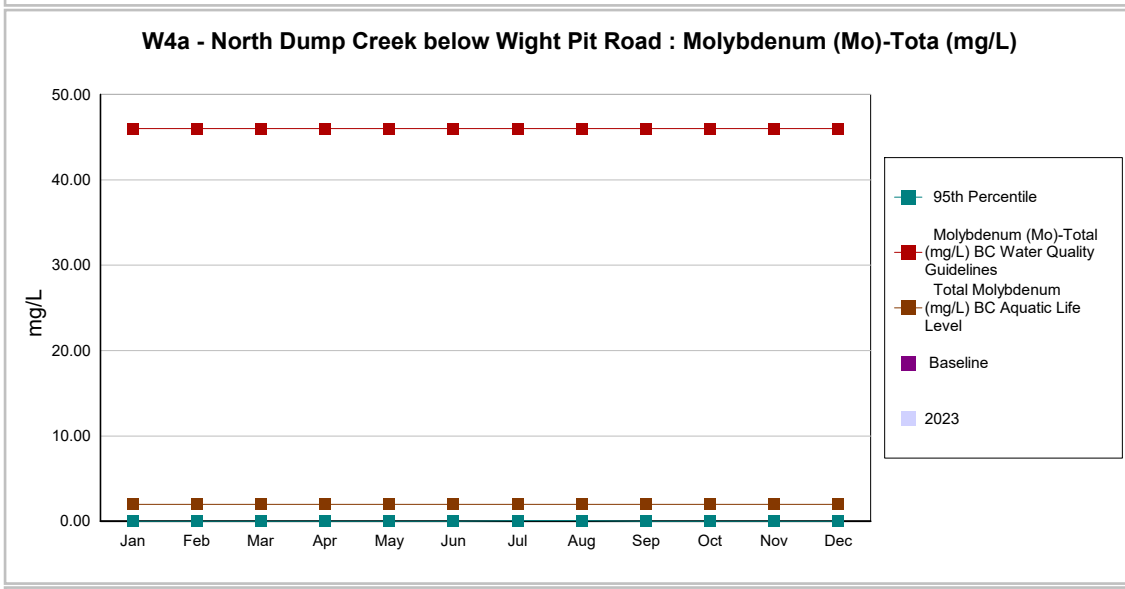
Annual Report SW vs BCWQG

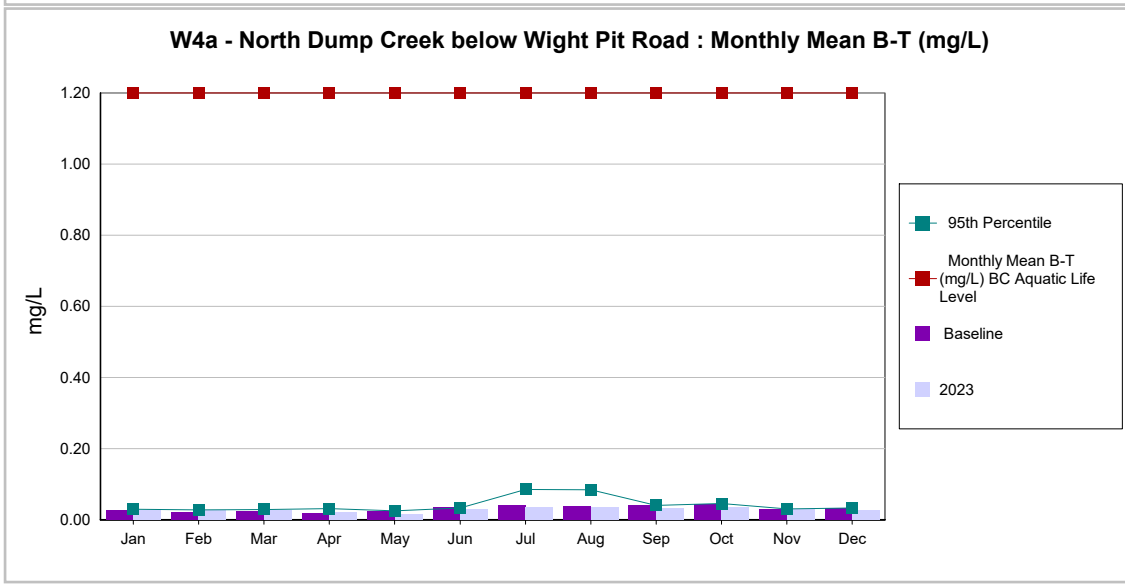
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







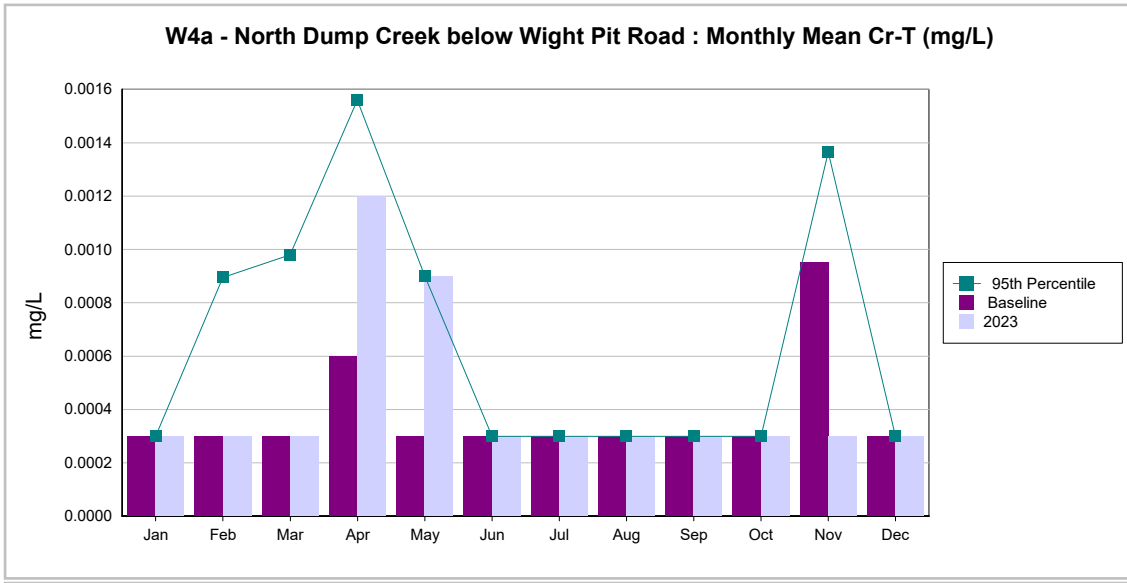
Water Quality Report

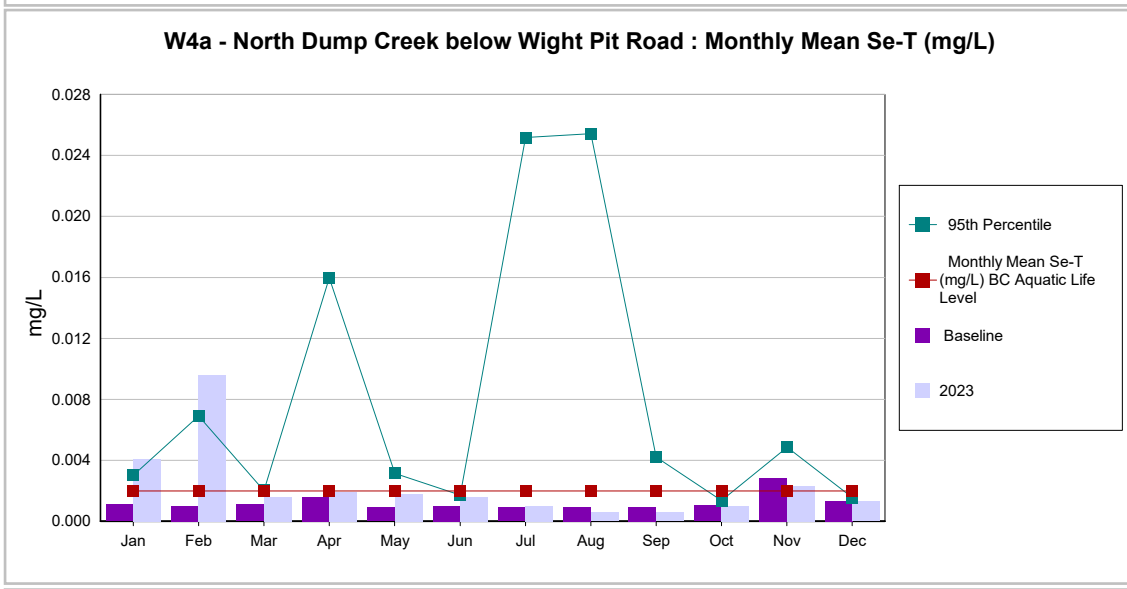
Annual Report SW vs BCWQG

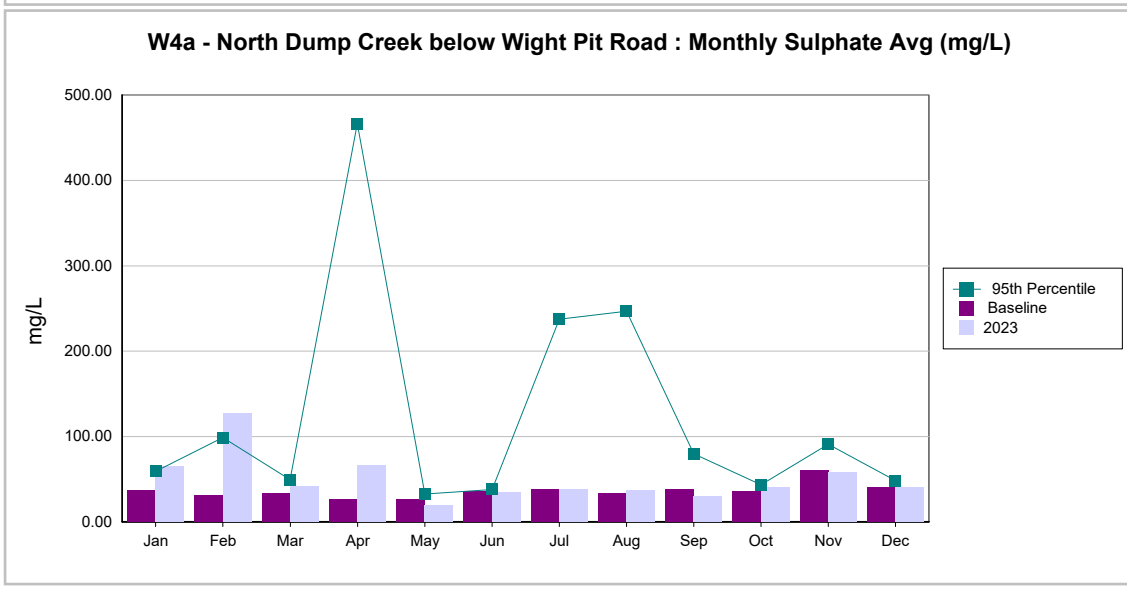
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







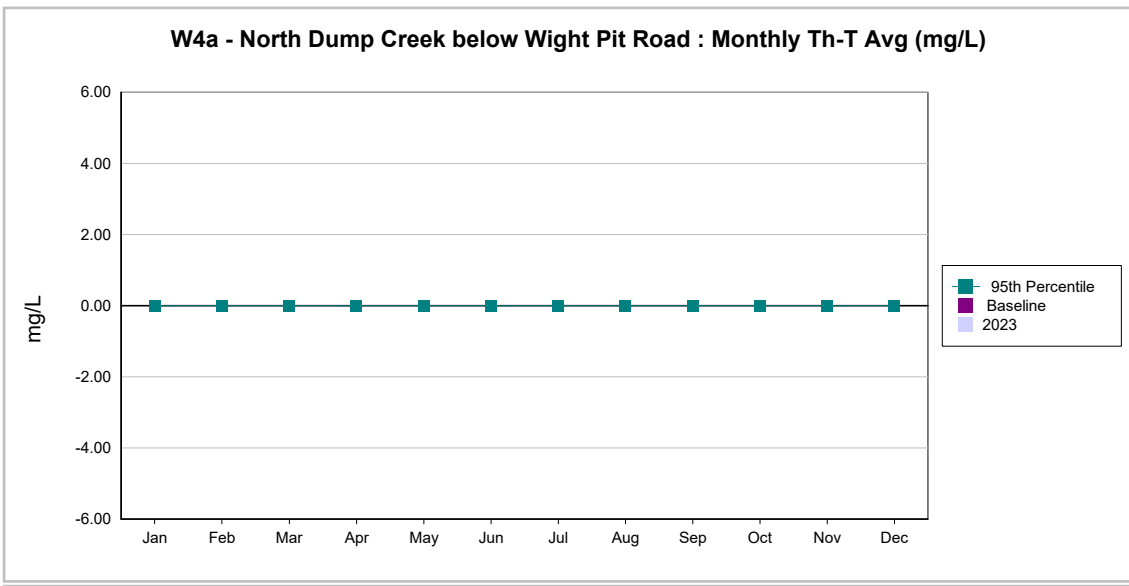
Water Quality Report

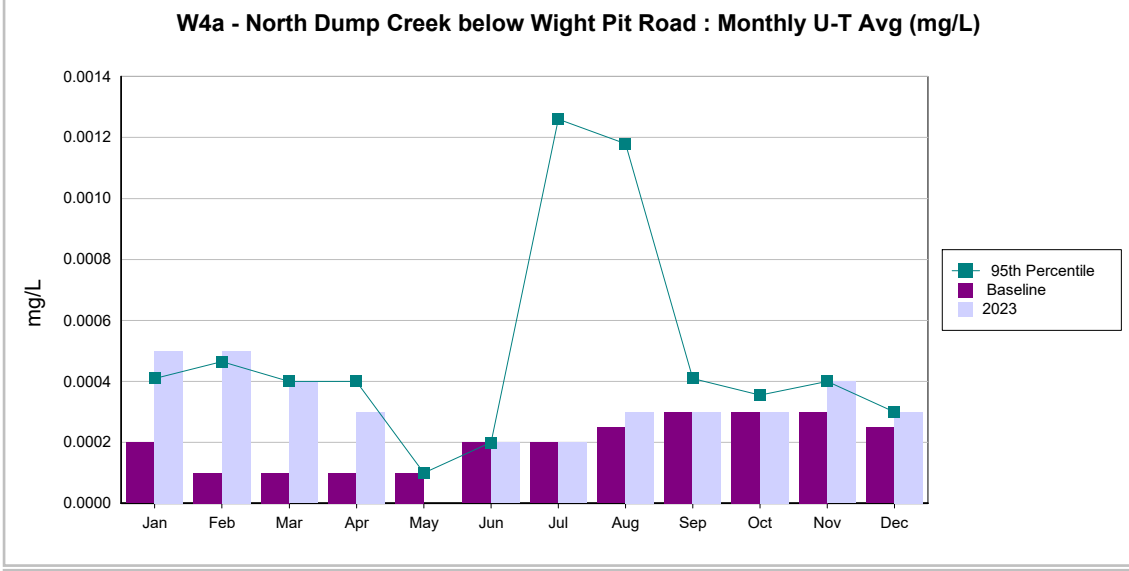
Annual Report SW vs BCWQG

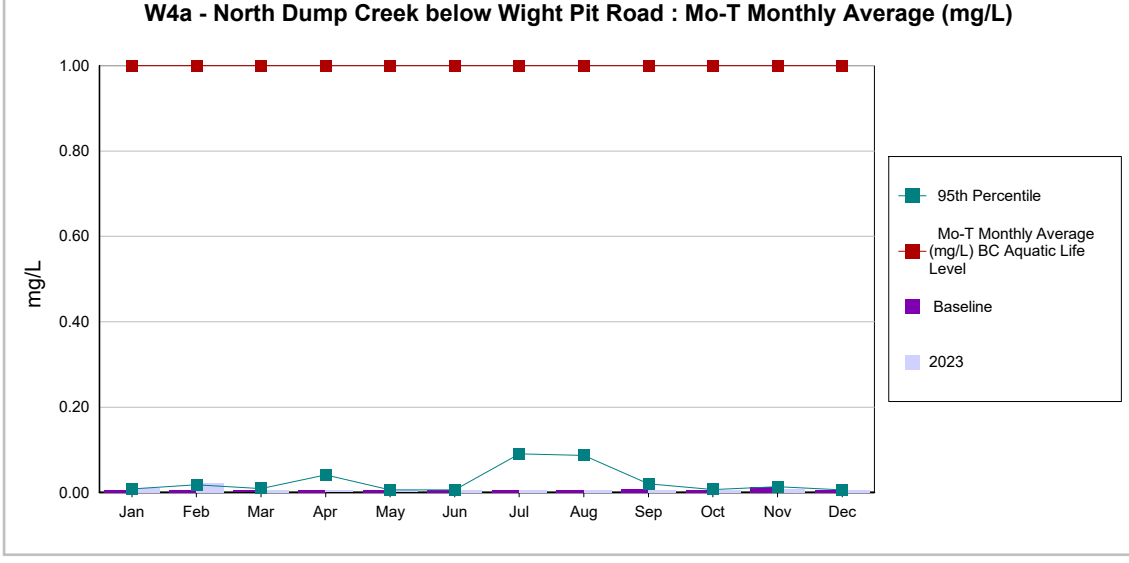
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







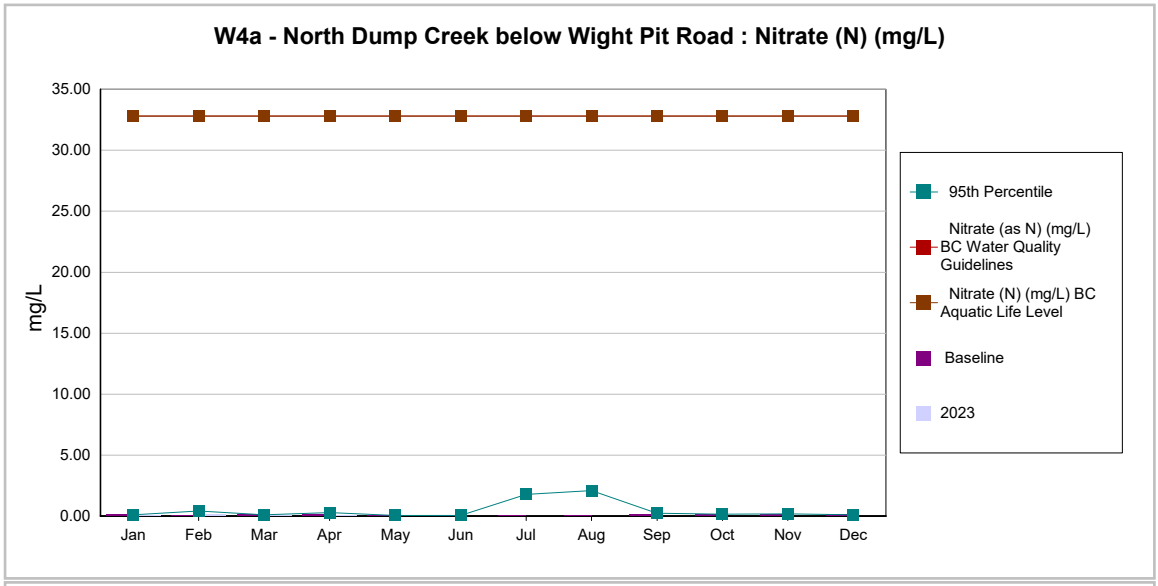
Water Quality Report

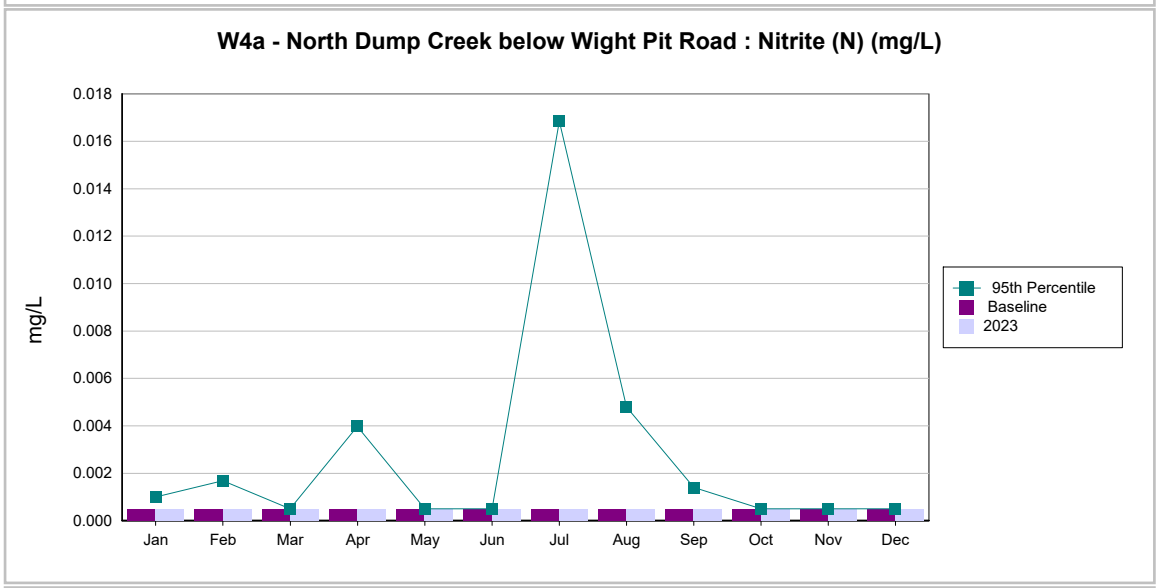
Annual Report SW vs BCWQG

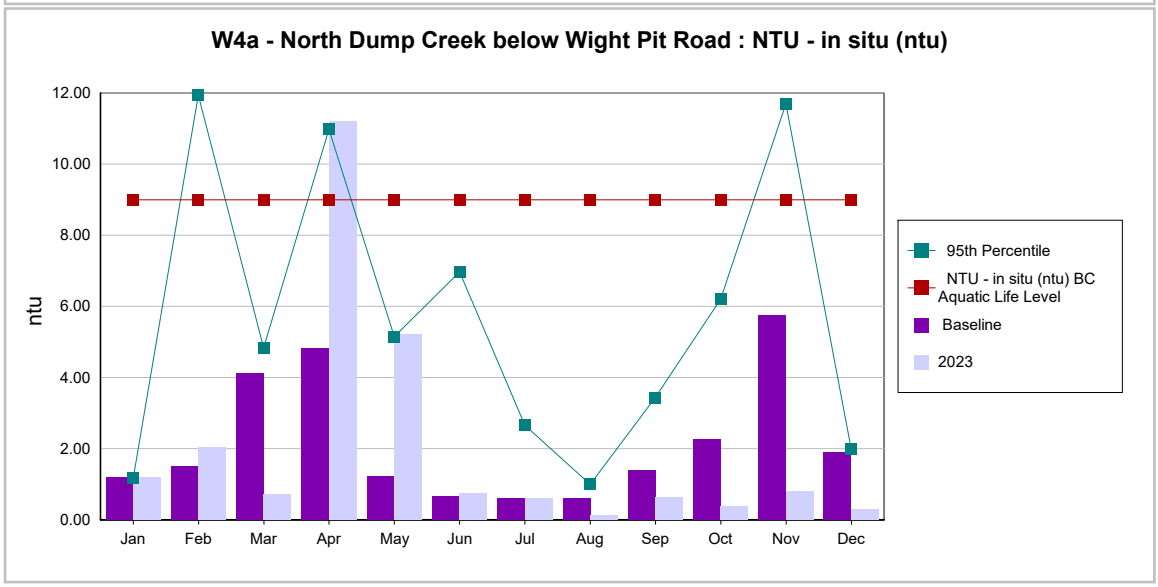
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

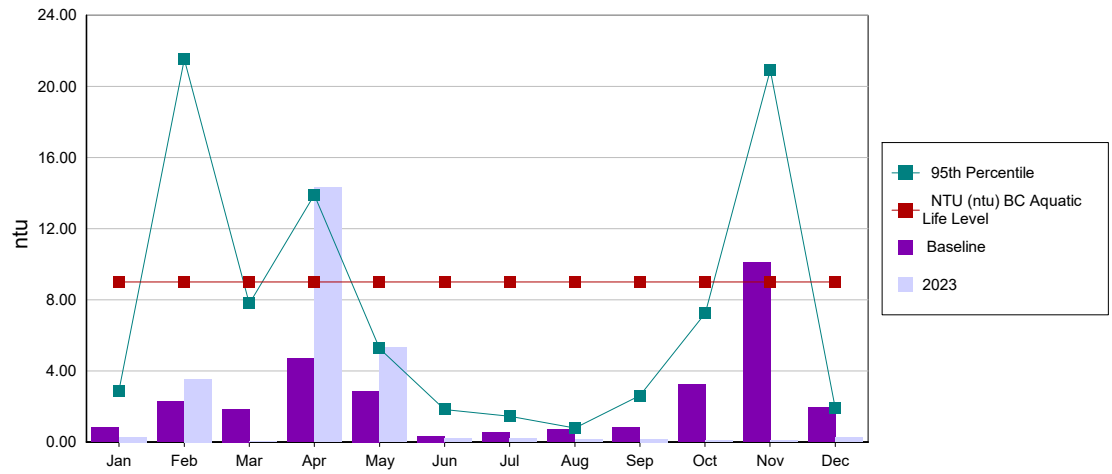
Annual Report SW vs BCWQG

Mount Polley

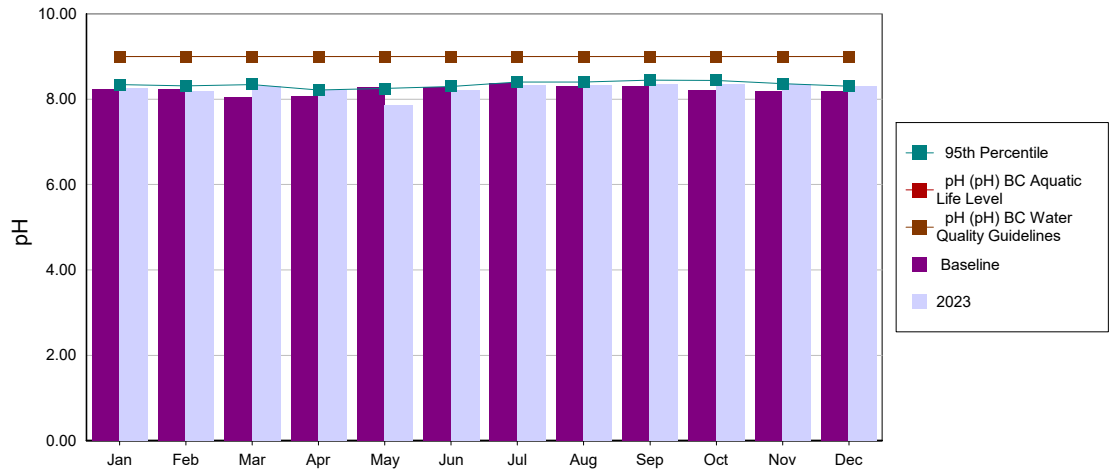
Mining Corporation

IMPERIAL METALS CORPORATION

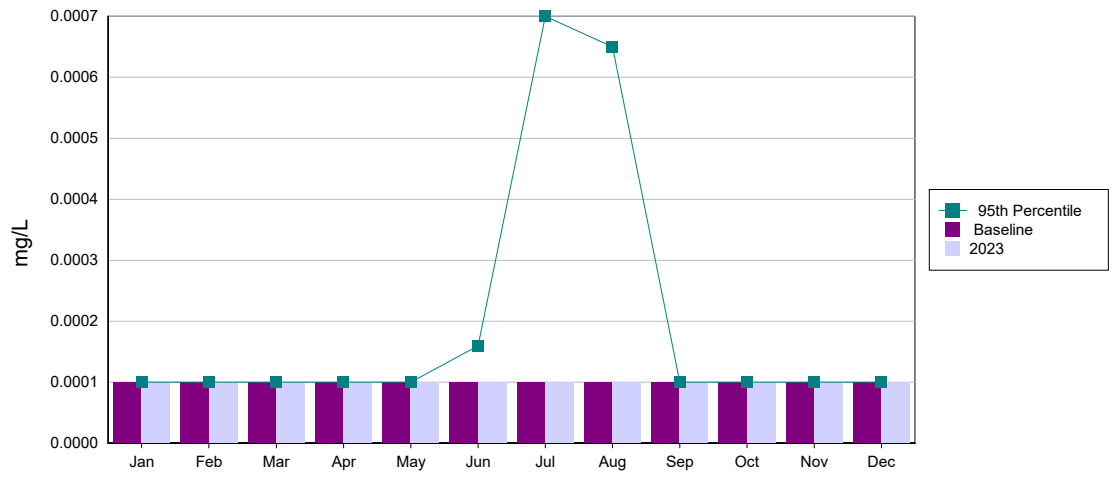
W4a - North Dump Creek below Wight Pit Road : NTU (ntu)



W4a - North Dump Creek below Wight Pit Road : pH (pH)



W4a - North Dump Creek below Wight Pit Road : Sb-T Monthly Avg (mg/L)



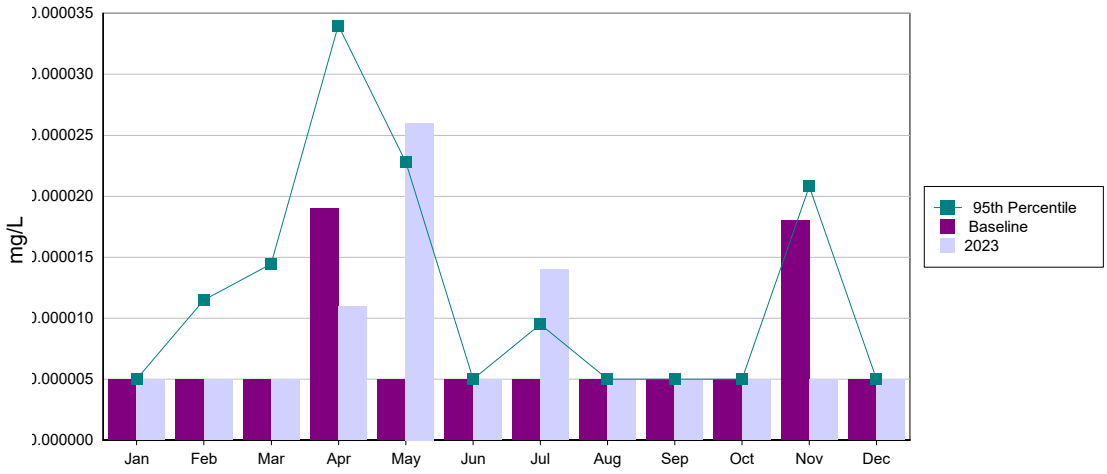
Water Quality Report

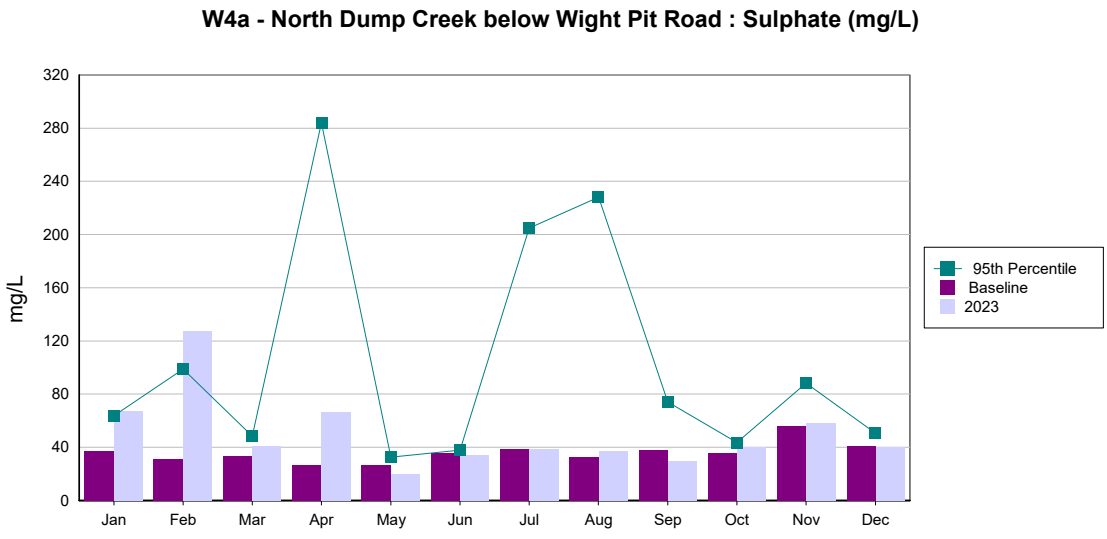
Annual Report SW vs BCWQG

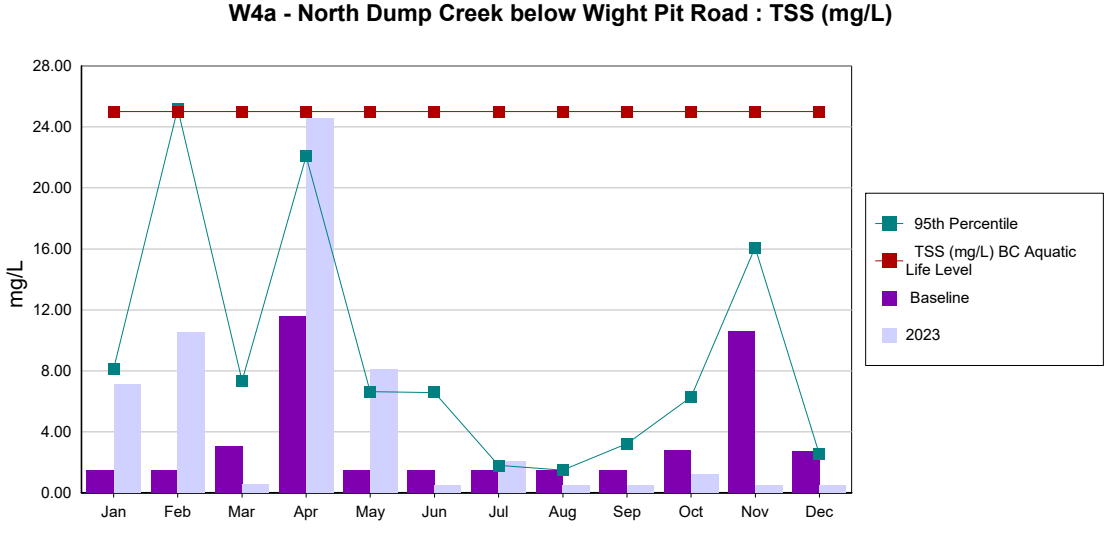
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

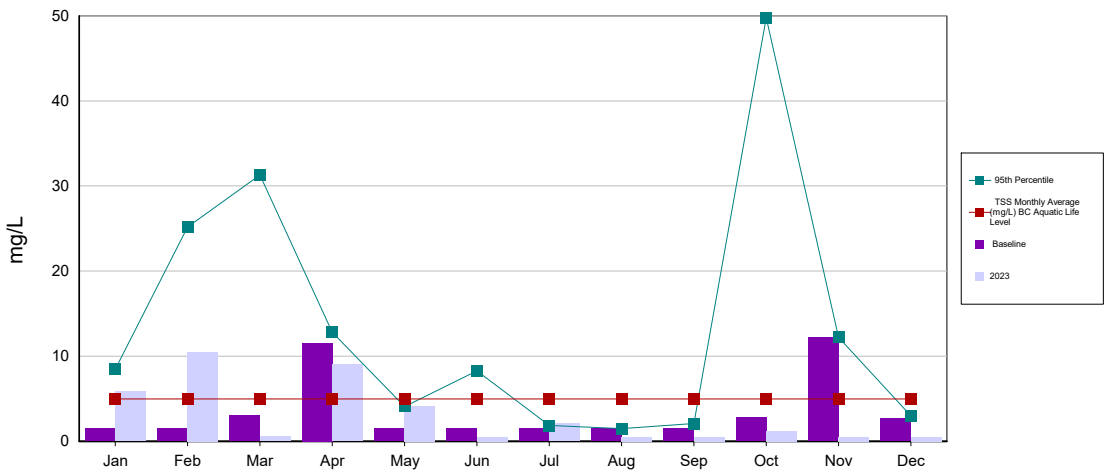
Annual Report SW vs BCWQG

Mount Polley

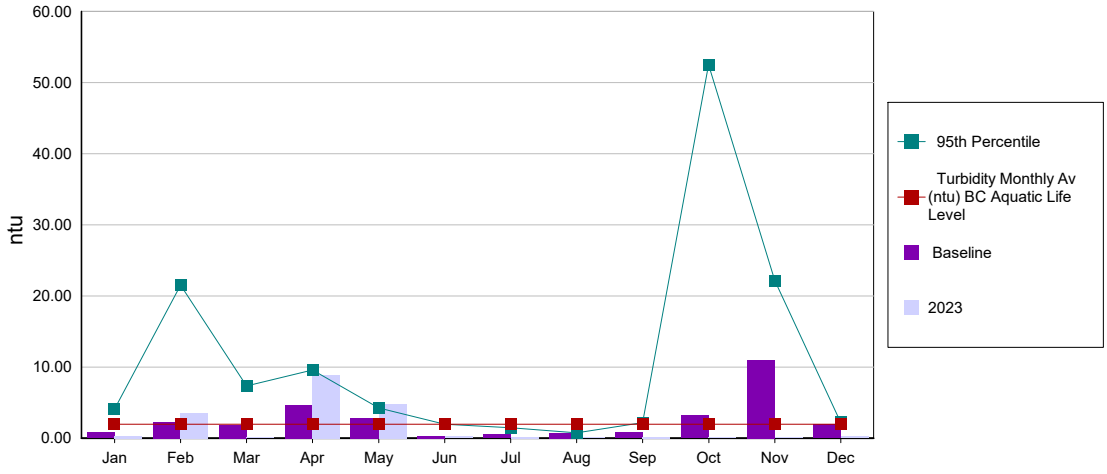
Mining Corporation

IMPERIAL METALS CORPORATION

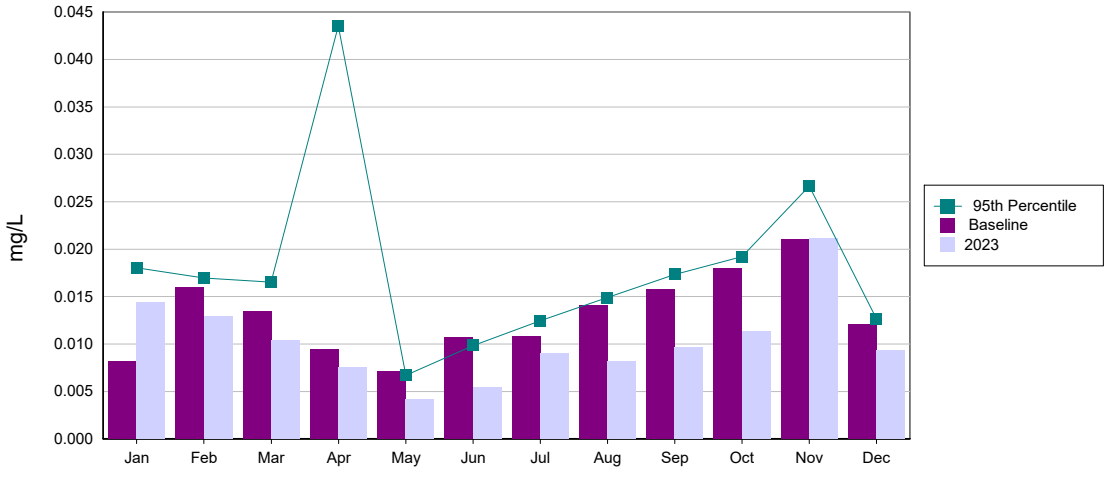
W4a - North Dump Creek below Wight Pit Road : TSS Monthly Average (mg/L)



W4a - North Dump Creek below Wight Pit Road : Turbidity Monthly Av (ntu)



W4a - North Dump Creek below Wight Pit Road : Zinc (Zn)-Total (mg/L)



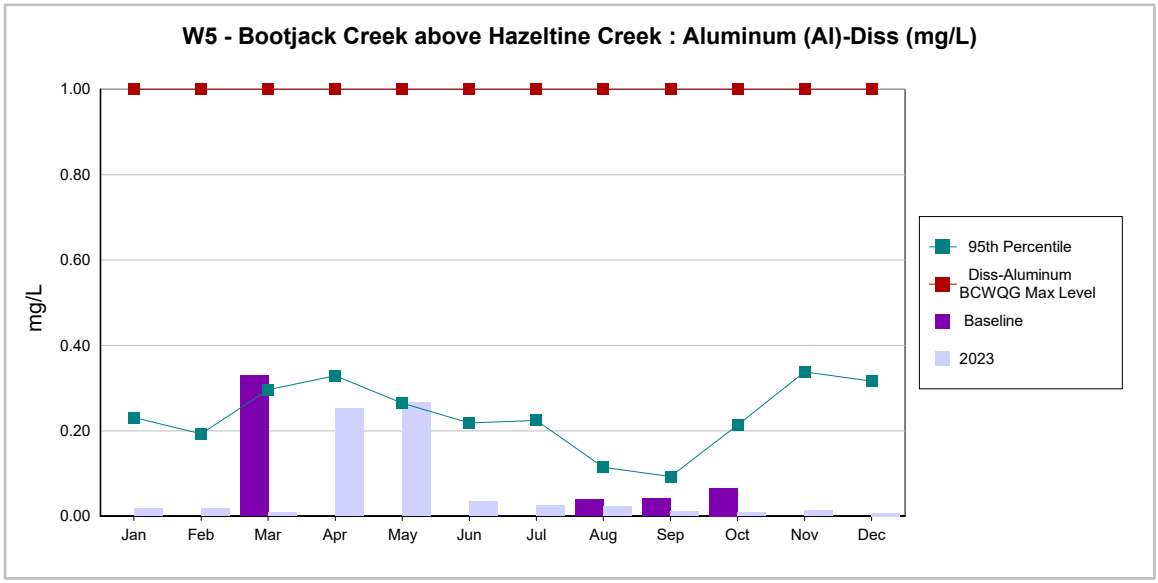
Water Quality Report

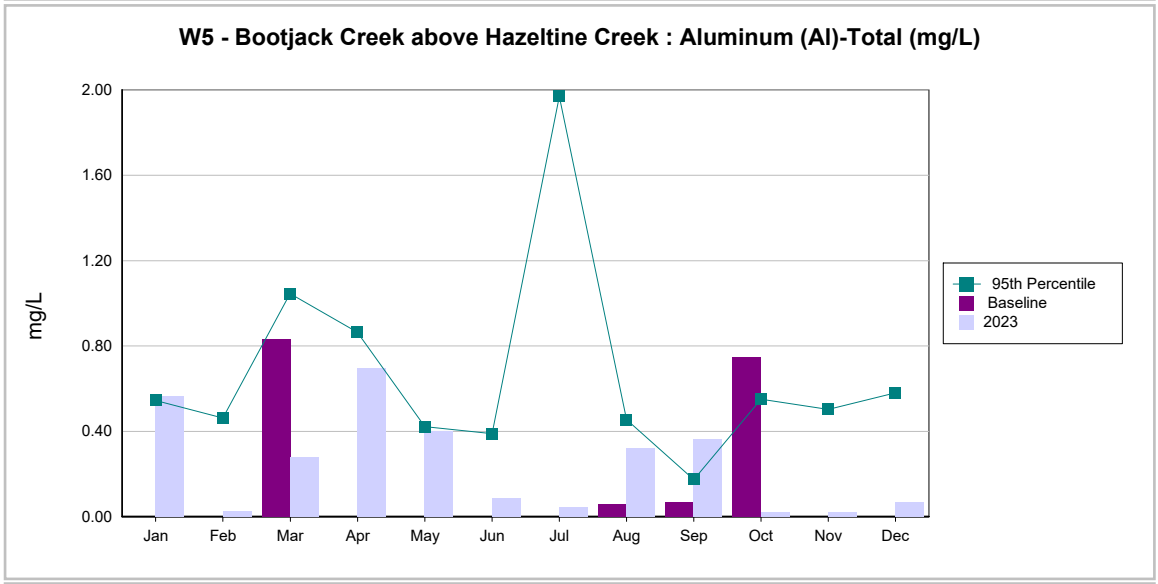
Annual Report SW vs BCWQG

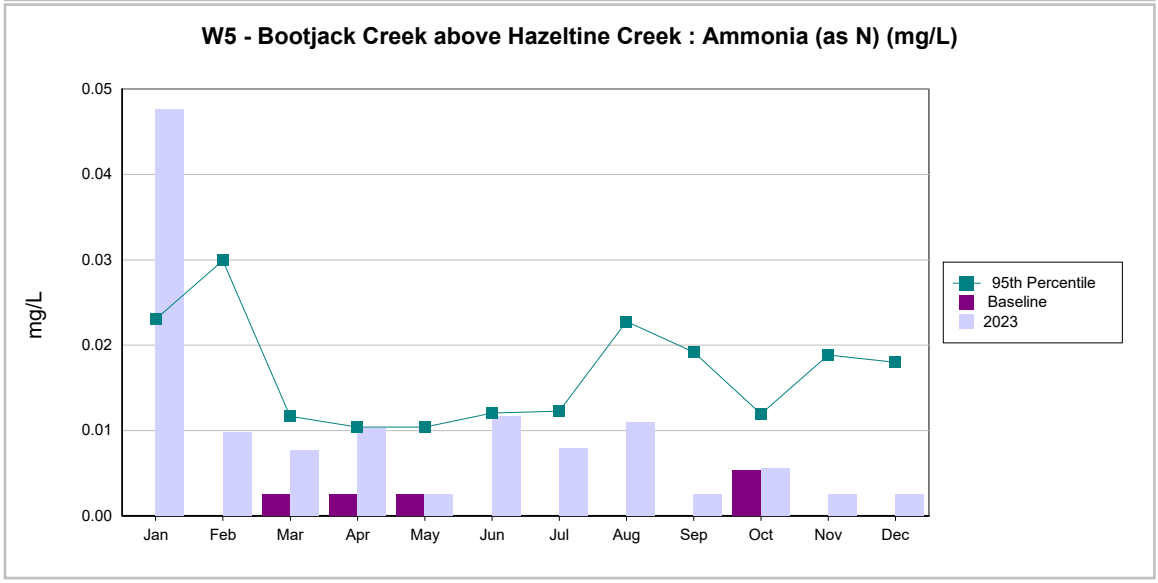
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







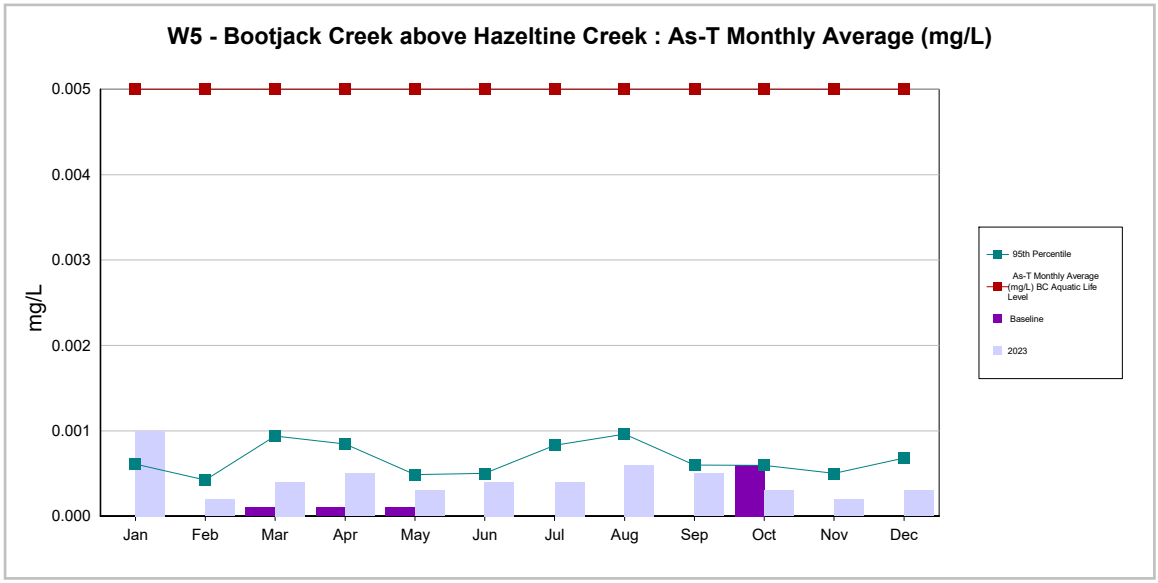
Water Quality Report

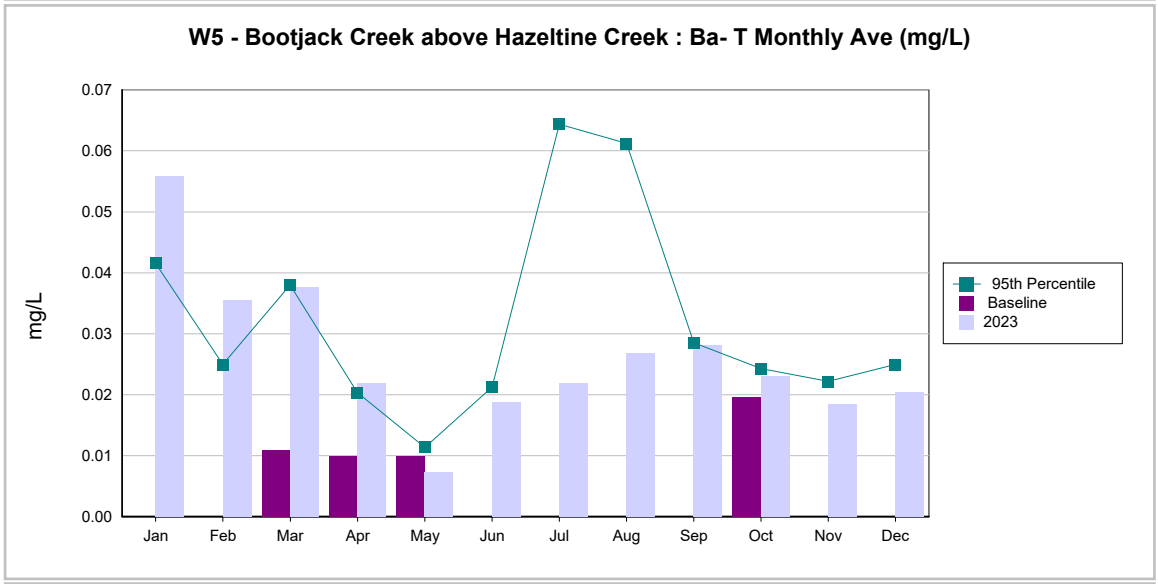
Annual Report SW vs BCWQG

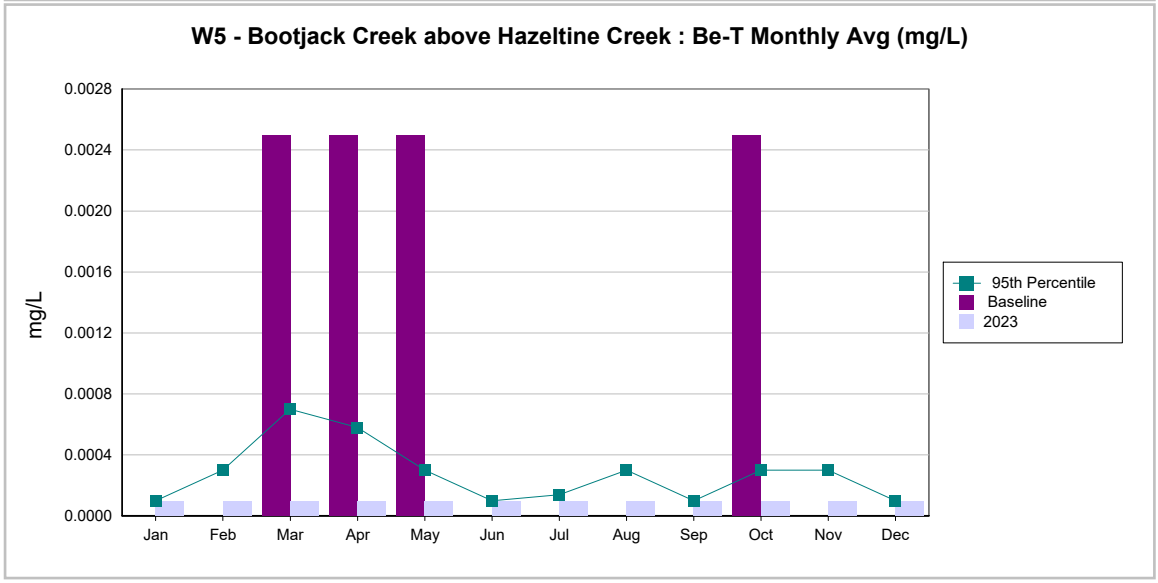
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







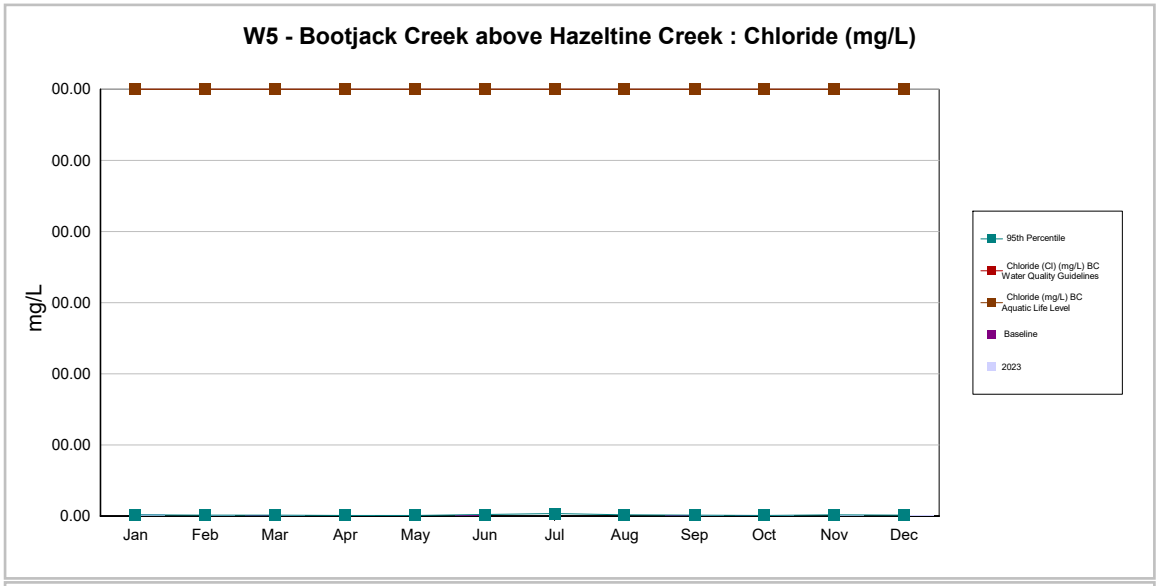
Water Quality Report

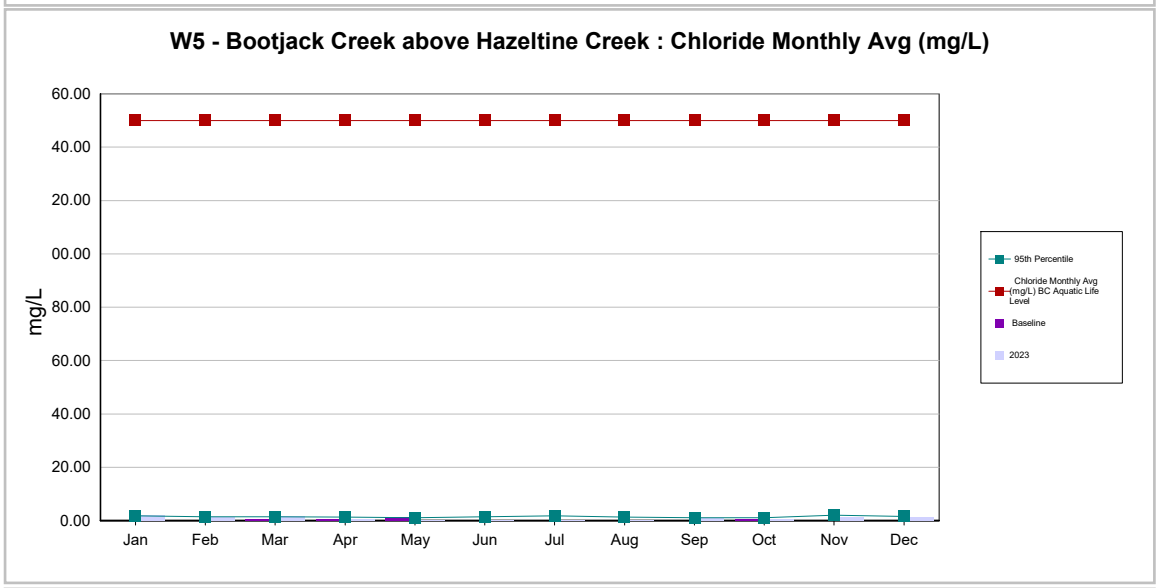
Annual Report SW vs BCWQG

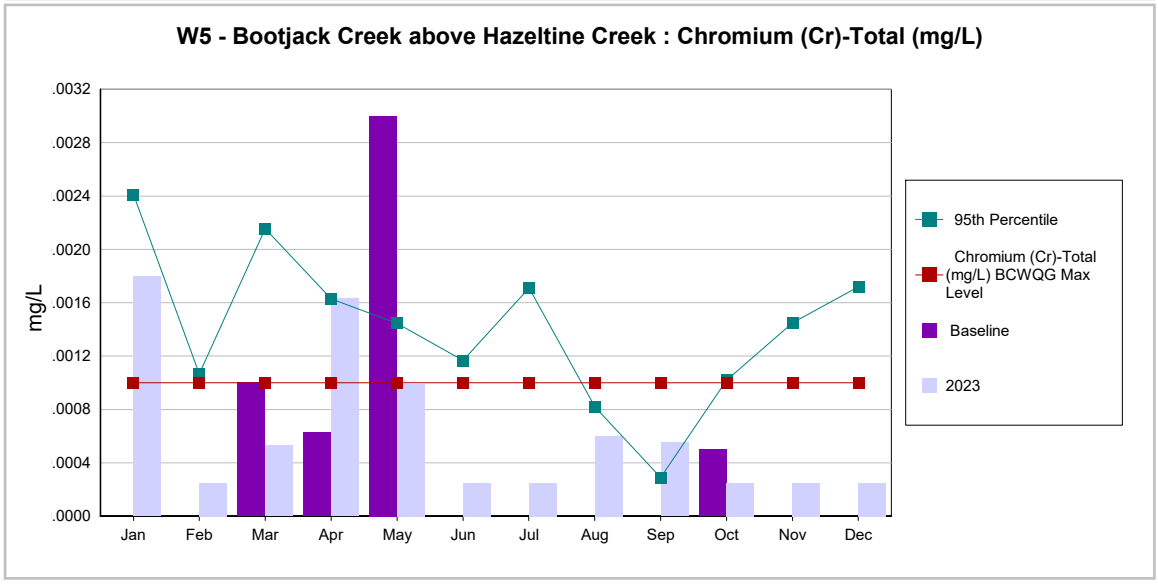
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







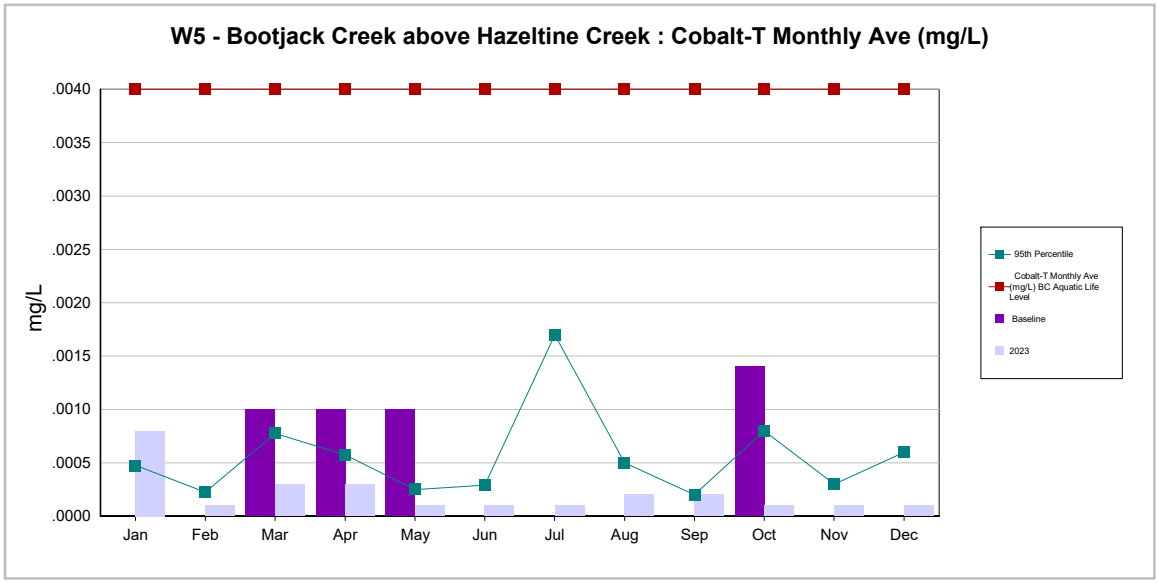
Water Quality Report

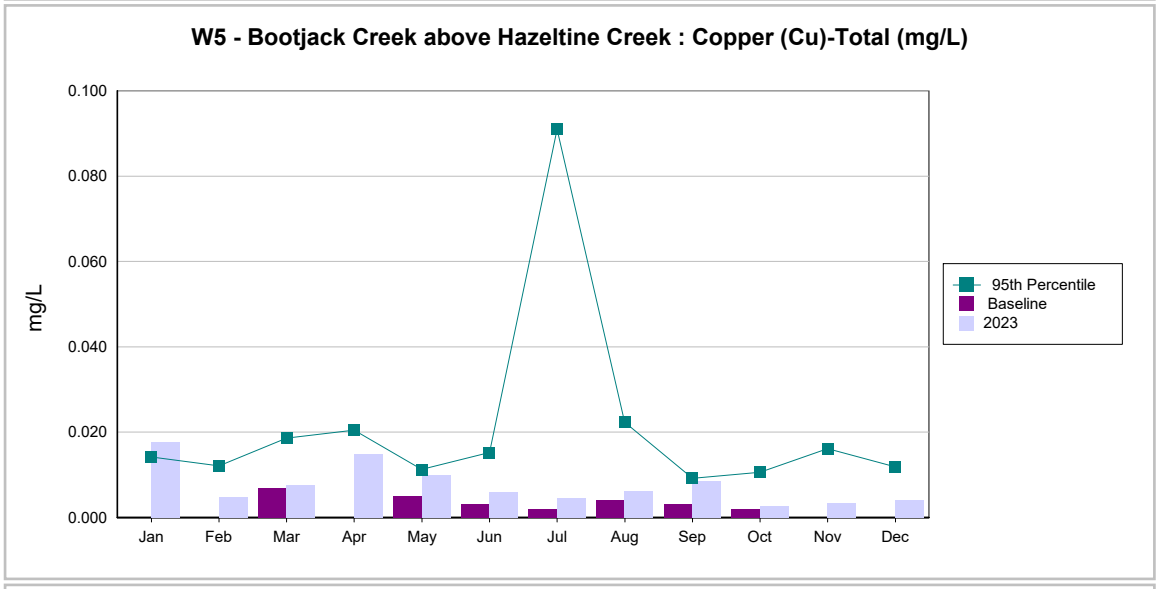
Annual Report SW vs BCWQG

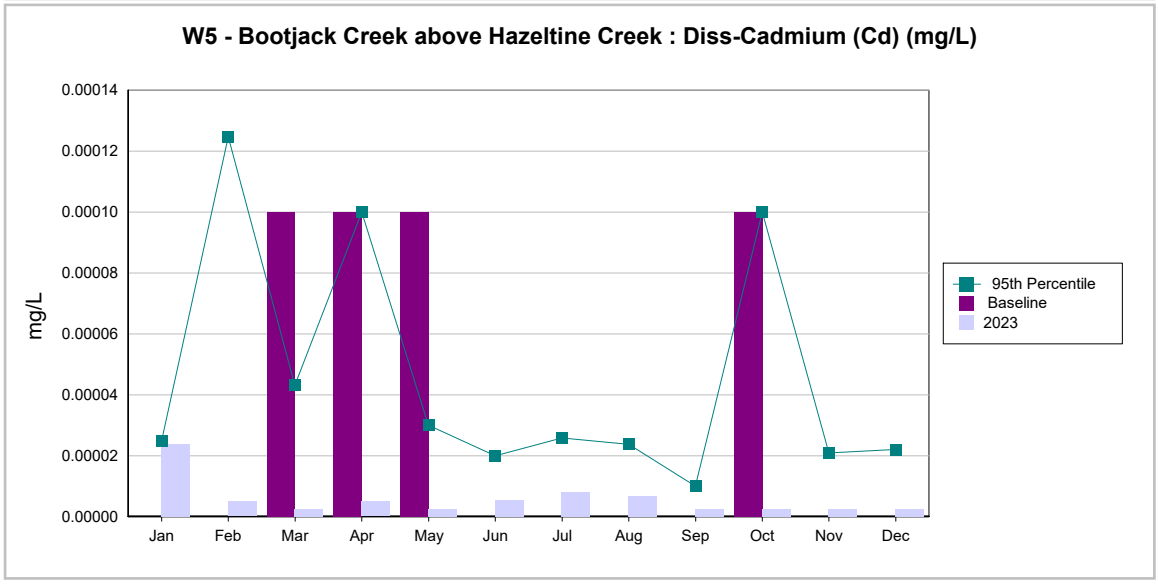
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







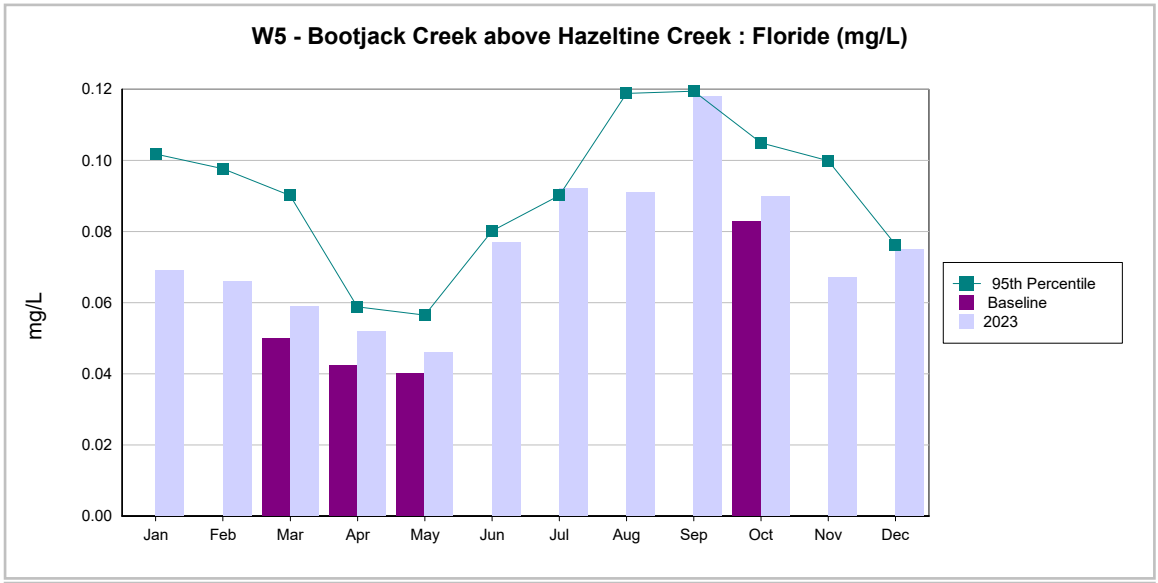
Water Quality Report

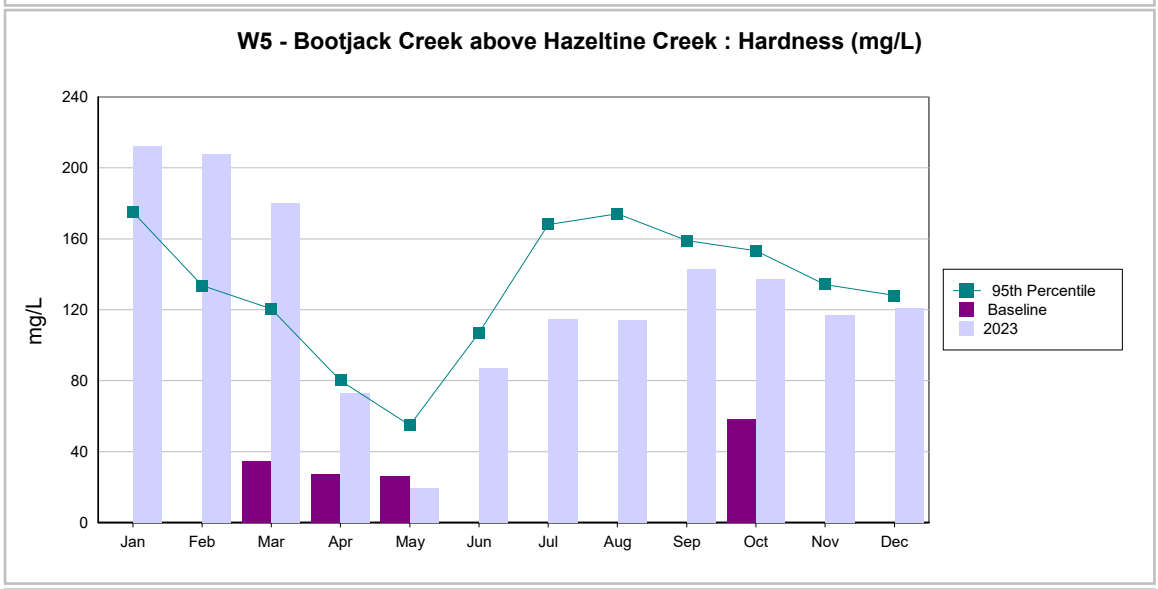
Annual Report SW vs BCWQG

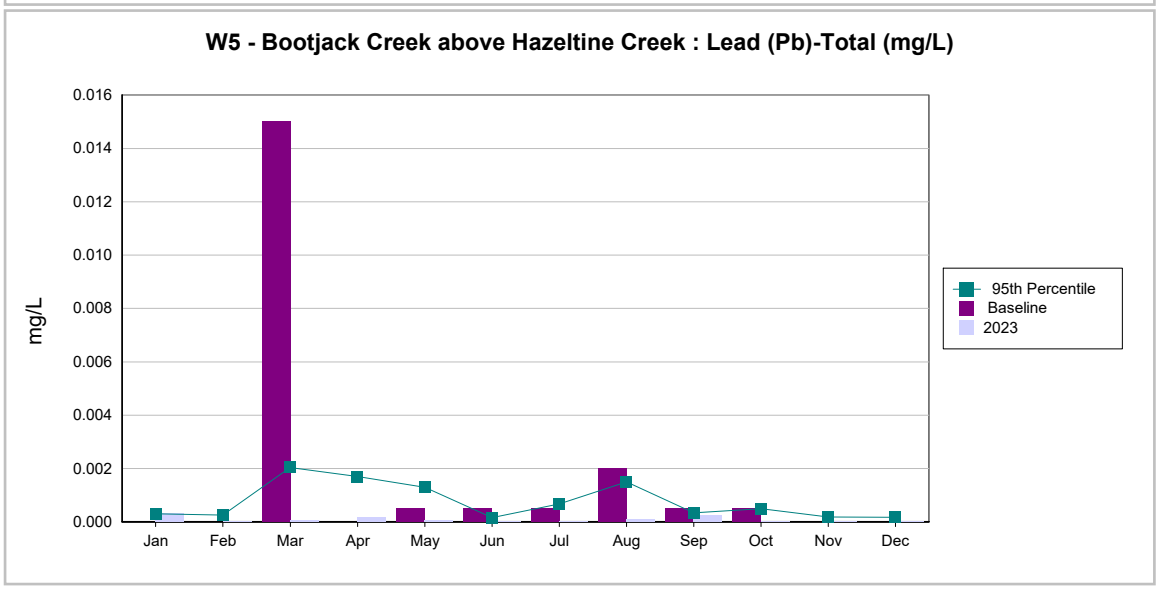
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







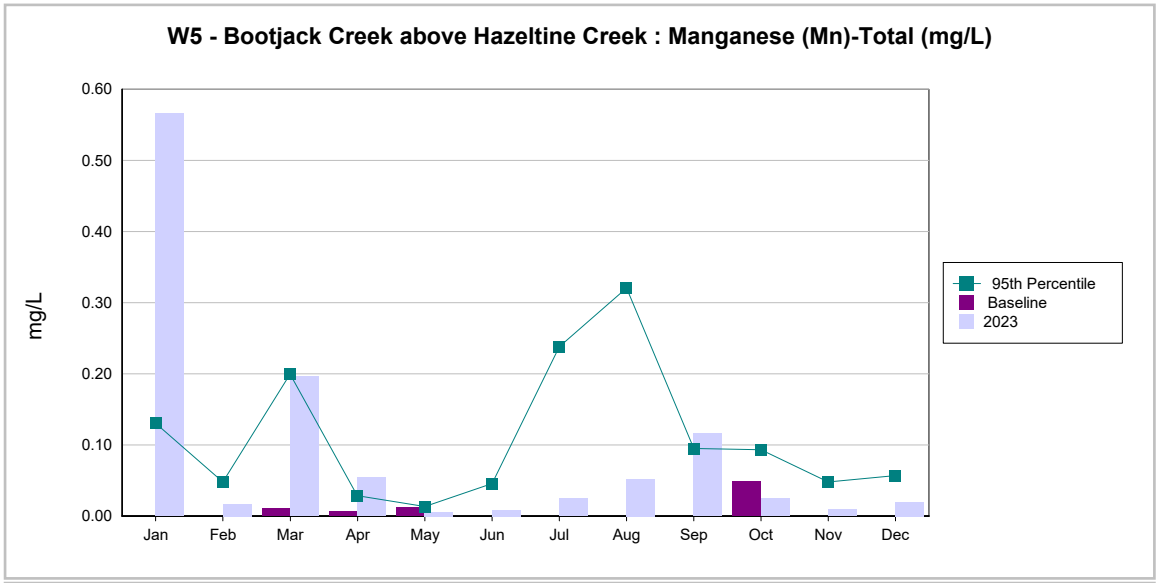
Water Quality Report

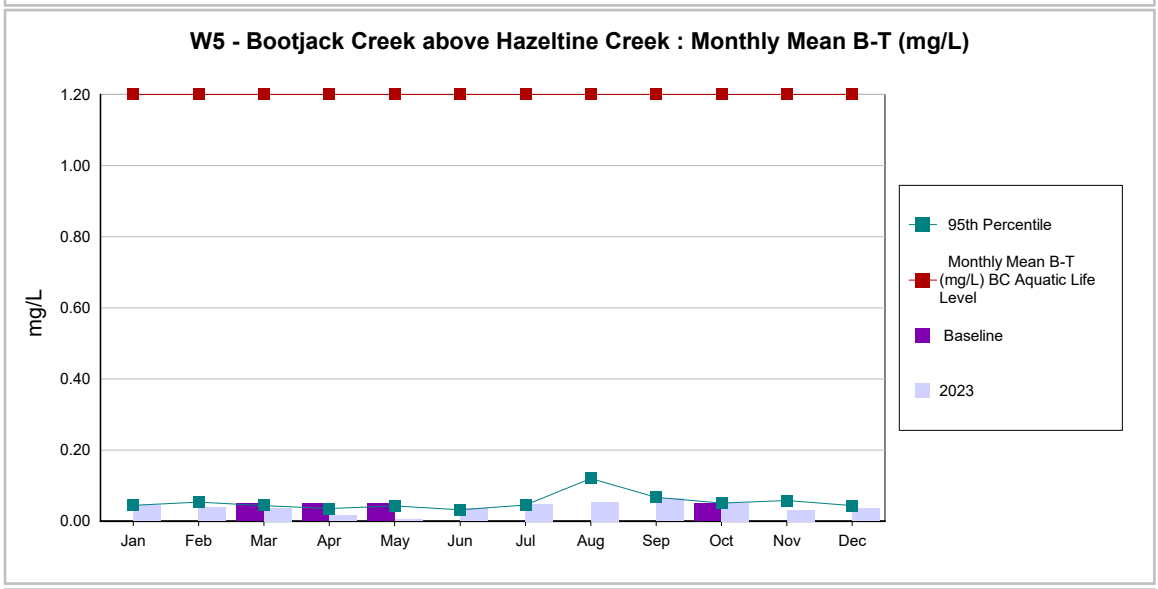
Annual Report SW vs BCWQG

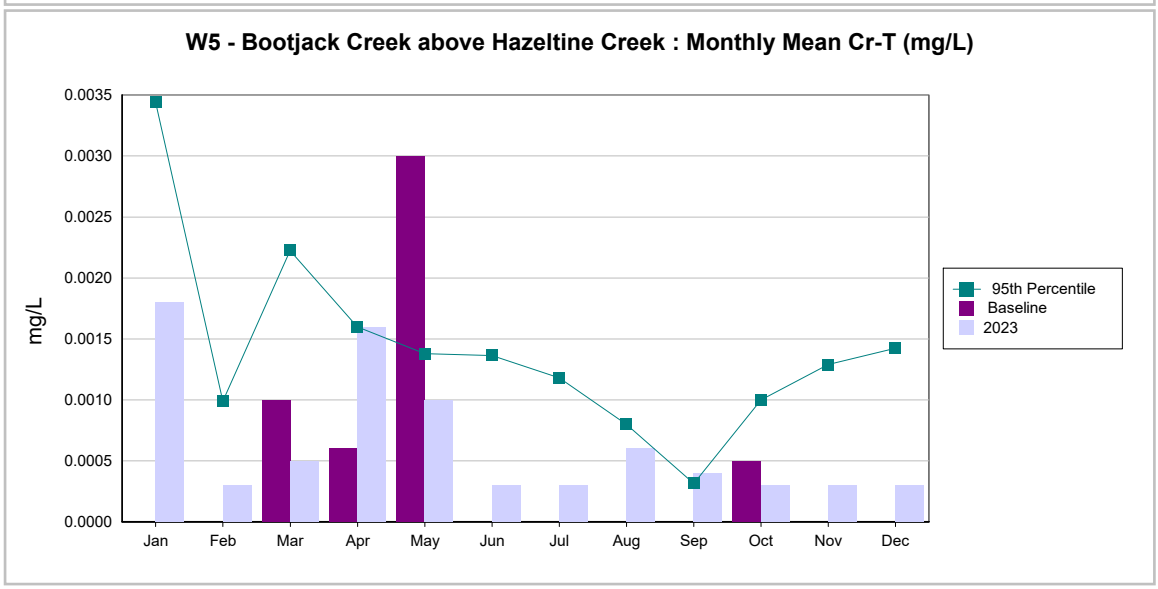
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







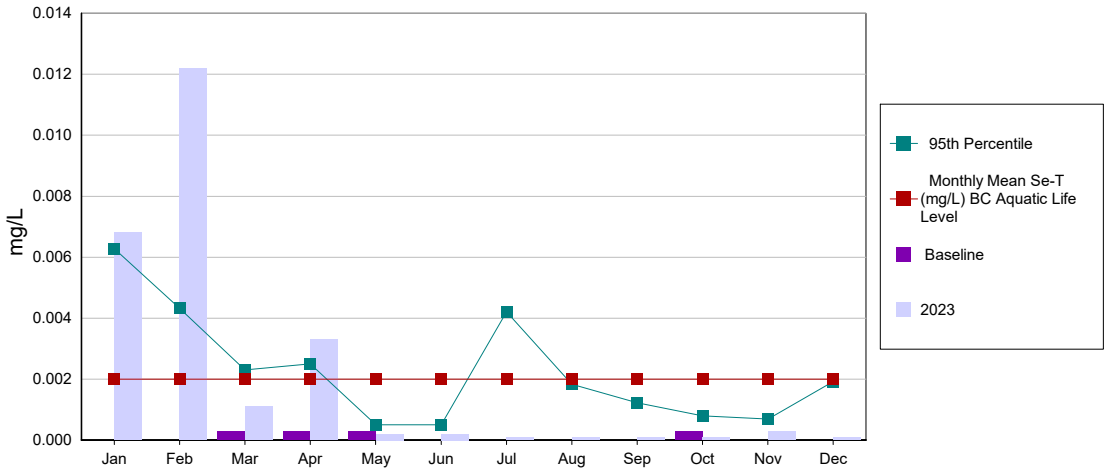
Water Quality Report

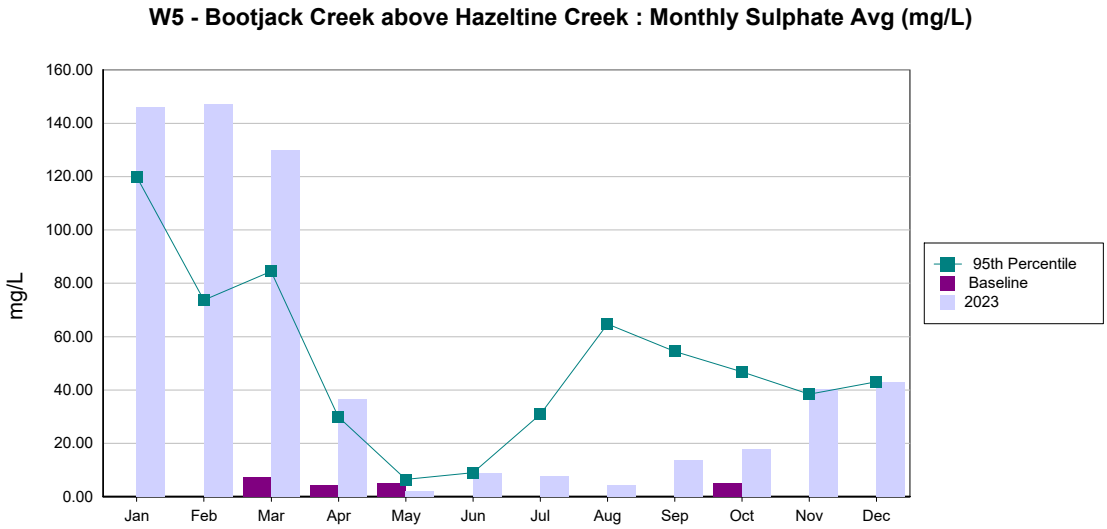
Annual Report SW vs BCWQG

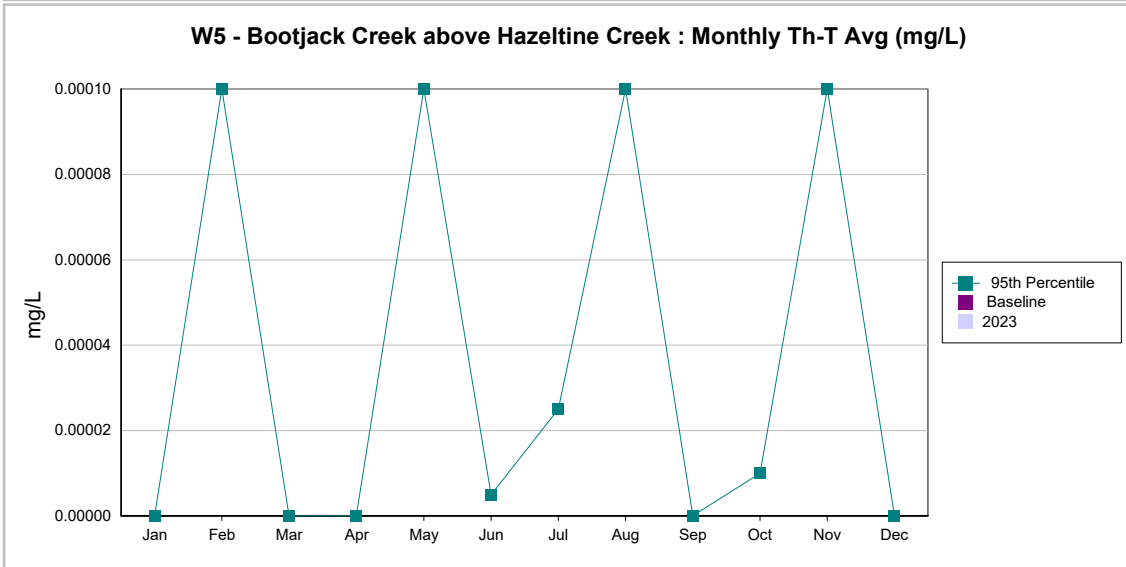
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







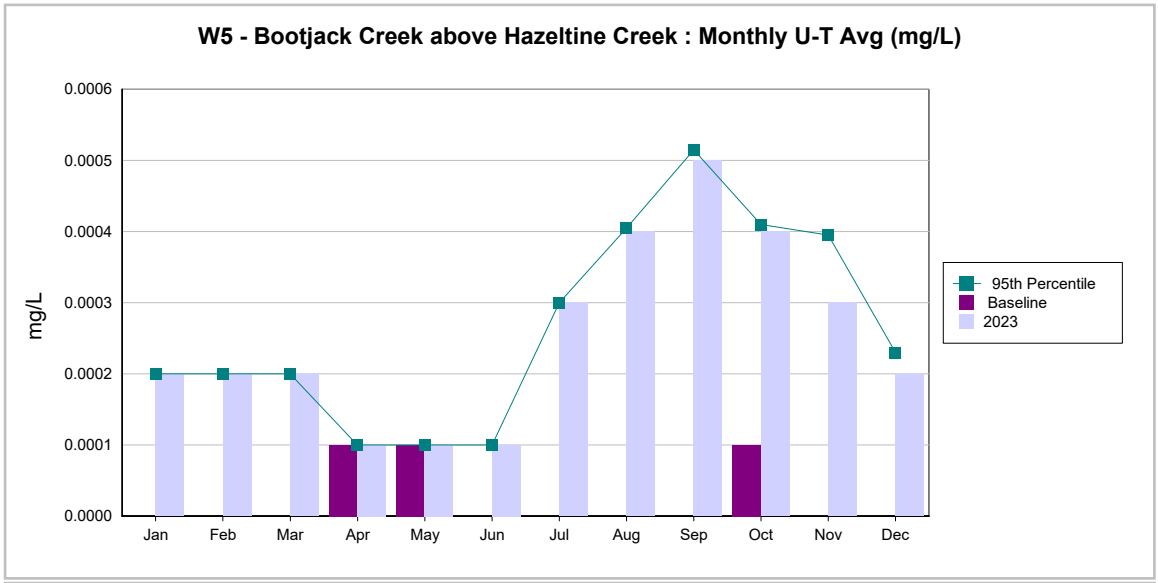
Water Quality Report

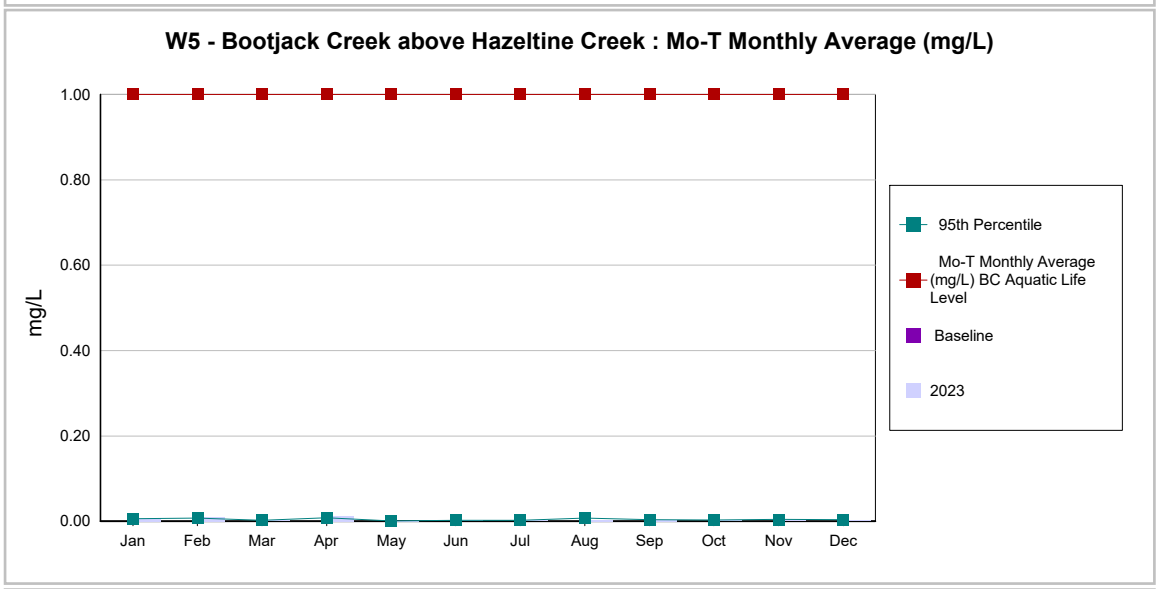
Annual Report SW vs BCWQG

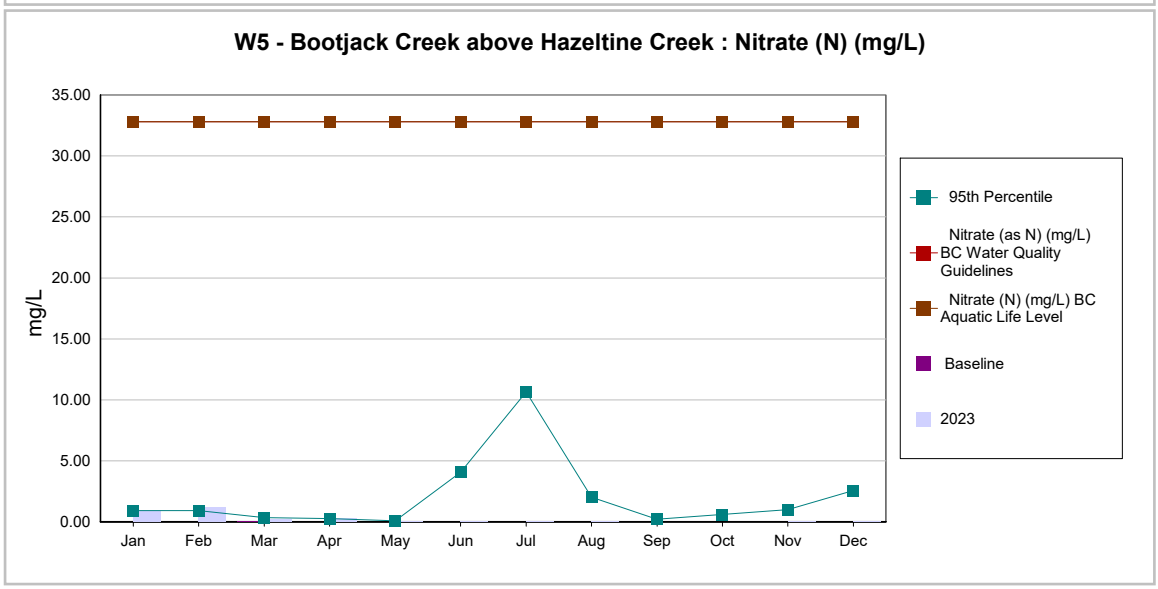
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







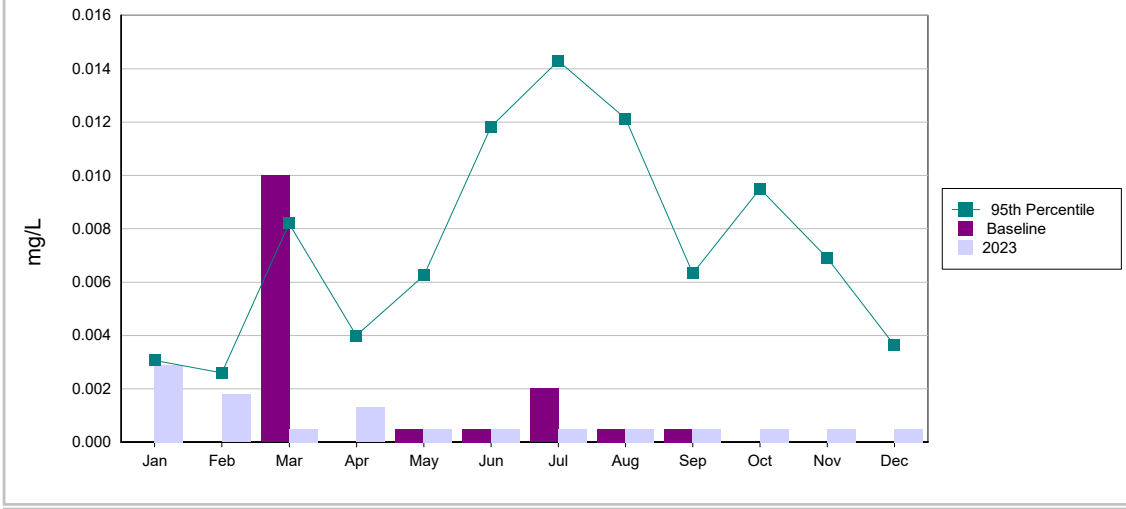
Water Quality Report

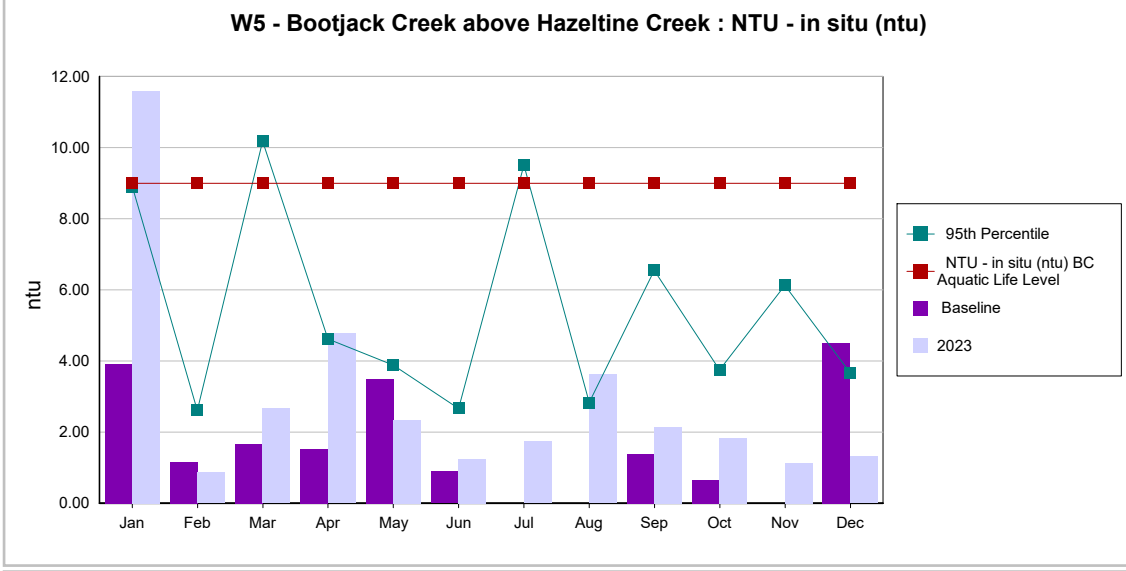
Annual Report SW vs BCWQG

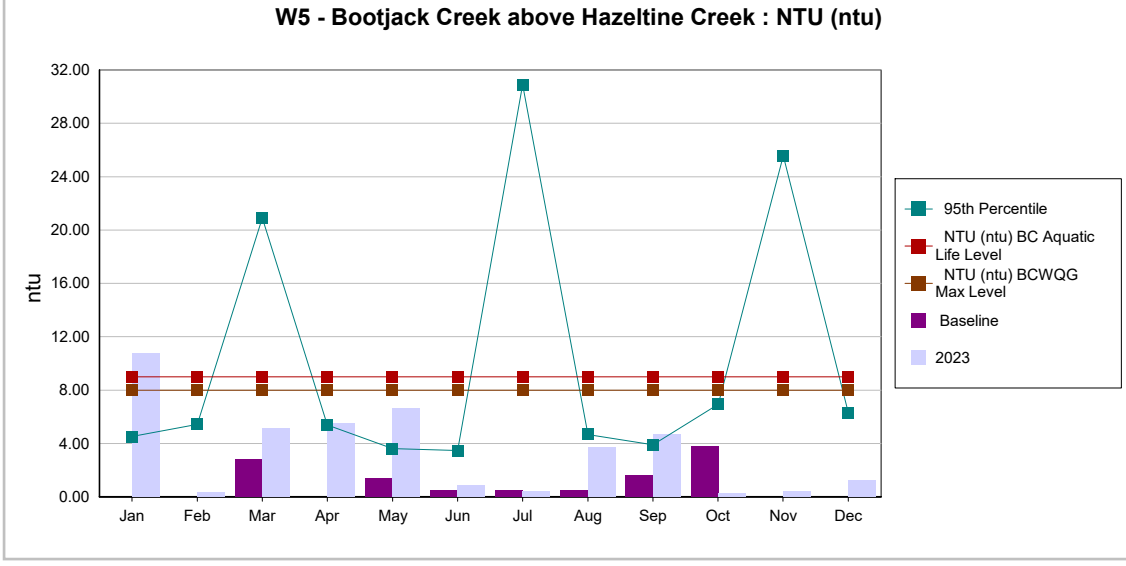
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







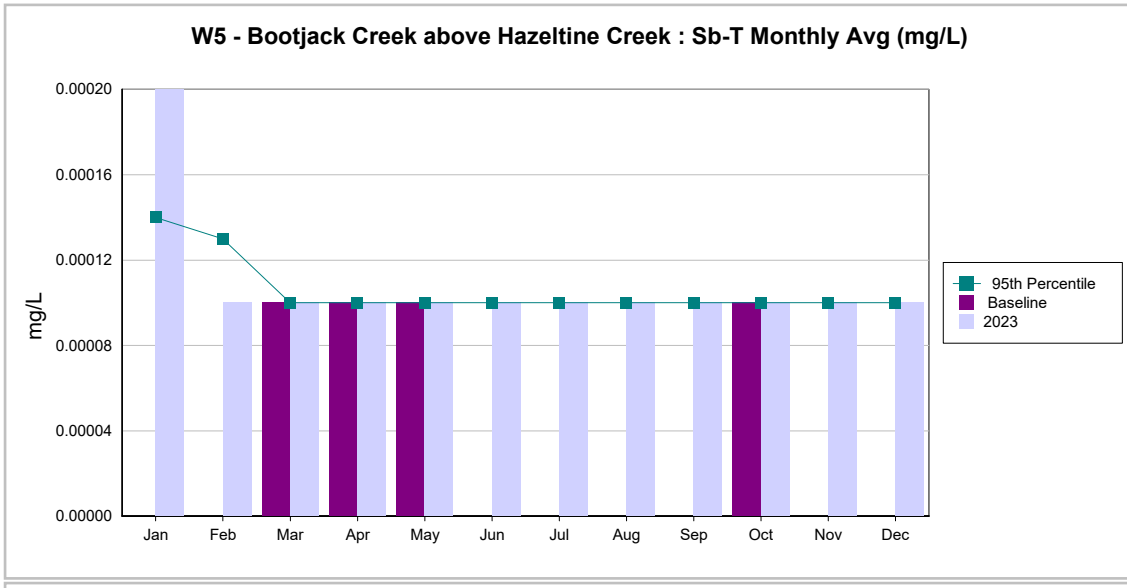
Water Quality Report

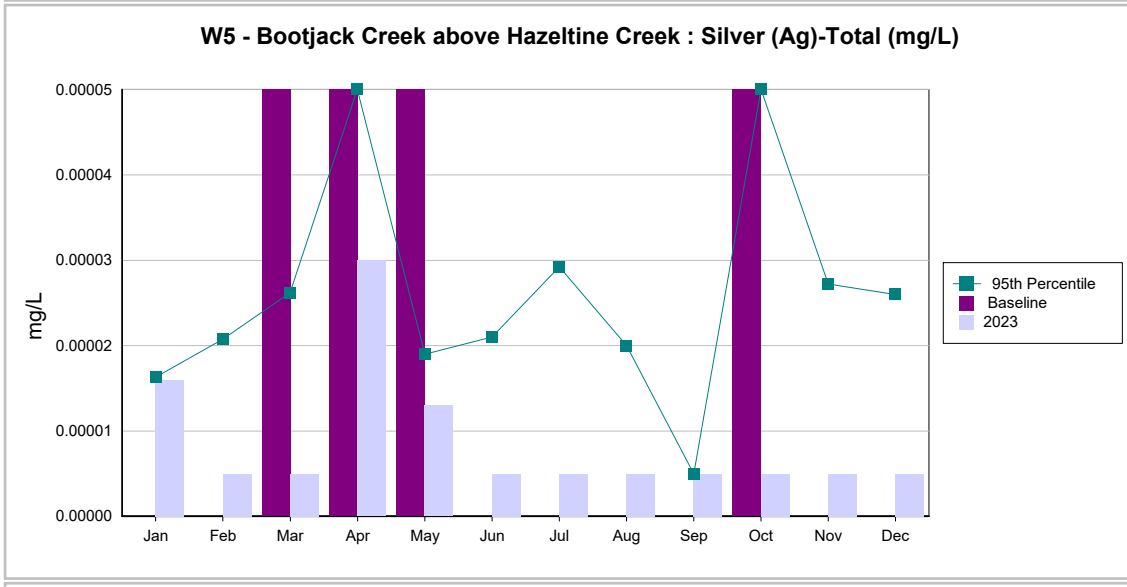
Annual Report SW vs BCWQG

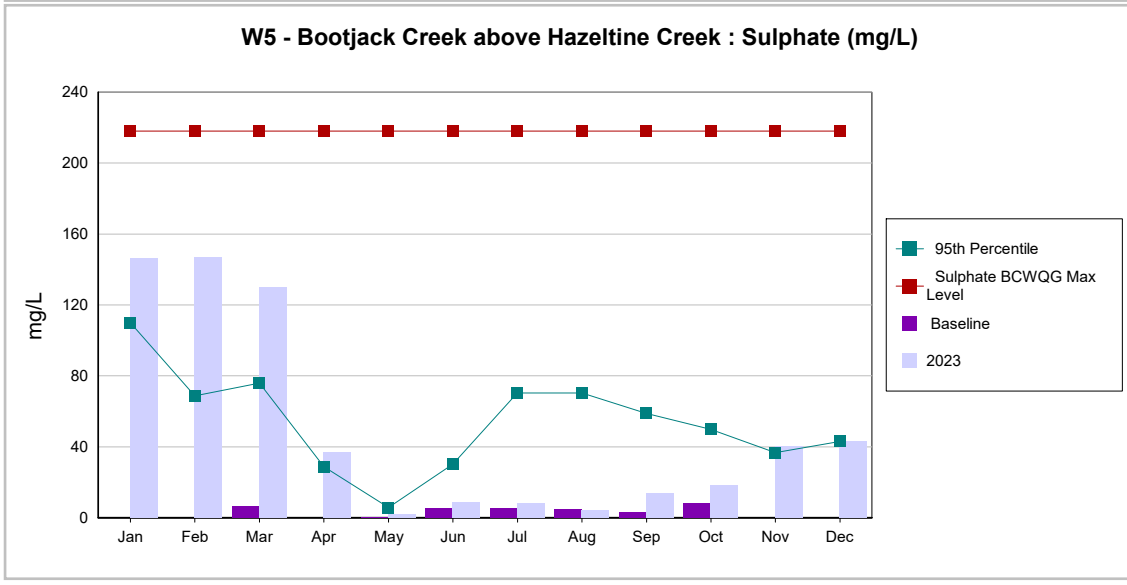
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

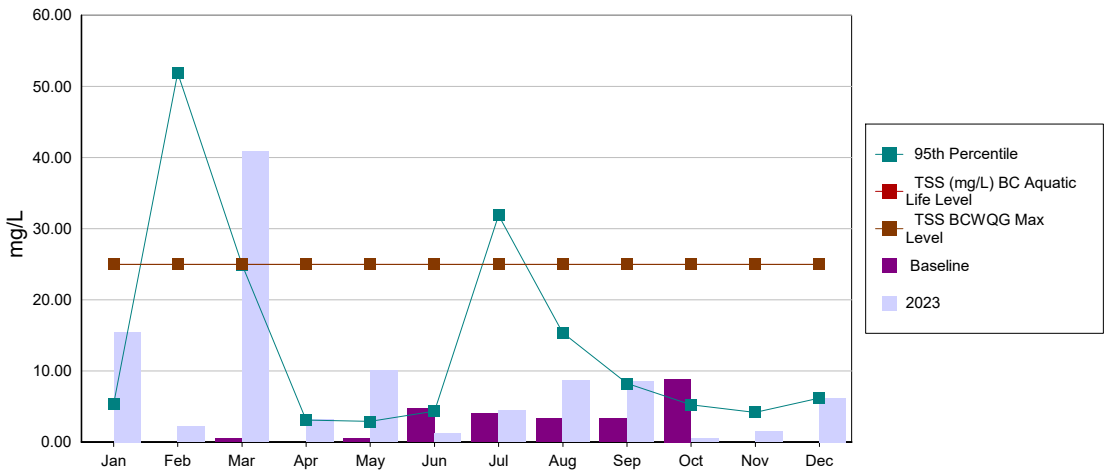
Annual Report SW vs BCWQG

Mount Polley

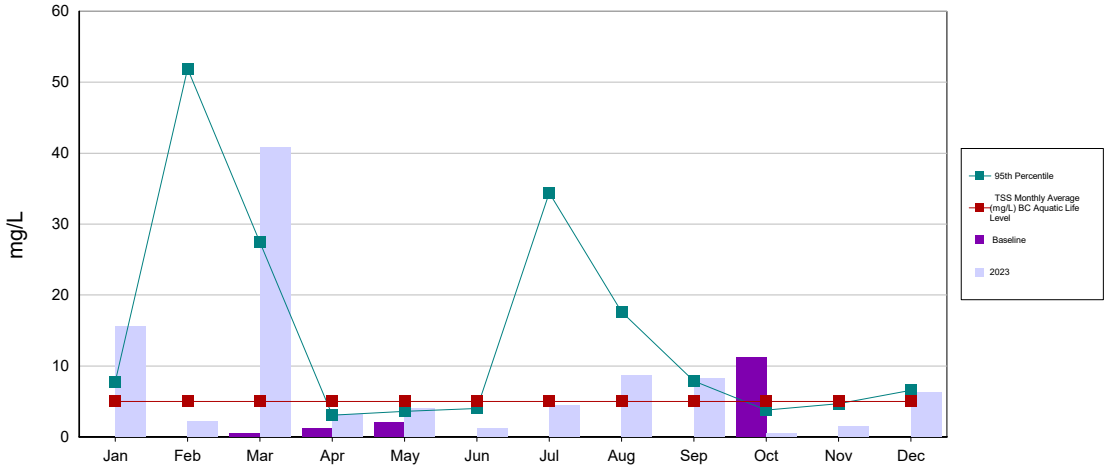
Mining Corporation

IMPERIAL METALS CORPORATION

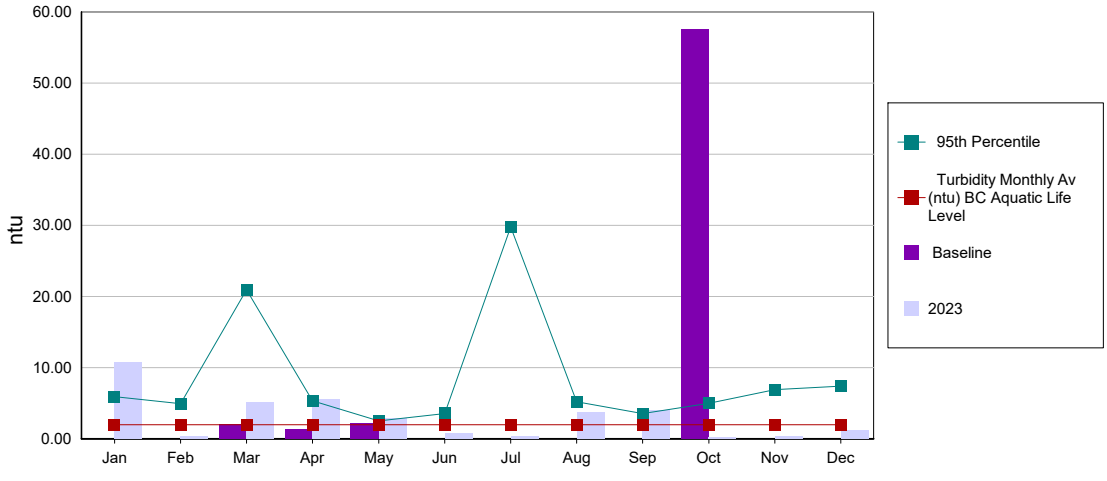
W5 - Bootjack Creek above Hazeltine Creek : TSS (mg/L)



W5 - Bootjack Creek above Hazeltine Creek : TSS Monthly Average (mg/L)



W5 - Bootjack Creek above Hazeltine Creek : Turbidity Monthly Av (ntu)



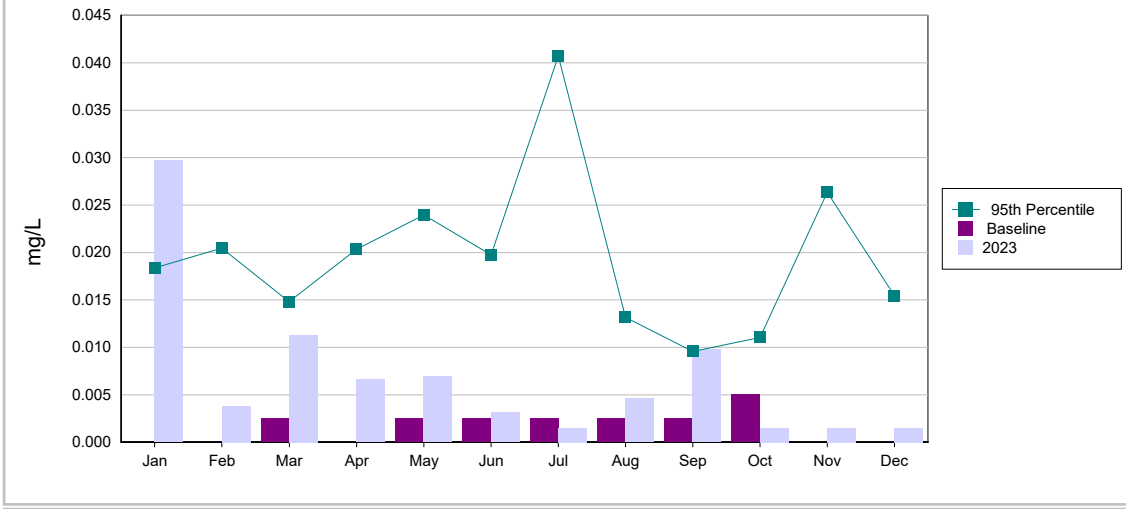
Water Quality Report

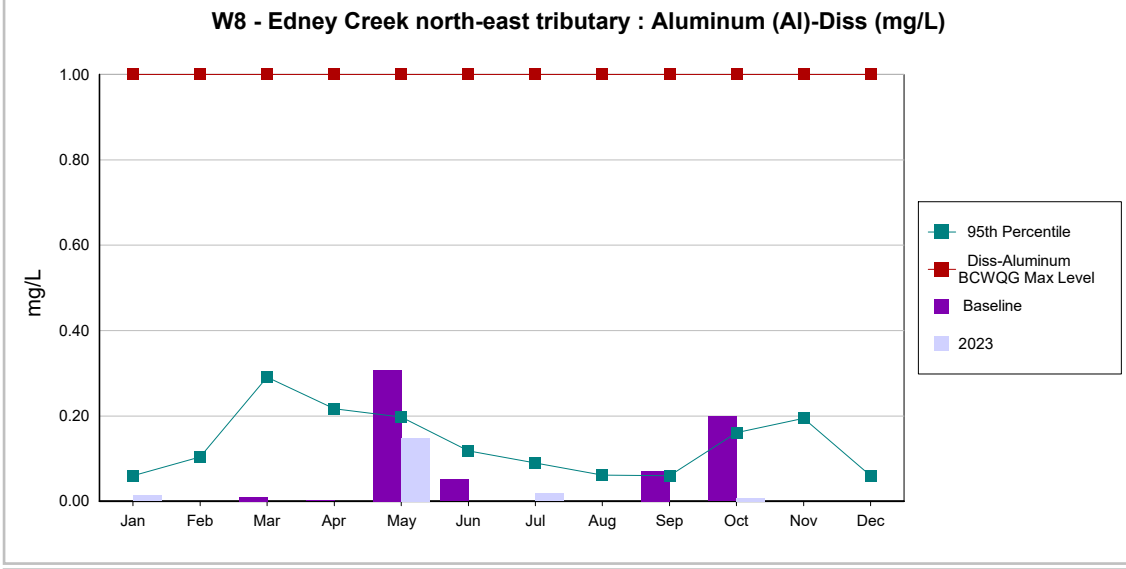
Annual Report SW vs BCWQG

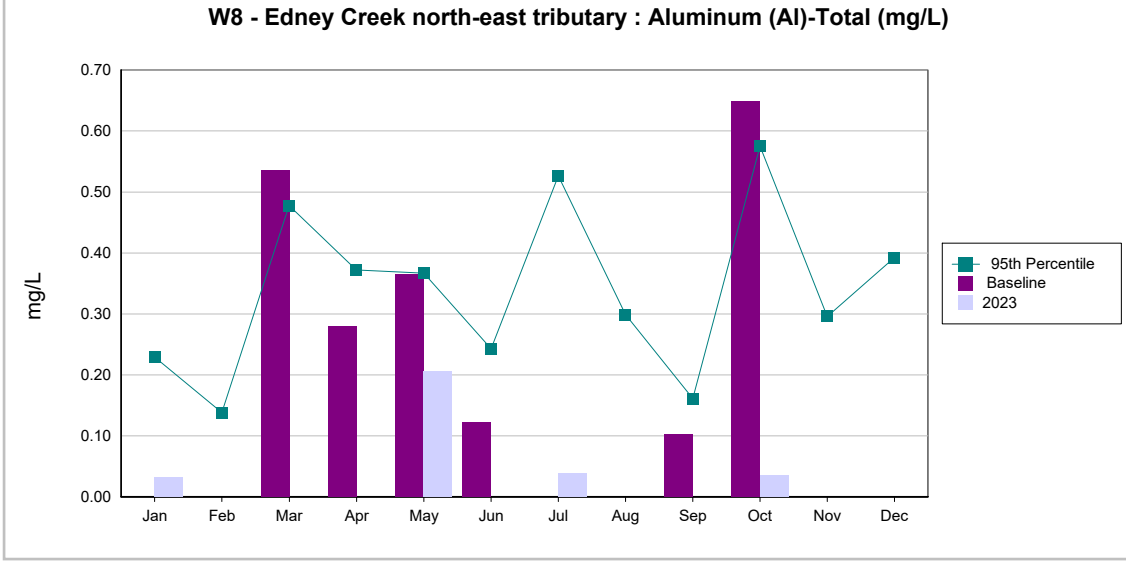
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







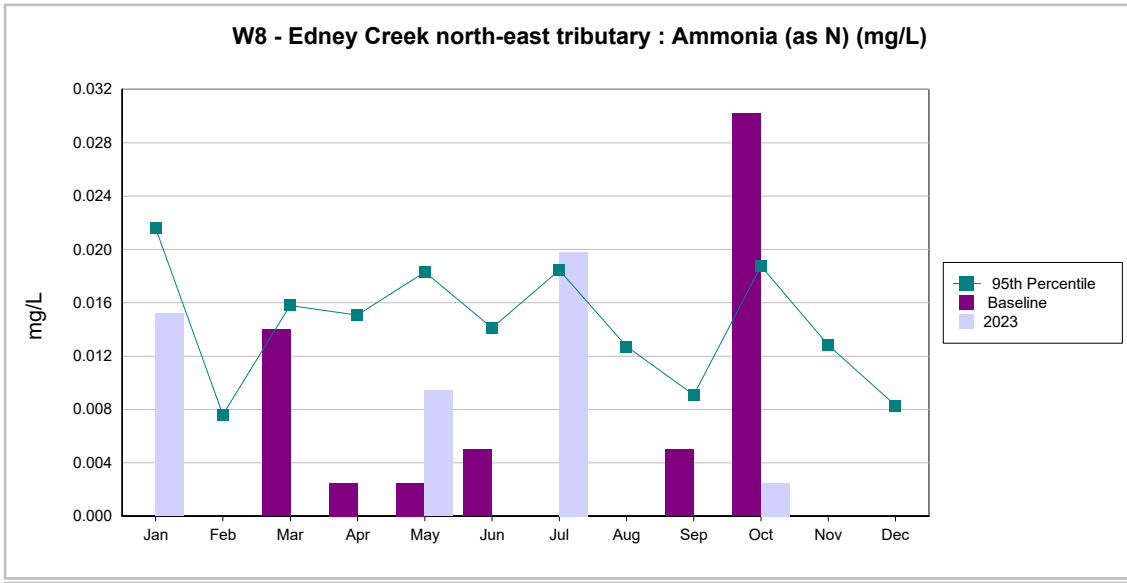
Water Quality Report

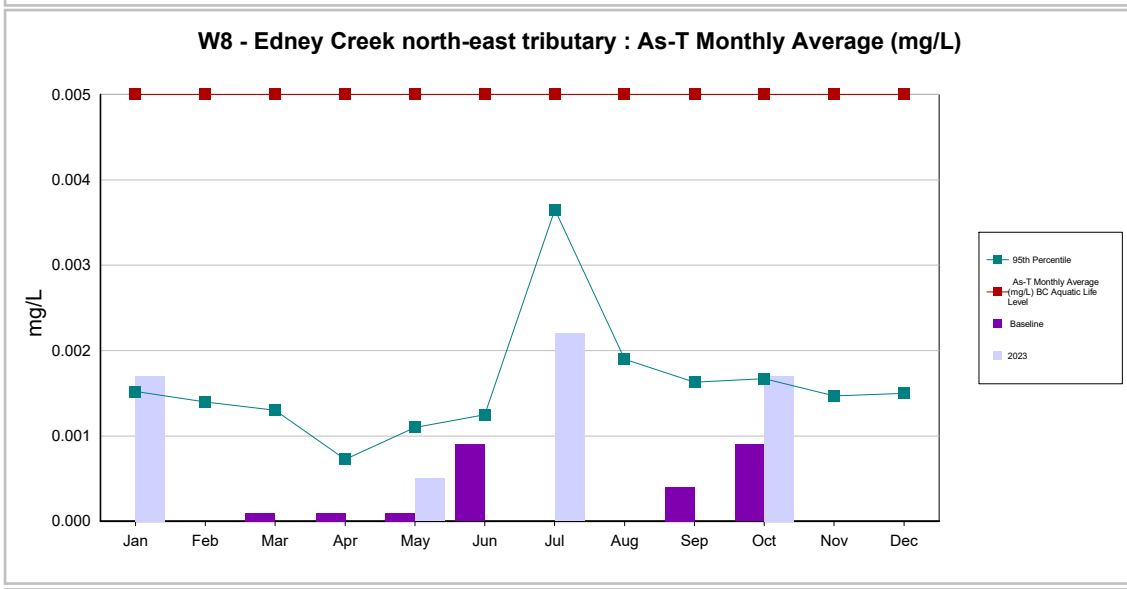
Annual Report SW vs BCWQG

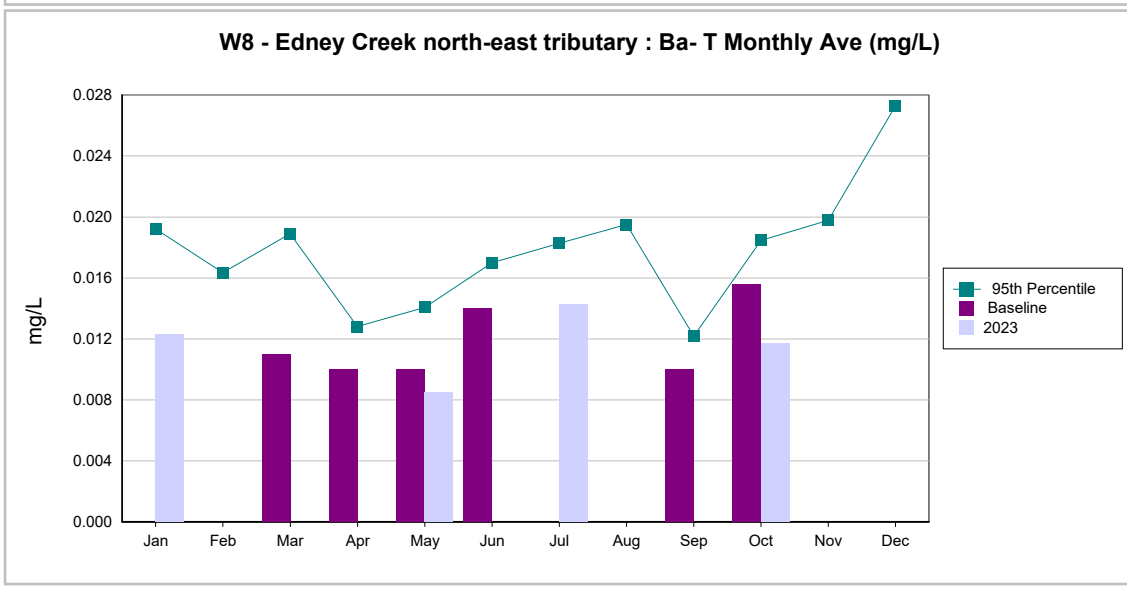
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







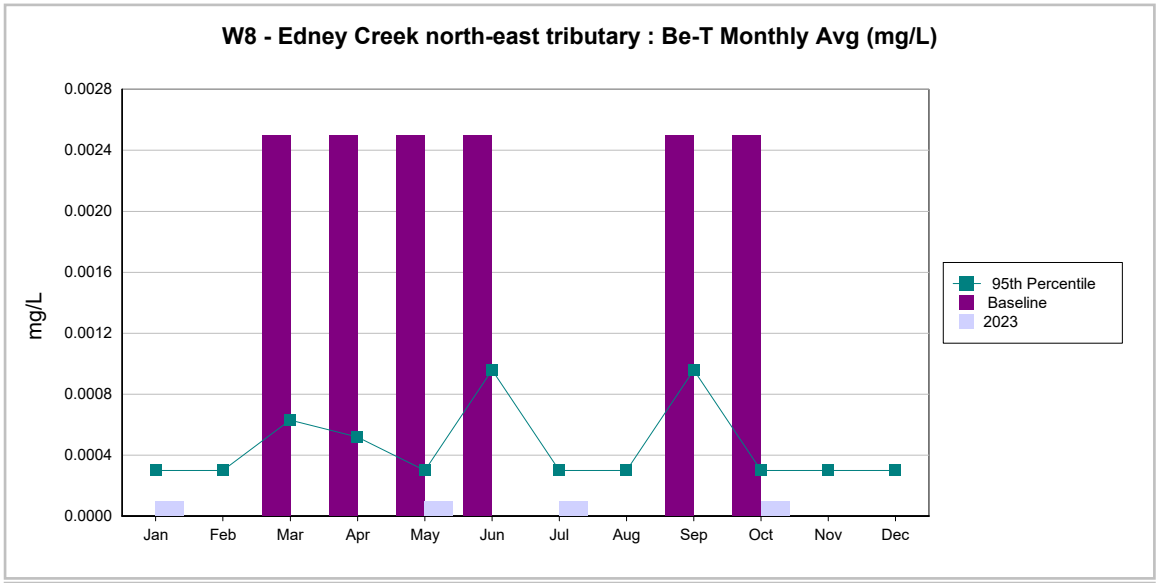
Water Quality Report

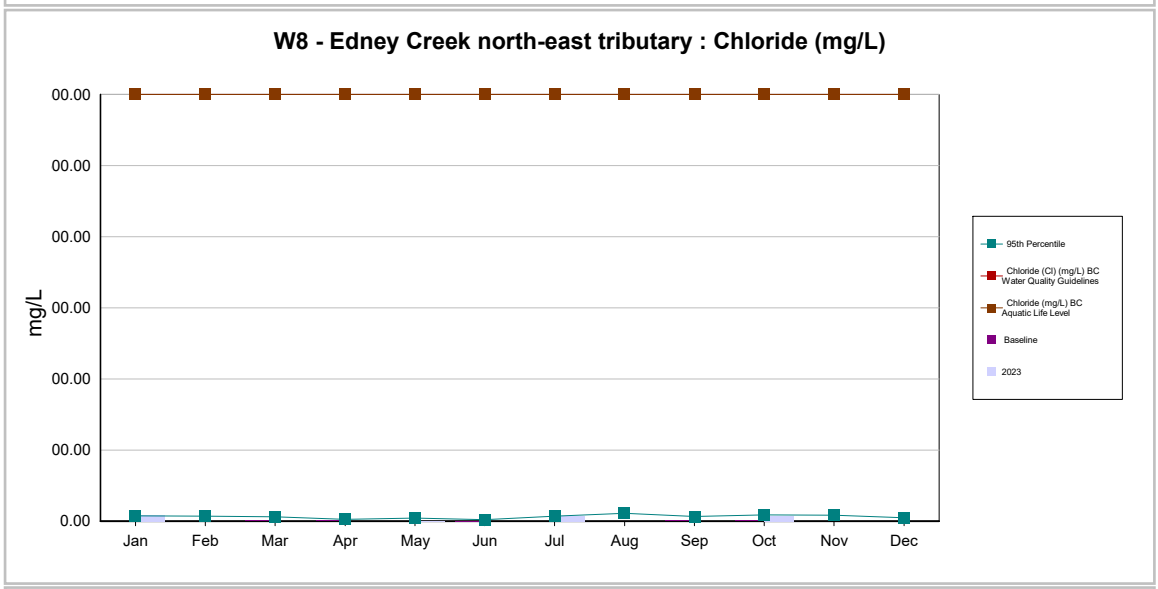
Annual Report SW vs BCWQG

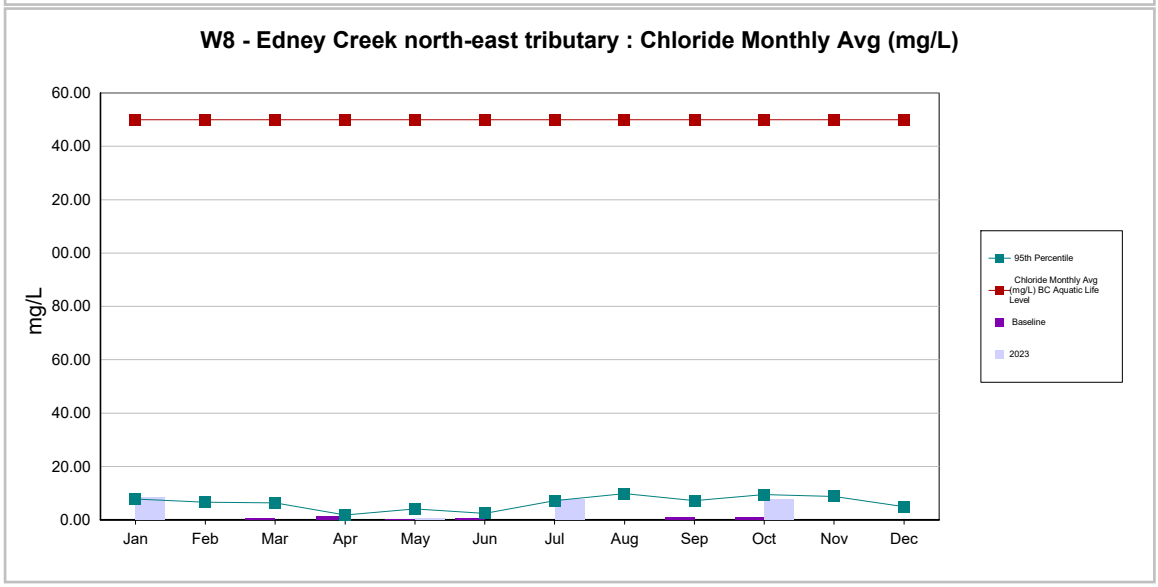
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







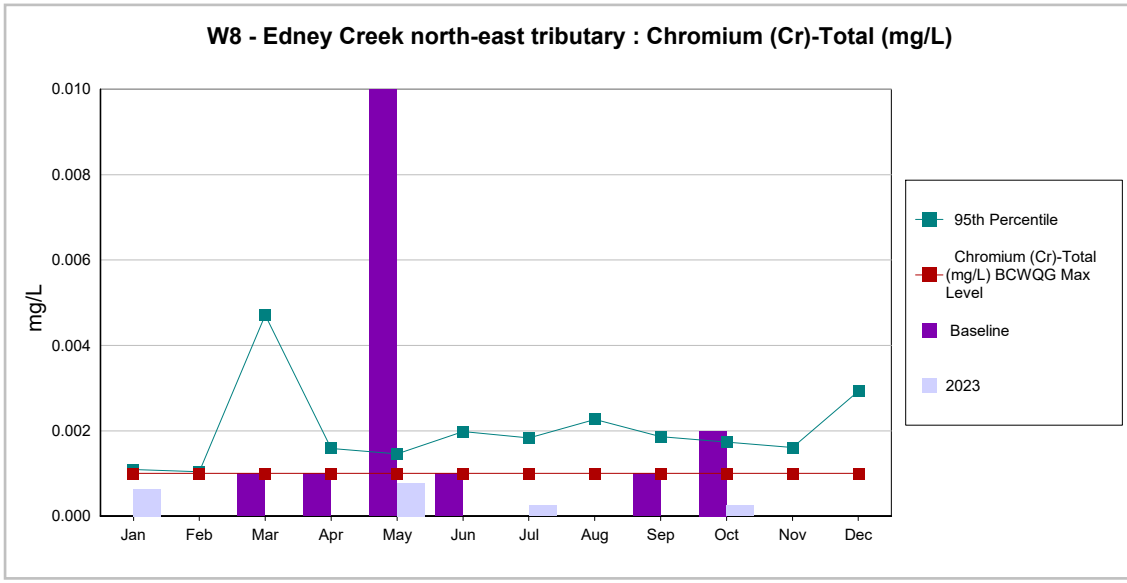
Water Quality Report

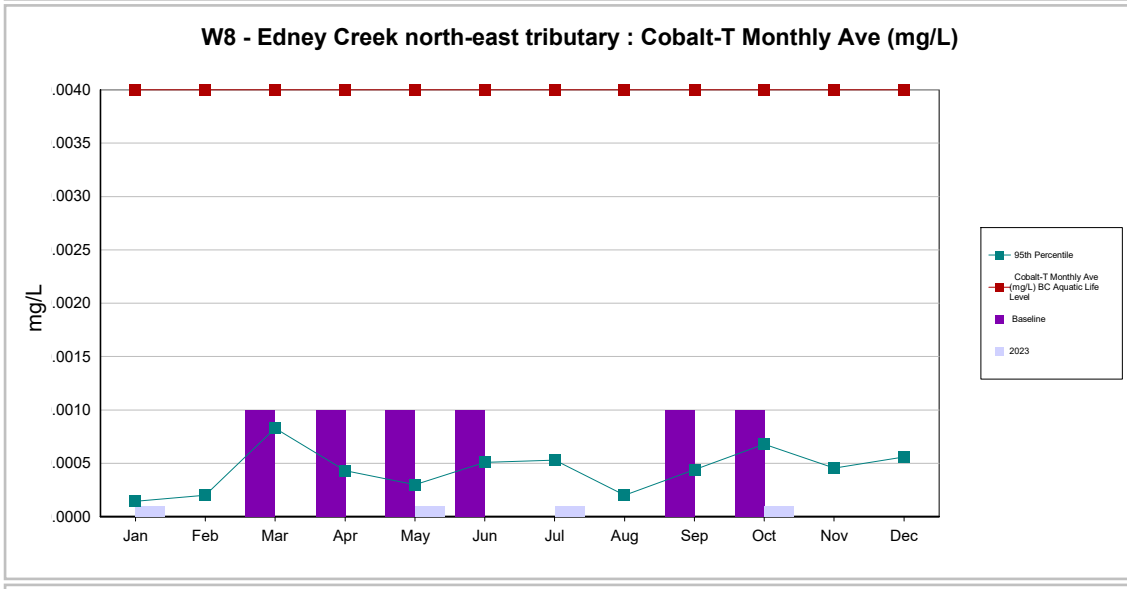
Annual Report SW vs BCWQG

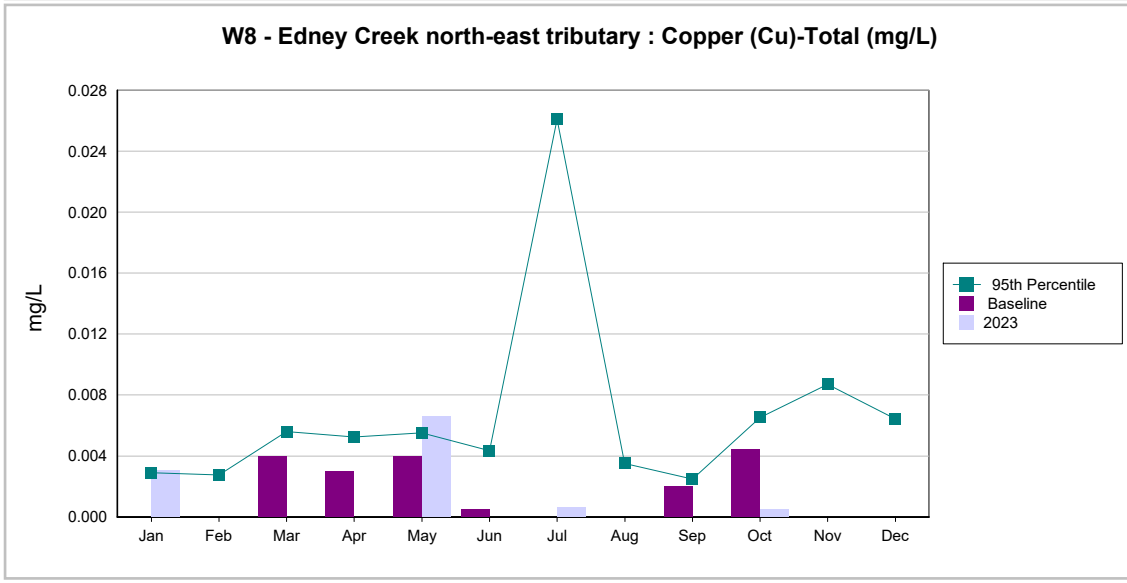
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







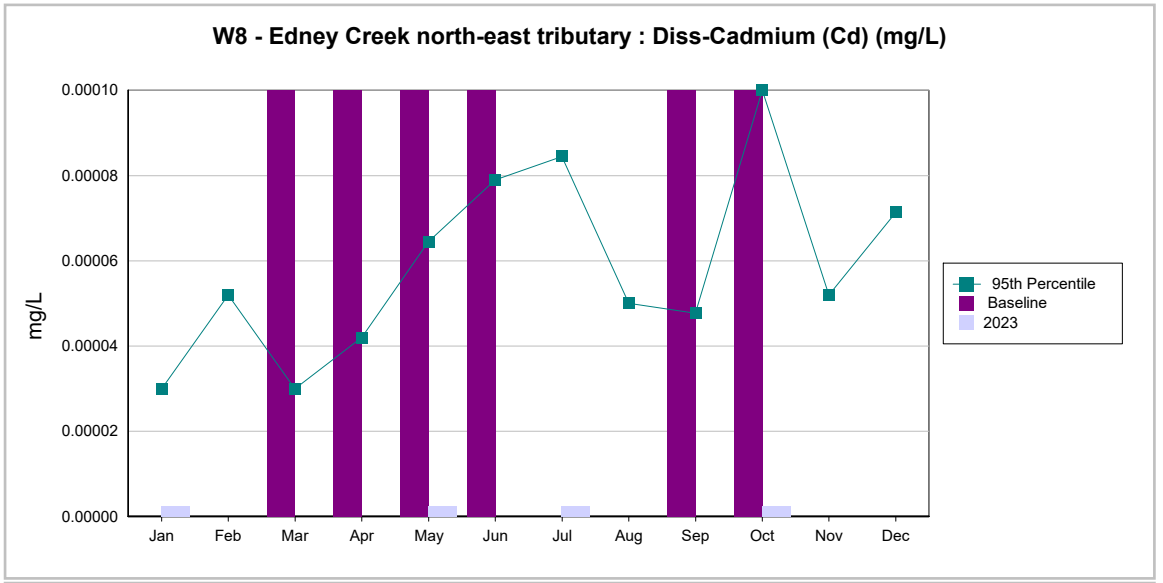
Water Quality Report

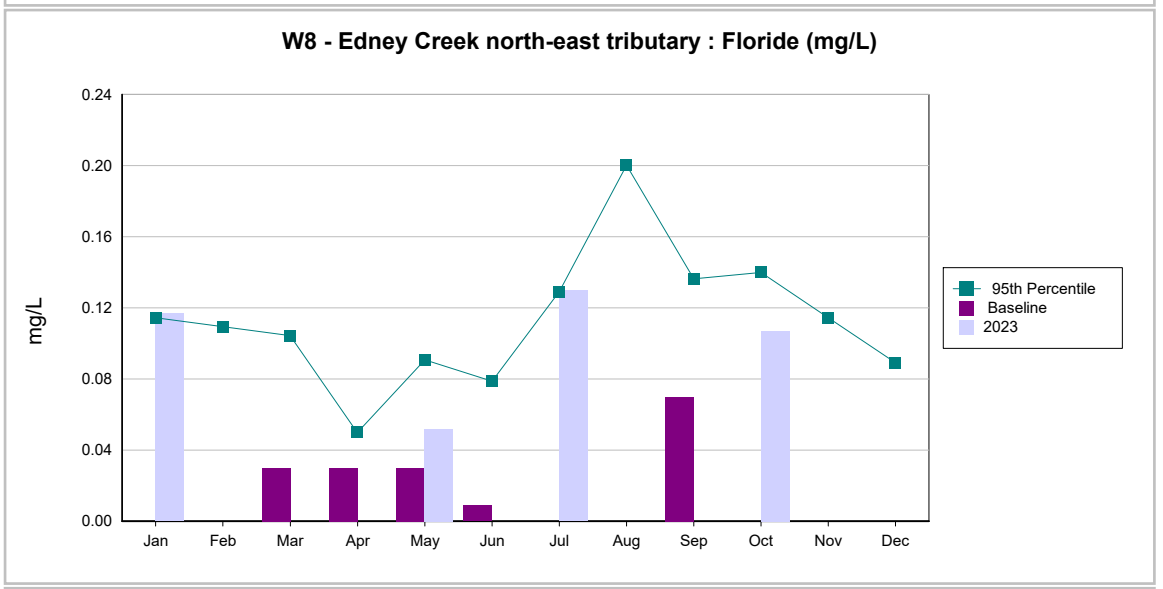
Annual Report SW vs BCWQG

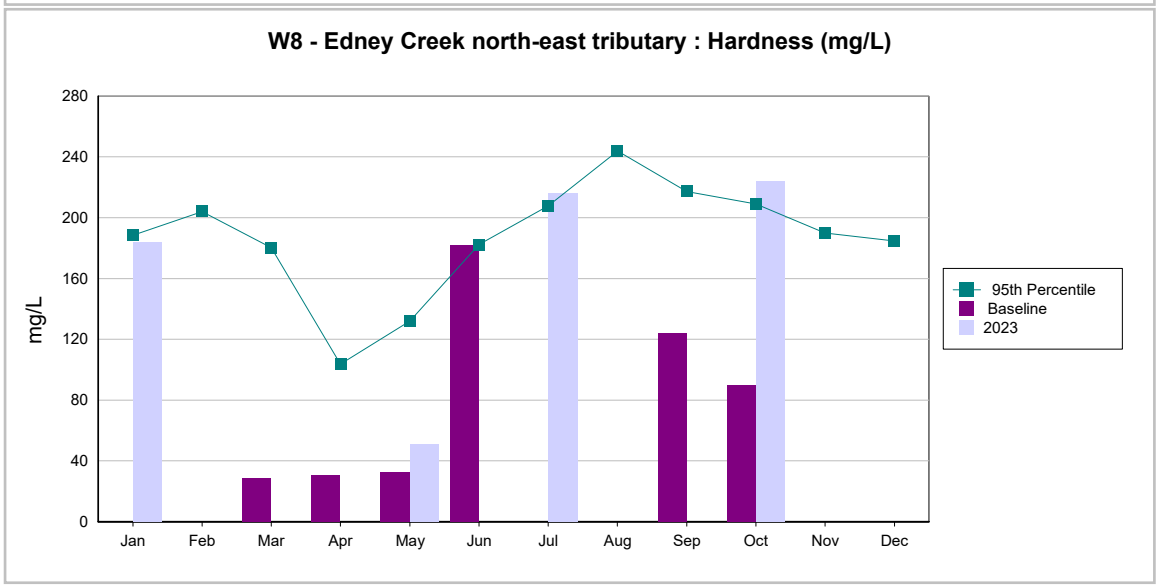
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







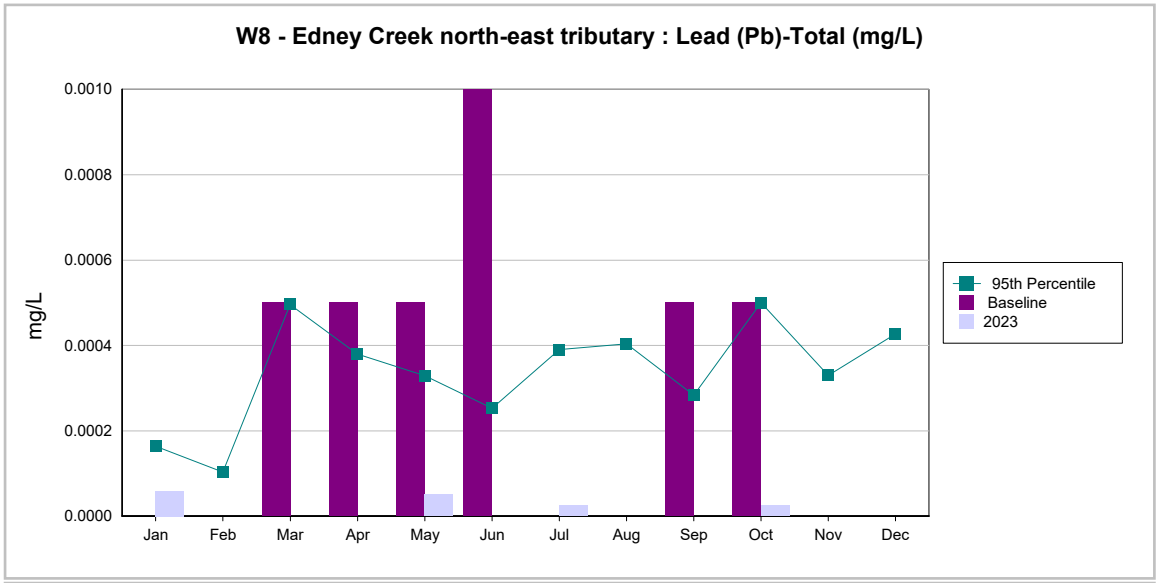
Water Quality Report

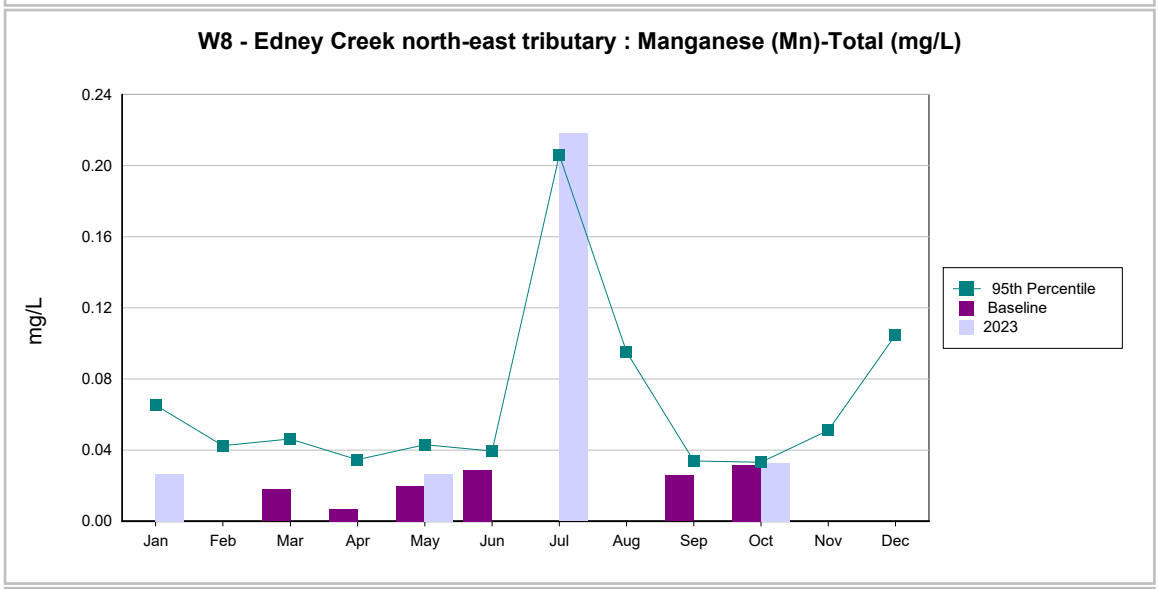
Annual Report SW vs BCWQG

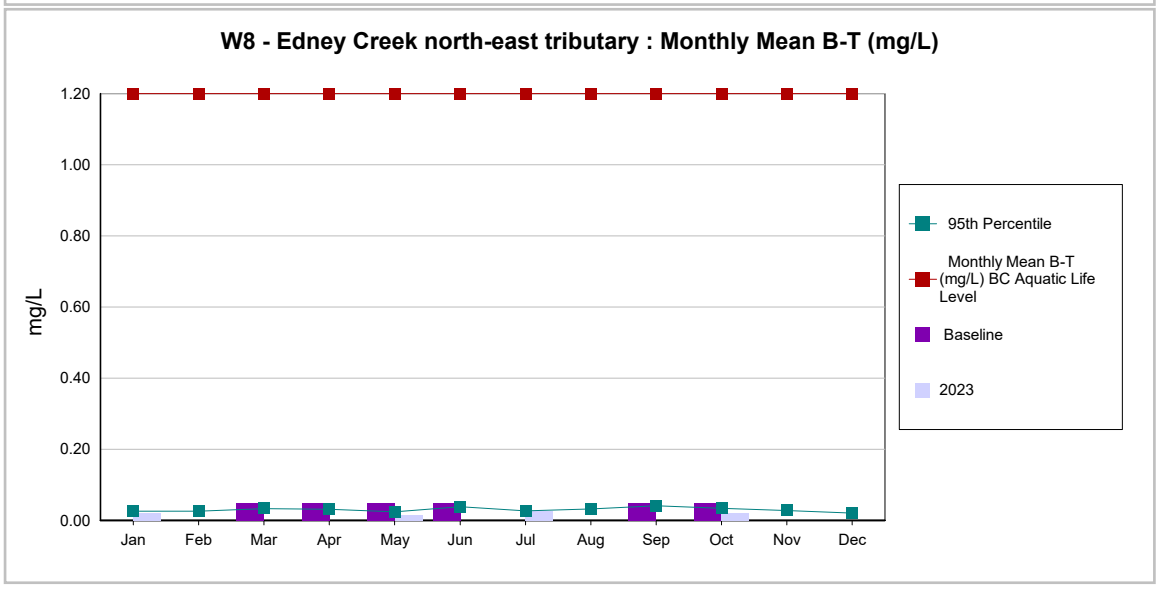
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







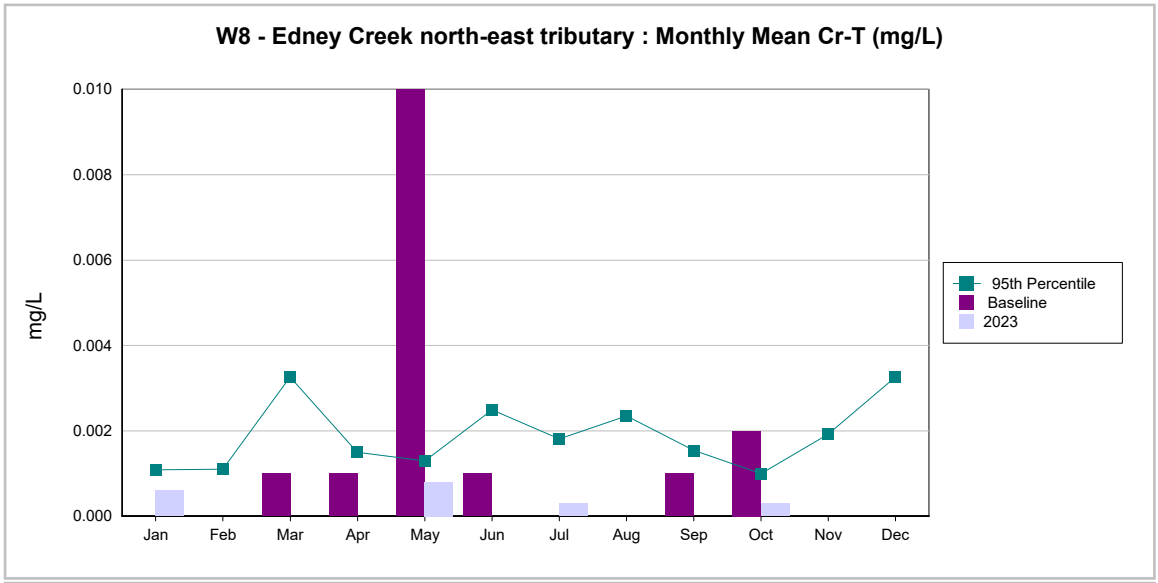
Water Quality Report

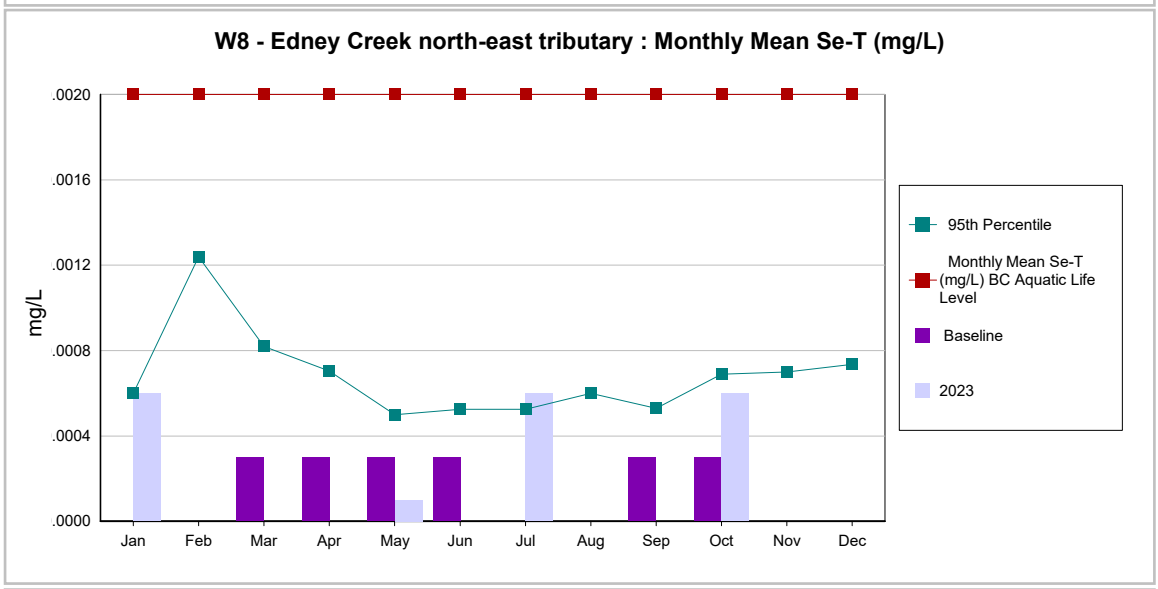
Annual Report SW vs BCWQG

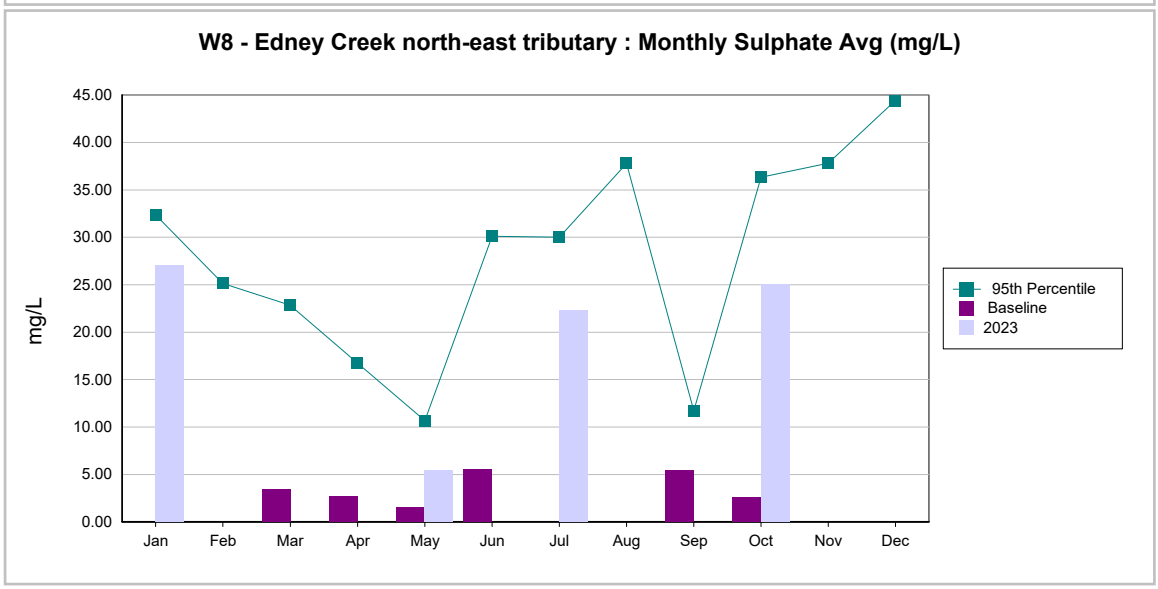
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







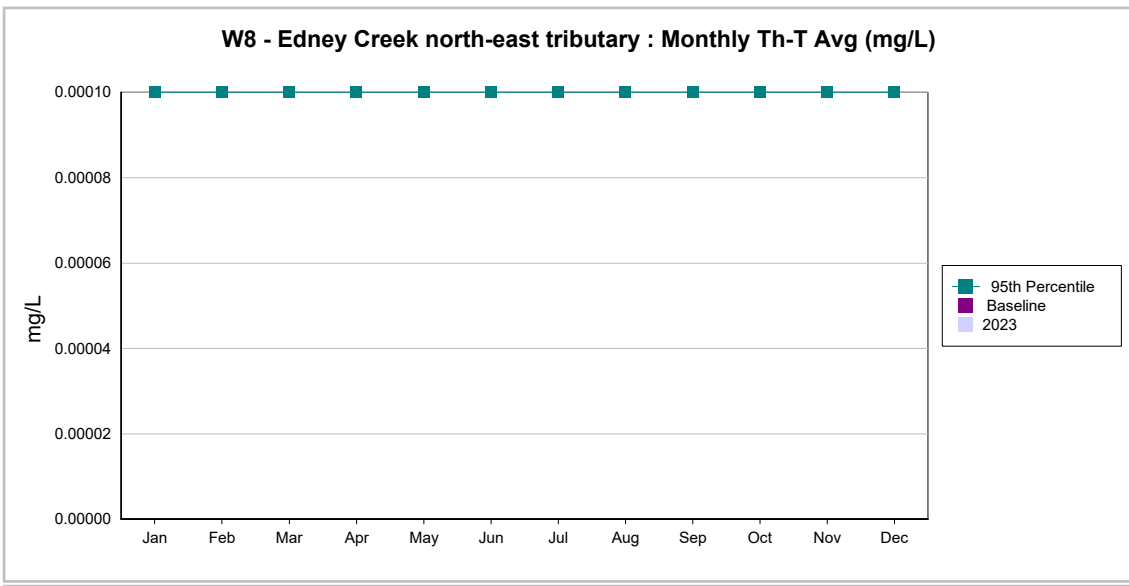
Water Quality Report

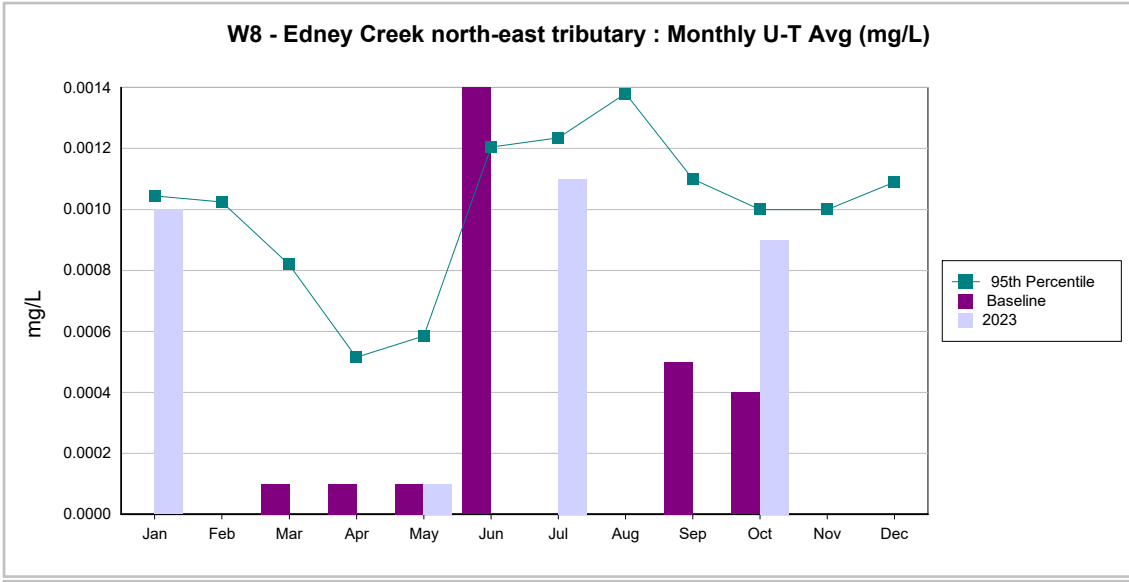
Annual Report SW vs BCWQG

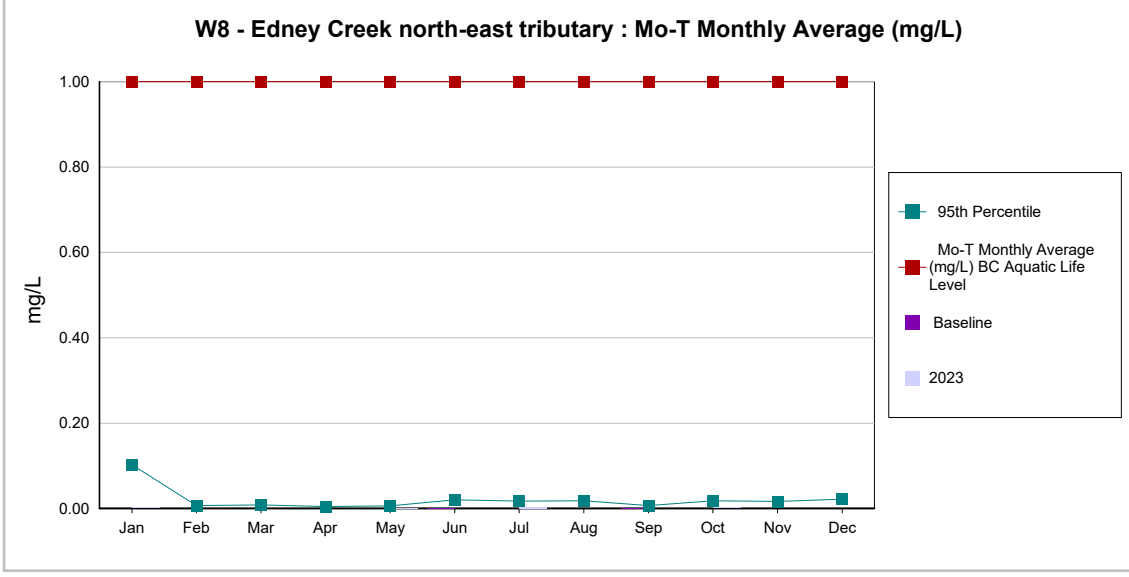
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







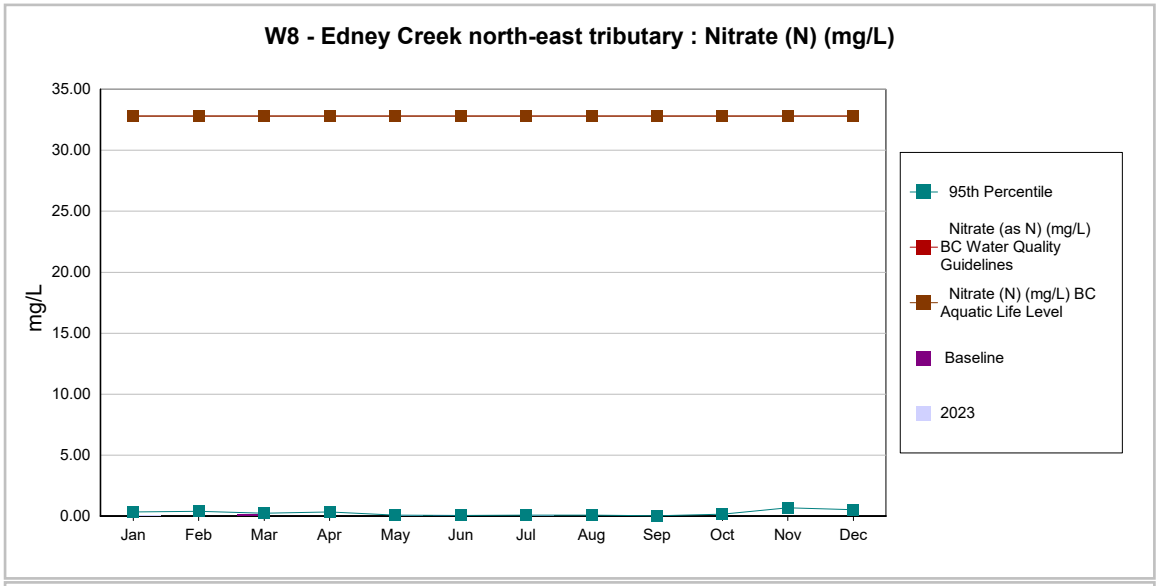
Water Quality Report

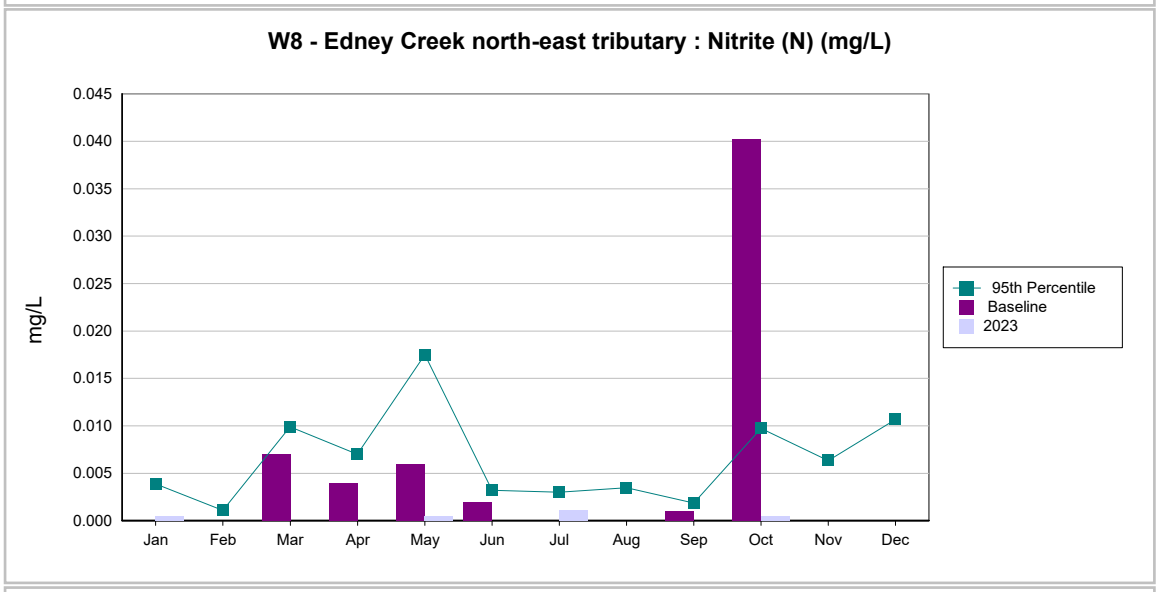
Annual Report SW vs BCWQG

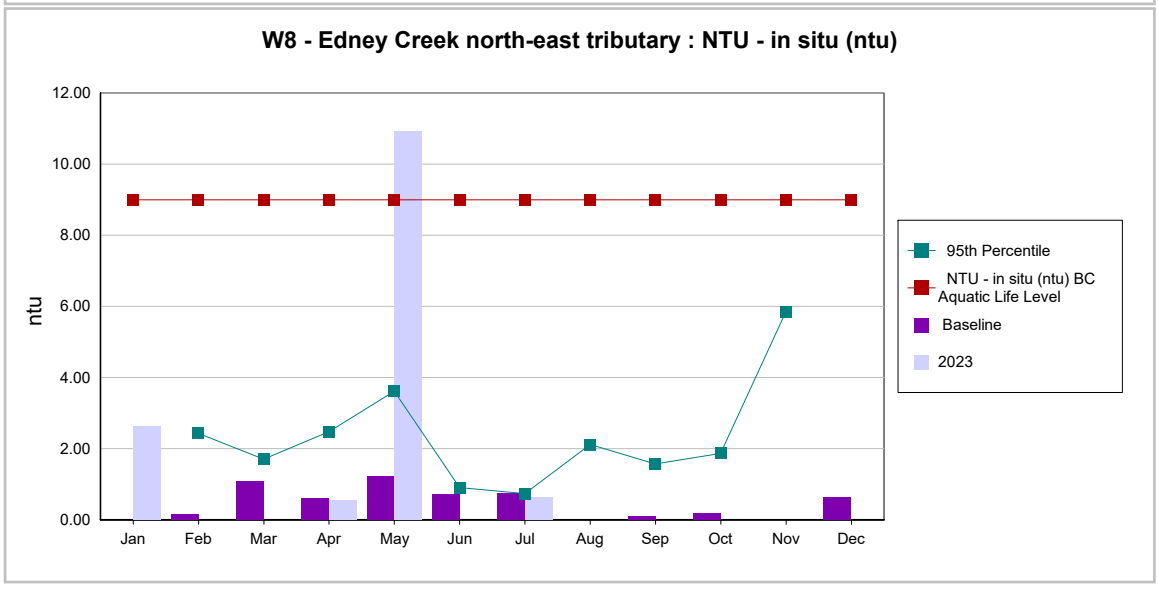
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







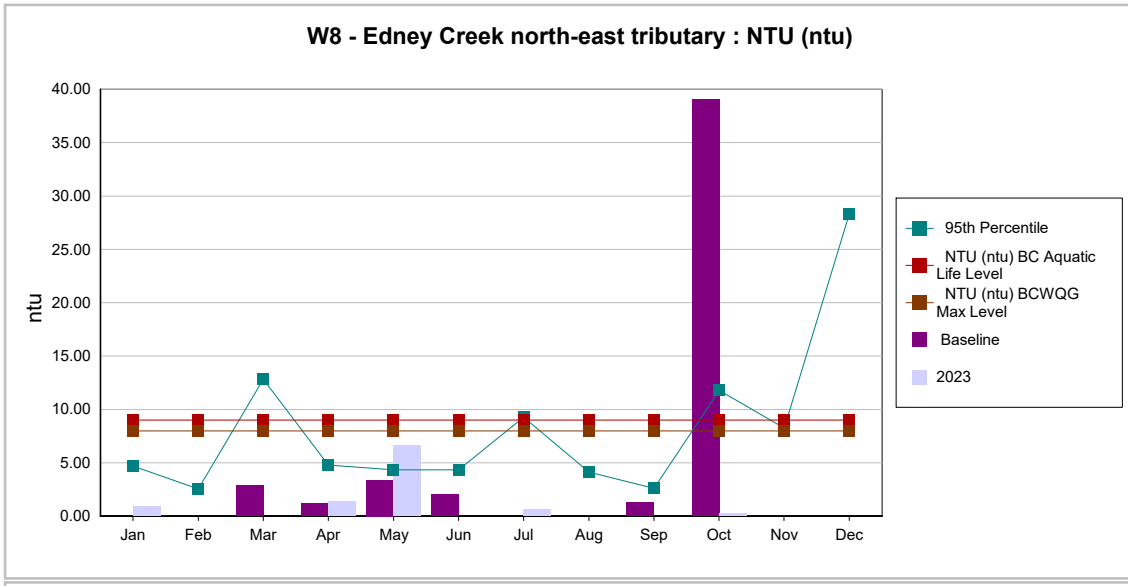
Water Quality Report

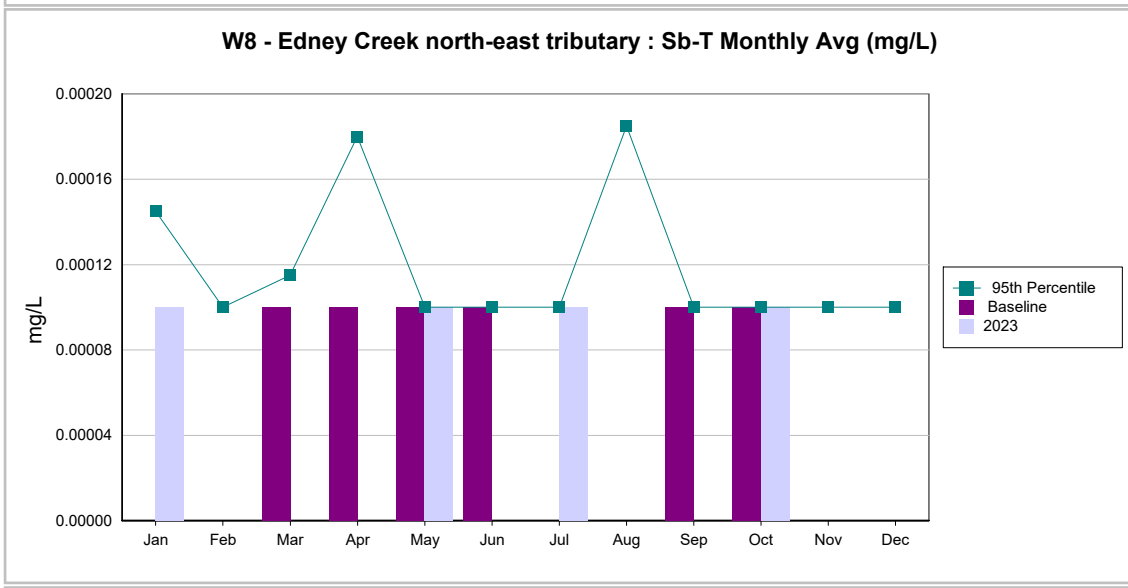
Annual Report SW vs BCWQG

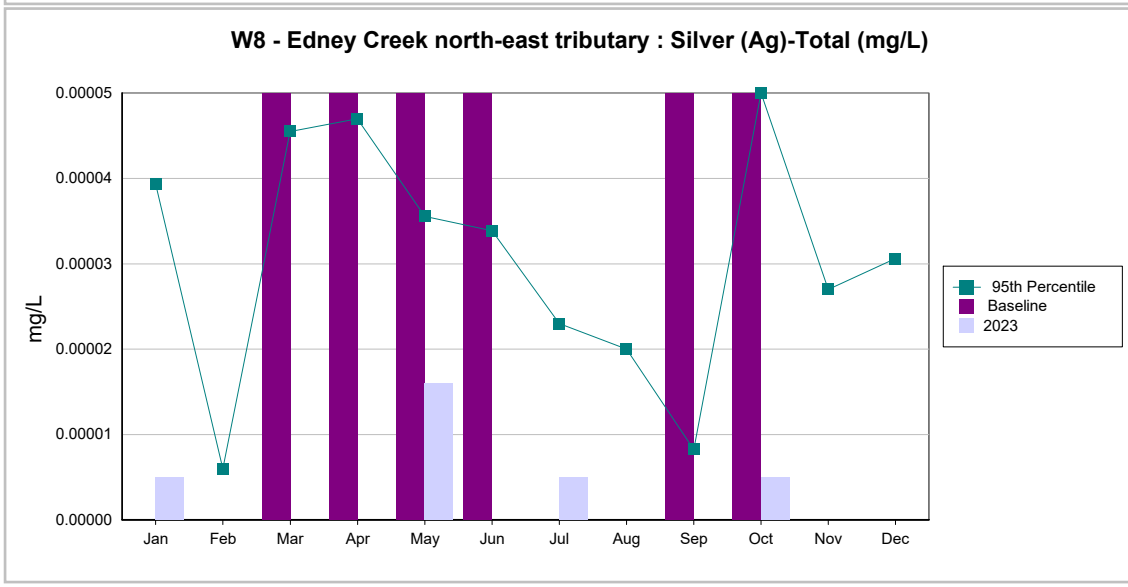
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







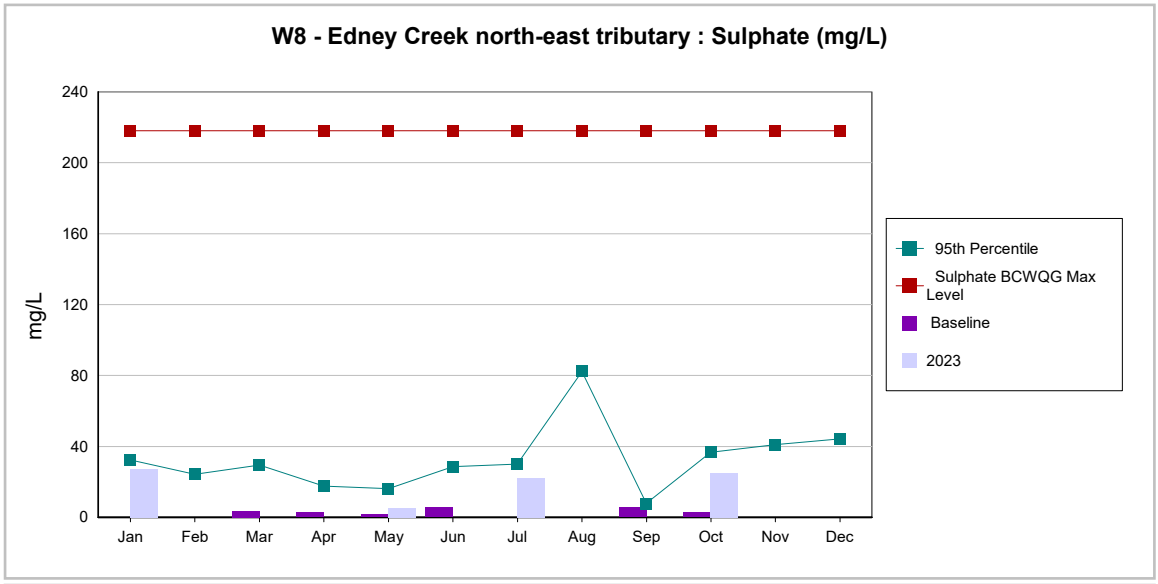
Water Quality Report

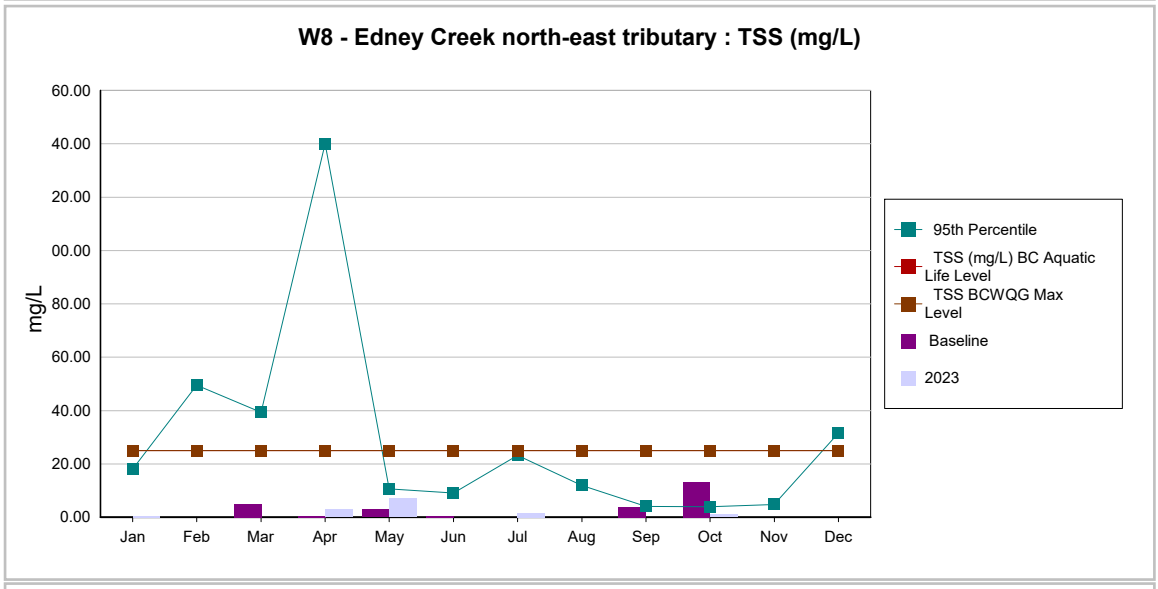
Annual Report SW vs BCWQG

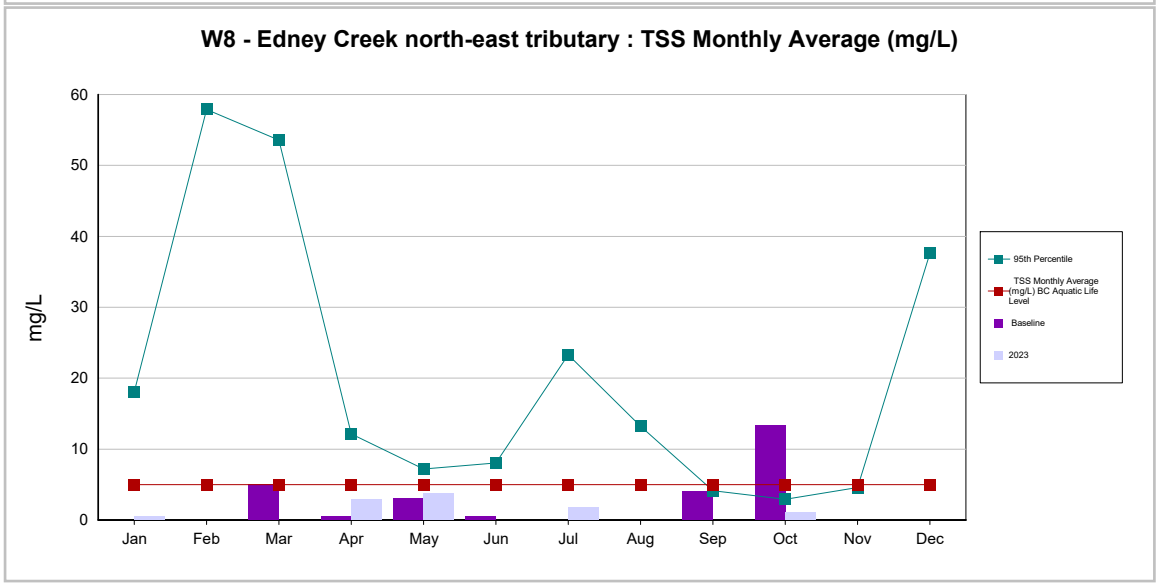
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







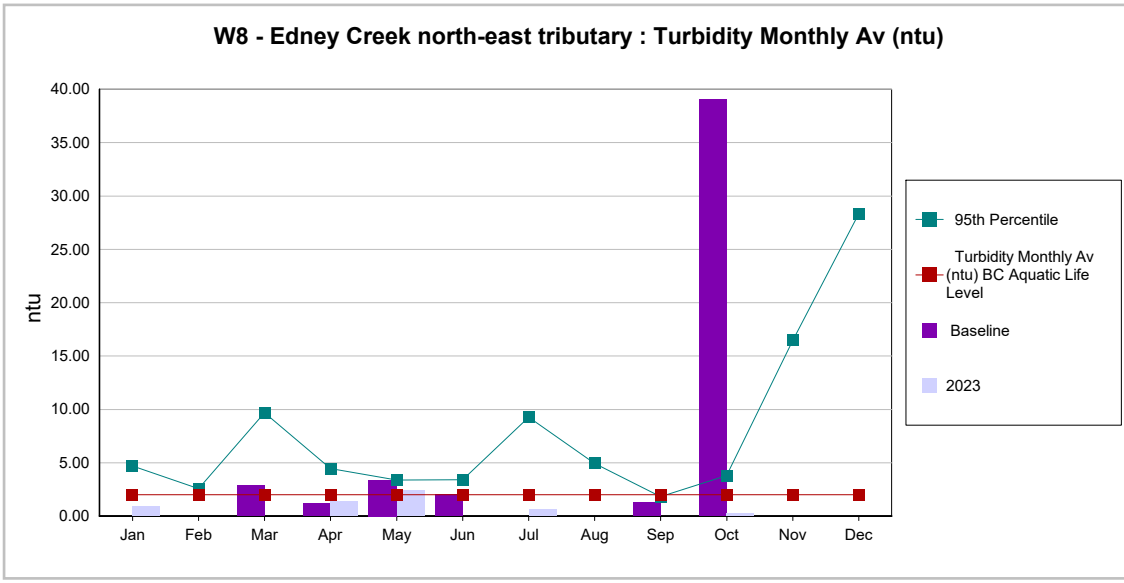
Water Quality Report

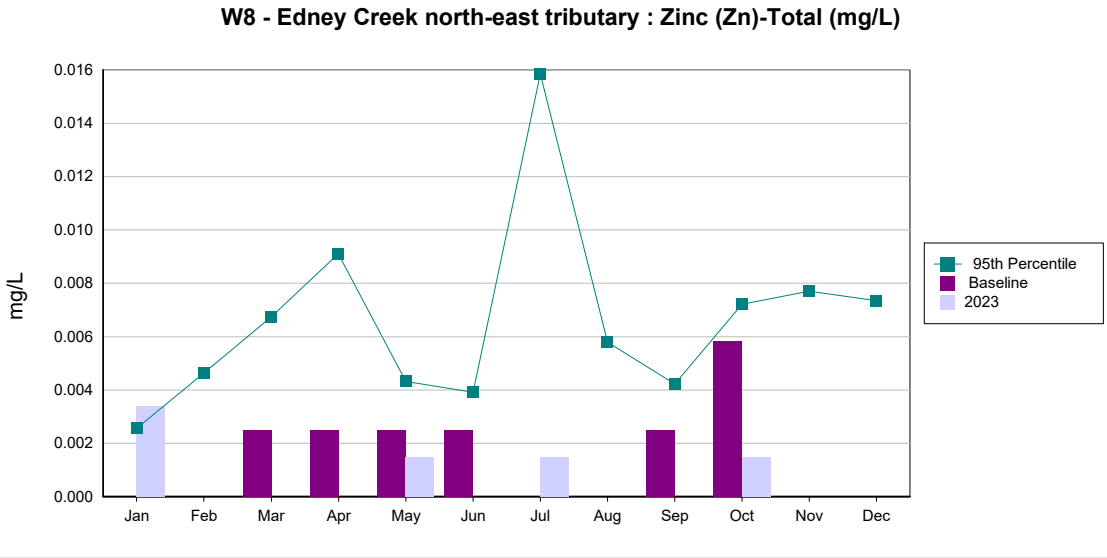
Annual Report SW vs BCWQG

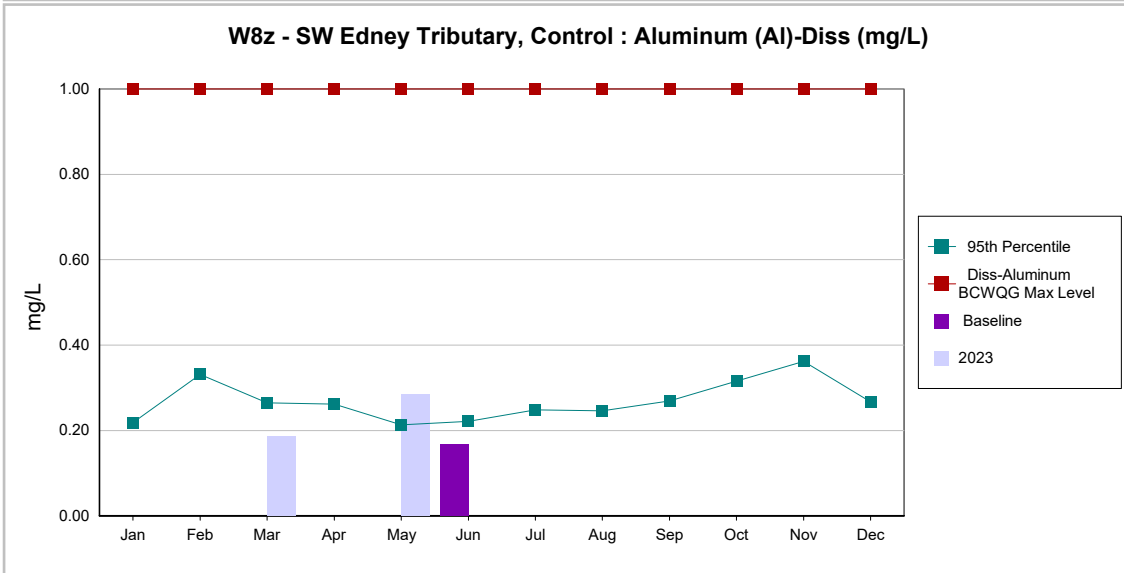
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







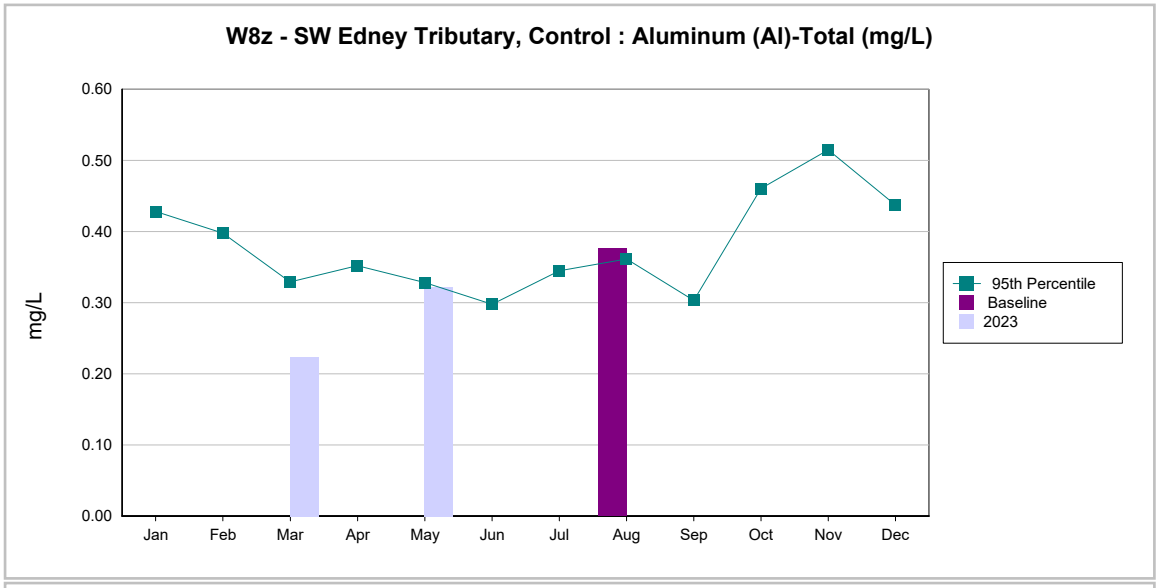
Water Quality Report

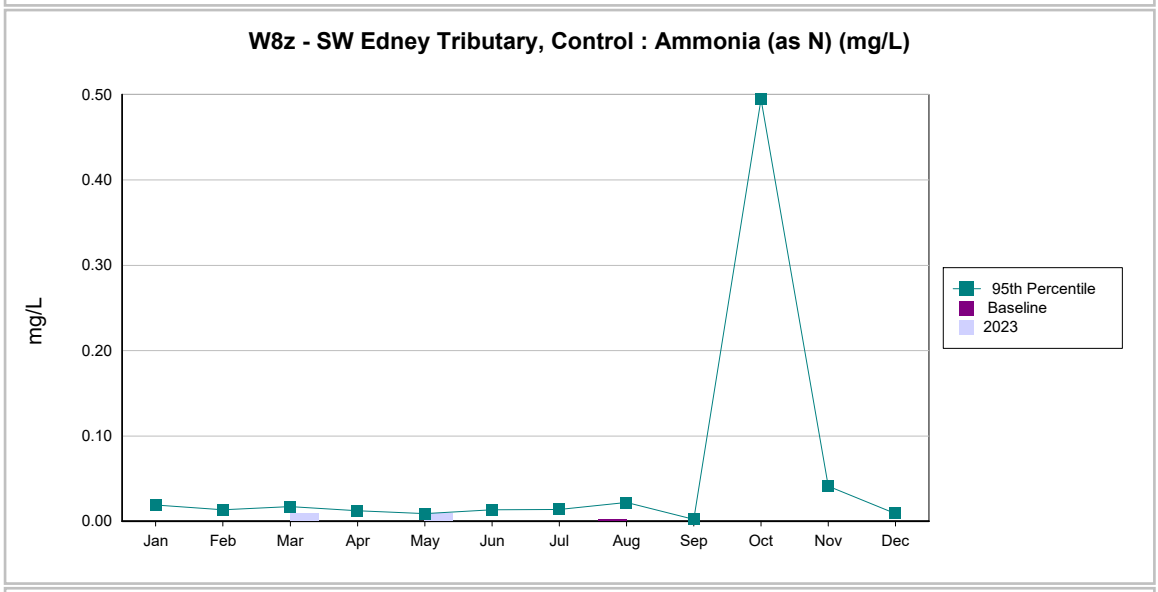
Annual Report SW vs BCWQG

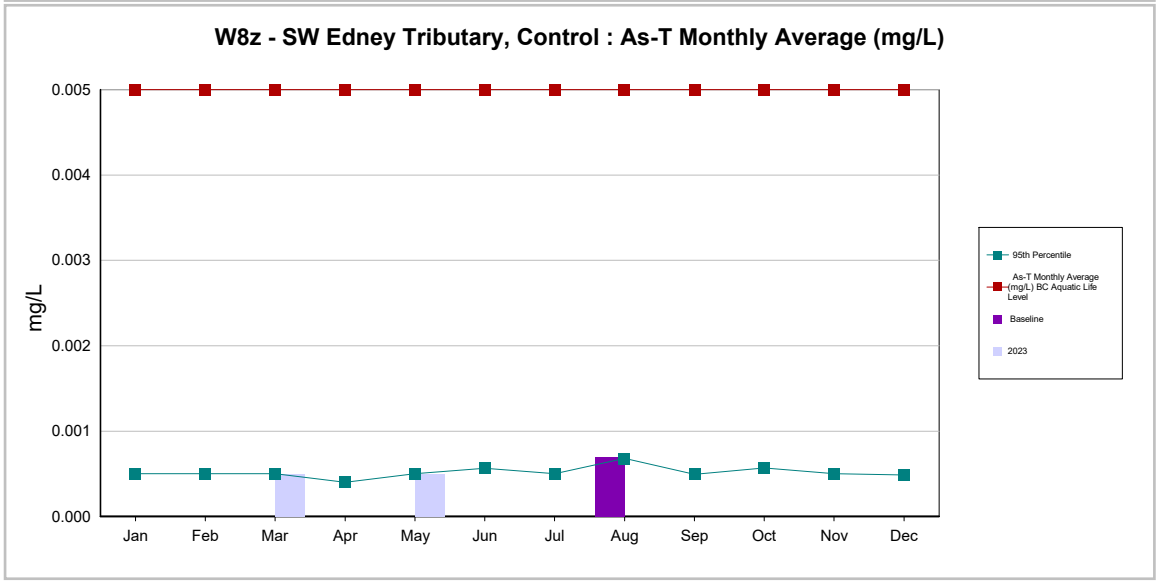
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







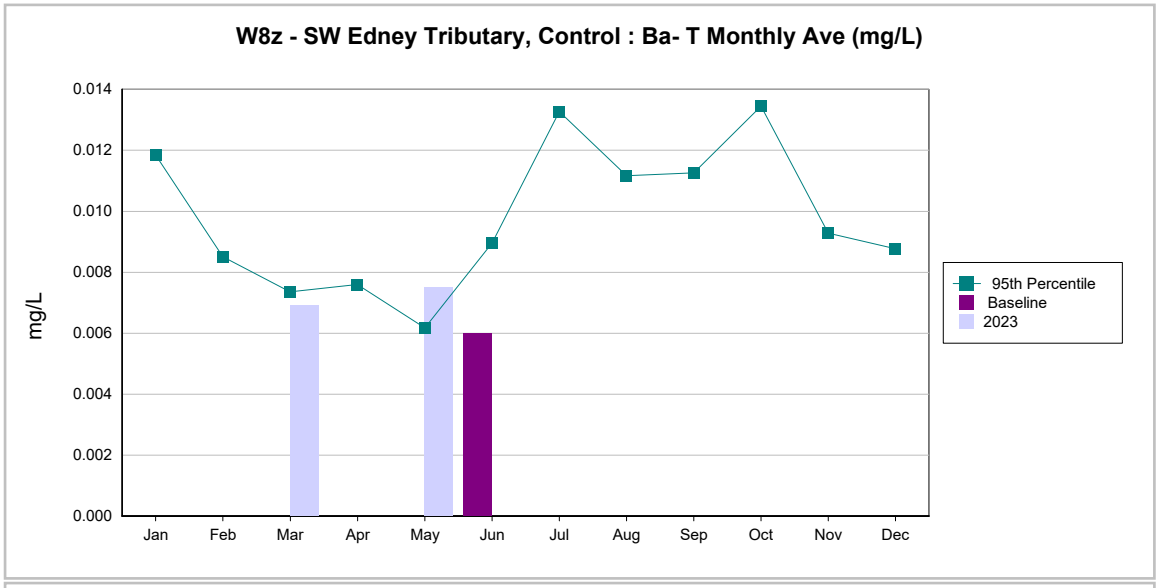
Water Quality Report

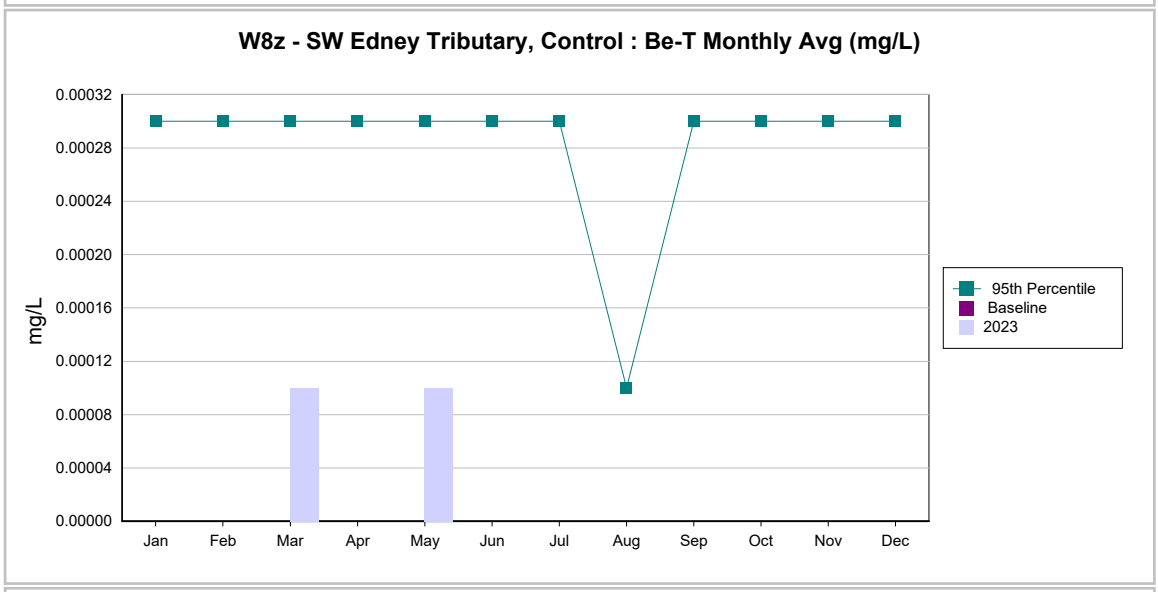
Annual Report SW vs BCWQG

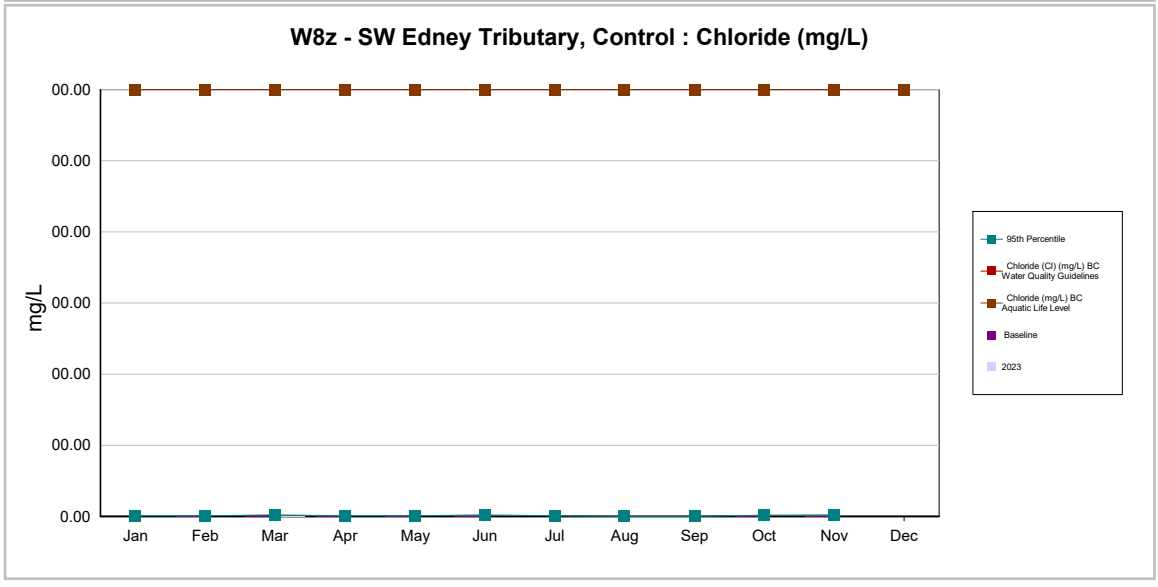
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







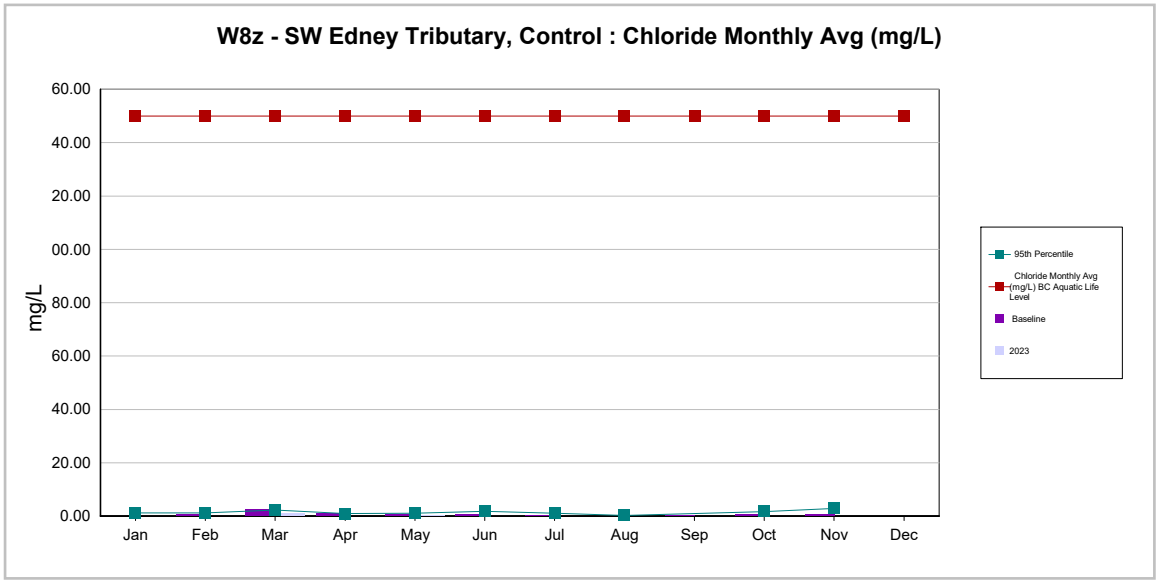
Water Quality Report

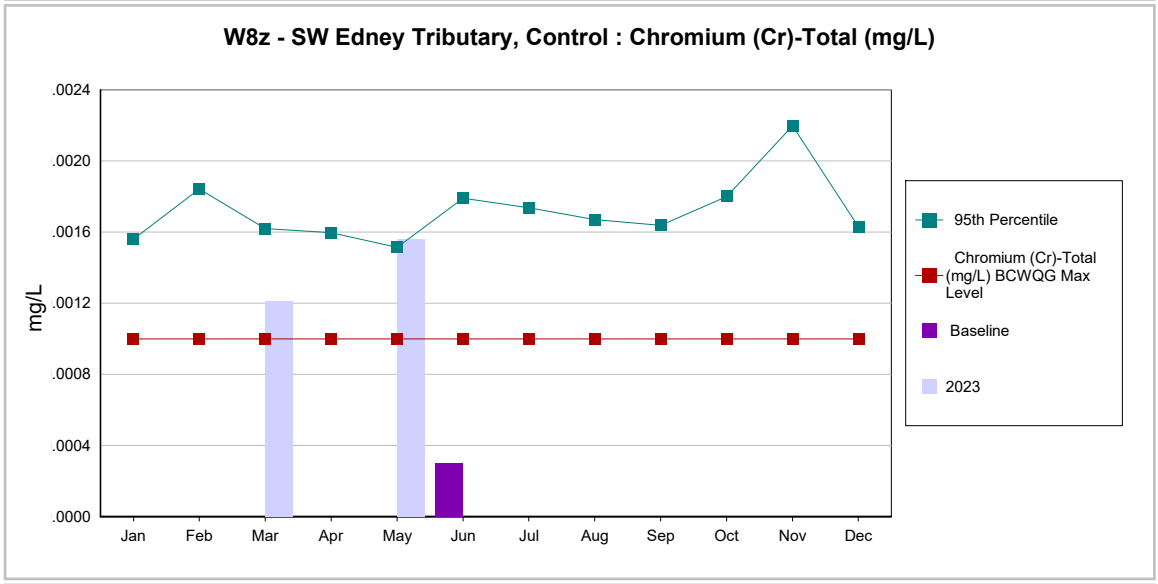
Annual Report SW vs BCWQG

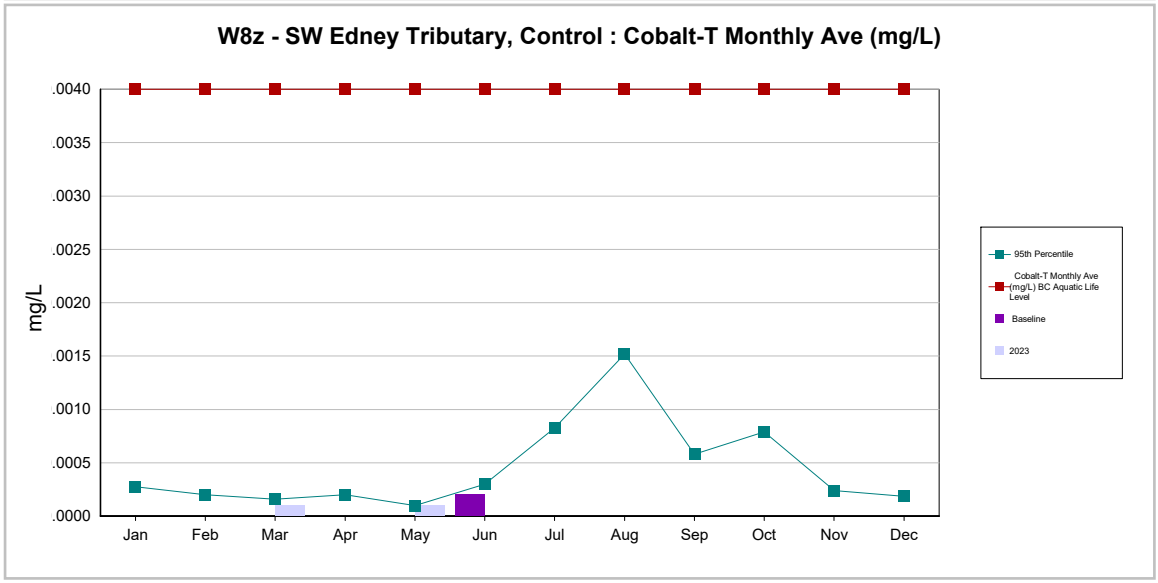
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







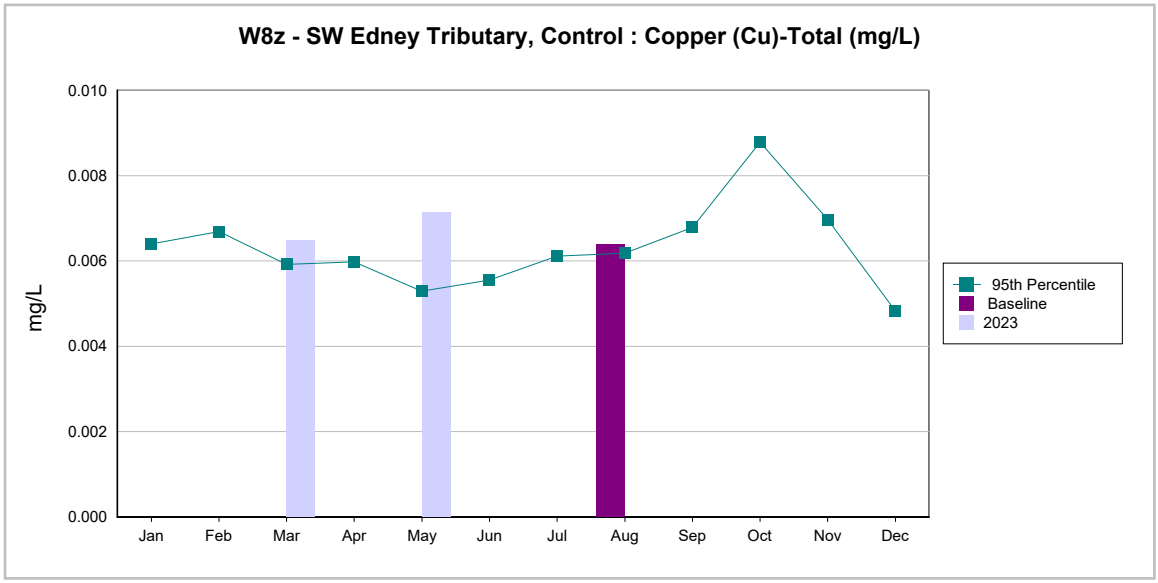
Water Quality Report

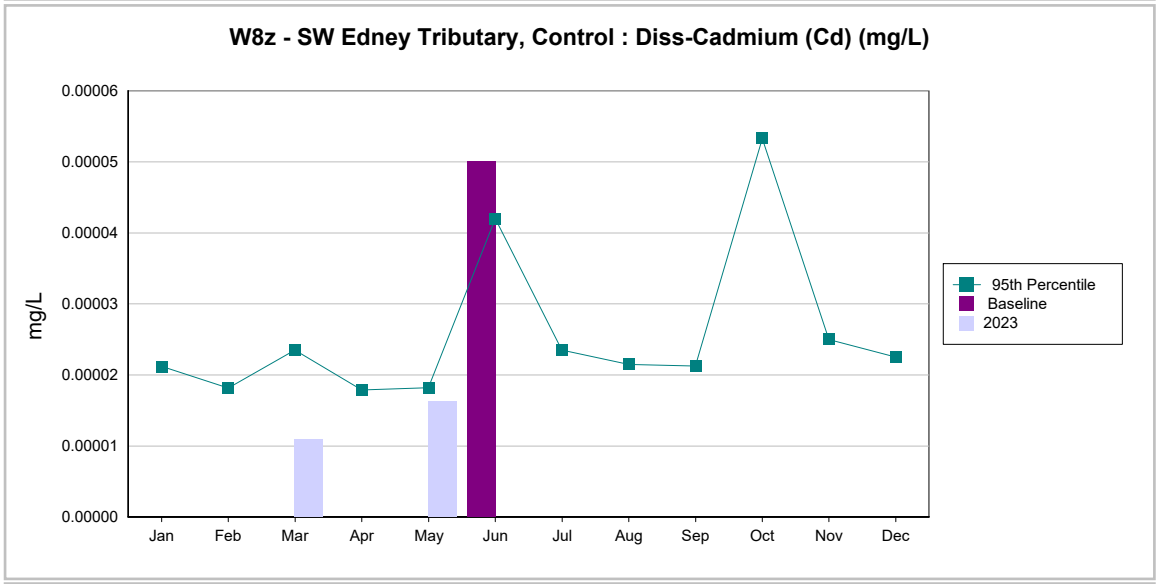
Annual Report SW vs BCWQG

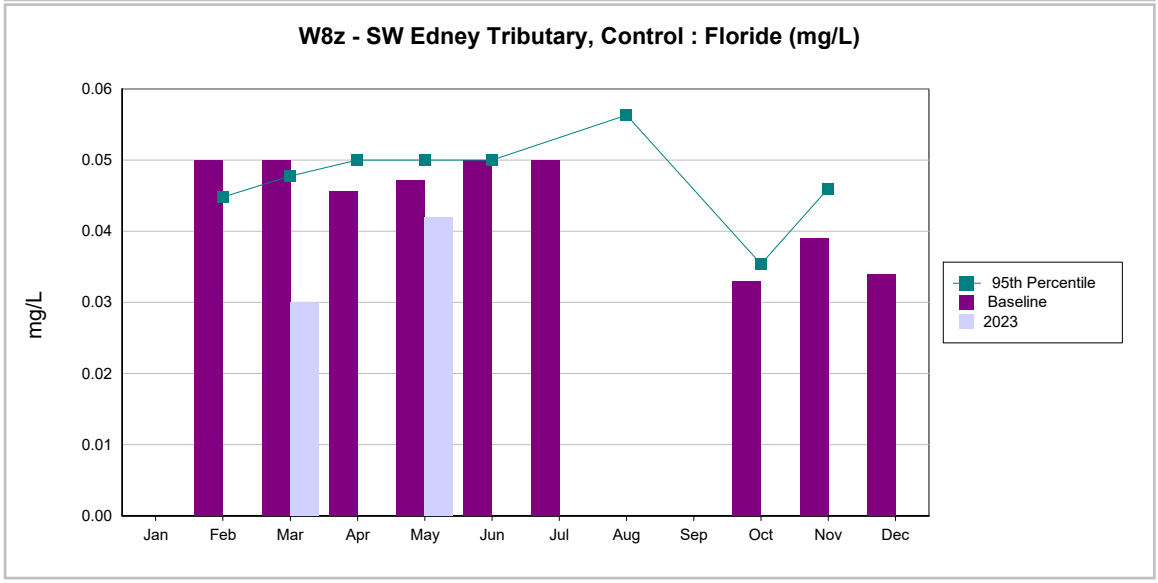
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







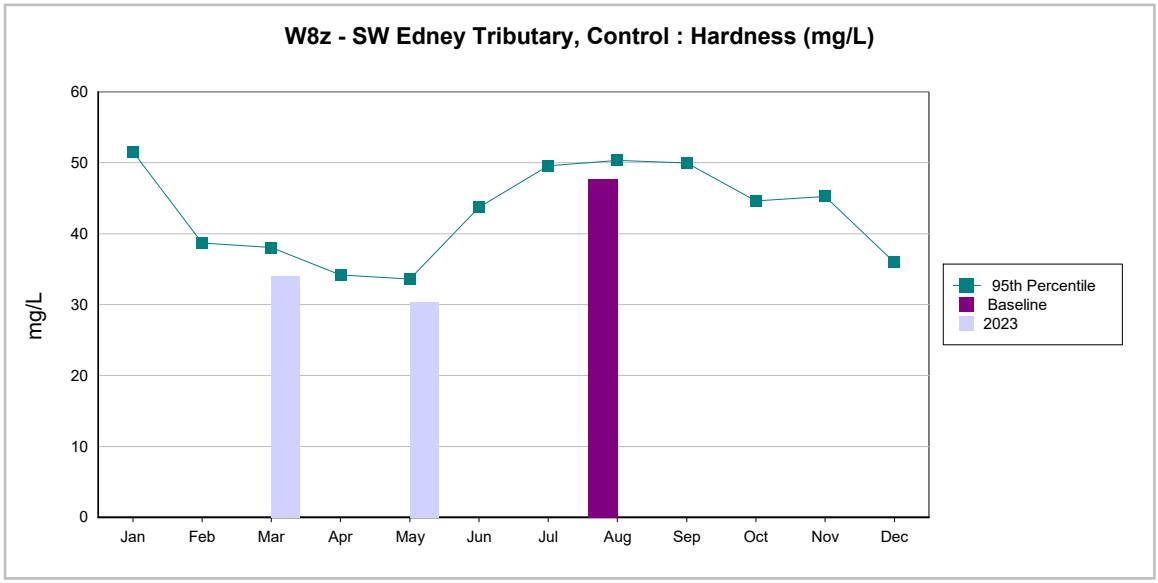
Water Quality Report

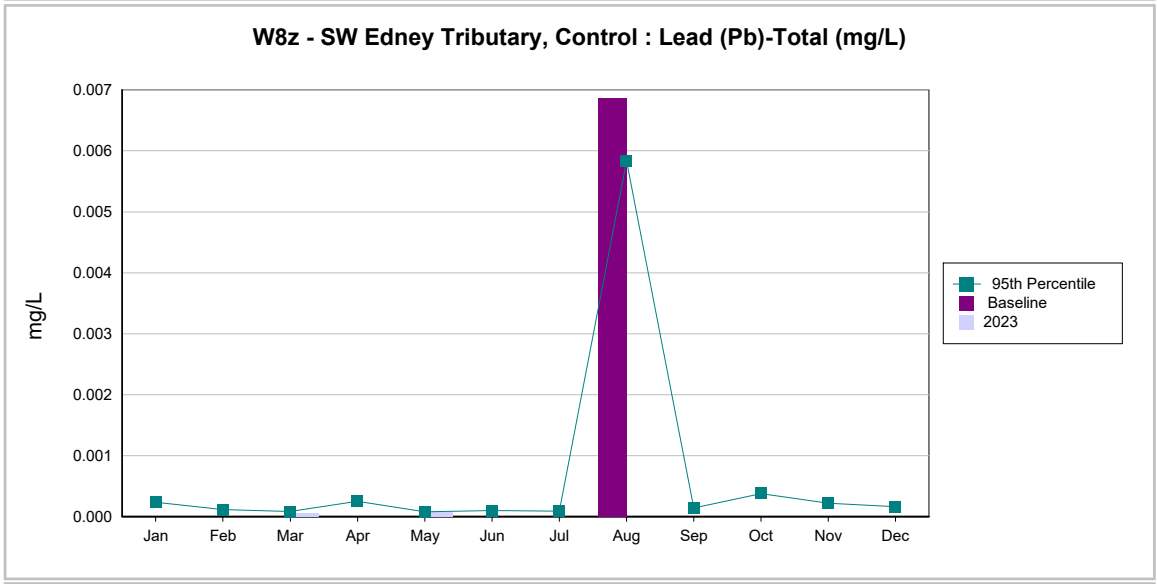
Annual Report SW vs BCWQG

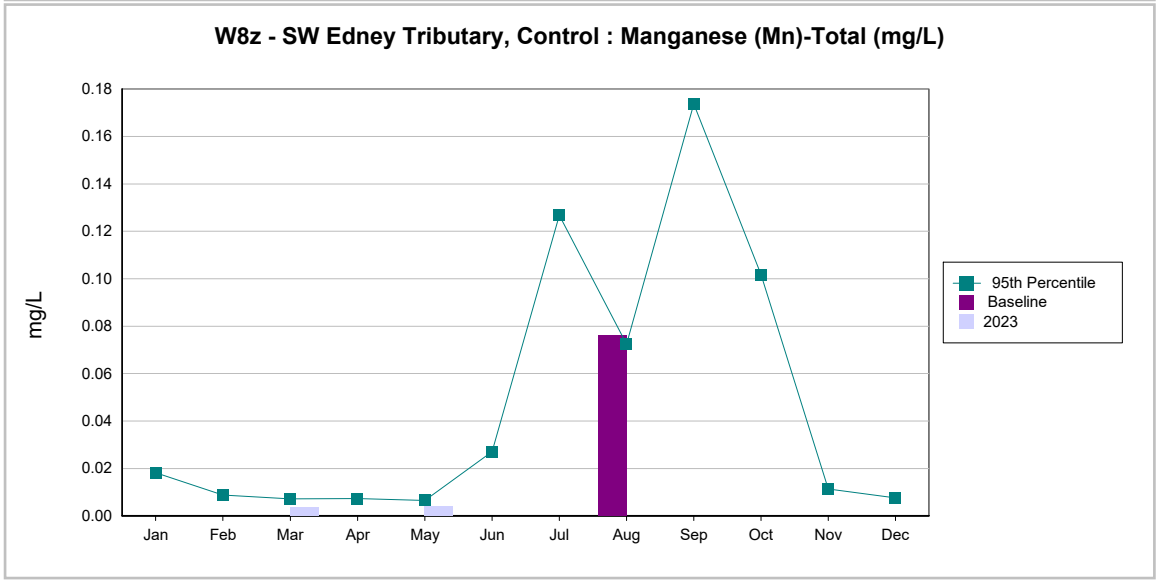
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



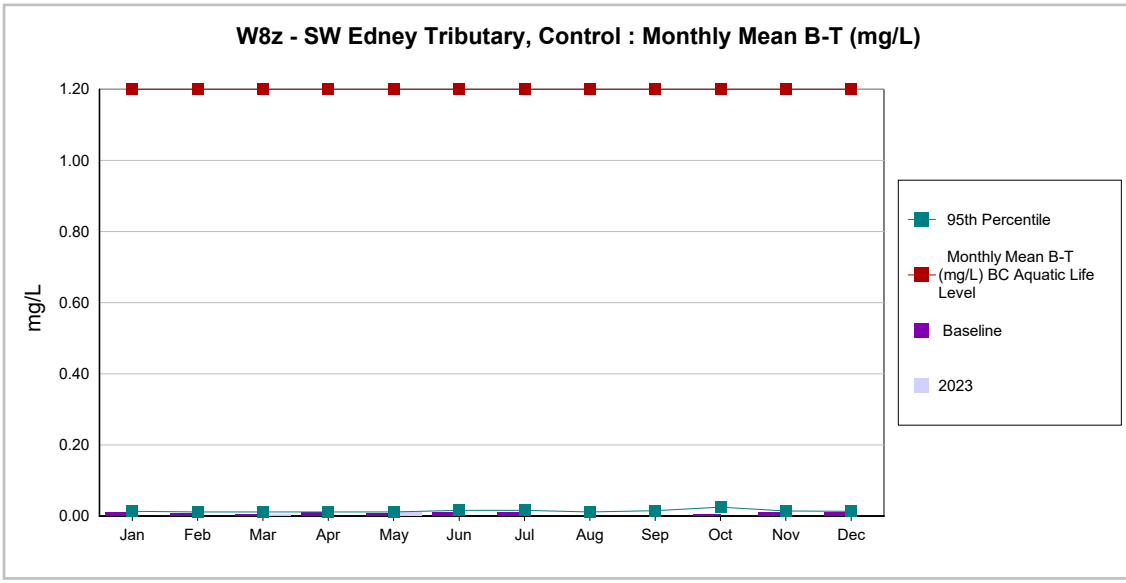


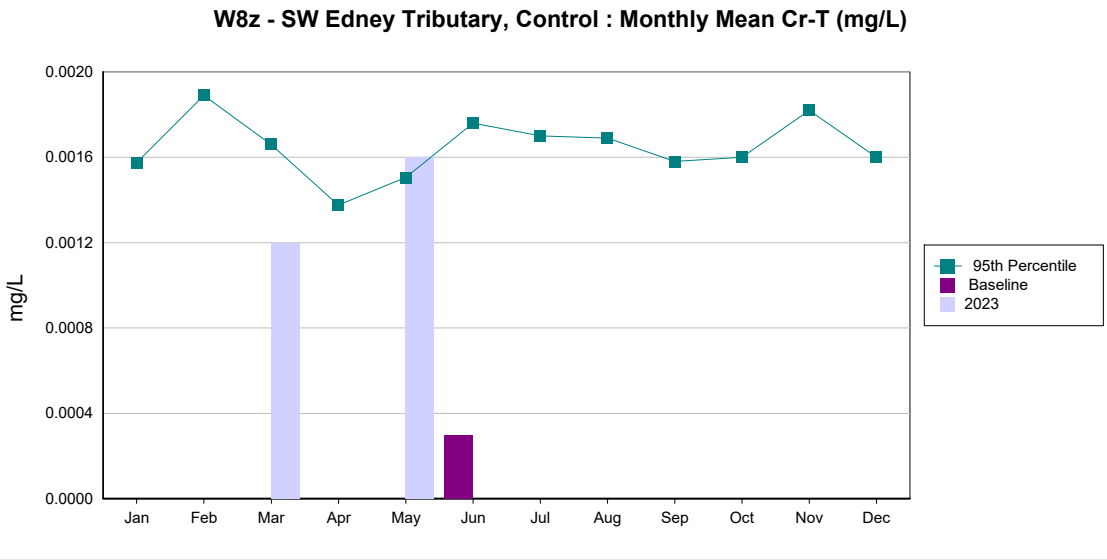


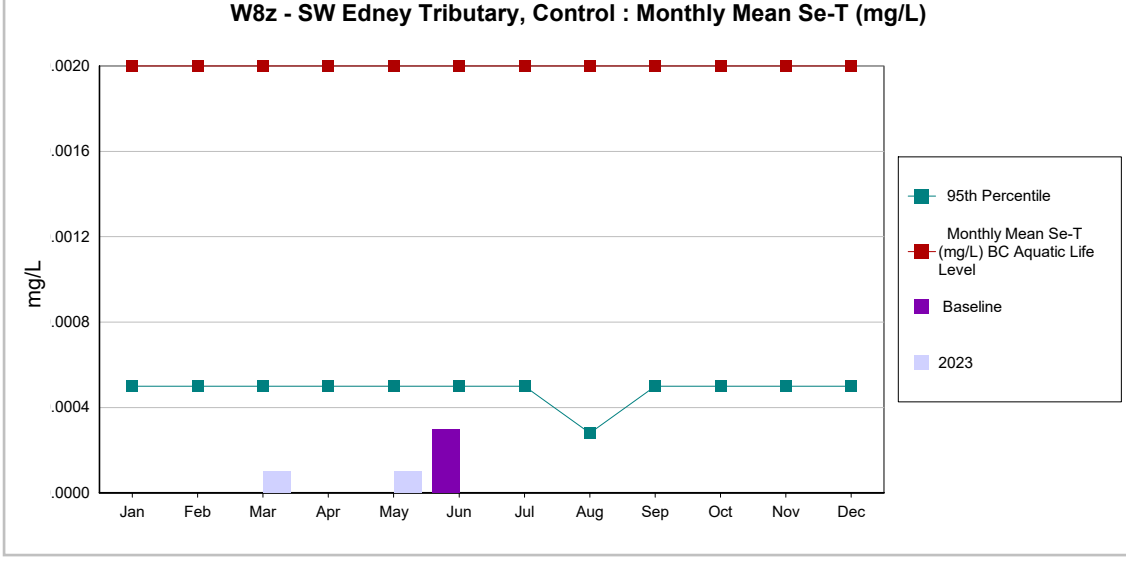
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







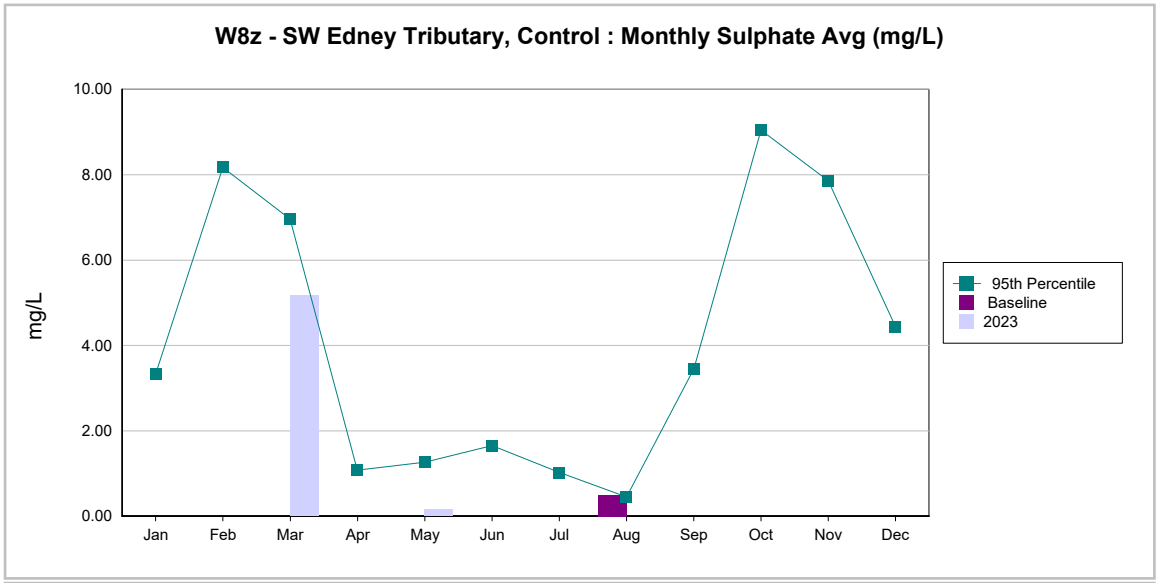
Water Quality Report

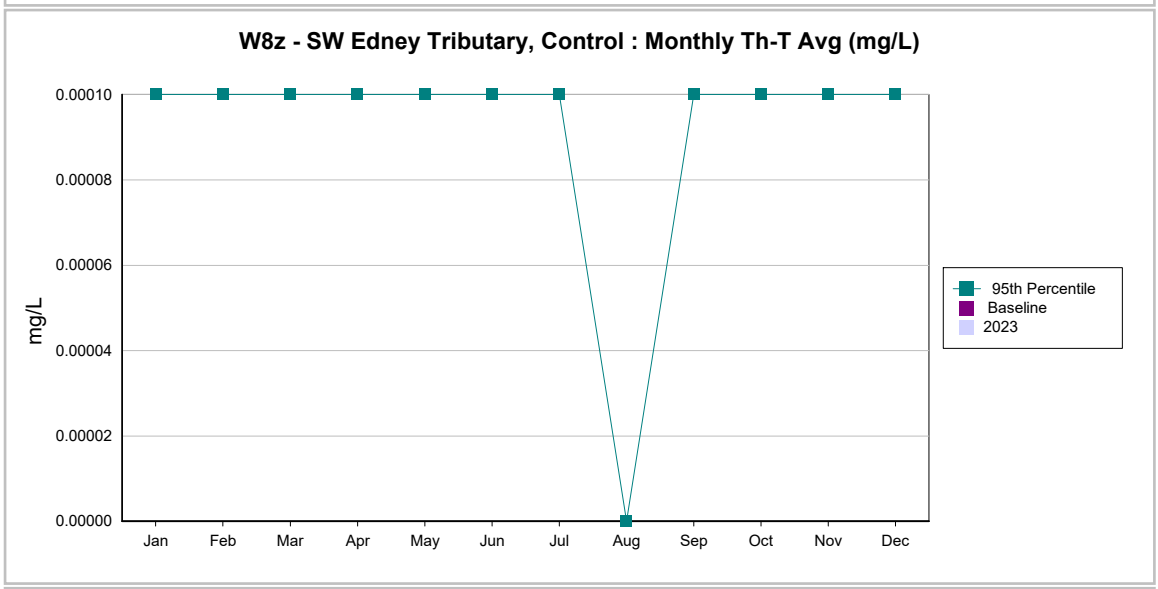
Annual Report SW vs BCWQG

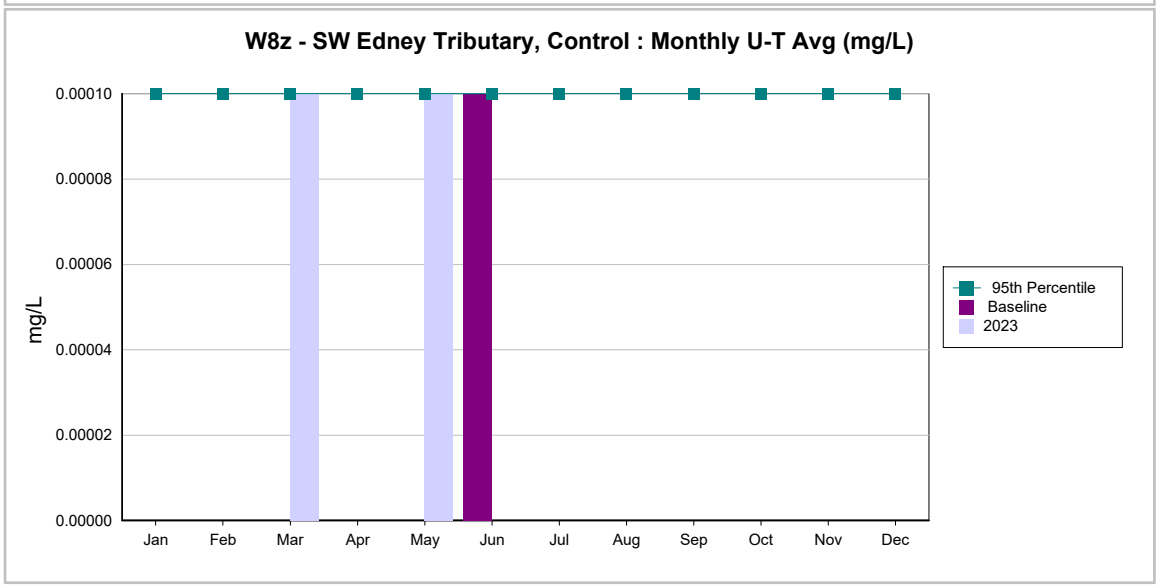
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







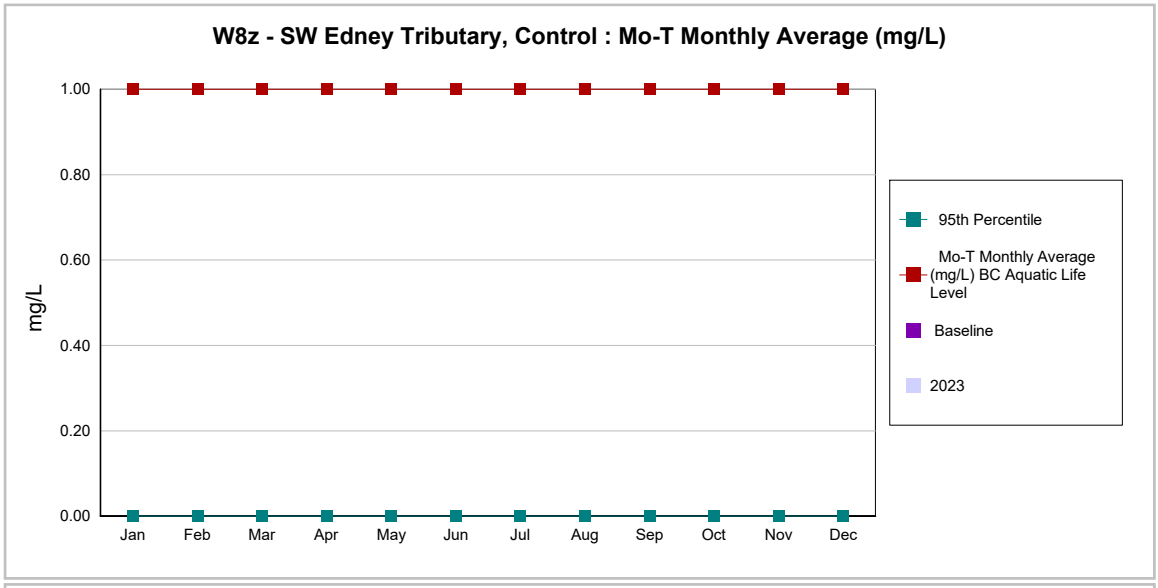
Water Quality Report

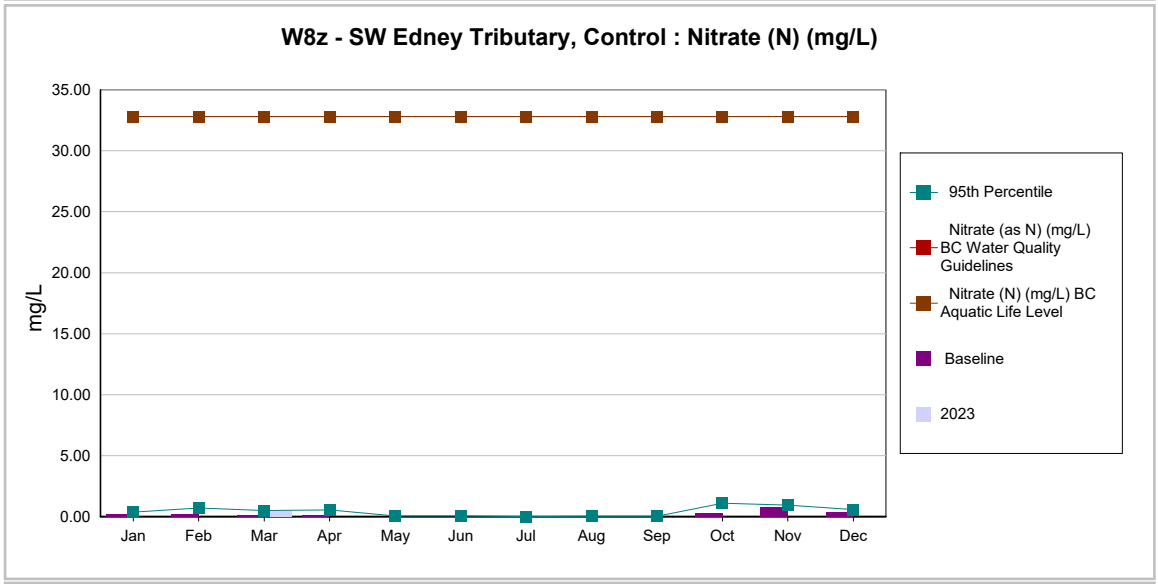
Annual Report SW vs BCWQG

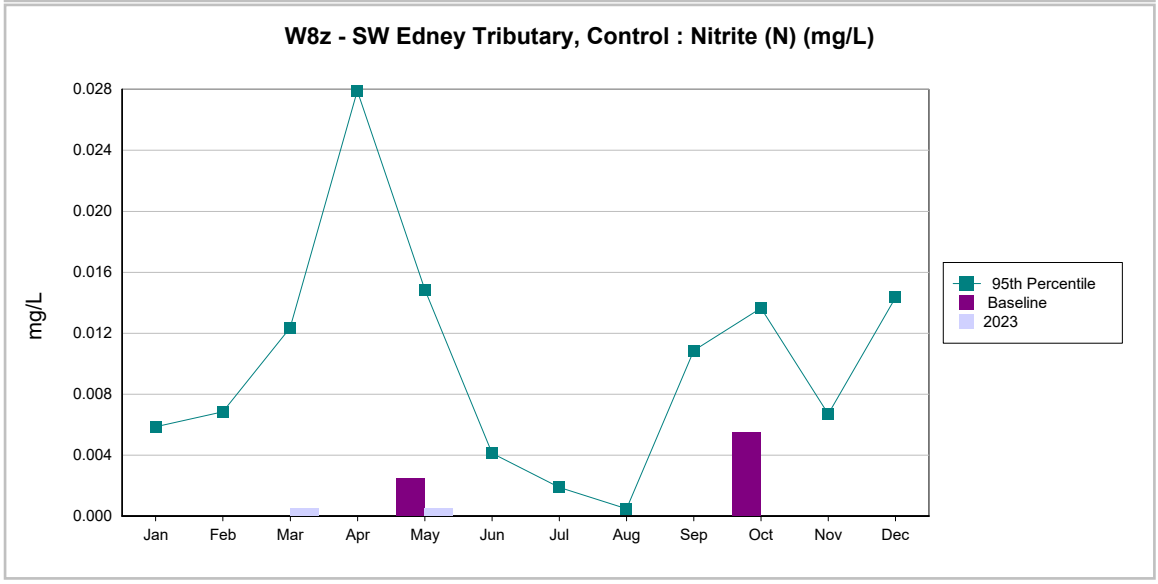
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







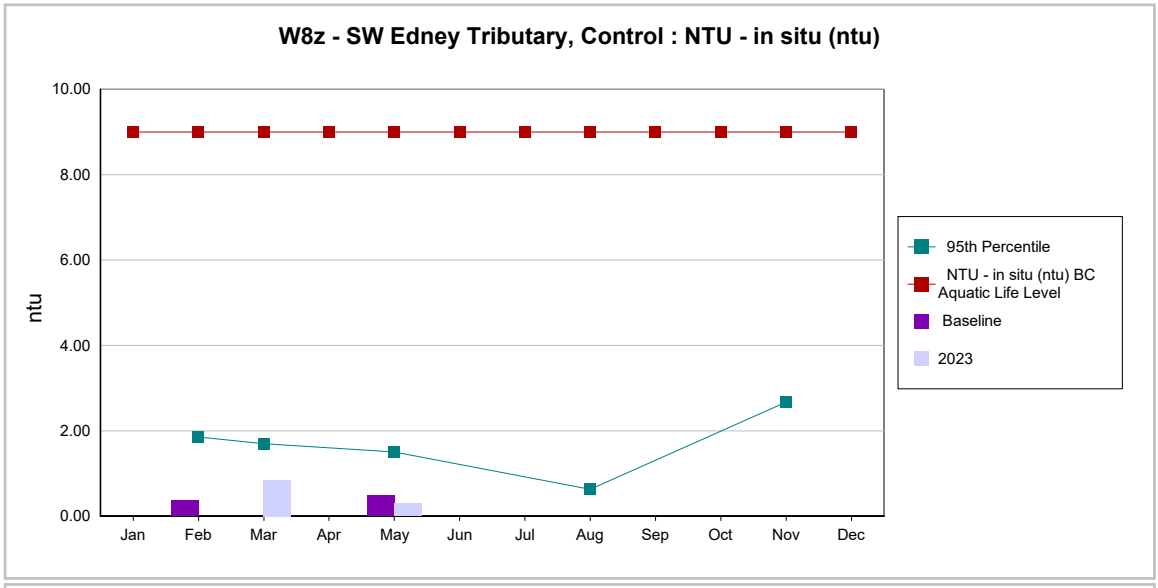
Water Quality Report

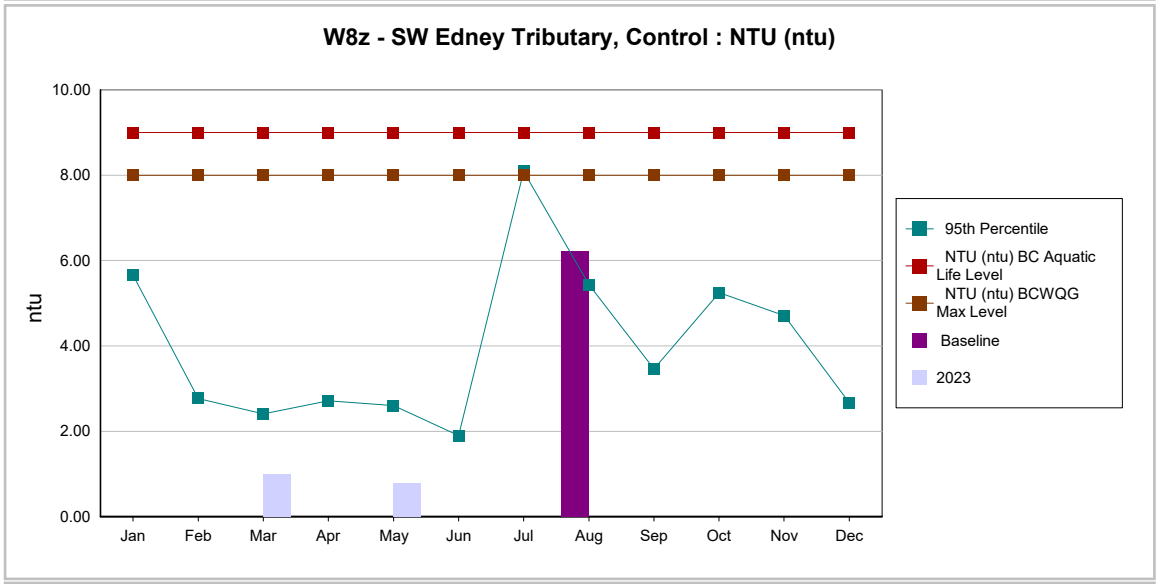
Annual Report SW vs BCWQG

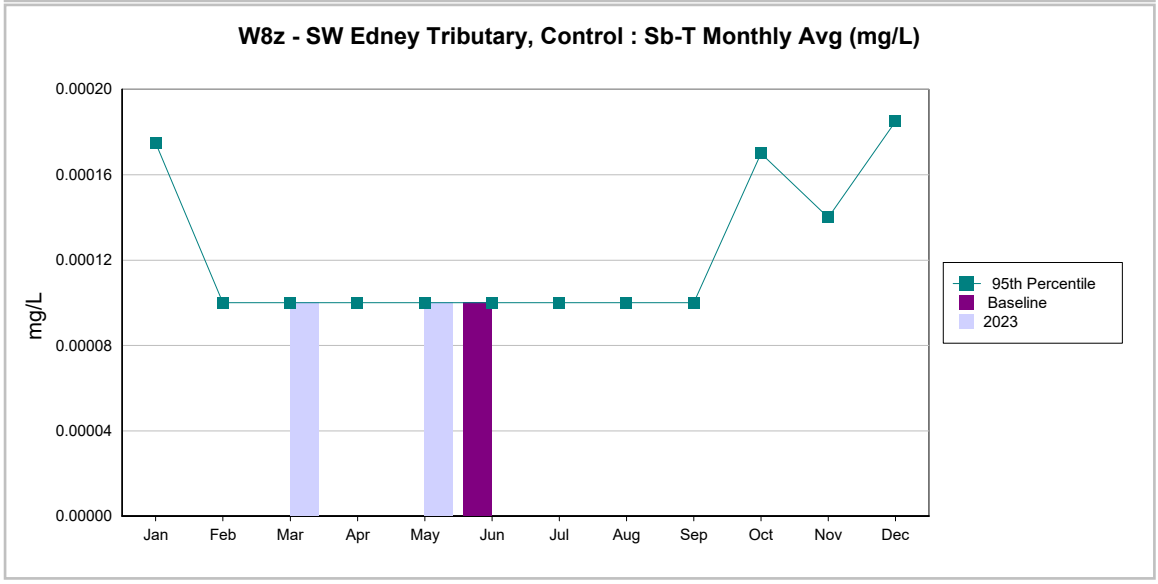
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







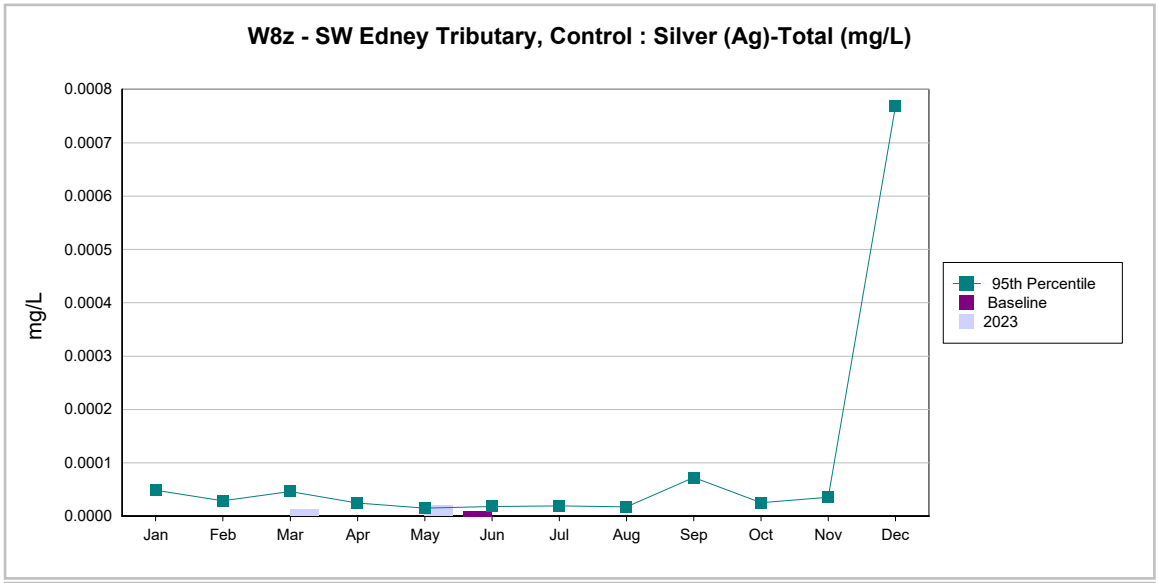
Water Quality Report

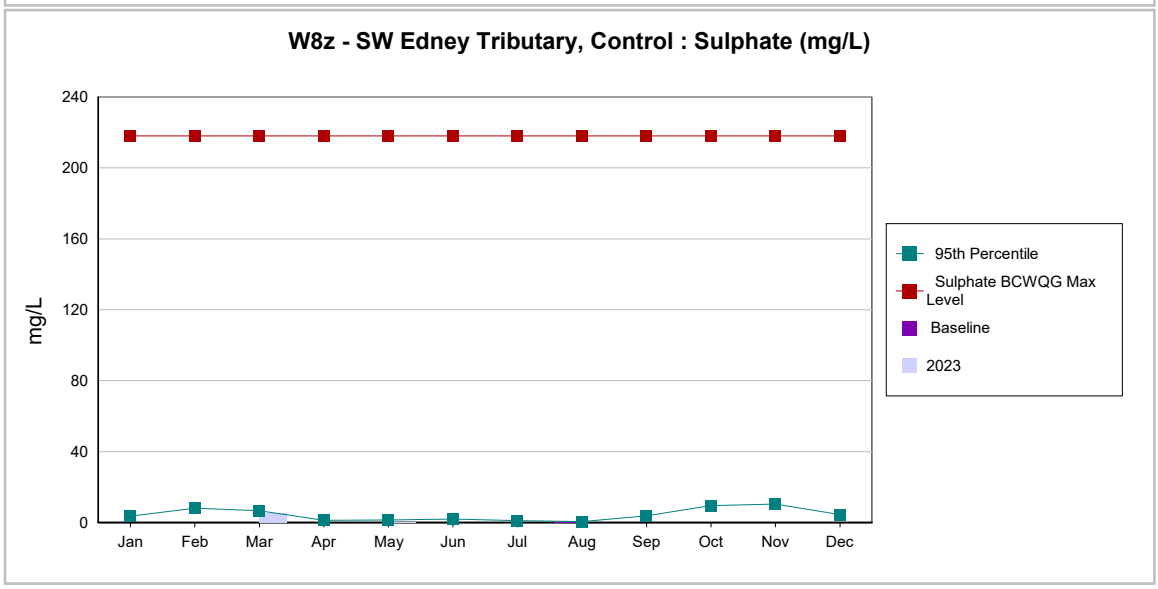
Annual Report SW vs BCWQG

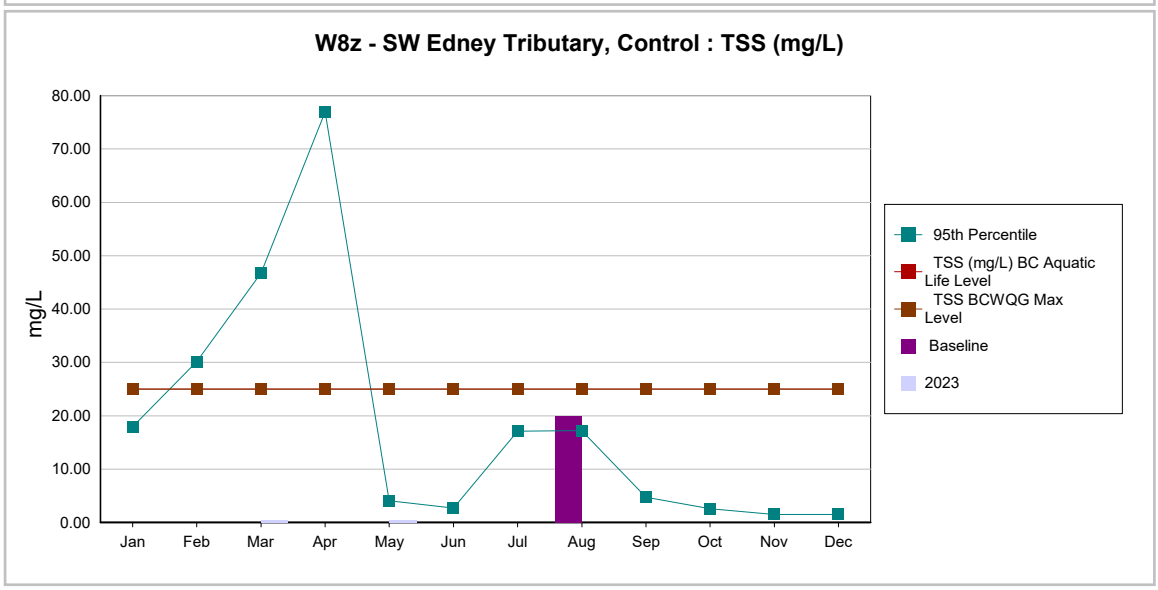
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







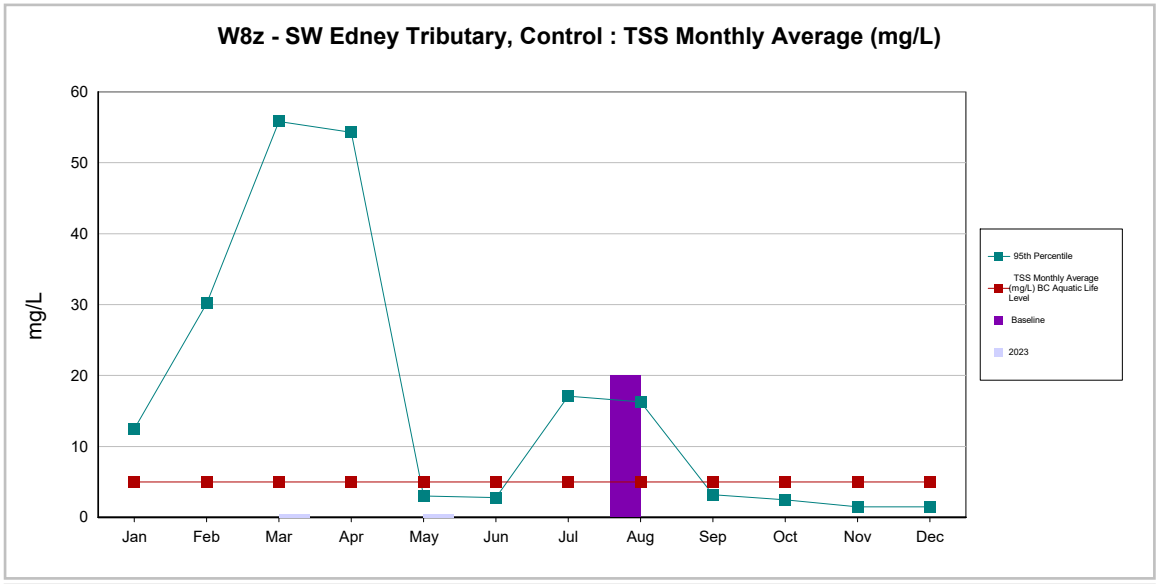
Water Quality Report

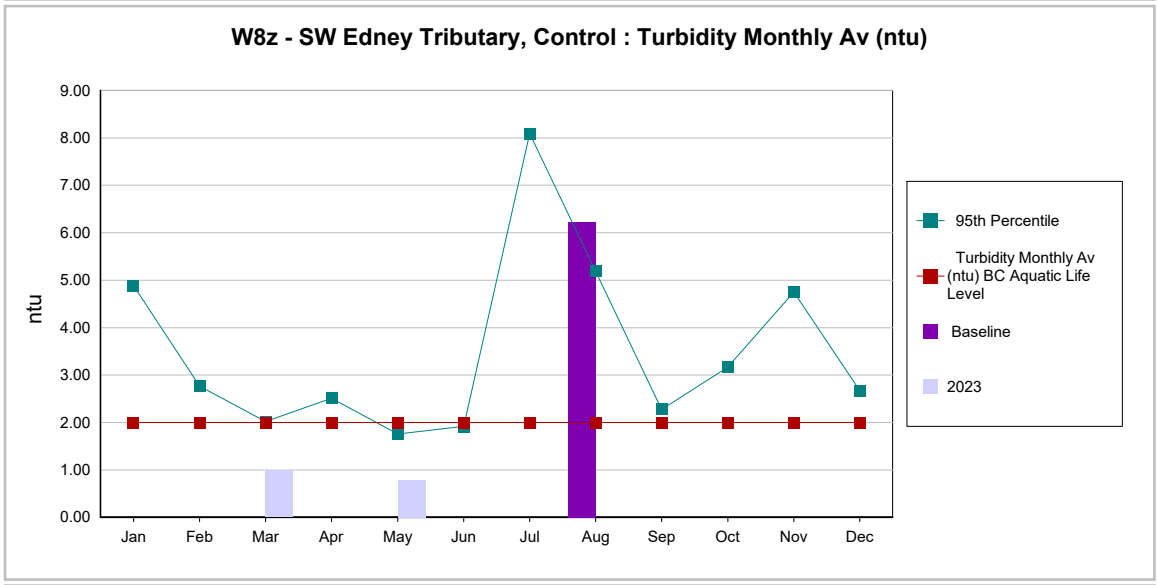
Annual Report SW vs BCWQG

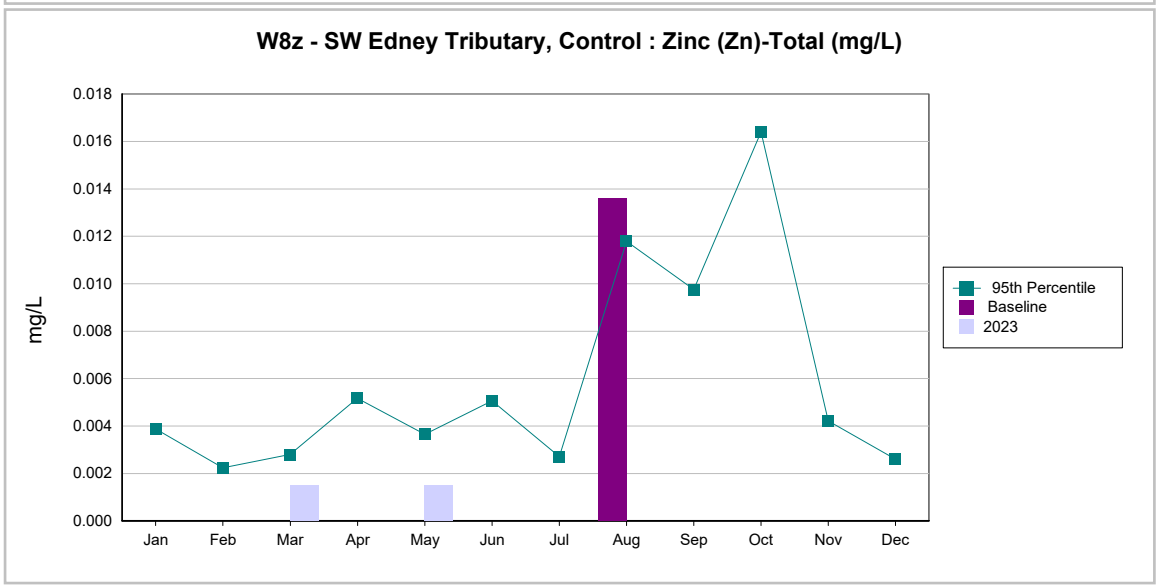
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







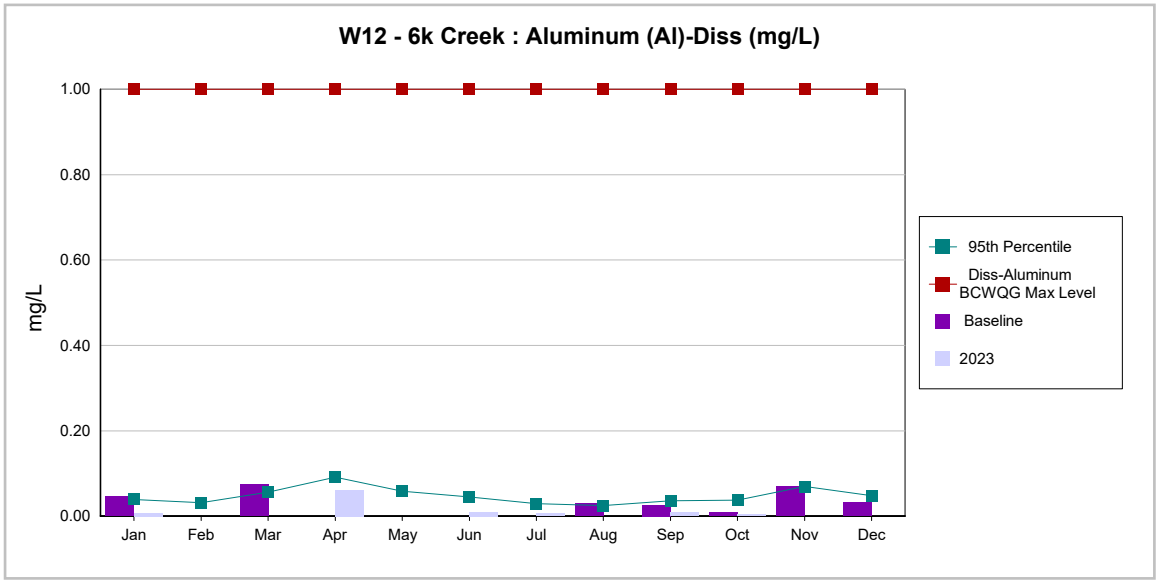
Water Quality Report

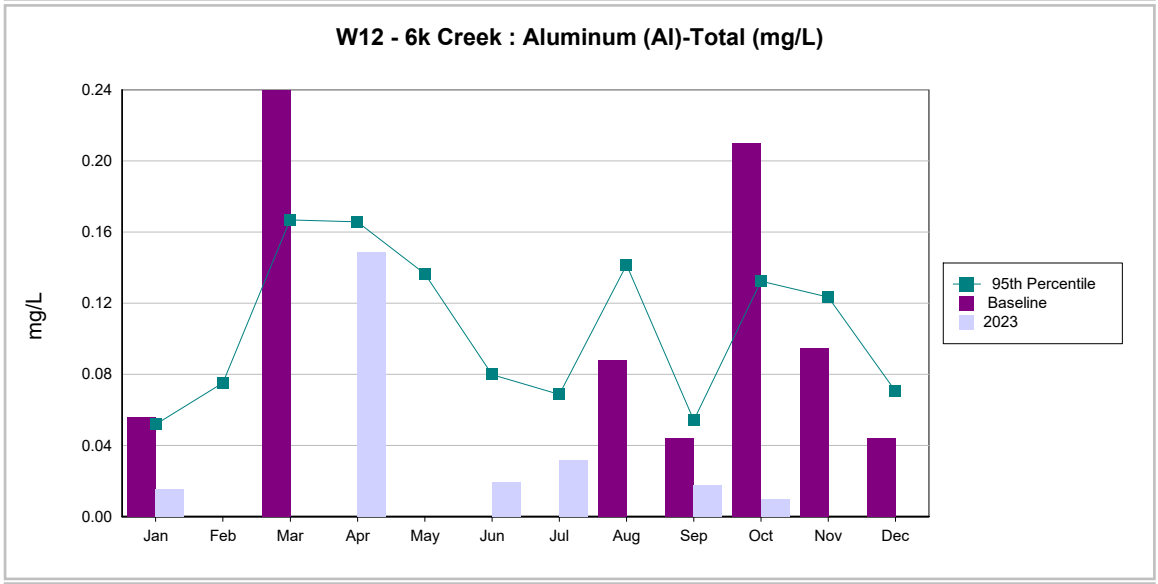
Annual Report SW vs BCWQG

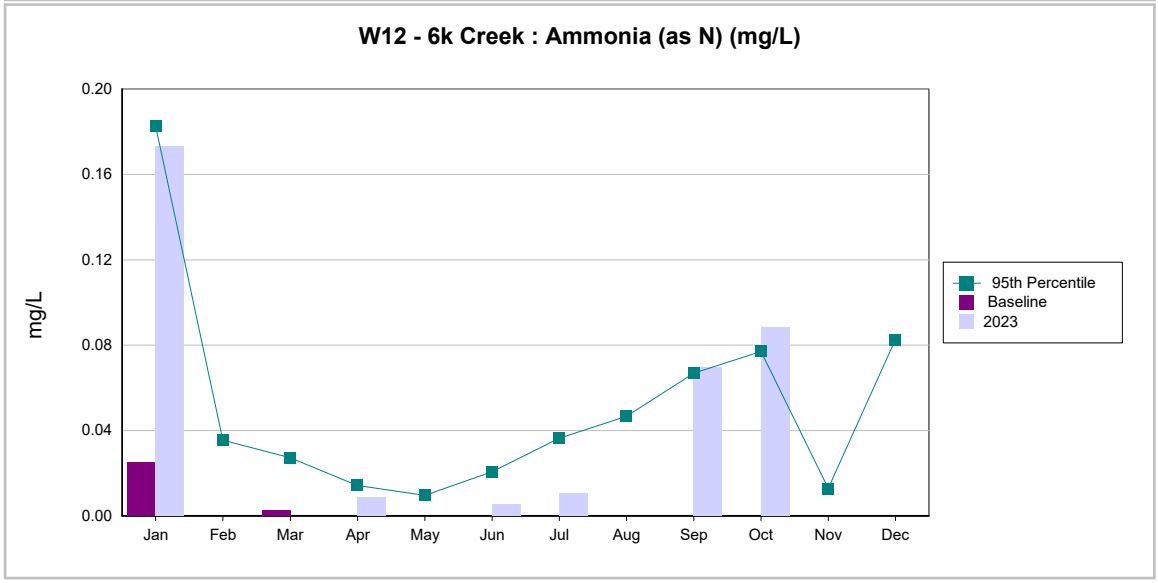
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







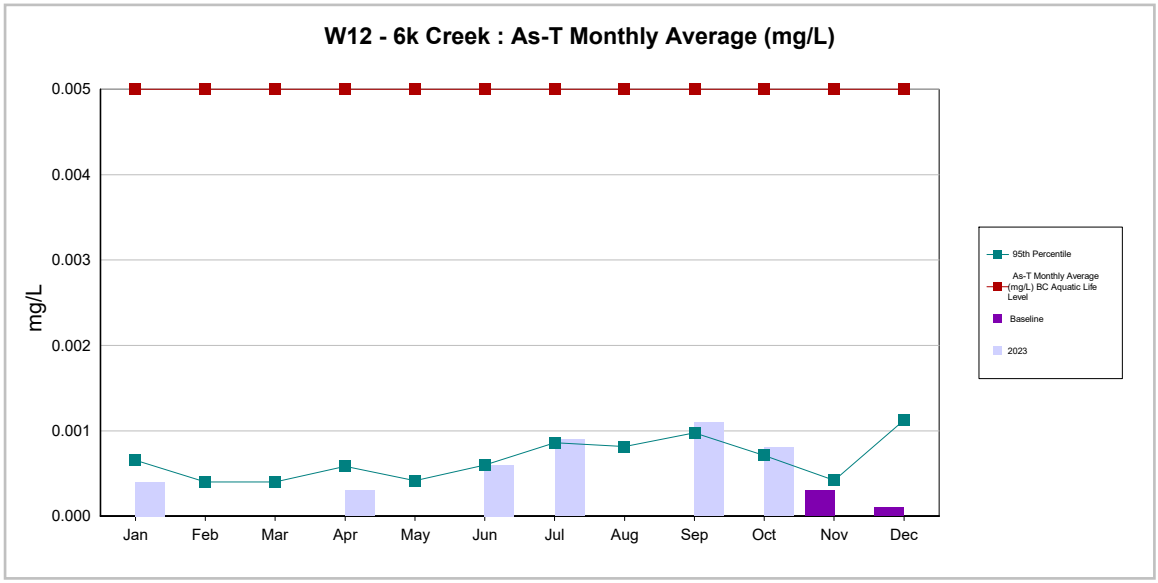
Water Quality Report

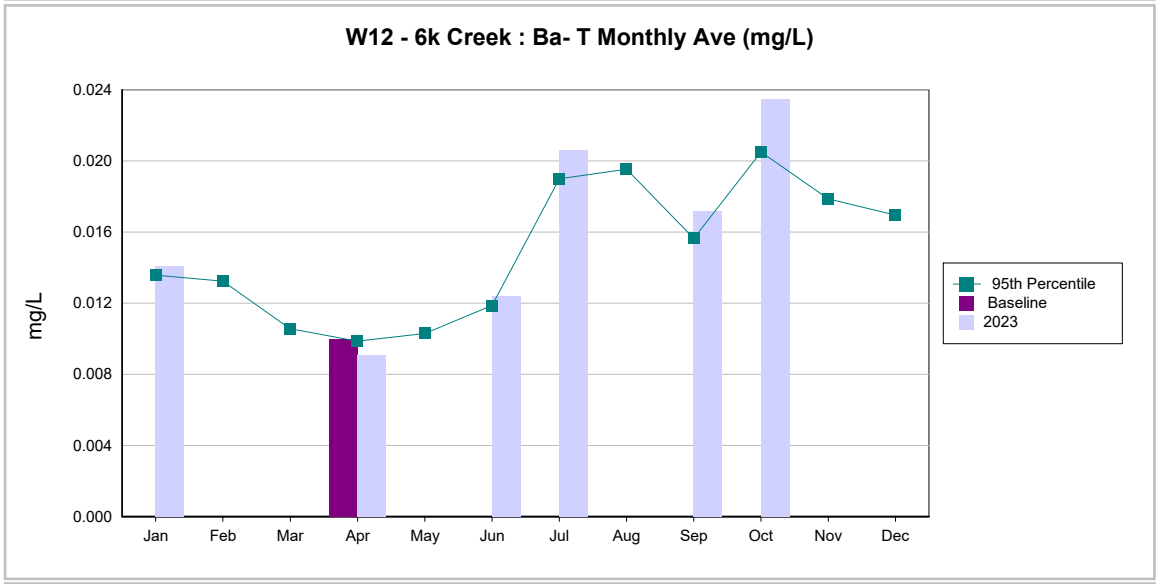
Annual Report SW vs BCWQG

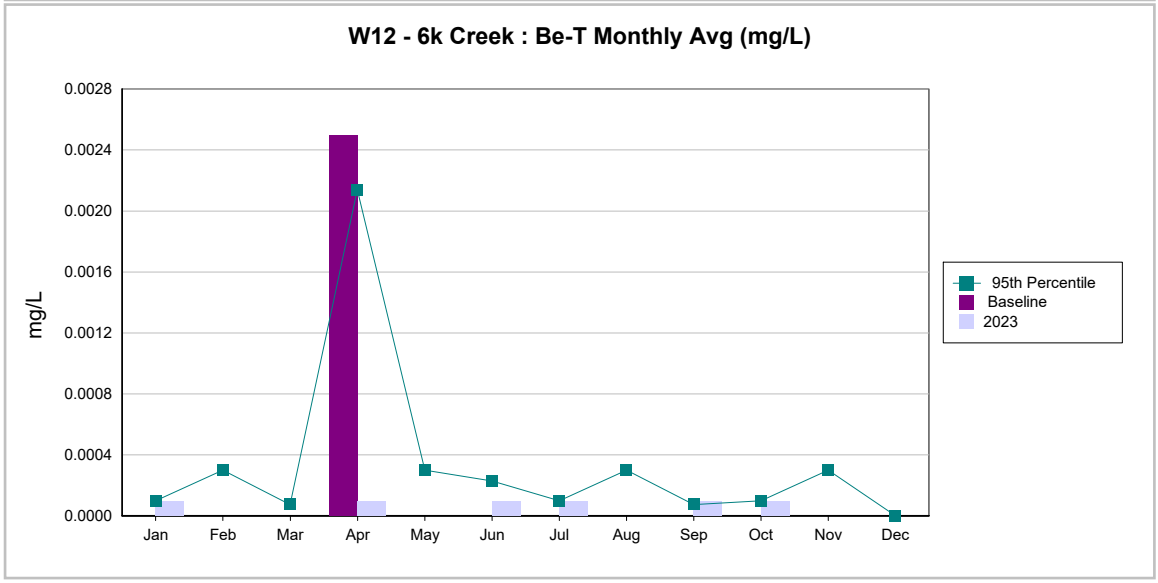
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







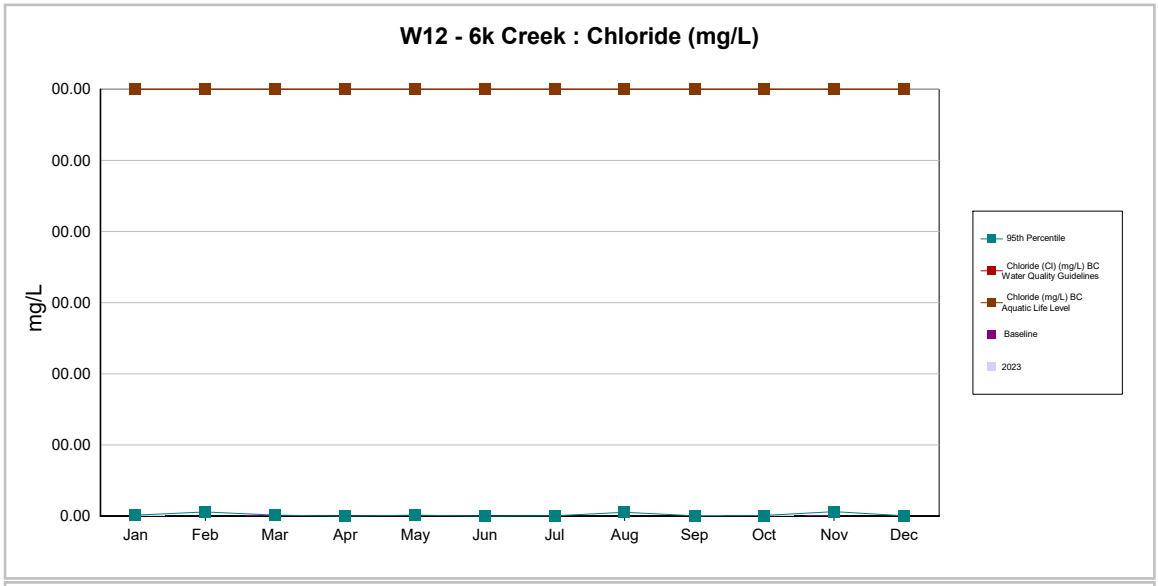
Water Quality Report

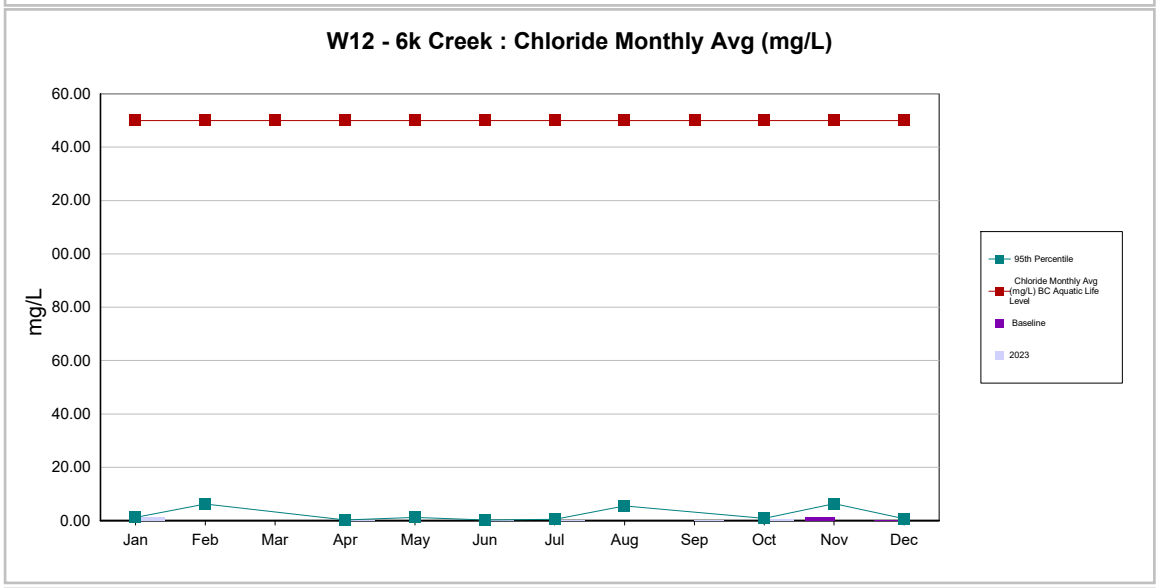
Annual Report SW vs BCWQG

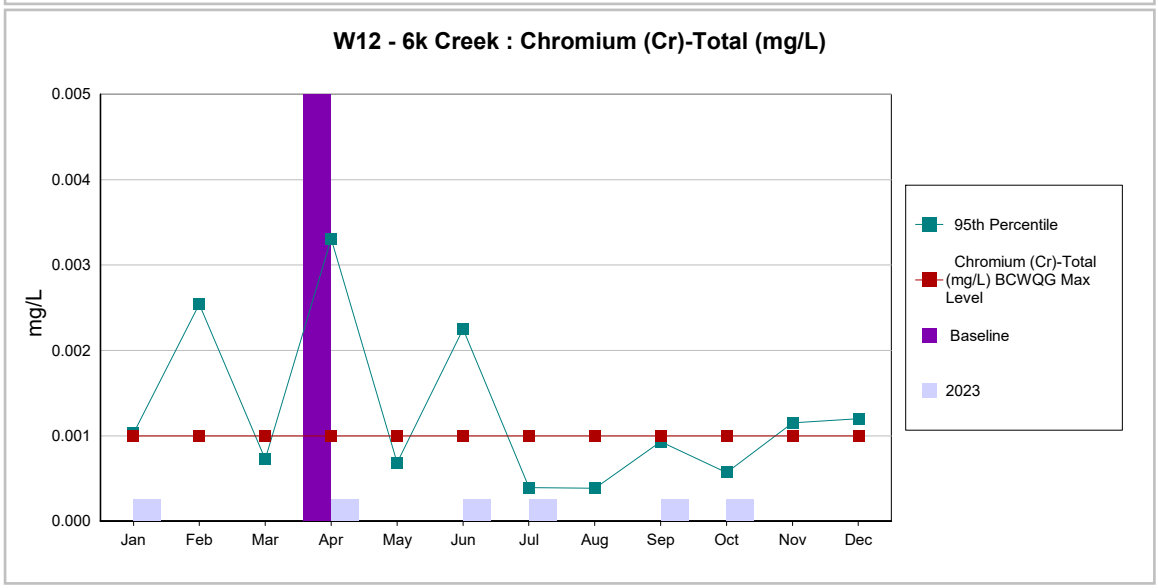
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



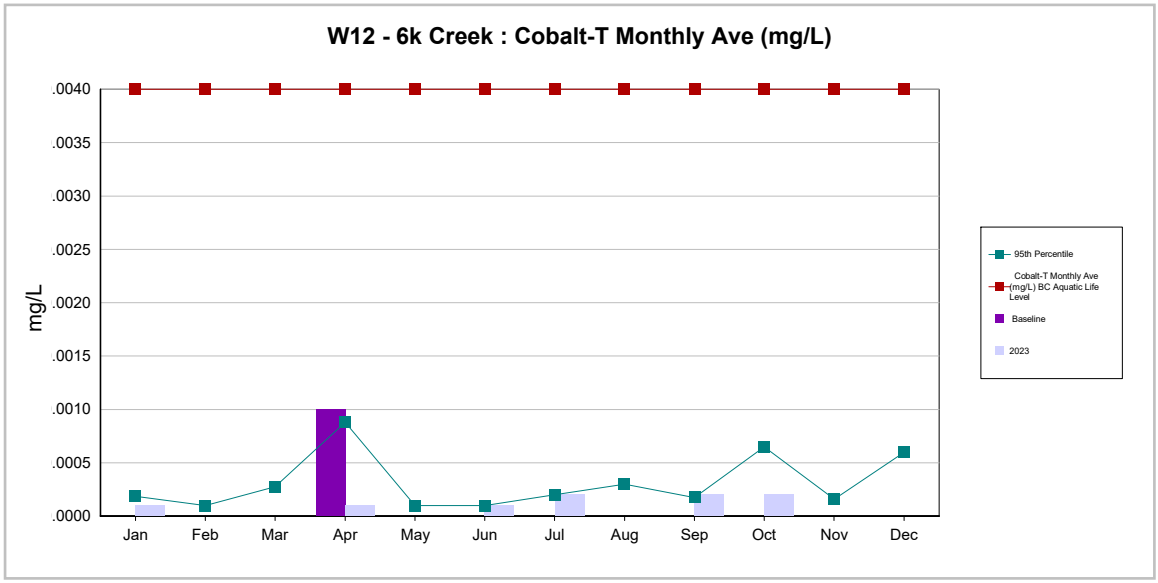


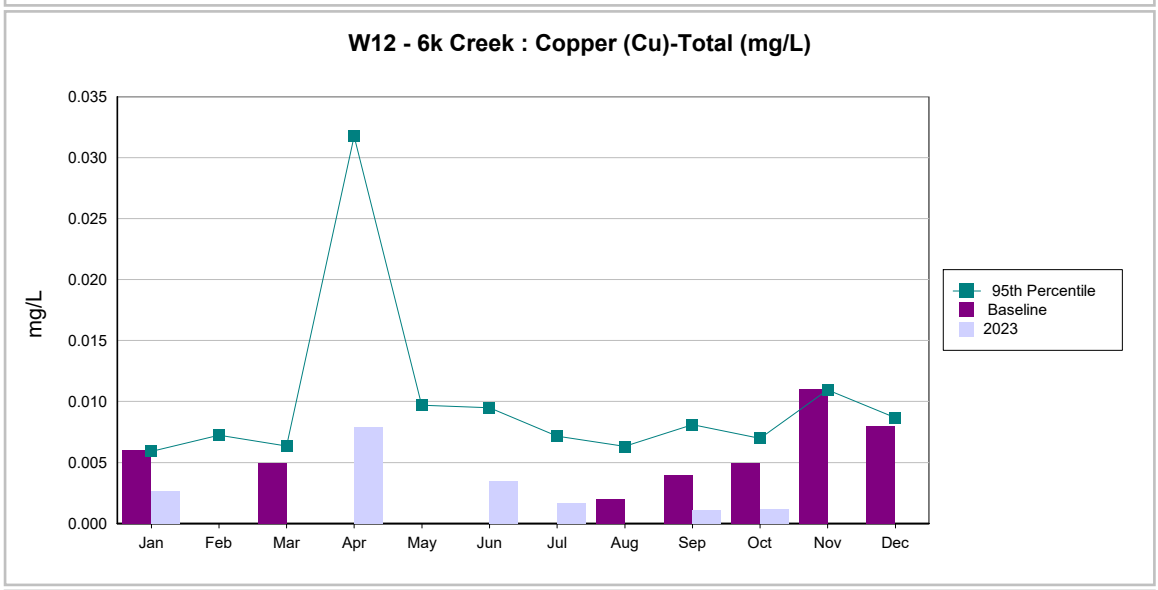


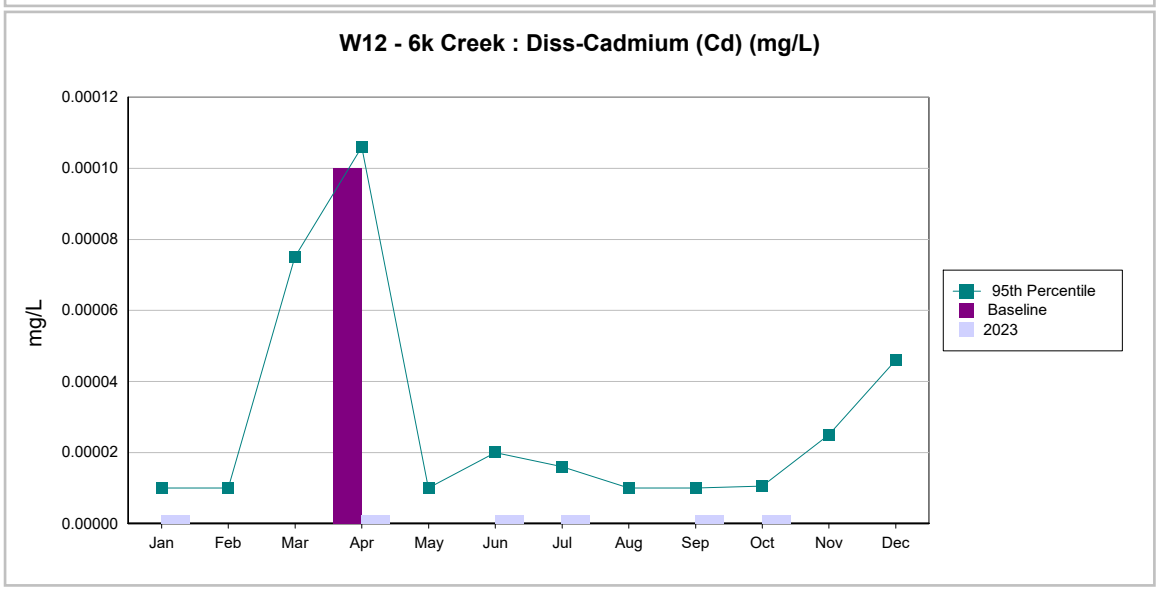
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







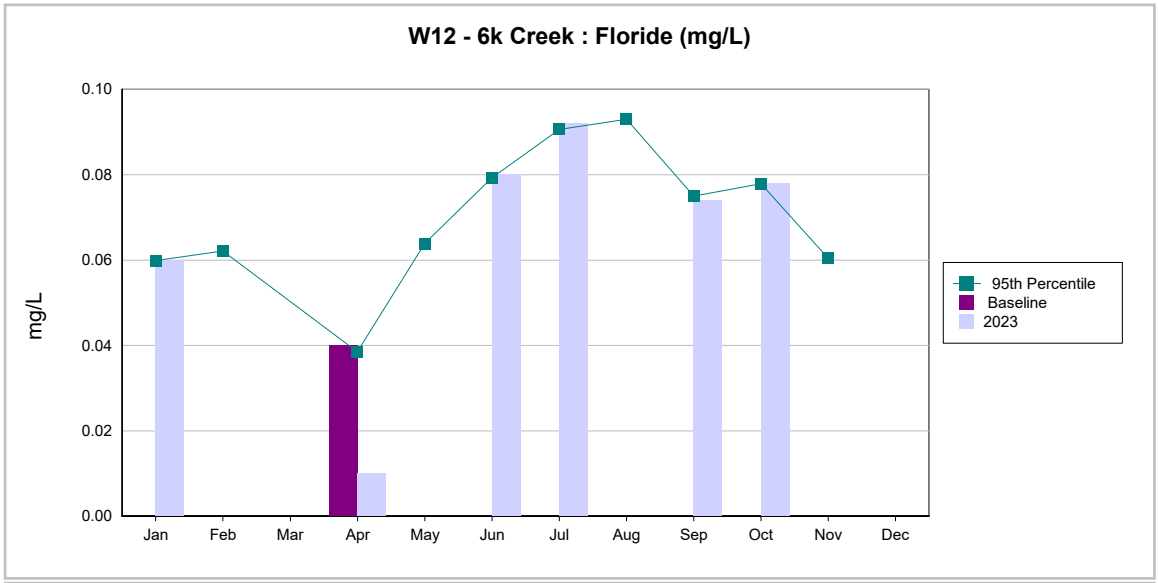
Water Quality Report

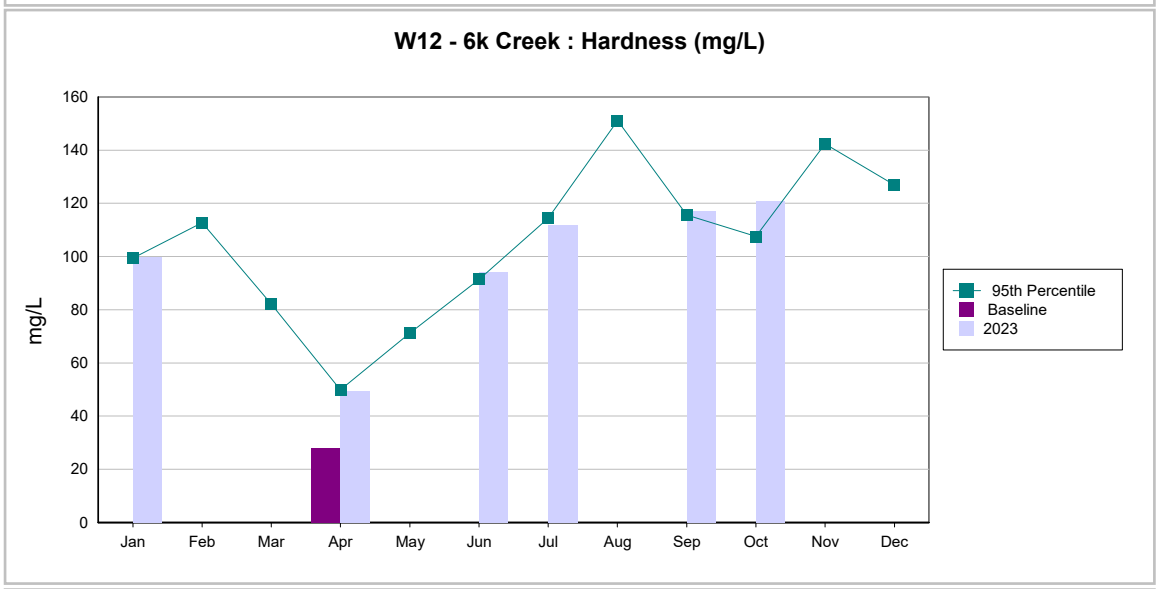
Annual Report SW vs BCWQG

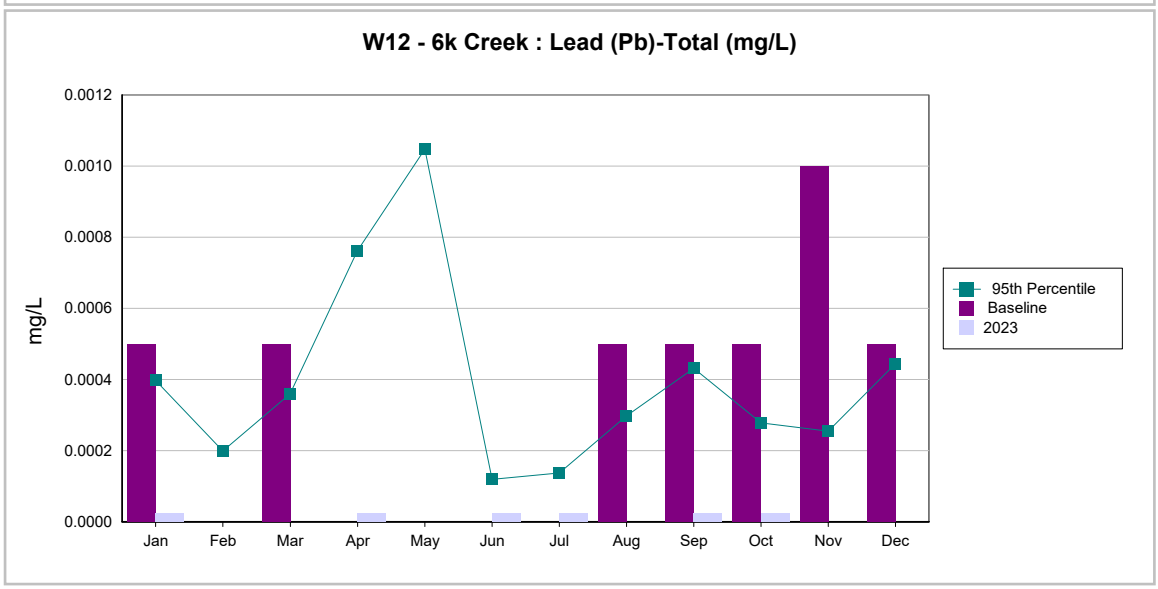
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



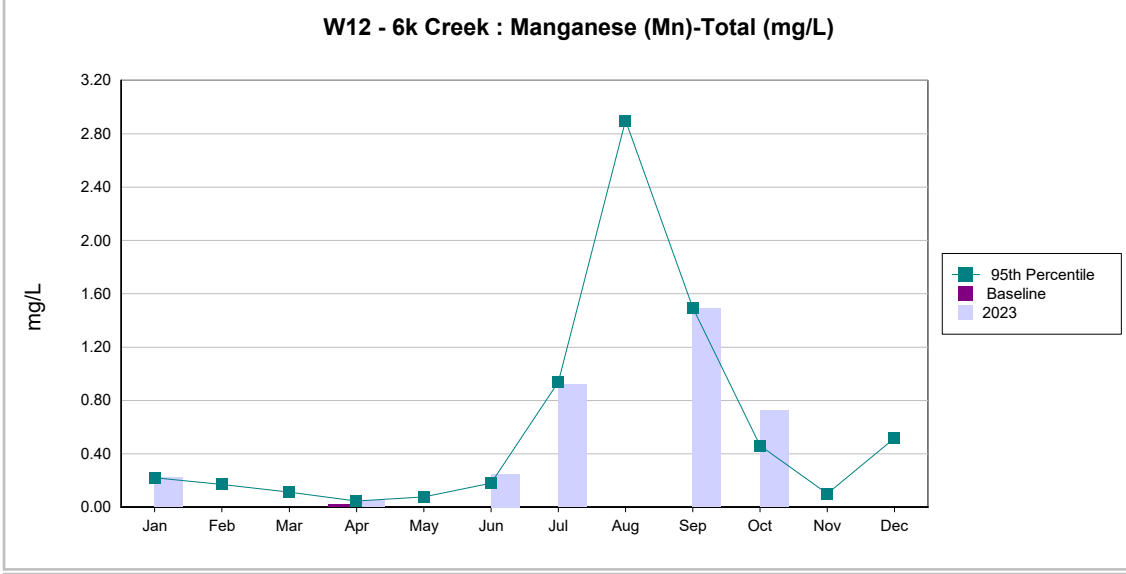


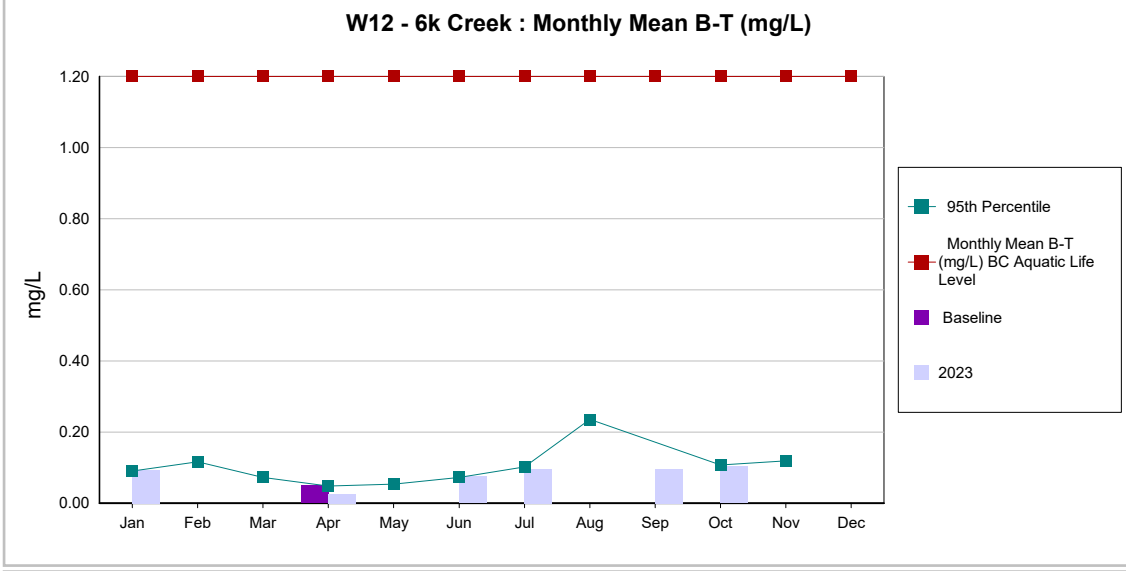


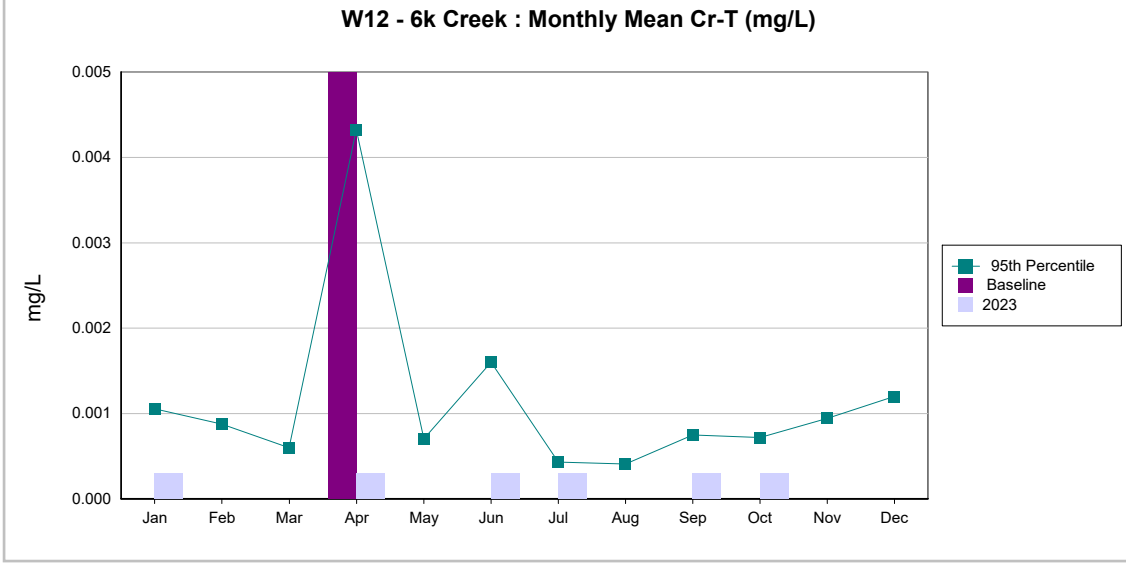
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







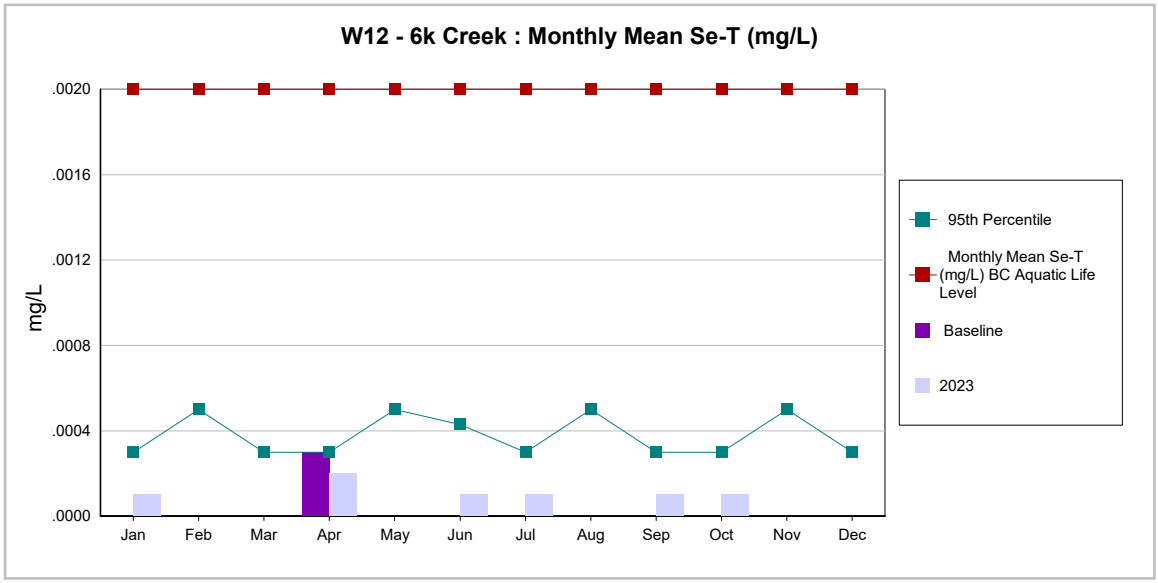
Water Quality Report

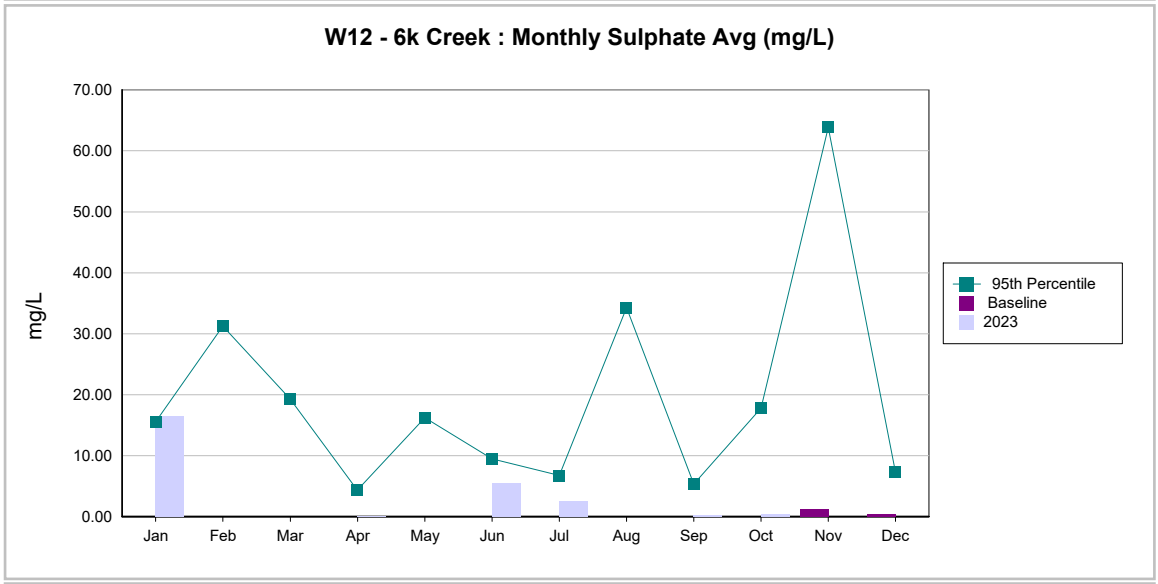
Annual Report SW vs BCWQG

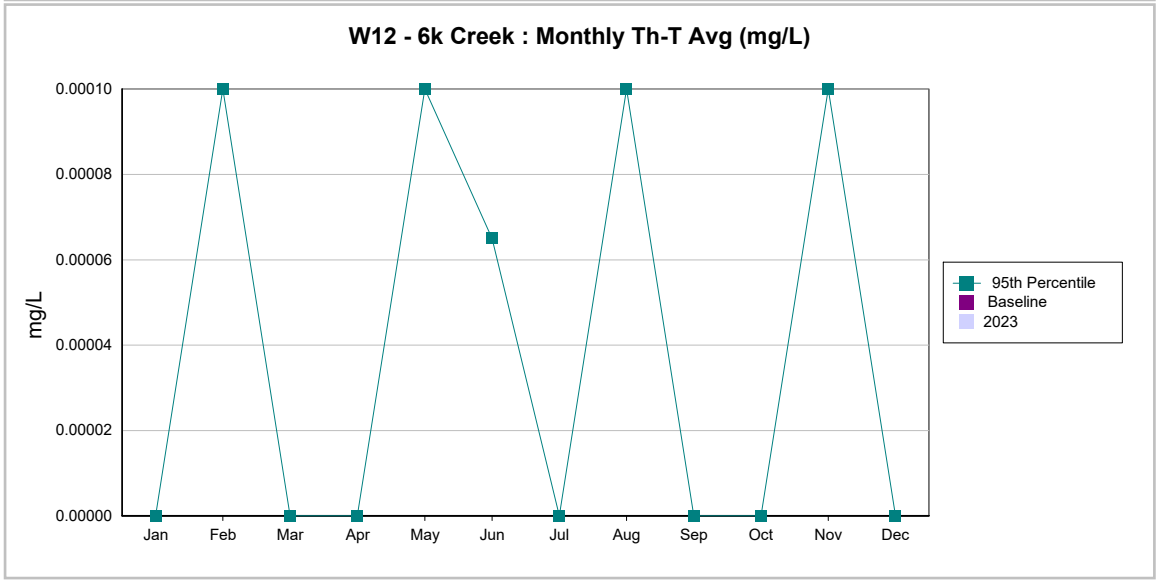
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







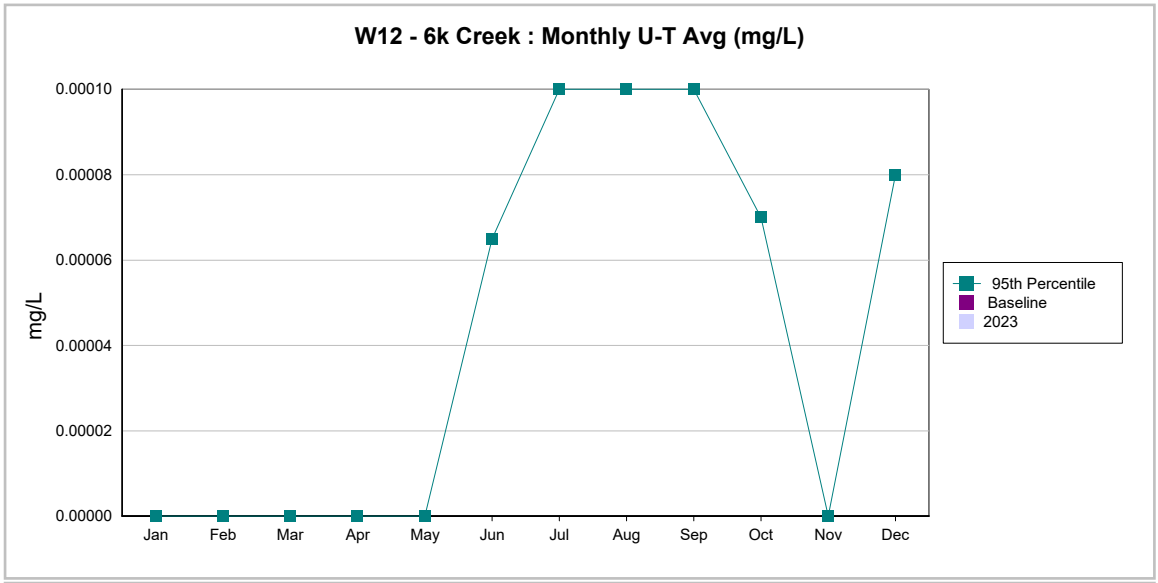
Water Quality Report

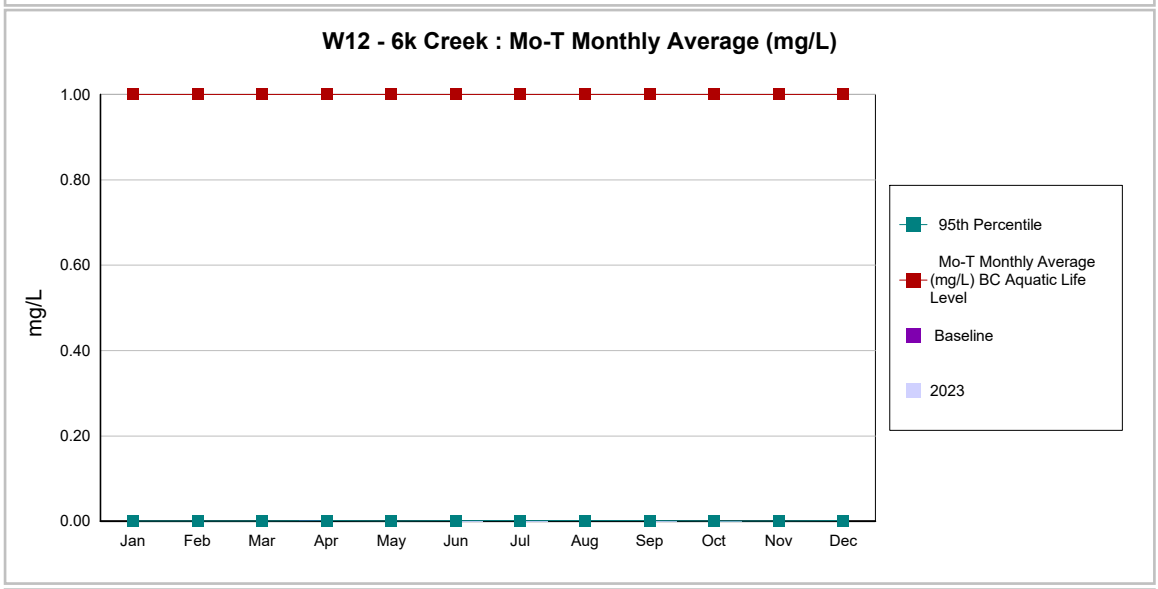
Annual Report SW vs BCWQG

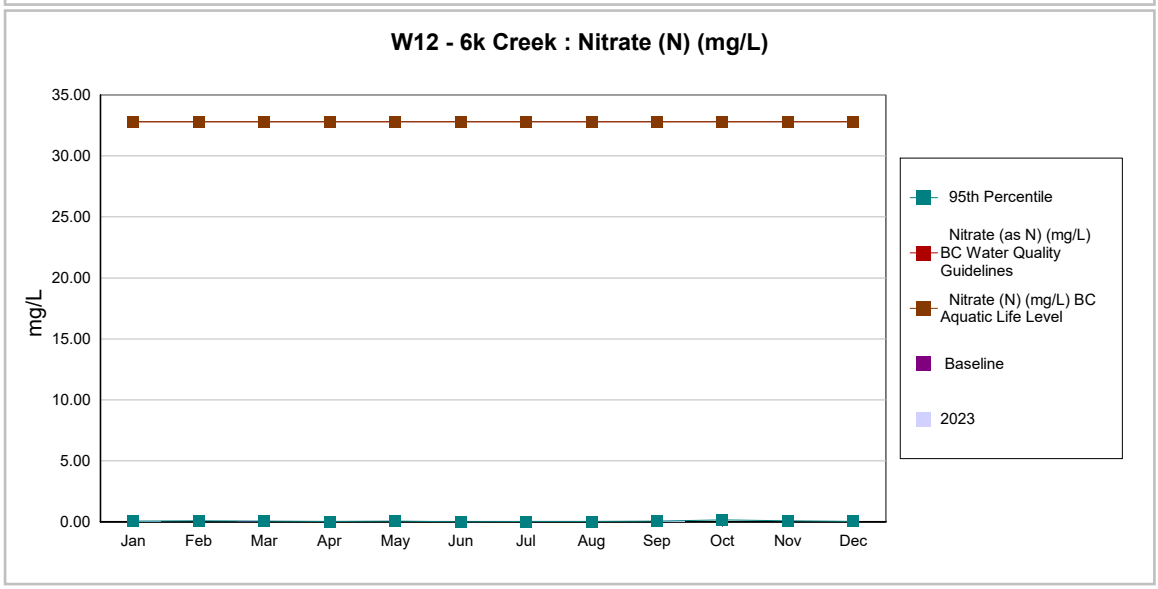
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



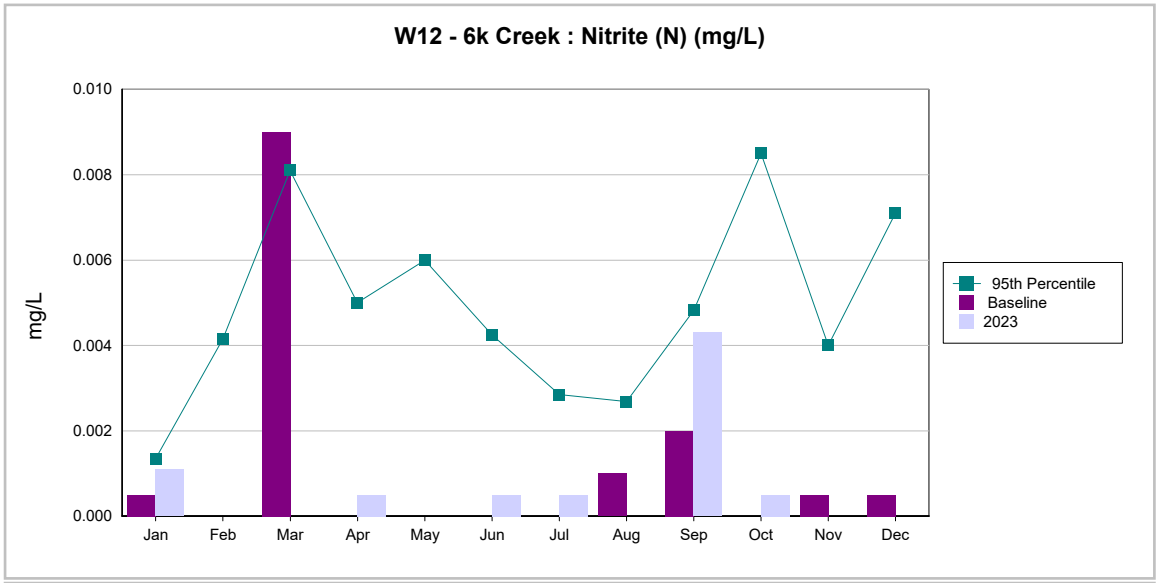


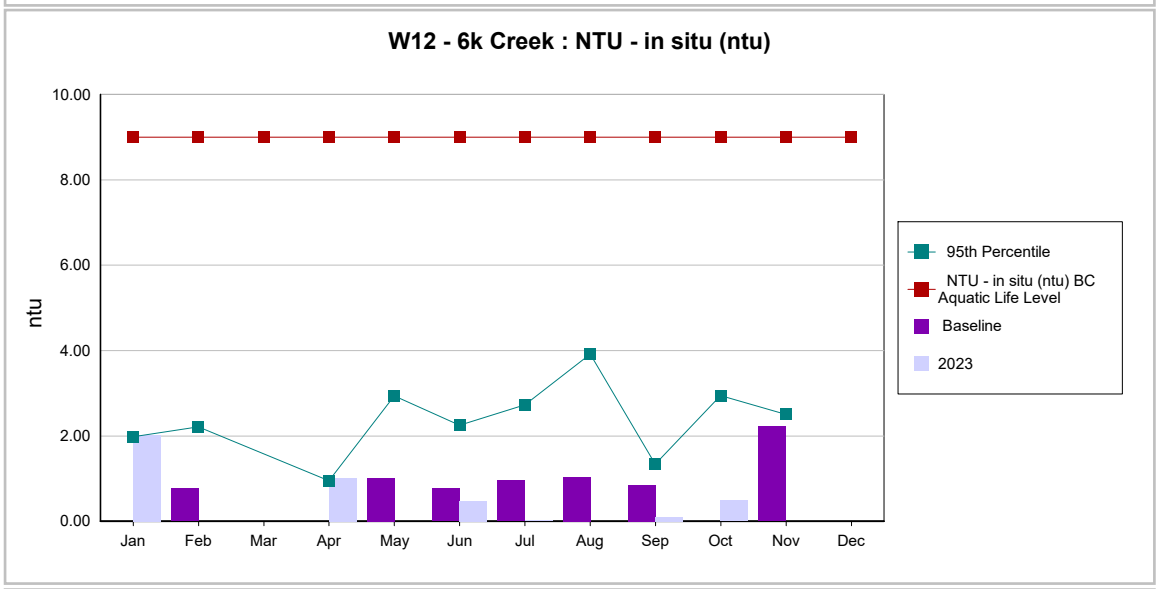


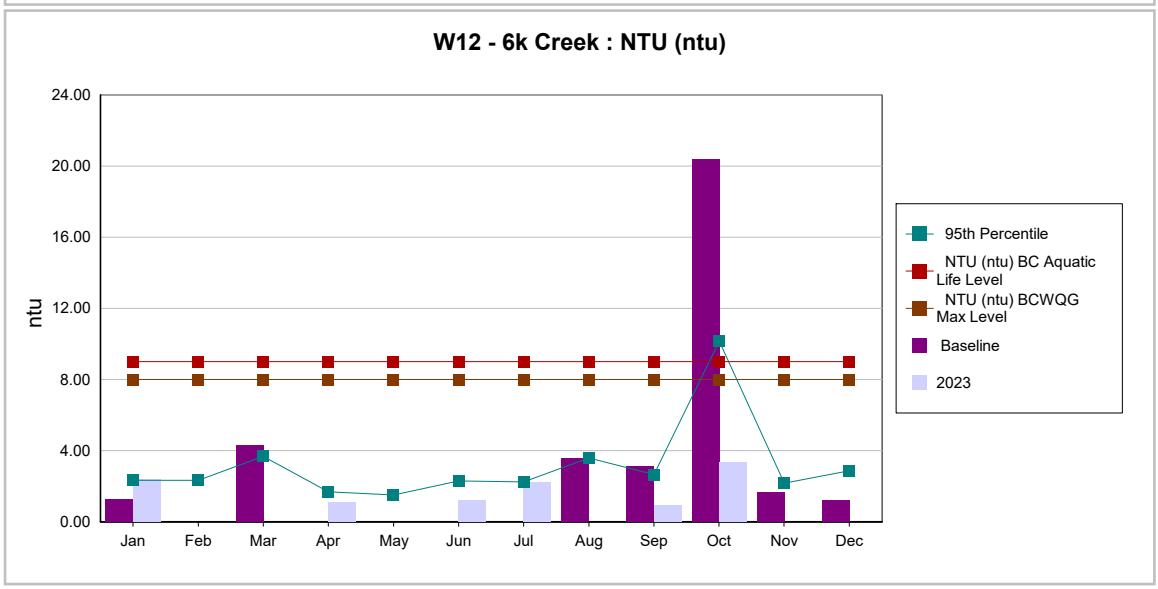
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION







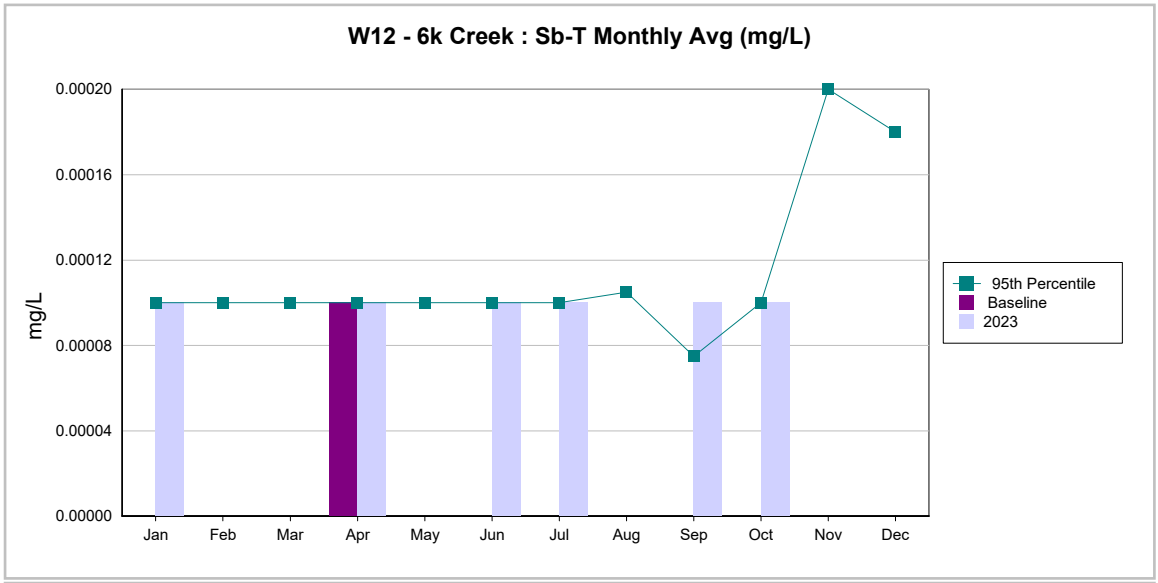
Water Quality Report

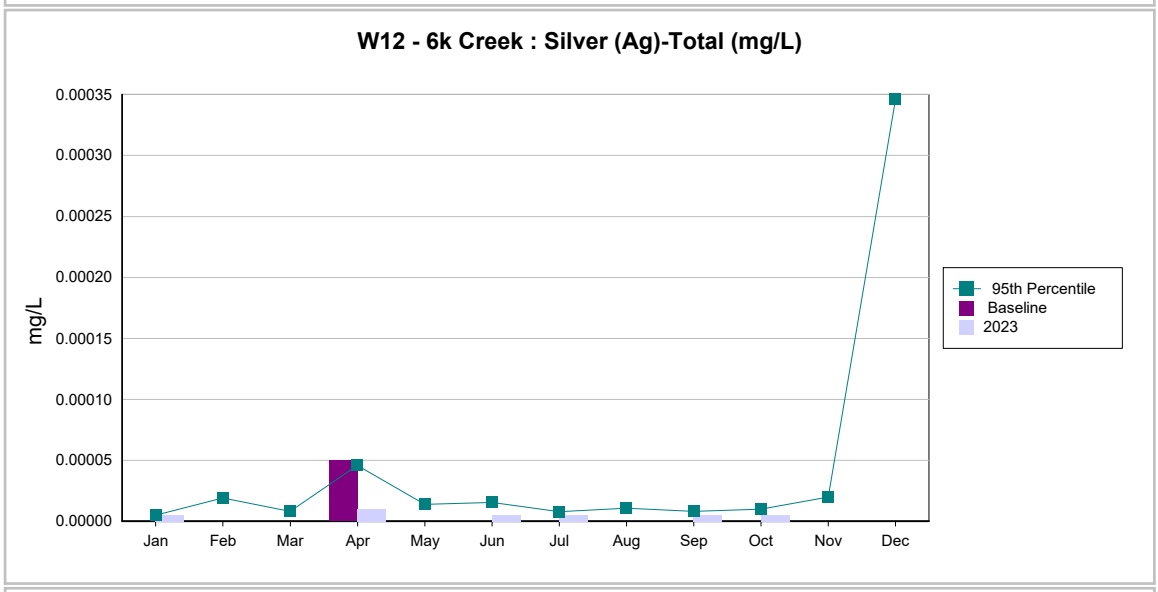
Annual Report SW vs BCWQG

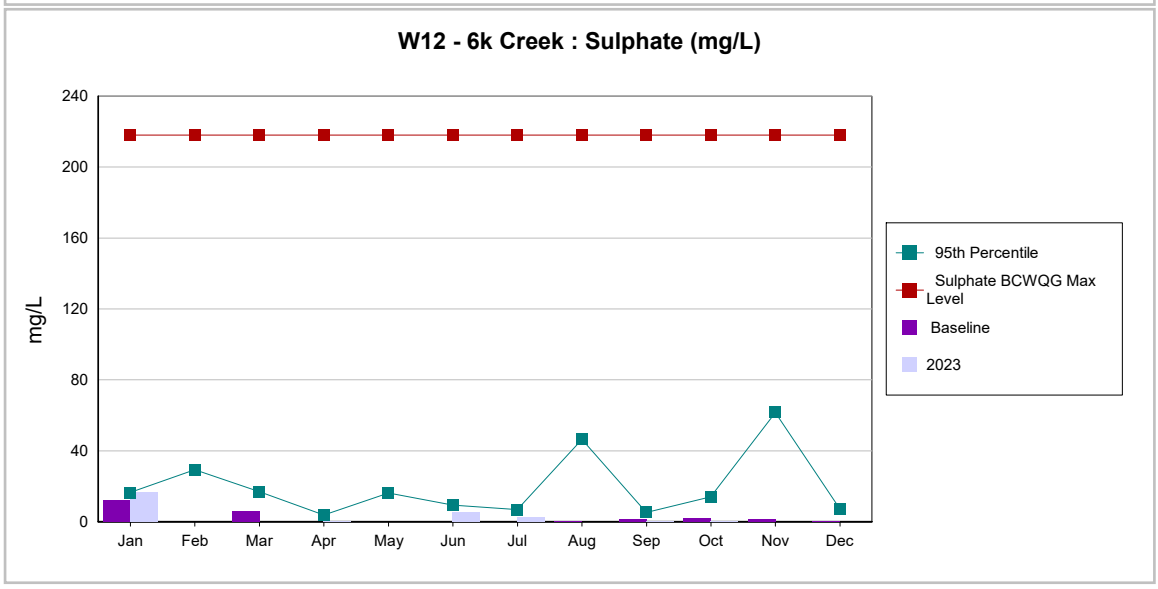
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







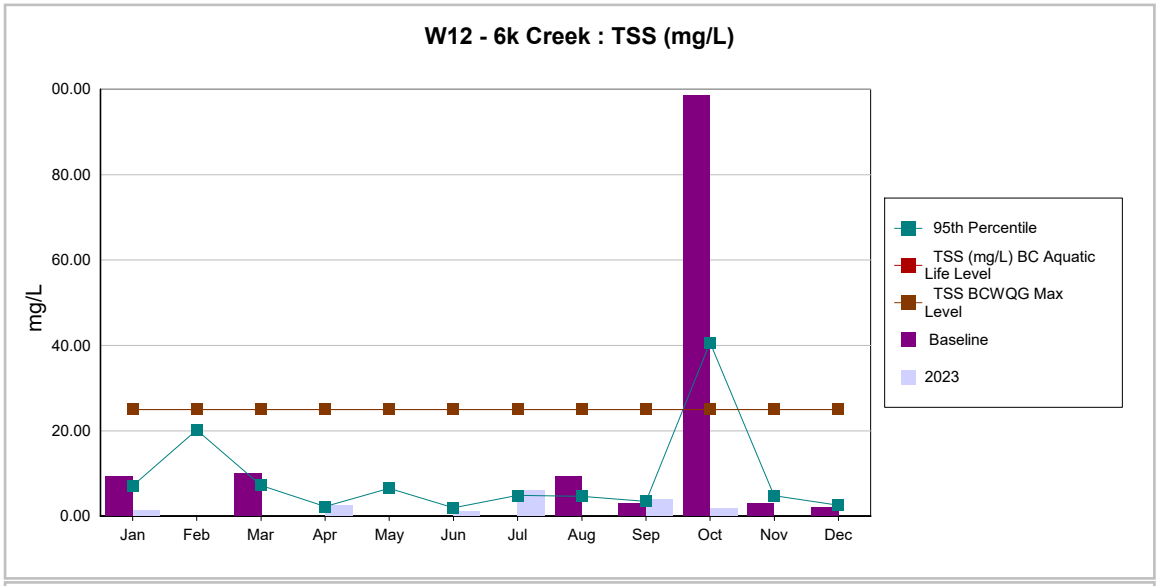
Water Quality Report

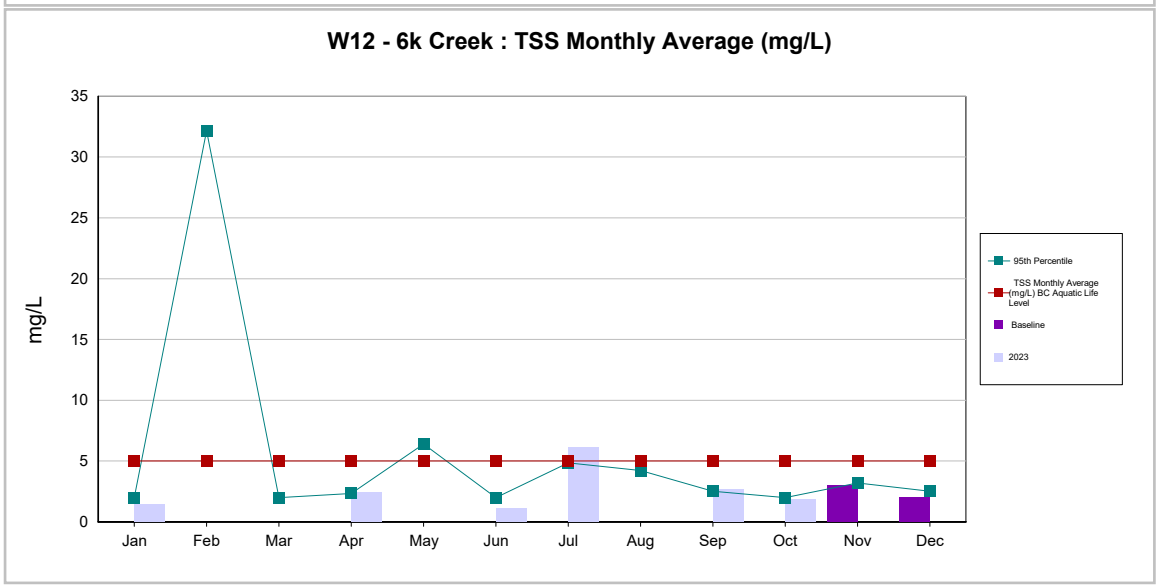
Annual Report SW vs BCWQG

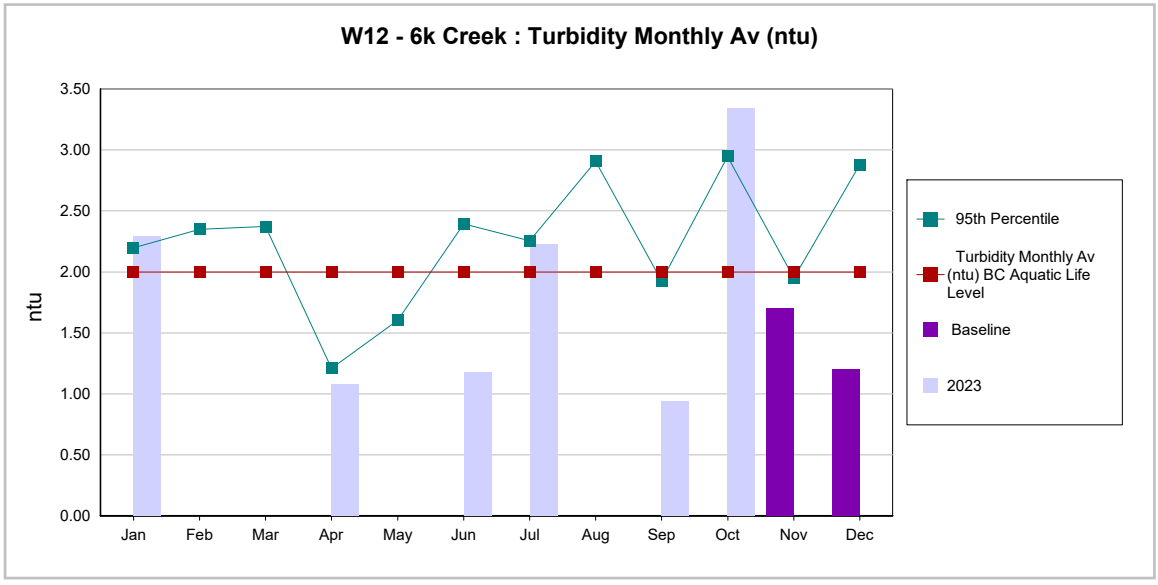
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







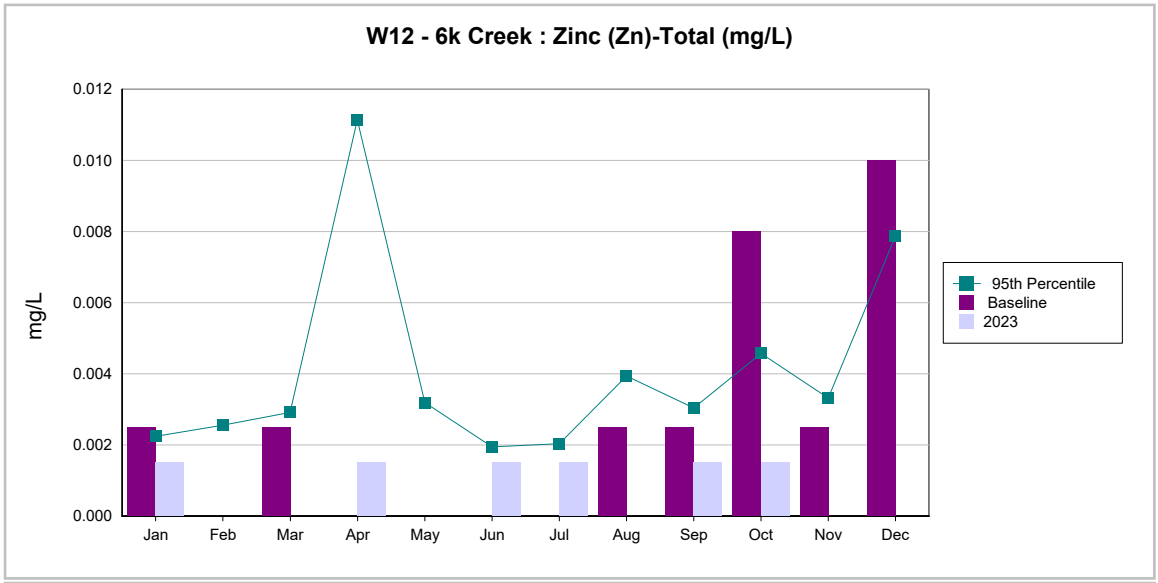
Water Quality Report

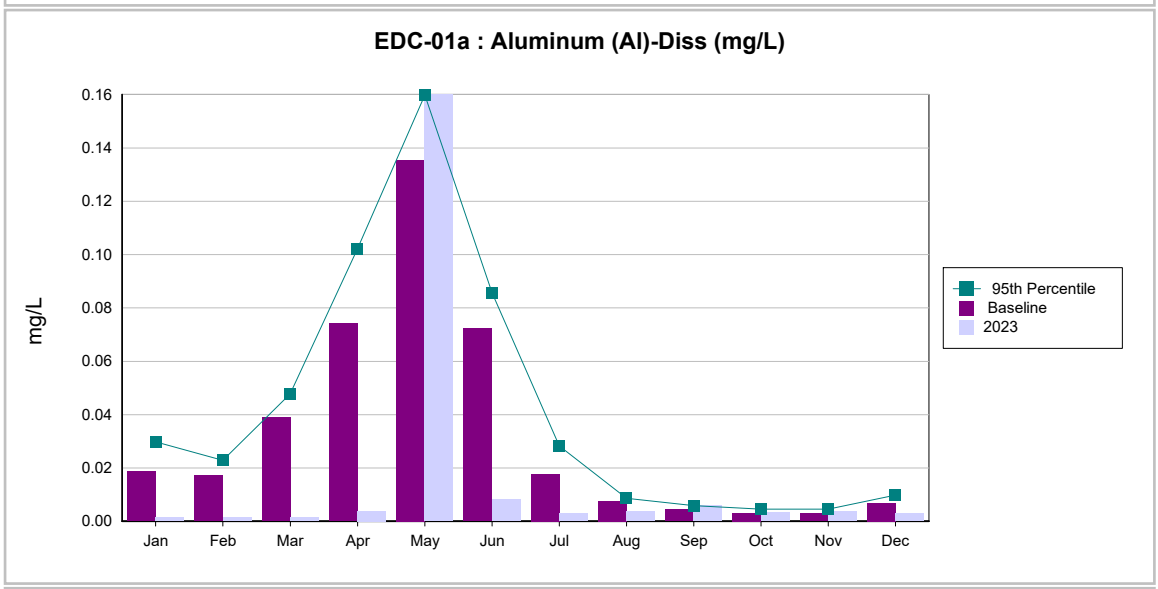
Annual Report SW vs BCWQG

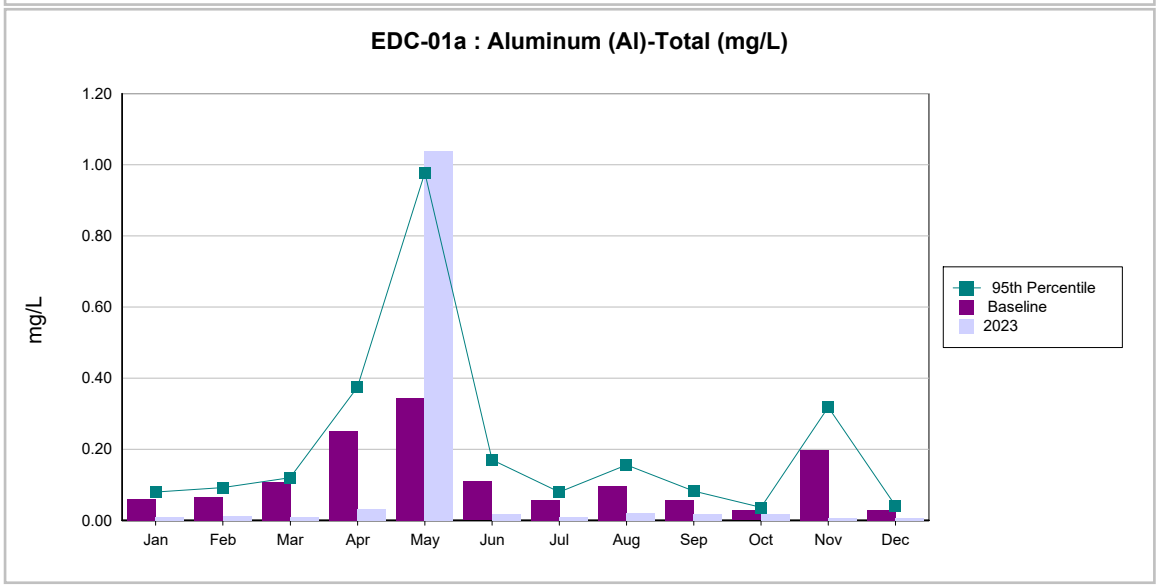
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







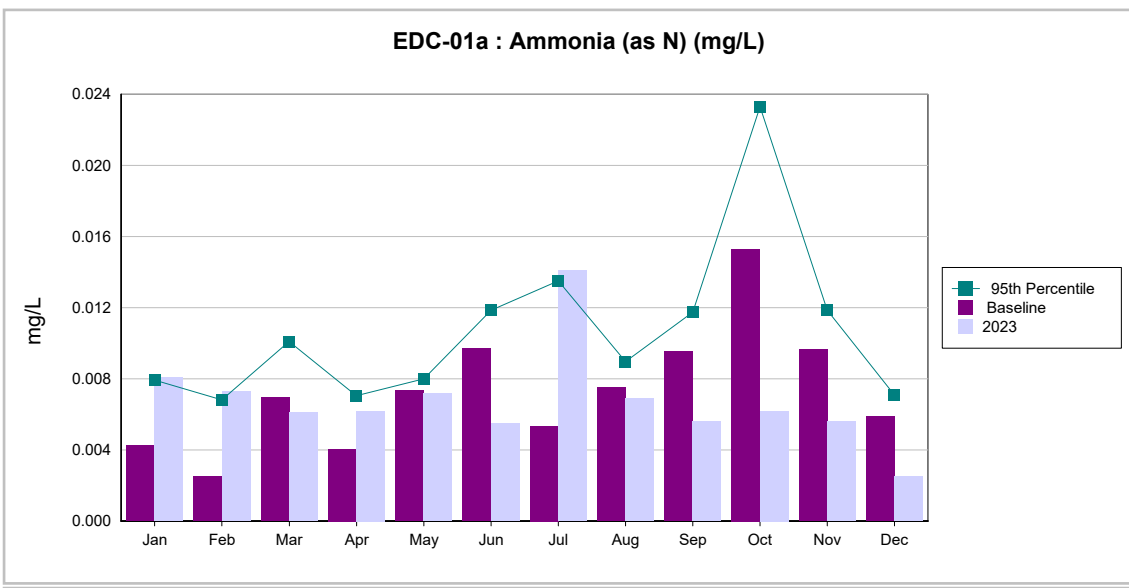
Water Quality Report

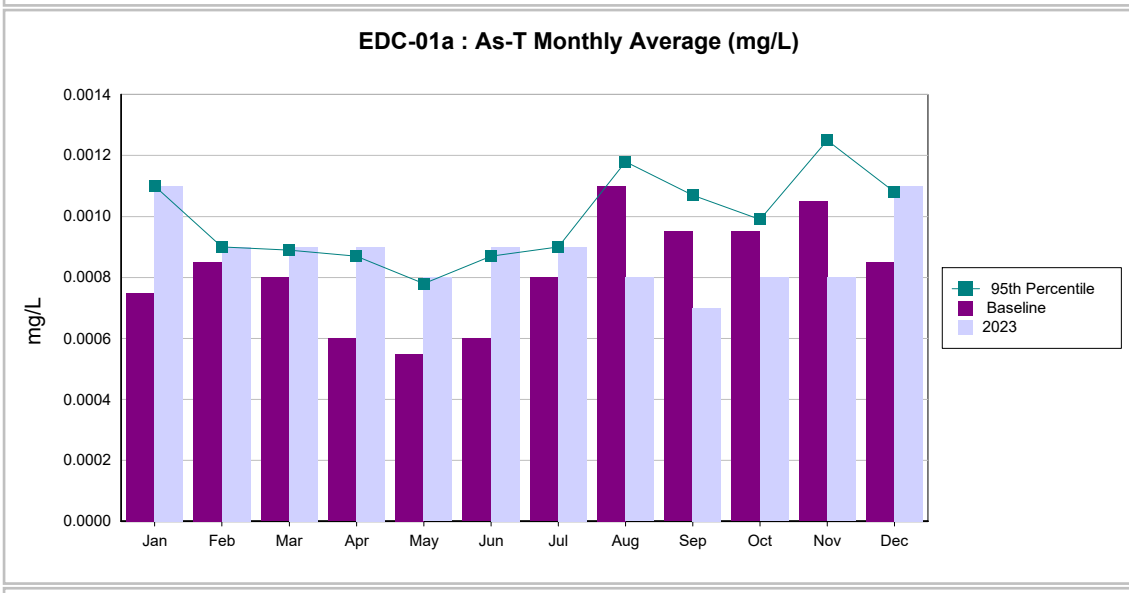
Annual Report SW vs BCWQG

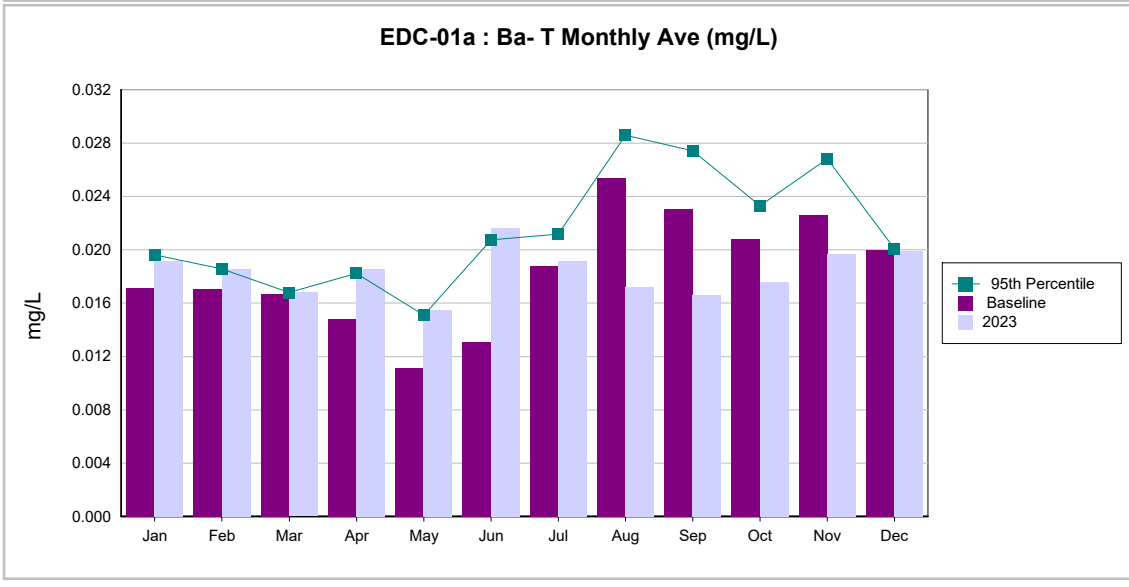
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







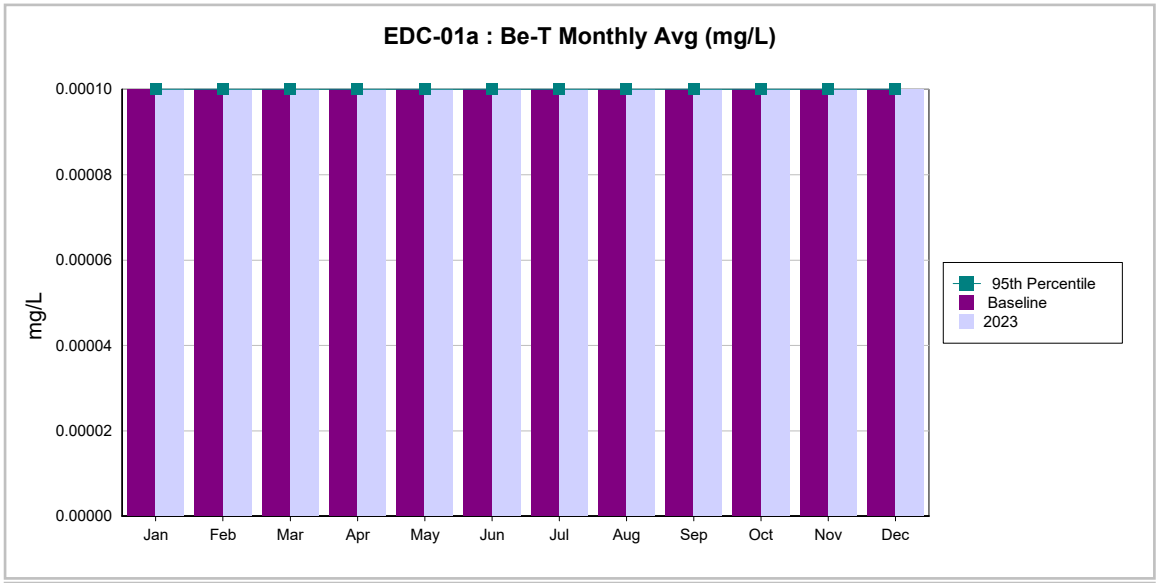
Water Quality Report

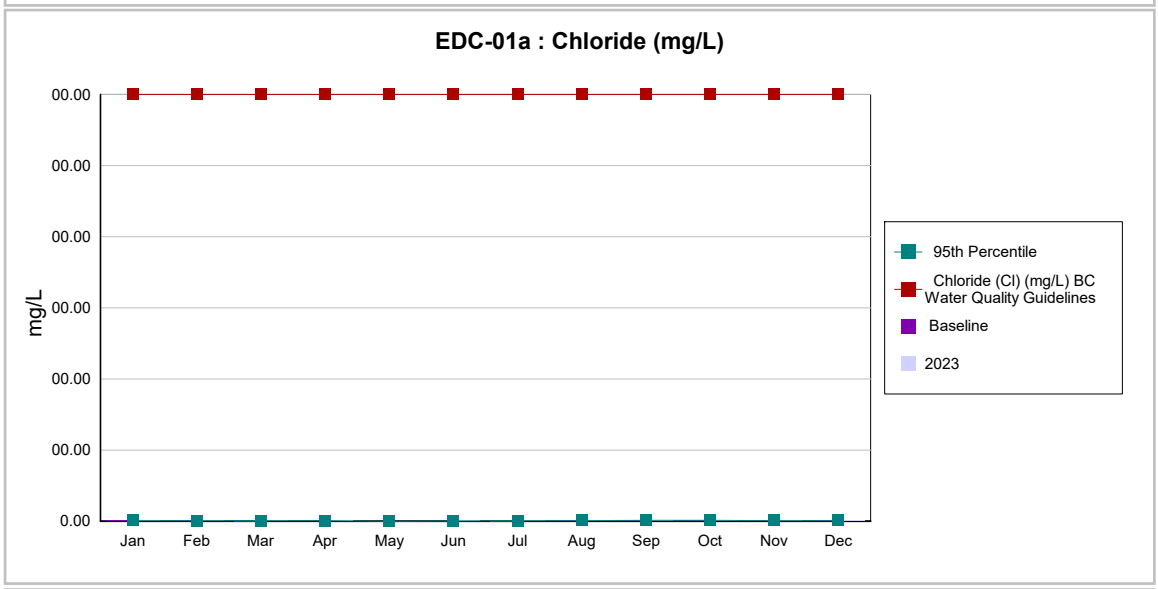
Annual Report SW vs BCWQG

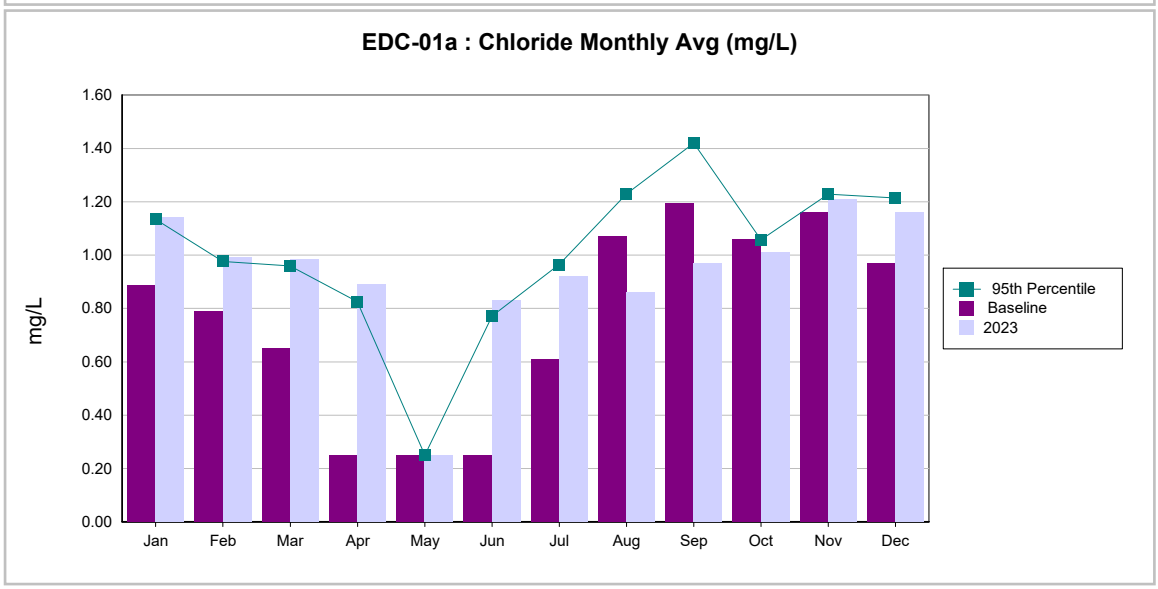
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







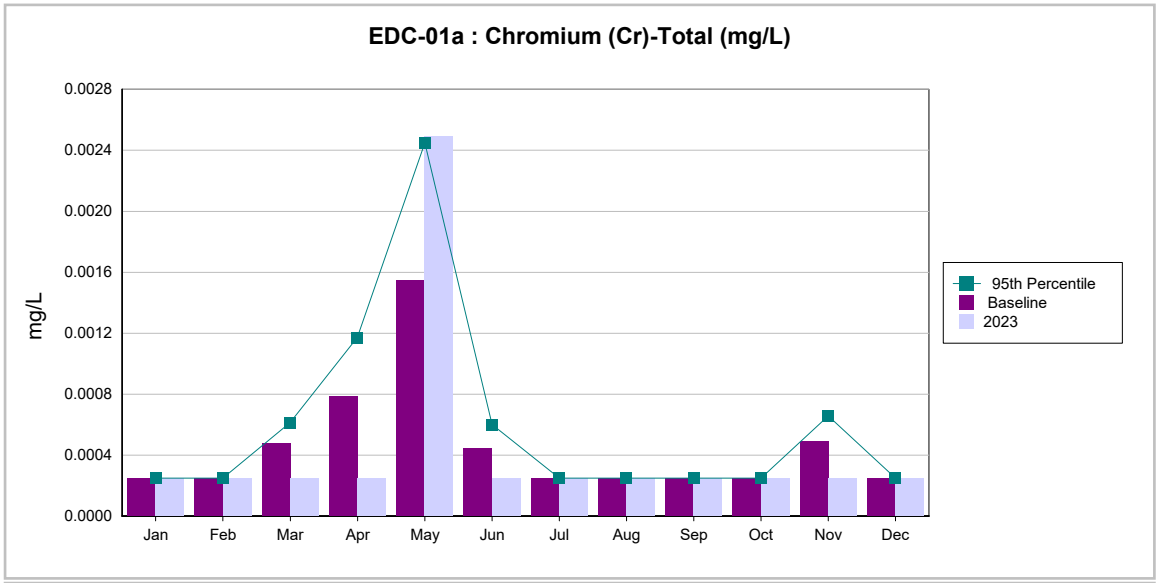
Water Quality Report

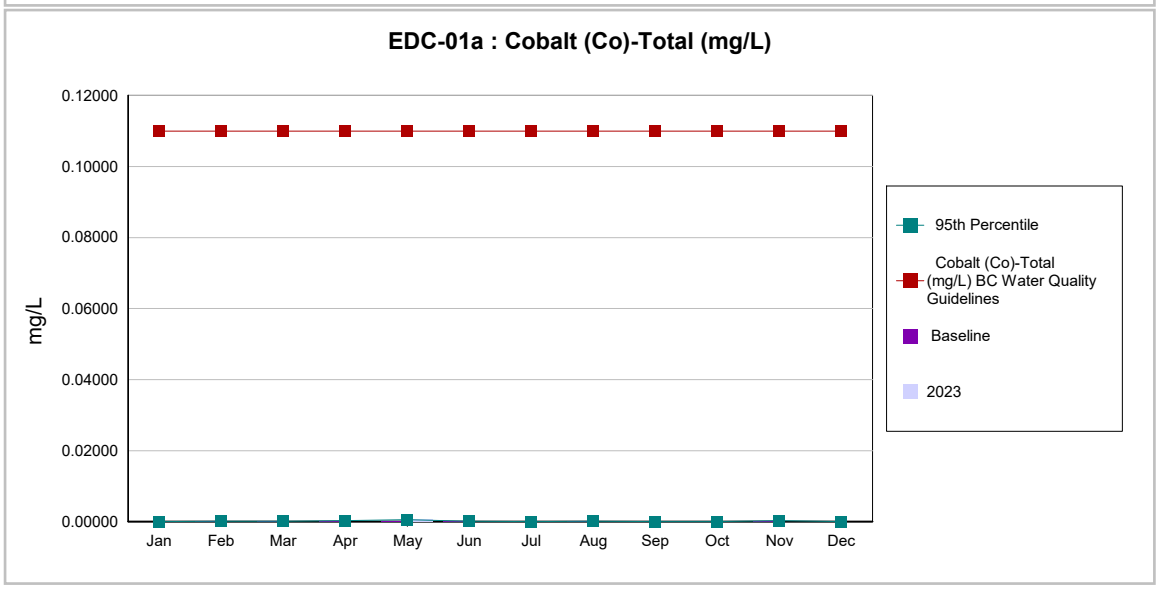
Annual Report SW vs BCWQG

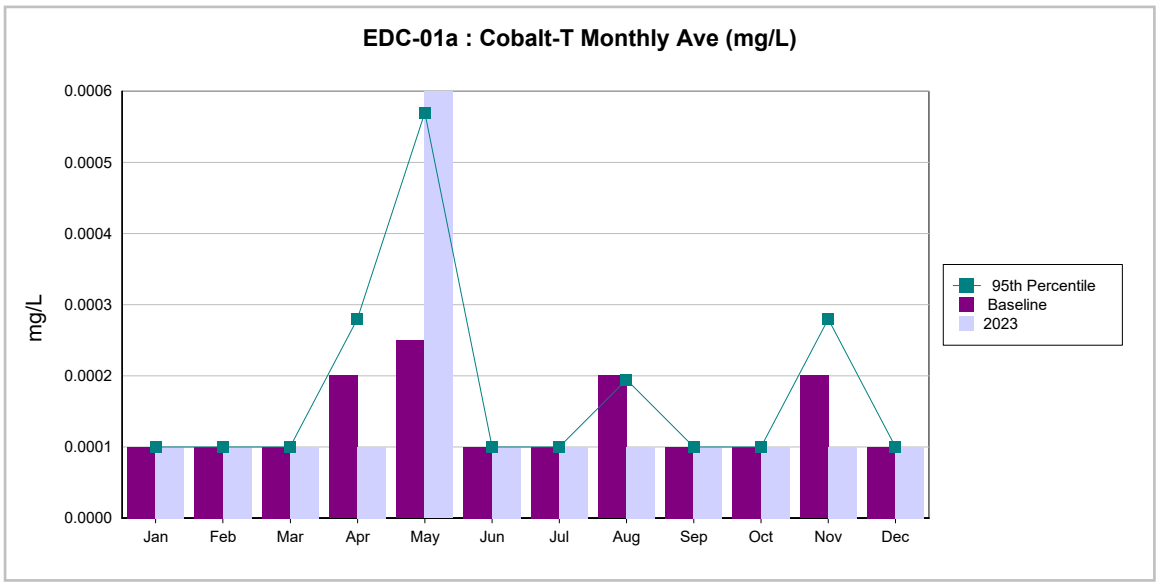
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







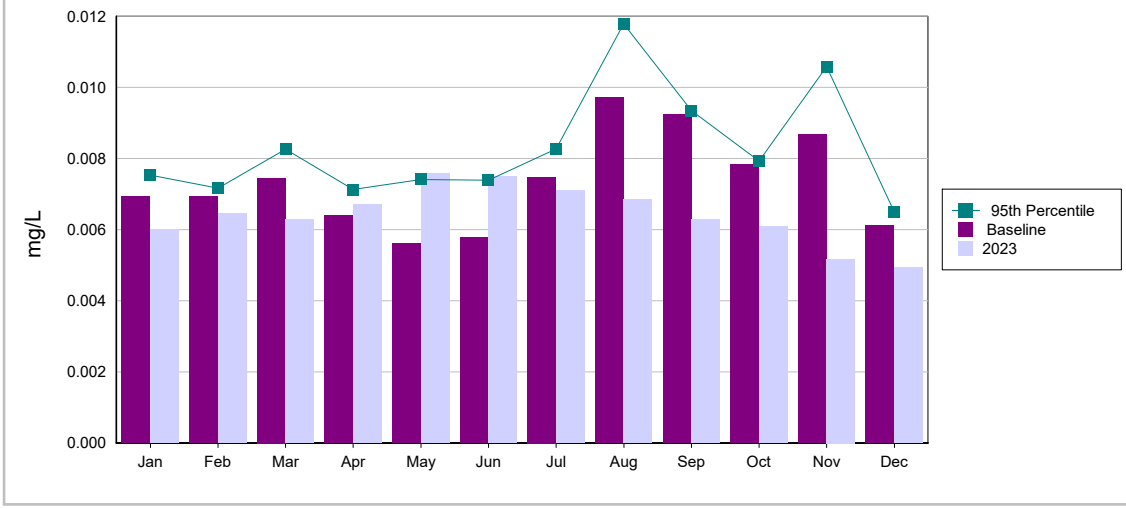
Water Quality Report

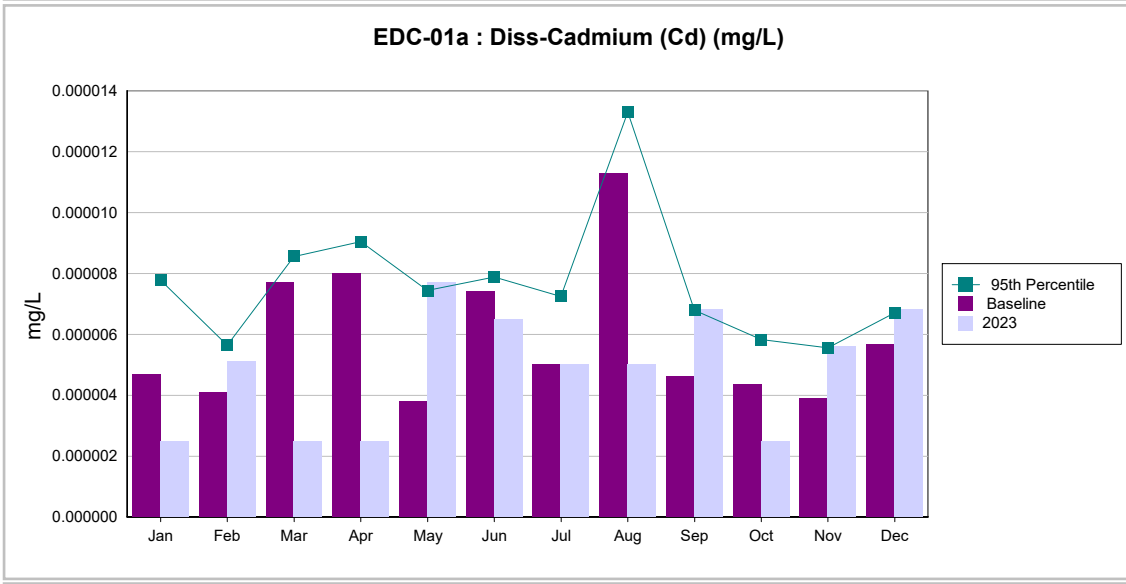
Annual Report SW vs BCWQG

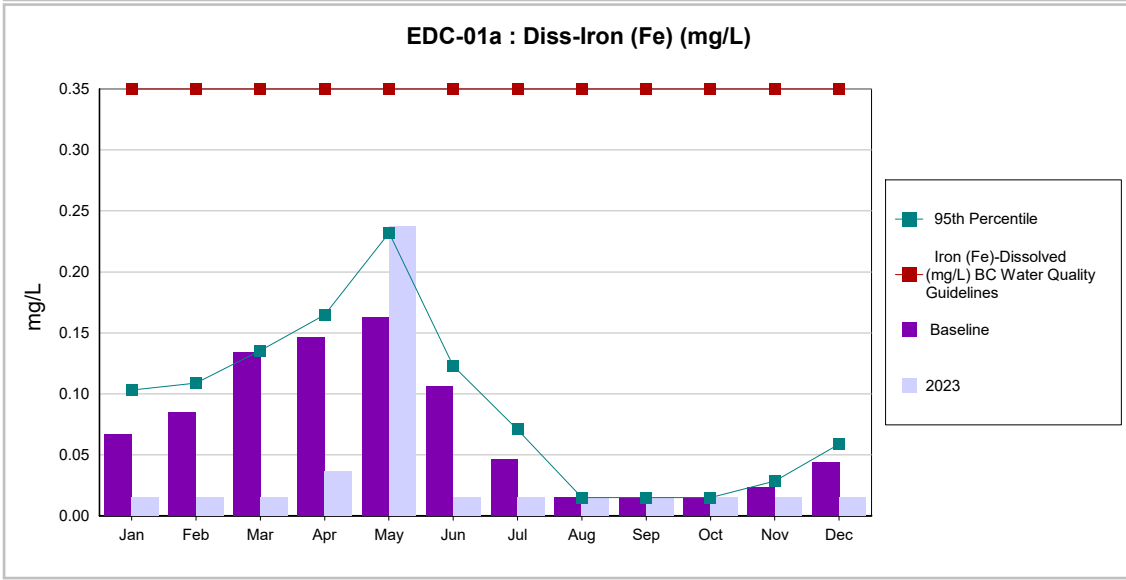
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







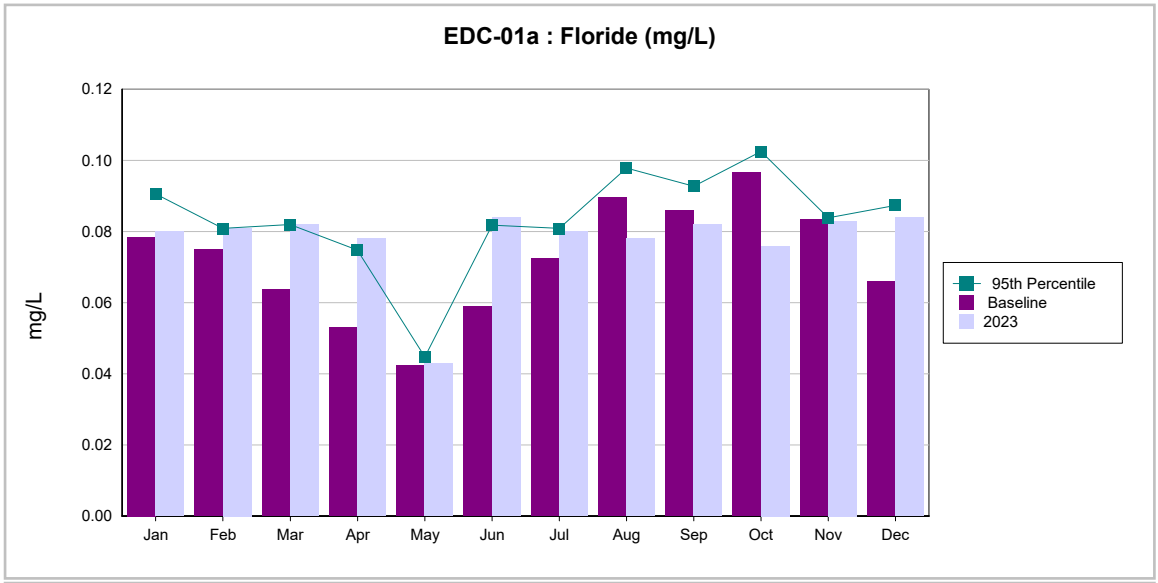
Water Quality Report

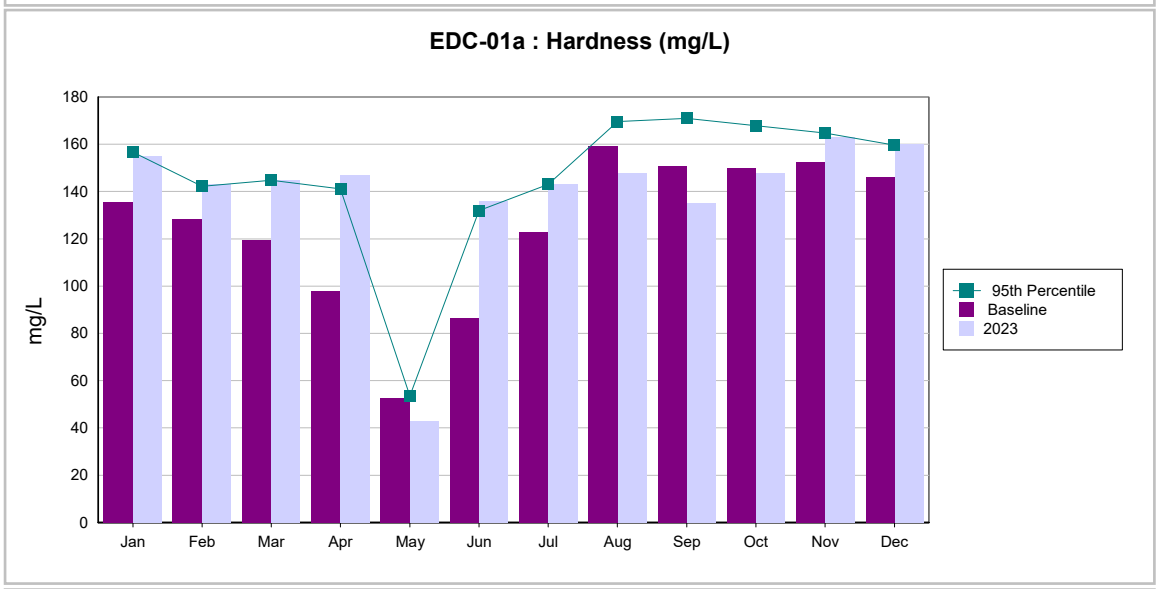
Annual Report SW vs BCWQG

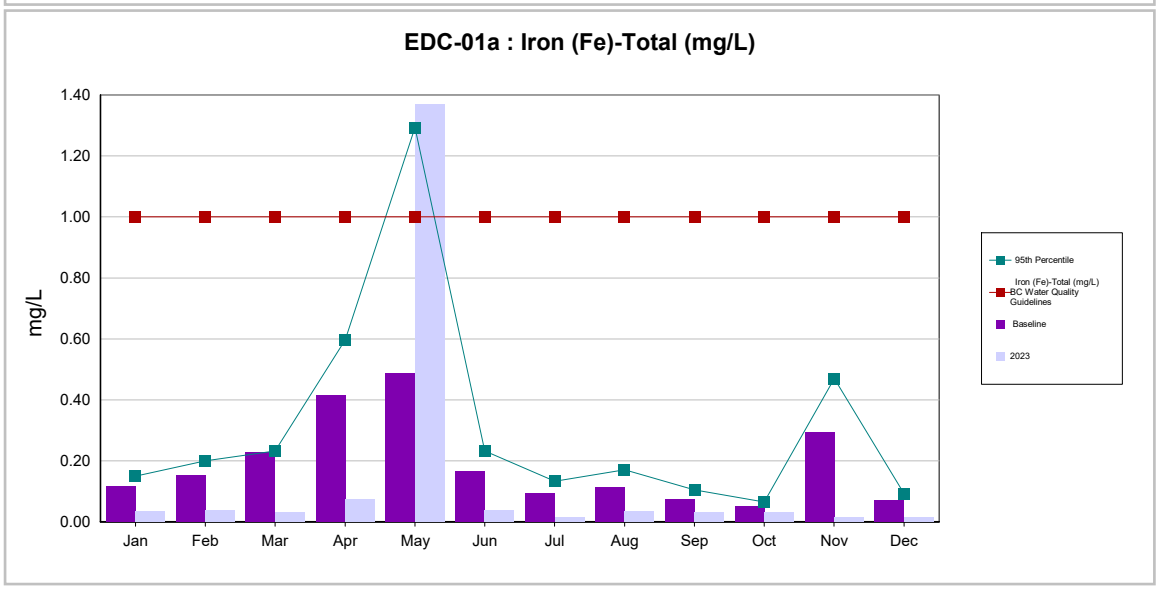
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







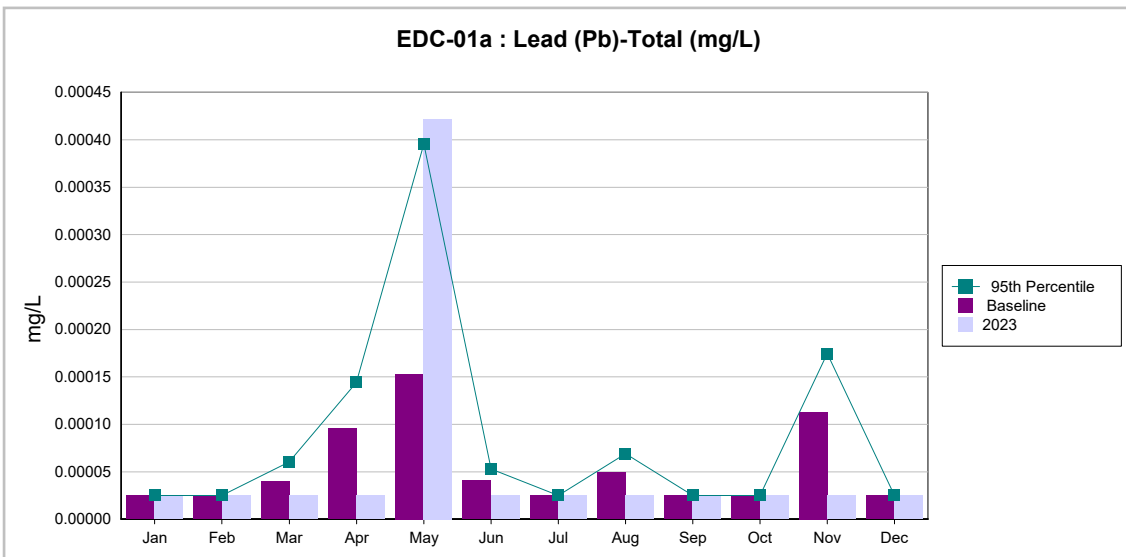
Water Quality Report

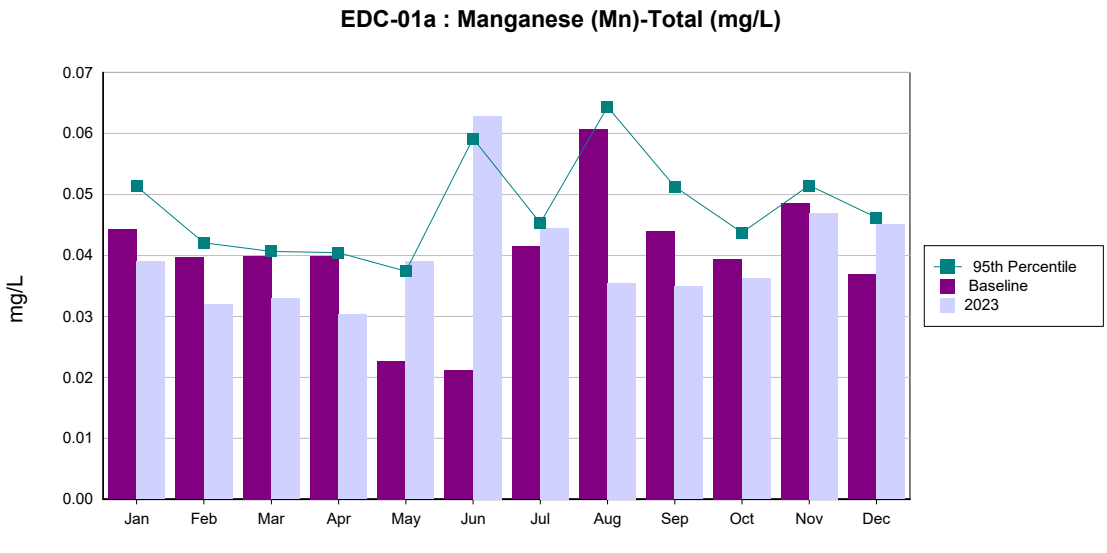
Annual Report SW vs BCWQG

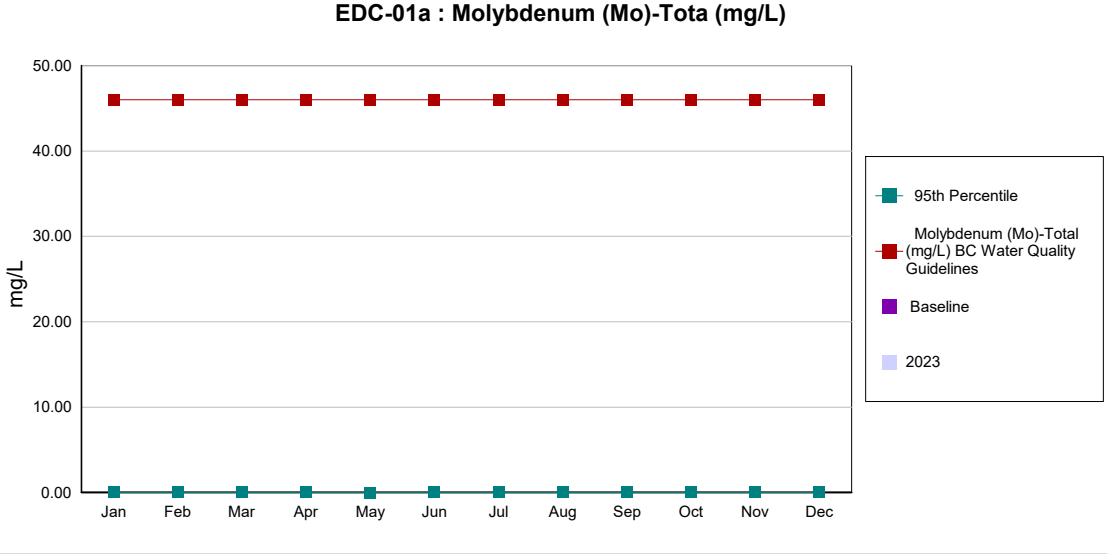
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







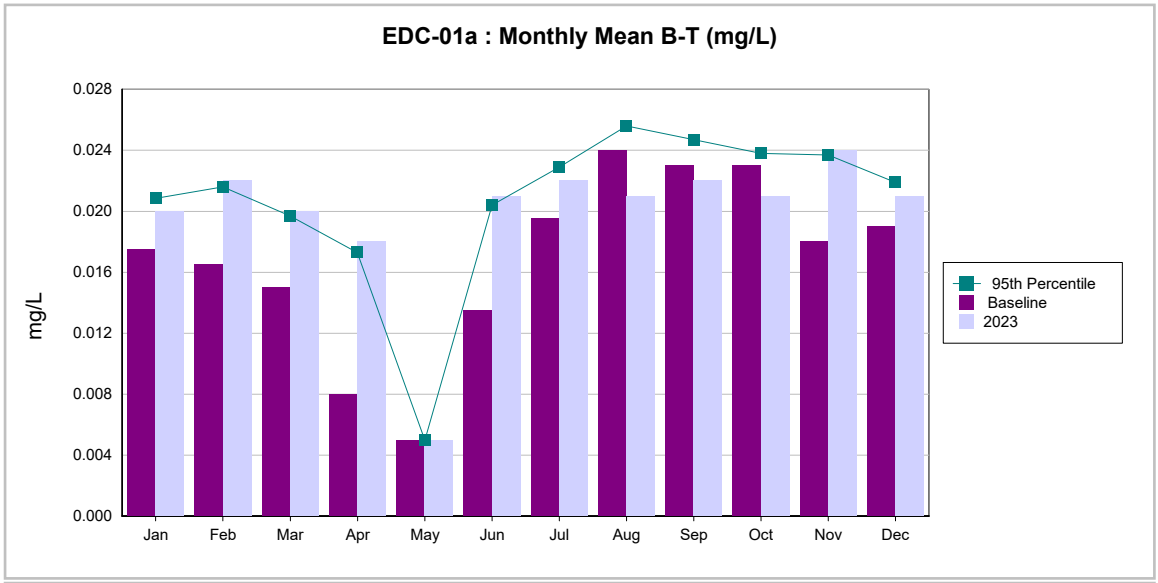
Water Quality Report

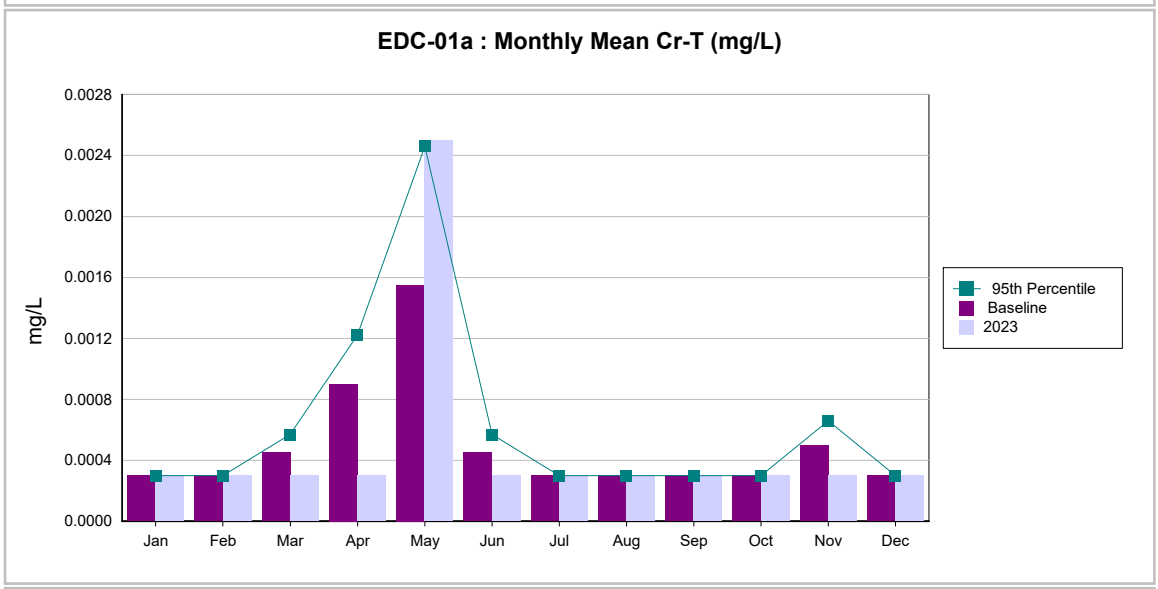
Annual Report SW vs BCWQG

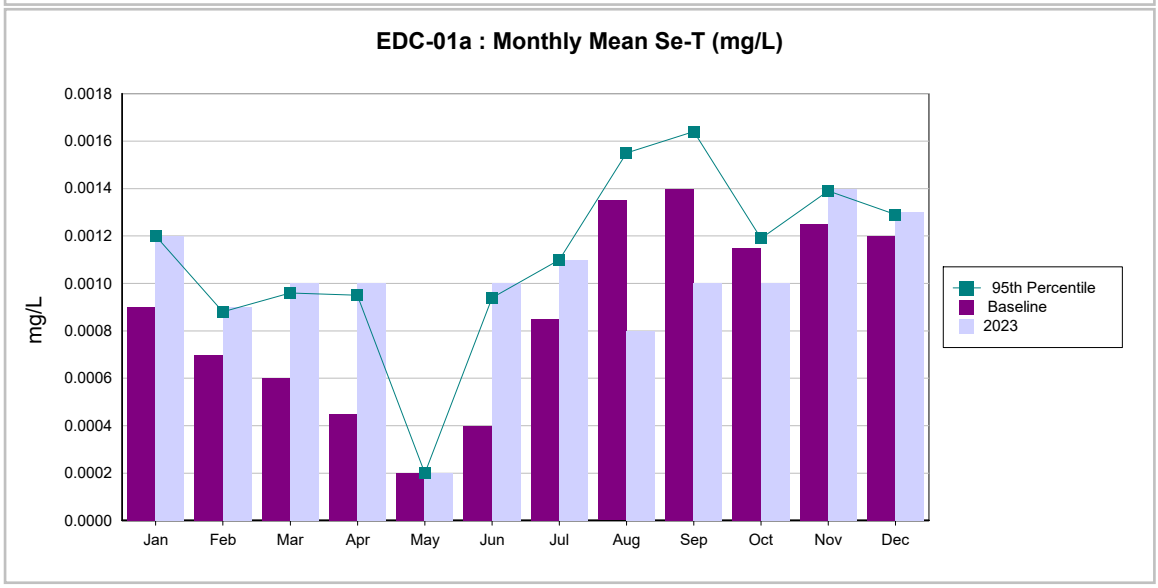
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







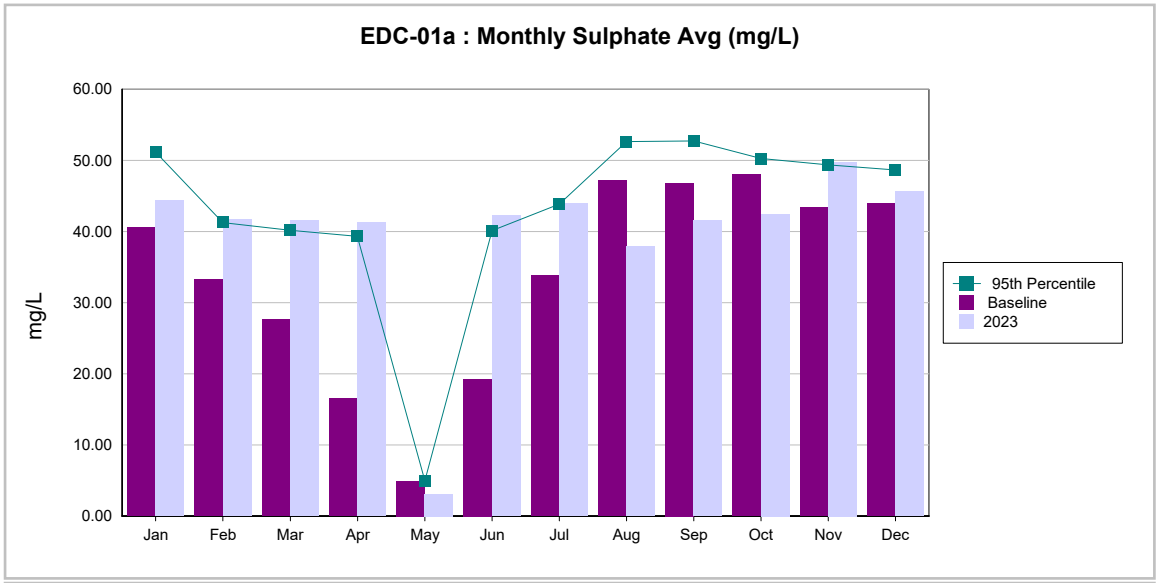
Water Quality Report

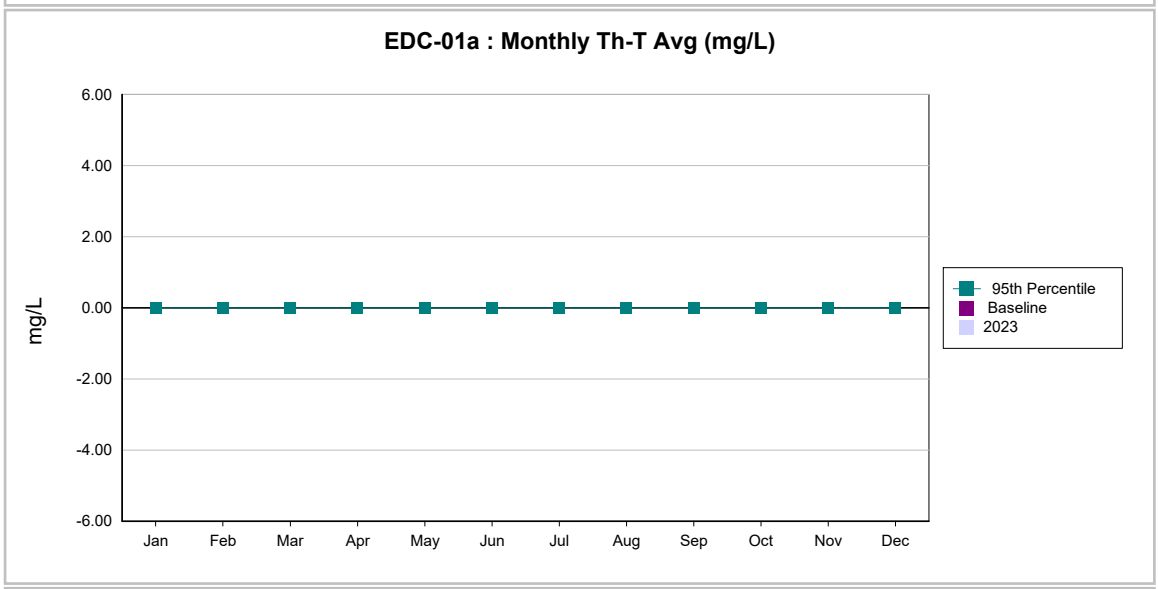
Annual Report SW vs BCWQG

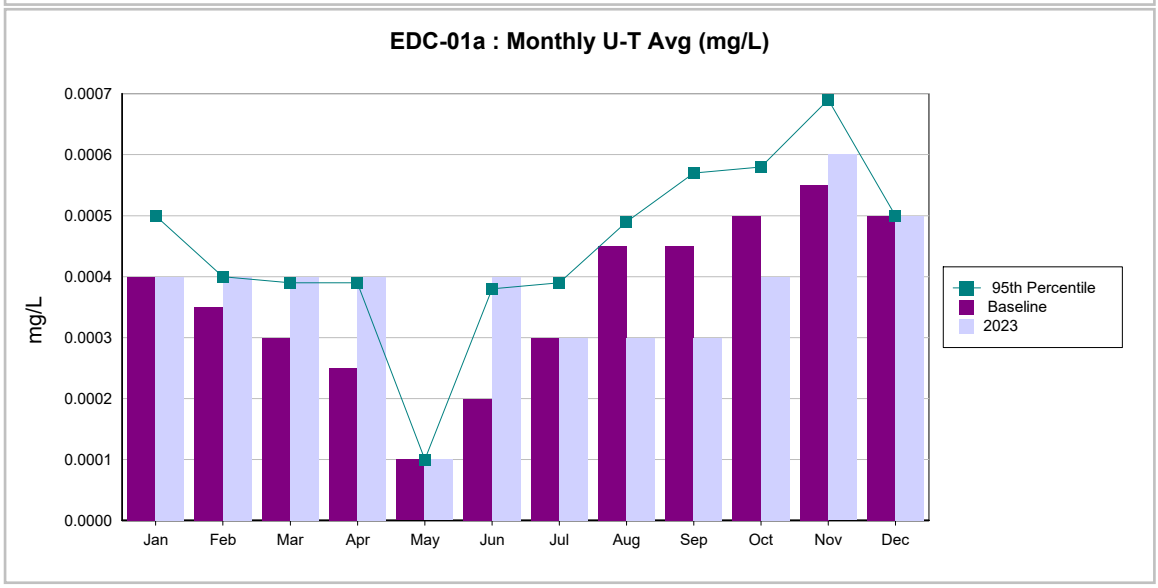
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







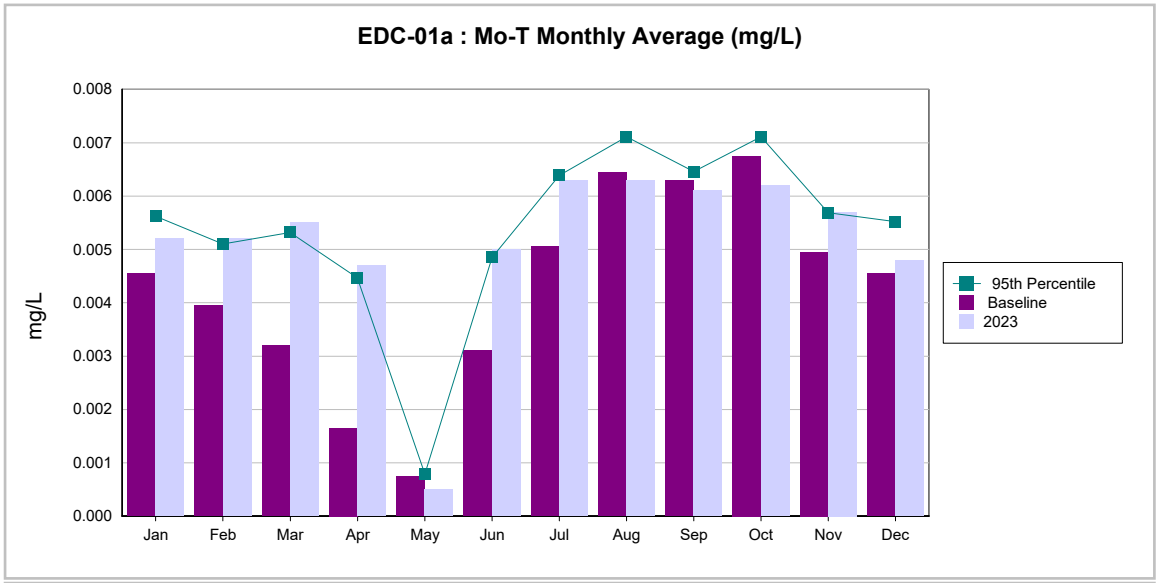
Water Quality Report

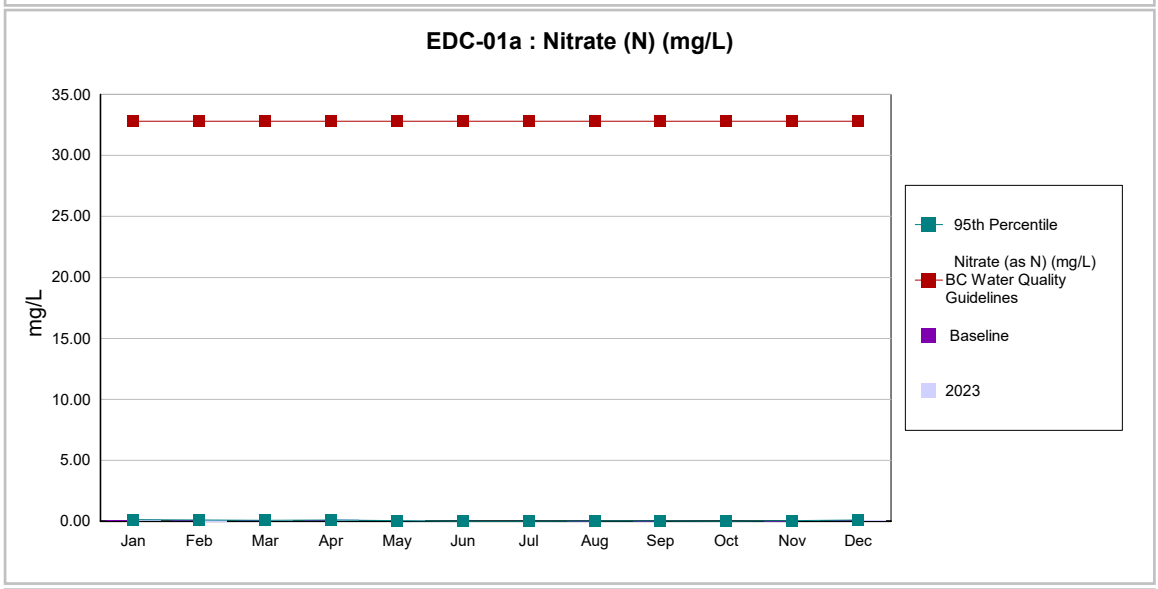
Annual Report SW vs BCWQG

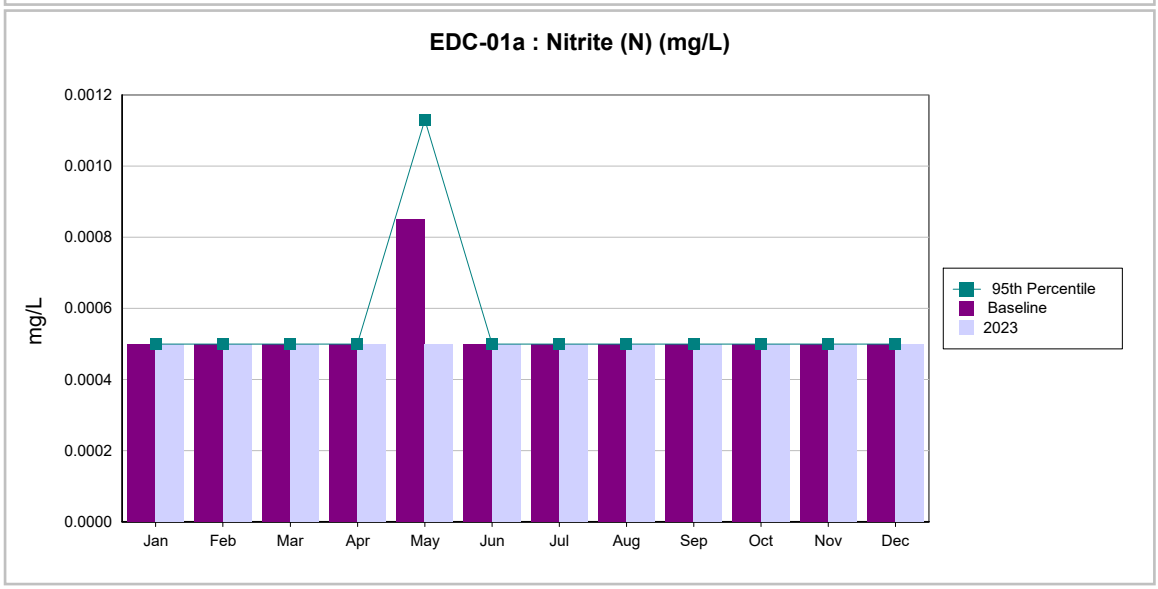
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







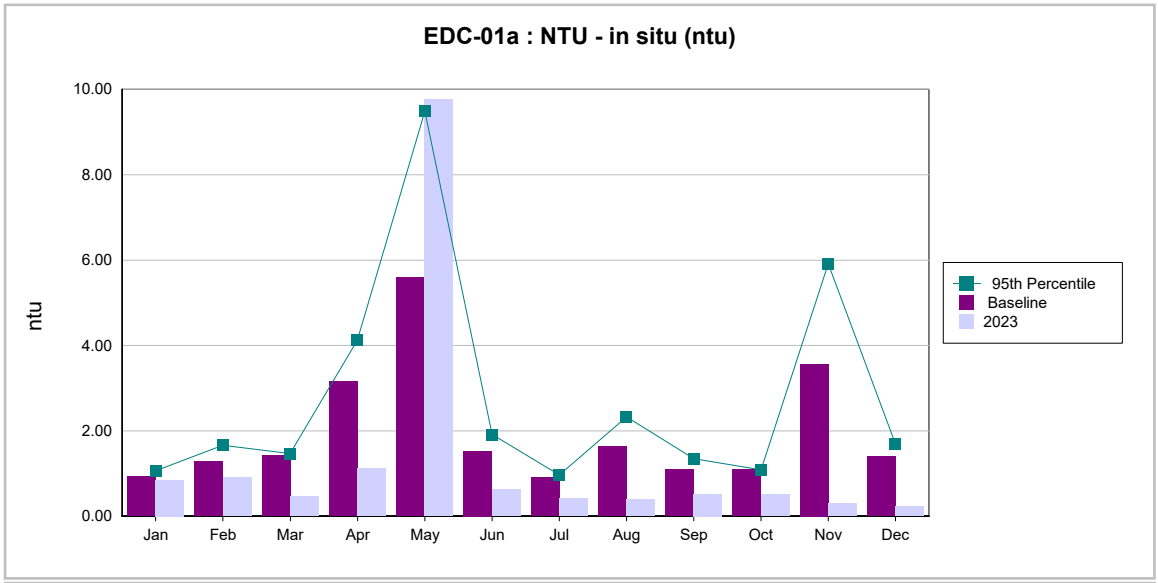
Water Quality Report

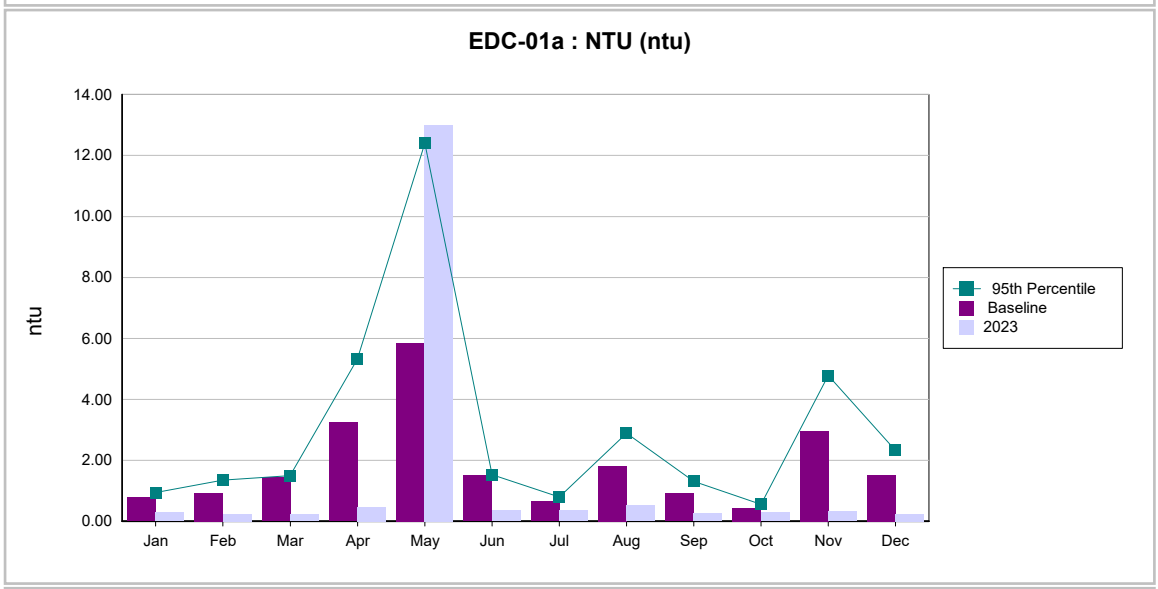
Annual Report SW vs BCWQG

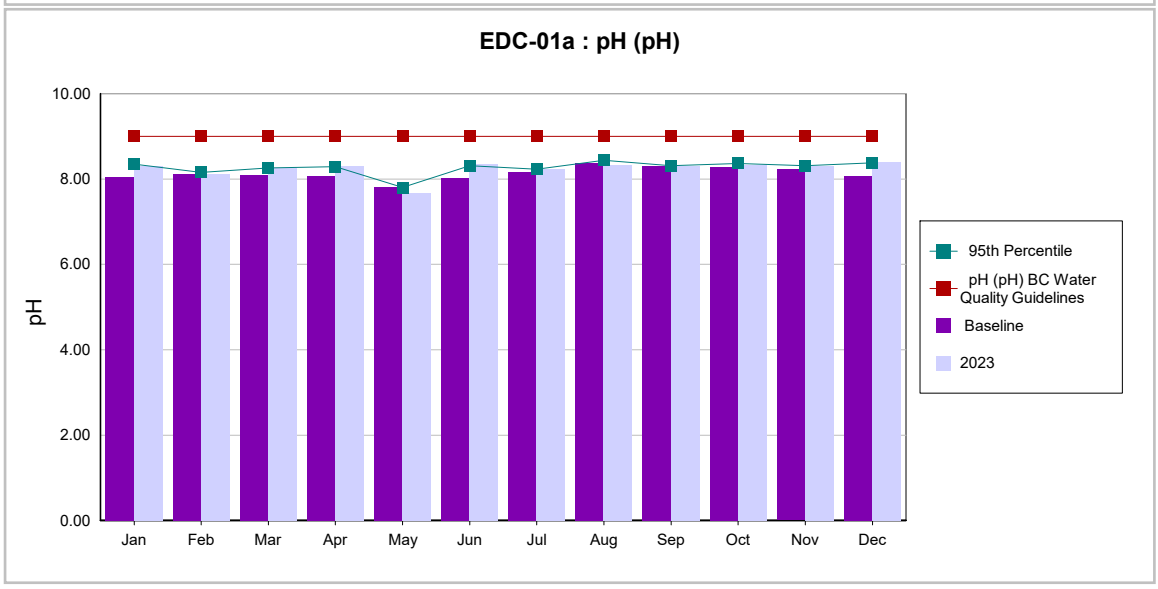
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







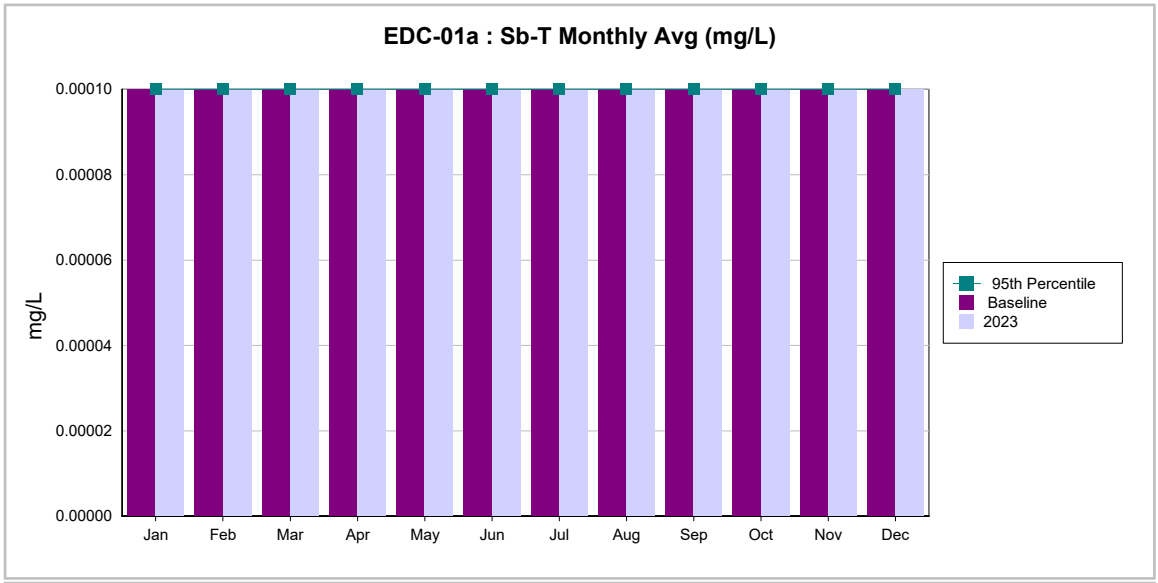
Water Quality Report

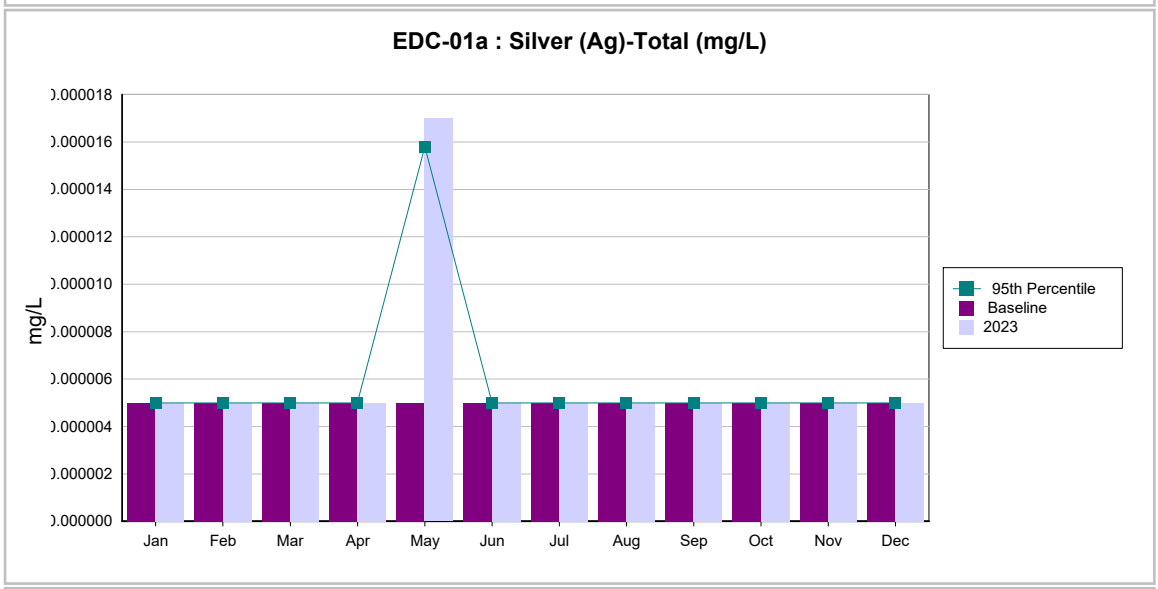
Annual Report SW vs BCWQG

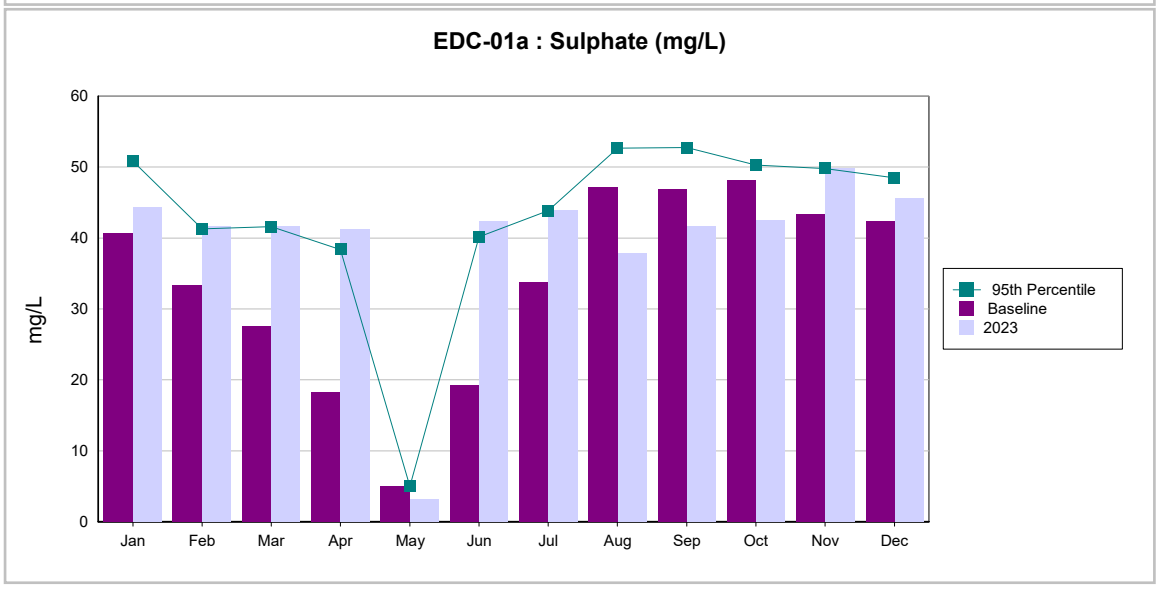
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







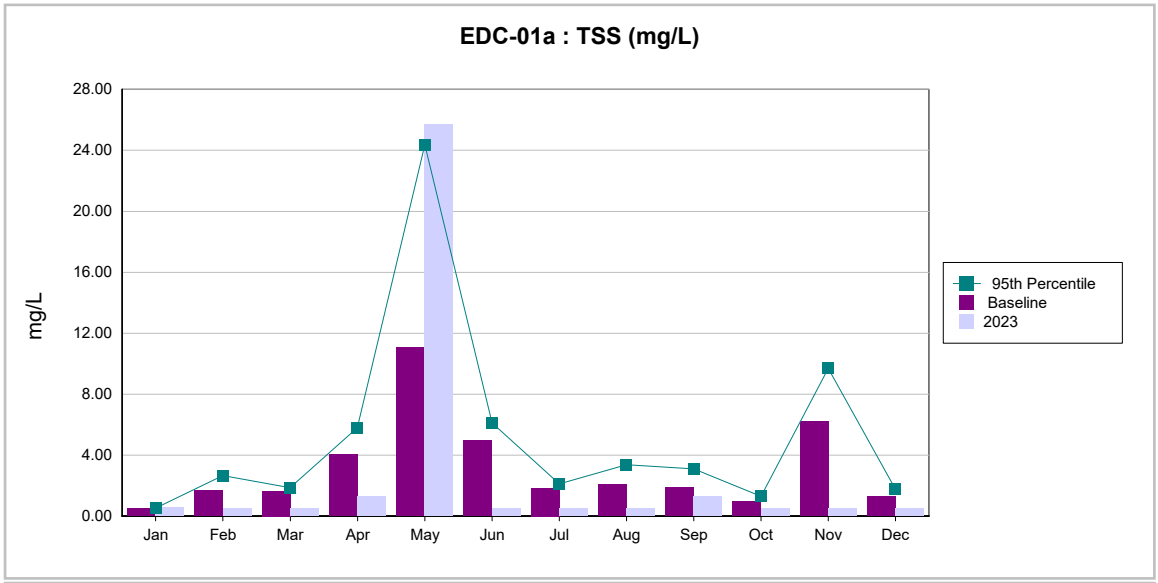
Water Quality Report

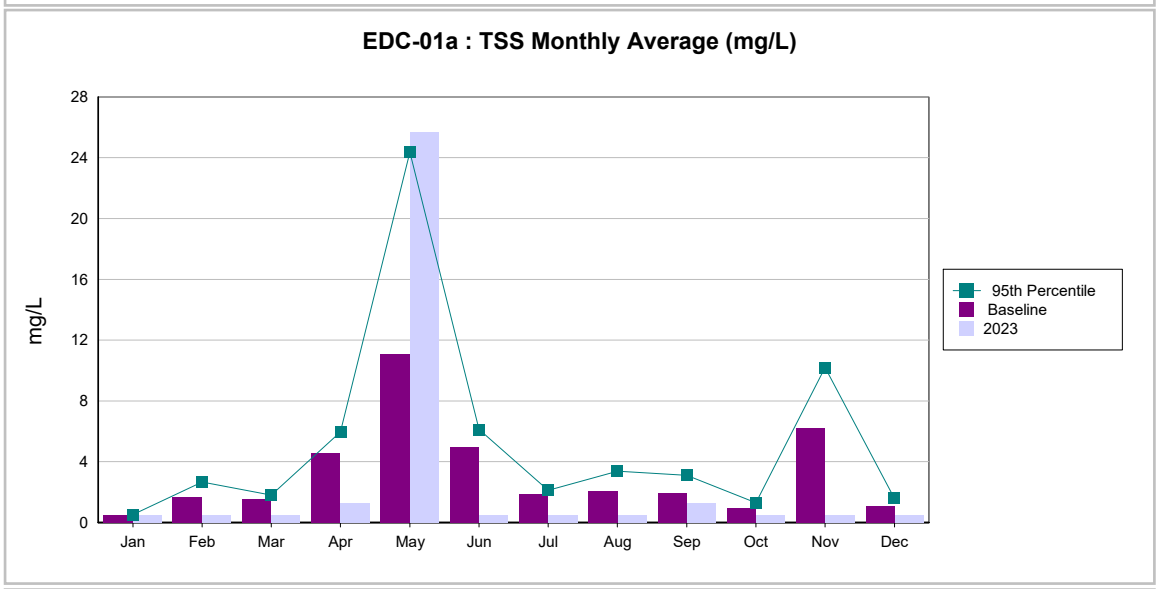
Annual Report SW vs BCWQG

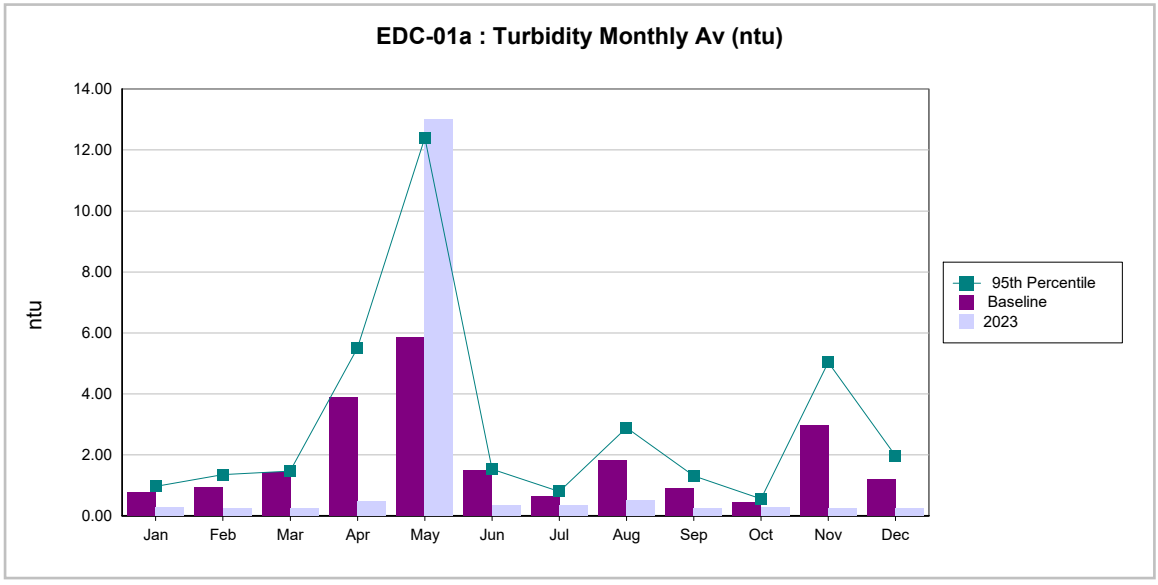
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







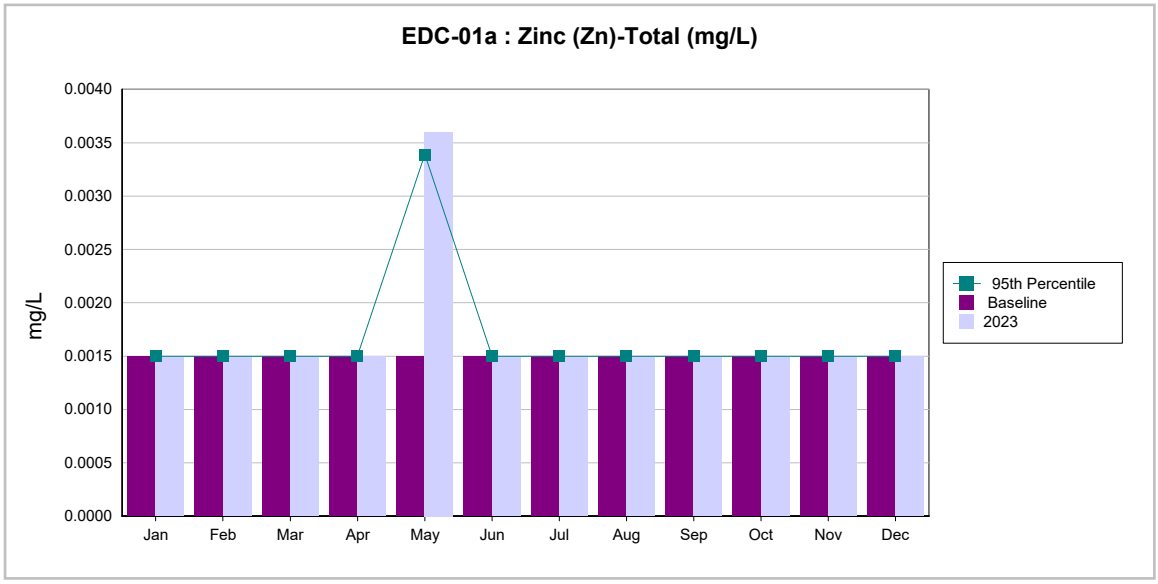
Water Quality Report

Annual Report SW vs BCWQG

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



Water Quality Report

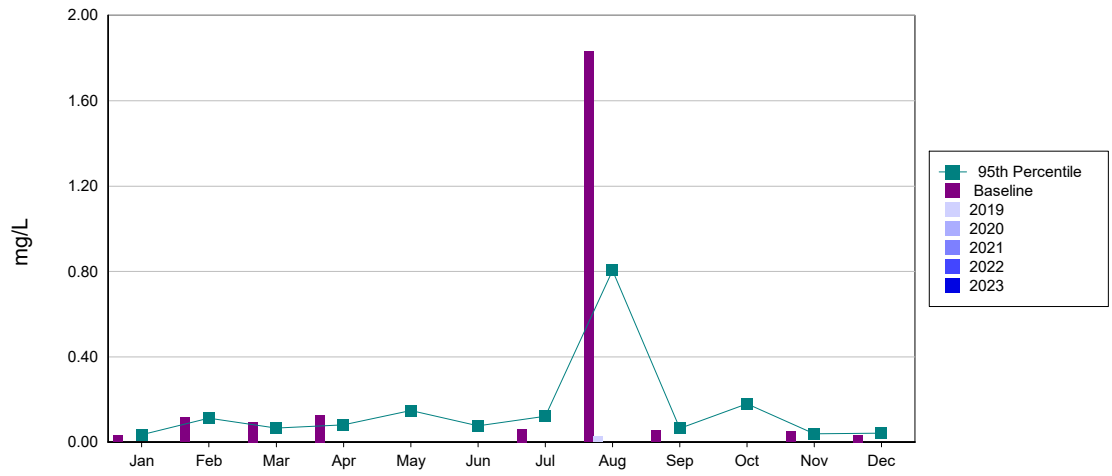
Annual Report Contact Water

Mount Polley

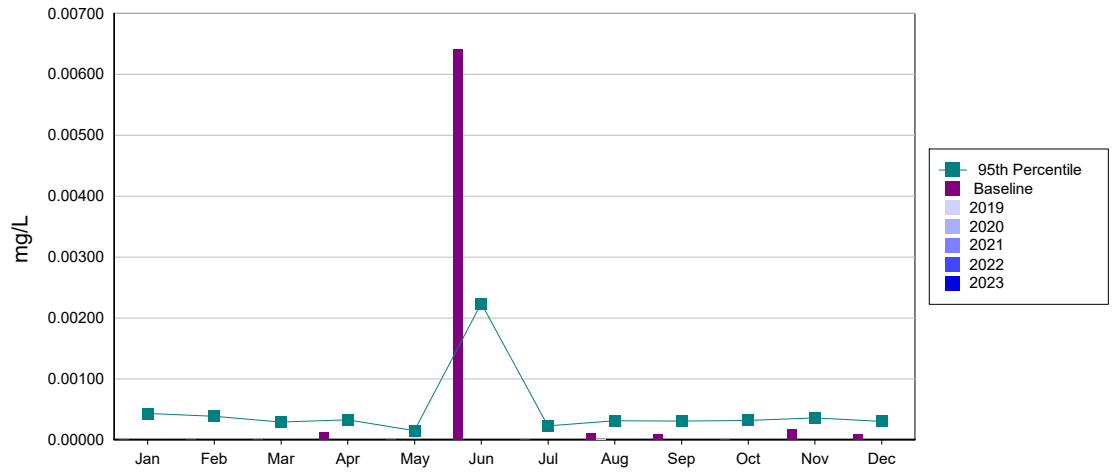
Mining Corporation

IMPERIAL METALS CORPORATION

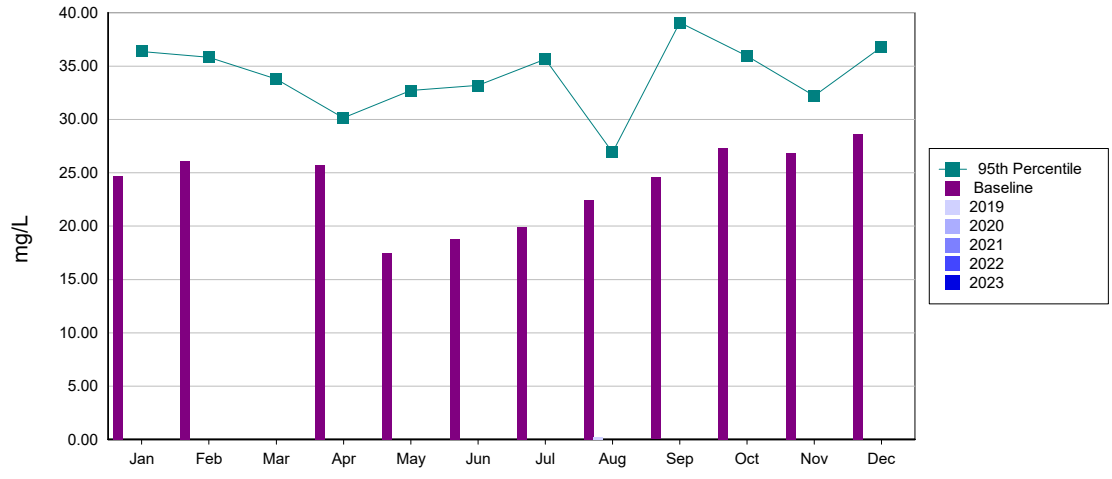
E1 - Tailings Impoundment Supernatant : Aluminum (Al)-Diss (mg/L)



E1 - Tailings Impoundment Supernatant : Cadmium (Cd)-Total (mg/L)



E1 - Tailings Impoundment Supernatant : Chloride (mg/L)



Water Quality Report

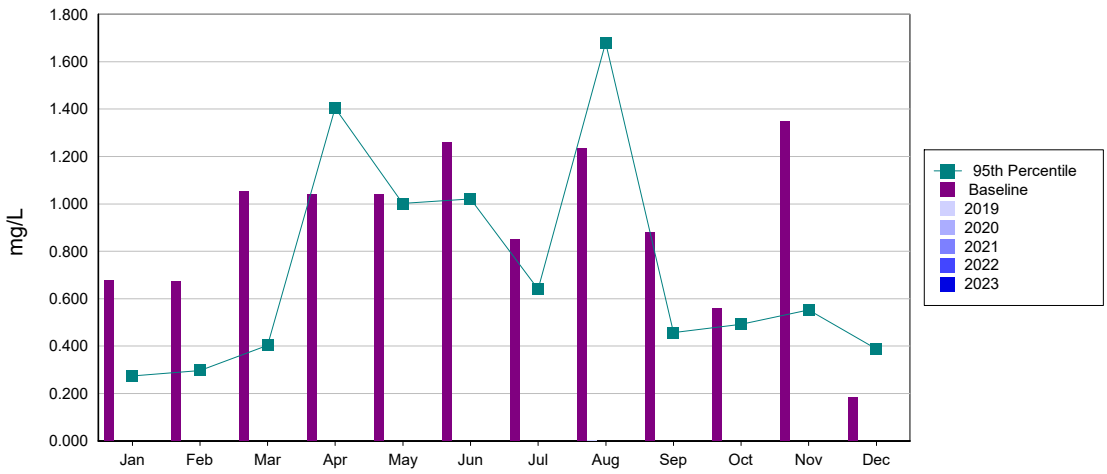
Annual Report Contact Water

Mount Polley

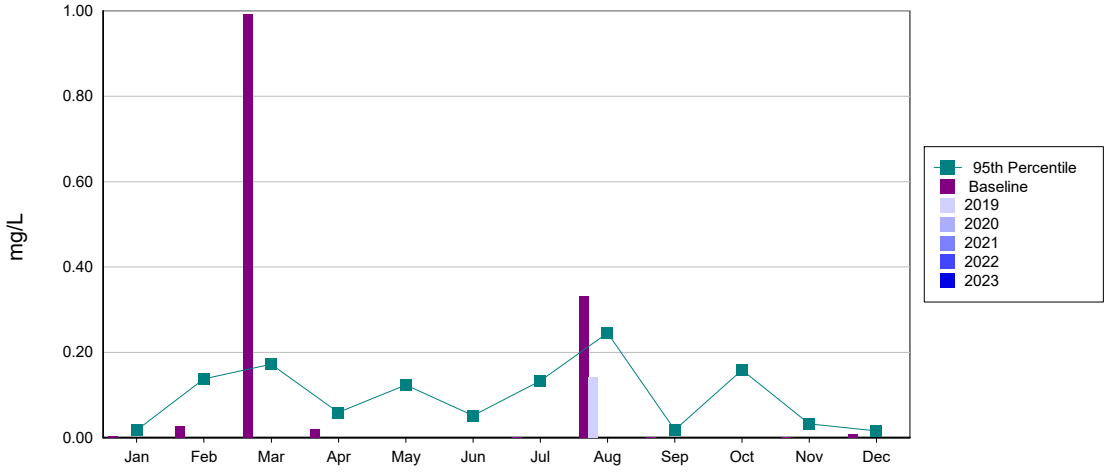
Mining Corporation

IMPERIAL METALS CORPORATION

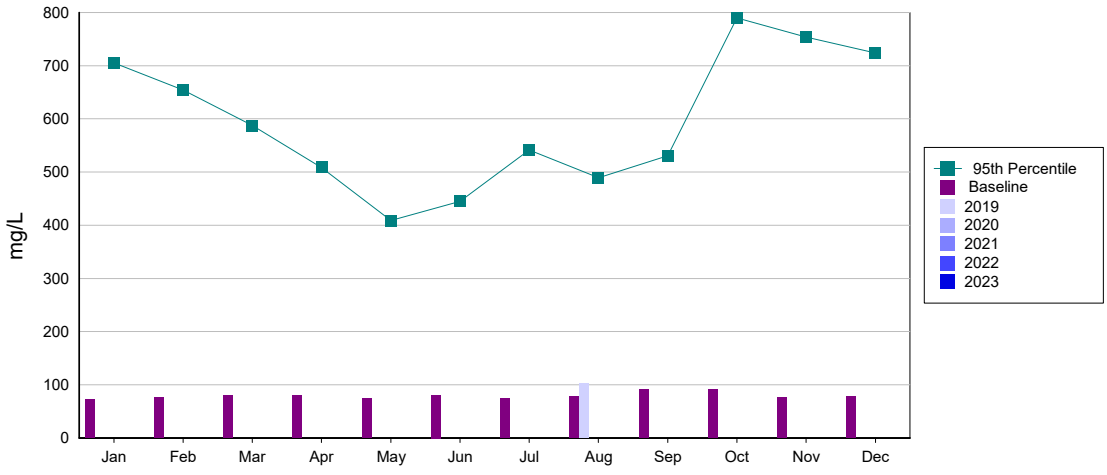
E1 - Tailings Impoundment Supernatant : Copper (Cu)-Total (mg/L)



E1 - Tailings Impoundment Supernatant : Diss-Iron (Fe) (mg/L)



E1 - Tailings Impoundment Supernatant : Hardness (mg/L)



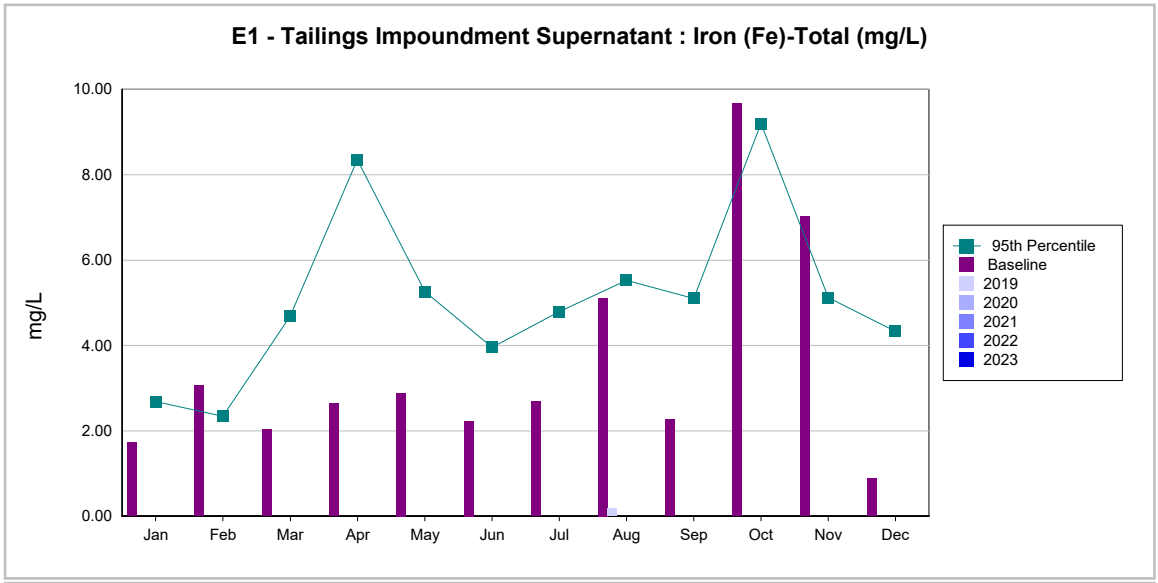
Water Quality Report

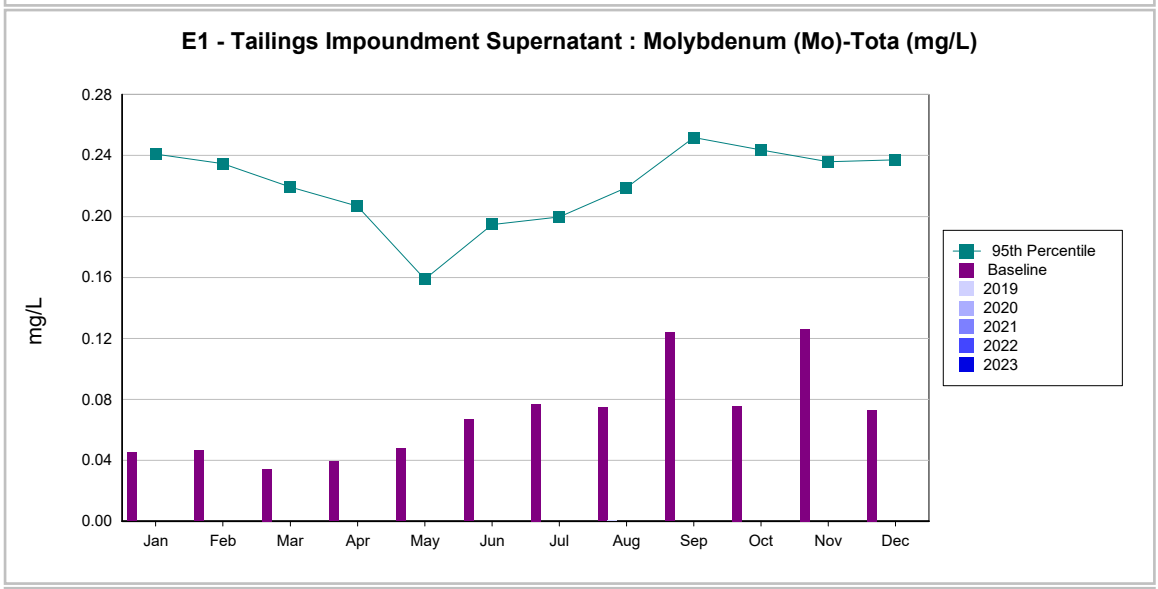
Annual Report Contact Water

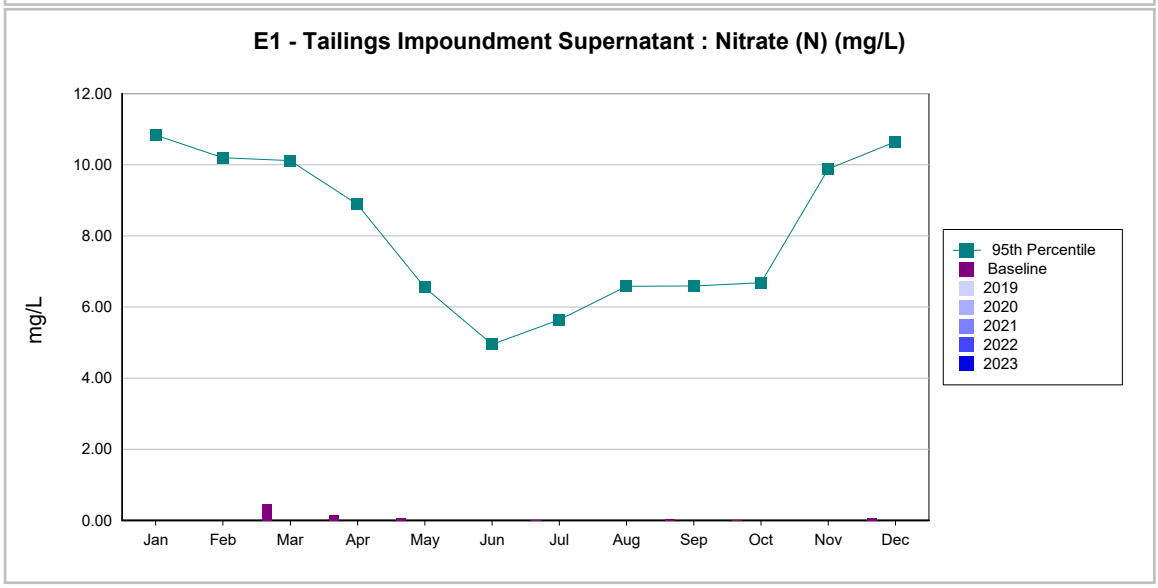
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

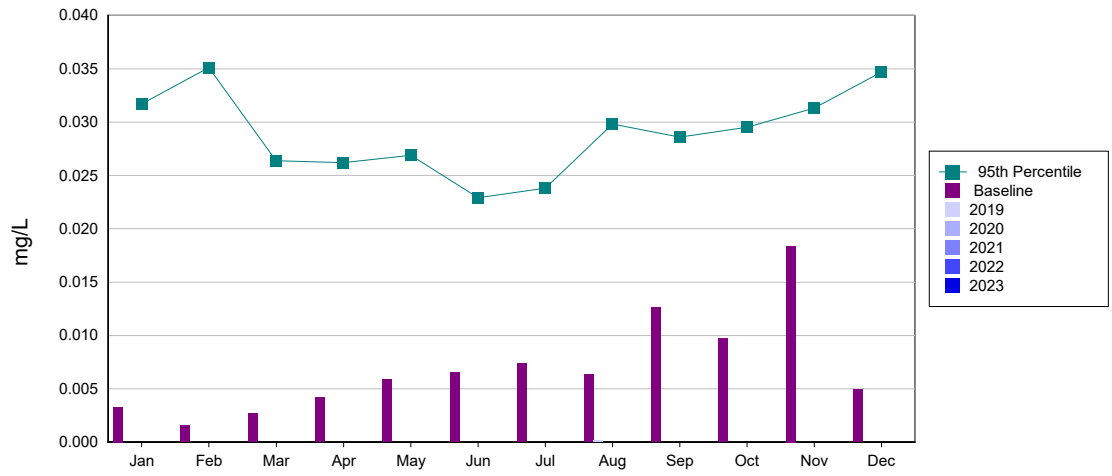
Annual Report Contact Water

Mount Polley

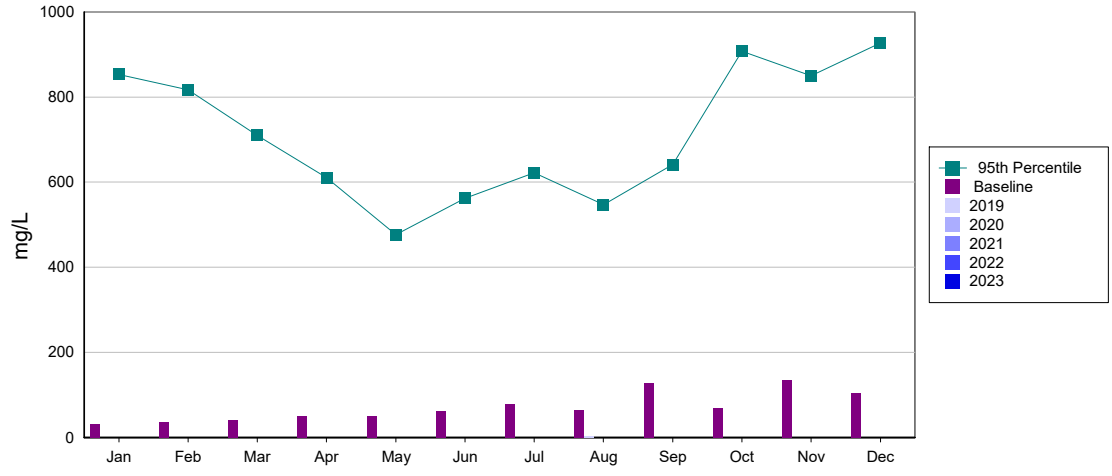
Mining Corporation

IMPERIAL METALS CORPORATION

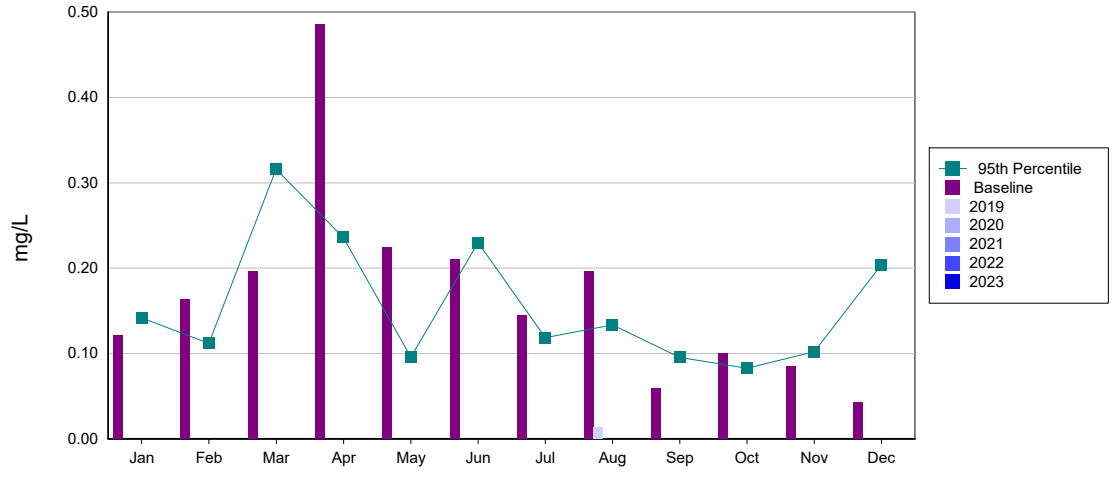
E1 - Tailings Impoundment Supernatant : Selenium (Se)-Total (mg/L)



E1 - Tailings Impoundment Supernatant : Sulphate (mg/L)



E1 - Tailings Impoundment Supernatant : Total Phosphorus (mg/L)



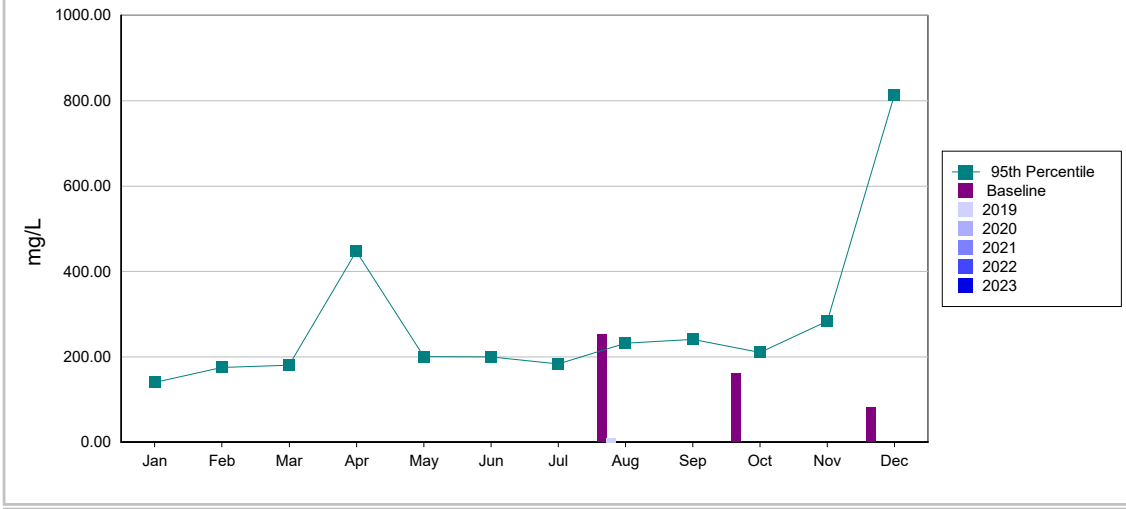
Water Quality Report

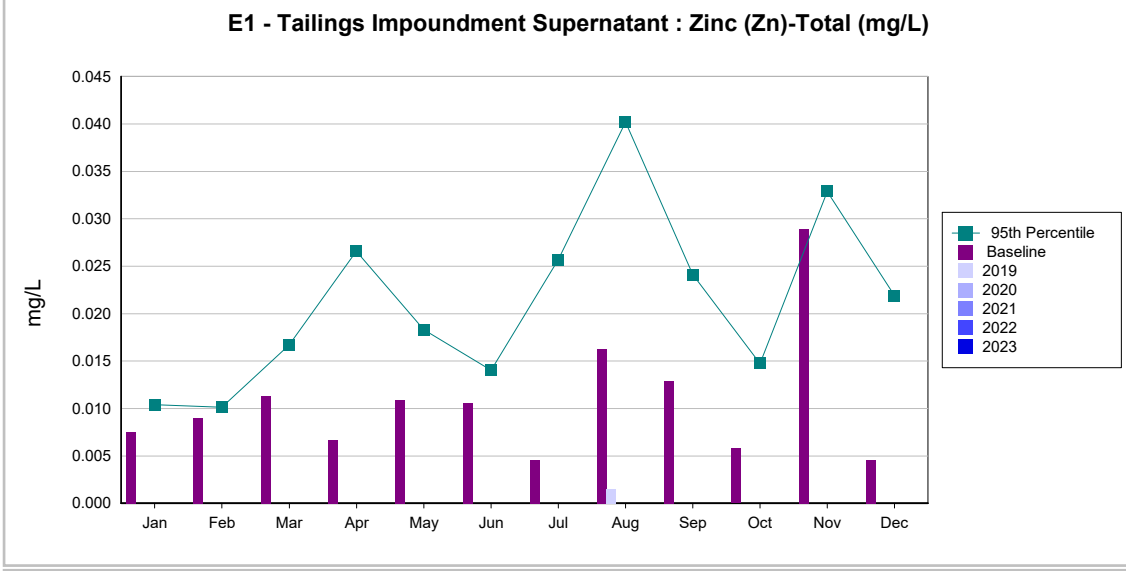
Annual Report Contact Water

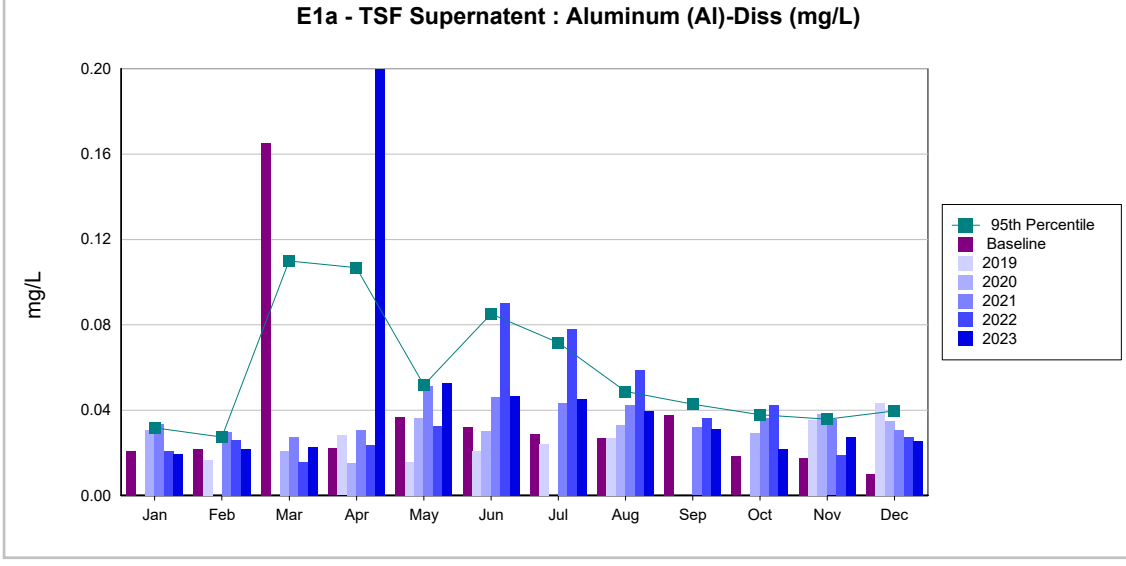
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

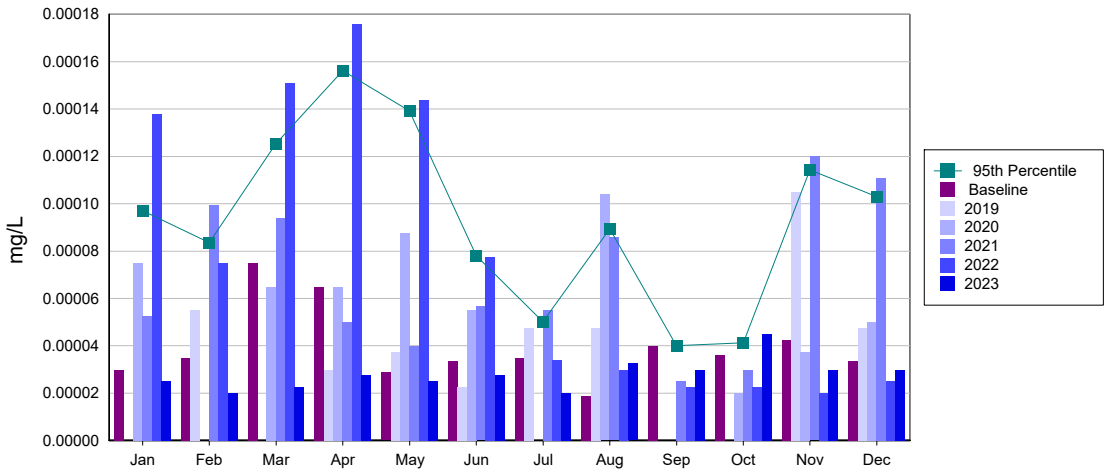
Annual Report Contact Water

Mount Polley

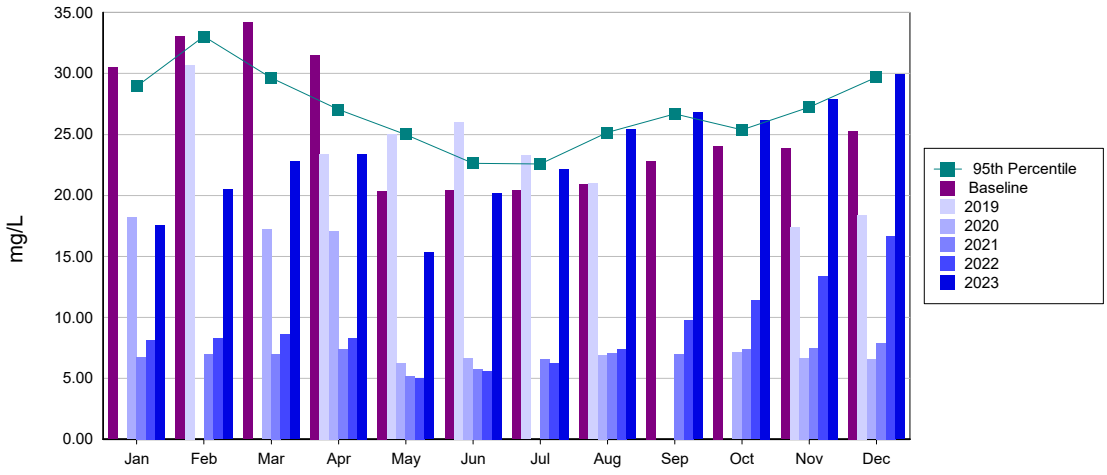
Mining Corporation

IMPERIAL METALS CORPORATION

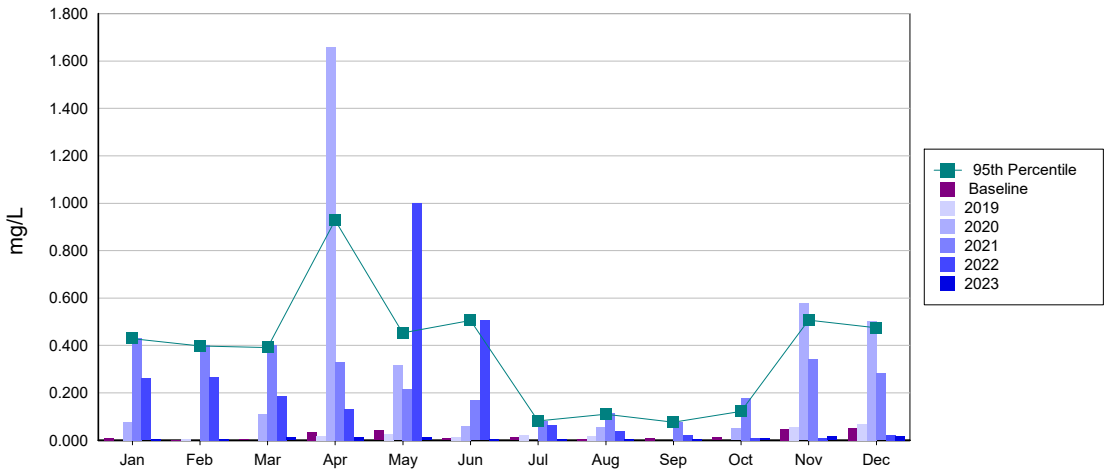
E1a - TSF Supernatent : Cadmium (Cd)-Total (mg/L)



E1a - TSF Supernatent : Chloride (mg/L)



E1a - TSF Supernatent : Copper (Cu)-Total (mg/L)



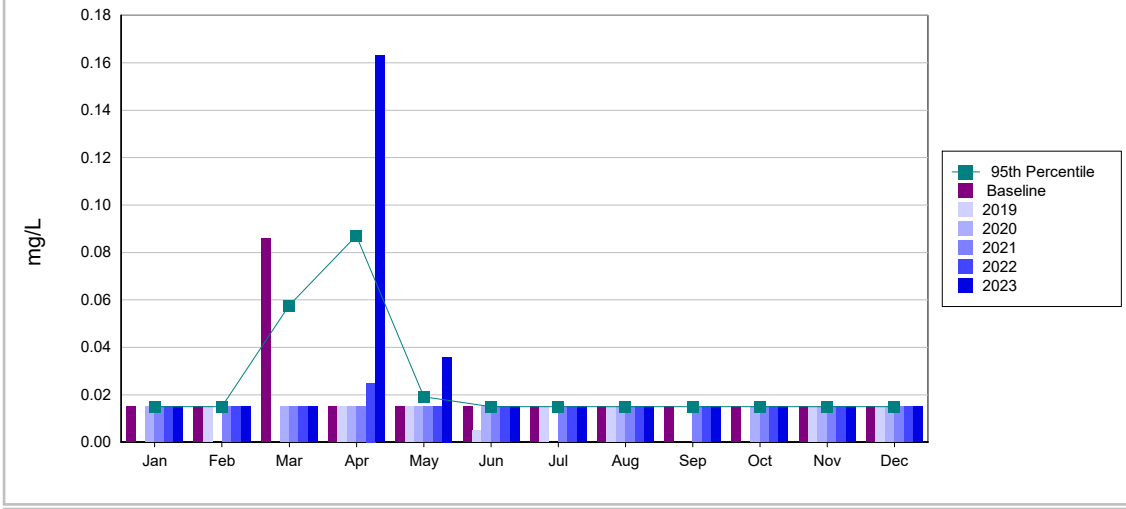
Water Quality Report

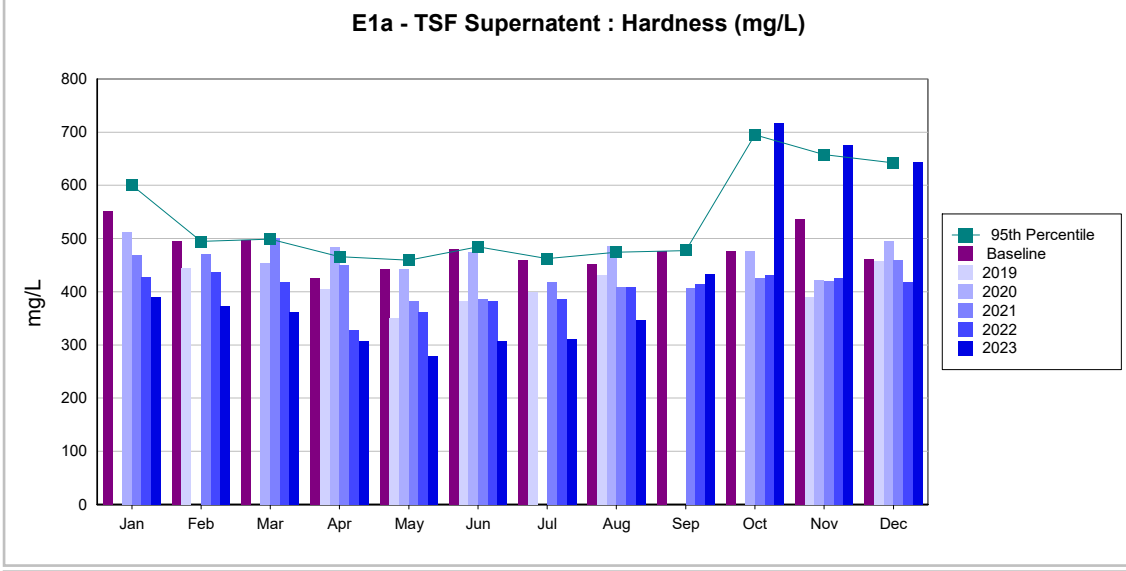
Annual Report Contact Water

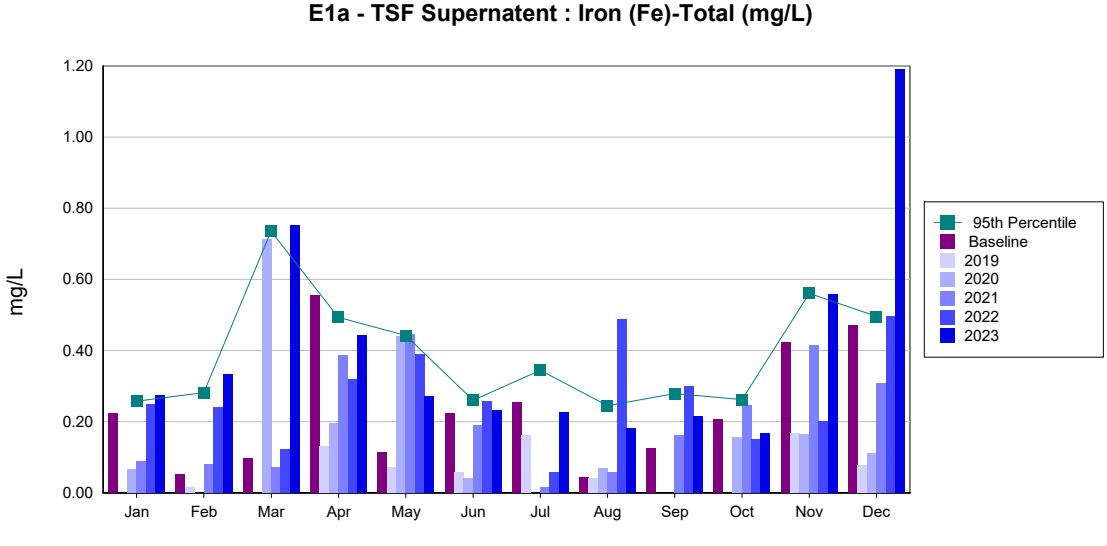
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







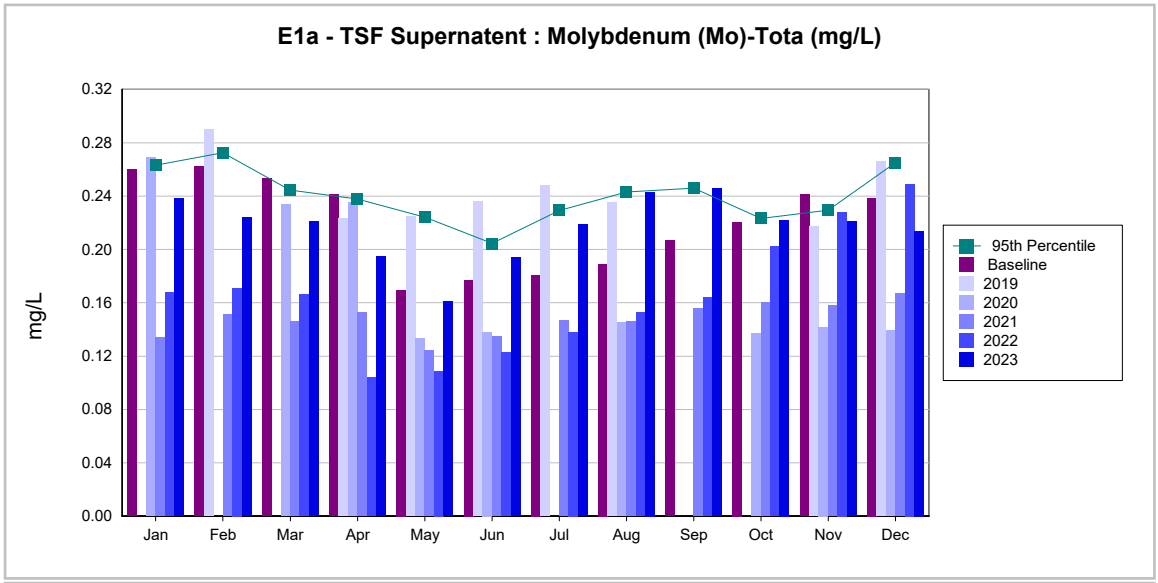
Water Quality Report

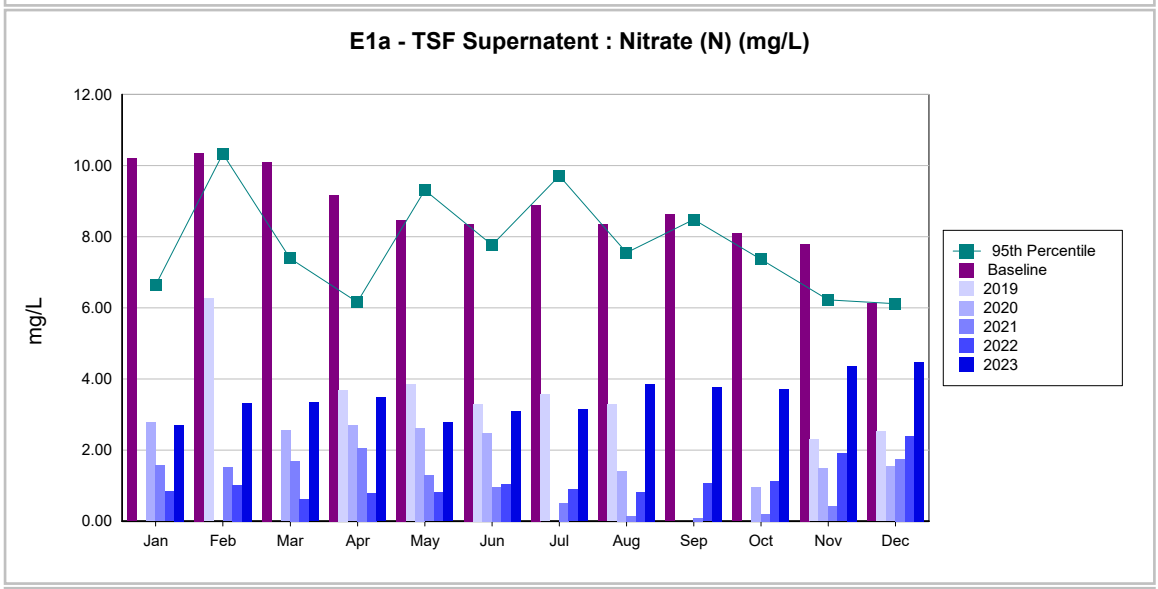
Annual Report Contact Water

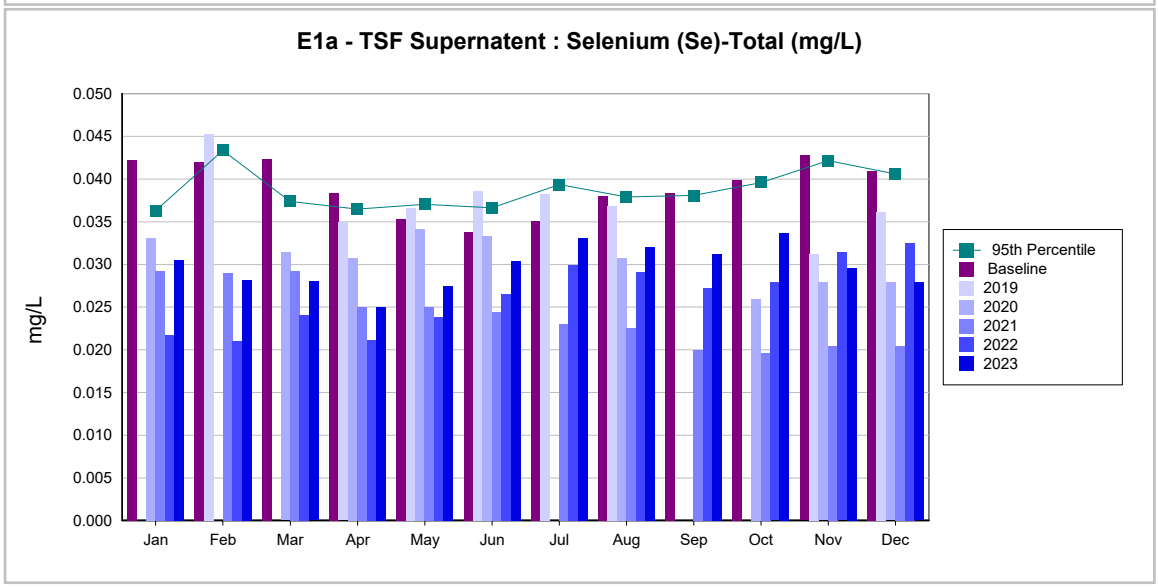
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







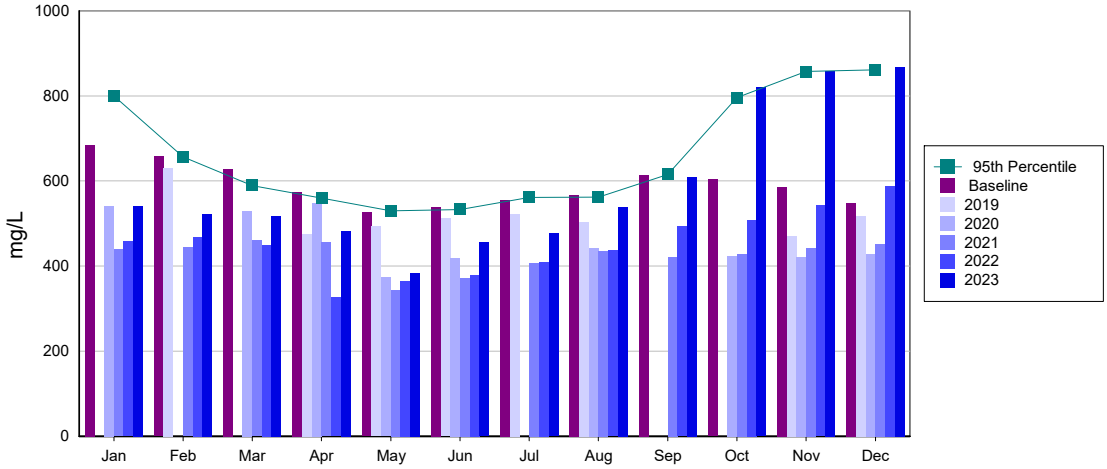
Water Quality Report

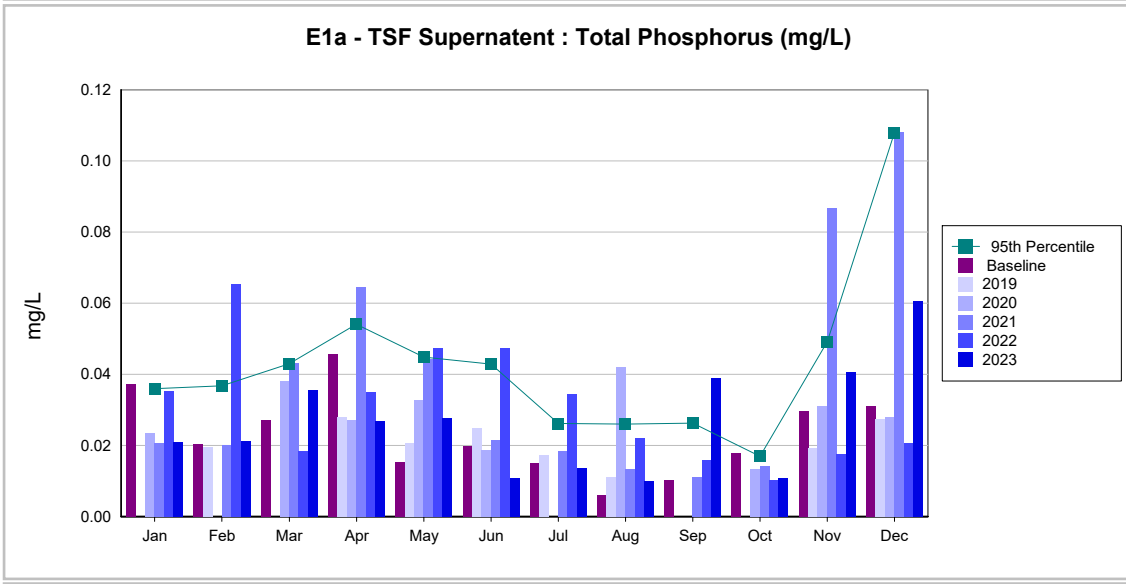
Annual Report Contact Water

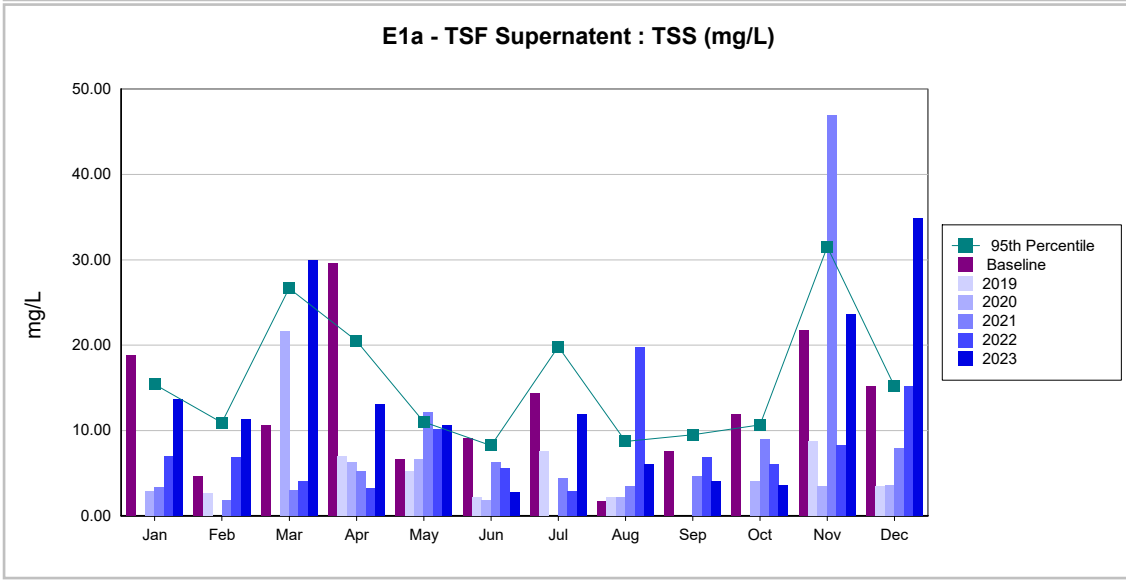
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







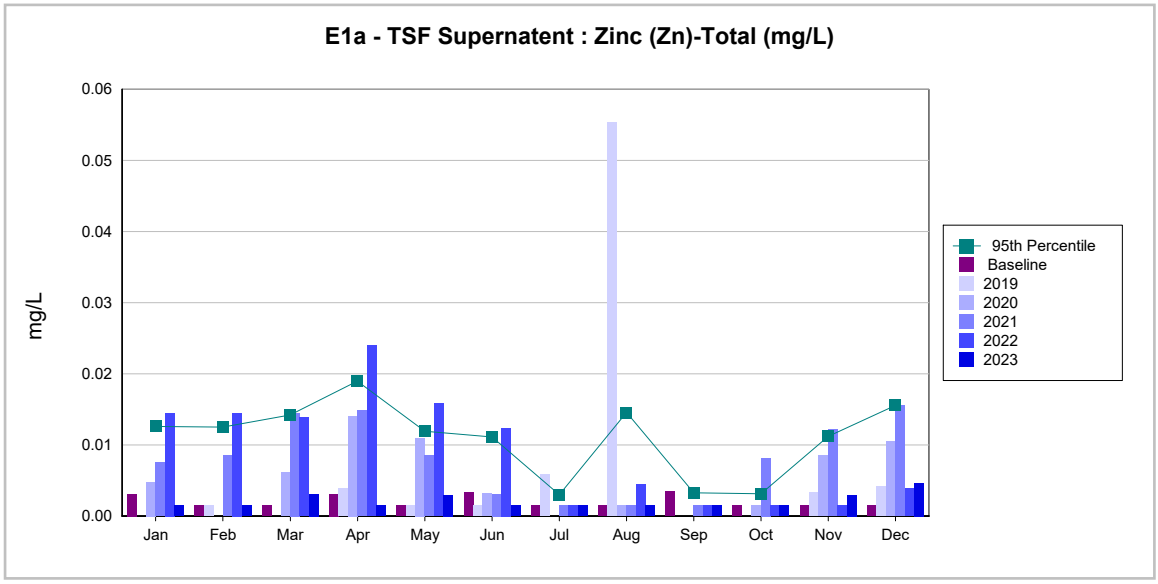
Water Quality Report

Annual Report Contact Water

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION



Grid Format Report : E1 - Tailings Impoundment Supernatant

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-06

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E225309 :
	12-Aug-19
Anions and Nutrients	
Chloride (mg/L)	<0.50
Nitrate (N) (mg/L)	0.0056
Sulphate (mg/L)	2.76
Total Phosphorus (mg/L)	0.0140
Dissolved Metals	
Aluminum (Al)-Diss (mg/L)	0.0259
Diss-Iron (Fe) (mg/L)	0.142
Physical Test	
Hardness (mg/L)	102
TSS (mg/L)	10.4
Total Metals	
Cadmium (Cd)-Total (mg/L)	0.0000113
Copper (Cu)-Total (mg/L)	0.00313
Iron (Fe)-Total (mg/L)	0.192
Molybdenum (Mo)-Tota (mg/L)	0.000733
Selenium (Se)-Total (mg/L)	0.000152
Zinc (Zn)-Total (mg/L)	<0.0030

Grid Format Report : E1 - Tailings Impoundment Supernatant

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-06



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E225309 : E1						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Chloride (mg/L)	1	0	0.25000	0.25000	0.25000	37.60000	
Nitrate (N) (mg/L)	1	1	0.00560	0.00560	0.00560	10.60000	
Sulphate (mg/L)	1	1	2.76000	2.76000	2.76000	822.40000	
Total Phosphorus (mg/L)	1	1	0.01400	0.01400	0.01400	0.17525	
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	1	1	0.02590	0.02590	0.02590	0.09198	
Diss-Iron (Fe) (mg/L)	1	1	0.14200	0.14200	0.14200	0.08700	
Physical Test							
Hardness (mg/L)	1	1	102.00000	102.00000	102.00000	683.55000	
TSS (mg/L)	1	1	10.40000	10.40000	10.40000	251.65000	
Total Metals							
Cadmium (Cd)-Total (mg/L)	1	1	0.00001	0.00001	0.00001	0.00035	
Copper (Cu)-Total (mg/L)	1	1	0.00313	0.00313	0.00313	0.92300	
Iron (Fe)-Total (mg/L)	1	1	0.19200	0.19200	0.19200	5.54250	
Molybdenum (Mo)-Tota (mg/L)	1	1	0.00073	0.00073	0.00073	0.23625	
Selenium (Se)-Total (mg/L)	1	1	0.00015	0.00015	0.00015	2.08900	
Zinc (Zn)-Total (mg/L)	1	0	0.00150	0.00150	0.00150	0.02493	

Grid Format Report : E1a - TSF Supernatent

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-06

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E225309 : E1a														
	6-Feb-19	23-Apr-19	9-May-19	3-Jun-19	2-Jul-19	1-Aug-19	18-Nov-19	9-Dec-19	28-Jan-20	24-Mar-20	16-Apr-20	4-May-20	27-May-20	23-Jun-20	13-Aug-20
Anions and Nutrients															
Chloride (mg/L)	30.7	23.4	25.0	26.0	23.3	21.0	17.4	18.4	18.2	17.2	17.1	5.67	6.24	6.65	6.81
Nitrate (N) (mg/L)	6.27	3.70	3.85	3.30	3.56	3.29	2.30	2.52	2.78	2.56	2.69	2.32	2.63	2.48	1.42
Sulphate (mg/L)	631	476	493	512	523	503	470	518	542	530	549	321	373	420	440
Total Phosphorus (mg/L)	0.0195	0.0279	0.0207	<0.050	0.0174	0.0111	0.0193	0.0276	0.0236	0.0381	0.0272	0.0329	0.0230	0.0188	0.0125
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0168	0.0281	0.0158	0.0208	0.0243	0.0268	0.0353	0.0432	0.0309	0.0208	0.0152	0.0362	0.0299	0.0304	0.0263
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.010	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	445	404	351	383	399	432	391	457	512	454	484	346	442	475	466
TSS (mg/L)	2.6	7.0	5.2	2.2	7.6	2.2	8.8	3.4	2.9	21.6	6.3	6.6	6.0	1.8	2.2
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.00011	<0.000060	<0.000075	<0.000045	<0.000095	<0.000095	<0.00021	<0.000095	<0.000150	<0.000130	<0.000130	<0.000175	<0.000115	<0.000110	0.000104
Copper (Cu)-Total (mg/L)	0.00463	0.0192	0.0271	0.0124	0.0211	0.0185	0.0556	0.0686	0.0774	0.110	1.66	0.316	0.156	0.0618	0.0311
Iron (Fe)-Total (mg/L)	<0.030	0.132	0.072	0.058	0.162	0.040	0.167	0.077	0.066	0.714	0.195	0.441	0.326	0.041	0.048
Molybdenum (Mo)-Tota (mg/L)	0.290	0.223	0.225	0.236	0.248	0.235	0.217	0.266	0.269	0.234	0.235	0.0909	0.133	0.138	0.142
Selenium (Se)-Total (mg/L)	0.0453	0.0349	0.0366	0.0386	0.0382	0.0369	0.0312	0.0362	0.0331	0.0314	0.0308	0.0262	0.0342	0.0333	0.0308
Zinc (Zn)-Total (mg/L)	<0.0030	0.0039	<0.0030	<0.0030	0.0059	0.0553	0.0034	0.0042	0.0048	0.0061	0.0141	0.0110	0.0072	0.0032	<0.0030

	E225309 : E1a														
	31-Aug-20	21-Oct-20	11-Nov-20	24-Nov-20	1-Dec-20	8-Dec-20	21-Dec-20	5-Jan-21	19-Jan-21	3-Feb-21	23-Feb-21	9-Mar-21	22-Mar-21	7-Apr-21	20-Apr-21
Anions and Nutrients															
Chloride (mg/L)	6.94	7.12	6.30	6.65	6.42	6.56	6.55	6.70	6.75	6.60	7.00	6.89	7.02	7.38	4.25
Nitrate (N) (mg/L)	1.16	0.962	1.26	1.49	1.47	1.49	1.55	1.57	1.49	1.40	1.52	1.56	1.70	1.58	2.06
Sulphate (mg/L)	443	424	397	422	423	428	426	439	431	425	444	435	460	456	327
Total Phosphorus (mg/L)	0.0420	0.0135	0.0311	0.0146	0.0192	0.0186	0.0281	0.0207	0.0200	0.0113	0.0202	0.0425	0.0433	0.0282	0.0644
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0332	0.0293	0.0380	0.0312	0.0349	0.0323	0.0340	0.0335	0.0304	0.0299	0.0261	0.0272	0.0241	0.0305	0.0247
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	486	477	408	423	403	425	496	456	469	461	470	443	500	451	388
TSS (mg/L)	1.0	4.0	3.5	3.2	3.6	2.5	<1.2	2.0	3.3	1.4	1.9	1.4	3.0	1.6	5.2
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.0000700	<0.0000400	<0.0000700	<0.0000750	<0.0000950	<0.0000900	<0.000100	<0.0000850	<0.000105	<0.0000900	0.0000994	<0.0000800	0.0000940	<0.000100	<0.0000900
Copper (Cu)-Total (mg/L)	0.0546	0.0495	0.577	0.503	0.503	0.474	0.426	0.432	0.428	0.396	0.401	0.380	0.401	0.330	0.222
Iron (Fe)-Total (mg/L)	0.070	0.156	0.164	0.101	0.111	0.106	0.098	0.090	0.082	0.039	0.079	0.071	0.072	0.103	0.387
Molybdenum (Mo)-Tota (mg/L)	0.145	0.137	0.140	0.142	0.139	0.139	0.129	0.134	0.126	0.148	0.151	0.141	0.146	0.153	0.0982
Selenium (Se)-Total (mg/L)	0.0295	0.0260	0.0244	0.0279	0.0279	0.0264	0.0272	0.0292	0.0268	0.0253	0.0290	0.0292	0.0264	0.0250	0.0212
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0075	0.0085	0.0071	0.0066	0.0105	0.0067	0.0076	0.0074	0.0086	0.0114	0.0145	0.0149	0.0149

	E225309 : E1a														
	3-May-21	17-May-21	27-May-21	1-Jun-21	7-Jun-21	14-Jun-21	21-Jun-21	28-Jun-21	5-Jul-21	12-Jul-21	19-Jul-21	26-Jul-21	4-Aug-21	10-Aug-21	23-Aug-21
Anions and Nutrients															
Chloride (mg/L)	2.31	5.02	5.19	5.53	5.37	5.55	5.80	5.60	5.86	6.18	6.31	6.56	6.58	7.06	6.88
Nitrate (N) (mg/L)	1.30	1.10	1.01	0.968	0.977	0.825	0.741	0.636	0.528	0.416	0.294	0.188	0.150	0.136	0.144
Sulphate (mg/L)	214	341	343	354	372	360	368	370	372	398	407	407	402	435	420
Total Phosphorus (mg/L)	0.0443	0.0290	0.0388	0.0144	0.0193	0.0216	0.0163	0.0094	0.0090	0.0123	0.0184	0.0096	0.0088	0.0124	0.0116
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0499	0.0515	0.0501	0.0462	0.0412	0.0424	0.0398	0.0422	0.0416	0.0433	0.0361	0.0432	0.0403	0.0423	0.0356
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	257	345	383	364	368	370	386	374	381	419	374	403	373	397	393
TSS (mg/L)	4.2	6.8	12.2	6.3	3.6	5.1	2.8	1.2	2.1	<1.0	1.2	4.4	3.4	2.9	1.3
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.0000550	<0.0000500	<0.0000800	<0.0000800	0.0000566	0.0000429	<0.0000600	<0.0000850	<0.0000500	<0.0000500	<0.000110	<0.0000500	0.0000319	<0.0000850	<0.000120
Copper (Cu)-Total (mg/L)	0.143	0.103	0.218	0.149	0.167	0.122	0.0980	0.0770	0.0827	0.0808	0.0733	0.0792	0.115	0.108	0.102
Iron (Fe)-Total (mg/L)	0.196	0.179	0.447	0.134	0.190	0.072	0.047	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.046	0.058
Molybdenum (Mo)-Tota (mg/L)	0.0653	0.122	0.124	0.135	0.121	0.127	0.130	0.129	0.133	0.138	0.147	0.145	0.130	0.145	0.146
Selenium (Se)-Total (mg/L)	0.0180	0.0250	0.0244	0.0239	0.0244	0.0224	0.0227	0.0220	0.0226	0.0221	0.0230	0.0227	0.0226	0.0206	0.0215
Zinc (Zn)-Total (mg/L)	0.0036	0.0085	0.0065	<0.0030	0.0031	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

	E225309 : E1a														
	30-Aug-21	8-Sep-21	14-Sep-21	20-Sep-21	29-Sep-21	4-Oct-21	12-Oct-21	19-Oct-21	26-Oct-21	2-Nov-21	9-Nov-21	17-Nov-21	25-Nov-21	2-Dec-21	8-Dec-21
Anions and Nutrients															
Chloride (mg/L)	6.89	6.83	7.02	6.63	6.98	7.04	7.39	7.01	7.22	7.43	7.33	6.44	6.52	6.71	6.97
Nitrate (N) (mg/L)	0.127	0.0908	0.0724	0.0556	0.0847	0.102	0.143	0.169	0.199	0.254	0.329	0.374	0.428	0.549	1.76
Sulphate (mg/L)	421	422	422	395	418	409	428	419	421	442	436	408	408	421	422
Total Phosphorus (mg/L)	0.0134	0.0097	0.0105	0.0104	0.0112	0.0127	0.0134	0.0130	0.0141	0.0140	0.0868	0.0164	0.0107	0.0158	0.108
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0330	0.0319	0.0293	0.0254	0.0253	0.0211	0.0210	0.0252	0.0363	0.0357	0.0249	0.0215	0.0225	0.0215	0.0309
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	409	386	400	407	408	413	409	425	396	407	394	420	421	420	409
TSS (mg/L)	2.5	4.3	1.0	4.7	4.3	4.3	5.6	6.7	9.0	8.5	46.9	13.4	9.5	5.3	5.6
Total Metals															
Cadmium (Cd)-Total (mg/L)	0.0000858	<0.0000400	<0.0000500	<0.0000350	<0.0000500	<0.0000450	<0.0000550	<0.0000500	0.0000297	<0.0000700	<0.0000800	0.000114	0.000120	0.000111	<0.000140
Copper (Cu)-Total (mg/L)	0.0872	0.0770	0.0758	0.0719	0.0708	0.0685	0.0692	0.104	0.178	0.198	0.294	0.343	0.290	0.247	0.254
Iron (Fe)-Total (mg/L)	0.038	0.041	0.040	0.101	0.162	0.150	0.246	0.149	0.208	0.257	0.288	0.416	0.341	0.232	0.255
Molybdenum (Mo)-Tota (mg/L)	0.146	0.154	0.154	0.151	0.156	0.152	0.160	0.150	0.154	0.158	0.154	0.134	0.142	0.132	0.136
Selenium (Se)-Total (mg/L)	0.0206	0.0200	0.0183	0.0187	0.0195	0.0192	0.0196	0.0187	0.0194	0.0196	0.0204	0.0204	0.0203	0.0205	0.0190
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0082	0.0046	0.0098	0.0112	0.0122	0.0119	0.0156

	E225309 : E1a														
	14-Dec-21	**20-Dec-21**	**4-Jan-22**	**11-Jan-22**	**18-Jan-22**	**25-Jan-22**	**2-Feb-22**	**15-Feb-22**	**22-Feb-22**	**15-Mar-22**	**5-Apr-22**	**12-Apr-22**	**25-Apr-22**	**17-May-22**	**8-Jun-22**
Anions and Nutrients															
Chloride (mg/L)	7.90	7.85	7.05	7.72	8.05	8.14	7.76	8.29	8.06	8.58	6.28	8.27	3.02	5.04	5.10
Nitrate (N) (mg/L)	0.478	0.461	0.449	0.492	0.826	0.839	0.508	0.558	1.02	0.619	0.792	0.553	0.355	0.812	0.803
Sulphate (mg/L)	453	453	414	450	458	450	452	468	464	449	326	235	152	366	378
Total Phosphorus (mg/L)	0.0042	0.0164	0.0147	0.0150	0.0354	0.0311	0.0142	0.0193	0.0655	0.0184	0.0099	0.0351	0.0162	0.0474	0.0414
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0198	0.0202	0.0210	0.0196	0.0166	0.0156	0.0156	0.0192	0.0259	0.0156	0.0125	0.0104	0.0239	0.0326	0.0834
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.050	<0.030	<0.030
Physical Test															
Hardness (mg/L)	460	436	423	427	427	413	419	437	422	419	328	244	190	363	382
TSS (mg/L)	7.9	7.2	7.0	5.8	4.7	3.8	6.9	4.2	5.0	4.1	1.3	1.1	3.2	10.1	4.1
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.000100	0.000103	<0.000125	<0.000125	<0.000130	0.000138	<0.000140	<0.000145	<0.000150	0.000151	0.000140	0.000176	0.0000444	0.000144	<0.000155
Copper (Cu)-Total (mg/L)	0.282	0.280	0.261	0.259	0.224	0.189	0.268	0.251	0.244	0.186	0.107	0.133	0.0416	0.999	0.506
Iron (Fe)-Total (mg/L)	0.308	0.252	0.184	0.245	0.170	0.248	0.242	0.196	0.174	0.122	0.084	0.112	0.319	0.390	0.259
Molybdenum (Mo)-Tota (mg/L)	0.167	0.159	0.168	0.154	0.161	0.154	0.171	0.171	0.164	0.166	0.104	0.0785	0.0447	0.109	0.121
Selenium (Se)-Total (mg/L)	0.0205	0.0197	0.0217	0.0207	0.0202	0.0211	0.0210	0.0207	0.0210	0.0241	0.0212	0.0179	0.00741	0.0238	0.0233
Zinc (Zn)-Total (mg/L)	0.0106	0.0117	0.0099	0.0106	0.0116	0.0145	0.0115	0.0110	0.0145	0.0139	0.0148	0.0240	<0.0150	0.0158	0.0124

	E225309 : E1a														
	22-Jun-22	29-Jun-22	6-Jul-22	12-Jul-22	19-Jul-22	28-Jul-22	11-Aug-22	24-Aug-22	6-Sep-22	22-Sep-22	4-Oct-22	11-Oct-22	18-Oct-22	25-Oct-22	3-Nov-22
Anions and Nutrients															
Chloride (mg/L)	4.91	5.60	5.73	5.68	6.25	6.07	7.09	7.42	7.65	9.79	9.95	10.6	11.2	11.4	11.6
Nitrate (N) (mg/L)	1.05	0.979	0.890	0.736	0.738	0.668	0.822	0.791	0.810	1.07	1.08	1.08	1.13	1.14	1.31
Sulphate (mg/L)	351	379	387	390	395	410	437	426	443	493	486	495	502	509	506
Total Phosphorus (mg/L)	0.0475	0.0217	0.0168	0.0134	0.0345	0.0082	0.0221	0.0056	0.0160	0.0140	0.0102	0.0073	0.0102	0.0062	0.0177
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0798	0.0903	0.0779	0.0660	0.0583	0.0683	0.0588	0.0462	0.0364	0.0323	0.0350	0.0339	0.0424	0.0324	0.0191
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	379	369	386	376	373	385	395	409	364	415	431	401	401	409	425
TSS (mg/L)	4.2	5.6	2.9	2.2	2.3	<1.0	19.7	<1.0	6.9	6.5	2.8	<1.0	6.1	<1.0	7.0
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.000105	<0.0000800	<0.0000650	0.0000340	<0.0000400	<0.0000450	<0.0000500	<0.0000600	<0.0000450	<0.0000350	<0.0000350	<0.0000350	<0.0000350	<0.0000450	<0.0000400
Copper (Cu)-Total (mg/L)	0.168	0.101	0.0642	0.0466	0.0395	0.0539	0.0397	0.0124	0.0230	0.0184	0.00828	0.00639	0.00740	0.00491	0.00720
Iron (Fe)-Total (mg/L)	0.180	0.139	0.057	0.050	0.052	<0.030	0.489	<0.030	0.299	0.263	0.107	0.062	0.152	0.061	0.201
Molybdenum (Mo)-Tota (mg/L)	0.121	0.123	0.123	0.131	0.126	0.138	0.149	0.153	0.158	0.164	0.173	0.193	0.195	0.202	0.195
Selenium (Se)-Total (mg/L)	0.0256	0.0266	0.0263	0.0262	0.0250	0.0299	0.0264	0.0291	0.0266	0.0272	0.0250	0.0263	0.0274	0.0279	0.0260
Zinc (Zn)-Total (mg/L)	0.0050	0.0034	<0.0030	<0.0030	<0.0030	<0.0030	0.0044	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

	E225309 : E1a														
	17-Nov-22	24-Nov-22	29-Nov-22	8-Dec-22	13-Dec-22	27-Dec-22	5-Jan-23	10-Jan-23	16-Jan-23	23-Jan-23	1-Feb-23	6-Feb-23	13-Feb-23	21-Feb-23	28-Feb-23
Anions and Nutrients															
Chloride (mg/L)	13.2	13.4	13.2	14.3	15.1	16.7	16.5	15.6	17.1	17.6	18.6	18.4	19.4	20.0	20.5
Nitrate (N) (mg/L)	1.80	1.90	1.91	1.93	2.18	2.40	2.41	2.29	2.65	2.71	2.95	3.09	3.24	3.04	3.32
Sulphate (mg/L)	543	539	534	554	546	589	542	499	516	499	517	503	505	505	522
Total Phosphorus (mg/L)	0.0162	0.0155	0.0138	0.0095	0.0206	0.0070	0.0210	0.0076	0.0159	0.0078	0.0213	0.0194	0.0136	0.0164	0.0092
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0165	0.0153	0.0136	0.0276	0.0143	0.0143	0.0184	0.0155	0.0195	0.0185	0.0150	0.0170	0.0156	0.0218	0.0159
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	411	420	398	419	365	414	391	373	352	375	373	367	343	335	329
TSS (mg/L)	8.3	7.1	2.0	<1.0	15.2	1.9	13.6	<1.0	8.0	7.5	11.3	10.7	7.0	6.7	<1.0
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.0000400	<0.0000350	<0.0000400	<0.0000500	<0.0000250	<0.0000400	<0.0000500	<0.0000300	<0.0000300	<0.0000450	<0.0000400	<0.0000300	<0.0000100	<0.0000400	<0.0000250
Copper (Cu)-Total (mg/L)	0.00980	0.00307	0.00259	0.00157	0.0219	0.00144	0.00428	0.00331	0.00320	0.00120	0.00470	0.00469	0.00289	0.00242	0.00139
Iron (Fe)-Total (mg/L)	0.188	0.104	<0.030	<0.030	0.496	<0.030	0.276	0.142	0.177	<0.030	0.333	0.254	0.195	0.142	<0.030
Molybdenum (Mo)-Tota (mg/L)	0.214	0.228	0.218	0.223	0.223	0.249	0.220	0.231	0.238	0.214	0.224	0.214	0.216	0.211	0.220
Selenium (Se)-Total (mg/L)	0.0301	0.0297	0.0314	0.0285	0.0286	0.0325	0.0298	0.0289	0.0283	0.0305	0.0282	0.0282	0.0276	0.0269	0.0270
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	0.0039	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

	E225309 : E1a														
	6-Mar-23	14-Mar-23	21-Mar-23	29-Mar-23	6-Apr-23	13-Apr-23	20-Apr-23	26-Apr-23	3-May-23	8-May-23	15-May-23	29-May-23	8-Jun-23	12-Jun-23	29-Jun-23
Anions and Nutrients															
Chloride (mg/L)	20.7	22.7	22.7	22.8	23.4	13.0	15.5	14.1	13.8	13.4	14.4	15.3	17.2	17.5	20.2
Nitrate (N) (mg/L)	3.18	3.34	3.30	3.31	3.48	2.38	3.00	2.75	2.78	2.70	2.58	2.53	2.80	2.81	3.10
Sulphate (mg/L)	490	517	497	479	482	314	367	352	352	359	374	383	416	410	456
Total Phosphorus (mg/L)	0.0186	0.0146	0.0147	0.0356	0.0260	0.0185	0.0152	0.0268	0.0169	0.0278	0.0161	0.0149	0.0077	0.0084	0.0108
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0186	0.0184	0.0149	0.0229	0.0248	0.200	0.0221	0.0285	0.0351	0.0382	0.0528	0.0432	0.0429	0.0381	0.0467
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	0.163	<0.030	<0.030	<0.030	<0.030	<0.030	0.036	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	361	313	324	322	307	253	271	264	263	262	272	278	306	293	307
TSS (mg/L)	11.5	9.0	8.8	30.0	13.1	3.5	5.2	10.3	6.9	1.6	9.1	10.6	1.9	2.7	2.8
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.0000150	<0.0000450	<0.0000400	<0.0000350	<0.0000550	<0.0000300	0.0000186	<0.0000350	<0.0000250	<0.0000350	<0.0000500	<0.0000500	<0.0000350	<0.0000400	<0.0000550
Copper (Cu)-Total (mg/L)	0.00305	0.00562	0.00247	0.0110	0.00990	0.00276	0.00564	0.0148	0.00751	0.0116	0.0122	0.00780	0.00351	0.00265	0.00596
Iron (Fe)-Total (mg/L)	0.214	0.200	0.052	0.754	0.443	0.106	0.136	0.266	0.122	0.230	0.273	0.197	0.104	0.035	0.232
Molybdenum (Mo)-Tota (mg/L)	0.221	0.212	0.218	0.212	0.195	0.0964	0.114	0.143	0.158	0.146	0.161	0.161	0.183	0.170	0.194
Selenium (Se)-Total (mg/L)	0.0257	0.0262	0.0280	0.0248	0.0241	0.0120	0.0177	0.0250	0.0239	0.0245	0.0269	0.0275	0.0277	0.0294	0.0304
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0031	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0030	<0.0030	<0.0030	<0.0030	<0.0030

	E225309 : E1a														
	13-Jul-23	25-Jul-23	3-Aug-23	9-Aug-23	16-Aug-23	21-Aug-23	31-Aug-23	11-Sep-23	21-Sep-23	26-Sep-23	5-Oct-23	11-Oct-23	16-Oct-23	23-Oct-23	1-Nov-23
Anions and Nutrients															
Chloride (mg/L)	20.8	22.2	23.7	24.2	24.1	25.1	25.4	26.6	26.8	25.7	26.2	23.2	21.6	23.2	26.8
Nitrate (N) (mg/L)	3.15	3.13	3.43	3.49	3.60	3.82	3.87	3.78	3.63	3.62	3.72	3.51	3.09	3.30	3.88
Sulphate (mg/L)	475	477	512	500	499	529	538	585	595	609	820	773	726	788	857
Total Phosphorus (mg/L)	0.0054	0.0137	0.0092	0.0088	0.0087	0.0086	0.0099	0.0102	0.0102	0.0390	0.0086	0.0074	0.0089	0.0108	0.0068
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0454	0.0426	0.0395	0.0387	0.0383	0.0398	0.0372	0.0313	0.0262	0.0204	0.0123	0.0185	0.0197	0.0218	0.0171
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test															
Hardness (mg/L)	311	305	305	296	322	328	346	386	400	434	638	613	688	717	675
TSS (mg/L)	1.4	11.9	1.6	2.4	2.0	6.0	4.4	<1.0	2.6	4.0	3.0	2.5	2.8	3.6	<1.0
Total Metals															
Cadmium (Cd)-Total (mg/L)	<0.0000400	<0.0000100	<0.0000350	<0.0000550	<0.0000500	<0.0000650	<0.0000550	<0.0000450	<0.0000600	<0.0000350	<0.0000600	<0.0000750	<0.0000900	<0.0000200	<0.0000550
Copper (Cu)-Total (mg/L)	0.00379	0.00566	0.00242	0.00299	0.00494	0.00261	0.00642	0.00410	0.00386	0.00499	0.00216	0.00469	0.00723	0.00746	0.00412
Iron (Fe)-Total (mg/L)	0.055	0.227	0.070	0.113	0.180	0.103	0.181	0.107	0.118	0.216	0.128	0.081	0.127	0.169	0.046
Molybdenum (Mo)-Tota (mg/L)	0.219	0.219	0.226	0.232	0.237	0.243	0.243	0.246	0.246	0.243	0.222	0.215	0.220	0.205	0.221
Selenium (Se)-Total (mg/L)	0.0295	0.0331	0.0294	0.0314	0.0285	0.0313	0.0320	0.0312	0.0291	0.0281	0.0337	0.0283	0.0282	0.0263	0.0296
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0060

	E225309 : E1a							
	8-Nov-23	15-Nov-23	23-Nov-23	28-Nov-23	7-Dec-23	12-Dec-23	19-Dec-23	27-Dec-23
Anions and Nutrients								
Chloride (mg/L)	26.5	27.2	27.0	27.9	27.9	29.9	29.1	29.7
Nitrate (N) (mg/L)	3.93	3.95	4.36	4.36	4.47	4.43	4.40	4.48
Sulphate (mg/L)	844	815	830	859	861	847	840	868
Total Phosphorus (mg/L)	0.0070	0.0143	0.0406	0.0194	0.0081	0.0605	0.0114	0.0113
Dissolved Metals								
Aluminum (Al)-Diss (mg/L)	0.0274	0.0142	0.0187	0.0206	0.0182	0.0218	0.0255	0.0187
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Physical Test								
Hardness (mg/L)	657	616	641	621	644	642	604	561
TSS (mg/L)	2.9	1.3	23.6	7.6	1.6	34.9	3.7	<1.0
Total Metals								
Cadmium (Cd)-Total (mg/L)	<0.0000600	<0.0000600	<0.0000400	<0.0000500	<0.0000500	<0.0000600	<0.0000550	<0.0000400
Copper (Cu)-Total (mg/L)	0.00716	0.00329	0.0156	0.00544	0.00228	0.0187	0.00185	0.00226
Iron (Fe)-Total (mg/L)	0.105	0.087	0.558	0.274	0.041	1.19	0.066	0.053
Molybdenum (Mo)-Tota (mg/L)	0.215	0.208	0.201	0.209	0.214	0.211	0.208	0.208
Selenium (Se)-Total (mg/L)	0.0284	0.0262	0.0254	0.0260	0.0279	0.0271	0.0241	0.0245
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0047	<0.0030	<0.0030

Grid Format Report : E1a - TSF Supernatent

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-06



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E225309 : E1a						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Chloride (mg/L)	143	143	2.31000	30.70000	13.19972	33.08500	7.89313
Nitrate (N) (mg/L)	143	143	0.05560	6.27000	1.92449	10.28500	1.35186
Sulphate (mg/L)	143	143	152.00000	868.00000	477.76923	659.25000	132.20245
Total Phosphorus (mg/L)	143	142	0.00420	0.10800	0.02000	0.04443	0.01504
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	143	143	0.01040	0.20000	0.03189	0.05040	0.02029
Diss-Iron (Fe) (mg/L)	143	2	0.00500	0.16300	0.01618	0.01500	0.01254
Physical Test							
Hardness (mg/L)	143	143	190.00000	717.00000	408.58042	545.45000	93.37614
TSS (mg/L)	143	131	0.50000	46.90000	5.67762	28.38500	6.25600
Total Metals							
Cadmium (Cd)-Total (mg/L)	144	20	0.00001	0.00018	0.00004	0.00006	0.00003
Copper (Cu)-Total (mg/L)	144	144	0.00120	1.66000	0.12156	0.06958	0.20291
Iron (Fe)-Total (mg/L)	144	130	0.01500	1.19000	0.16804	0.54525	0.15866
Molybdenum (Mo)-Tota (mg/L)	144	144	0.04470	0.29000	0.17382	0.26085	0.04658
Selenium (Se)-Total (mg/L)	144	144	0.00741	0.04530	0.02602	0.04230	0.00520
Zinc (Zn)-Total (mg/L)	144	57	0.00150	0.05530	0.00484	0.00497	0.00625

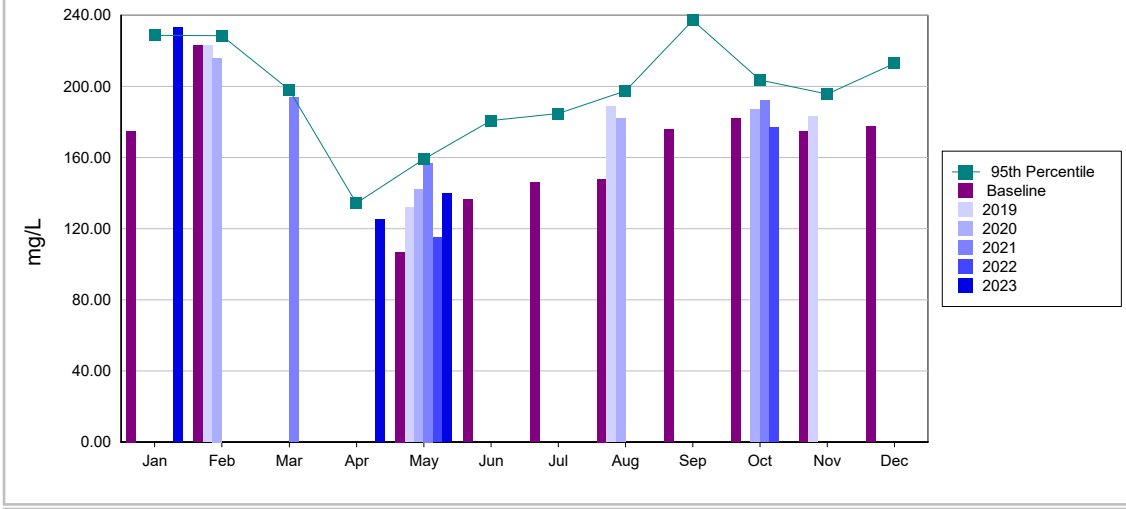
Water Quality Report

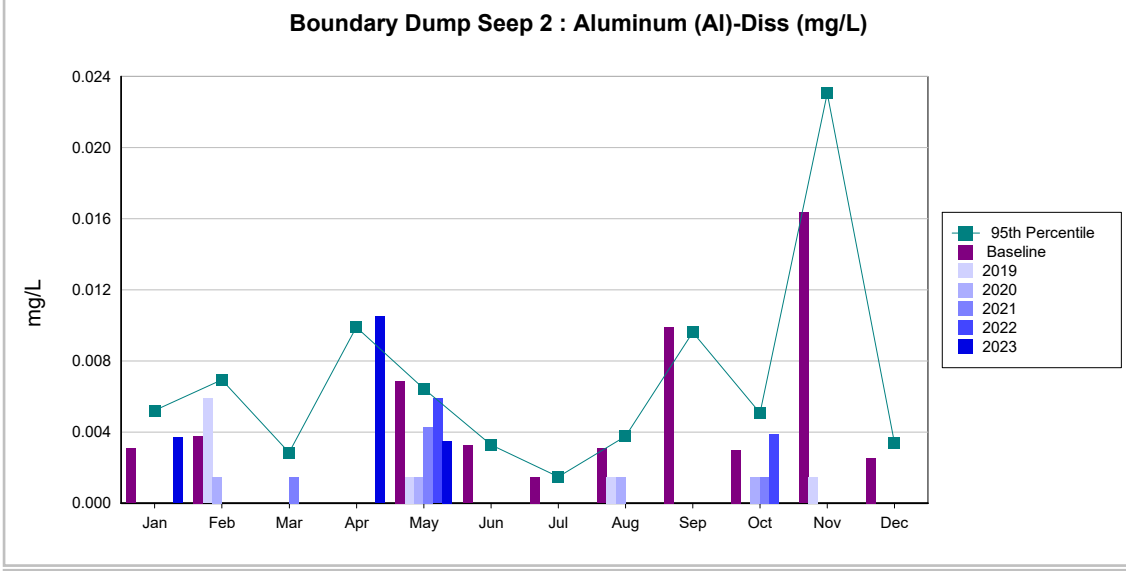
Annual Report Drainage Water

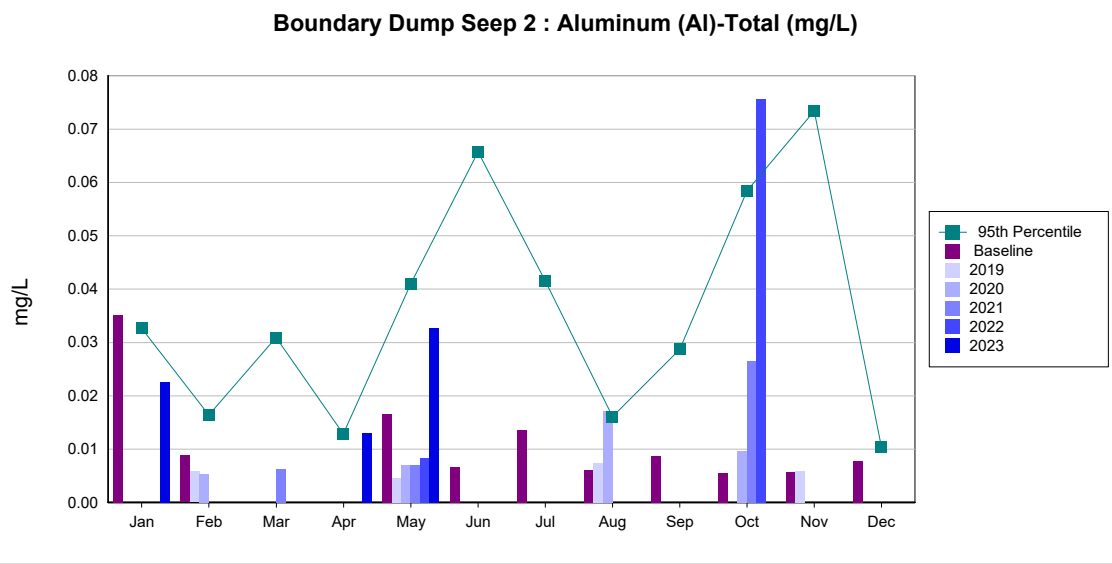
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

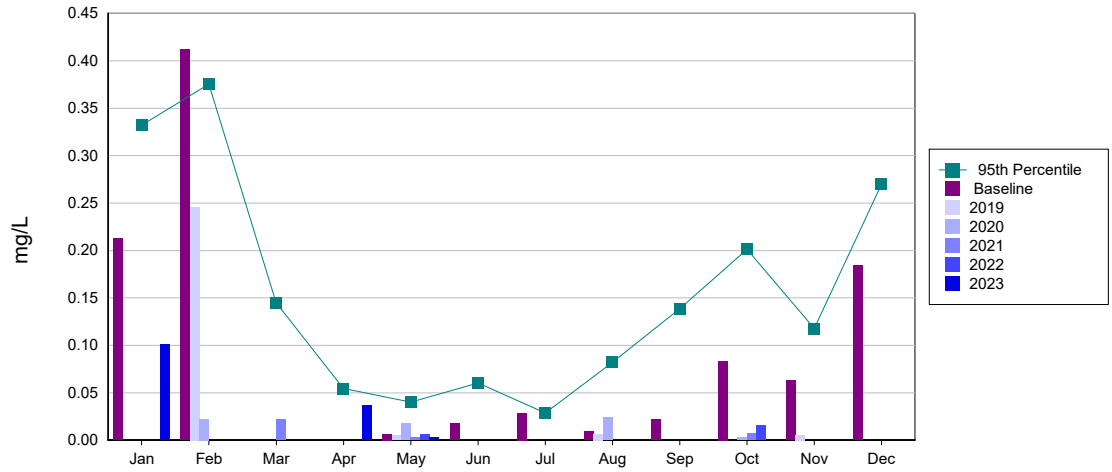
Annual Report Drainage Water

Mount Polley

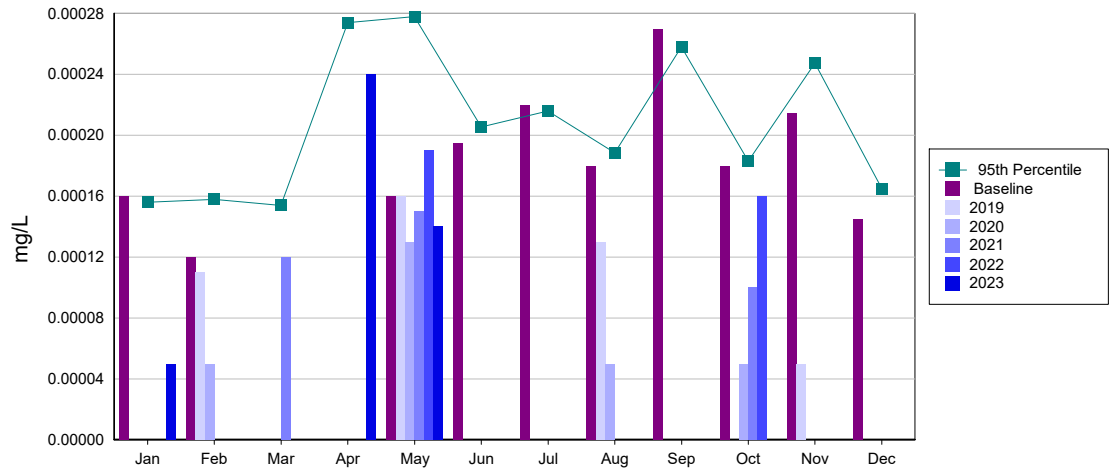
Mining Corporation

IMPERIAL METALS CORPORATION

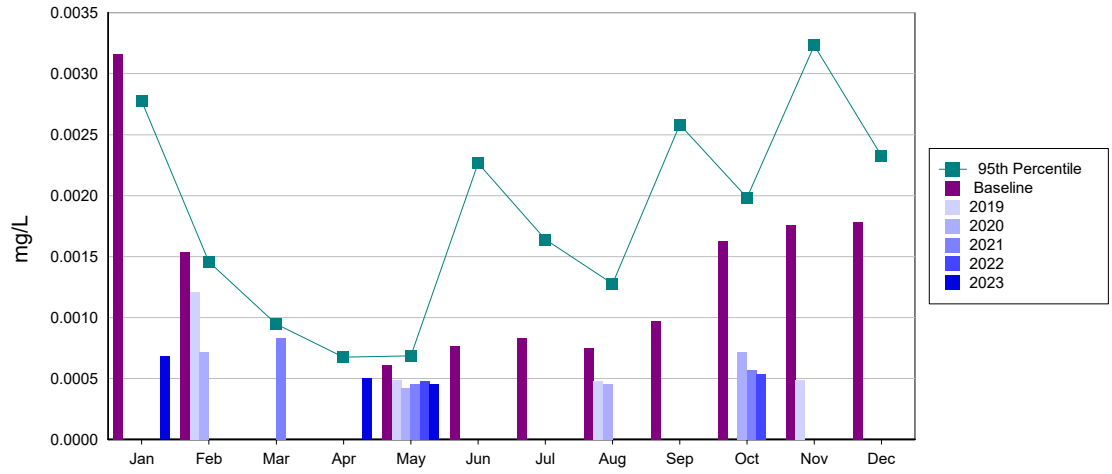
Boundary Dump Seep 2 : Ammonia (as N) (mg/L)



Boundary Dump Seep 2 : Antimony (Sb)-Total (mg/L)



Boundary Dump Seep 2 : Arsenic (As)-Total (mg/L)



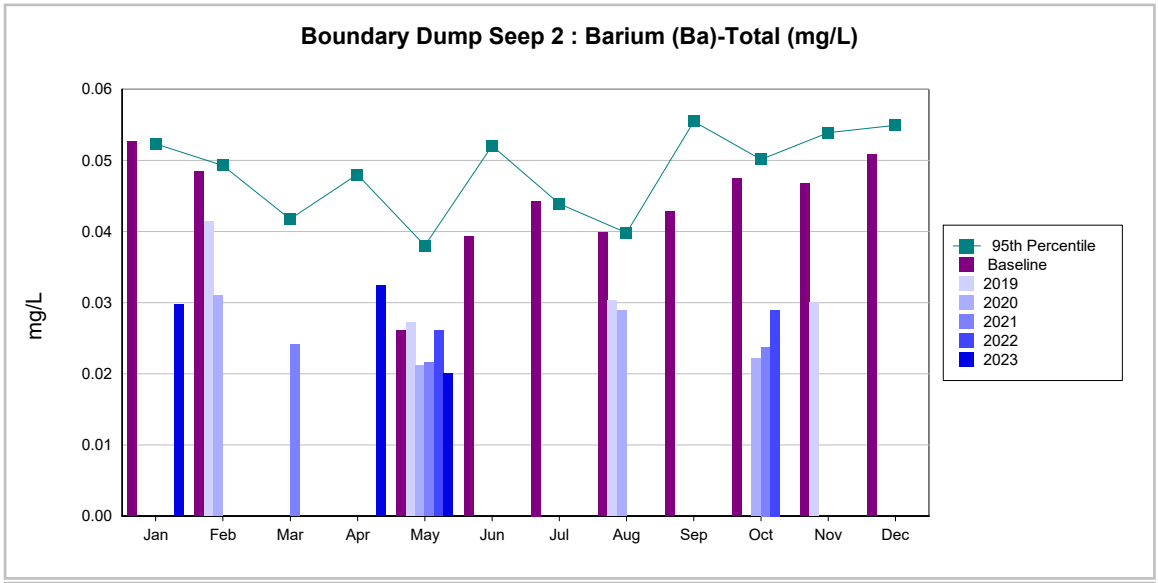
Water Quality Report

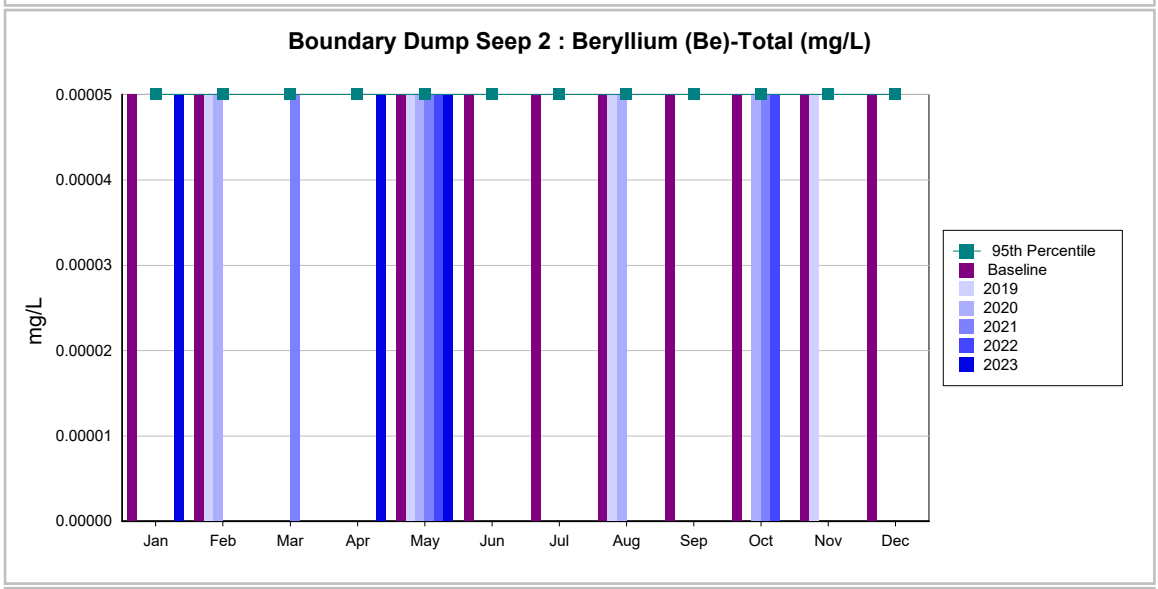
Annual Report Drainage Water

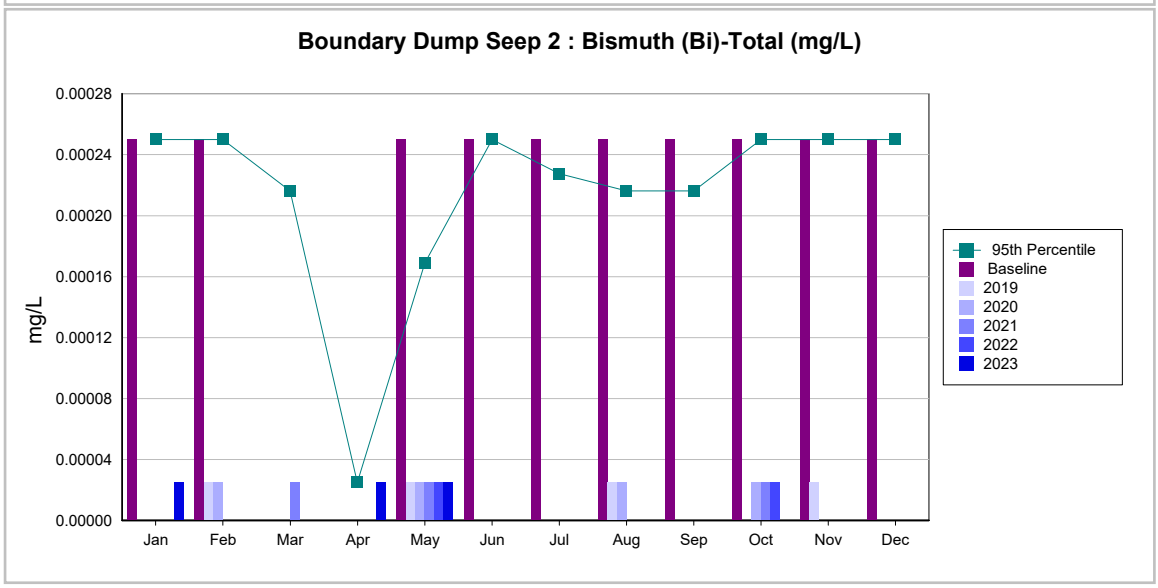
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

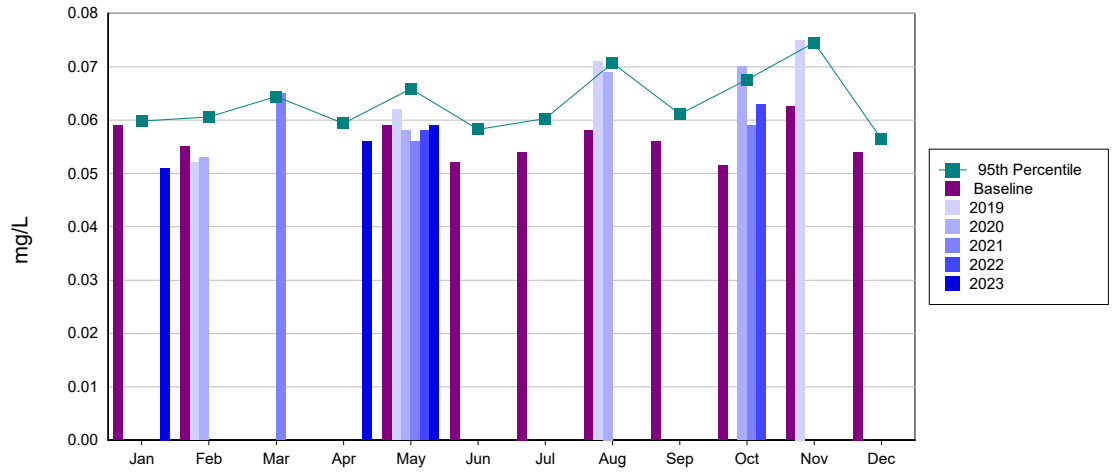
Annual Report Drainage Water

Mount Polley

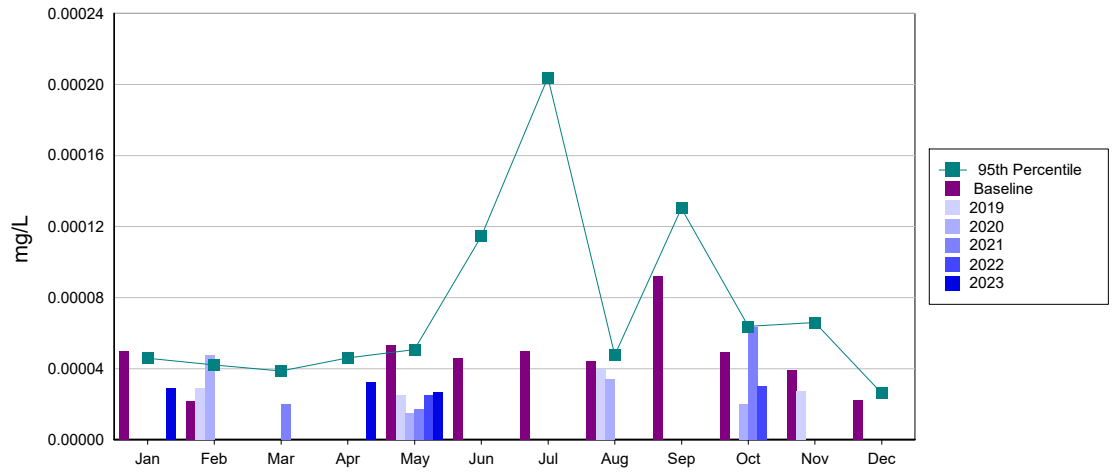
Mining Corporation

IMPERIAL METALS CORPORATION

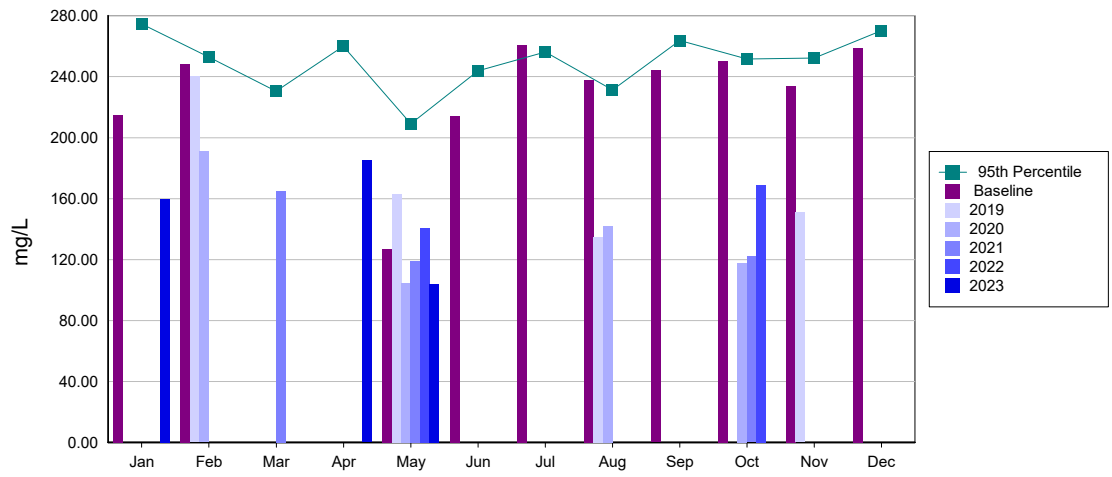
Boundary Dump Seep 2 : Boron (B)-Total (mg/L)



Boundary Dump Seep 2 : Cadmium (Cd)-Total (mg/L)



Boundary Dump Seep 2 : Calcium (Ca)-Total (mg/L)



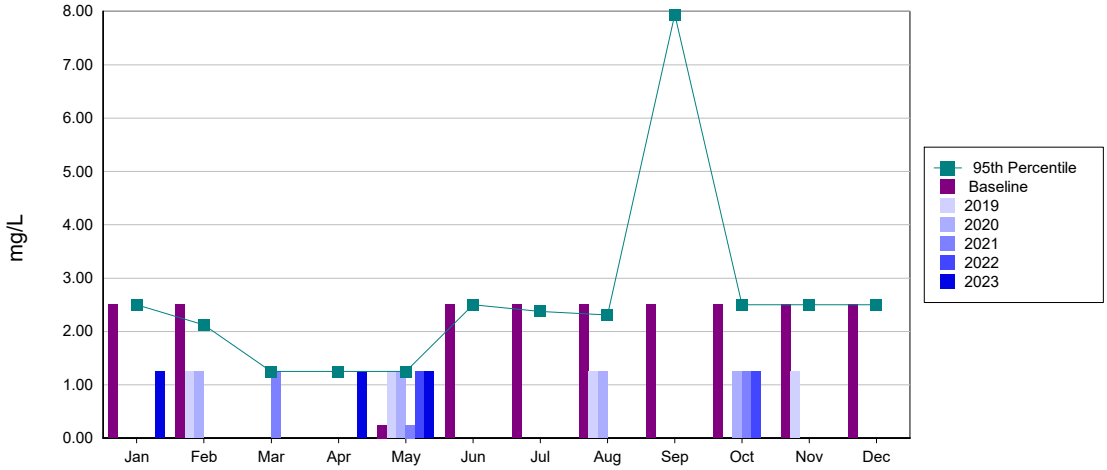
Water Quality Report

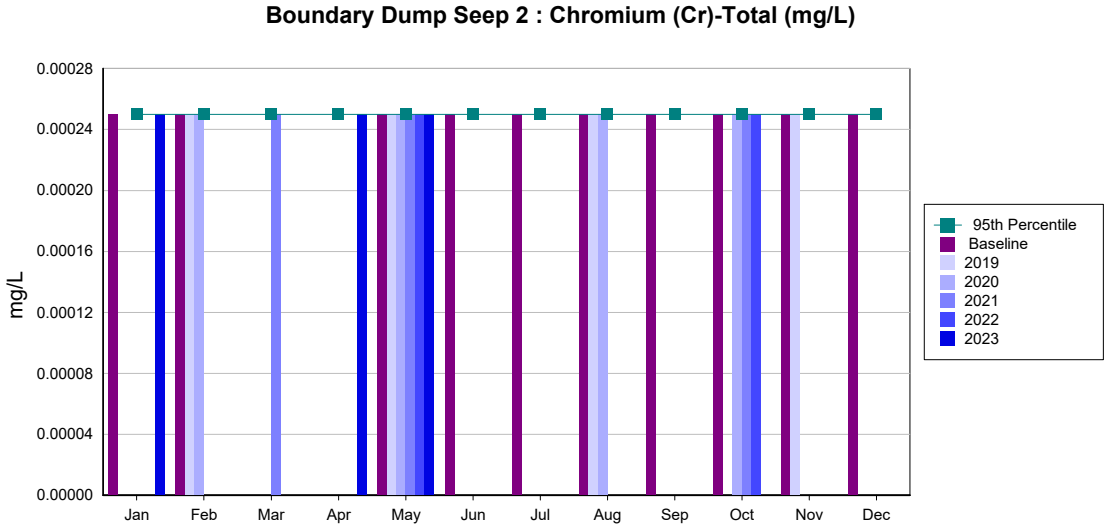
Annual Report Drainage Water

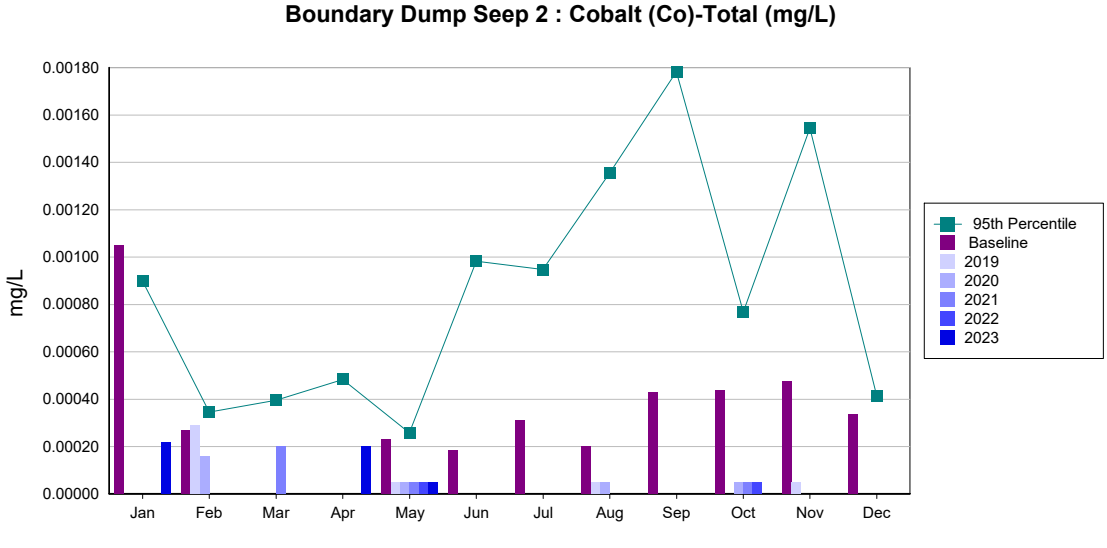
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







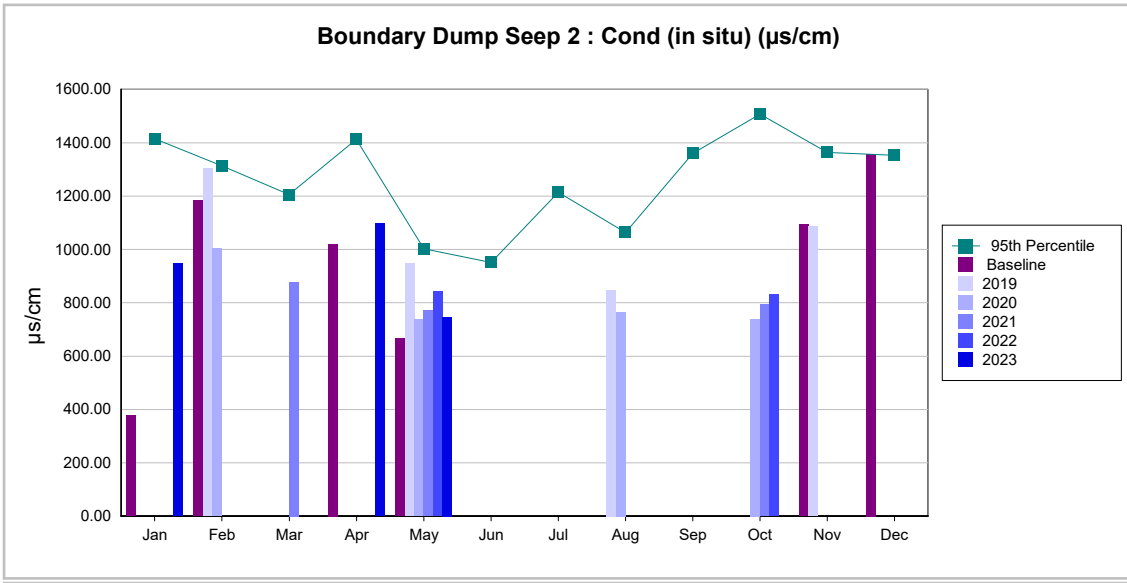
Water Quality Report

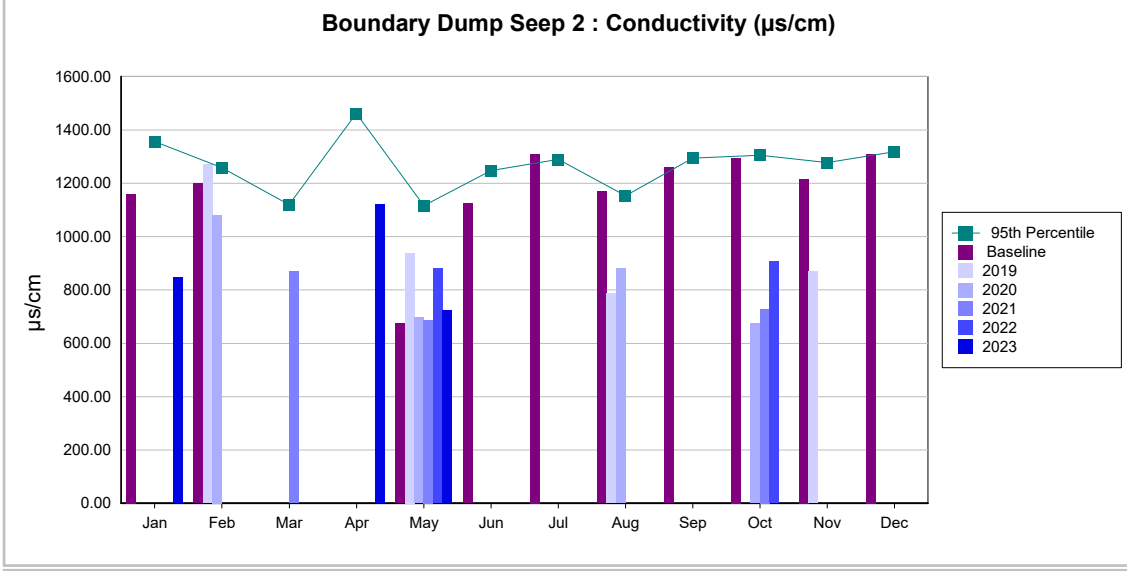
Annual Report Drainage Water

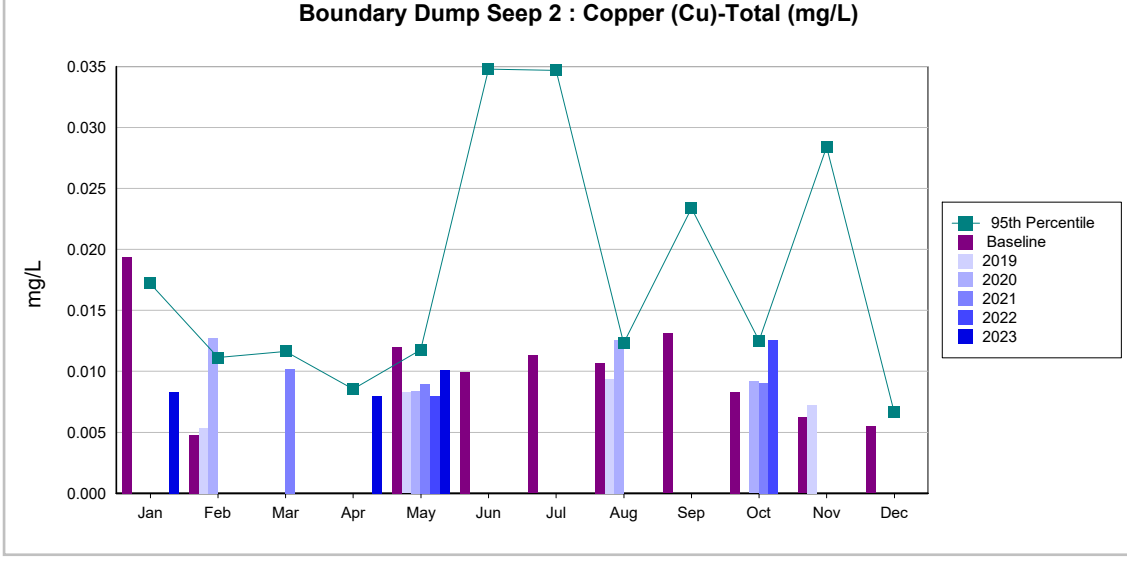
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

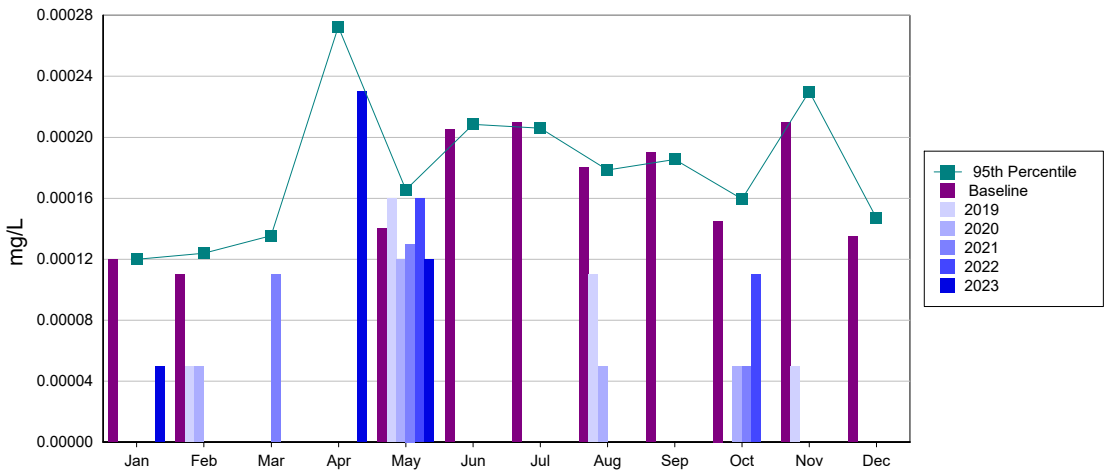
Annual Report Drainage Water

Mount Polley

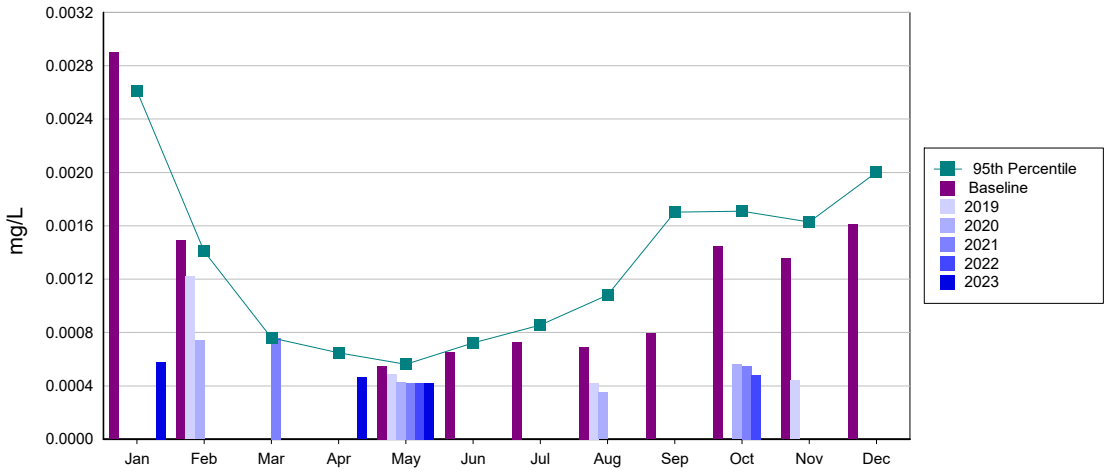
Mining Corporation

IMPERIAL METALS CORPORATION

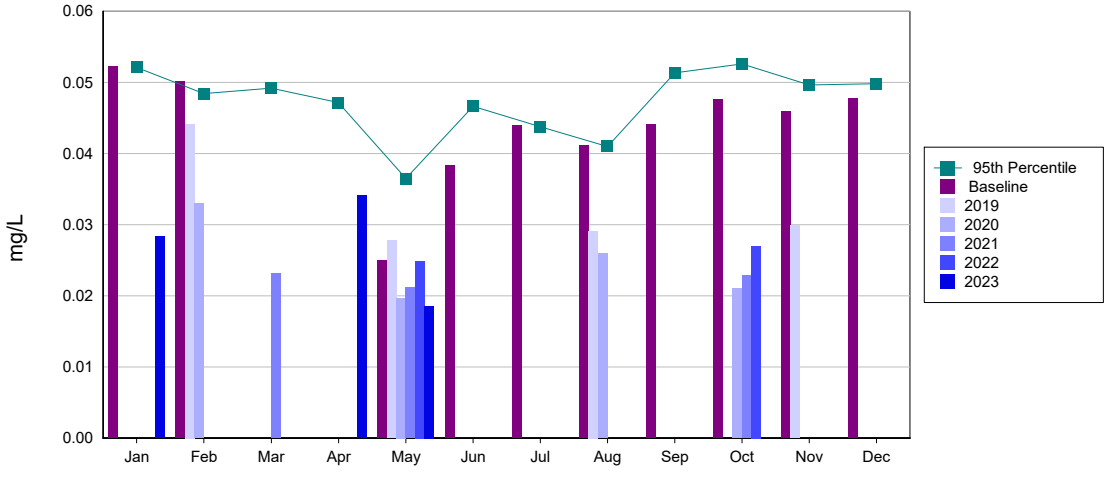
Boundary Dump Seep 2 : Diss-Antimony (Sb) (mg/L)



Boundary Dump Seep 2 : Diss-Arsenic (As) (mg/L)



Boundary Dump Seep 2 : Diss-Barium (Ba) (mg/L)



Water Quality Report

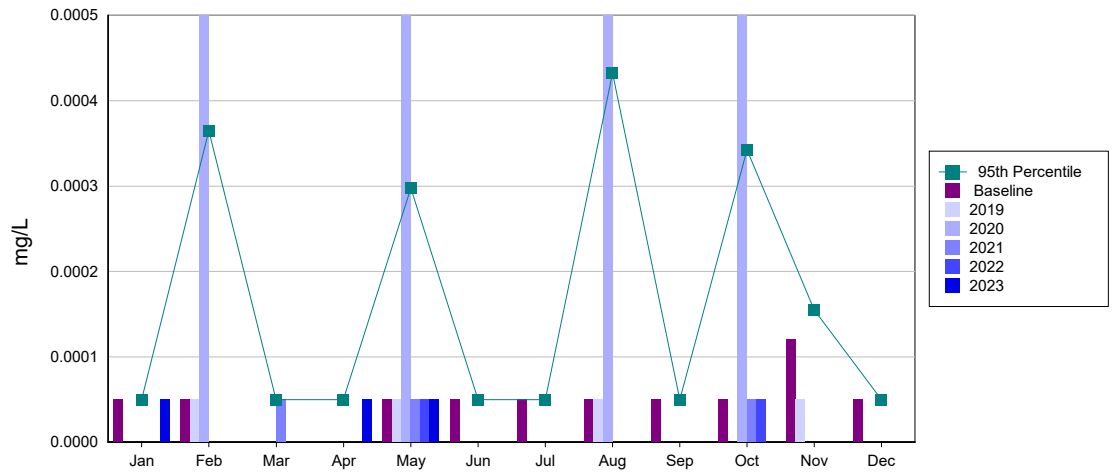
Annual Report Drainage Water

Mount Polley

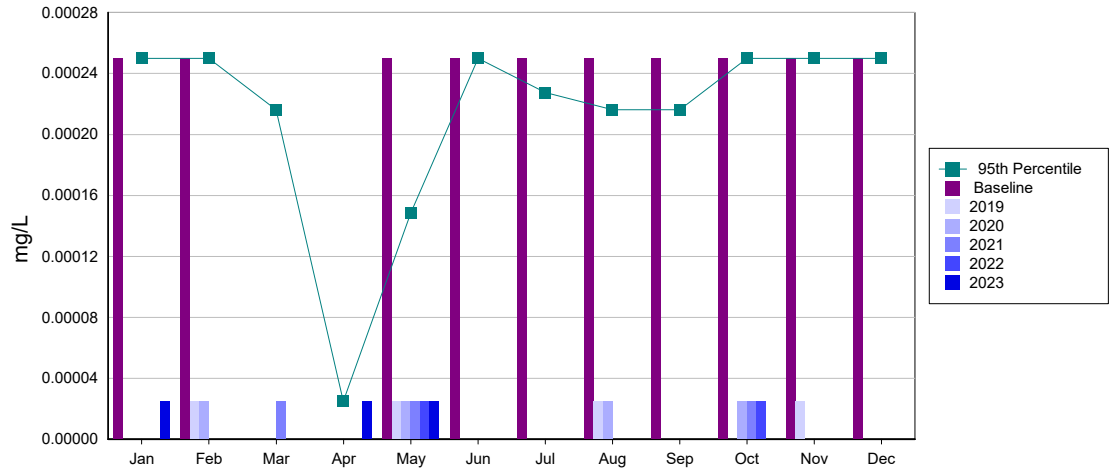
Mining Corporation

IMPERIAL METALS CORPORATION

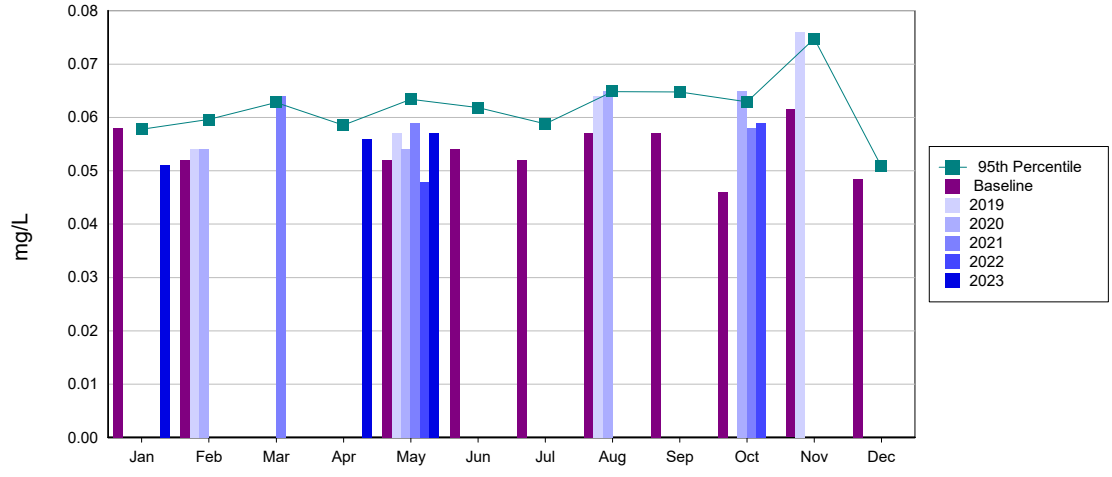
Boundary Dump Seep 2 : Diss-Beryllium (Be) (mg/L)



Boundary Dump Seep 2 : Diss-Bismuth (Bi) (mg/L)



Boundary Dump Seep 2 : Diss-Boron (B) (mg/L)



Water Quality Report

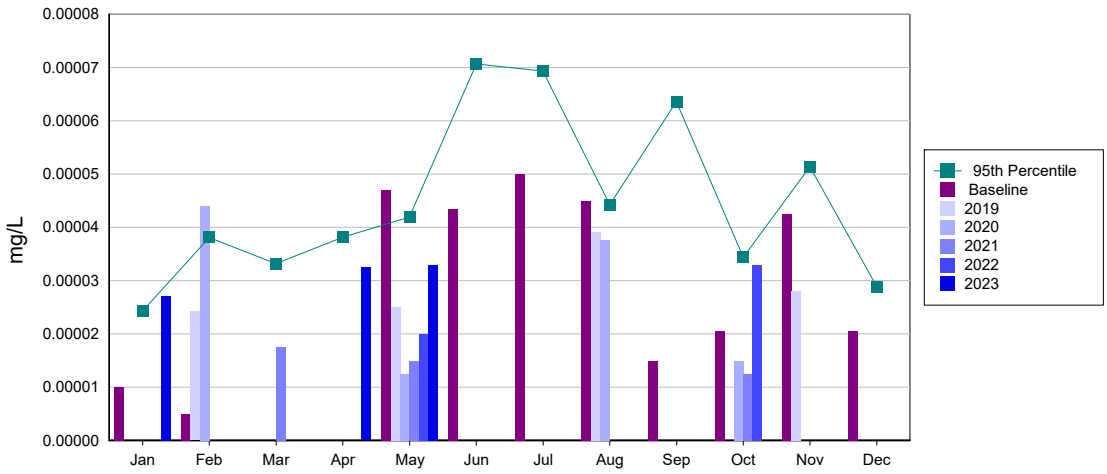
Annual Report Drainage Water

Mount Polley

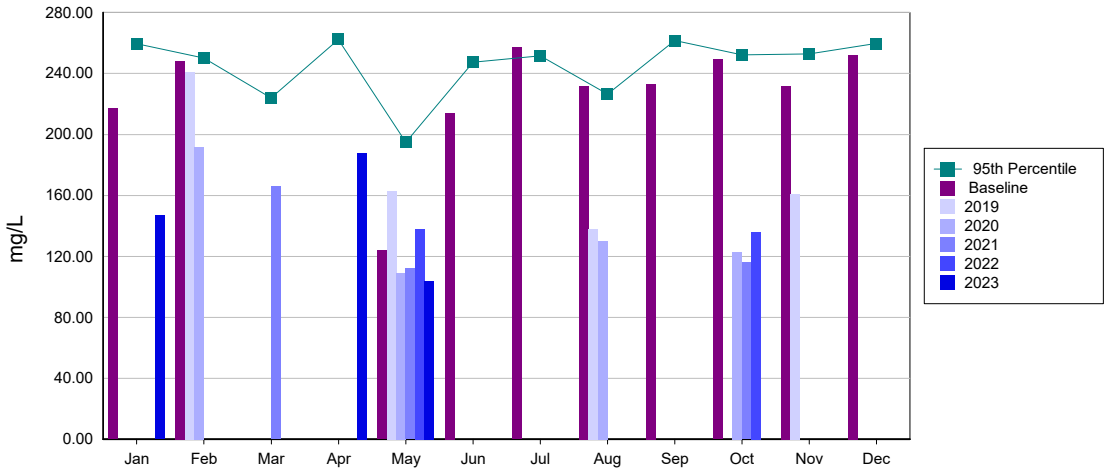
Mining Corporation

IMPERIAL METALS CORPORATION

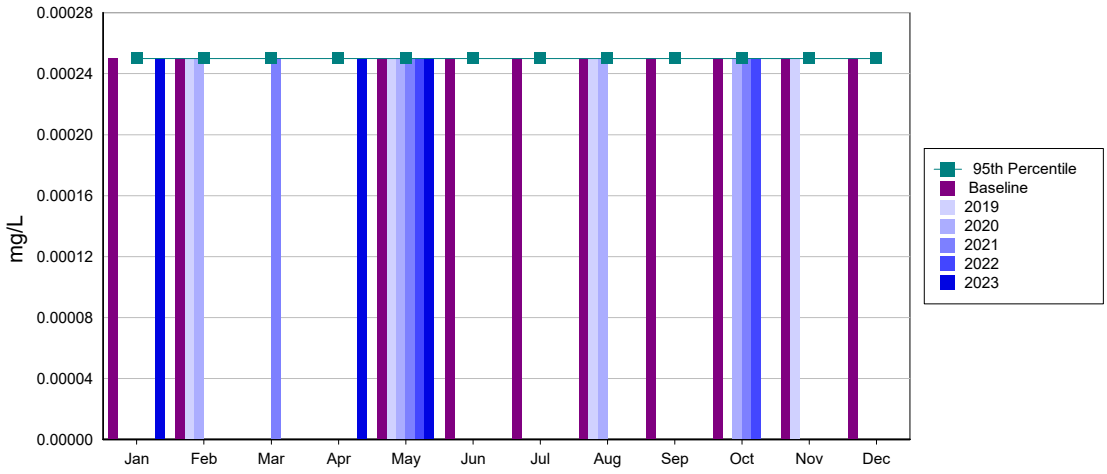
Boundary Dump Seep 2 : Diss-Cadmium (Cd) (mg/L)



Boundary Dump Seep 2 : Diss-Calcium (Ca) (mg/L)



Boundary Dump Seep 2 : Diss-Chromium (Cr) (mg/L)



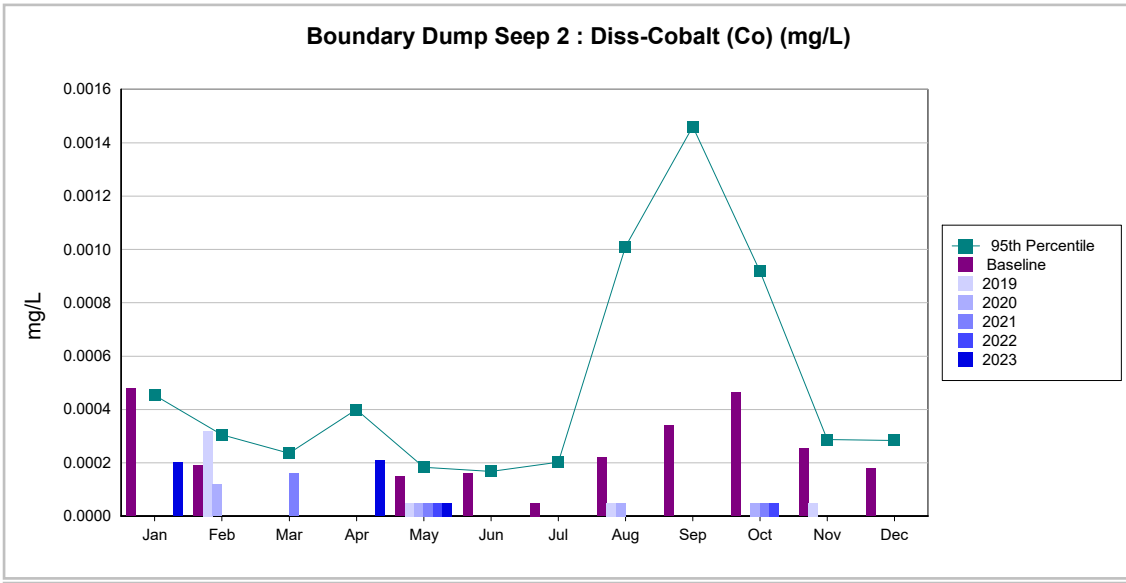
Water Quality Report

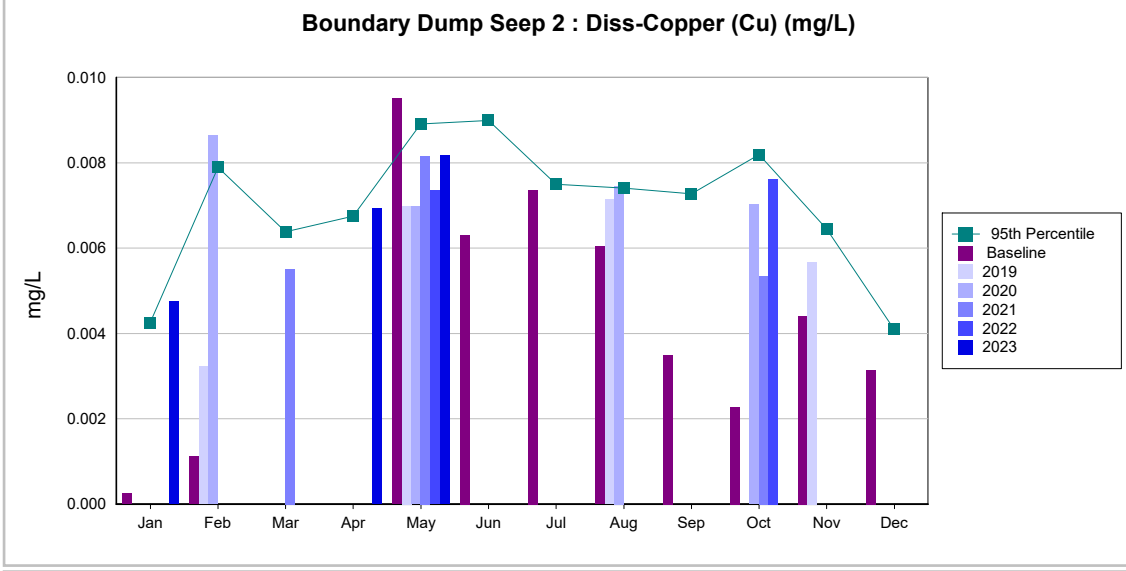
Annual Report Drainage Water

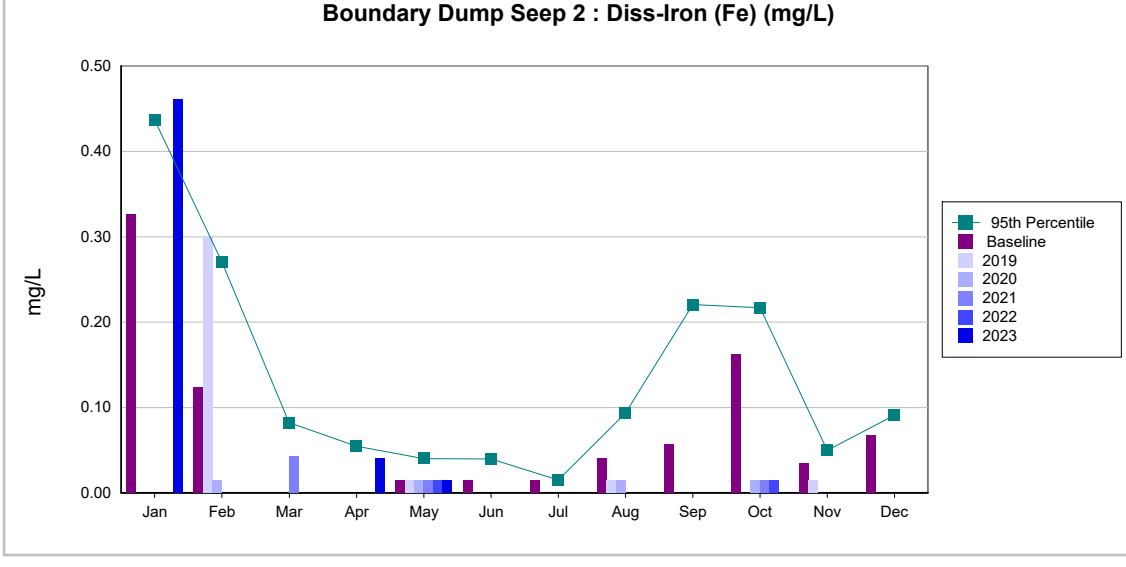
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

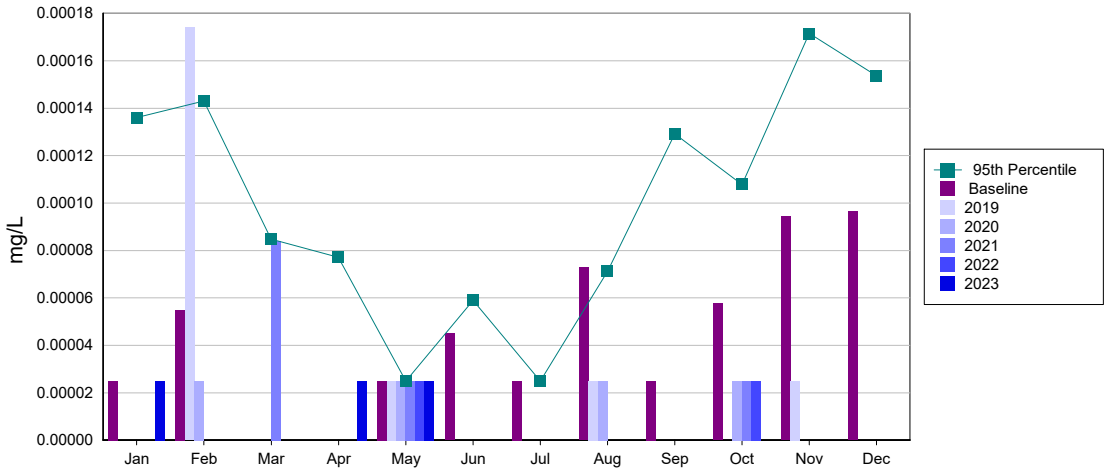
Annual Report Drainage Water

Mount Polley

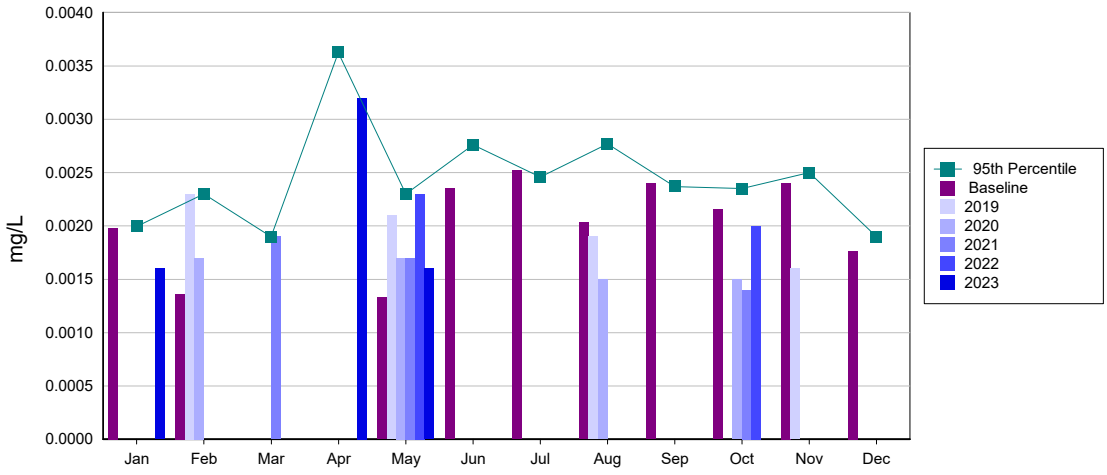
Mining Corporation

IMPERIAL METALS CORPORATION

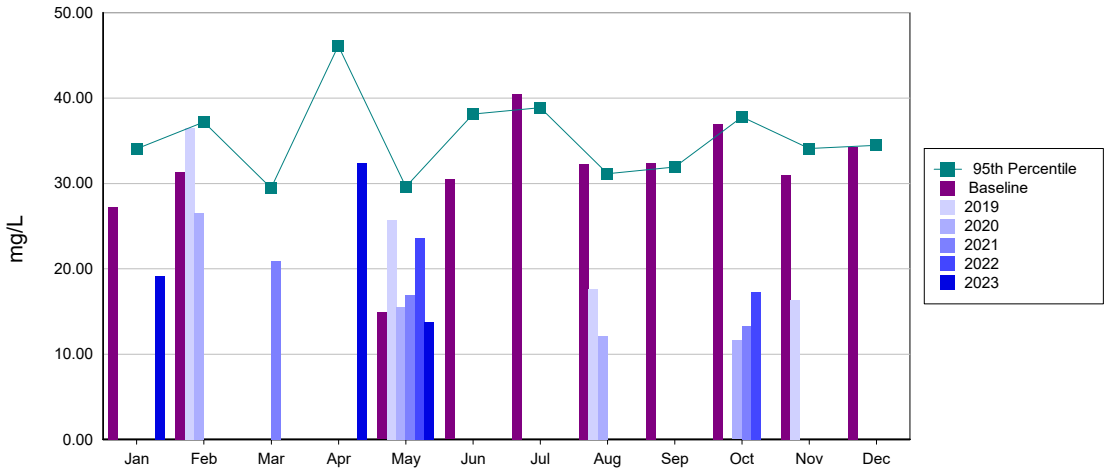
Boundary Dump Seep 2 : Diss-Lead (Pb) (mg/L)



Boundary Dump Seep 2 : Diss-Lithium (Li) (mg/L)



Boundary Dump Seep 2 : Diss-Magnesium (Mg) (mg/L)



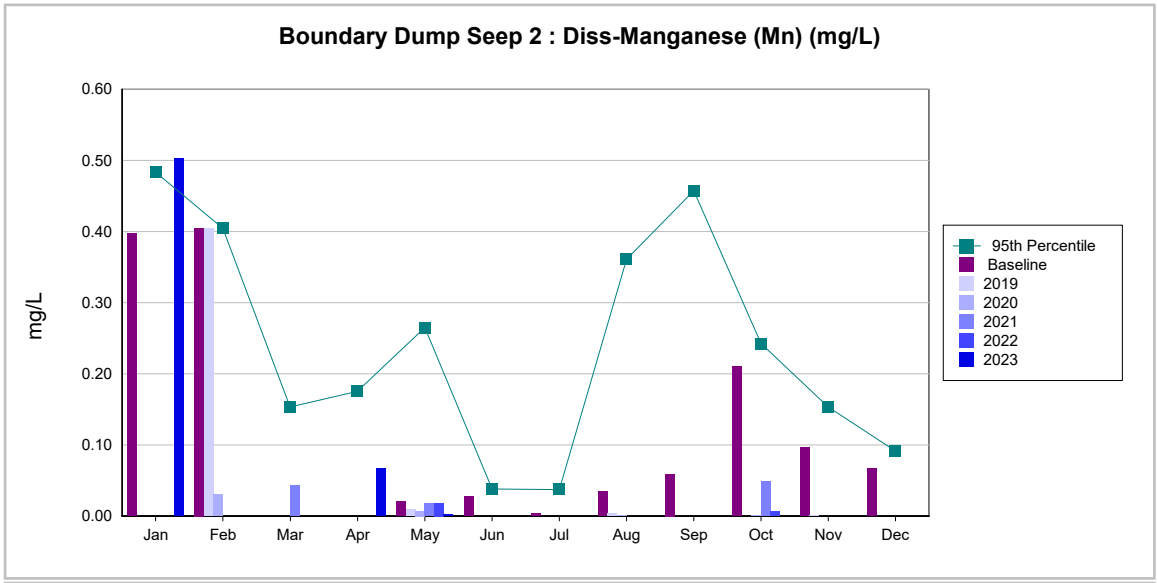
Water Quality Report

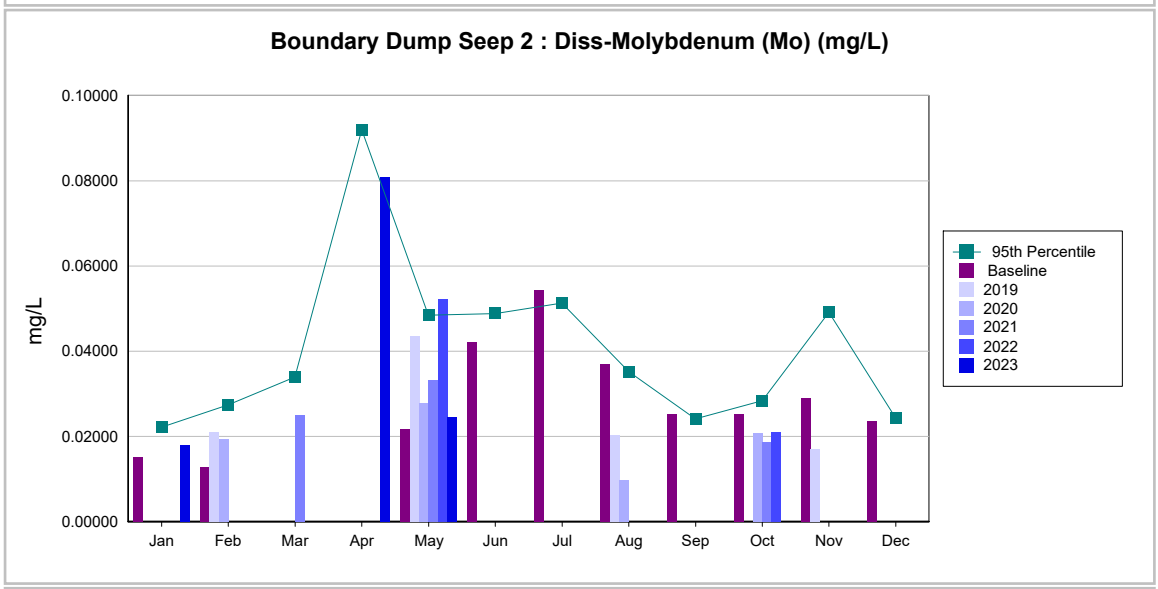
Annual Report Drainage Water

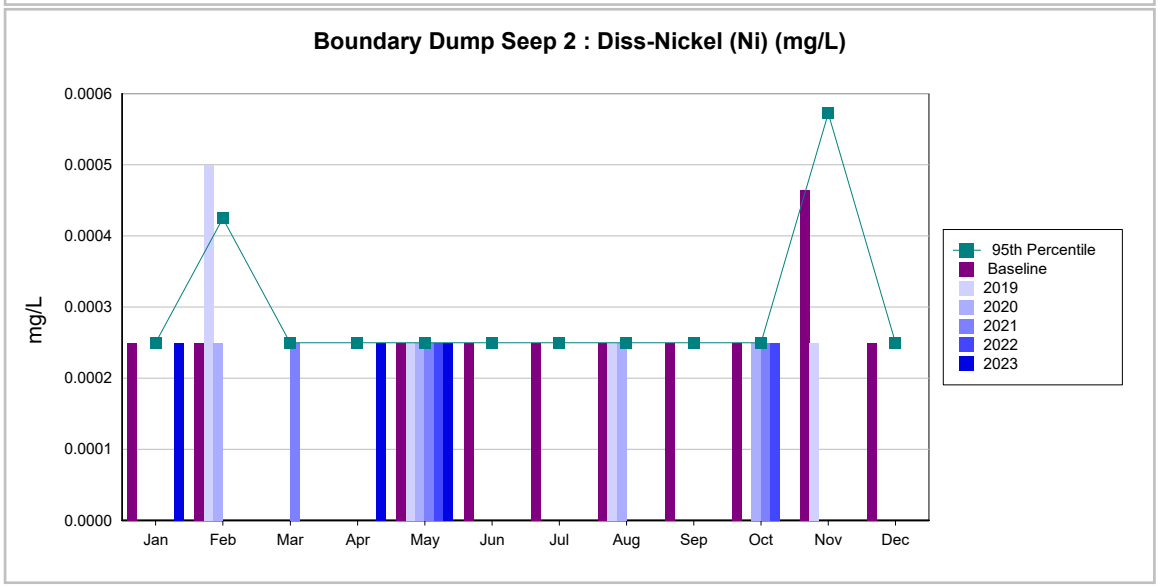
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







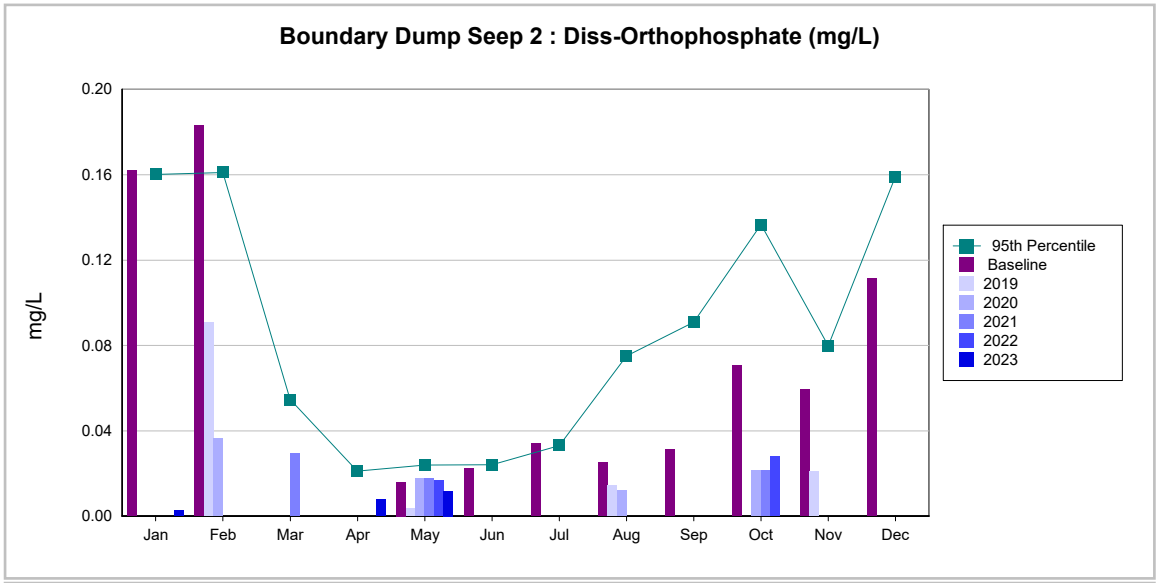
Water Quality Report

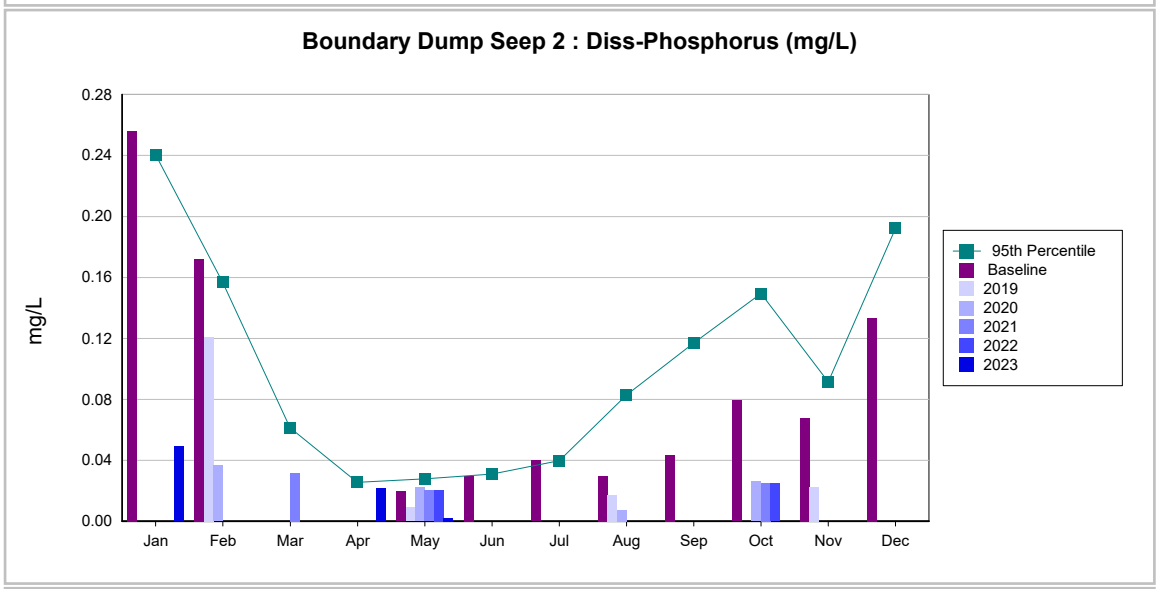
Annual Report Drainage Water

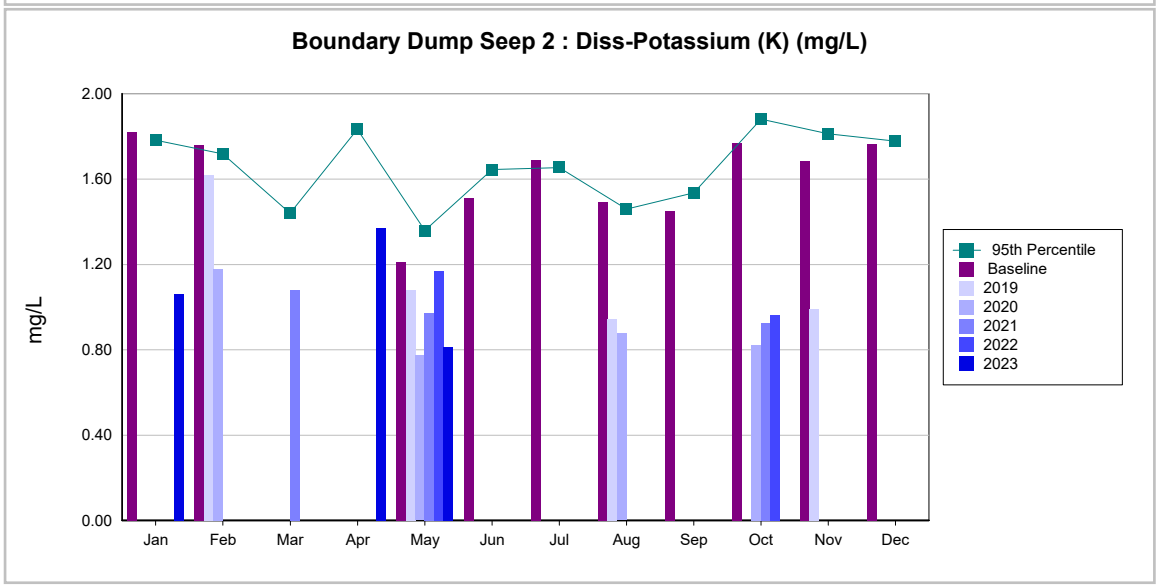
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







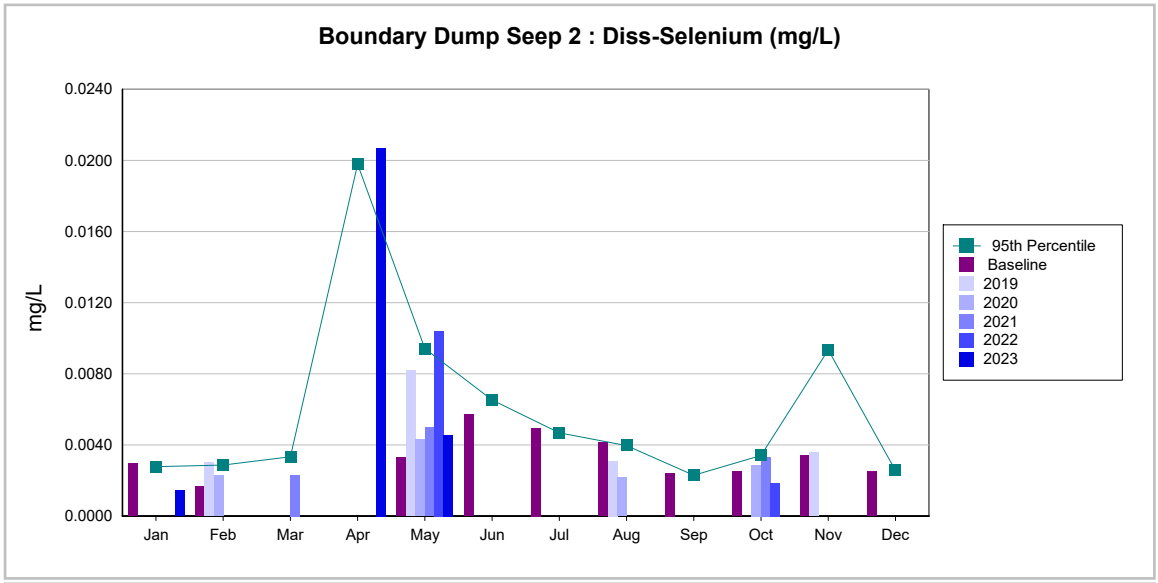
Water Quality Report

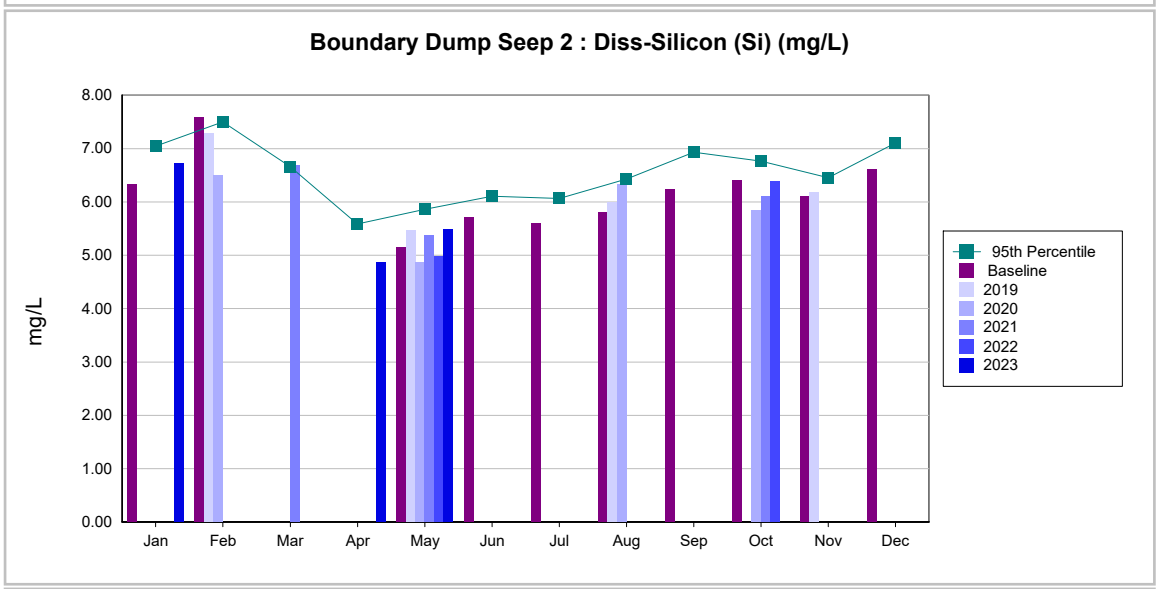
Annual Report Drainage Water

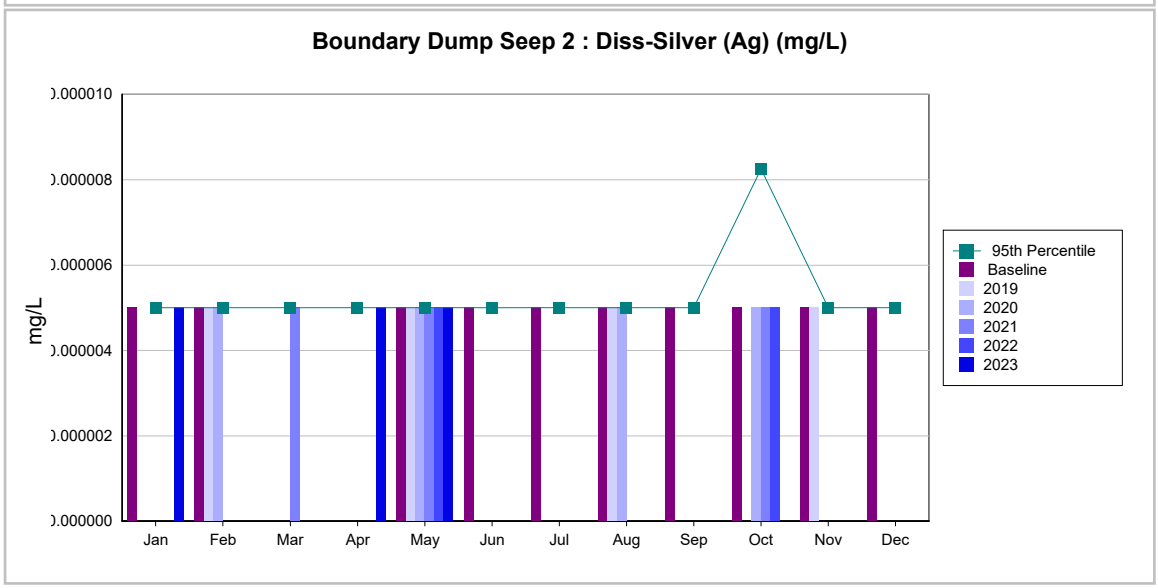
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







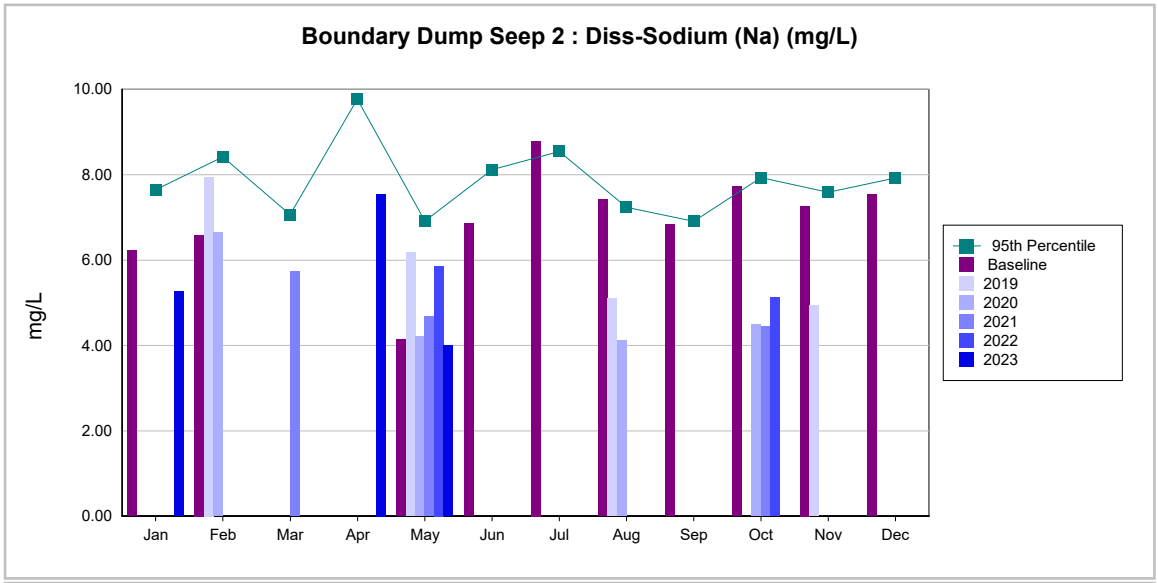
Water Quality Report

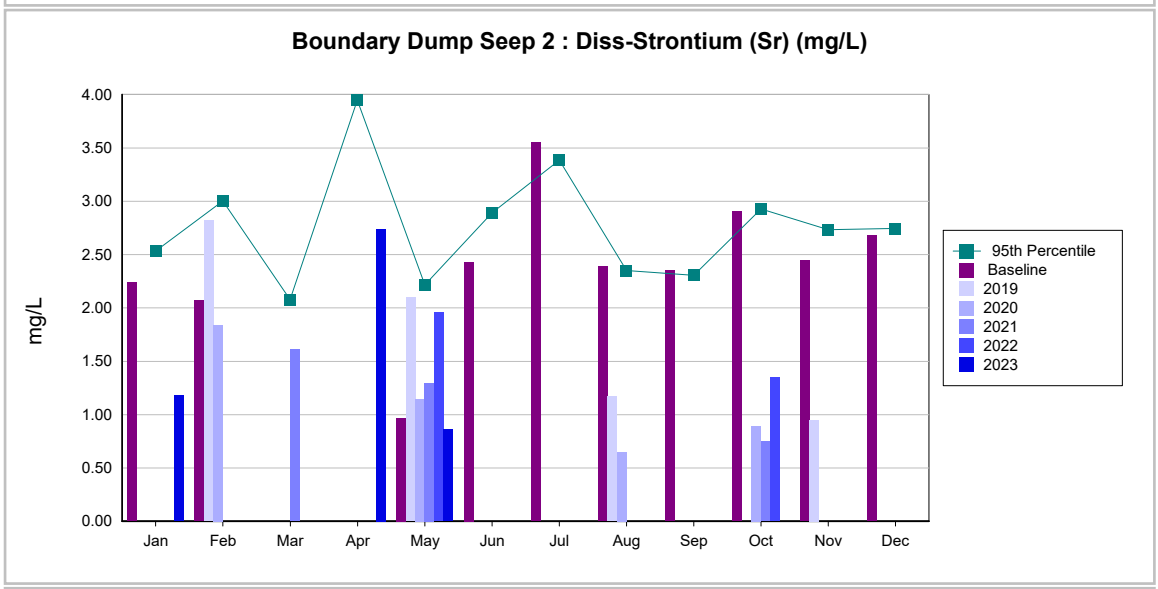
Annual Report Drainage Water

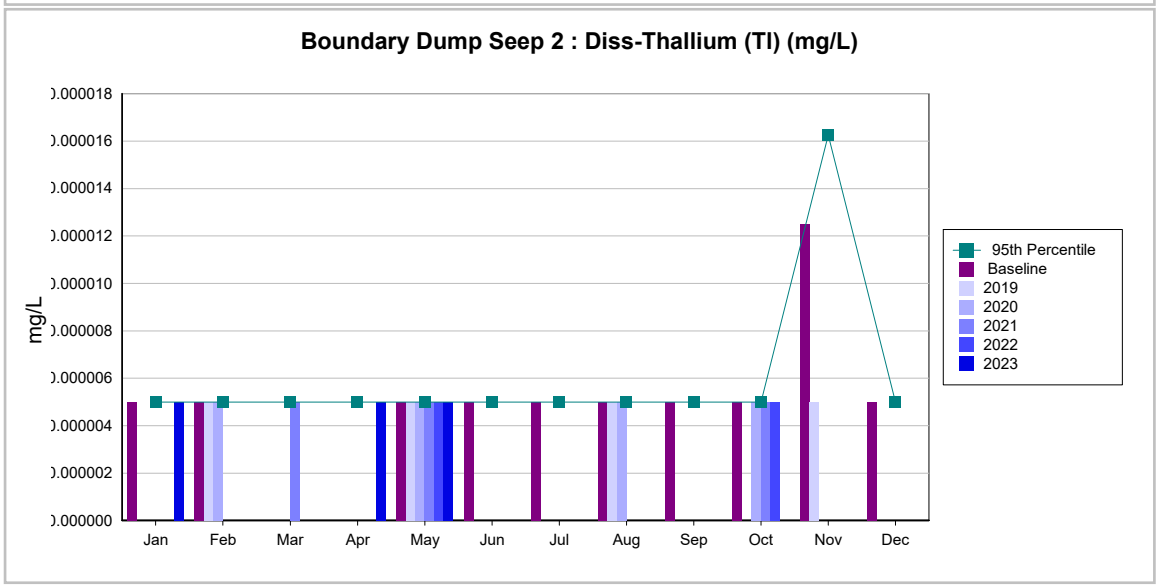
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







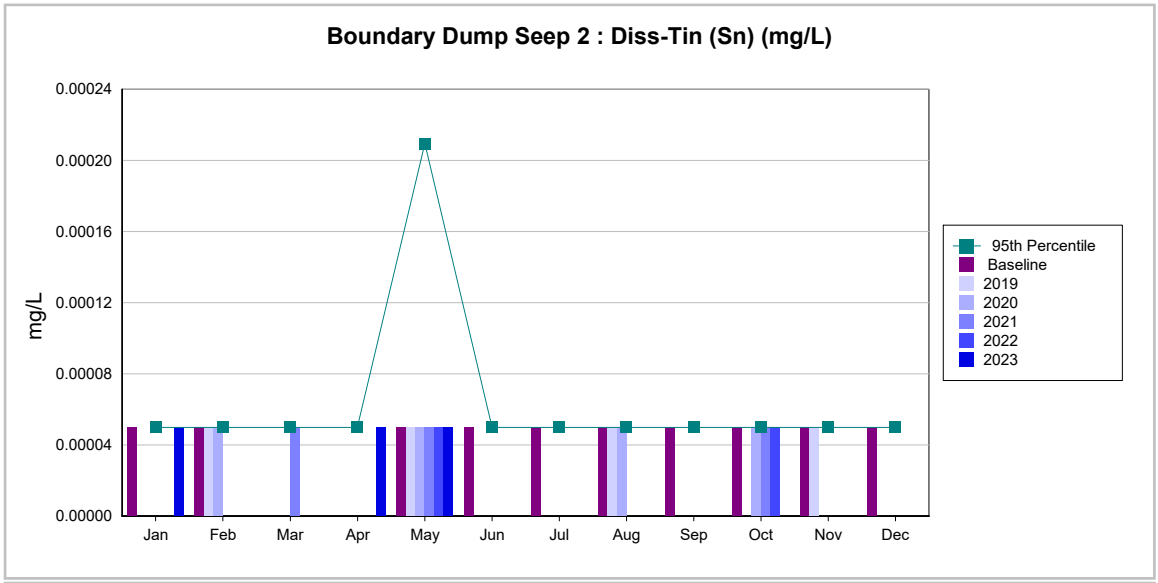
Water Quality Report

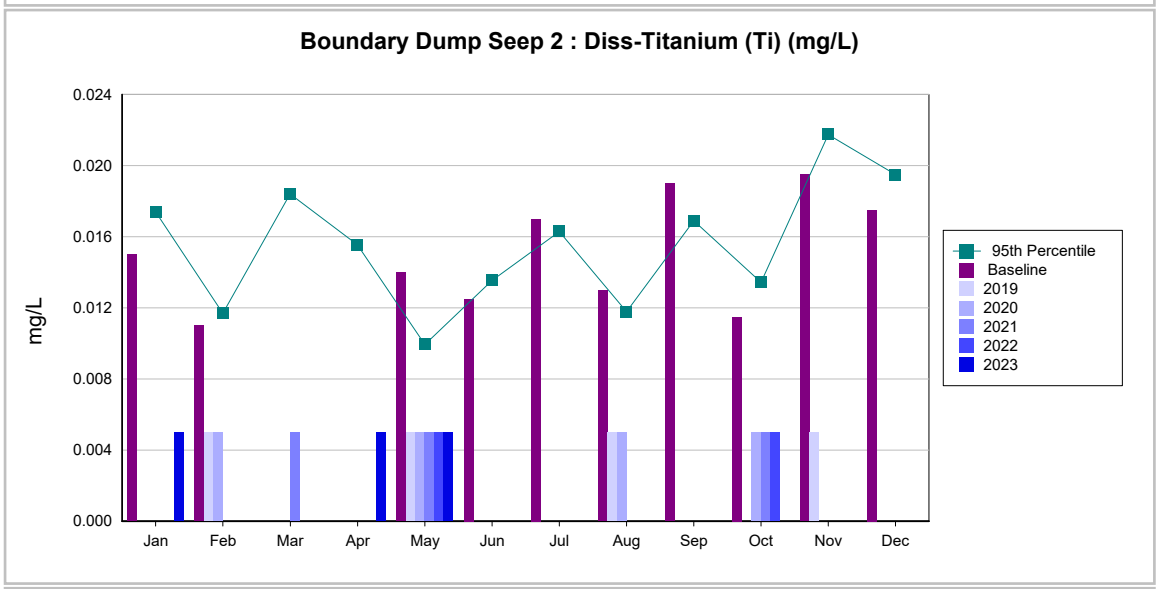
Annual Report Drainage Water

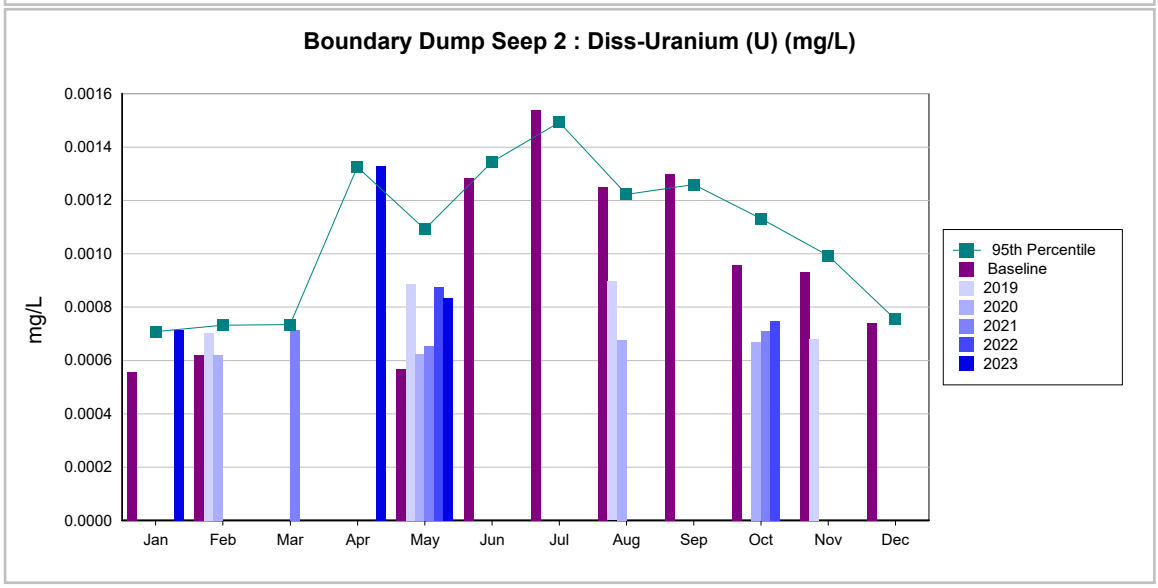
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







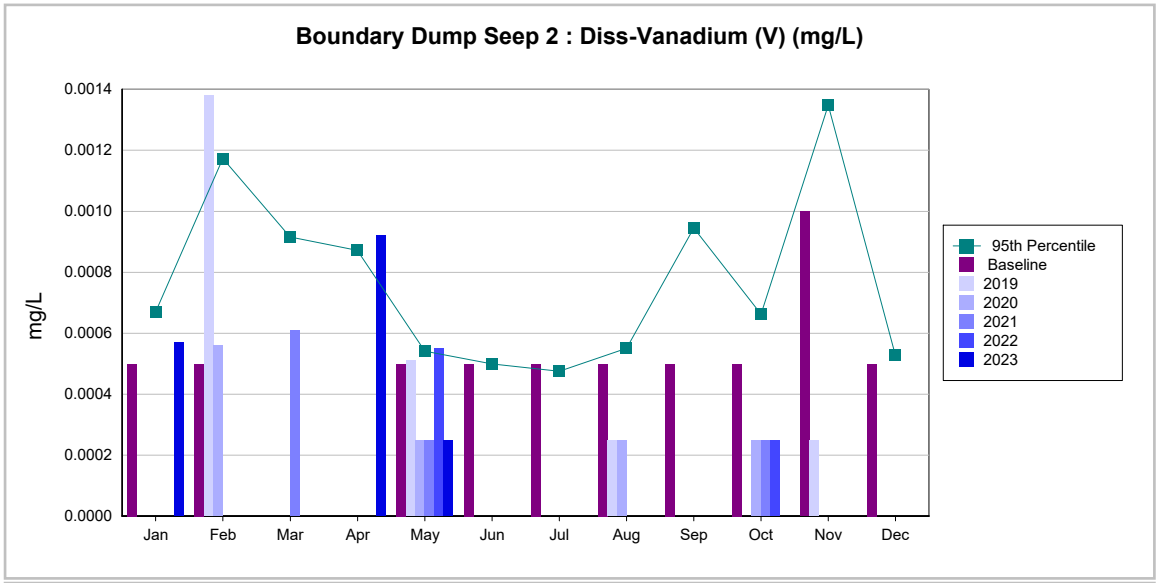
Water Quality Report

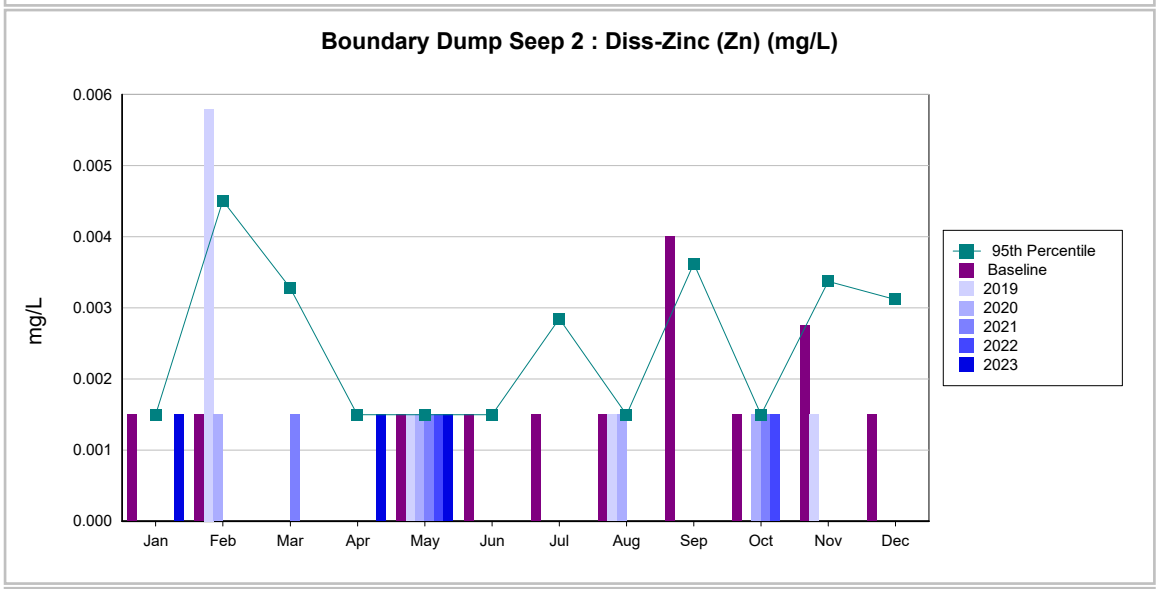
Annual Report Drainage Water

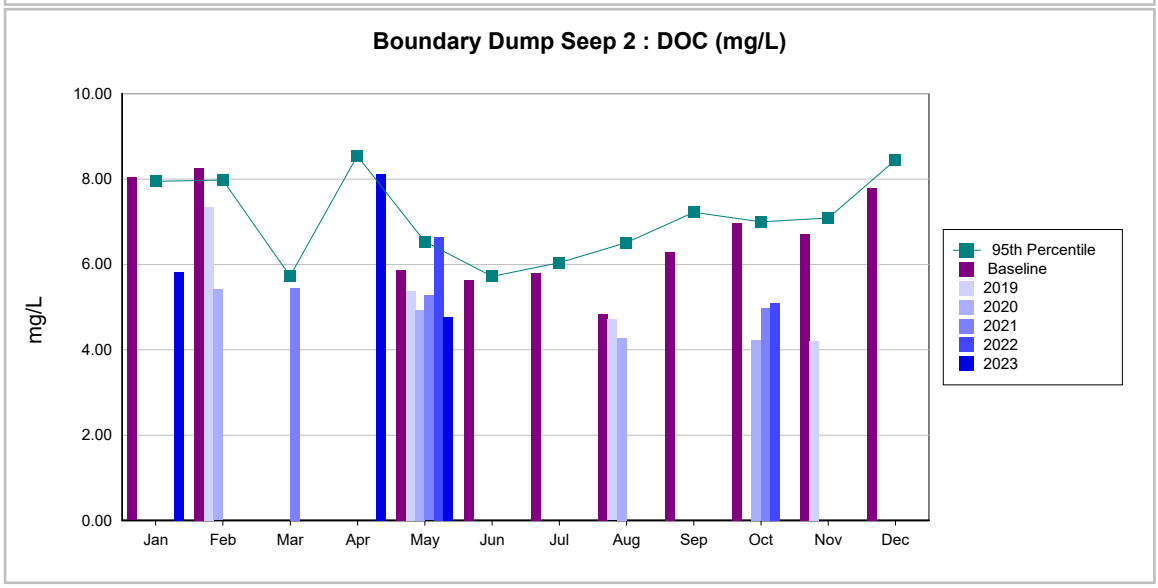
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

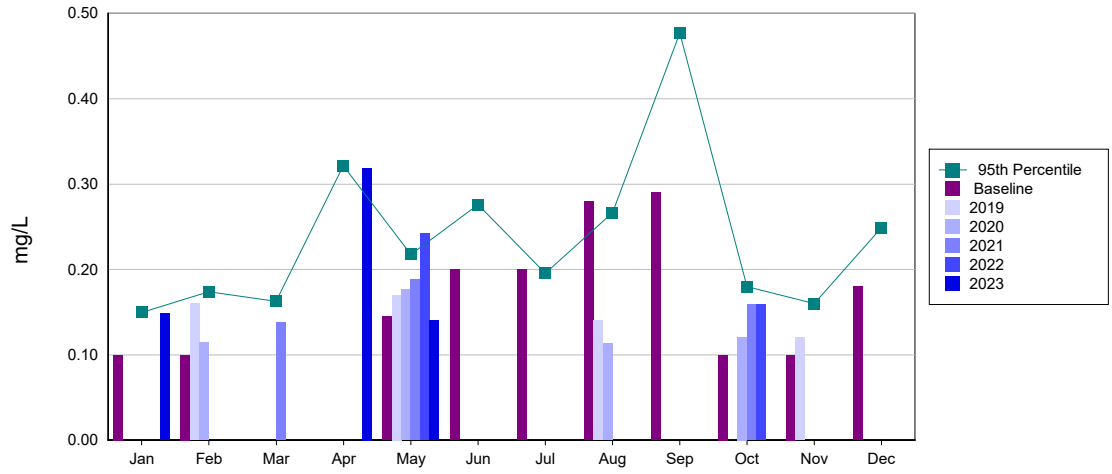
Annual Report Drainage Water

Mount Polley

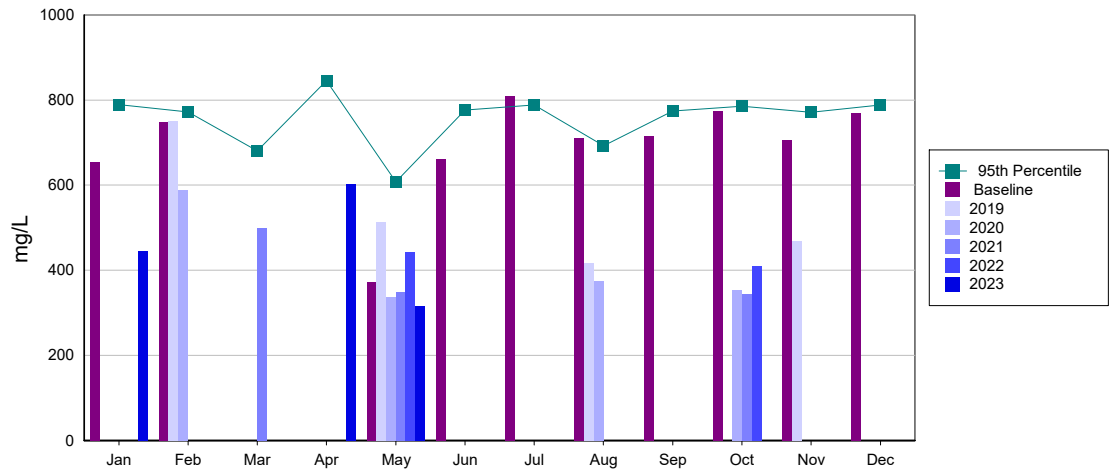
Mining Corporation

IMPERIAL METALS CORPORATION

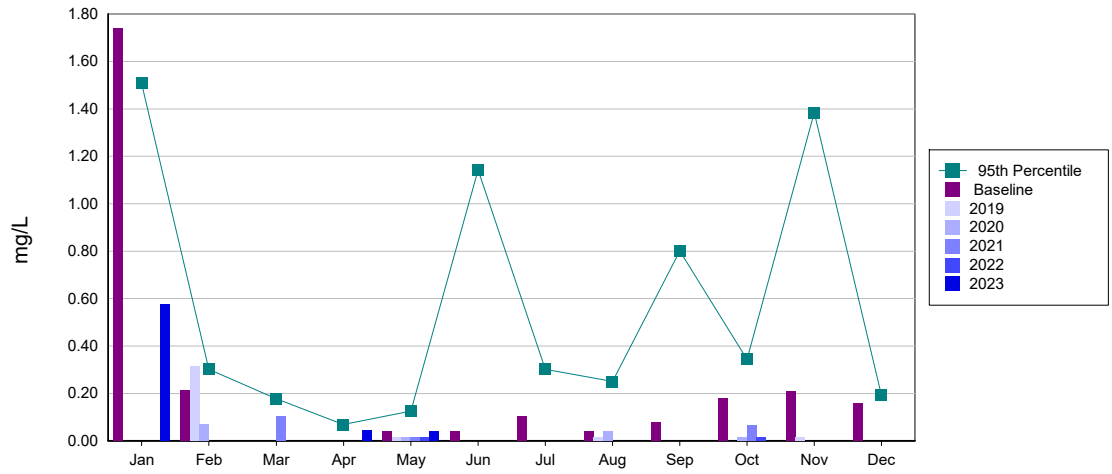
Boundary Dump Seep 2 : Floride (mg/L)



Boundary Dump Seep 2 : Hardness (mg/L)



Boundary Dump Seep 2 : Iron (Fe)-Total (mg/L)



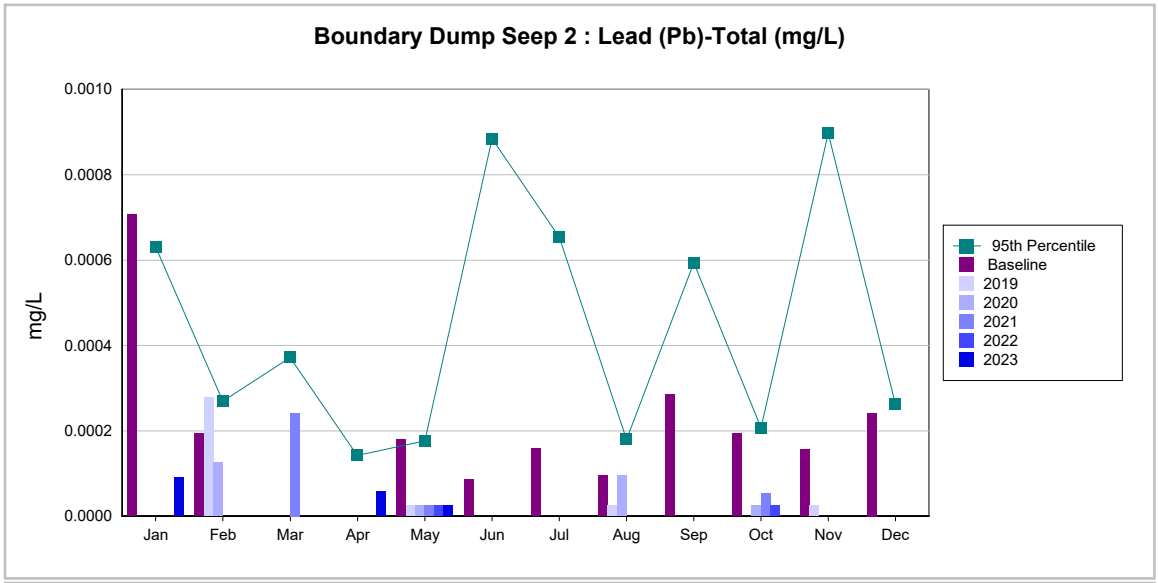
Water Quality Report

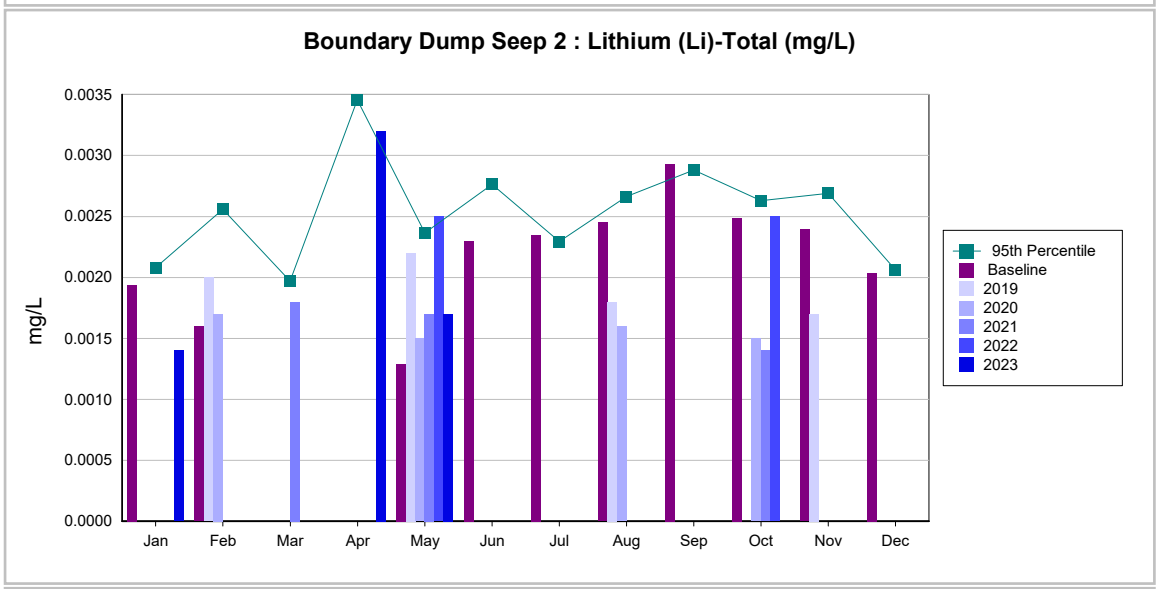
Annual Report Drainage Water

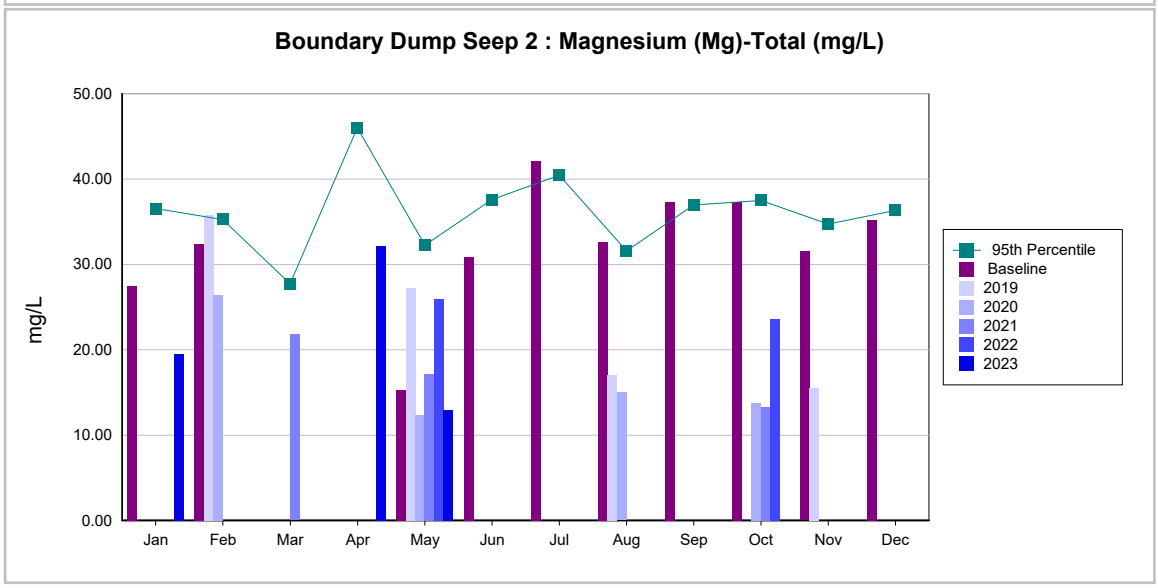
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







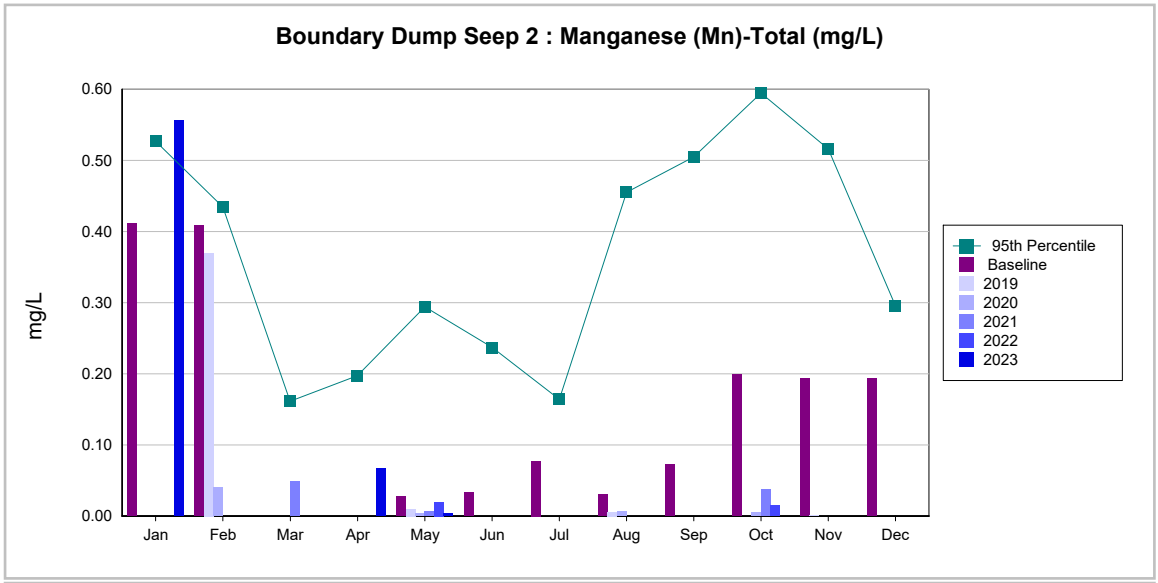
Water Quality Report

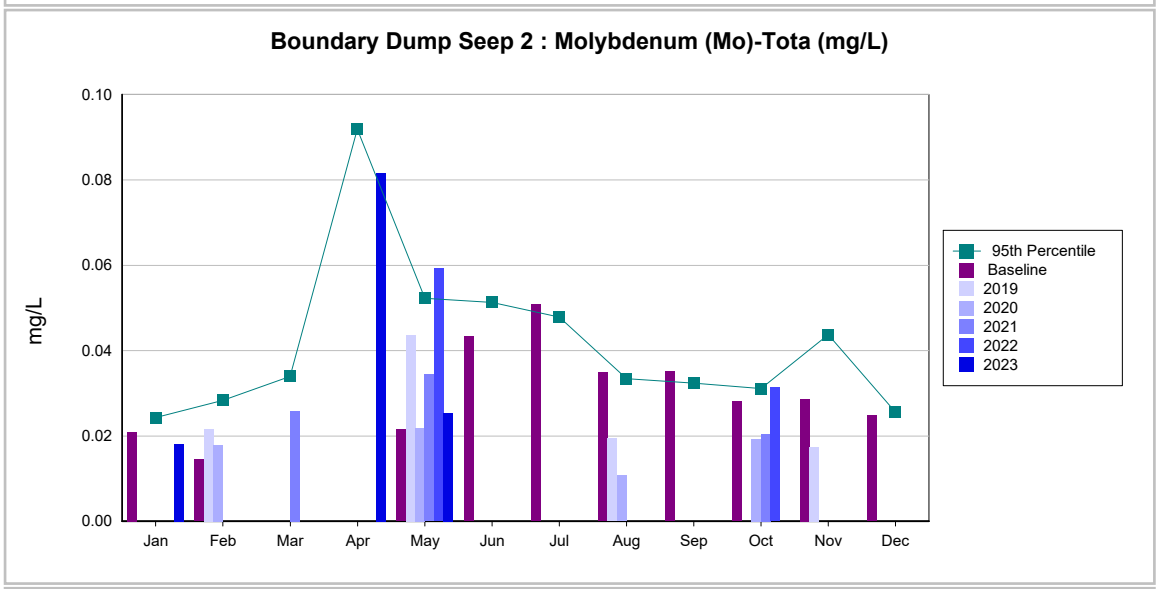
Annual Report Drainage Water

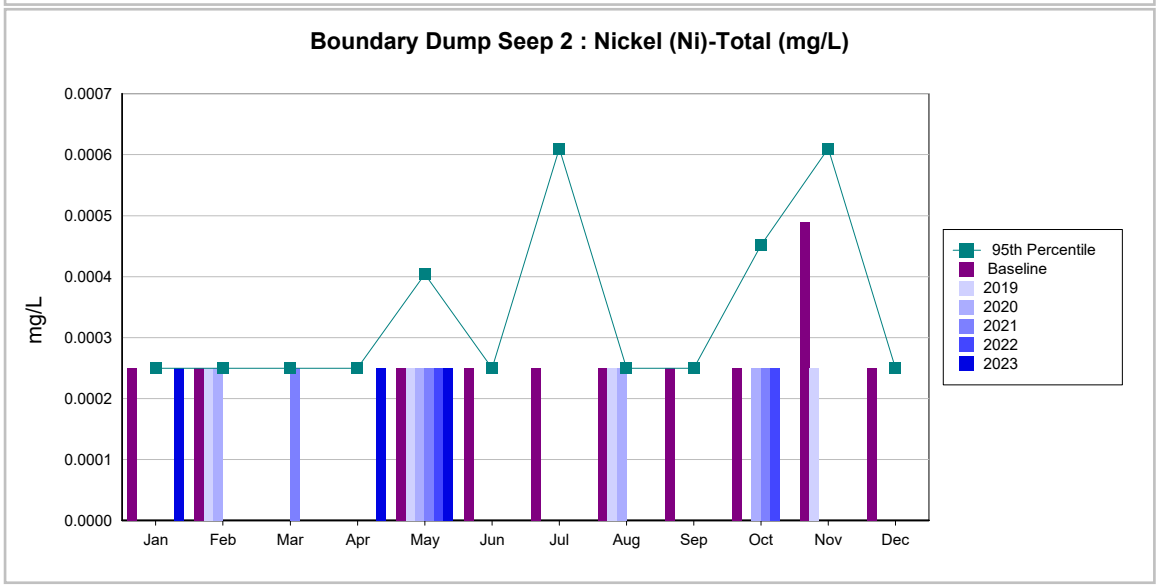
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







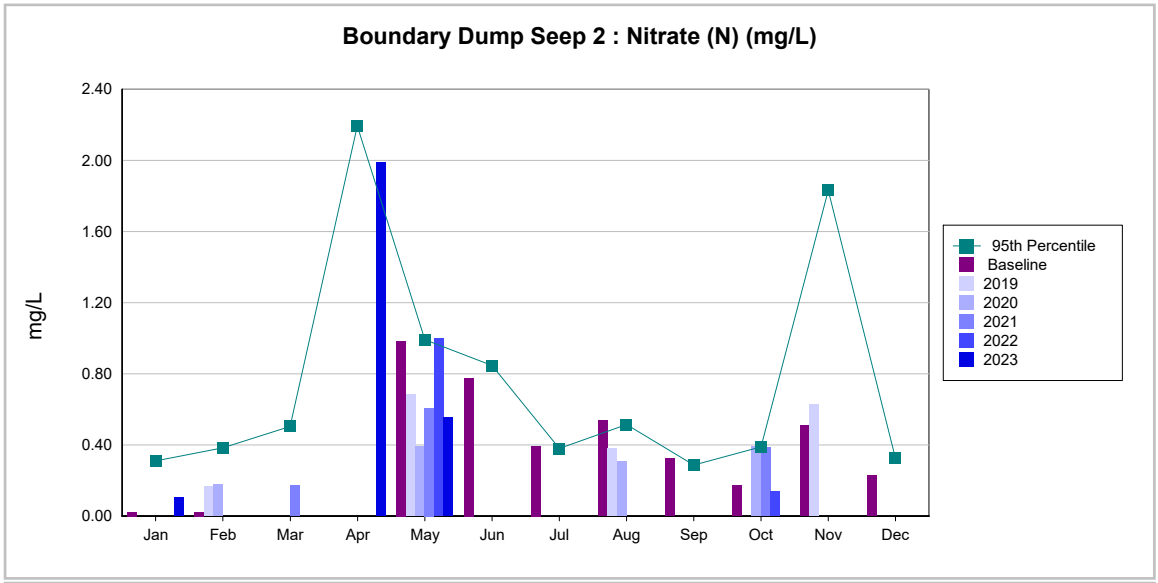
Water Quality Report

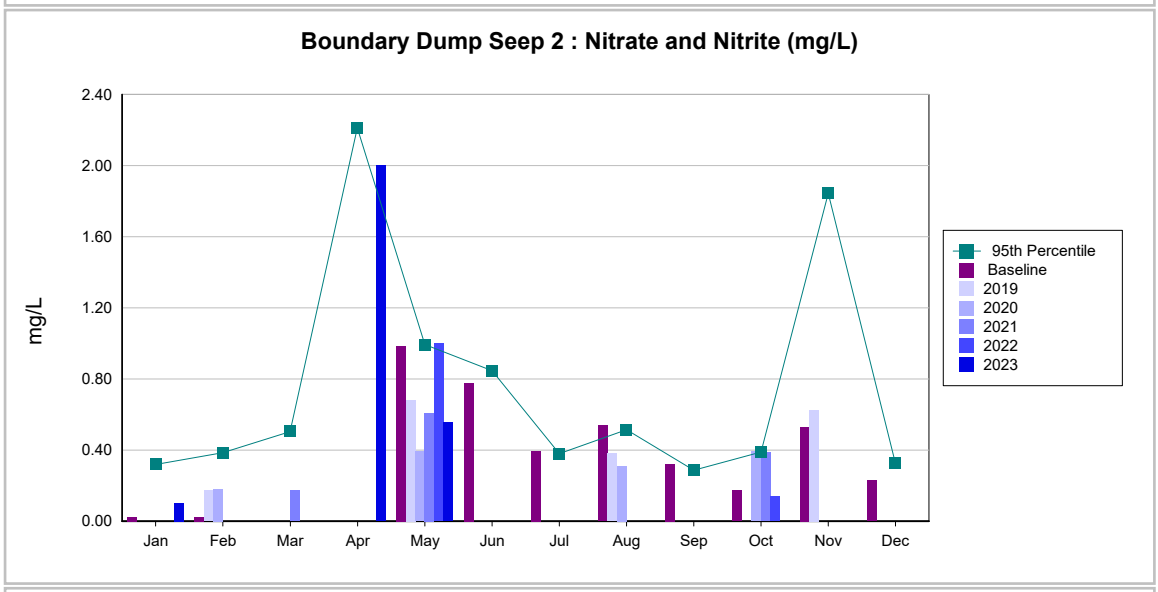
Annual Report Drainage Water

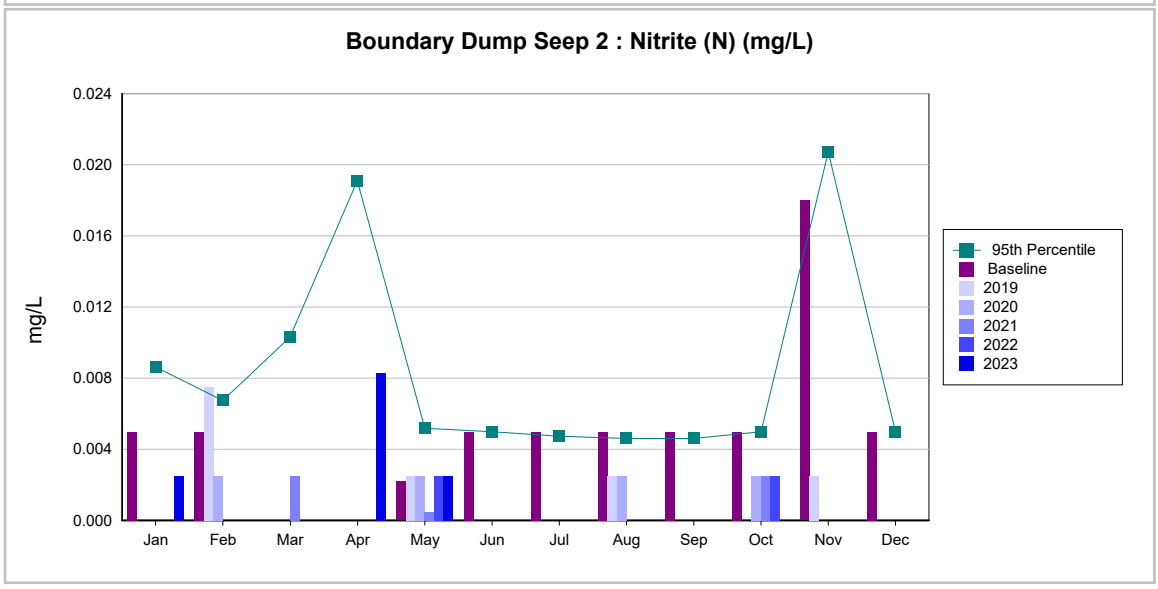
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







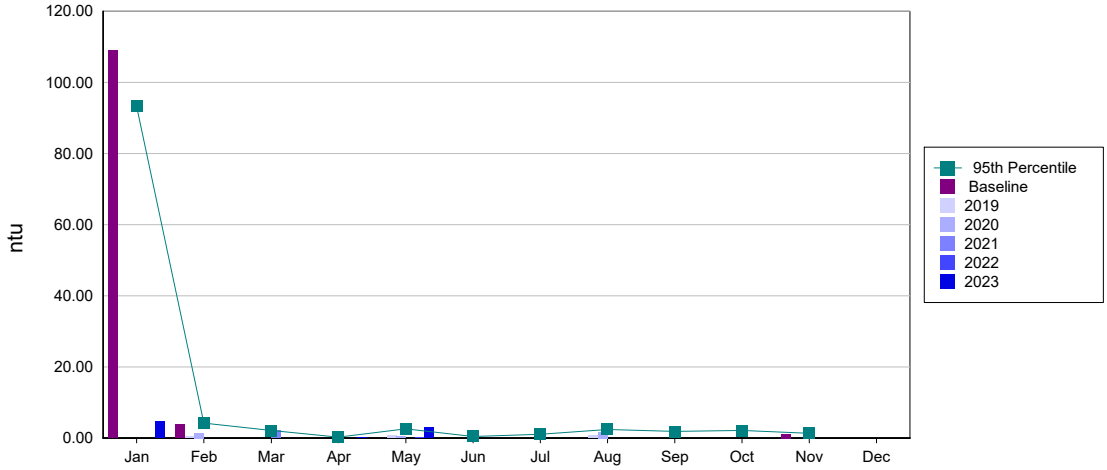
Water Quality Report

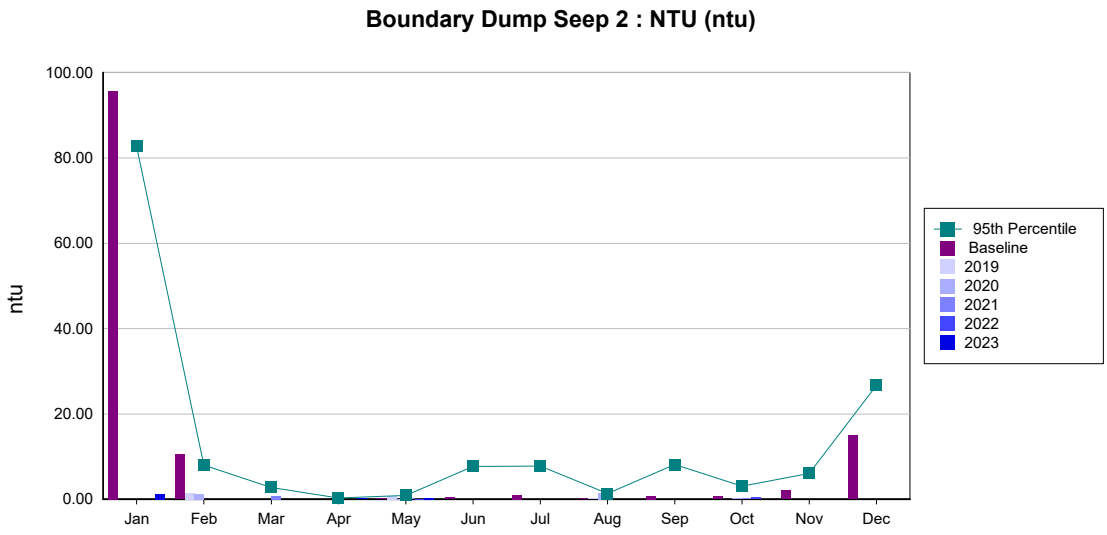
Annual Report Drainage Water

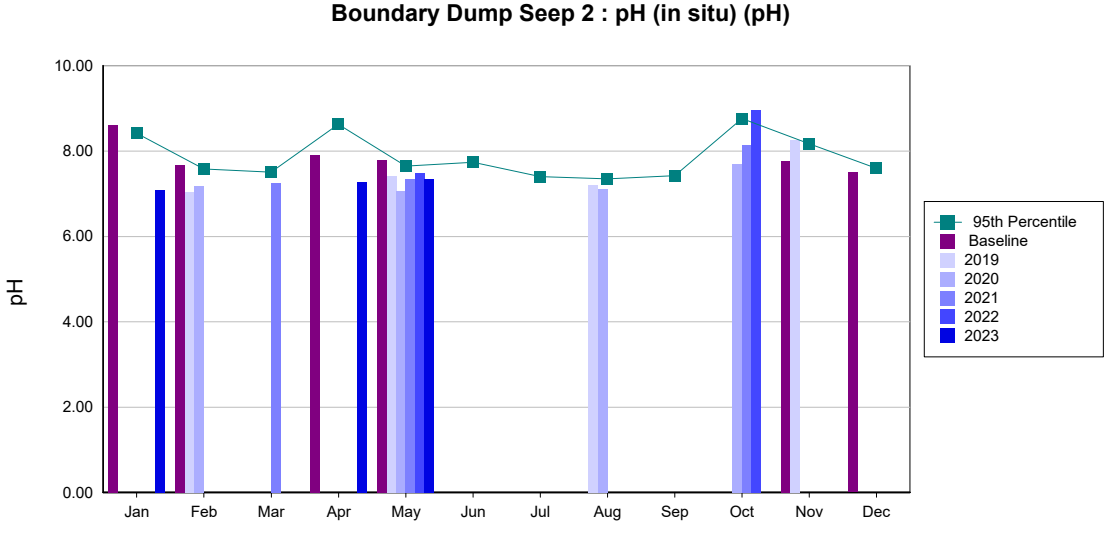
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







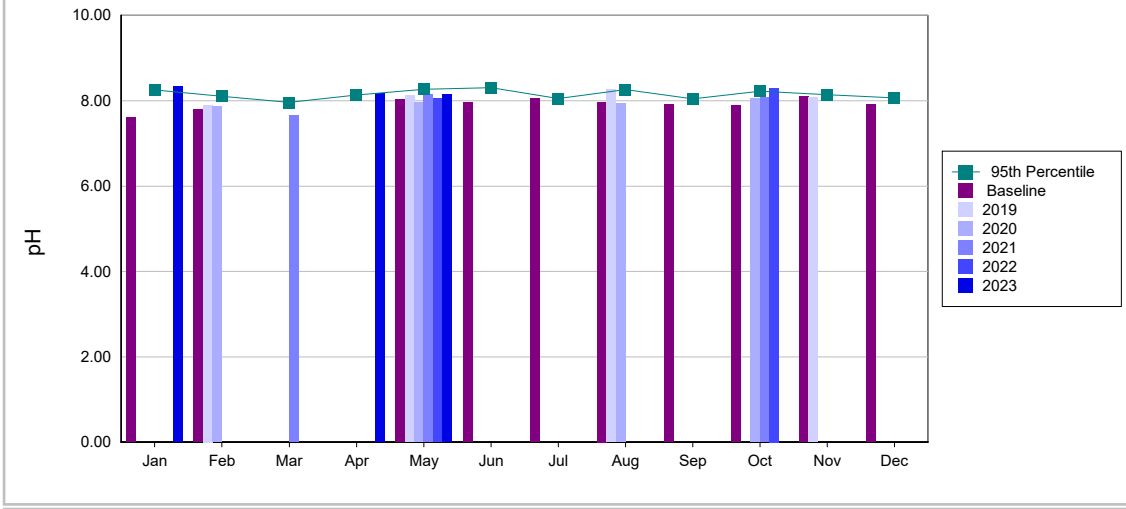
Water Quality Report

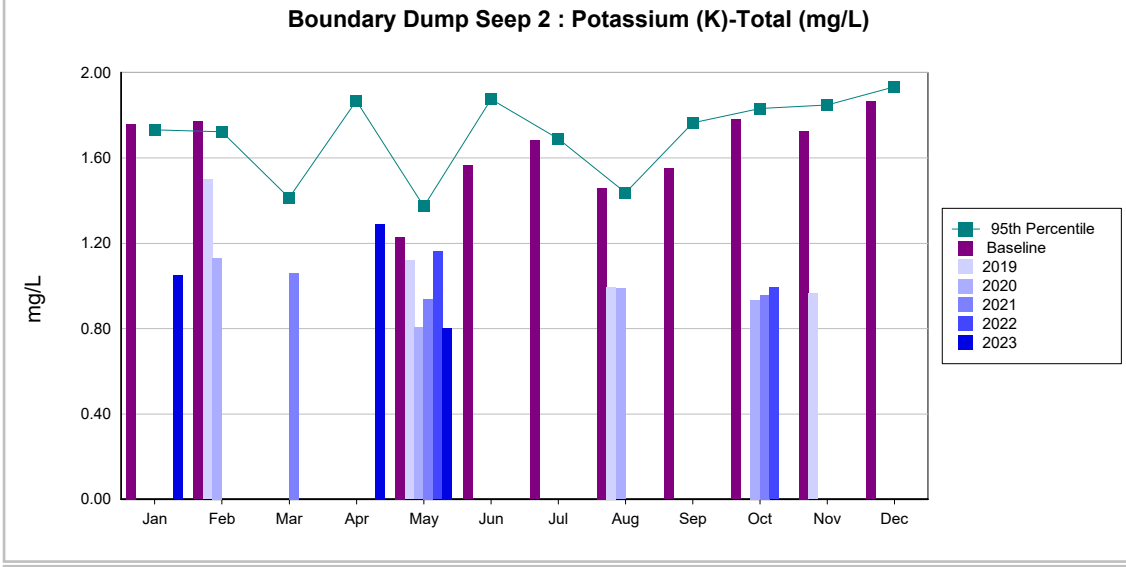
Annual Report Drainage Water

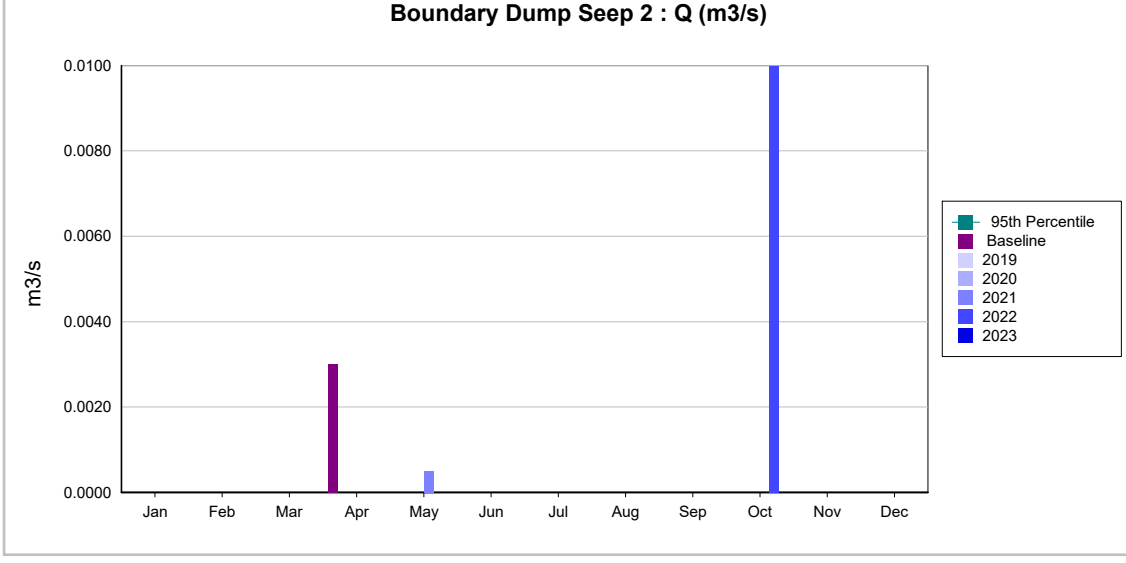
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

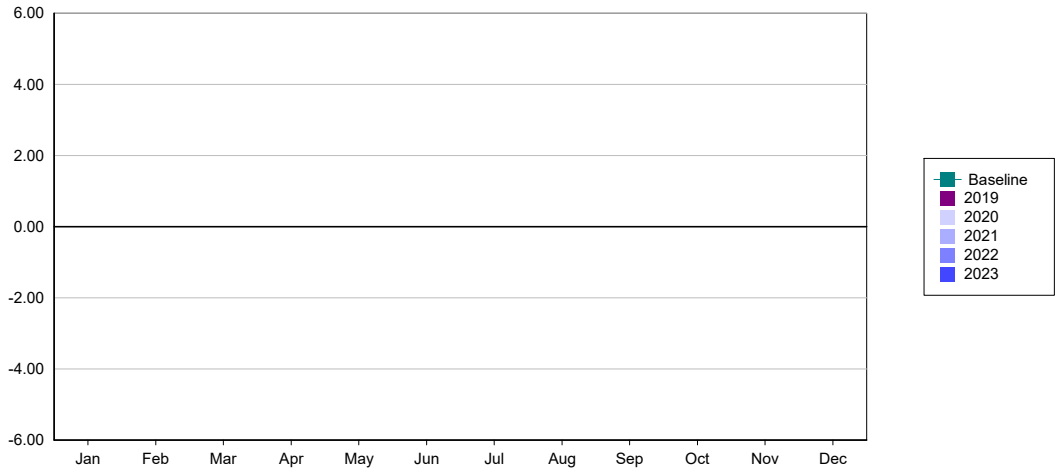
Annual Report Drainage Water

Mount Polley

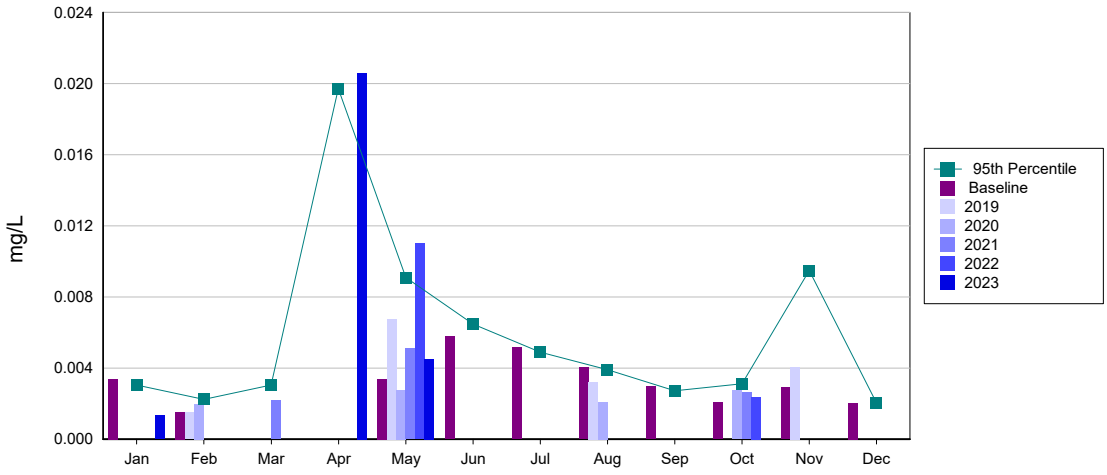
Mining Corporation

IMPERIAL METALS CORPORATION

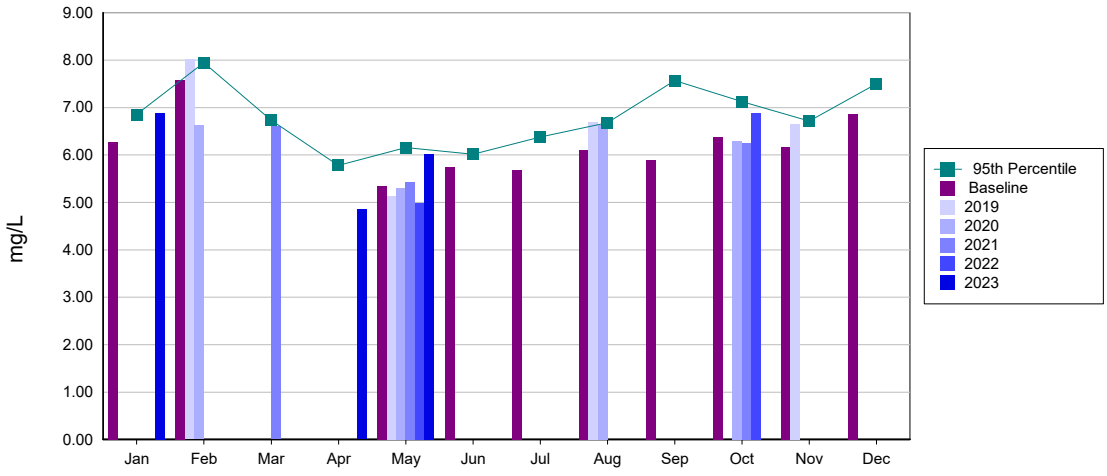
Boundary Dump Seep 2 : Sample Taken



Boundary Dump Seep 2 : Selenium (Se)-Total (mg/L)



Boundary Dump Seep 2 : Silicon (Si)-Total (mg/L)



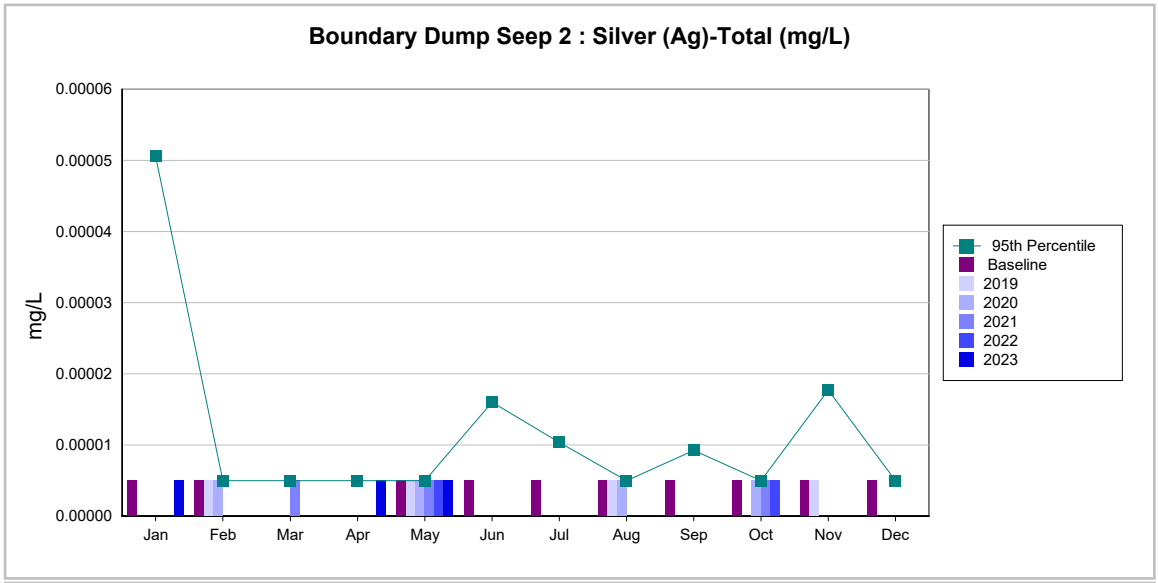
Water Quality Report

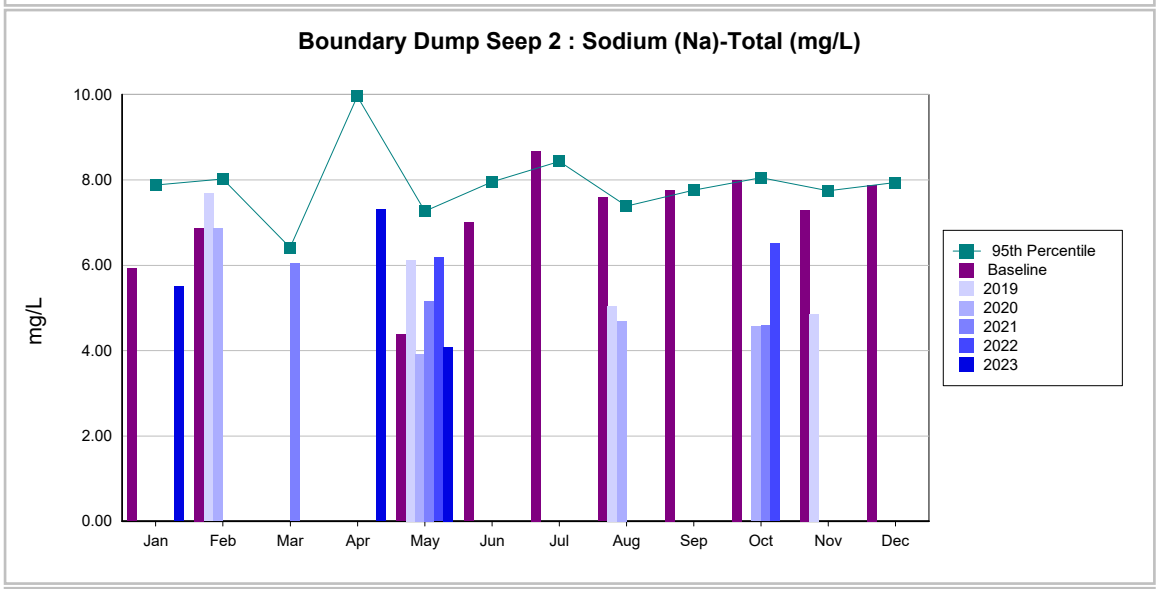
Annual Report Drainage Water

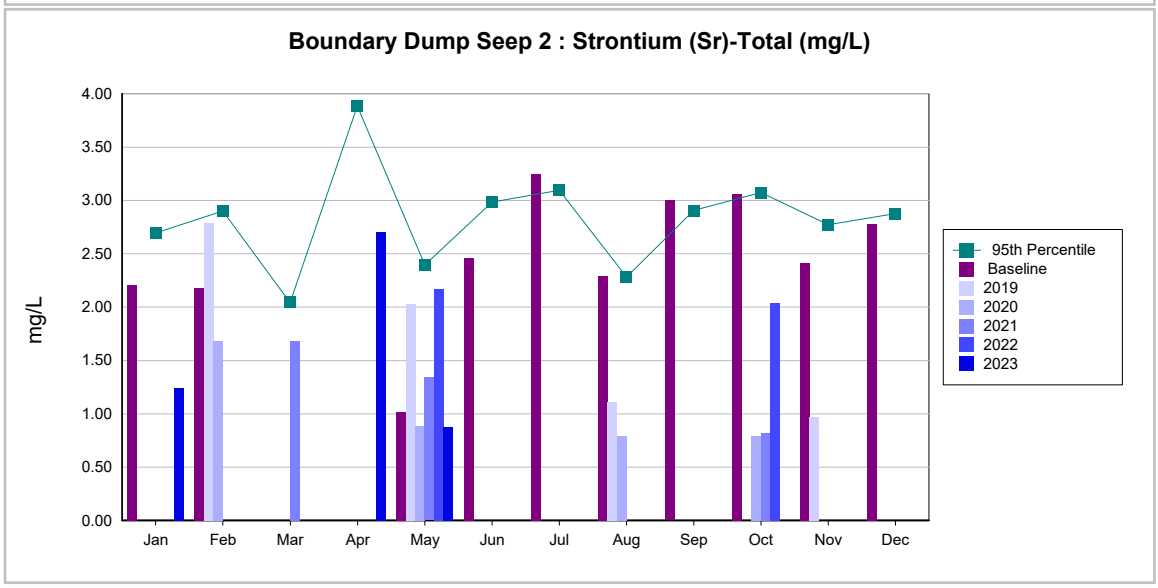
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







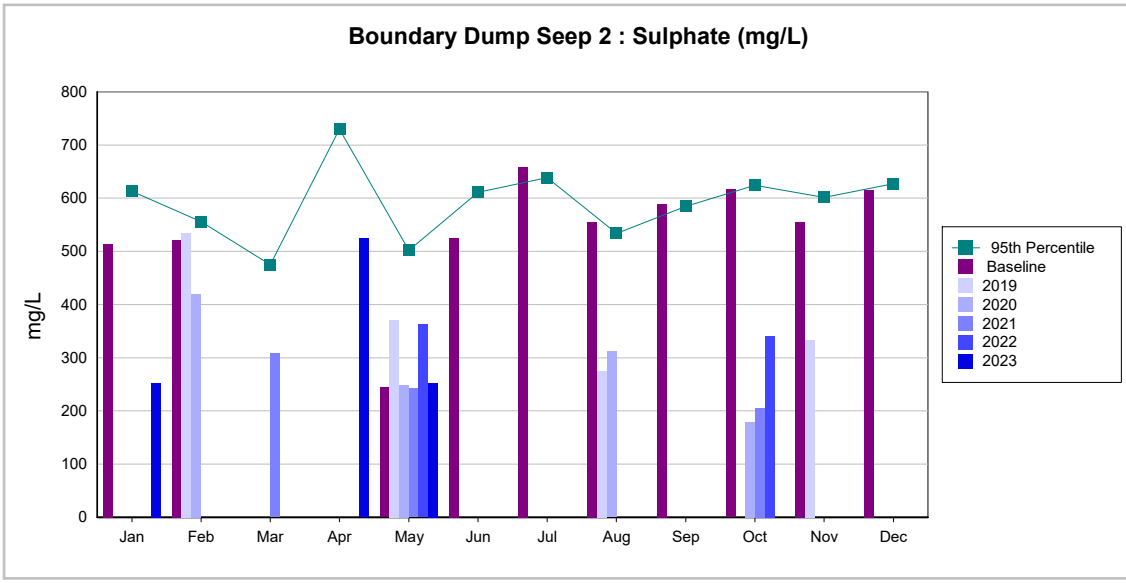
Water Quality Report

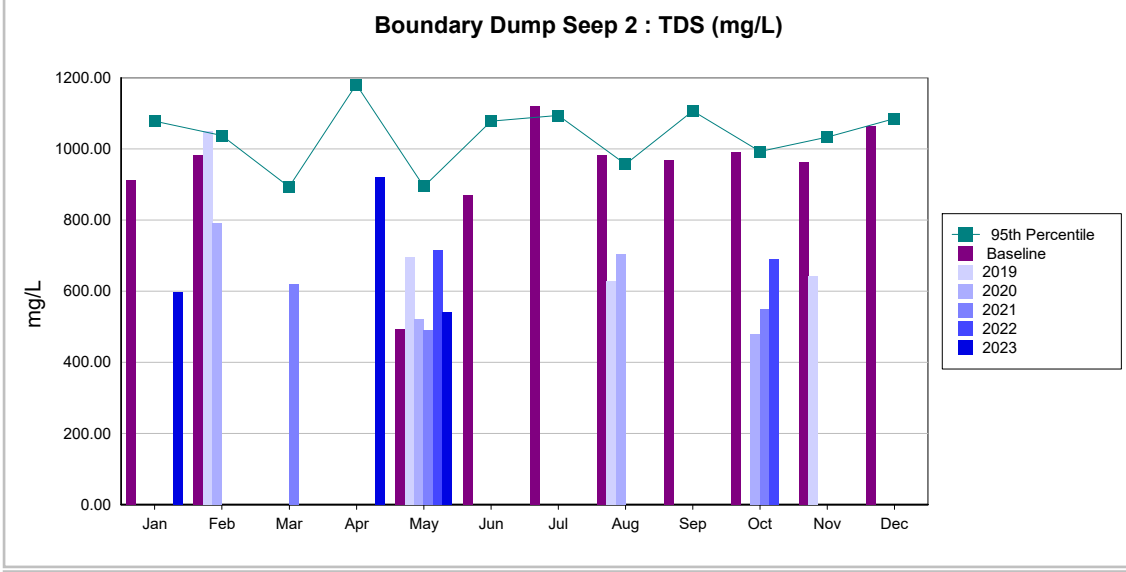
Annual Report Drainage Water

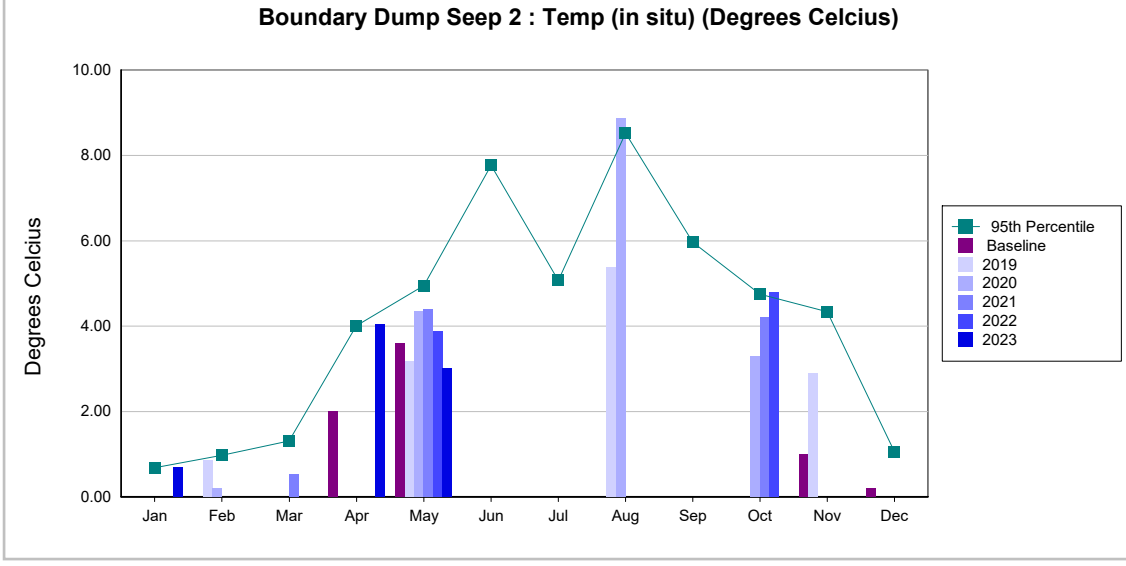
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

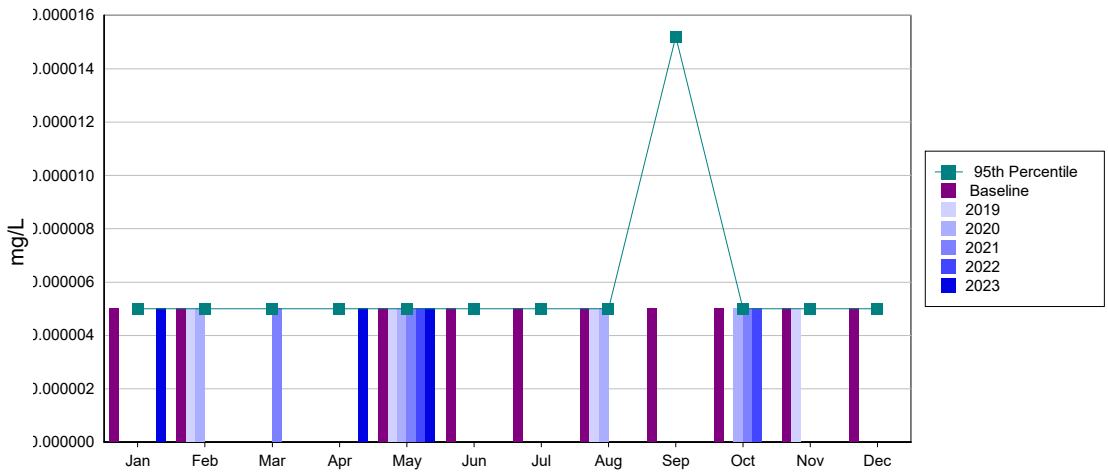
Annual Report Drainage Water

Mount Polley

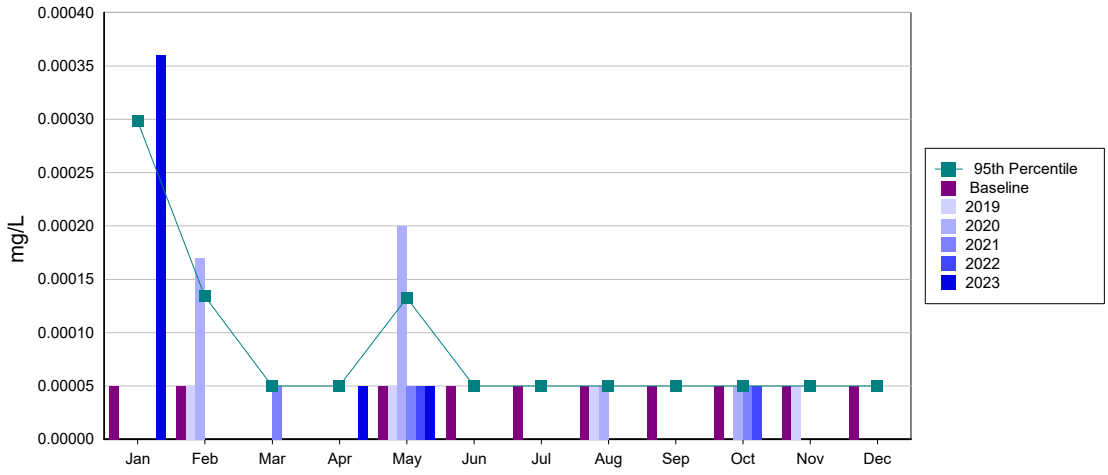
Mining Corporation

IMPERIAL METALS CORPORATION

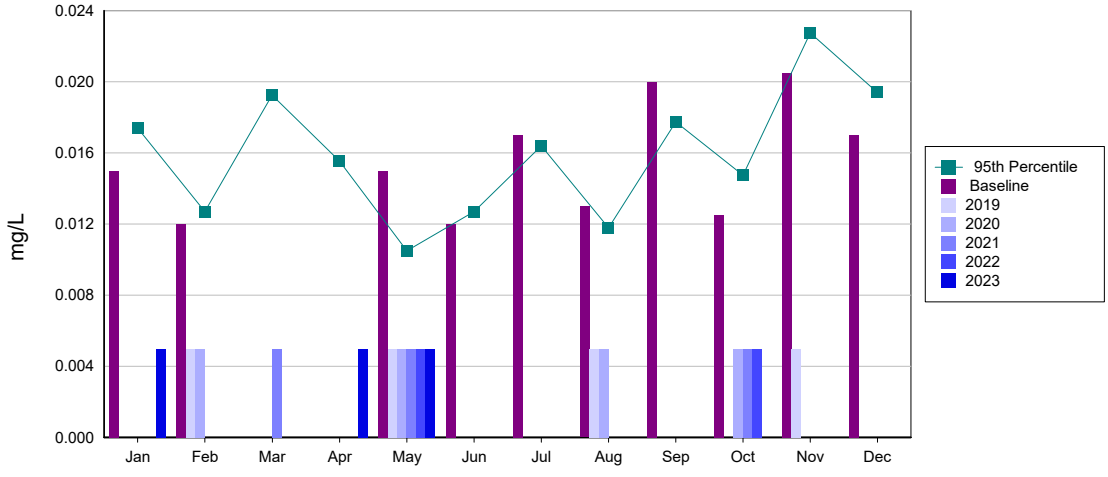
Boundary Dump Seep 2 : Thallium (Tl)-Total (mg/L)



Boundary Dump Seep 2 : Tin (Sn)-Total (mg/L)



Boundary Dump Seep 2 : Titanium (Ti)-Total (mg/L)



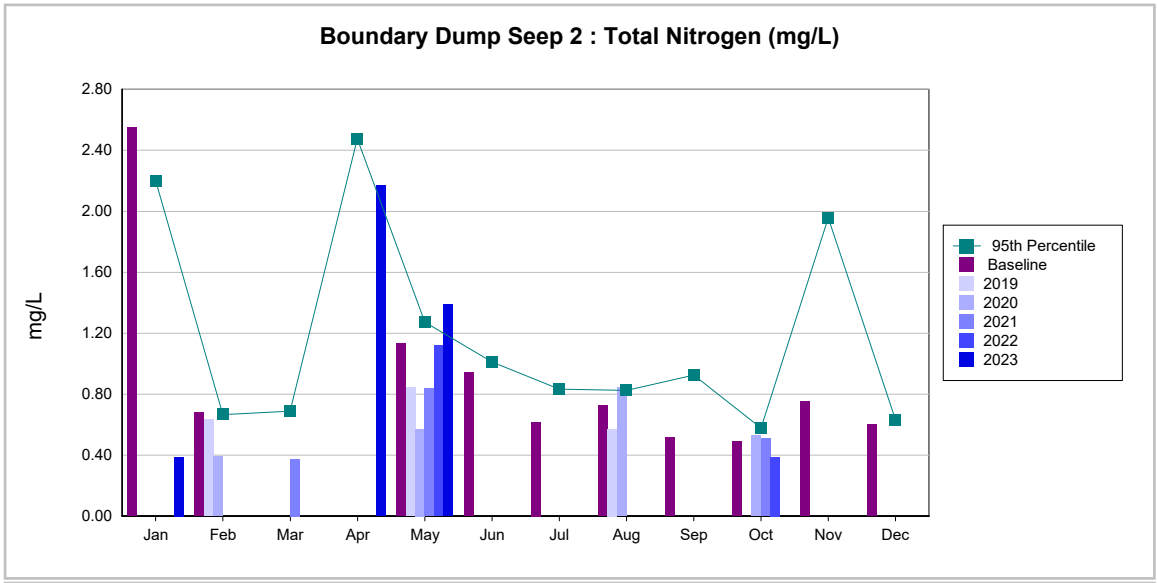
Water Quality Report

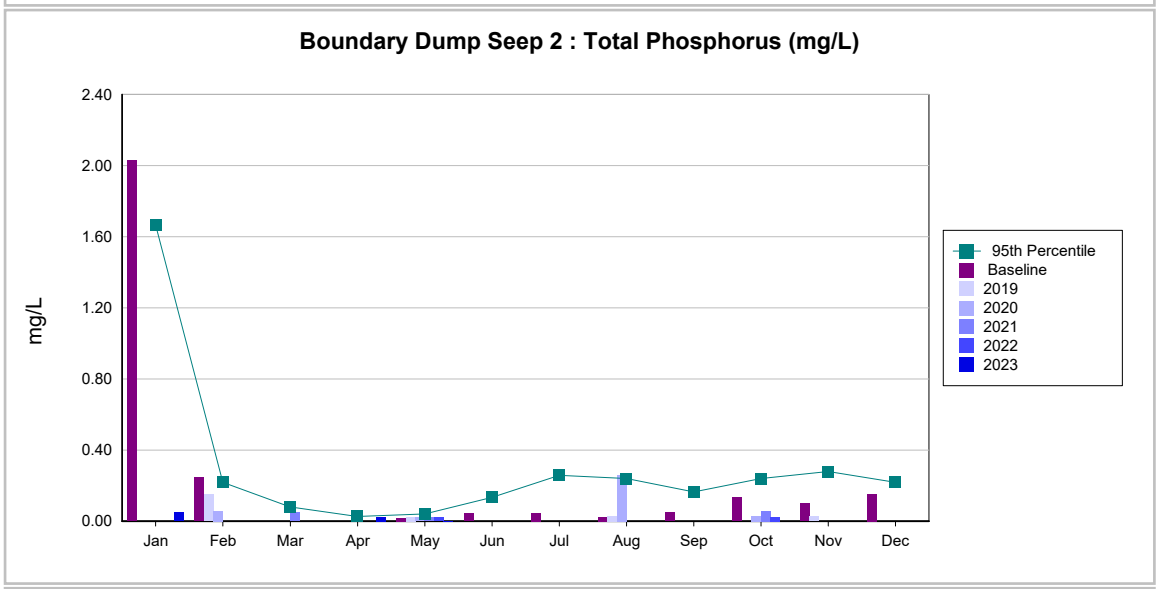
Annual Report Drainage Water

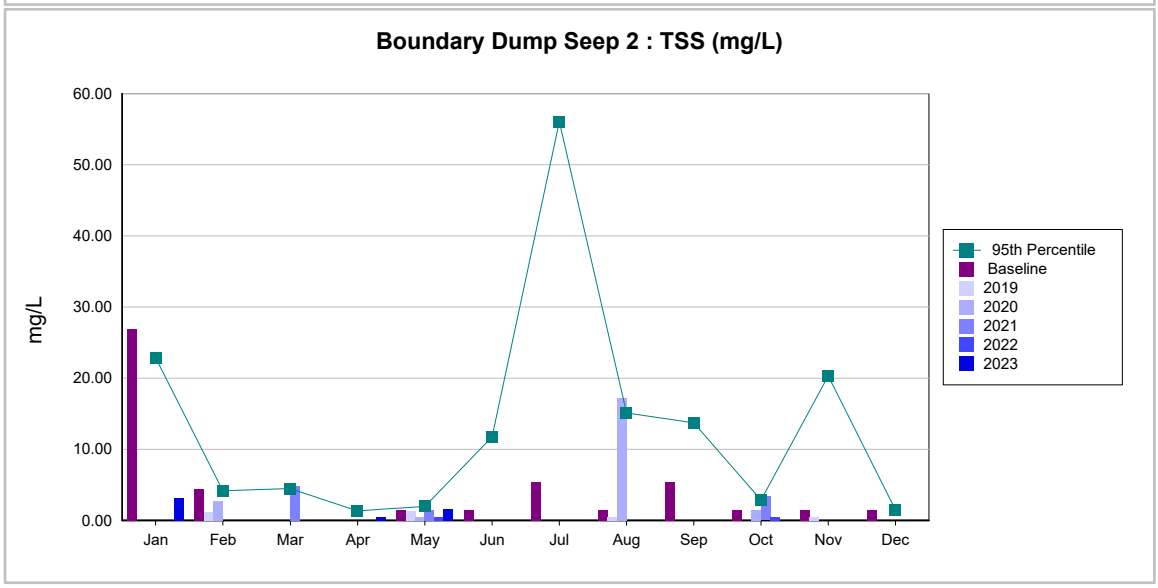
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







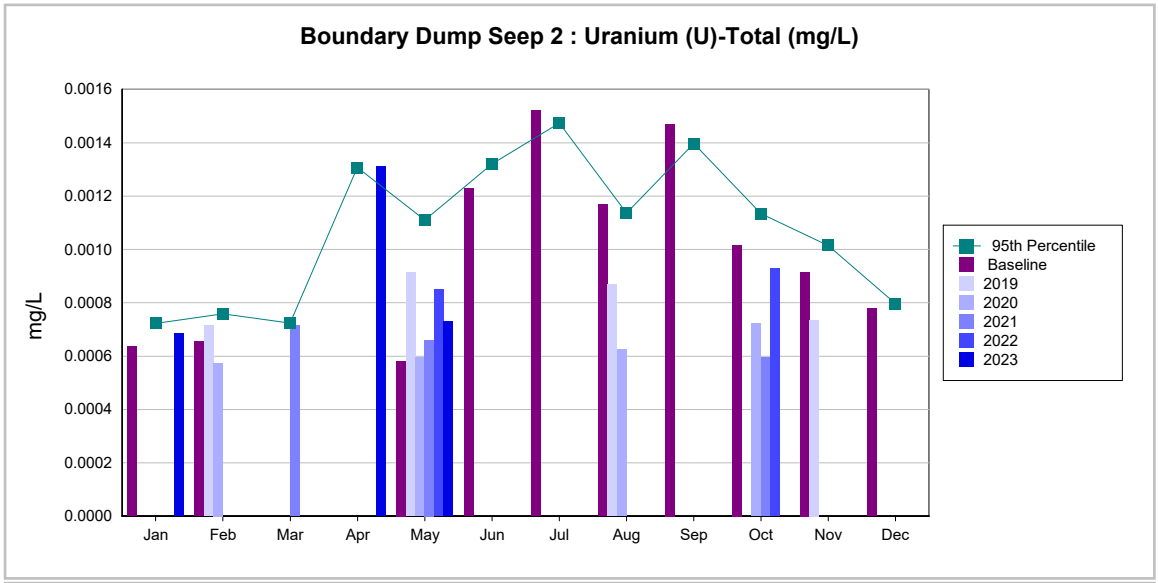
Water Quality Report

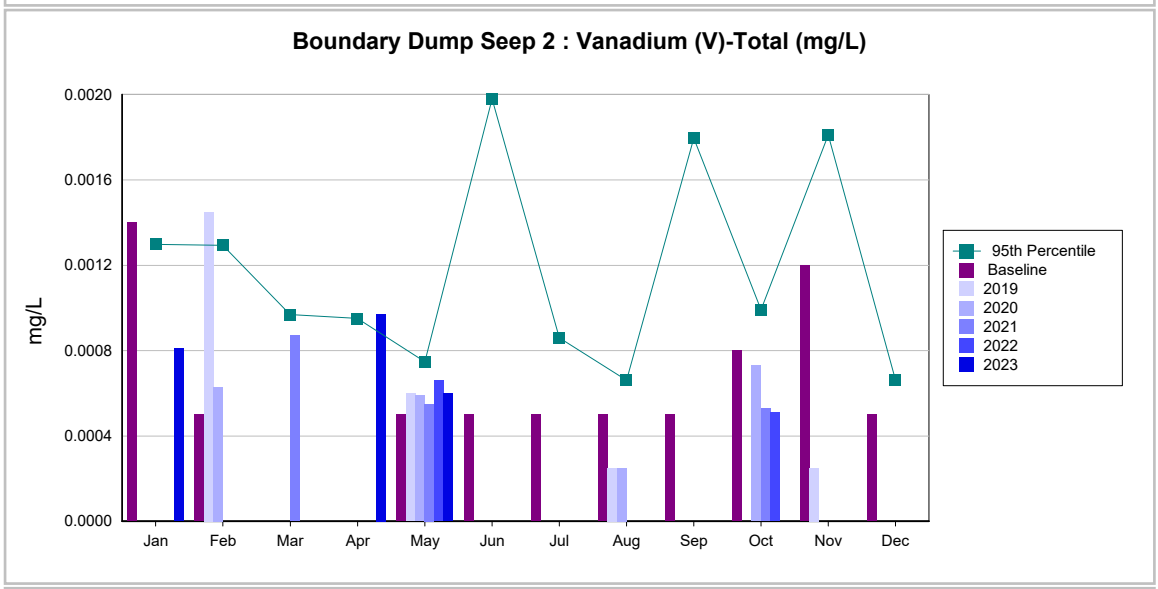
Annual Report Drainage Water

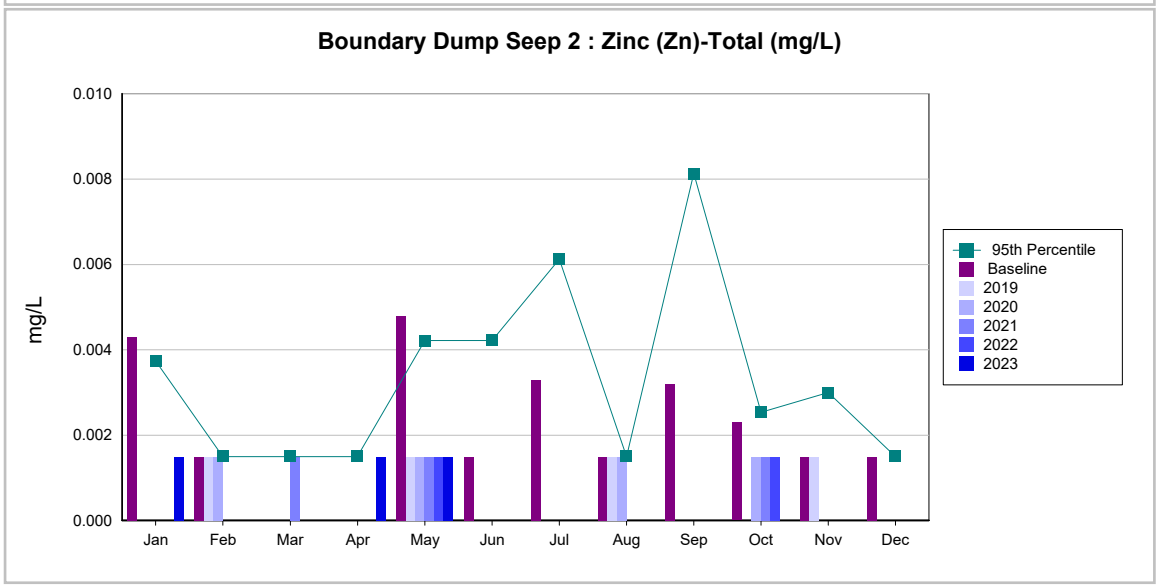
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







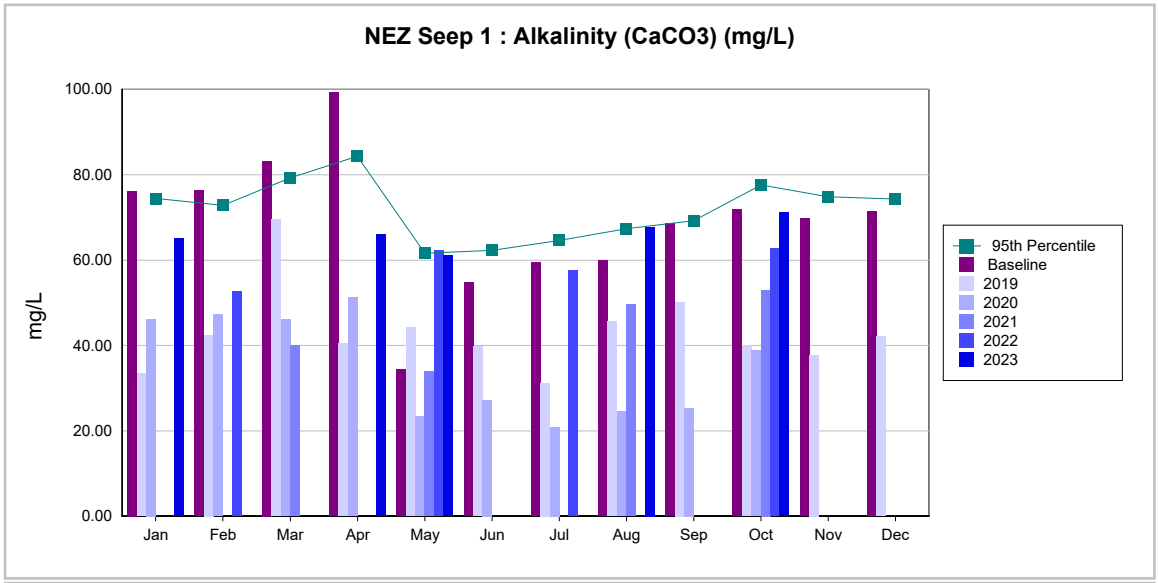
Water Quality Report

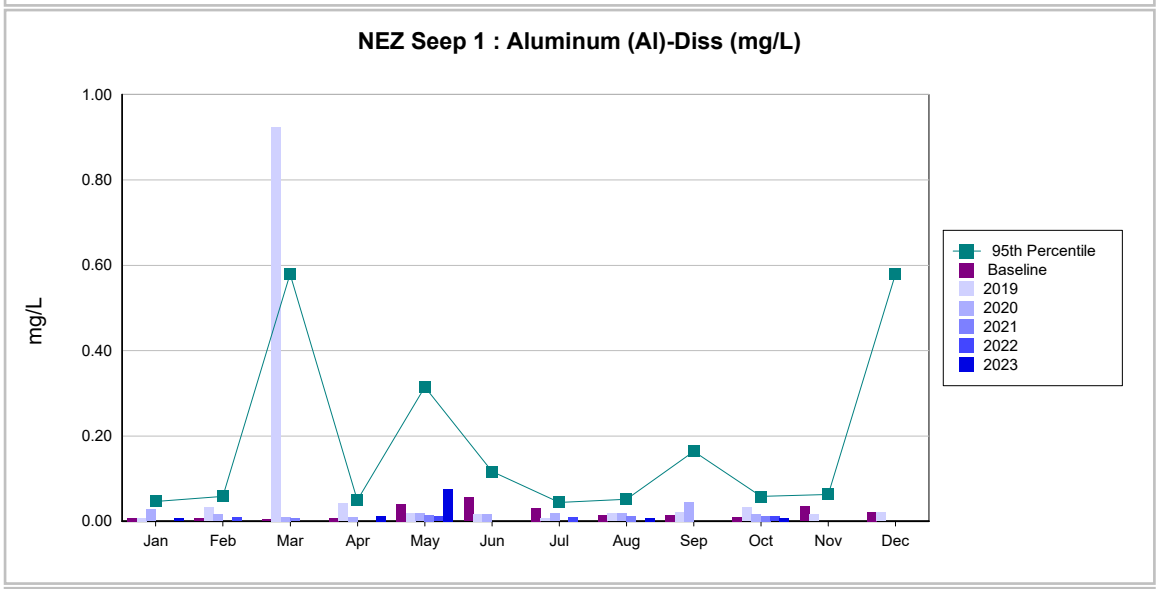
Annual Report Drainage Water

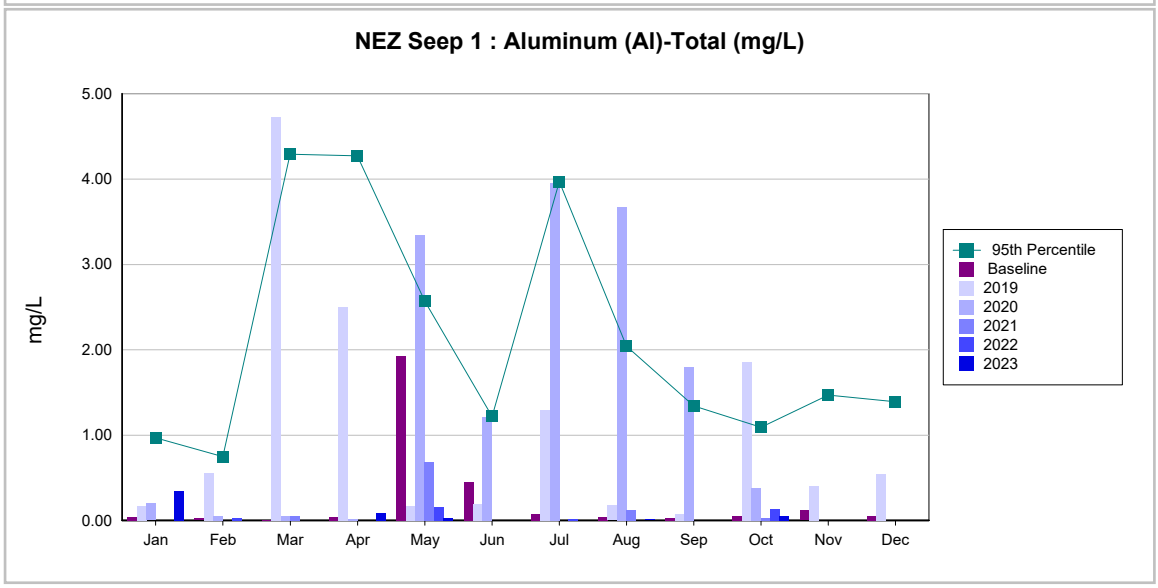
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







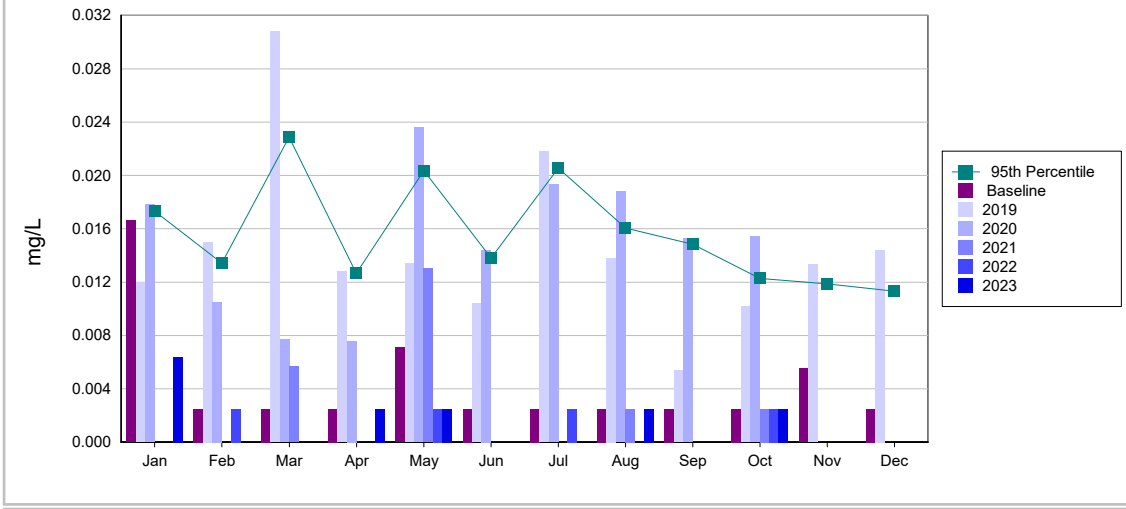
Water Quality Report

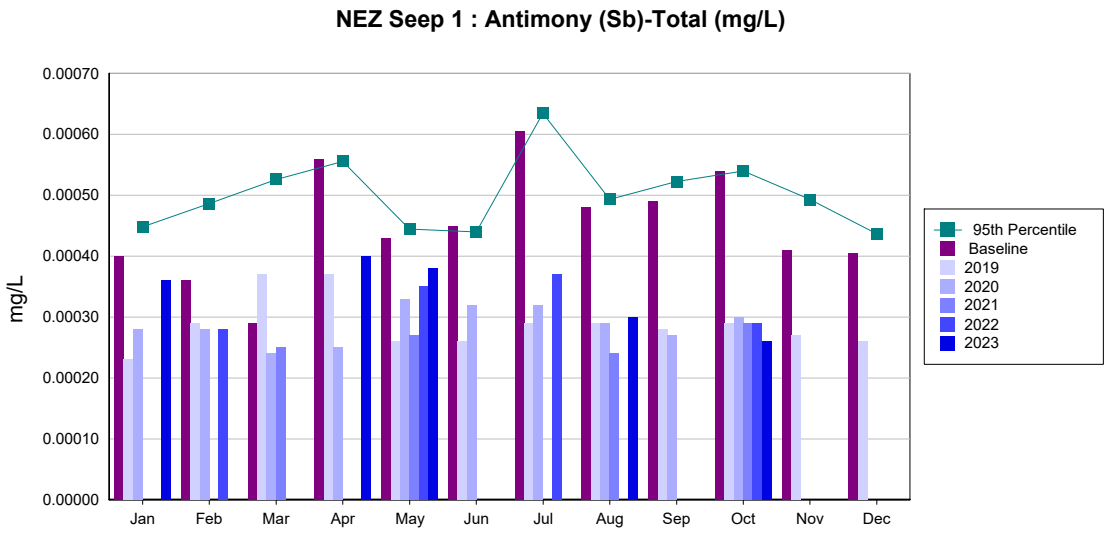
Annual Report Drainage Water

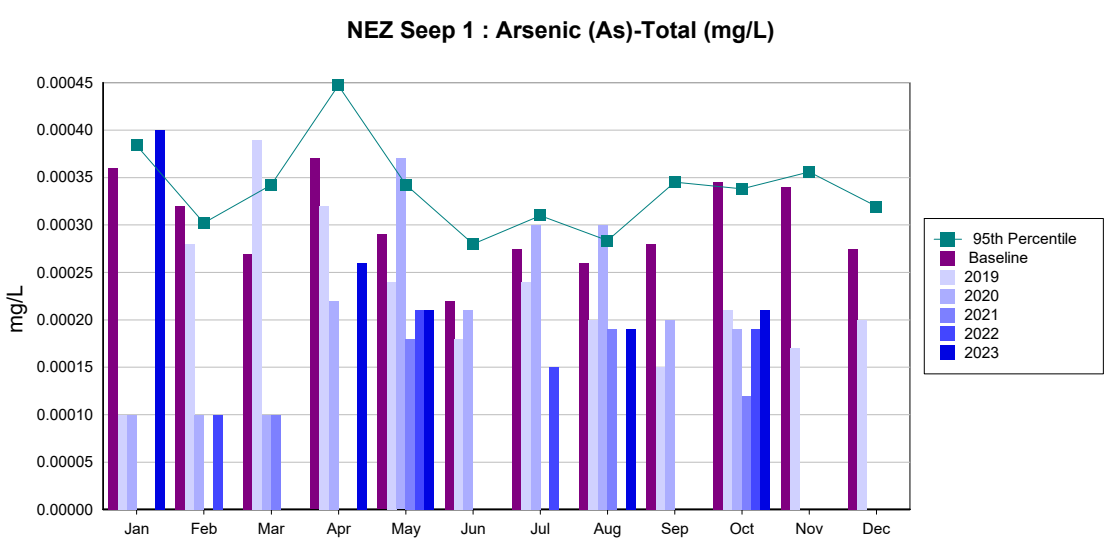
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







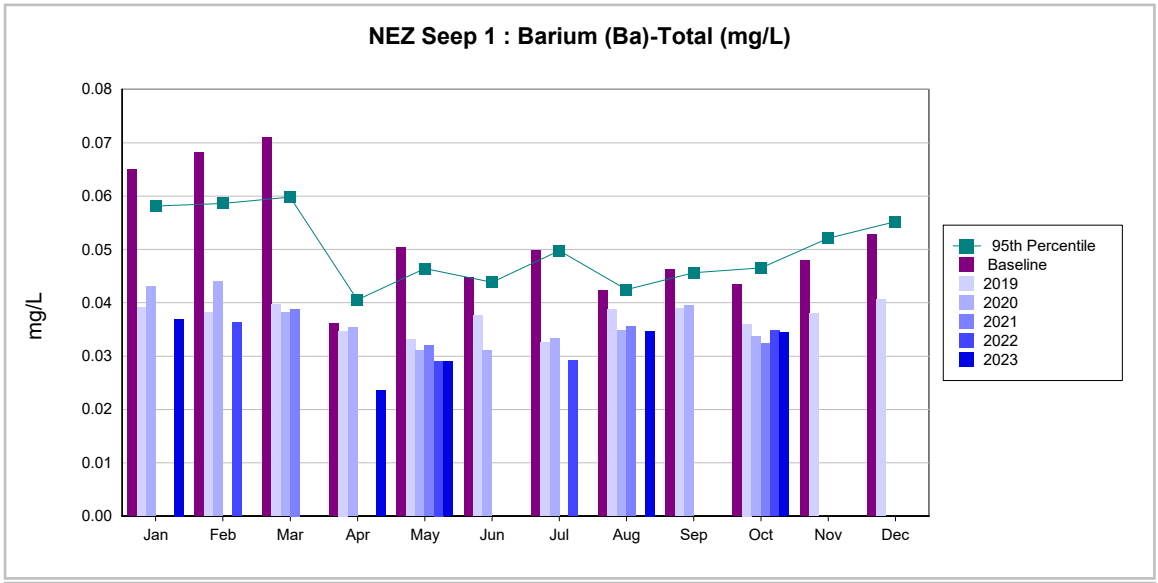
Water Quality Report

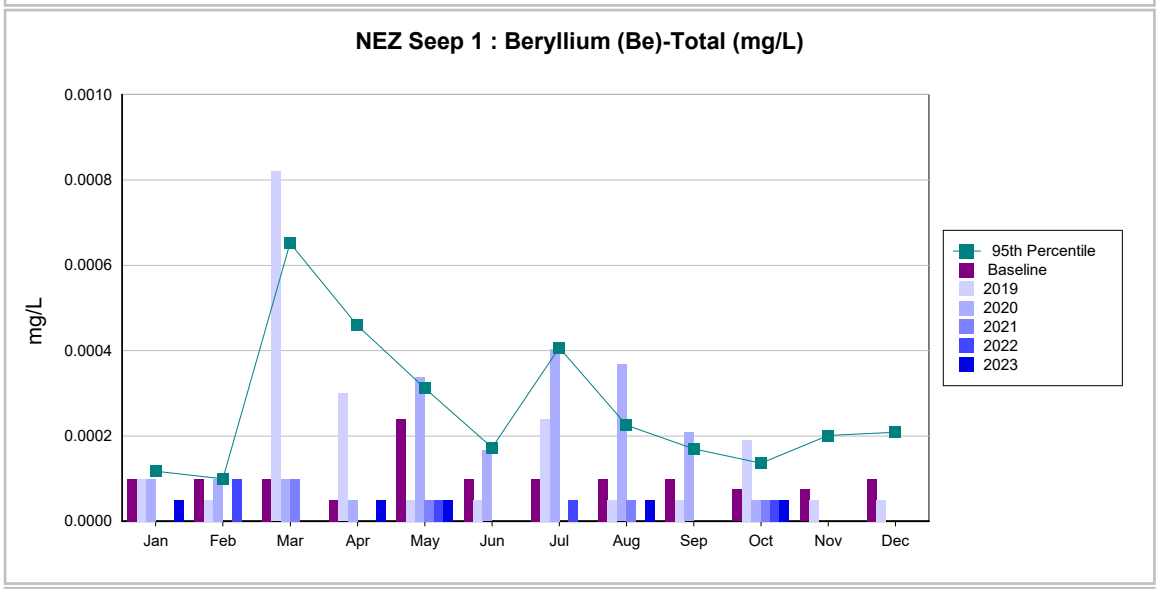
Annual Report Drainage Water

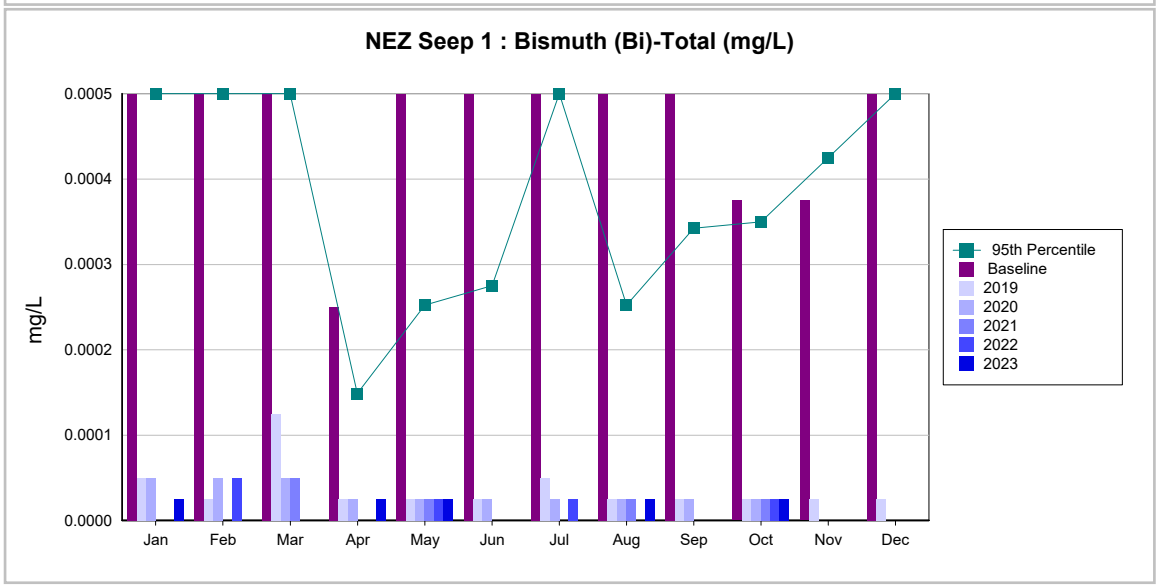
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







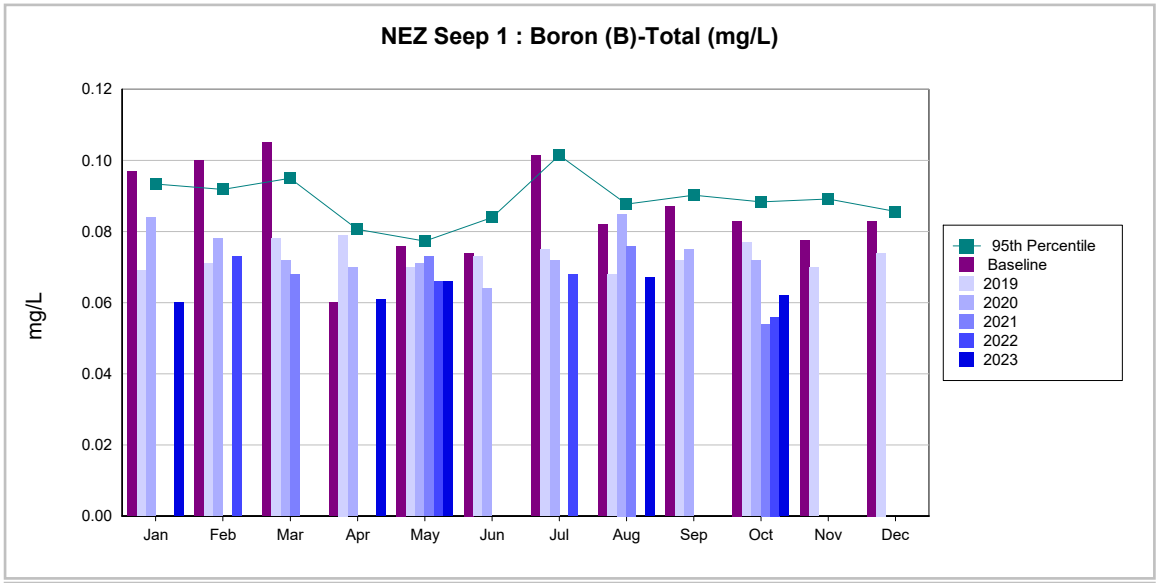
Water Quality Report

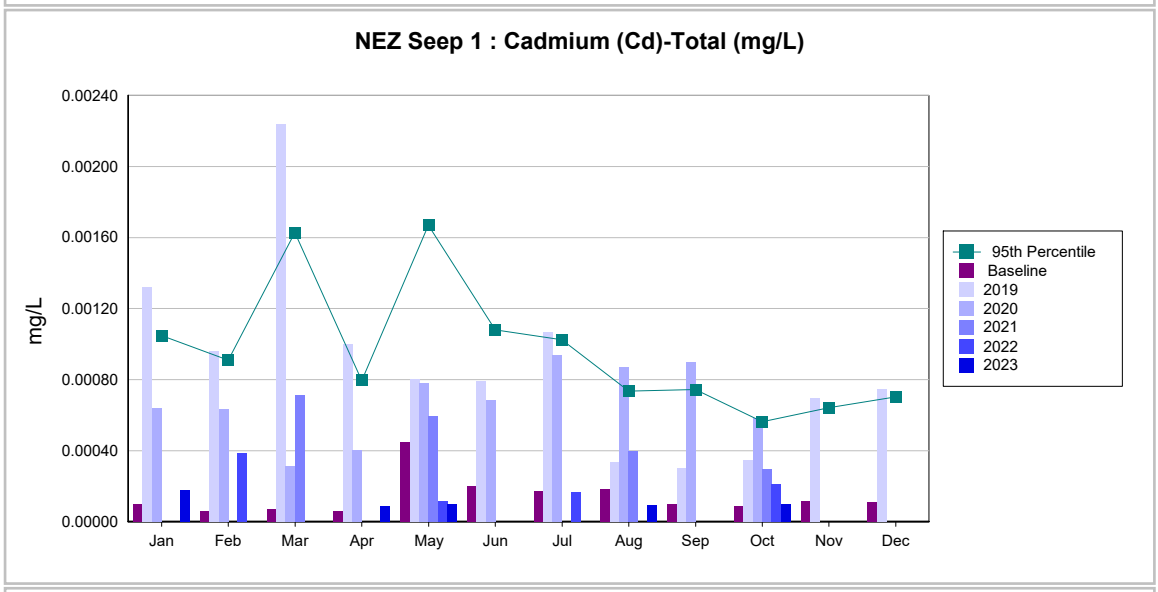
Annual Report Drainage Water

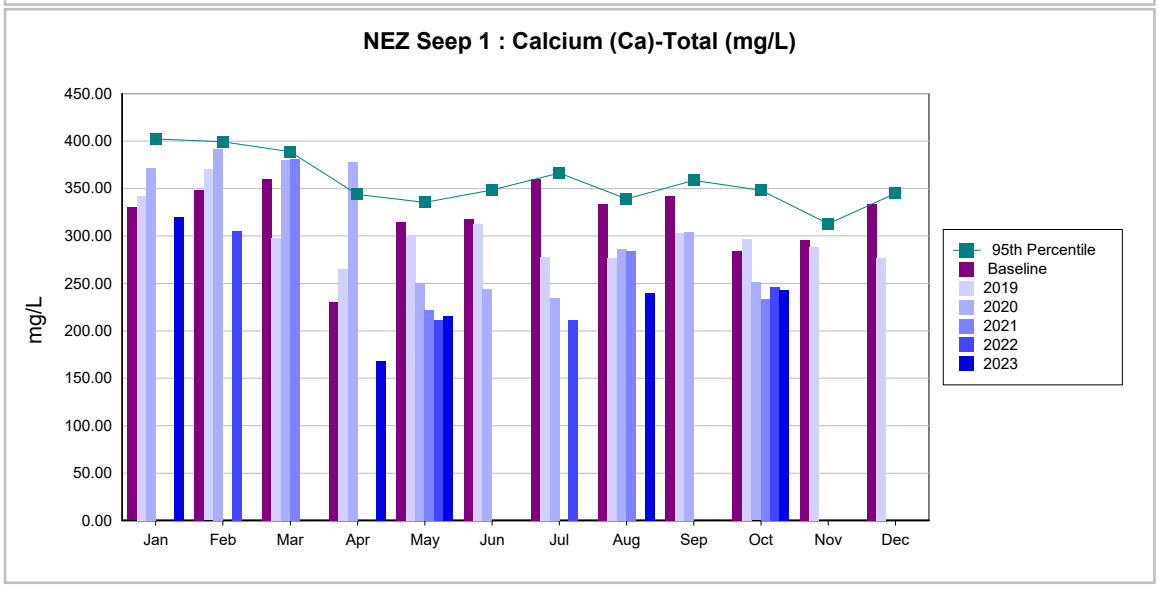
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







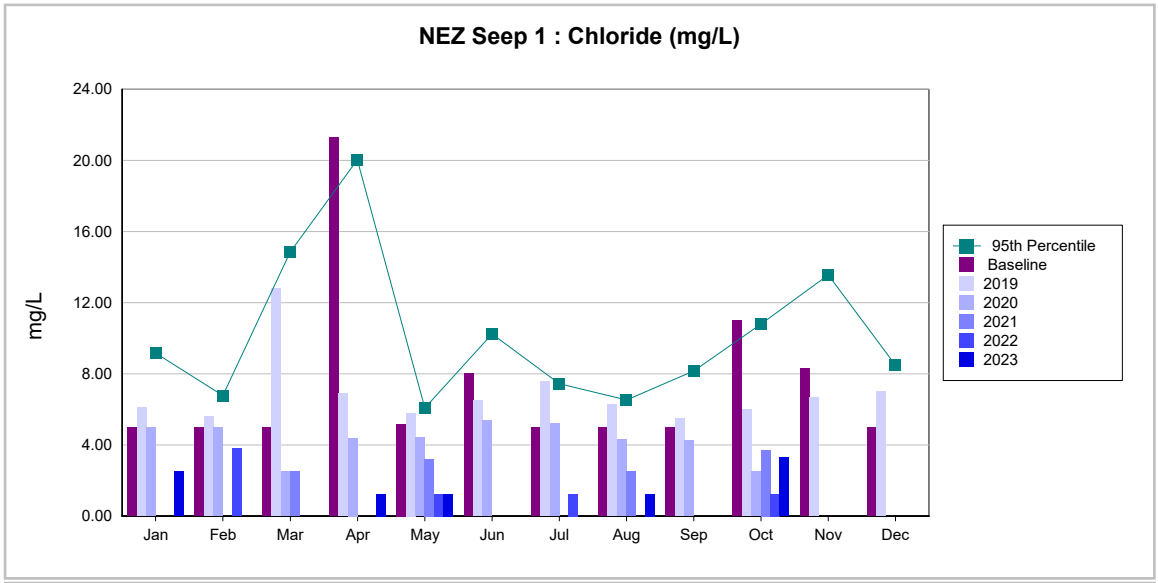
Water Quality Report

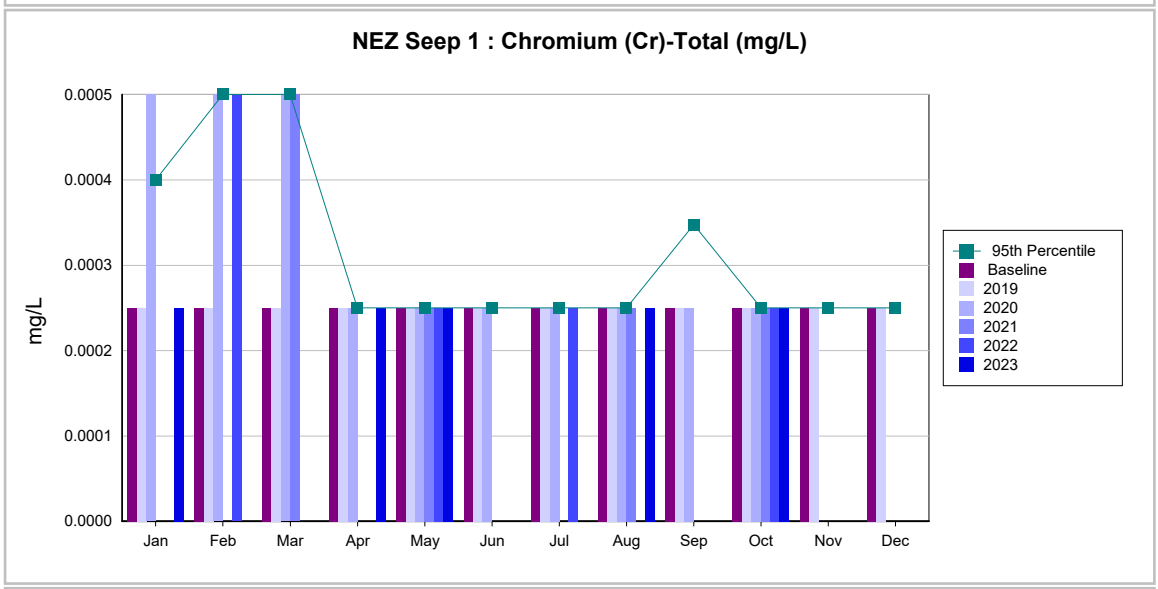
Annual Report Drainage Water

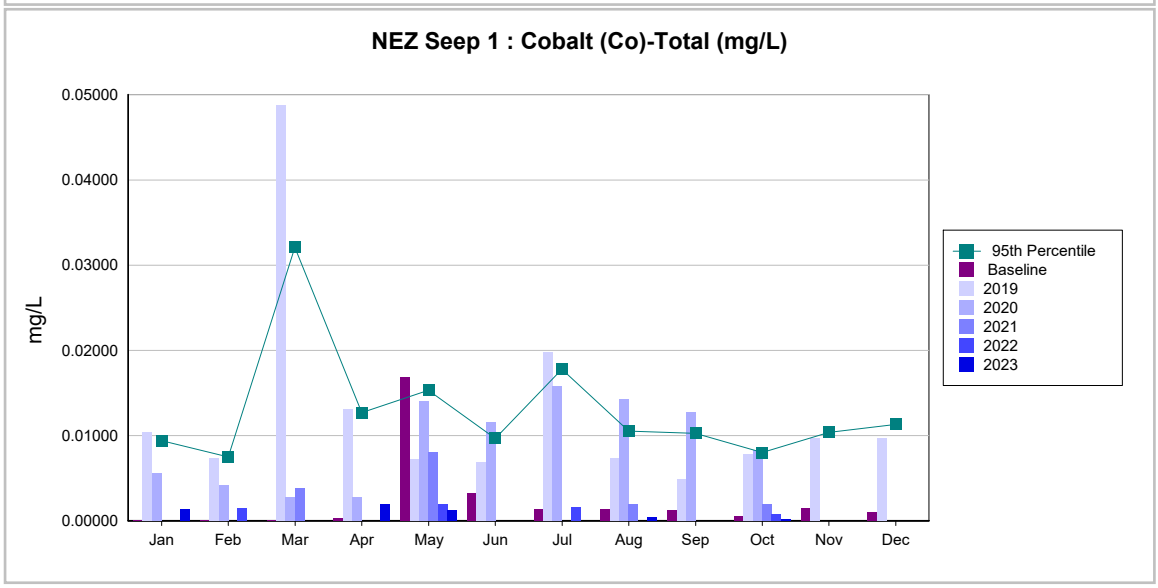
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







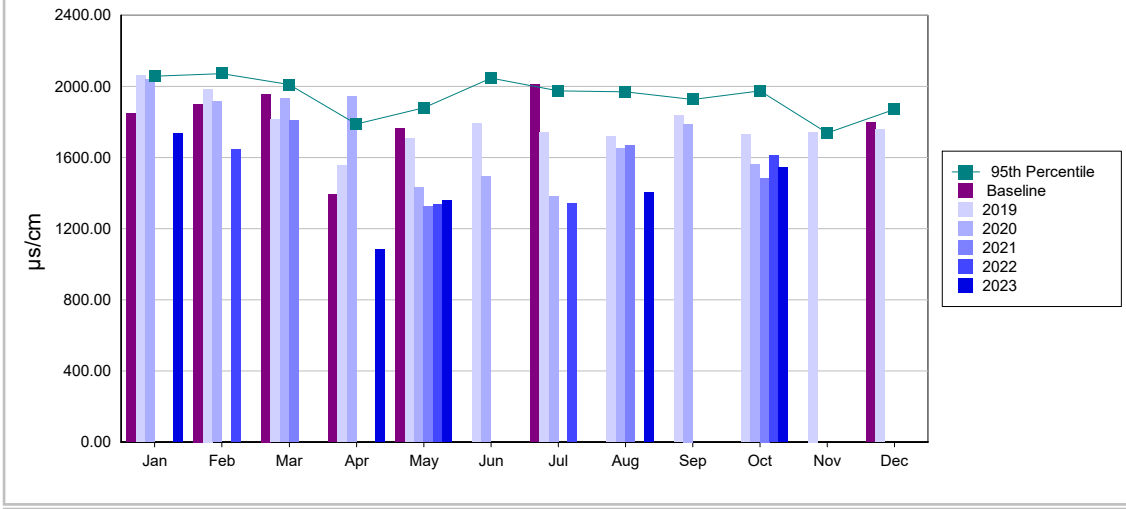
Water Quality Report

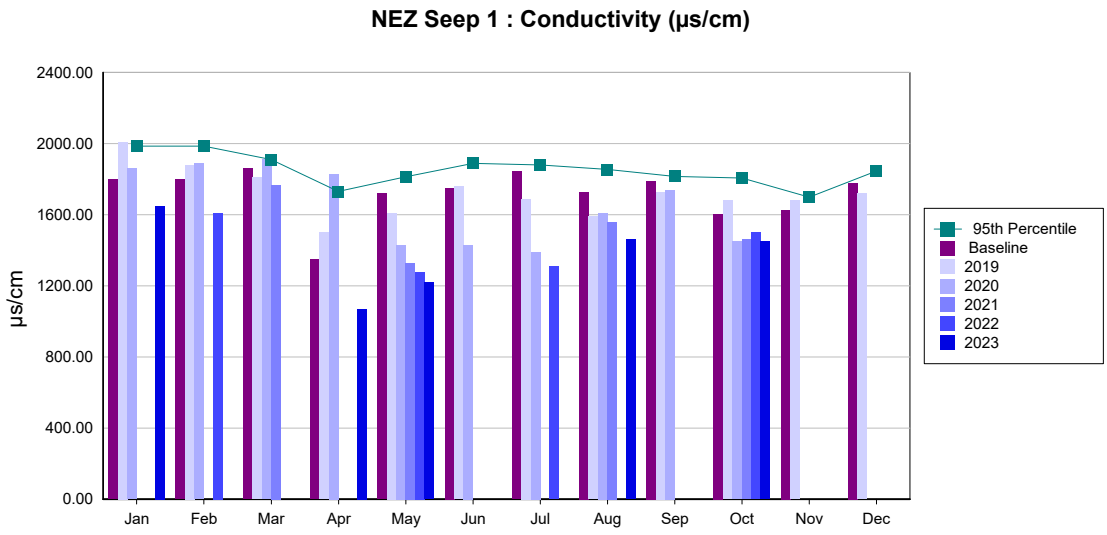
Annual Report Drainage Water

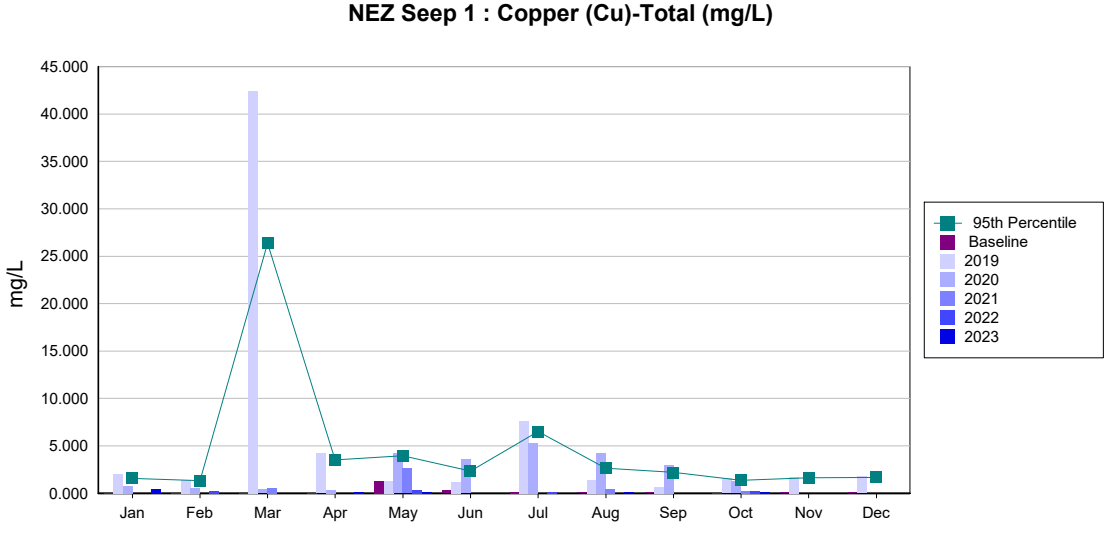
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







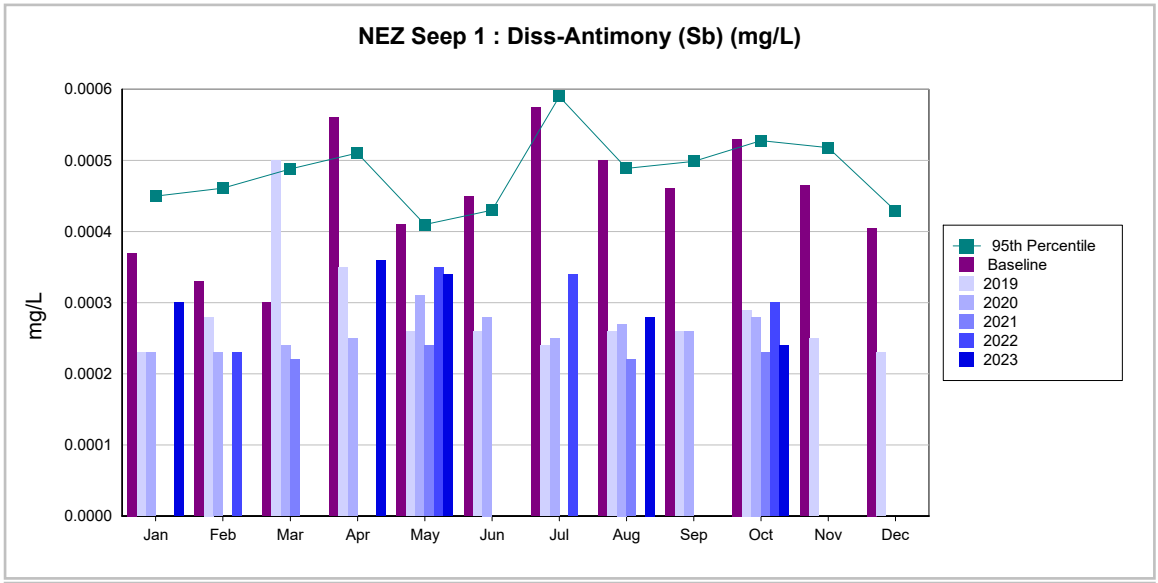
Water Quality Report

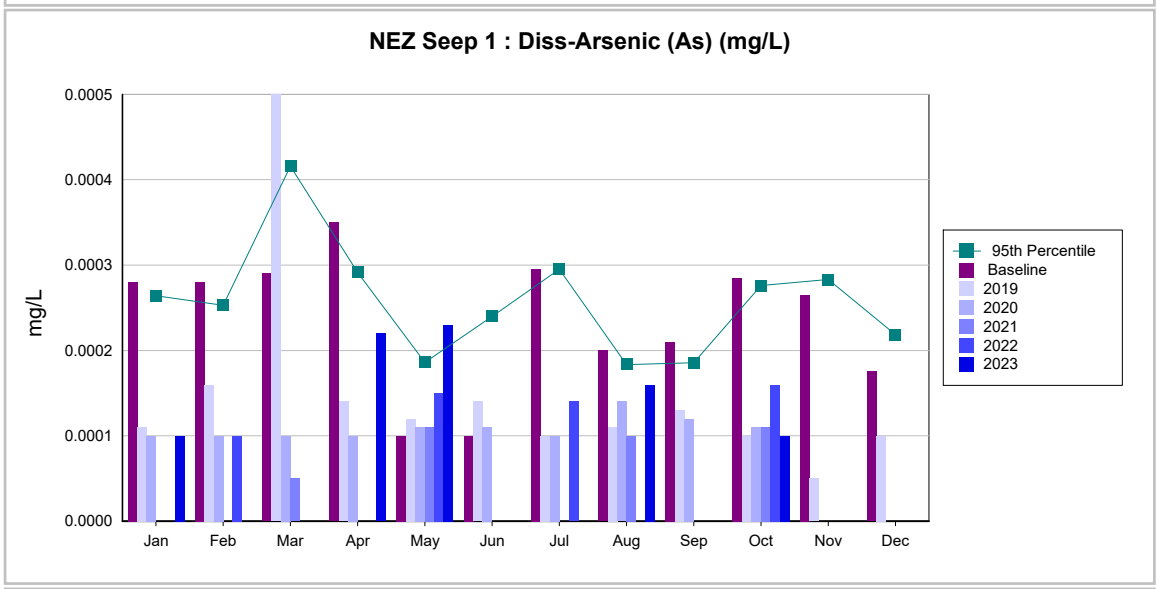
Annual Report Drainage Water

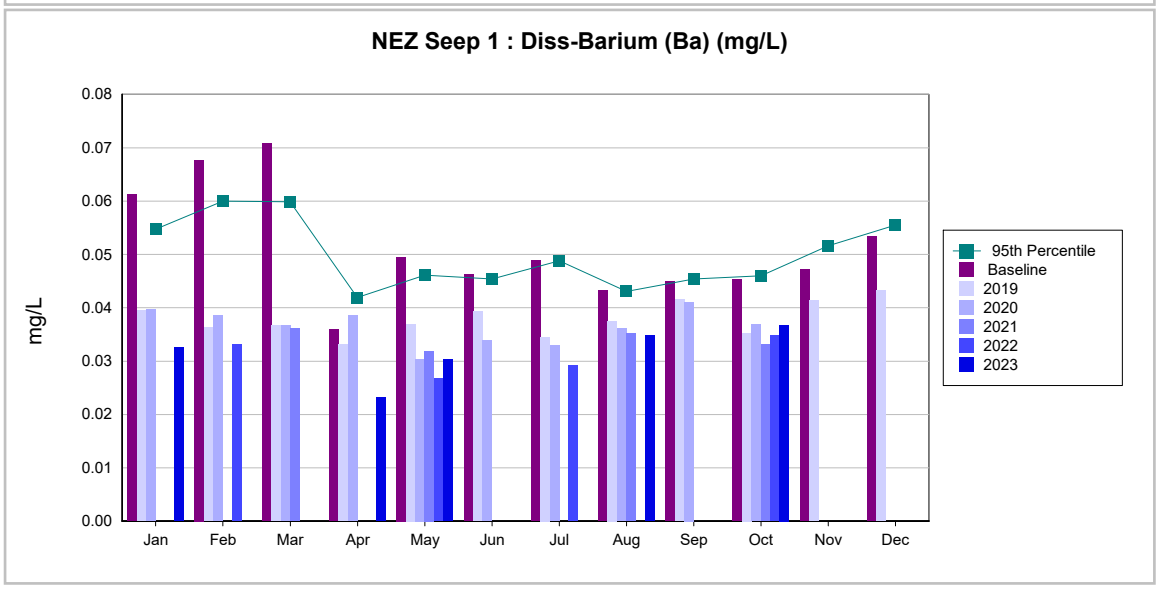
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







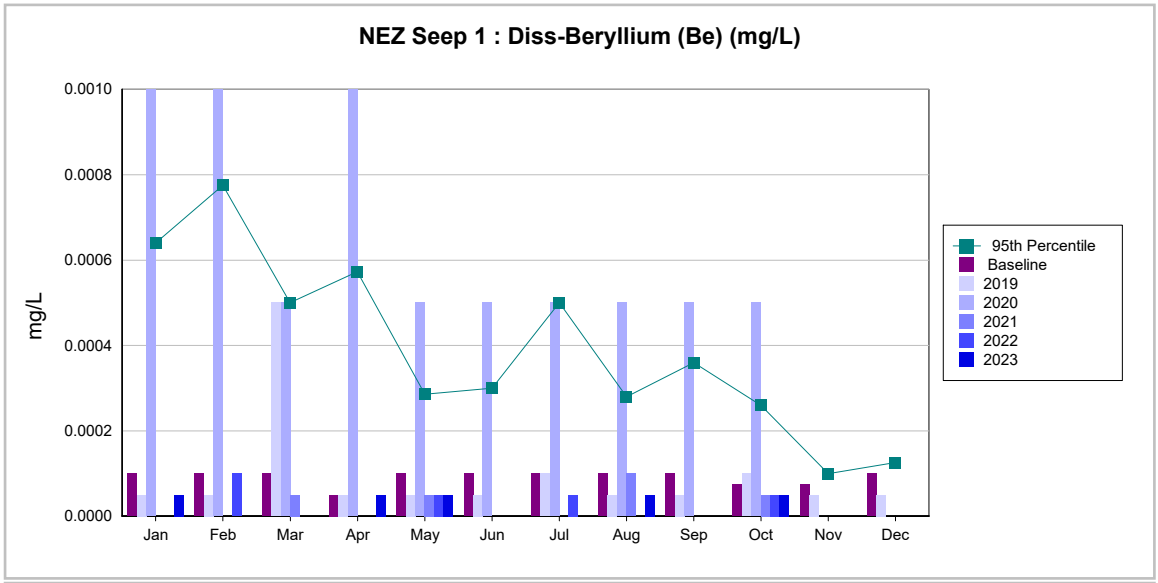
Water Quality Report

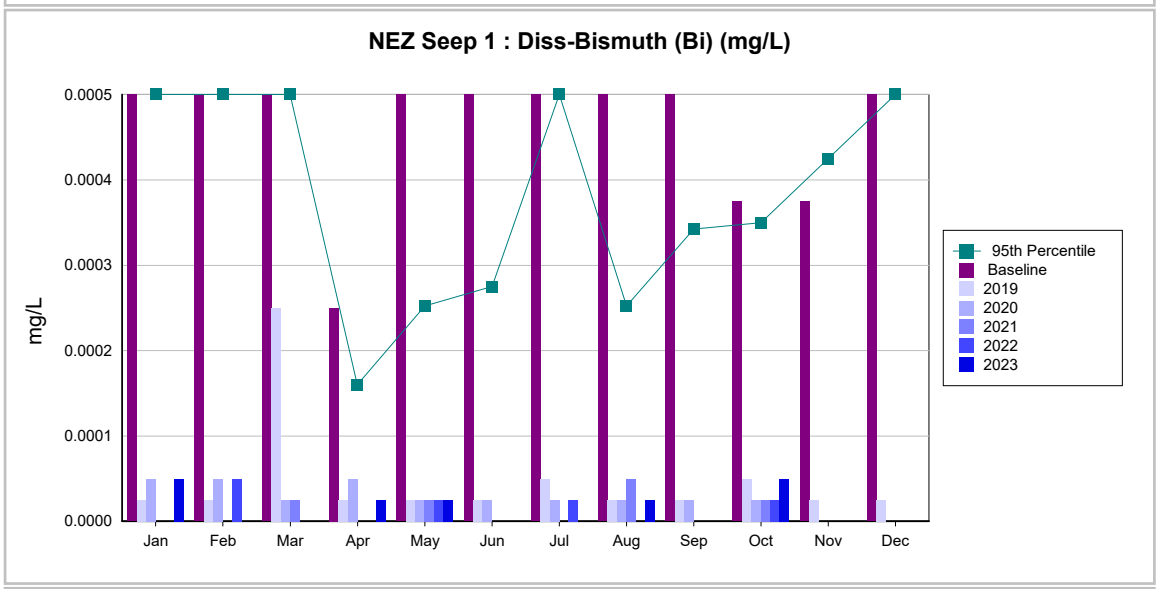
Annual Report Drainage Water

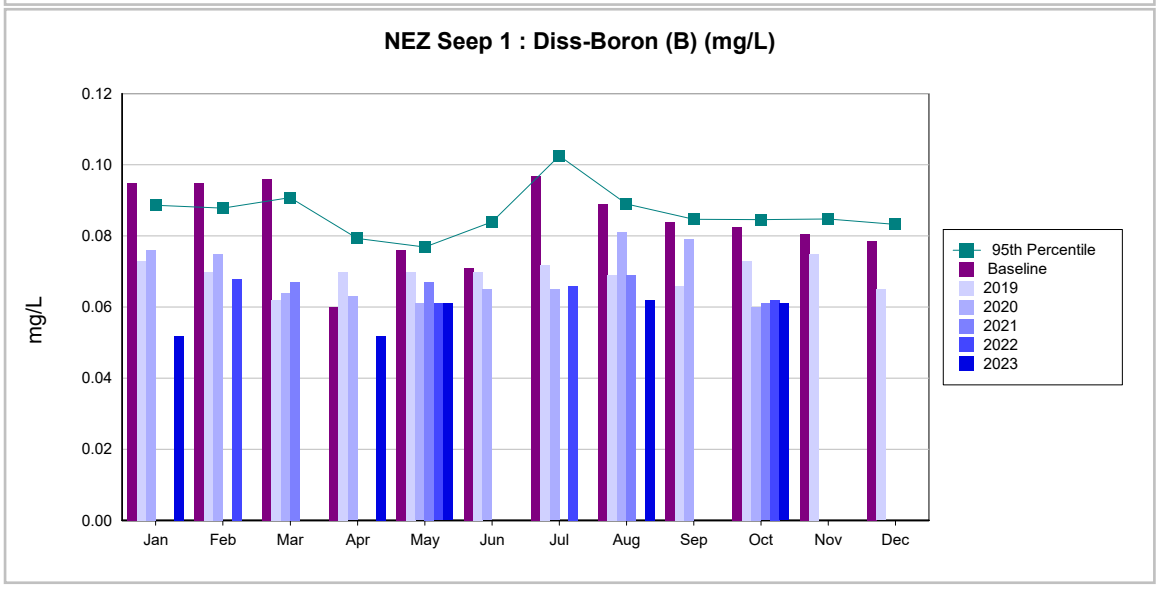
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







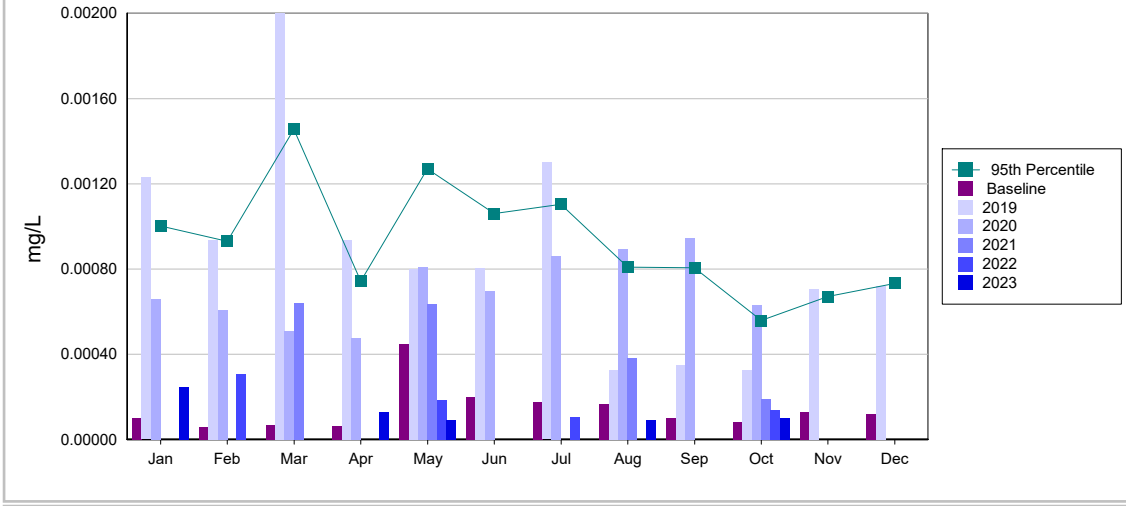
Water Quality Report

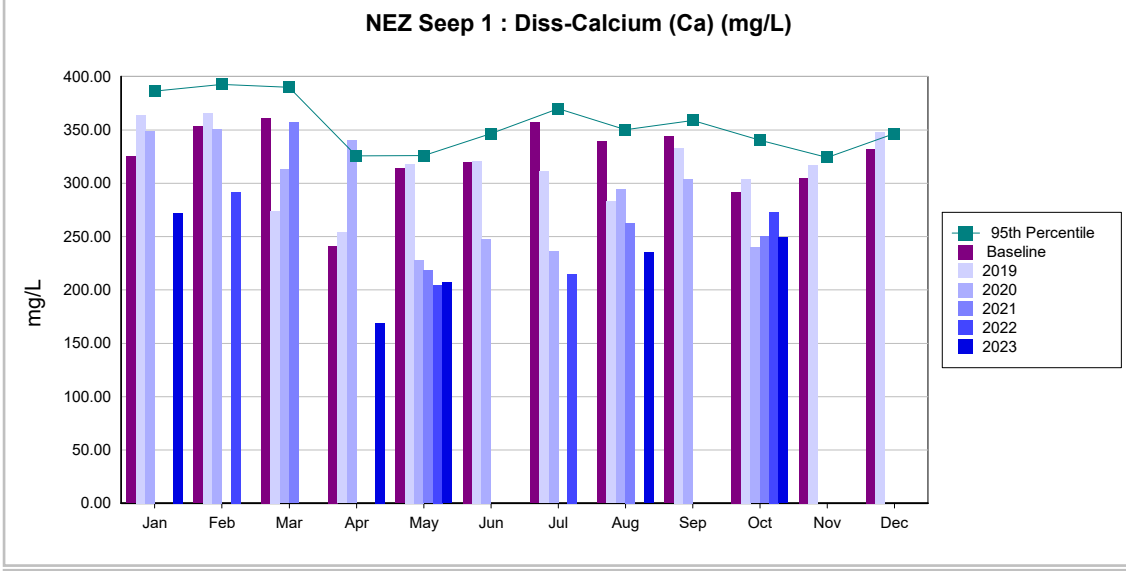
Annual Report Drainage Water

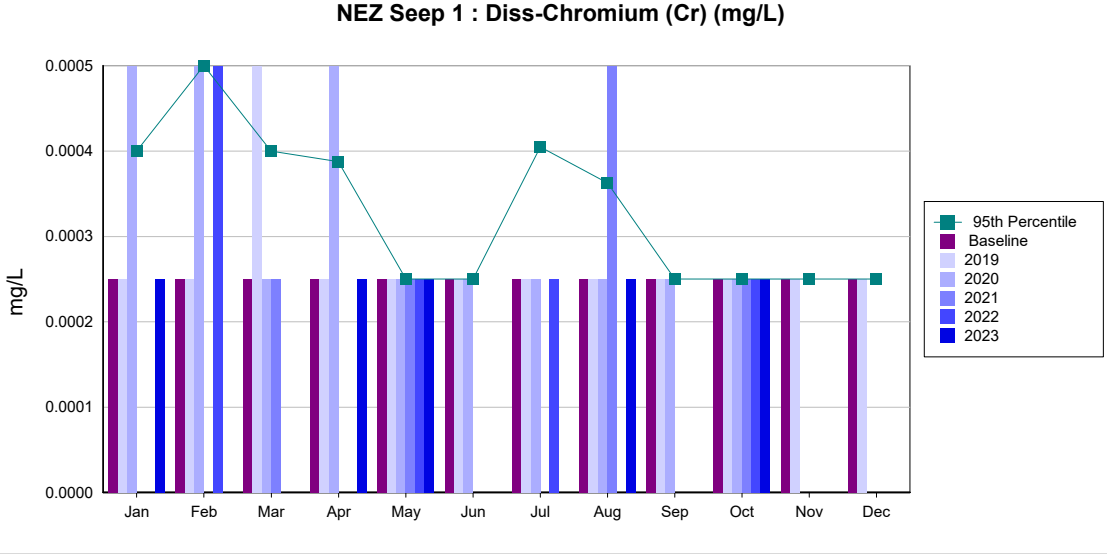
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







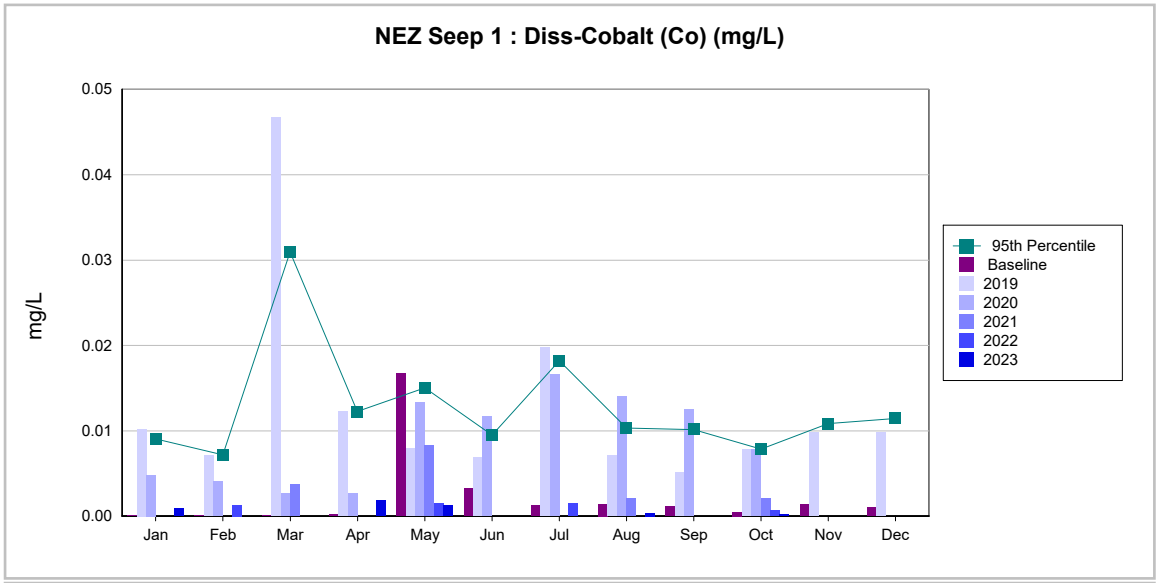
Water Quality Report

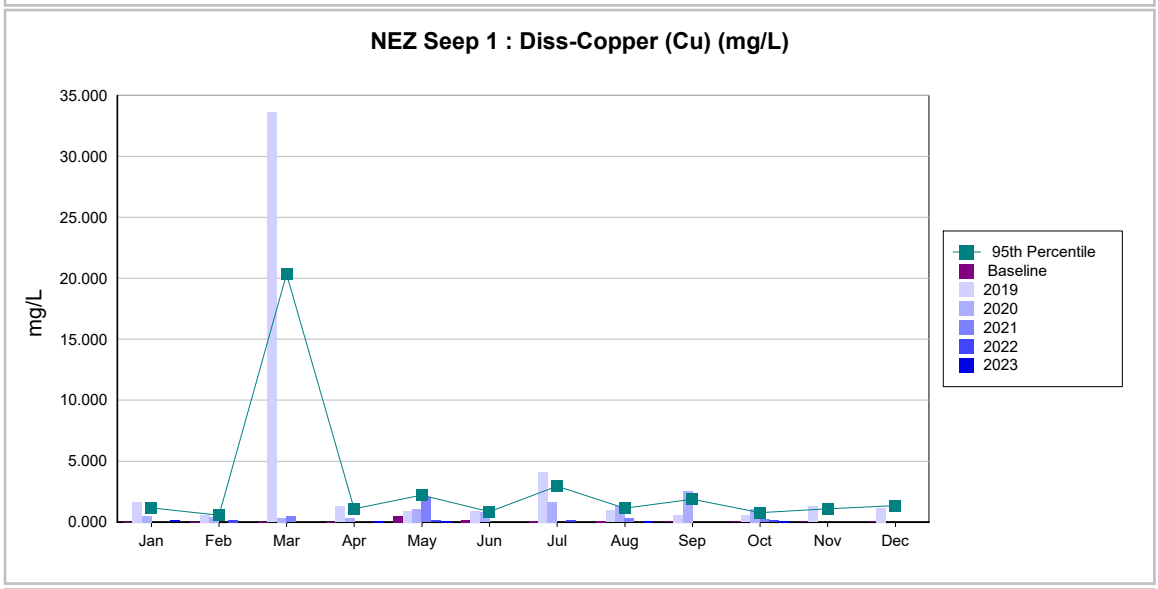
Annual Report Drainage Water

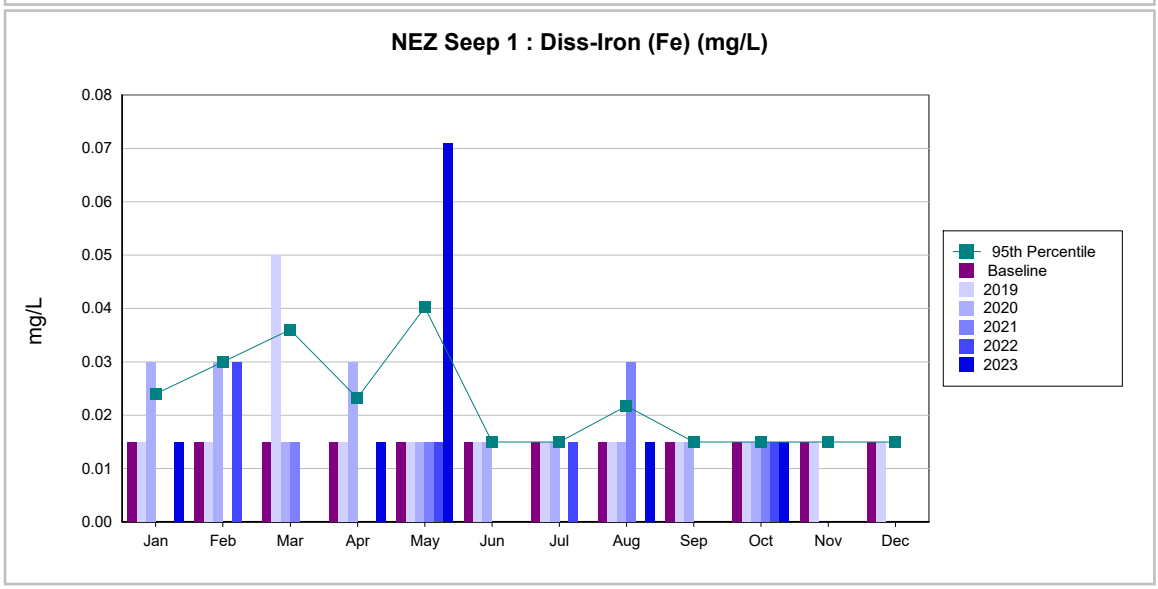
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







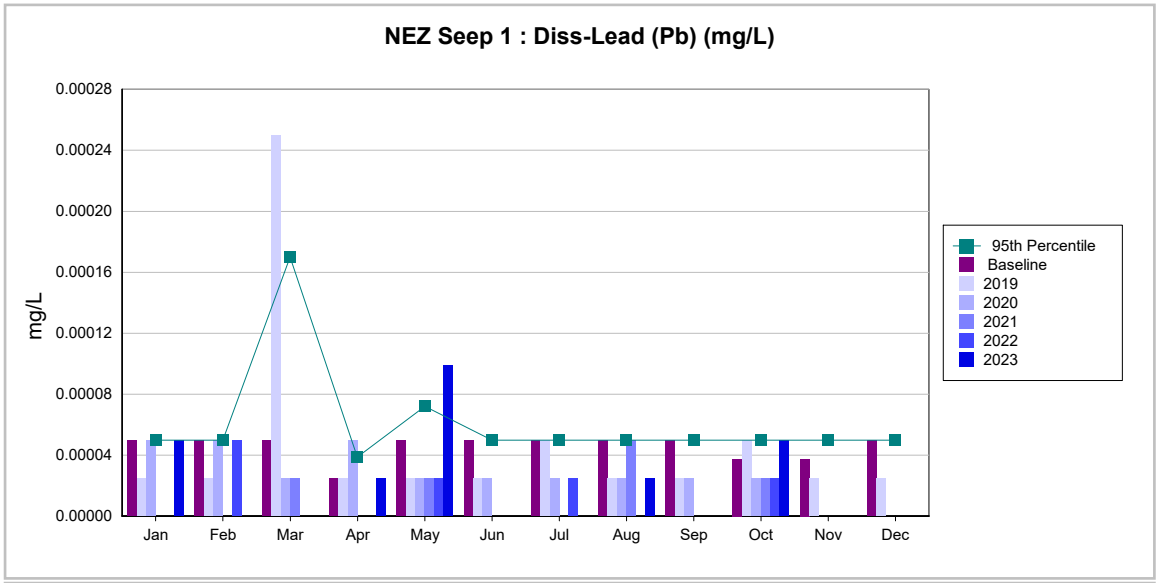
Water Quality Report

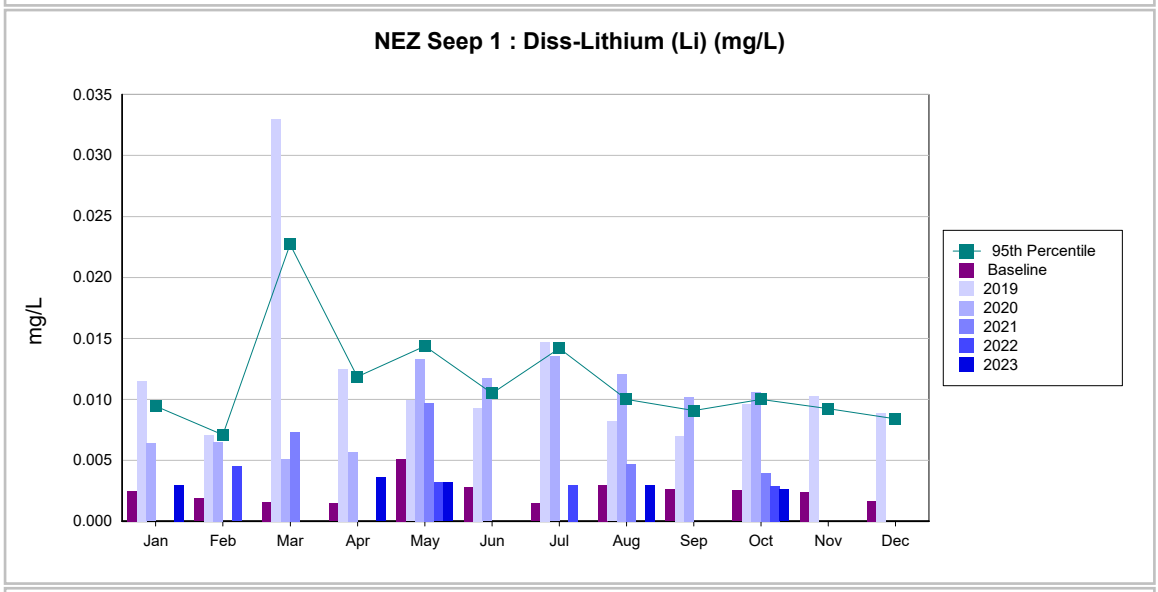
Annual Report Drainage Water

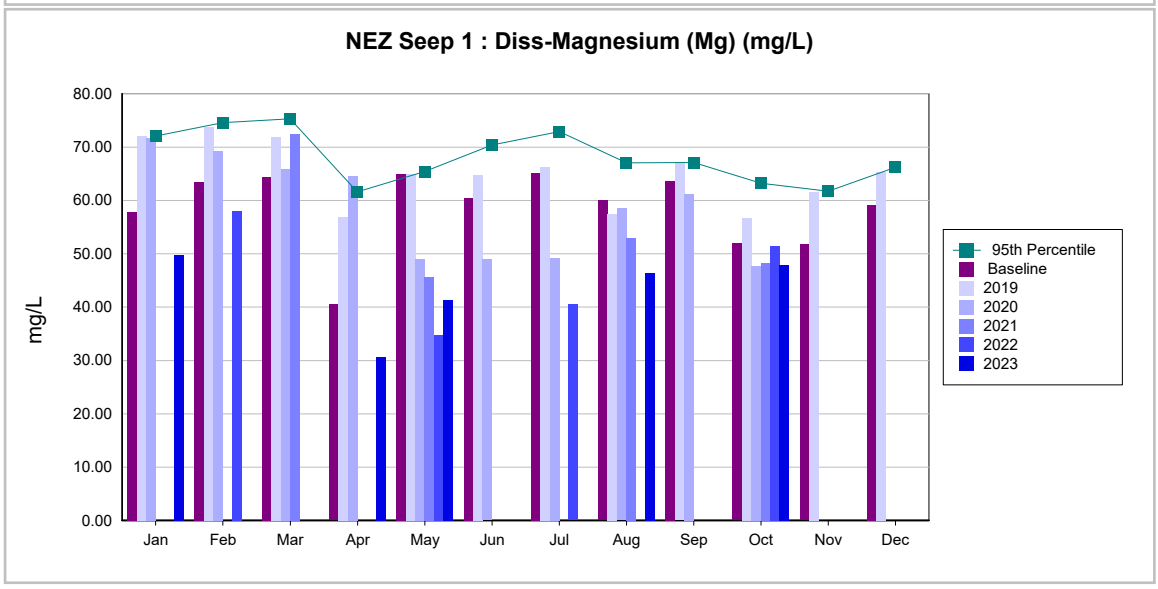
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







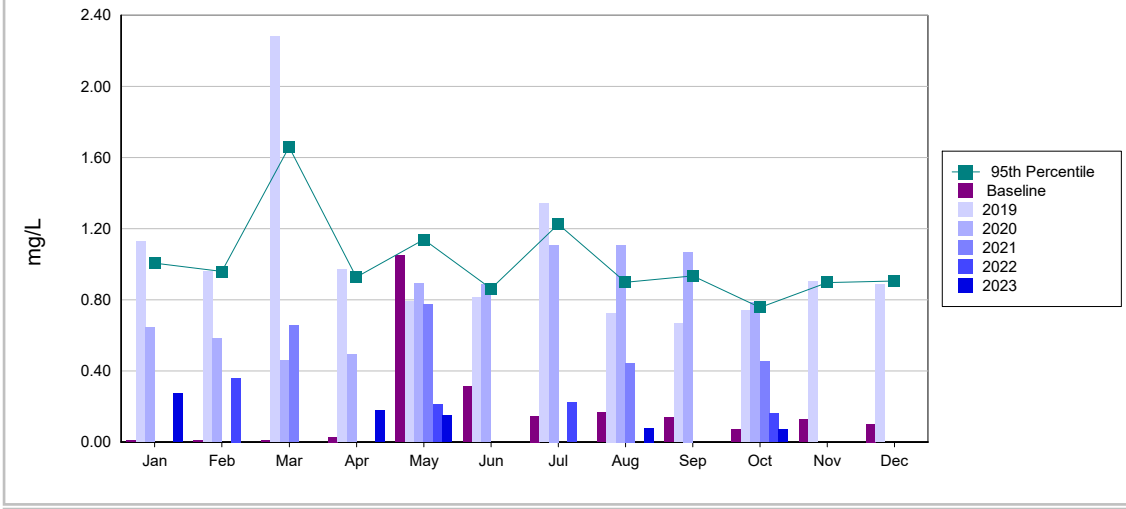
Water Quality Report

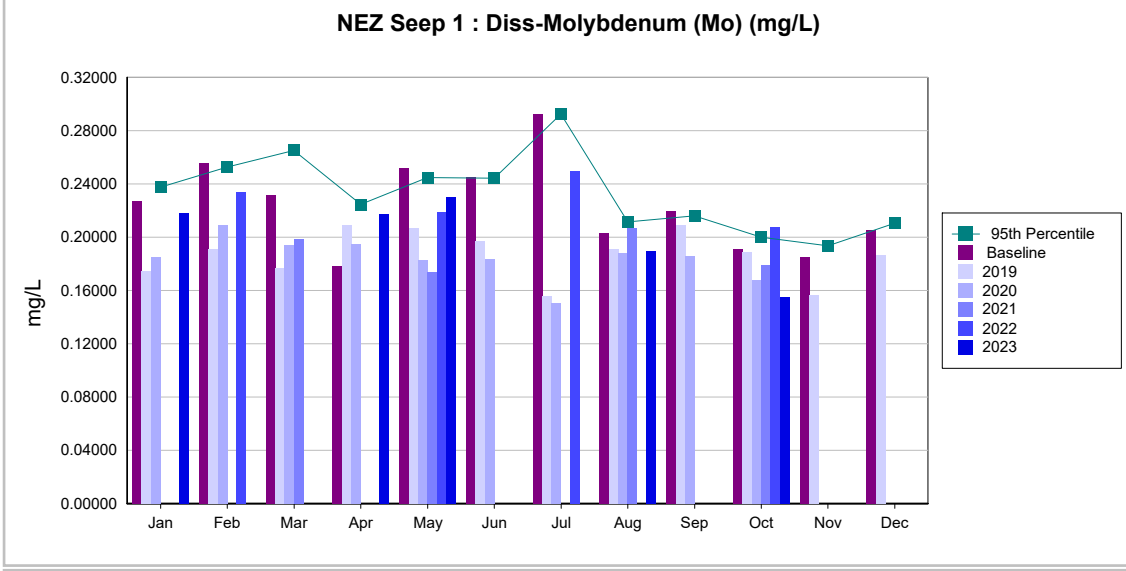
Annual Report Drainage Water

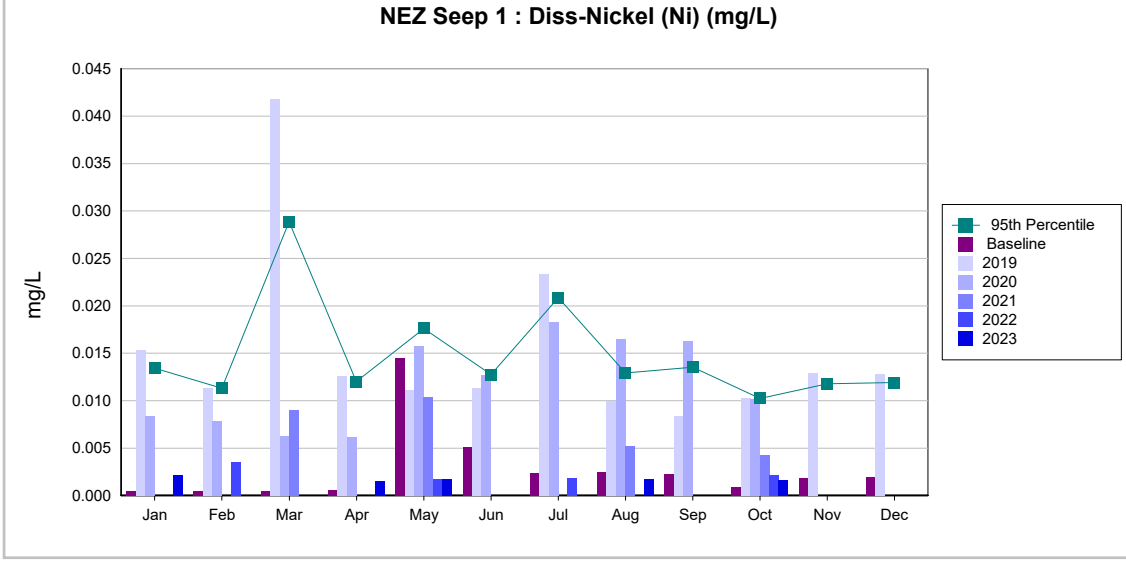
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







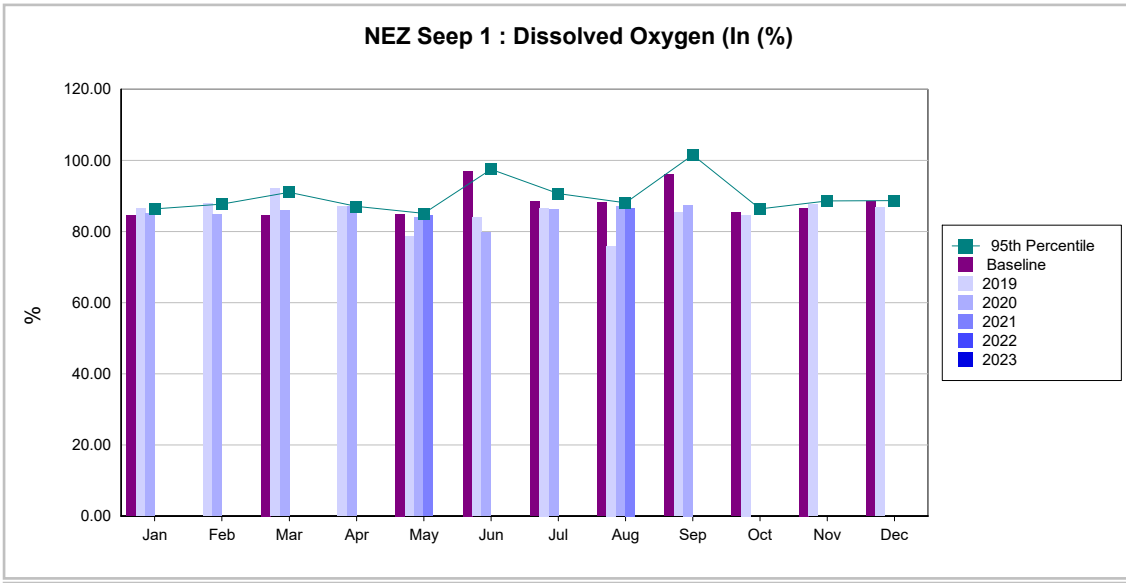
Water Quality Report

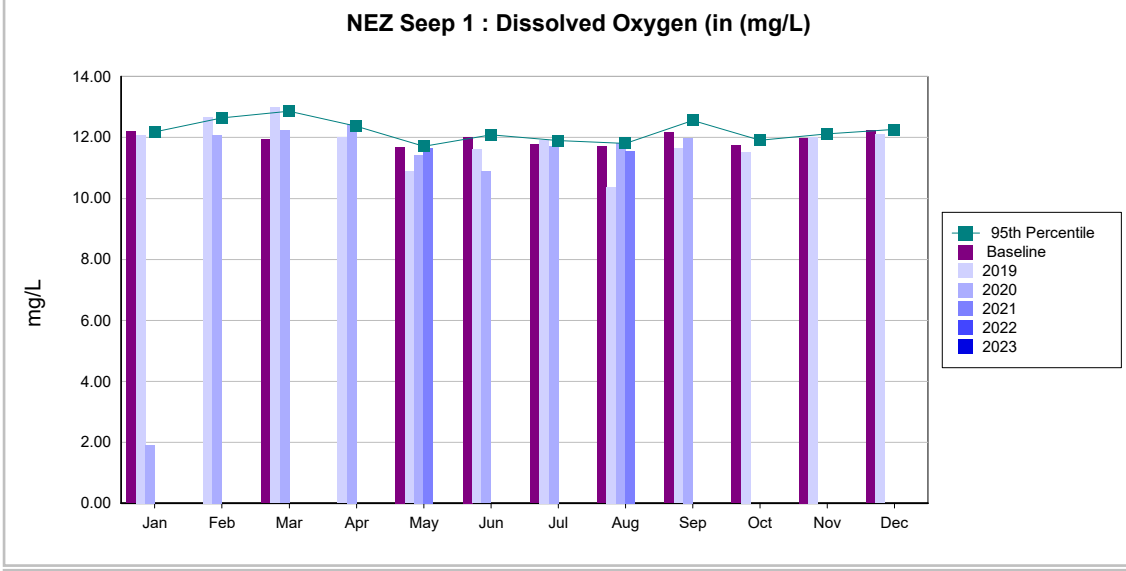
Annual Report Drainage Water

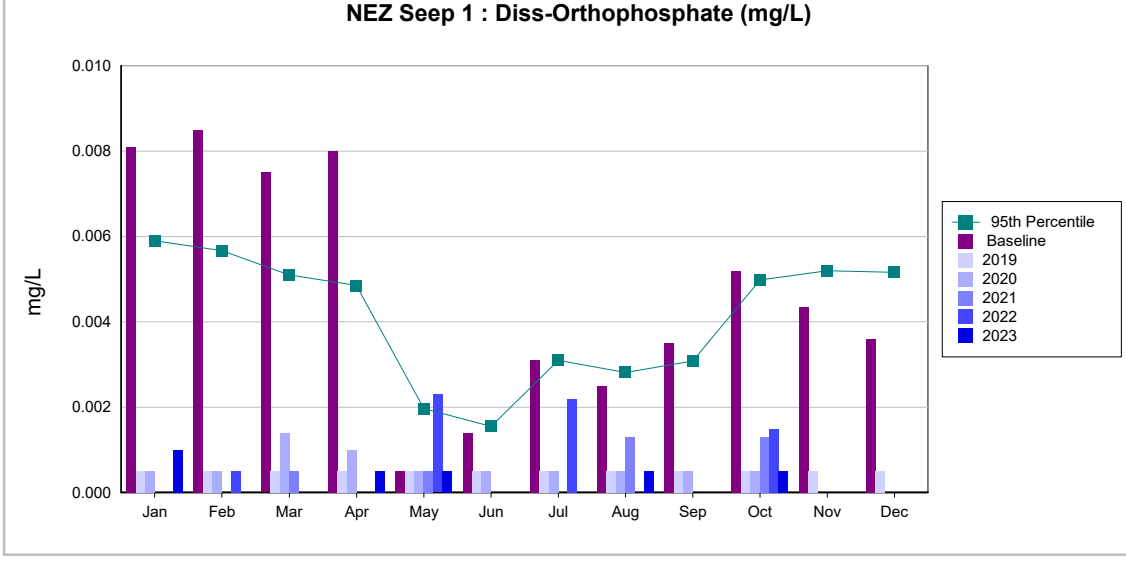
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







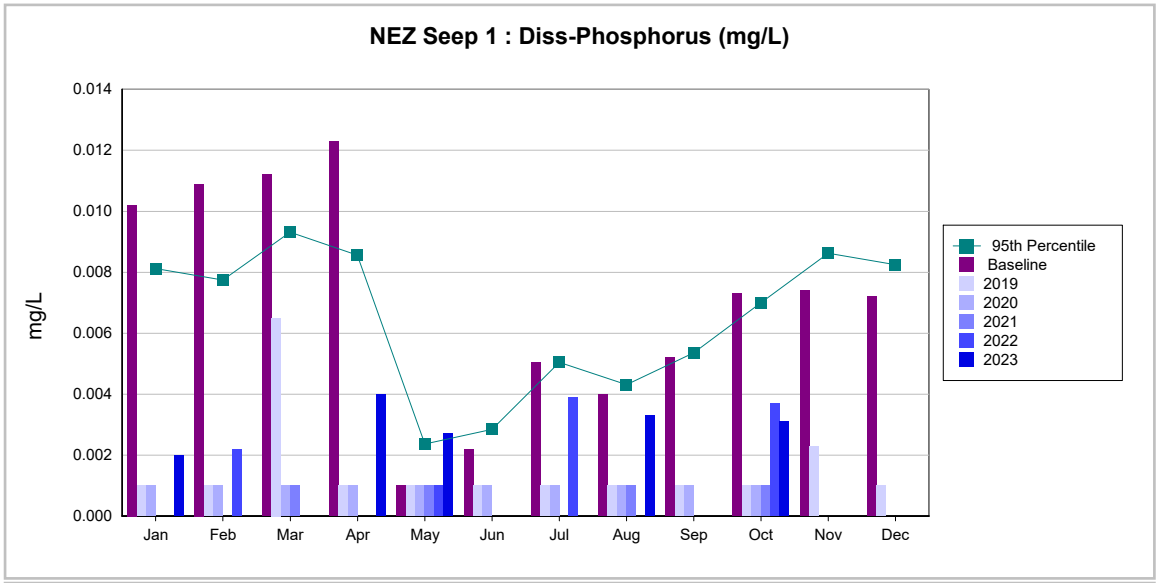
Water Quality Report

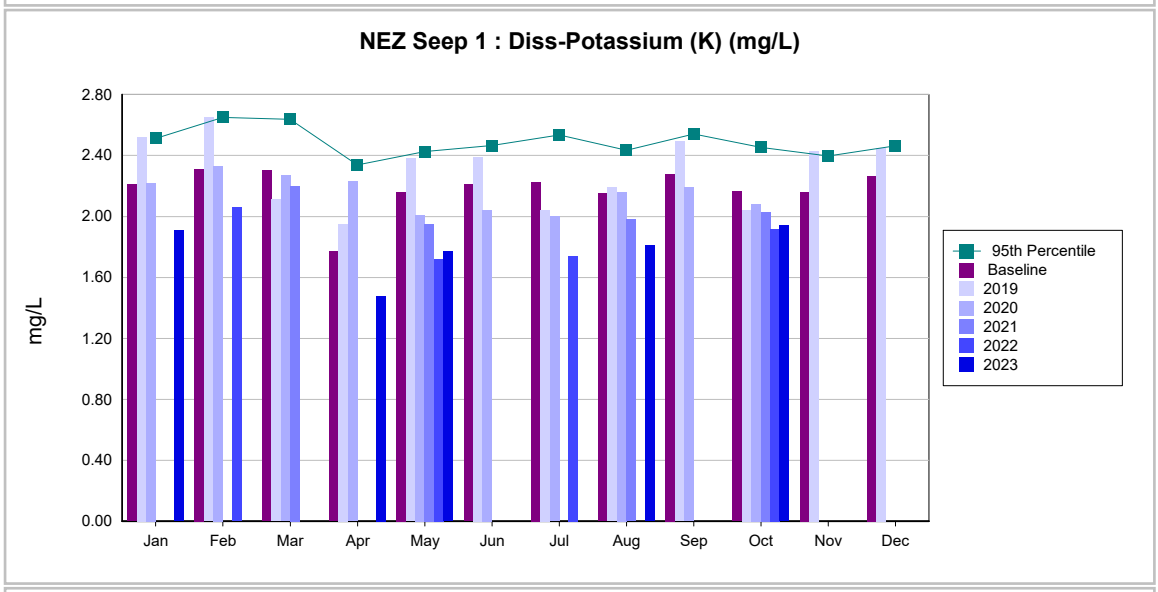
Annual Report Drainage Water

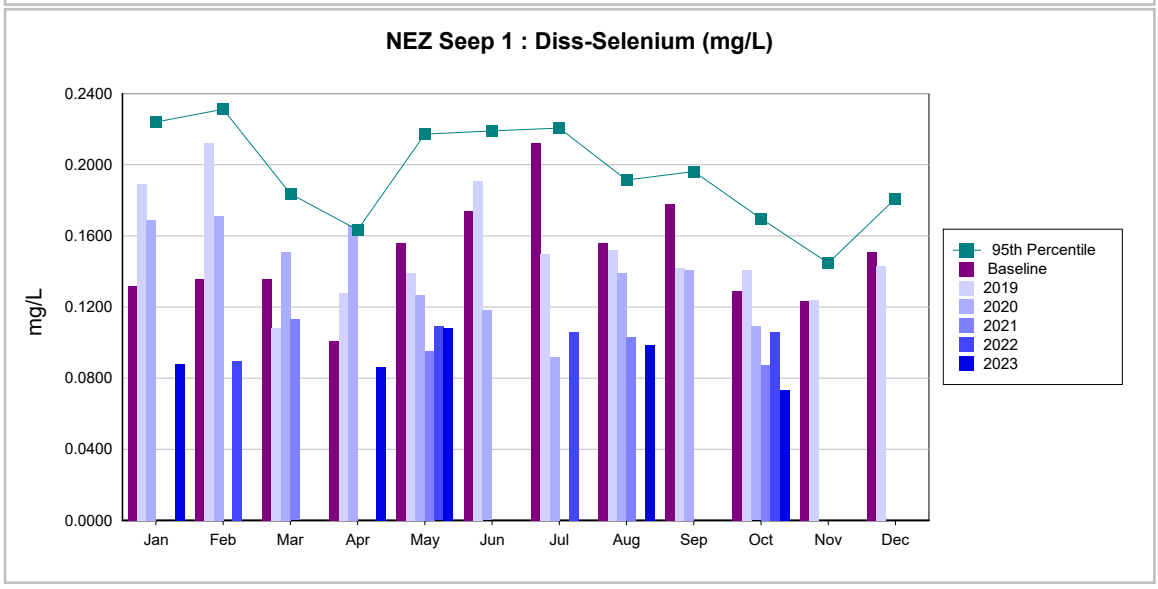
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







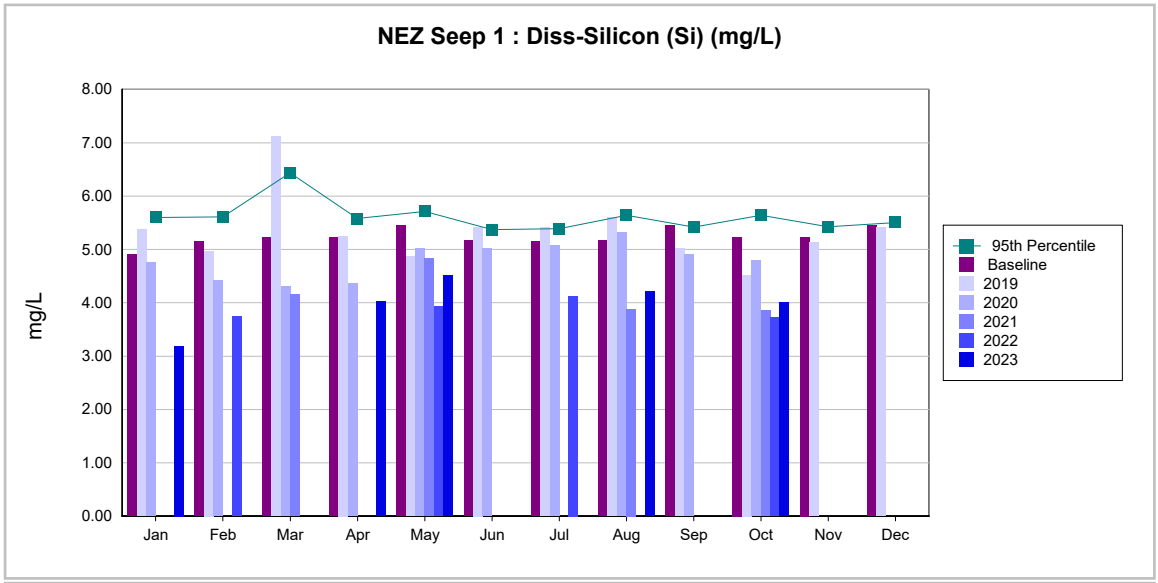
Water Quality Report

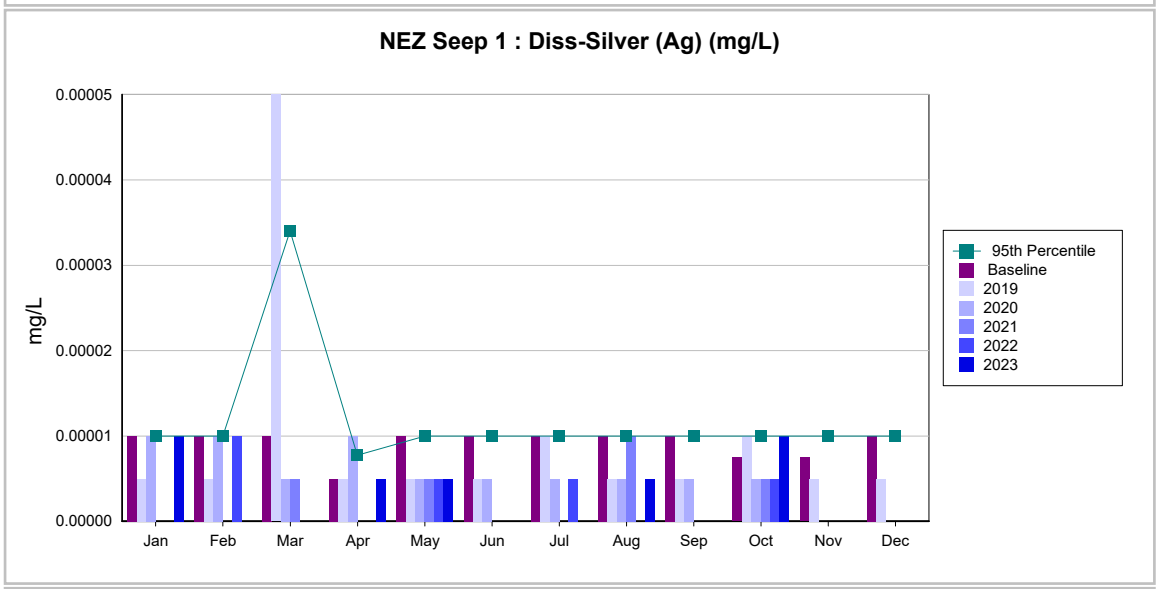
Annual Report Drainage Water

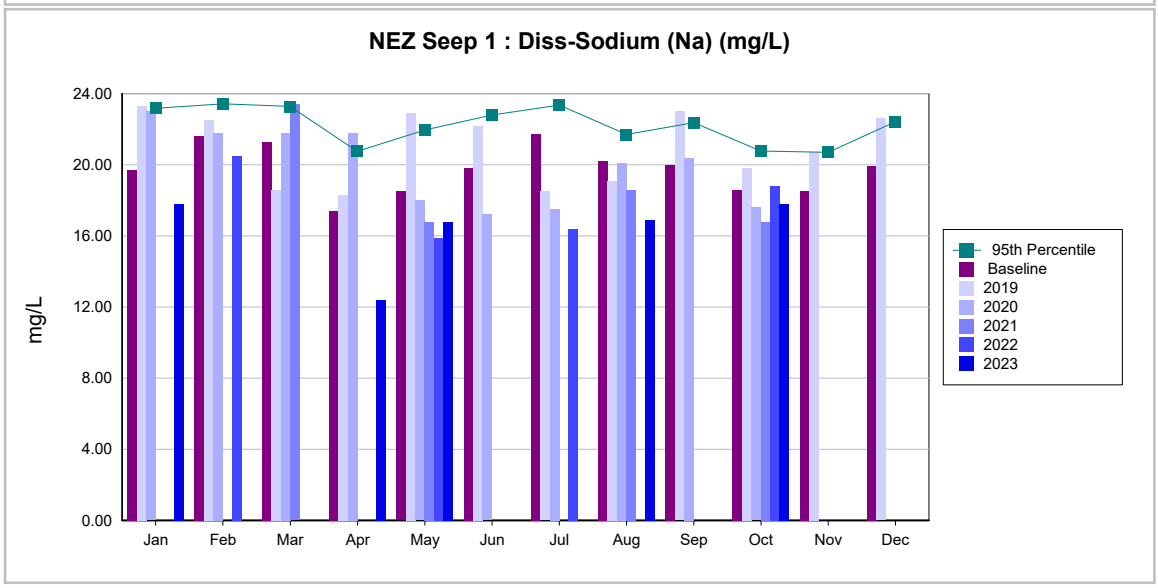
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







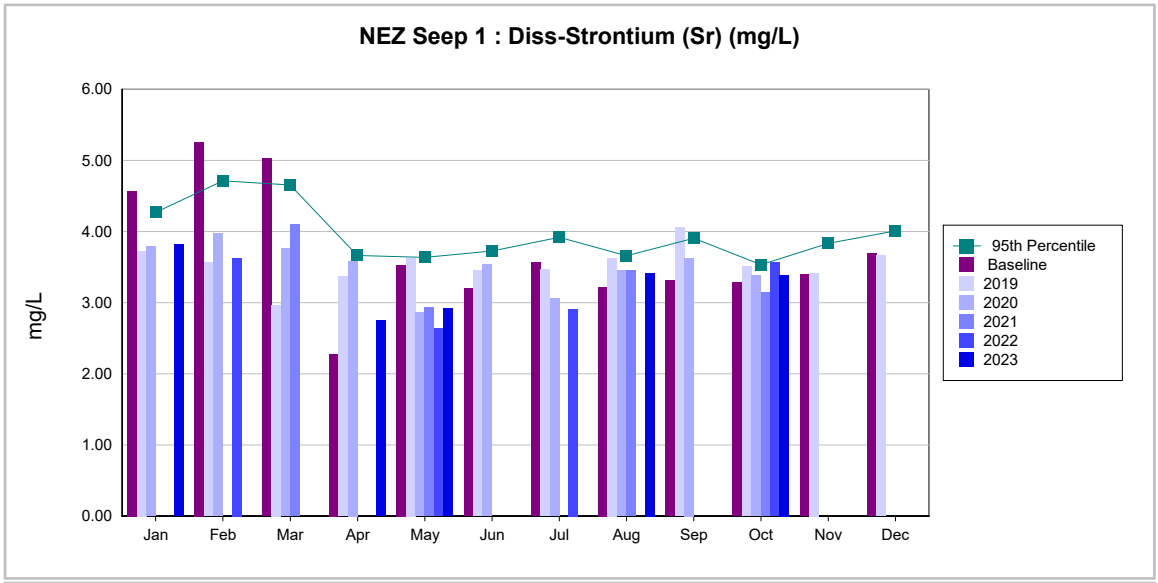
Water Quality Report

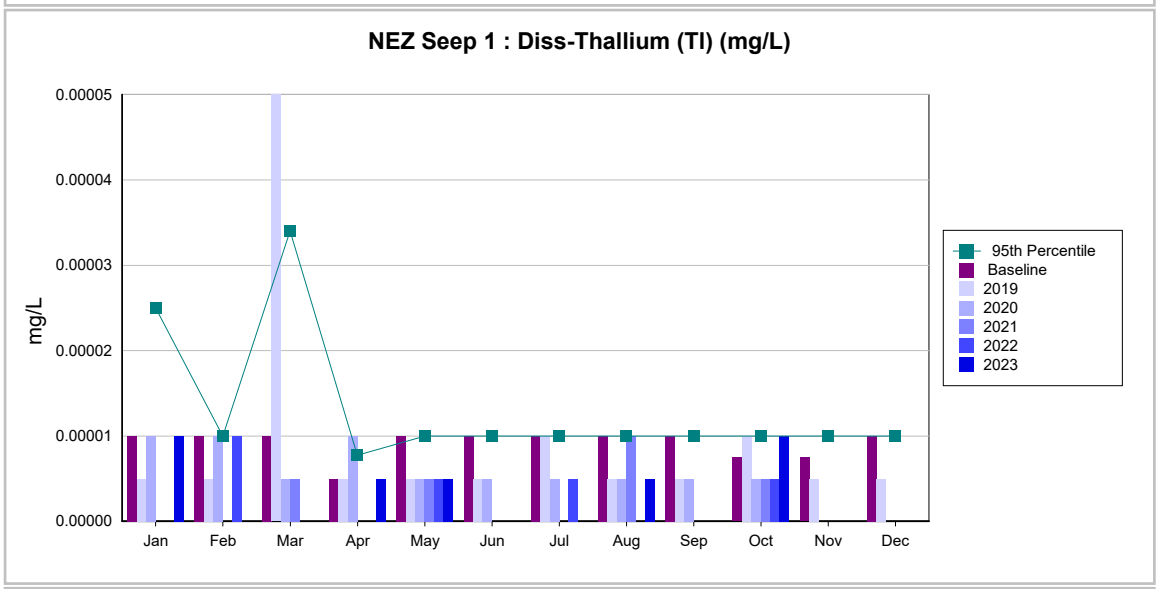
Annual Report Drainage Water

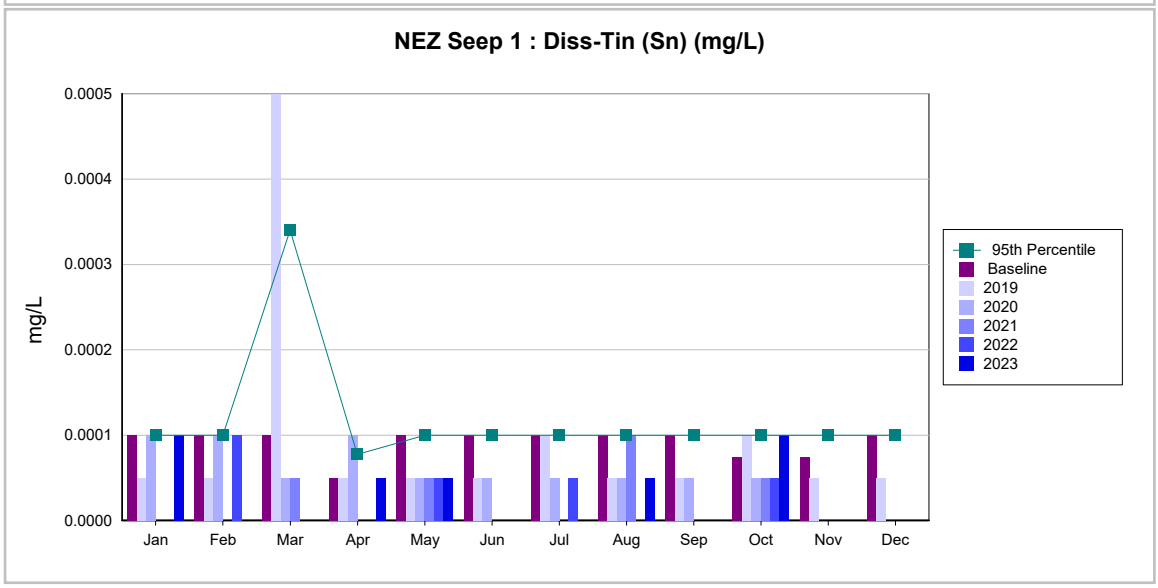
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







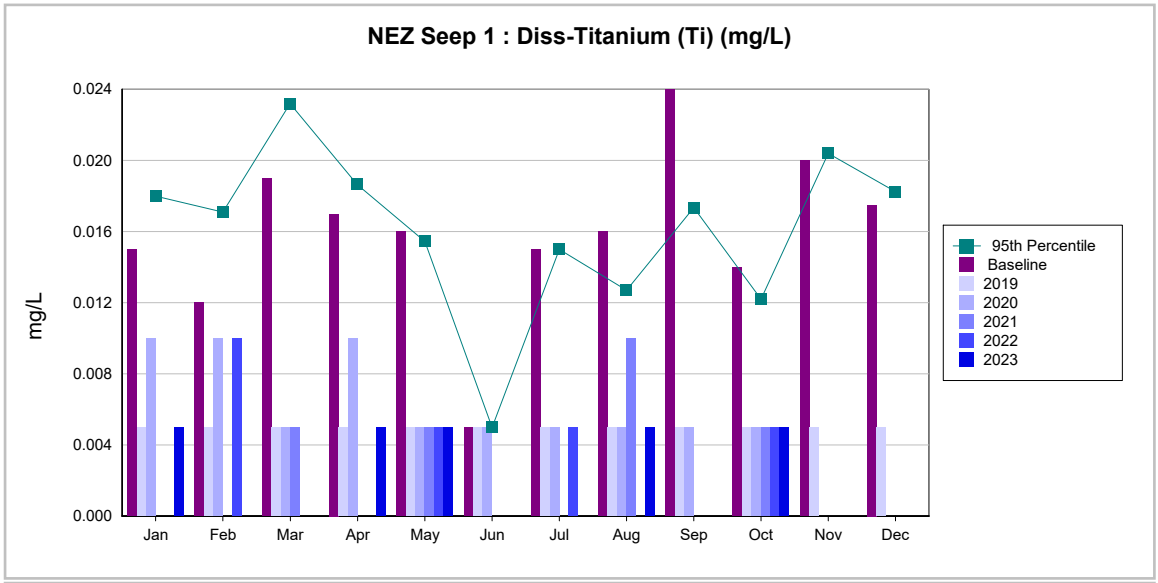
Water Quality Report

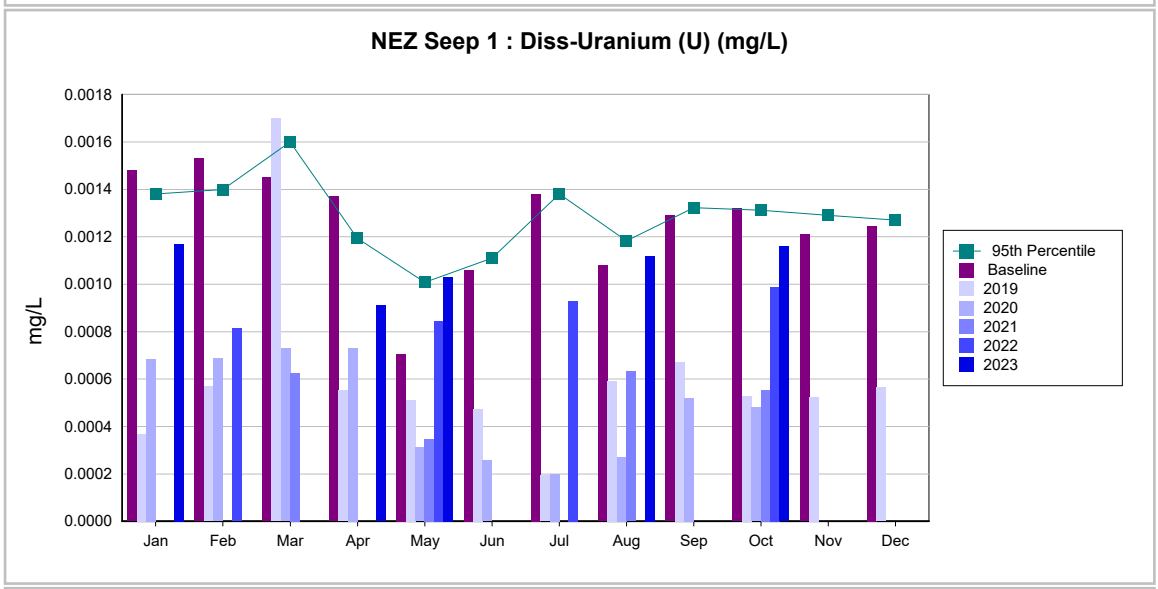
Annual Report Drainage Water

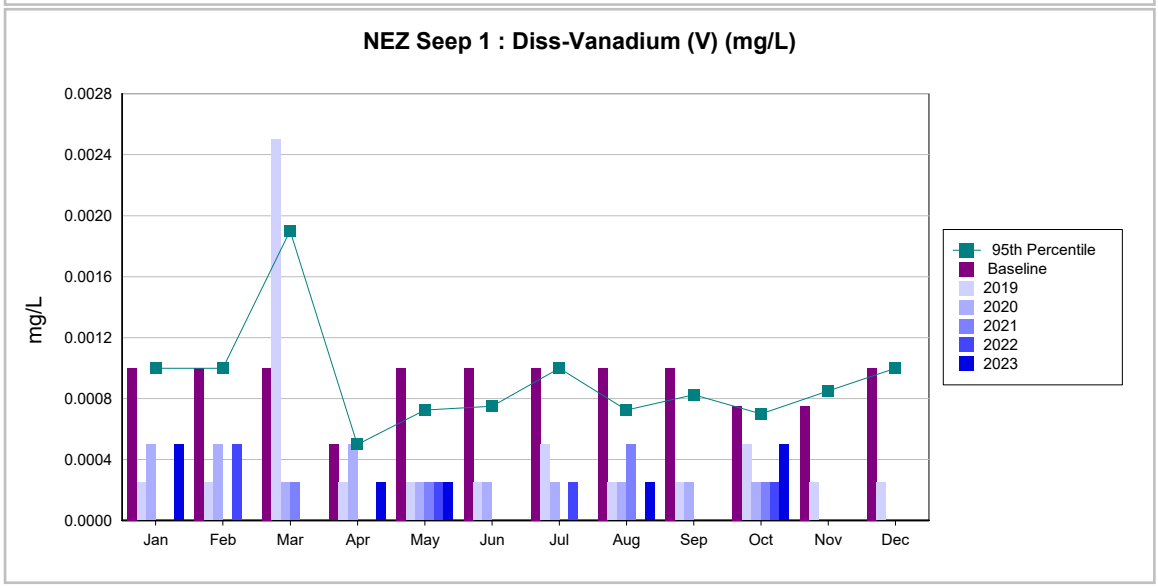
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







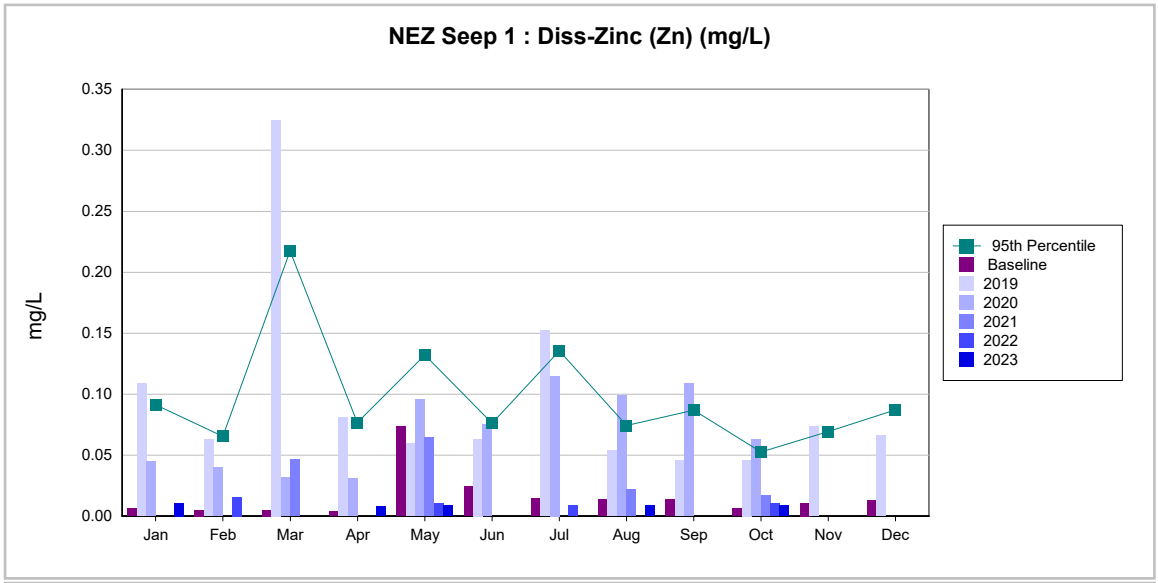
Water Quality Report

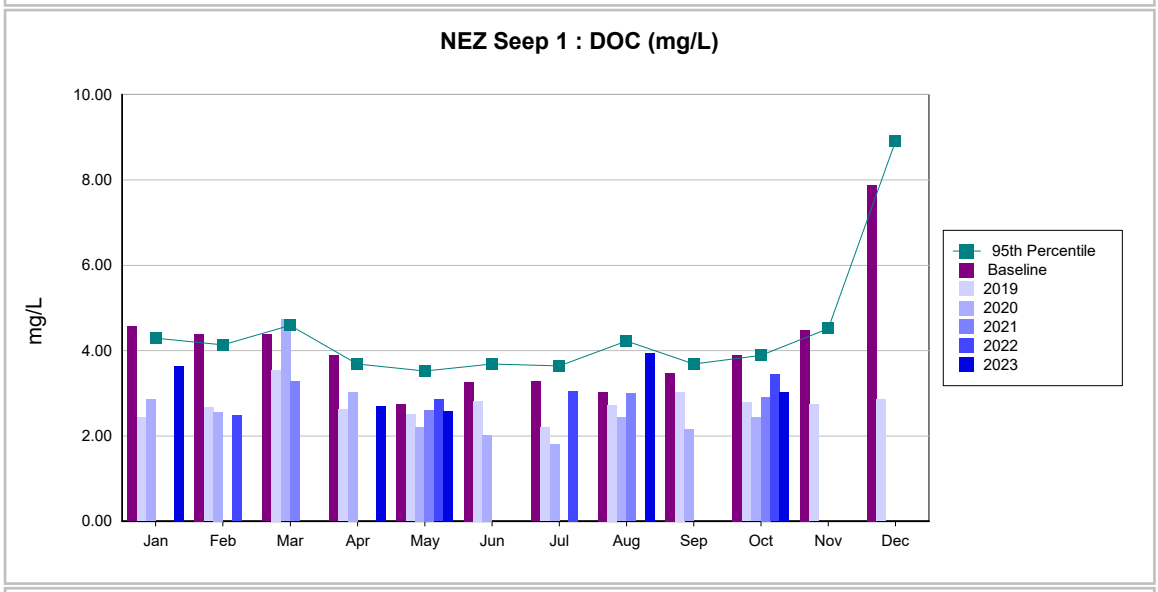
Annual Report Drainage Water

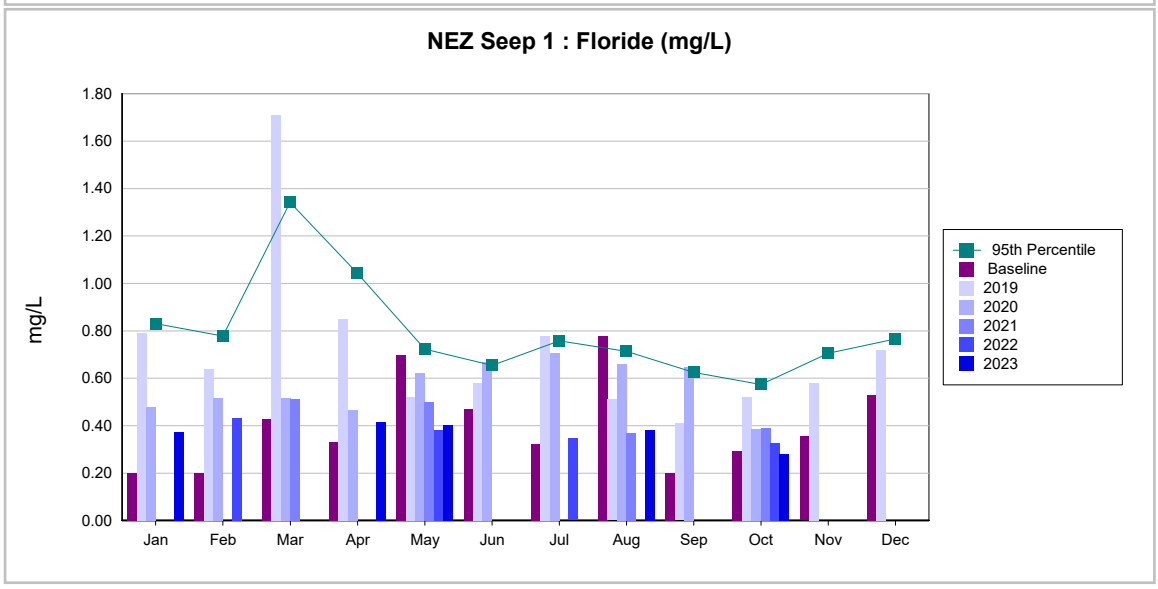
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

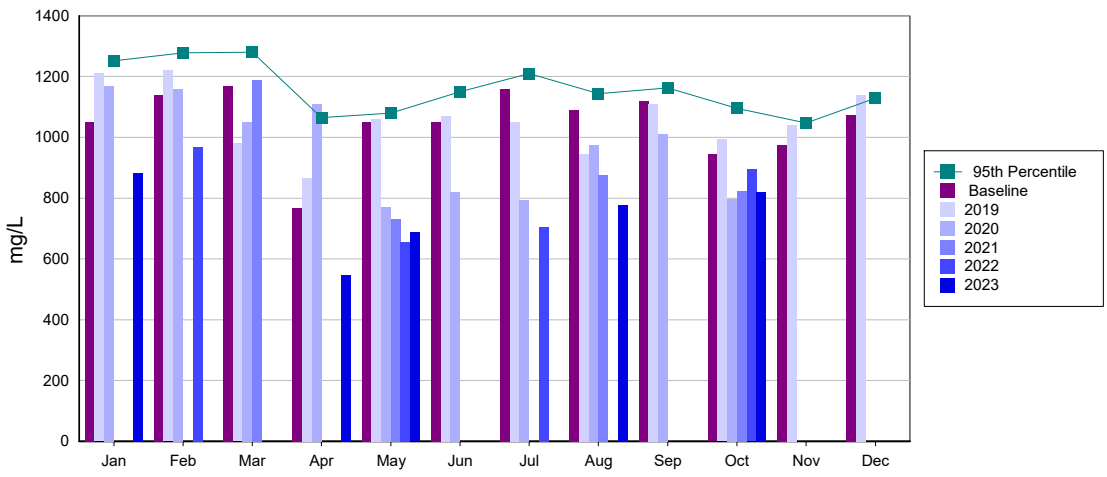
Annual Report Drainage Water

Mount Polley

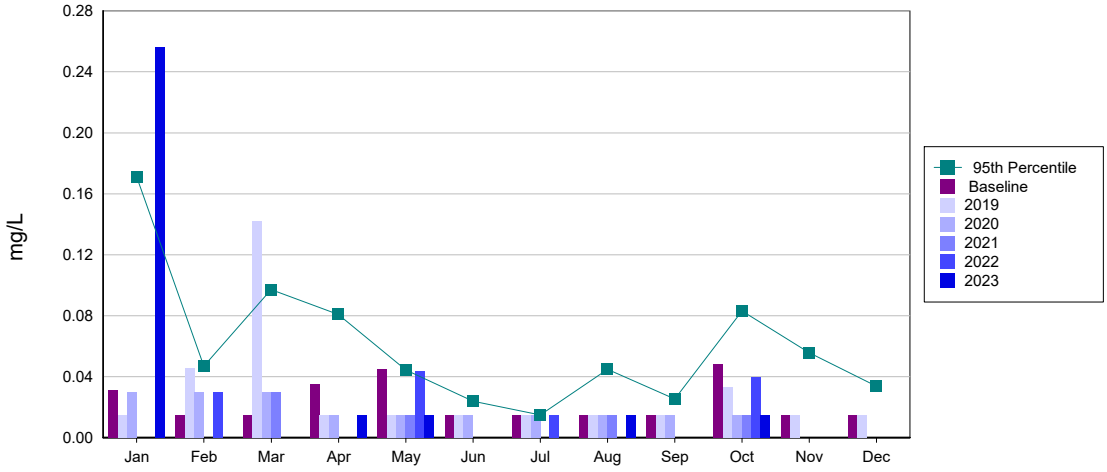
Mining Corporation

IMPERIAL METALS CORPORATION

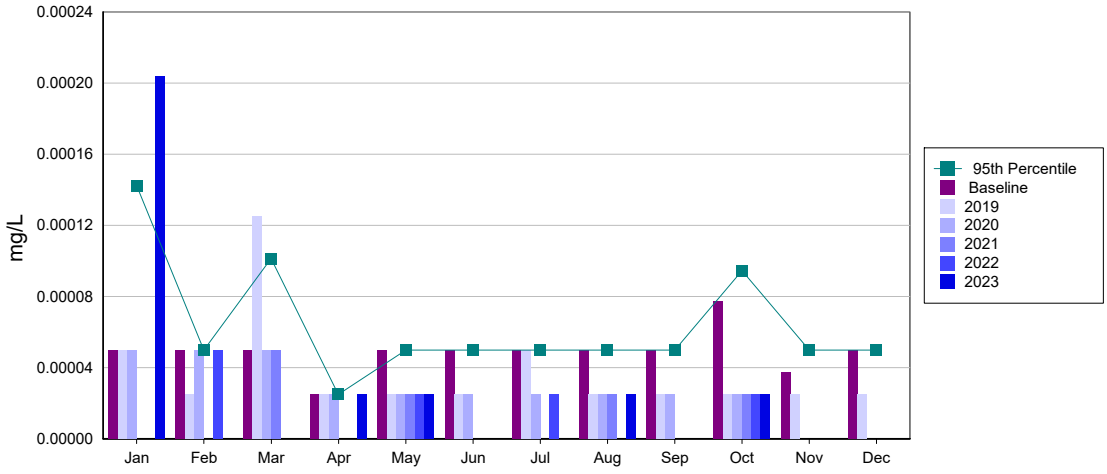
NEZ Seep 1 : Hardness (mg/L)



NEZ Seep 1 : Iron (Fe)-Total (mg/L)



NEZ Seep 1 : Lead (Pb)-Total (mg/L)



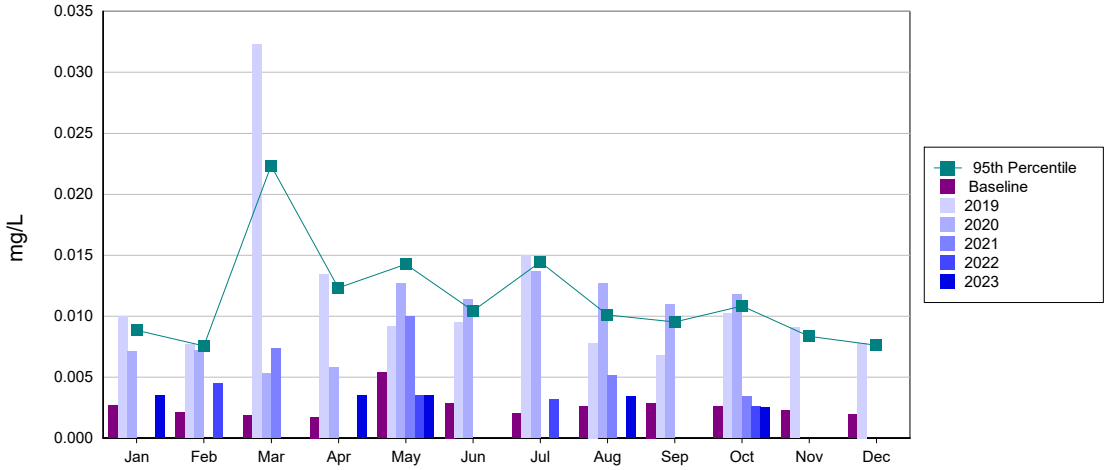
Water Quality Report

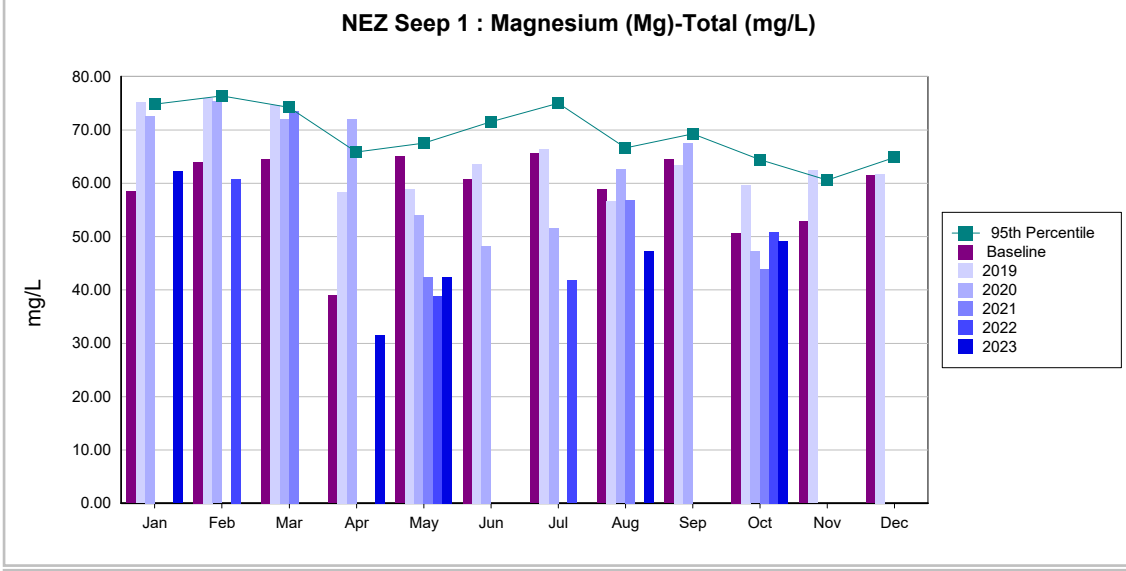
Annual Report Drainage Water

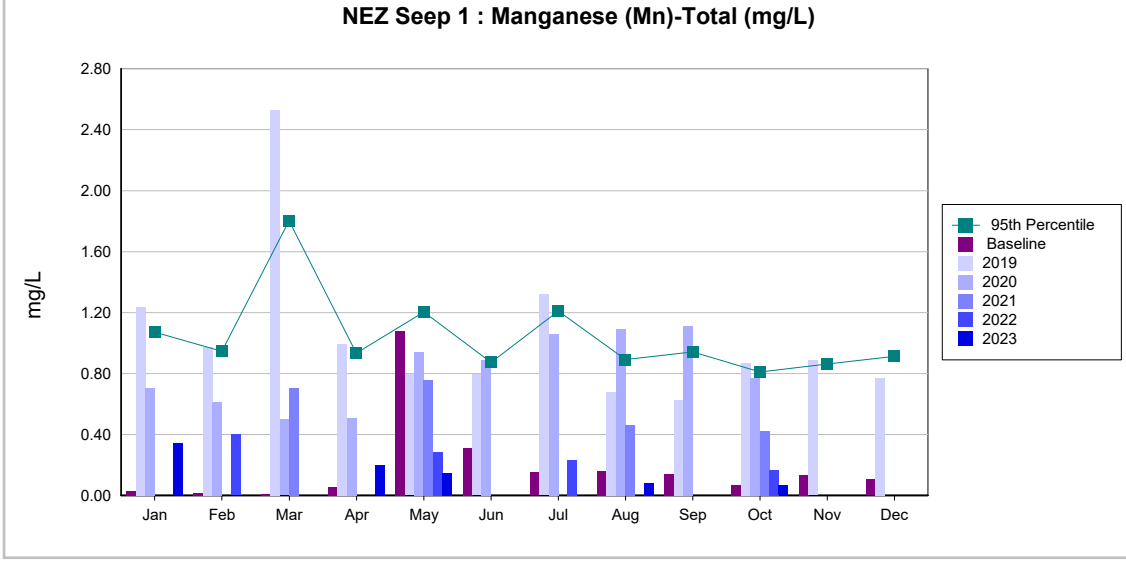
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







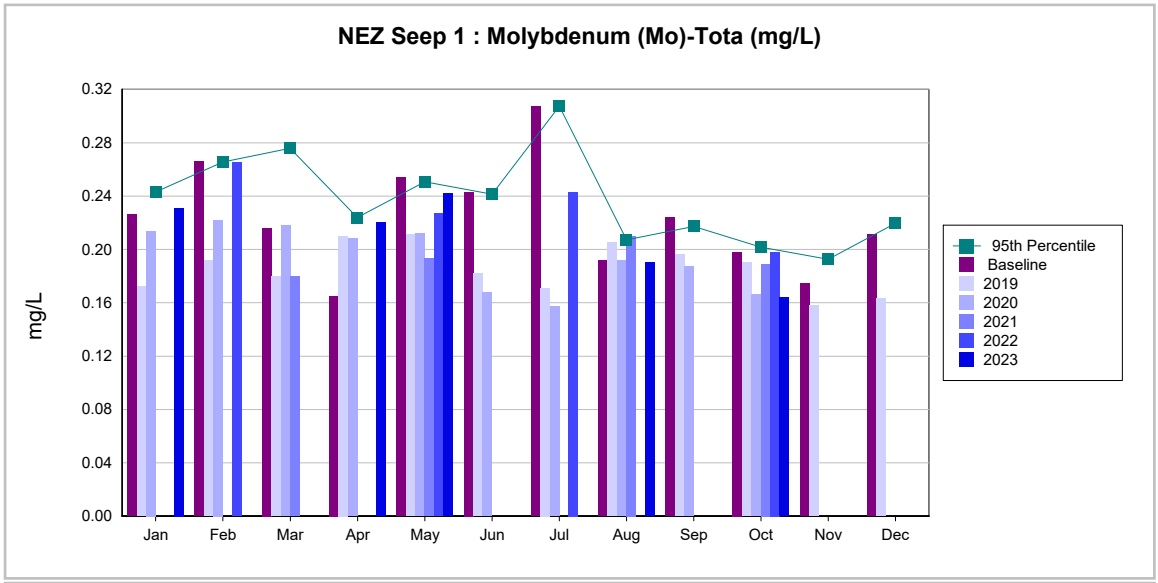
Water Quality Report

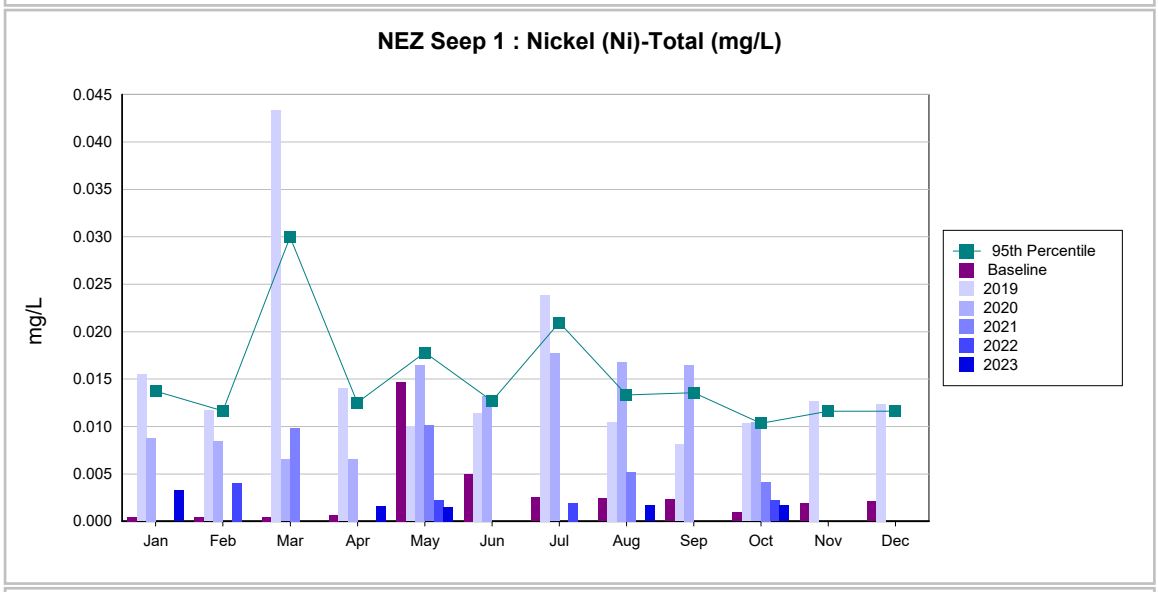
Annual Report Drainage Water

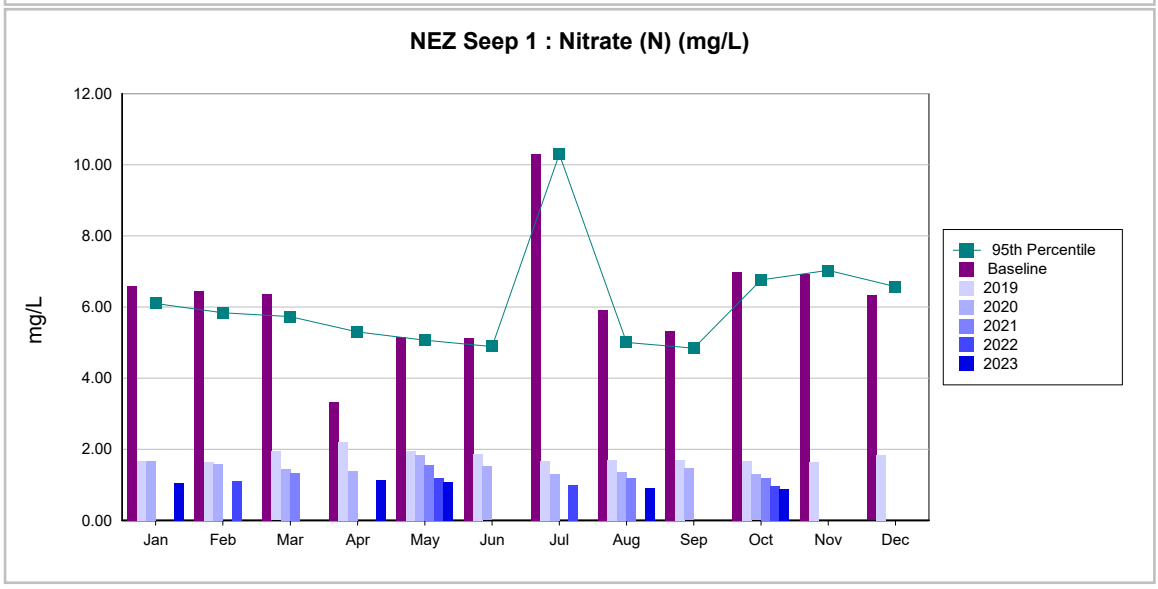
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







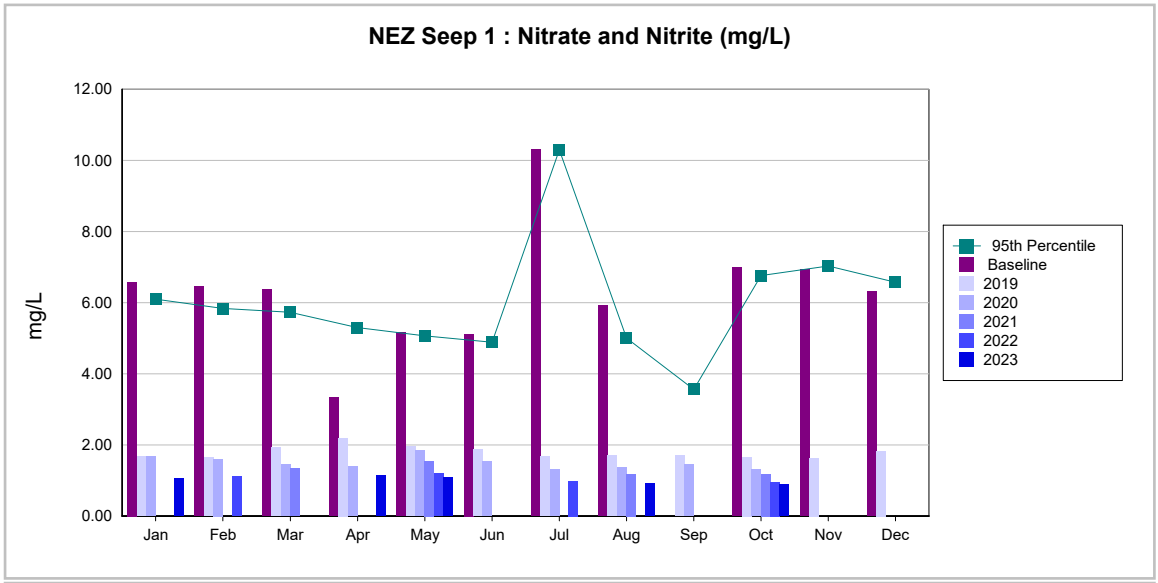
Water Quality Report

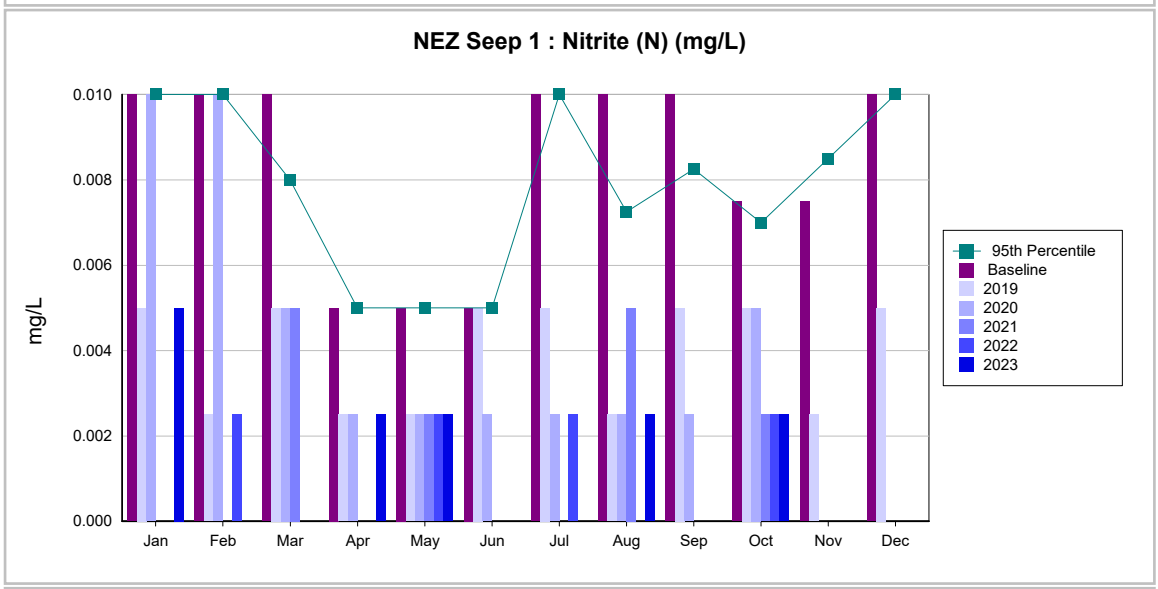
Annual Report Drainage Water

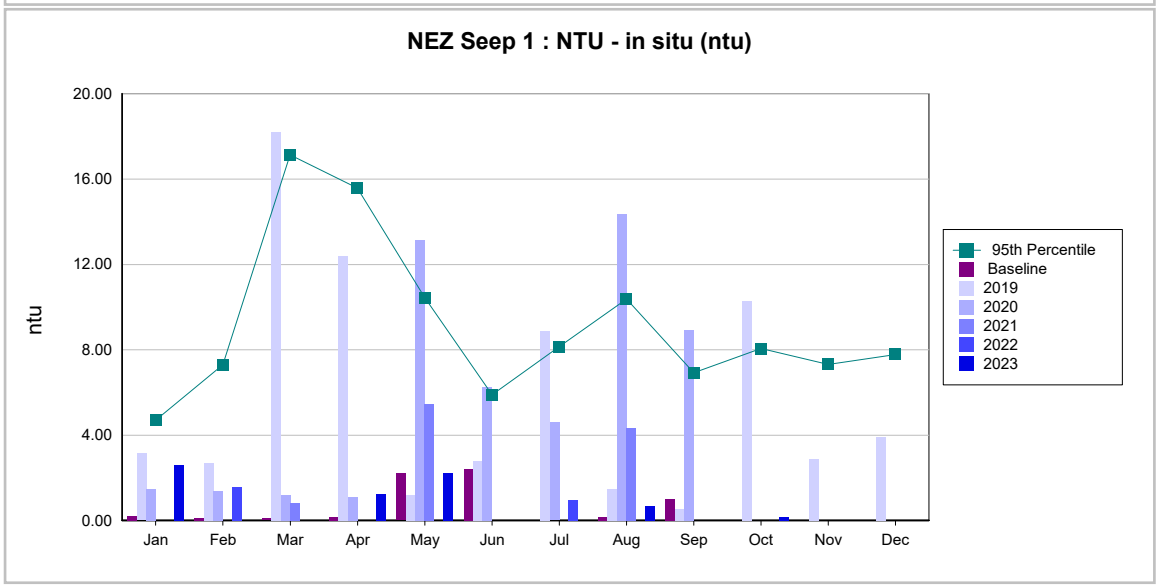
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







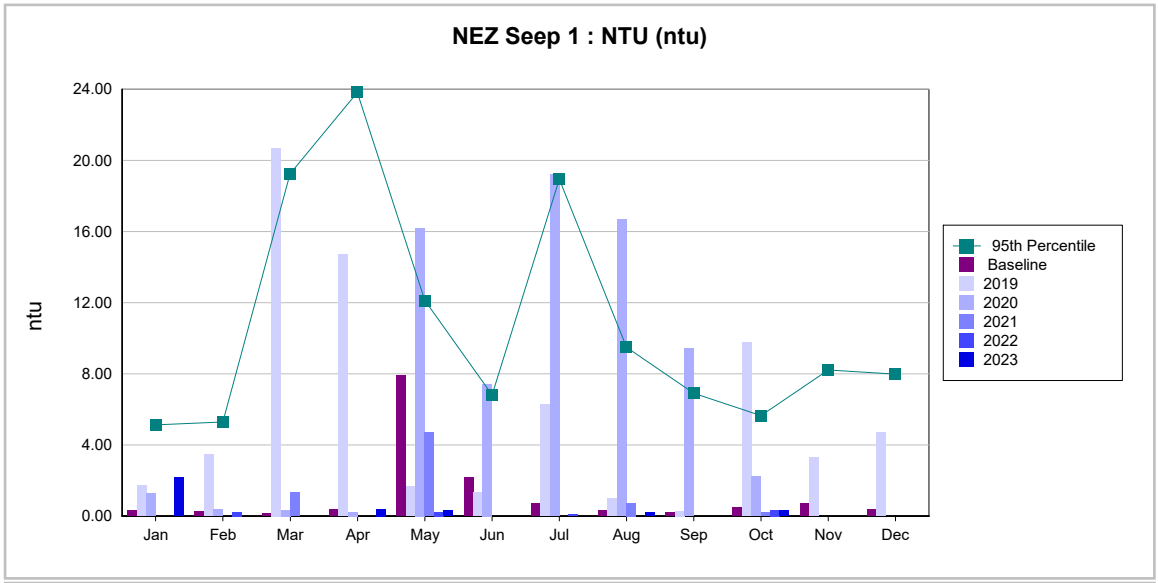
Water Quality Report

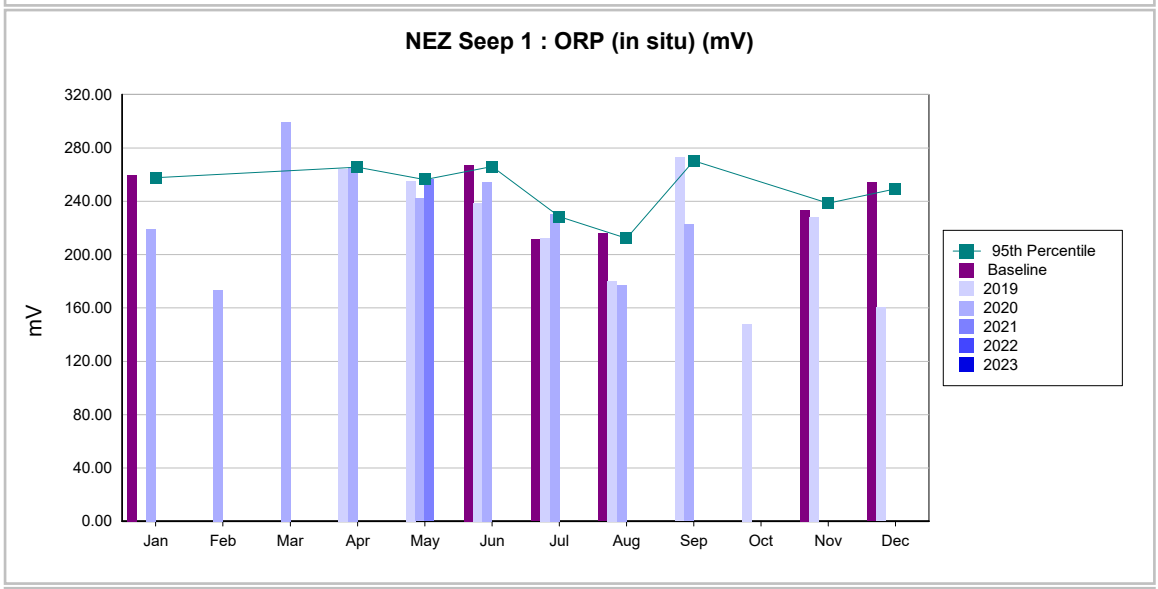
Annual Report Drainage Water

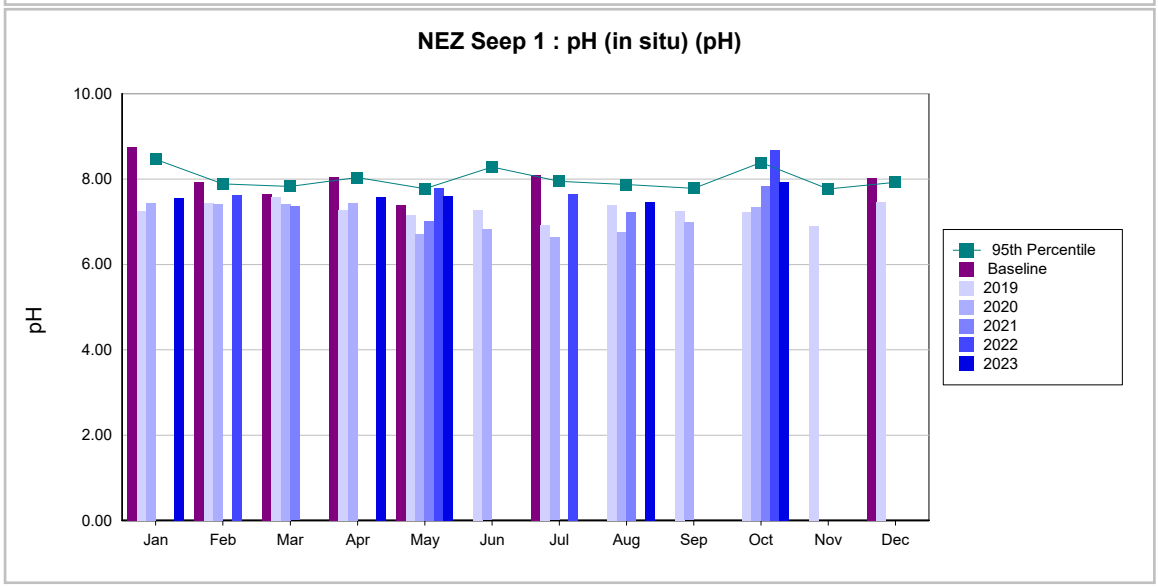
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







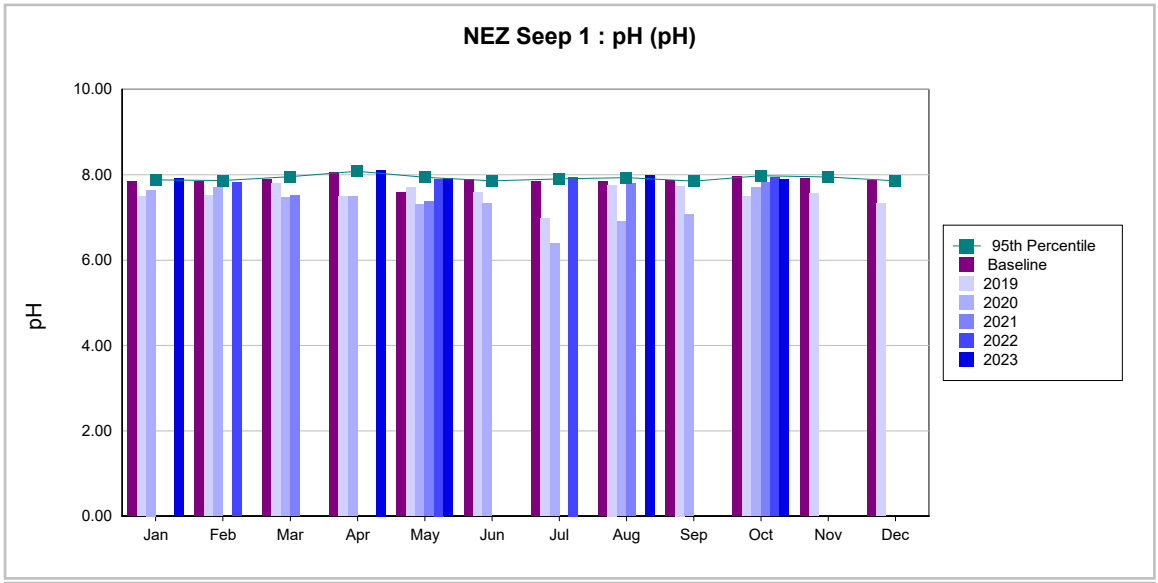
Water Quality Report

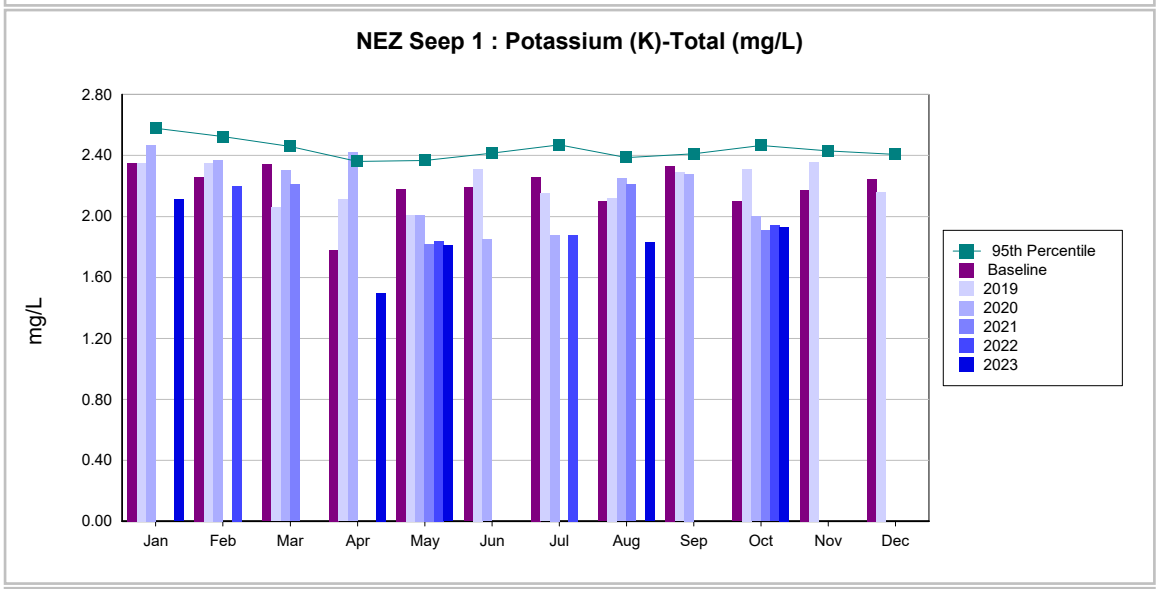
Annual Report Drainage Water

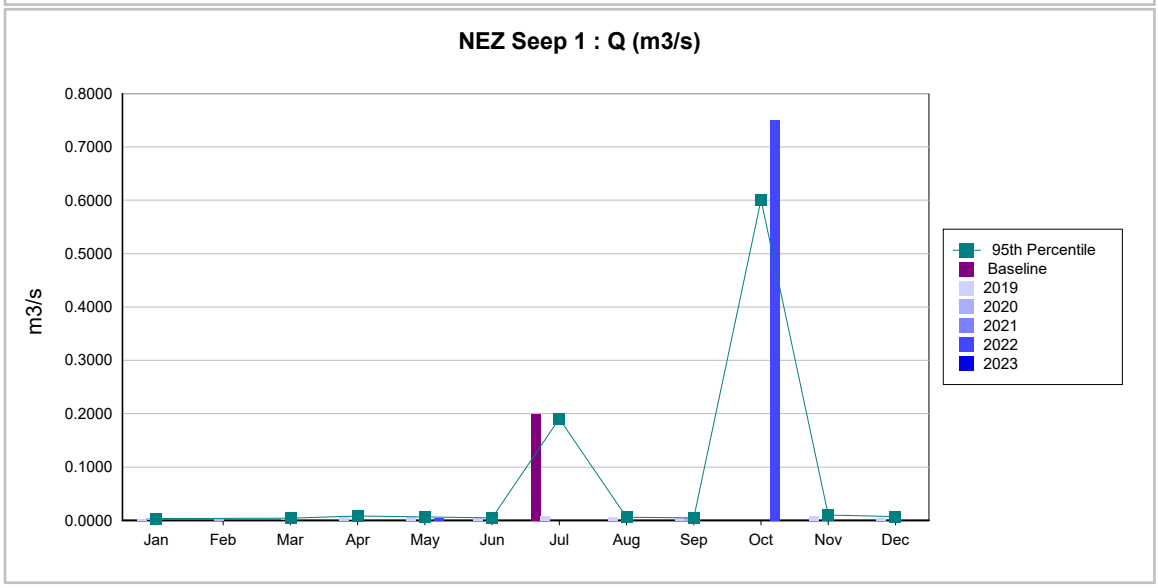
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







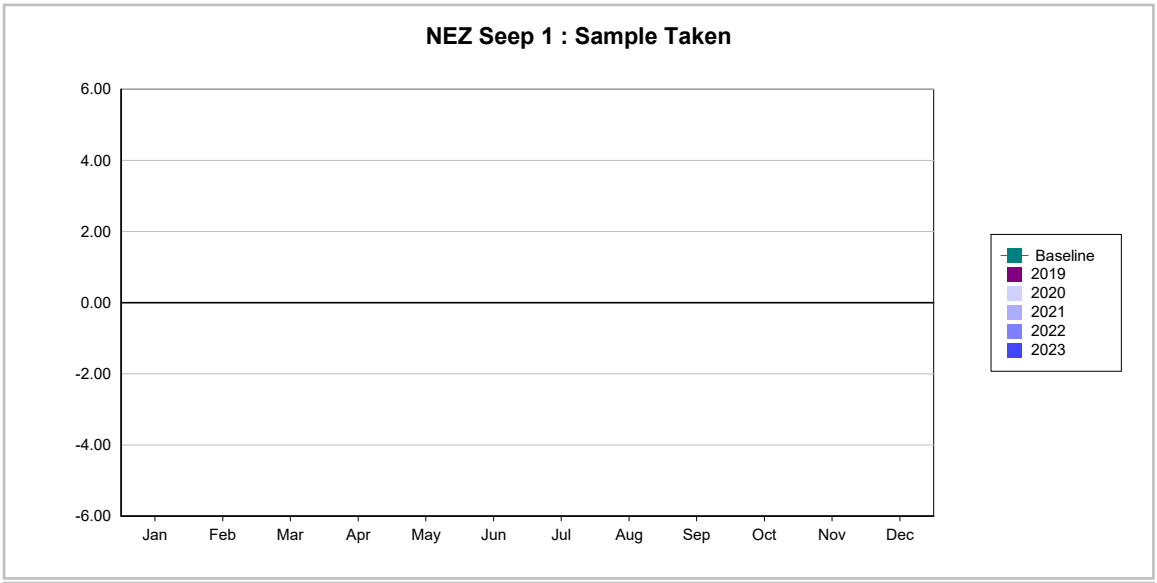
Water Quality Report

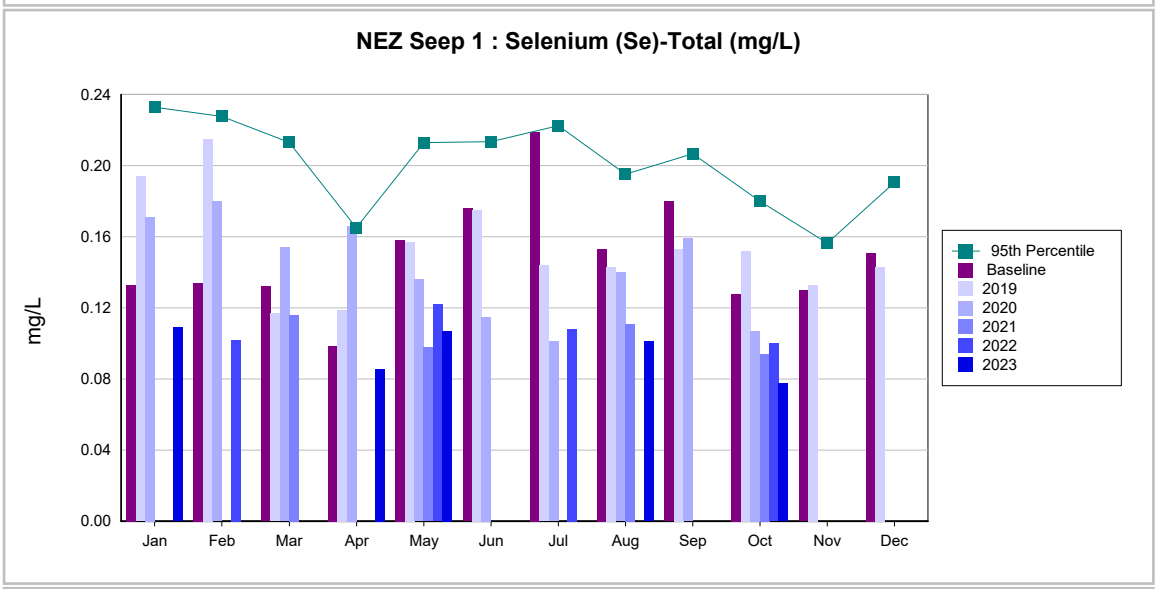
Annual Report Drainage Water

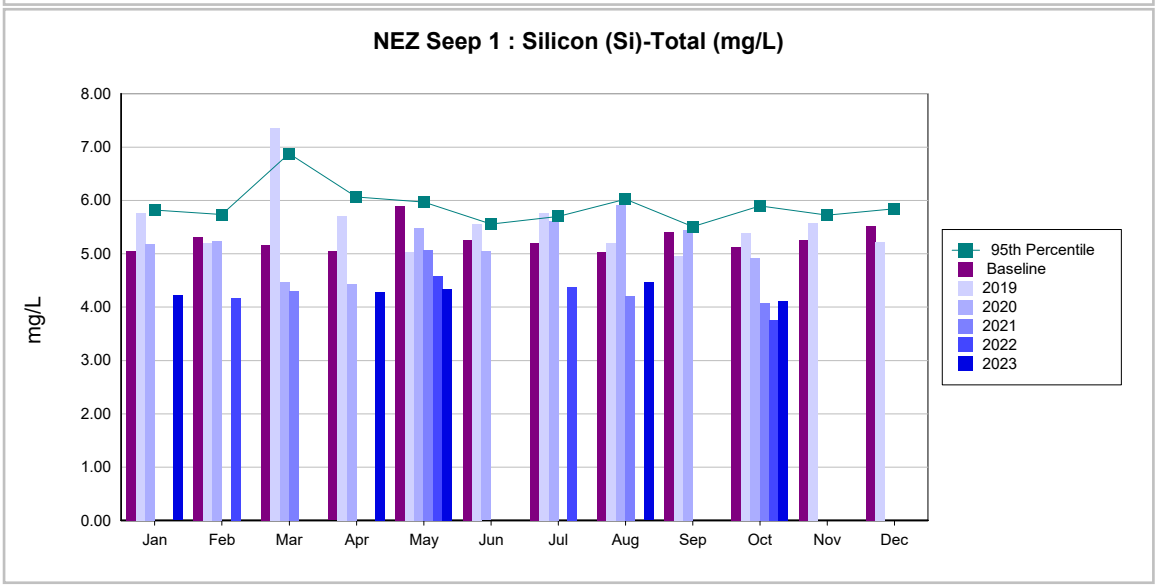
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

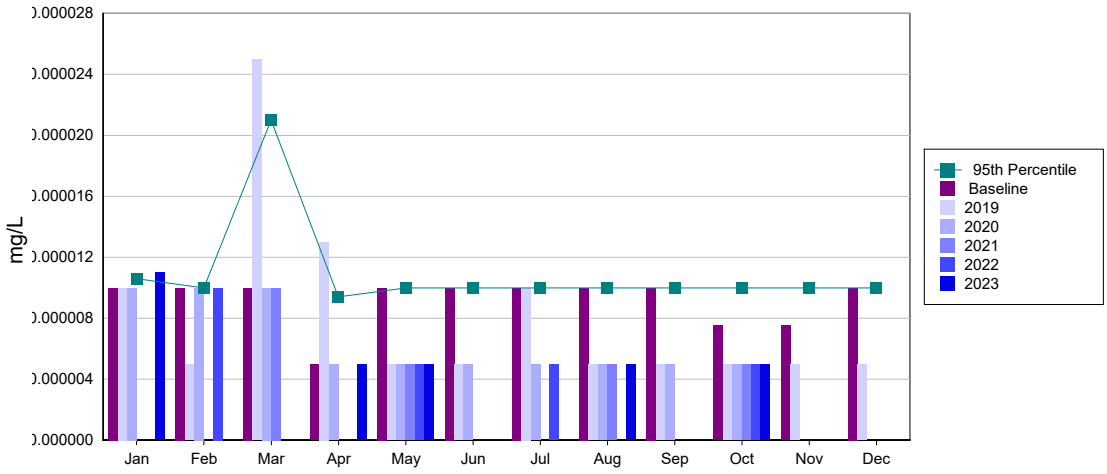
Annual Report Drainage Water

Mount Polley

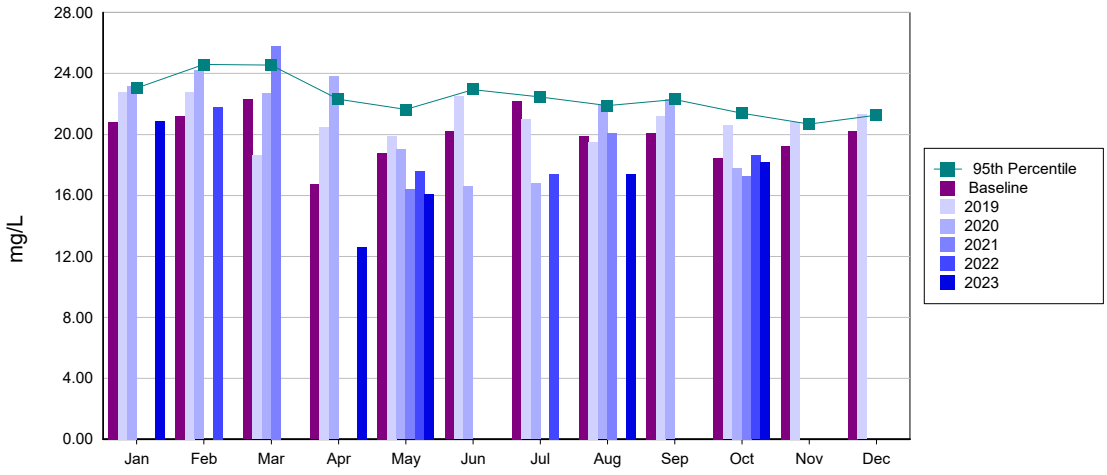
Mining Corporation

IMPERIAL METALS CORPORATION

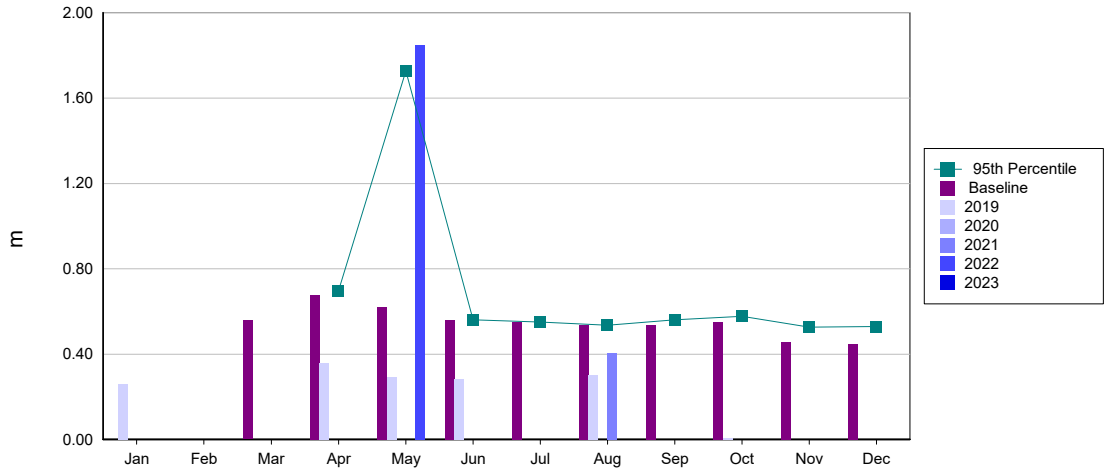
NEZ Seep 1 : Silver (Ag)-Total (mg/L)



NEZ Seep 1 : Sodium (Na)-Total (mg/L)



NEZ Seep 1 : Staff Gauge (m)



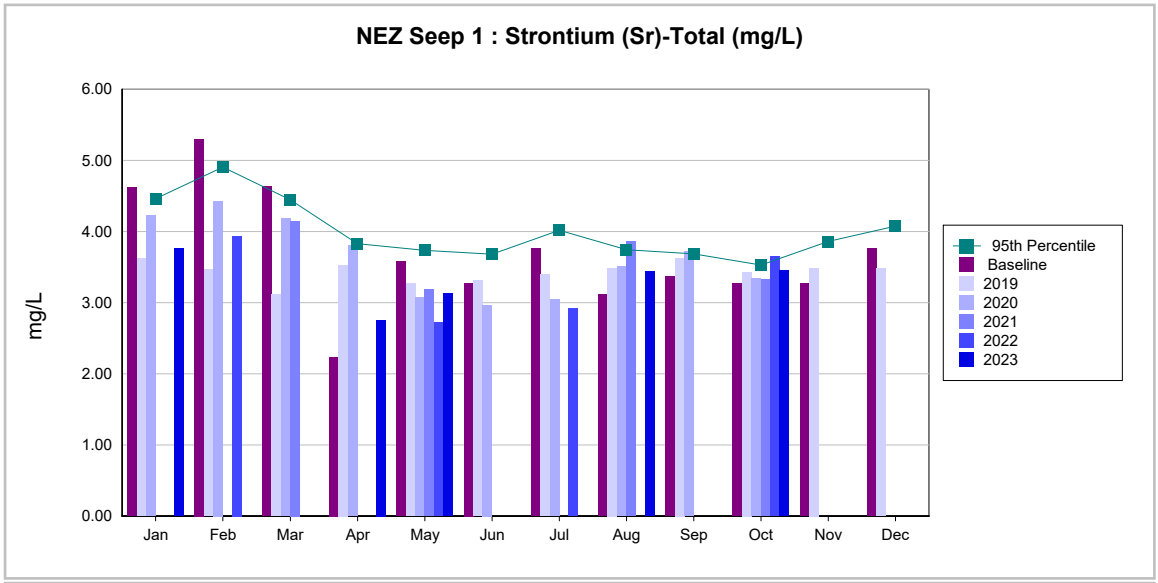
Water Quality Report

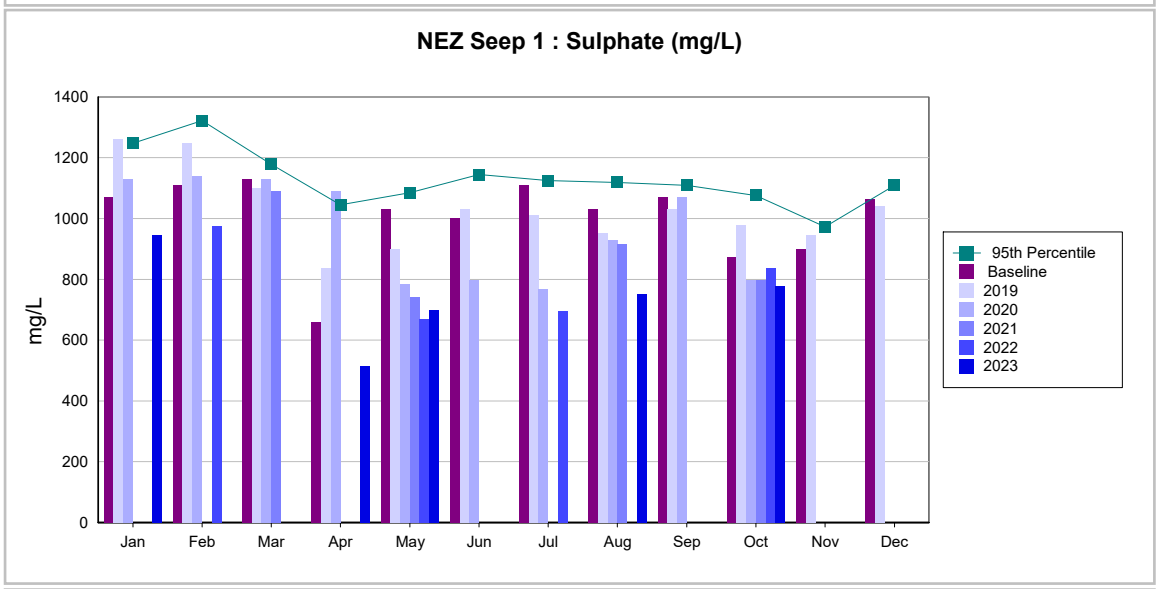
Annual Report Drainage Water

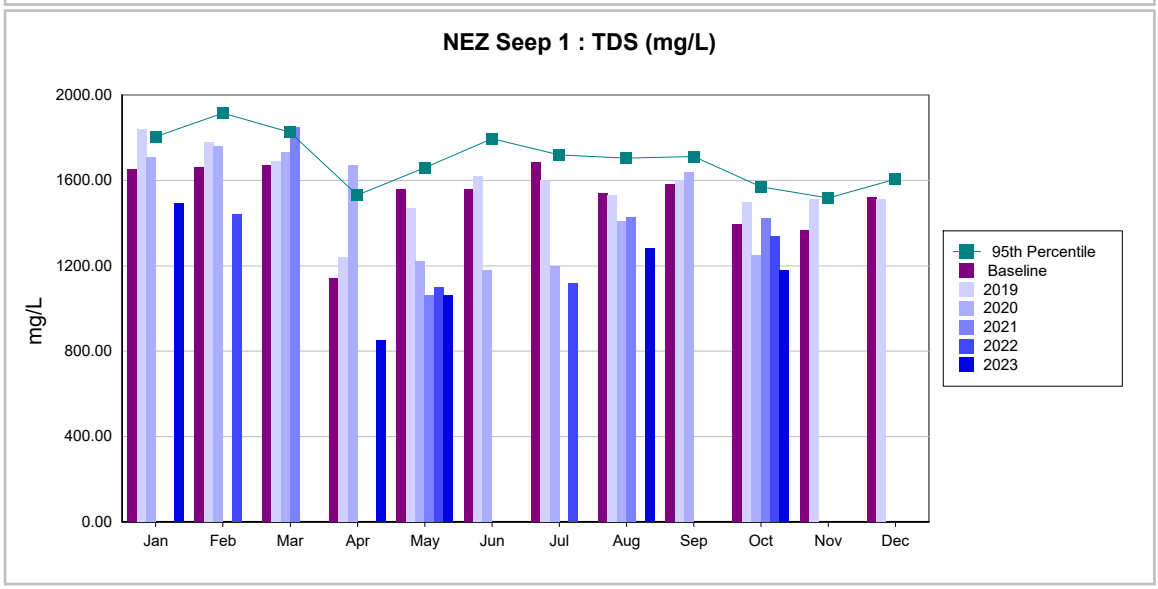
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







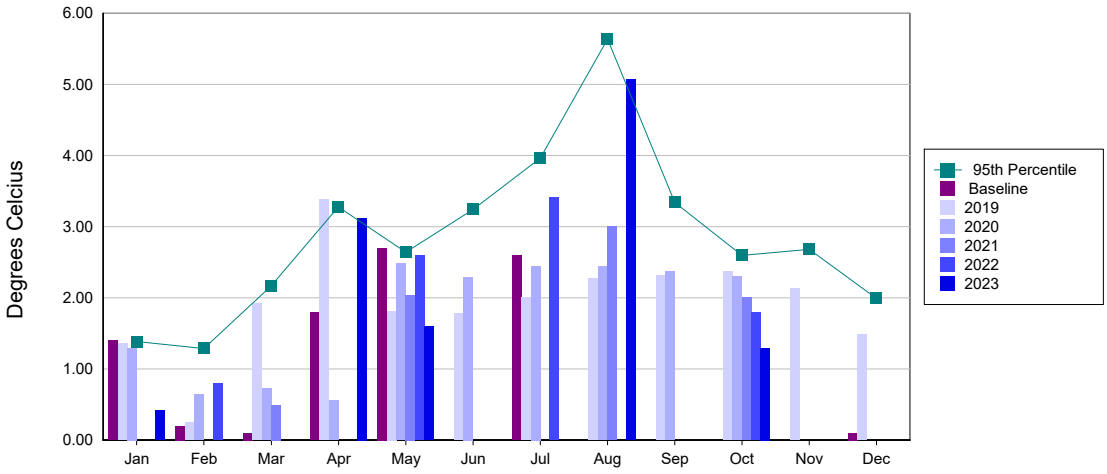
Water Quality Report

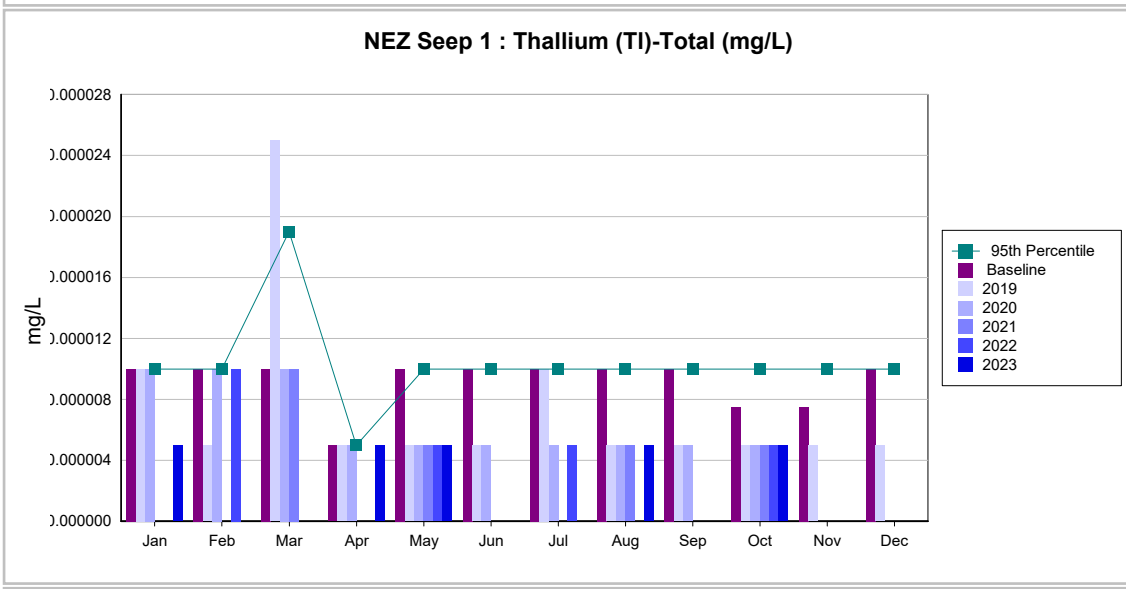
Annual Report Drainage Water

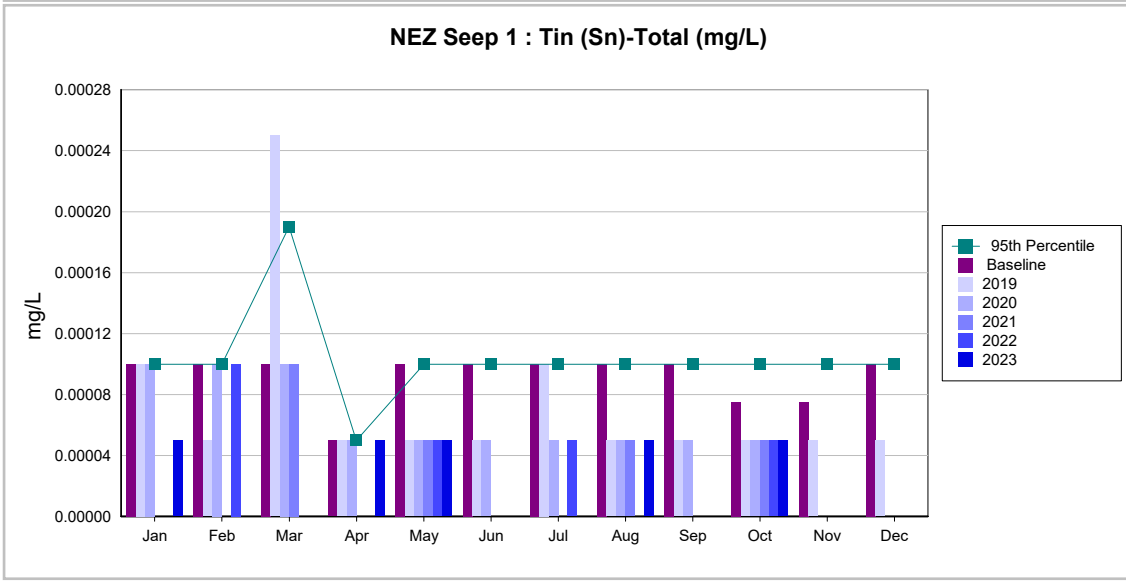
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







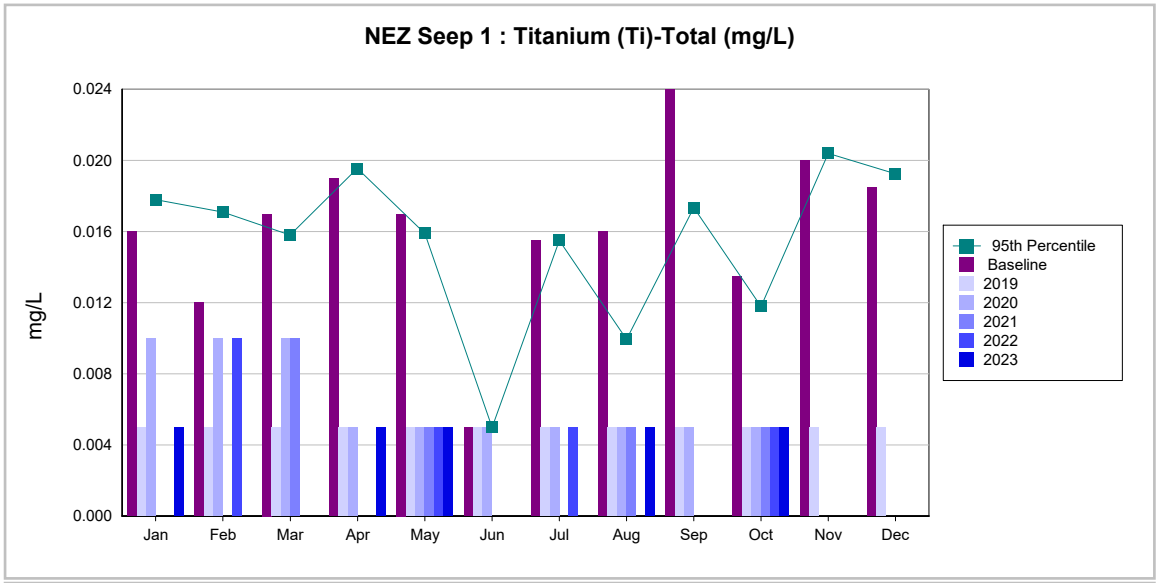
Water Quality Report

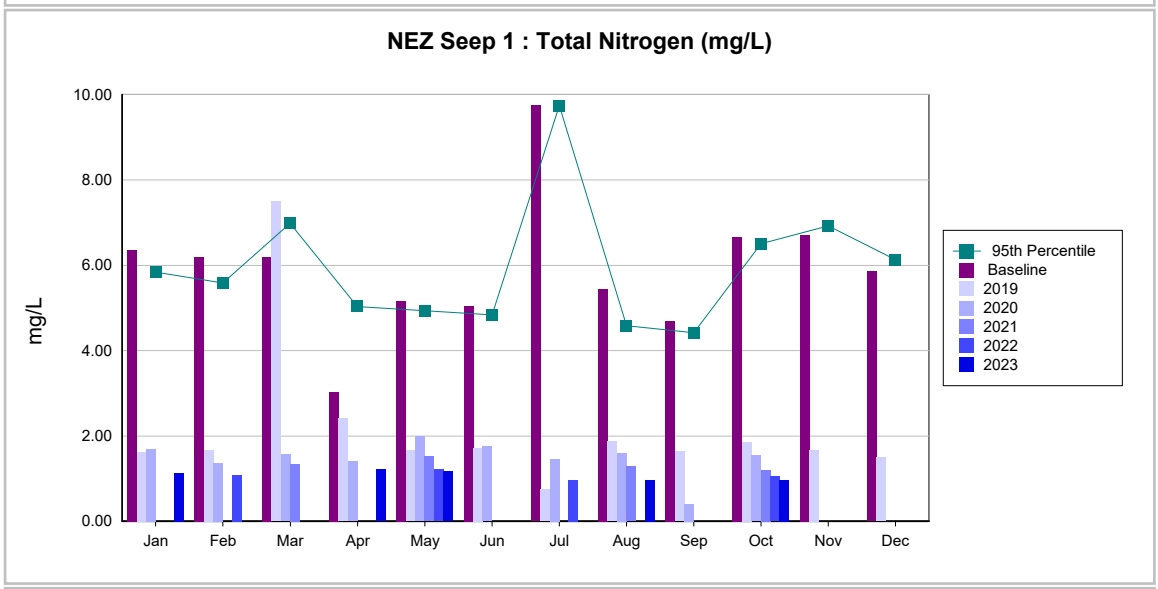
Annual Report Drainage Water

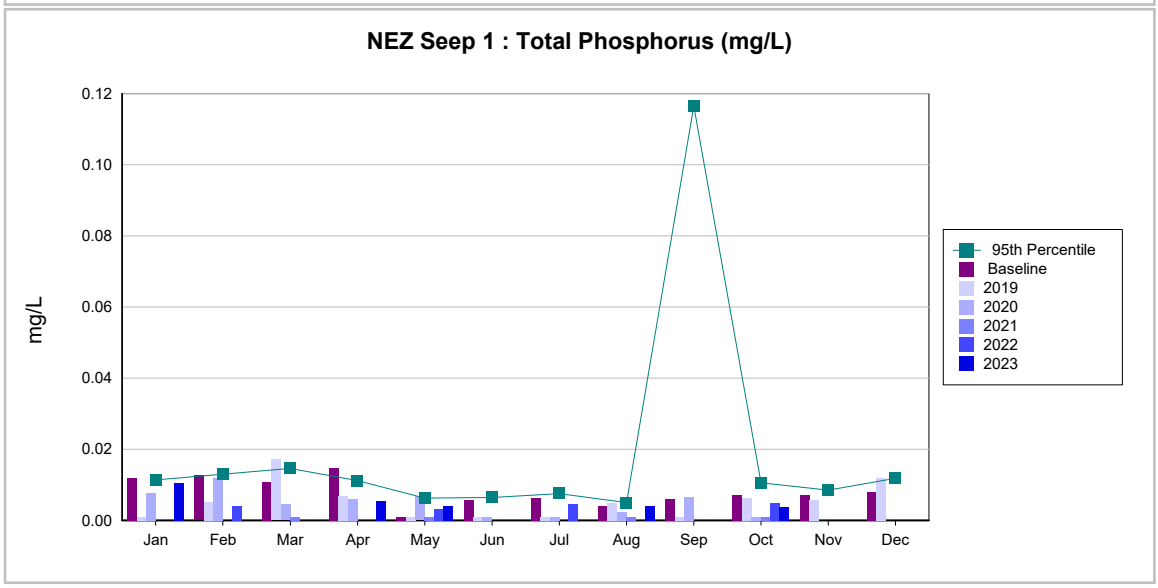
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







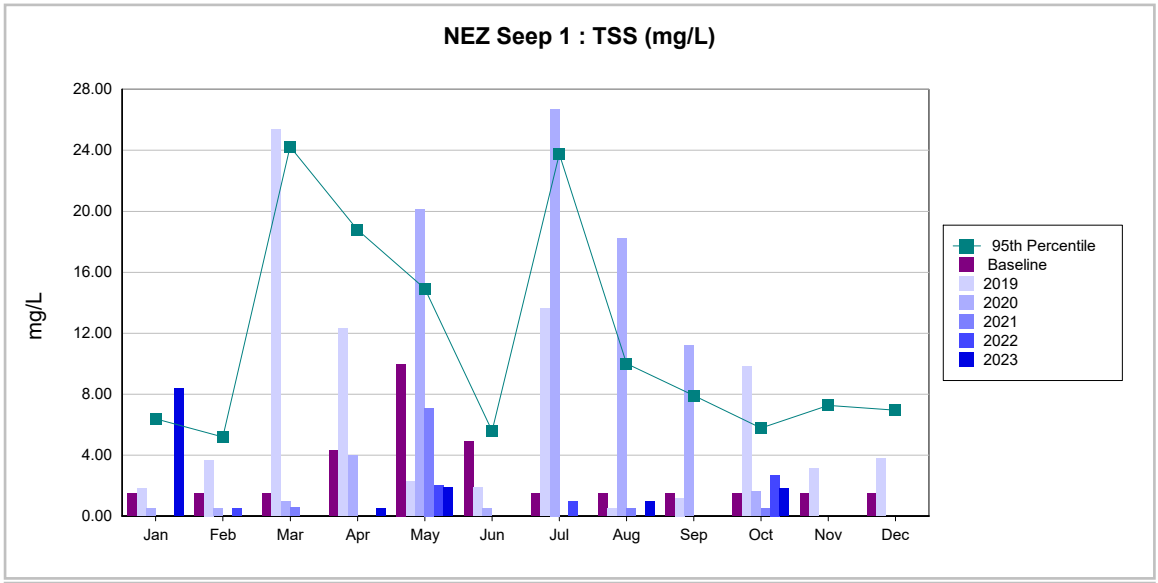
Water Quality Report

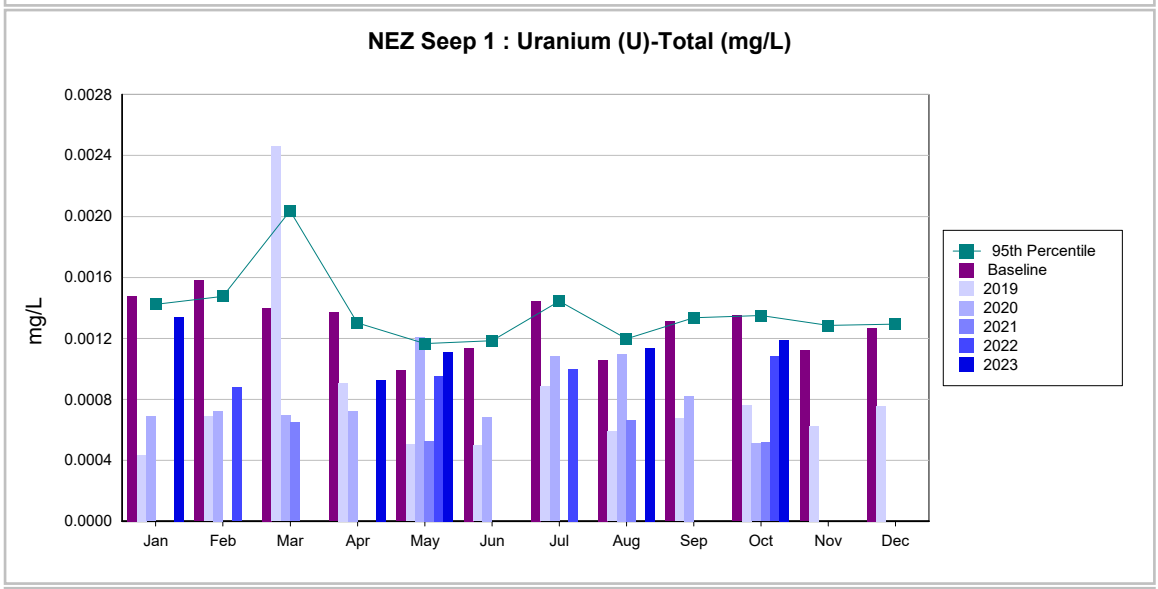
Annual Report Drainage Water

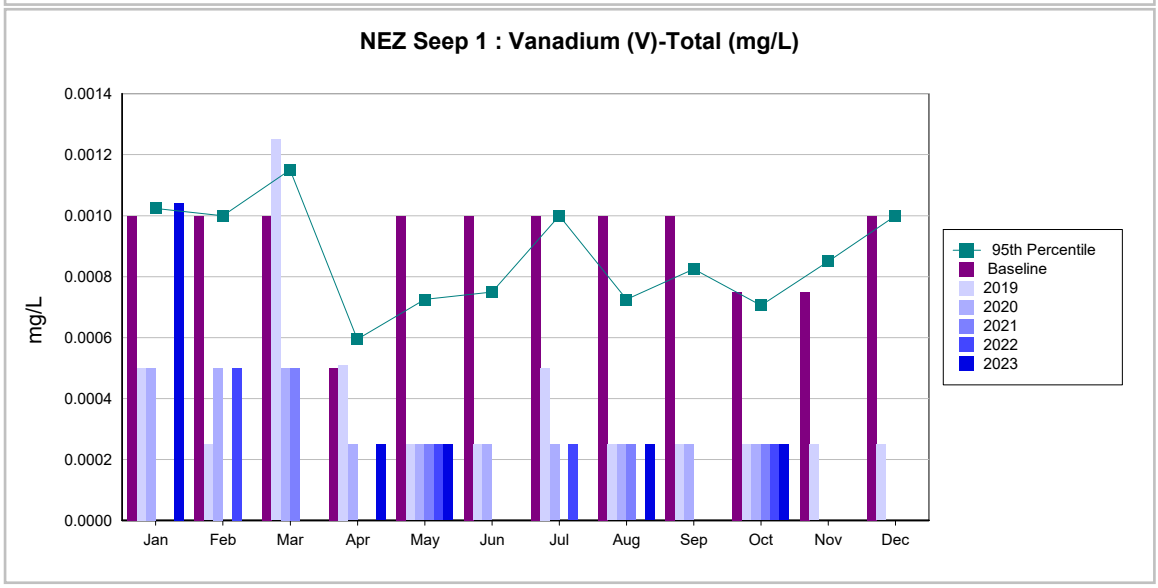
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

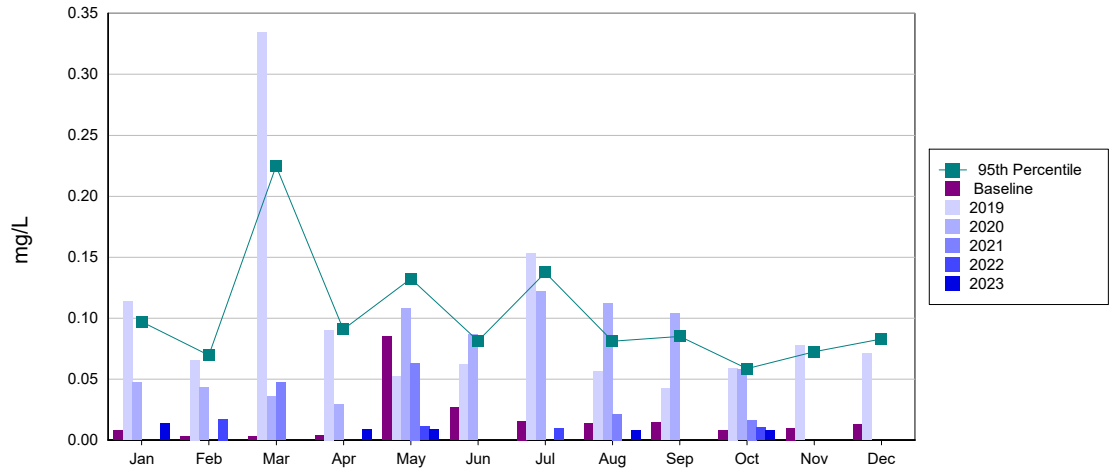
Annual Report Drainage Water

Mount Polley

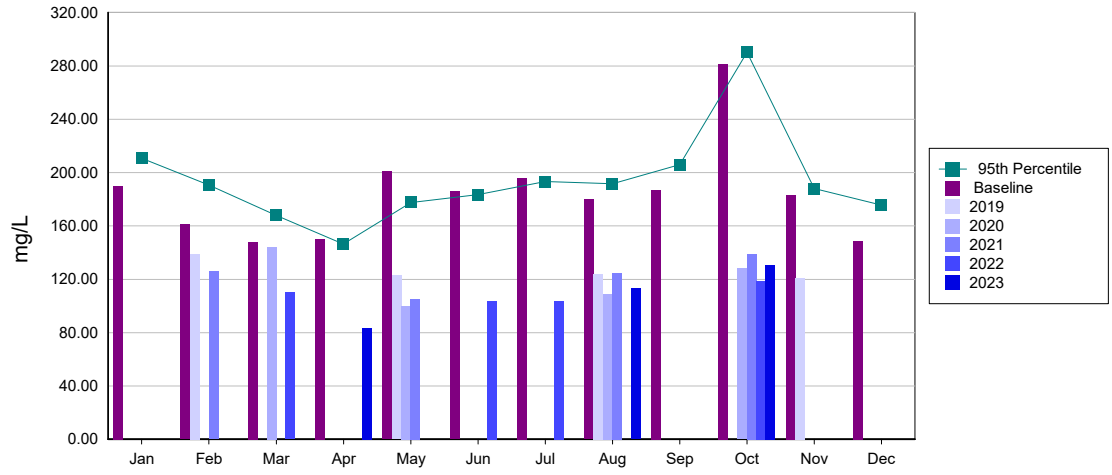
Mining Corporation

IMPERIAL METALS CORPORATION

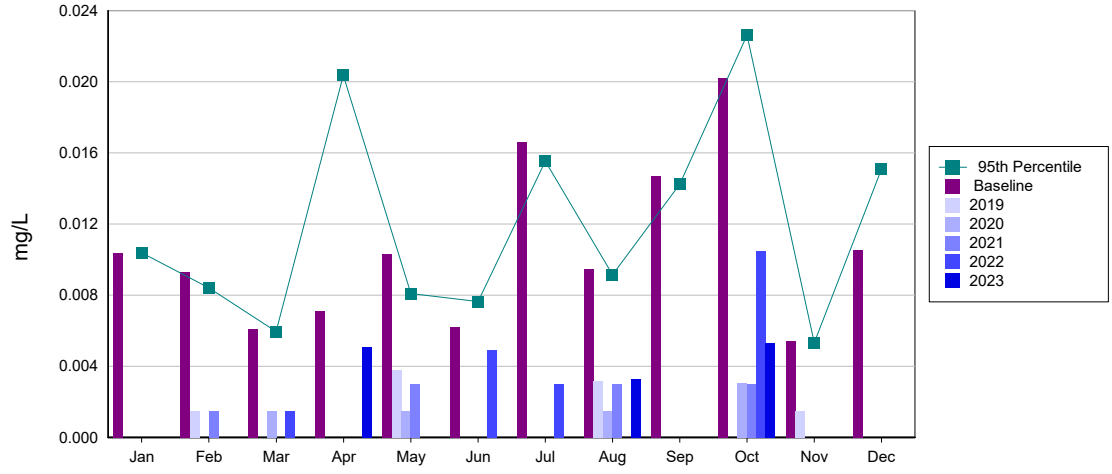
NEZ Seep 1 : Zinc (Zn)-Total (mg/L)



PAG Dump Seep 15 : Alkalinity (CaCO3) (mg/L)



PAG Dump Seep 15 : Aluminum (Al)-Diss (mg/L)



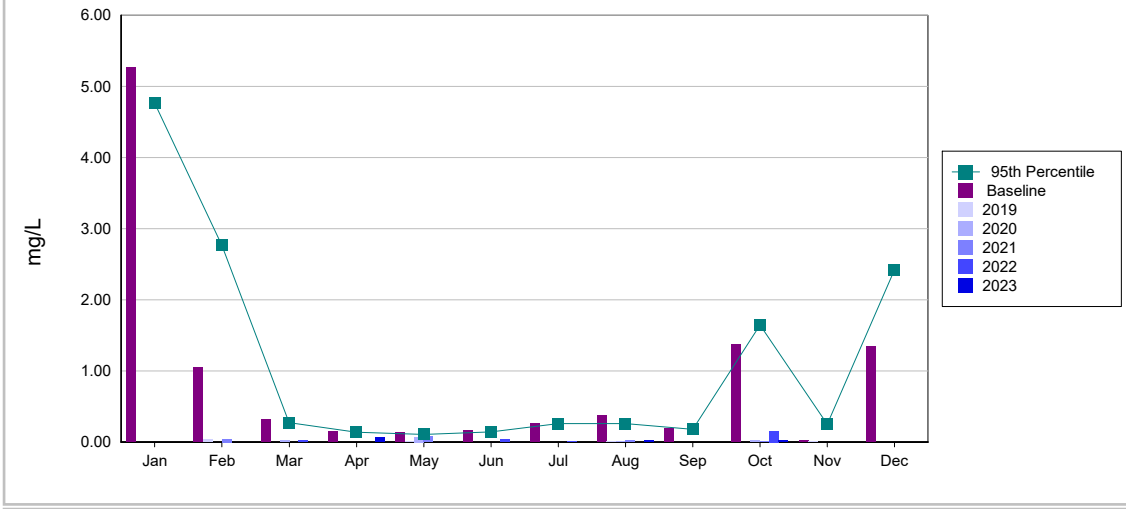
Water Quality Report

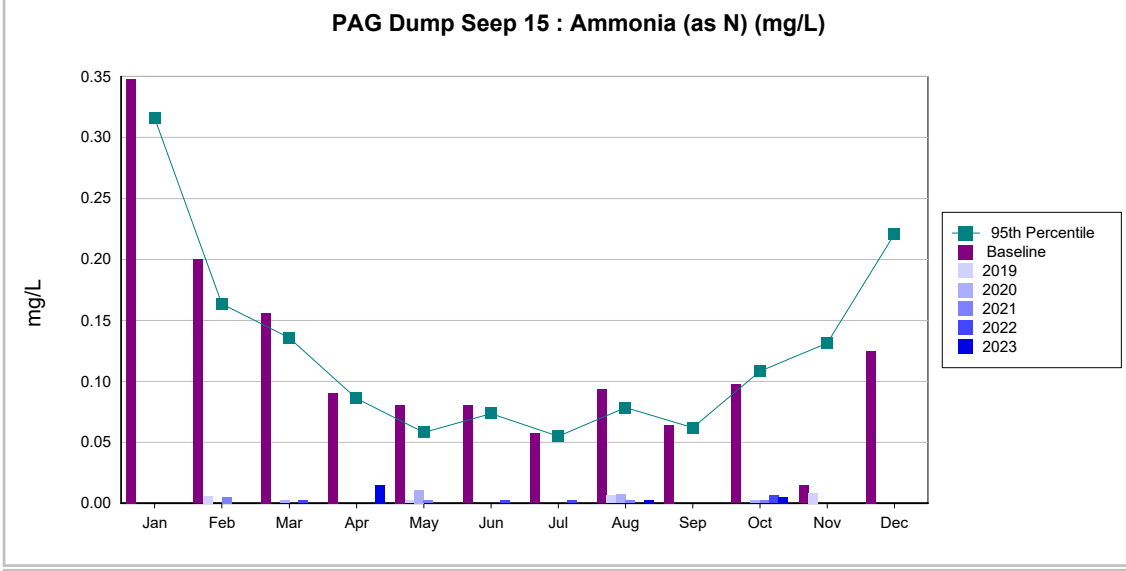
Annual Report Drainage Water

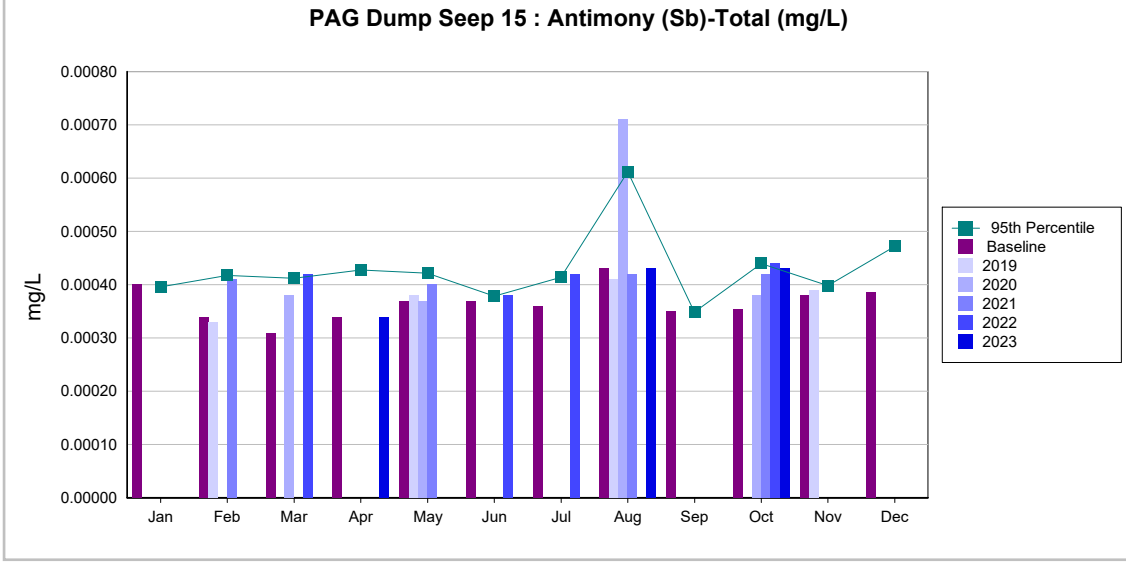
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







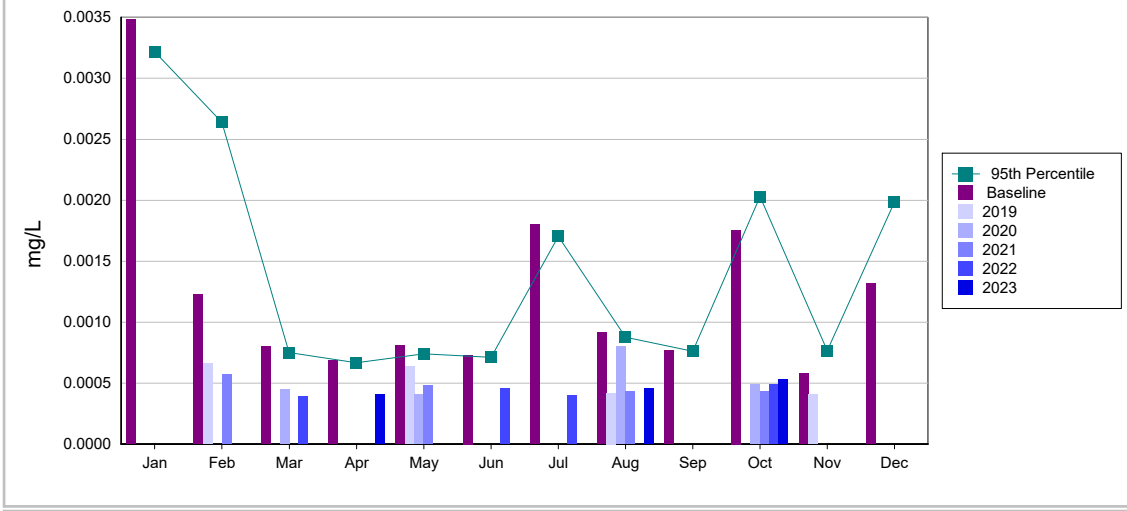
Water Quality Report

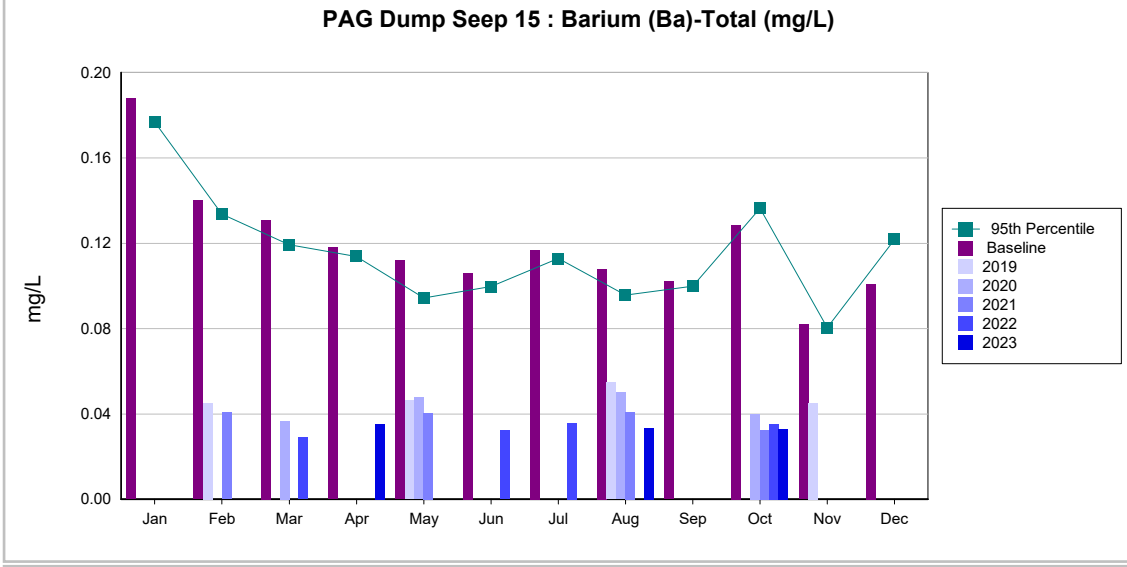
Annual Report Drainage Water

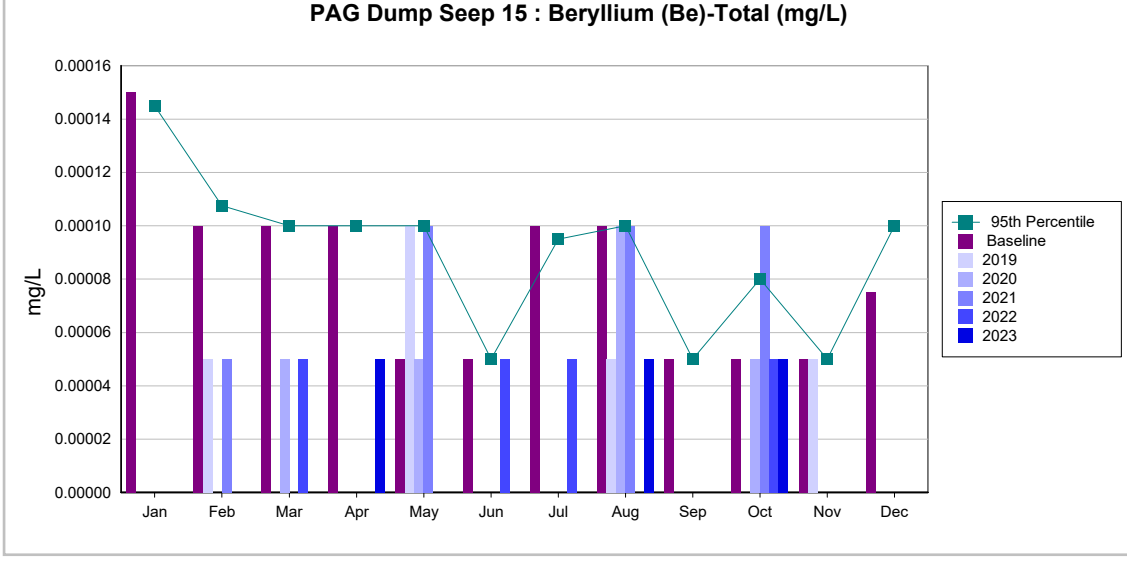
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







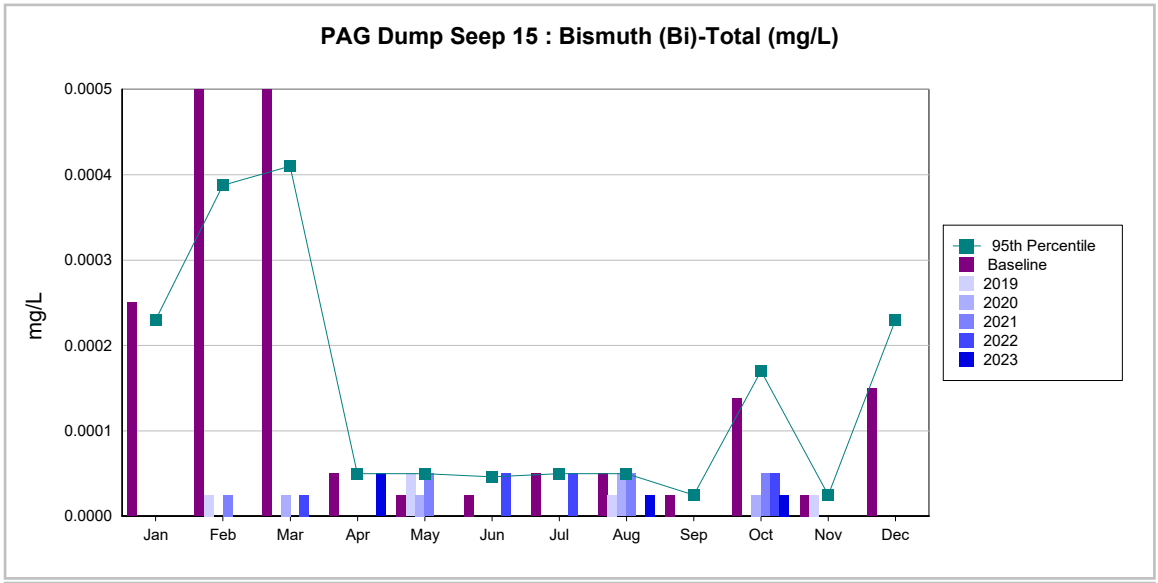
Water Quality Report

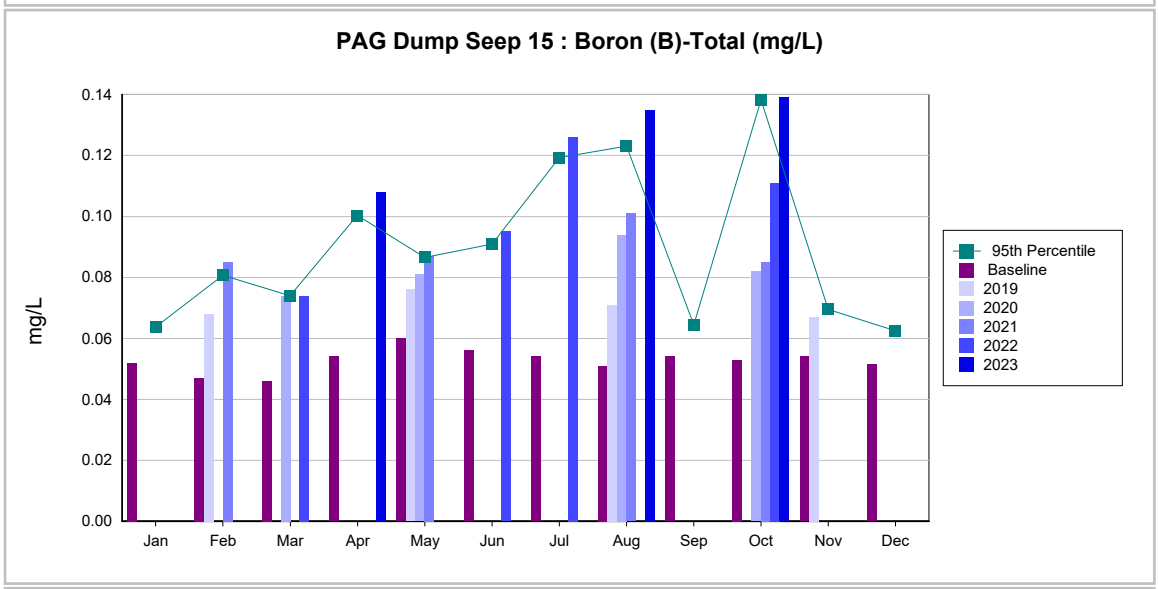
Annual Report Drainage Water

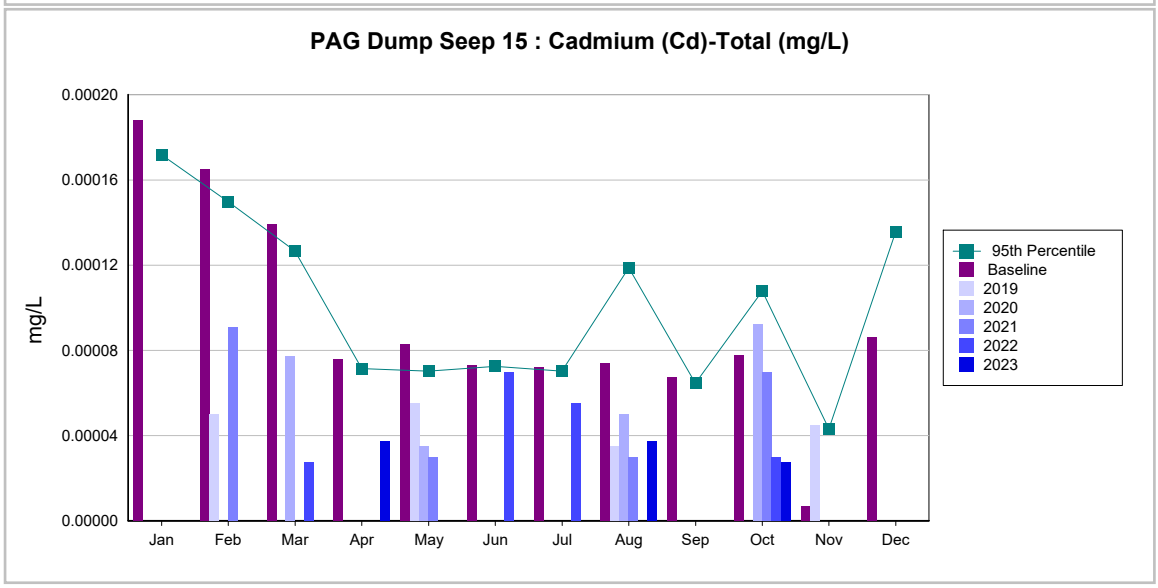
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

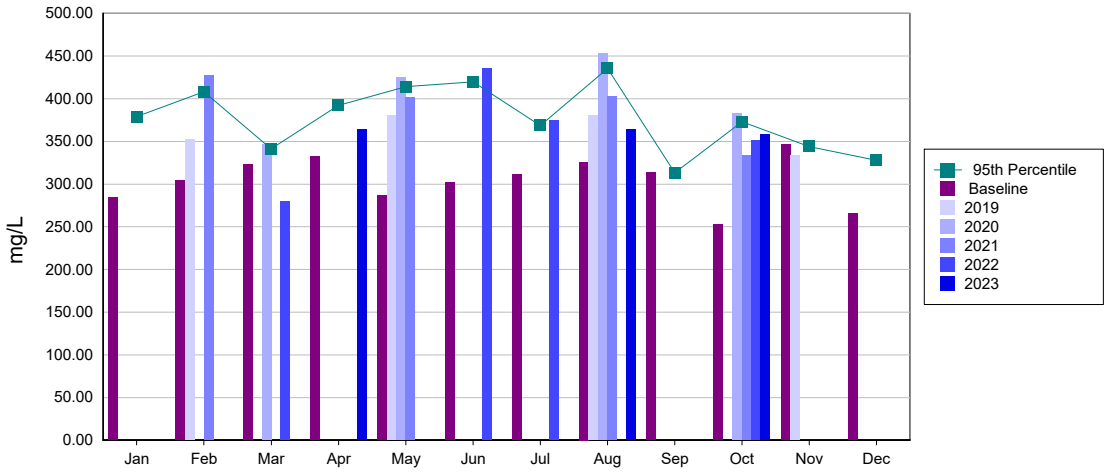
Annual Report Drainage Water

Mount Polley

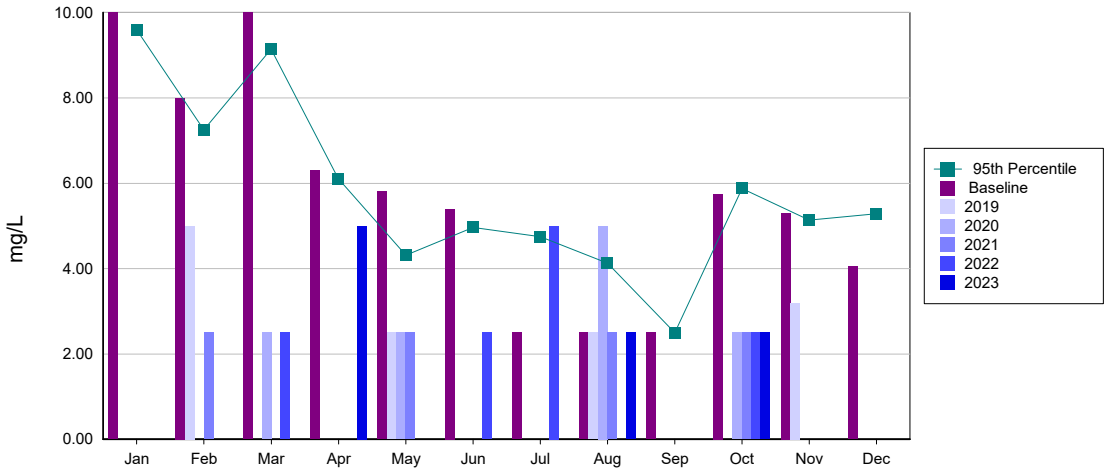
Mining Corporation

IMPERIAL METALS CORPORATION

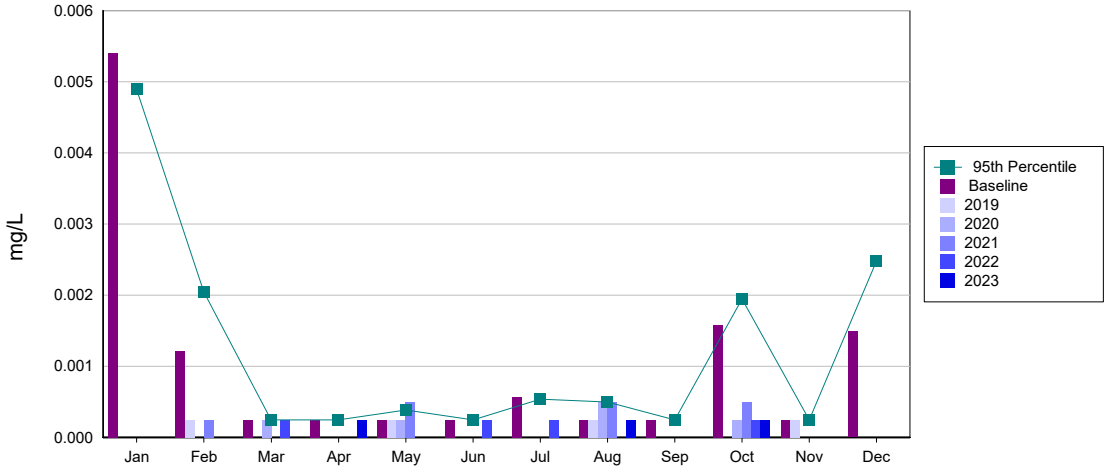
PAG Dump Seep 15 : Calcium (Ca)-Total (mg/L)



PAG Dump Seep 15 : Chloride (mg/L)



PAG Dump Seep 15 : Chromium (Cr)-Total (mg/L)



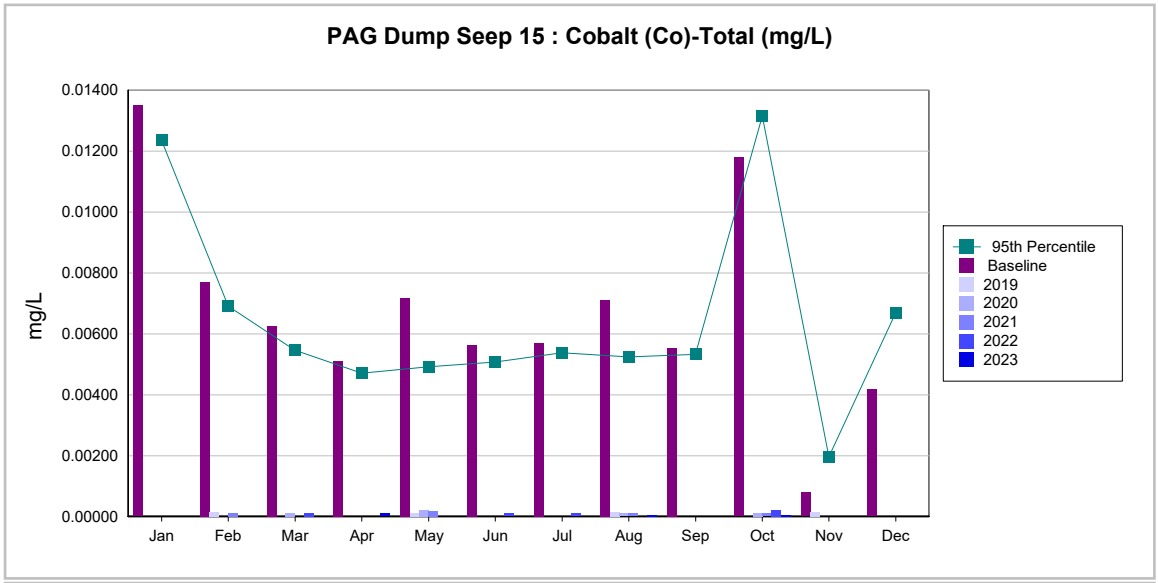
Water Quality Report

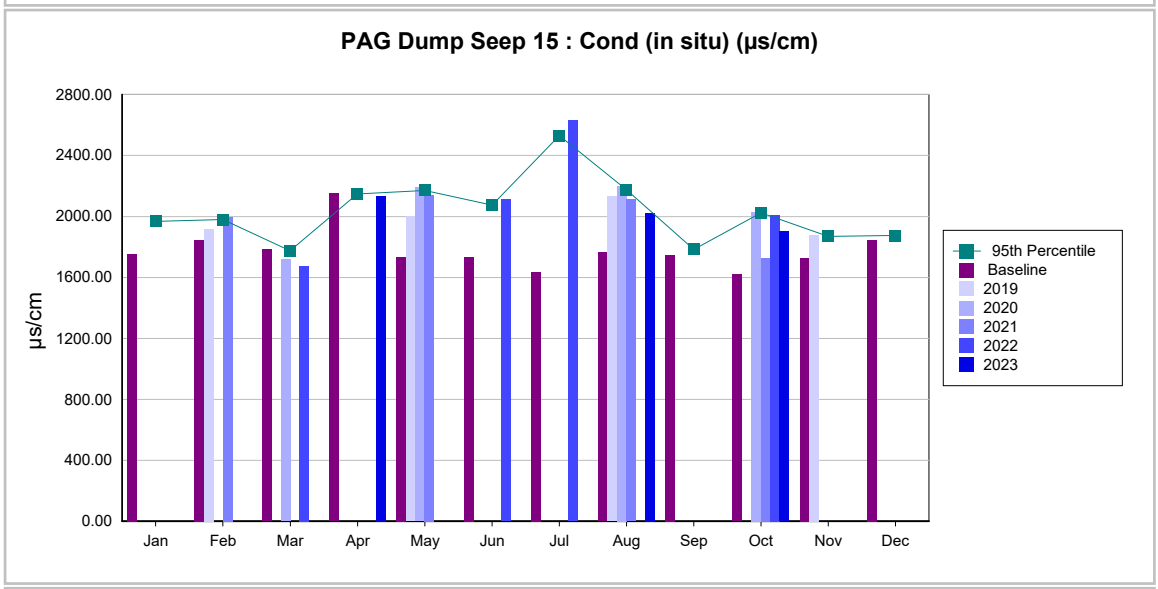
Annual Report Drainage Water

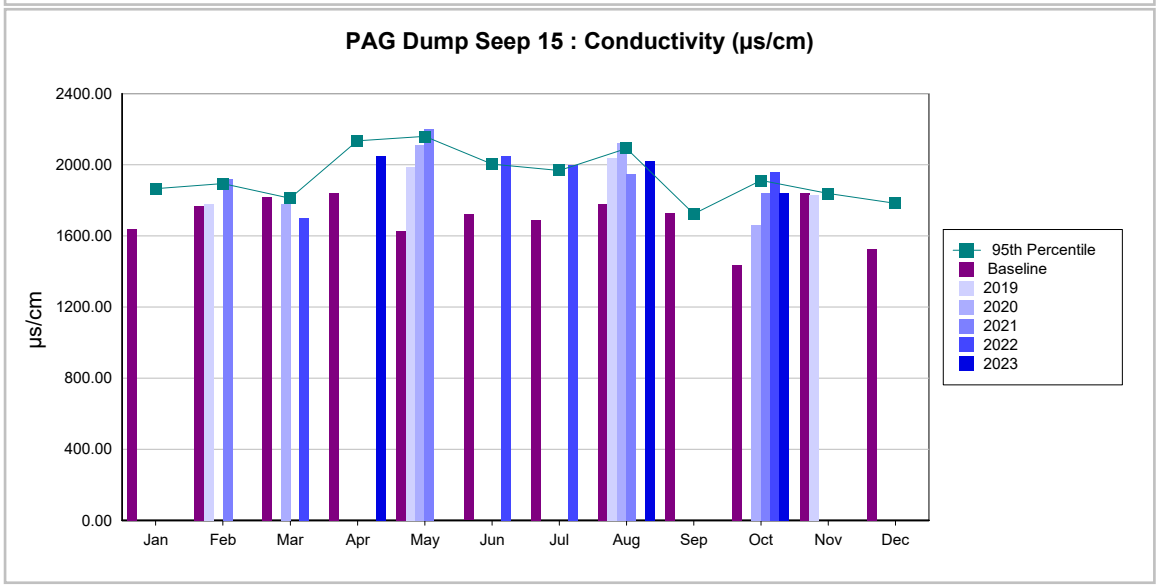
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







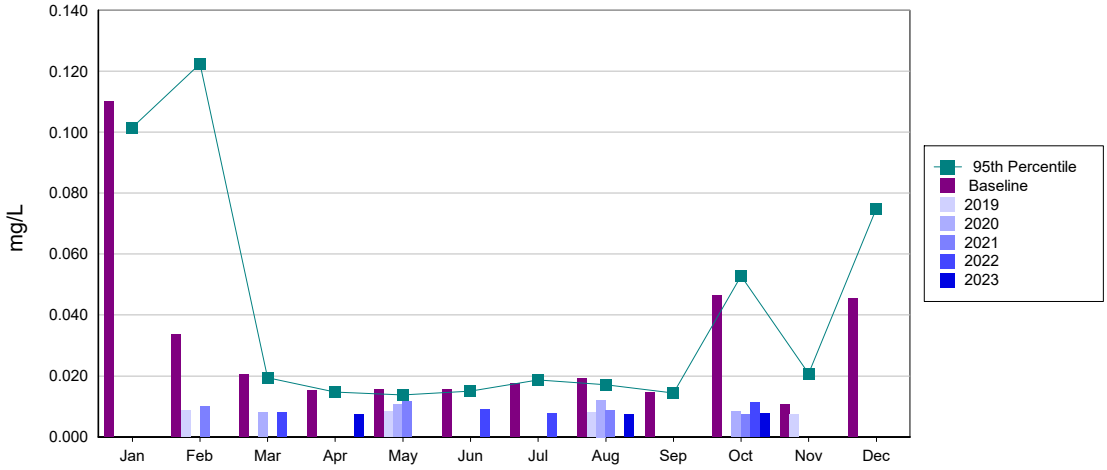
Water Quality Report

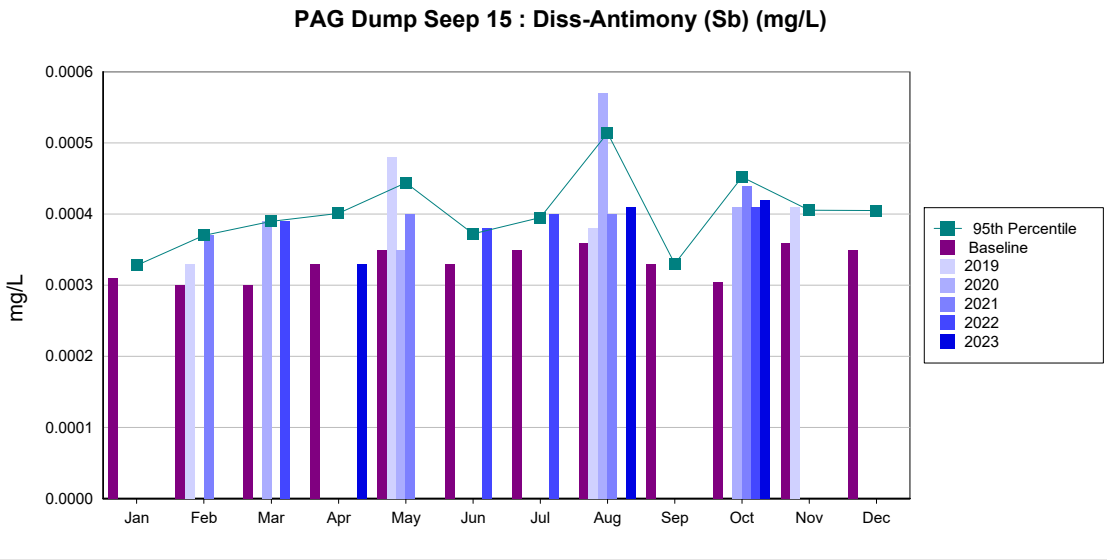
Annual Report Drainage Water

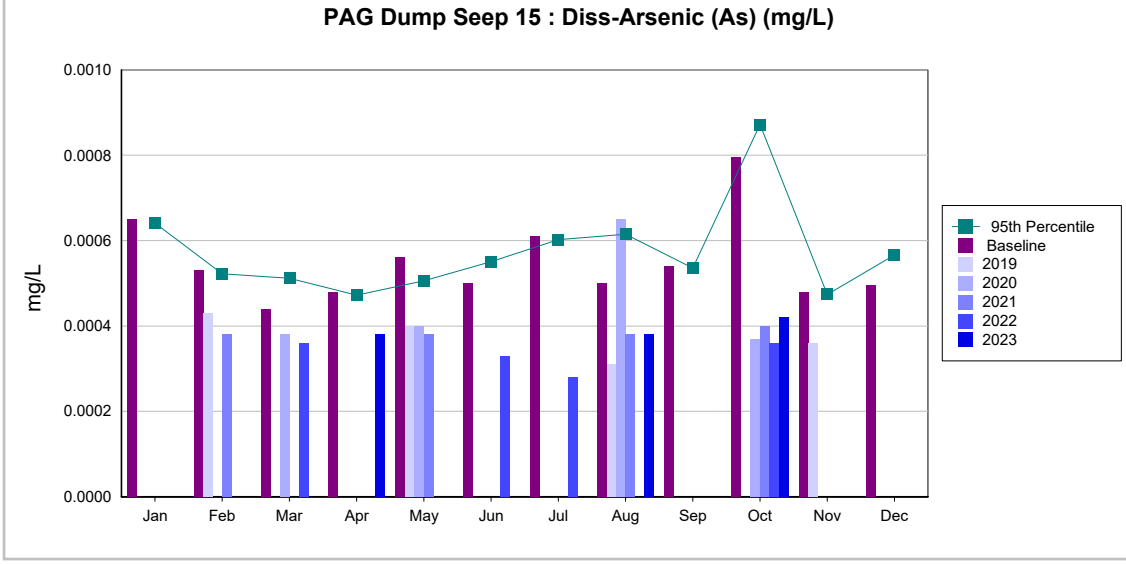
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







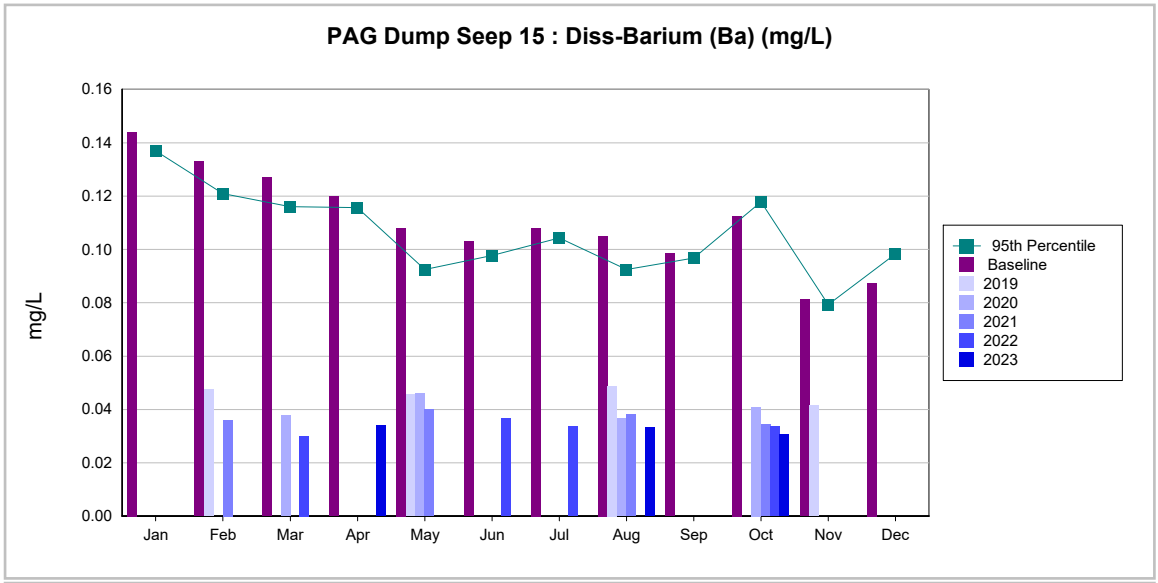
Water Quality Report

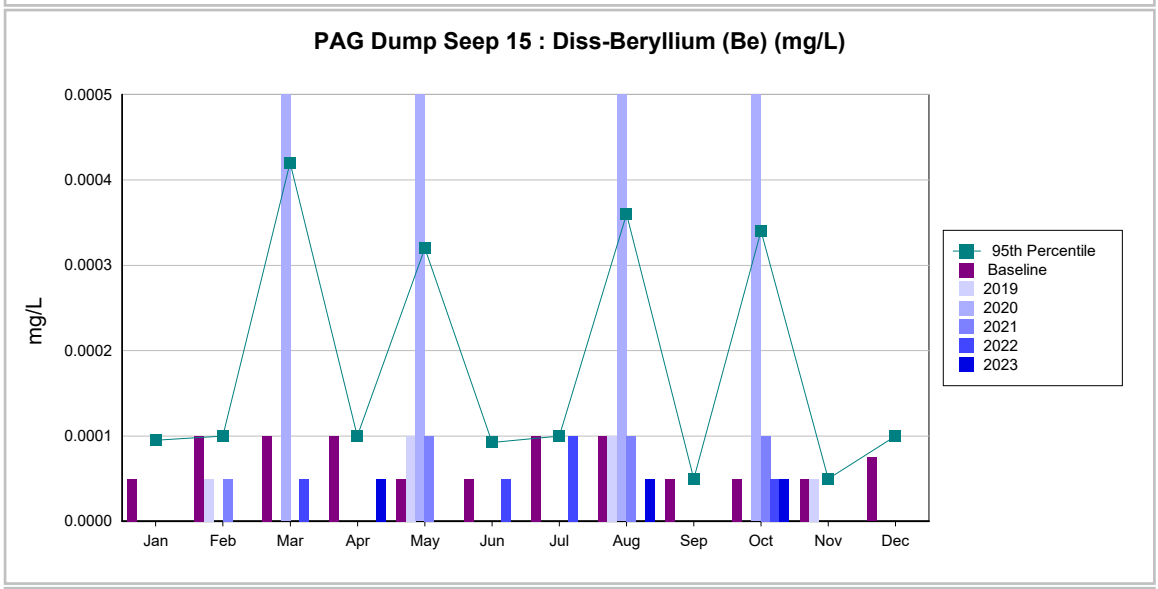
Annual Report Drainage Water

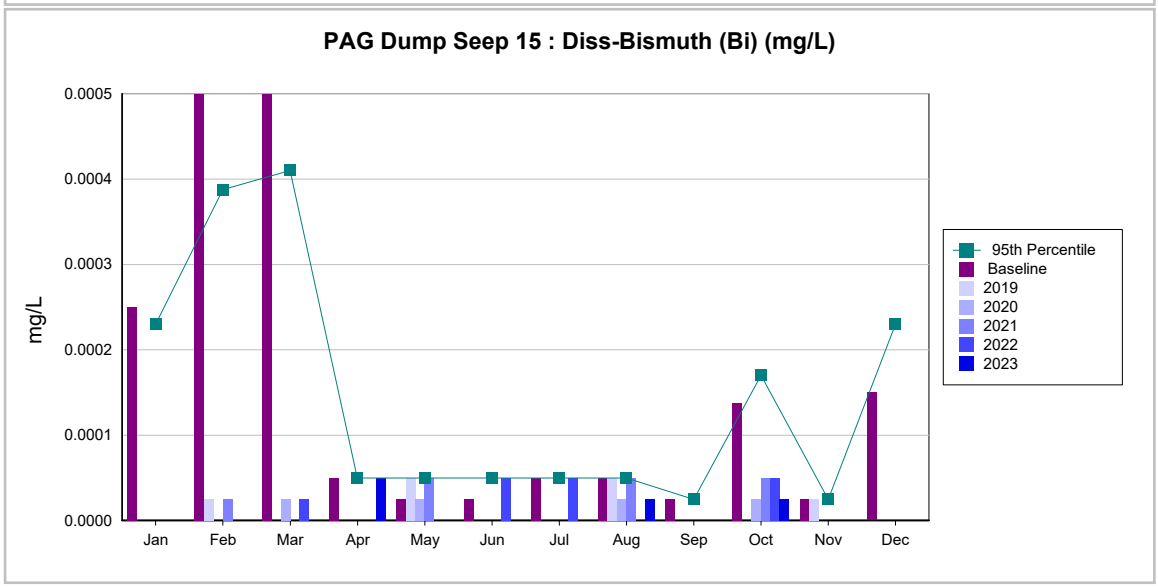
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







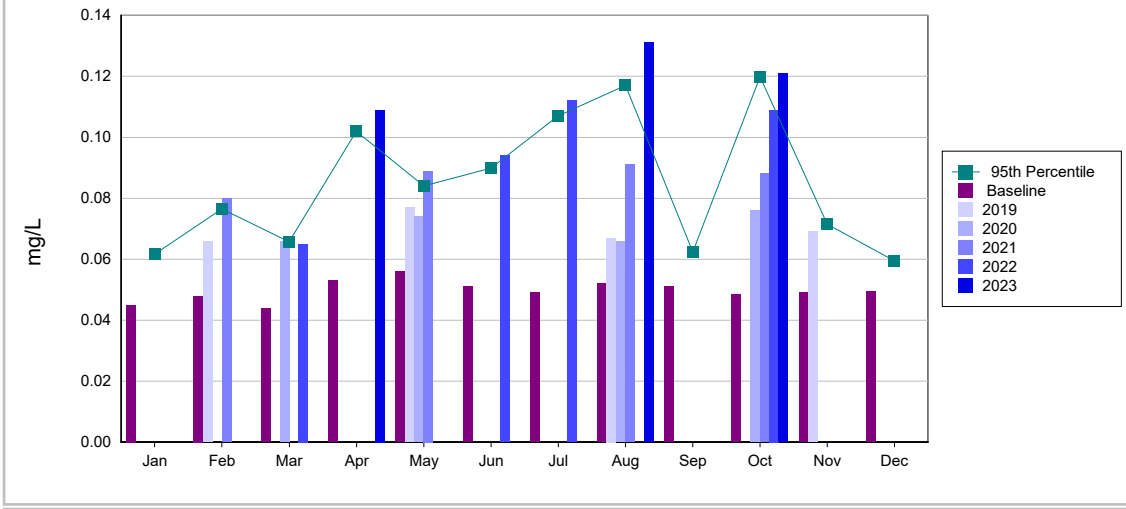
Water Quality Report

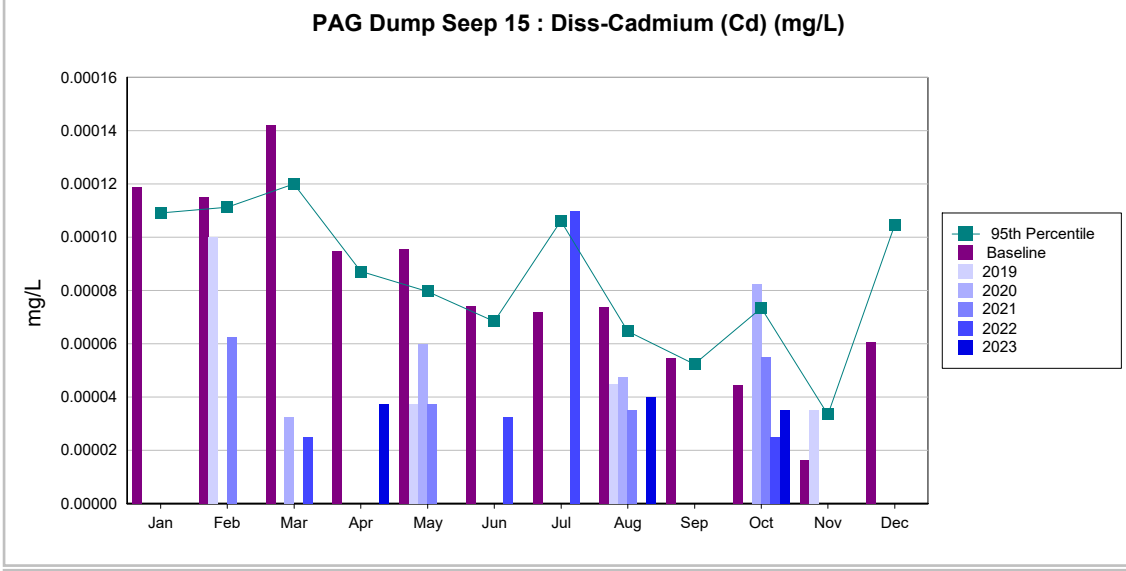
Annual Report Drainage Water

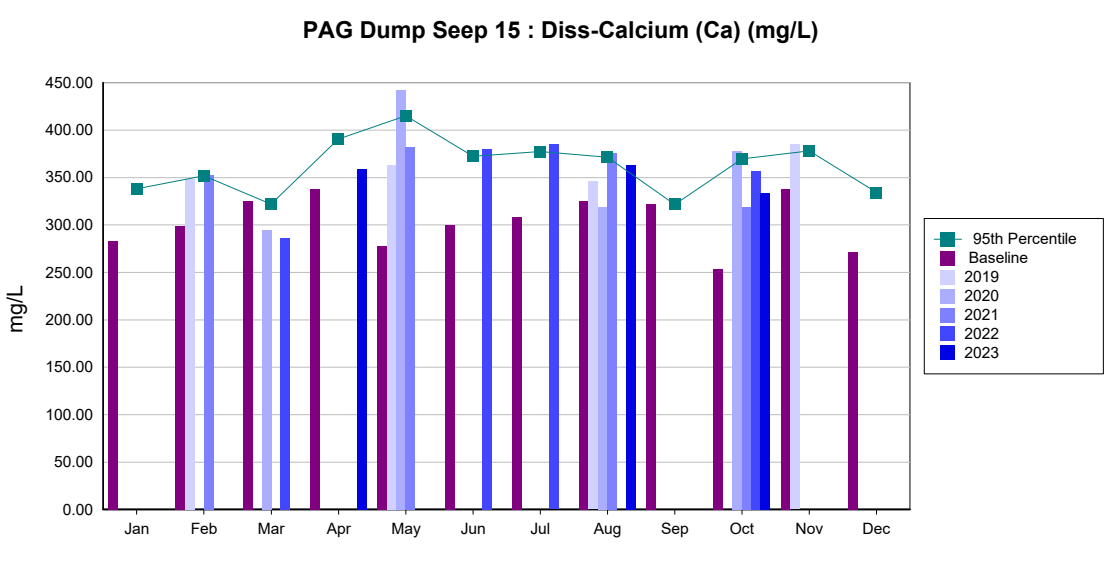
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







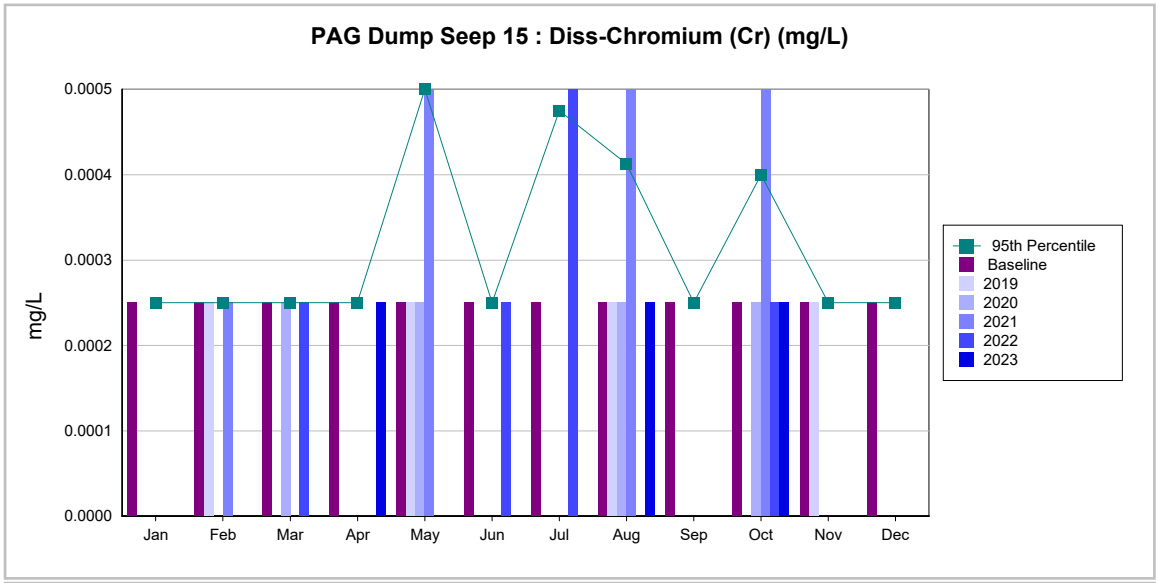
Water Quality Report

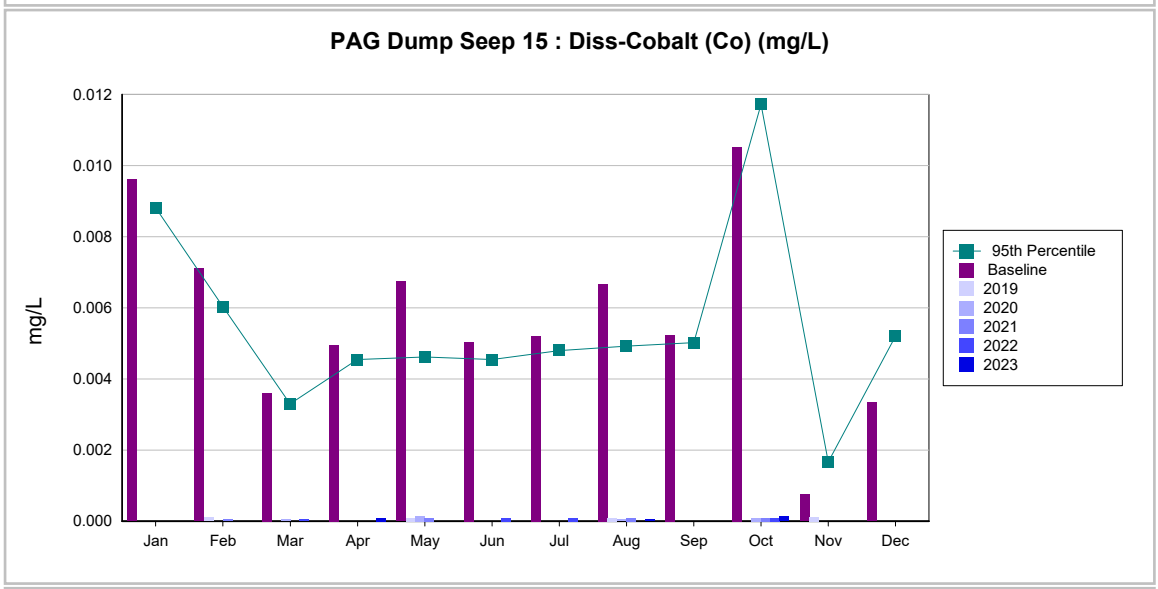
Annual Report Drainage Water

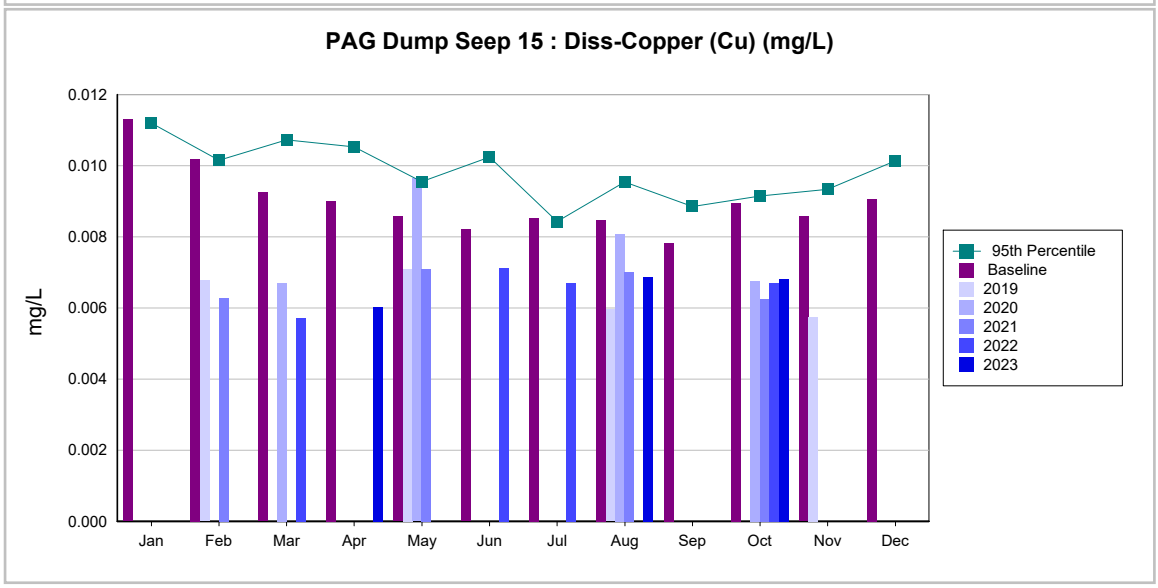
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







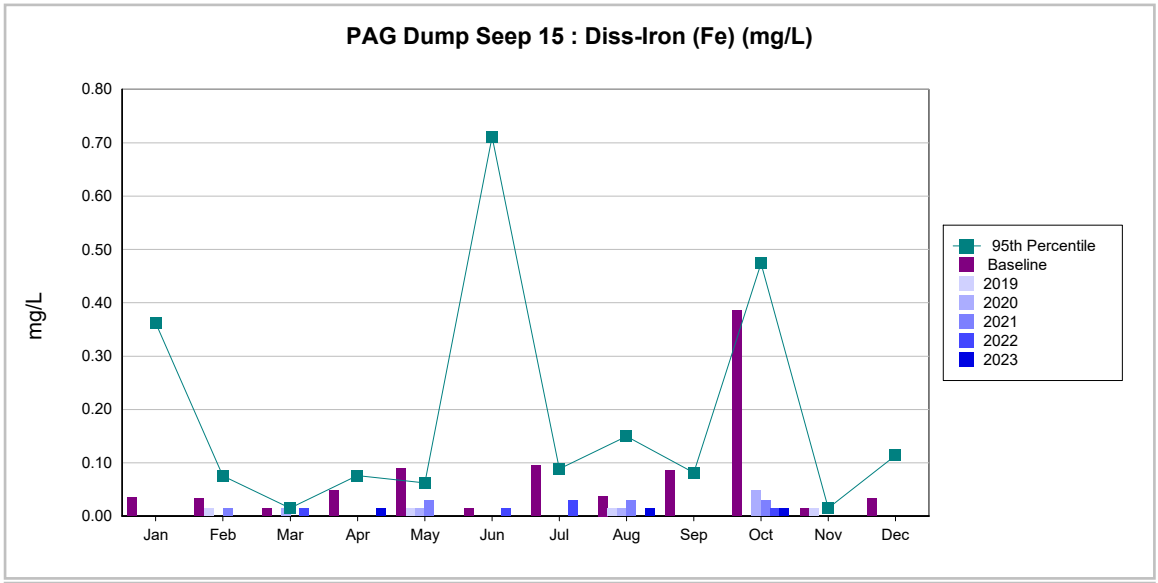
Water Quality Report

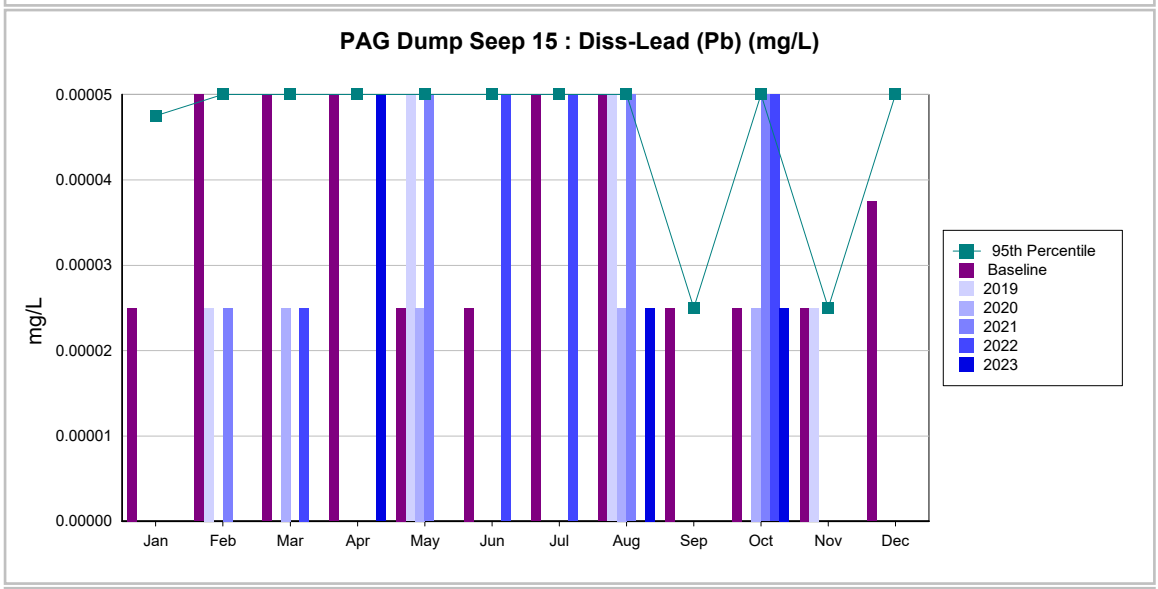
Annual Report Drainage Water

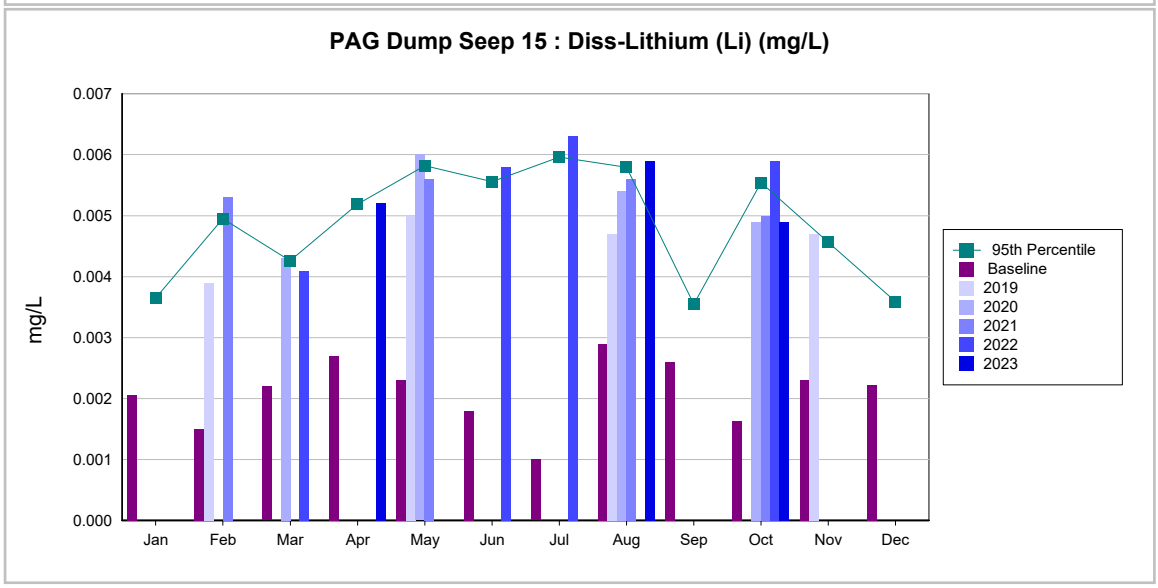
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







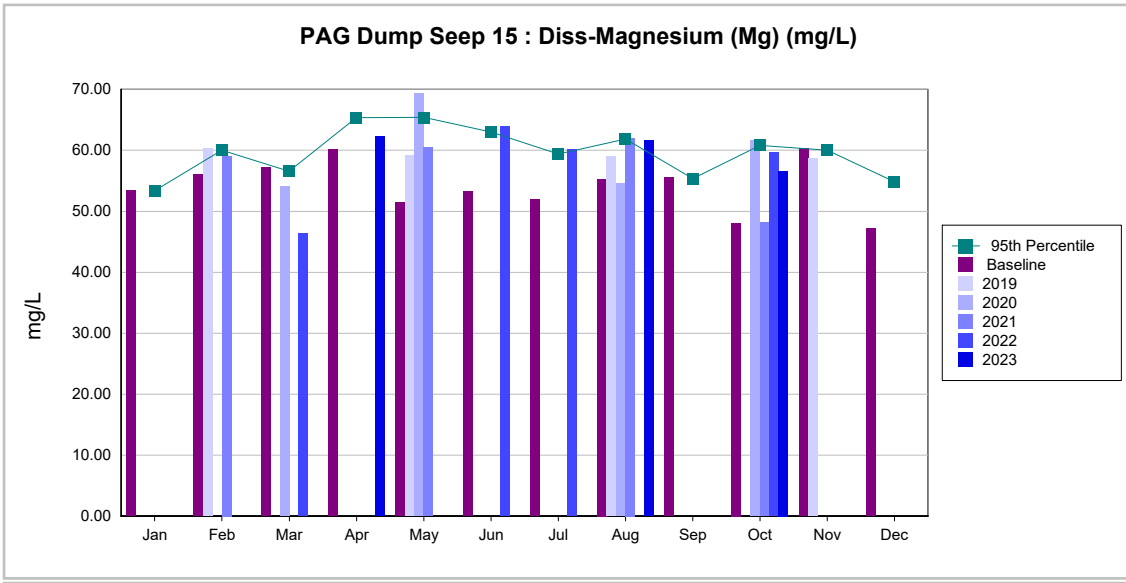
Water Quality Report

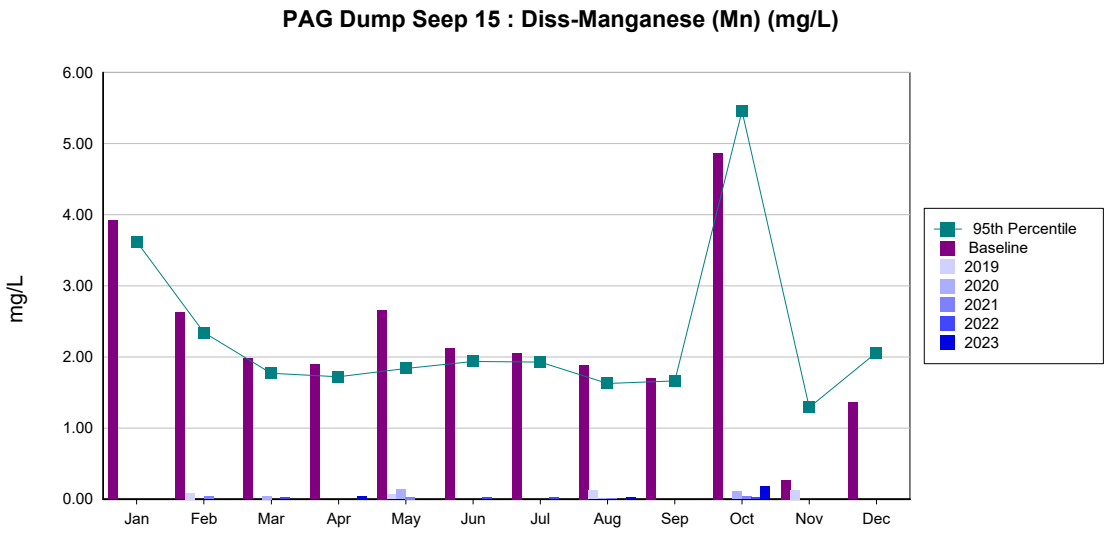
Annual Report Drainage Water

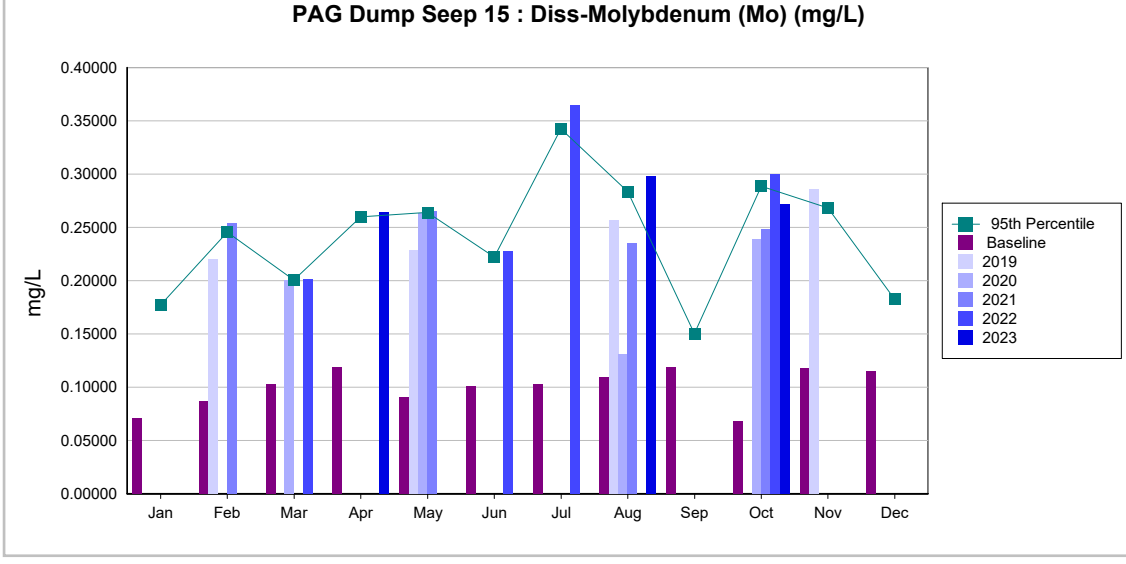
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







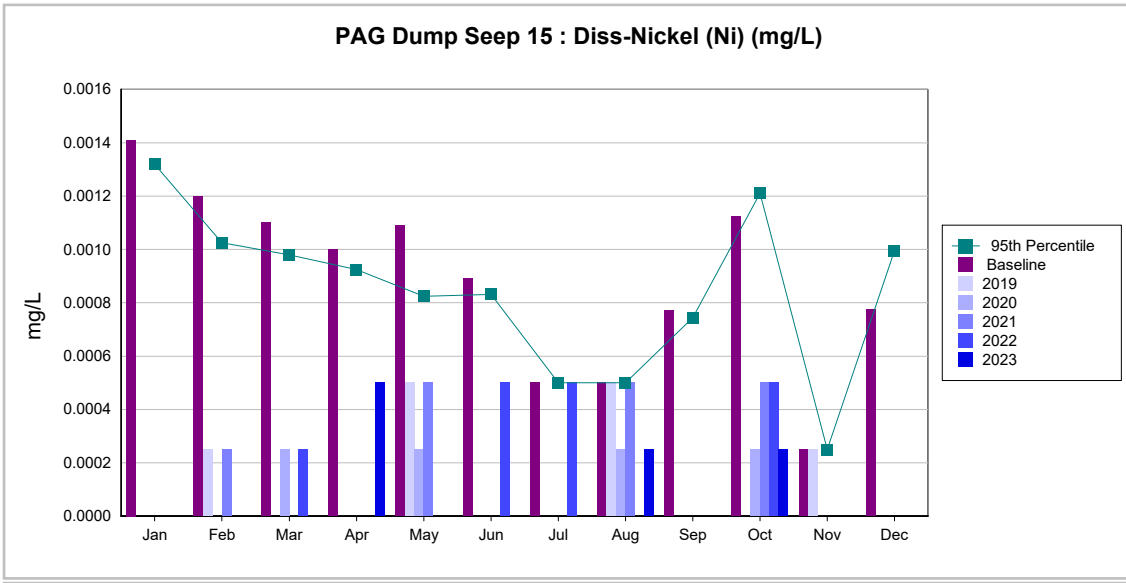
Water Quality Report

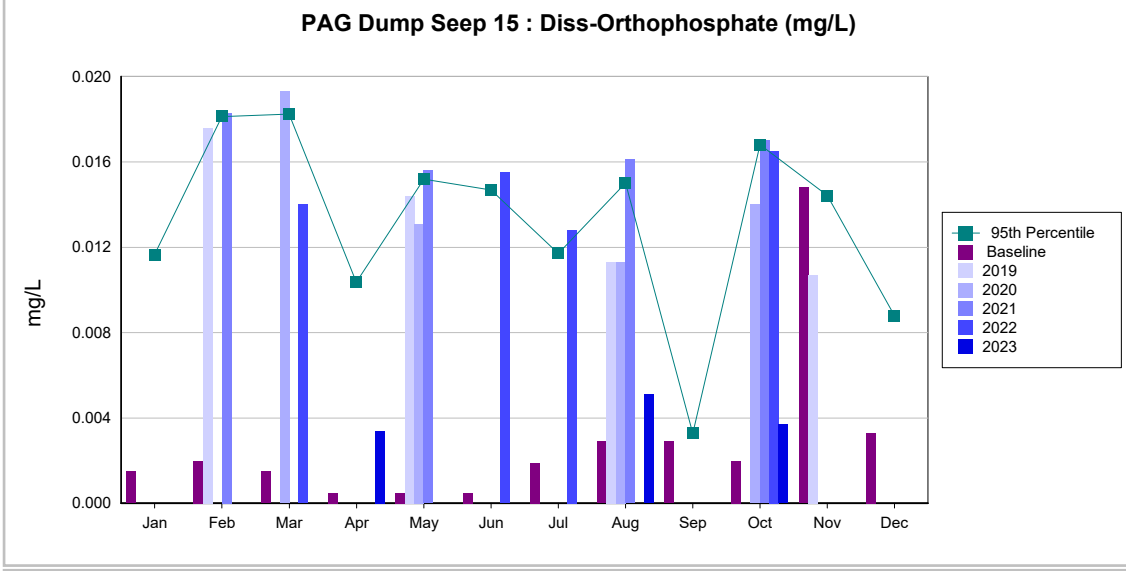
Annual Report Drainage Water

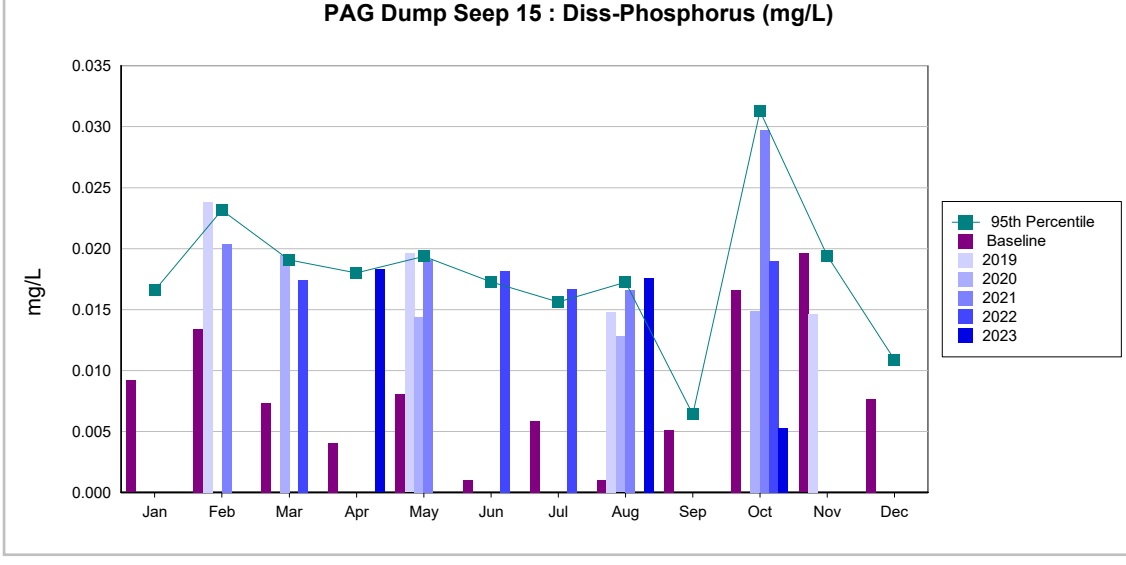
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







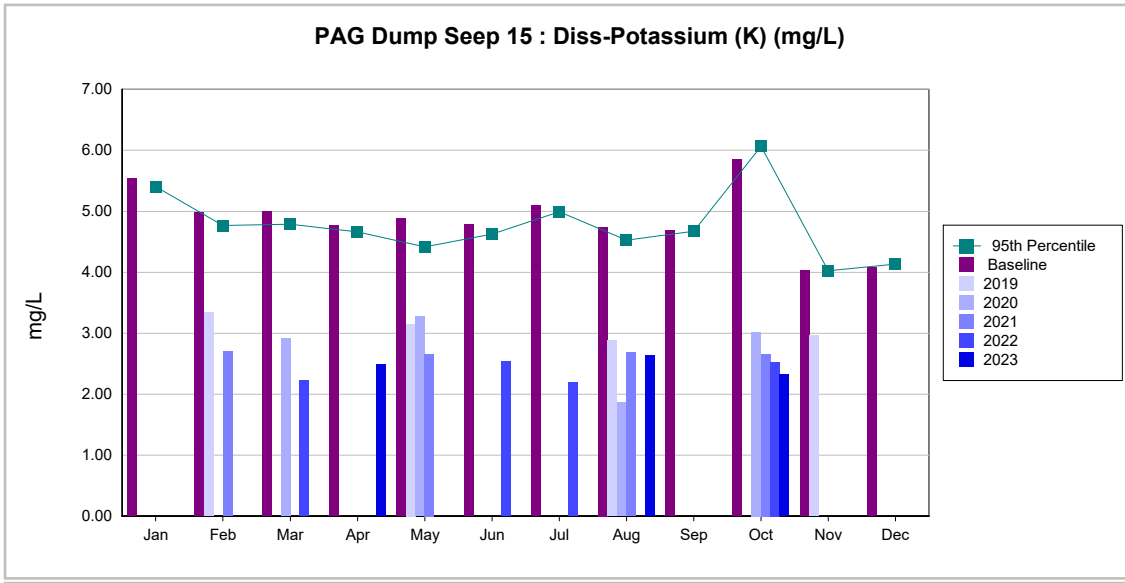
Water Quality Report

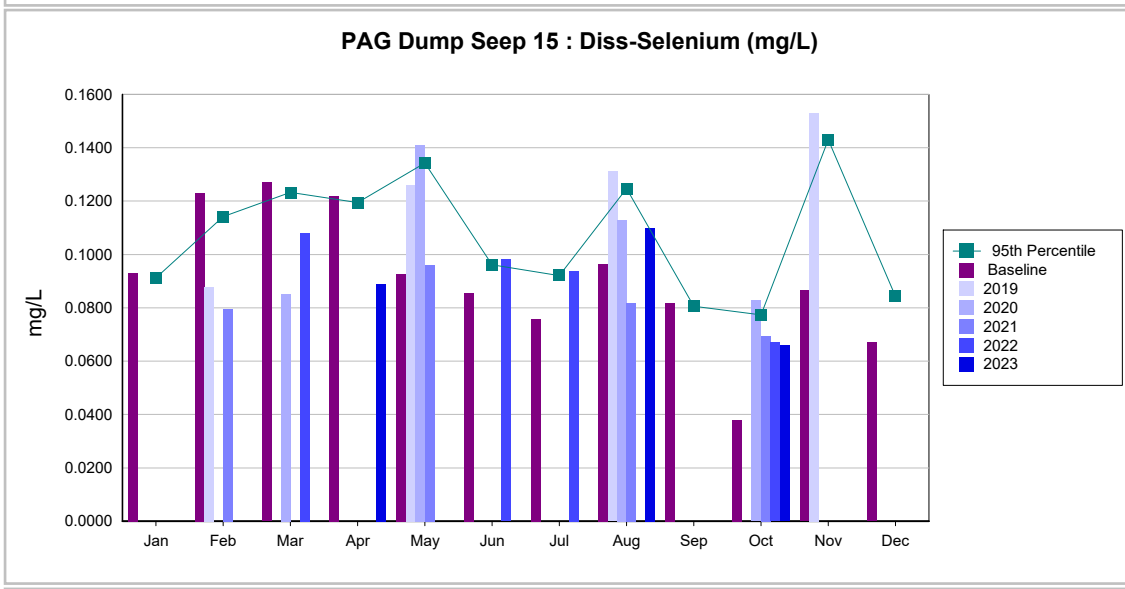
Annual Report Drainage Water

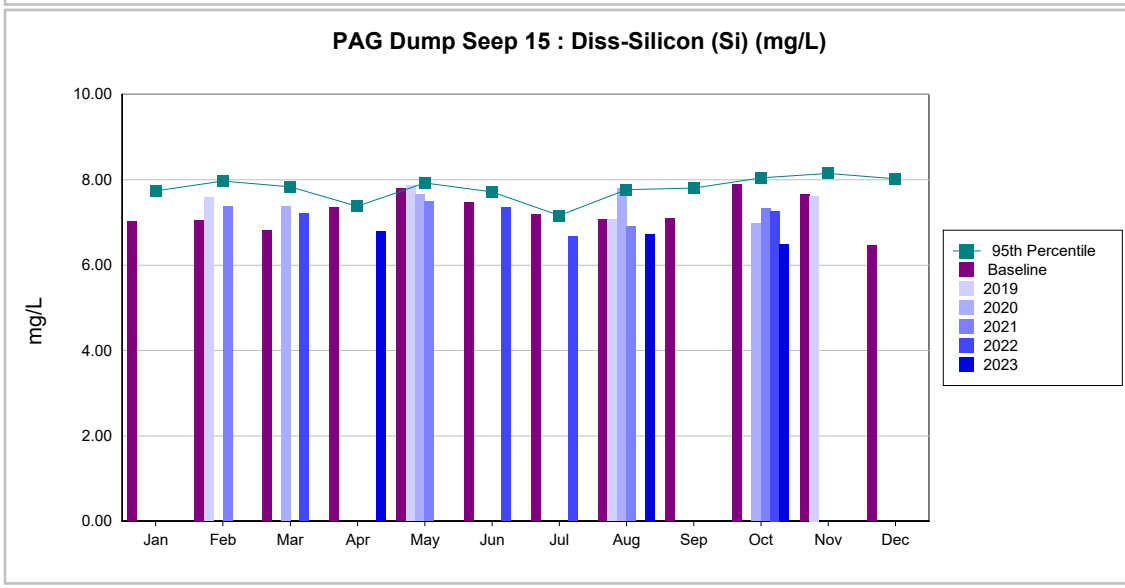
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







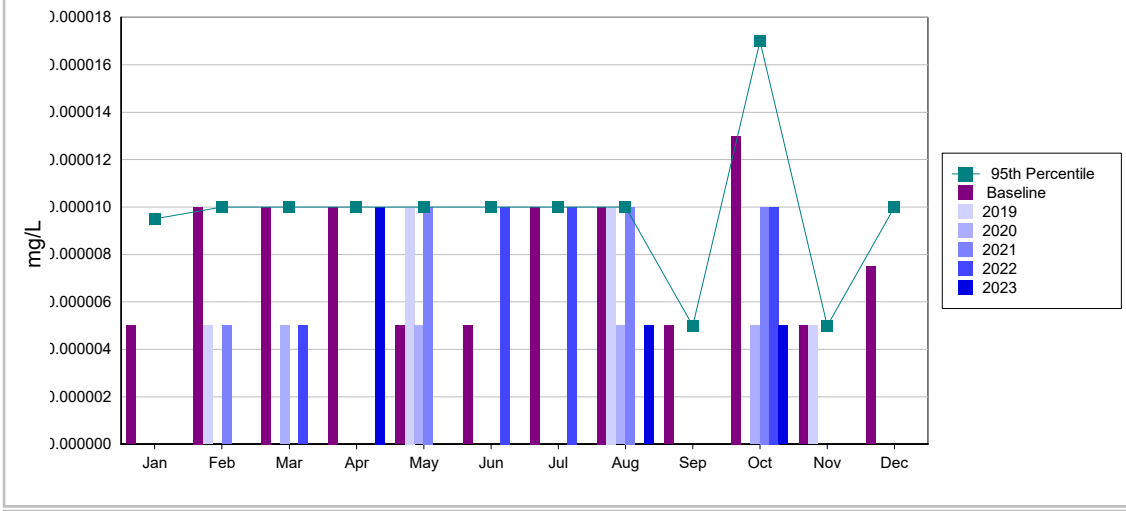
Water Quality Report

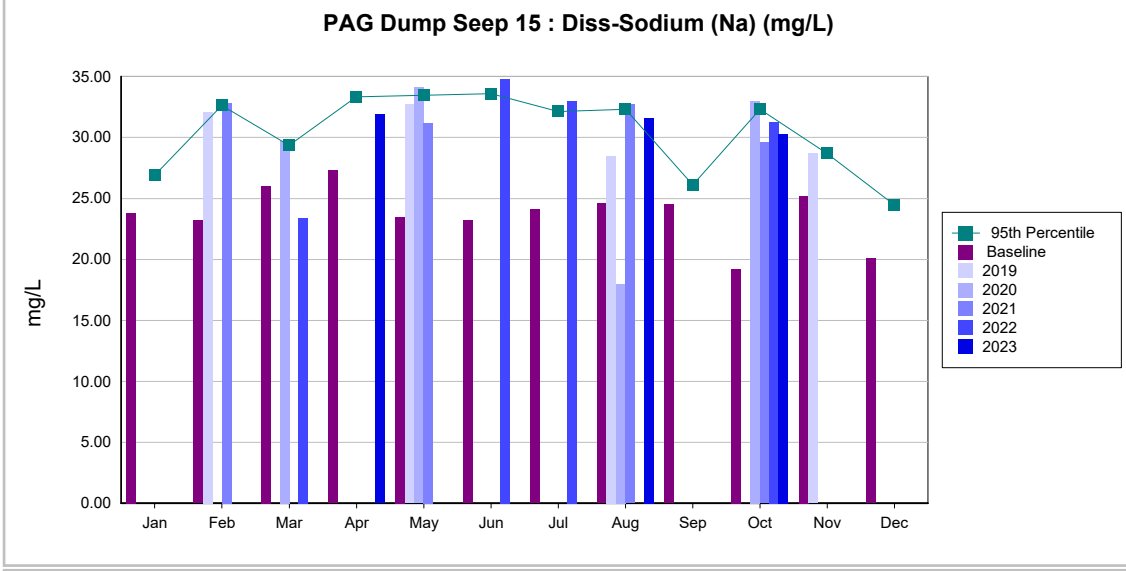
Annual Report Drainage Water

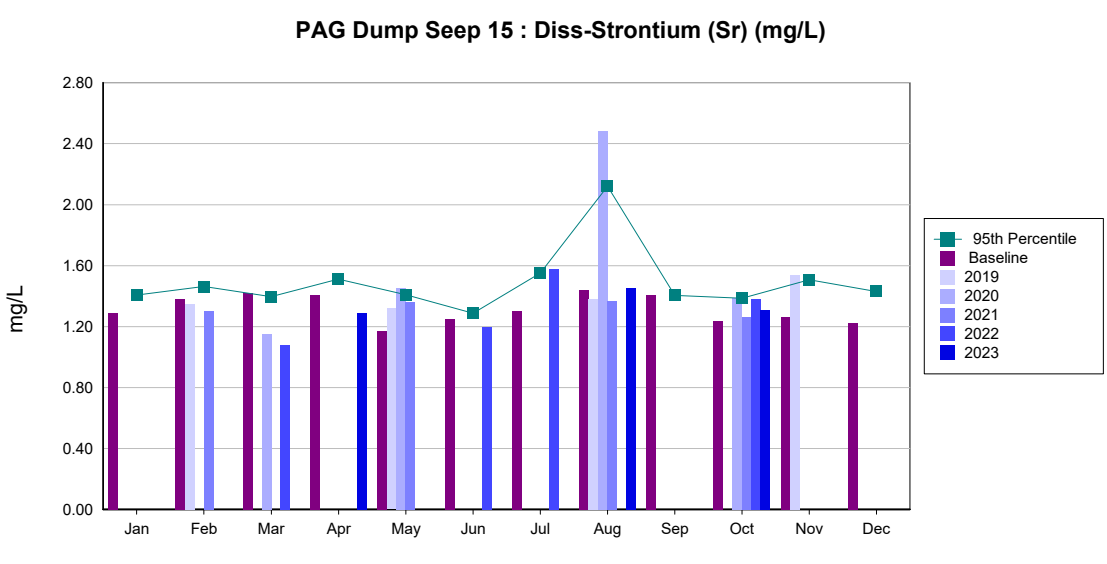
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







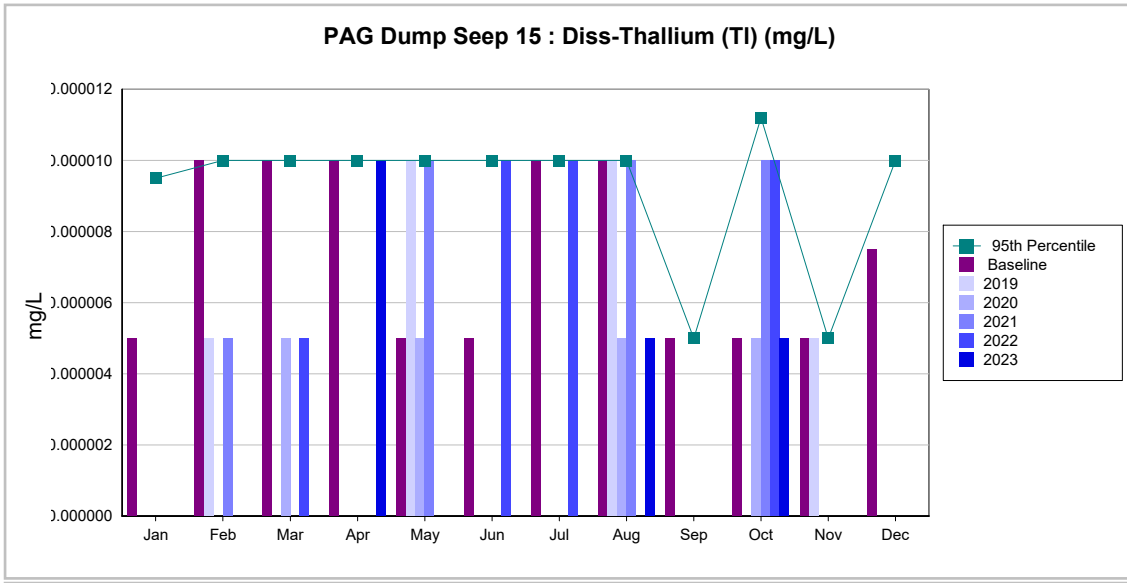
Water Quality Report

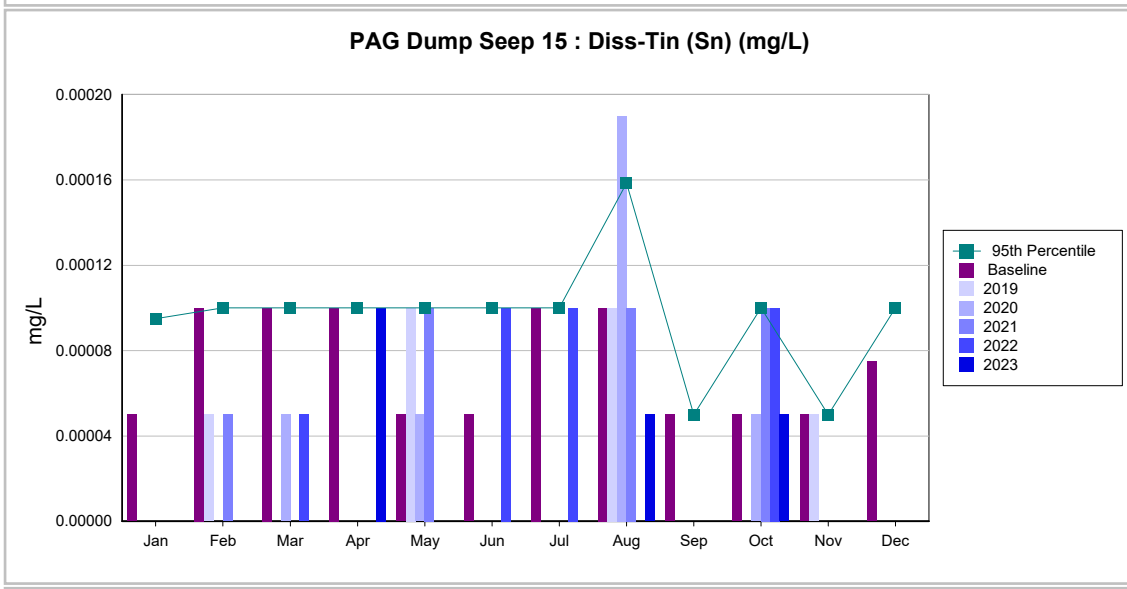
Annual Report Drainage Water

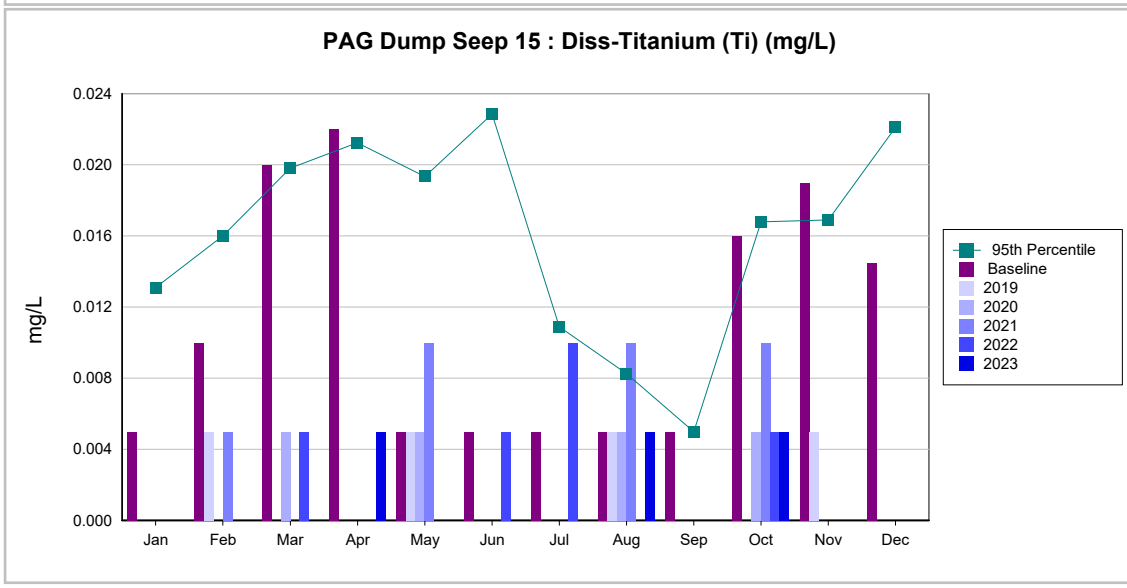
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







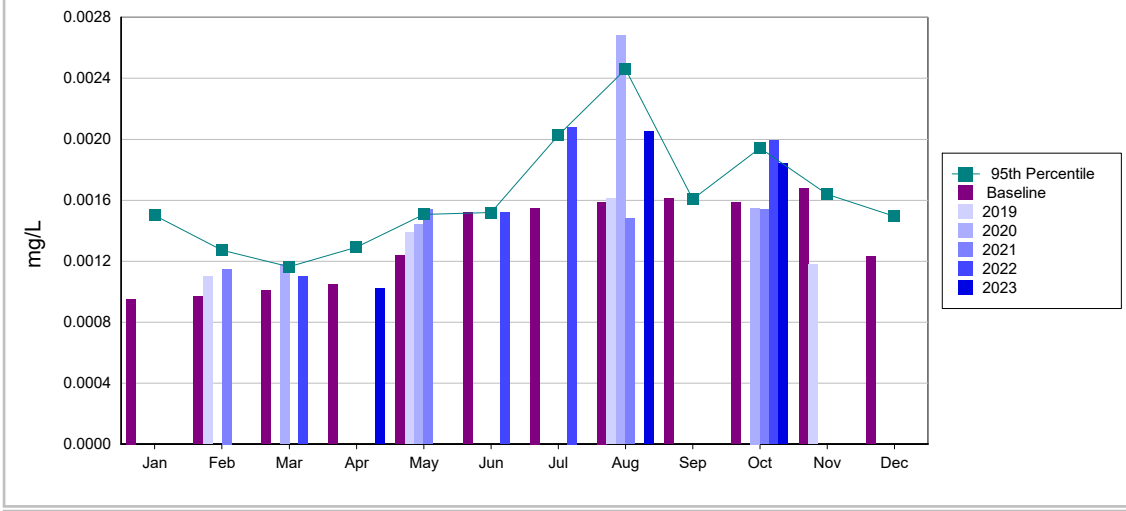
Water Quality Report

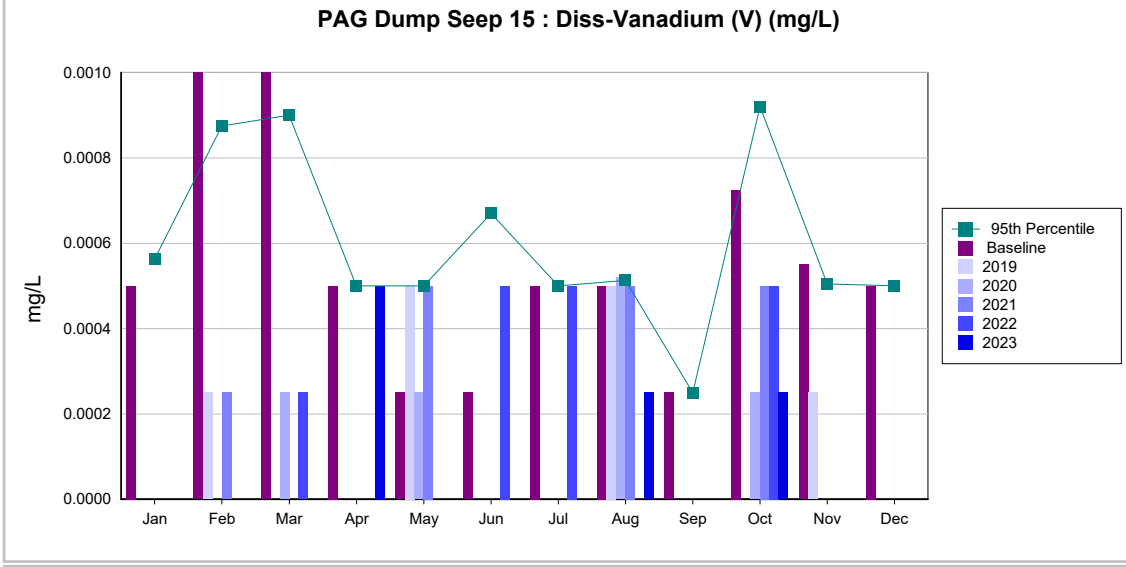
Annual Report Drainage Water

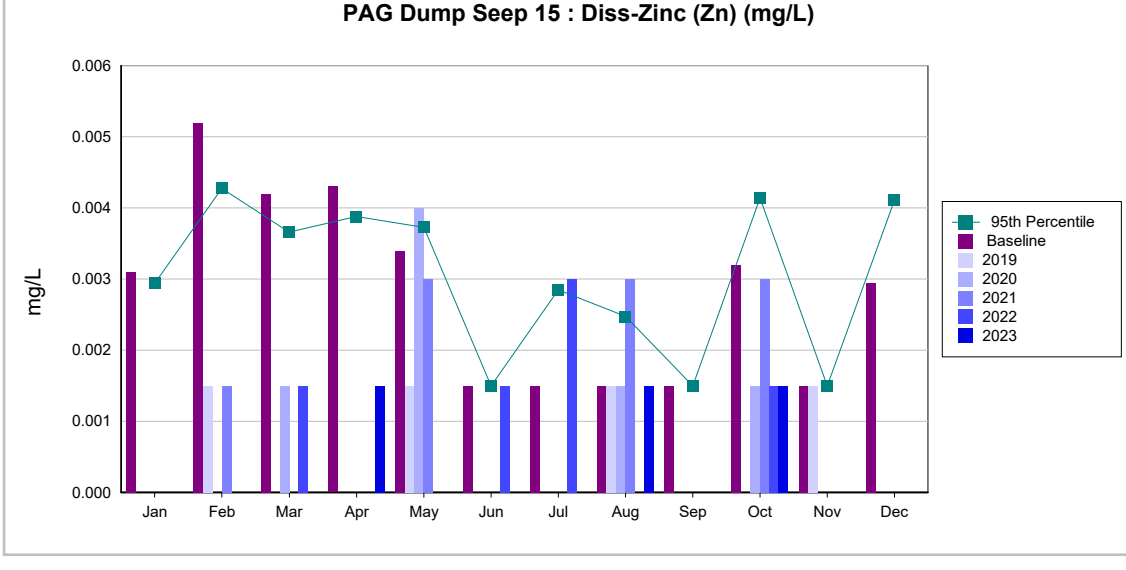
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







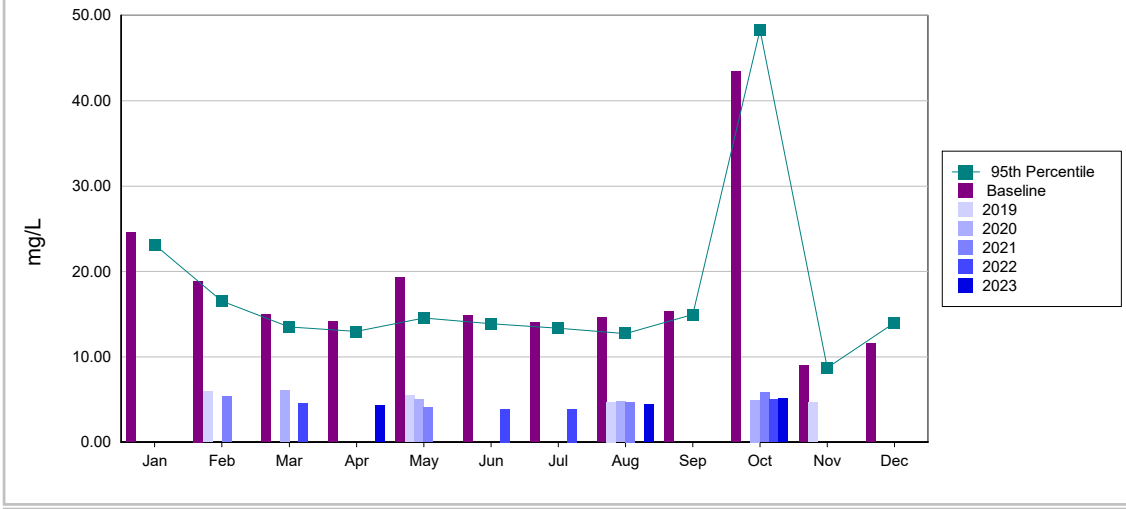
Water Quality Report

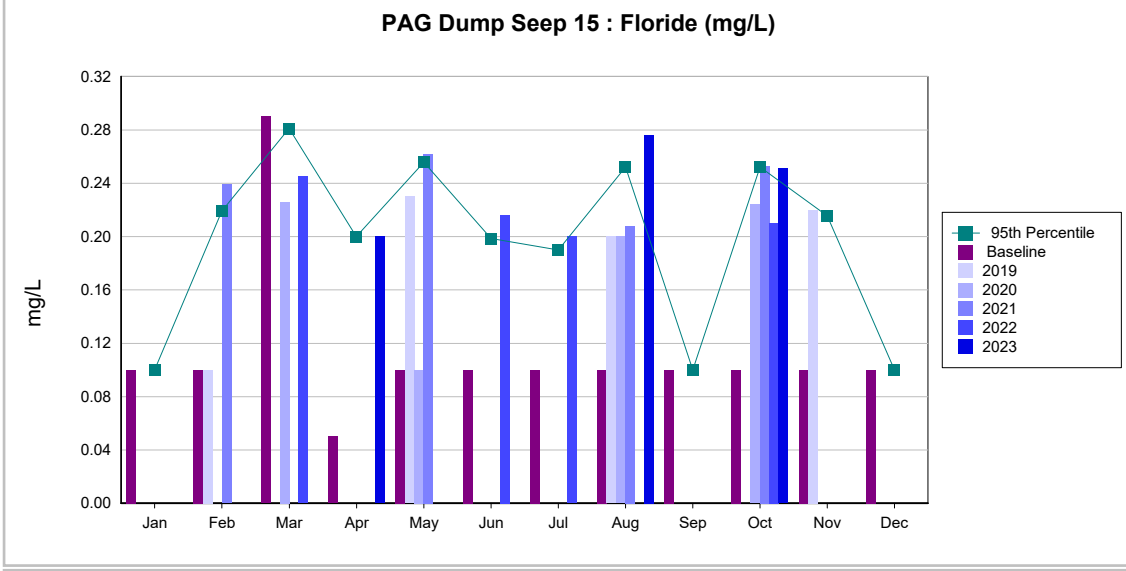
Annual Report Drainage Water

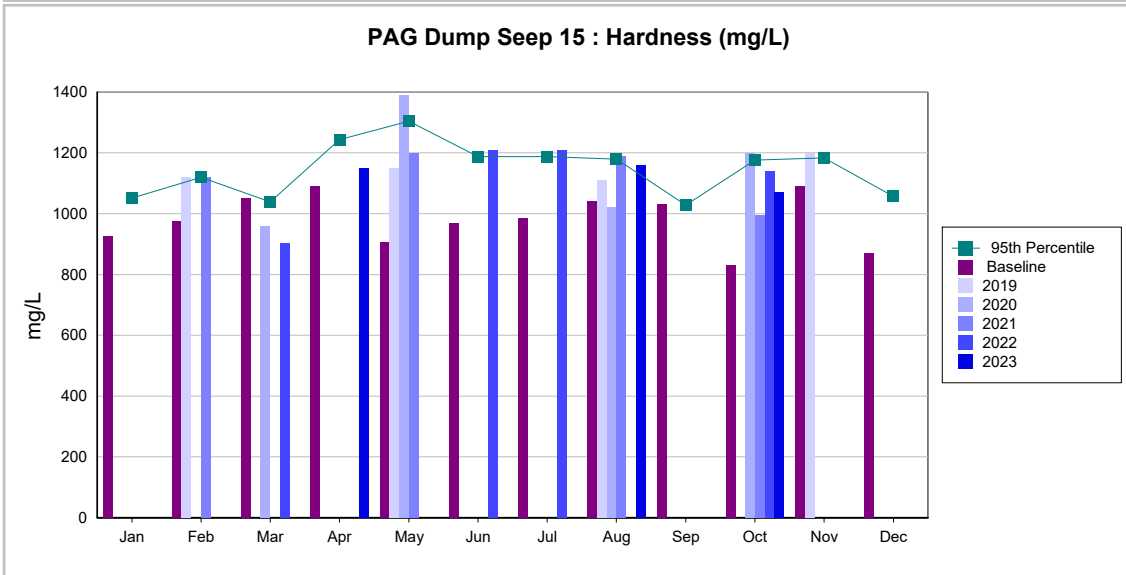
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







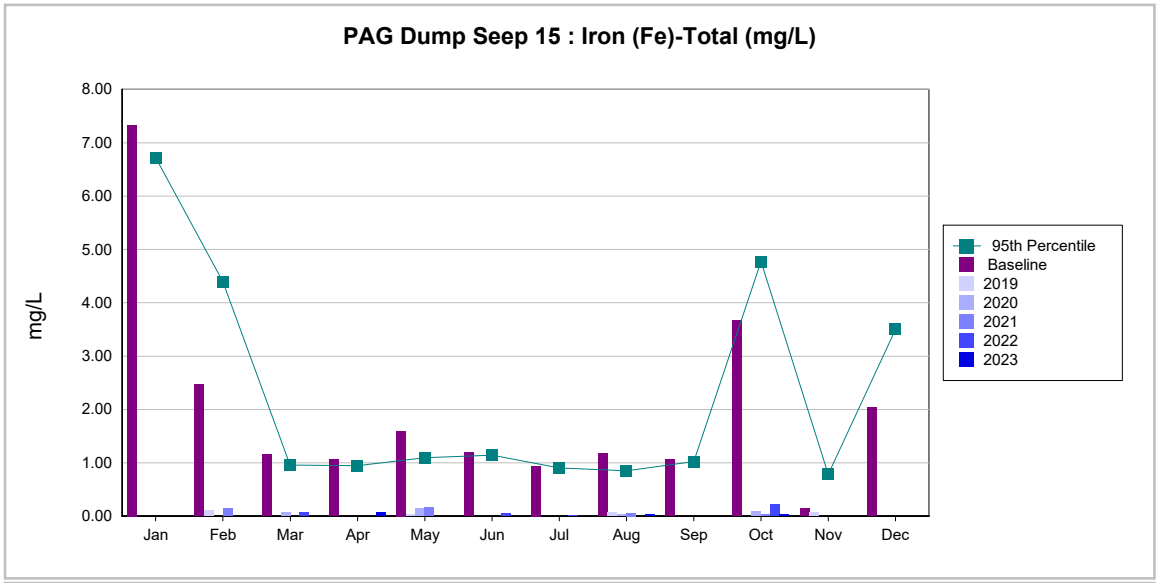
Water Quality Report

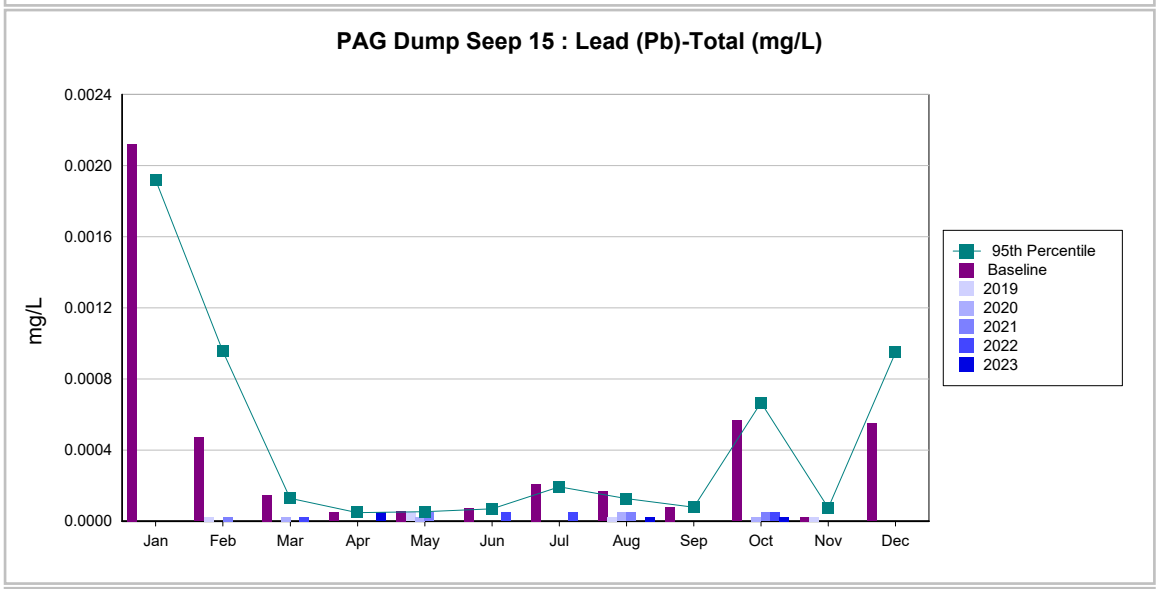
Annual Report Drainage Water

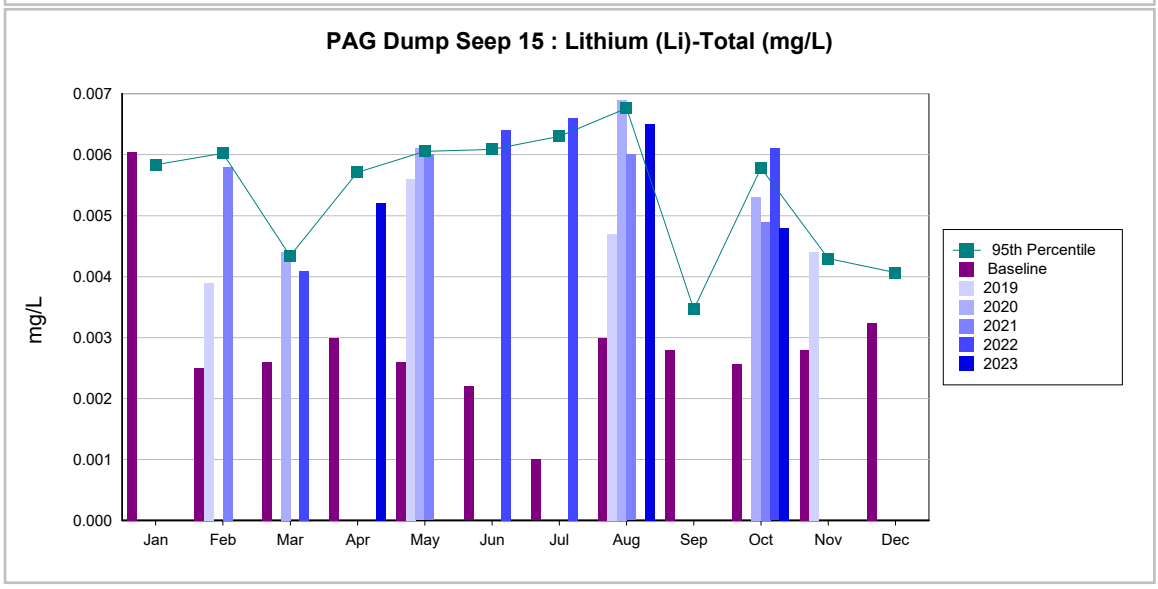
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







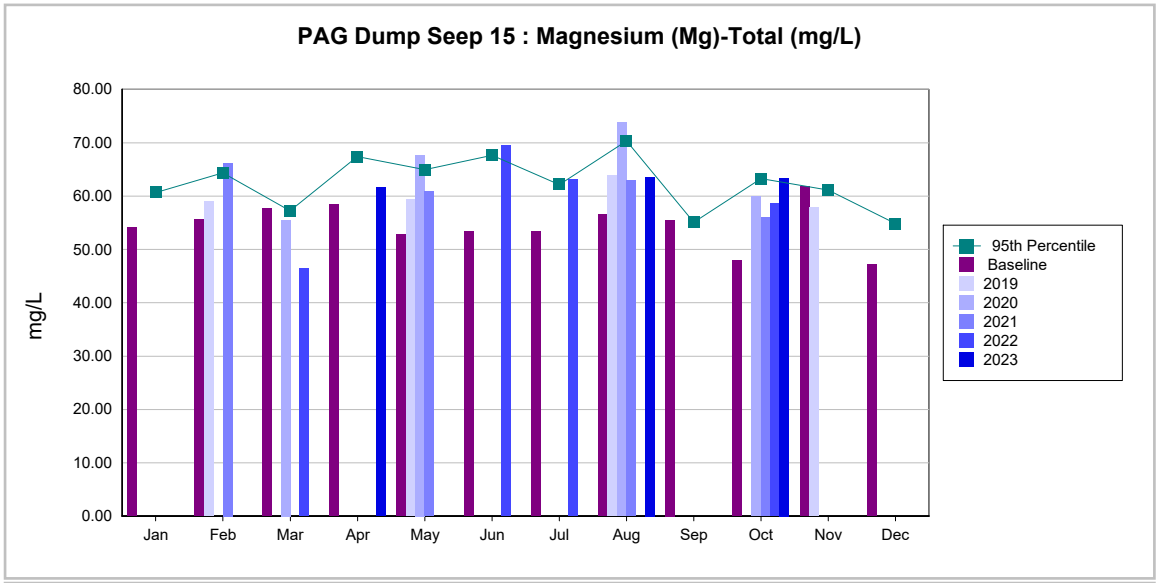
Water Quality Report

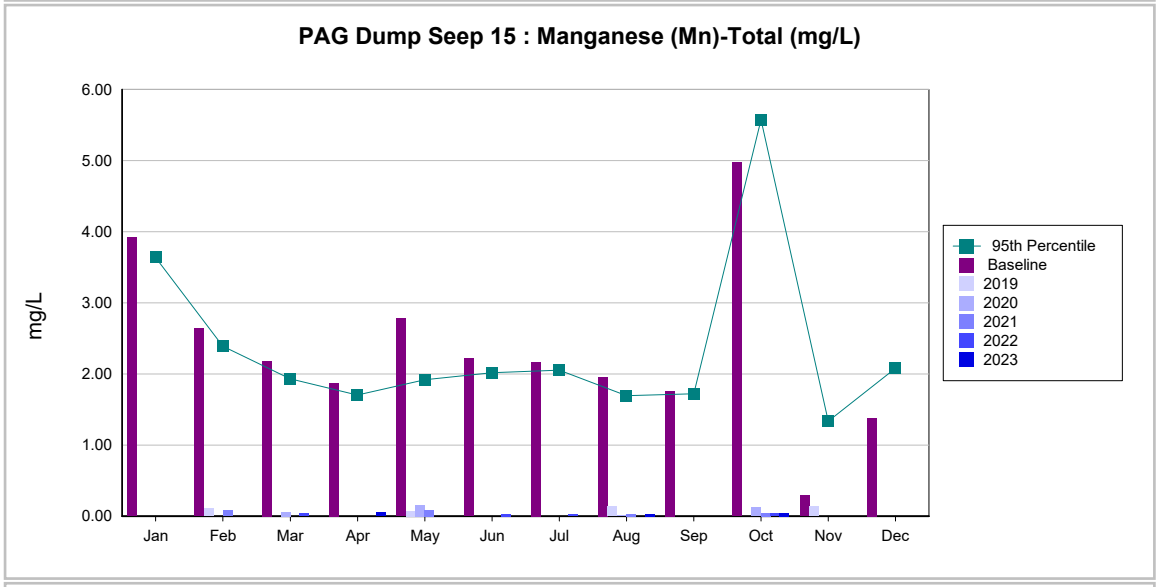
Annual Report Drainage Water

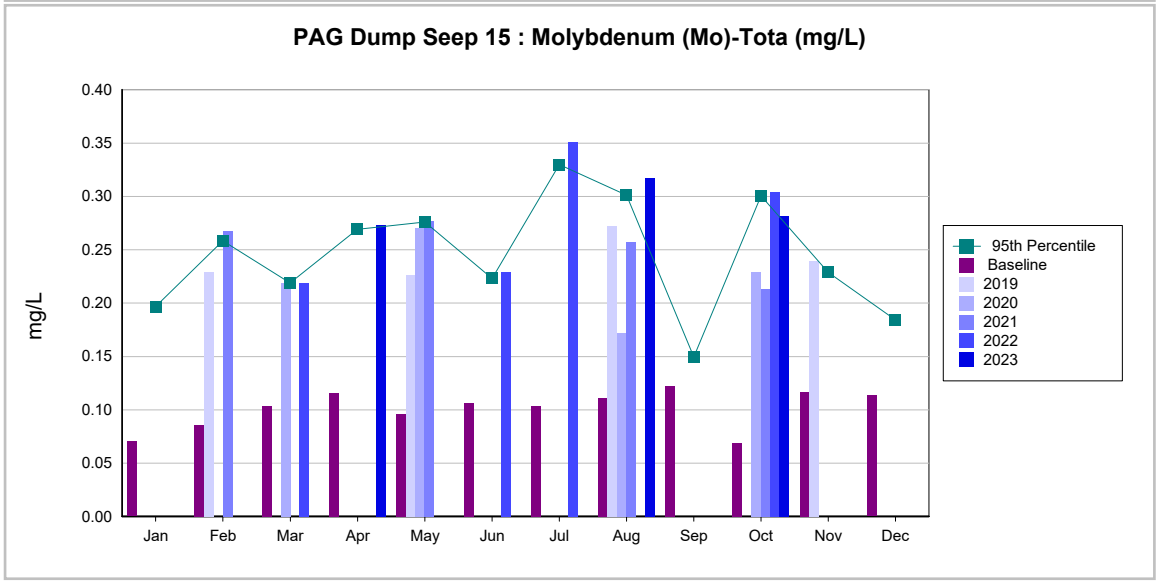
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







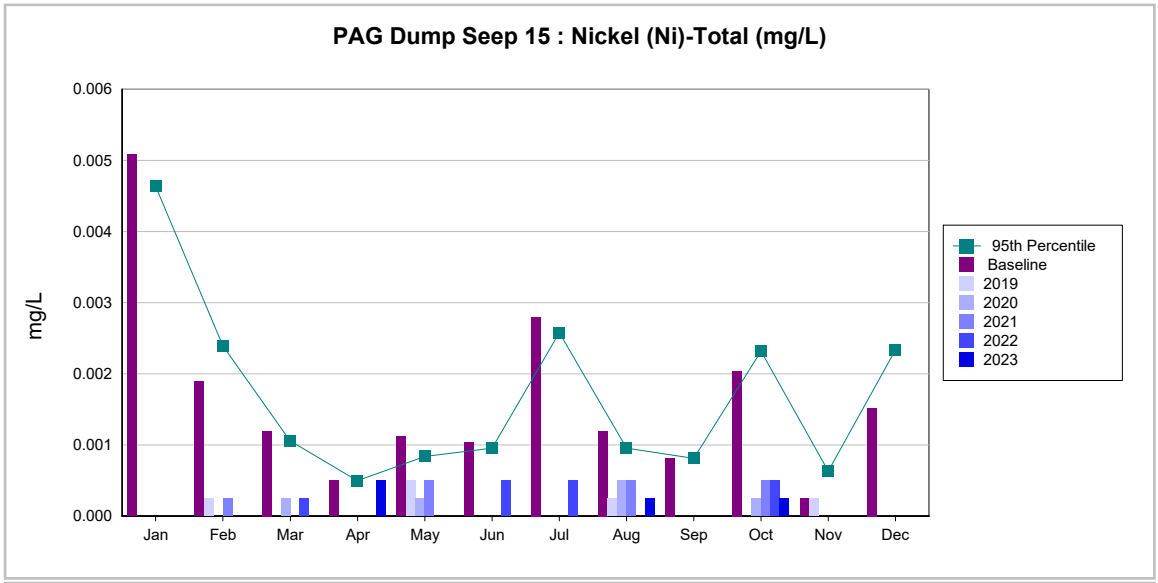
Water Quality Report

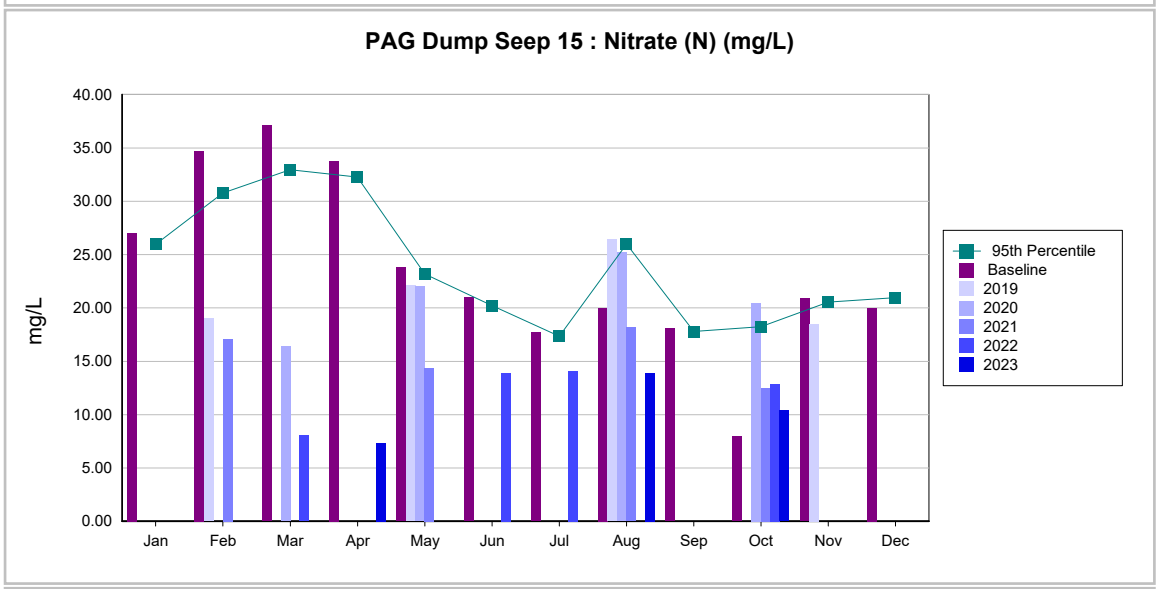
Annual Report Drainage Water

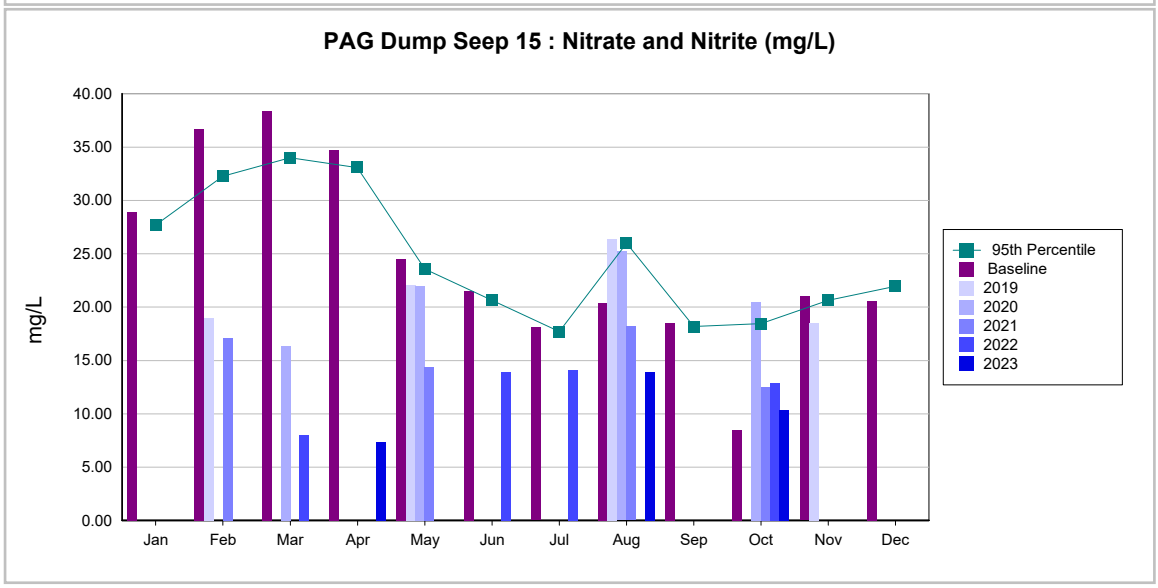
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







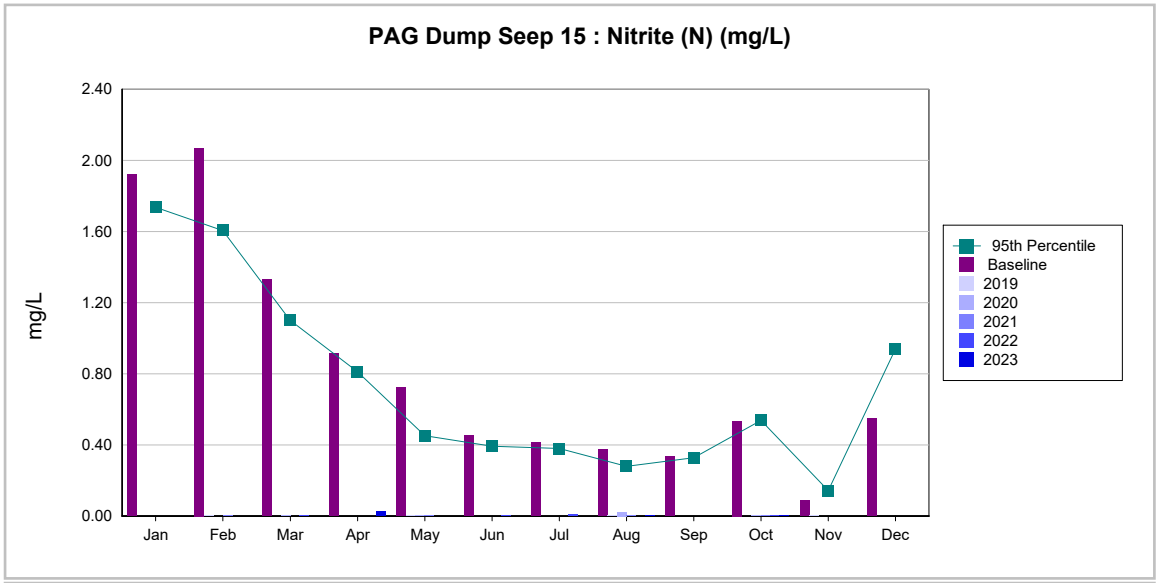
Water Quality Report

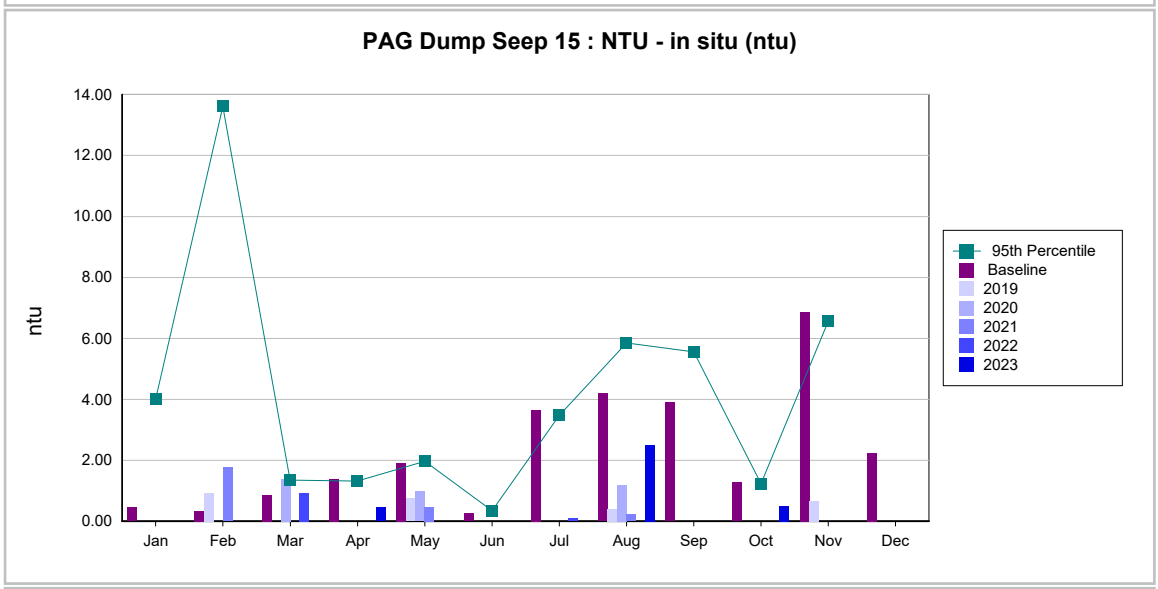
Annual Report Drainage Water

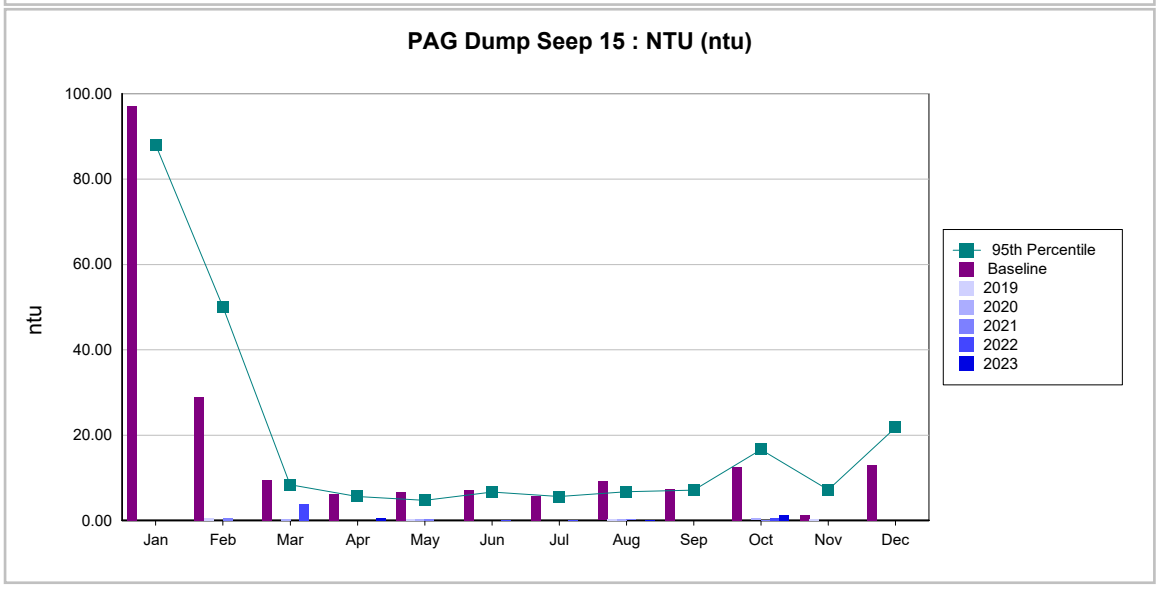
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







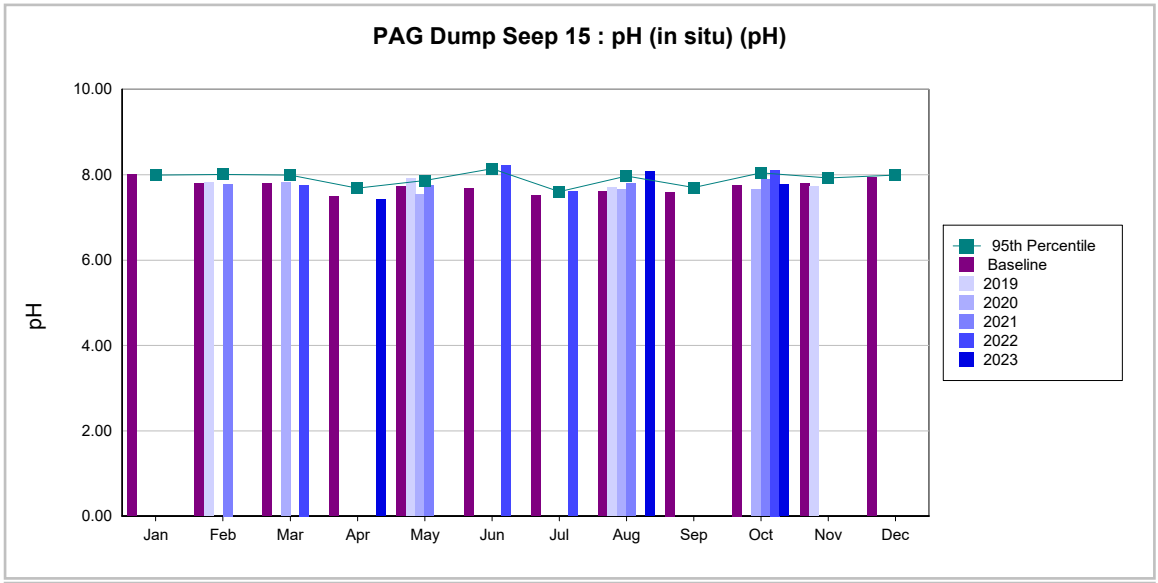
Water Quality Report

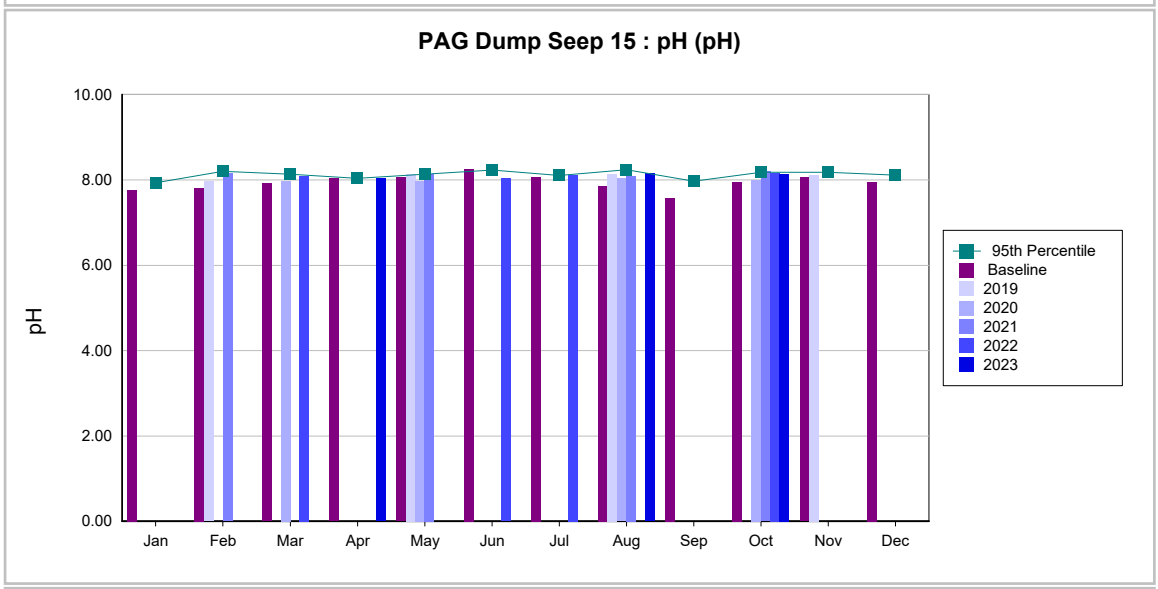
Annual Report Drainage Water

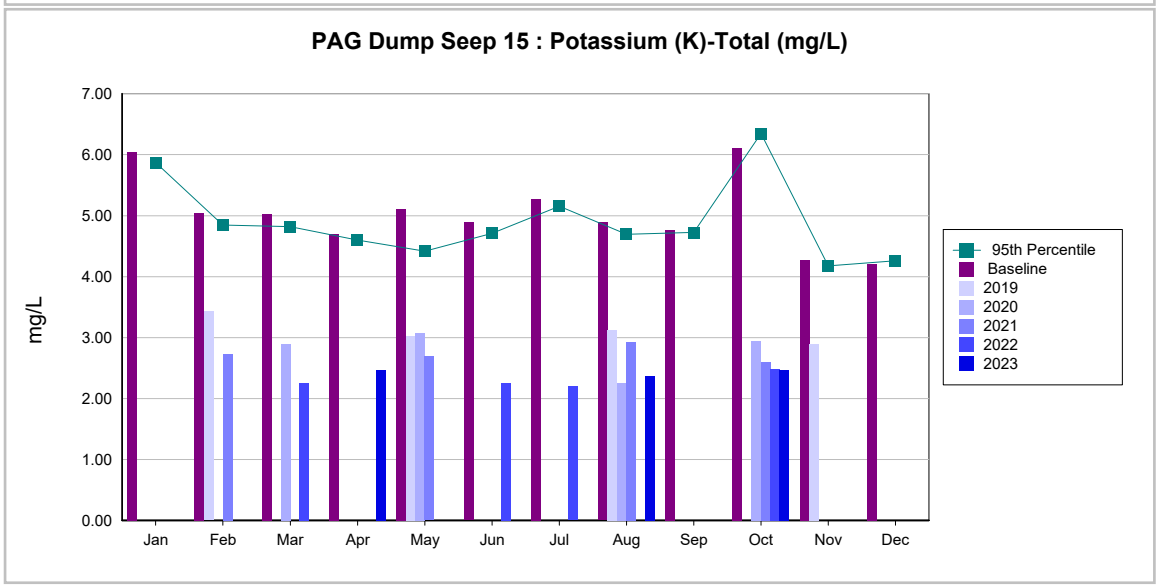
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







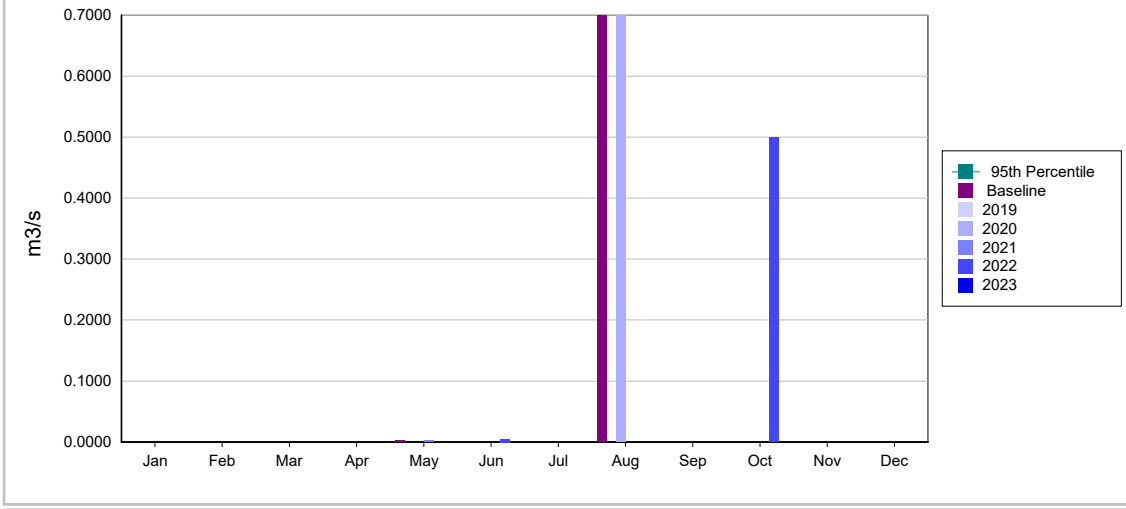
Water Quality Report

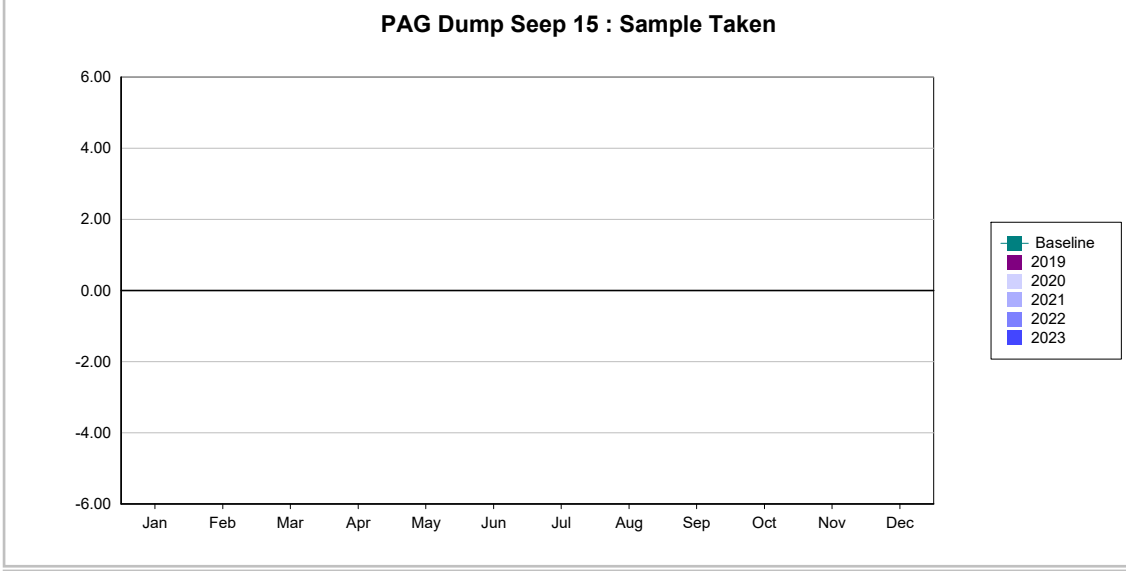
Annual Report Drainage Water

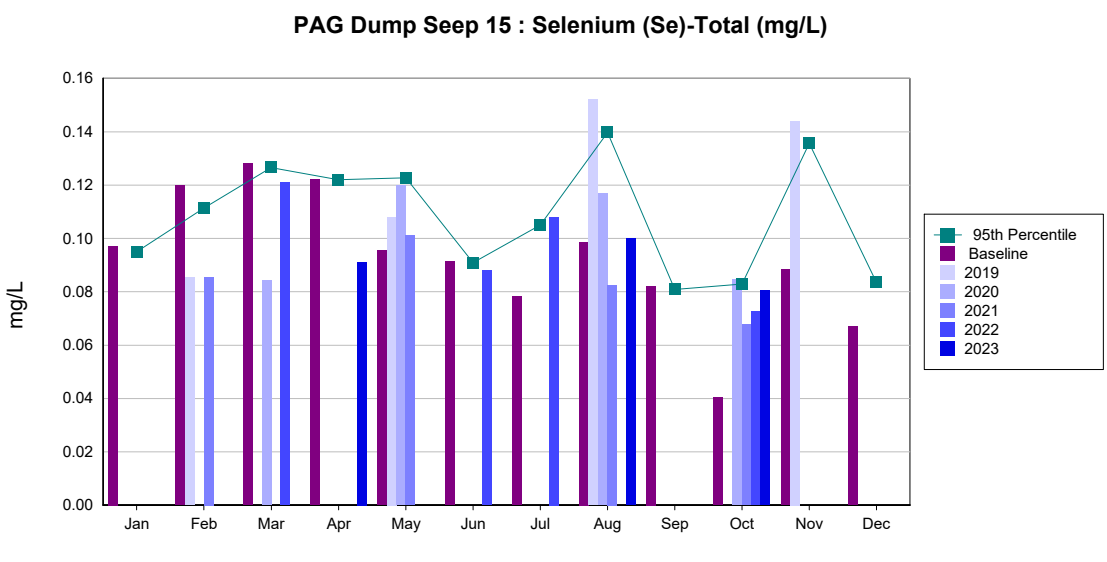
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







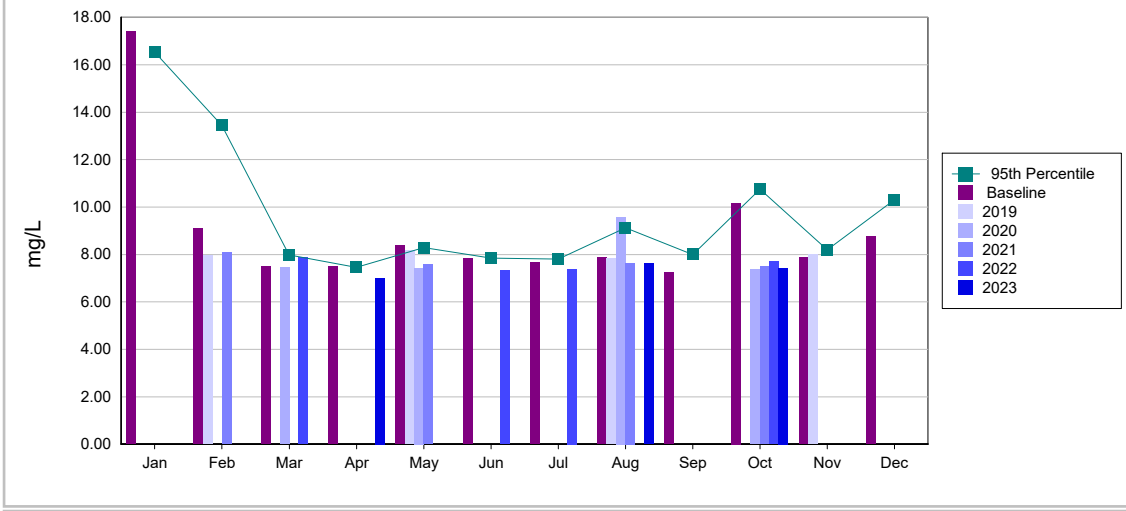
Water Quality Report

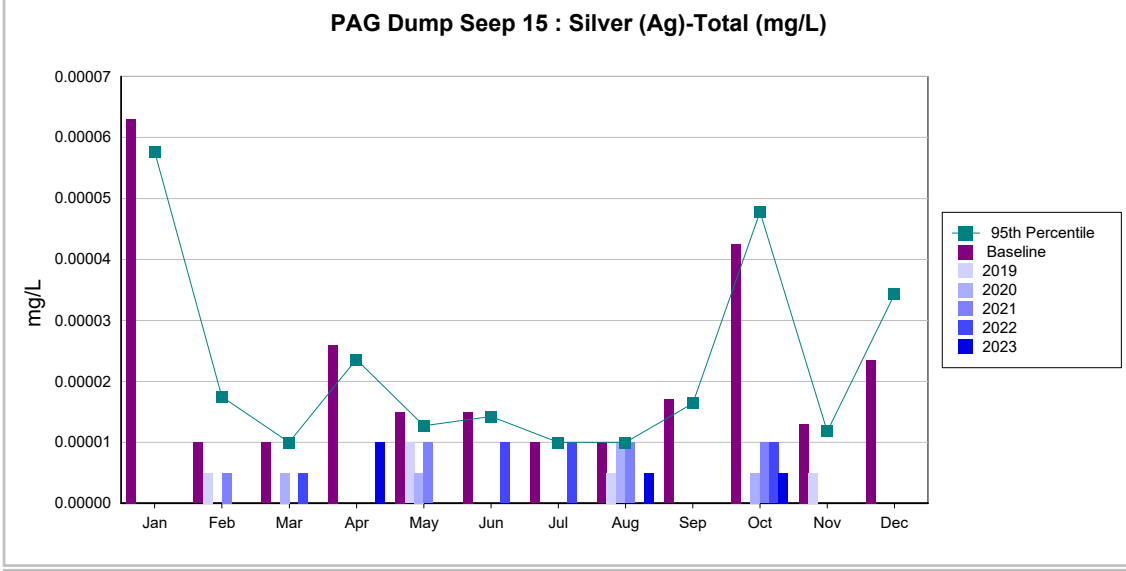
Annual Report Drainage Water

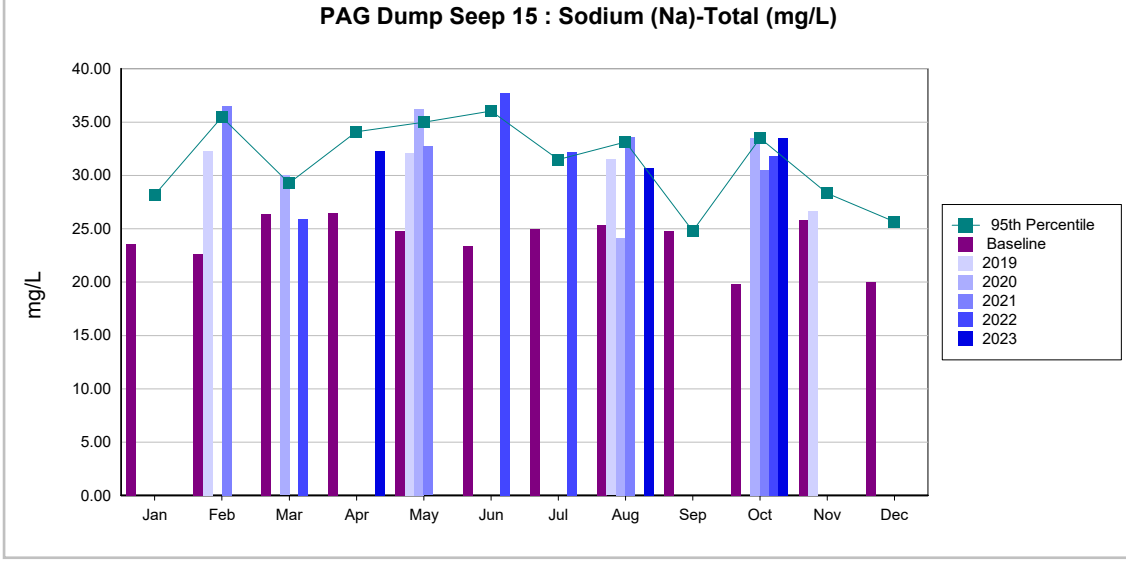
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

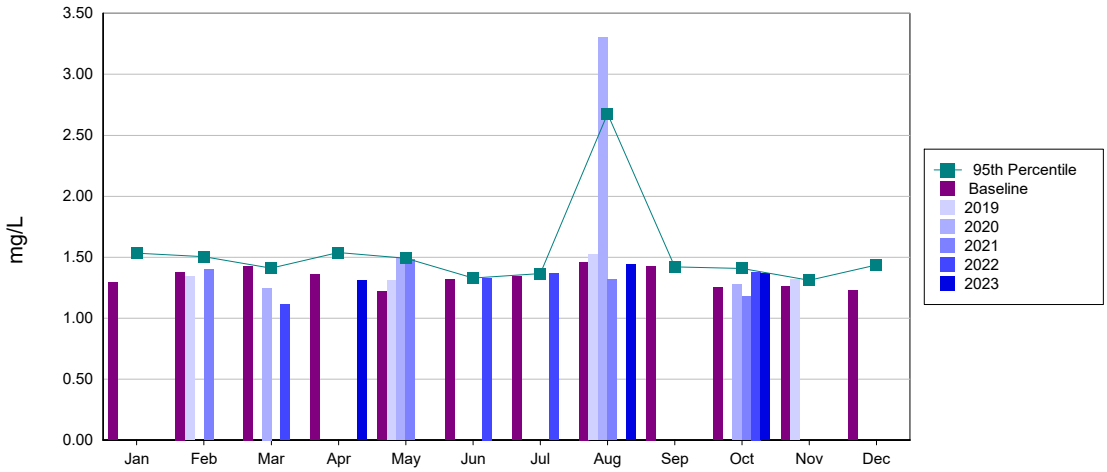
Annual Report Drainage Water

Mount Polley

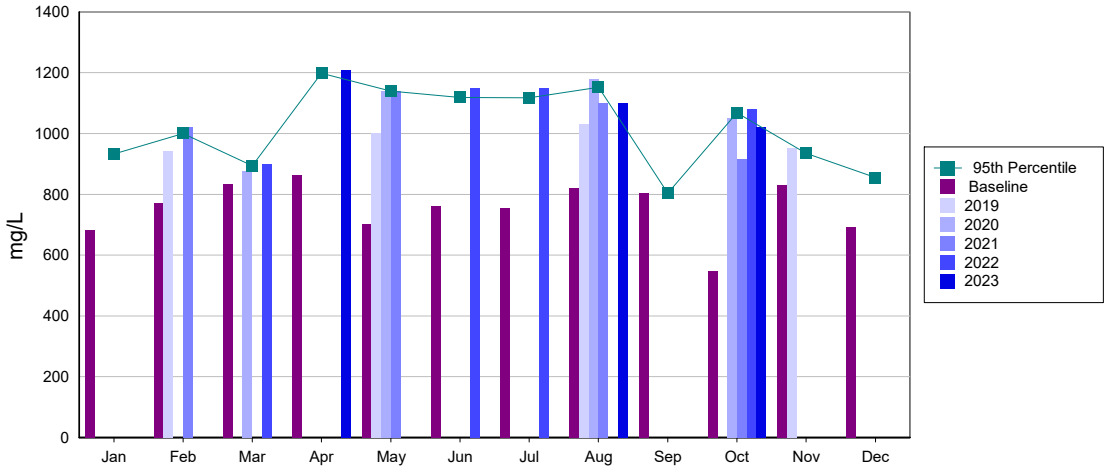
Mining Corporation

IMPERIAL METALS CORPORATION

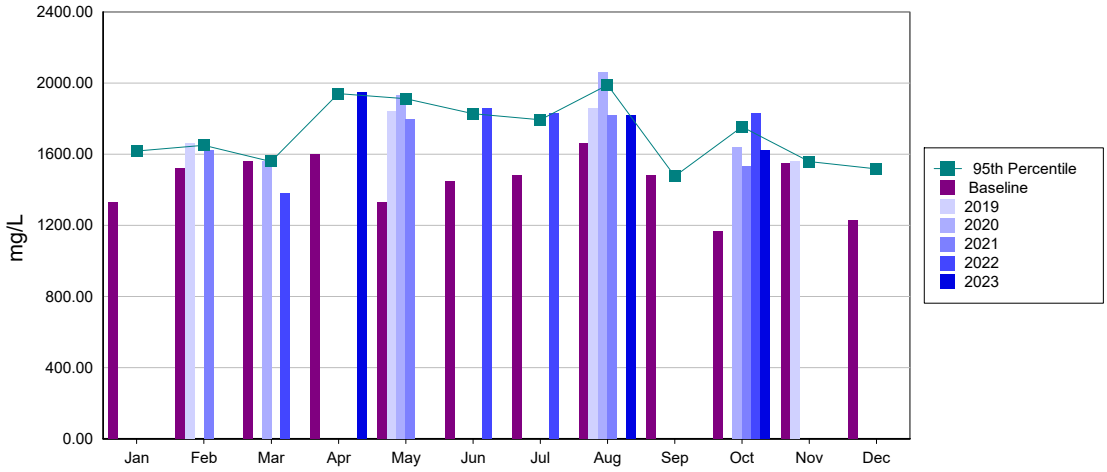
PAG Dump Seep 15 : Strontium (Sr)-Total (mg/L)



PAG Dump Seep 15 : Sulphate (mg/L)



PAG Dump Seep 15 : TDS (mg/L)



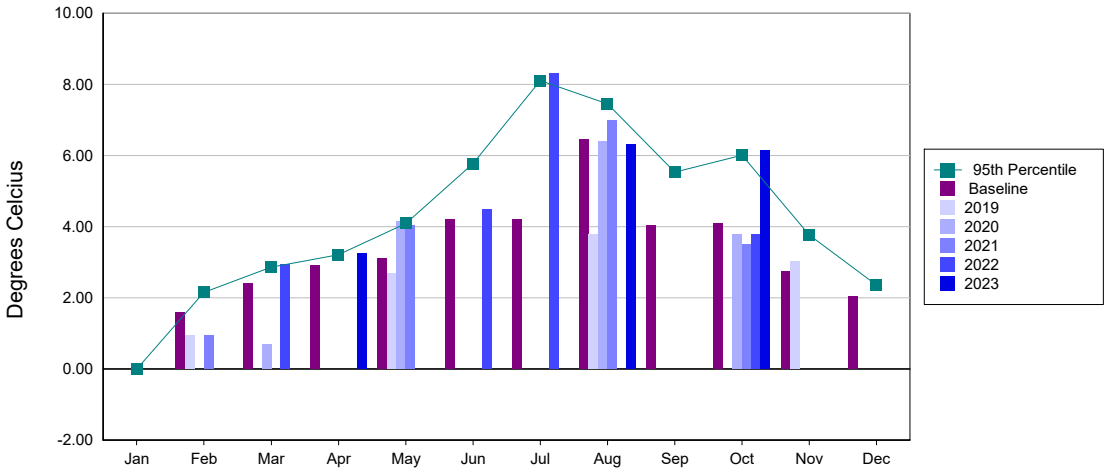
Water Quality Report

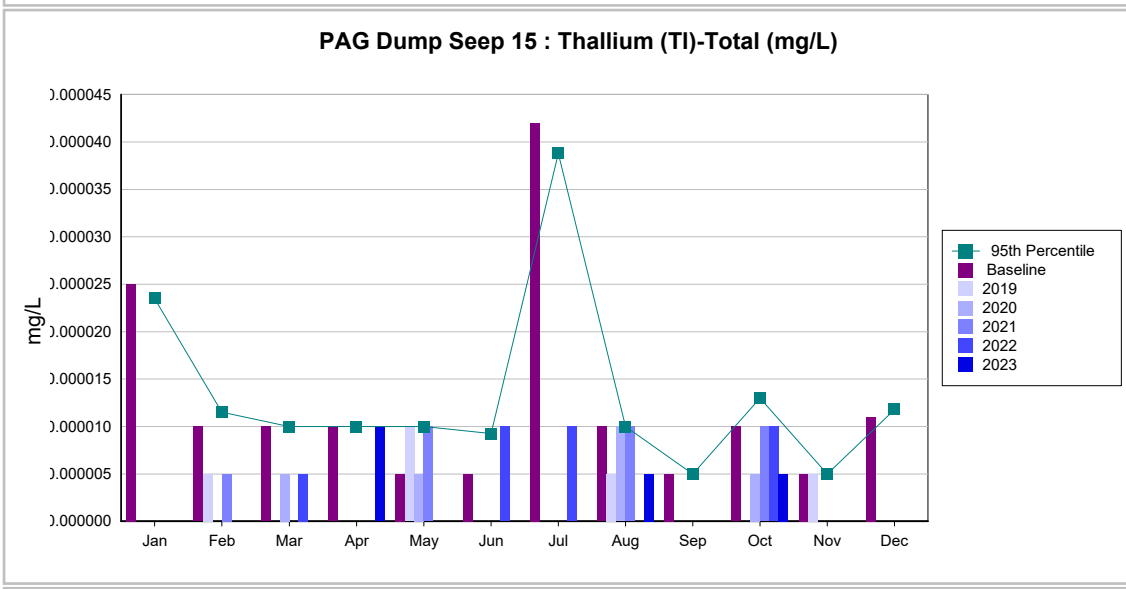
Annual Report Drainage Water

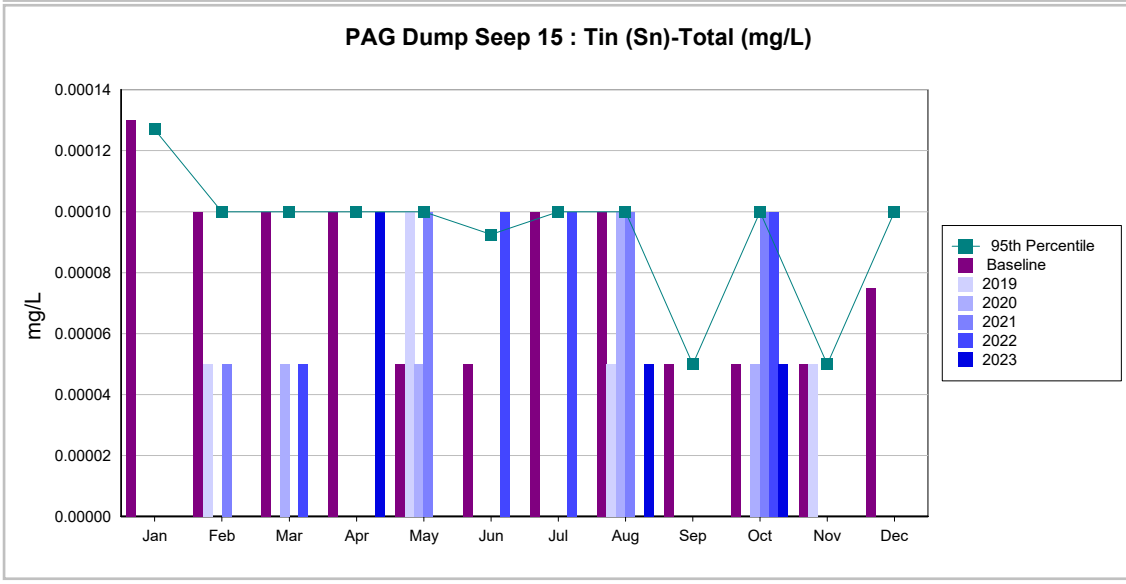
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







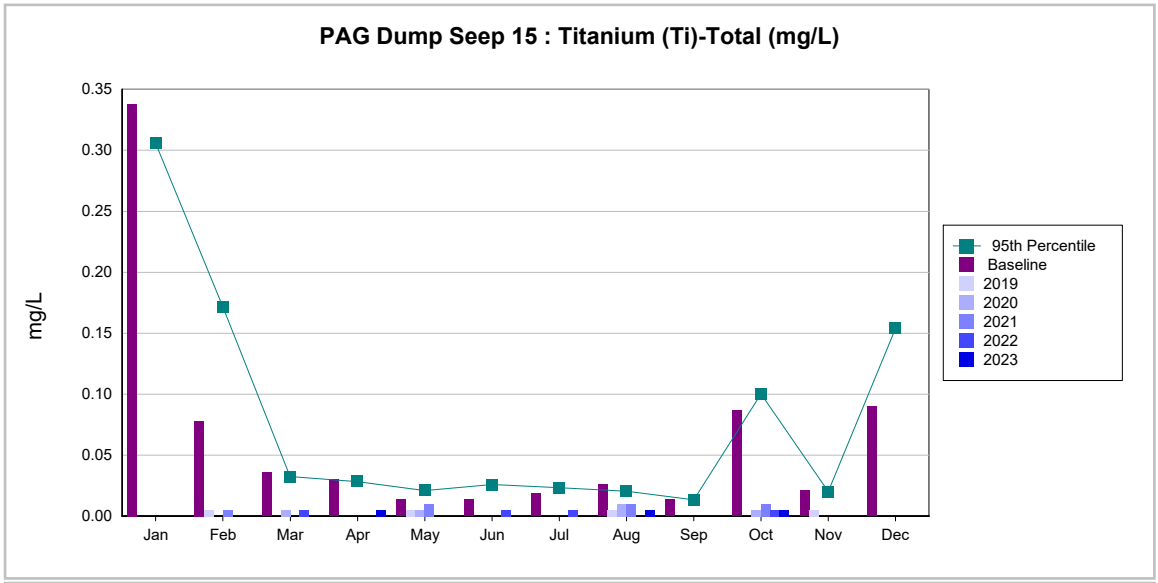
Water Quality Report

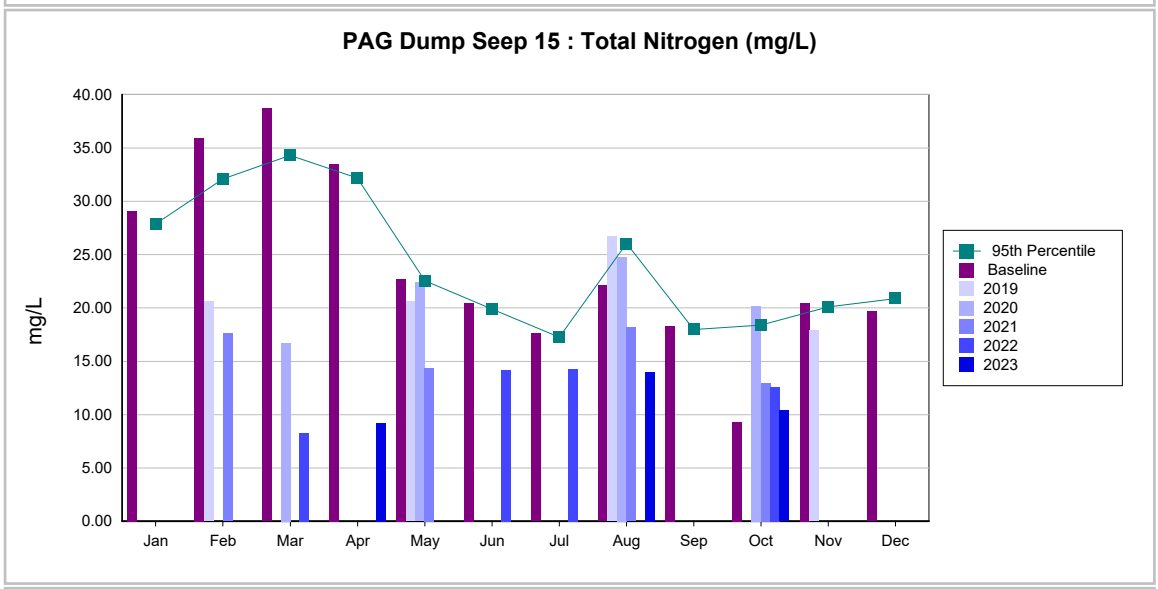
Annual Report Drainage Water

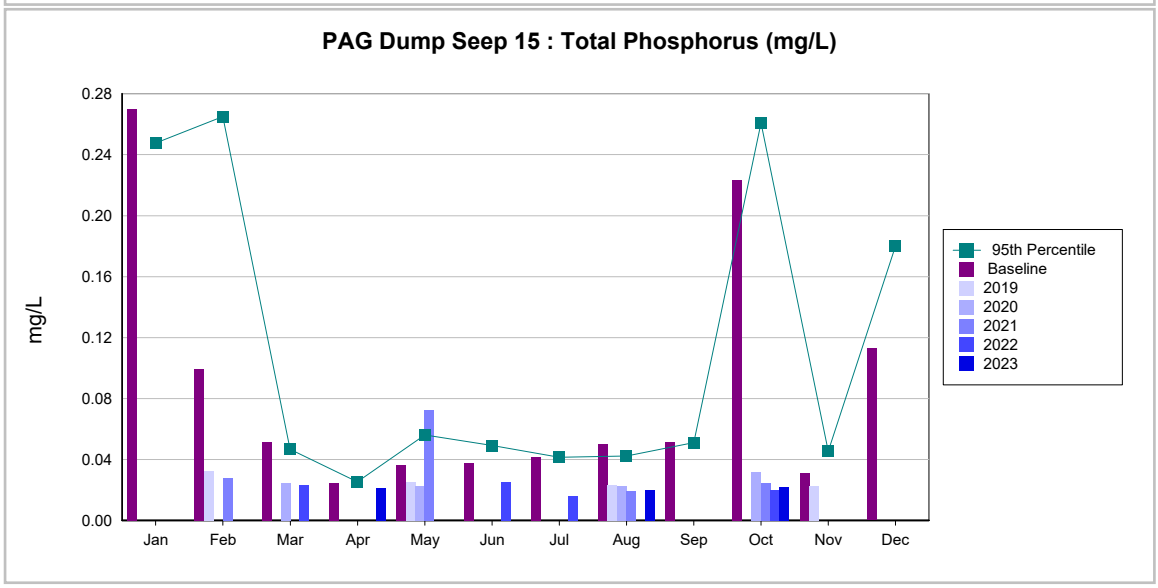
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







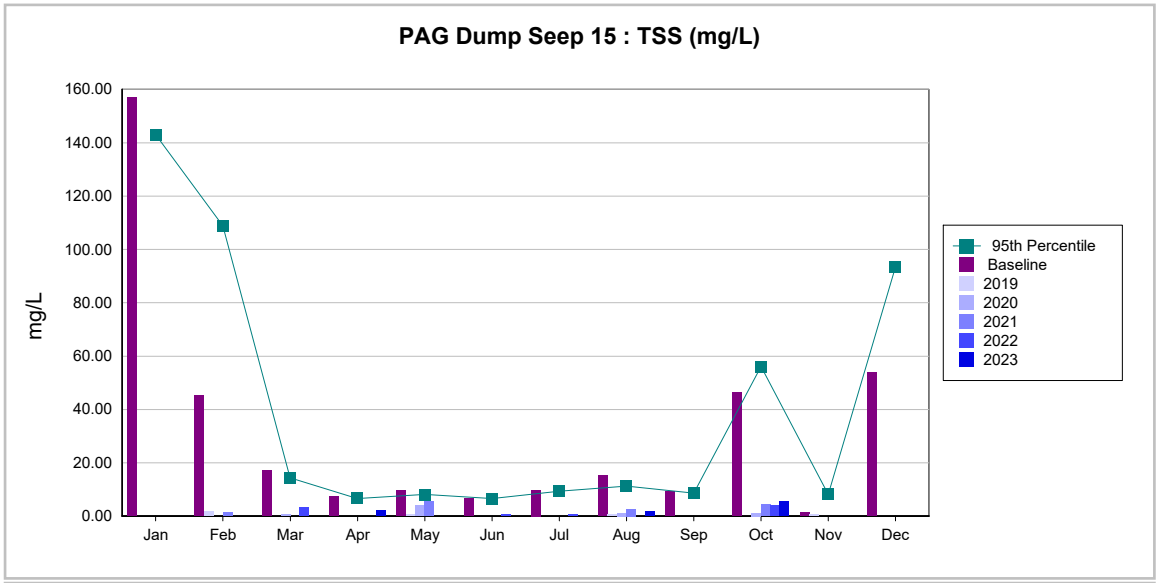
Water Quality Report

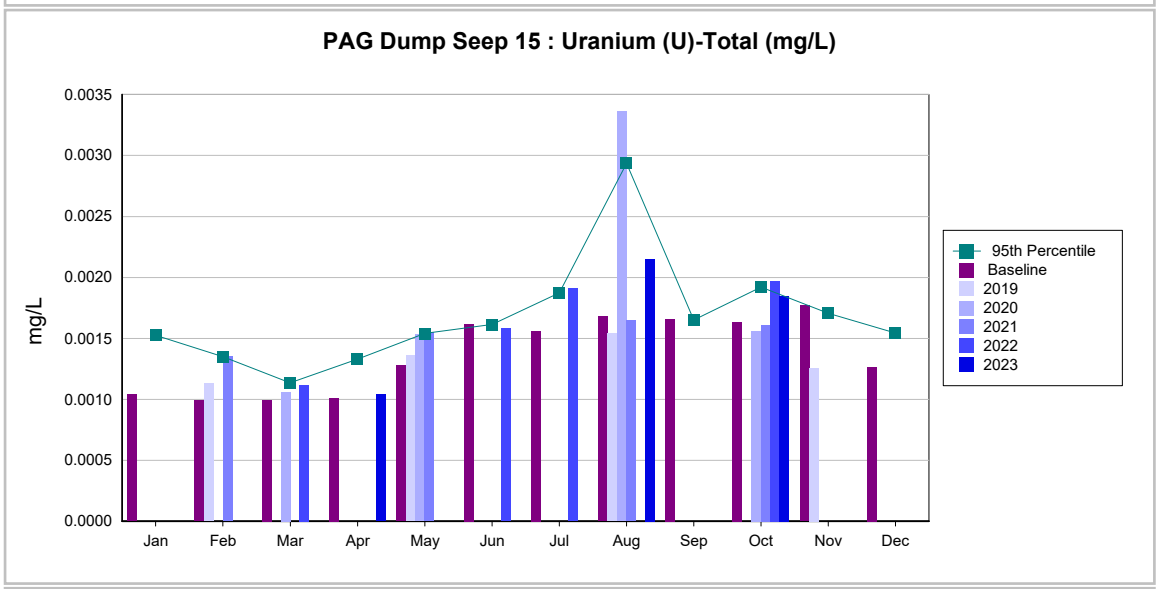
Annual Report Drainage Water

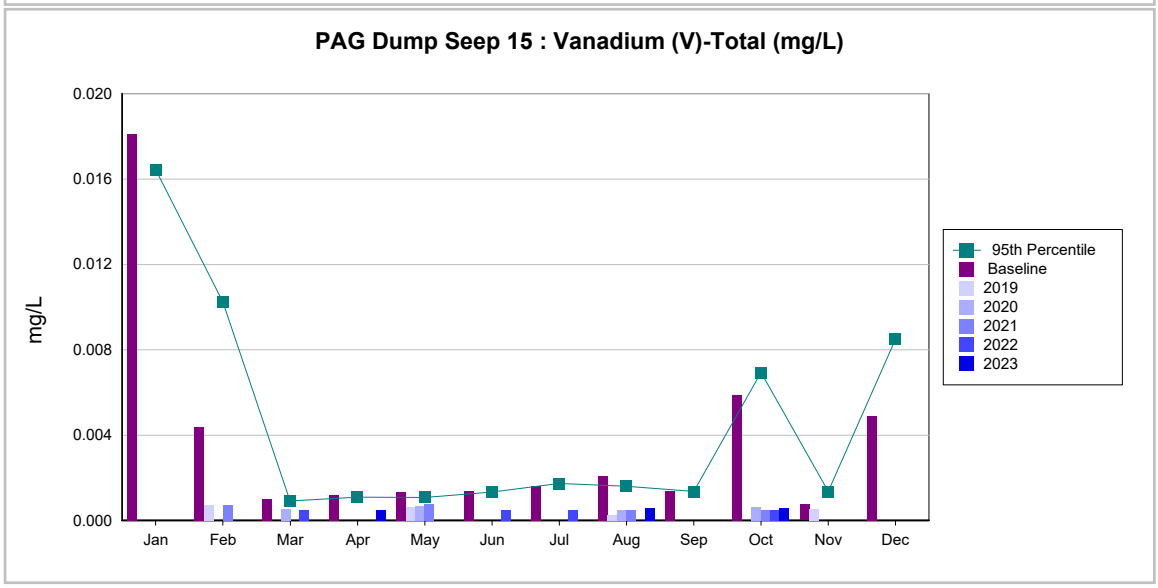
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







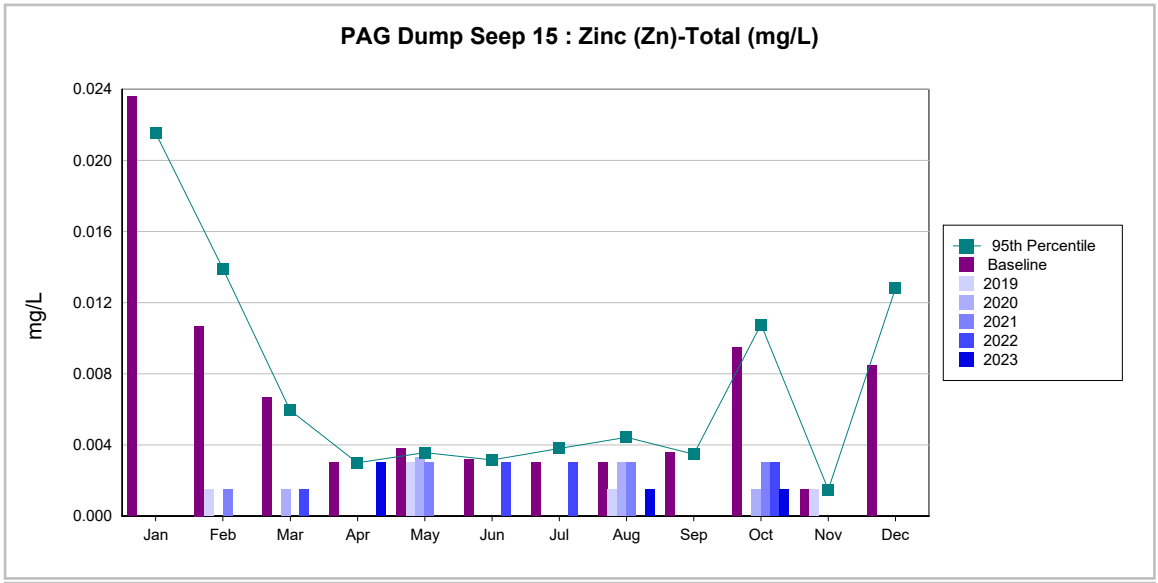
Water Quality Report

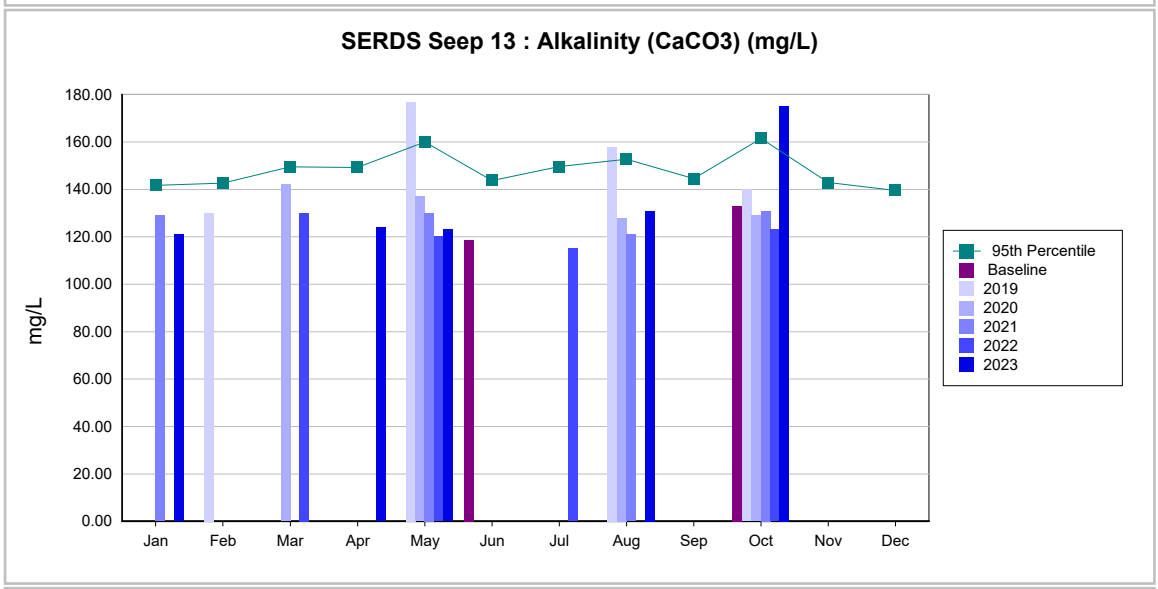
Annual Report Drainage Water

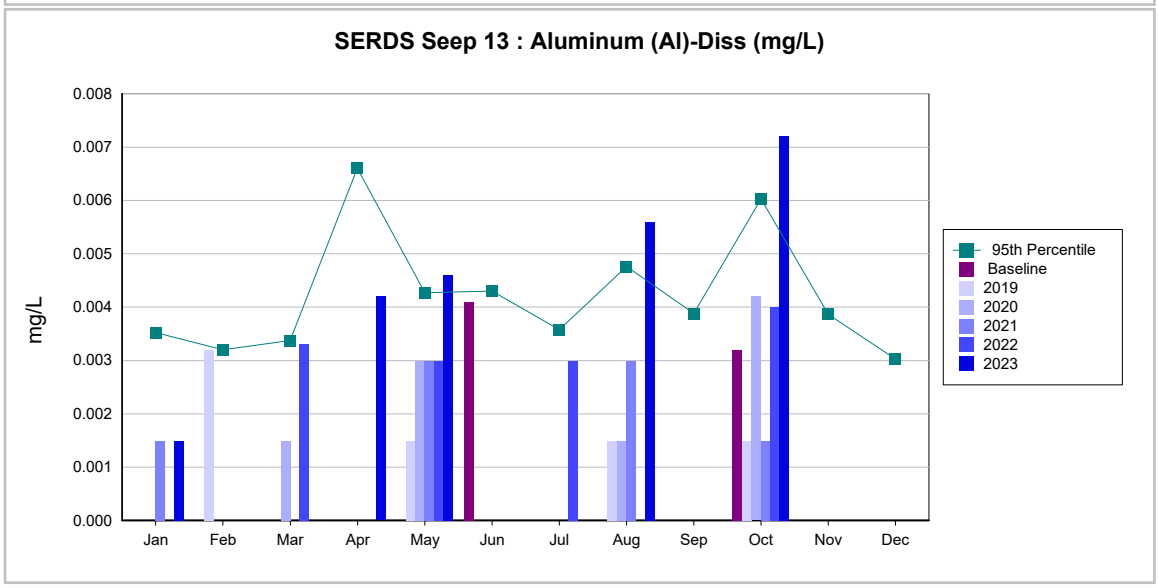
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







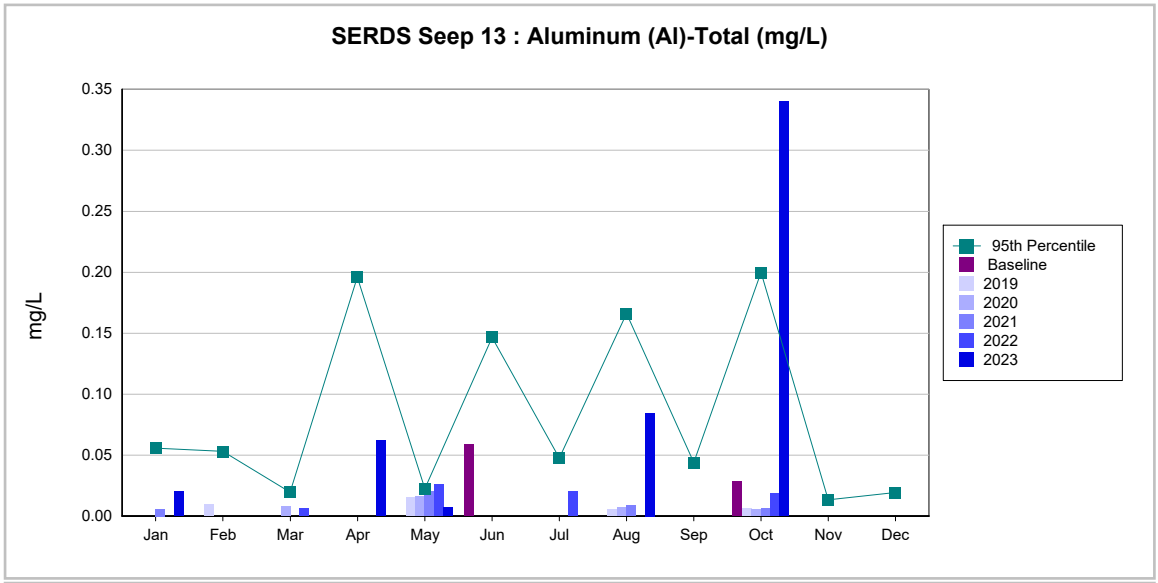
Water Quality Report

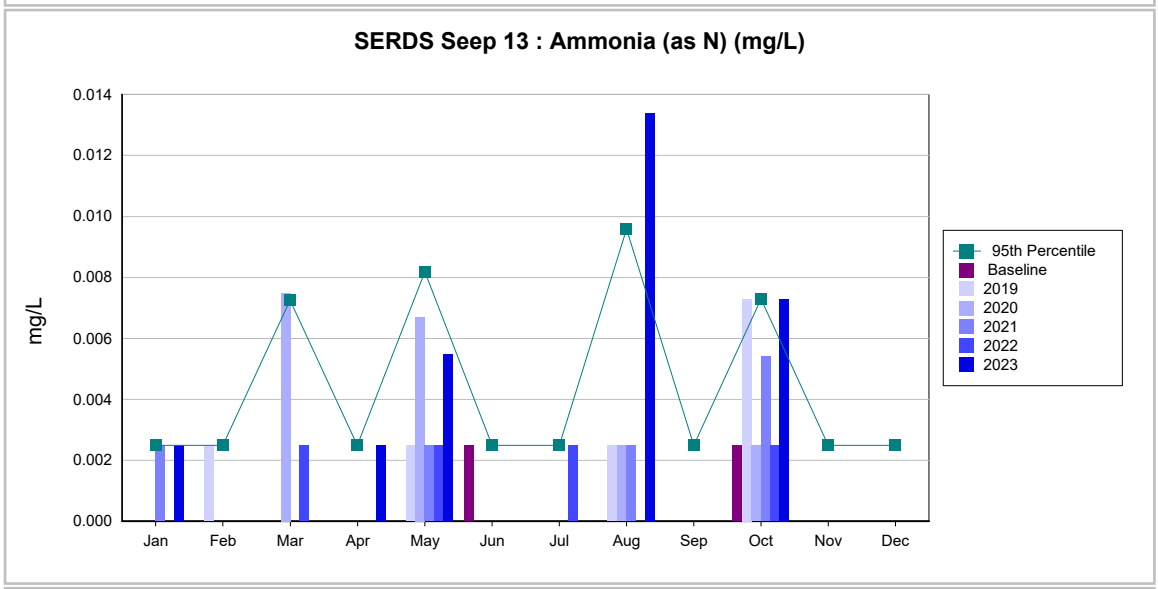
Annual Report Drainage Water

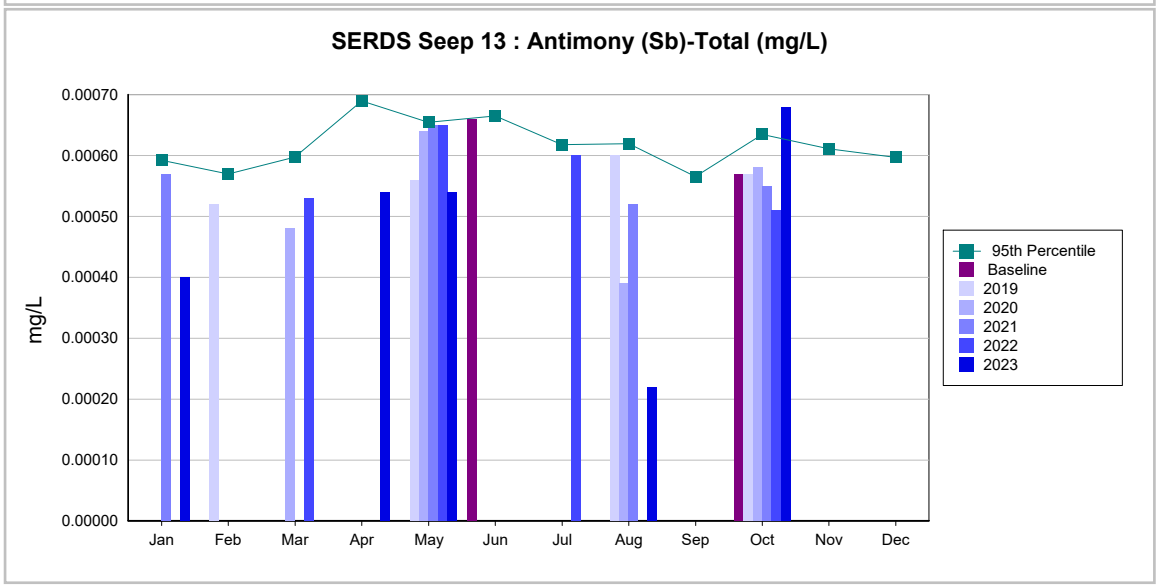
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







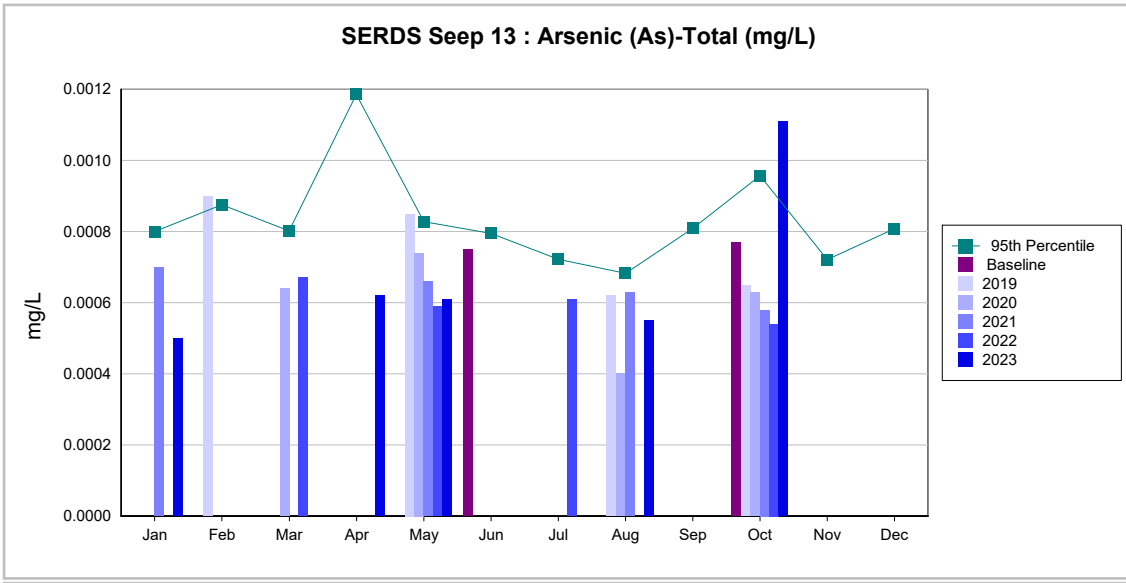
Water Quality Report

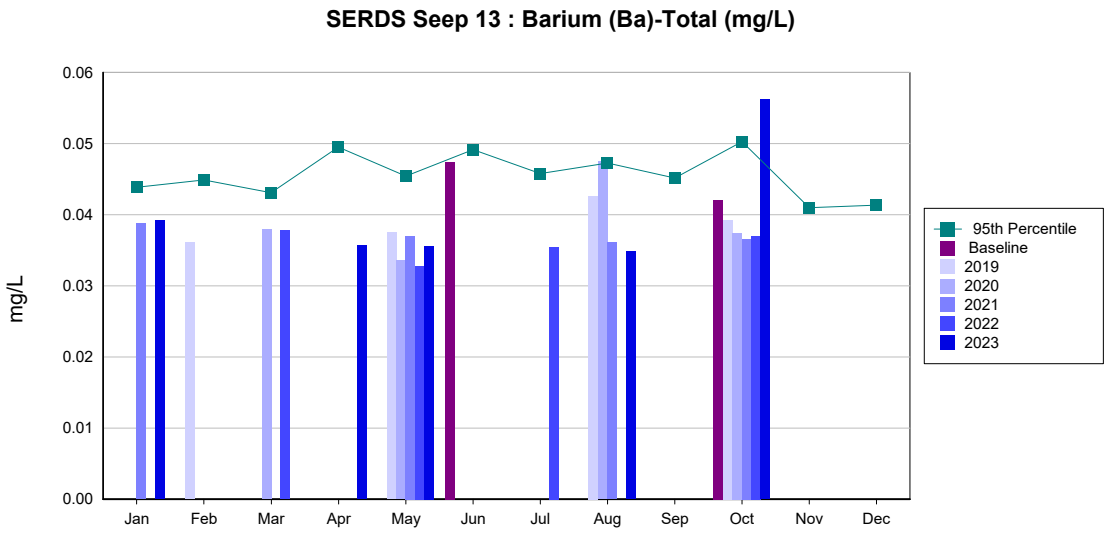
Annual Report Drainage Water

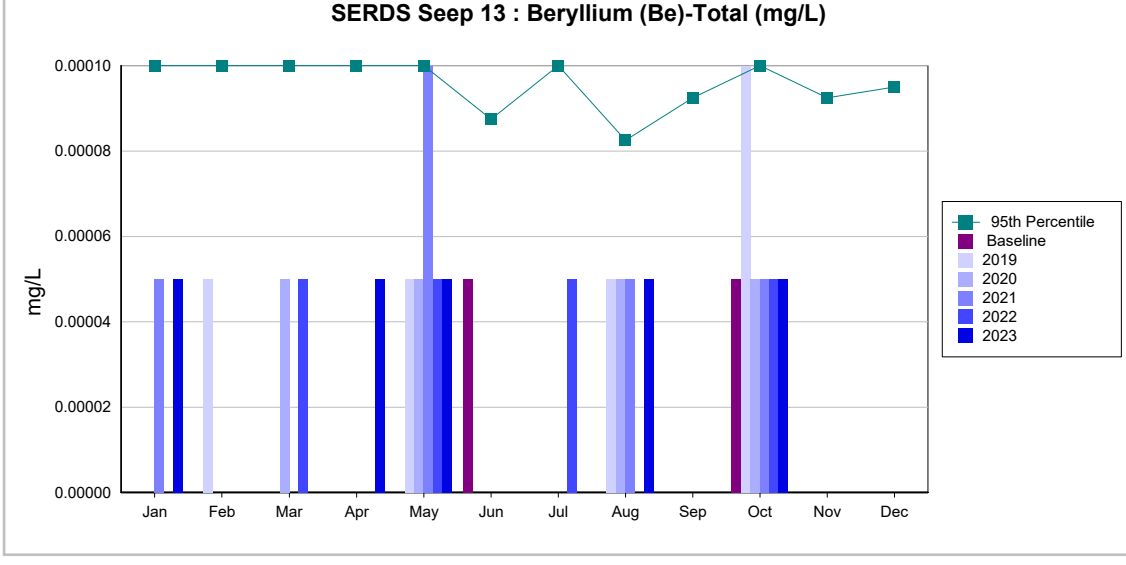
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







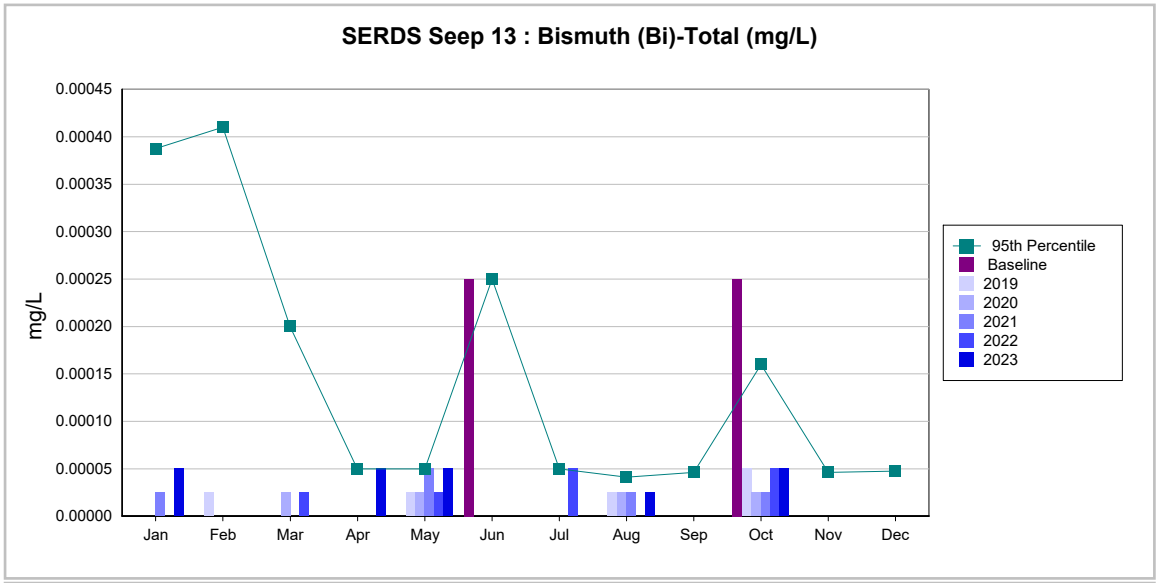
Water Quality Report

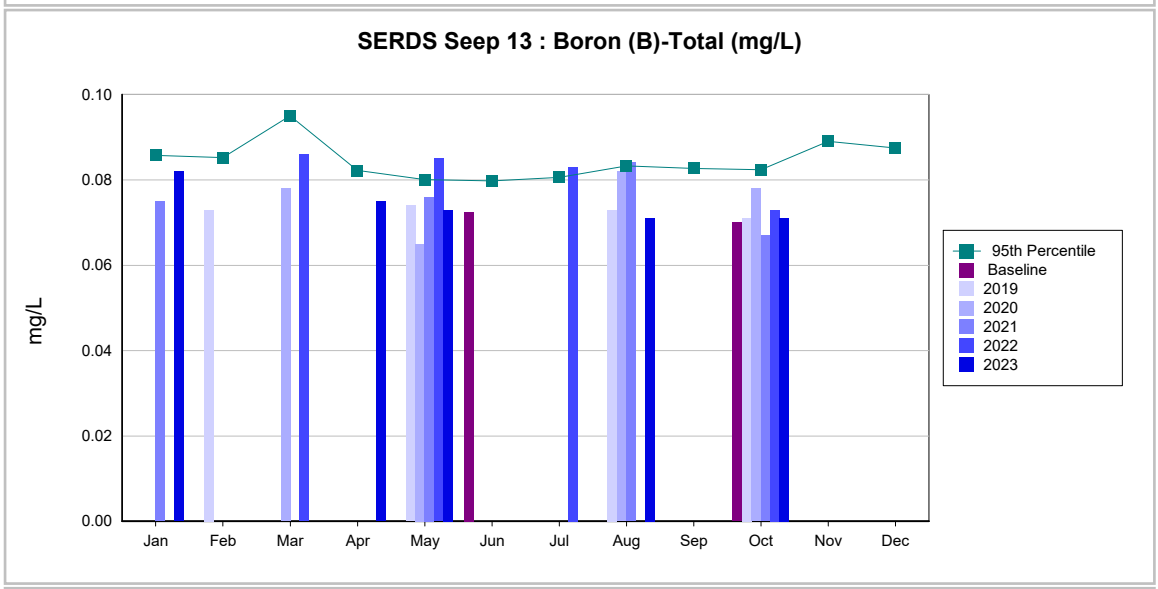
Annual Report Drainage Water

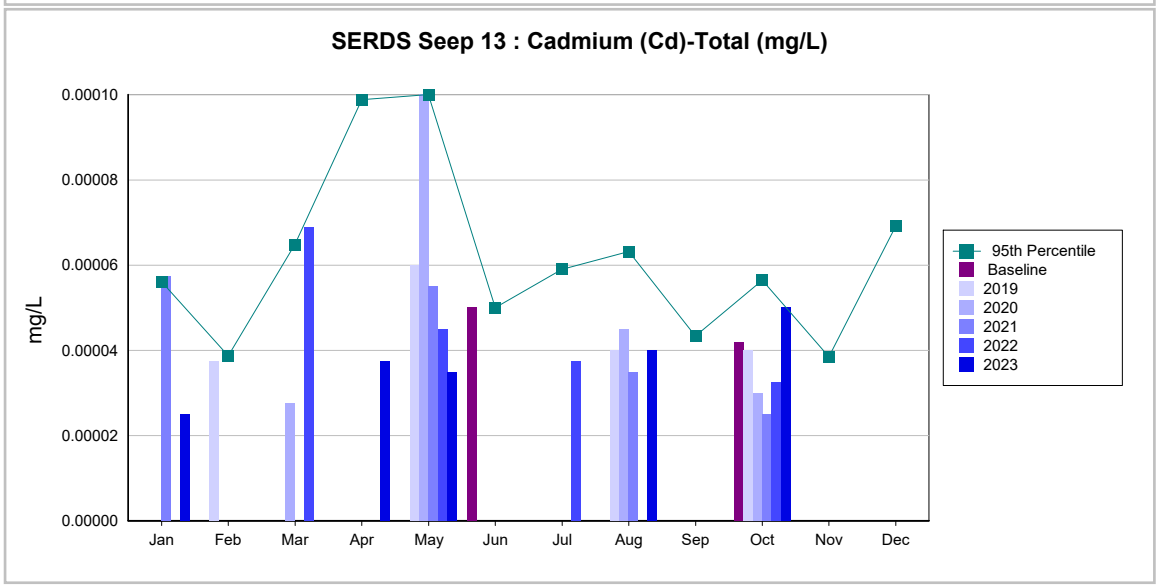
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







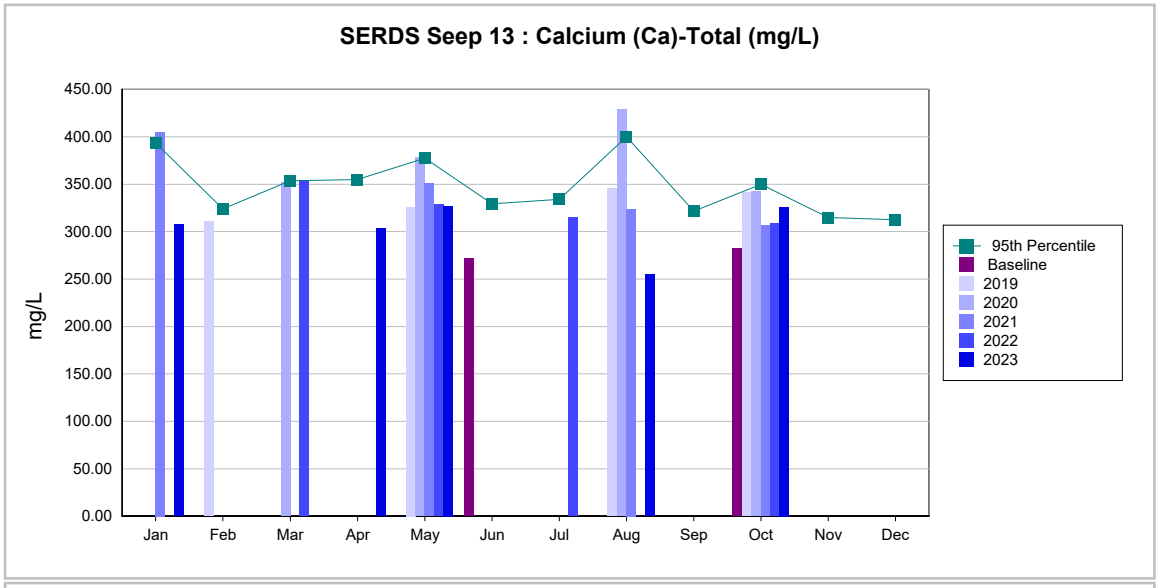
Water Quality Report

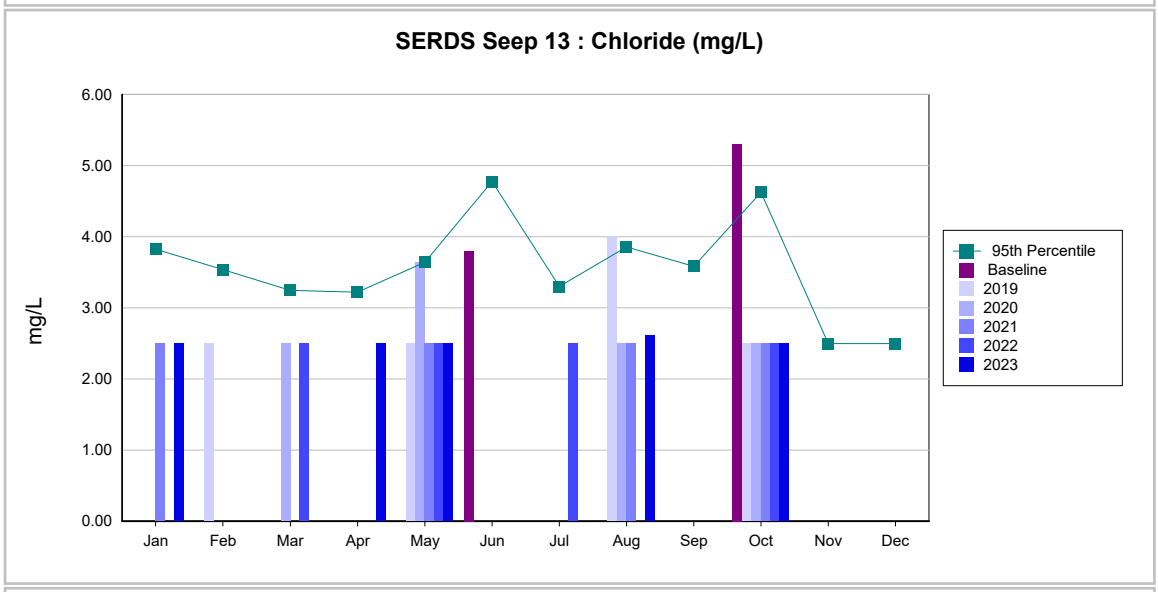
Annual Report Drainage Water

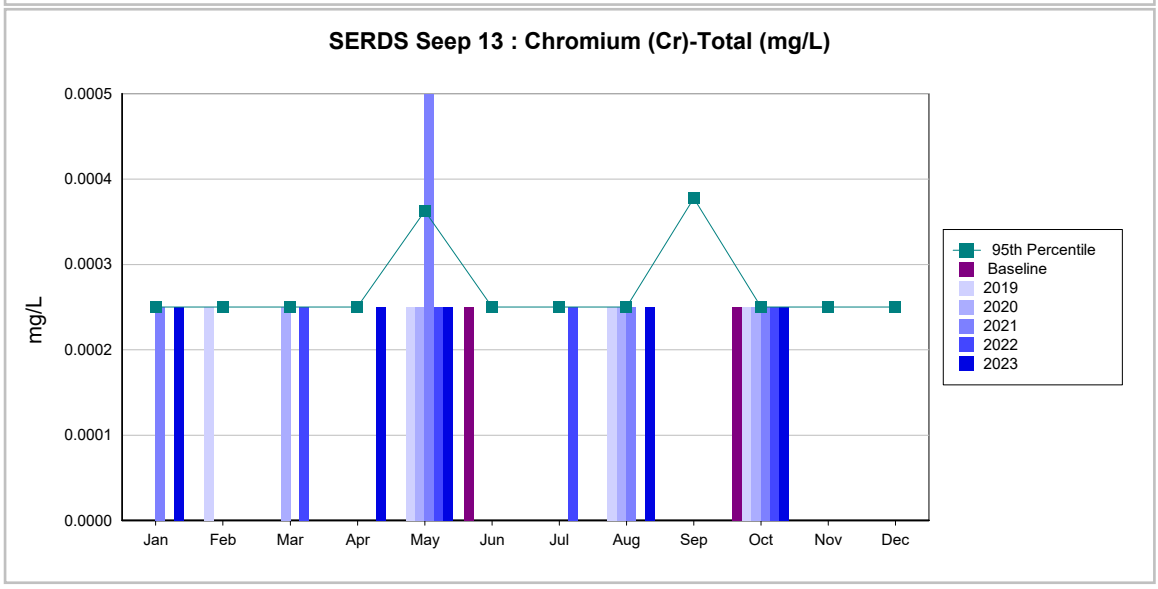
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







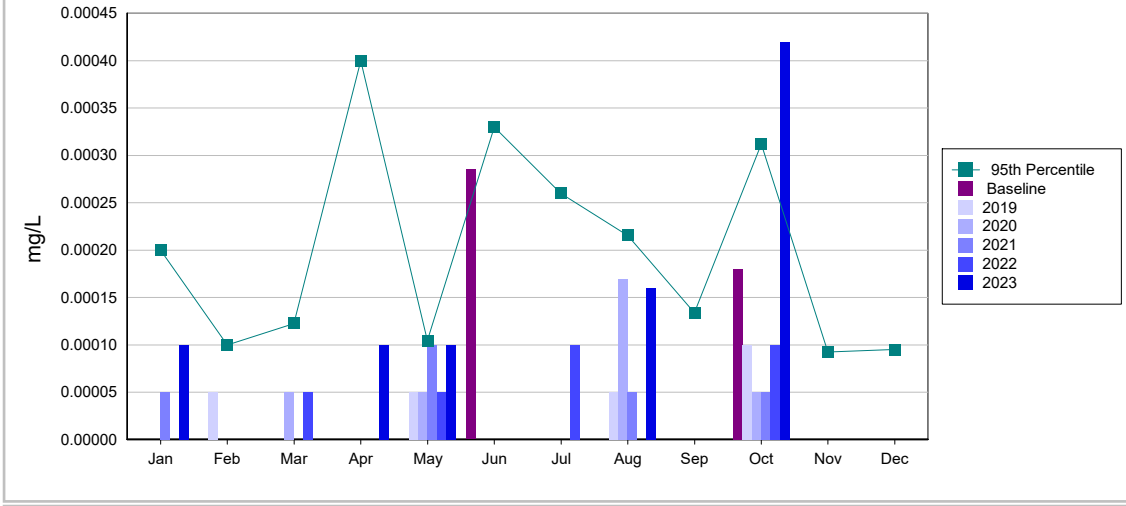
Water Quality Report

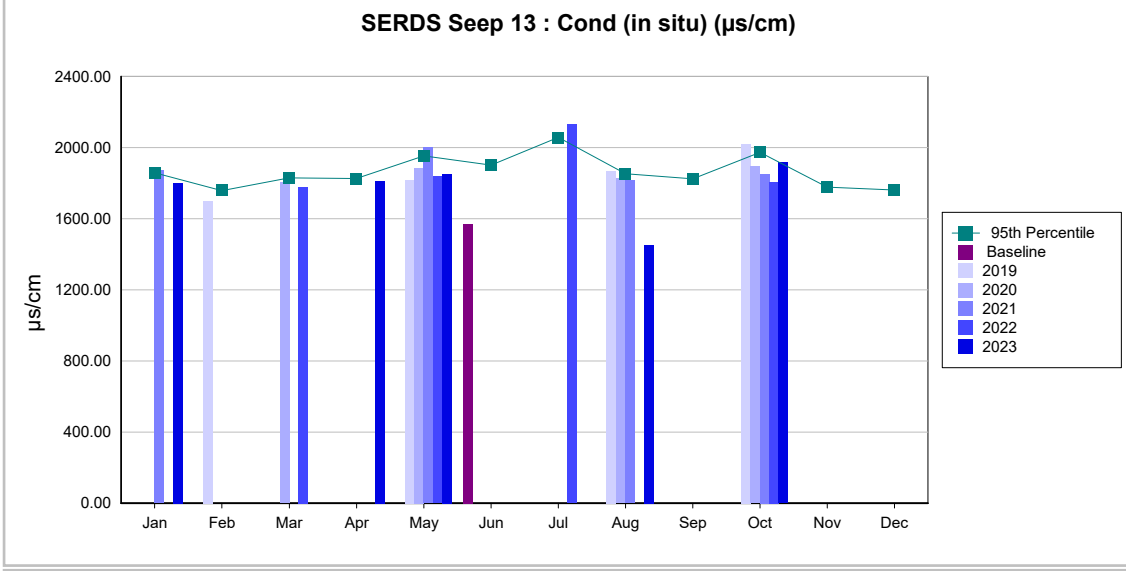
Annual Report Drainage Water

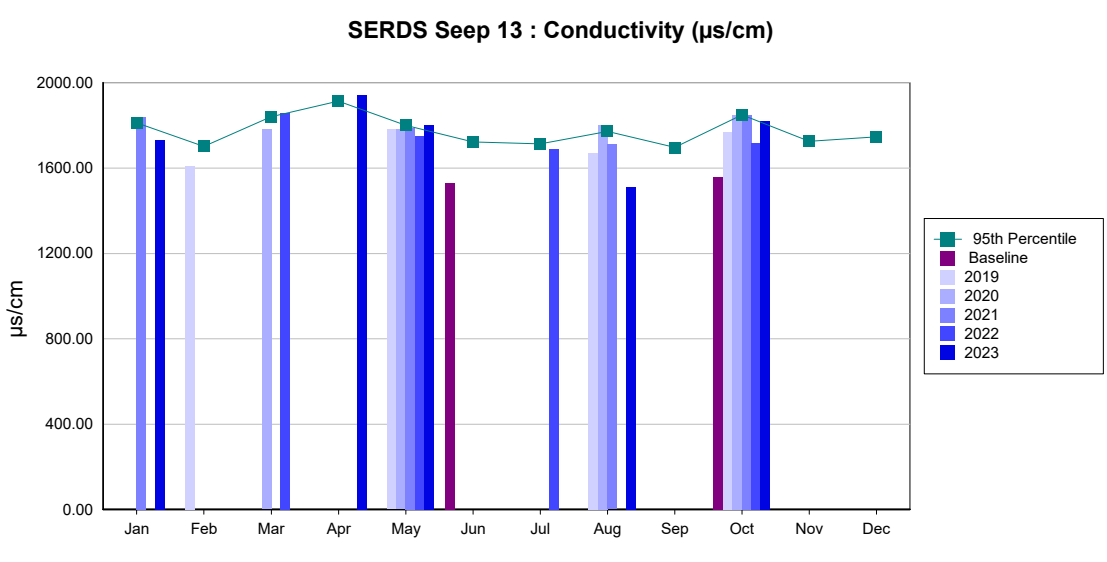
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







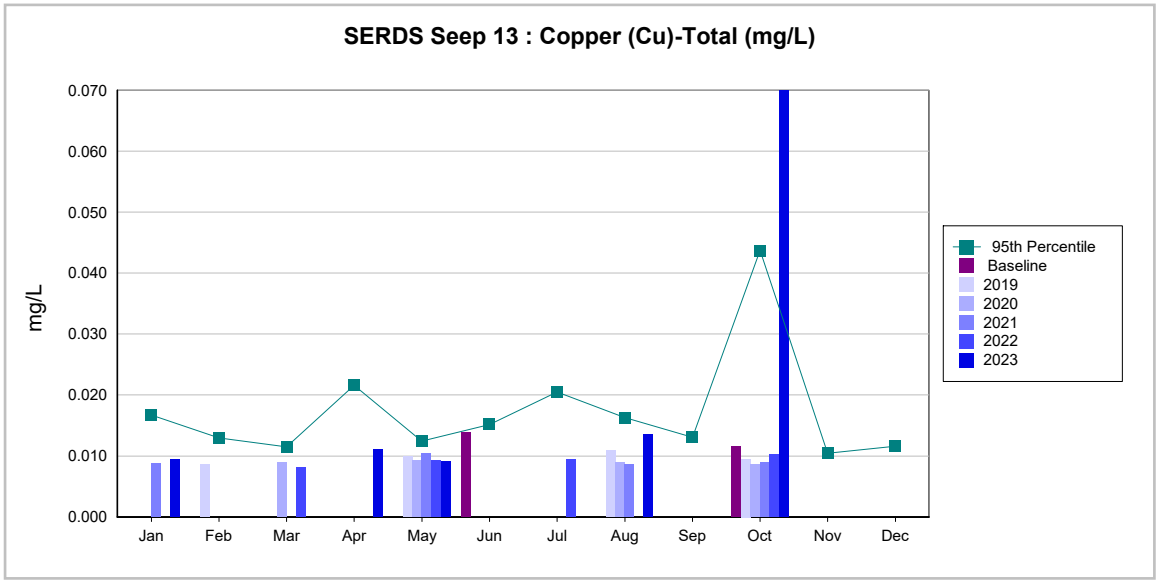
Water Quality Report

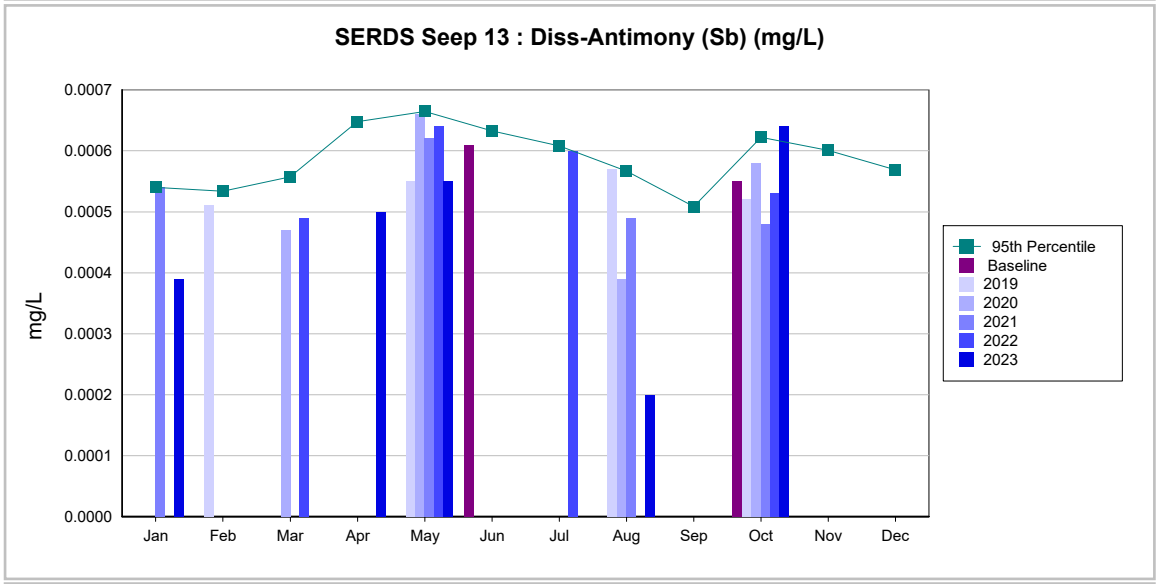
Annual Report Drainage Water

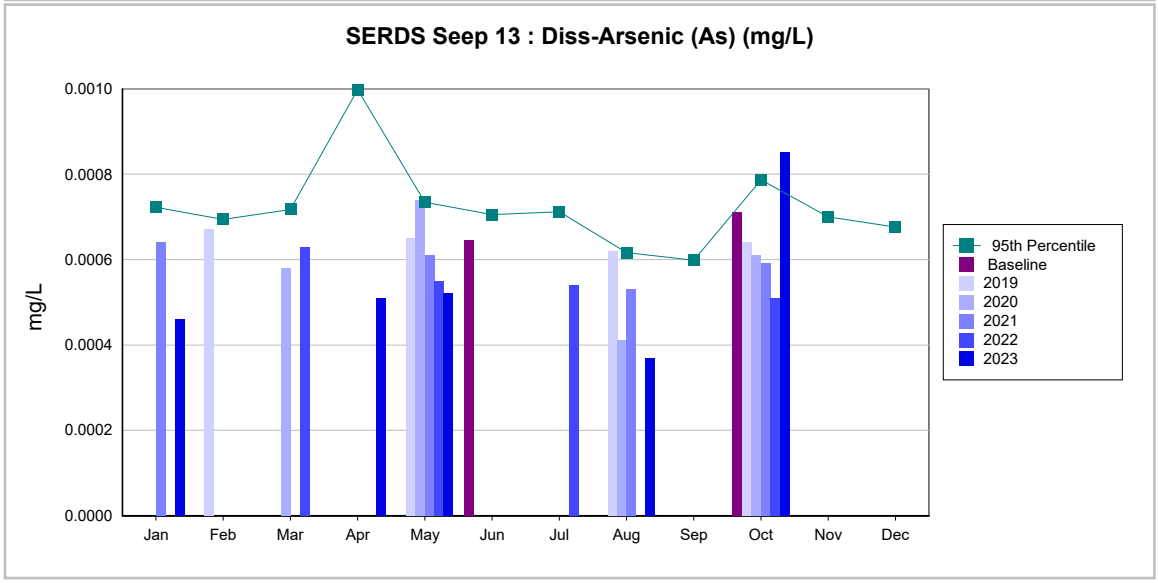
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







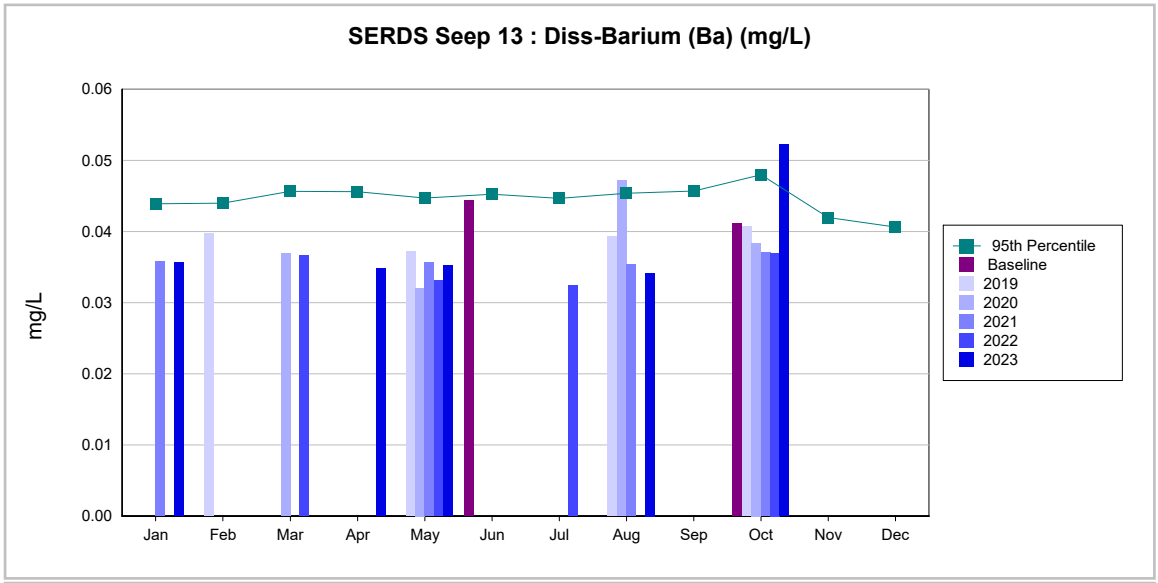
Water Quality Report

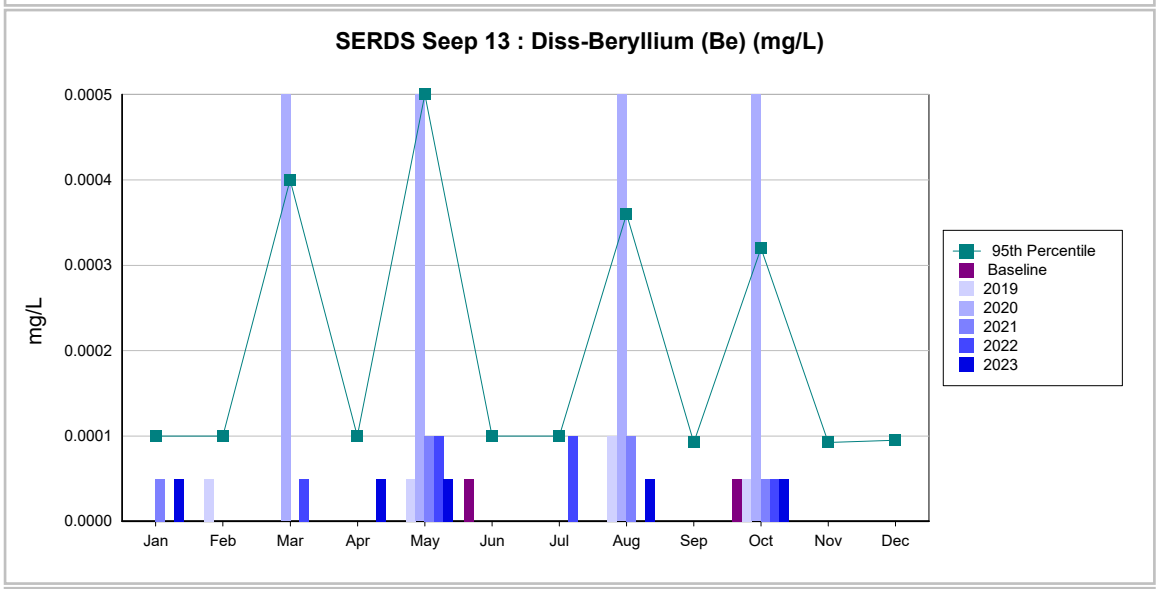
Annual Report Drainage Water

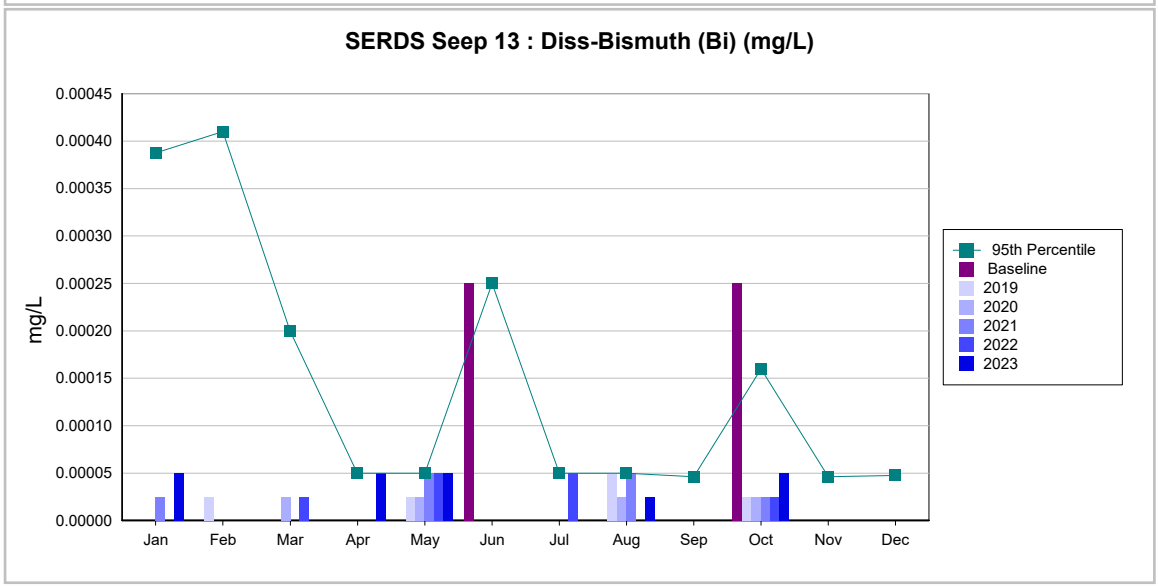
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







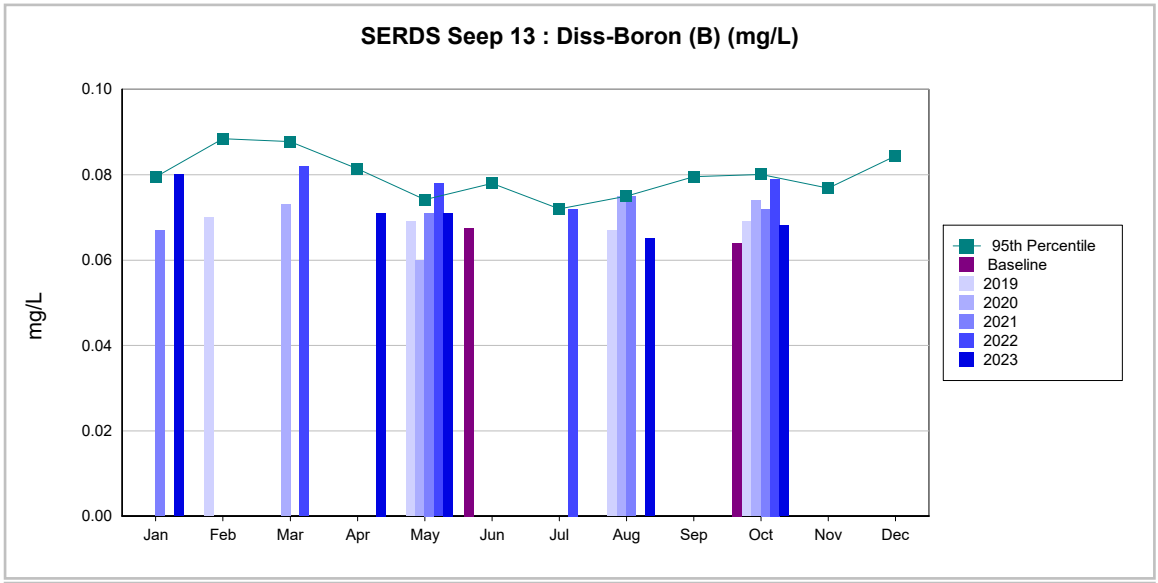
Water Quality Report

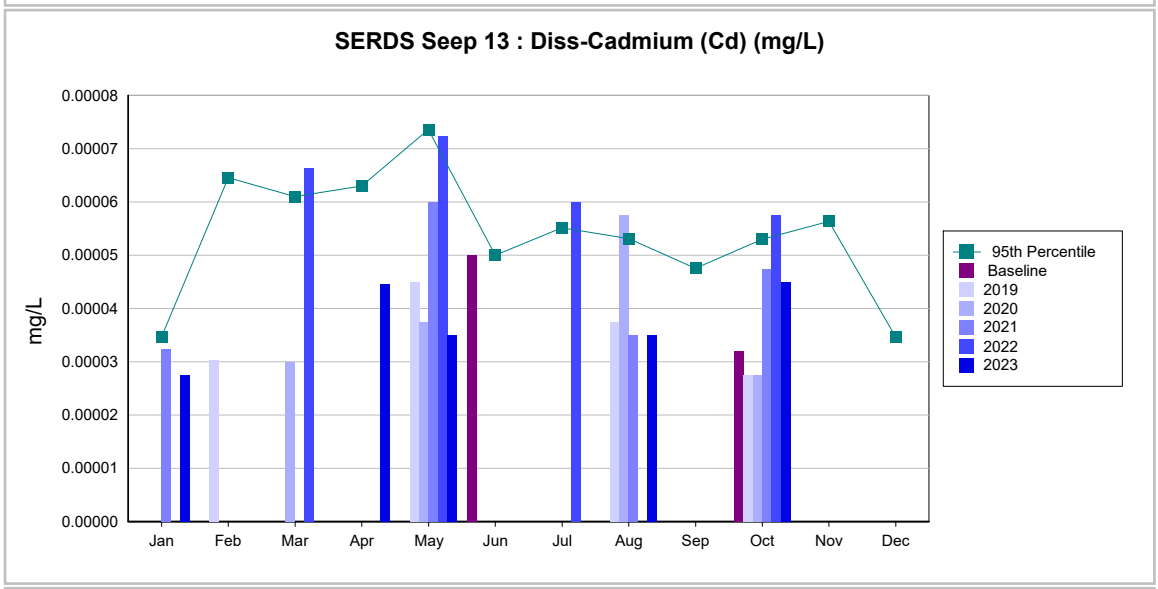
Annual Report Drainage Water

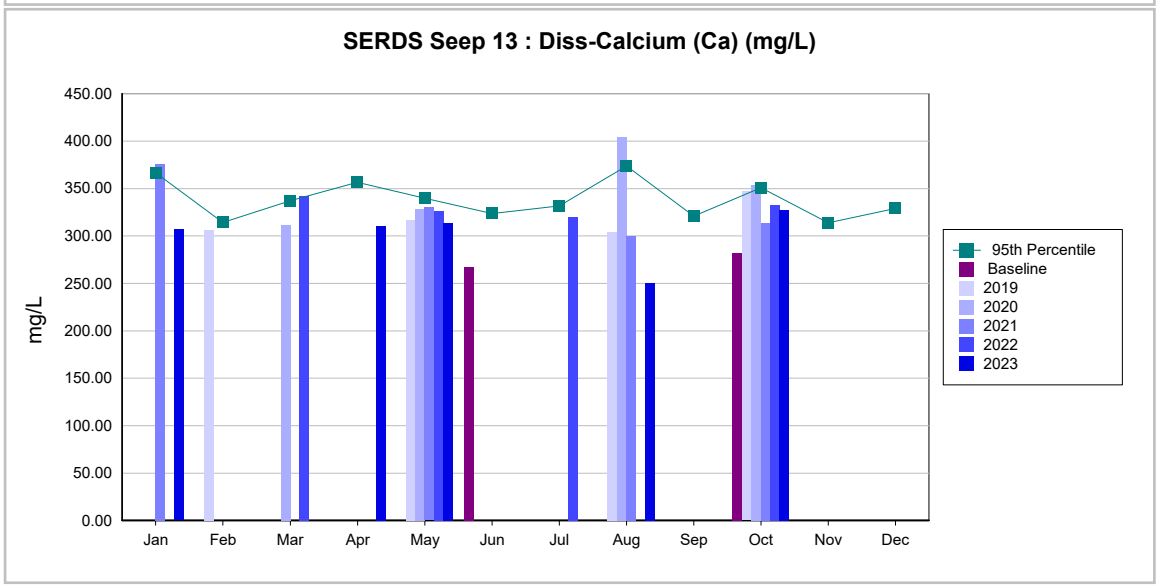
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







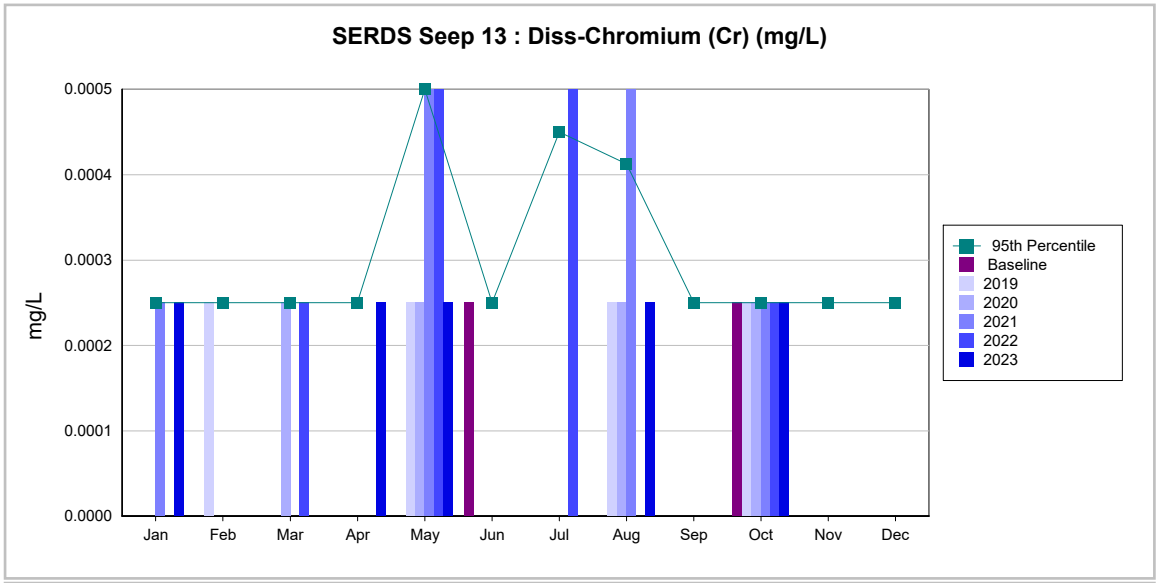
Water Quality Report

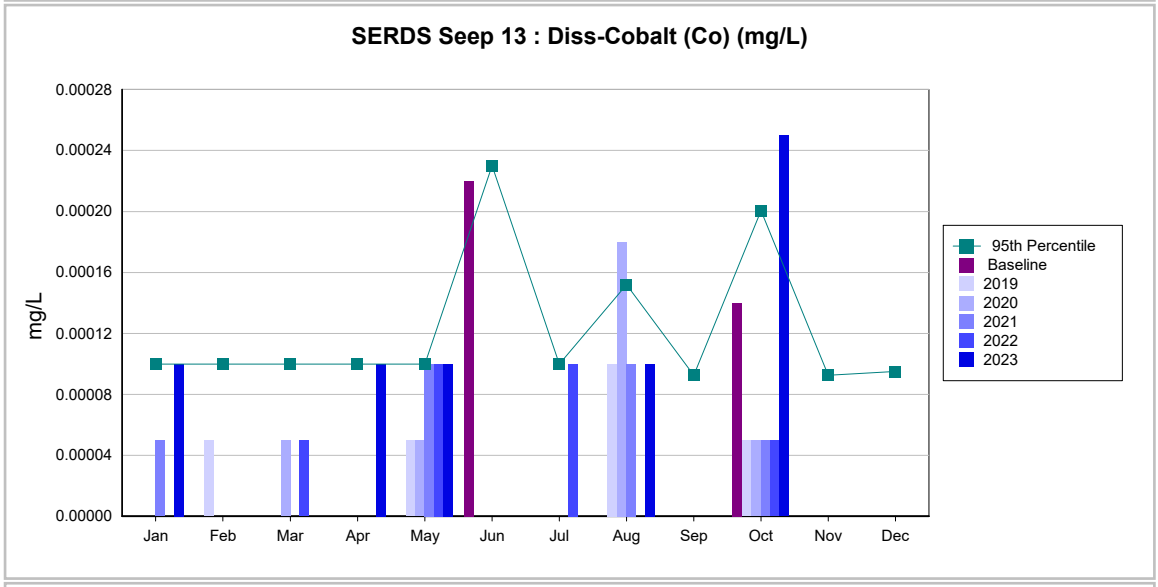
Annual Report Drainage Water

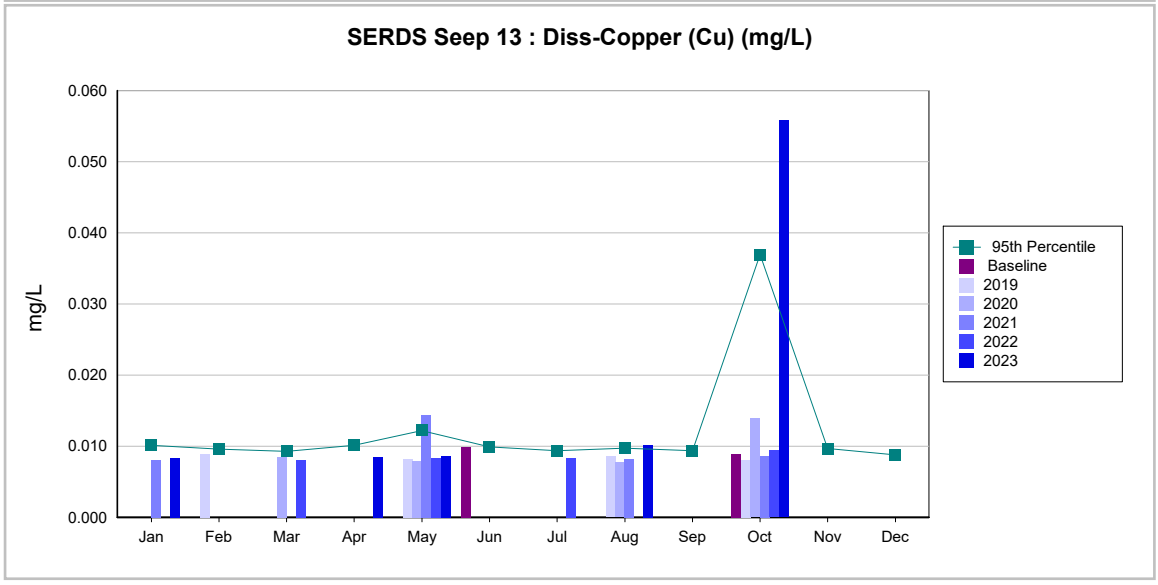
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







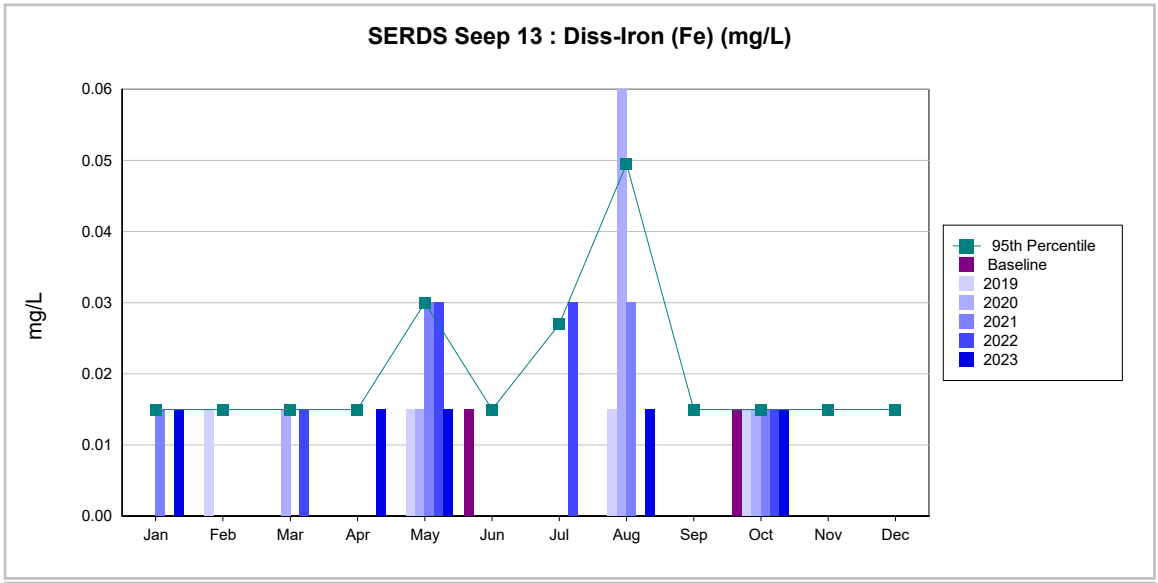
Water Quality Report

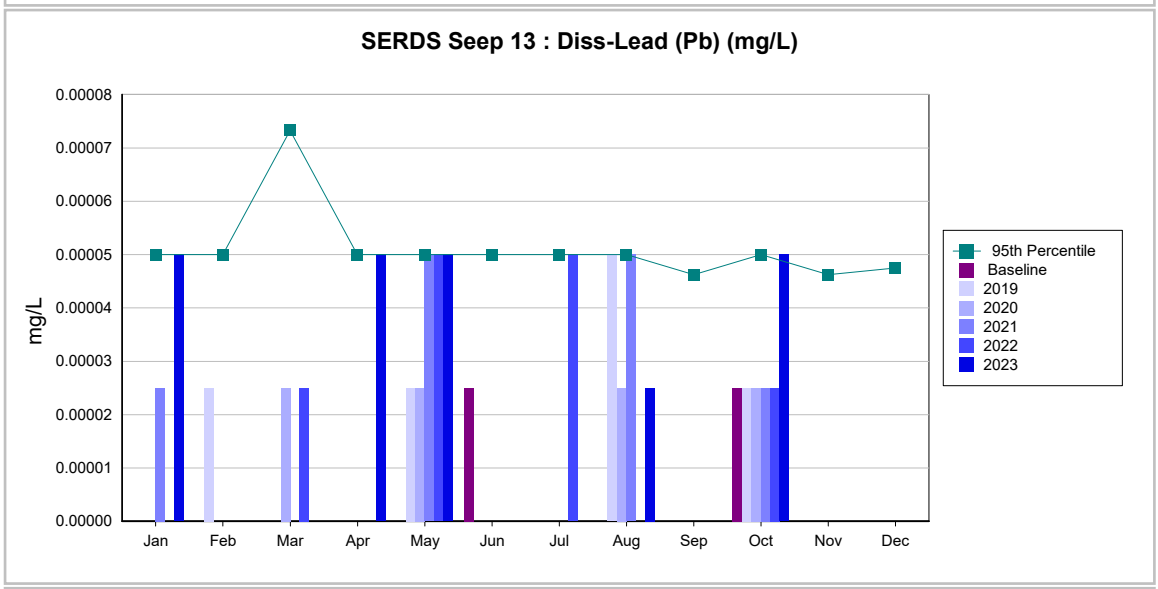
Annual Report Drainage Water

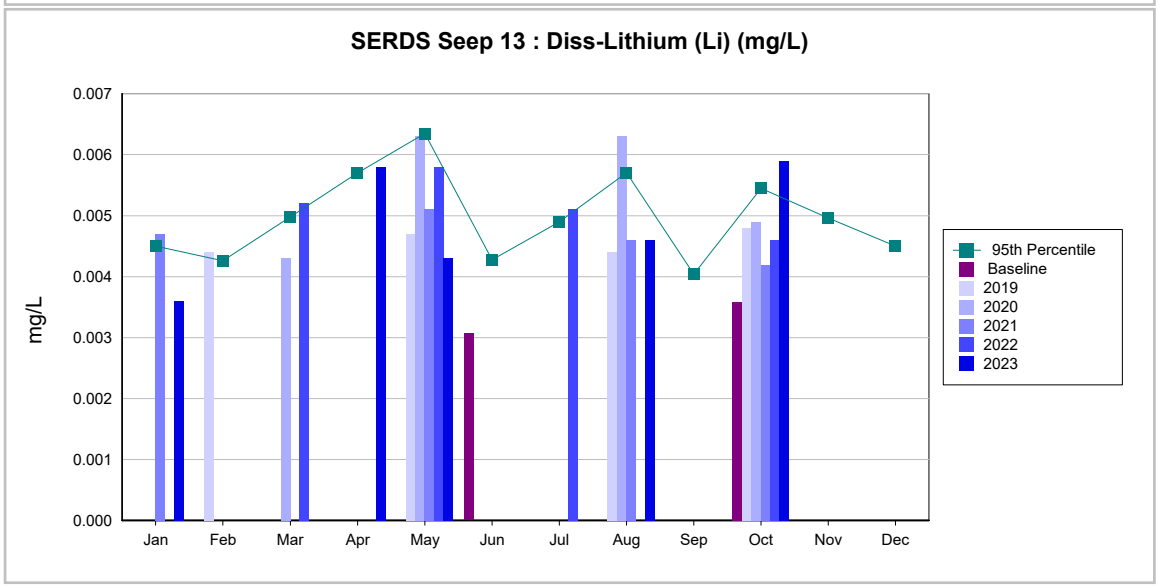
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







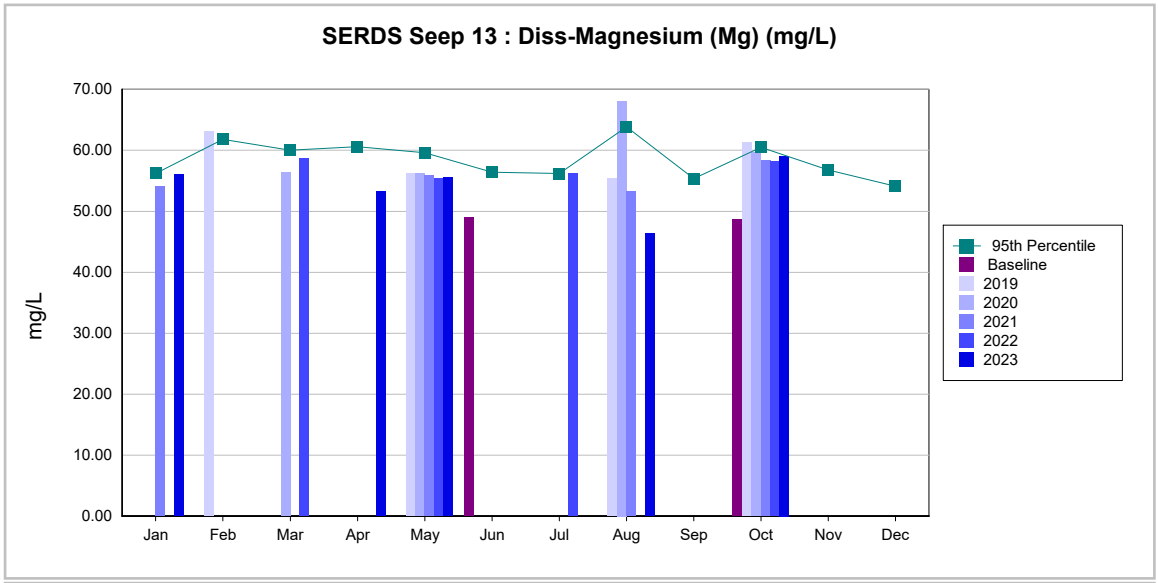
Water Quality Report

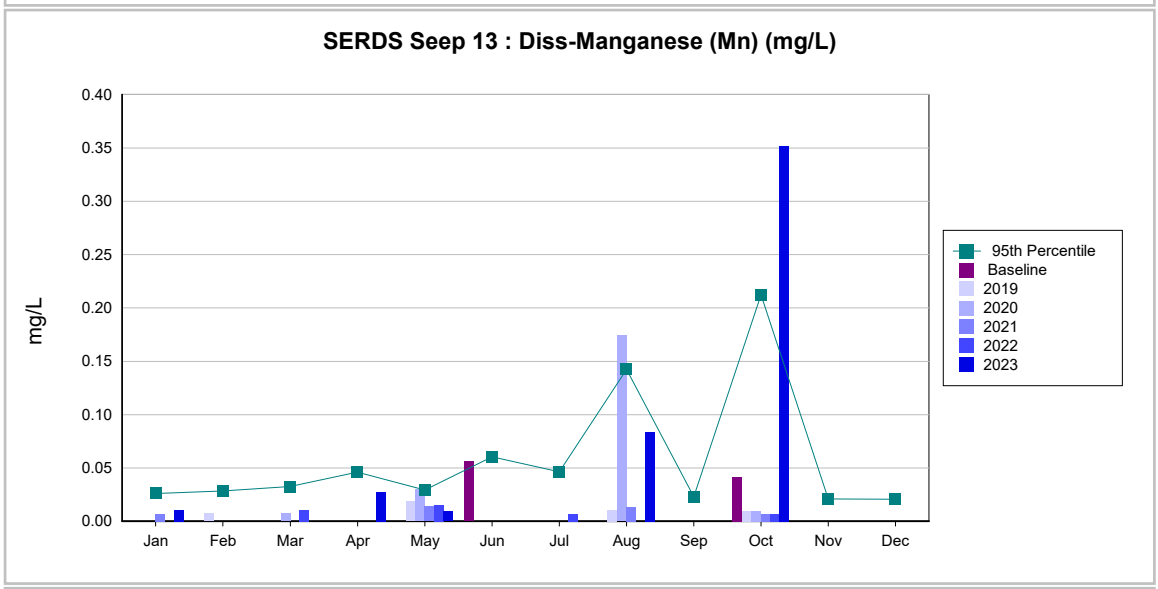
Annual Report Drainage Water

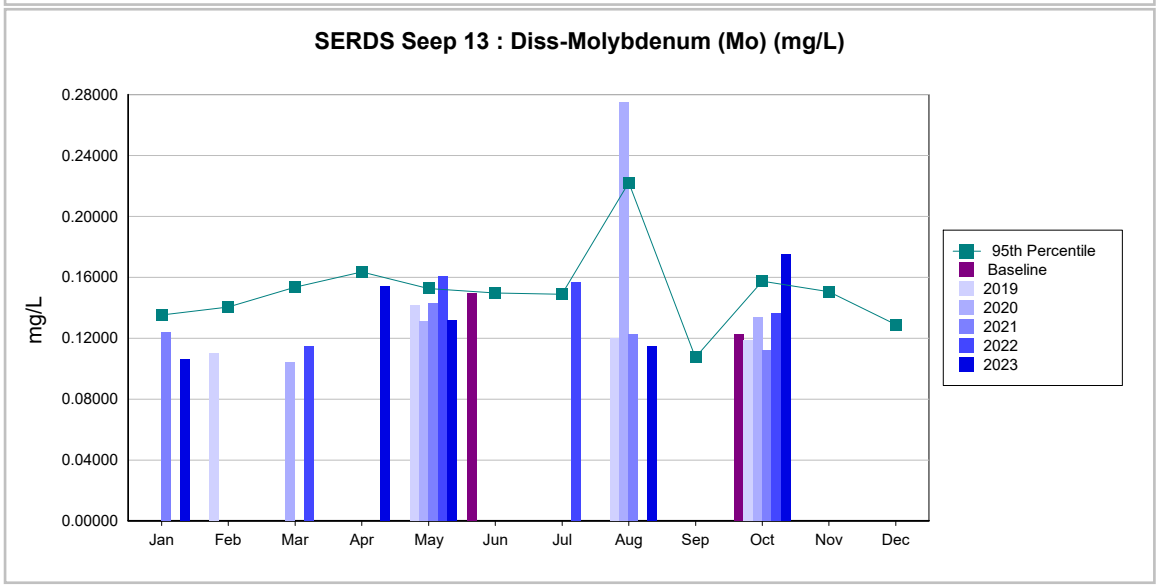
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







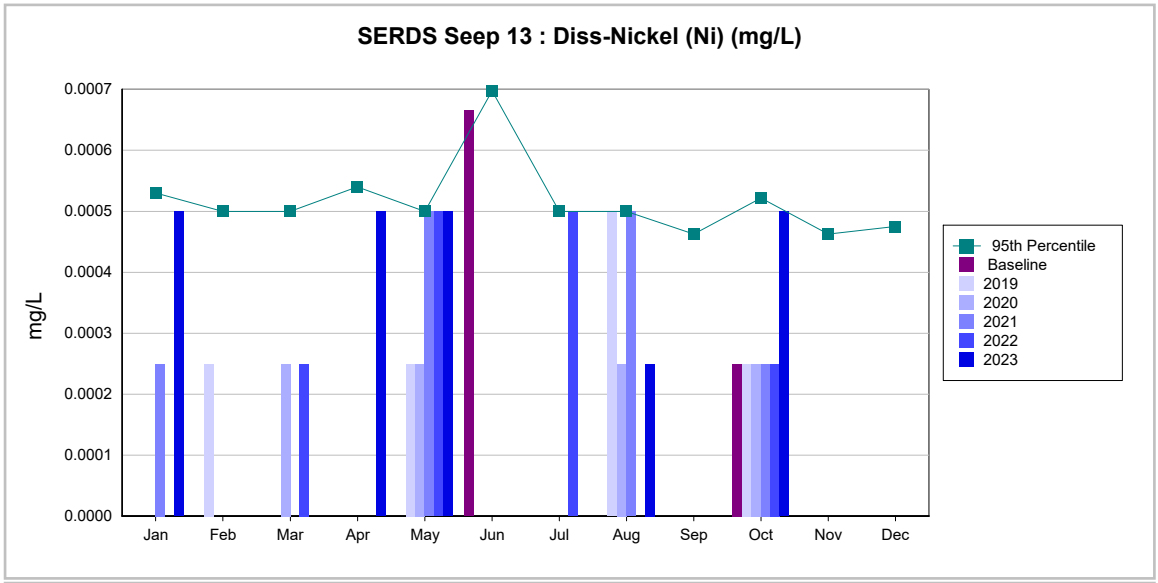
Water Quality Report

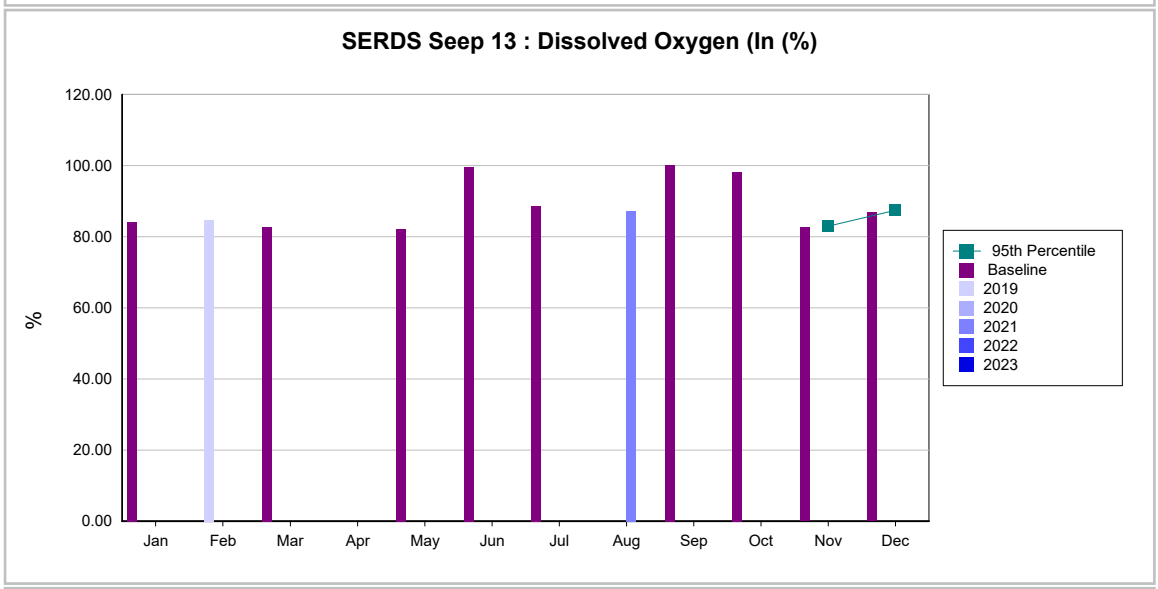
Annual Report Drainage Water

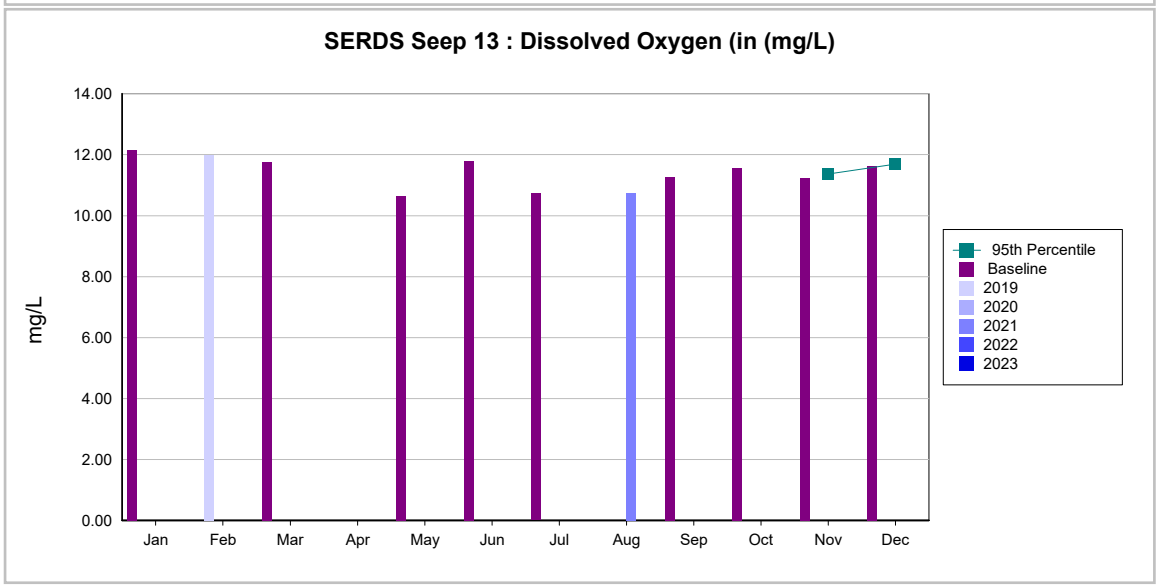
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







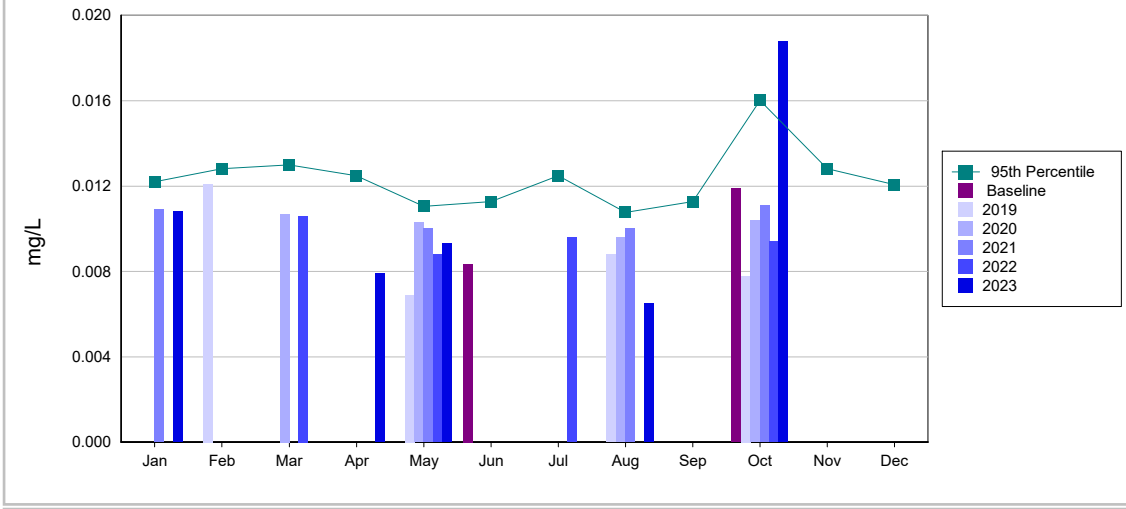
Water Quality Report

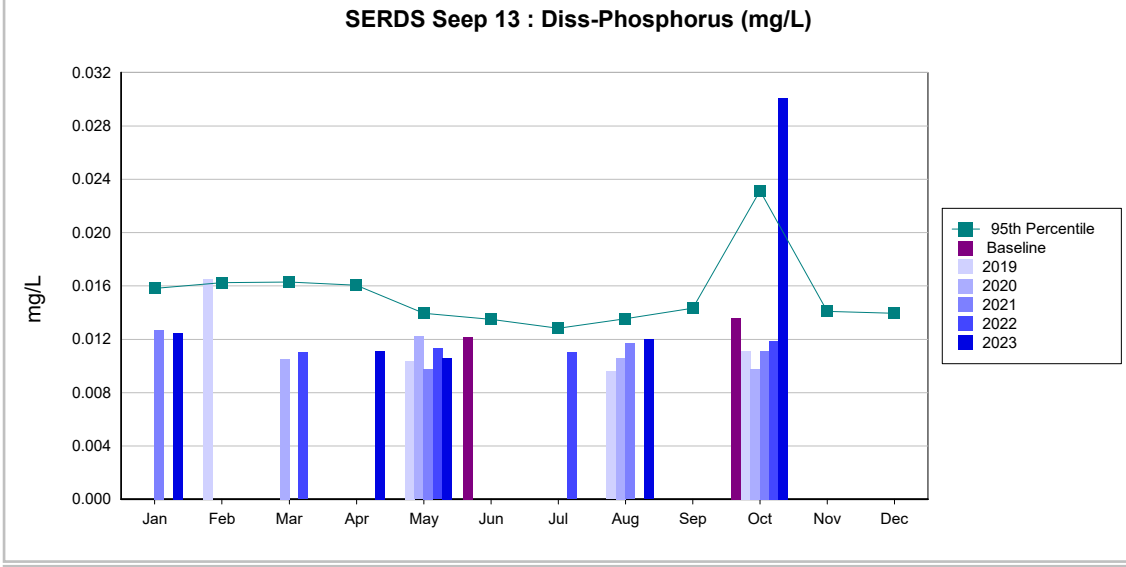
Annual Report Drainage Water

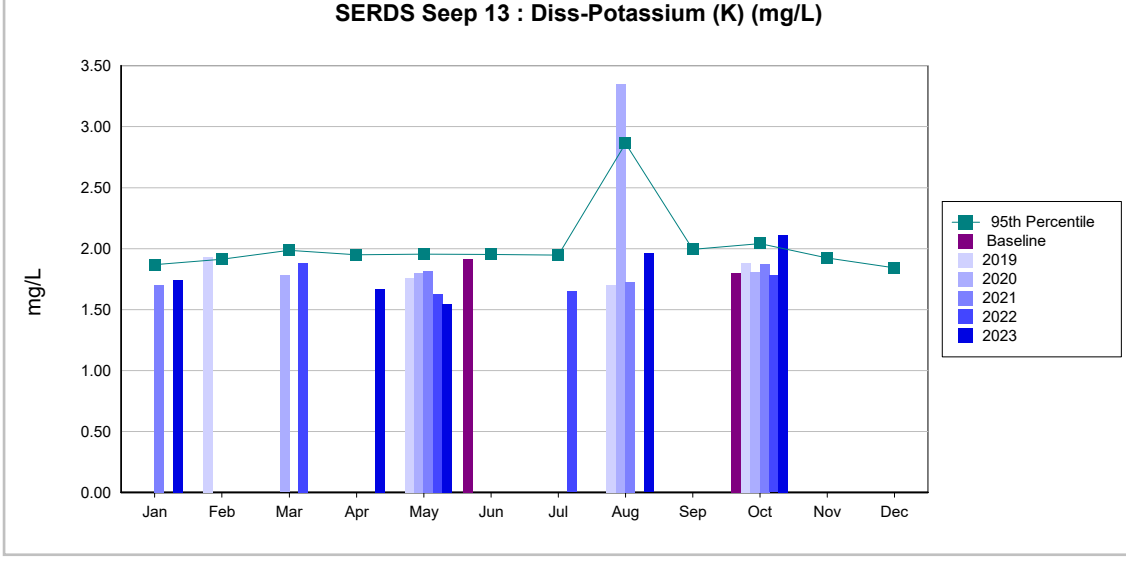
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







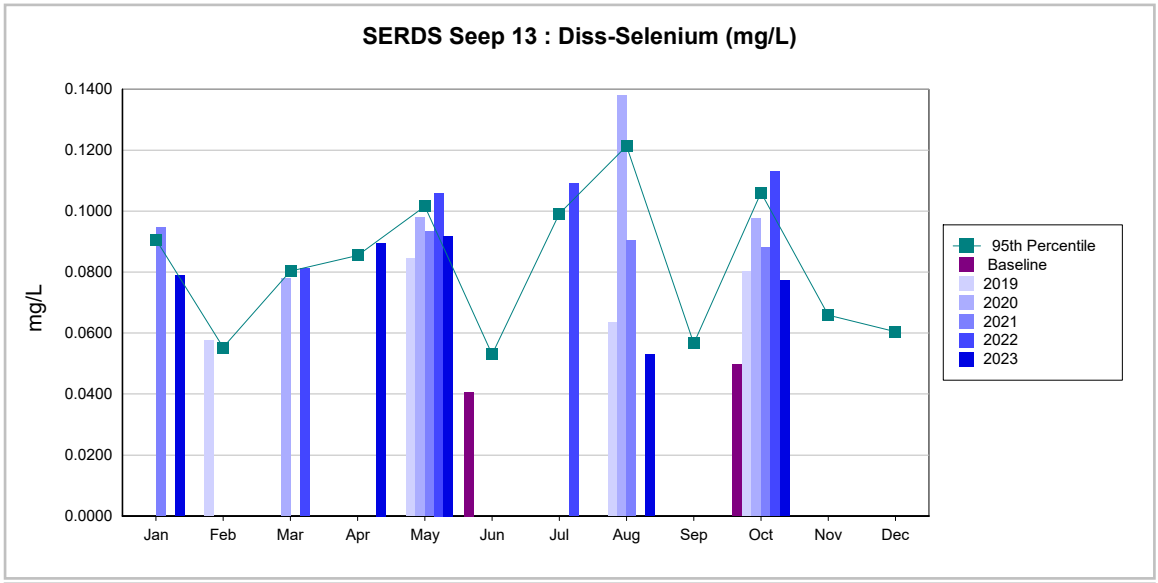
Water Quality Report

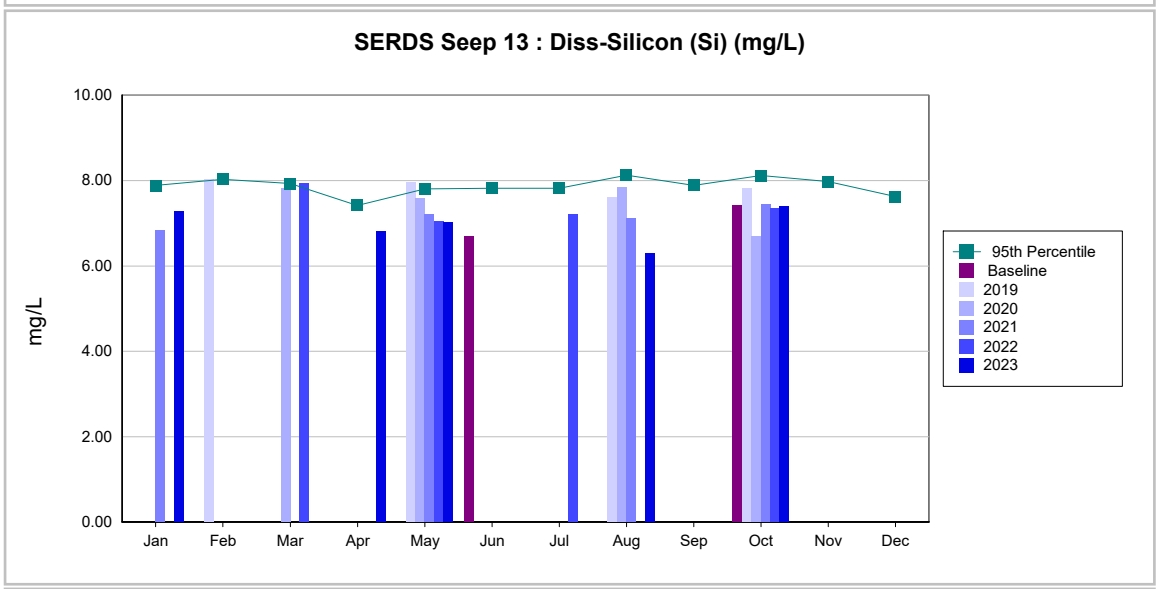
Annual Report Drainage Water

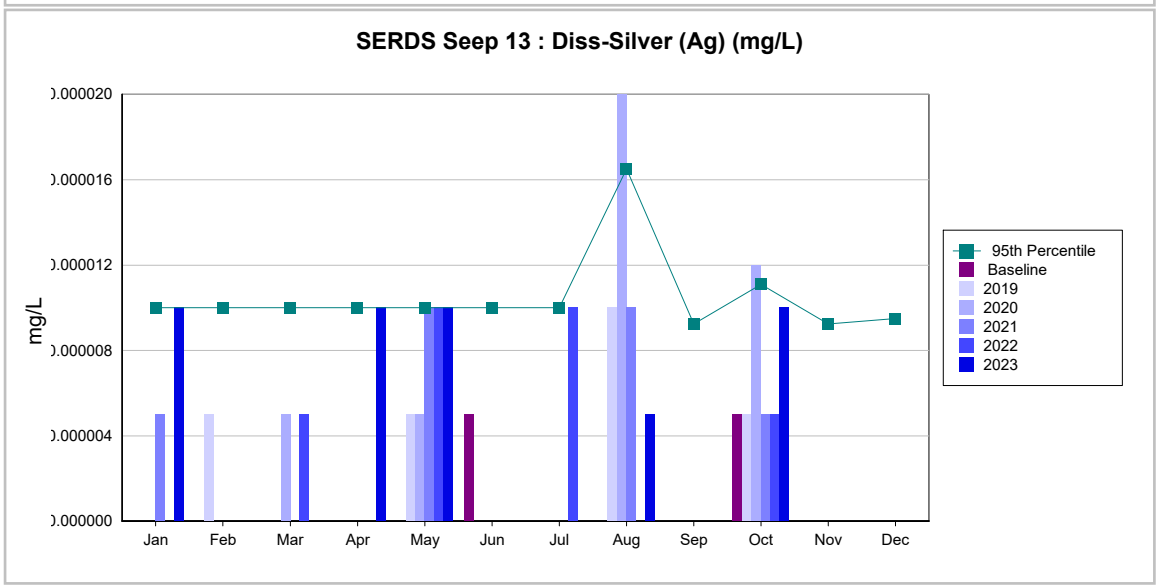
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







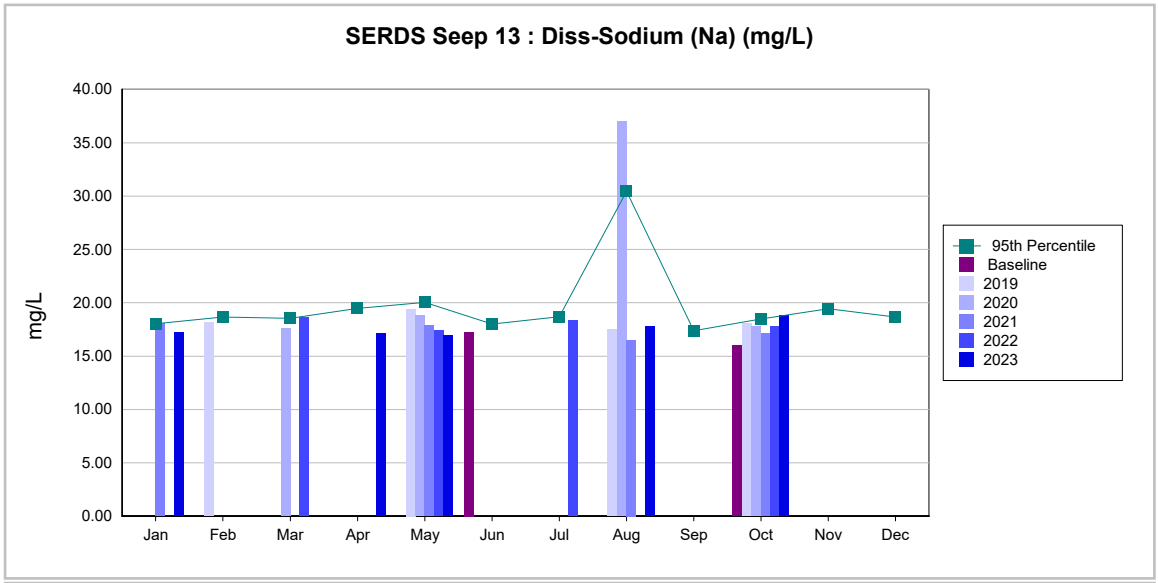
Water Quality Report

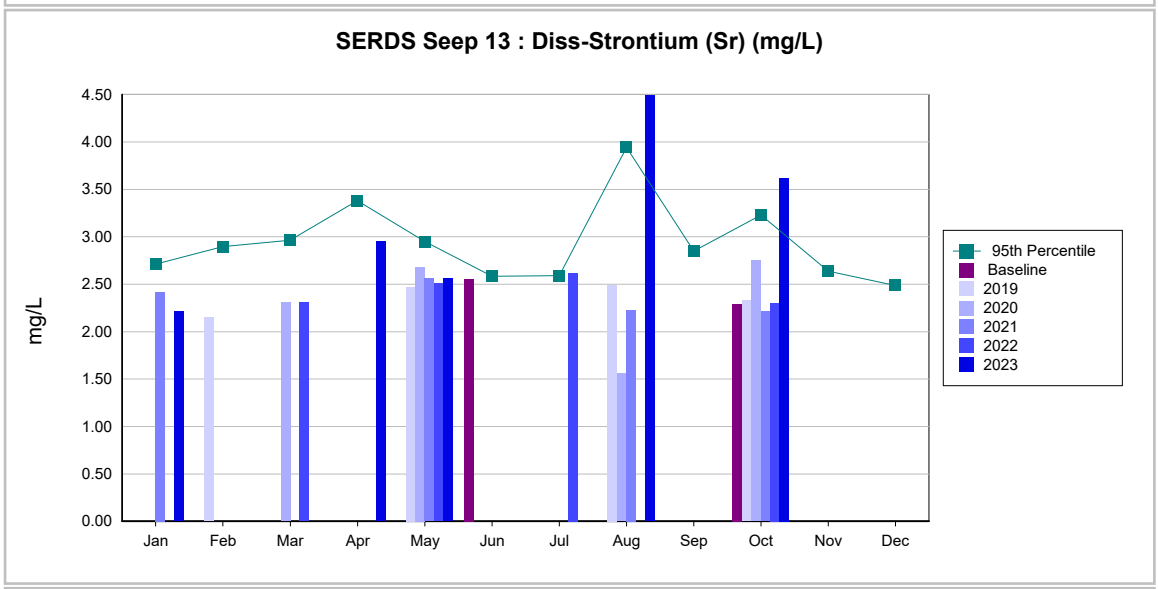
Annual Report Drainage Water

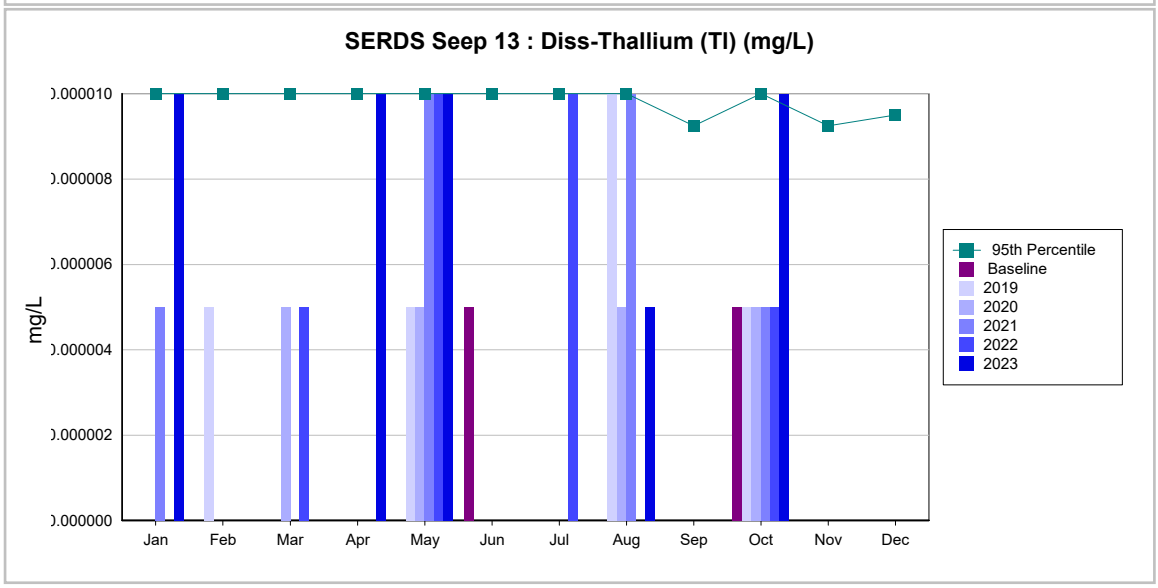
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







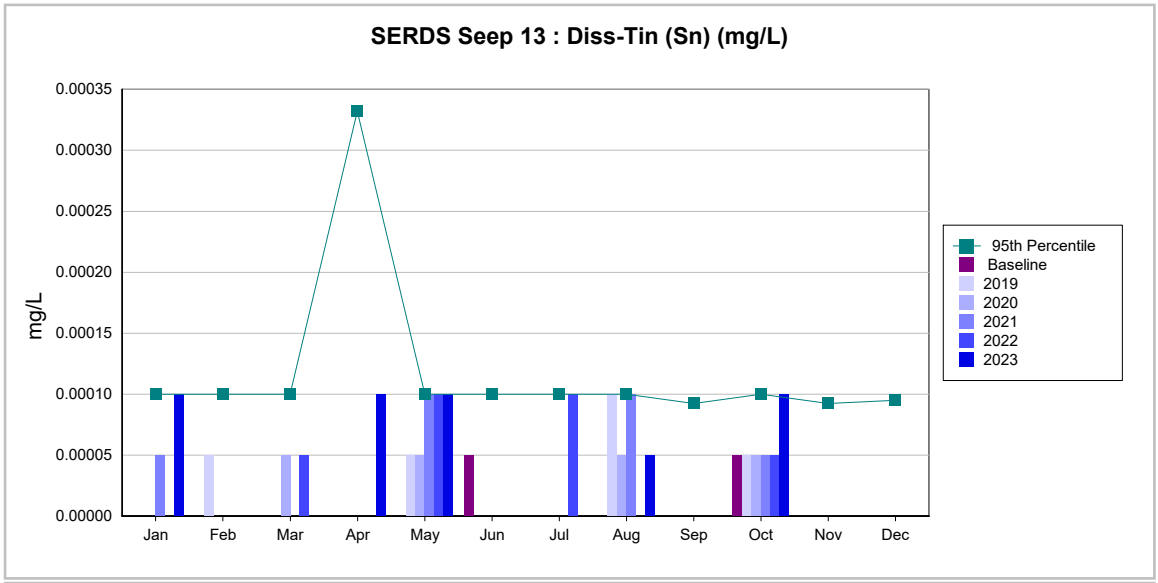
Water Quality Report

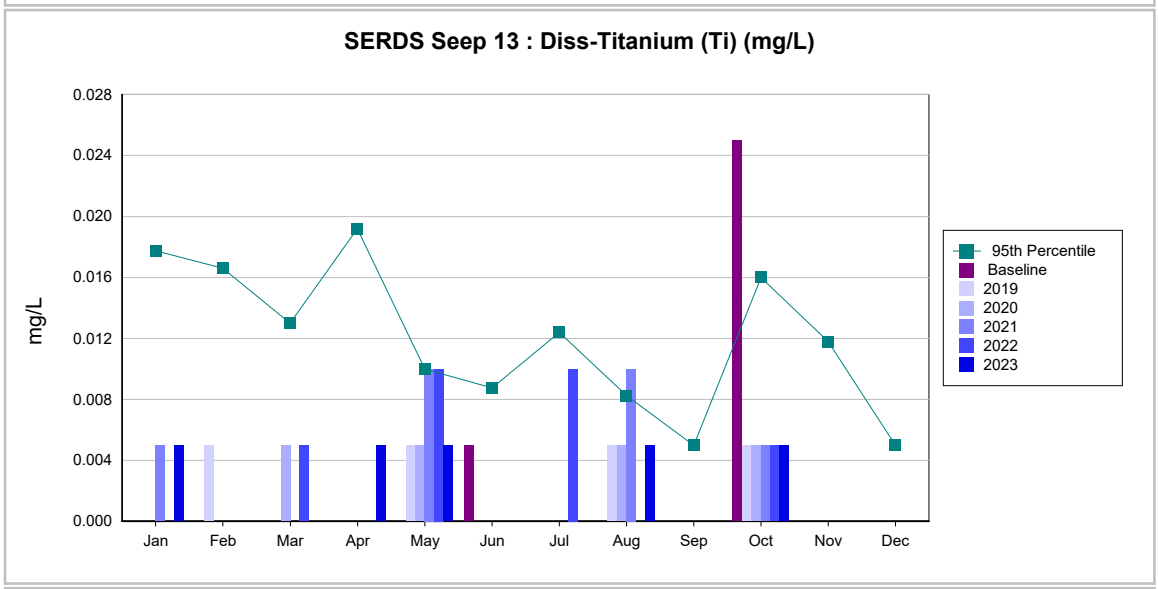
Annual Report Drainage Water

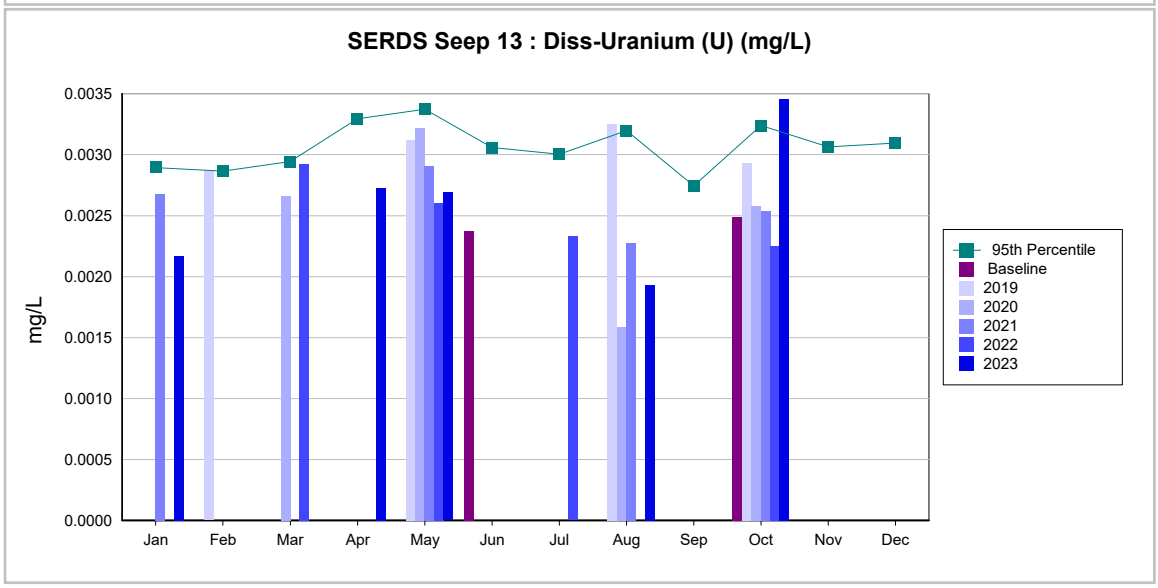
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







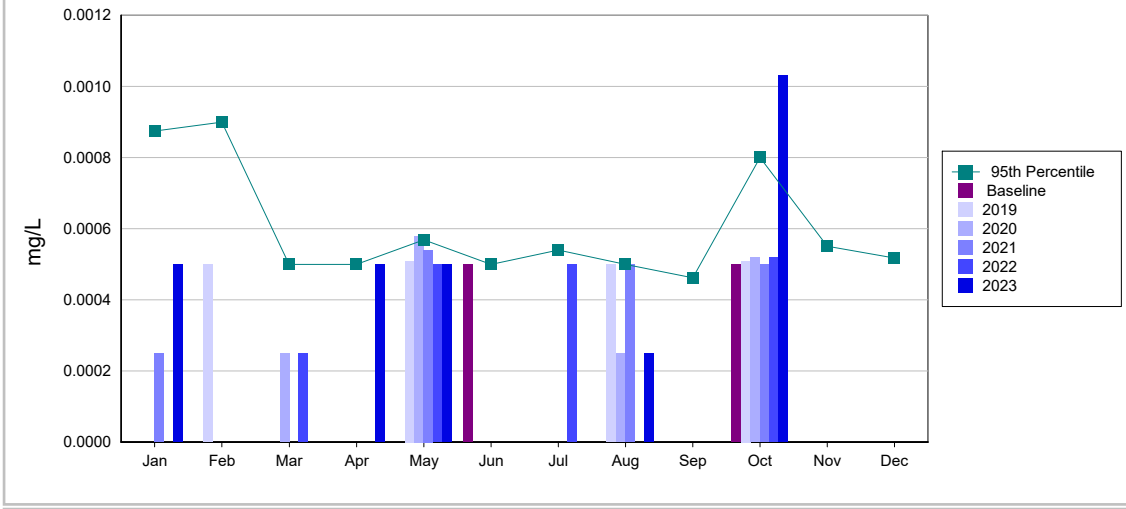
Water Quality Report

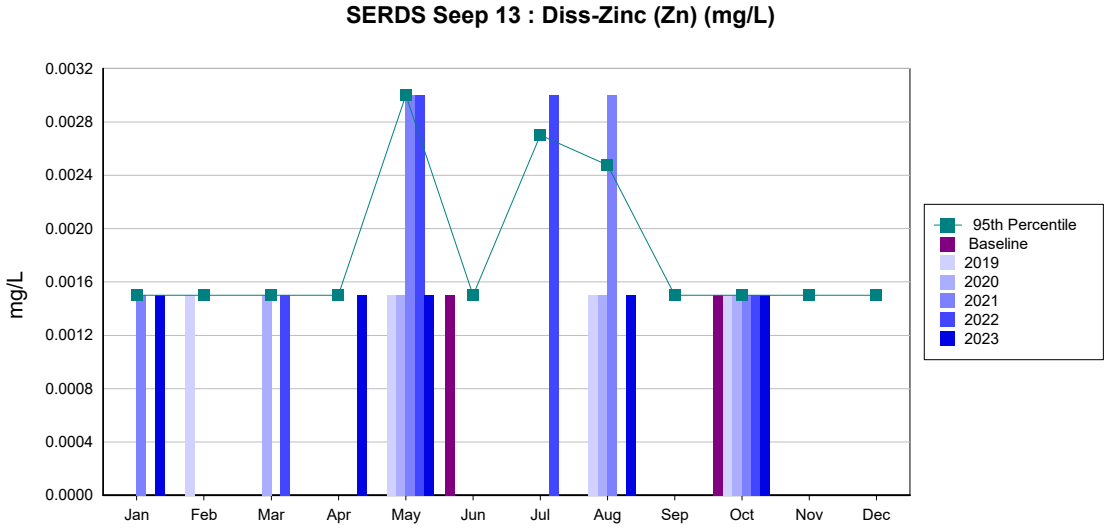
Annual Report Drainage Water

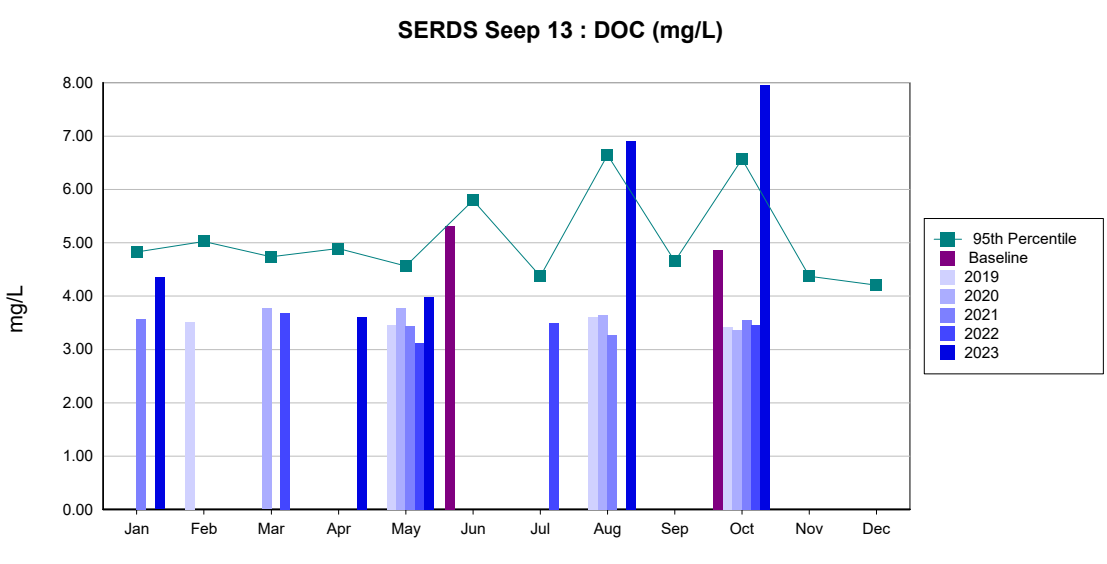
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







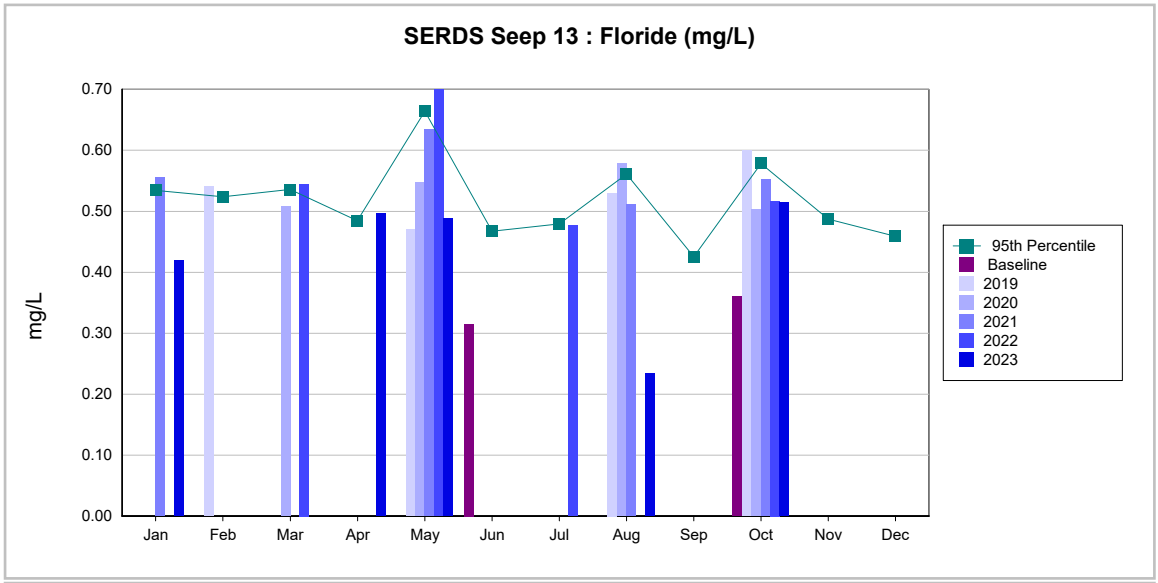
Water Quality Report

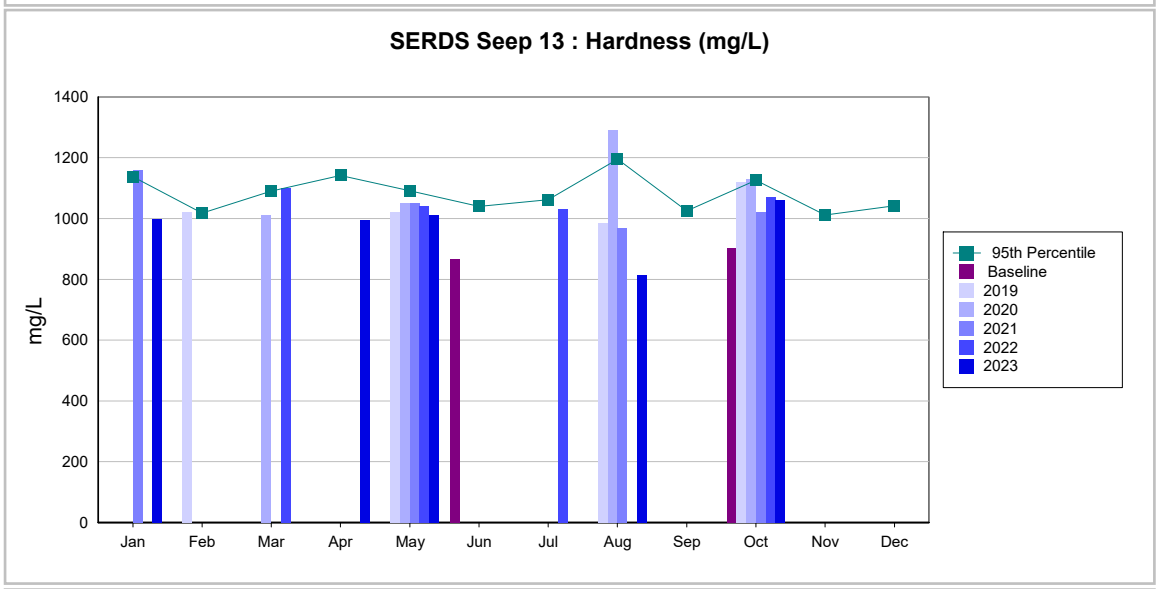
Annual Report Drainage Water

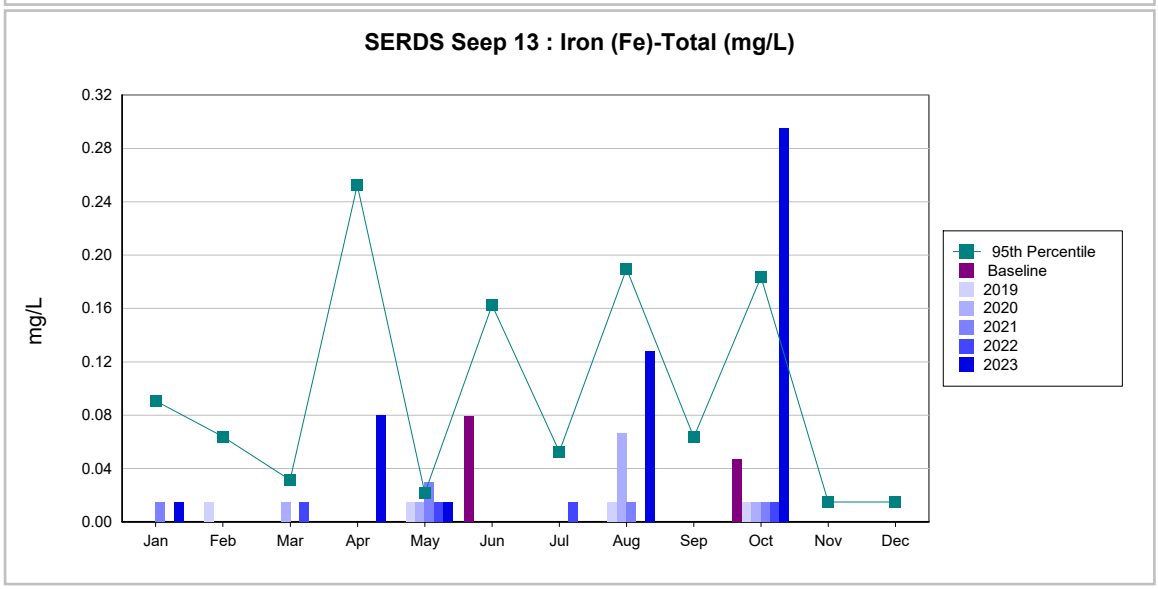
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







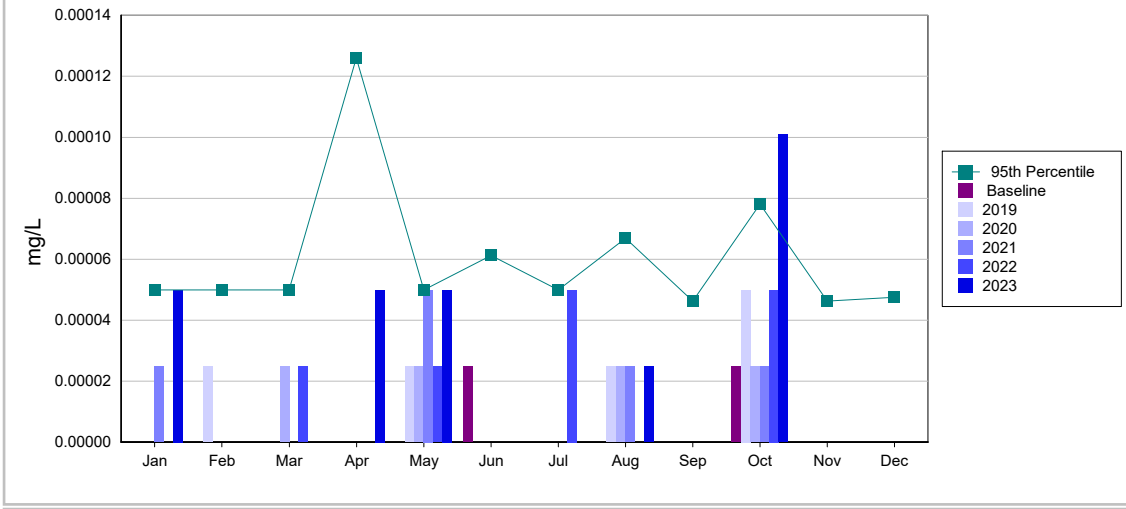
Water Quality Report

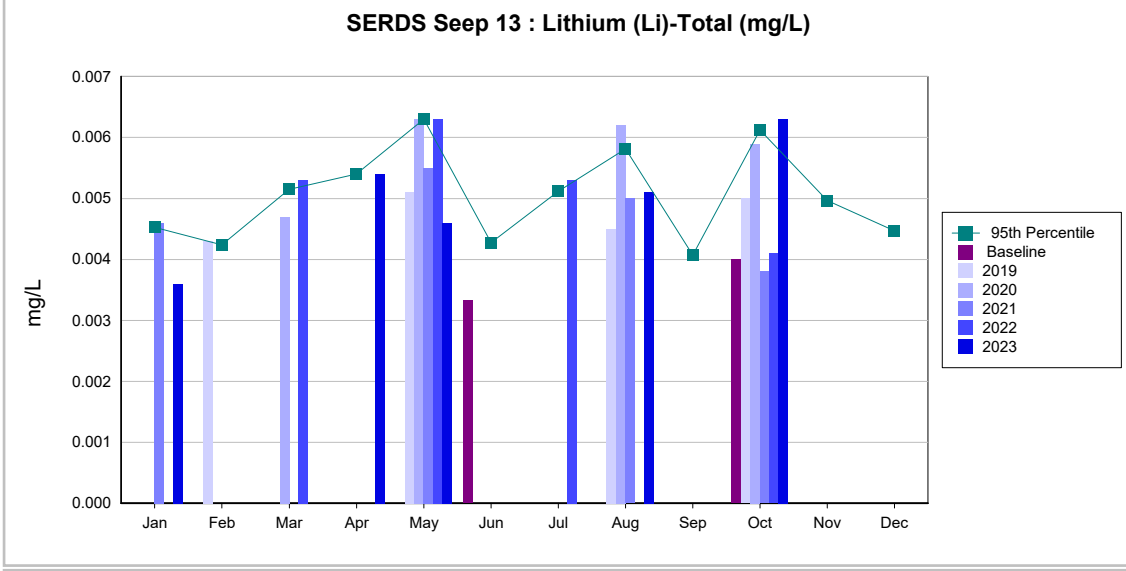
Annual Report Drainage Water

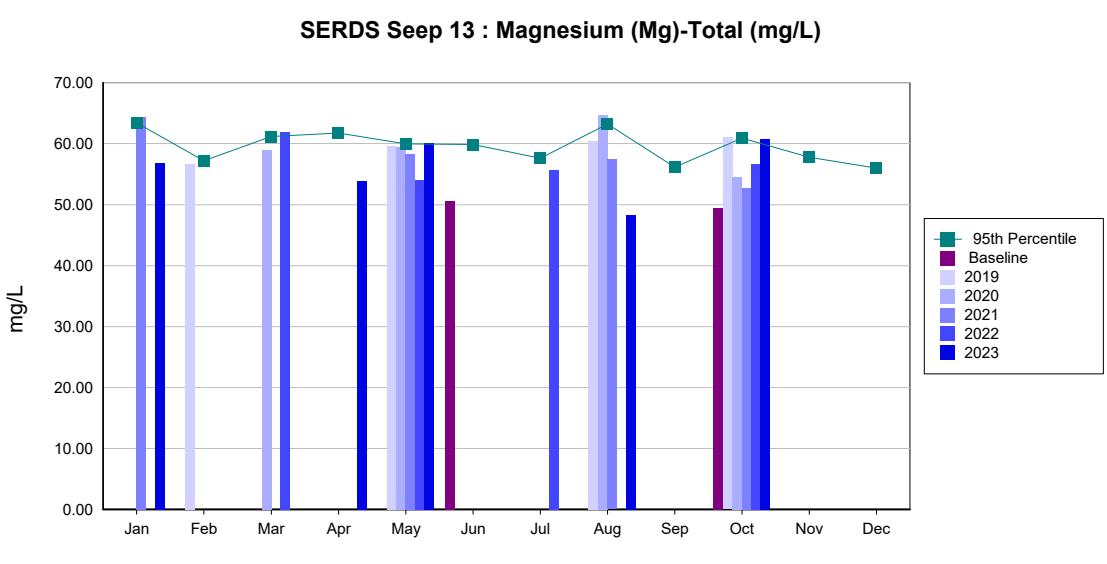
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







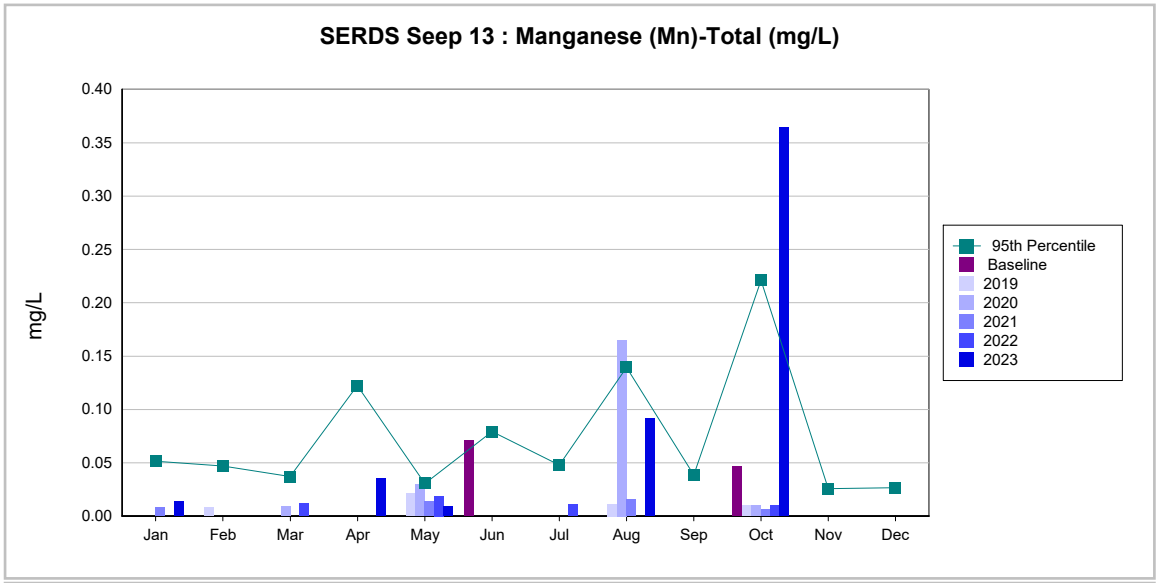
Water Quality Report

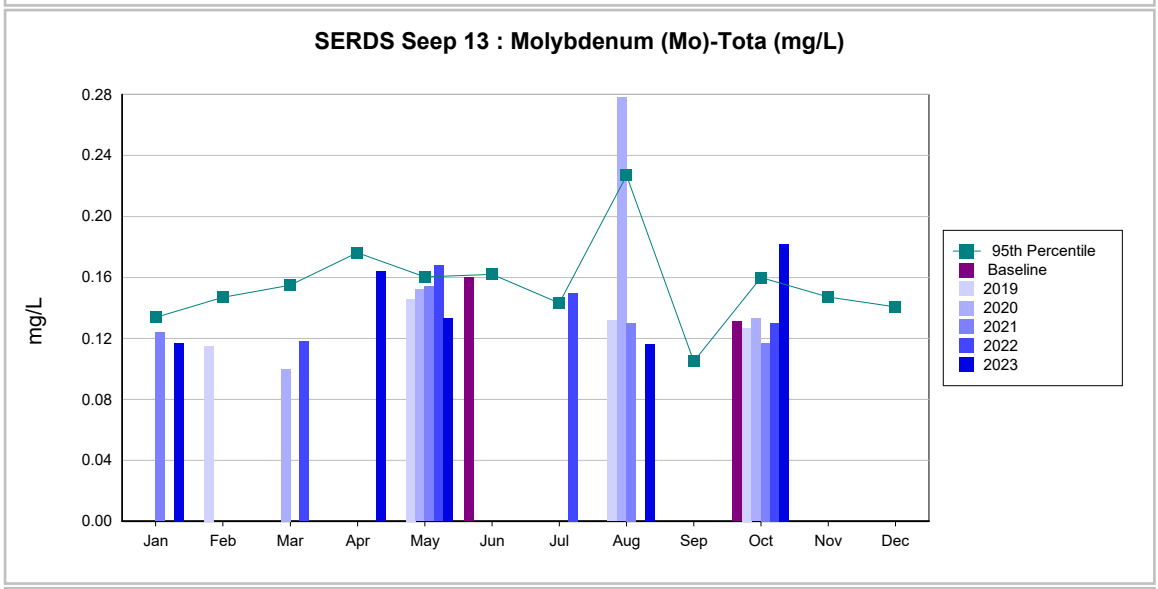
Annual Report Drainage Water

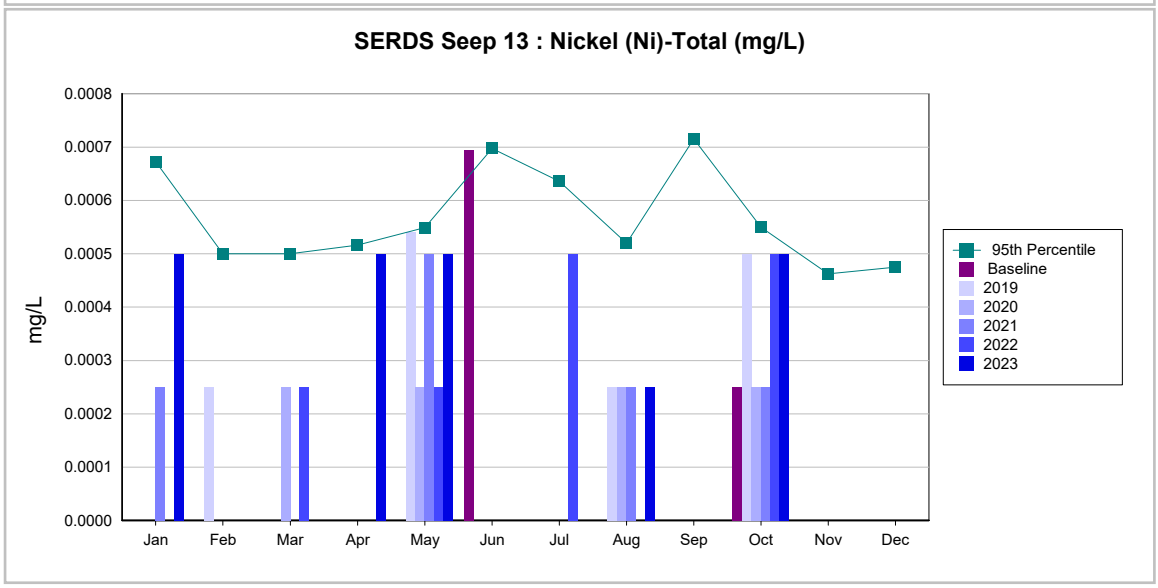
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







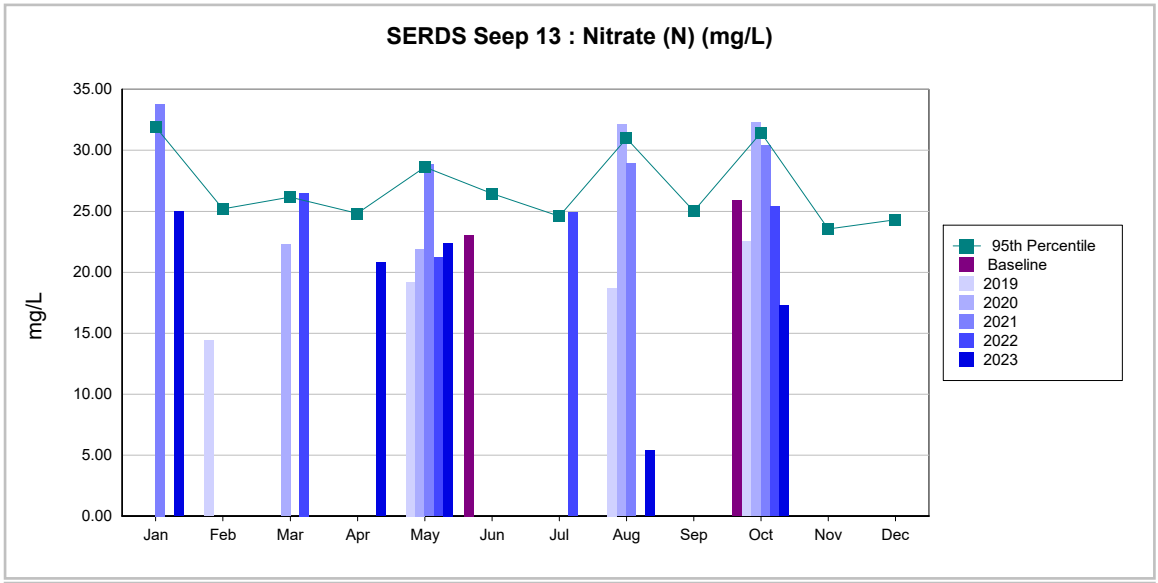
Water Quality Report

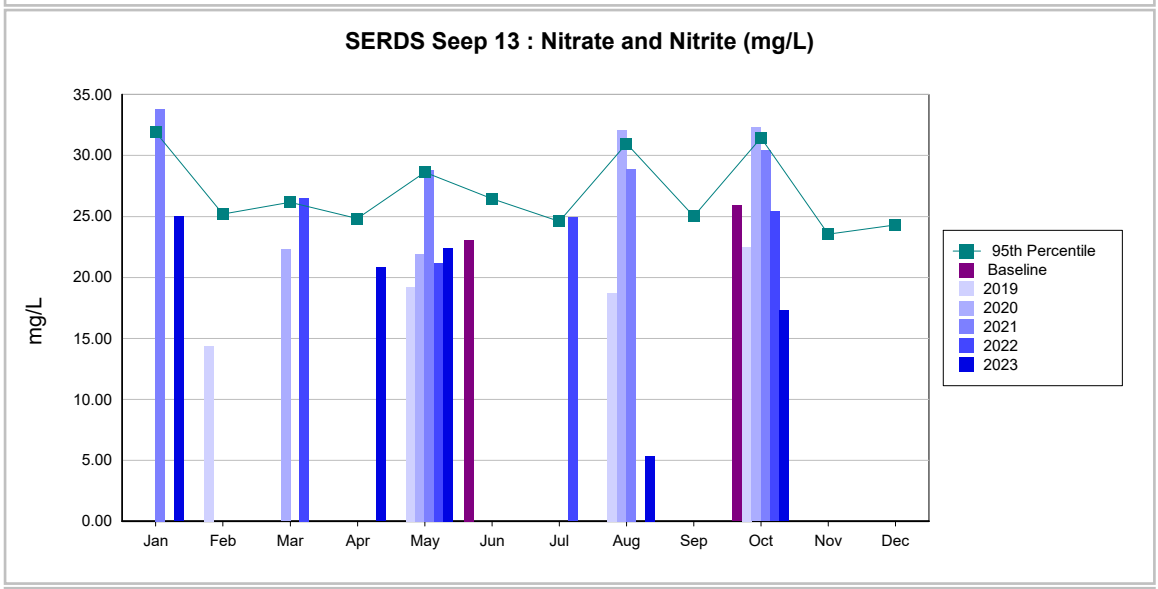
Annual Report Drainage Water

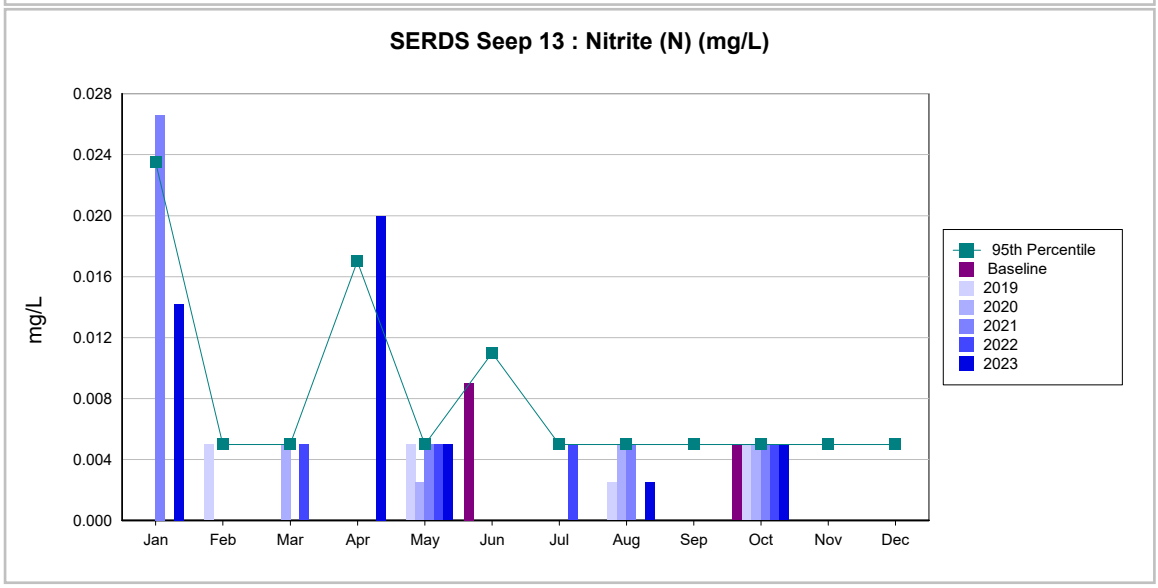
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







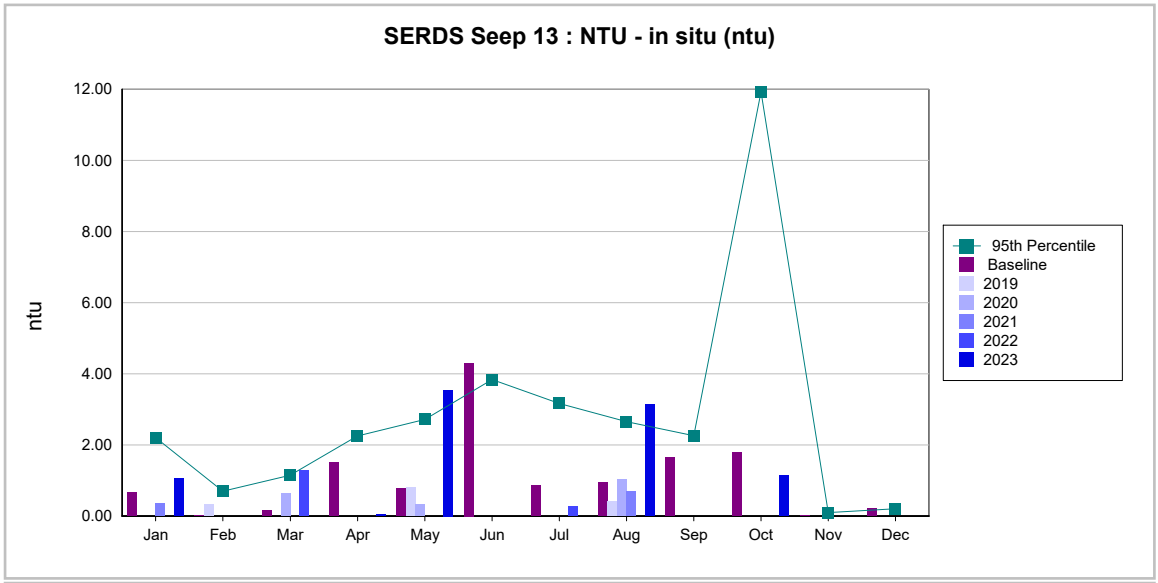
Water Quality Report

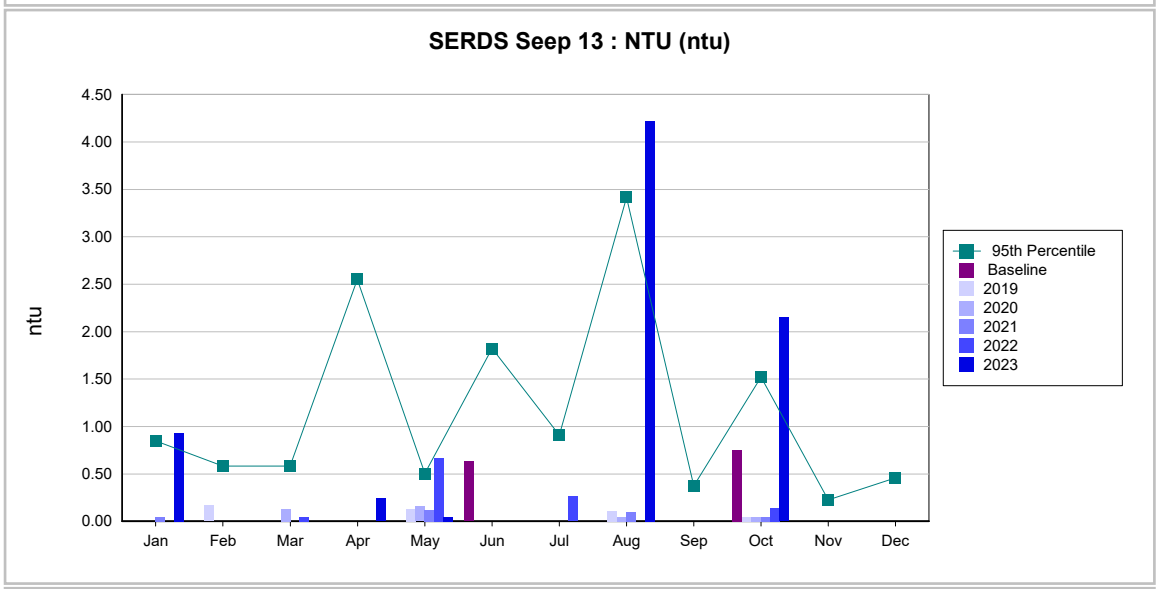
Annual Report Drainage Water

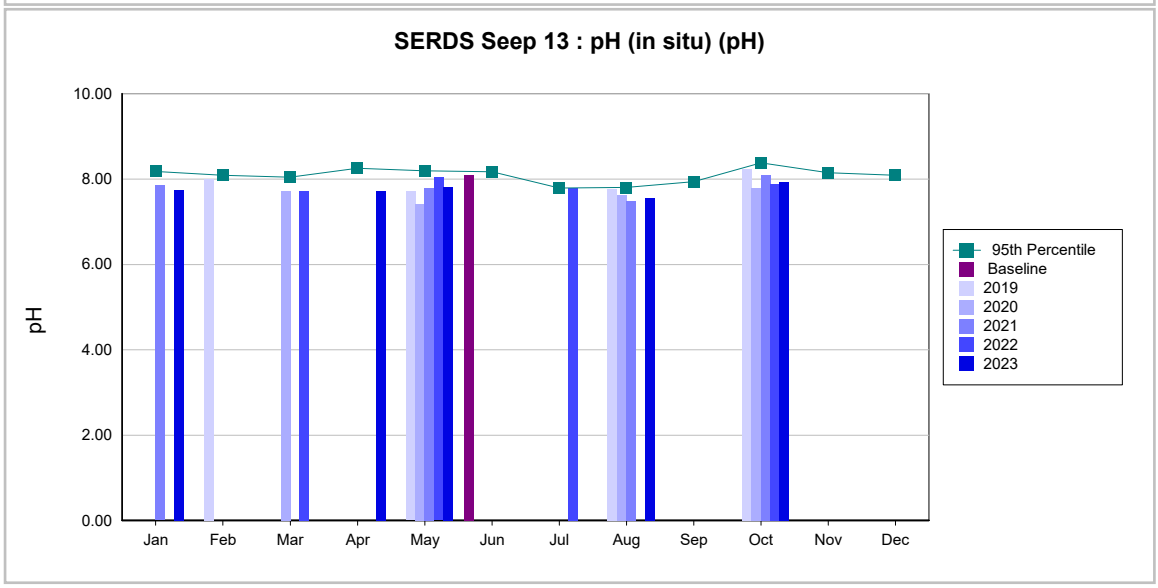
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







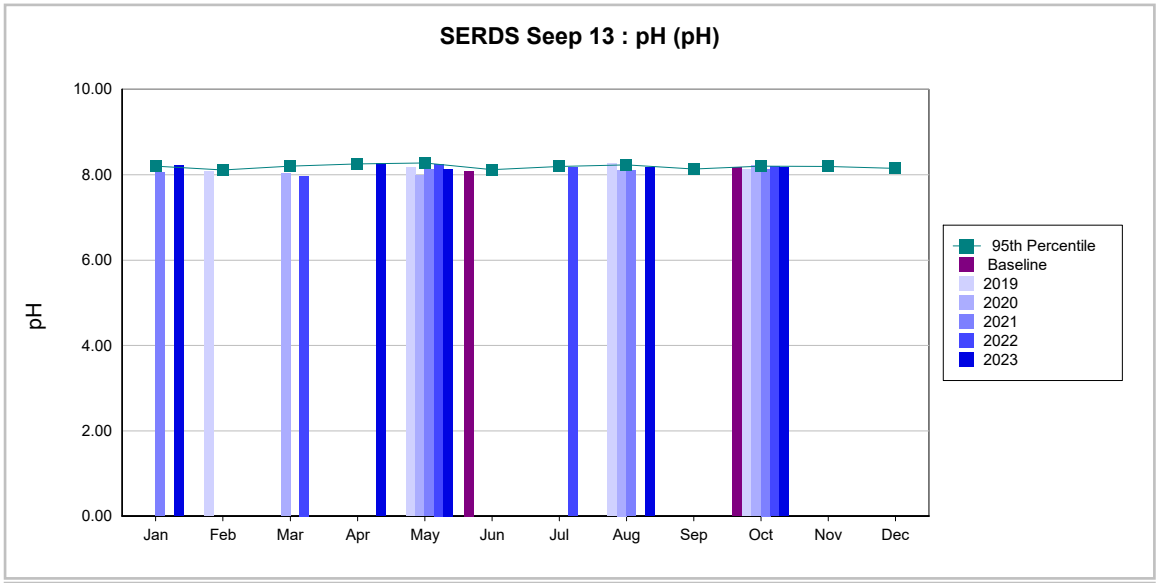
Water Quality Report

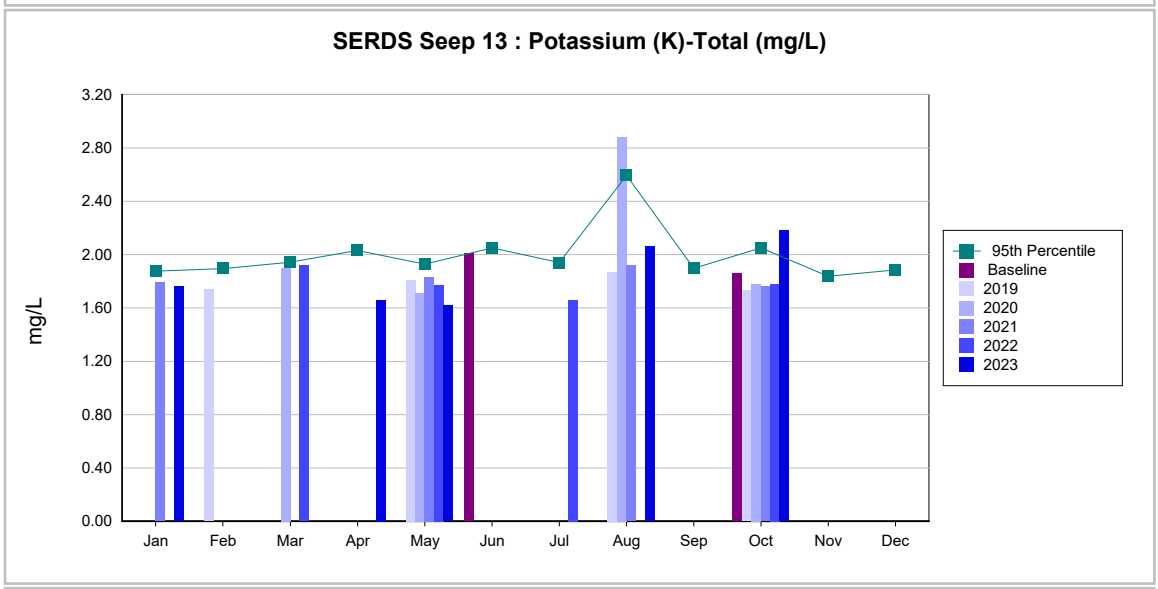
Annual Report Drainage Water

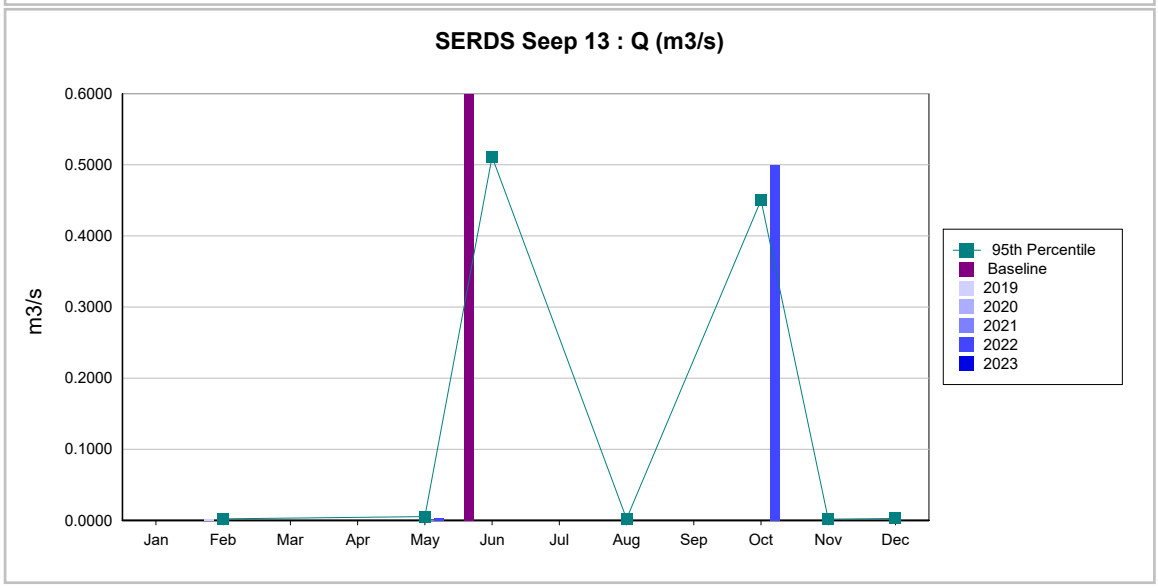
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







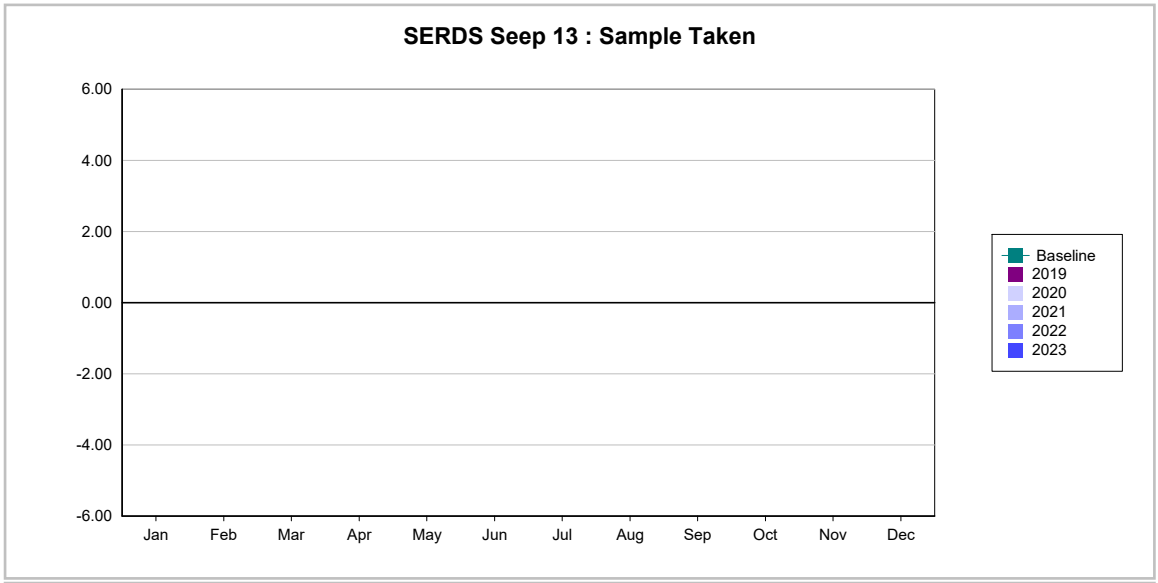
Water Quality Report

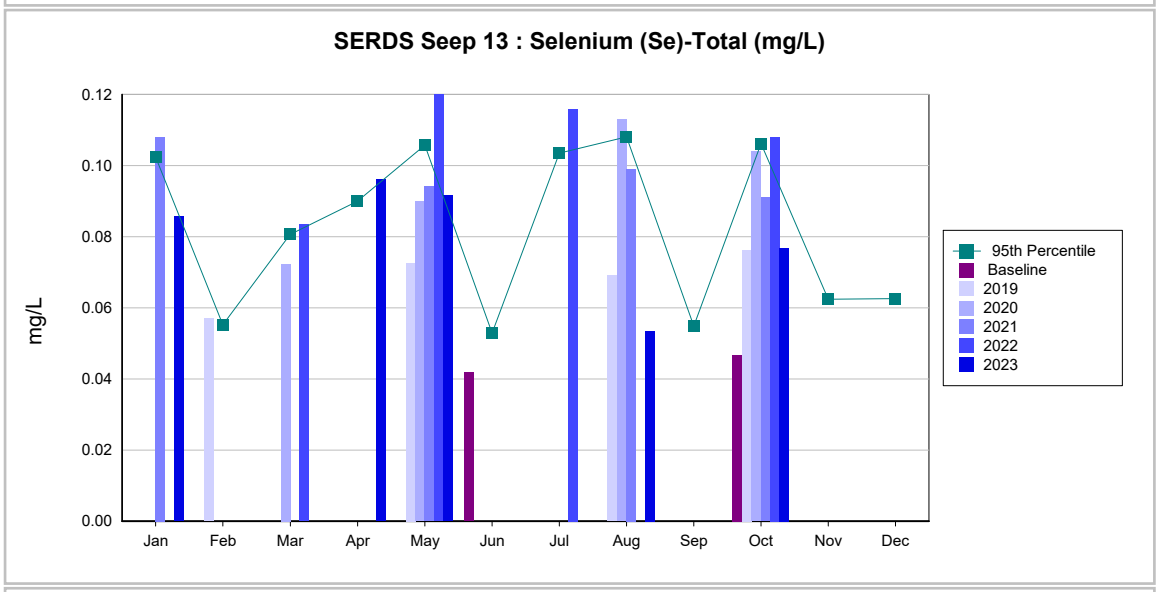
Annual Report Drainage Water

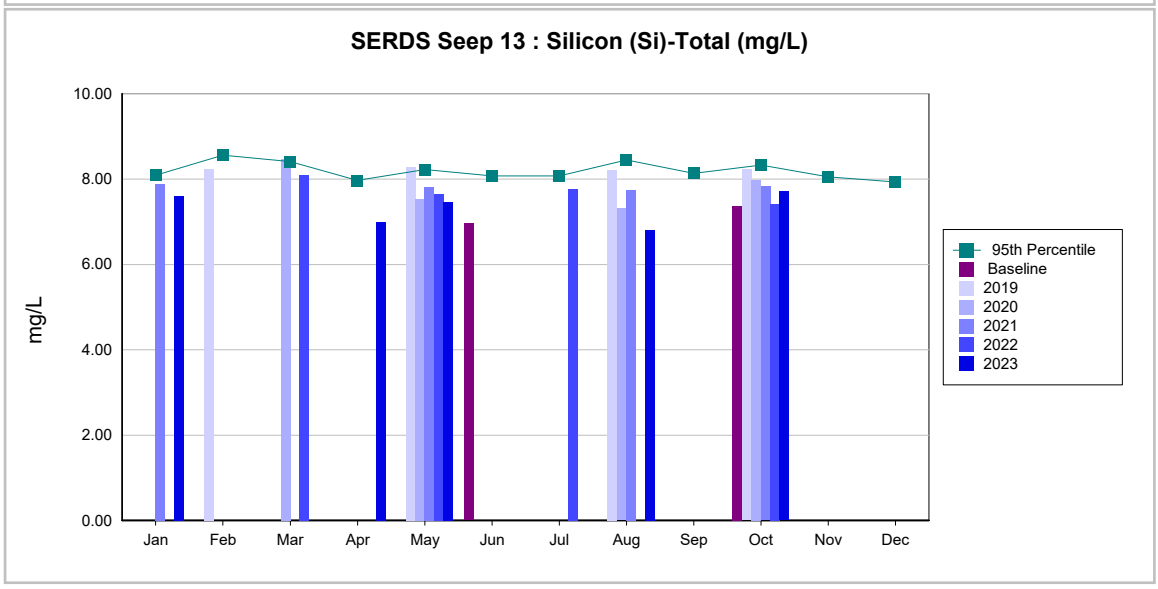
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







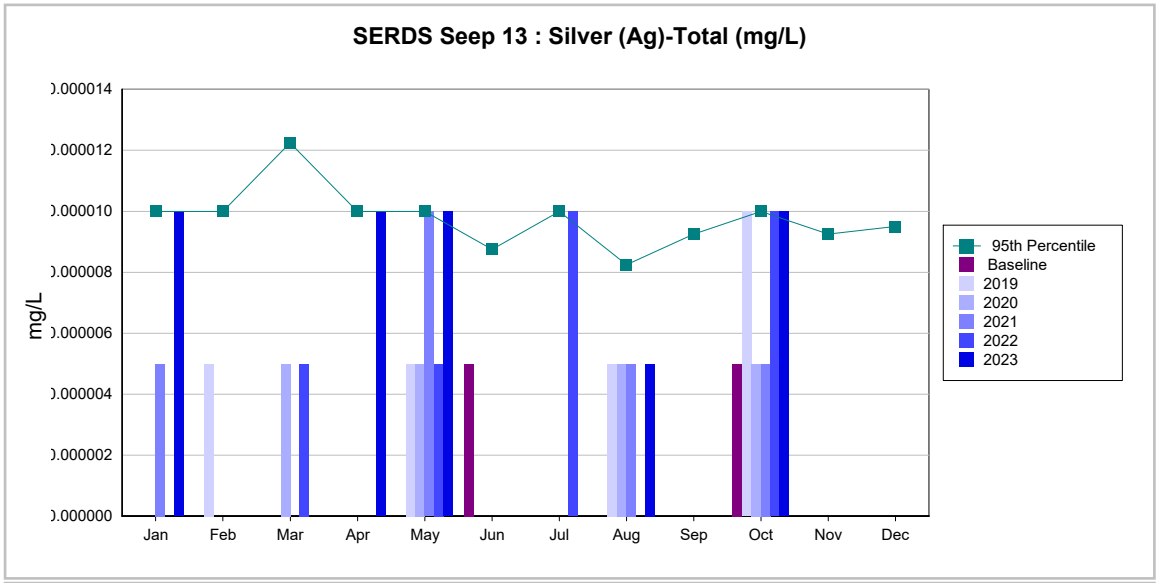
Water Quality Report

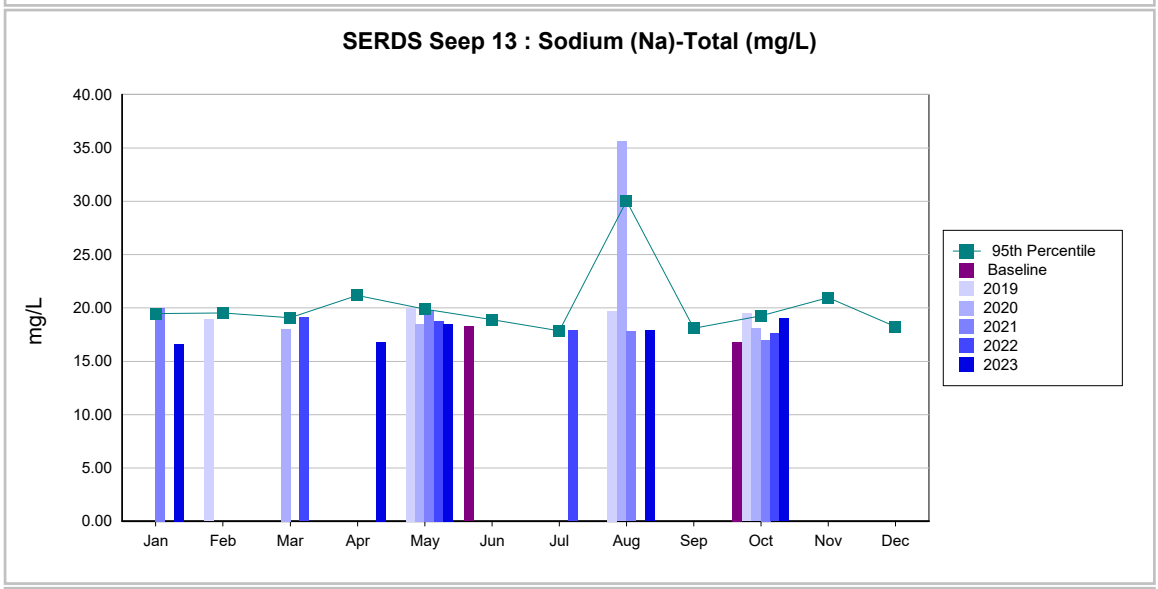
Annual Report Drainage Water

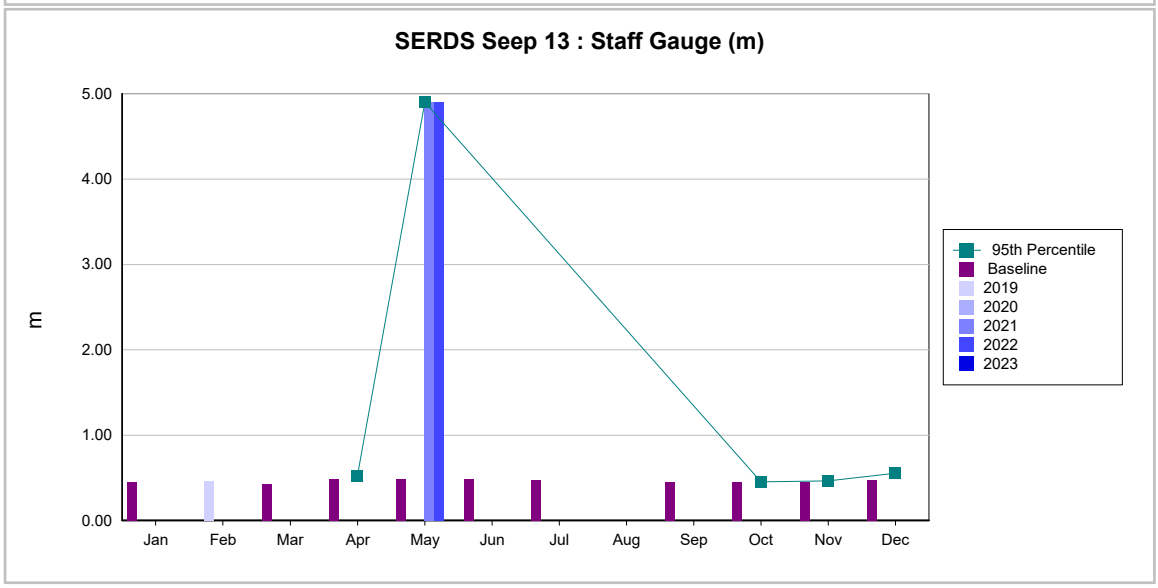
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







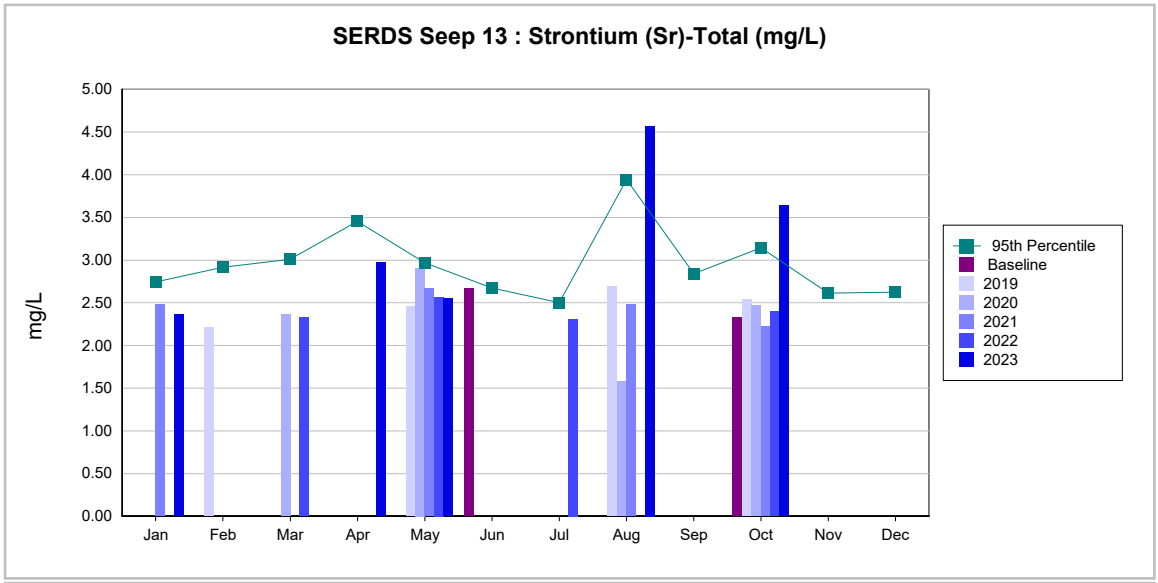
Water Quality Report

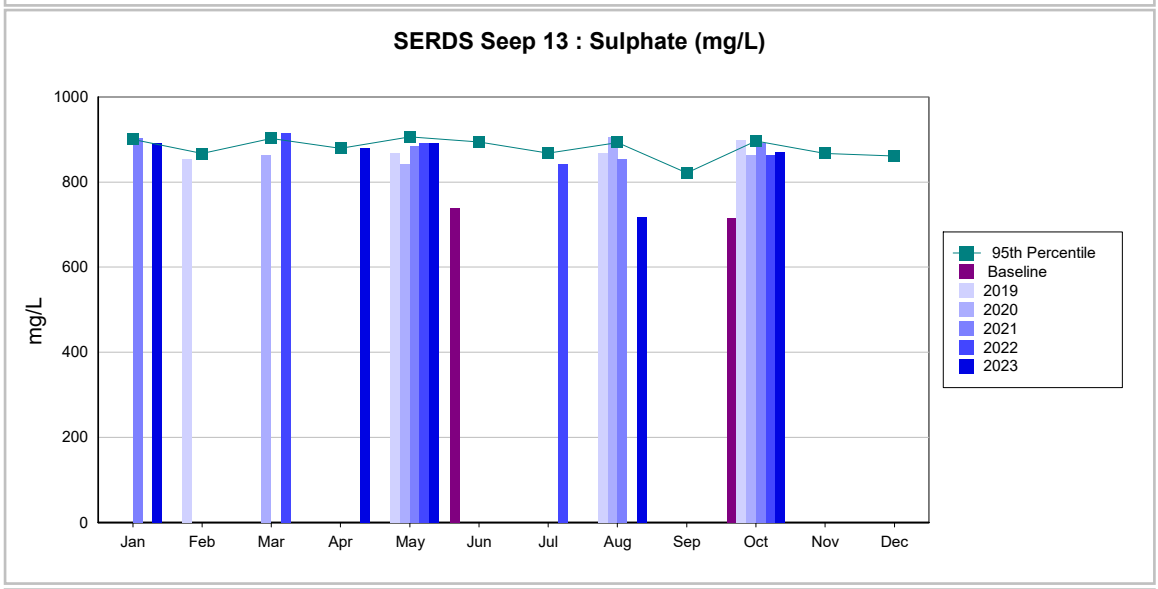
Annual Report Drainage Water

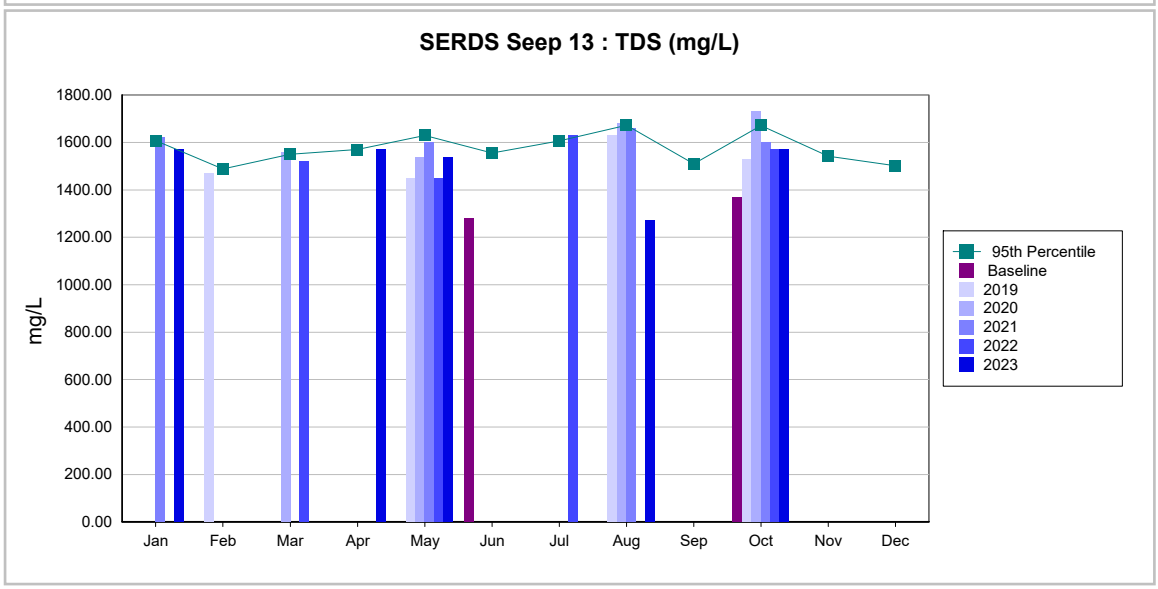
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







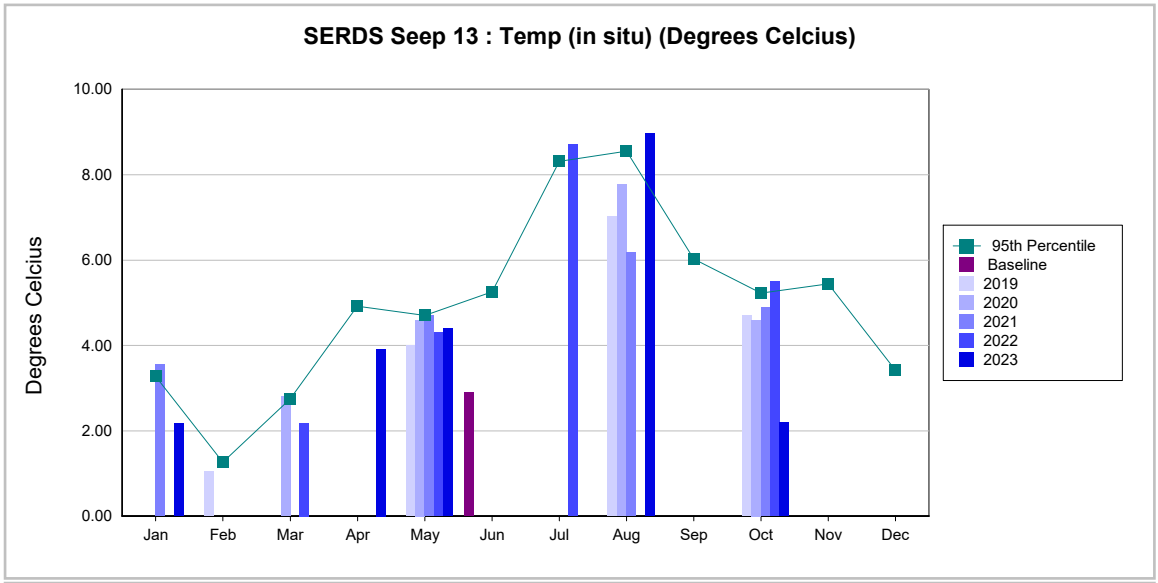
Water Quality Report

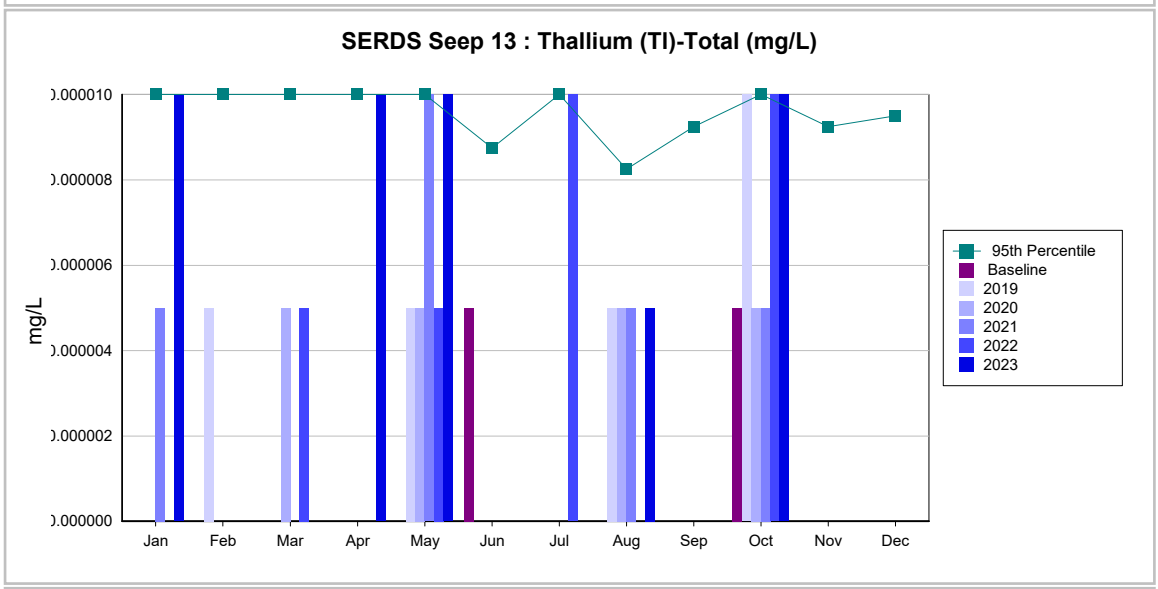
Annual Report Drainage Water

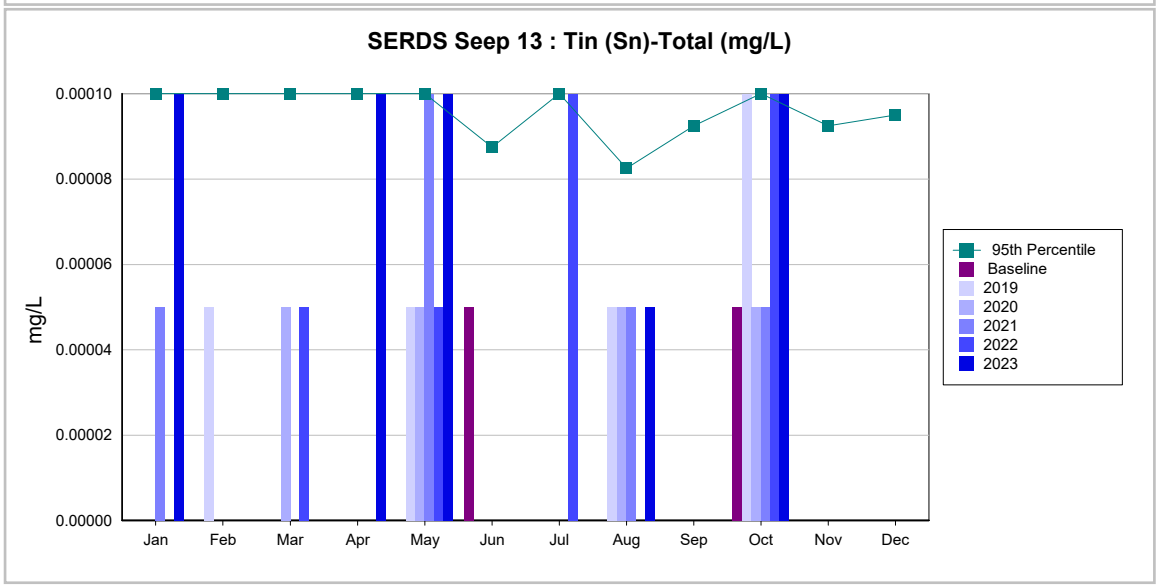
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







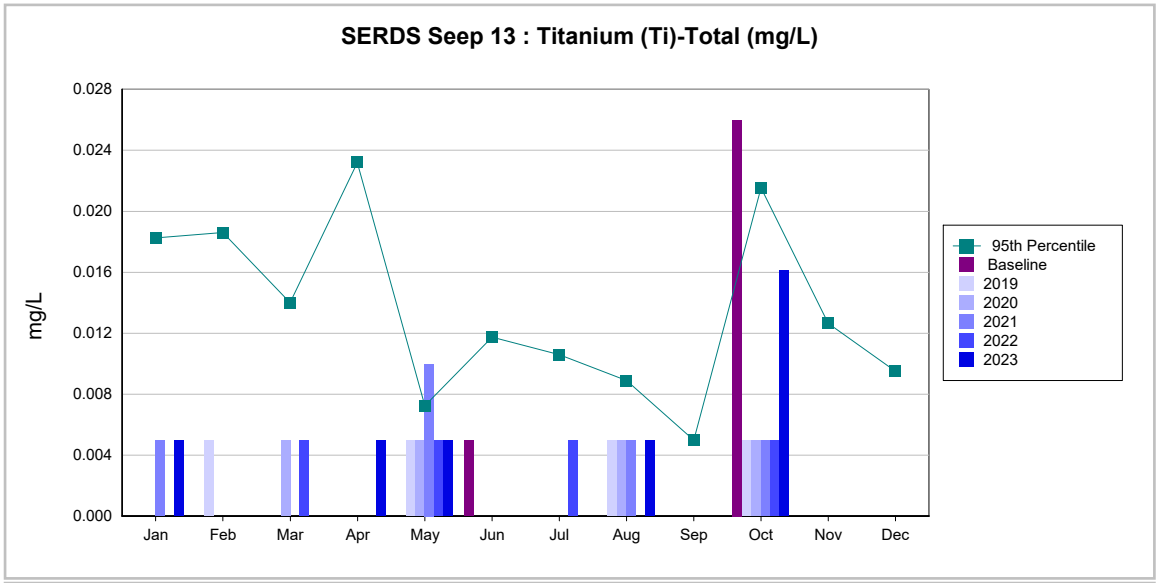
Water Quality Report

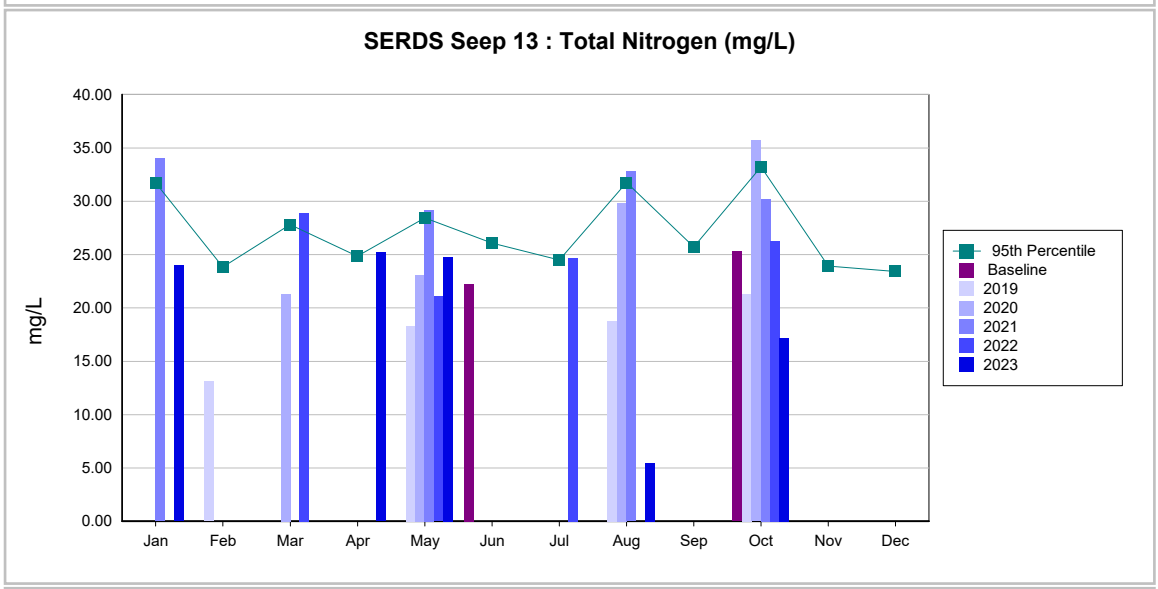
Annual Report Drainage Water

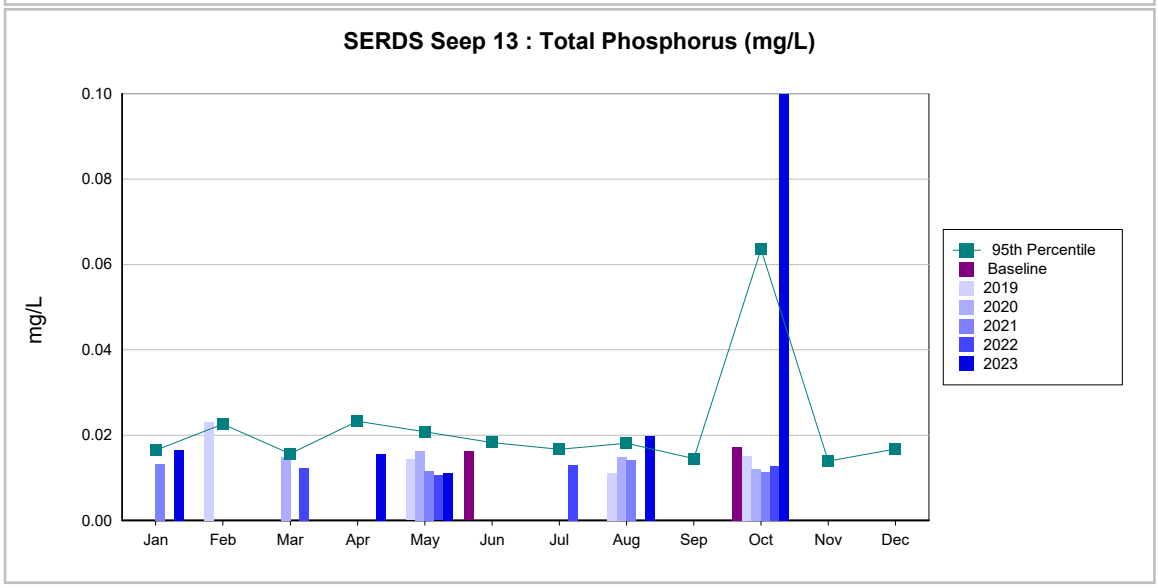
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







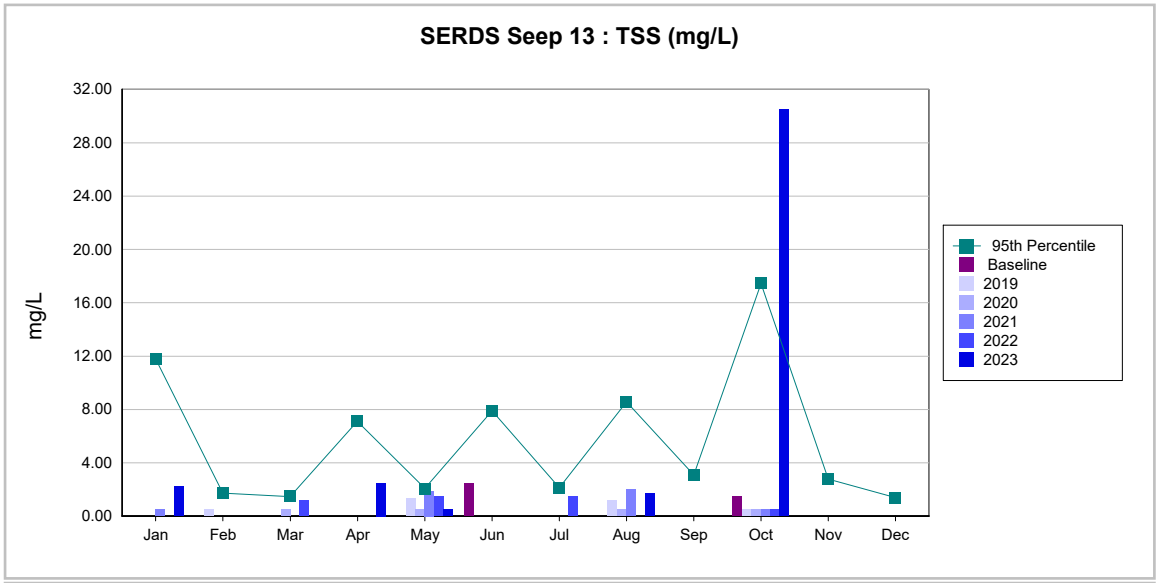
Water Quality Report

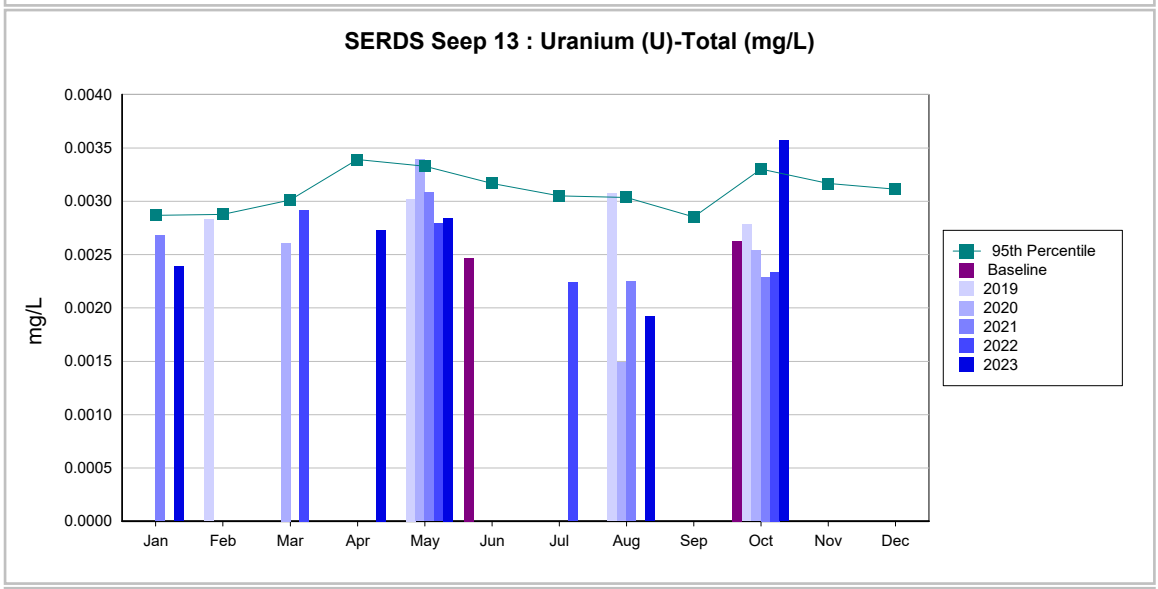
Annual Report Drainage Water

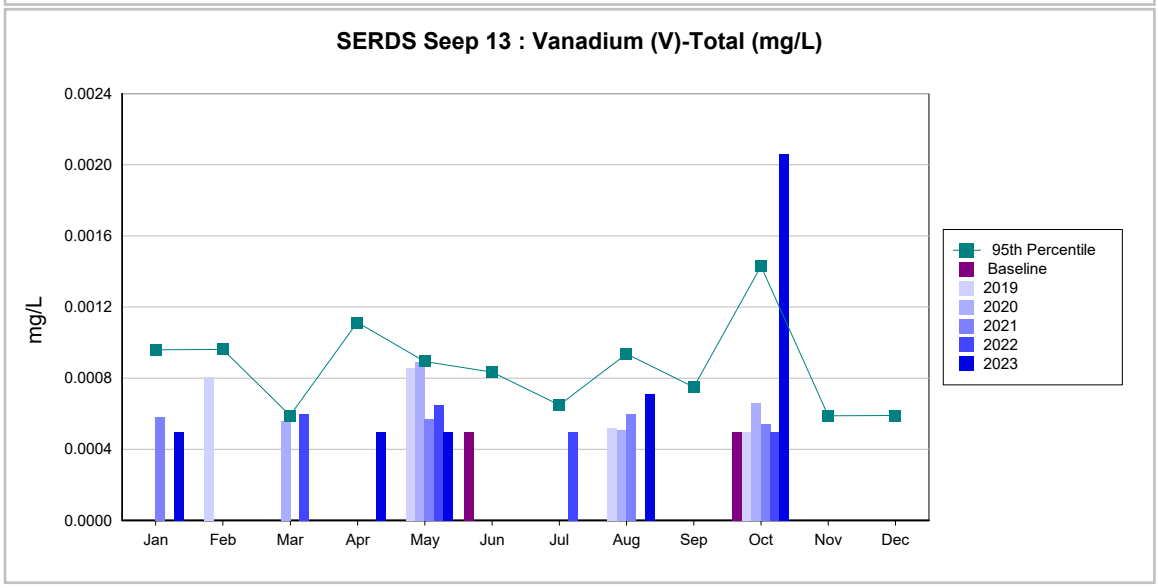
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







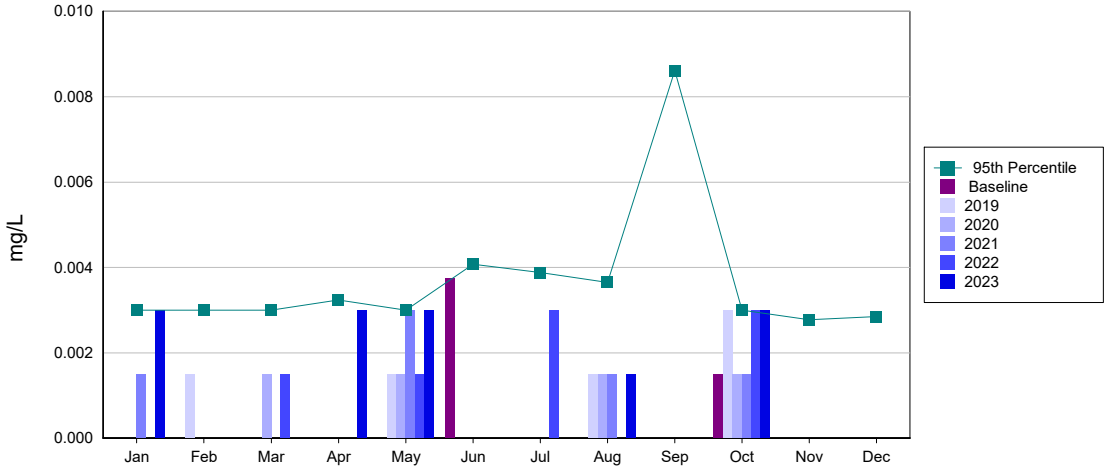
Water Quality Report

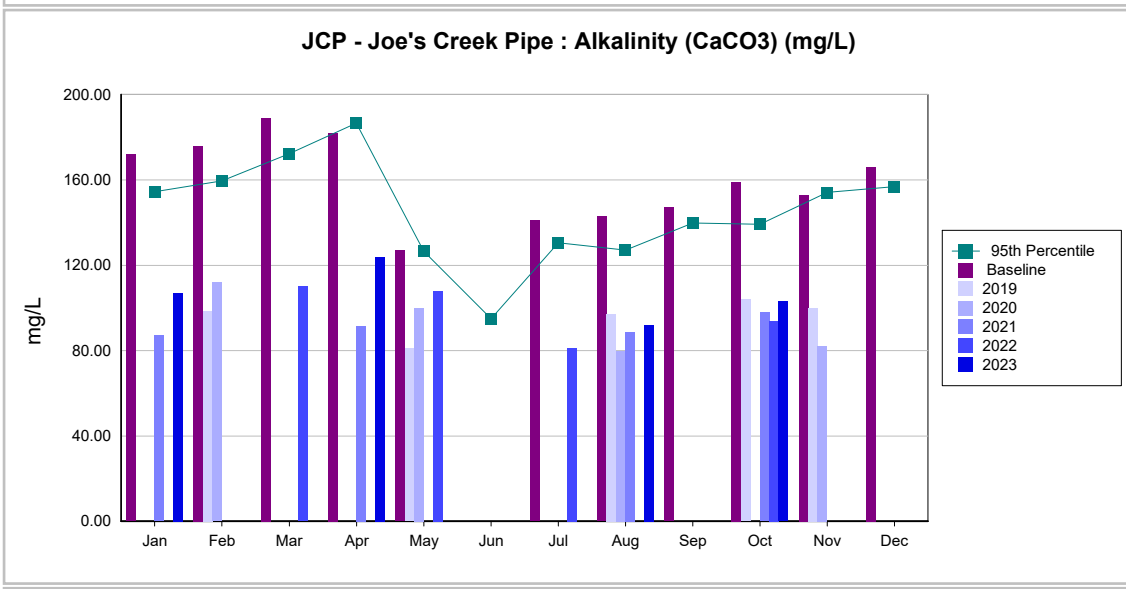
Annual Report Drainage Water

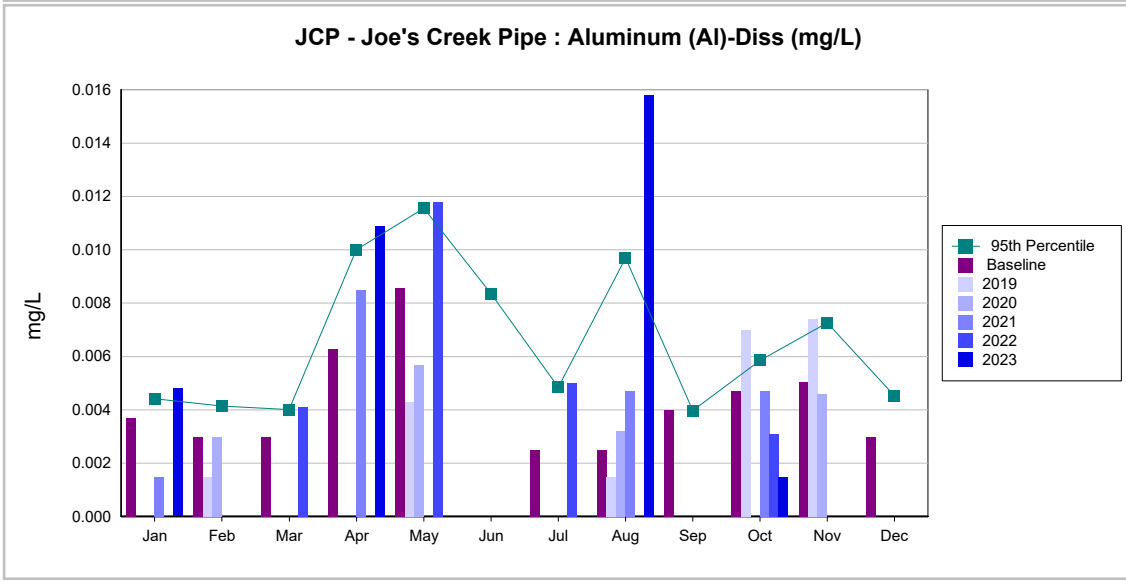
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







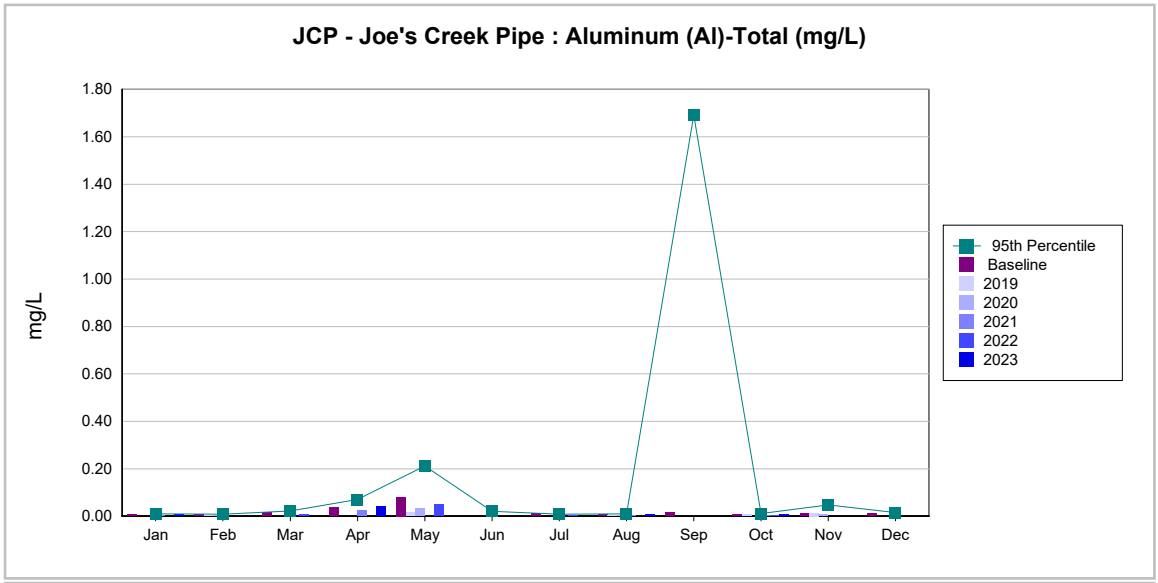
Water Quality Report

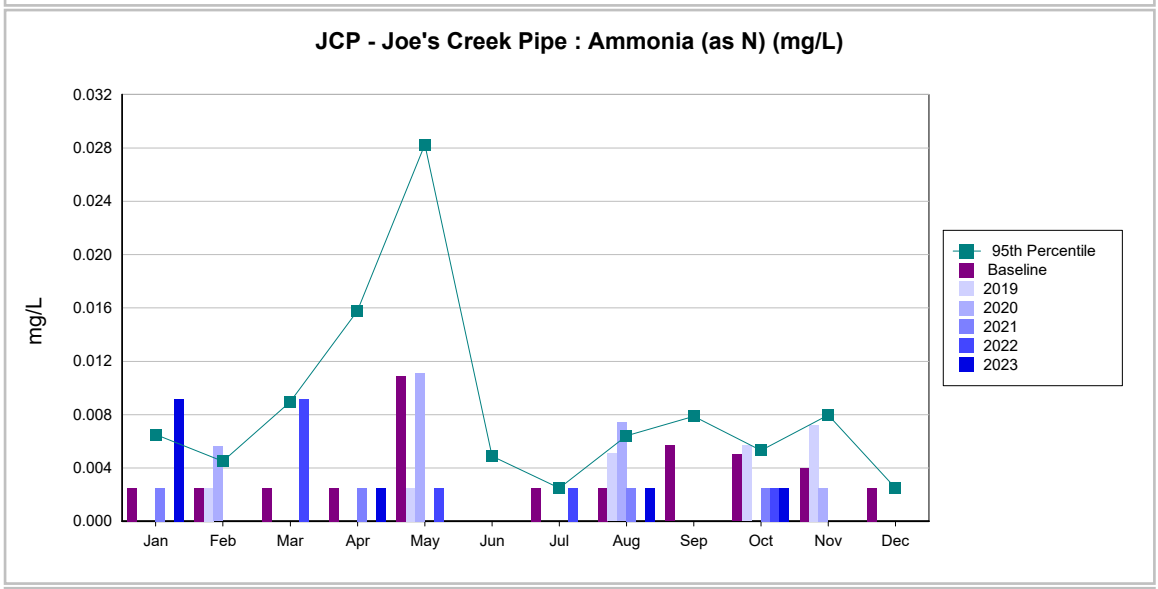
Annual Report Drainage Water

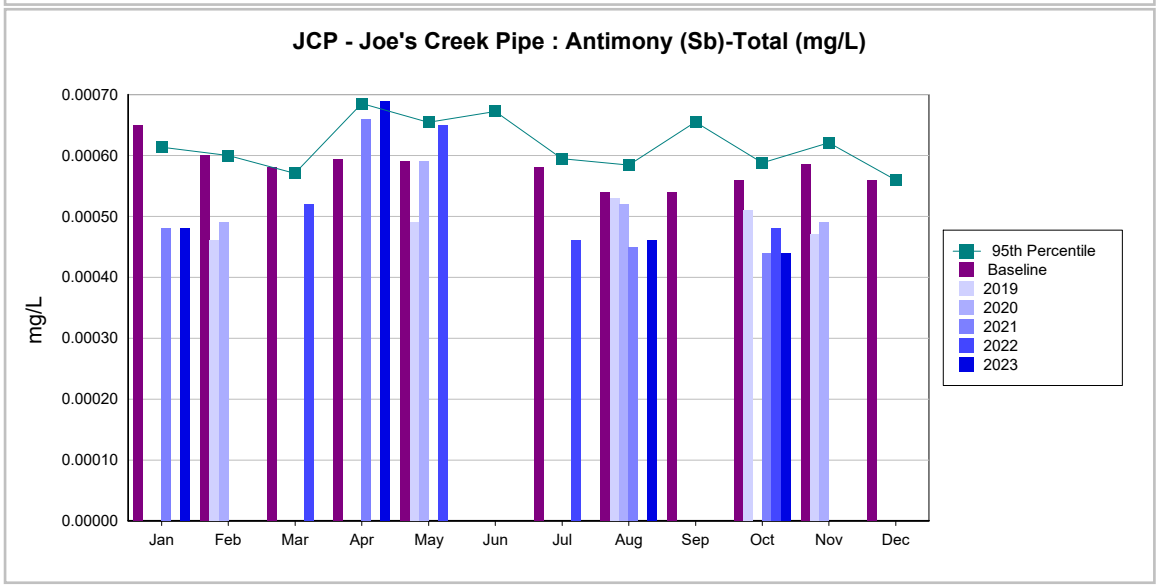
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







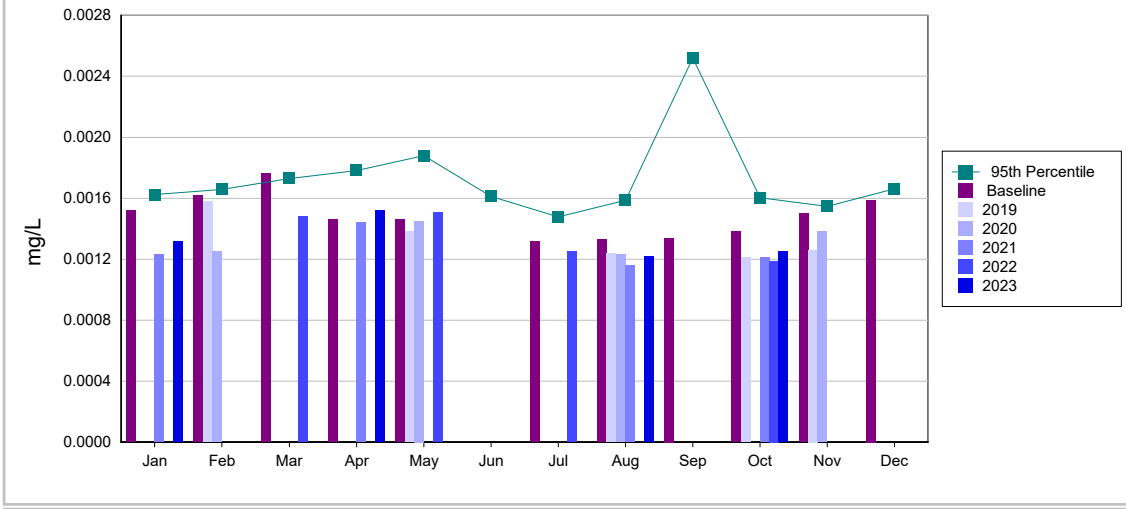
Water Quality Report

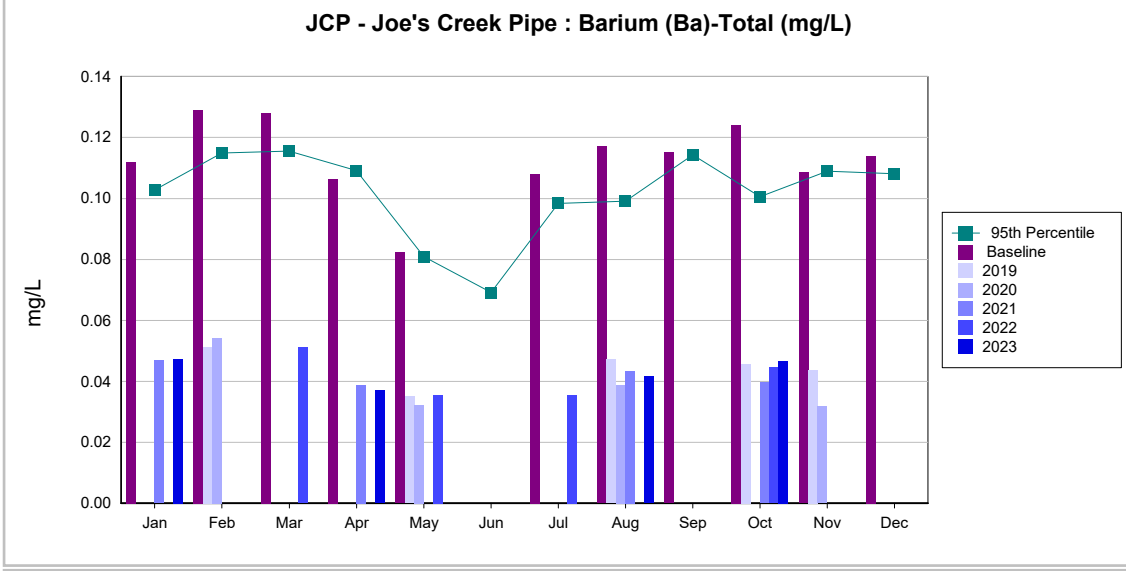
Annual Report Drainage Water

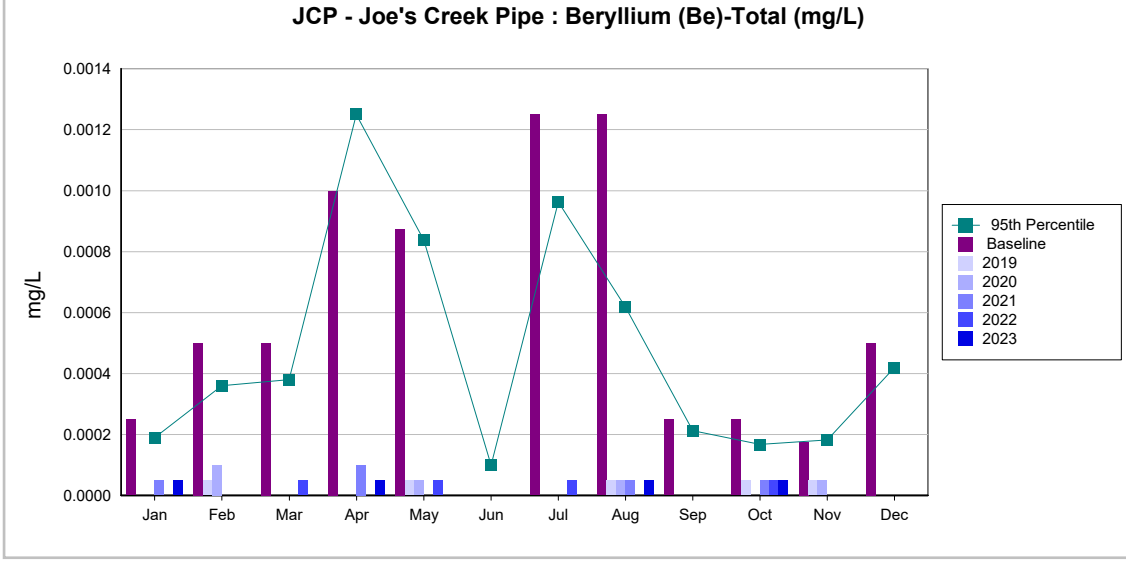
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







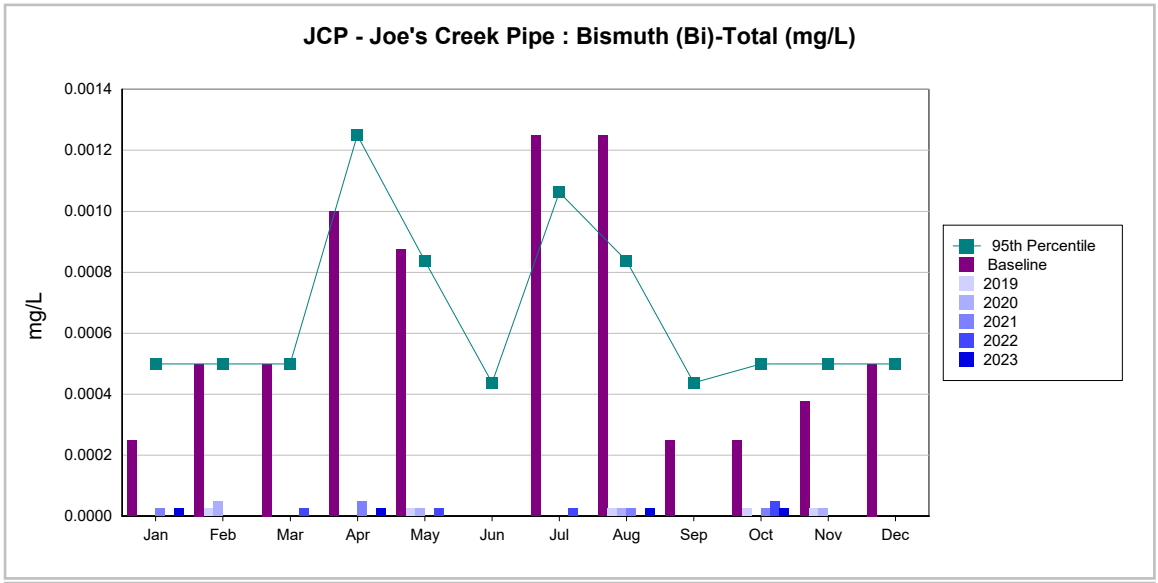
Water Quality Report

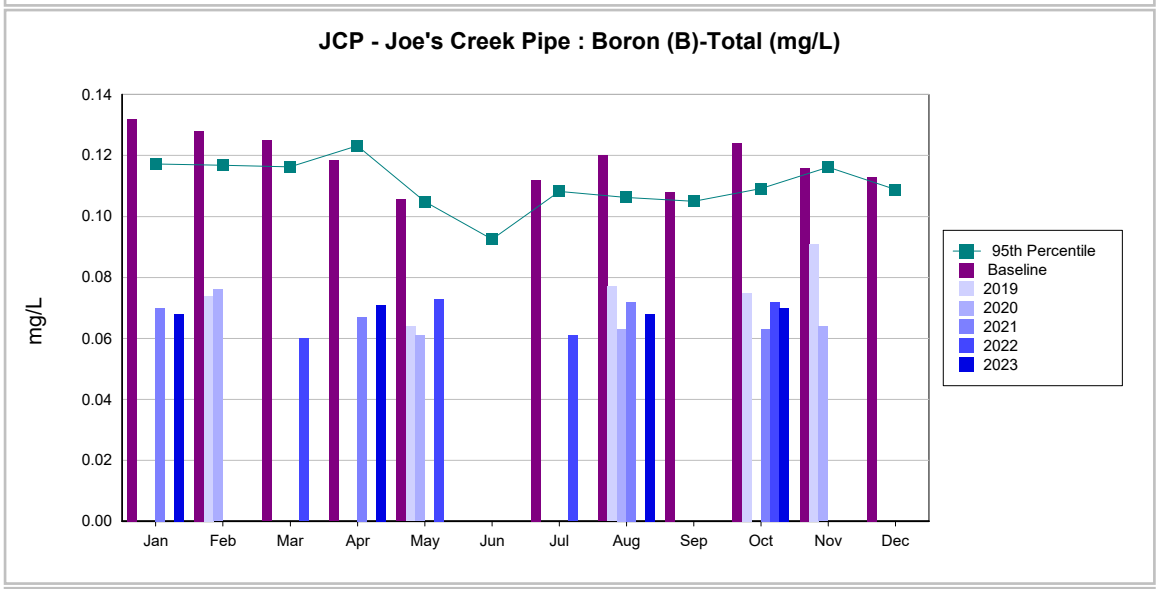
Annual Report Drainage Water

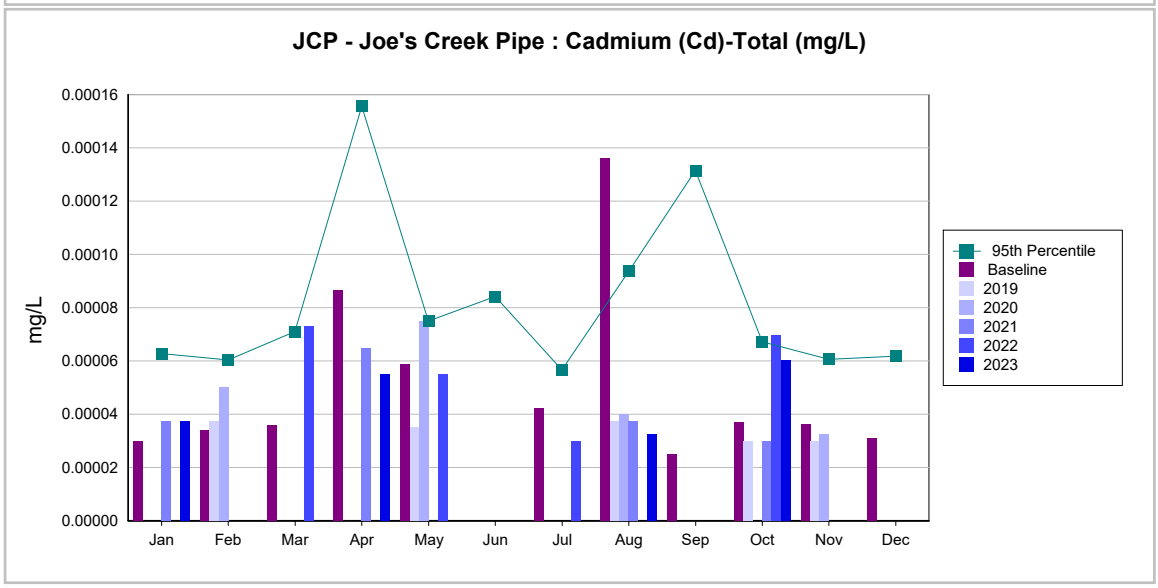
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







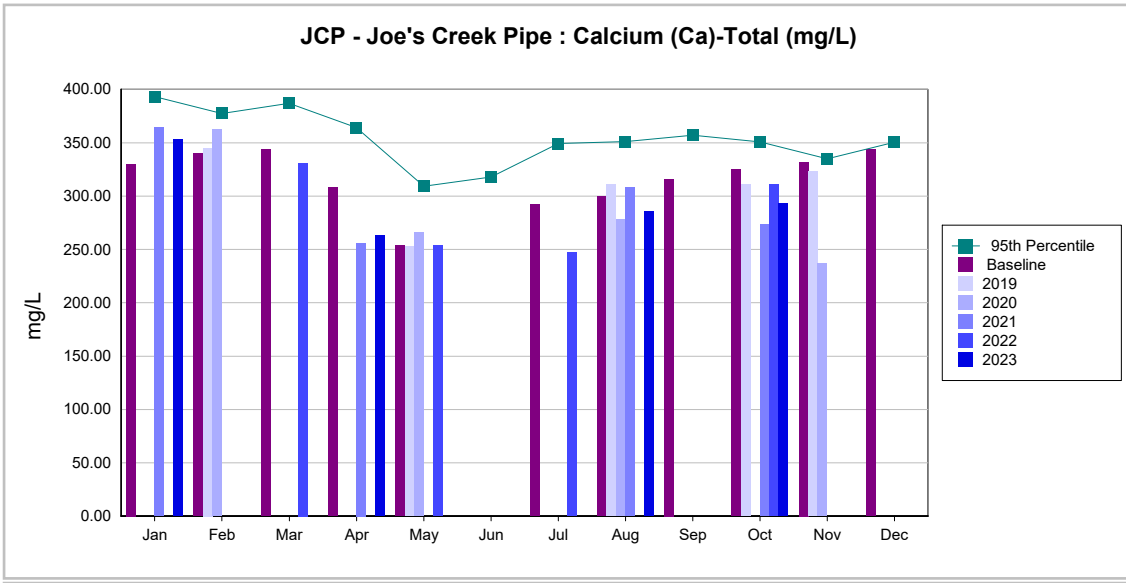
Water Quality Report

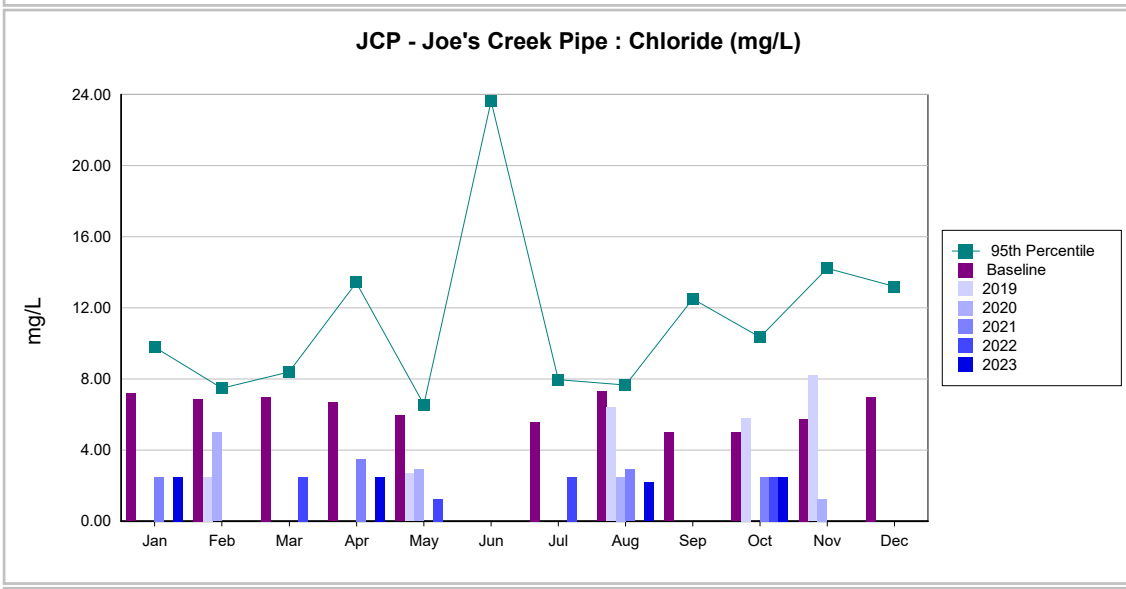
Annual Report Drainage Water

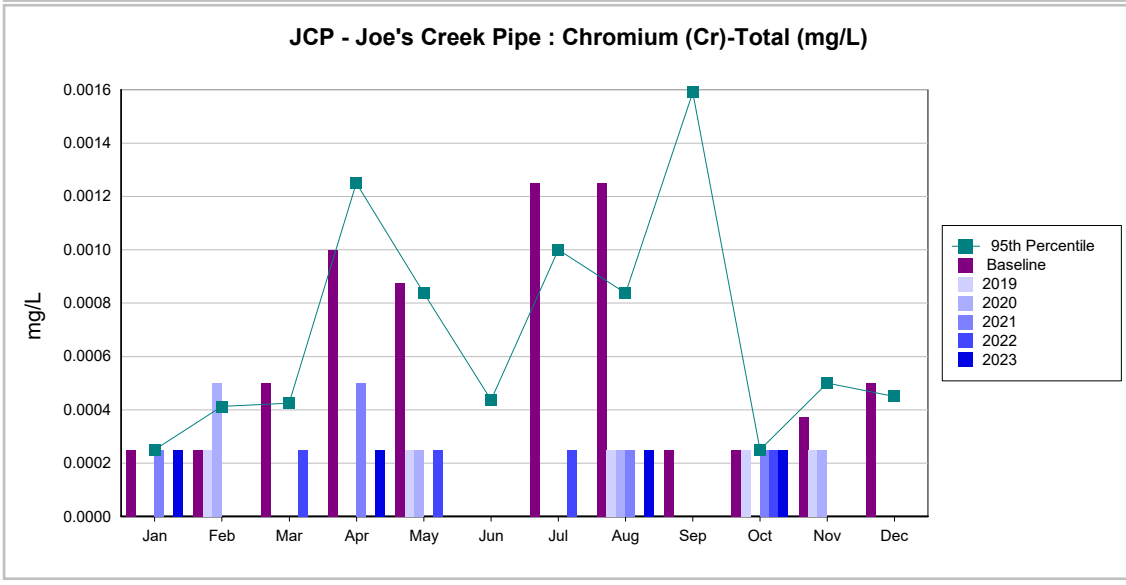
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







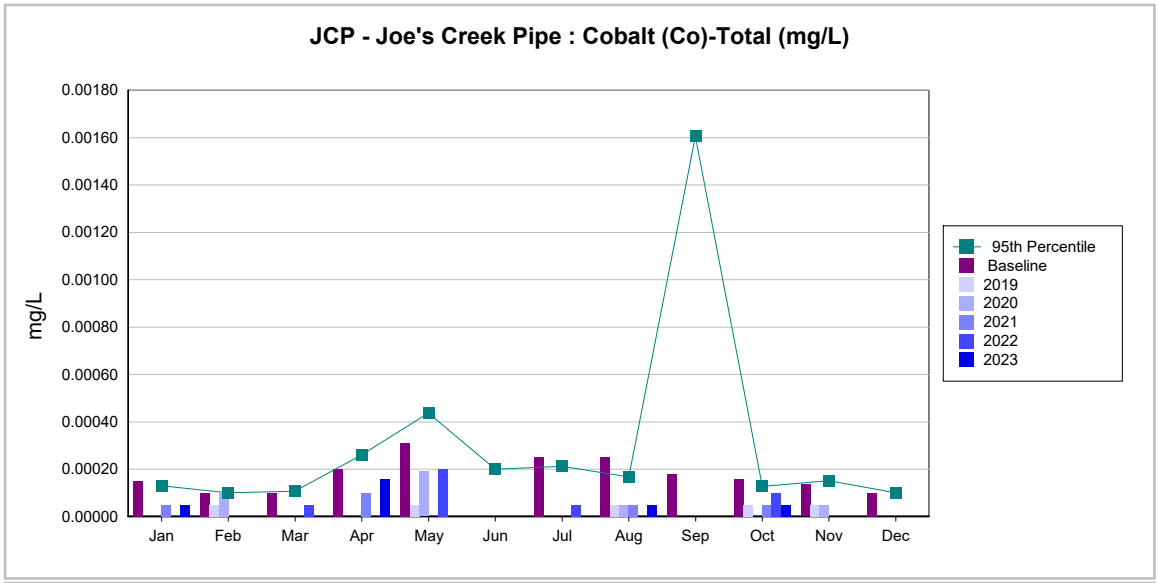
Water Quality Report

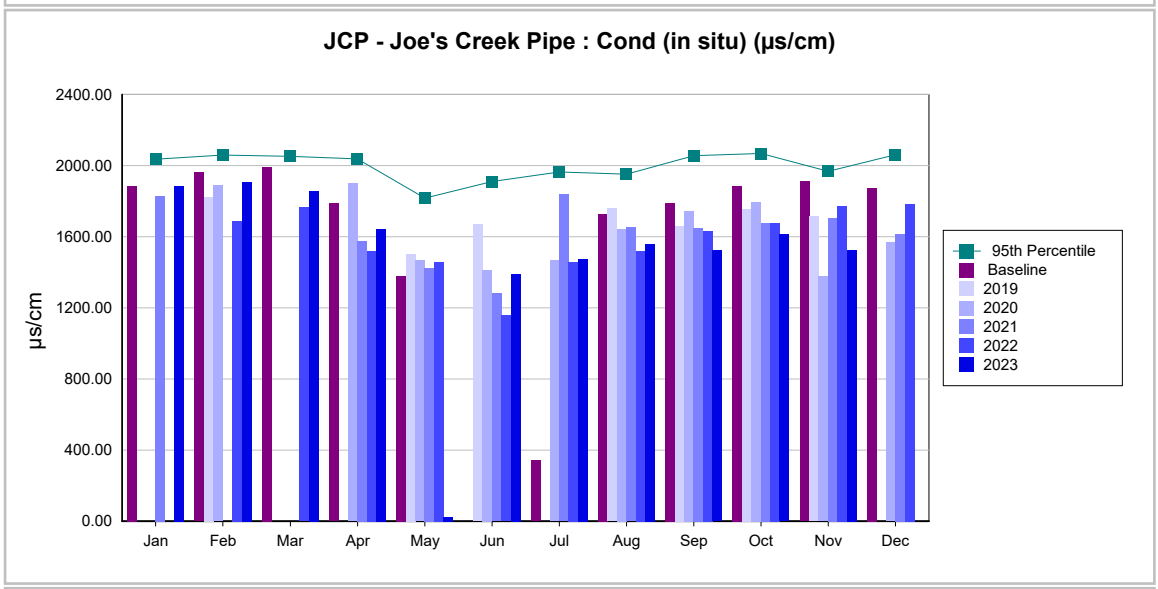
Annual Report Drainage Water

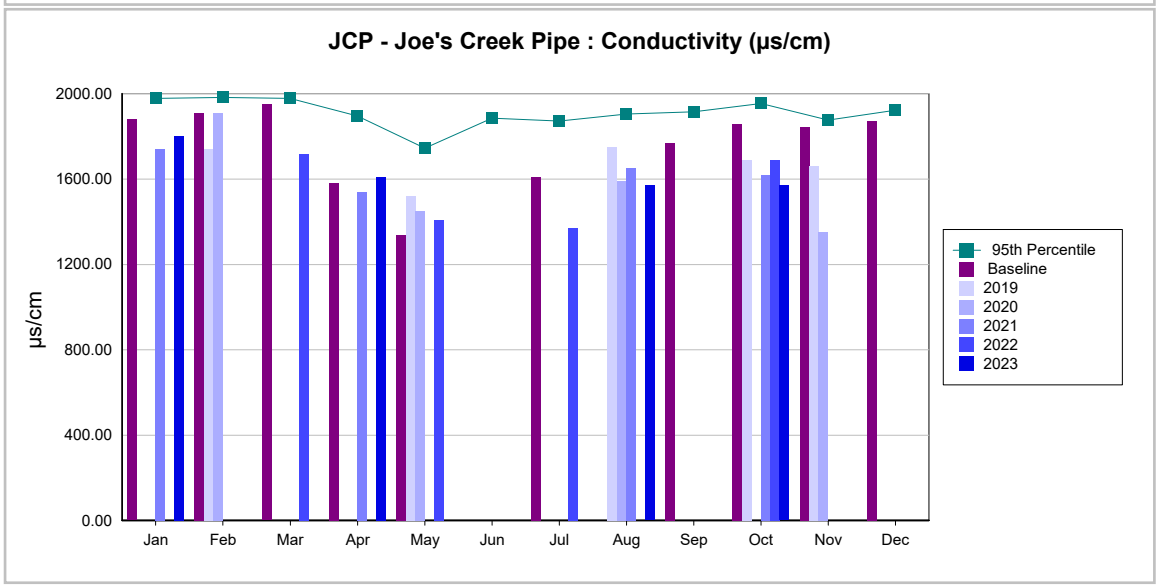
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







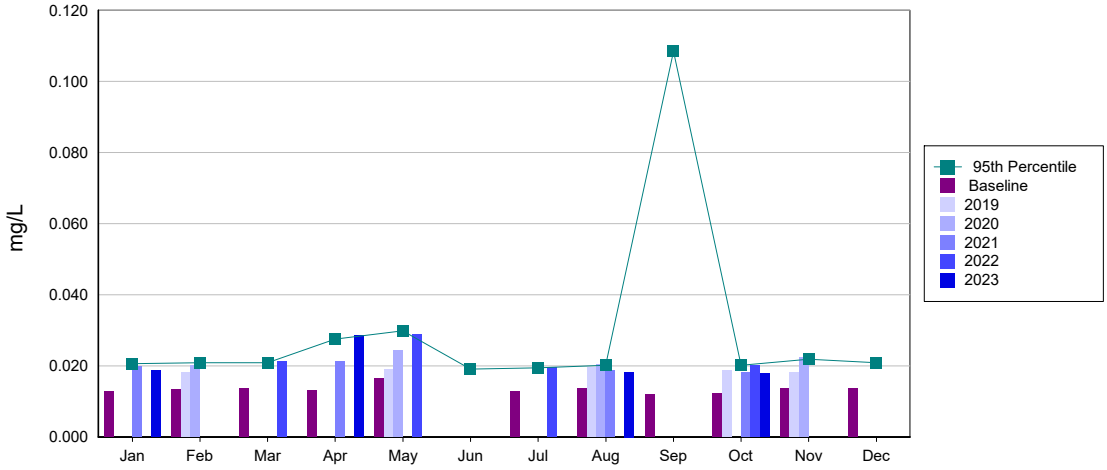
Water Quality Report

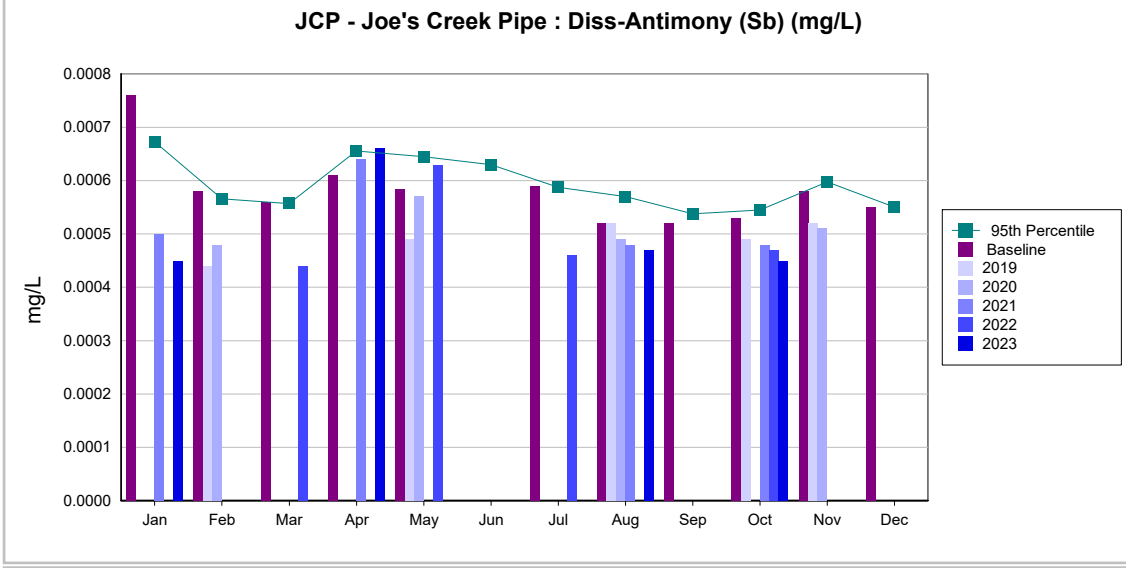
Annual Report Drainage Water

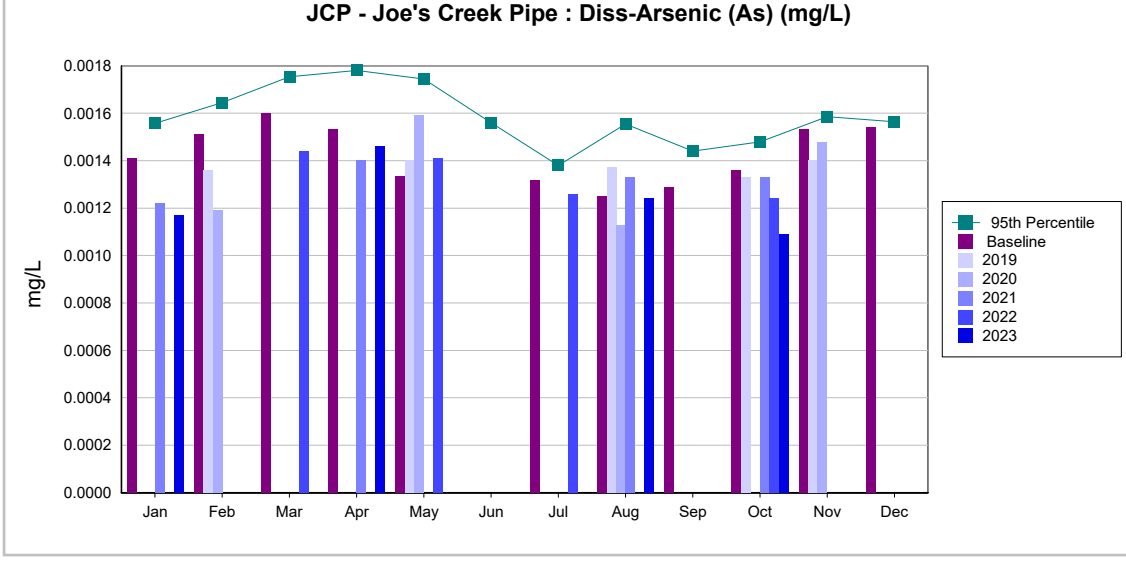
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







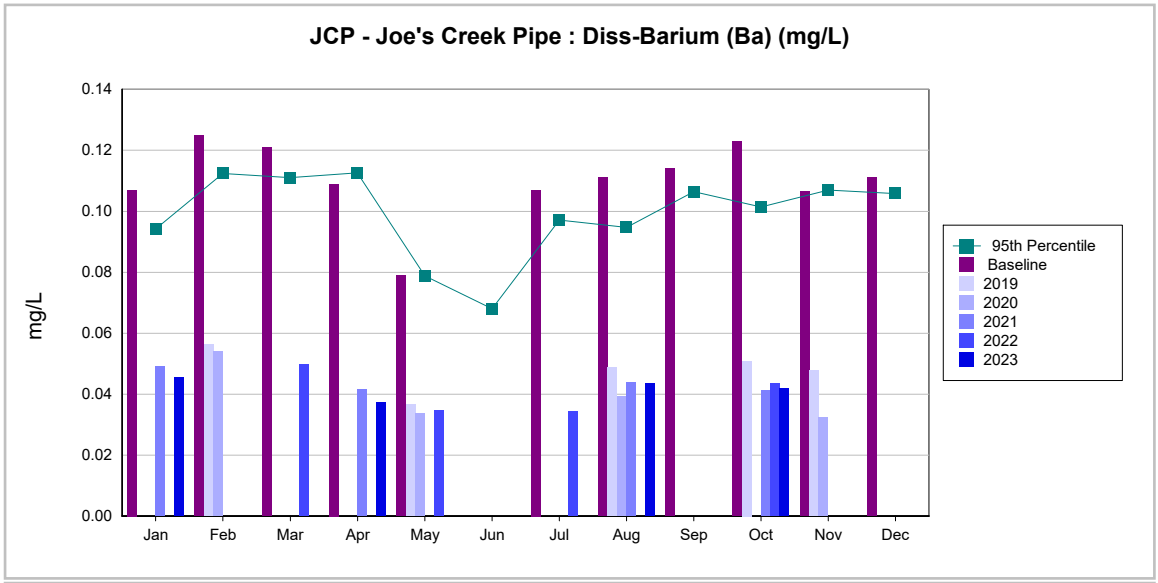
Water Quality Report

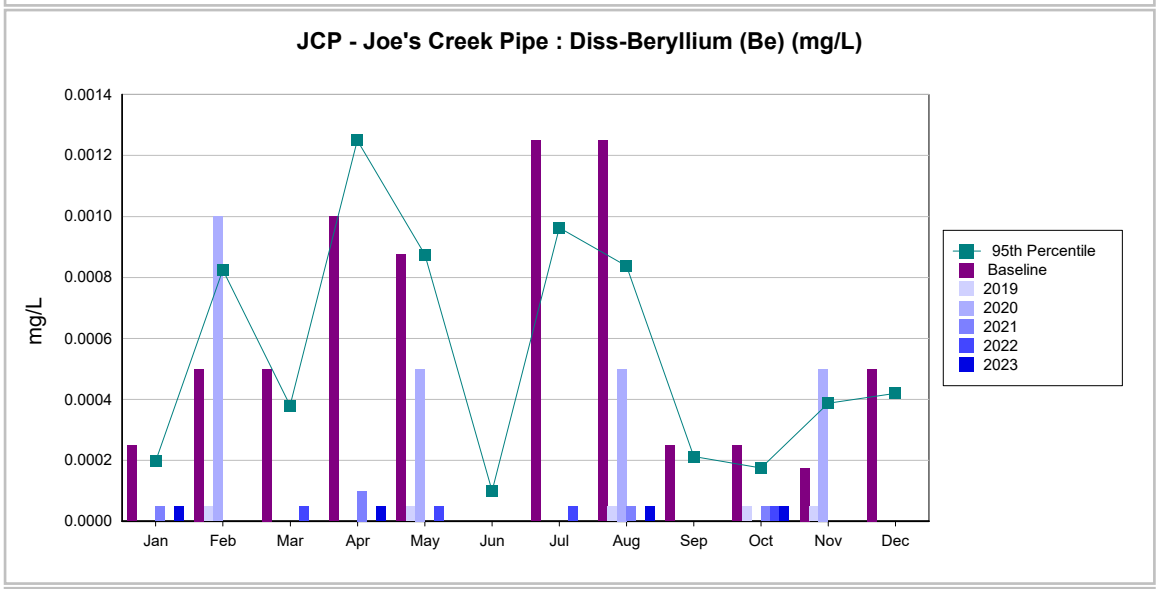
Annual Report Drainage Water

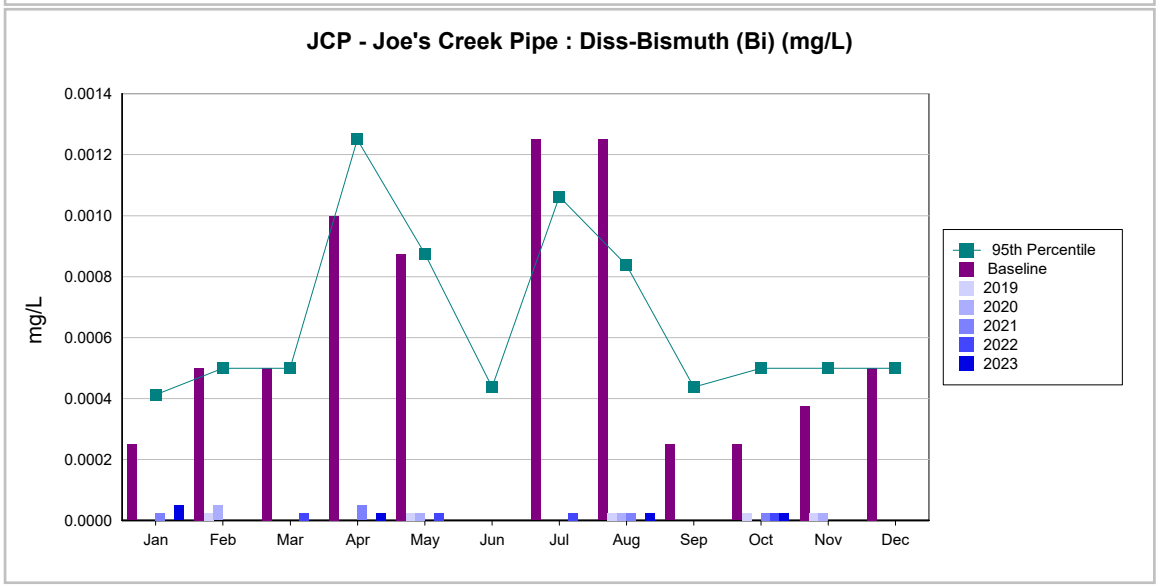
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







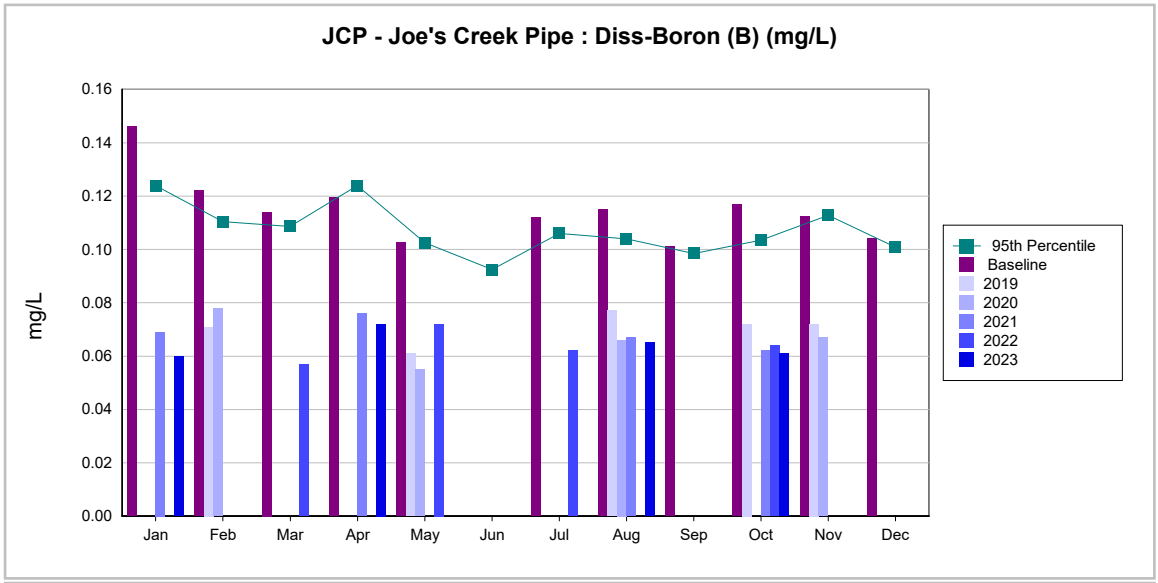
Water Quality Report

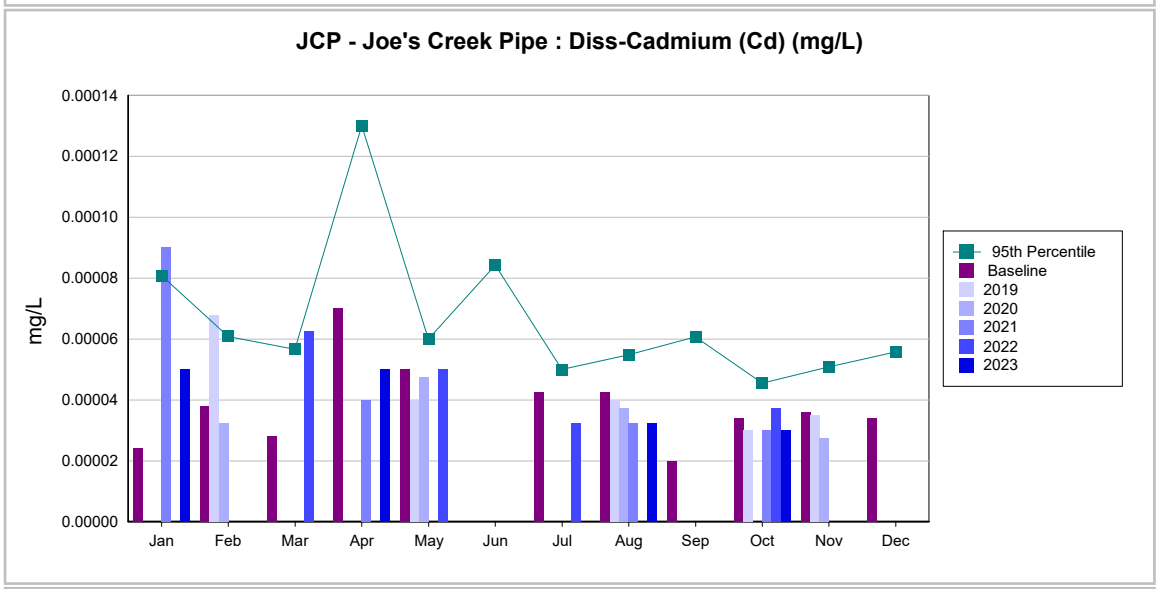
Annual Report Drainage Water

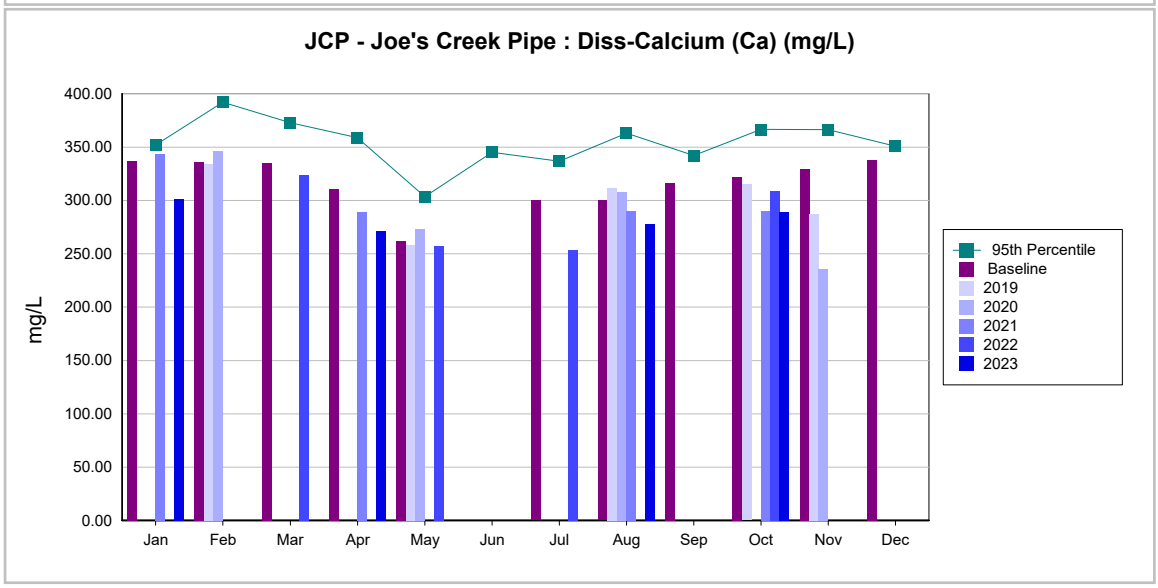
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







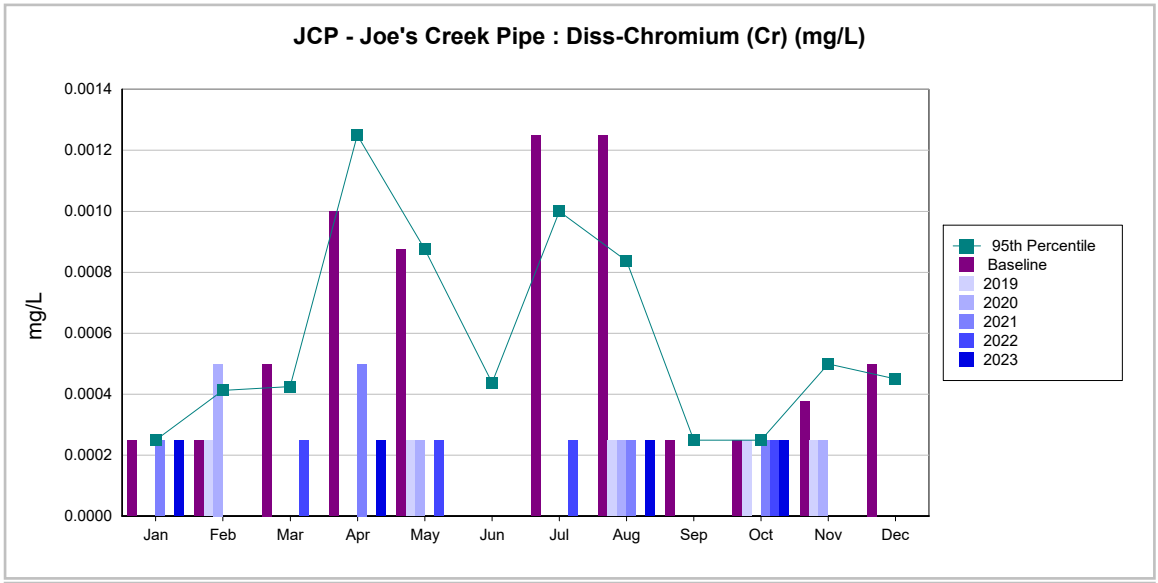
Water Quality Report

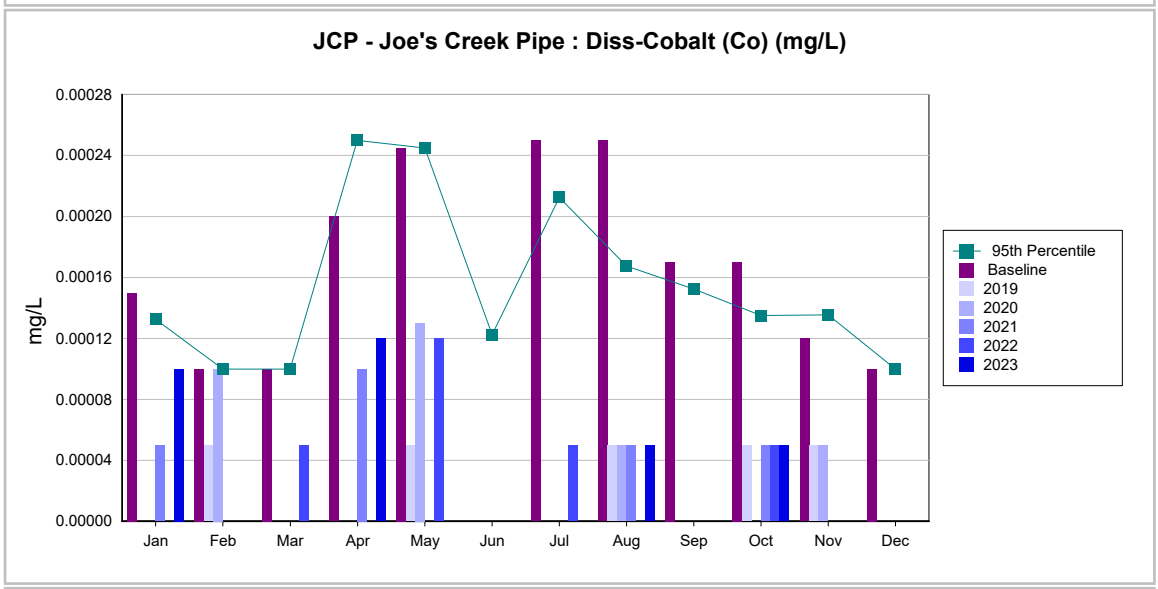
Annual Report Drainage Water

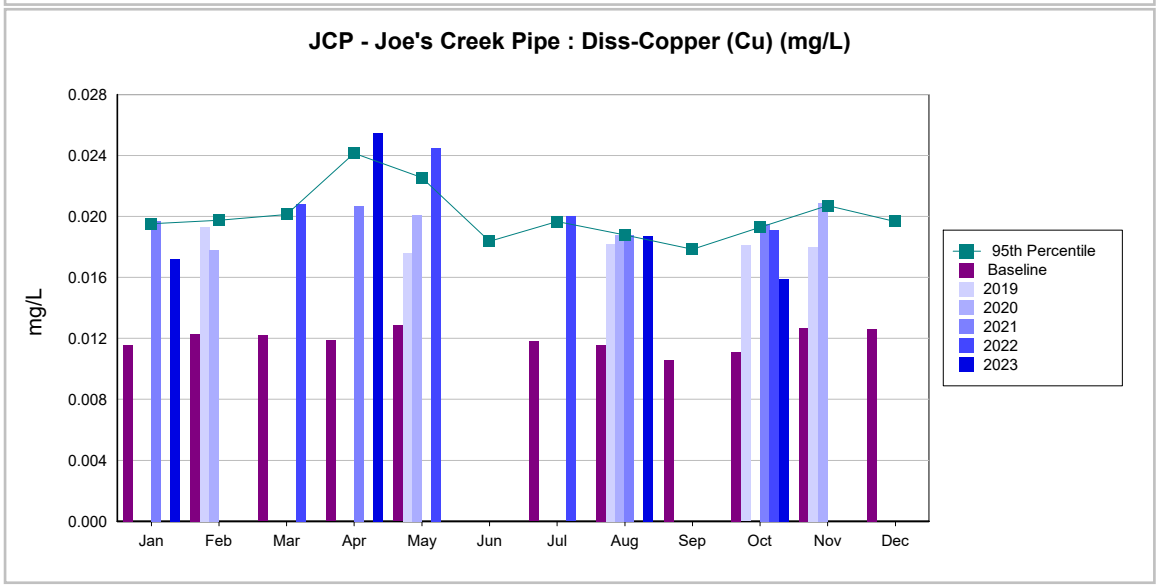
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







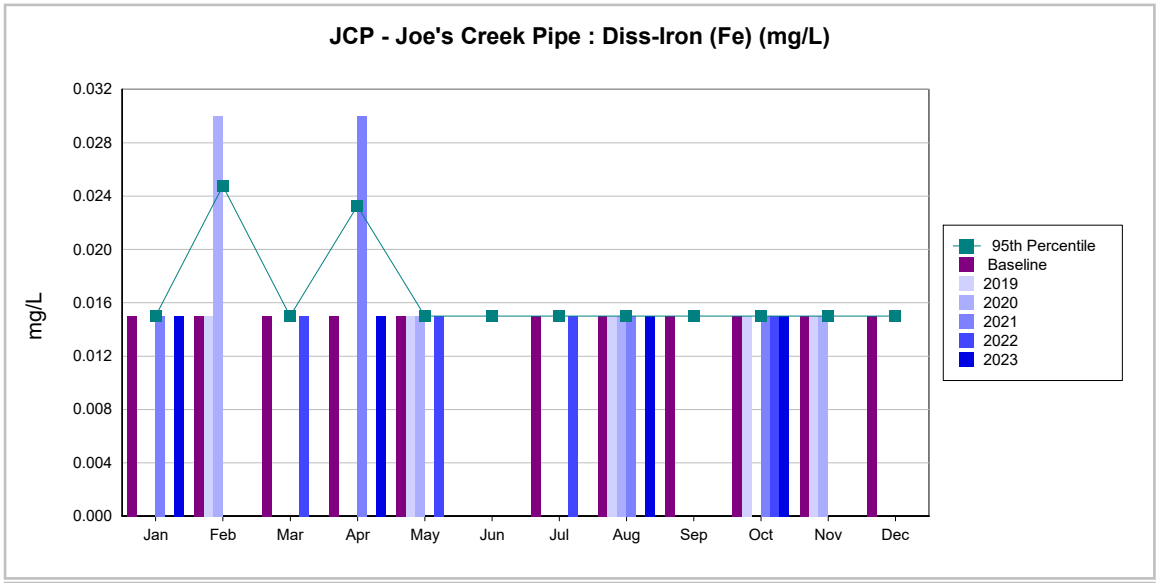
Water Quality Report

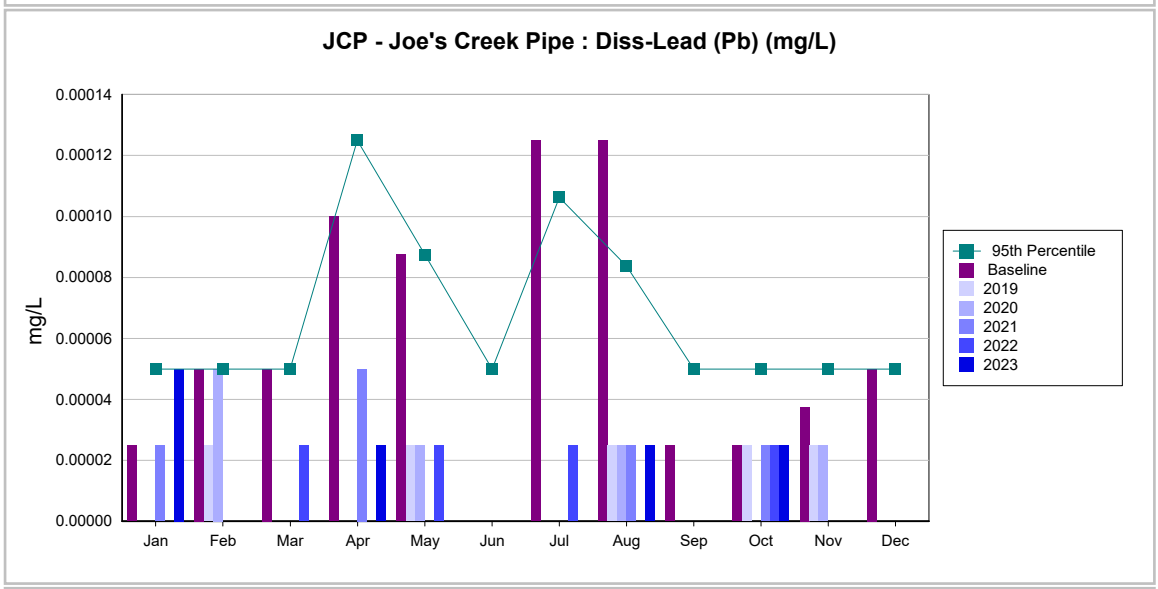
Annual Report Drainage Water

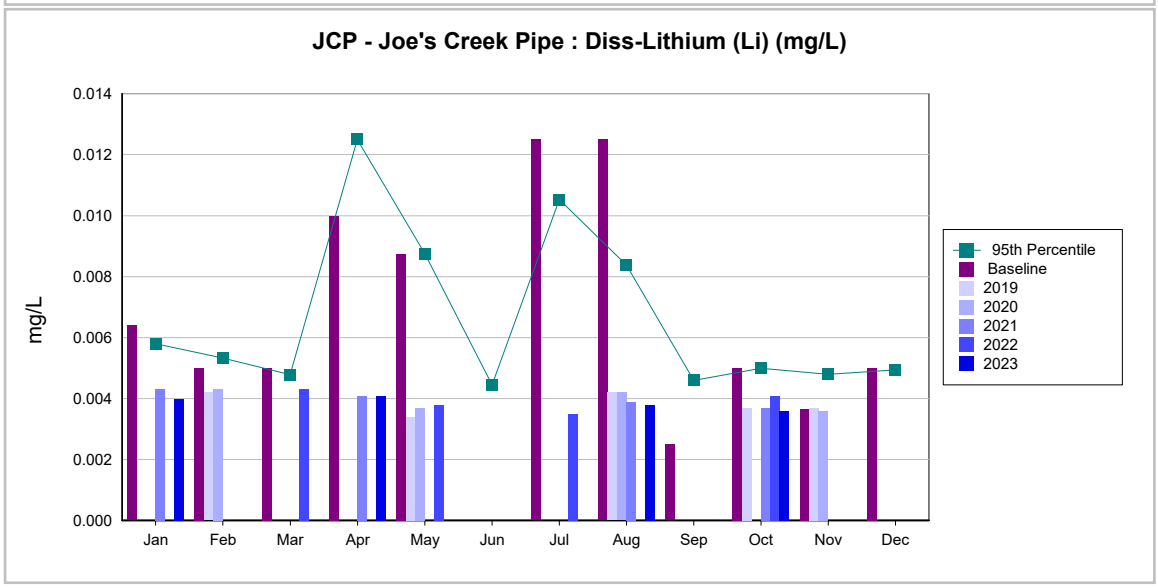
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







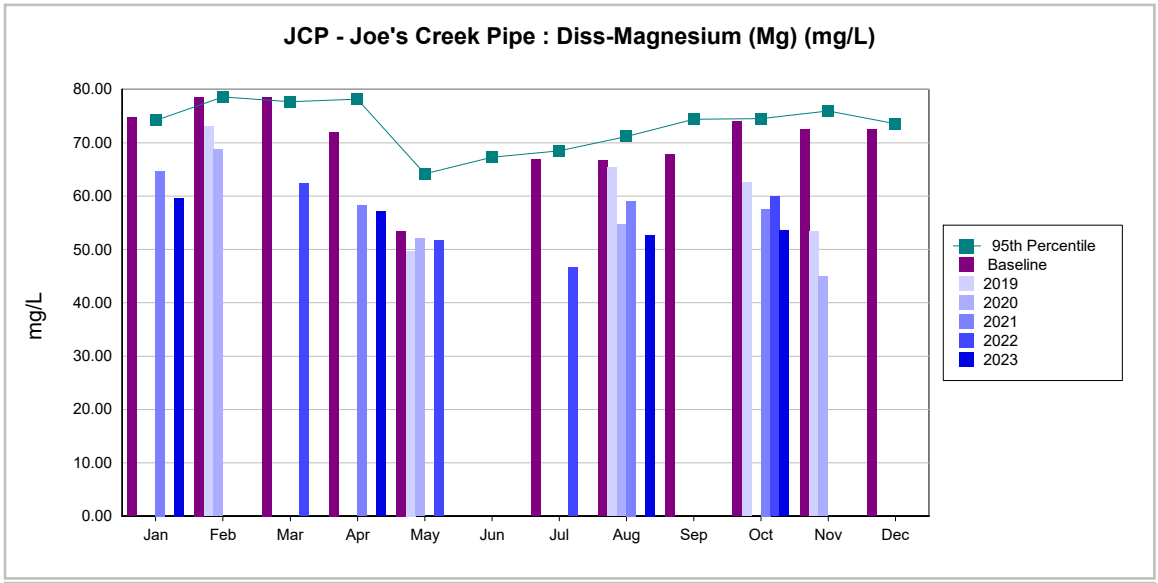
Water Quality Report

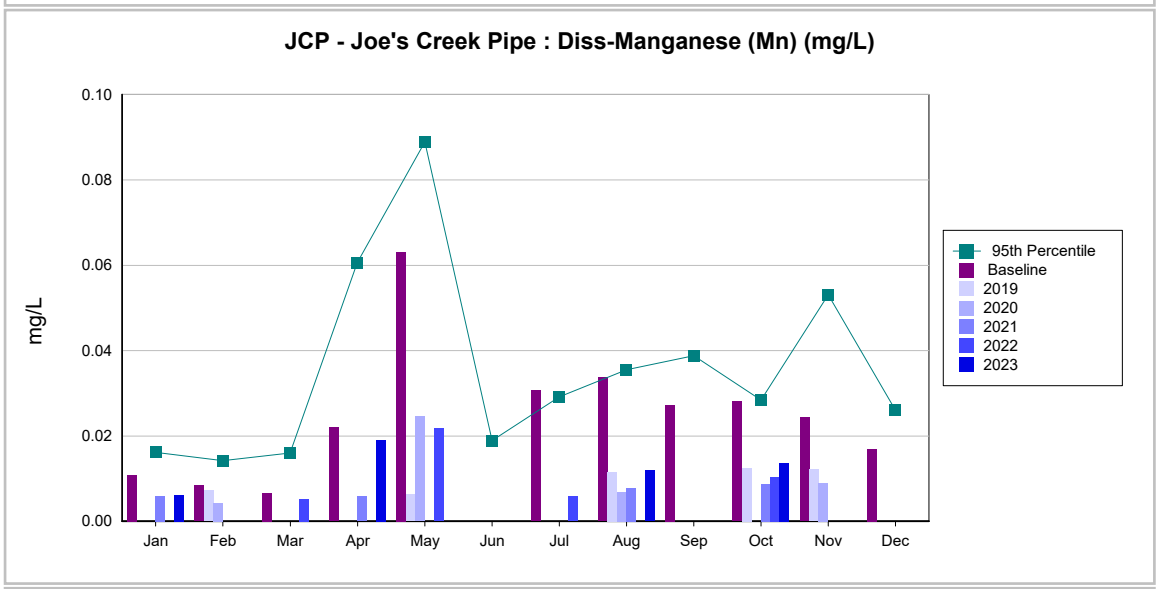
Annual Report Drainage Water

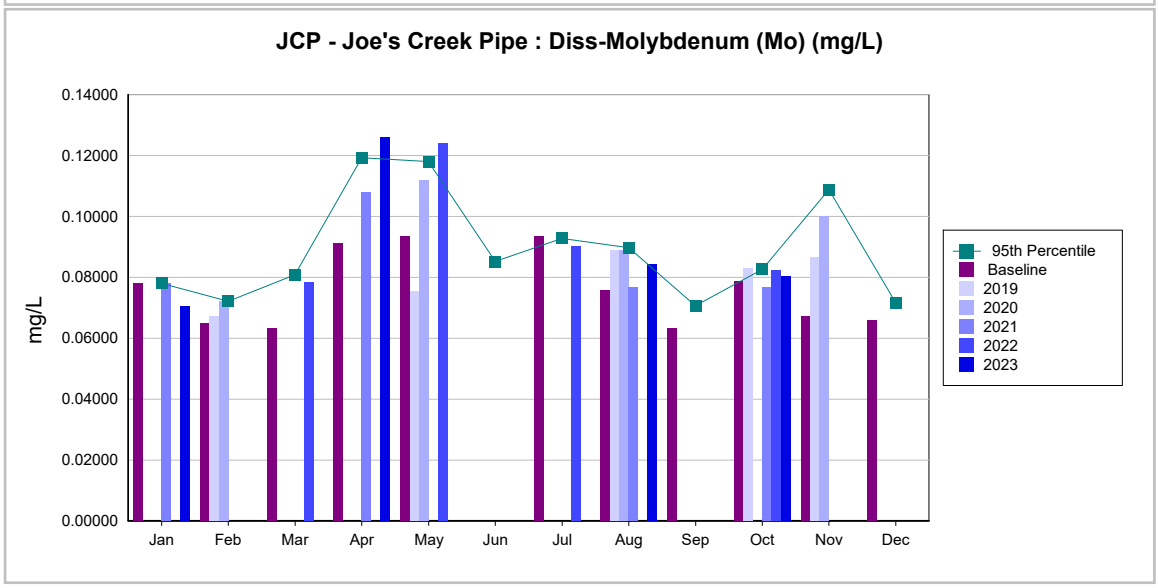
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







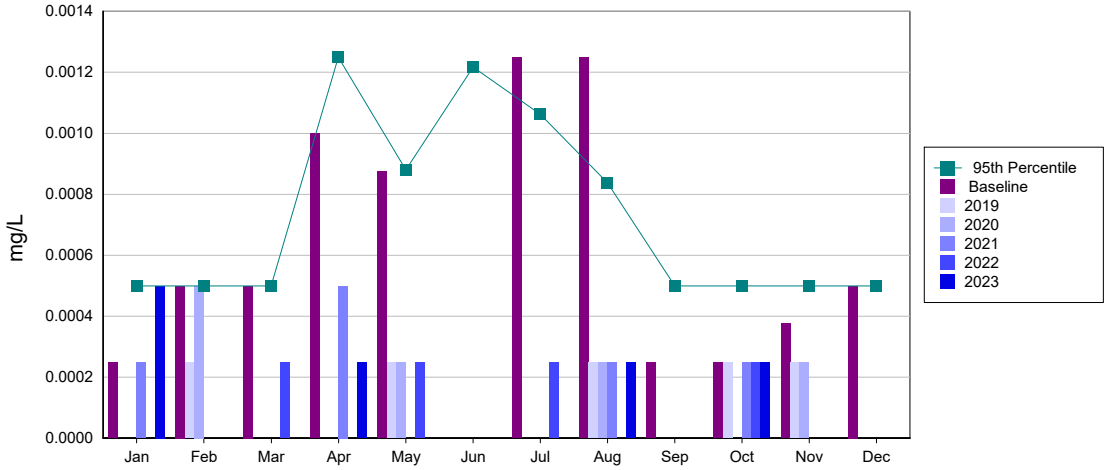
Water Quality Report

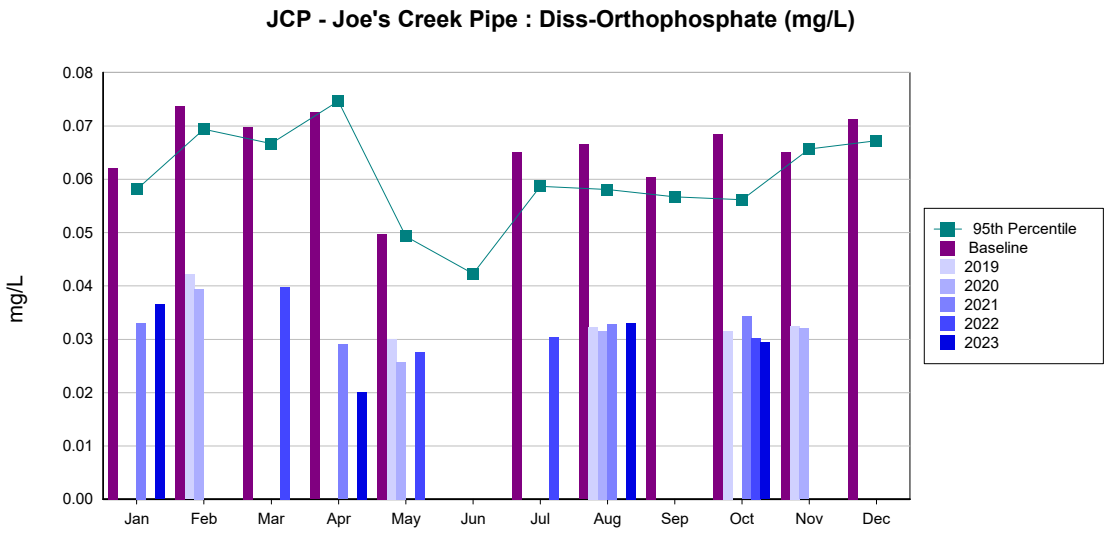
Annual Report Drainage Water

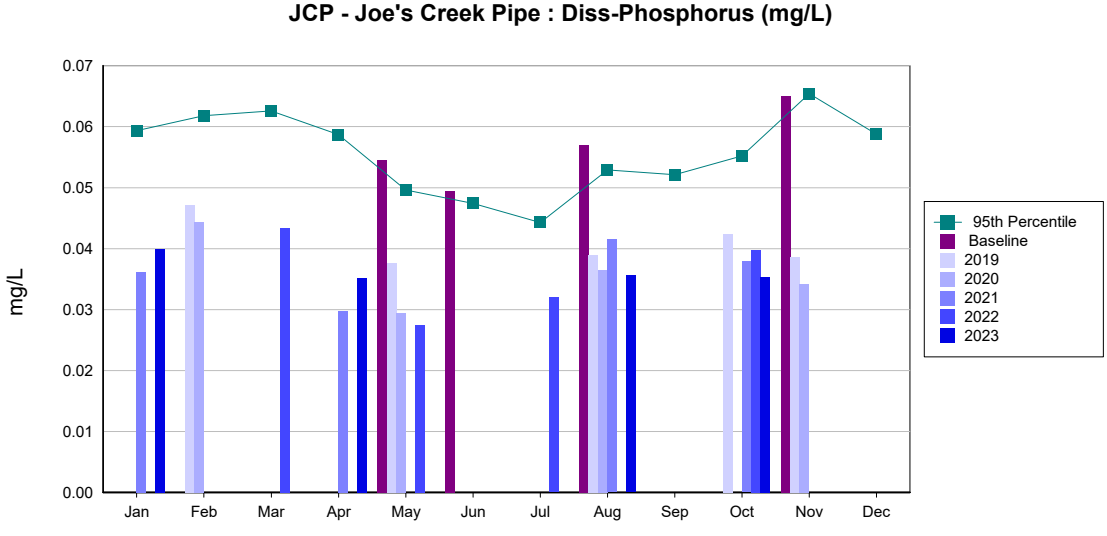
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







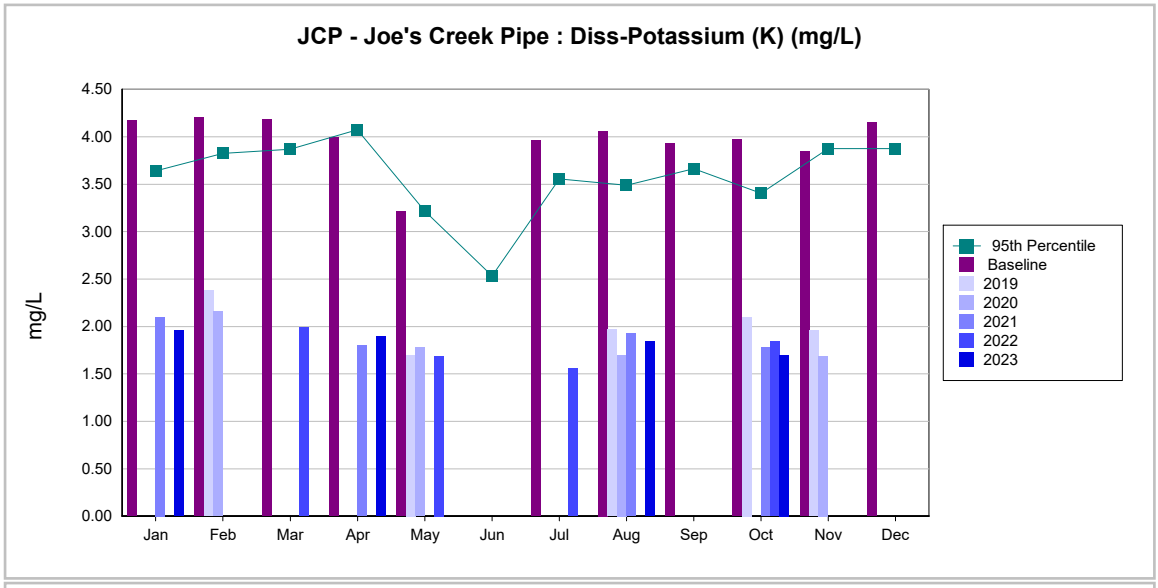
Water Quality Report

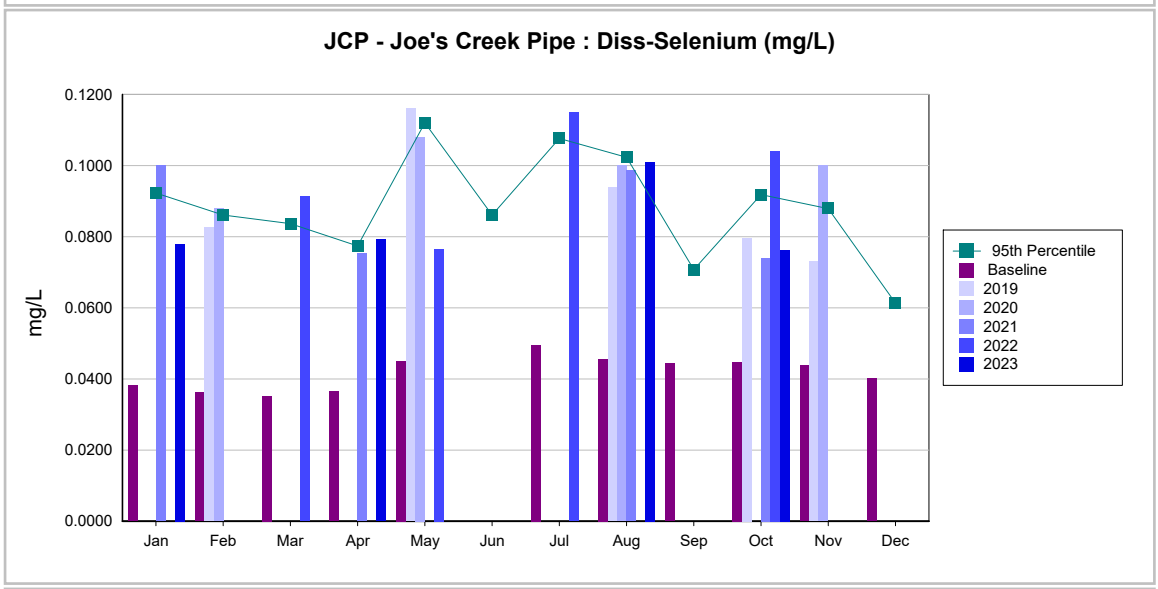
Annual Report Drainage Water

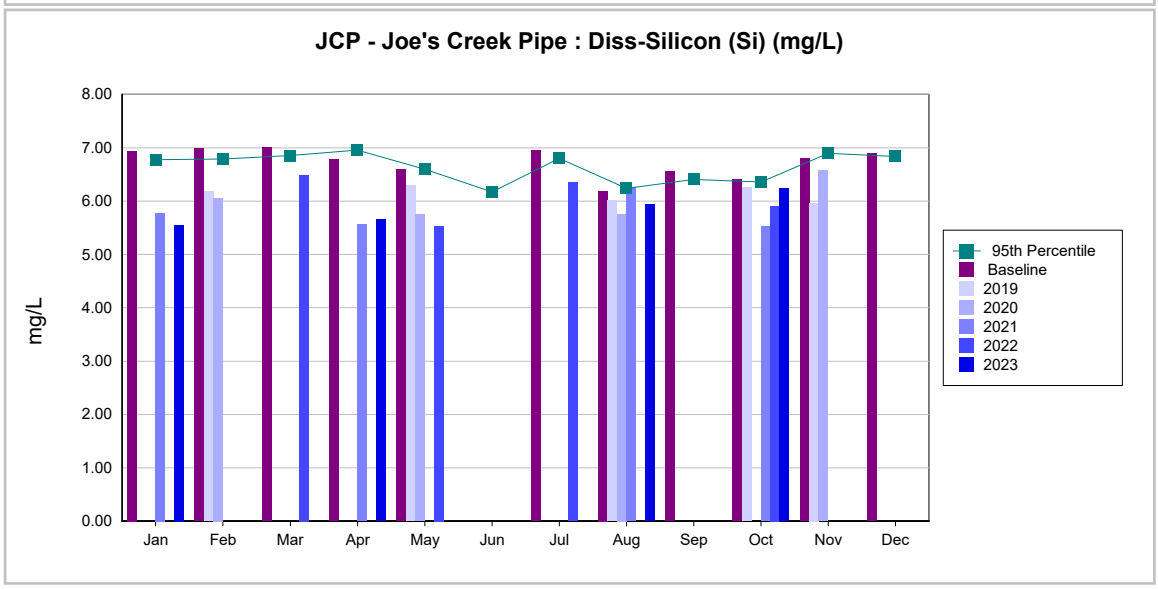
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







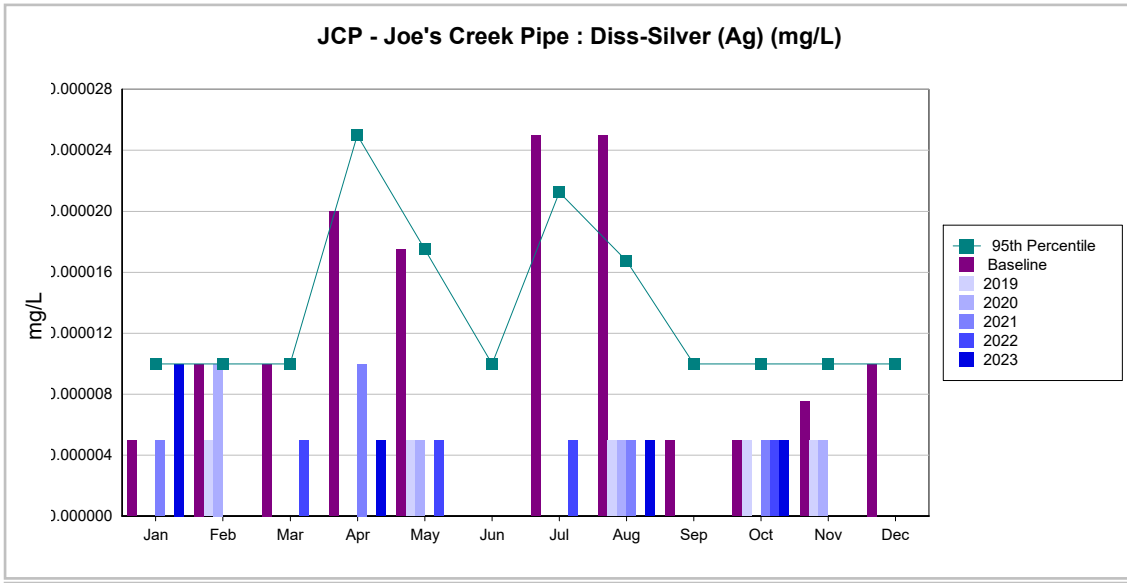
Water Quality Report

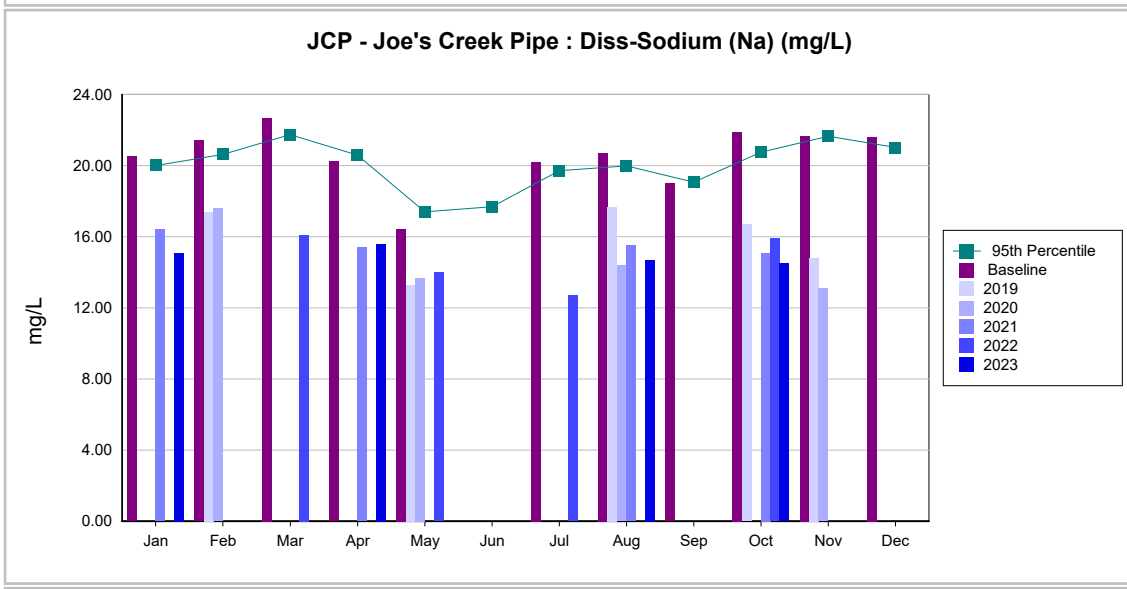
Annual Report Drainage Water

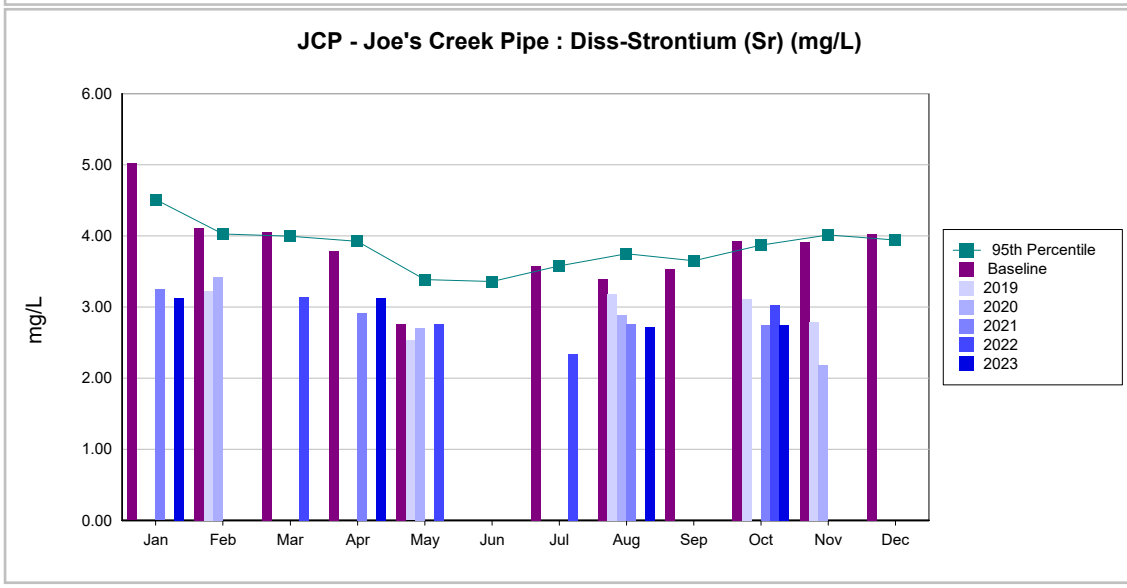
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







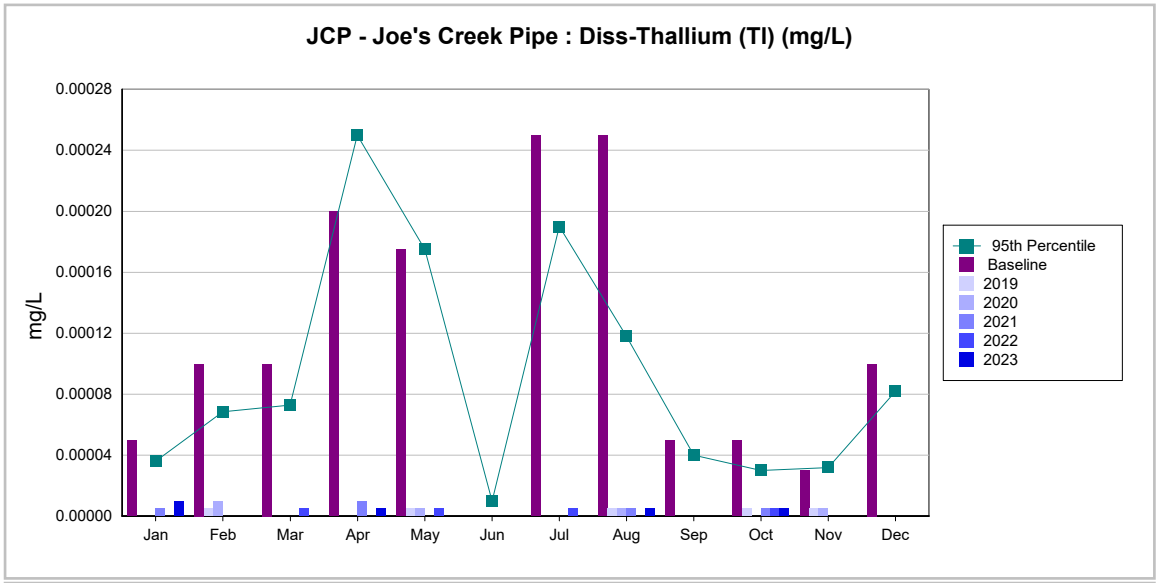
Water Quality Report

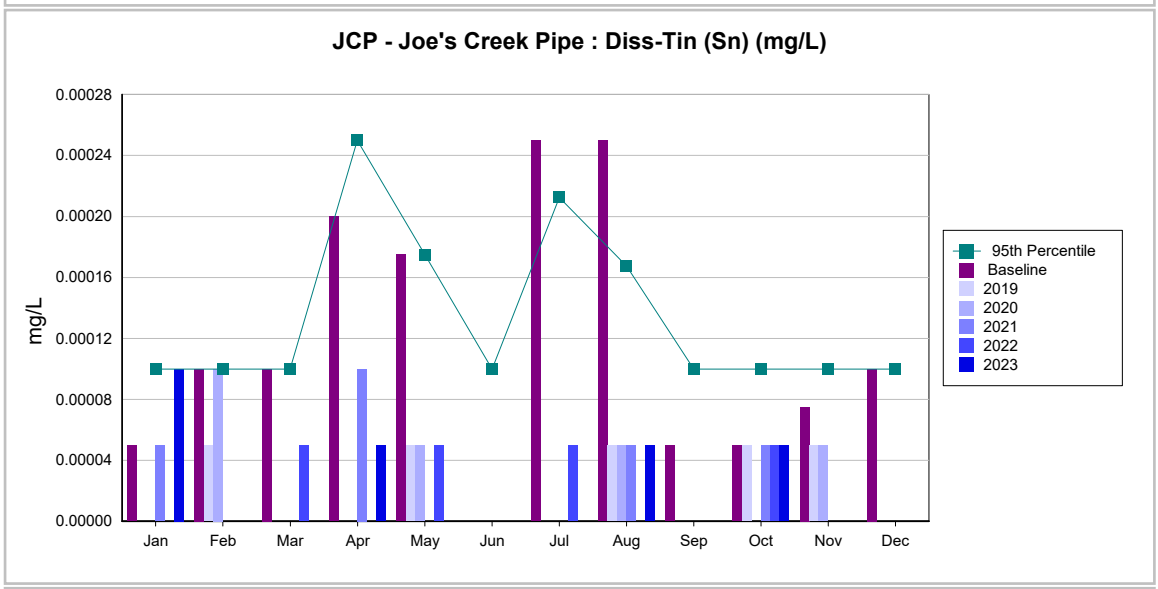
Annual Report Drainage Water

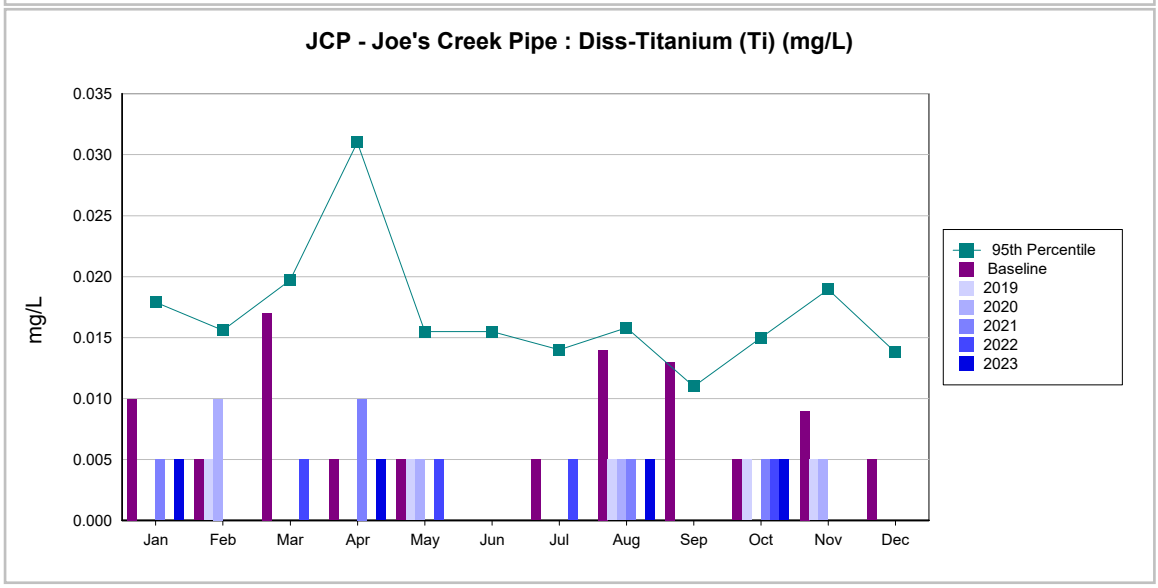
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







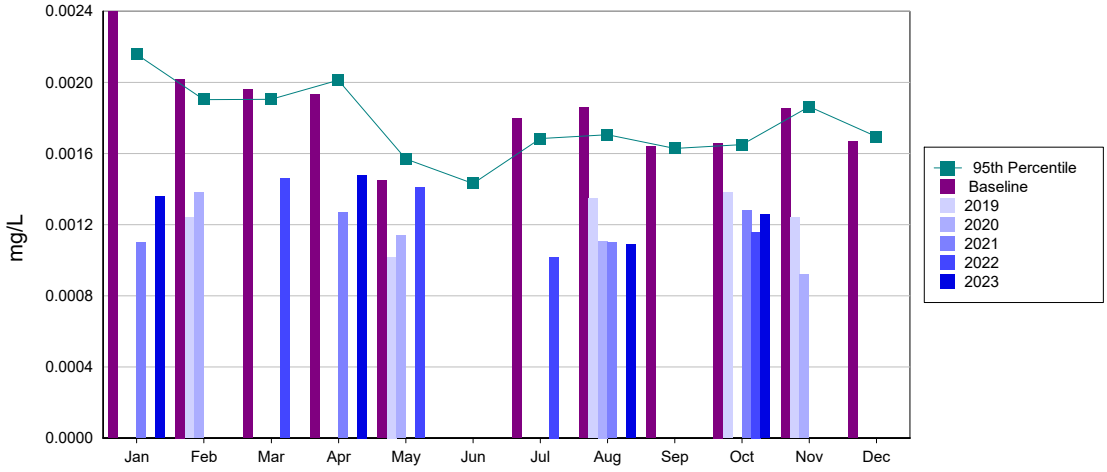
Water Quality Report

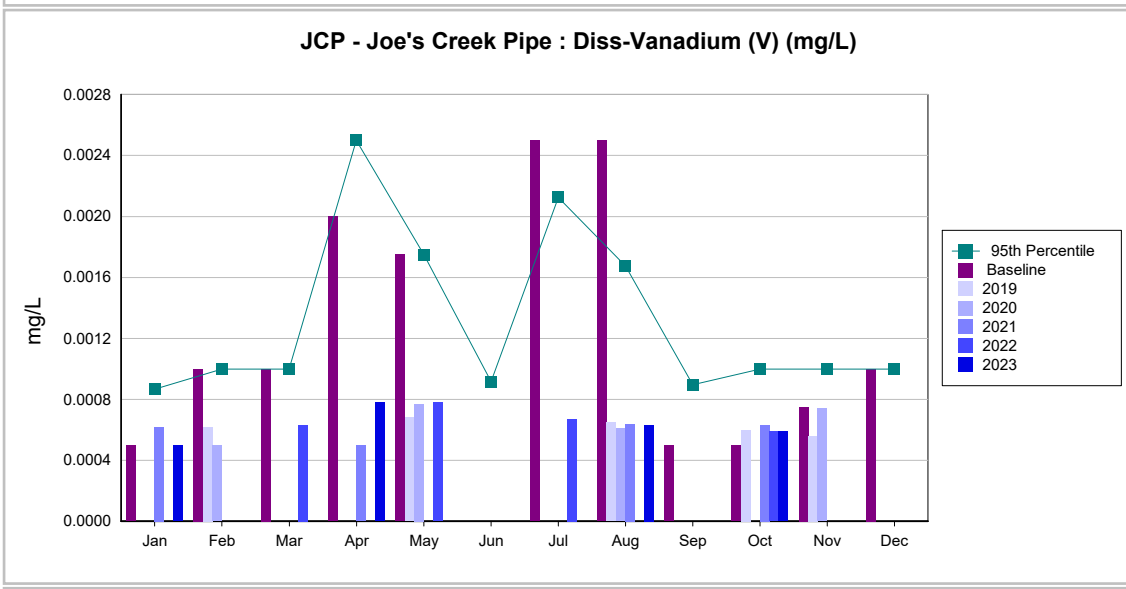
Annual Report Drainage Water

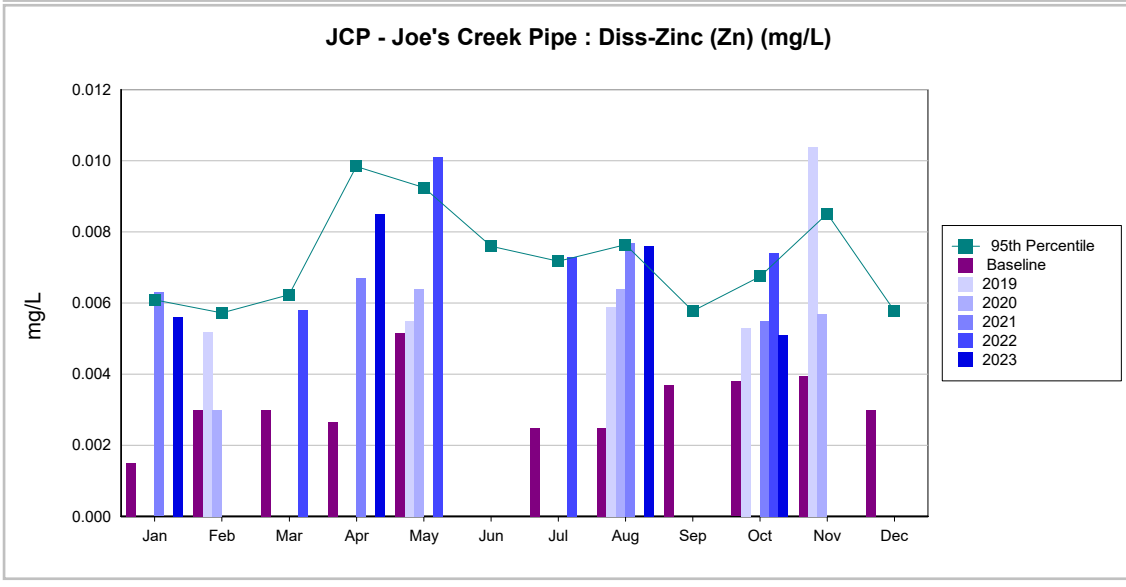
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







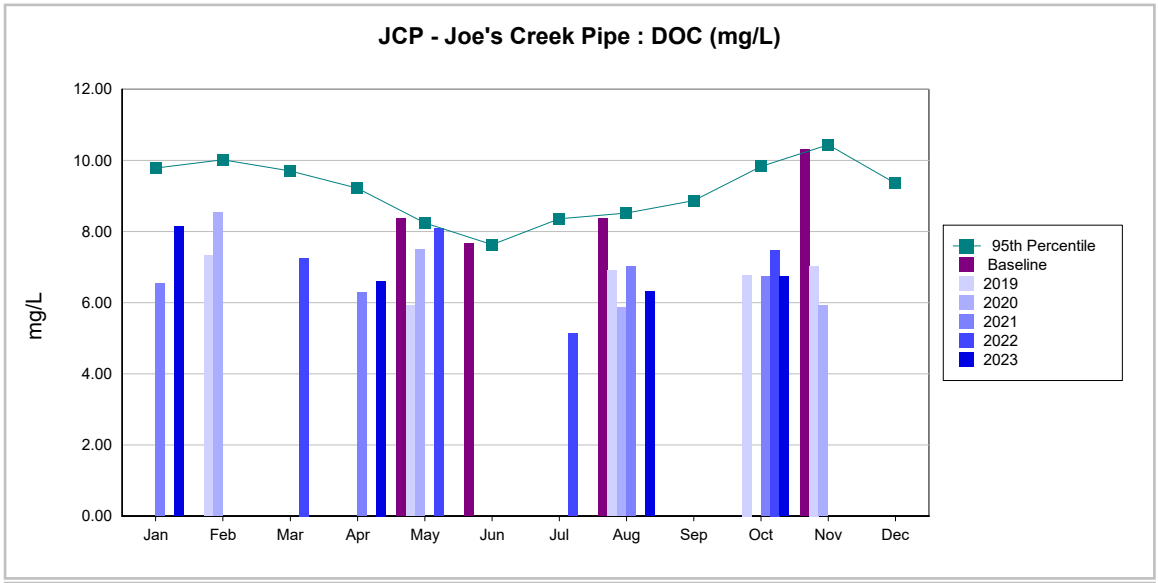
Water Quality Report

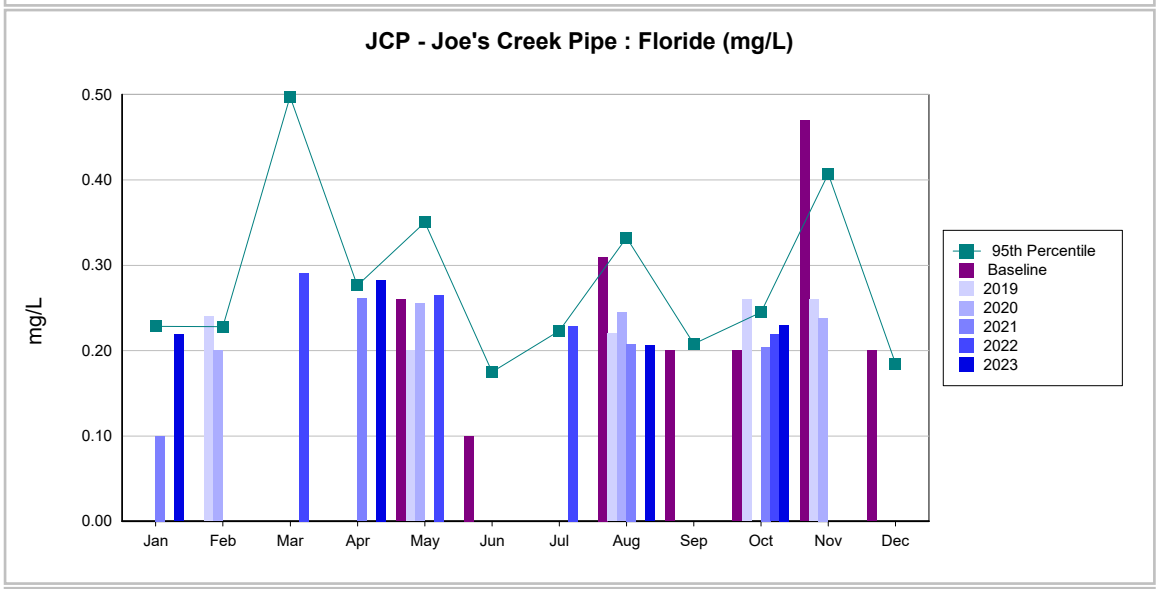
Annual Report Drainage Water

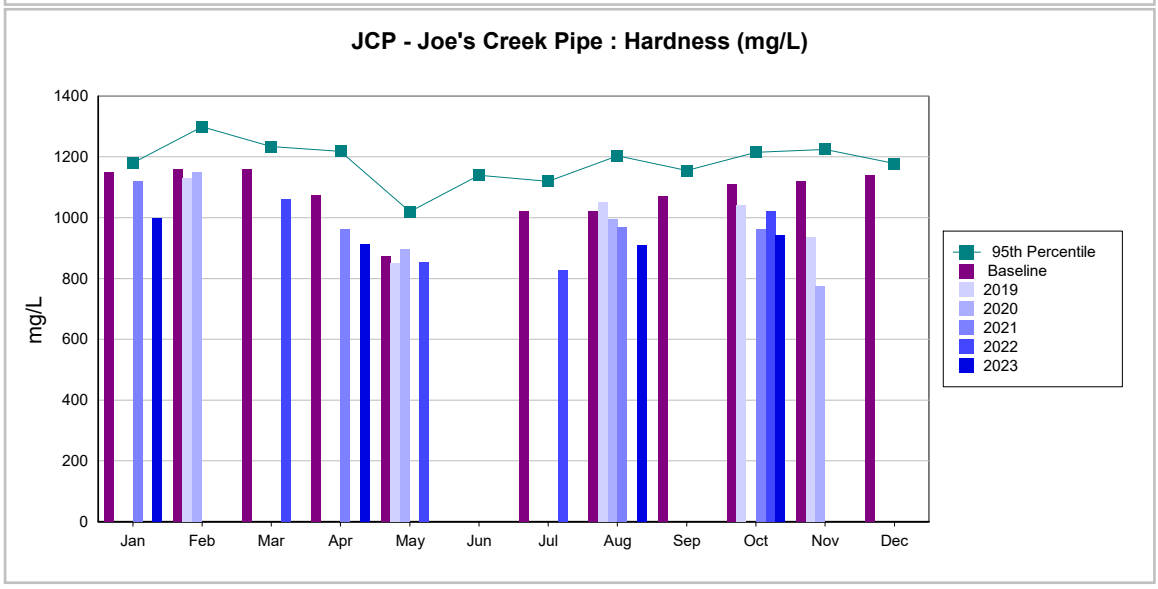
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







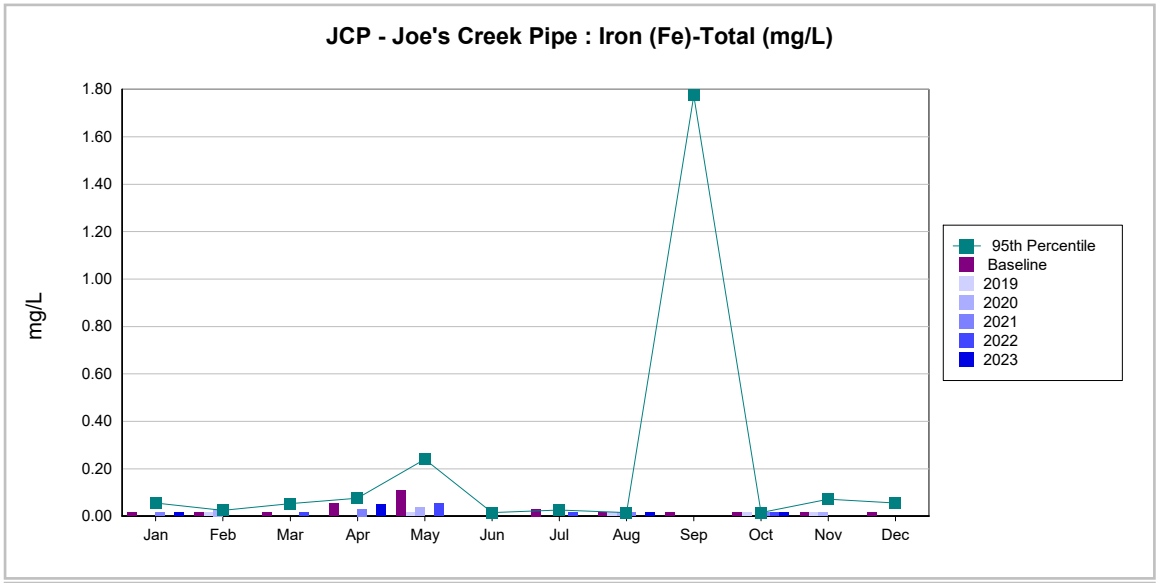
Water Quality Report

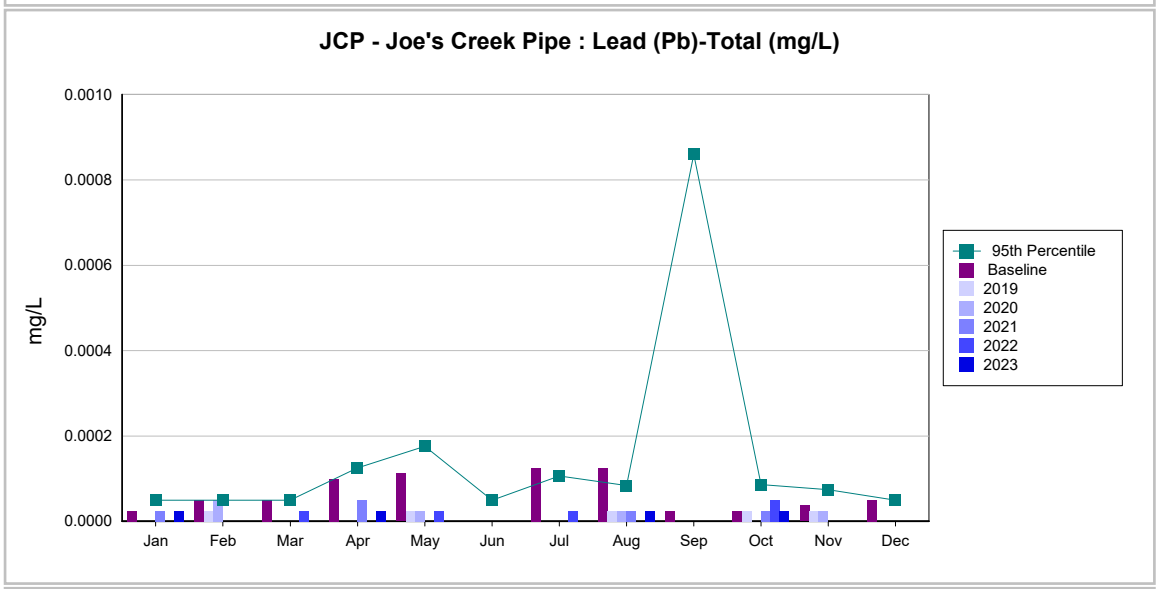
Annual Report Drainage Water

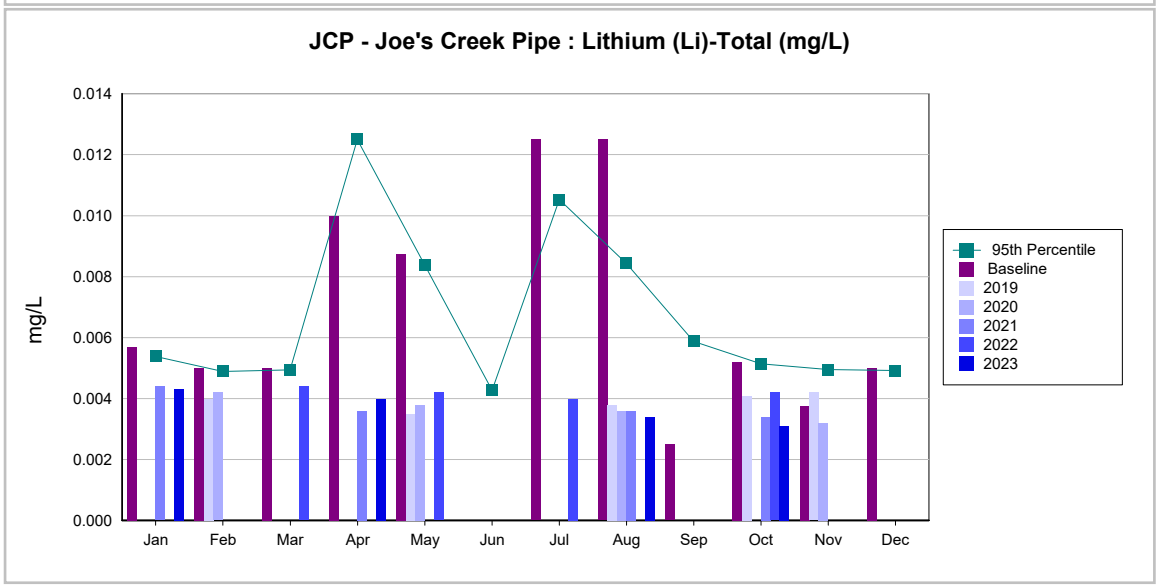
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







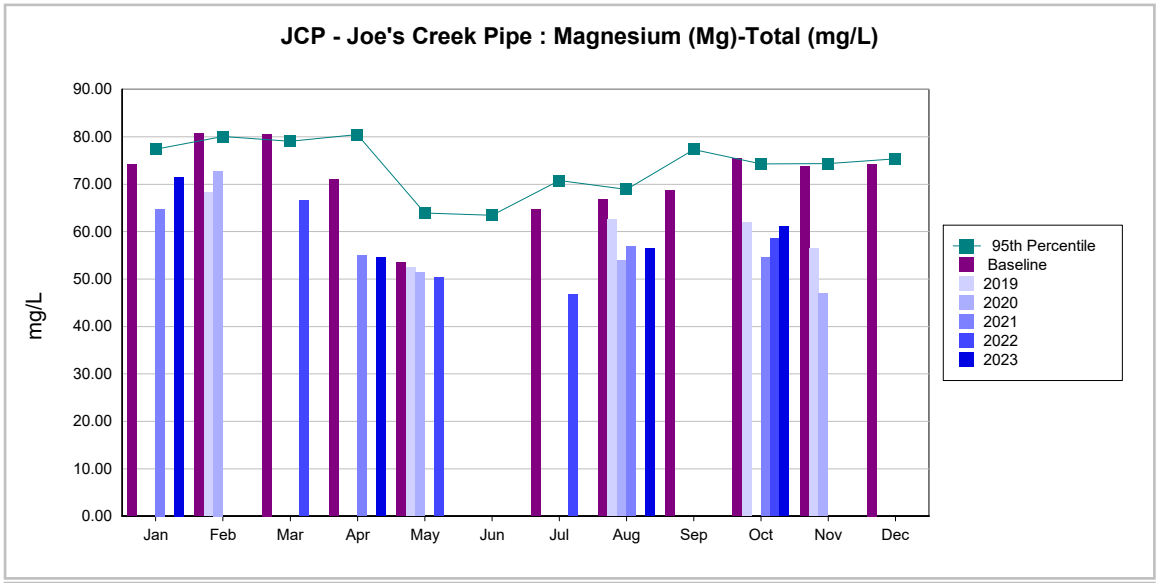
Water Quality Report

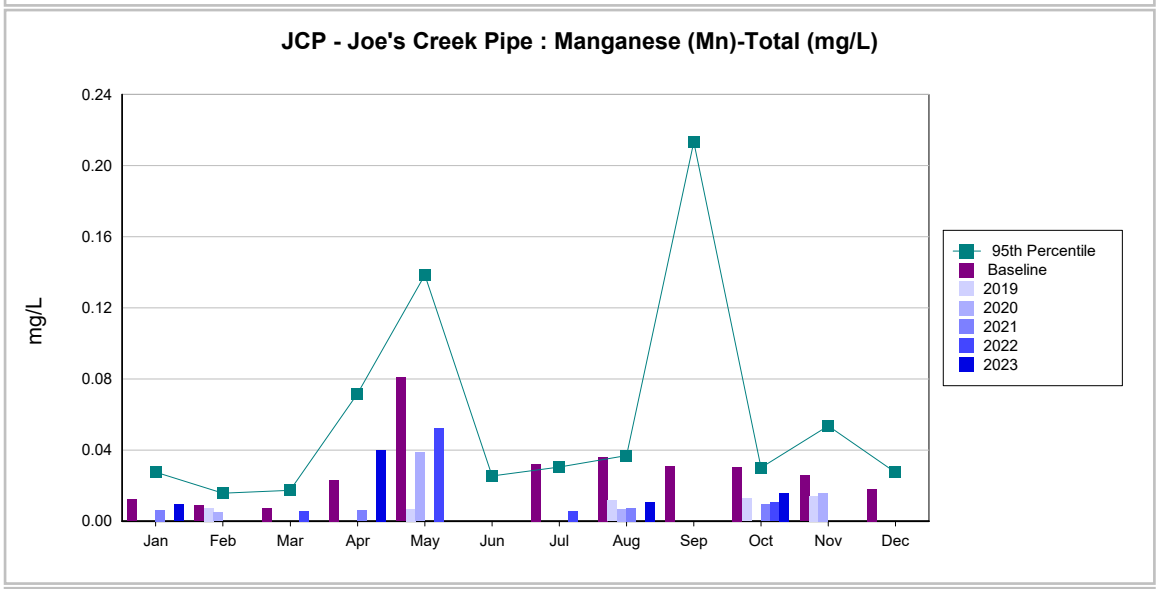
Annual Report Drainage Water

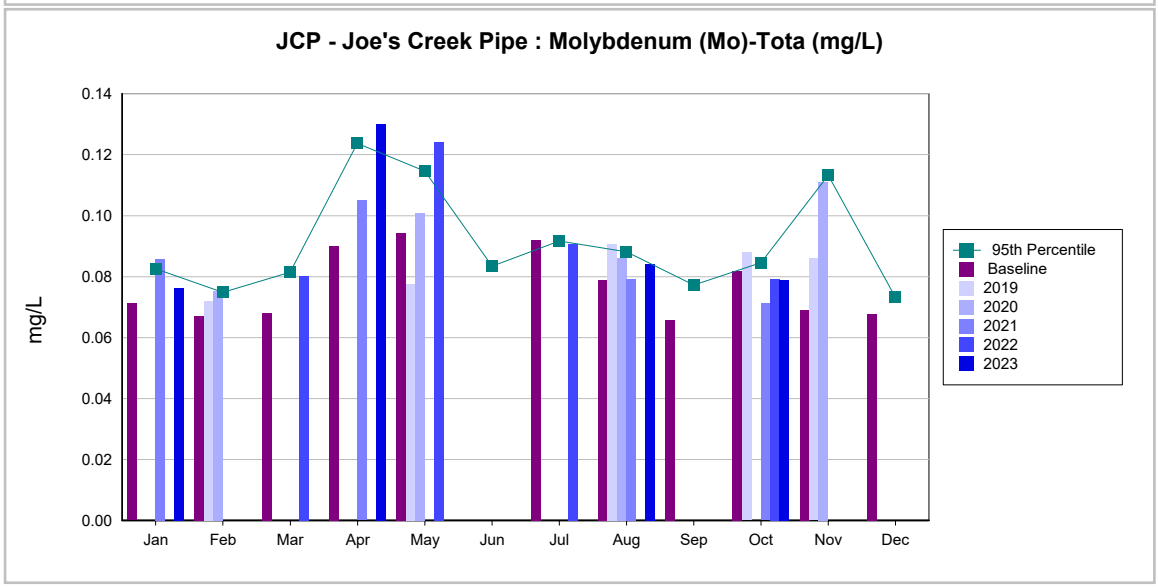
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







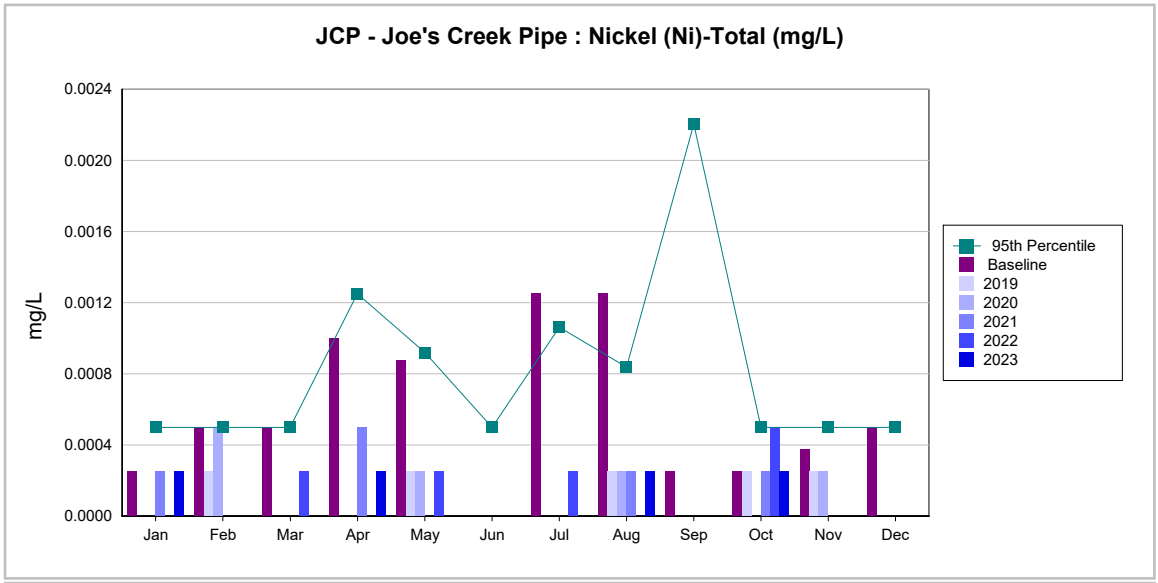
Water Quality Report

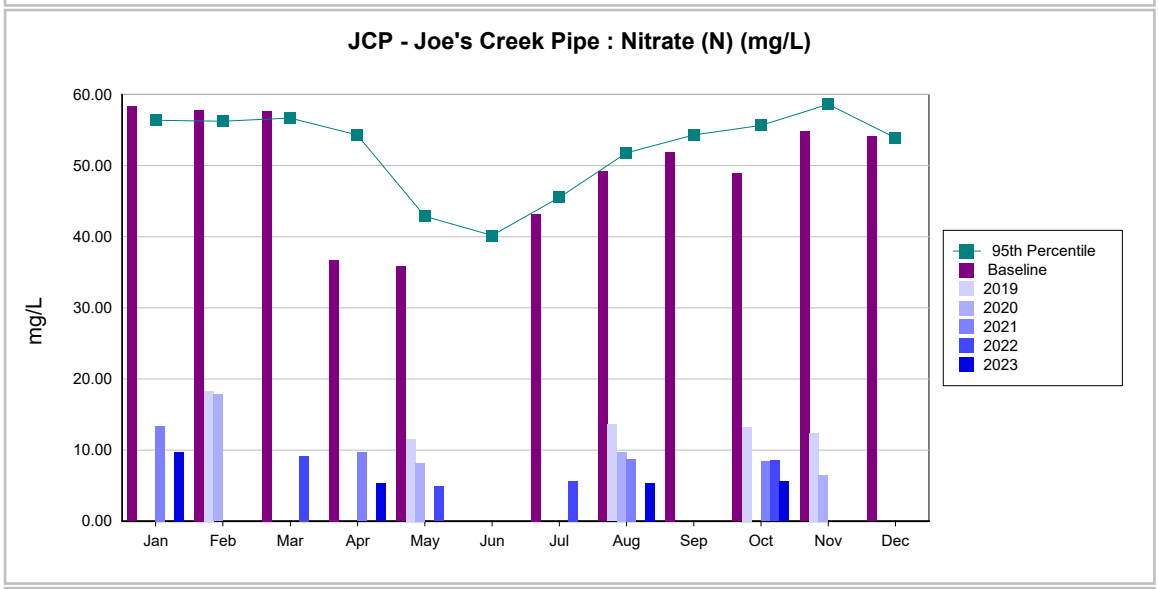
Annual Report Drainage Water

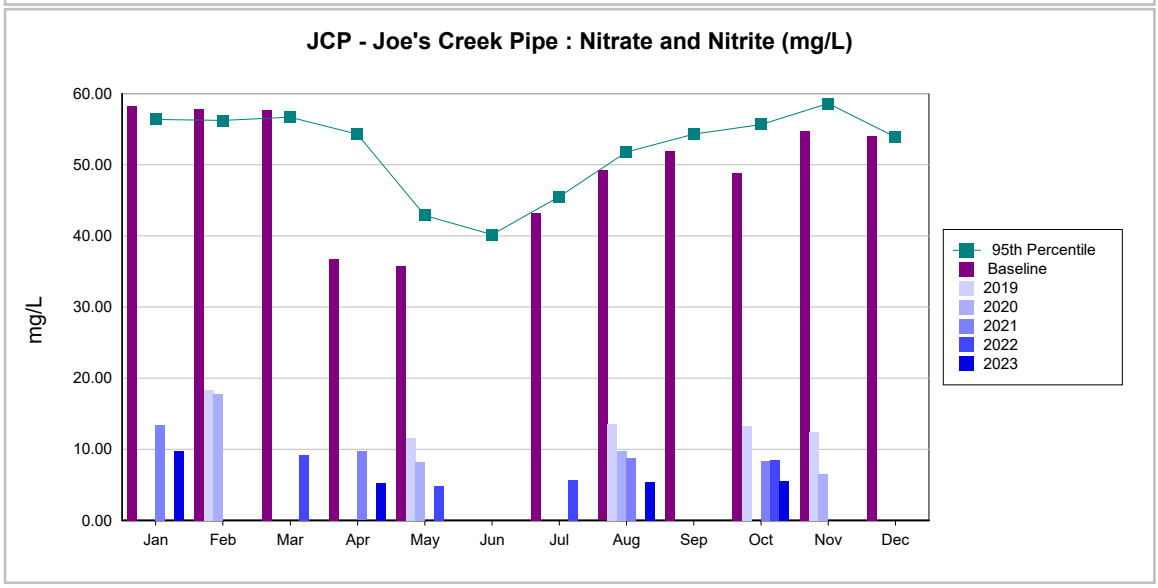
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







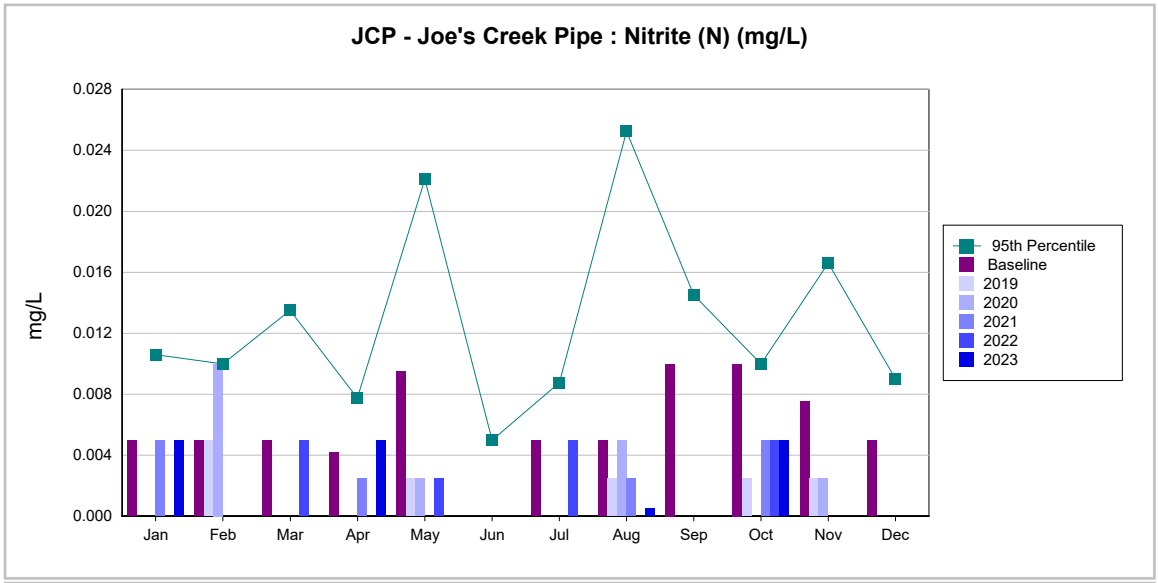
Water Quality Report

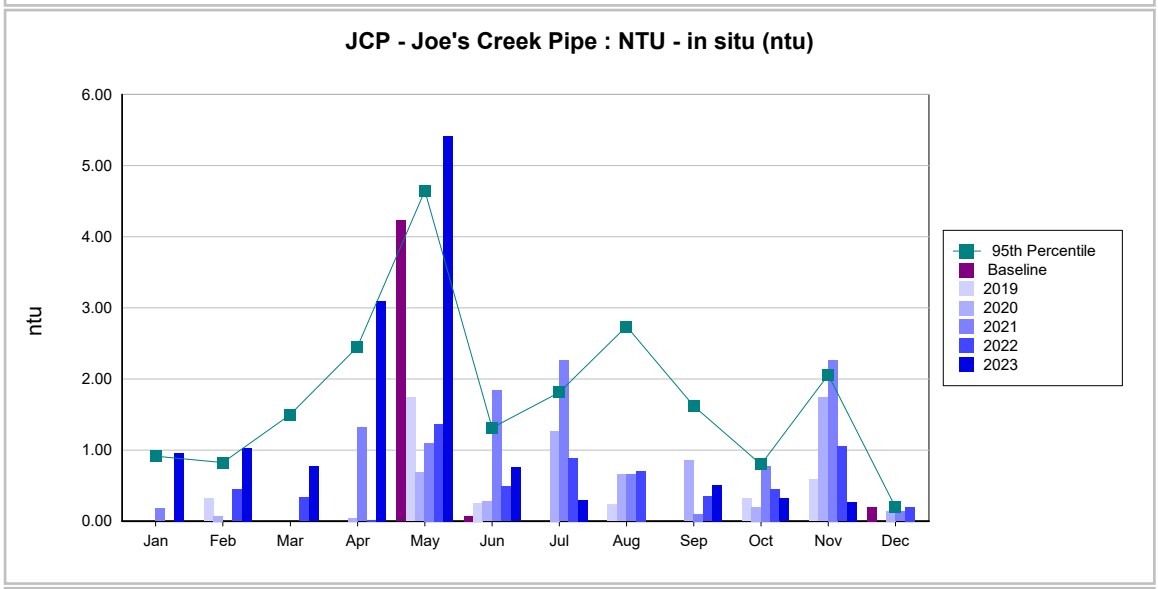
Annual Report Drainage Water

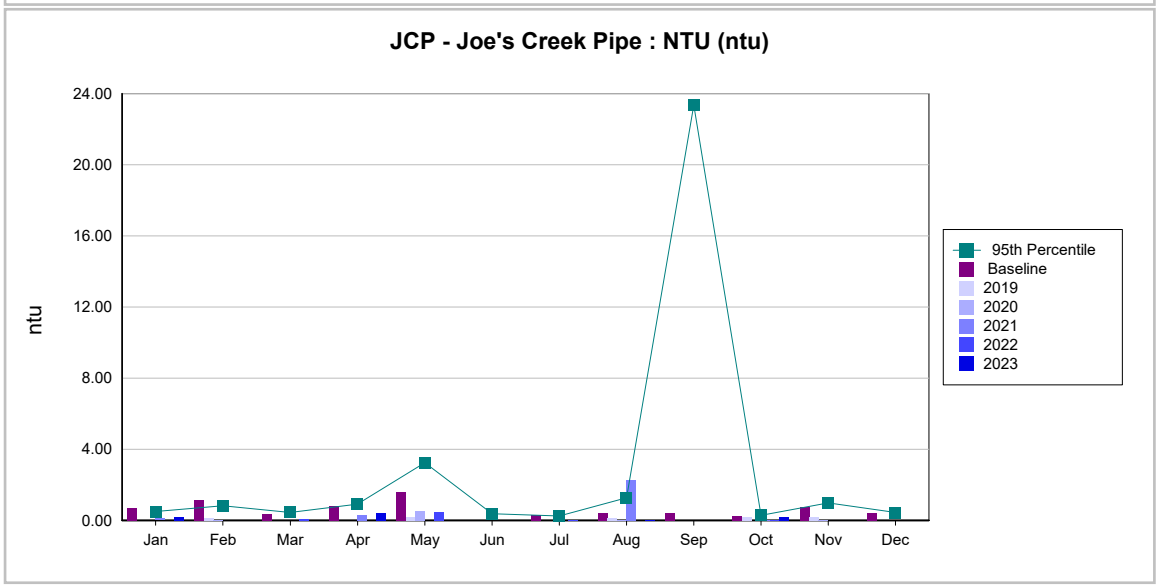
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







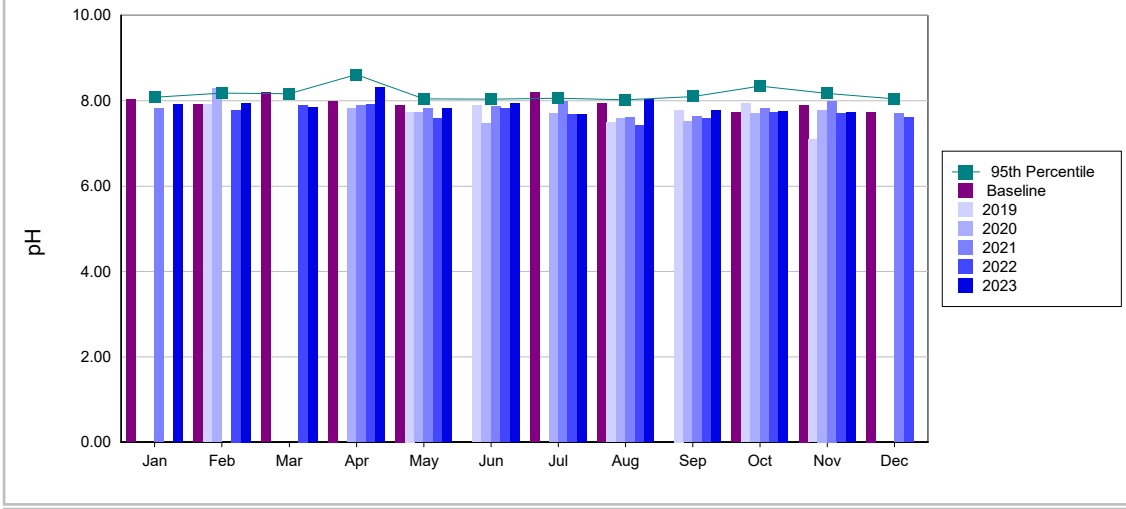
Water Quality Report

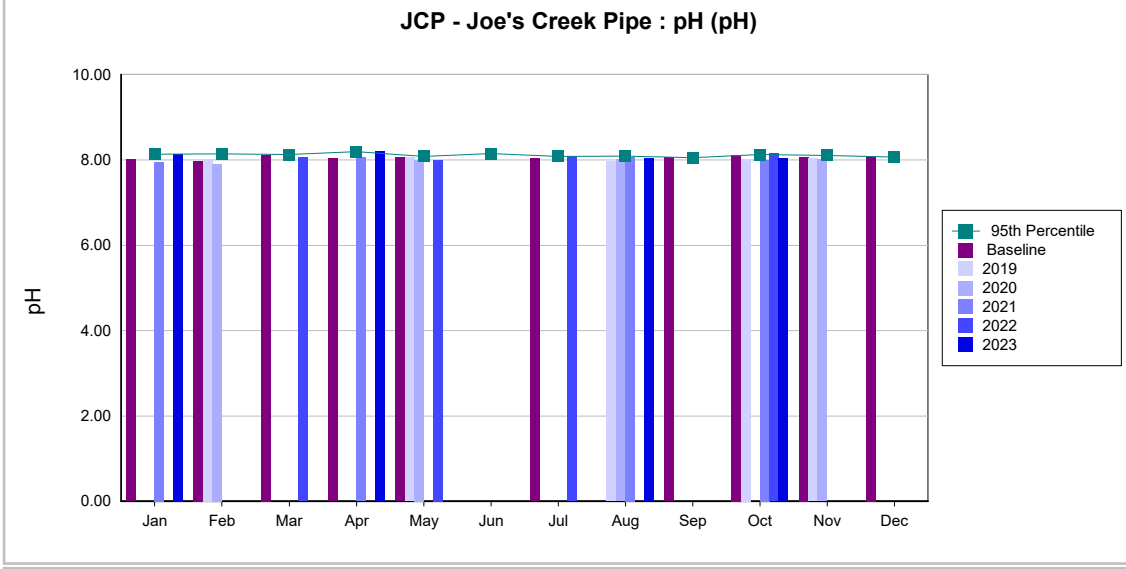
Annual Report Drainage Water

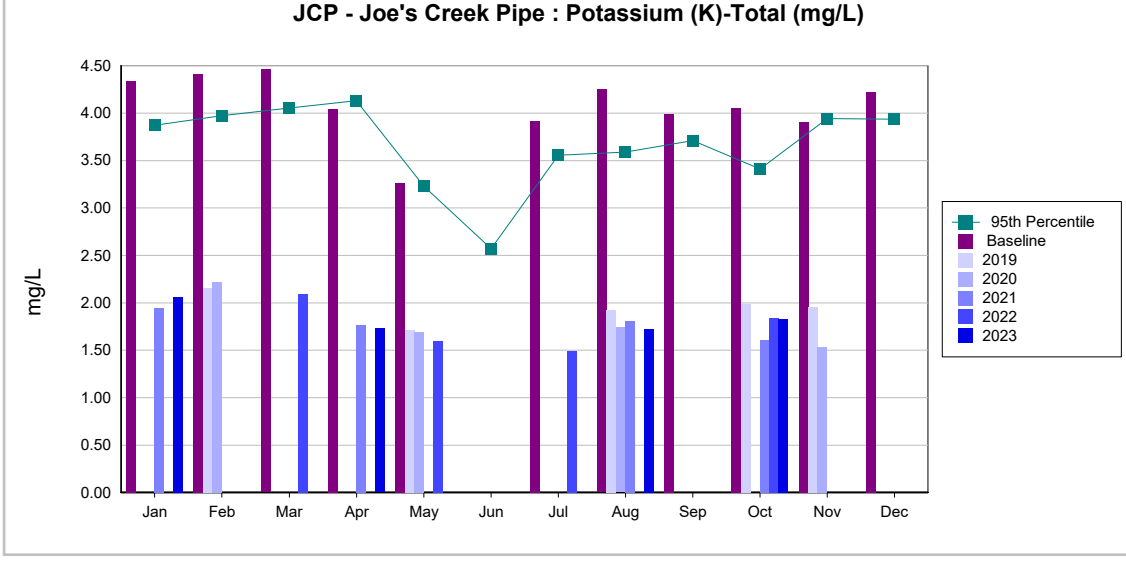
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







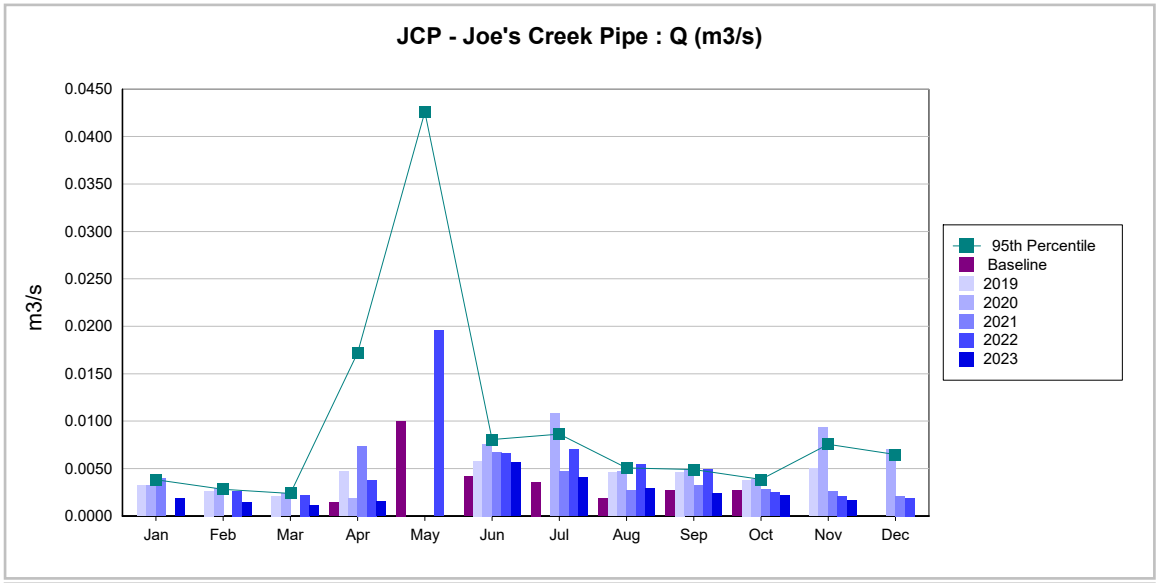
Water Quality Report

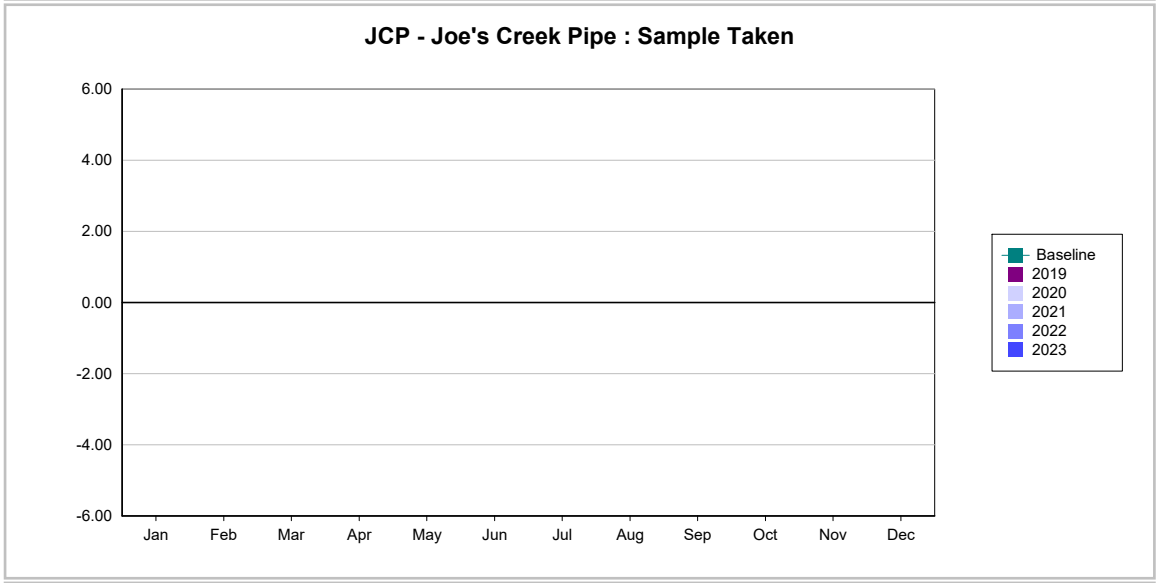
Annual Report Drainage Water

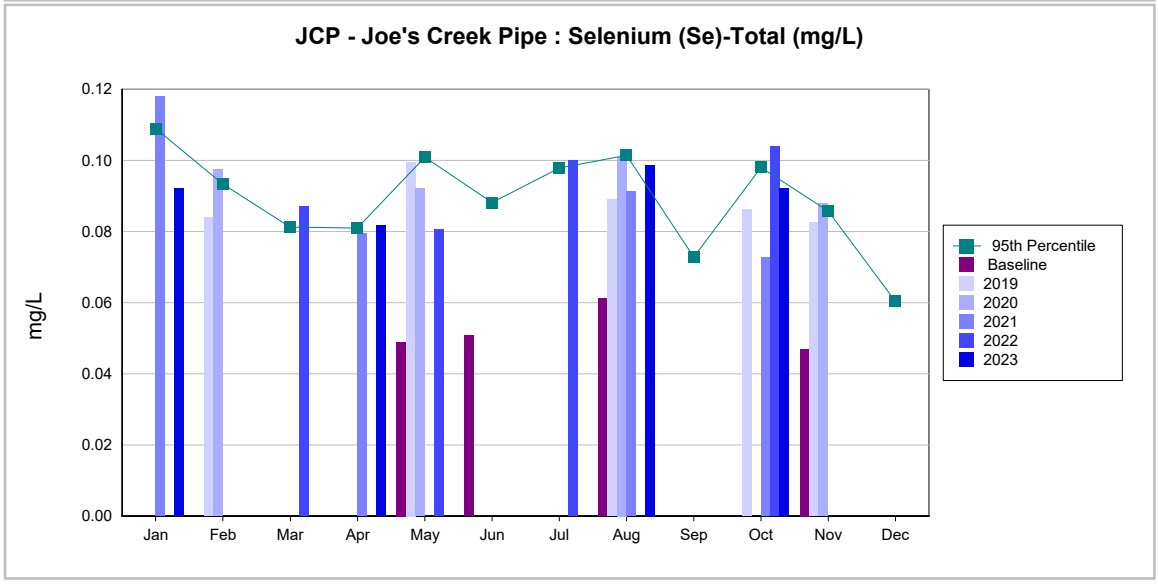
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







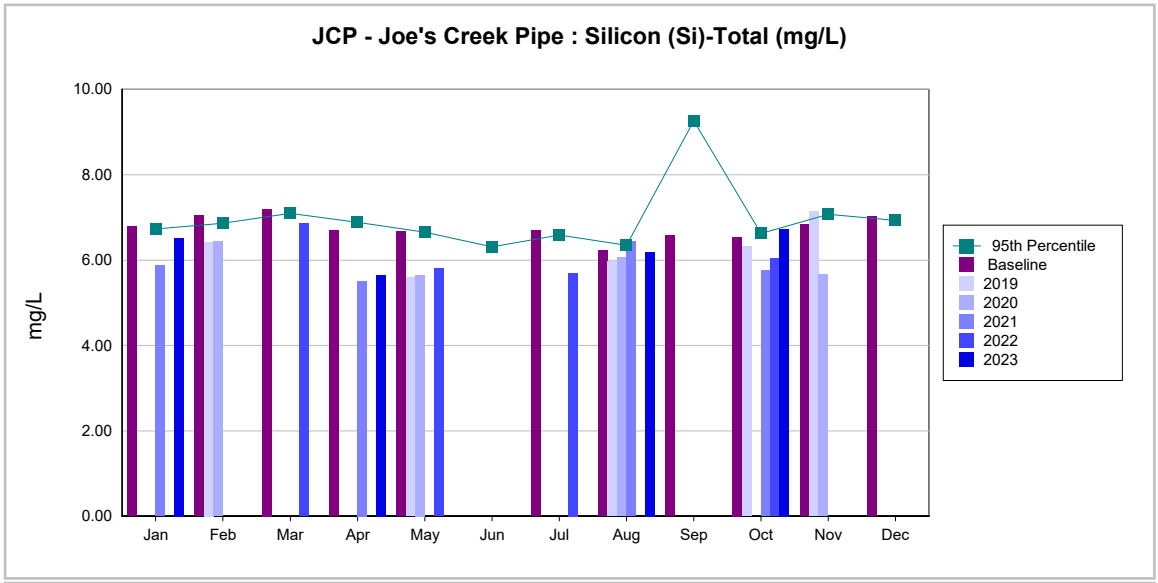
Water Quality Report

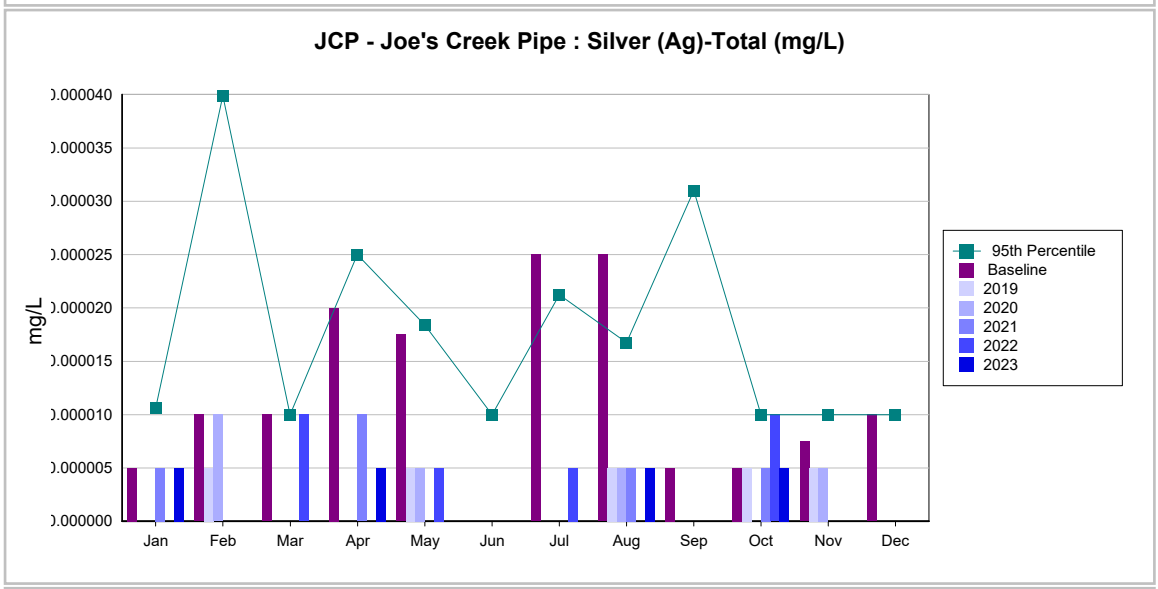
Annual Report Drainage Water

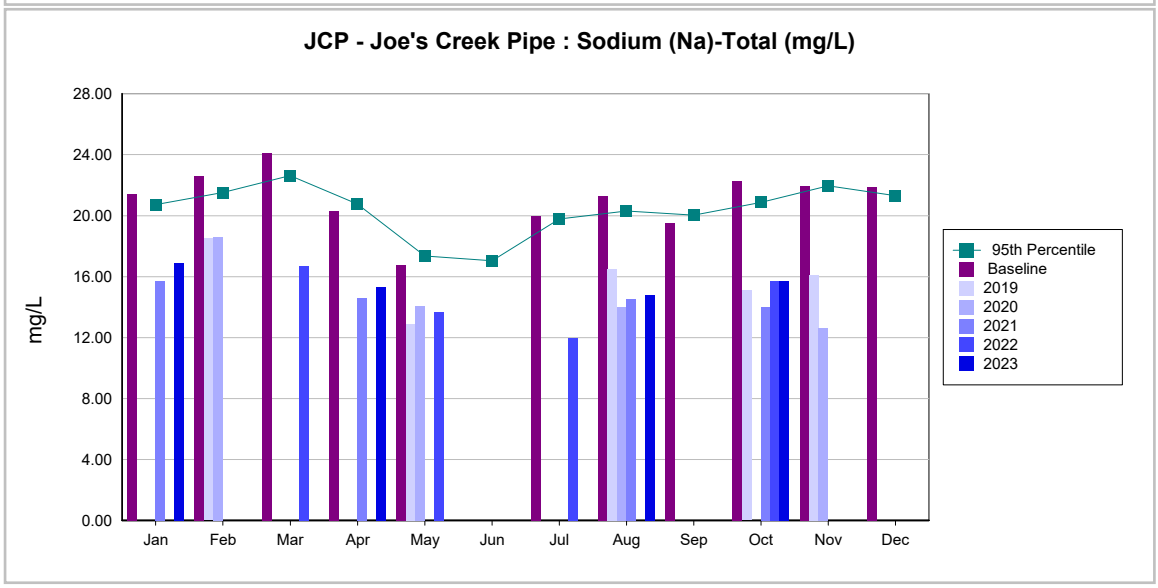
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







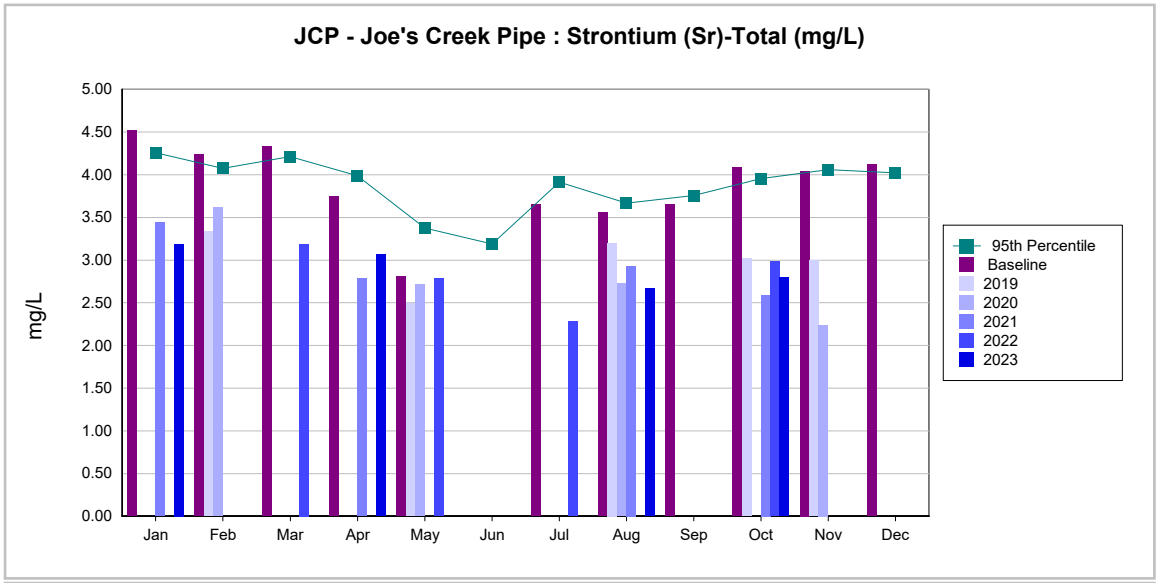
Water Quality Report

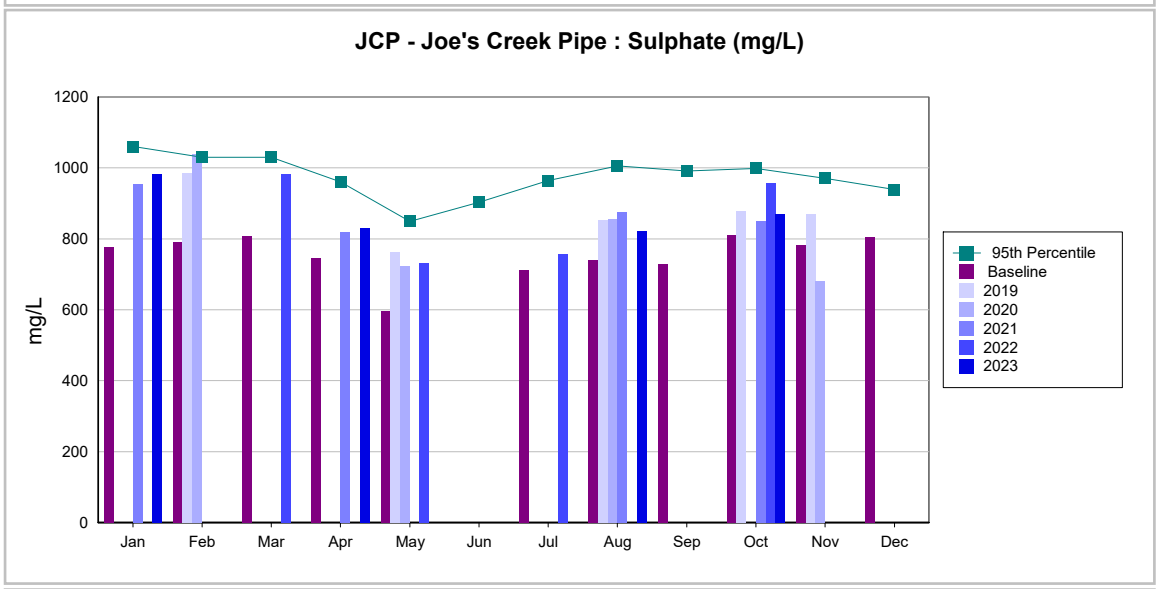
Annual Report Drainage Water

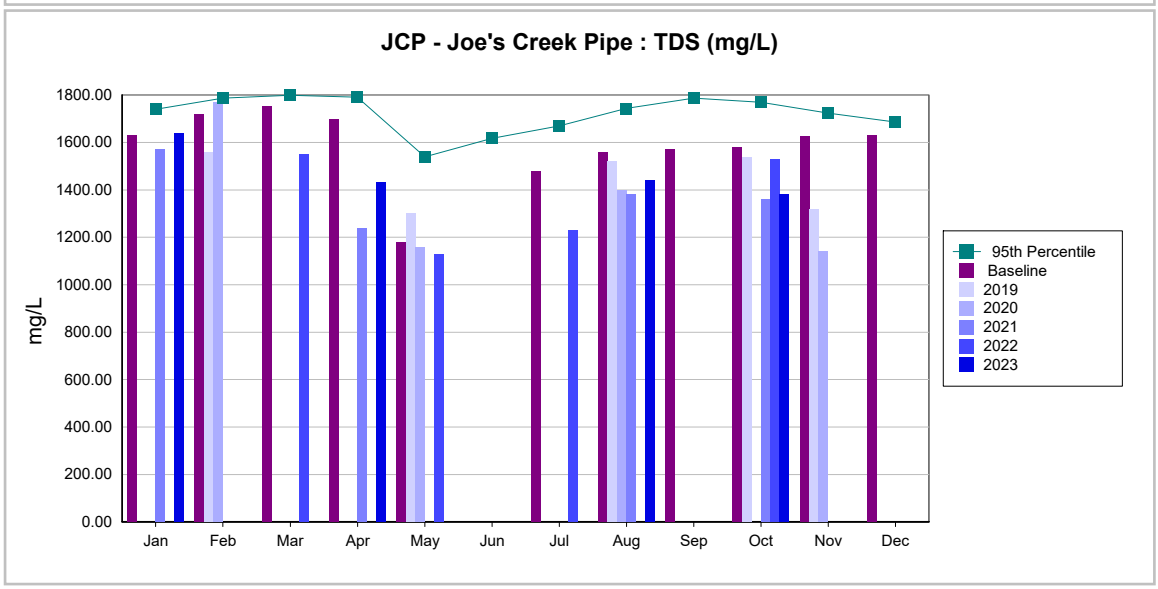
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







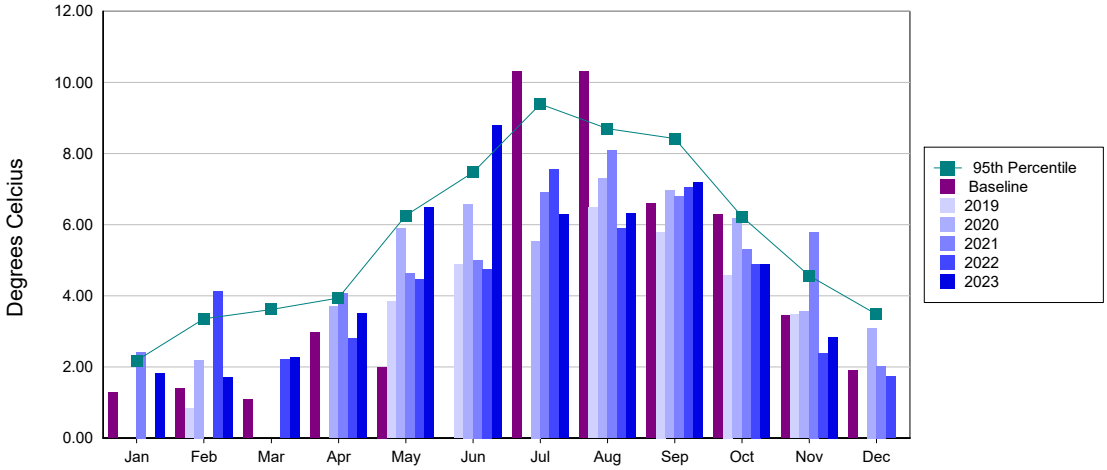
Water Quality Report

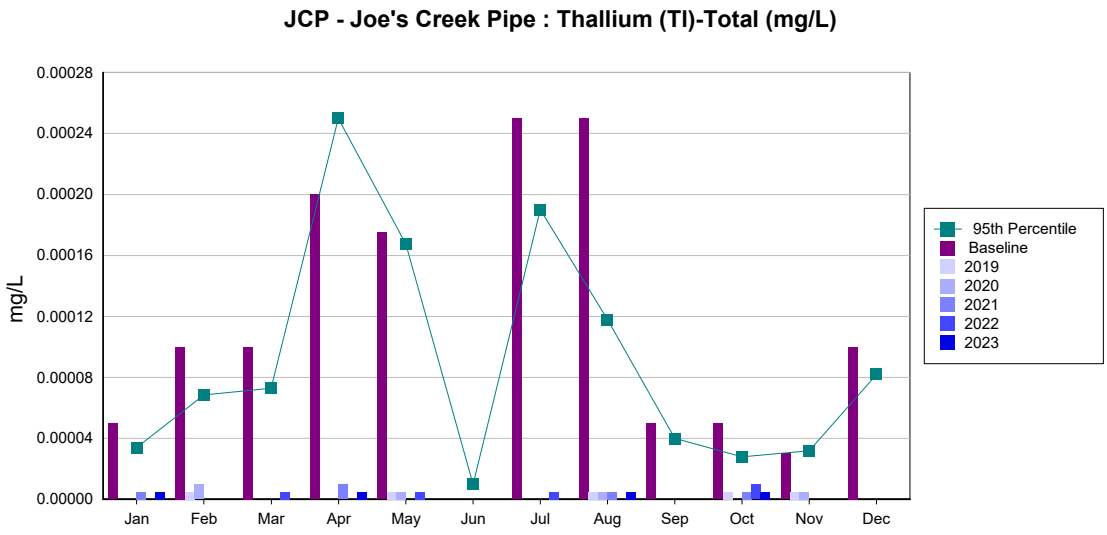
Annual Report Drainage Water

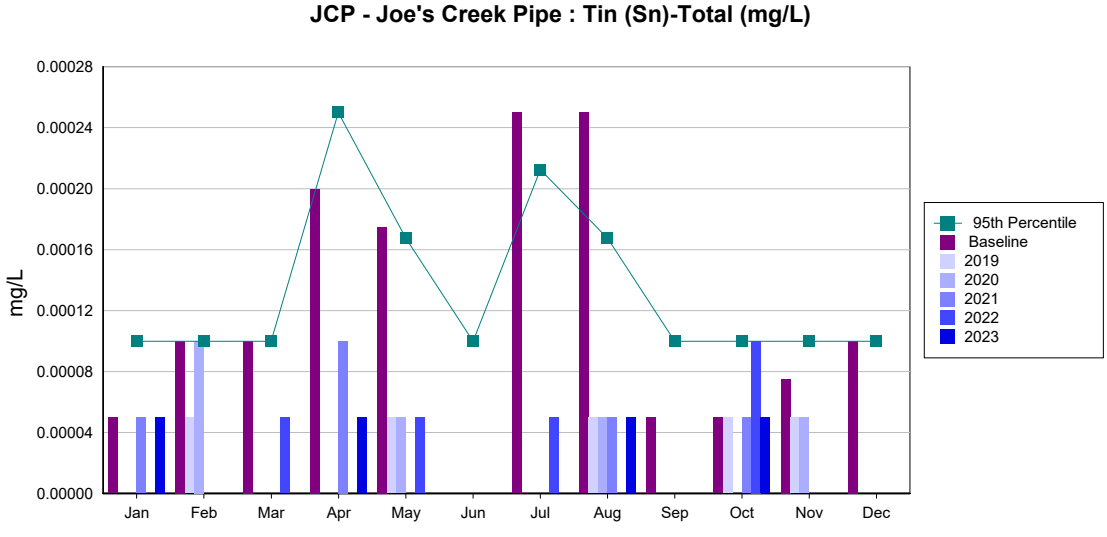
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







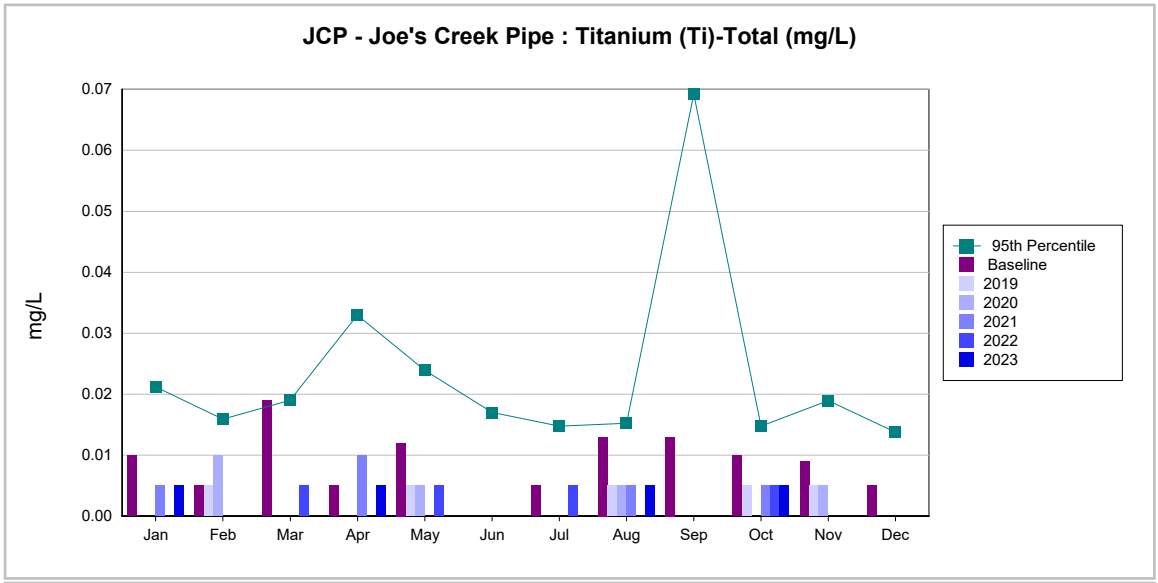
Water Quality Report

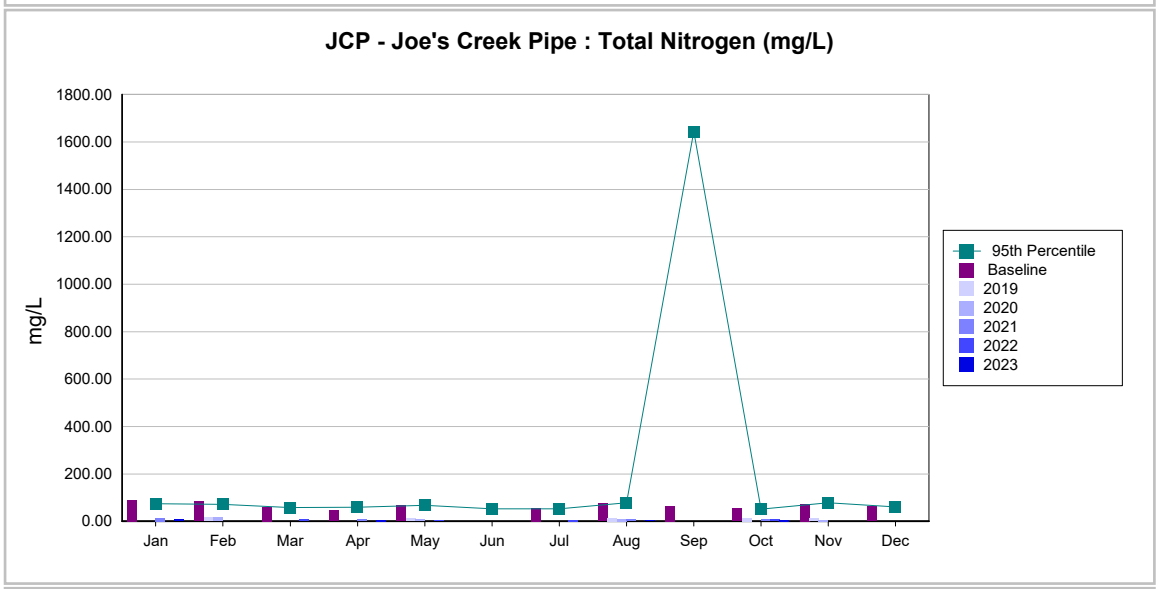
Annual Report Drainage Water

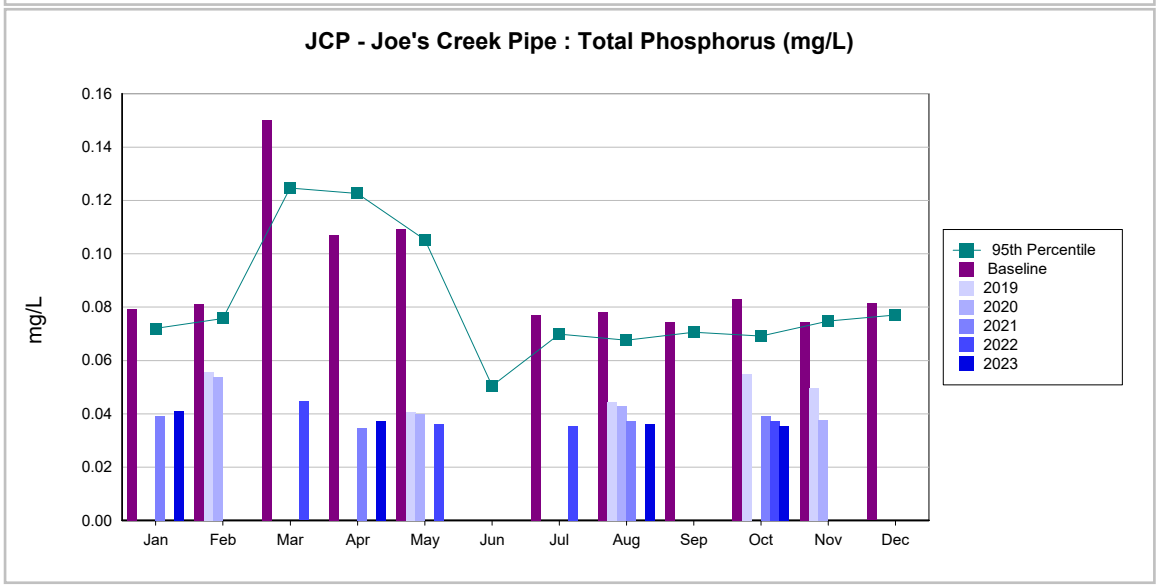
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







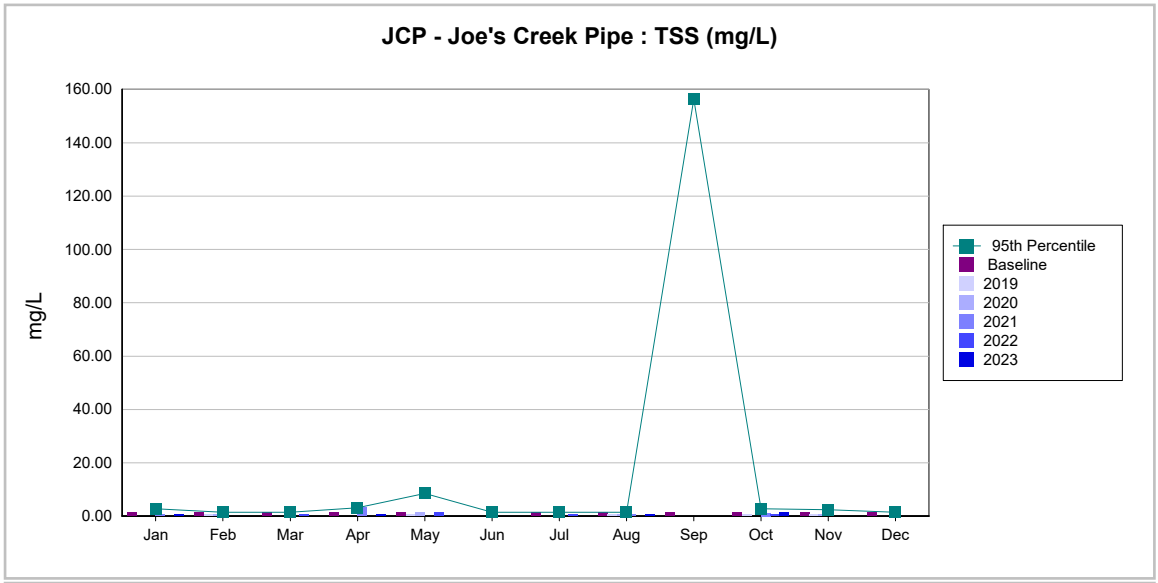
Water Quality Report

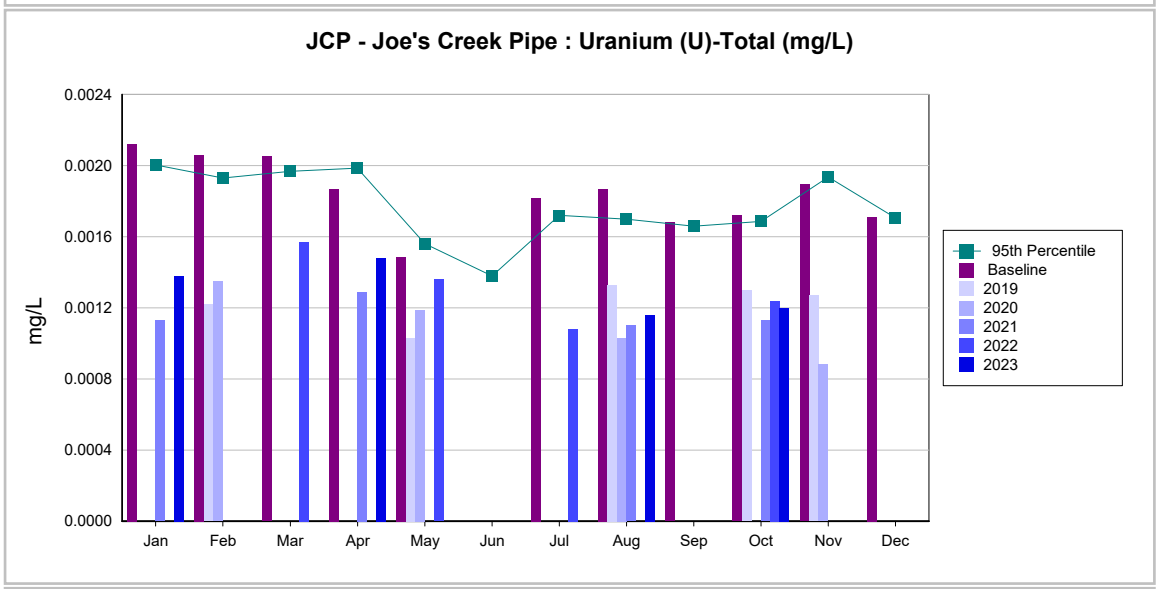
Annual Report Drainage Water

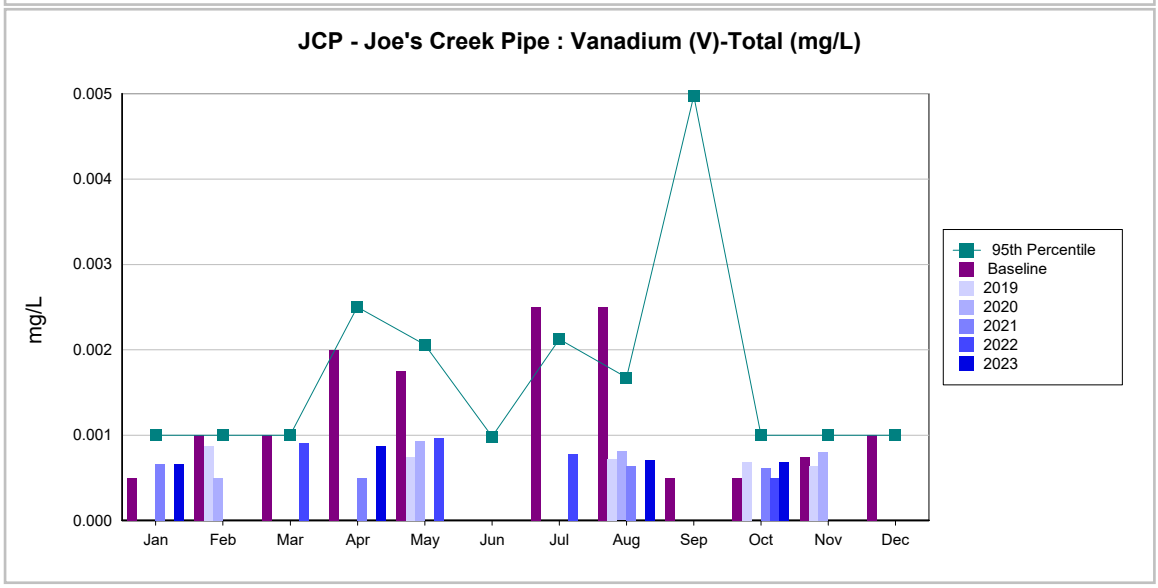
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

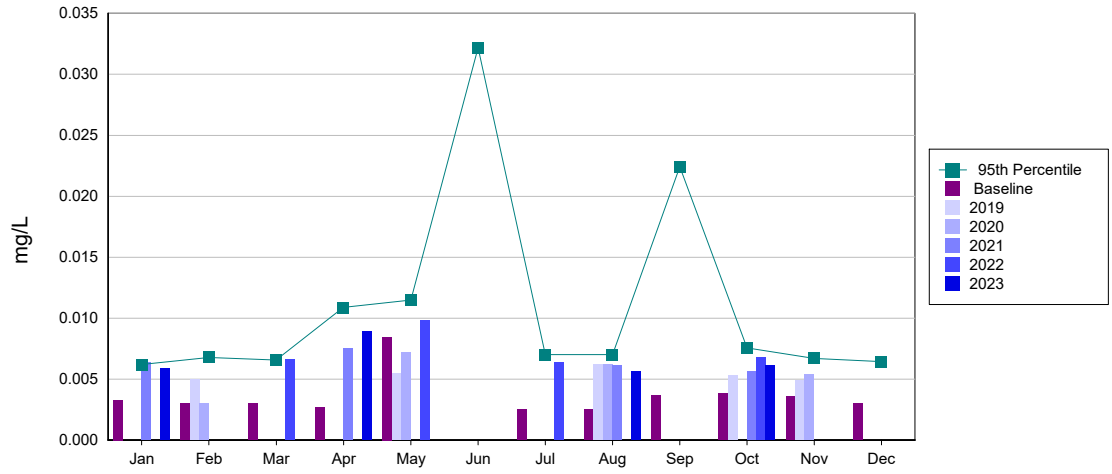
Annual Report Drainage Water

Mount Polley

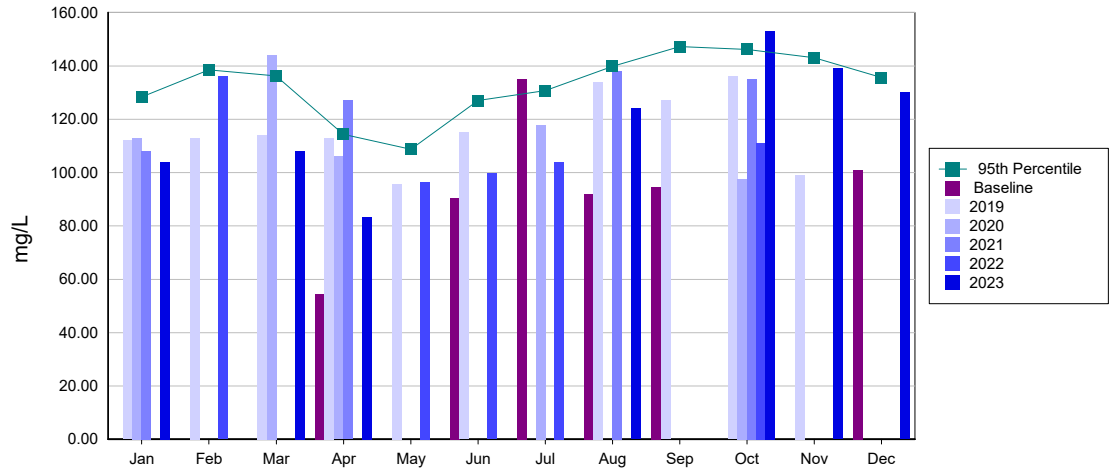
Mining Corporation

IMPERIAL METALS CORPORATION

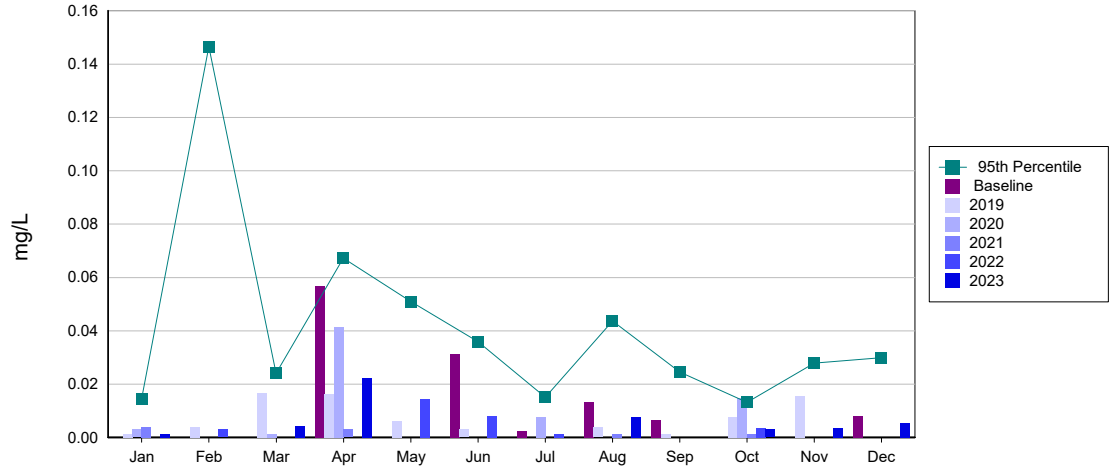
JCP - Joe's Creek Pipe : Zinc (Zn)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Alkalinity (CaCO3) (mg/L)



LD - Long Ditch at Pipe Outlet : Aluminum (Al)-Diss (mg/L)



Water Quality Report

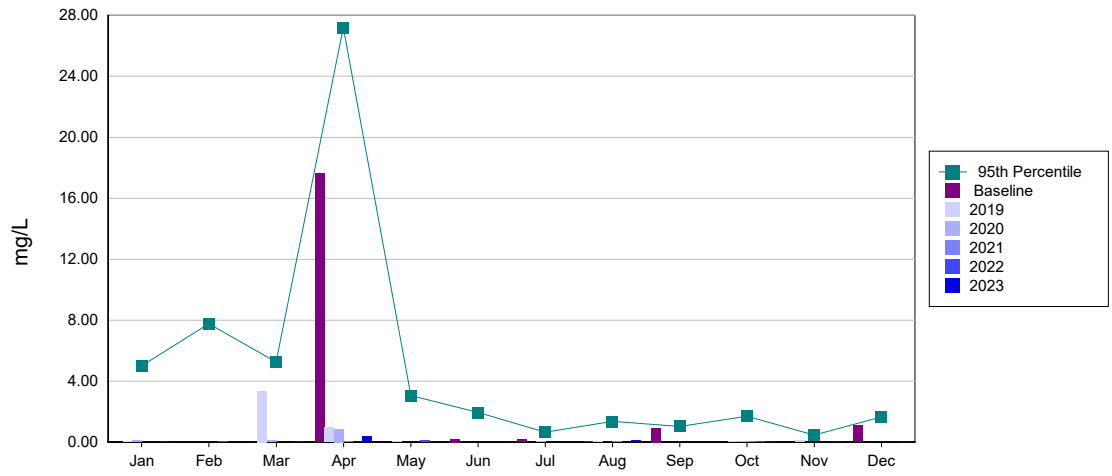
Annual Report Drainage Water

Mount Polley

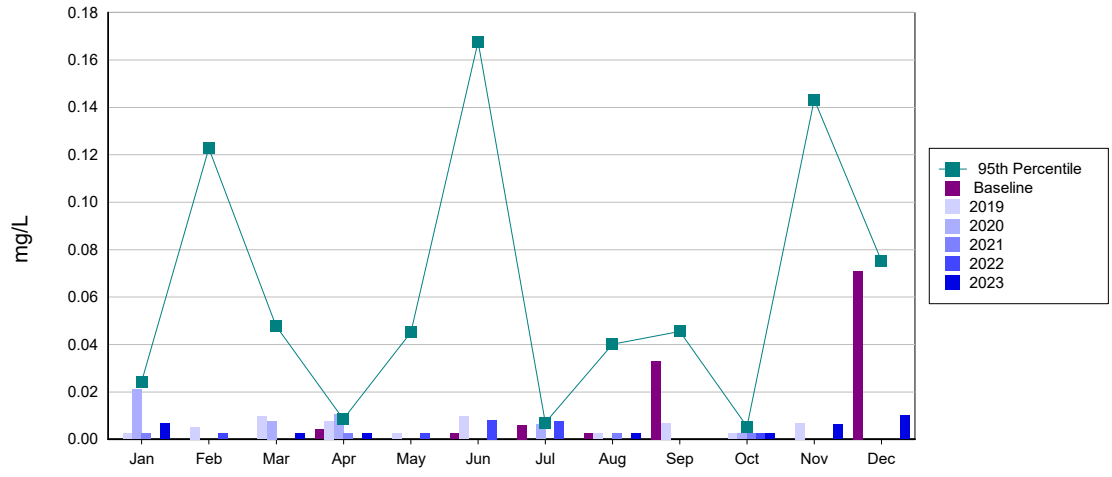
Mining Corporation

IMPERIAL METALS CORPORATION

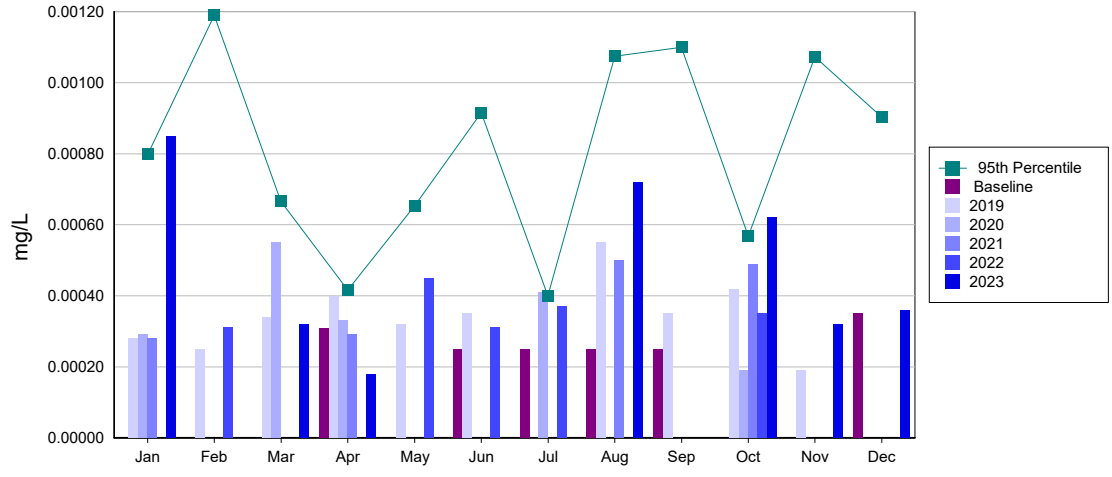
LD - Long Ditch at Pipe Outlet : Aluminum (Al)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Ammonia (as N) (mg/L)



LD - Long Ditch at Pipe Outlet : Antimony (Sb)-Total (mg/L)



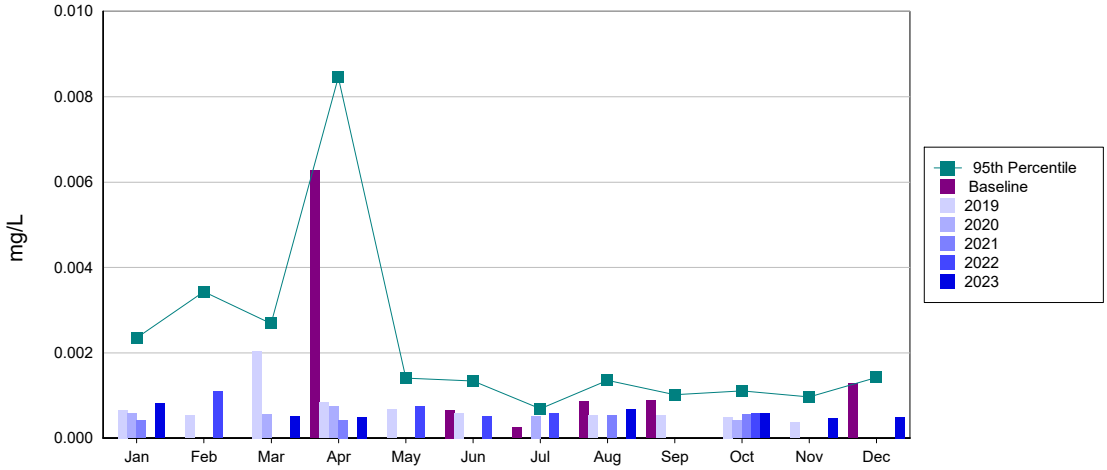
Water Quality Report

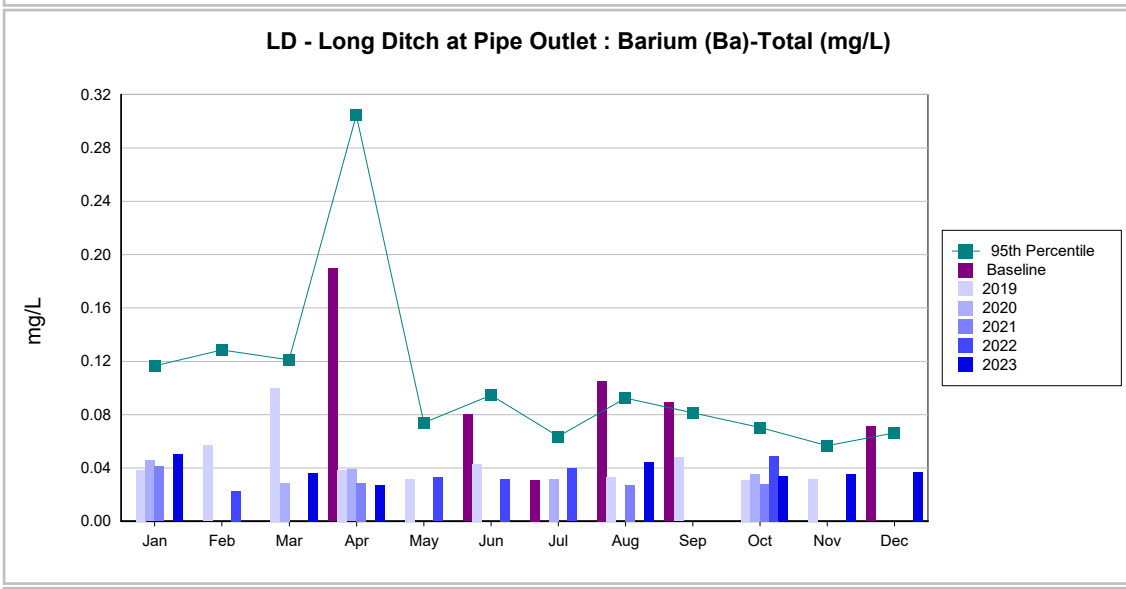
Annual Report Drainage Water

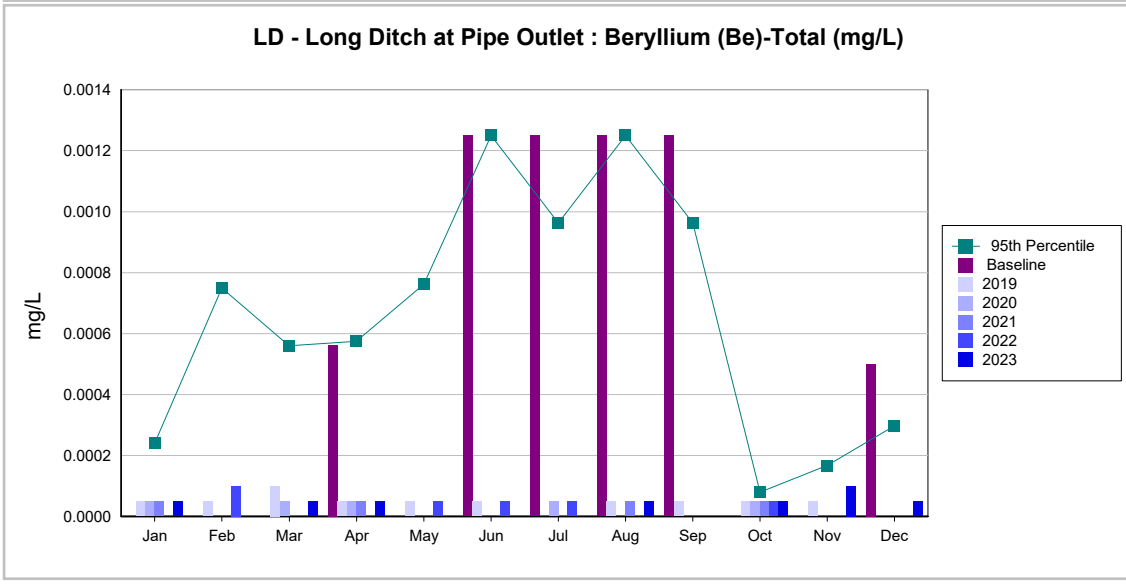
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

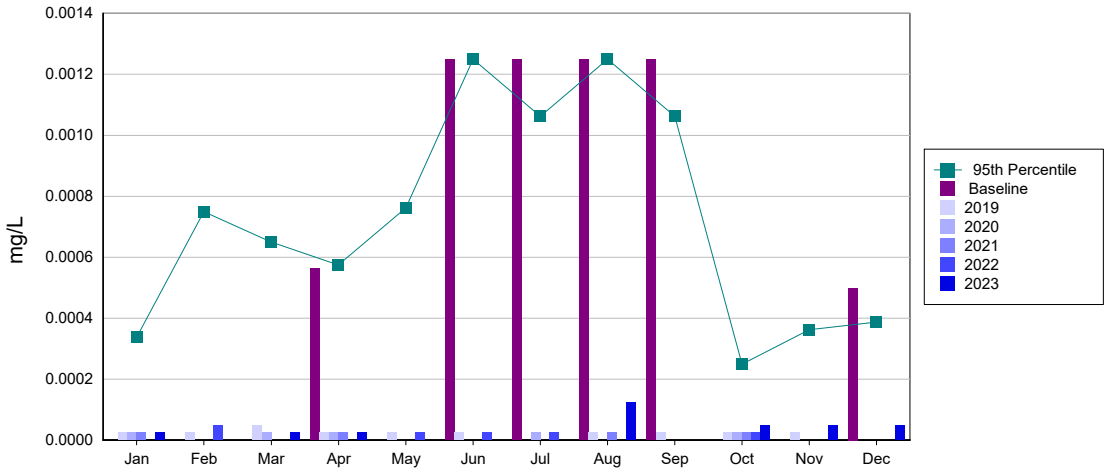
Annual Report Drainage Water

Mount Polley

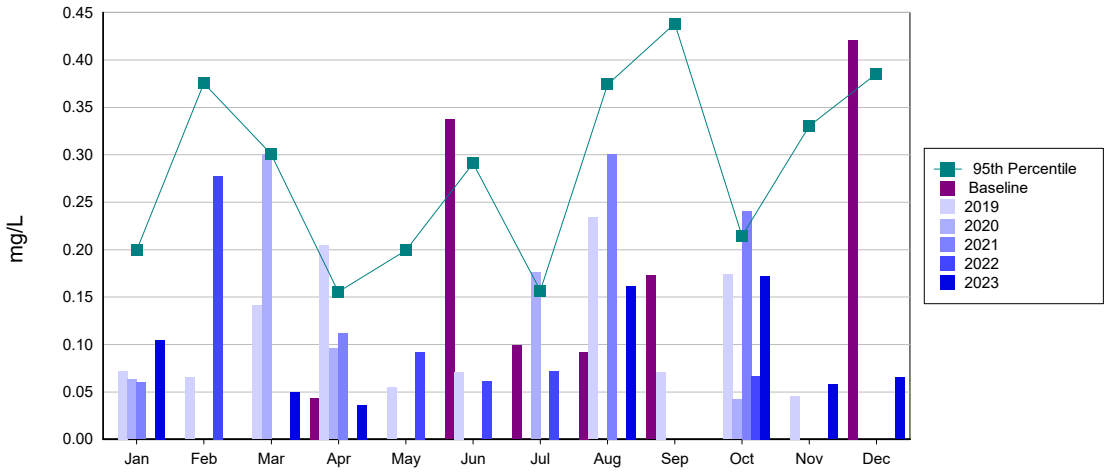
Mining Corporation

IMPERIAL METALS CORPORATION

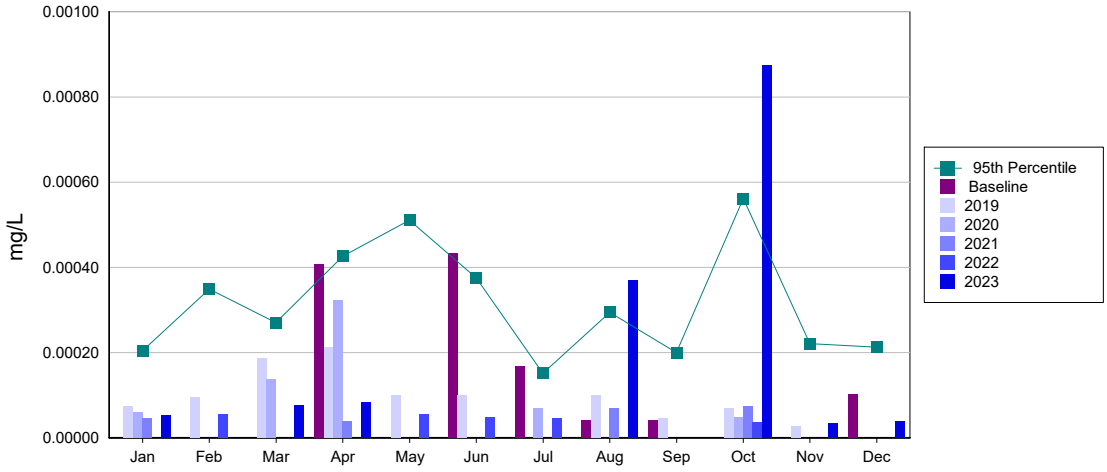
LD - Long Ditch at Pipe Outlet : Bismuth (Bi)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Boron (B)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Cadmium (Cd)-Total (mg/L)



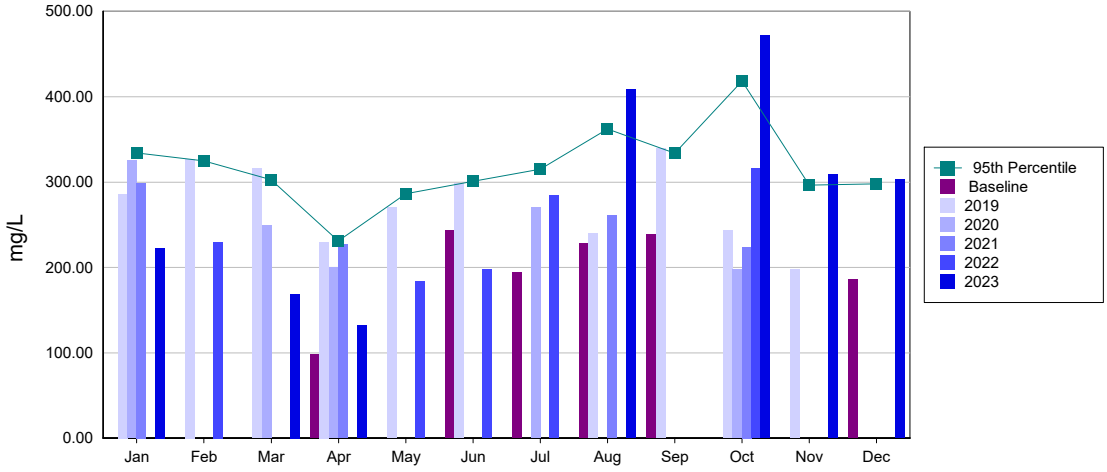
Water Quality Report

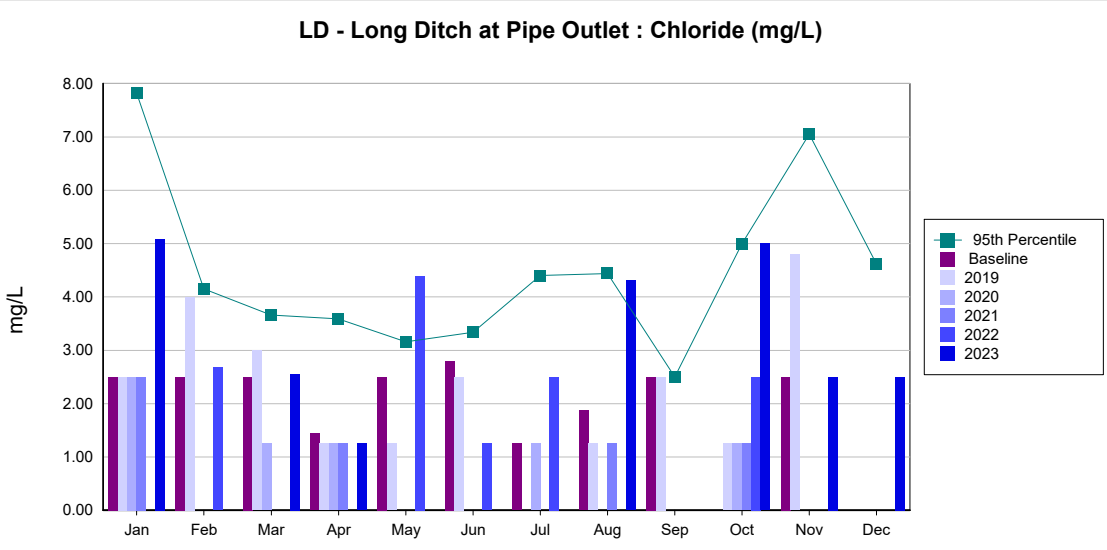
Annual Report Drainage Water

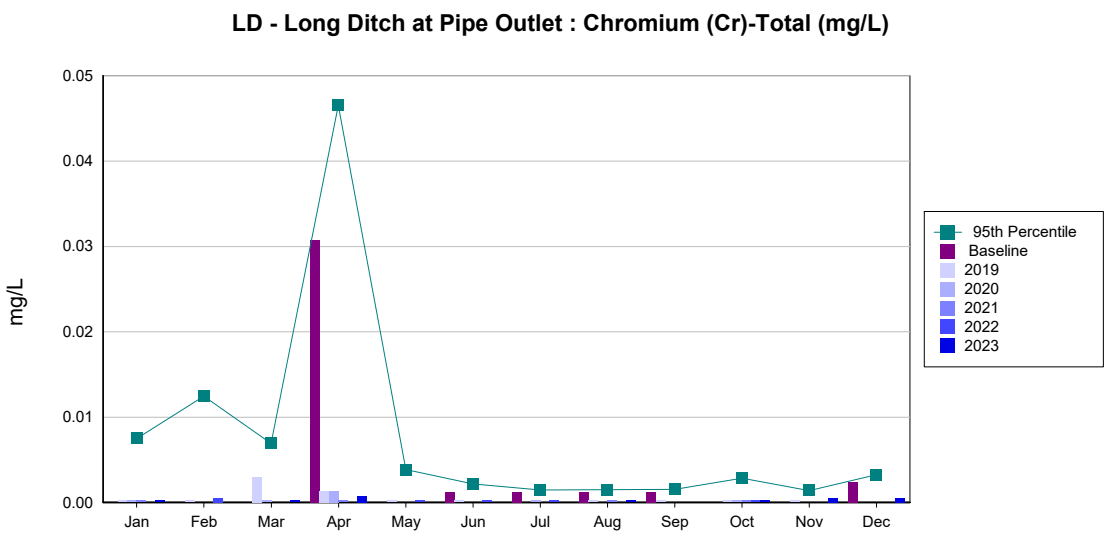
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

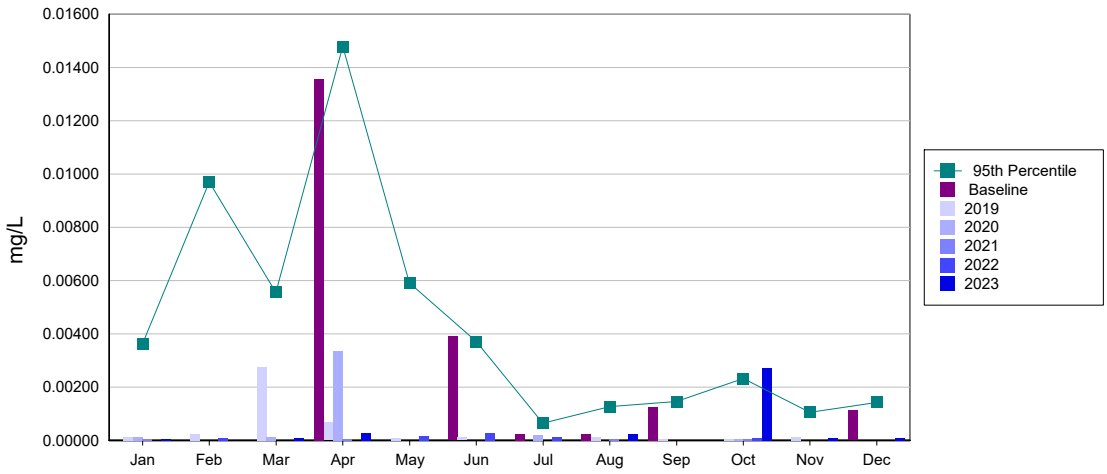
Annual Report Drainage Water

Mount Polley

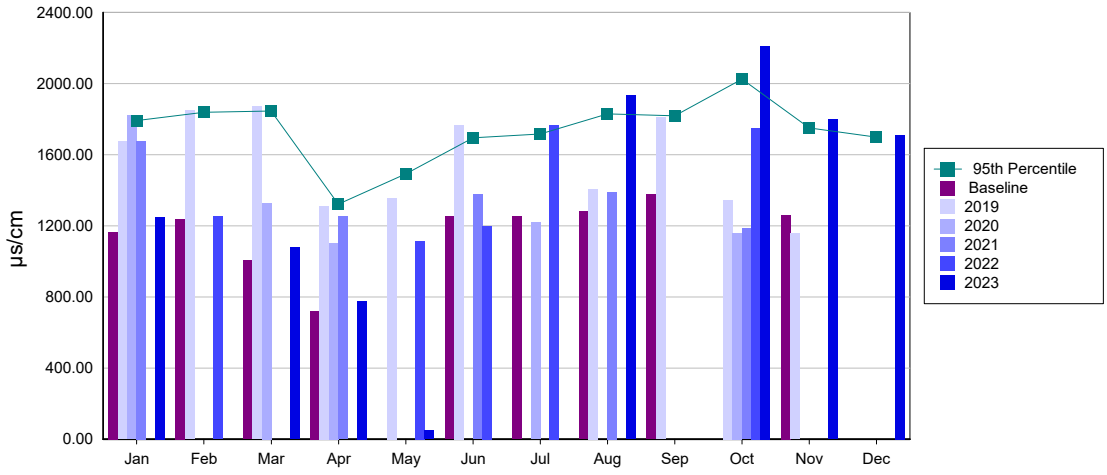
Mining Corporation

IMPERIAL METALS CORPORATION

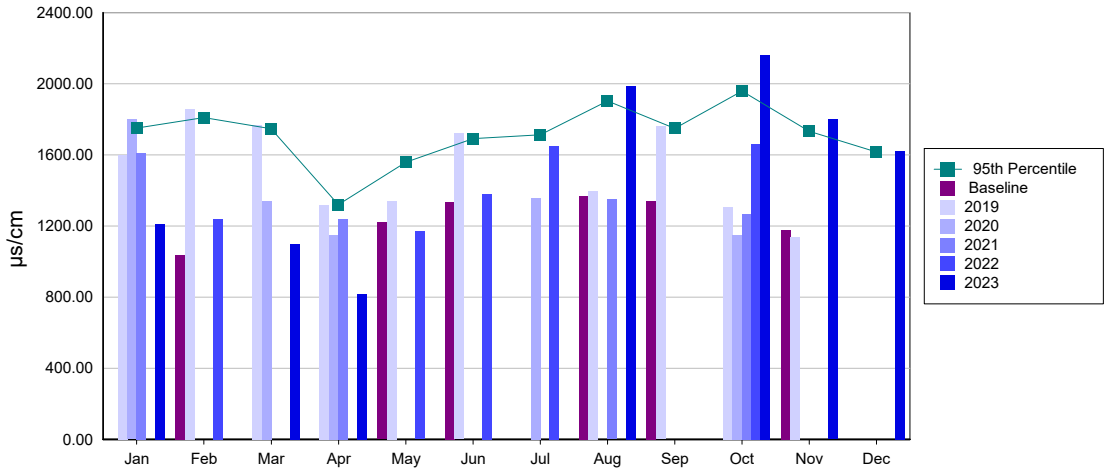
LD - Long Ditch at Pipe Outlet : Cobalt (Co)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Cond (in situ) (µs/cm)



LD - Long Ditch at Pipe Outlet : Conductivity (µs/cm)



Water Quality Report

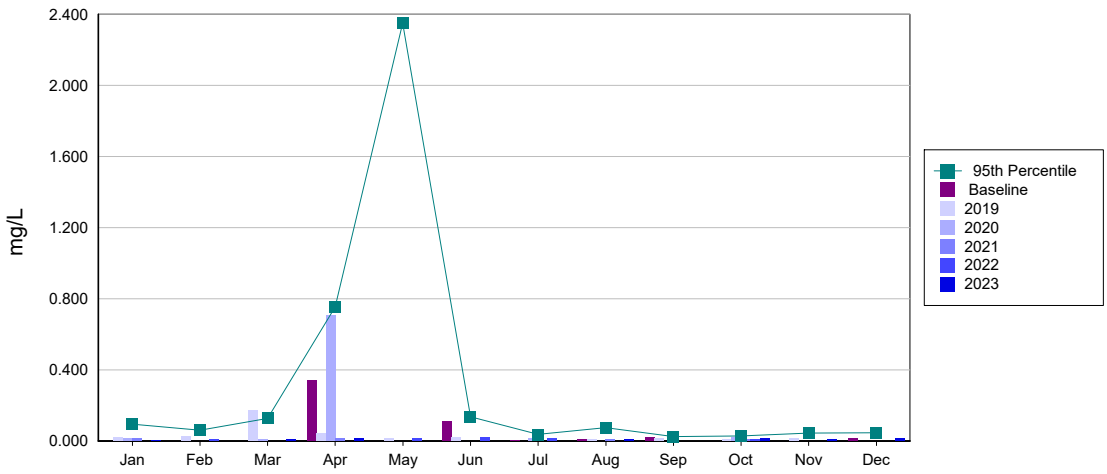
Annual Report Drainage Water

Mount Polley

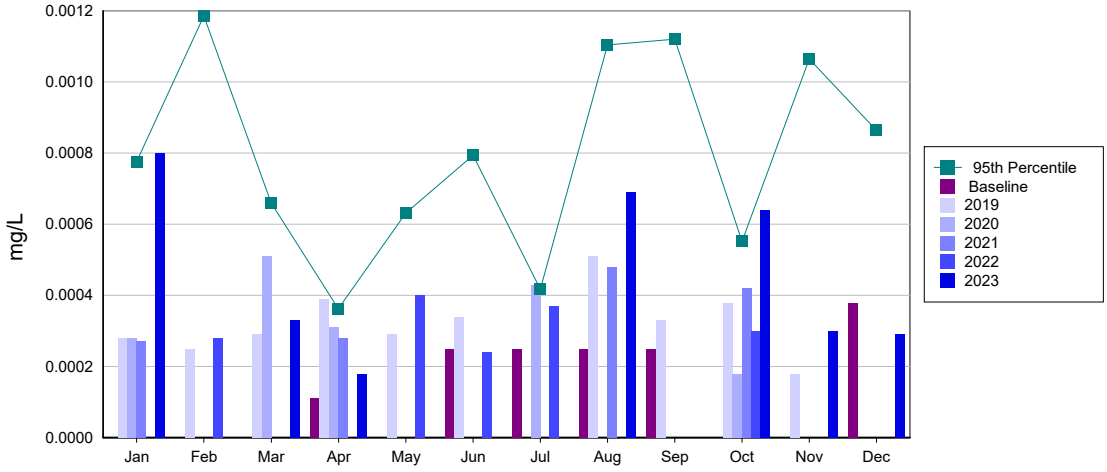
Mining Corporation

IMPERIAL METALS CORPORATION

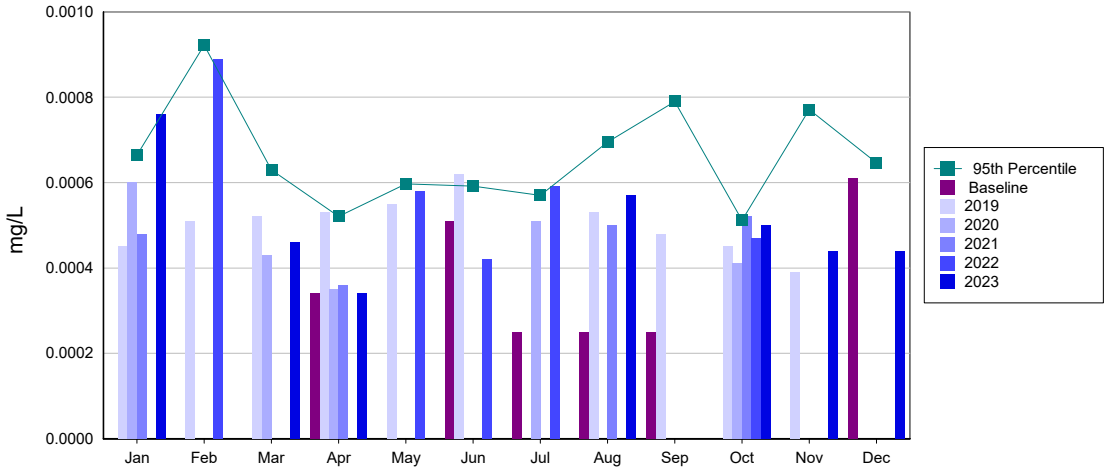
LD - Long Ditch at Pipe Outlet : Copper (Cu)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Antimony (Sb) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Arsenic (As) (mg/L)



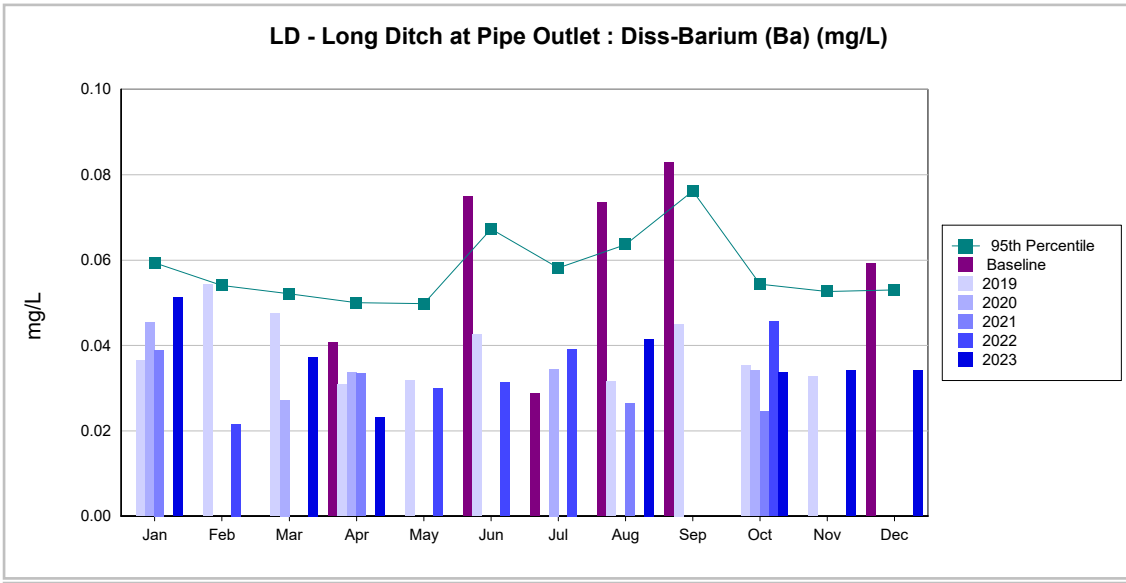
Water Quality Report

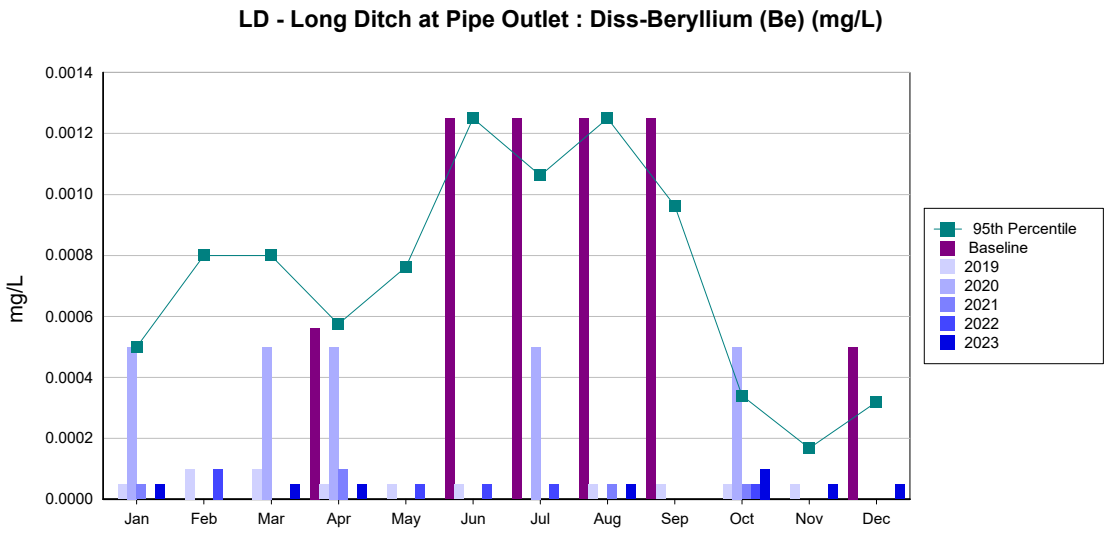
Annual Report Drainage Water

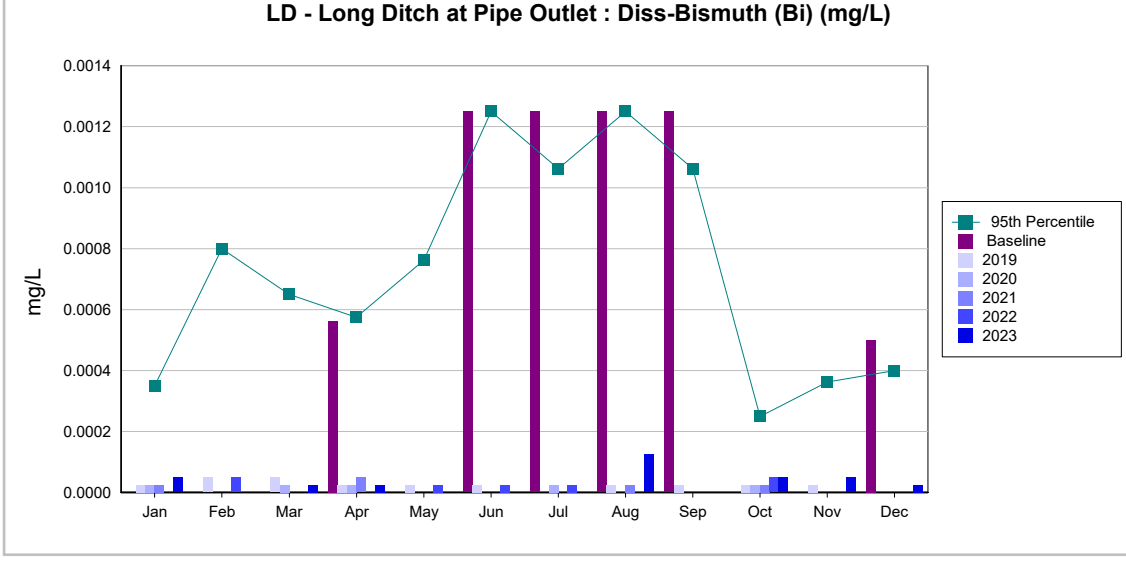
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







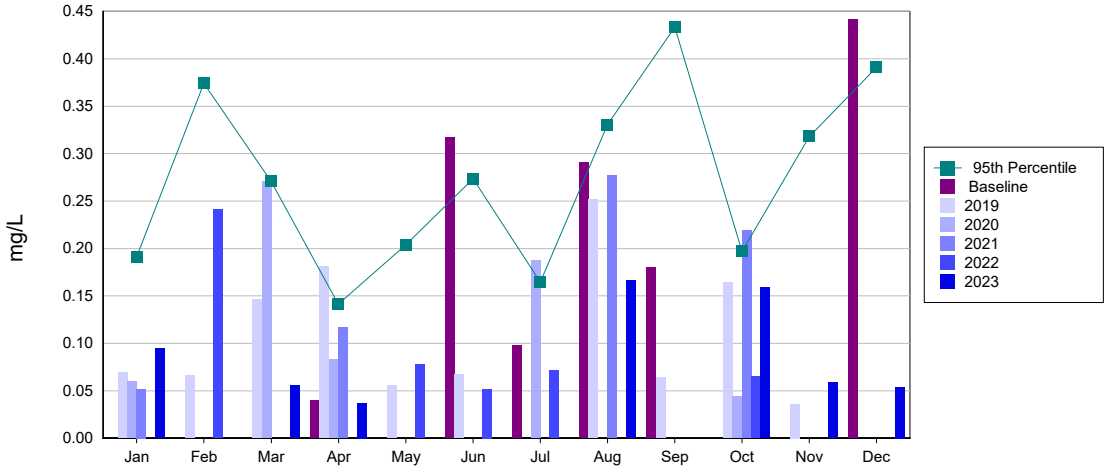
Water Quality Report

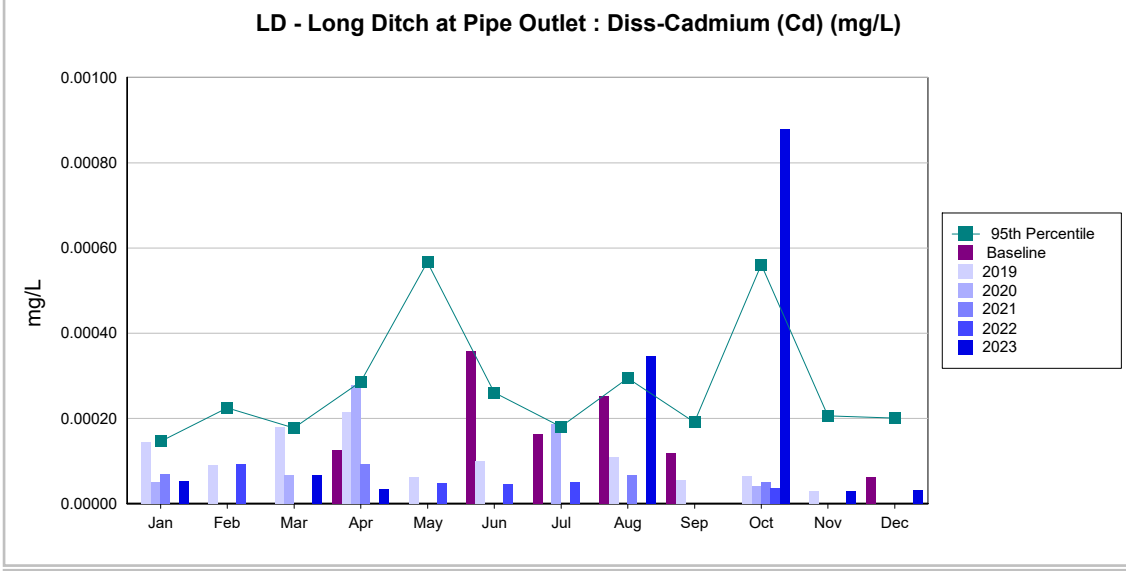
Annual Report Drainage Water

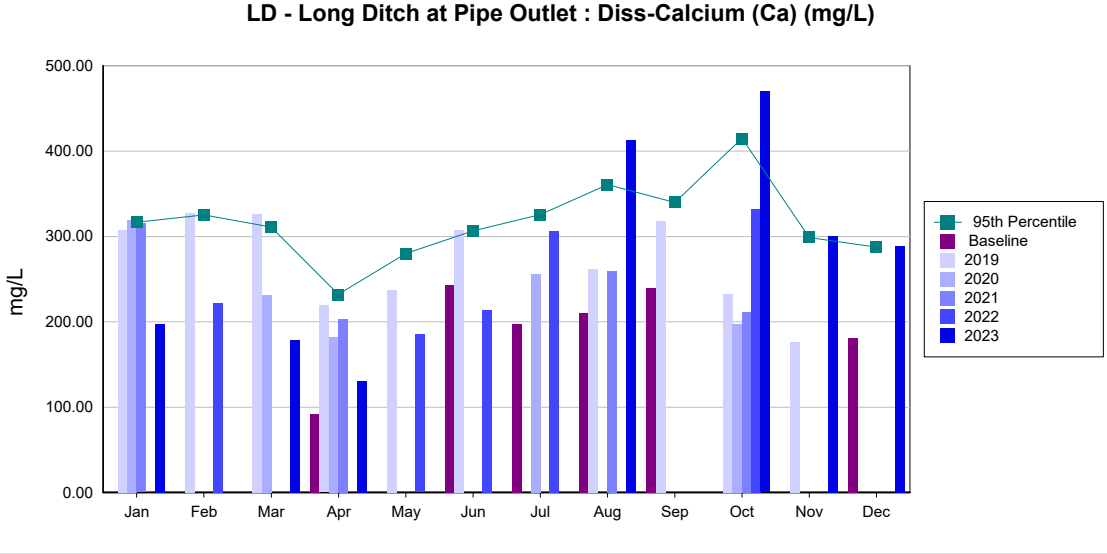
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

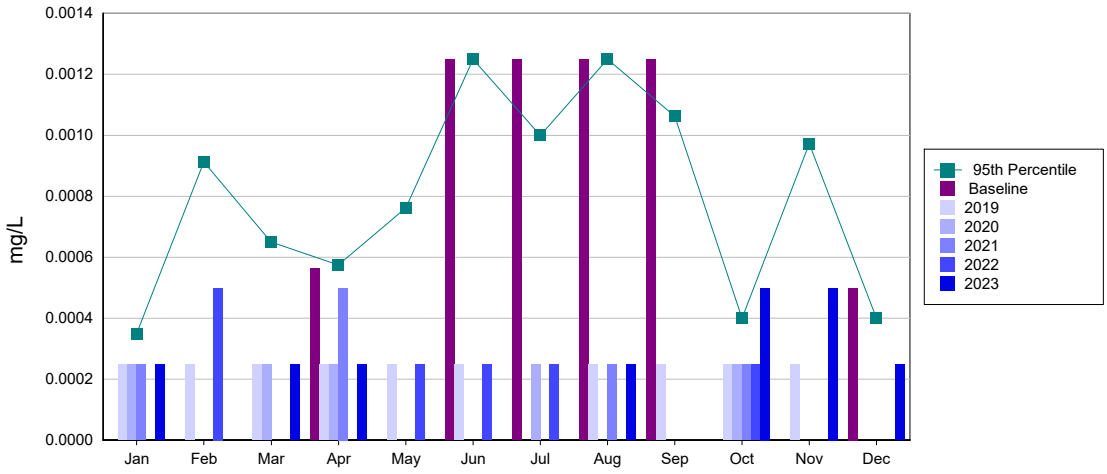
Annual Report Drainage Water

Mount Polley

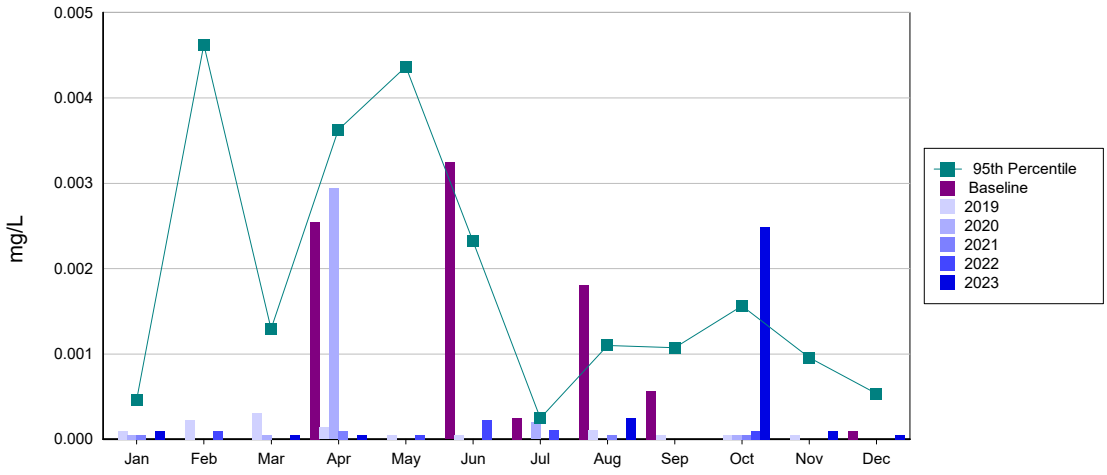
Mining Corporation

IMPERIAL METALS CORPORATION

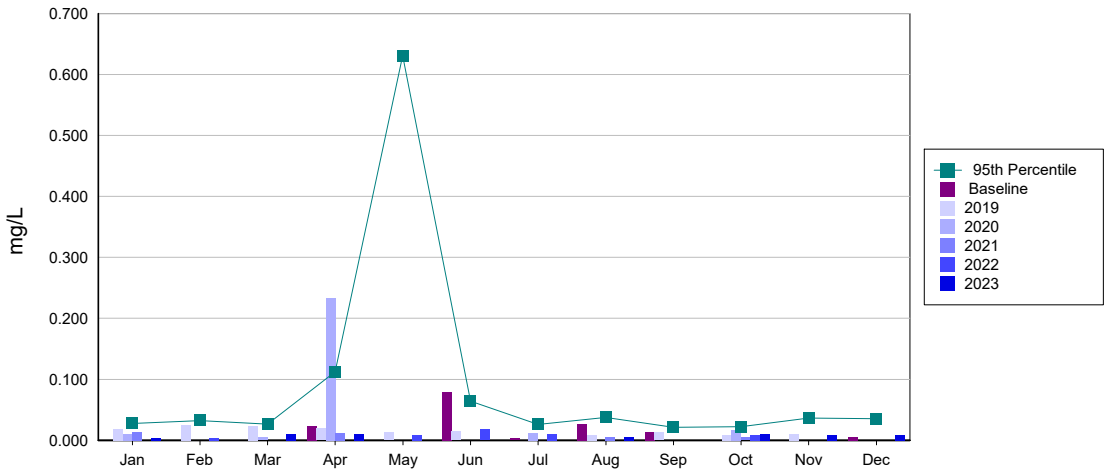
LD - Long Ditch at Pipe Outlet : Diss-Chromium (Cr) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Cobalt (Co) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Copper (Cu) (mg/L)



Water Quality Report

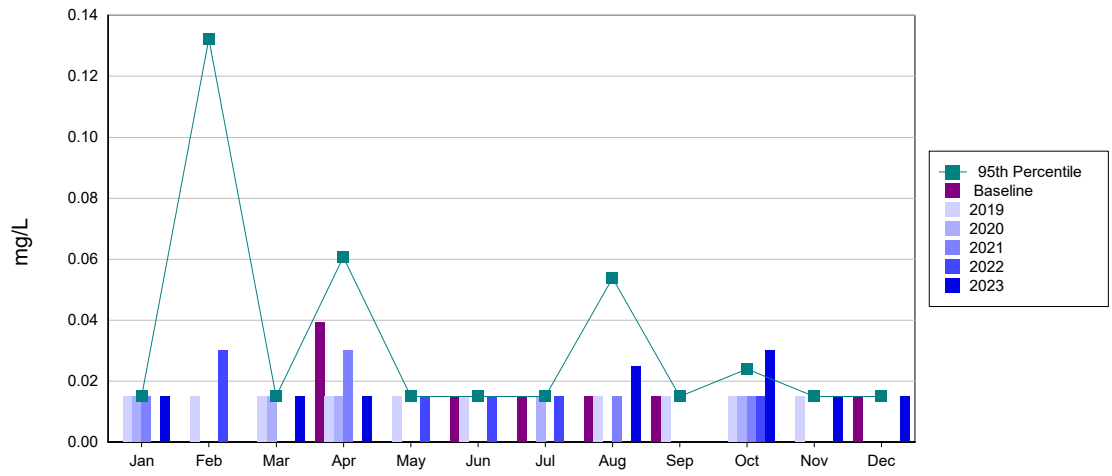
Annual Report Drainage Water

Mount Polley

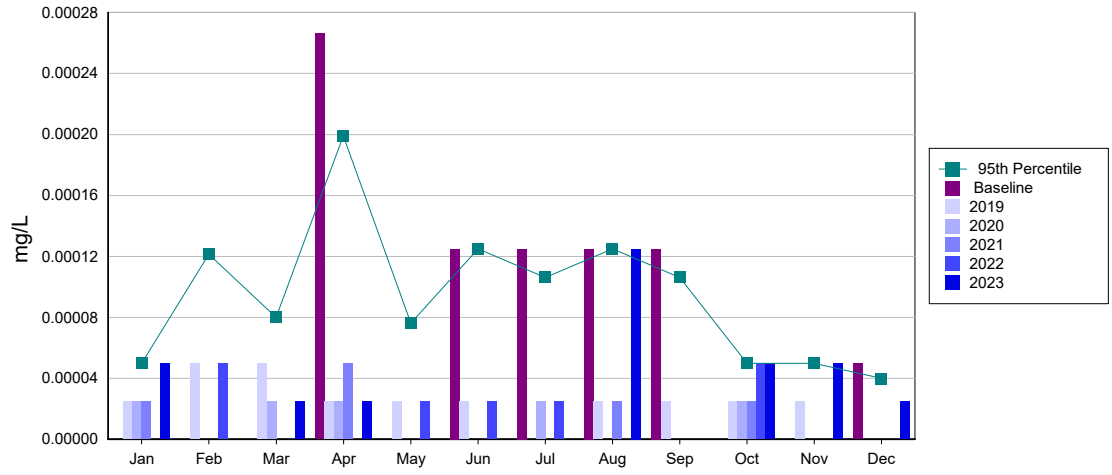
Mining Corporation

IMPERIAL METALS CORPORATION

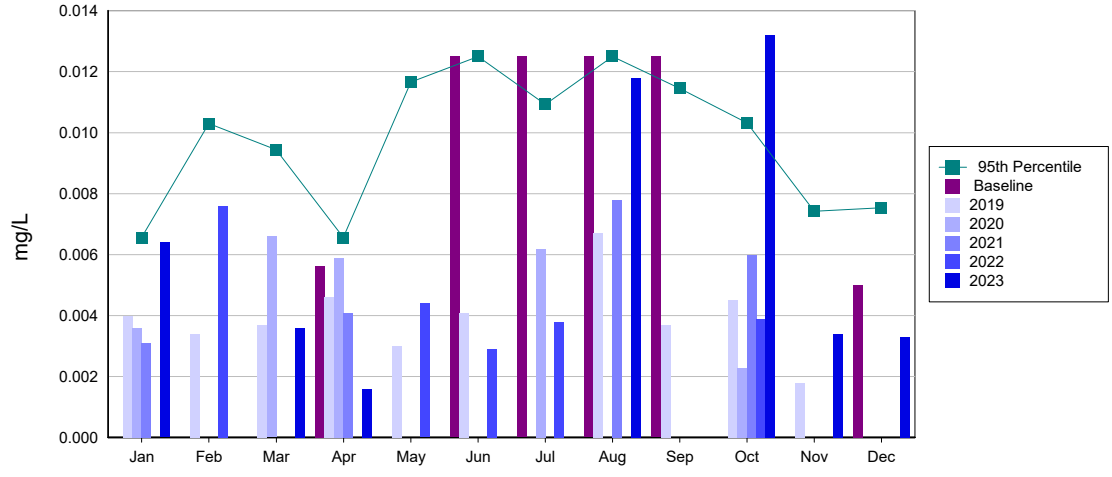
LD - Long Ditch at Pipe Outlet : Diss-Iron (Fe) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Lead (Pb) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Lithium (Li) (mg/L)



Water Quality Report

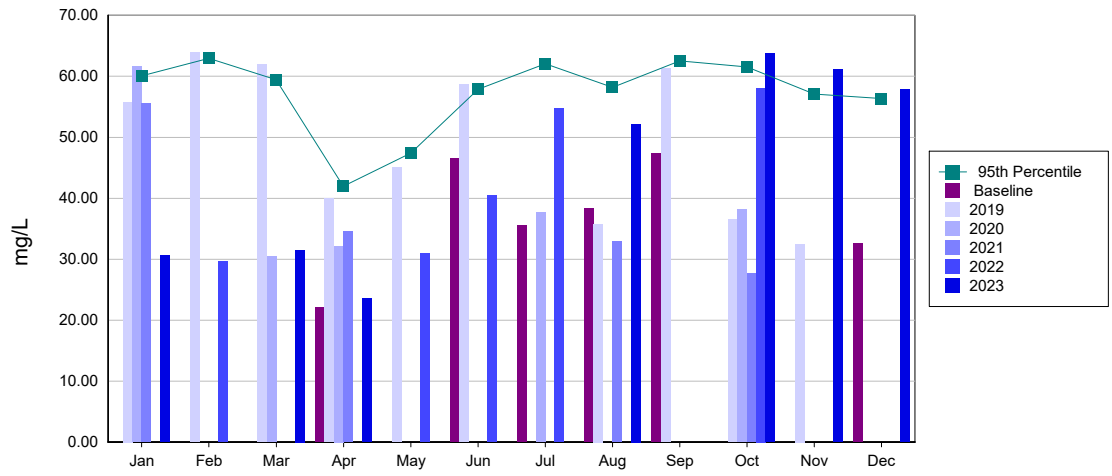
Annual Report Drainage Water

Mount Polley

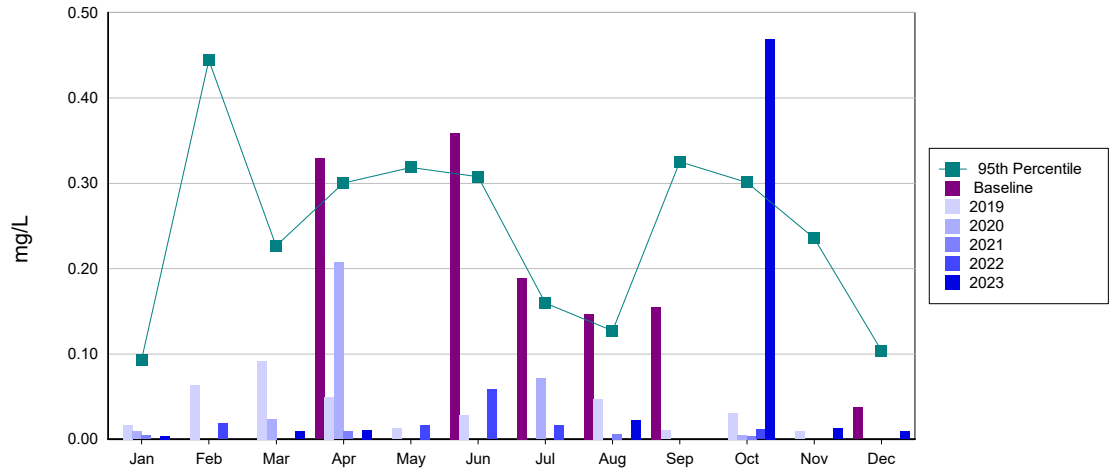
Mining Corporation

IMPERIAL METALS CORPORATION

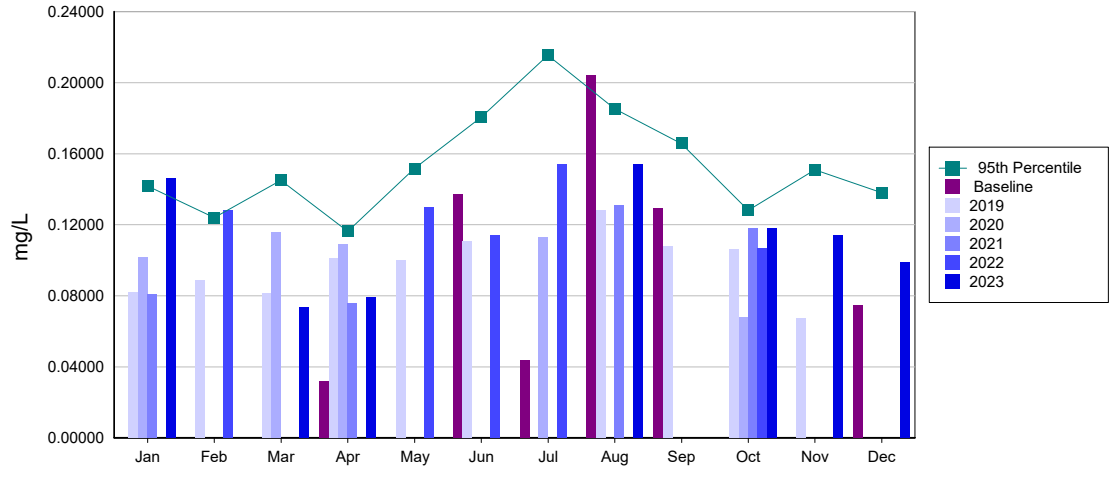
LD - Long Ditch at Pipe Outlet : Diss-Magnesium (Mg) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Manganese (Mn) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Molybdenum (Mo) (mg/L)



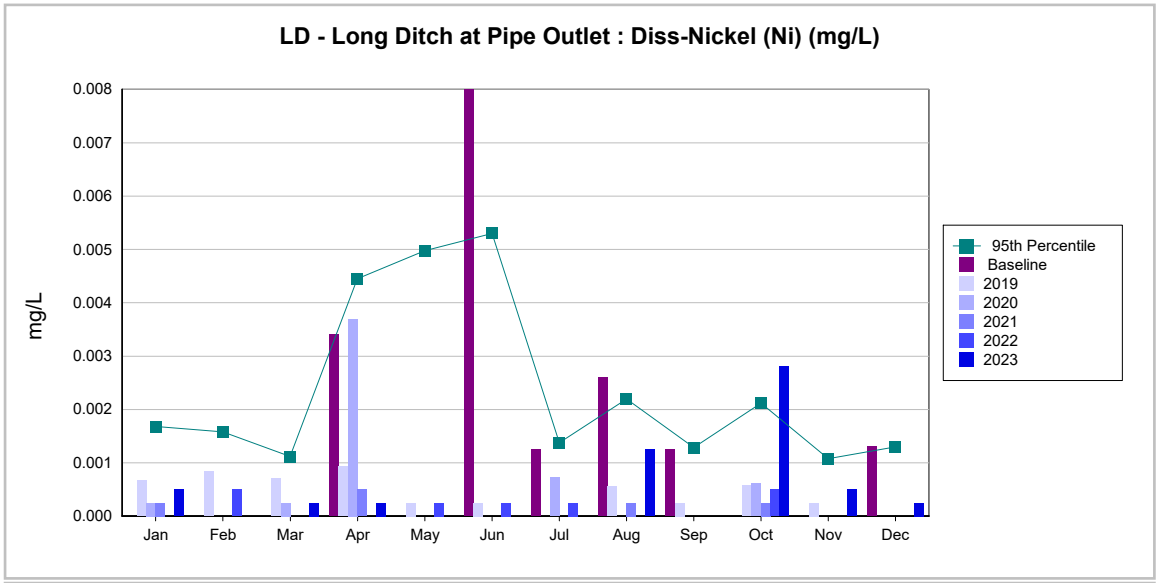
Water Quality Report

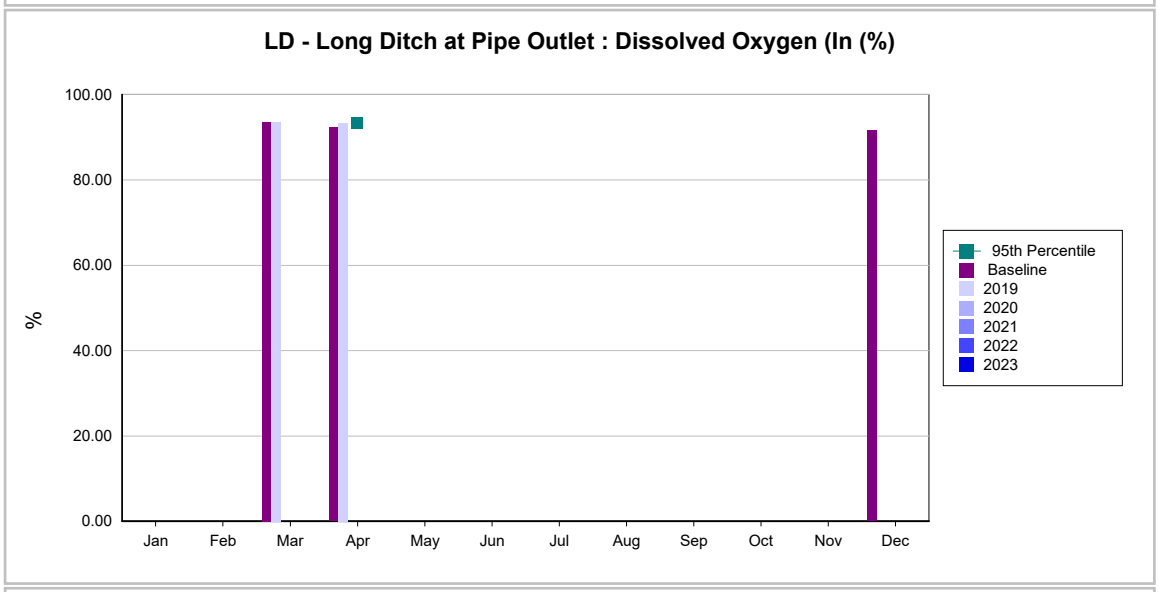
Annual Report Drainage Water

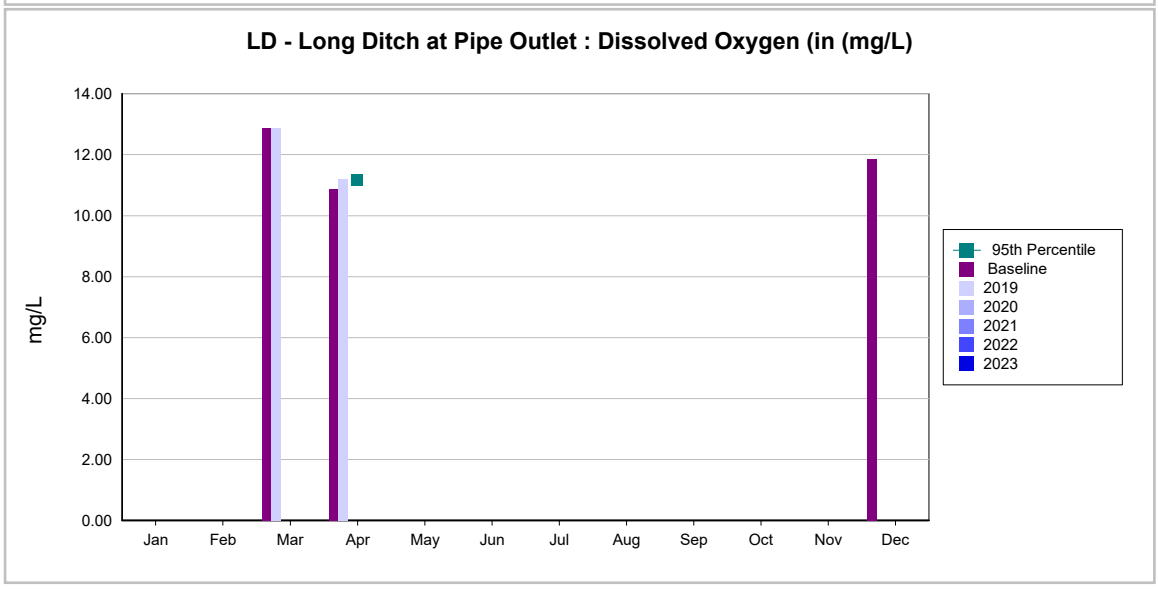
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

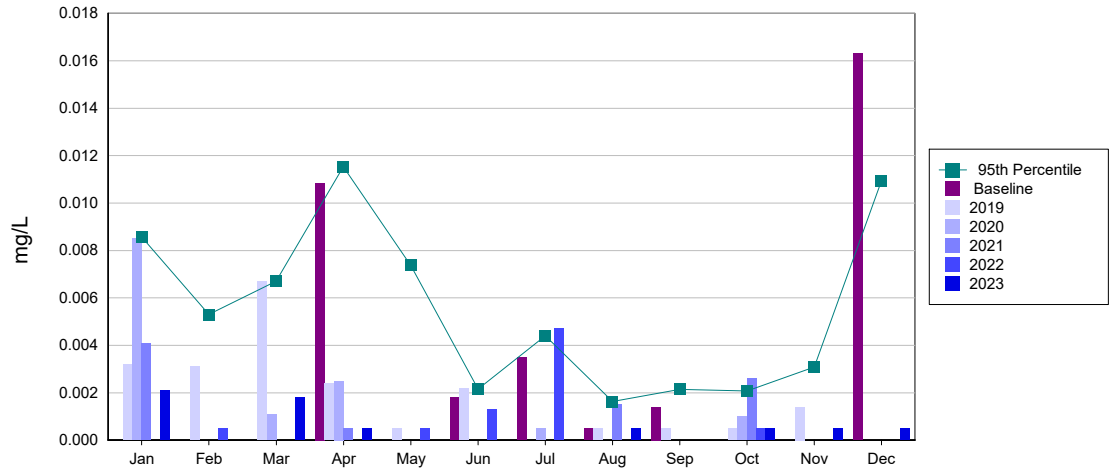
Annual Report Drainage Water

Mount Polley

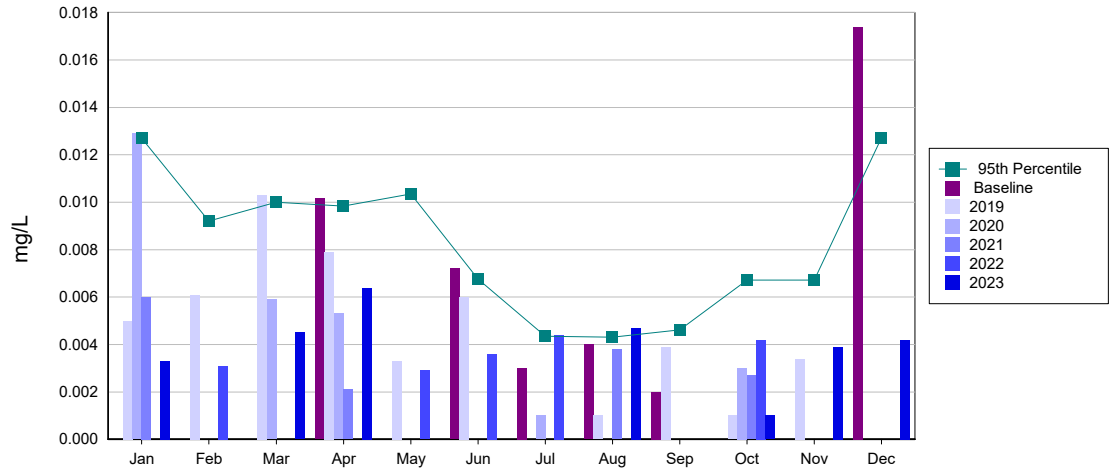
Mining Corporation

IMPERIAL METALS CORPORATION

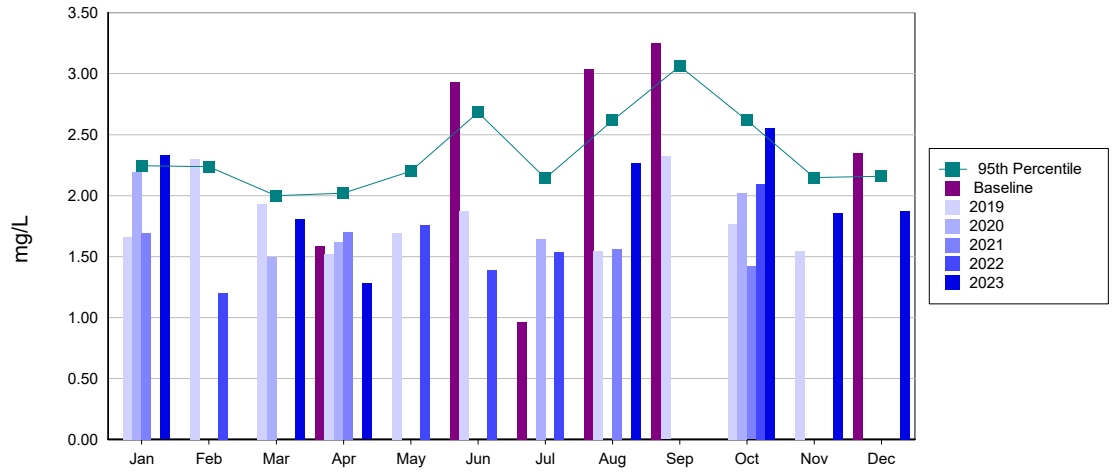
LD - Long Ditch at Pipe Outlet : Diss-Orthophosphate (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Phosphorus (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Potassium (K) (mg/L)



Water Quality Report

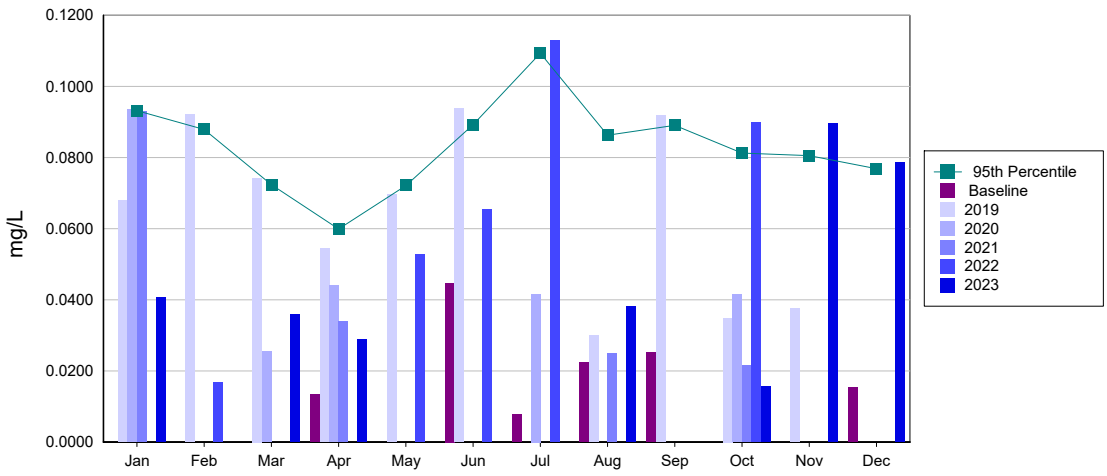
Annual Report Drainage Water

Mount Polley

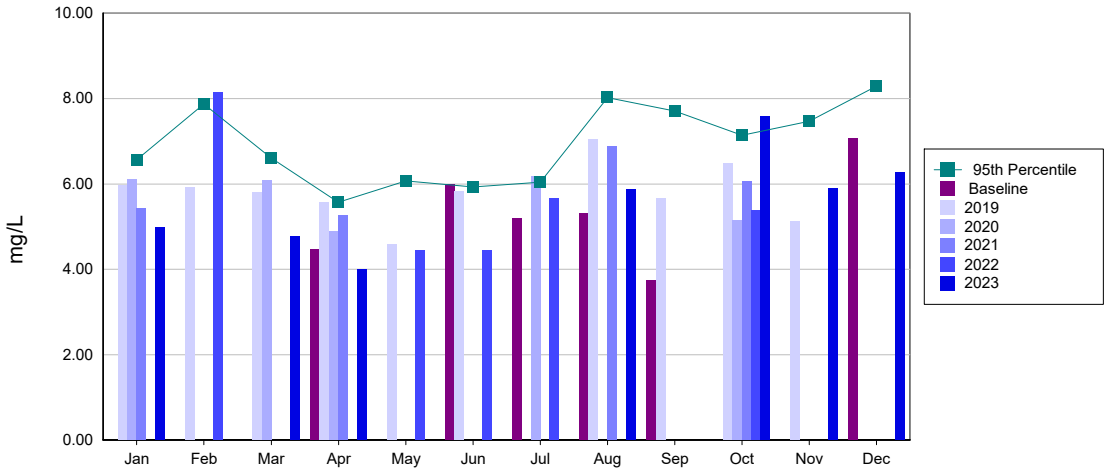
Mining Corporation

IMPERIAL METALS CORPORATION

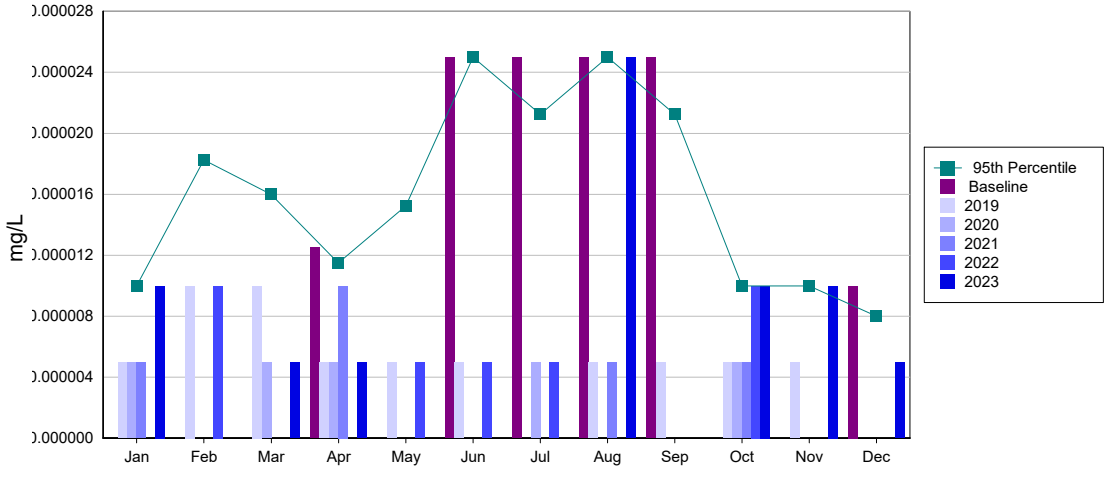
LD - Long Ditch at Pipe Outlet : Diss-Selenium (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Silicon (Si) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Silver (Ag) (mg/L)



Water Quality Report

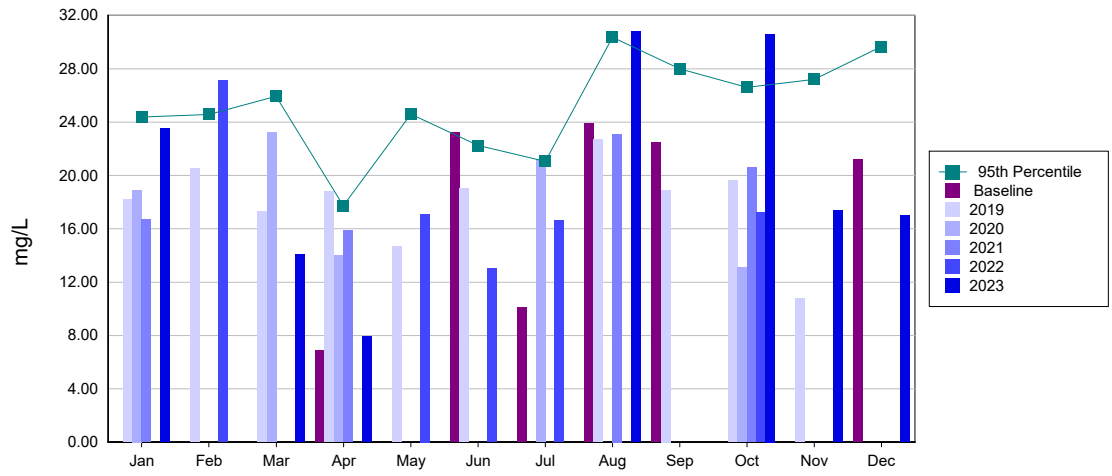
Annual Report Drainage Water

Mount Polley

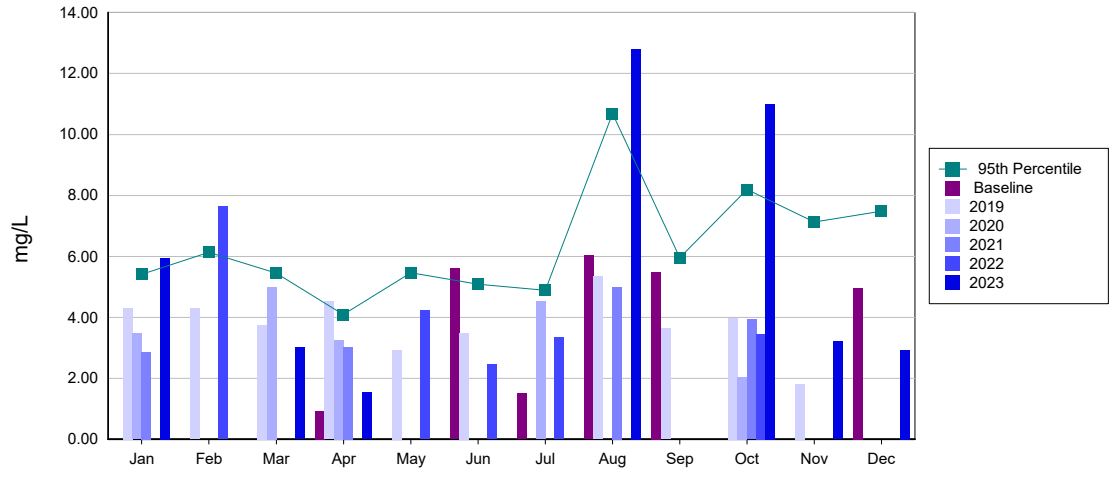
Mining Corporation

IMPERIAL METALS CORPORATION

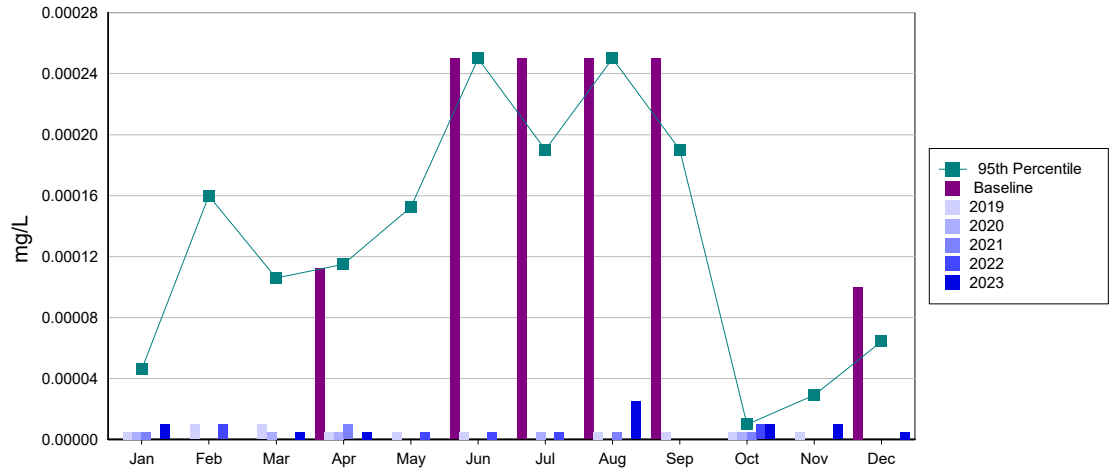
LD - Long Ditch at Pipe Outlet : Diss-Sodium (Na) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Strontium (Sr) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Thallium (Tl) (mg/L)



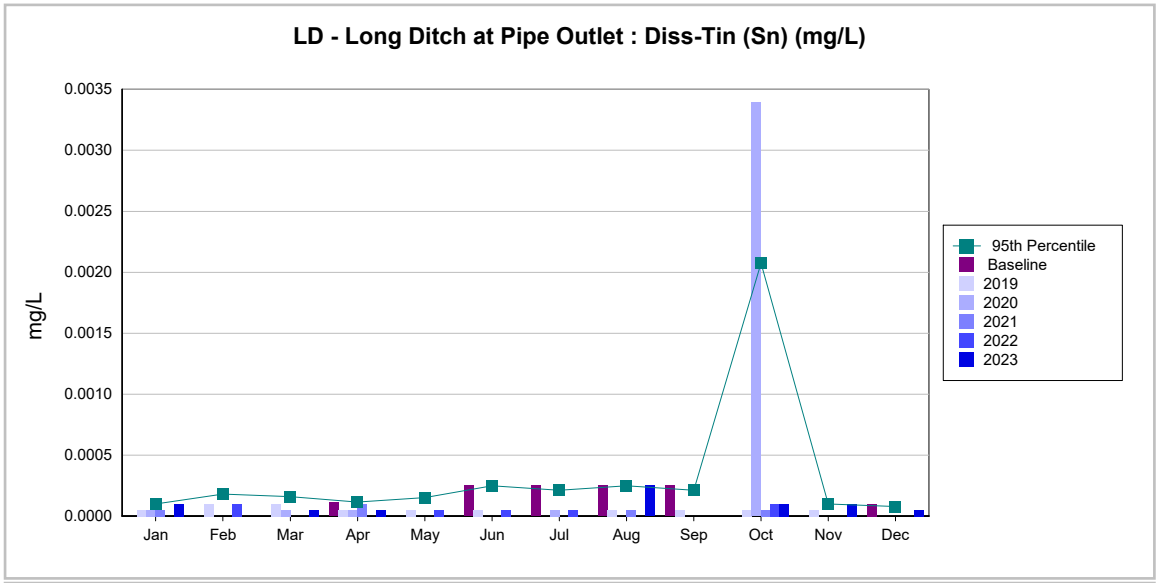
Water Quality Report

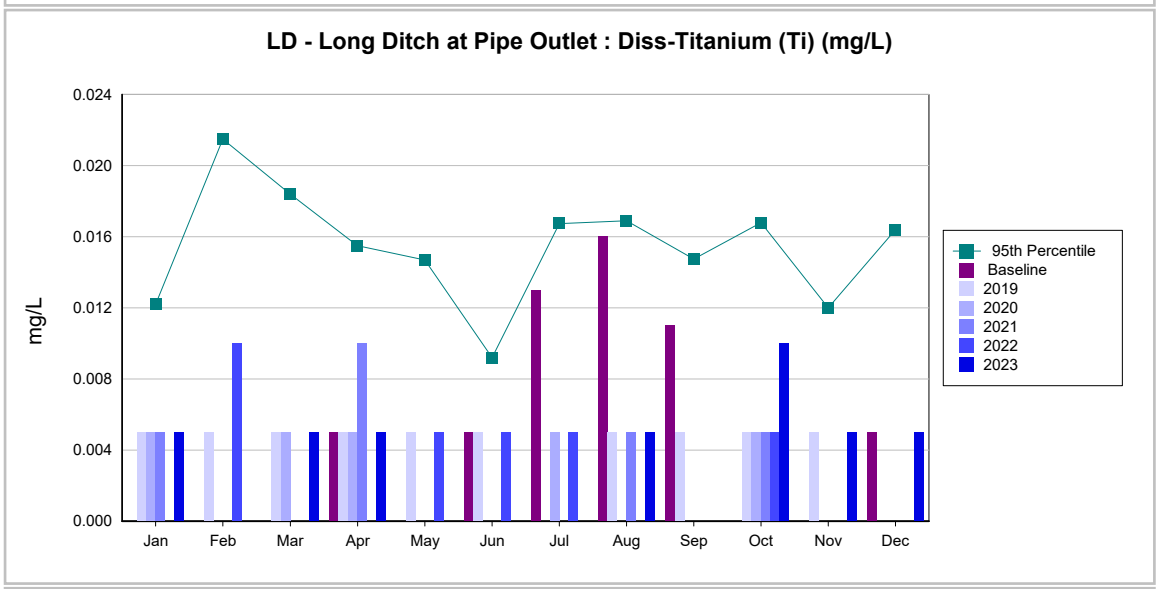
Annual Report Drainage Water

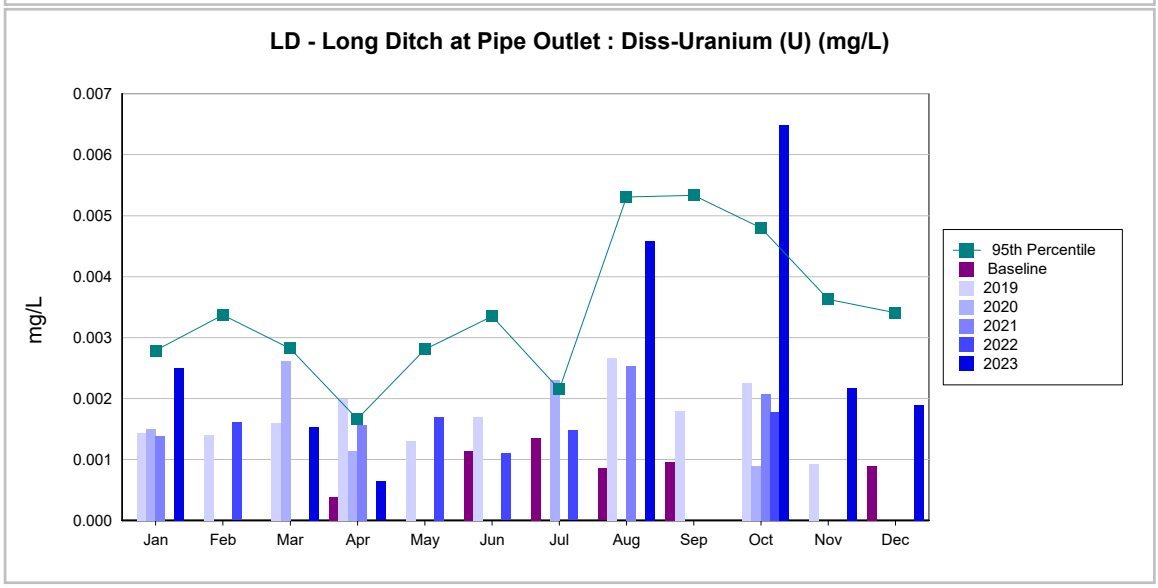
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

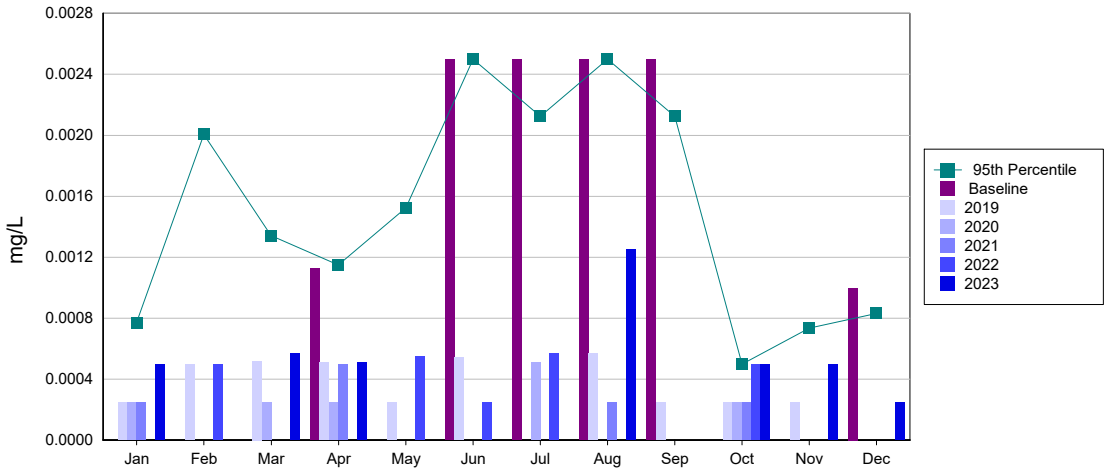
Annual Report Drainage Water

Mount Polley

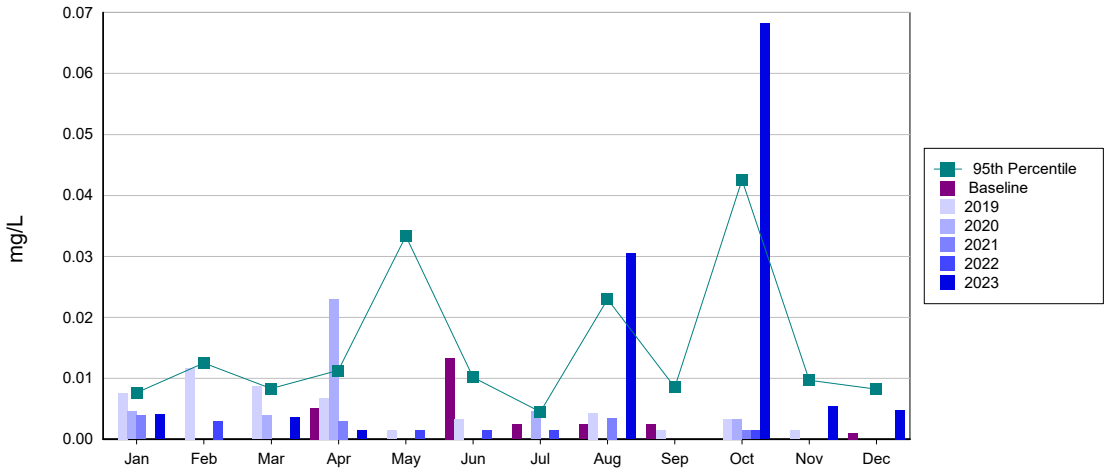
Mining Corporation

IMPERIAL METALS CORPORATION

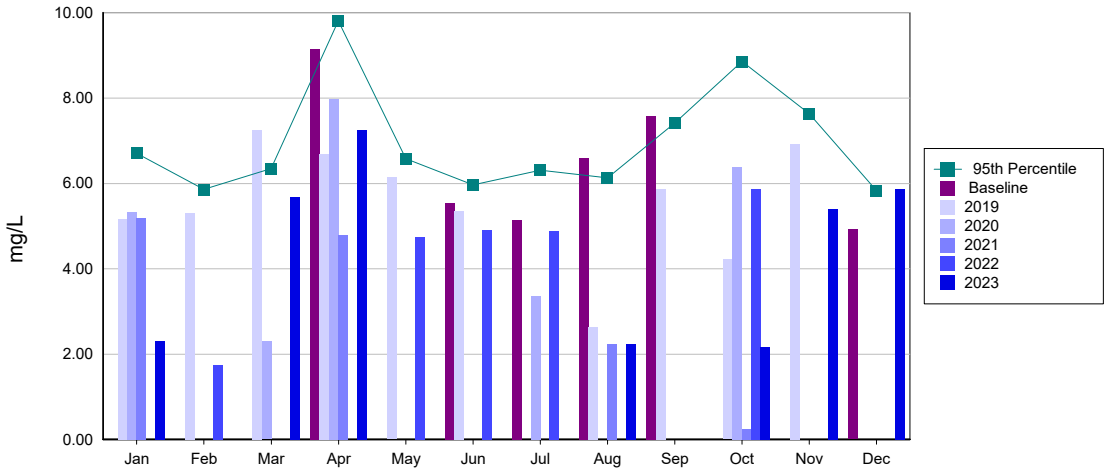
LD - Long Ditch at Pipe Outlet : Diss-Vanadium (V) (mg/L)



LD - Long Ditch at Pipe Outlet : Diss-Zinc (Zn) (mg/L)



LD - Long Ditch at Pipe Outlet : DOC (mg/L)



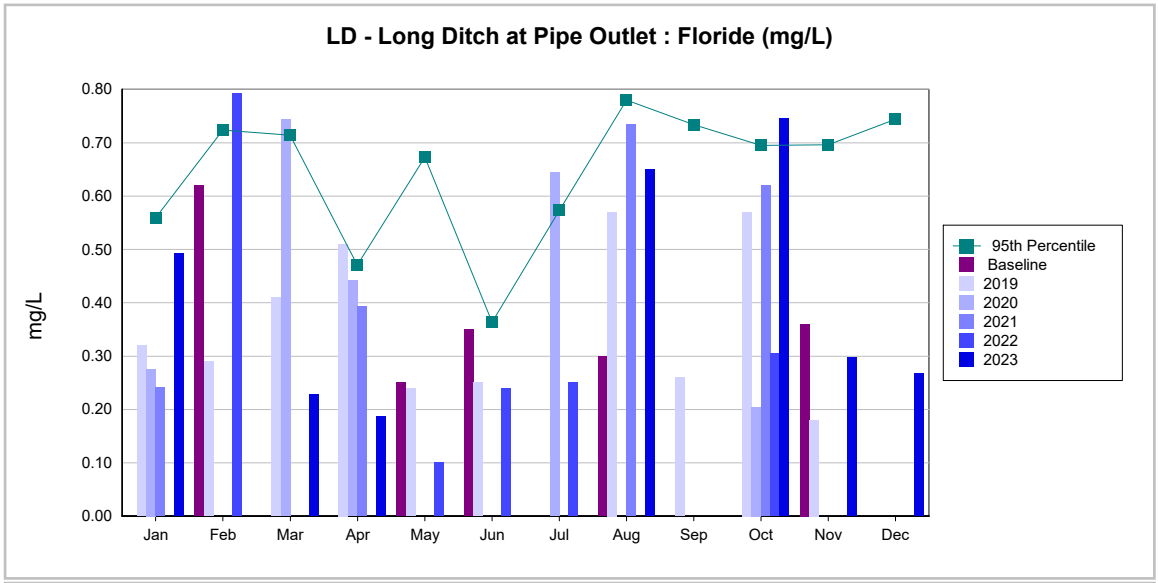
Water Quality Report

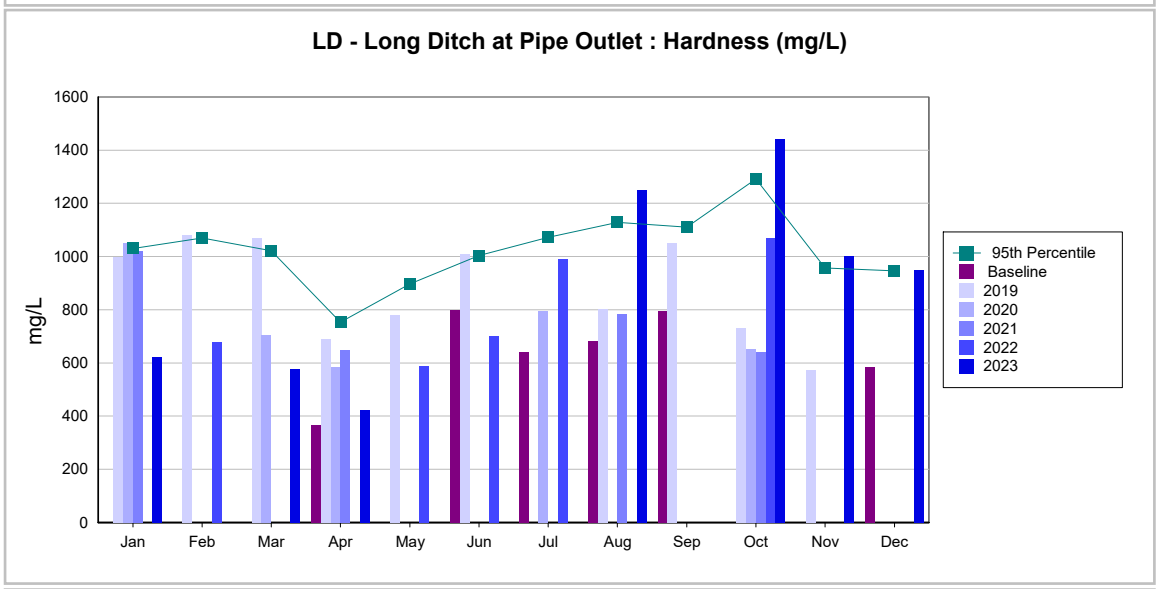
Annual Report Drainage Water

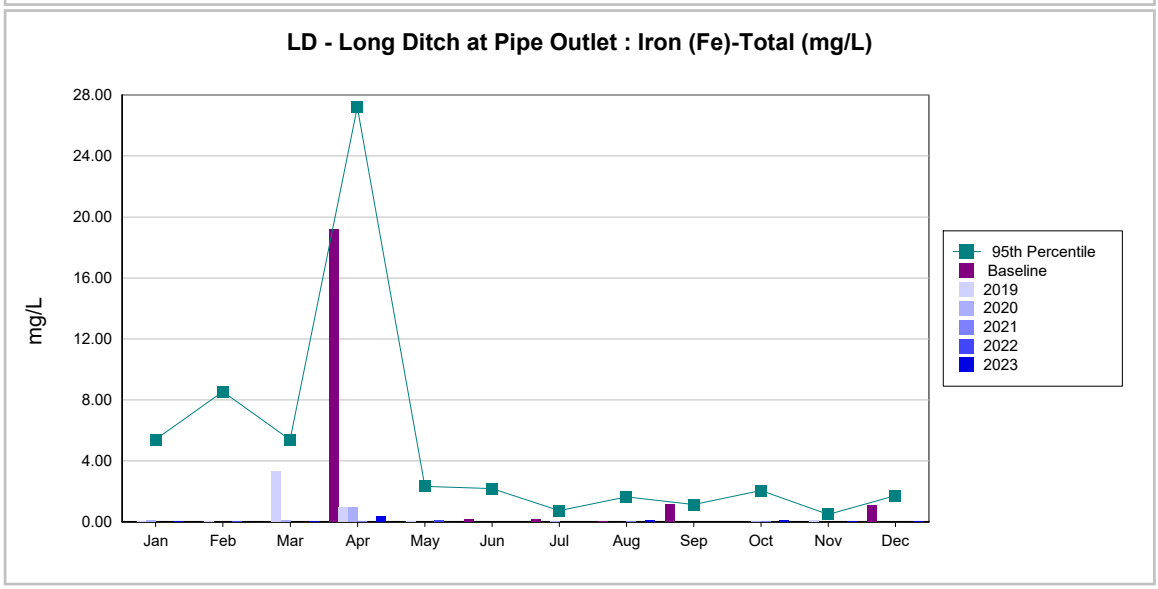
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







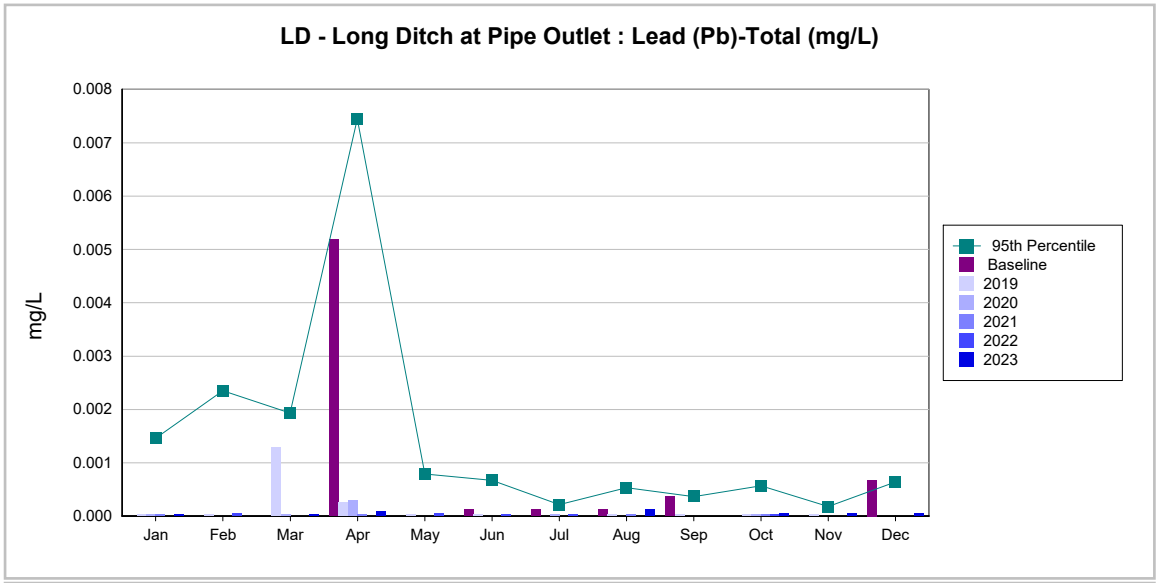
Water Quality Report

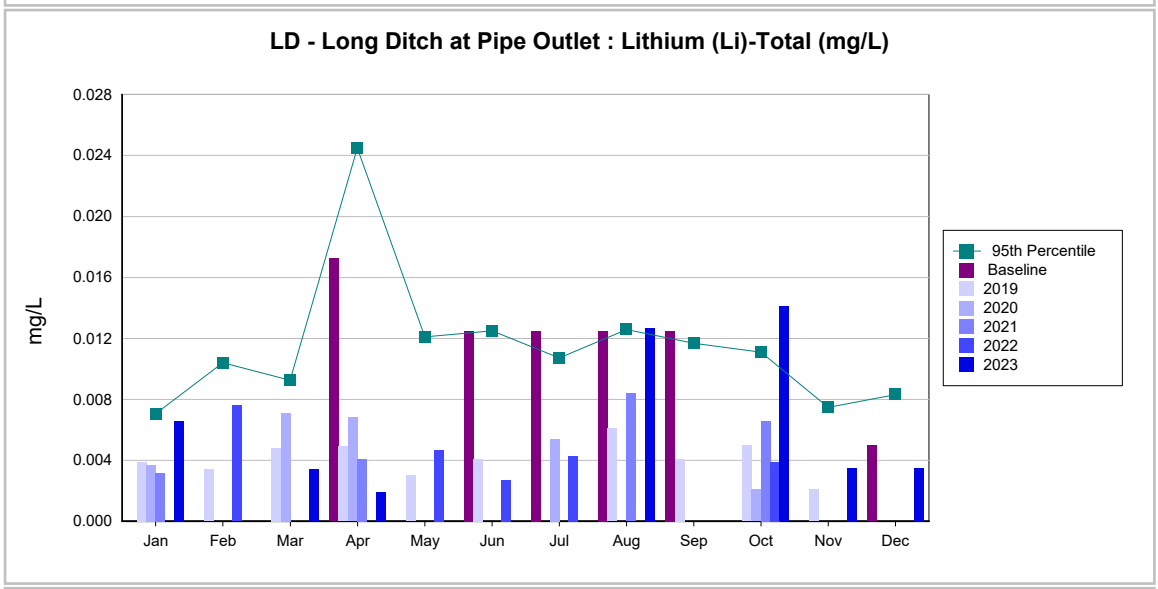
Annual Report Drainage Water

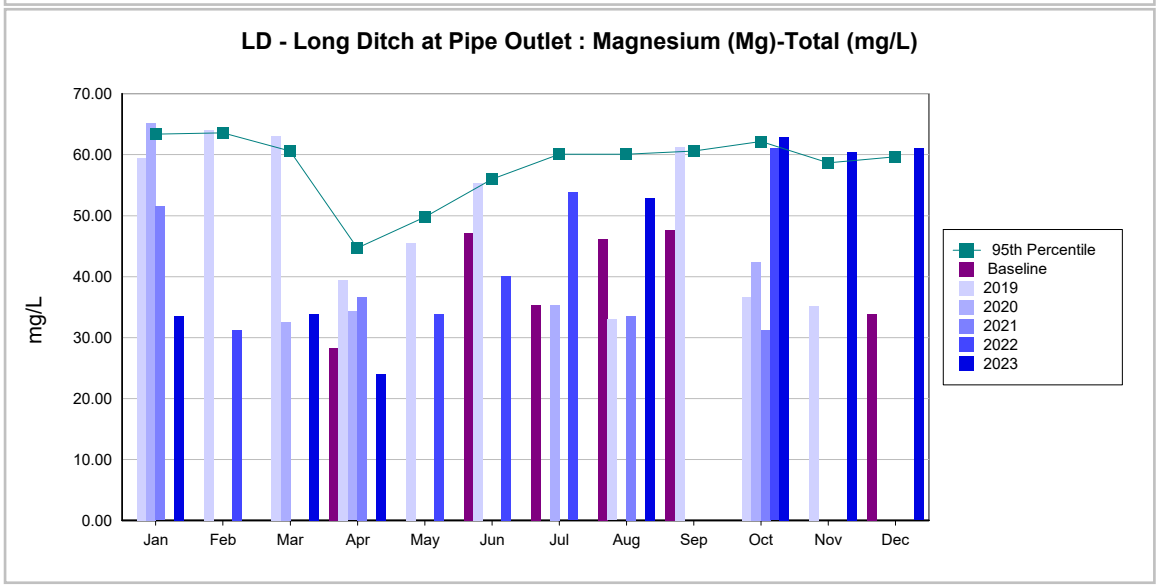
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

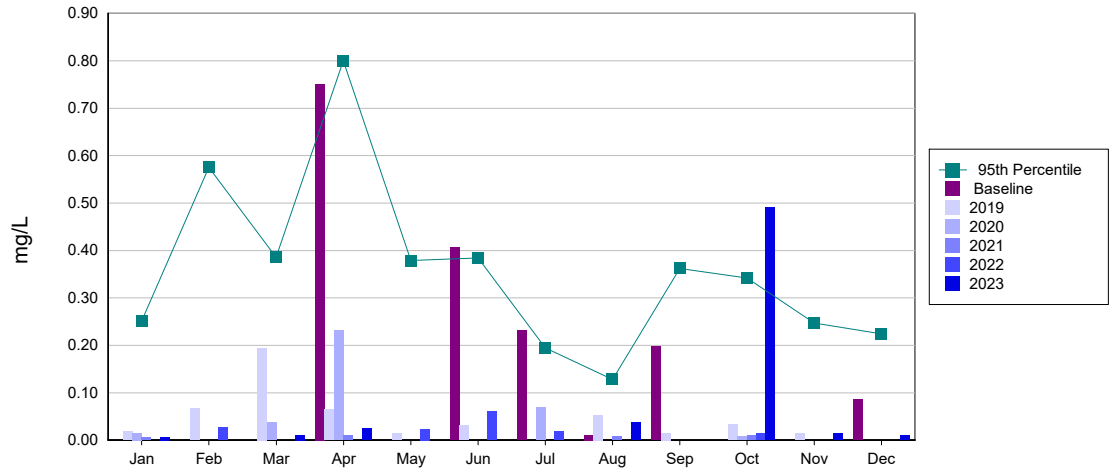
Annual Report Drainage Water

Mount Polley

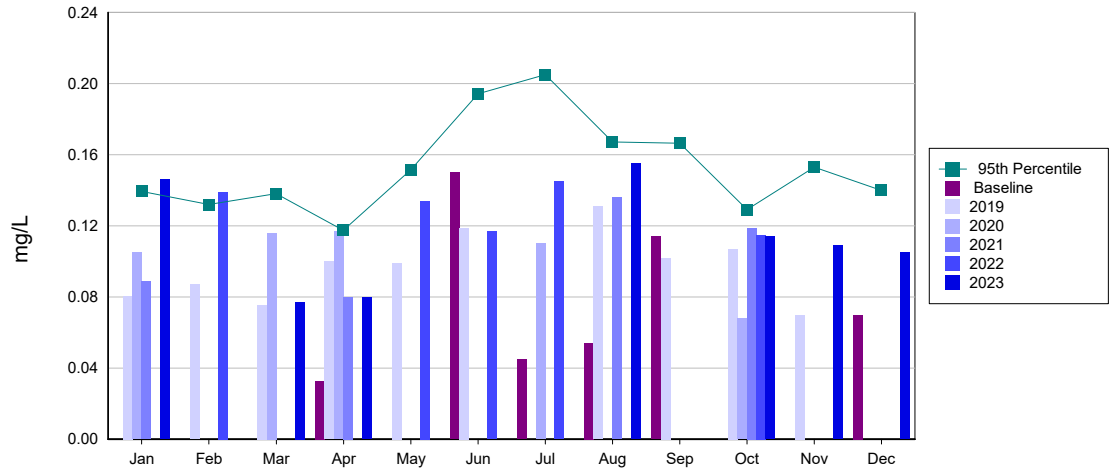
Mining Corporation

IMPERIAL METALS CORPORATION

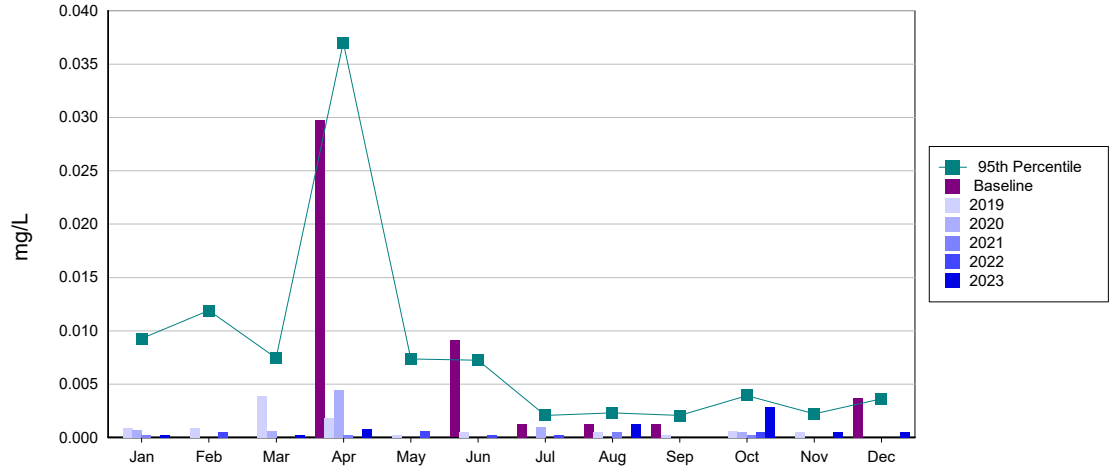
LD - Long Ditch at Pipe Outlet : Manganese (Mn)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Molybdenum (Mo)-Tota (mg/L)



LD - Long Ditch at Pipe Outlet : Nickel (Ni)-Total (mg/L)



Water Quality Report

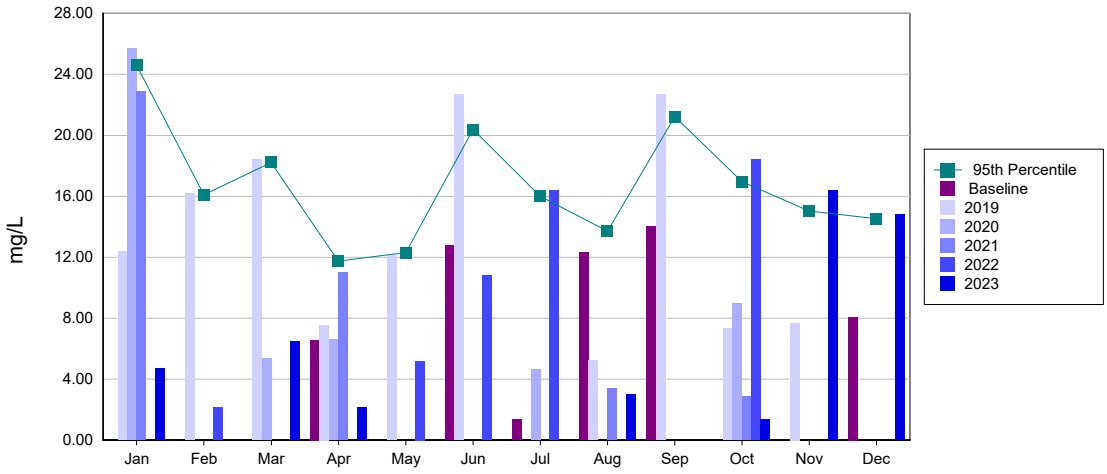
Annual Report Drainage Water

Mount Polley

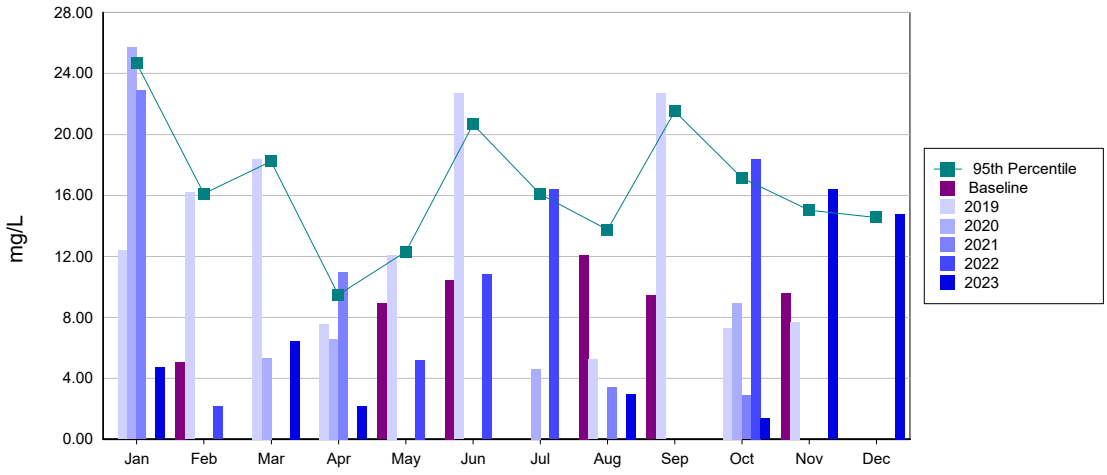
Mining Corporation

IMPERIAL METALS CORPORATION

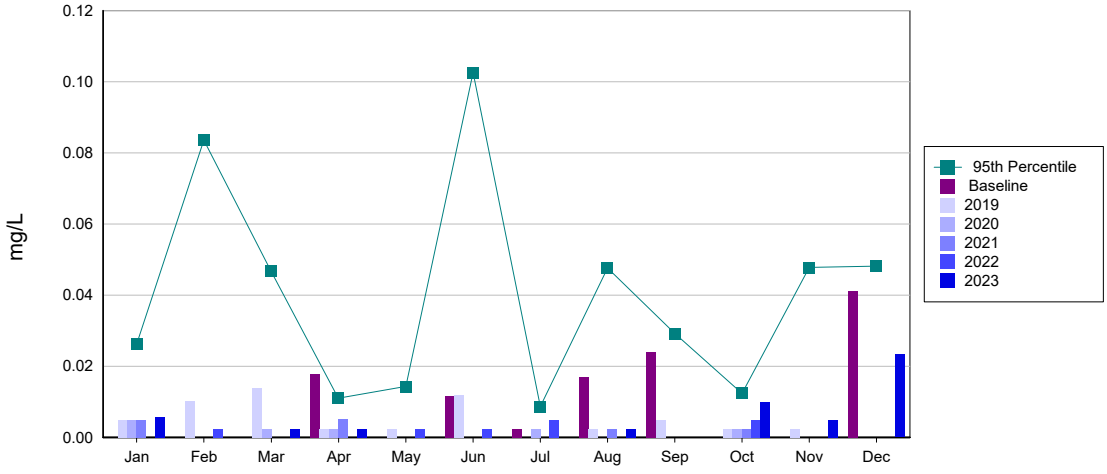
LD - Long Ditch at Pipe Outlet : Nitrate (N) (mg/L)



LD - Long Ditch at Pipe Outlet : Nitrate and Nitrite (mg/L)



LD - Long Ditch at Pipe Outlet : Nitrite (N) (mg/L)



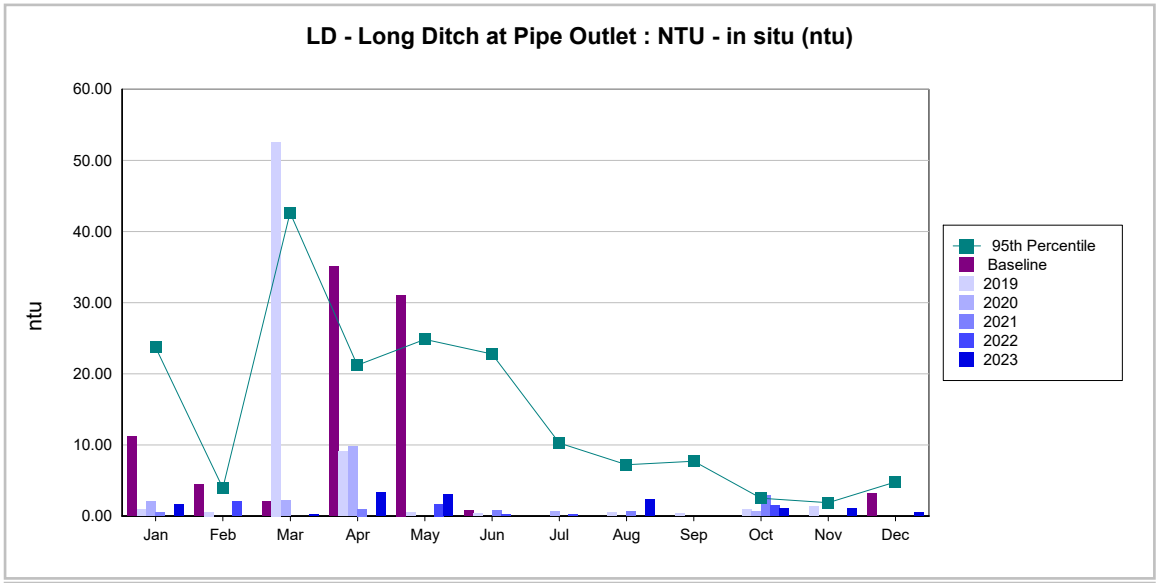
Water Quality Report

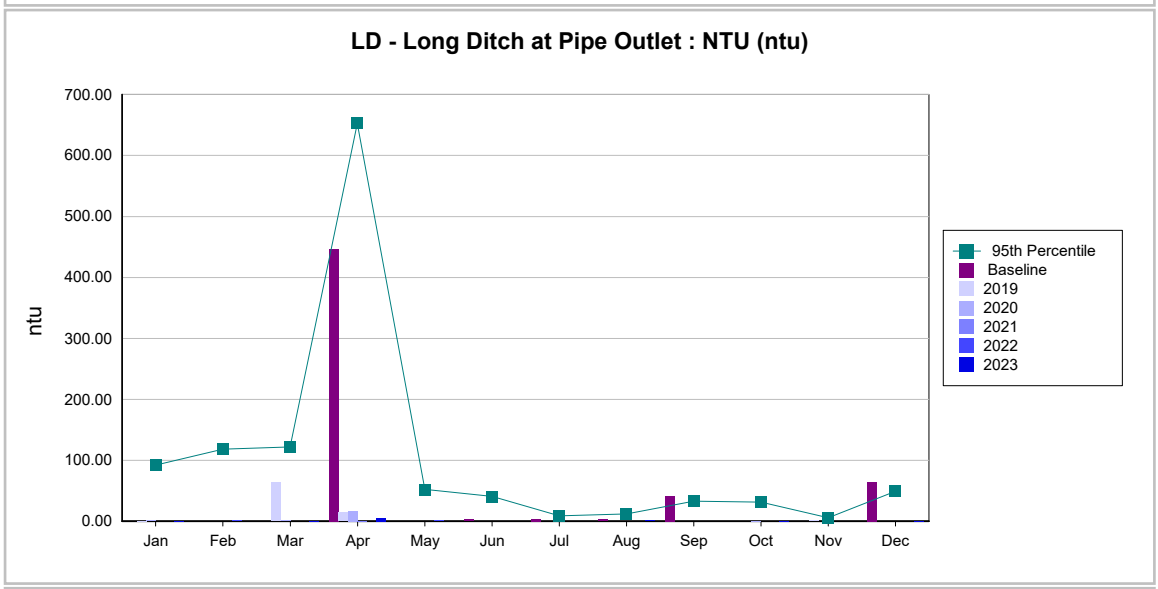
Annual Report Drainage Water

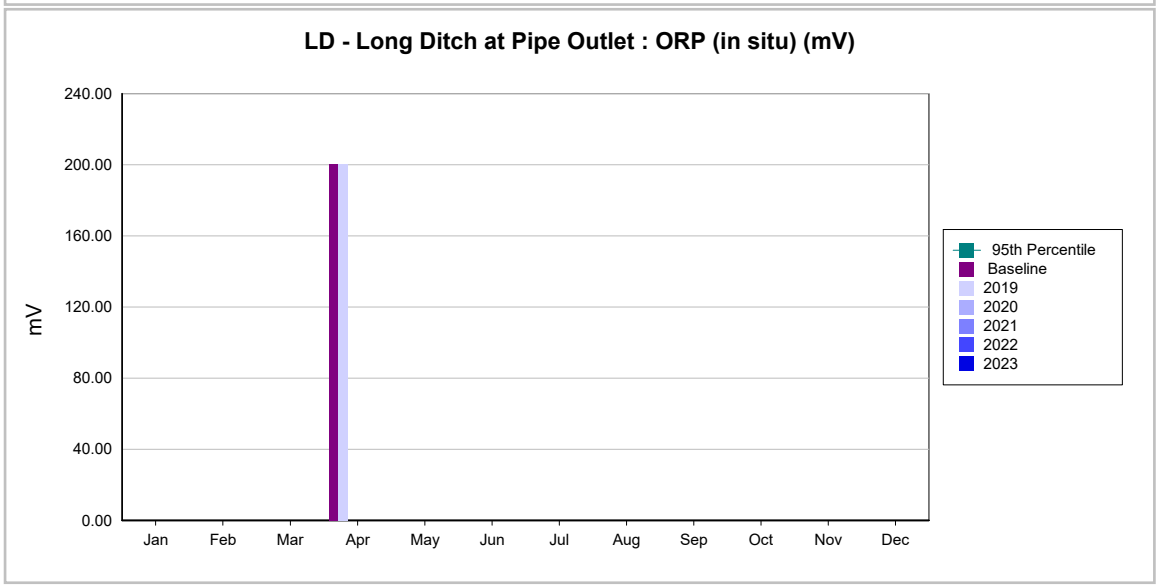
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

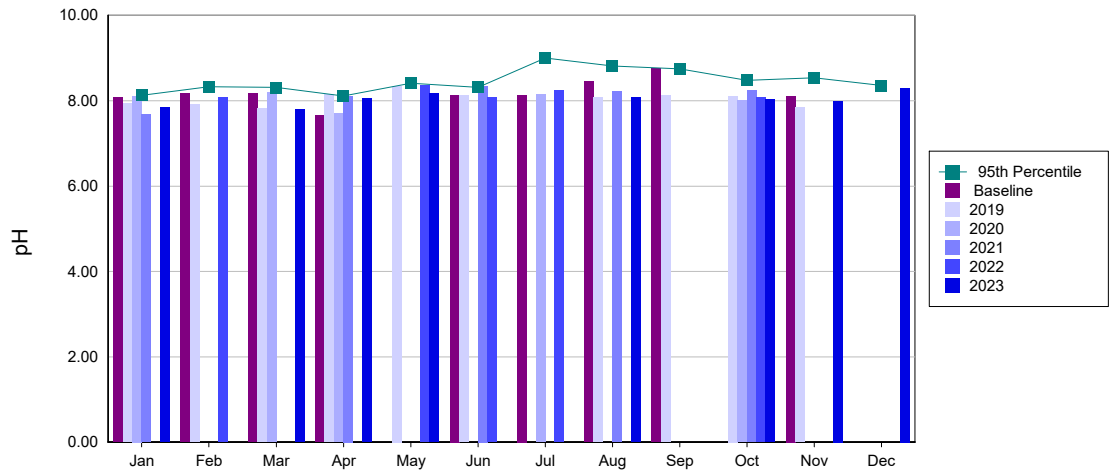
Annual Report Drainage Water

Mount Polley

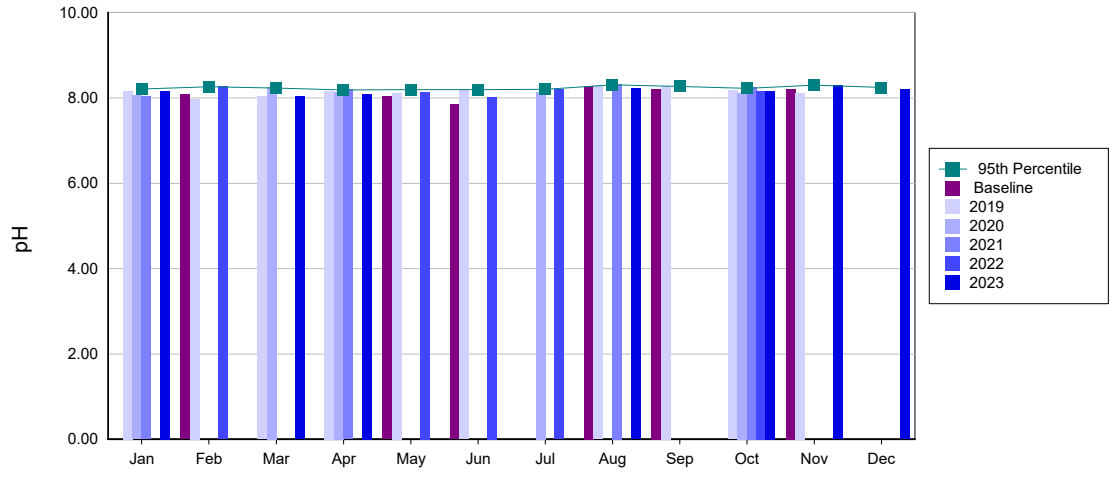
Mining Corporation

IMPERIAL METALS CORPORATION

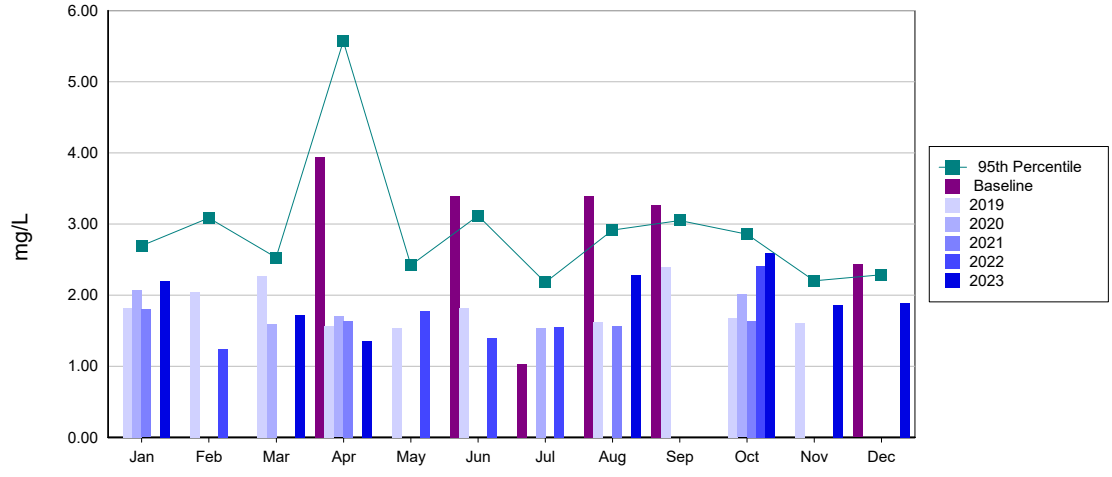
LD - Long Ditch at Pipe Outlet : pH (in situ) (pH)



LD - Long Ditch at Pipe Outlet : pH (pH)



LD - Long Ditch at Pipe Outlet : Potassium (K)-Total (mg/L)



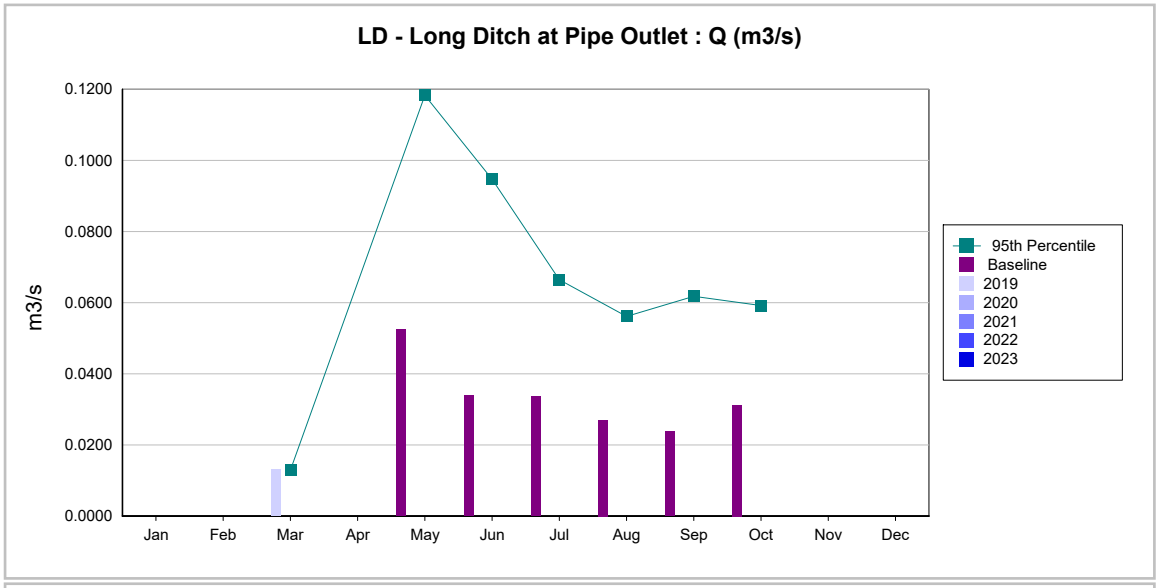
Water Quality Report

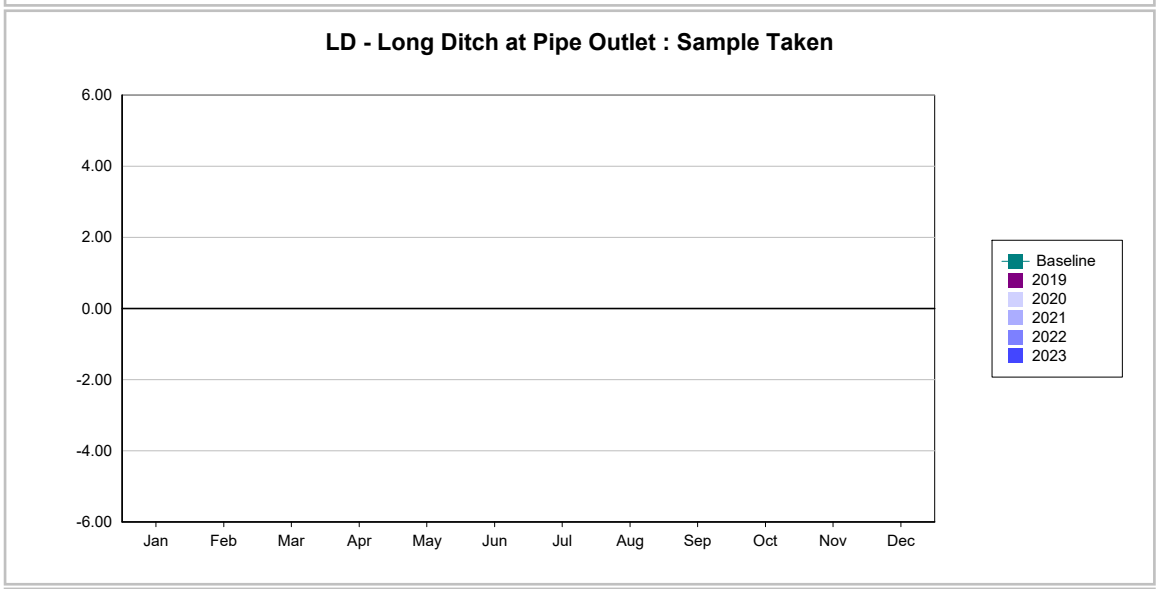
Annual Report Drainage Water

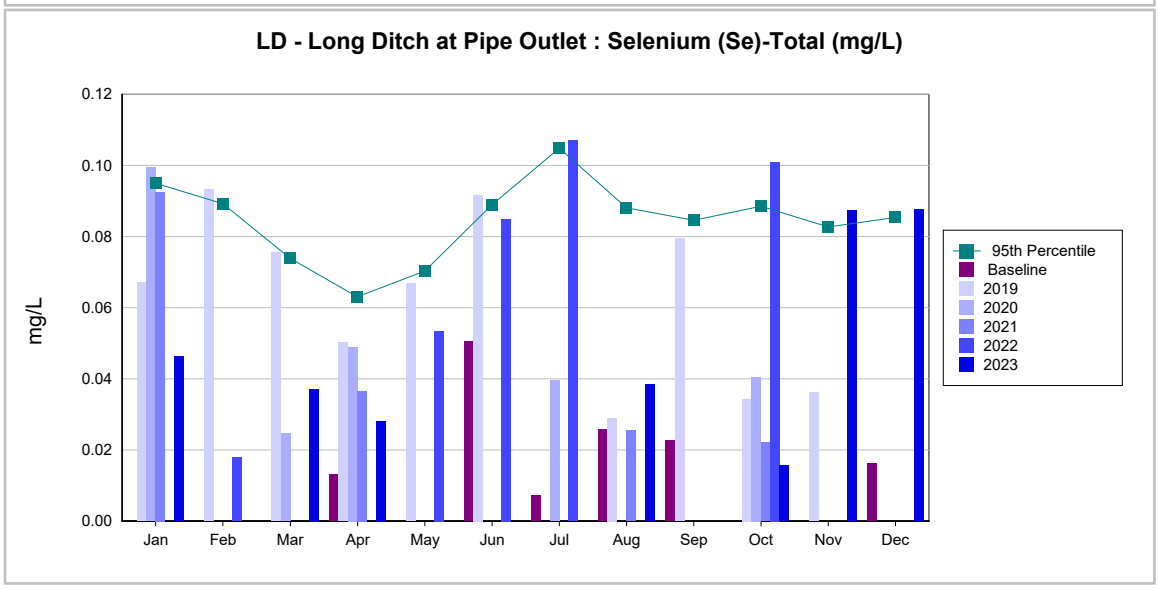
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







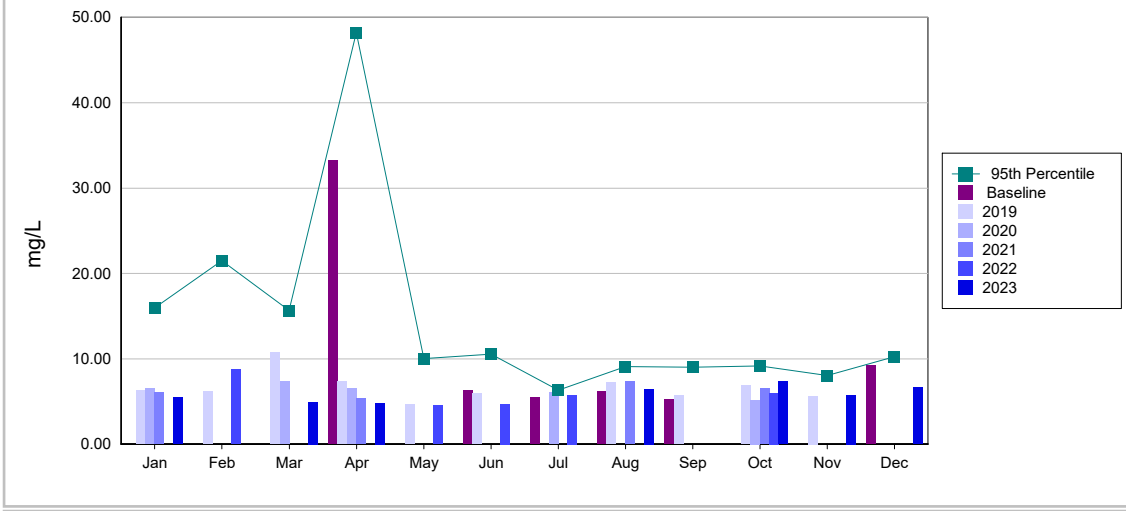
Water Quality Report

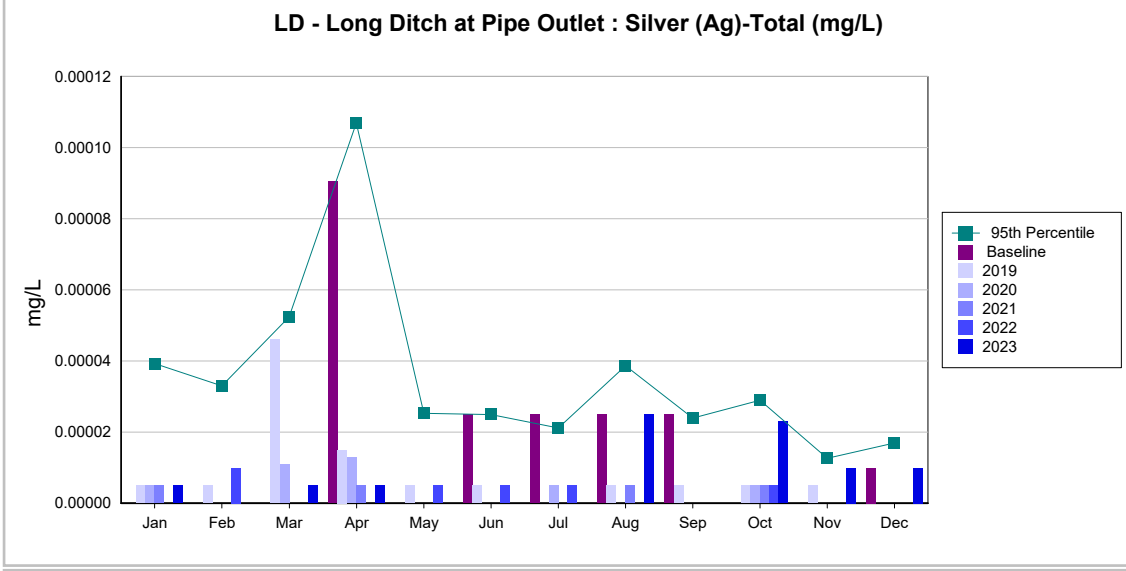
Annual Report Drainage Water

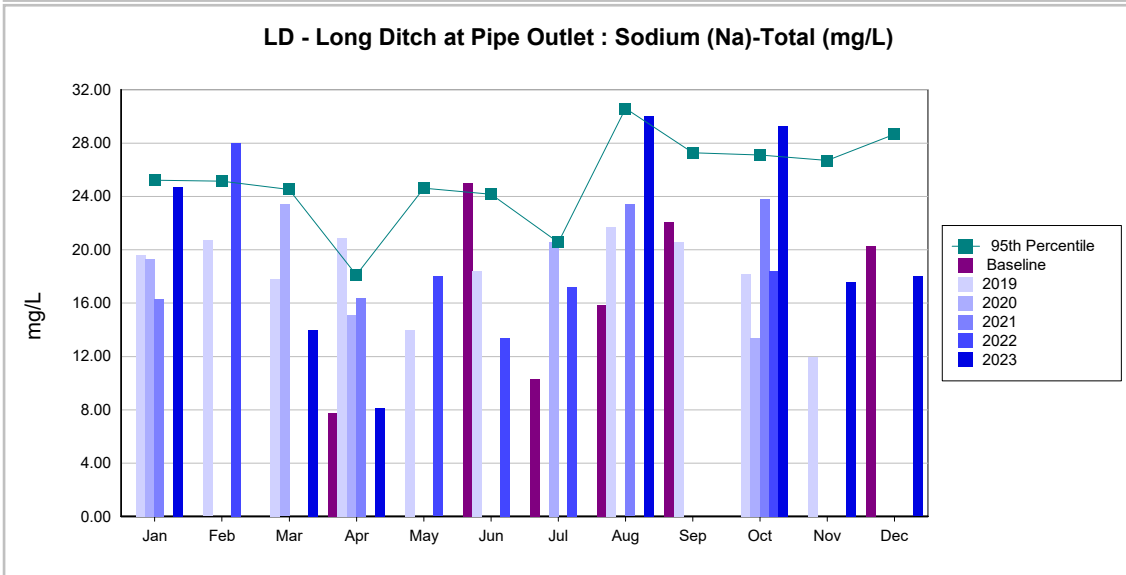
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

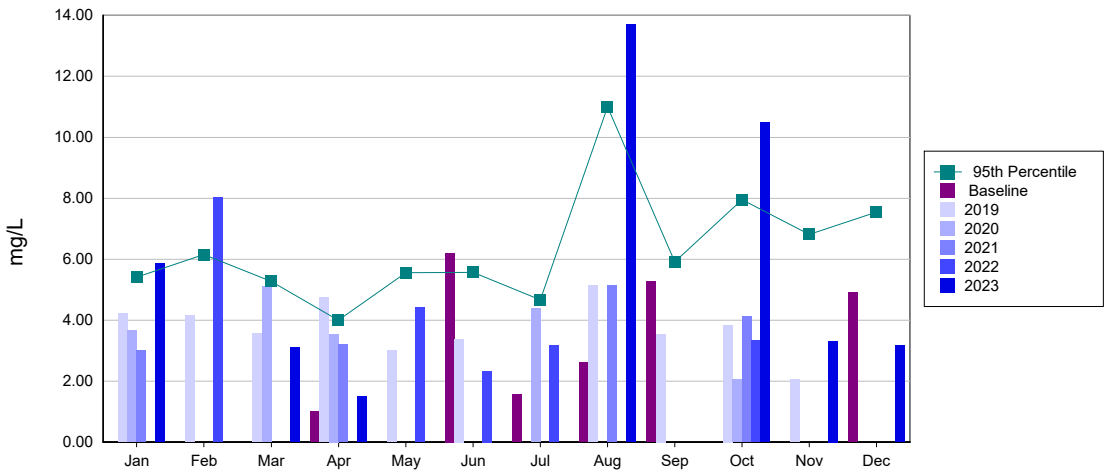
Annual Report Drainage Water

Mount Polley

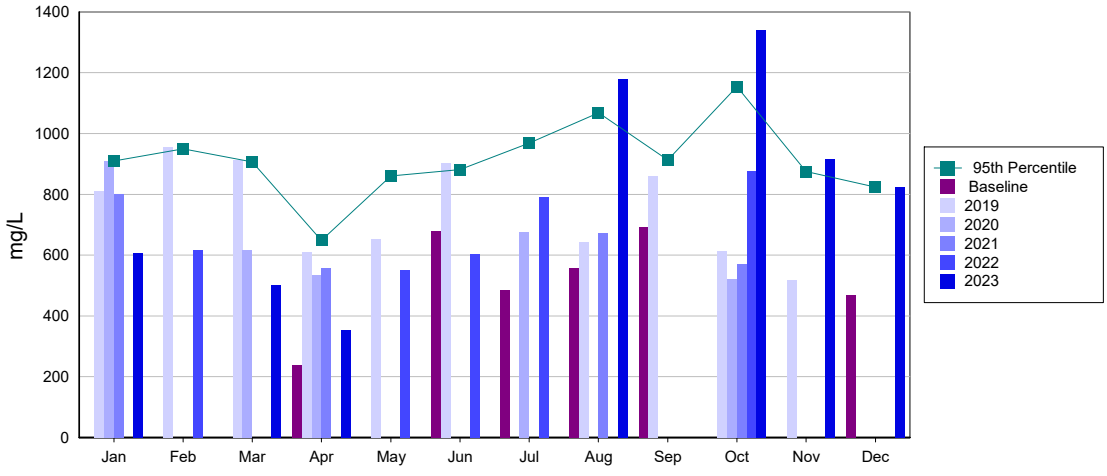
Mining Corporation

IMPERIAL METALS CORPORATION

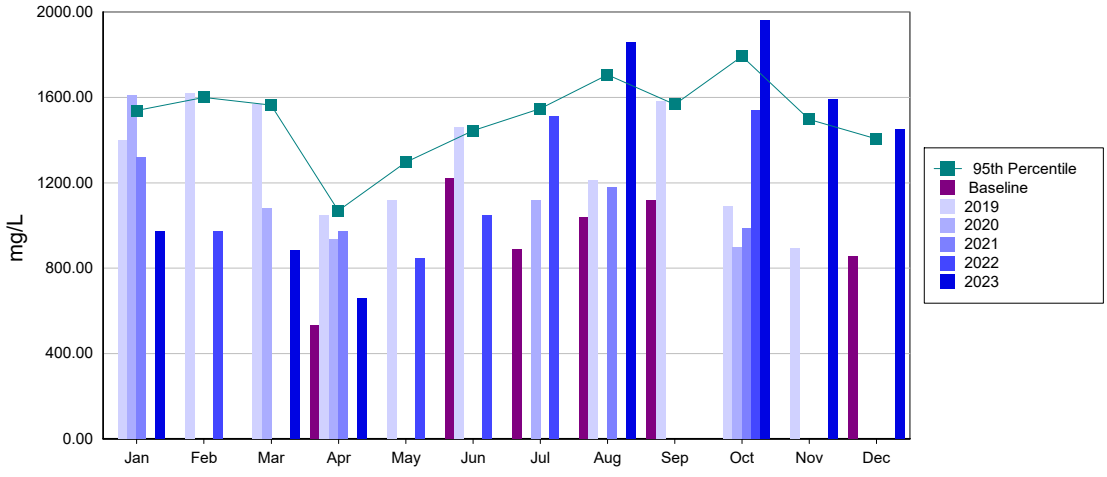
LD - Long Ditch at Pipe Outlet : Strontium (Sr)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Sulphate (mg/L)



LD - Long Ditch at Pipe Outlet : TDS (mg/L)



Water Quality Report

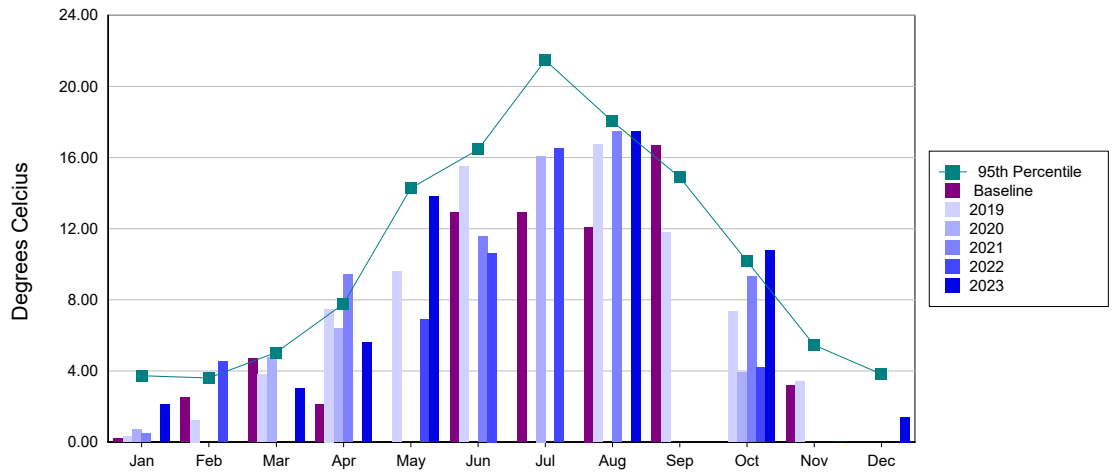
Annual Report Drainage Water

Mount Polley

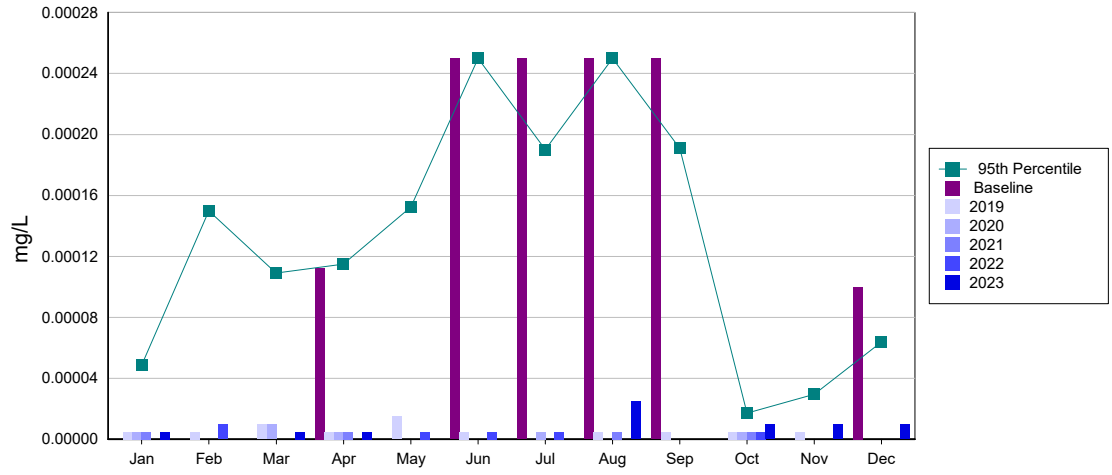
Mining Corporation

IMPERIAL METALS CORPORATION

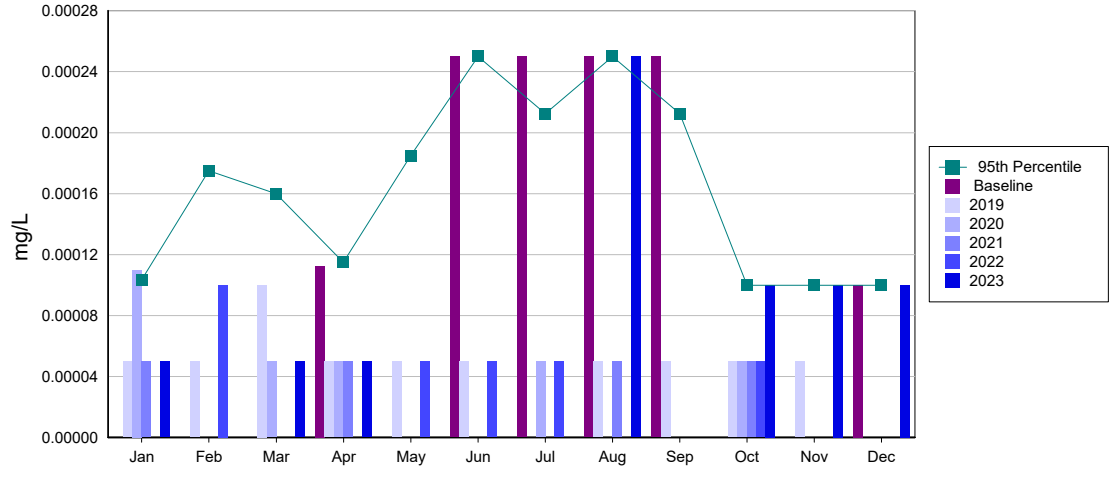
LD - Long Ditch at Pipe Outlet : Temp (in situ) (Degrees Celcius)



LD - Long Ditch at Pipe Outlet : Thallium (Tl)-Total (mg/L)



LD - Long Ditch at Pipe Outlet : Tin (Sn)-Total (mg/L)



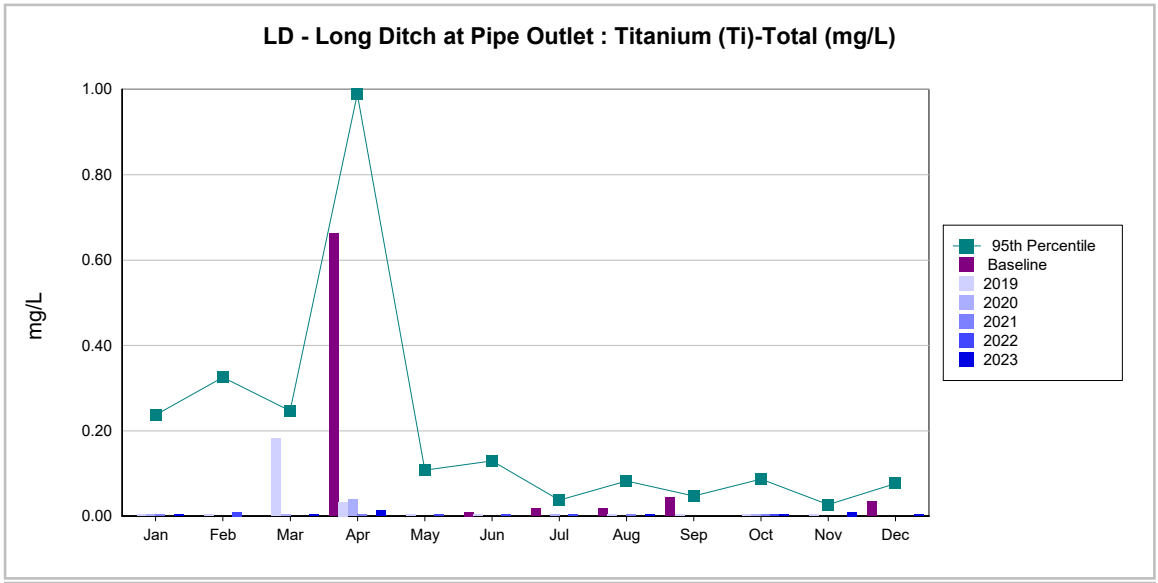
Water Quality Report

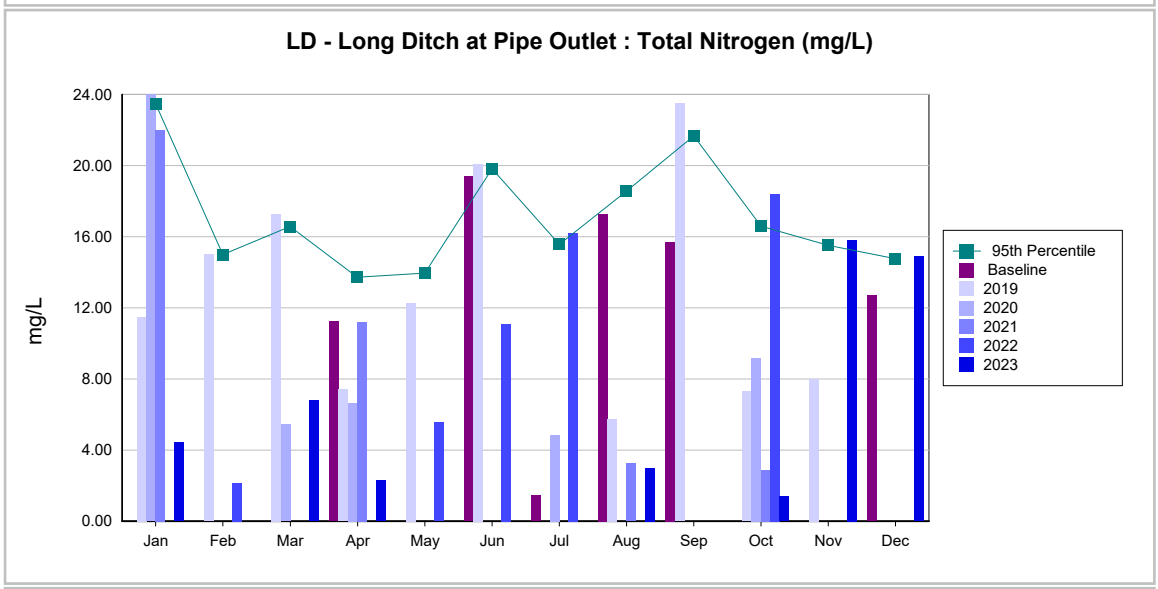
Annual Report Drainage Water

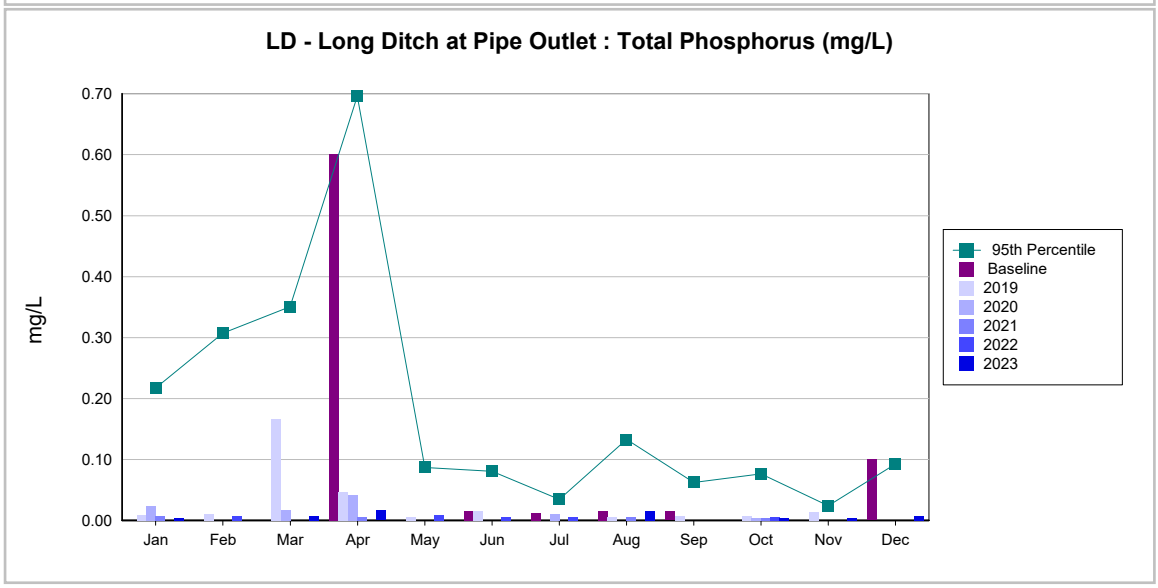
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







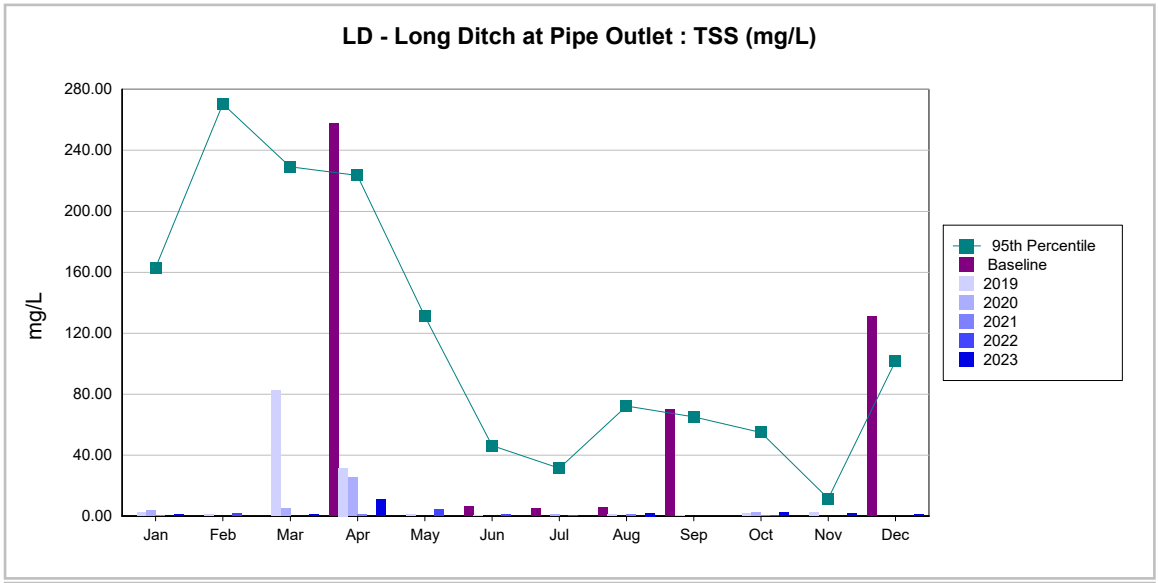
Water Quality Report

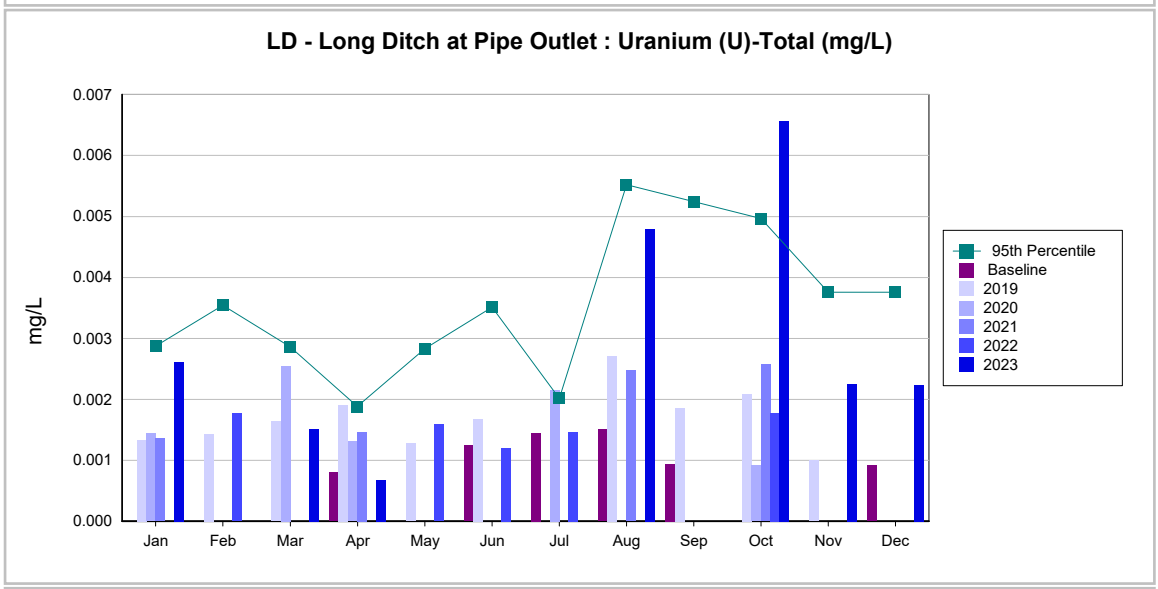
Annual Report Drainage Water

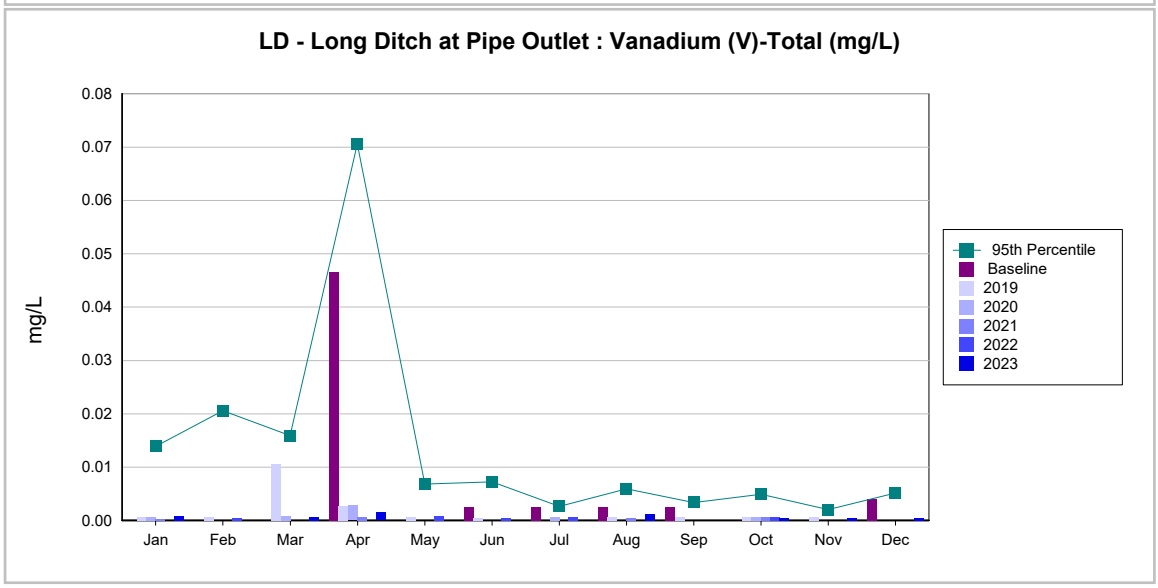
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







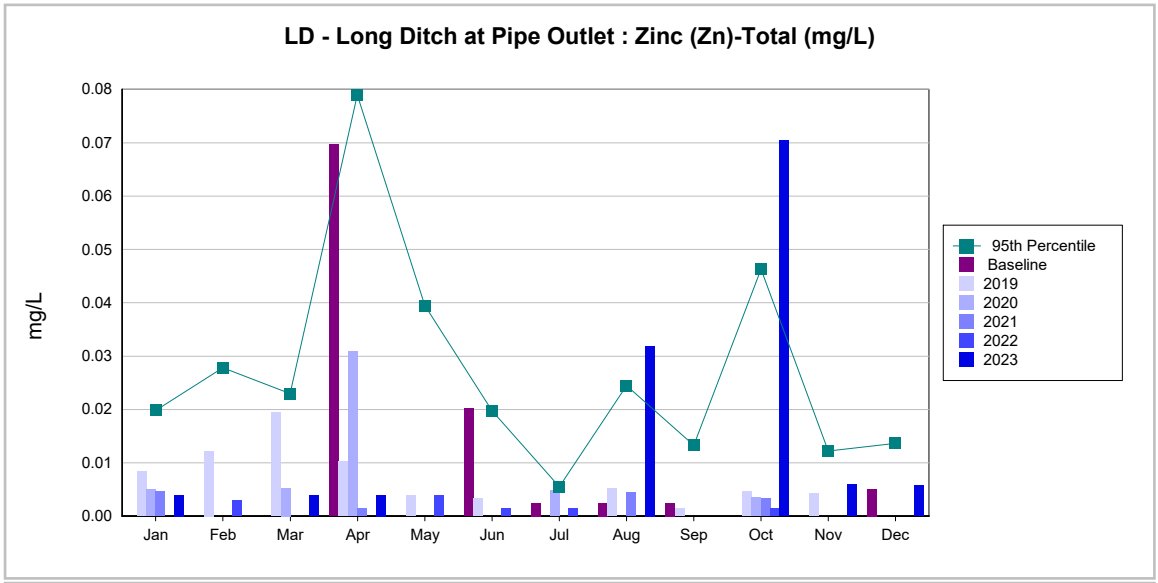
Water Quality Report

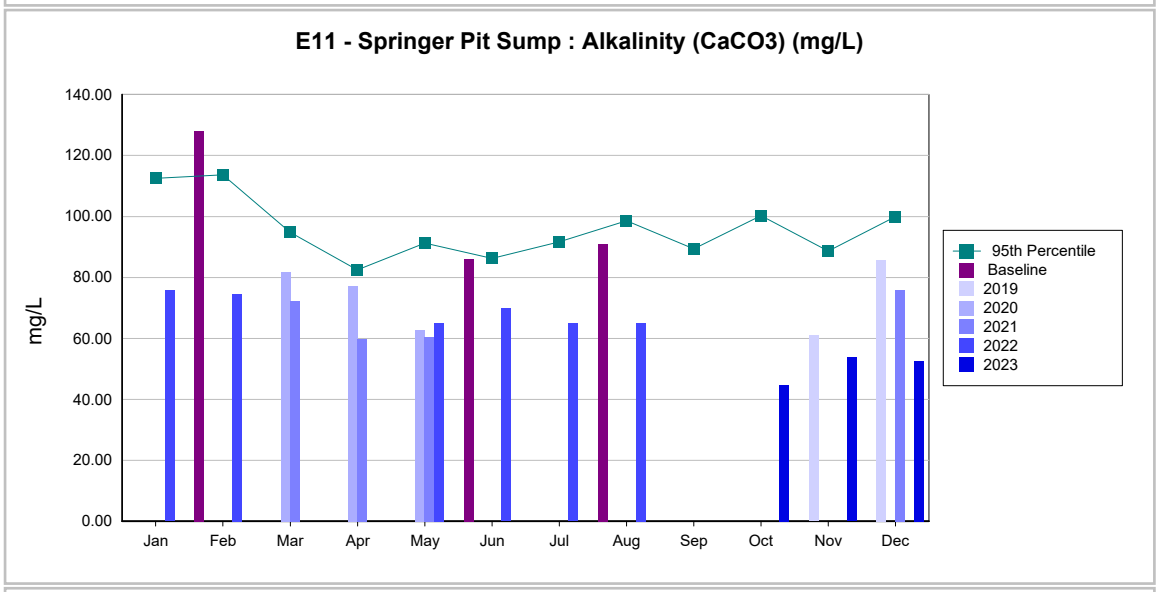
Annual Report Drainage Water

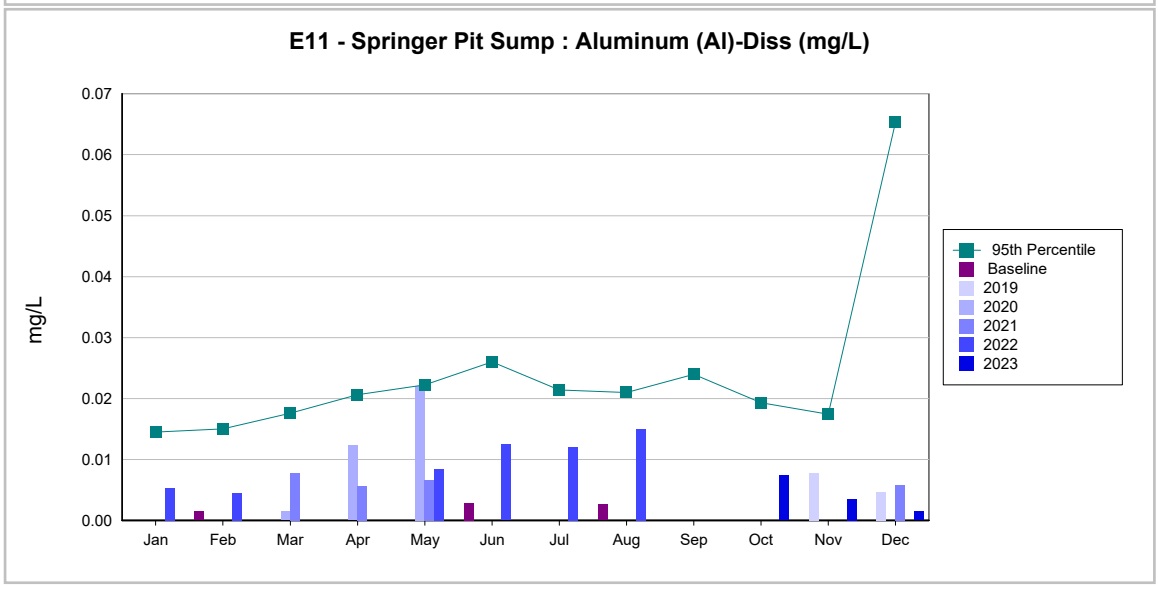
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







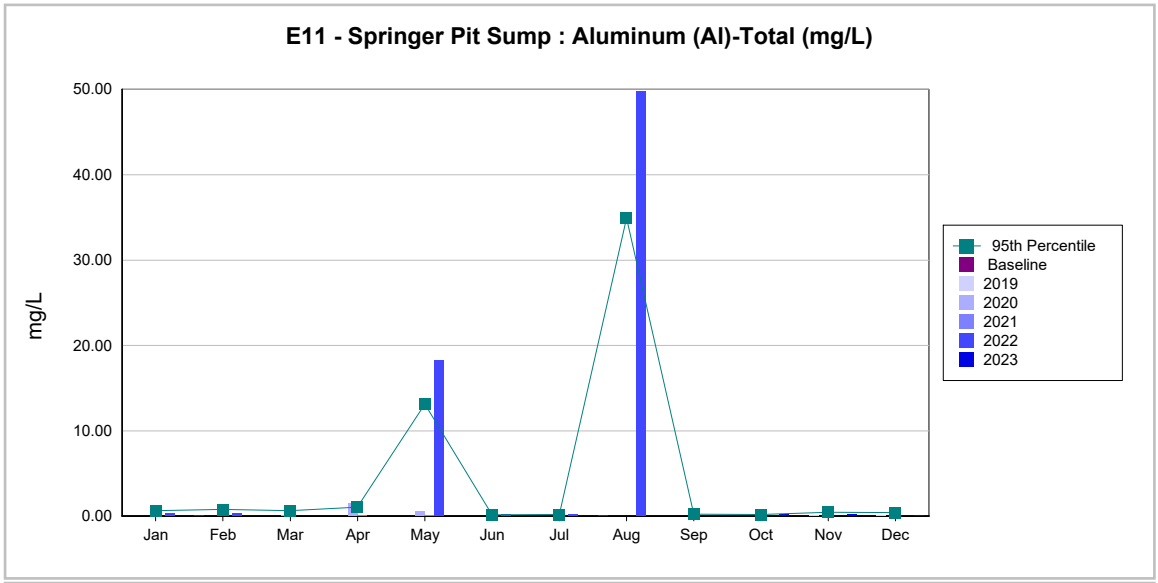
Water Quality Report

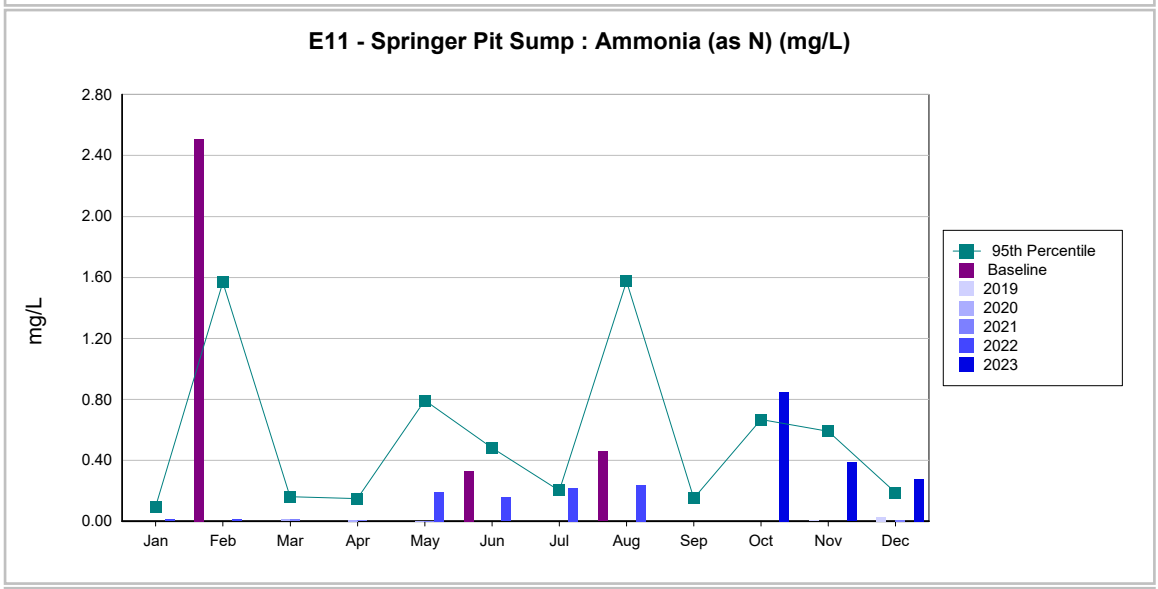
Annual Report Drainage Water

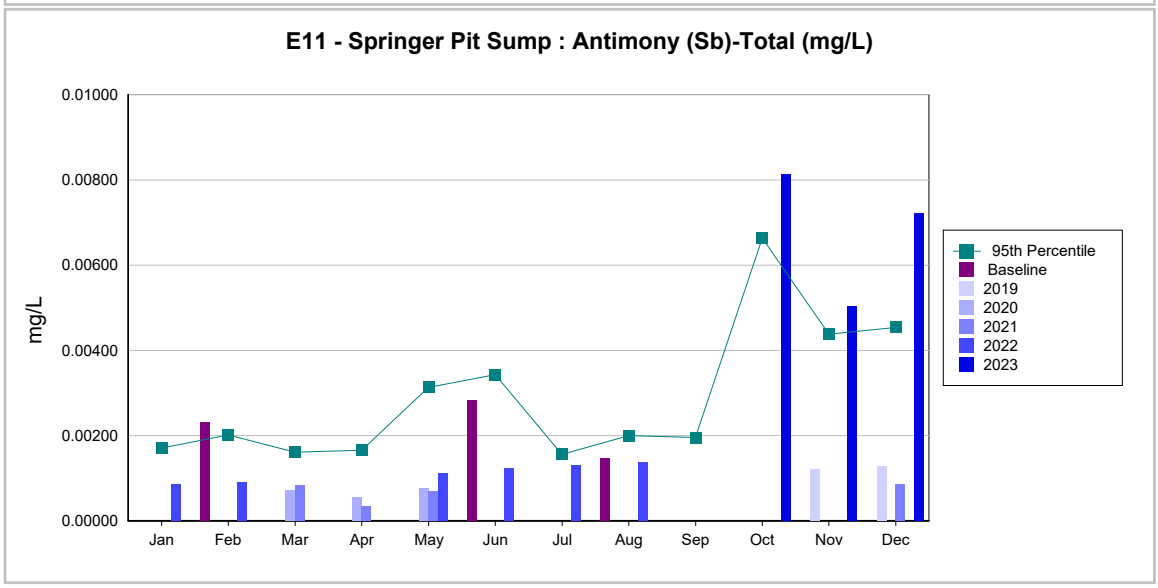
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







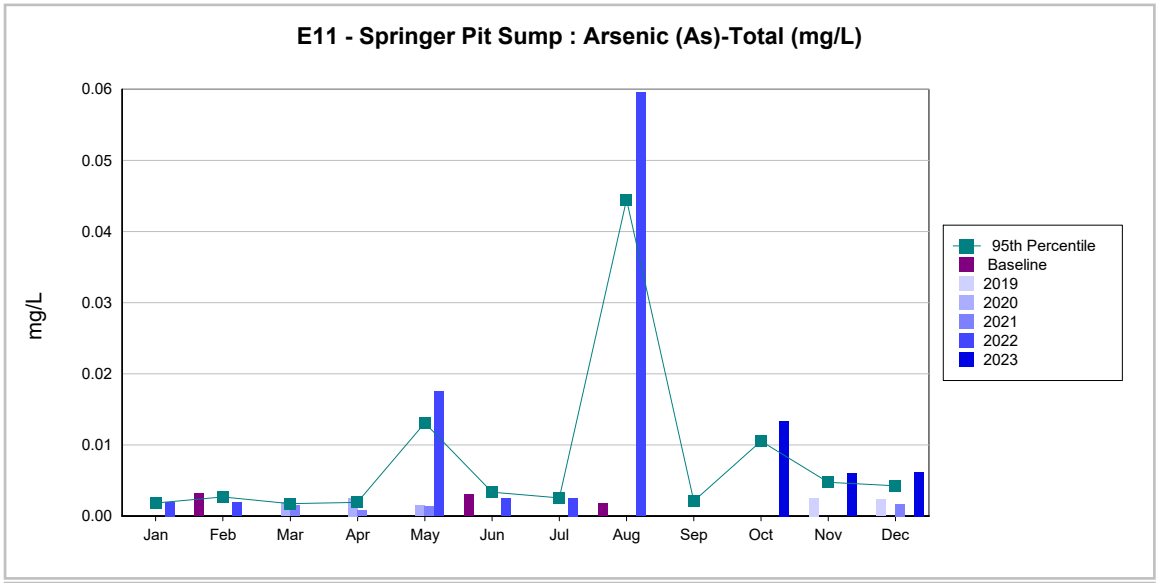
Water Quality Report

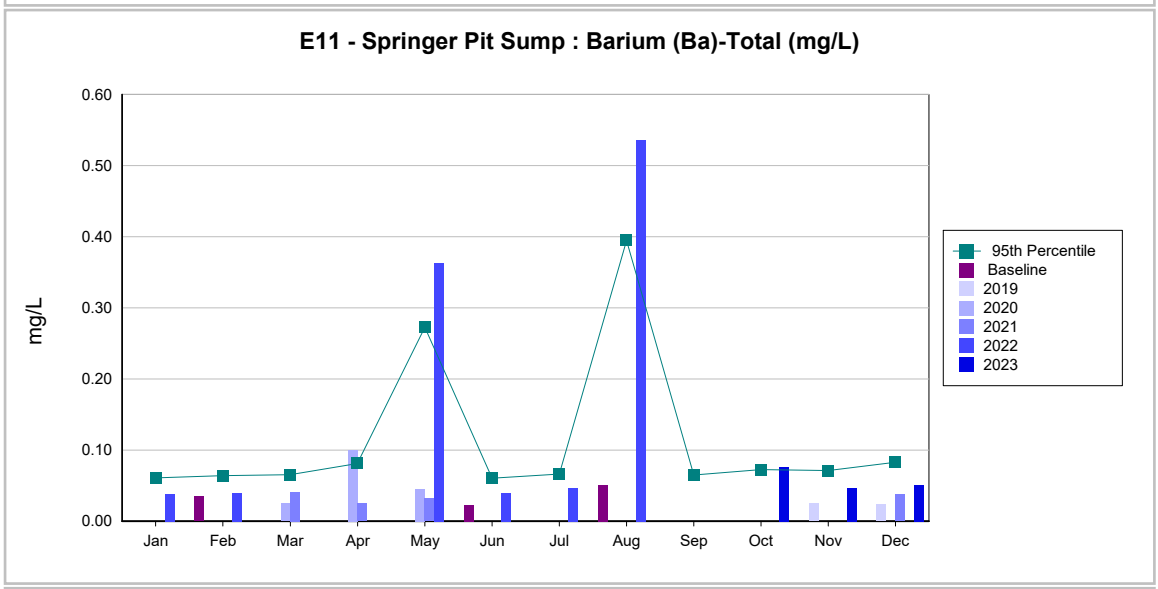
Annual Report Drainage Water

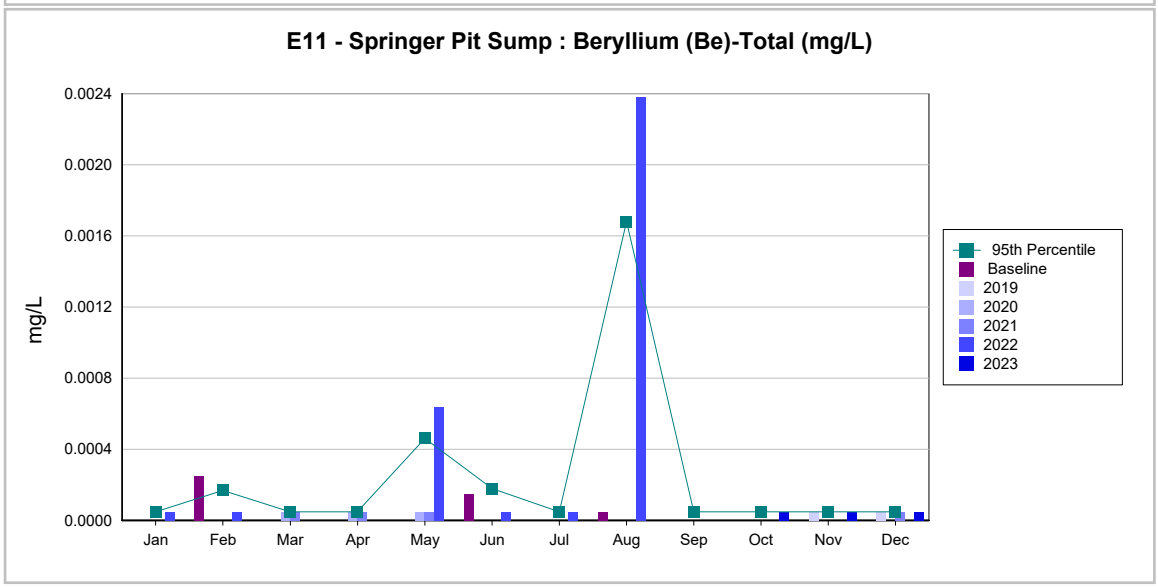
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







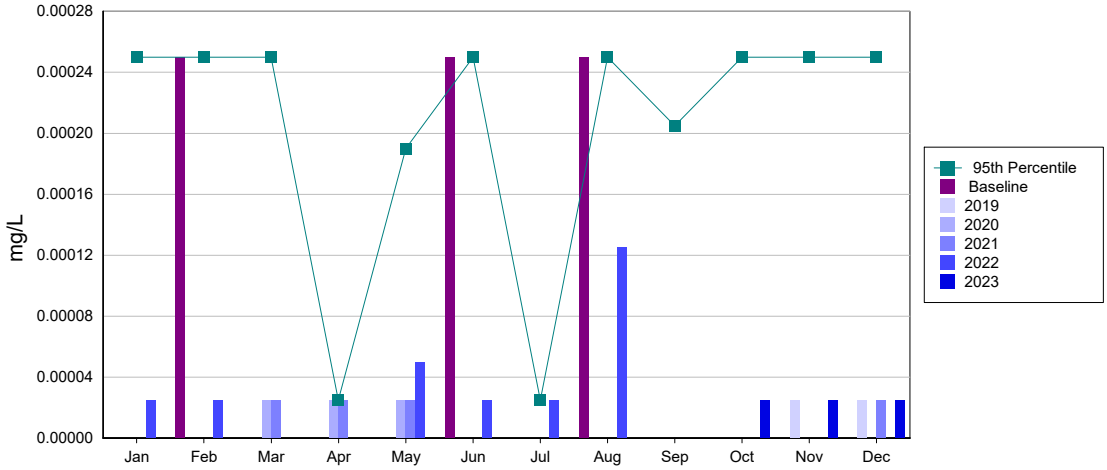
Water Quality Report

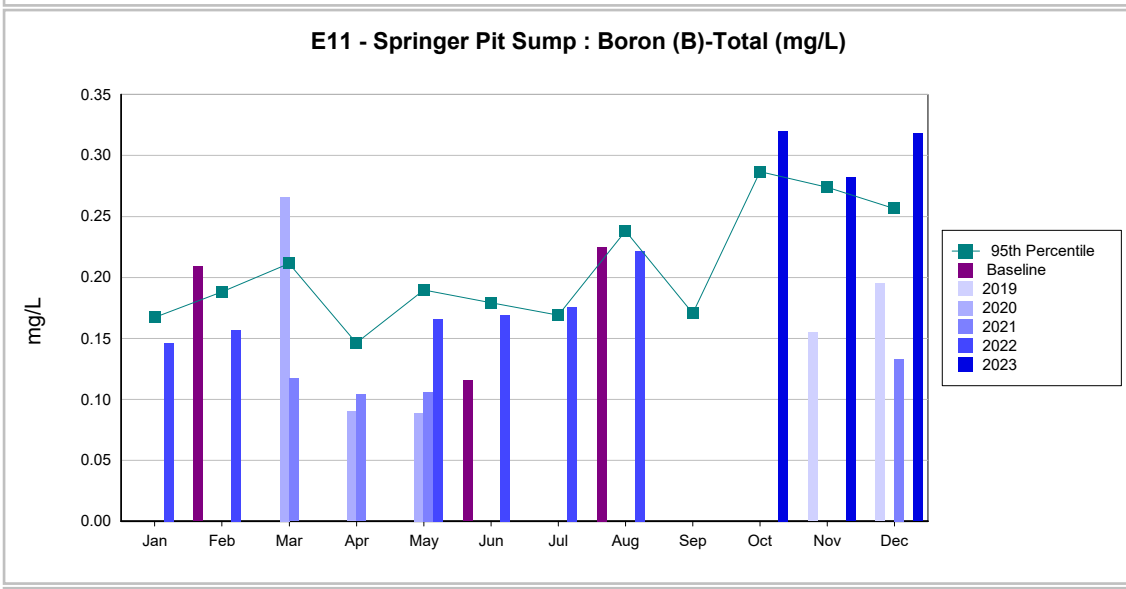
Annual Report Drainage Water

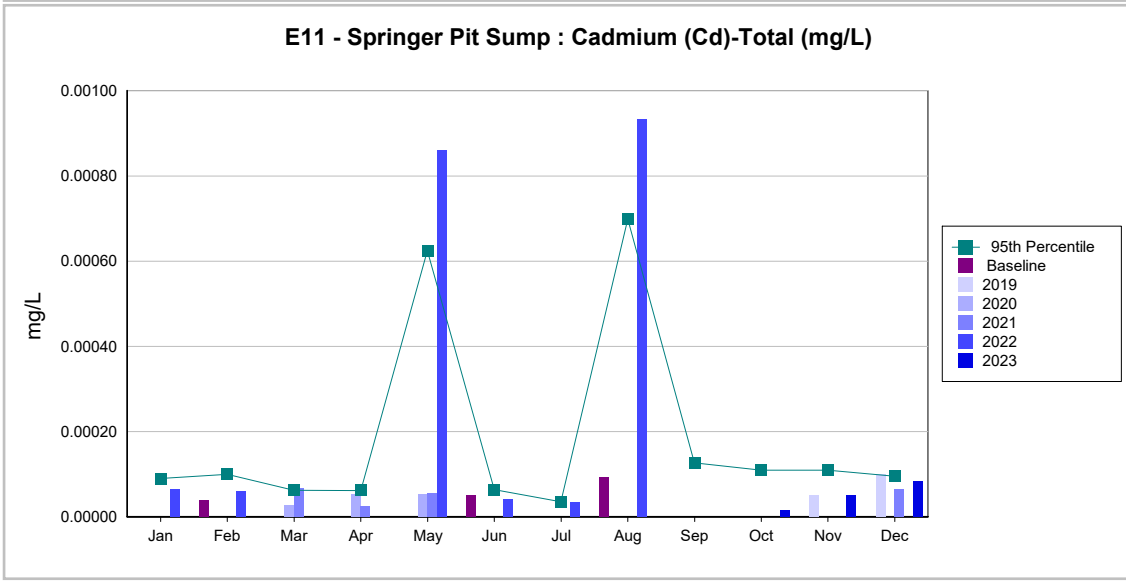
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







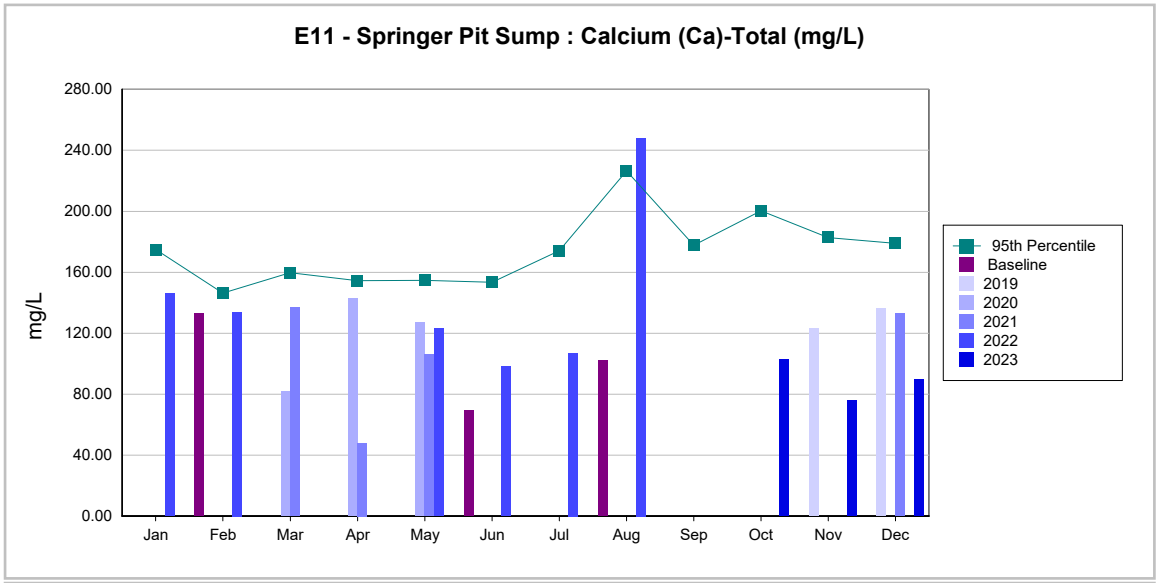
Water Quality Report

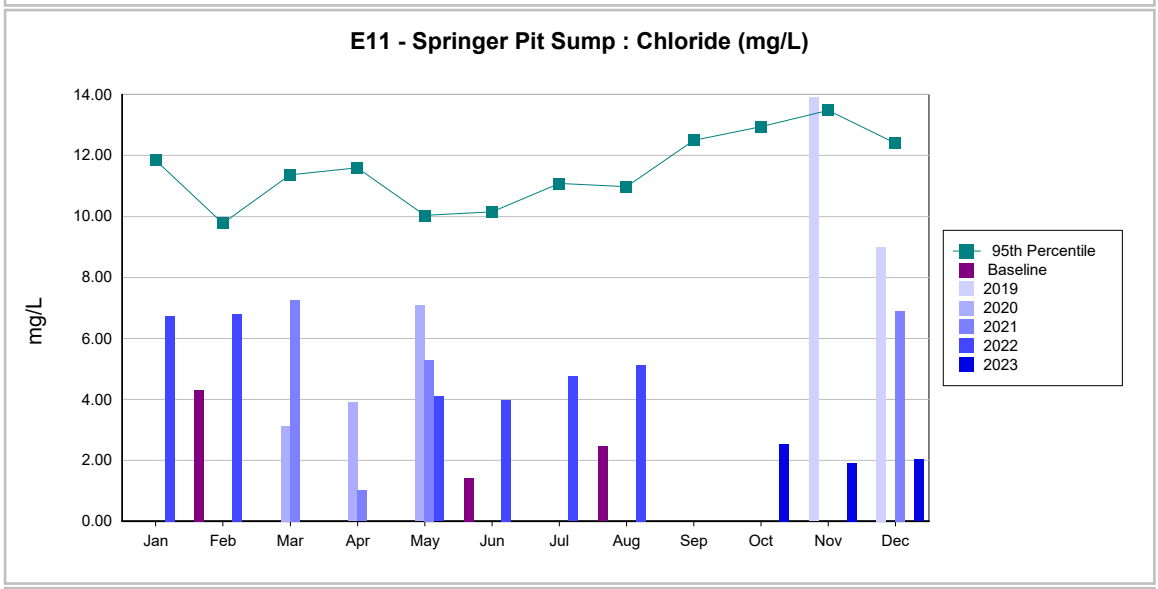
Annual Report Drainage Water

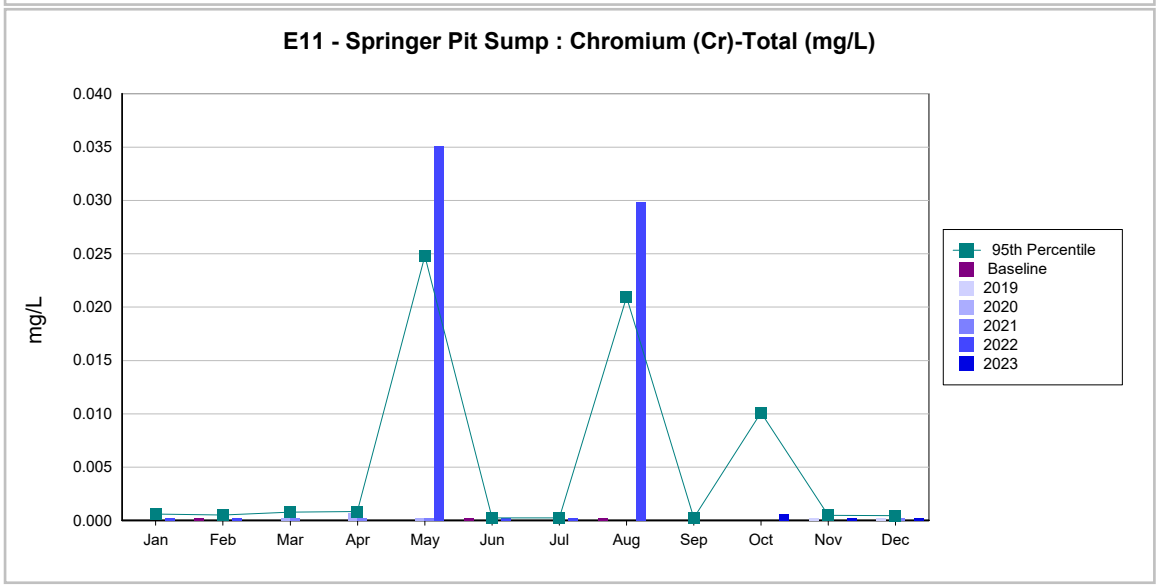
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







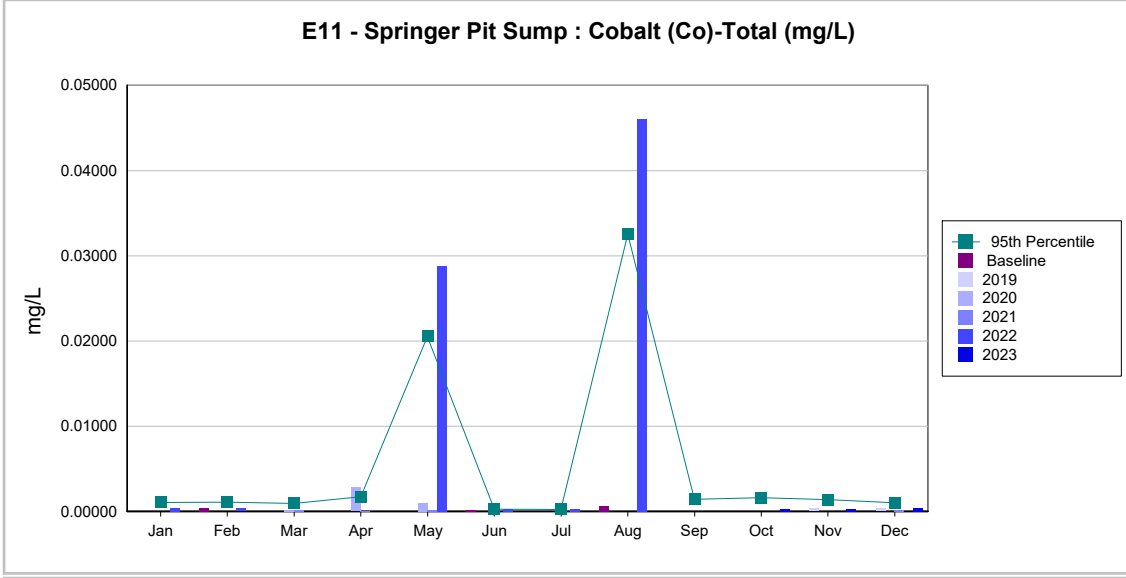
Water Quality Report

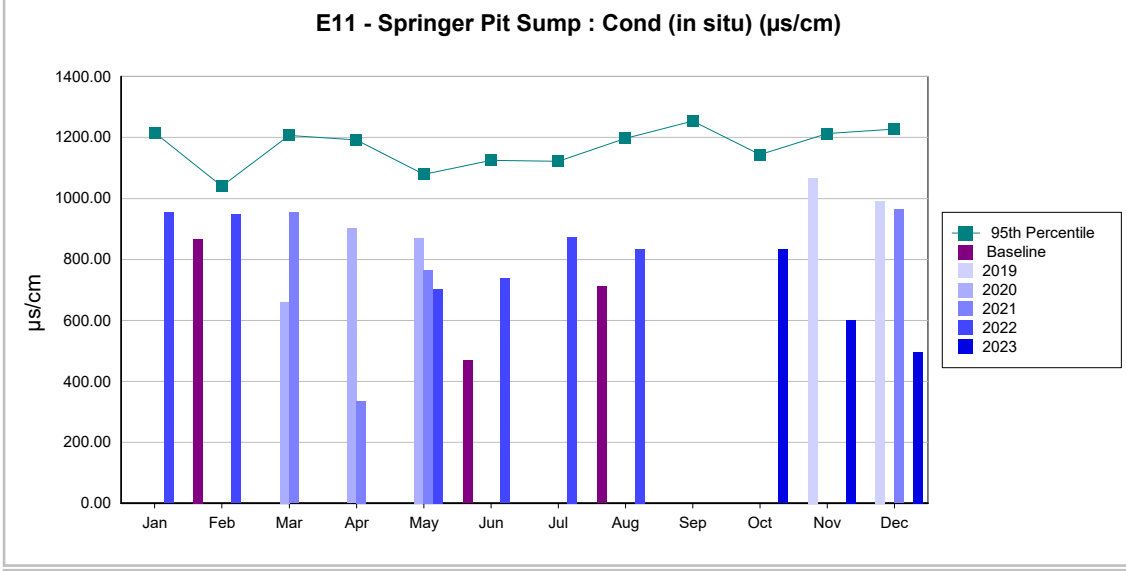
Annual Report Drainage Water

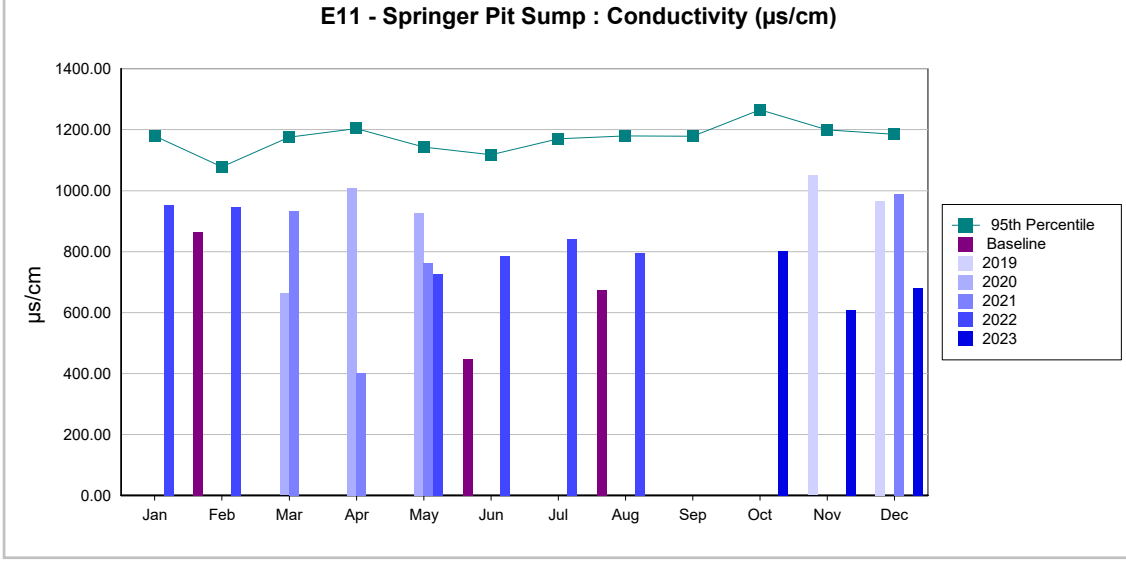
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







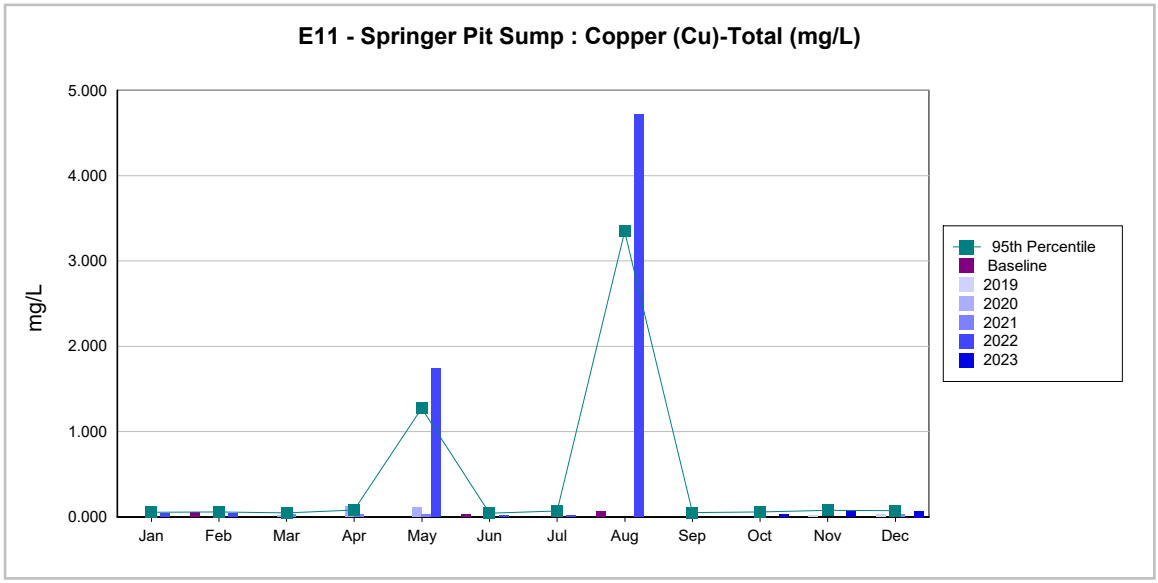
Water Quality Report

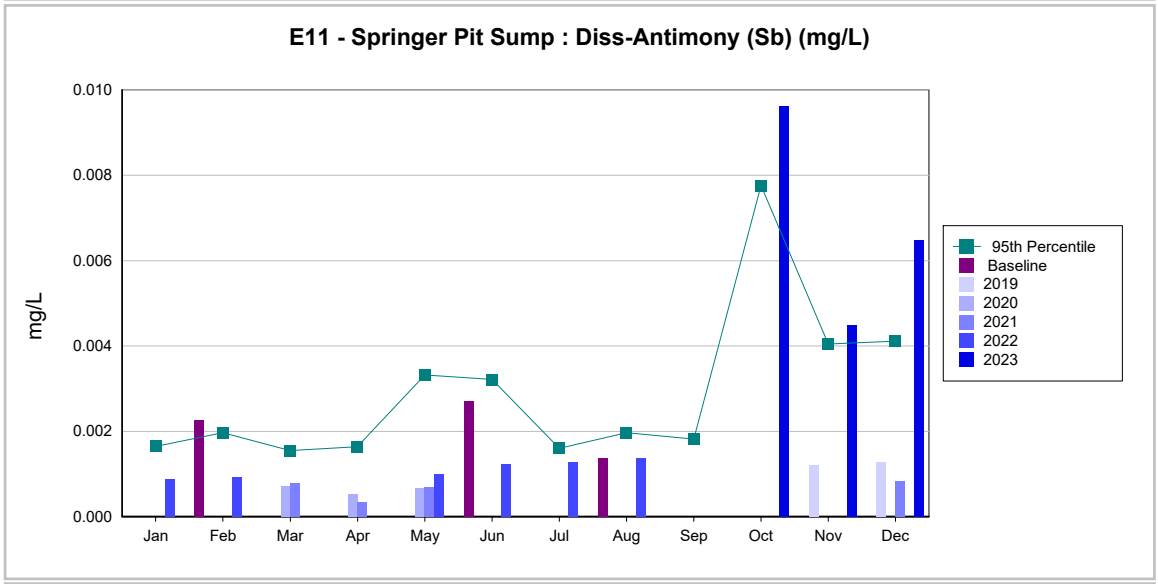
Annual Report Drainage Water

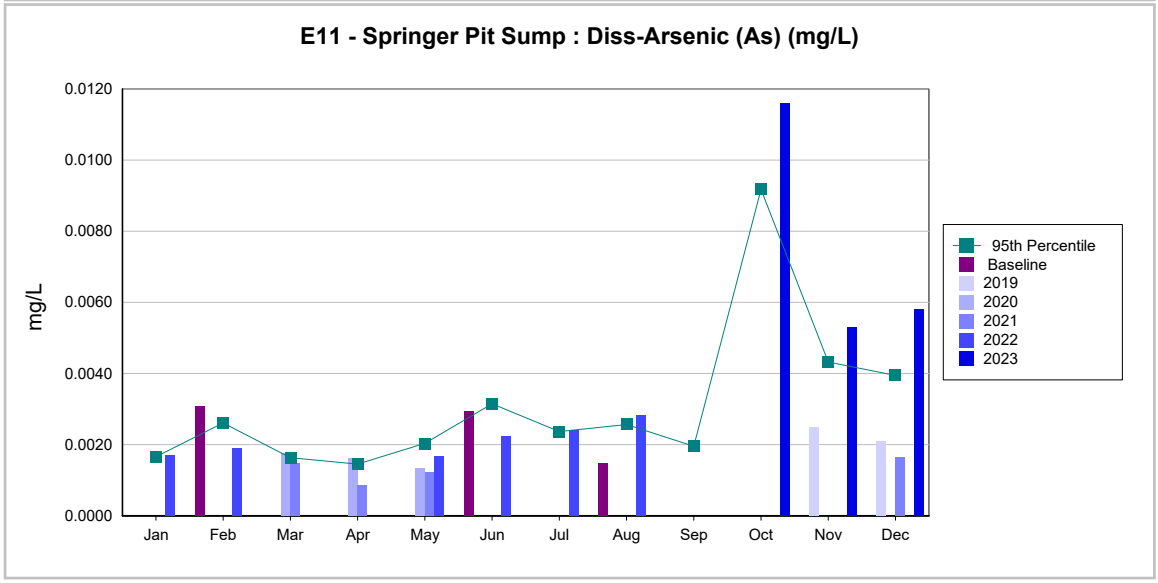
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







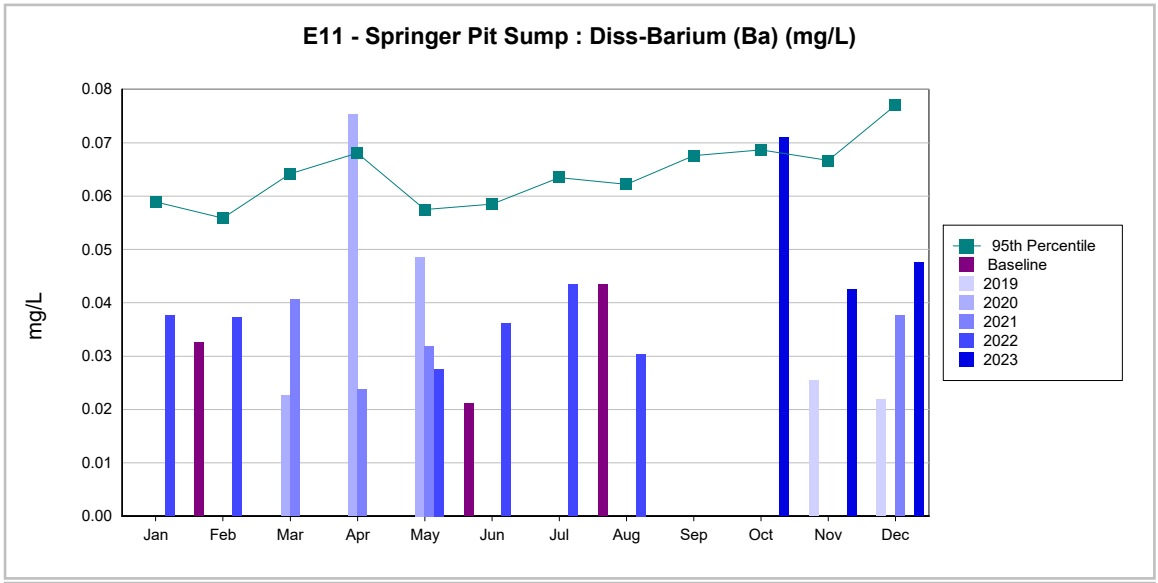
Water Quality Report

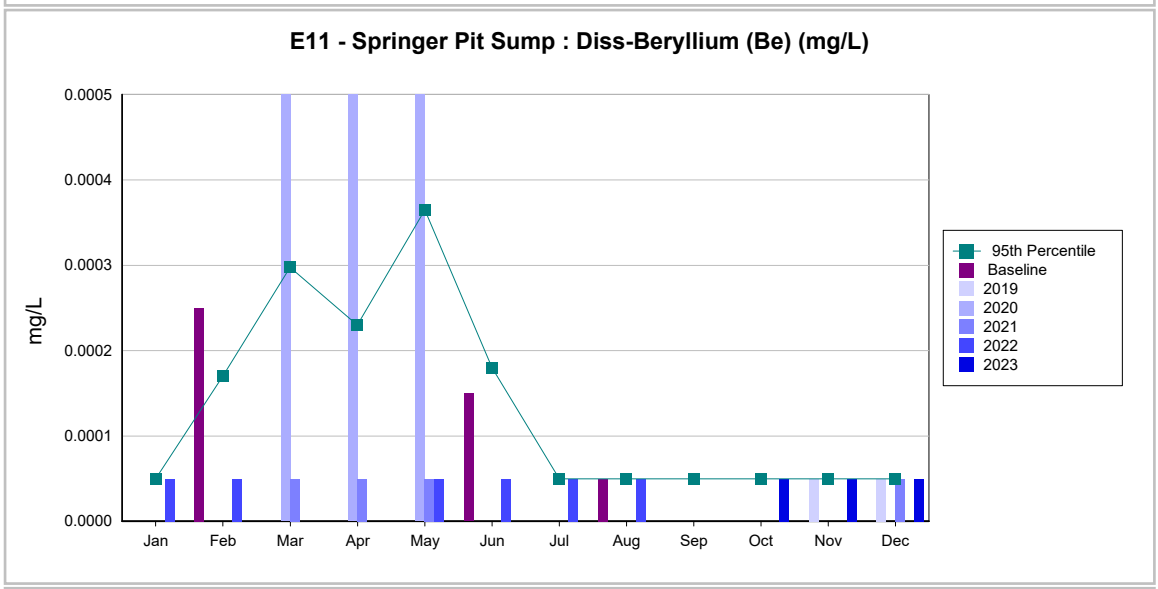
Annual Report Drainage Water

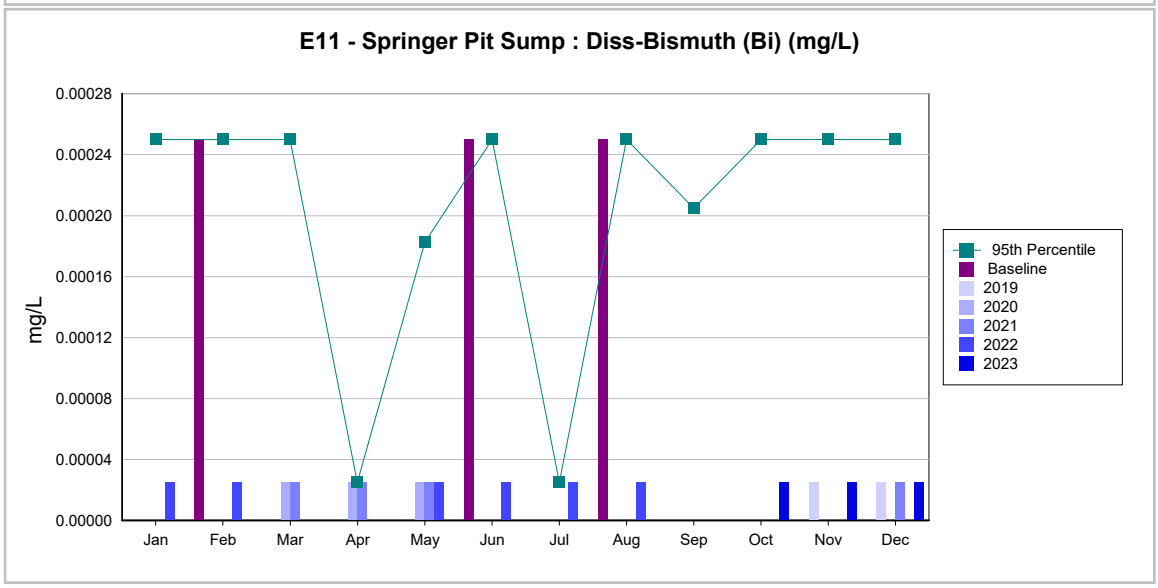
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







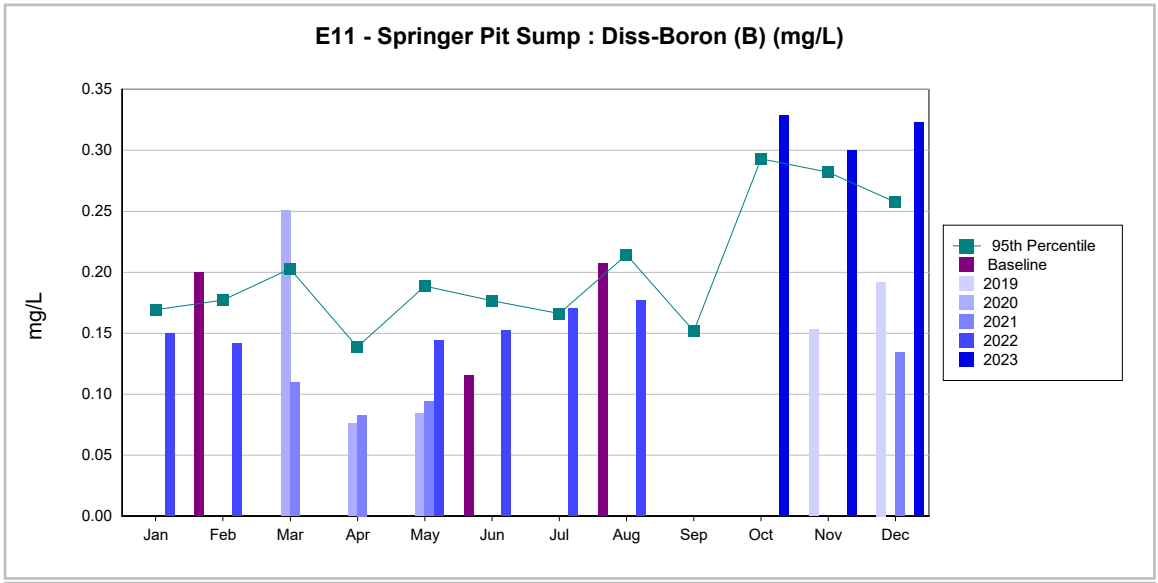
Water Quality Report

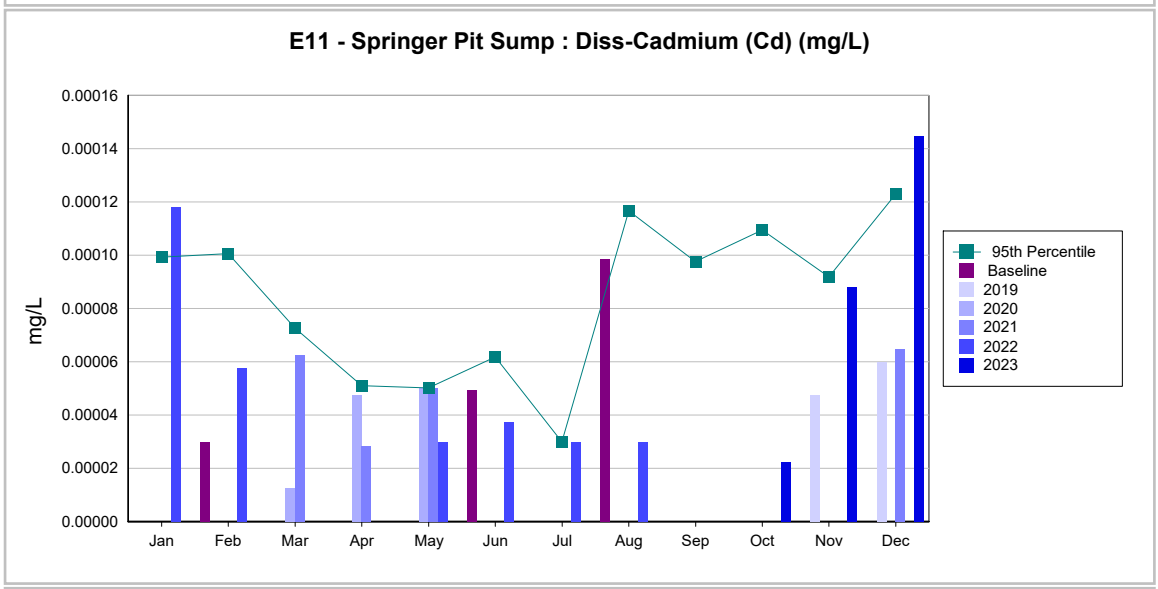
Annual Report Drainage Water

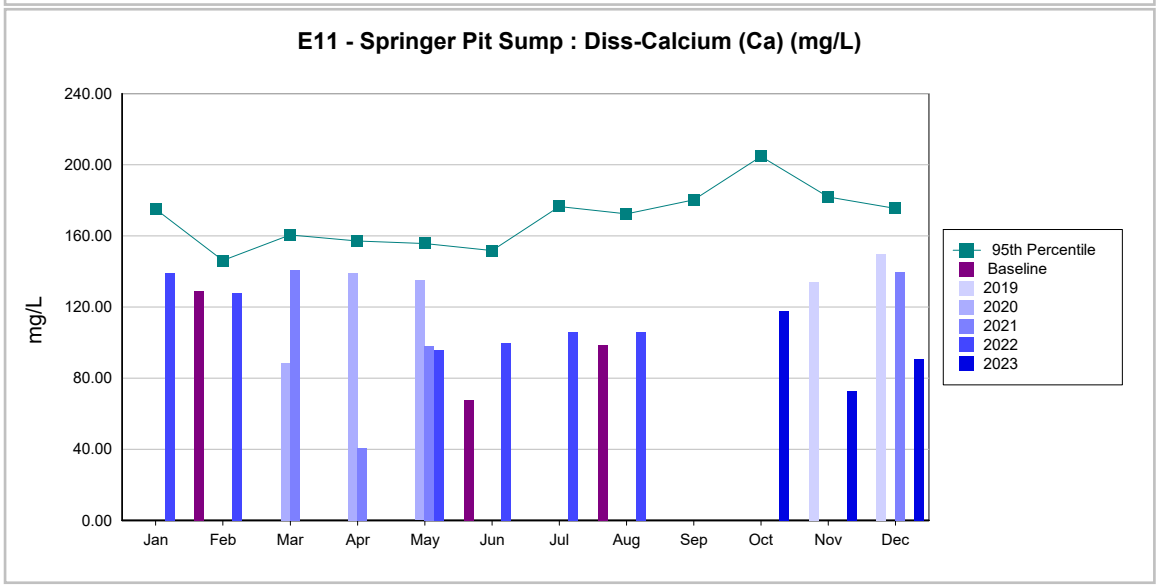
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







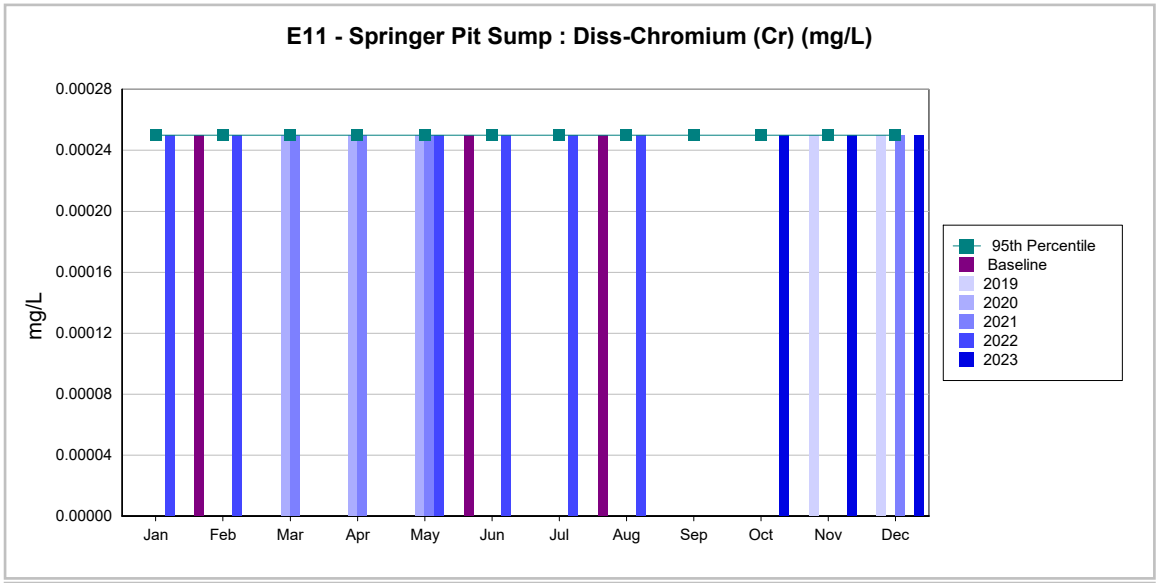
Water Quality Report

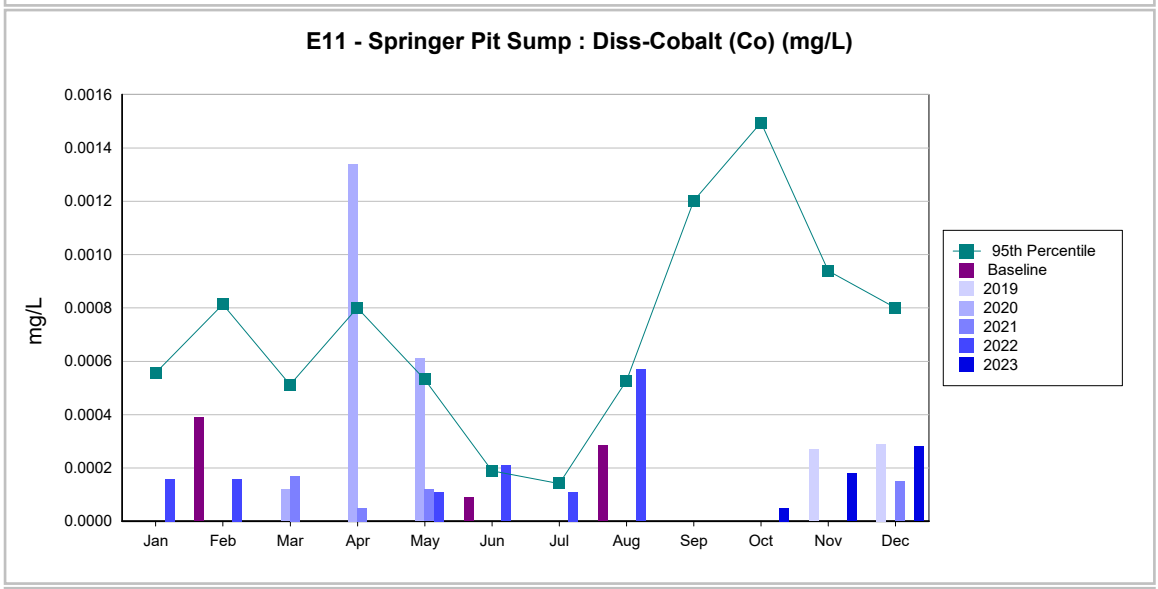
Annual Report Drainage Water

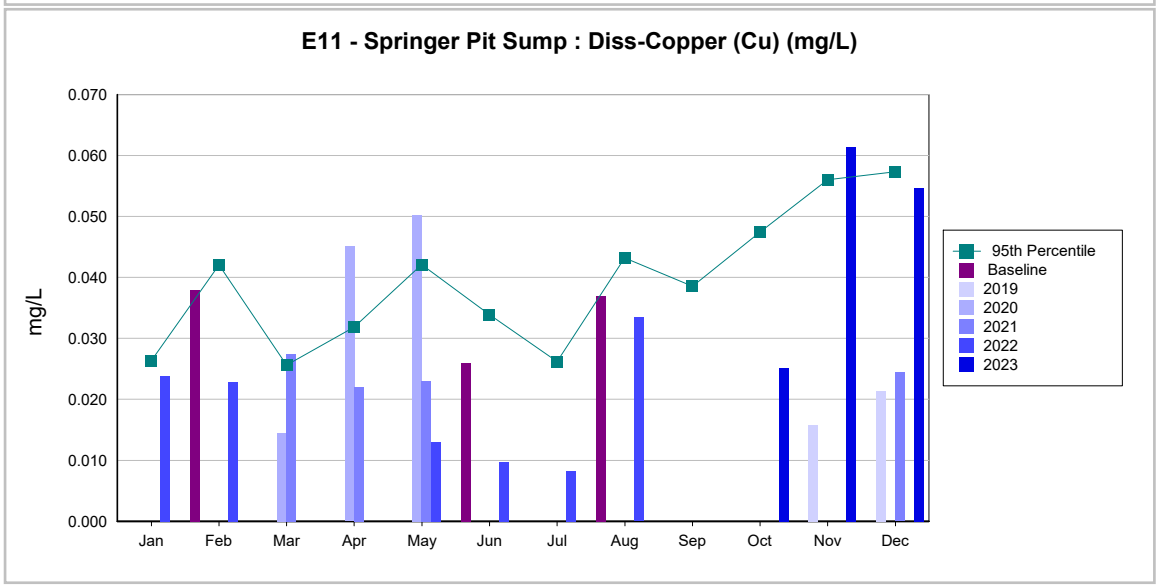
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







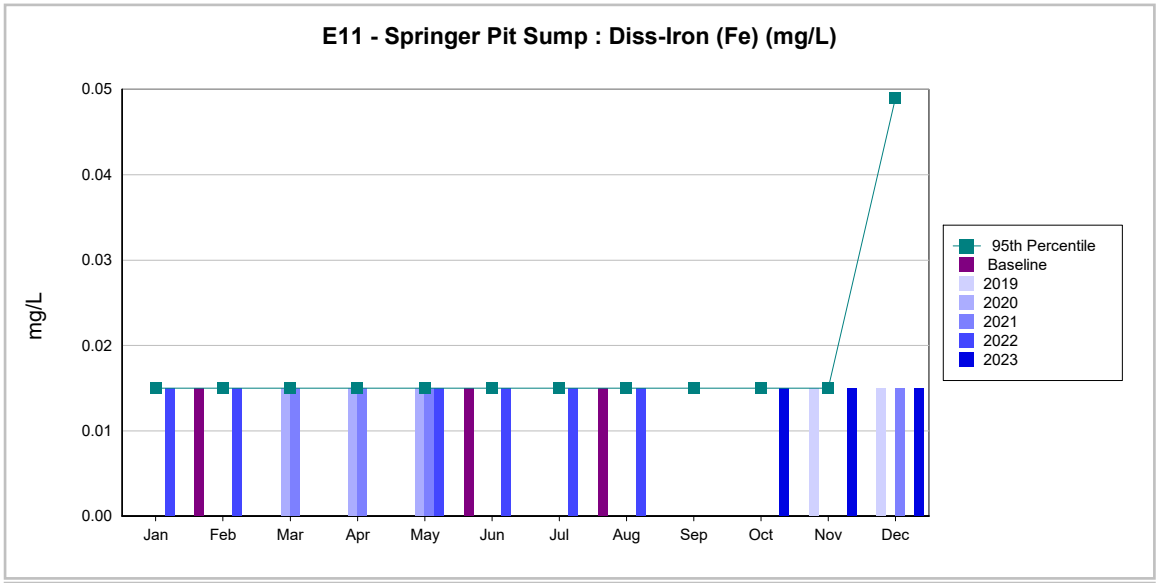
Water Quality Report

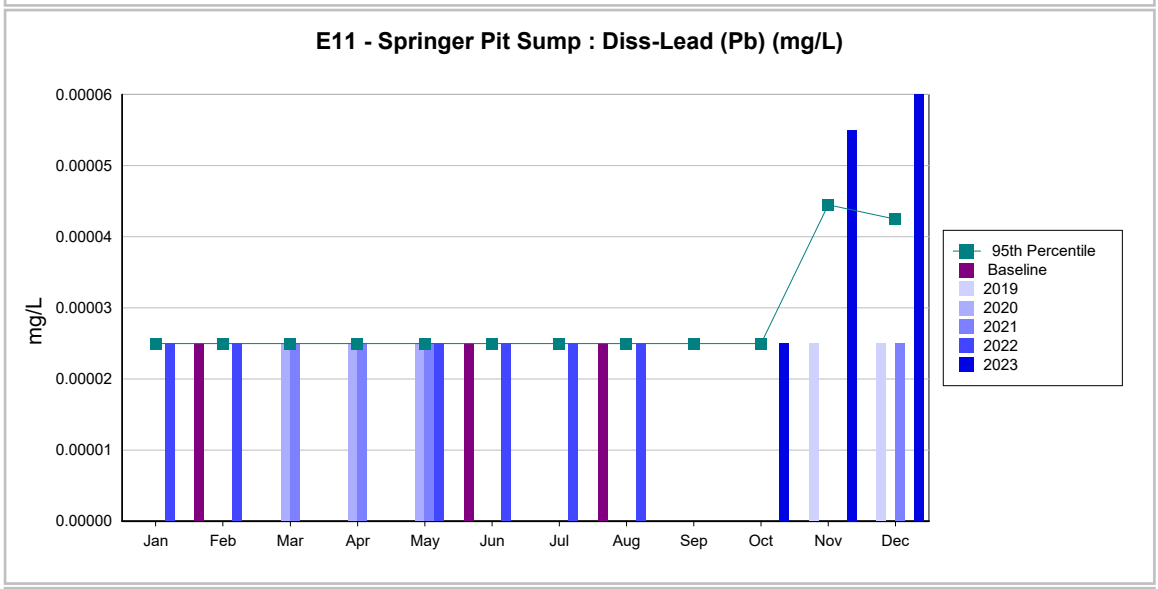
Annual Report Drainage Water

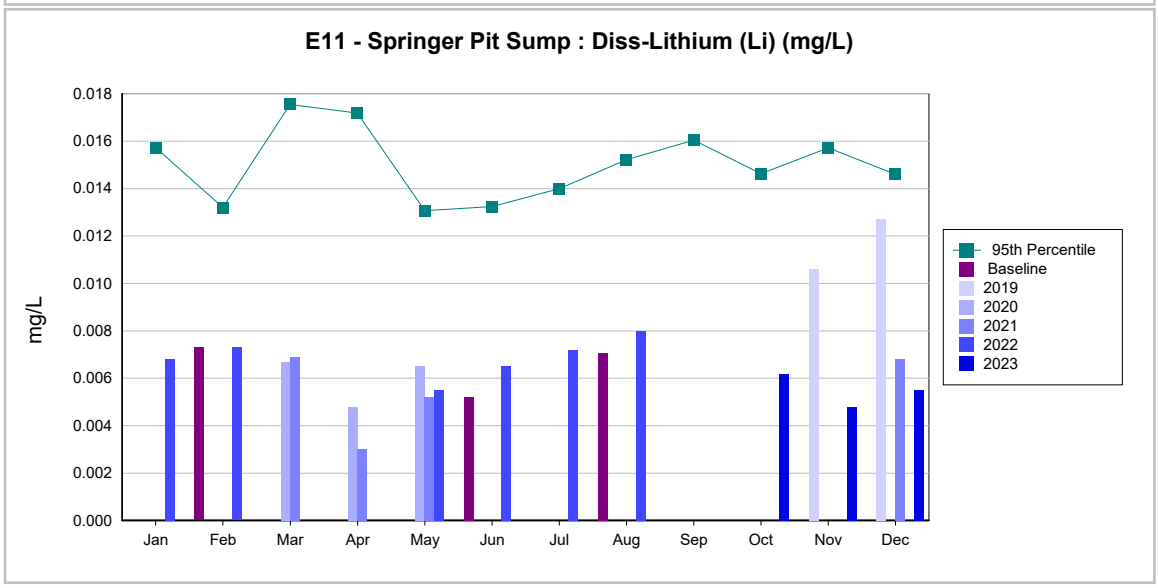
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







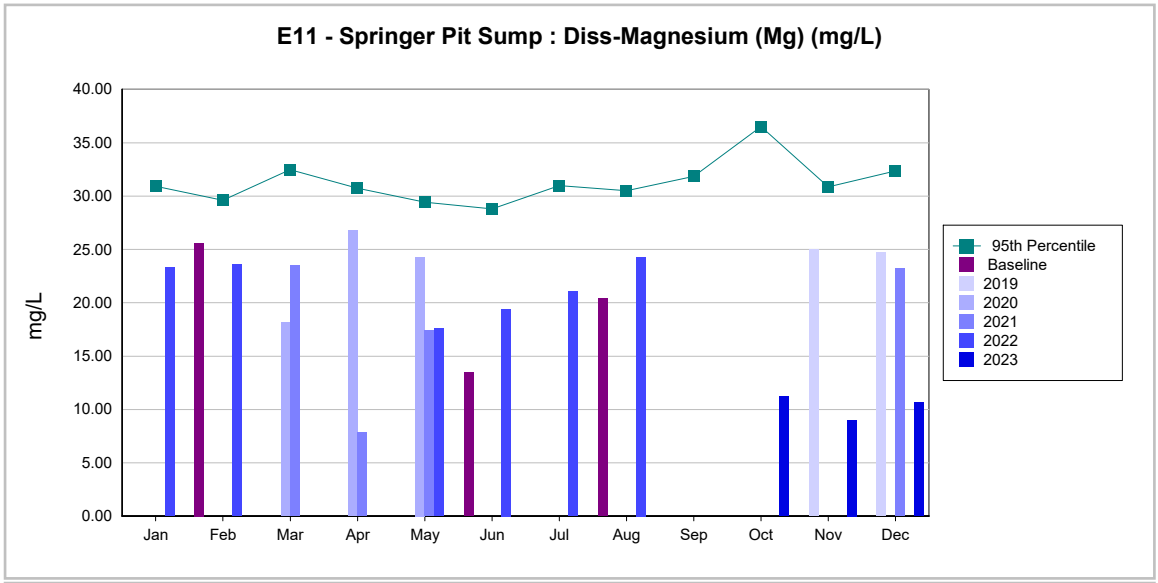
Water Quality Report

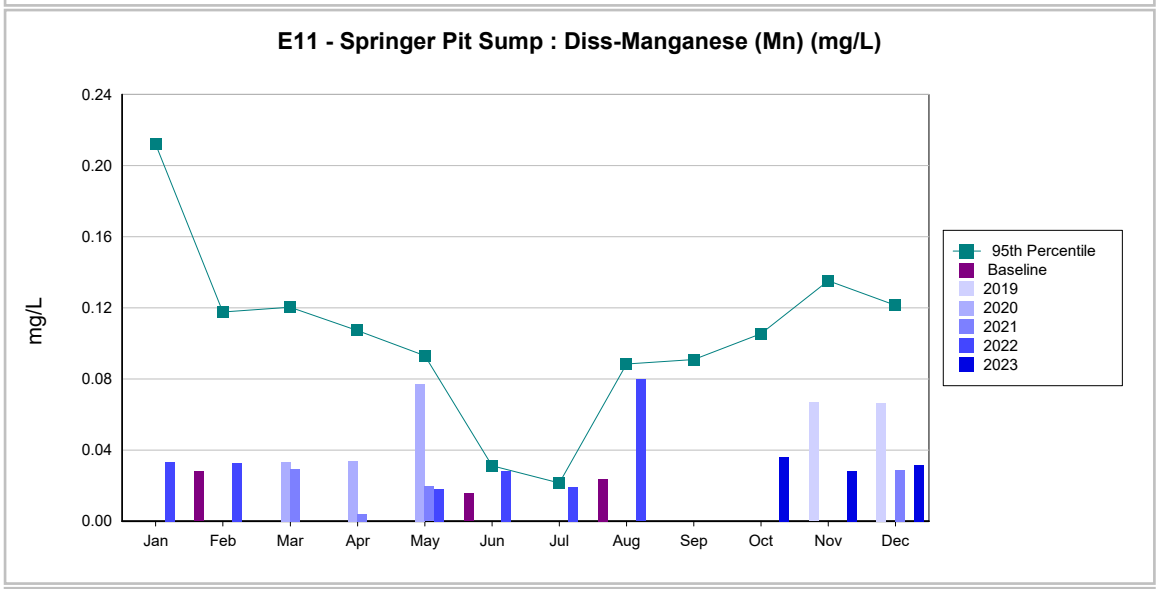
Annual Report Drainage Water

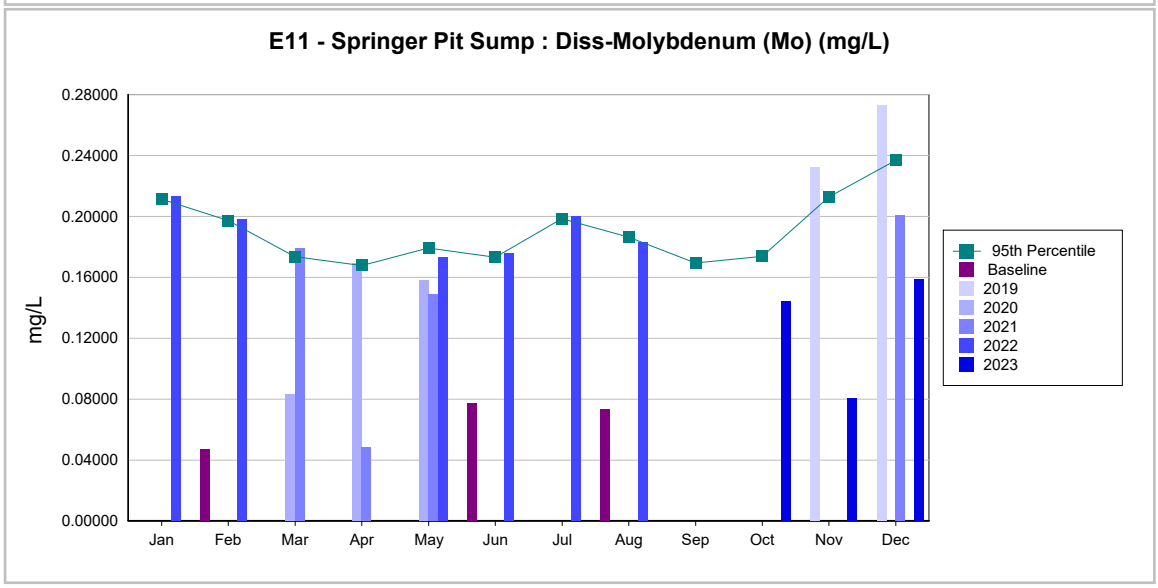
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







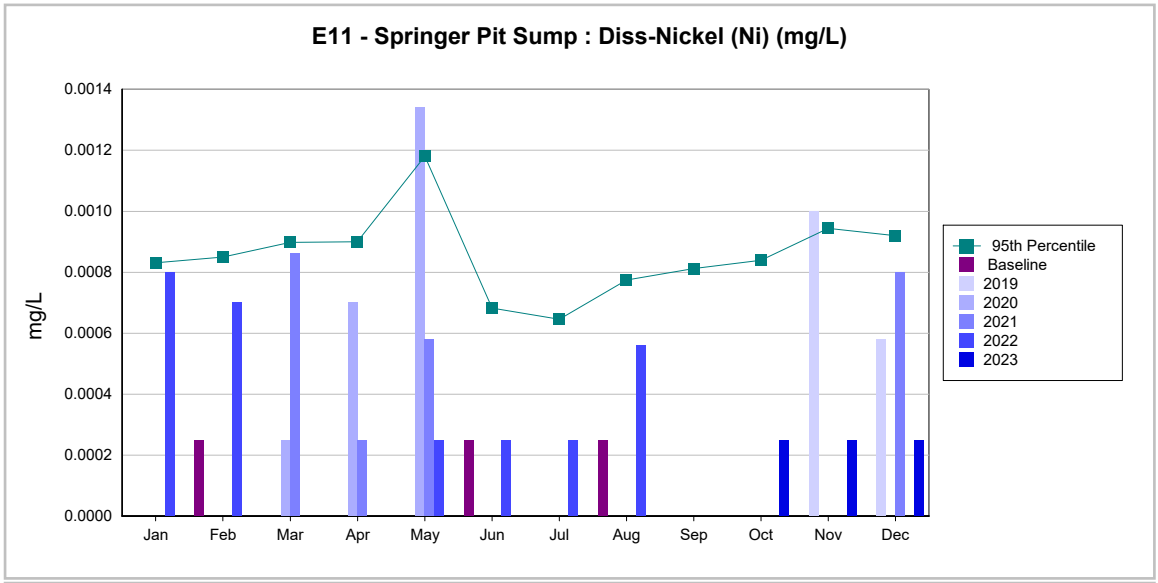
Water Quality Report

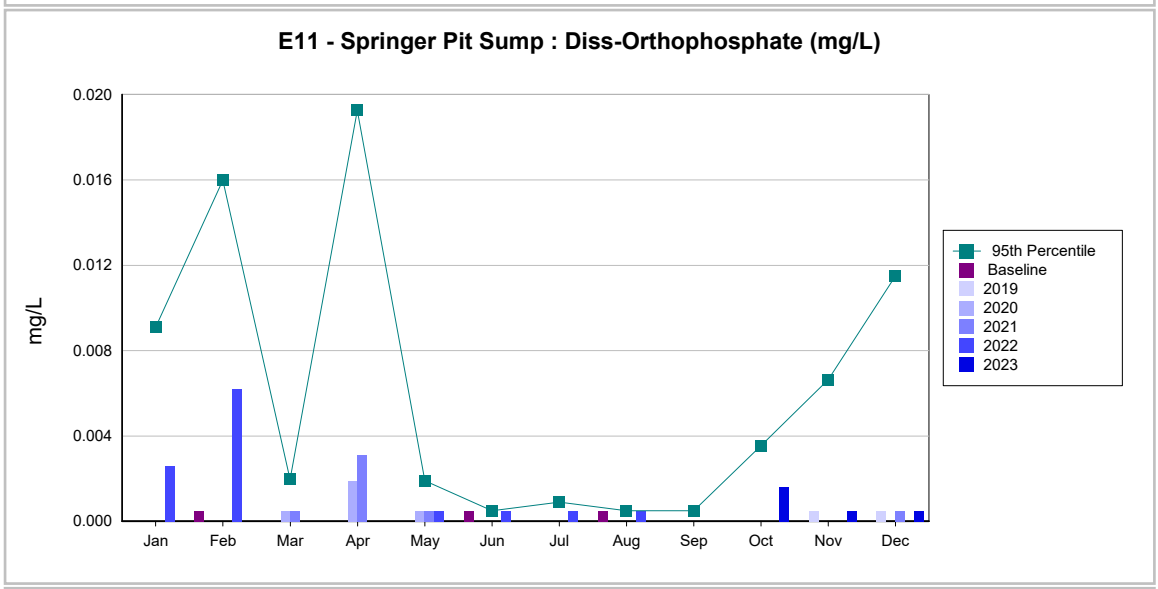
Annual Report Drainage Water

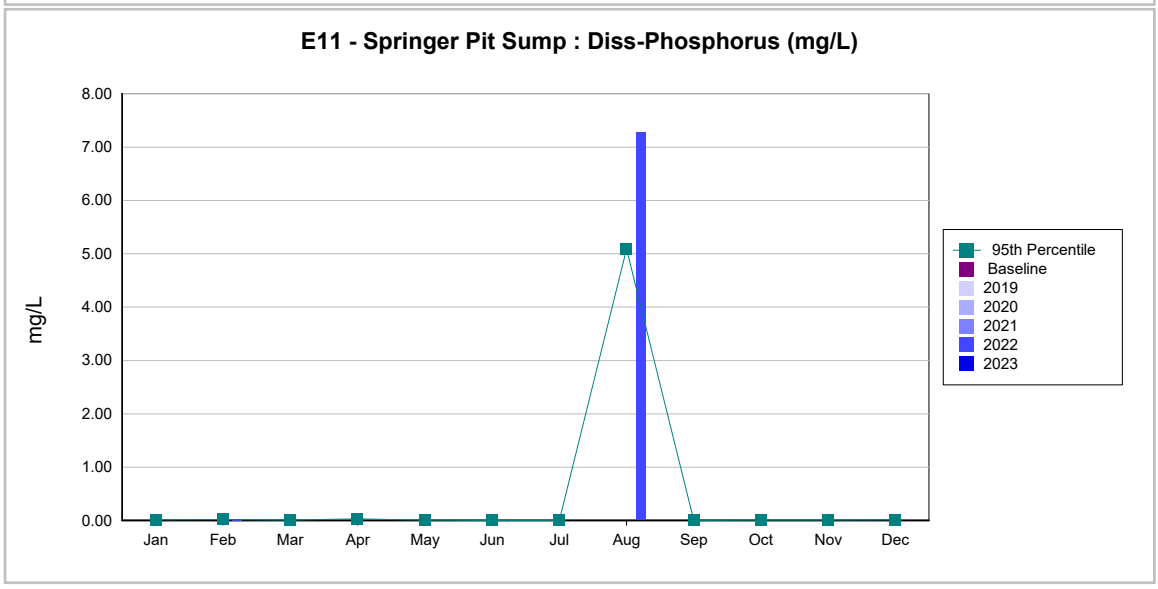
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







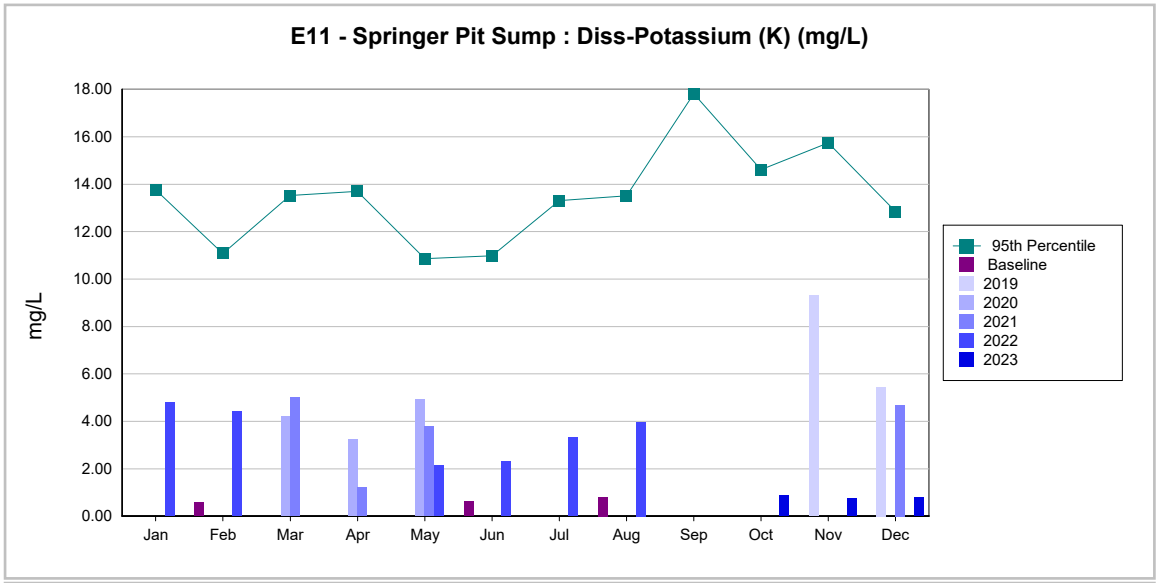
Water Quality Report

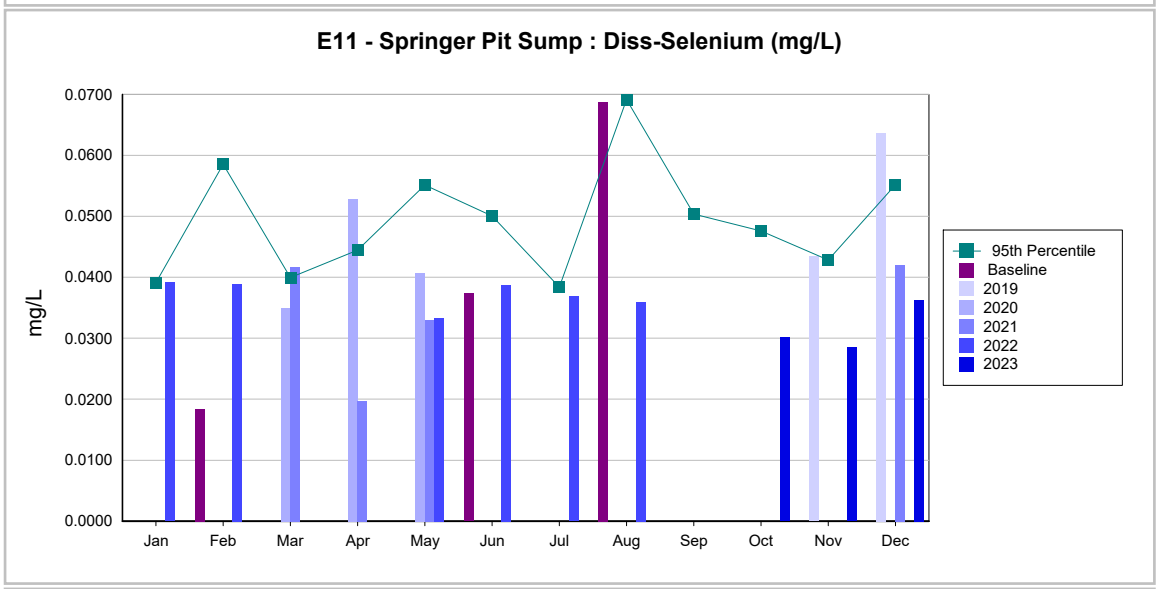
Annual Report Drainage Water

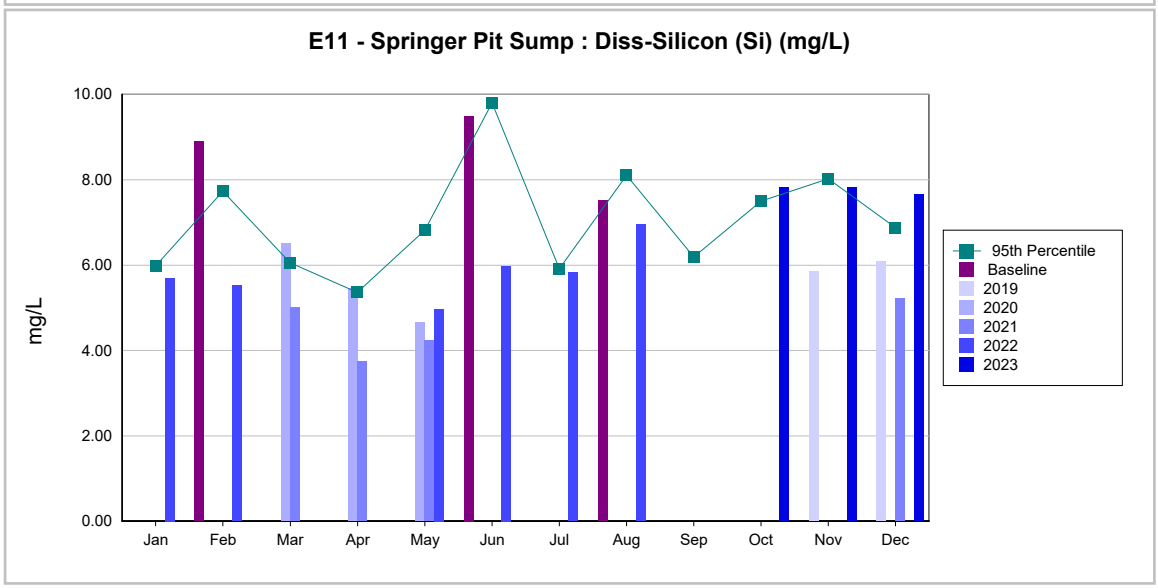
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







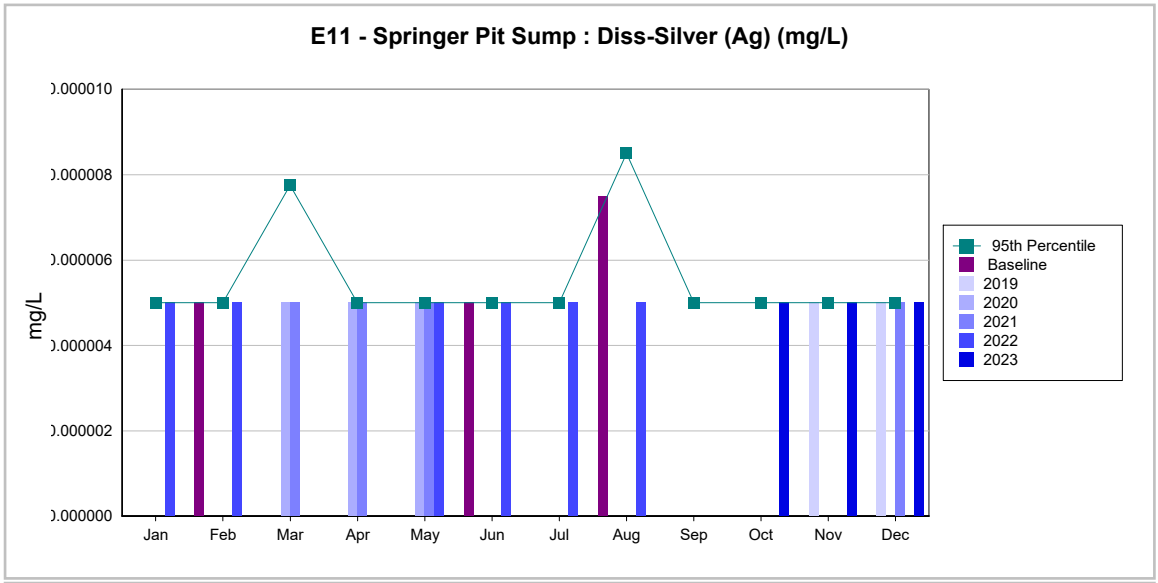
Water Quality Report

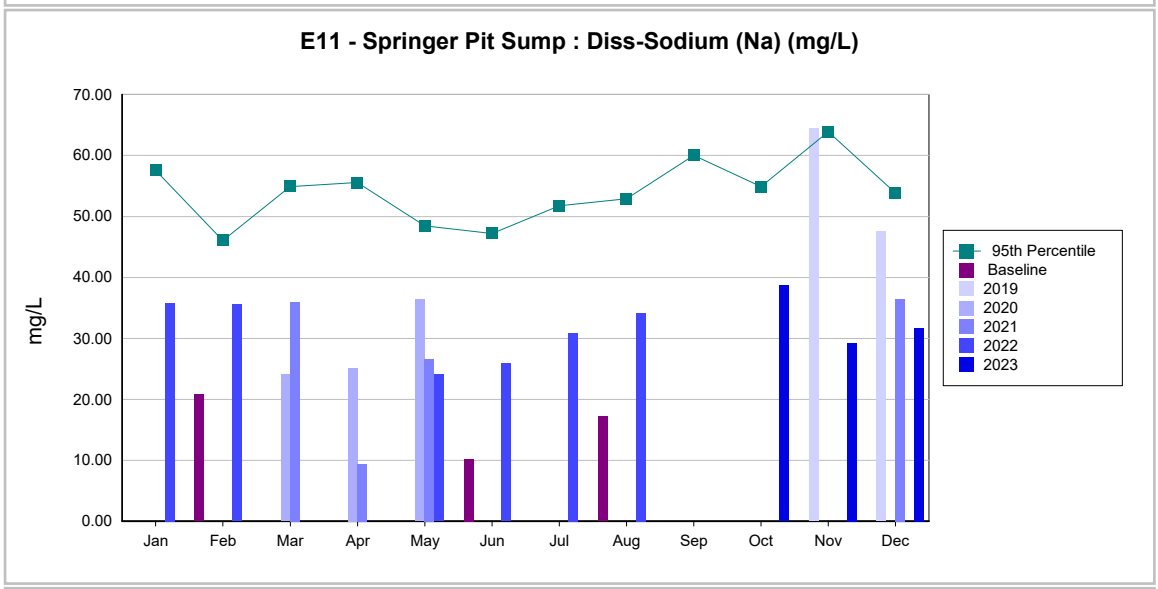
Annual Report Drainage Water

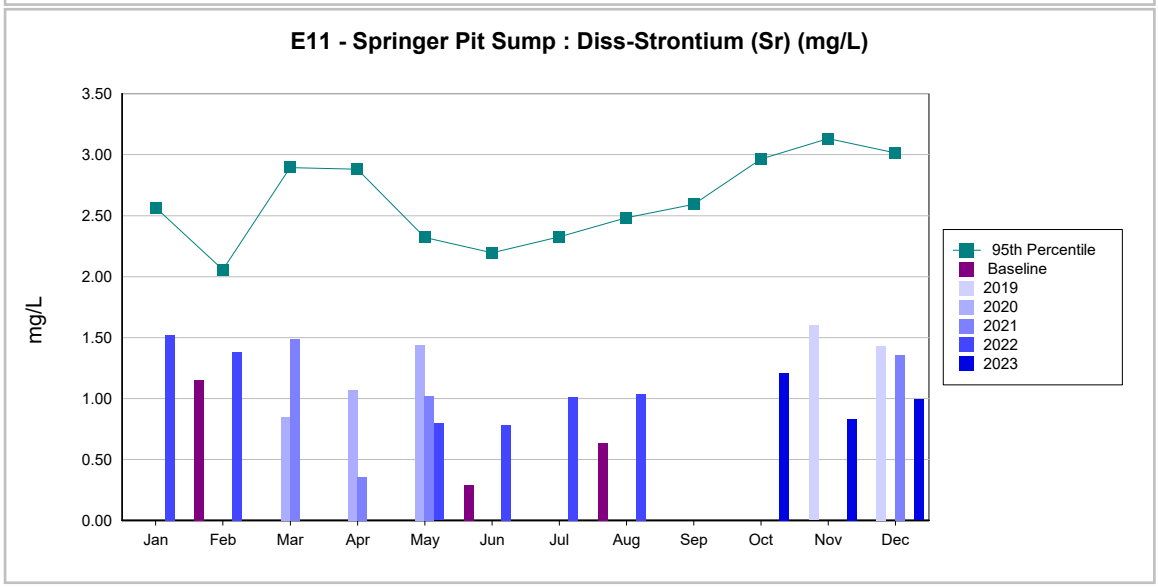
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







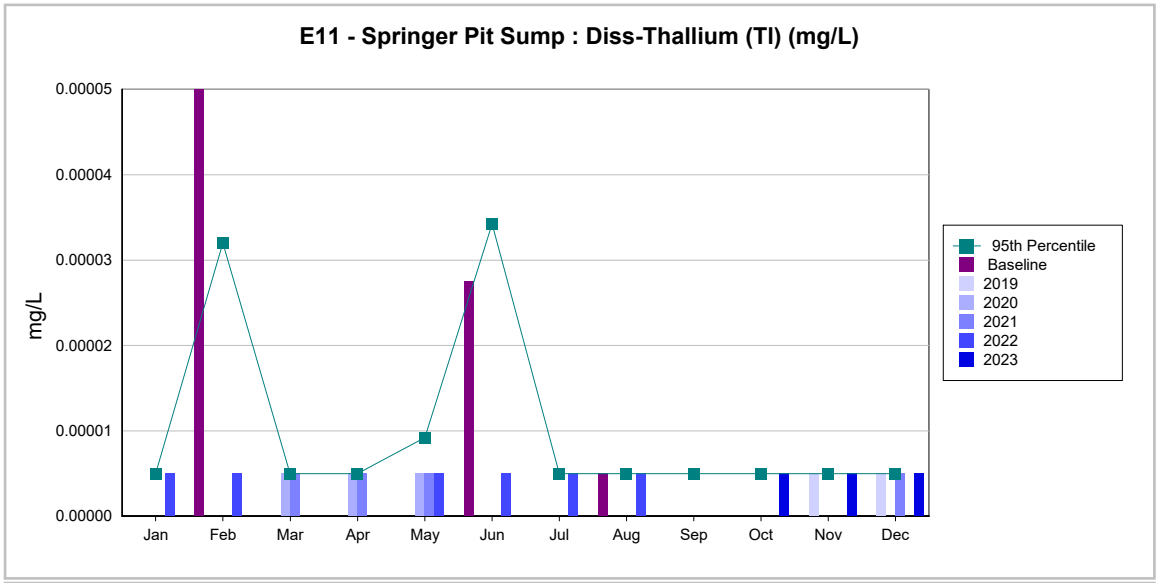
Water Quality Report

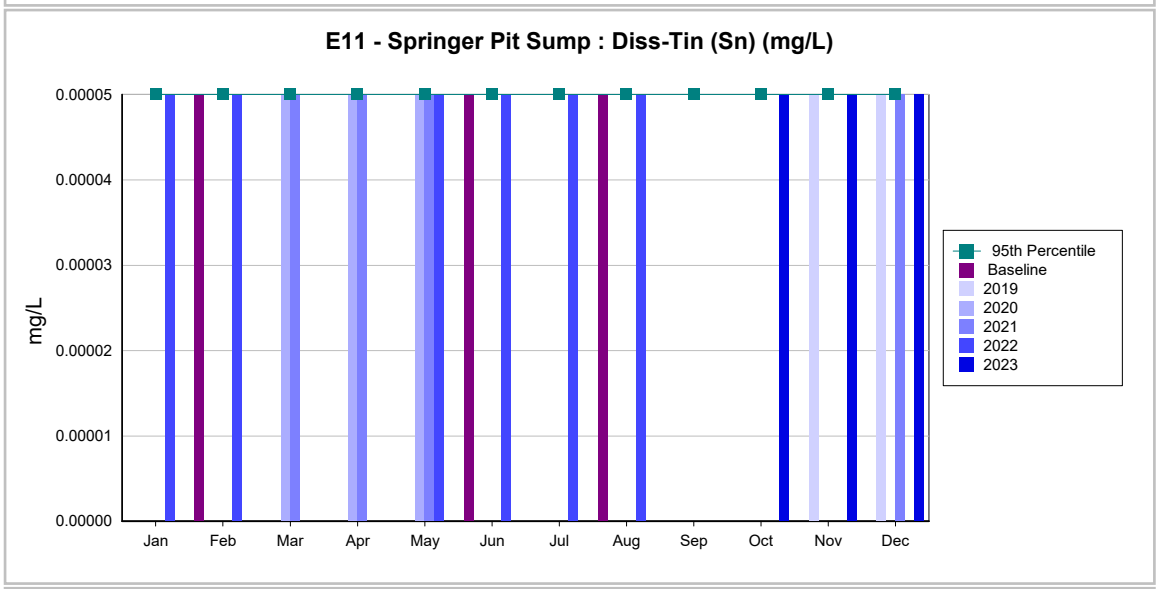
Annual Report Drainage Water

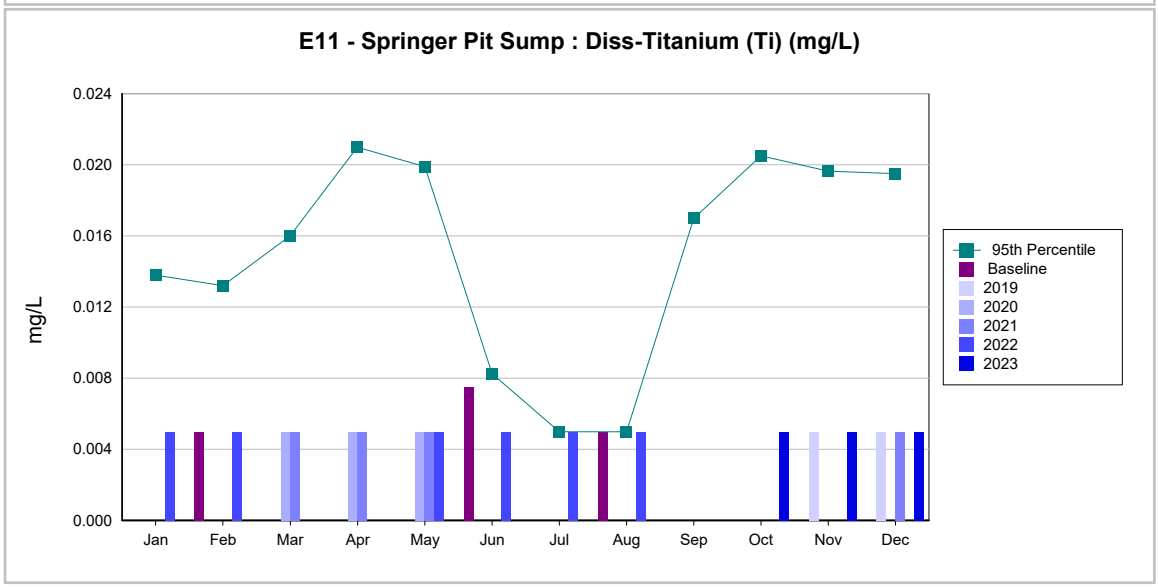
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







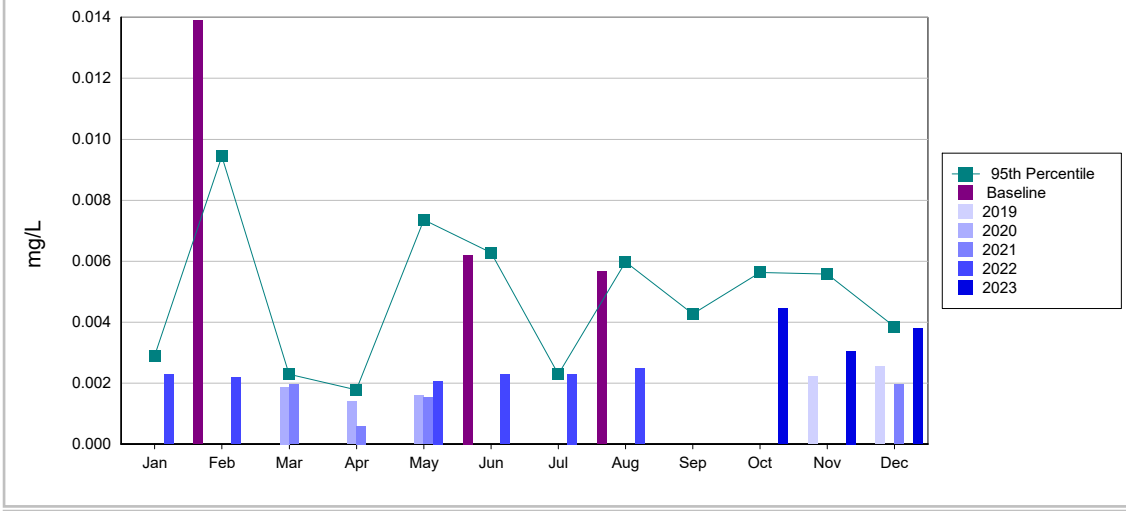
Water Quality Report

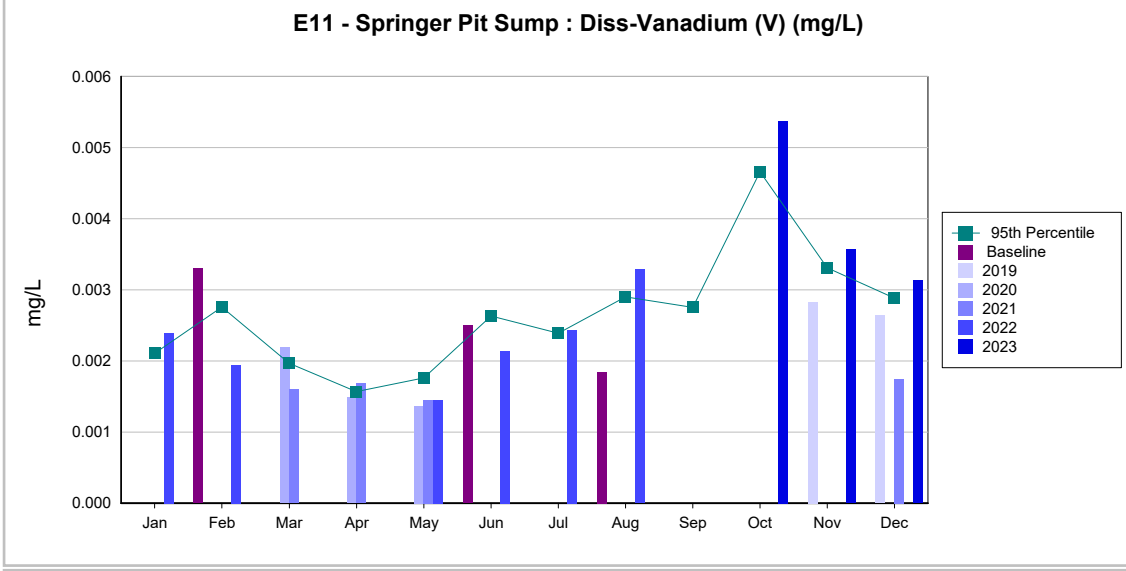
Annual Report Drainage Water

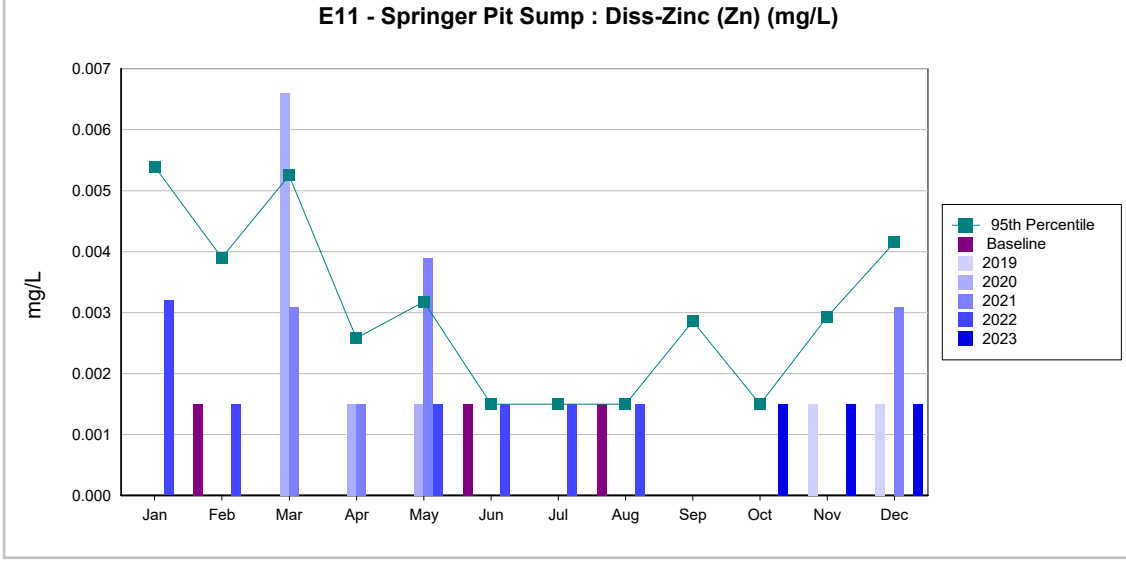
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







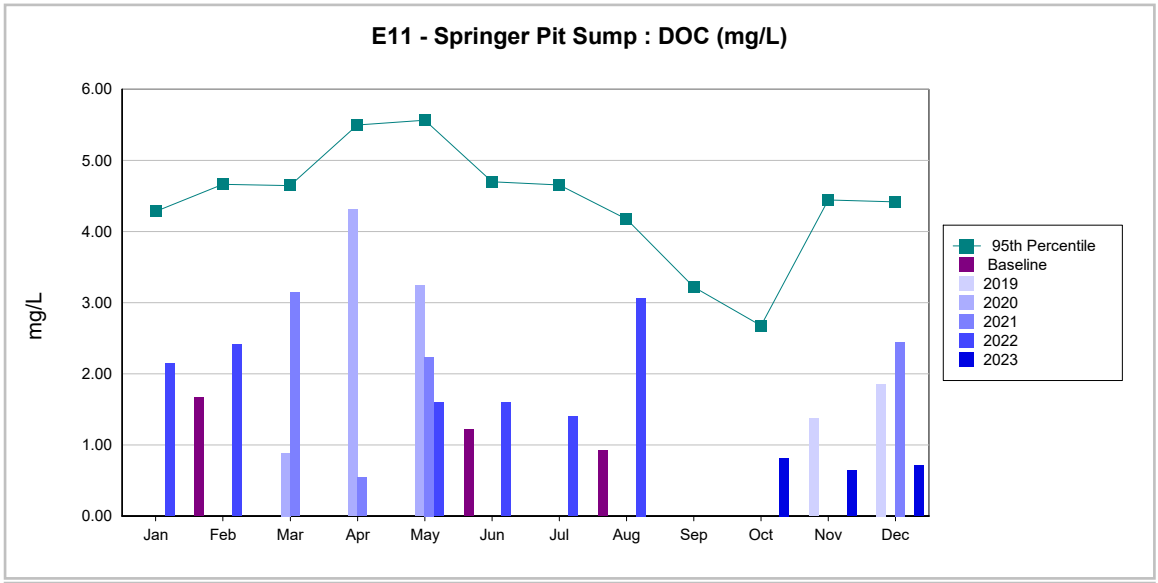
Water Quality Report

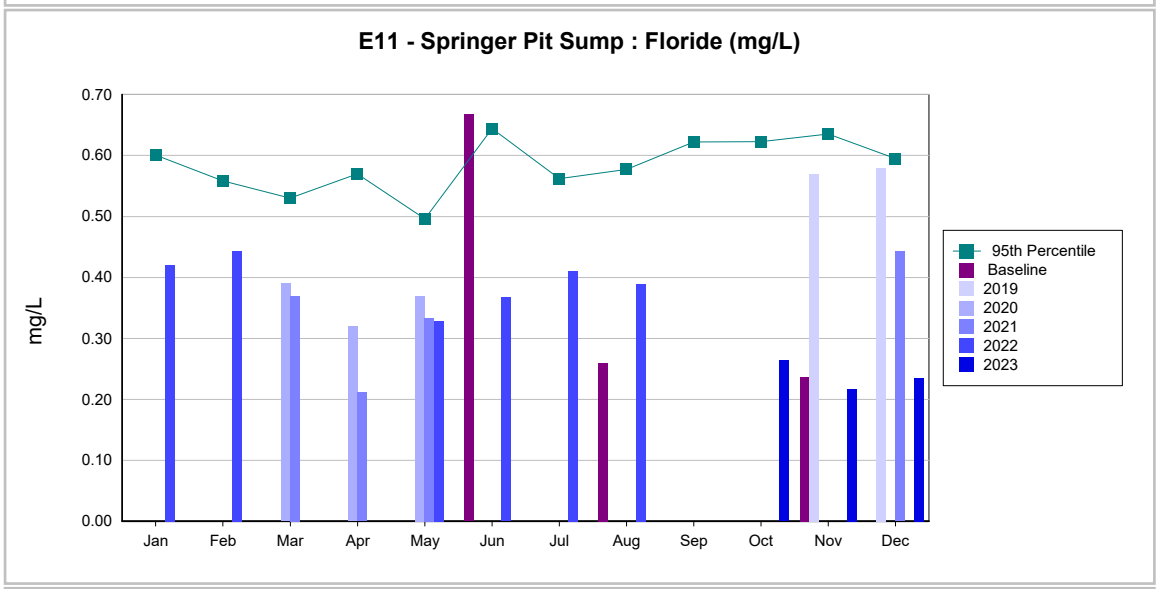
Annual Report Drainage Water

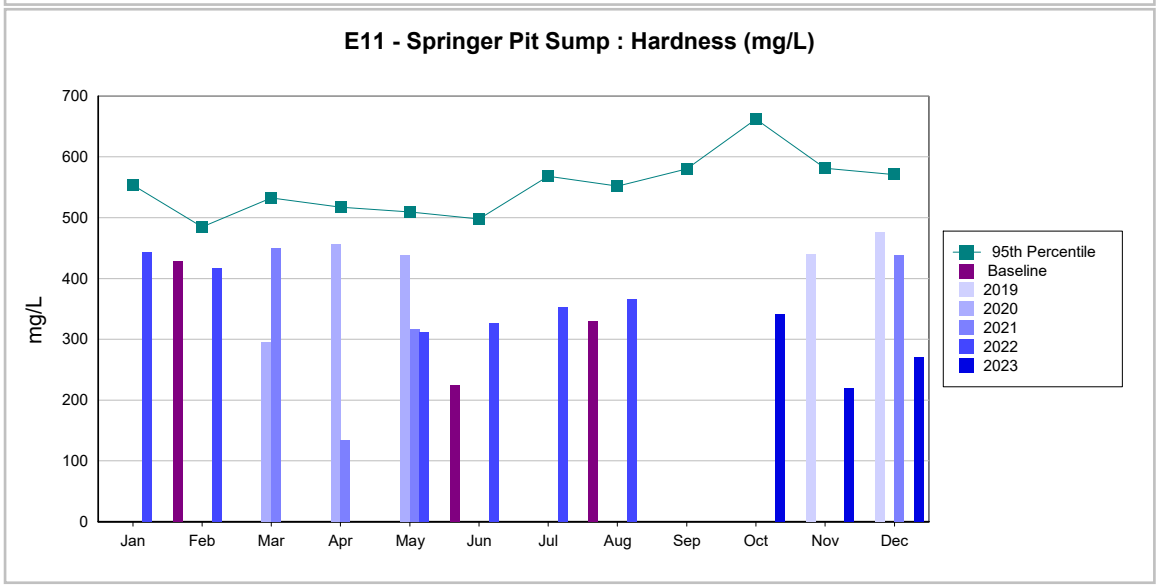
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







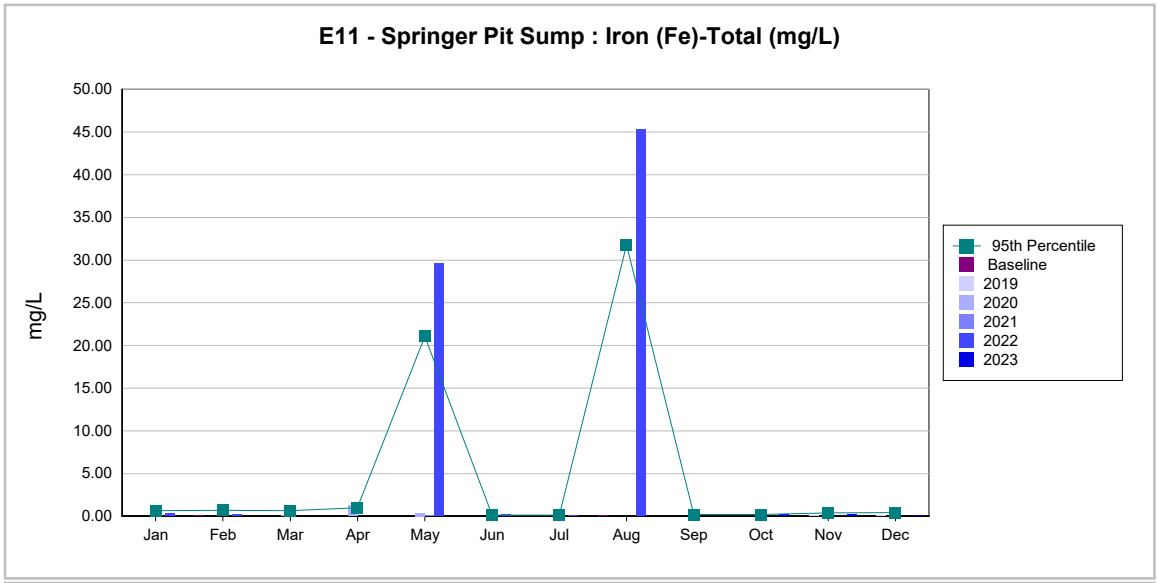
Water Quality Report

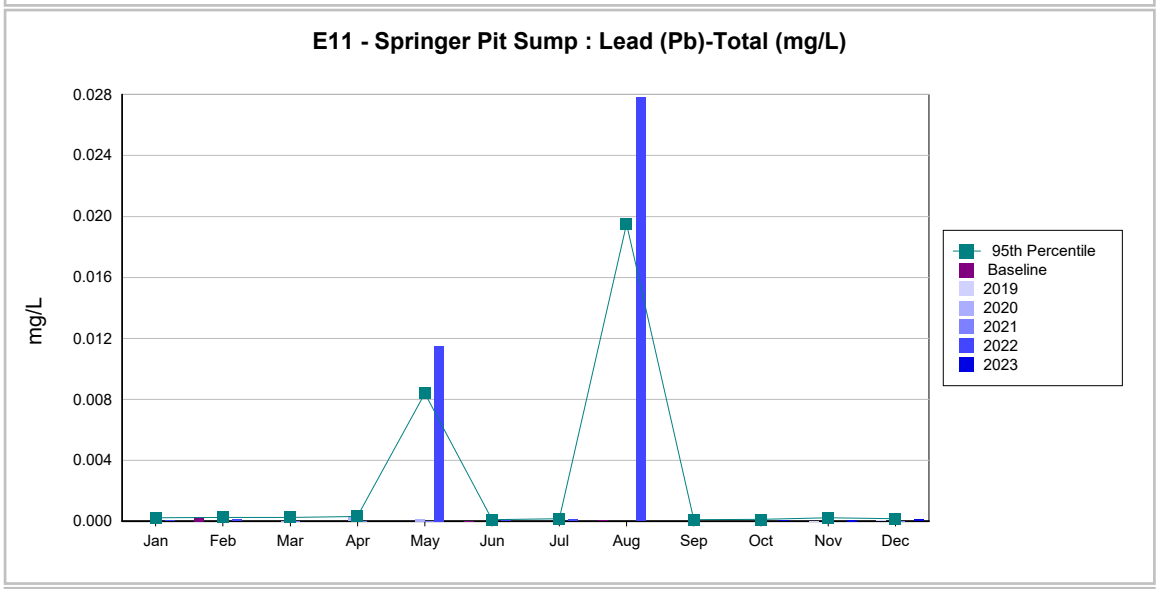
Annual Report Drainage Water

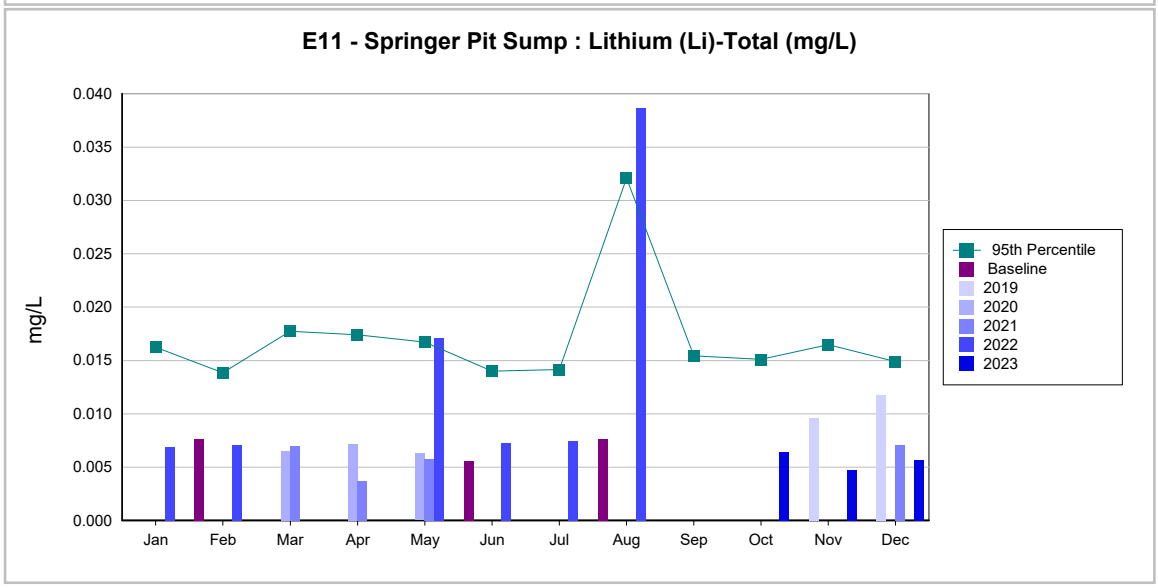
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







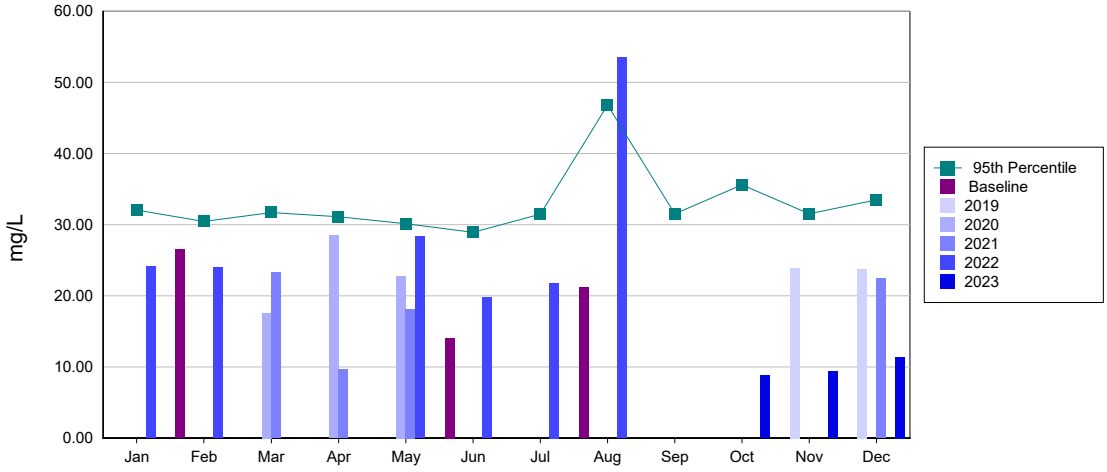
Water Quality Report

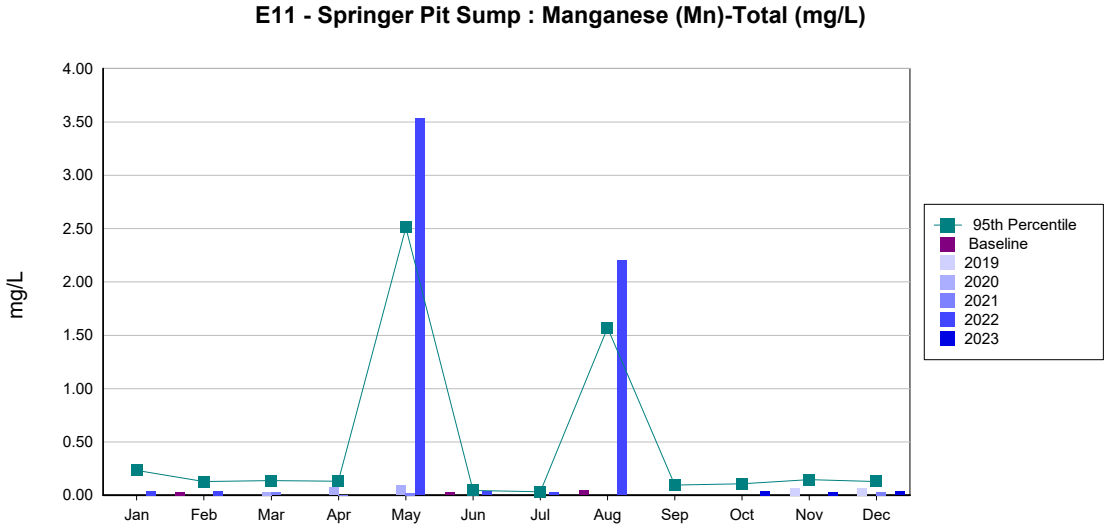
Annual Report Drainage Water

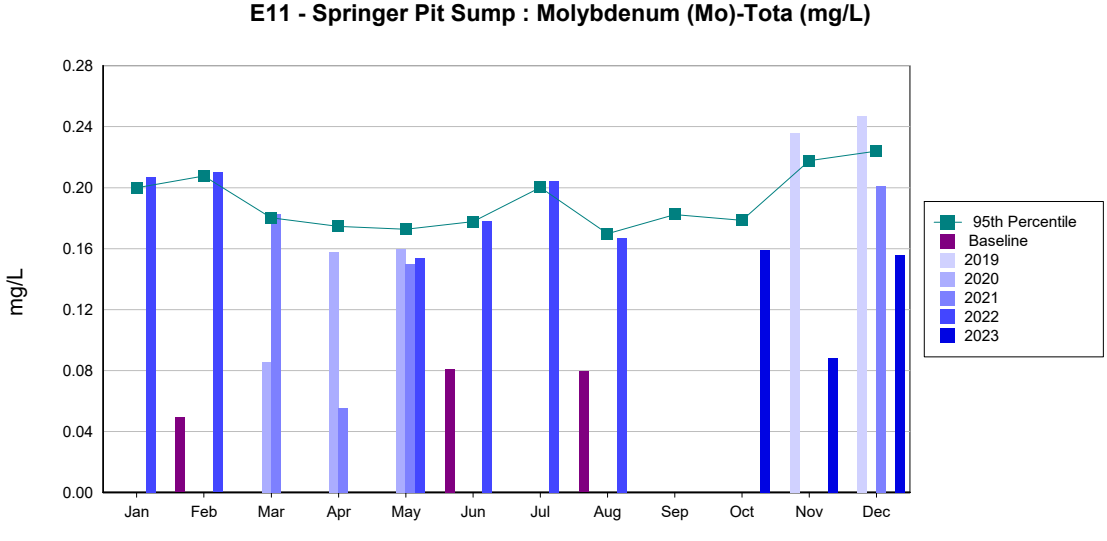
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







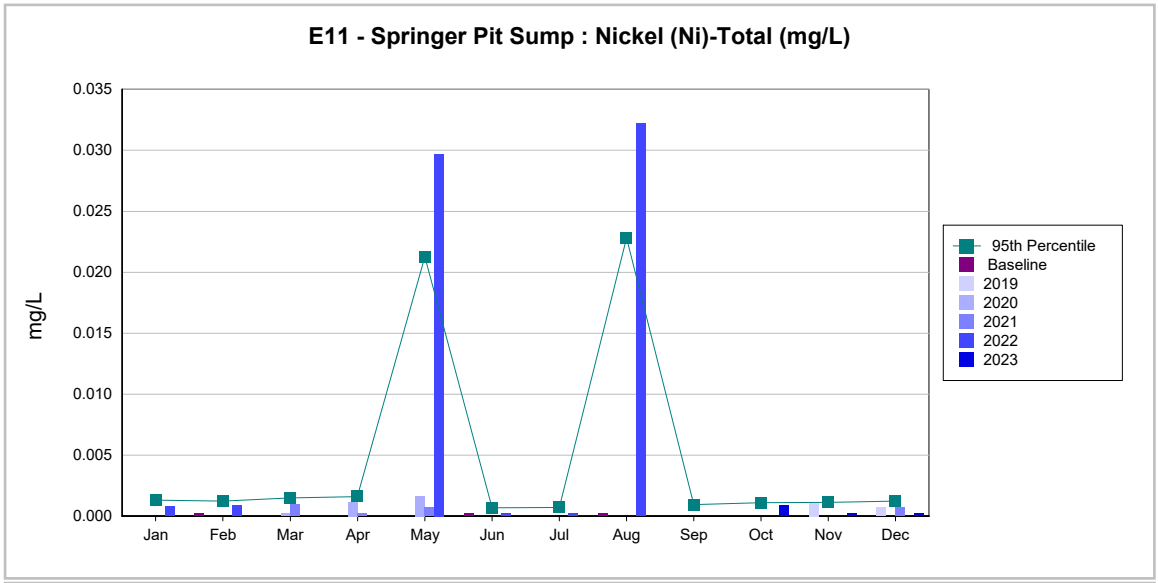
Water Quality Report

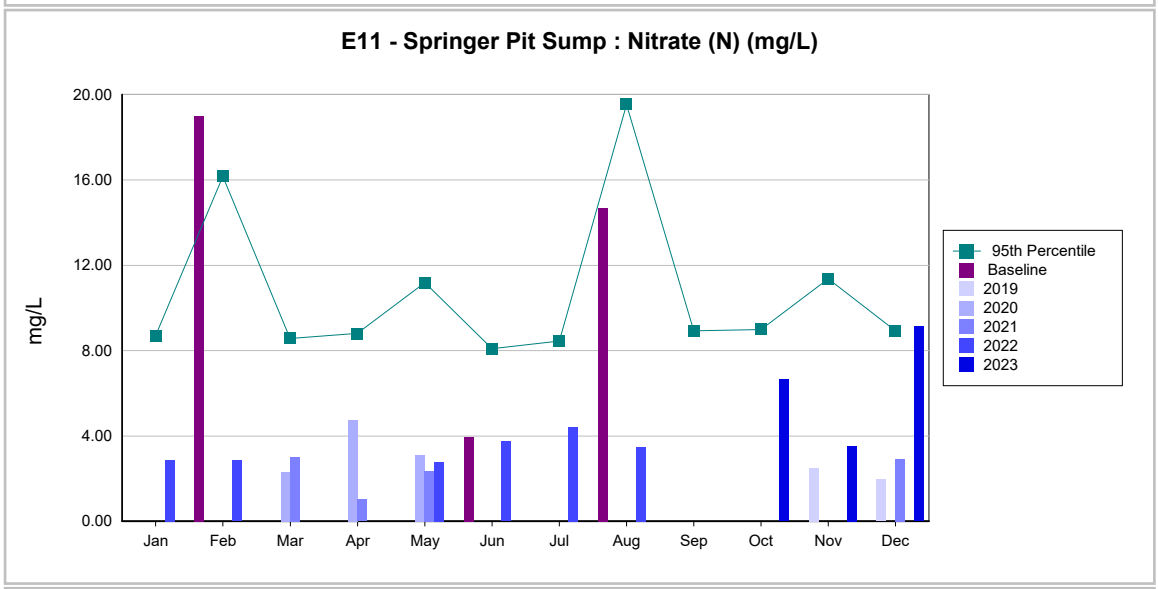
Annual Report Drainage Water

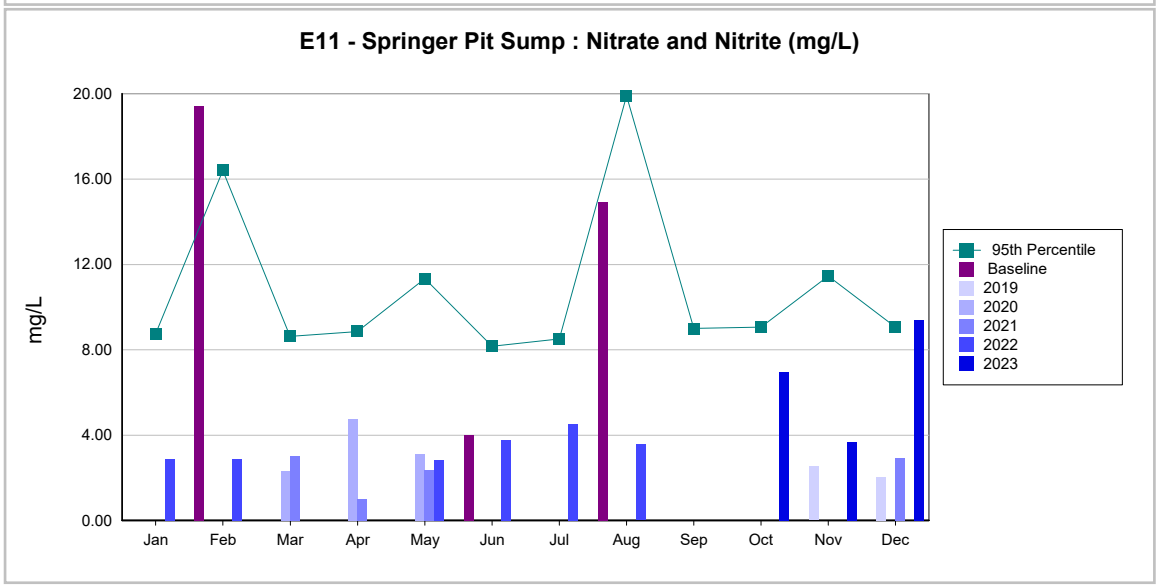
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







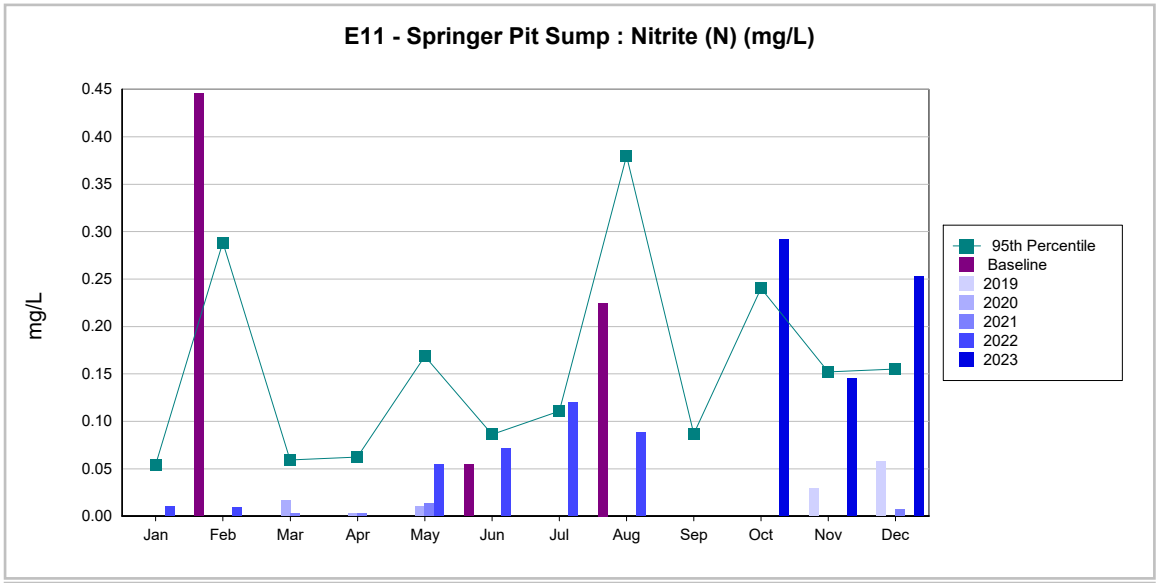
Water Quality Report

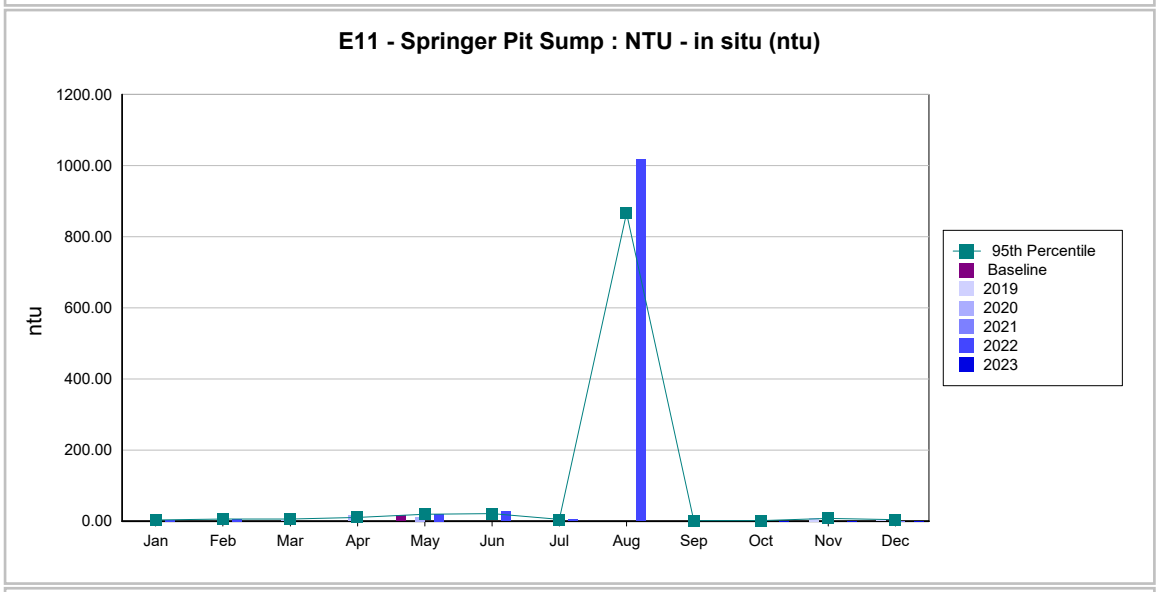
Annual Report Drainage Water

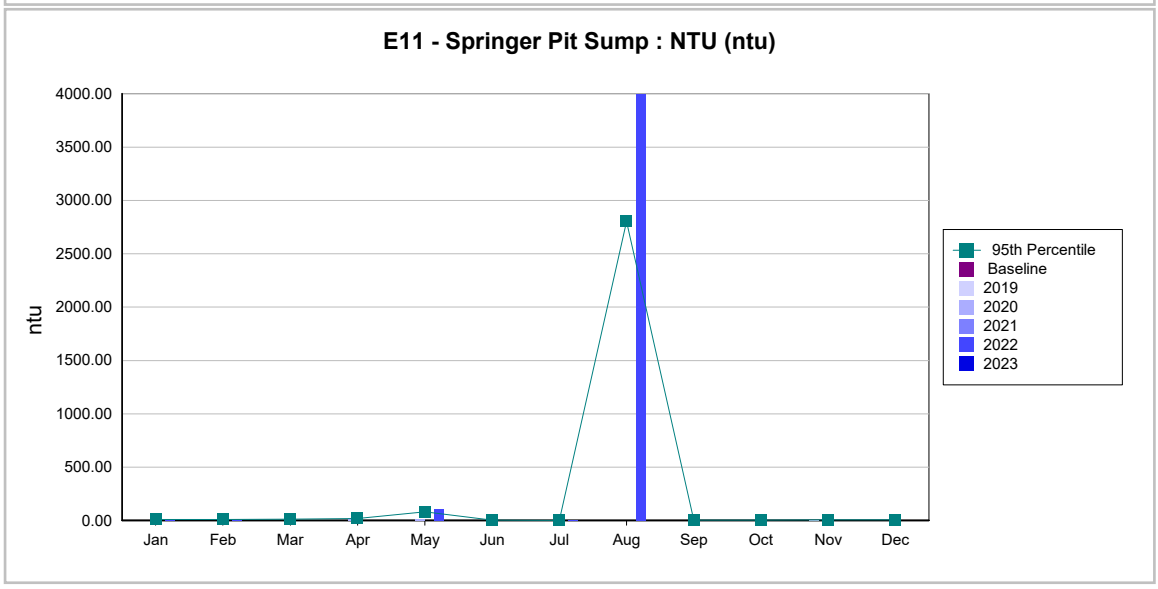
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







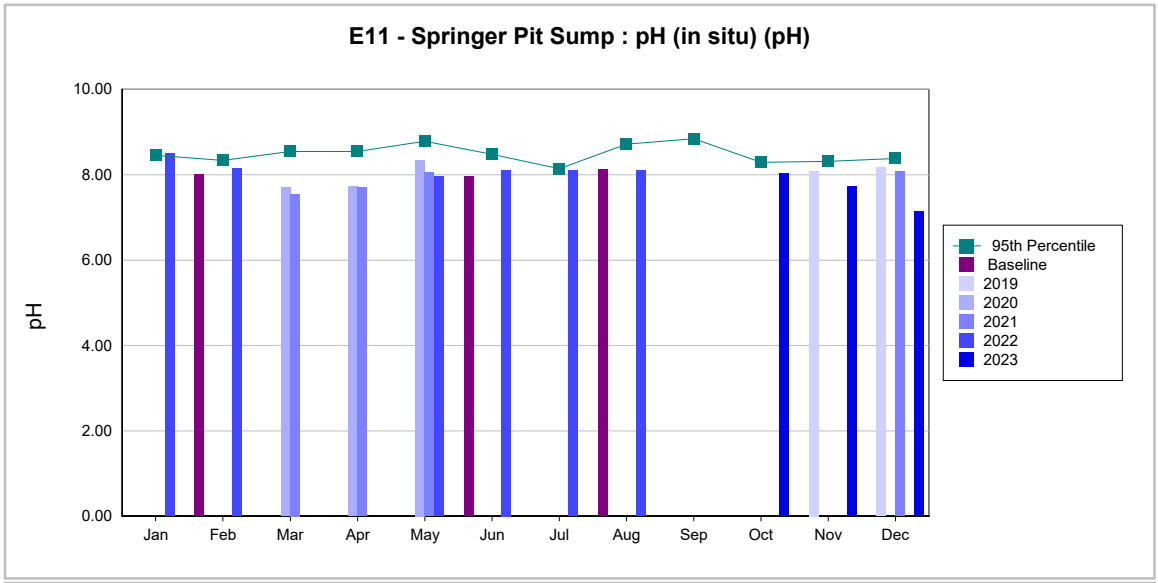
Water Quality Report

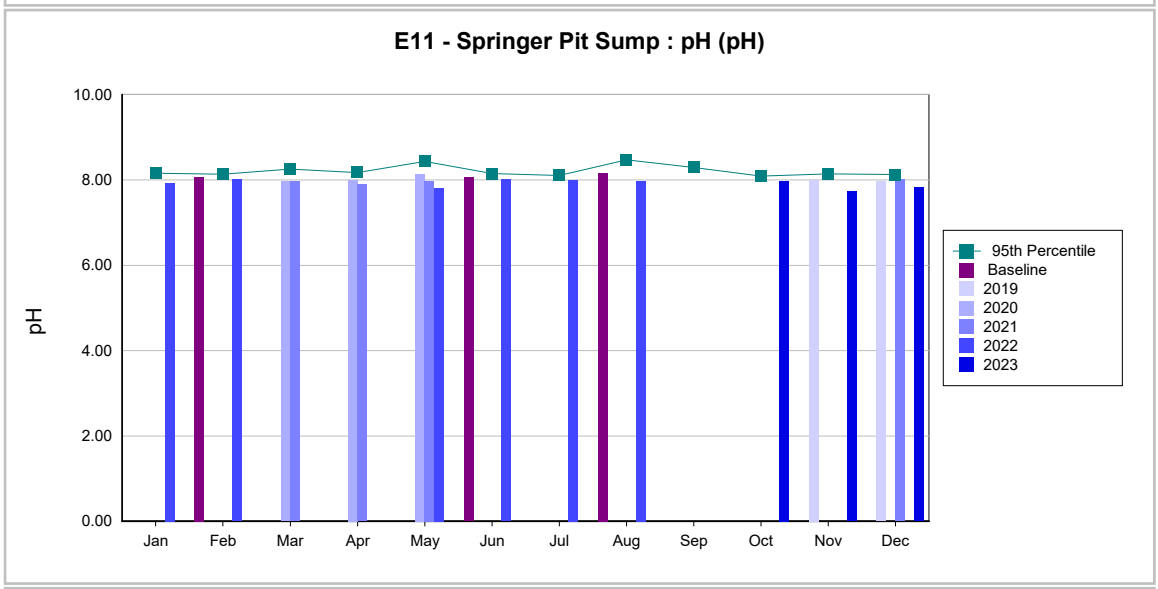
Annual Report Drainage Water

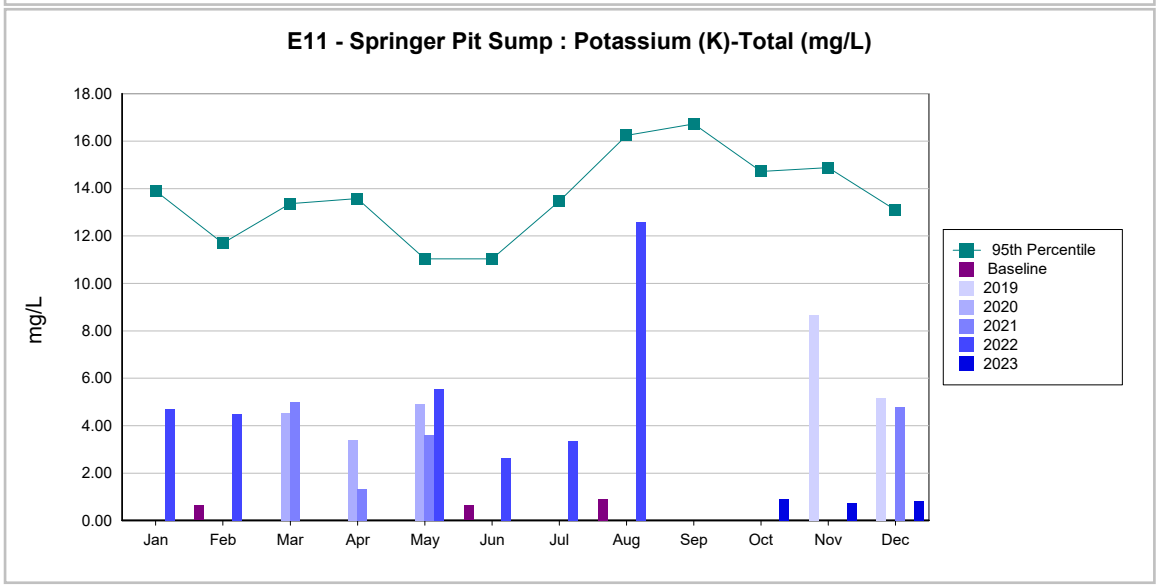
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







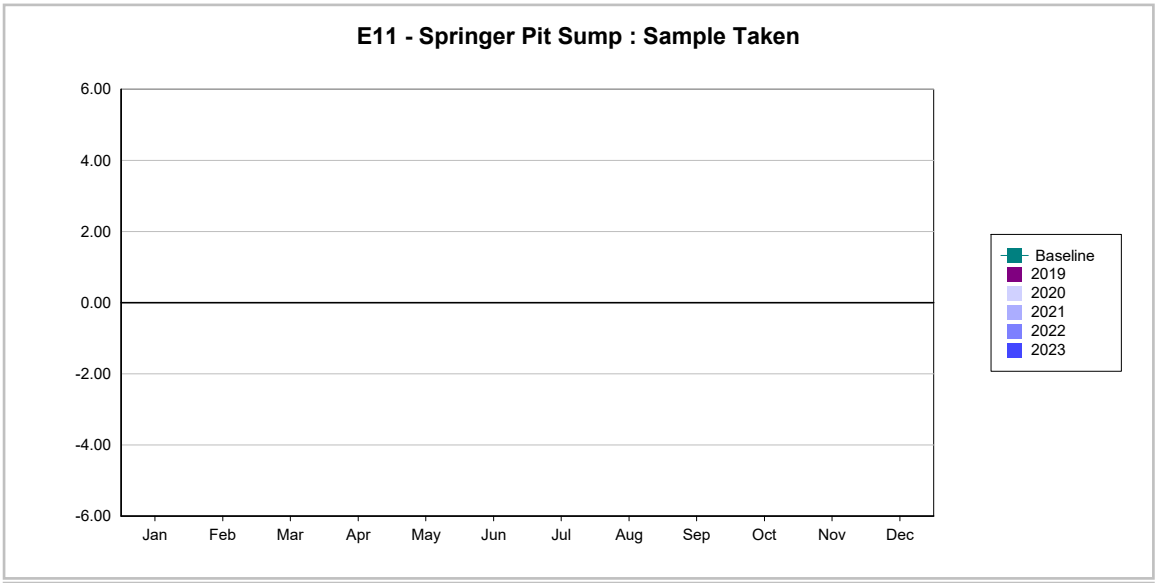
Water Quality Report

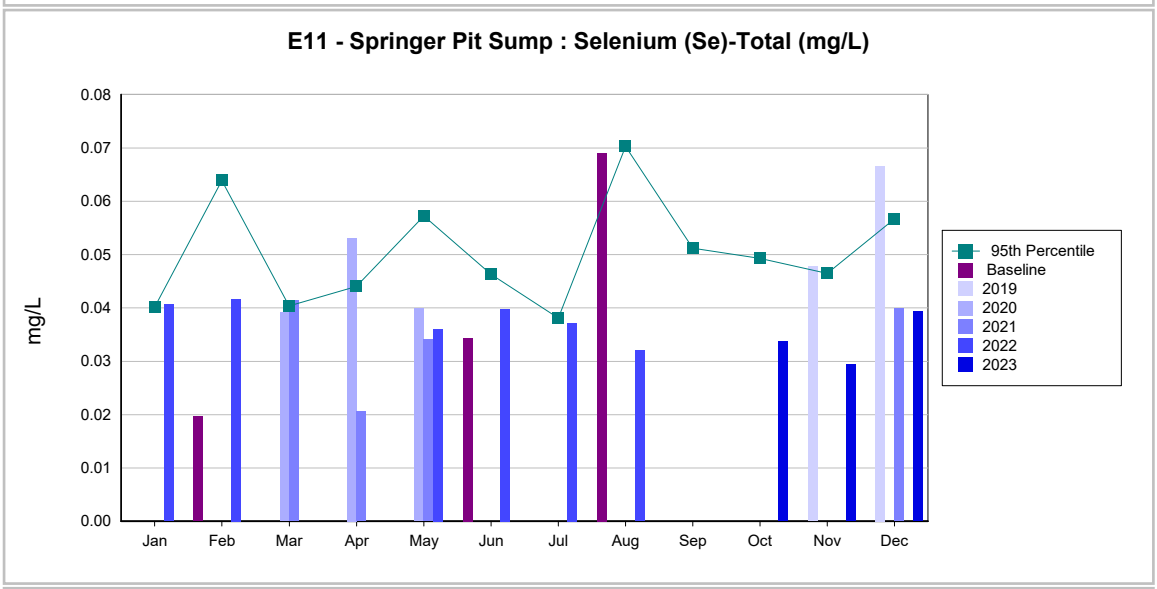
Annual Report Drainage Water

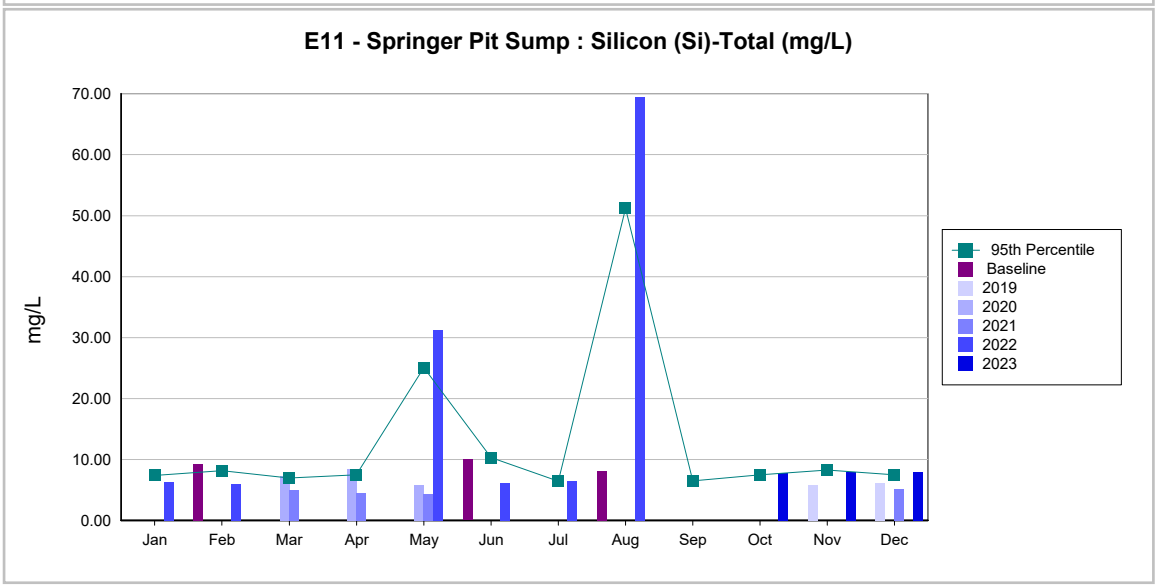
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







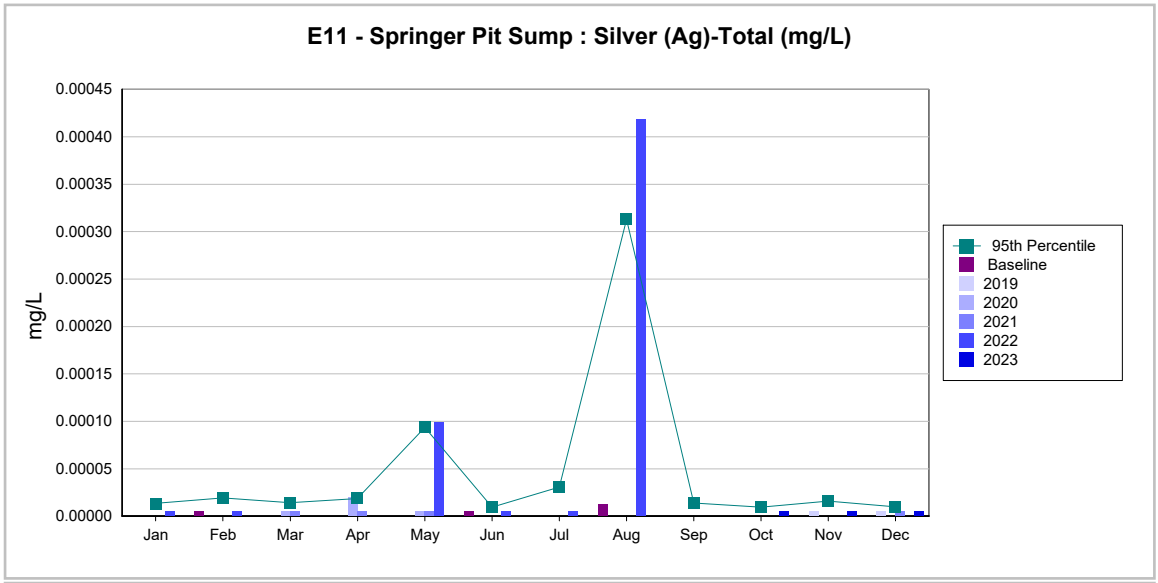
Water Quality Report

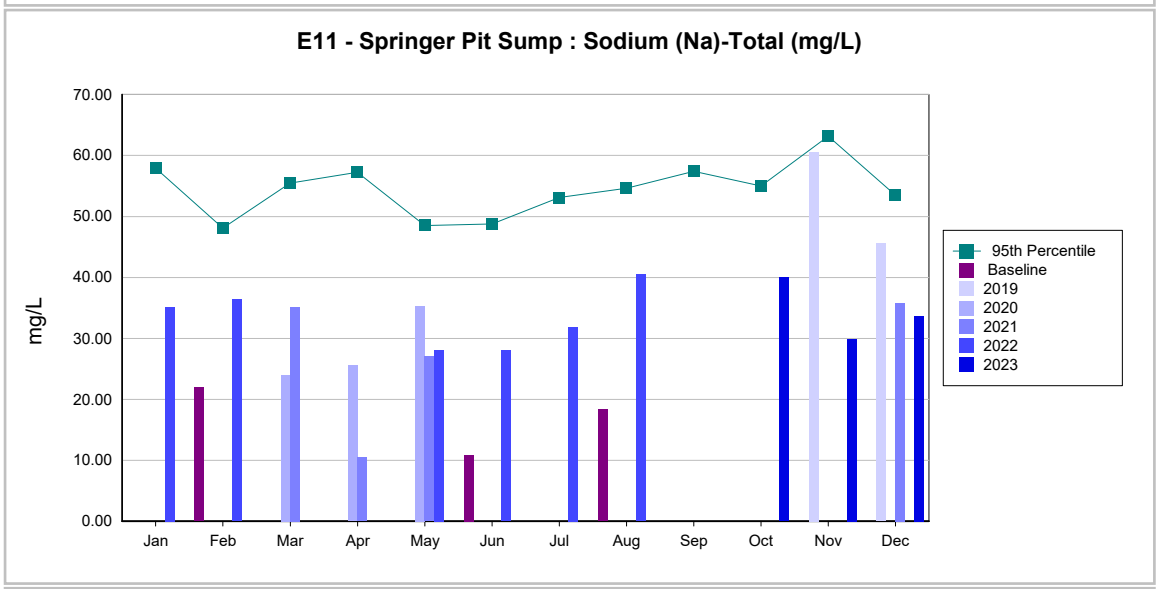
Annual Report Drainage Water

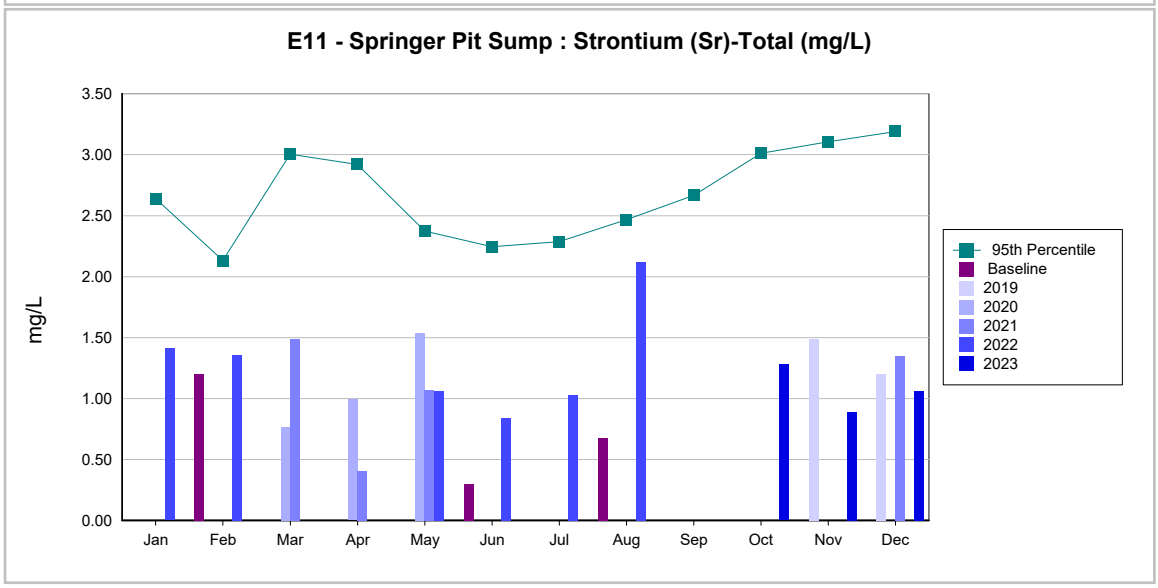
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







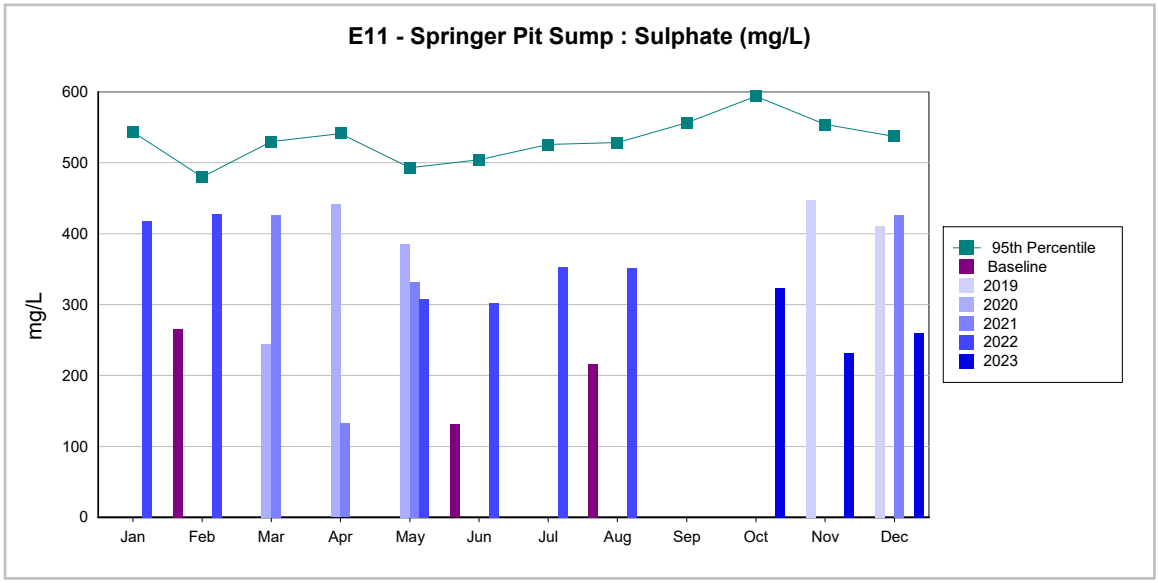
Water Quality Report

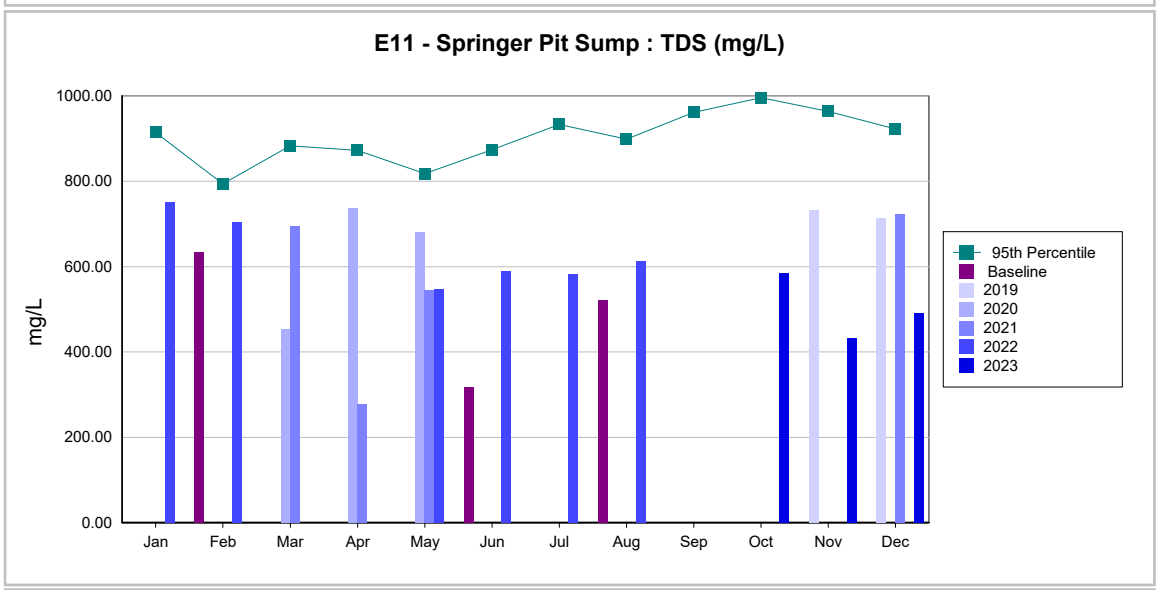
Annual Report Drainage Water

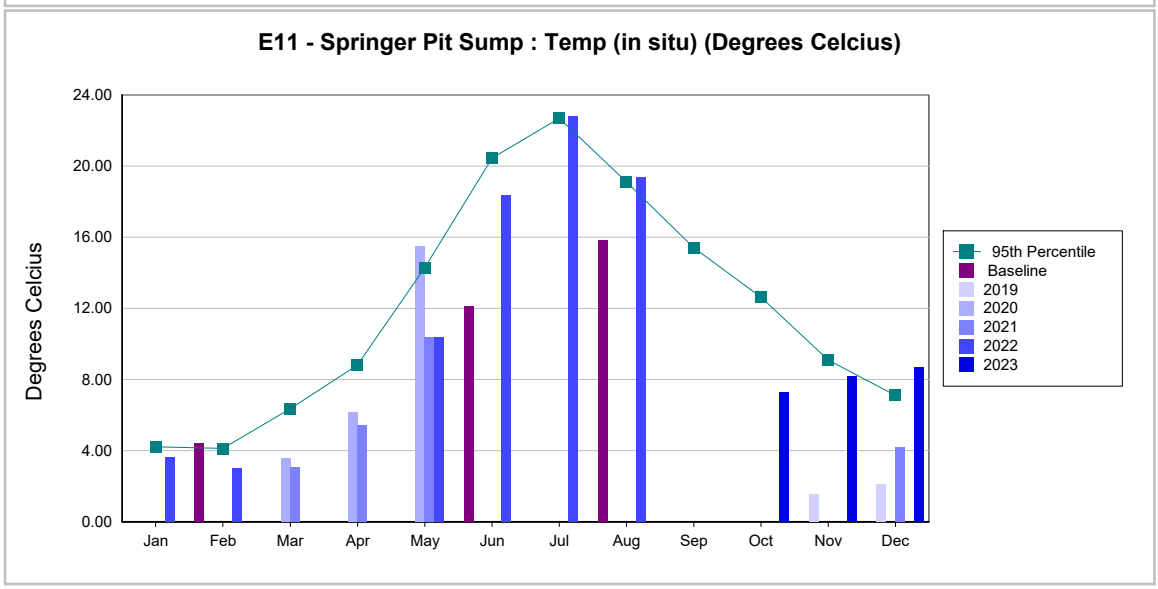
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







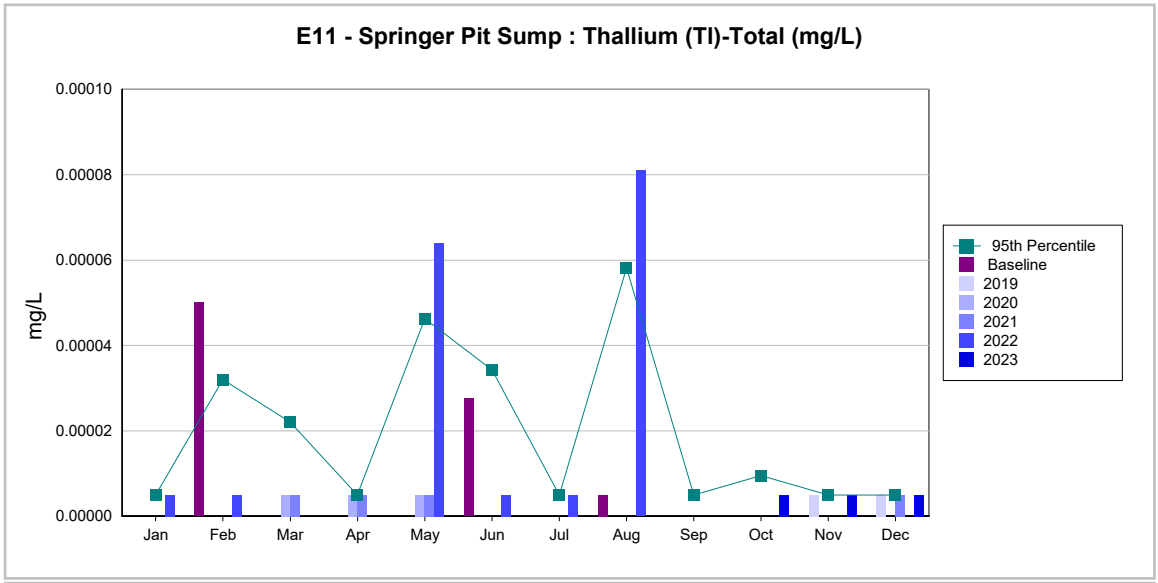
Water Quality Report

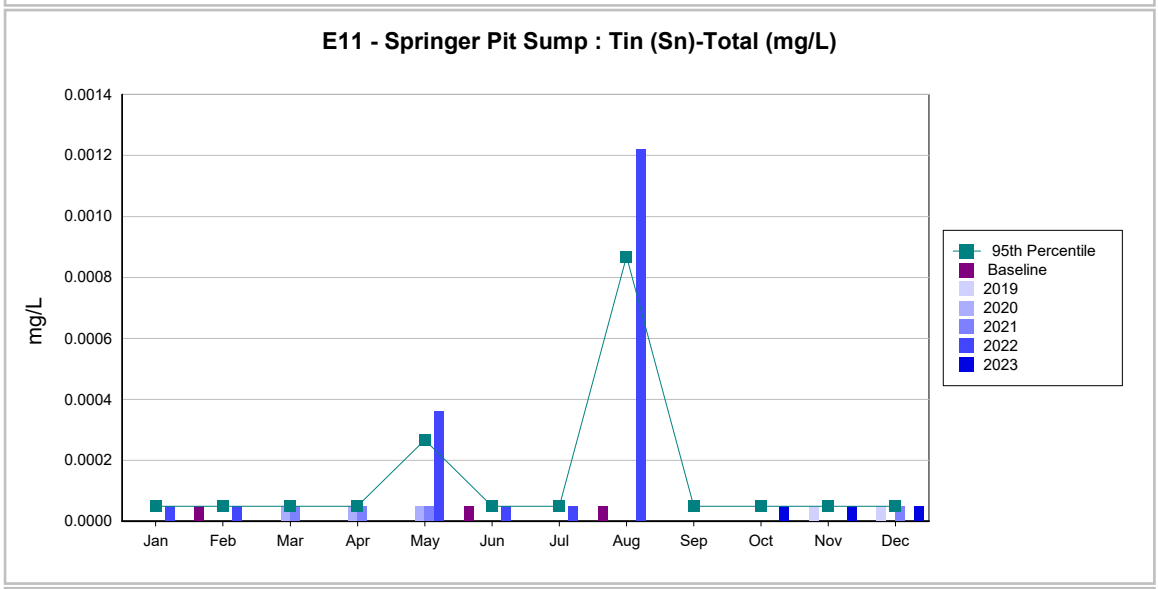
Annual Report Drainage Water

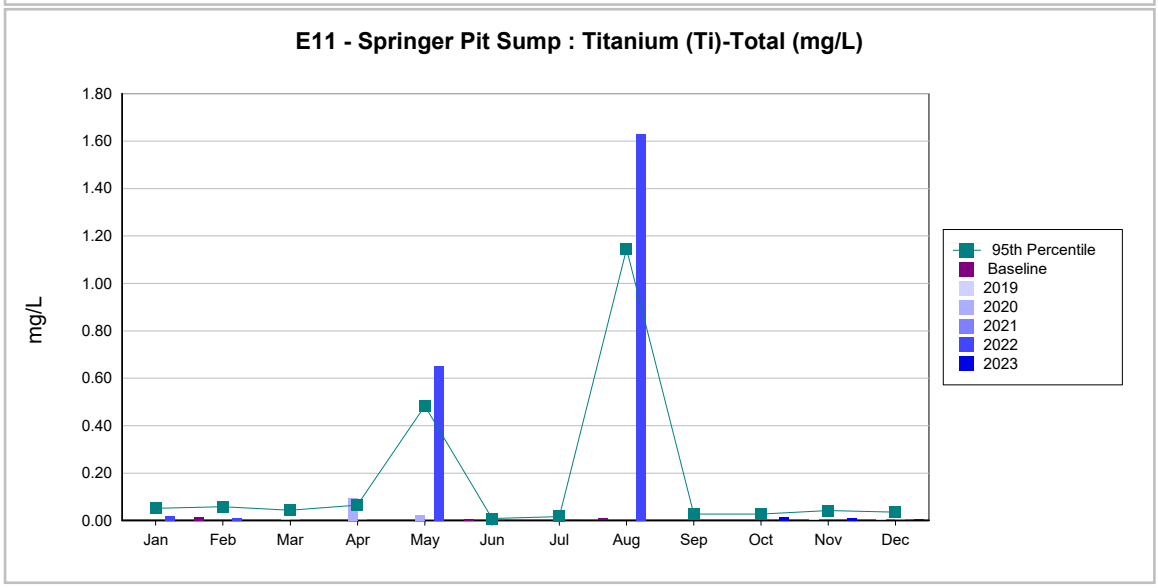
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







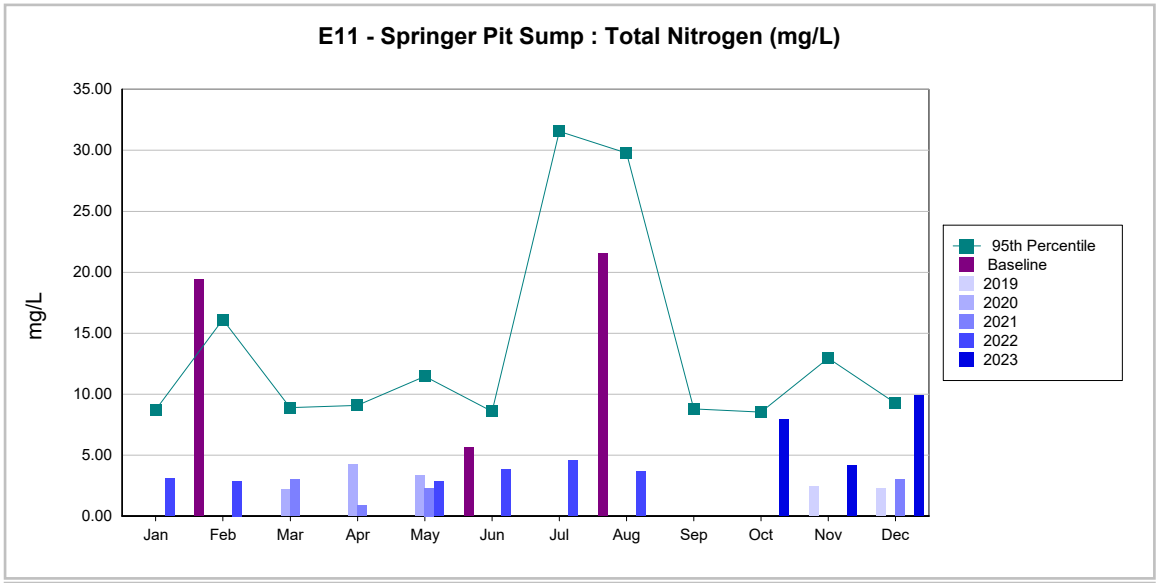
Water Quality Report

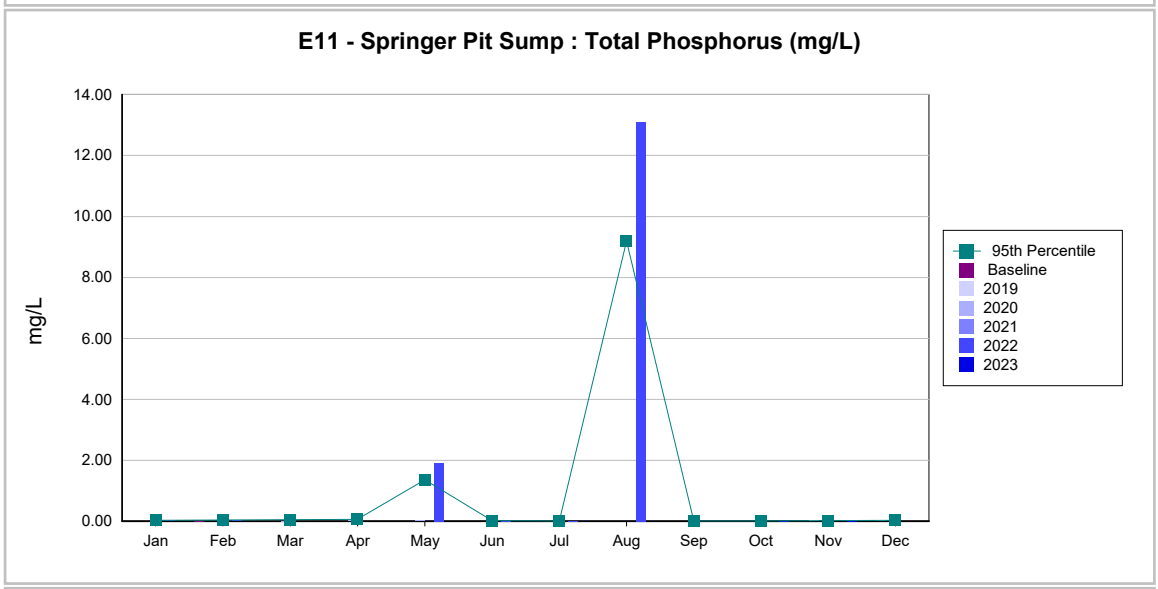
Annual Report Drainage Water

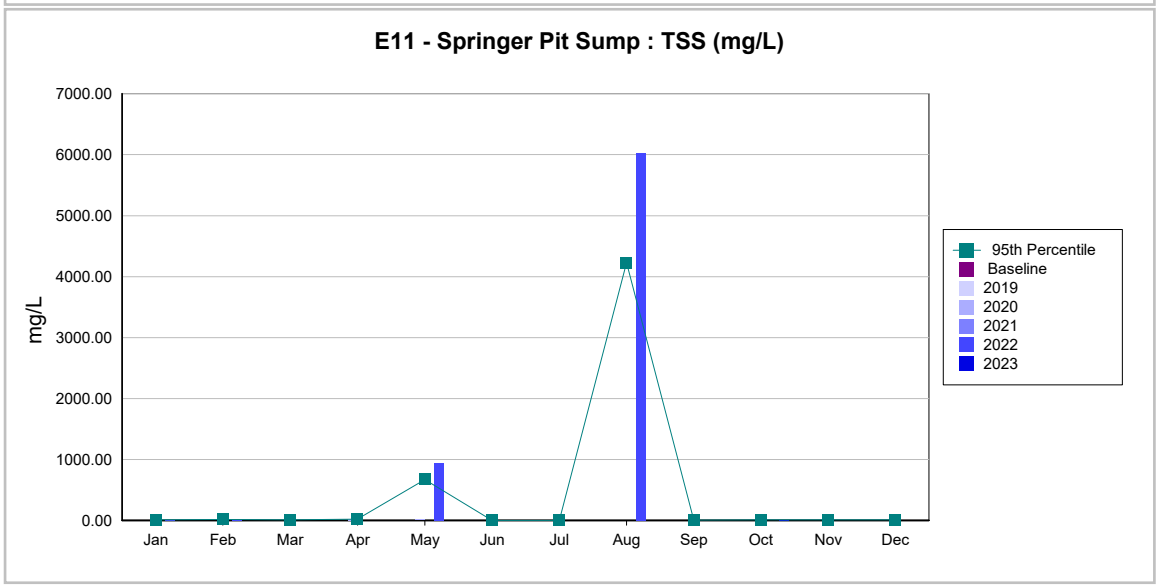
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







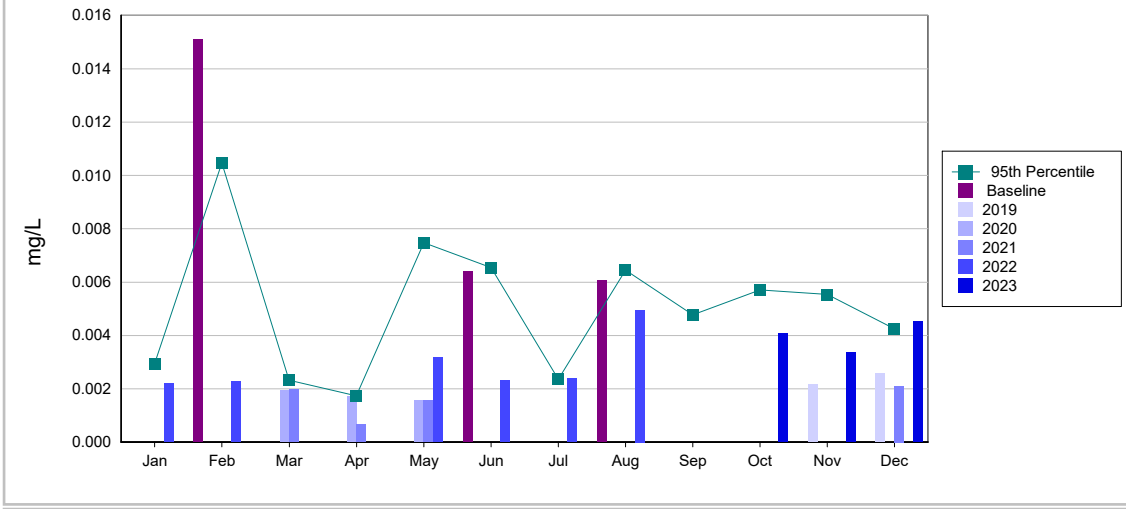
Water Quality Report

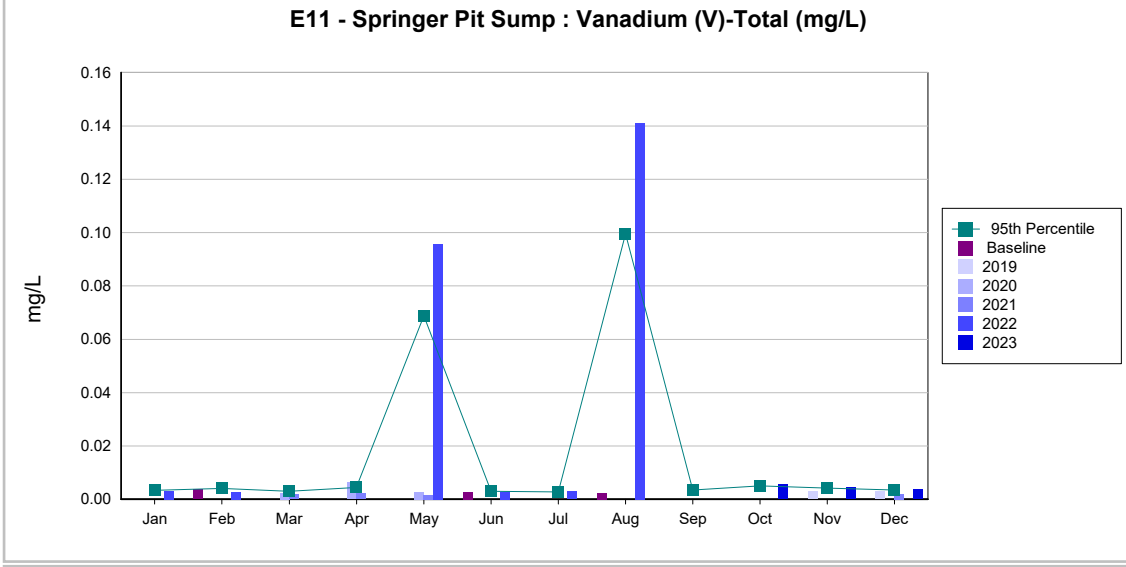
Annual Report Drainage Water

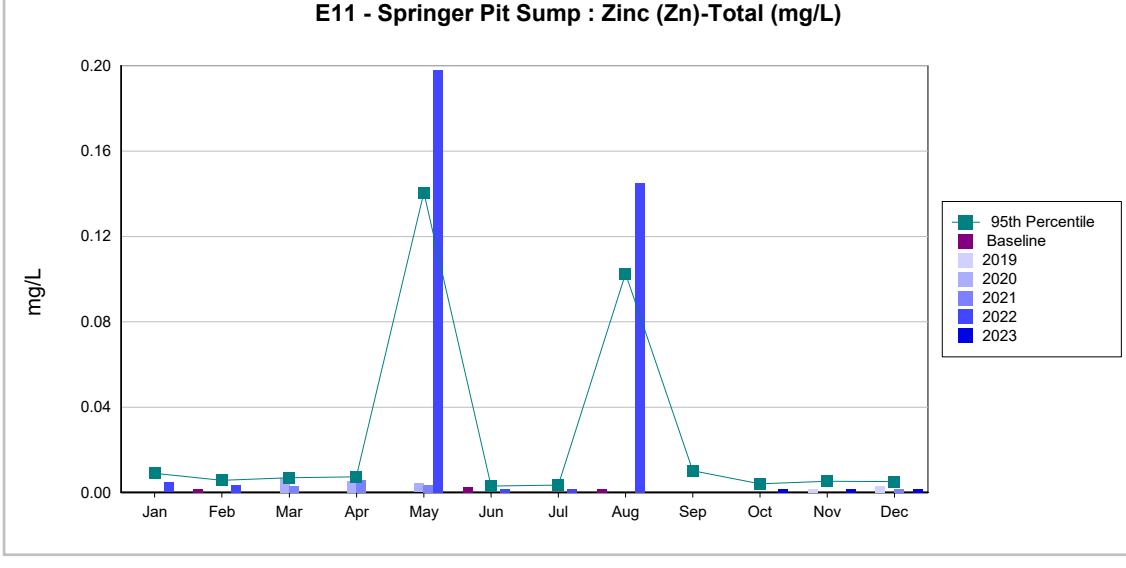
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







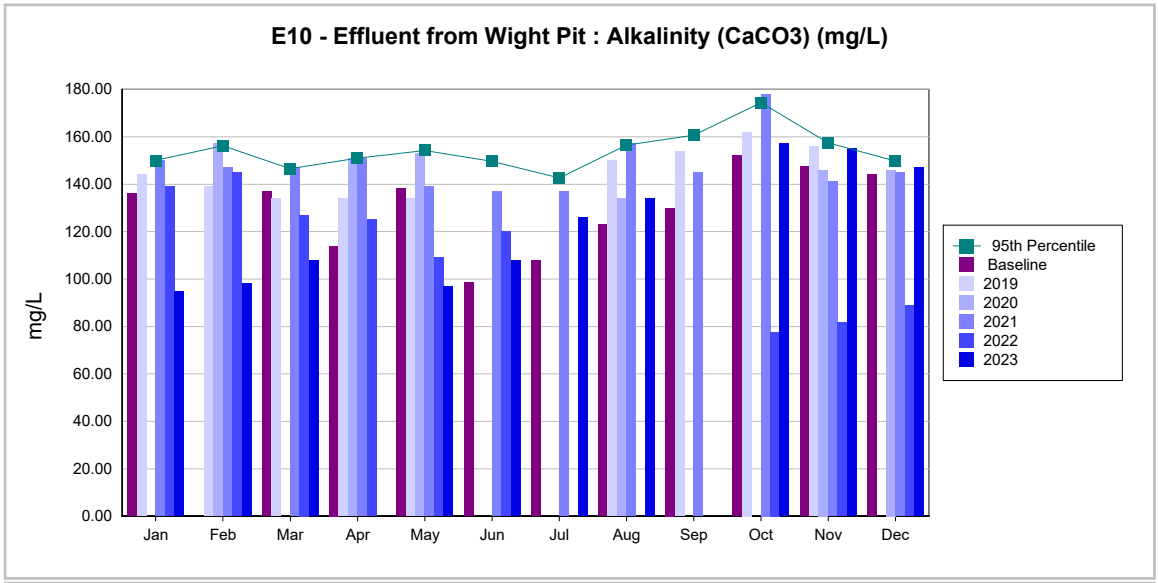
Water Quality Report

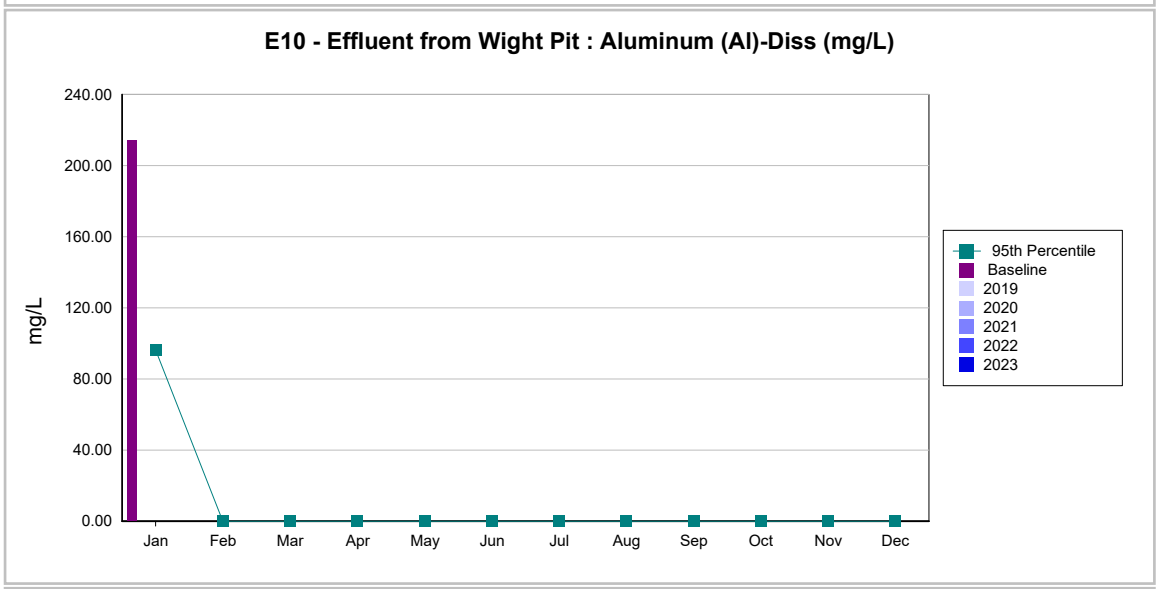
Annual Report Drainage Water

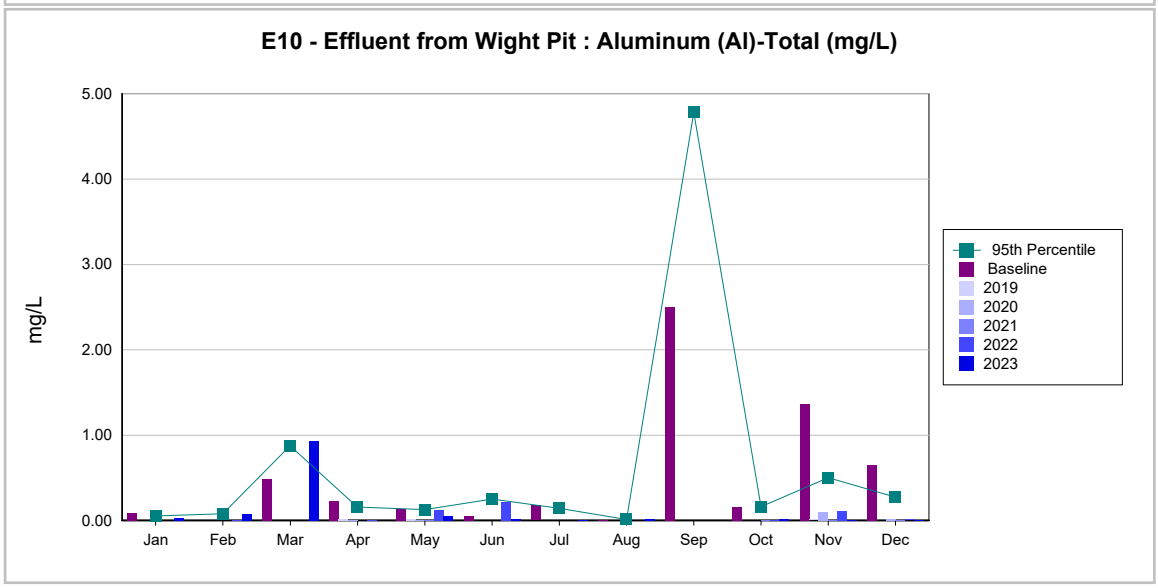
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







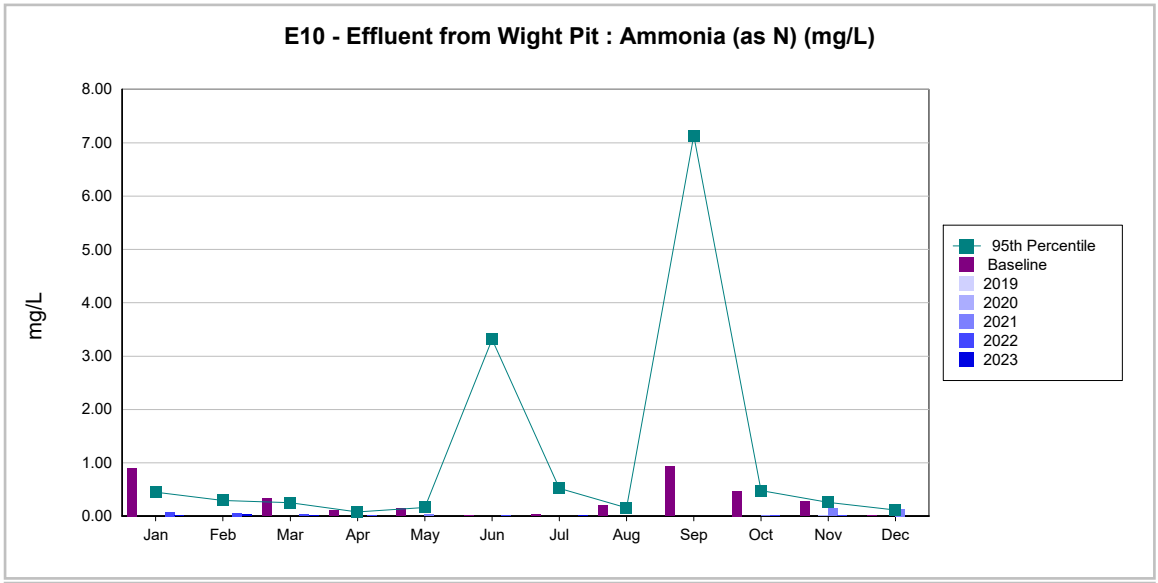
Water Quality Report

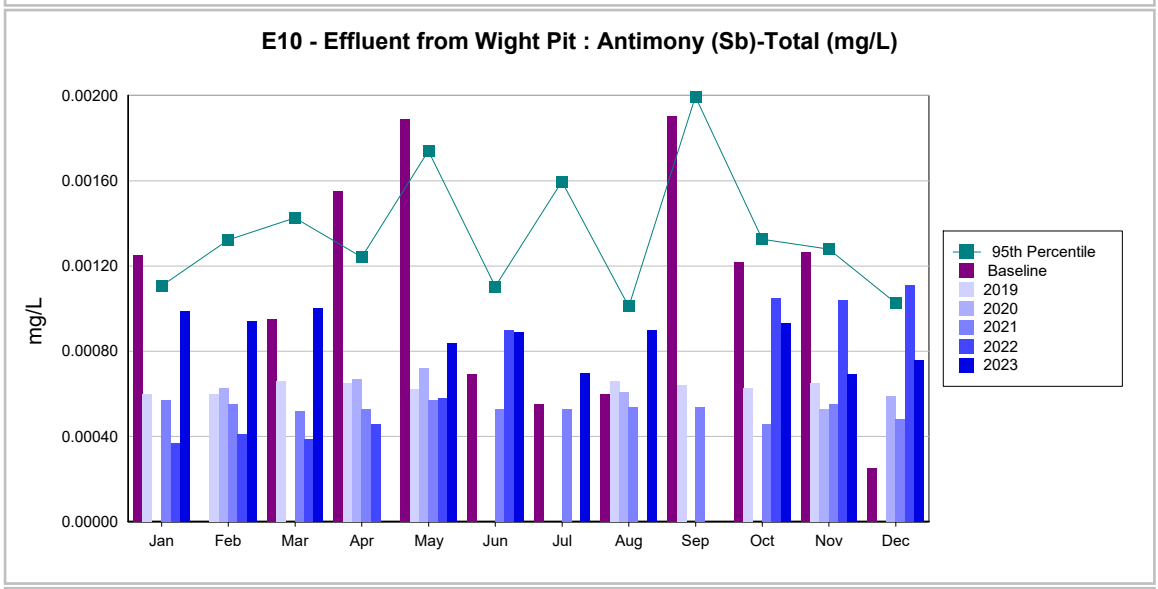
Annual Report Drainage Water

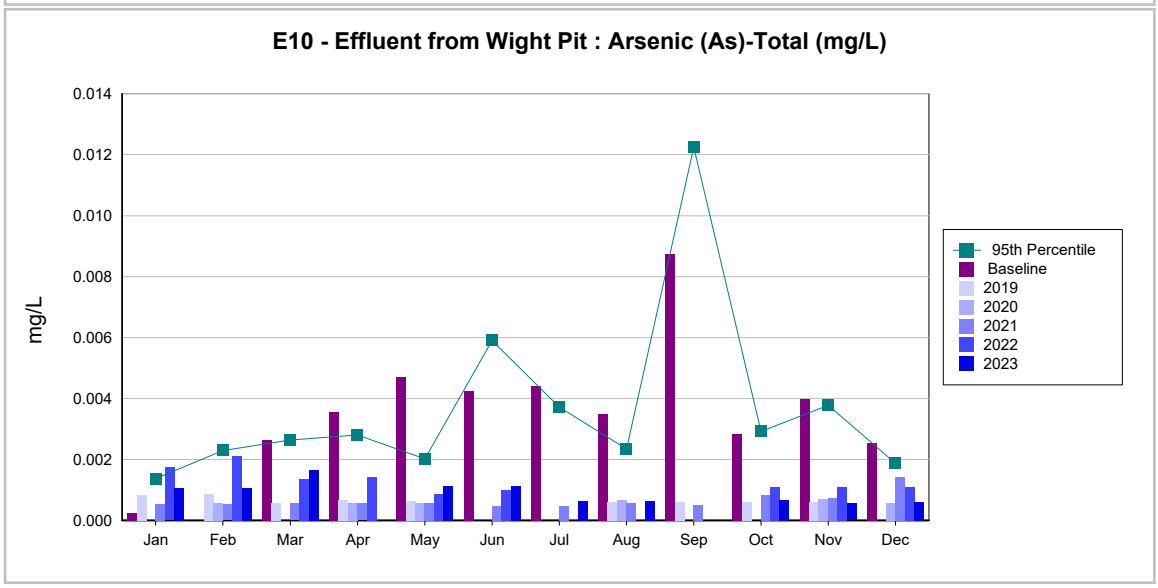
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







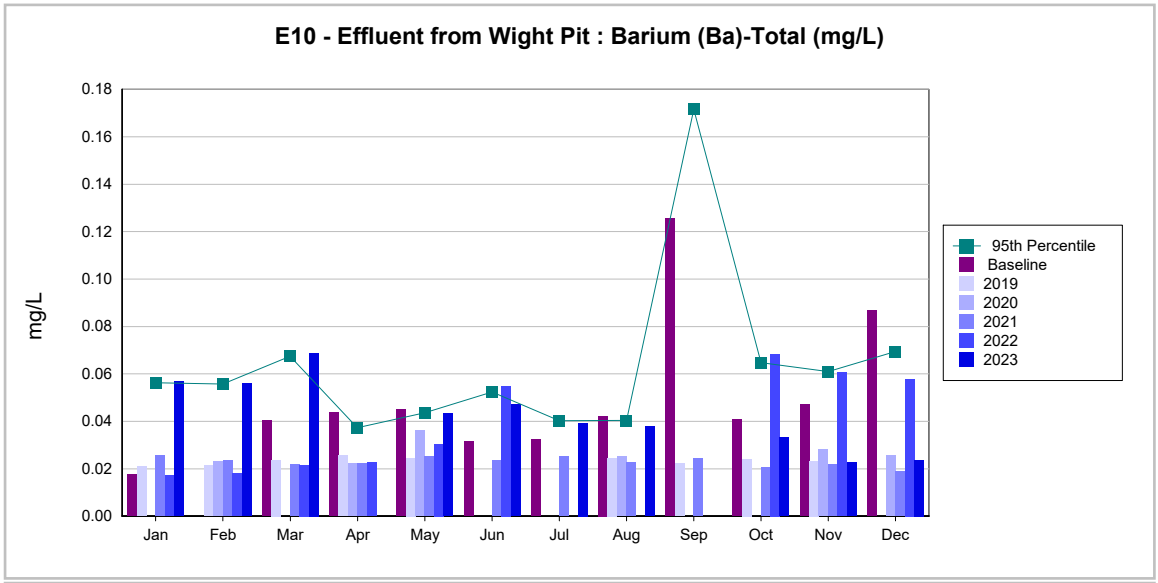
Water Quality Report

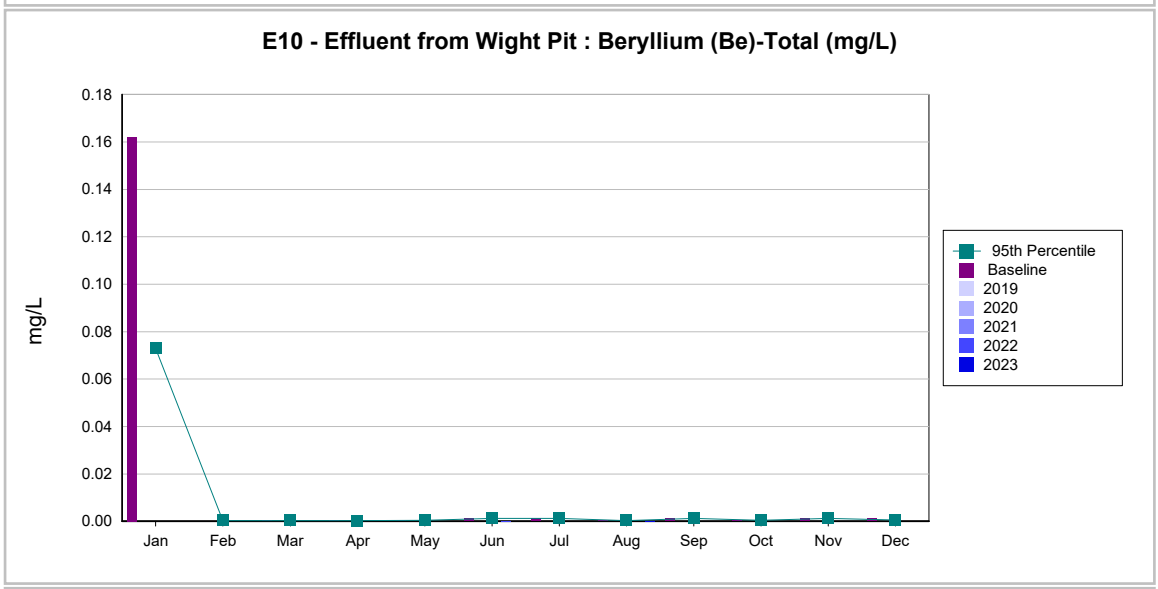
Annual Report Drainage Water

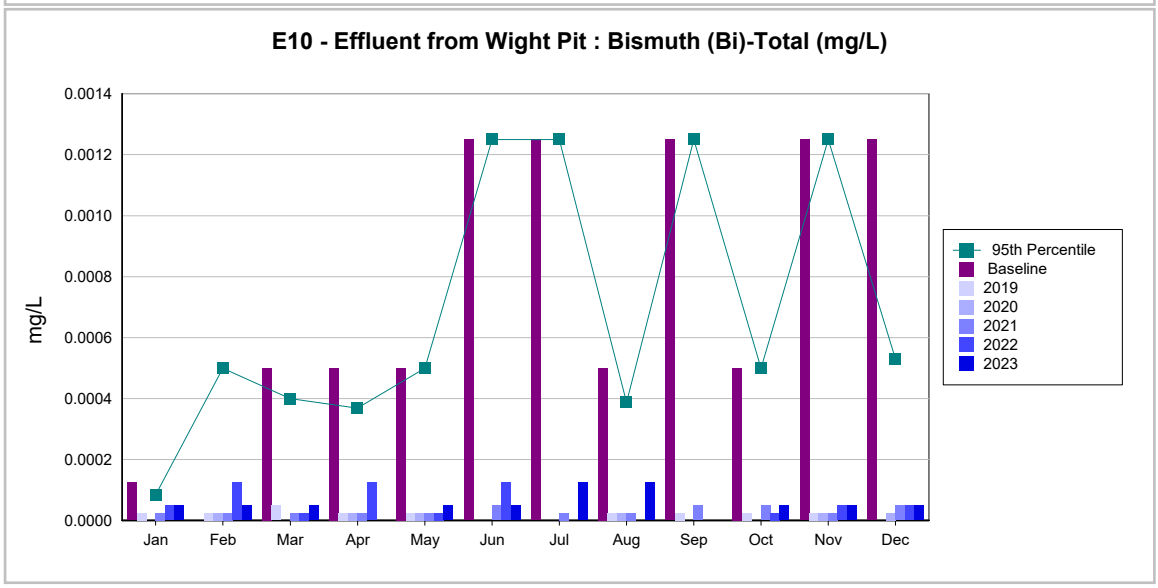
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







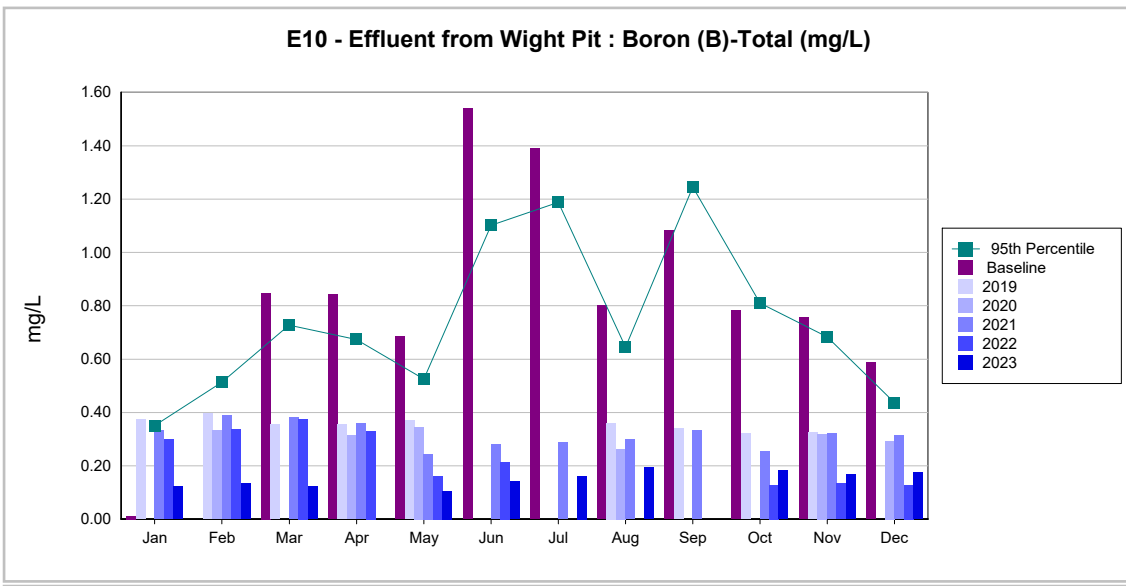
Water Quality Report

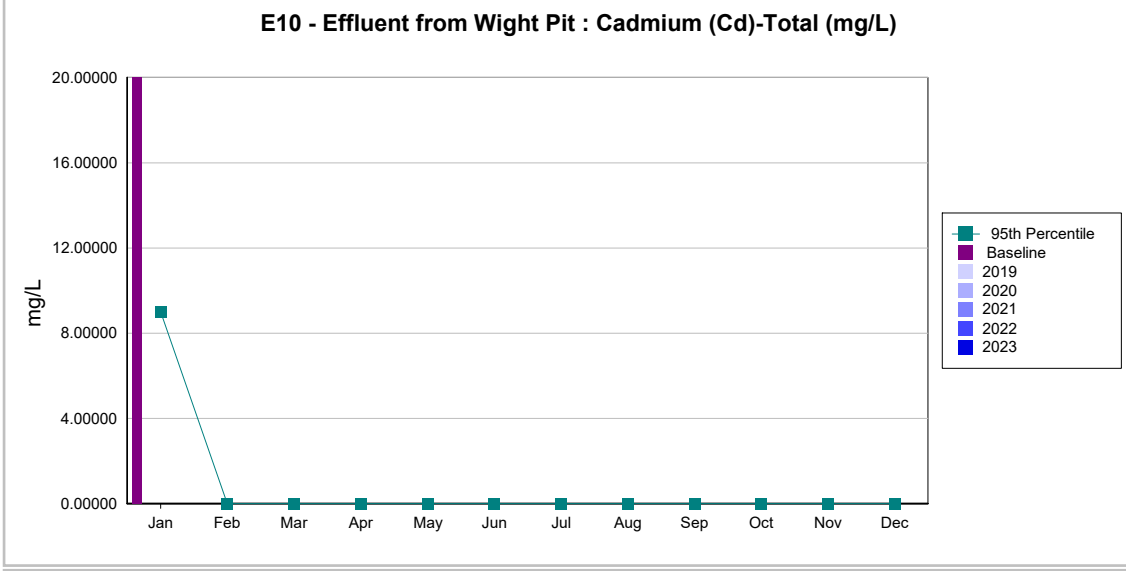
Annual Report Drainage Water

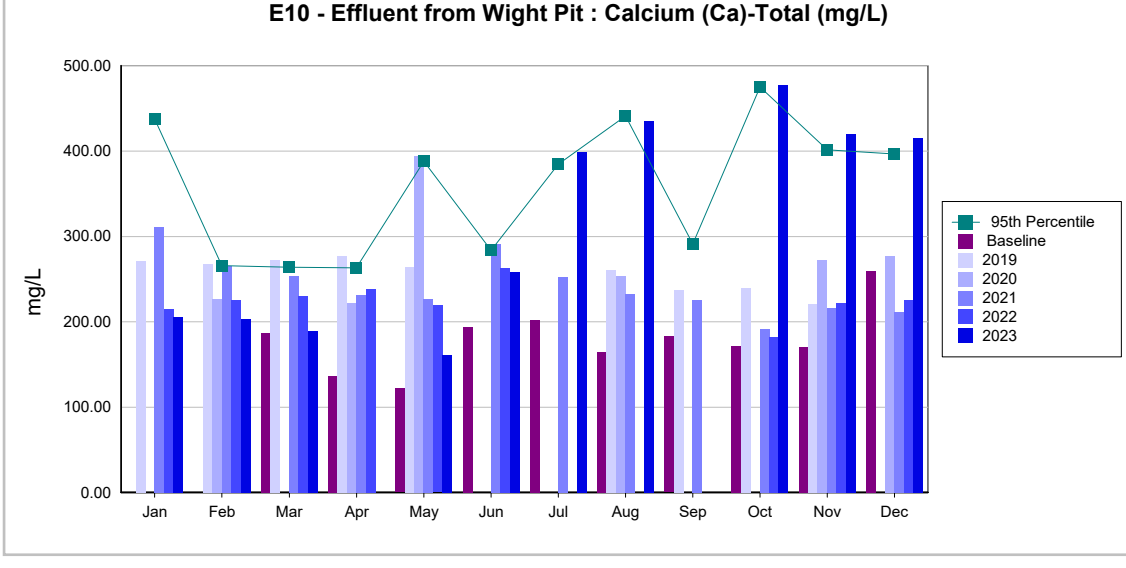
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







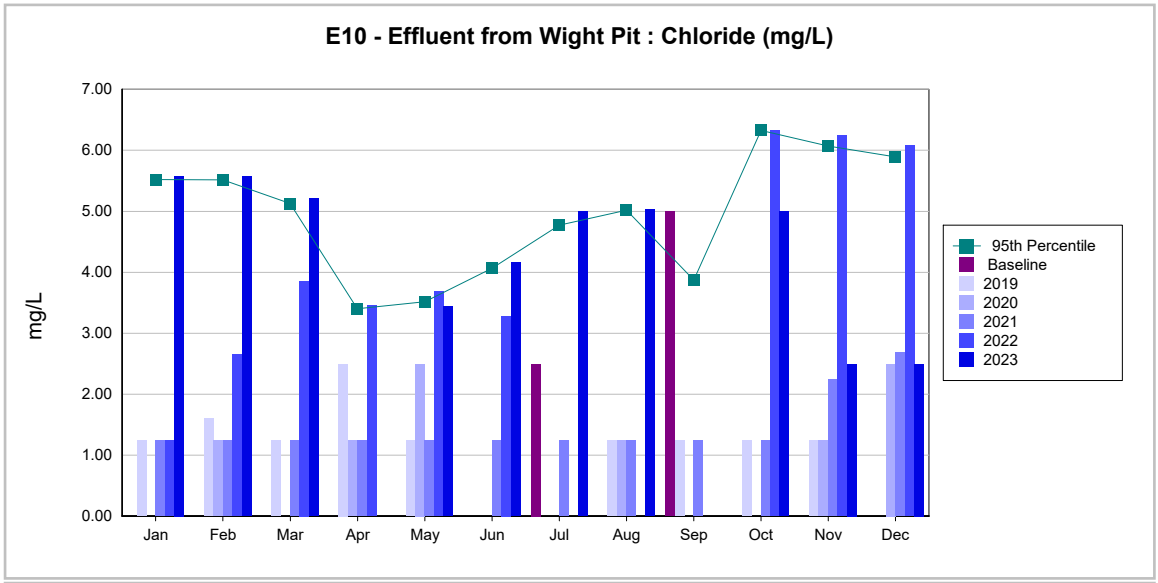
Water Quality Report

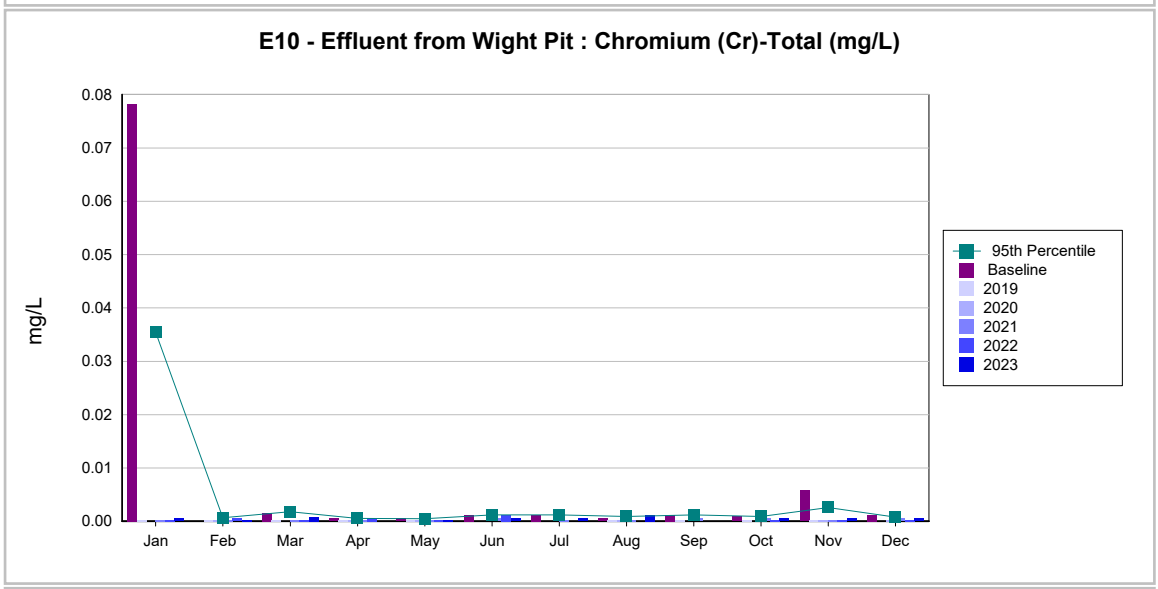
Annual Report Drainage Water

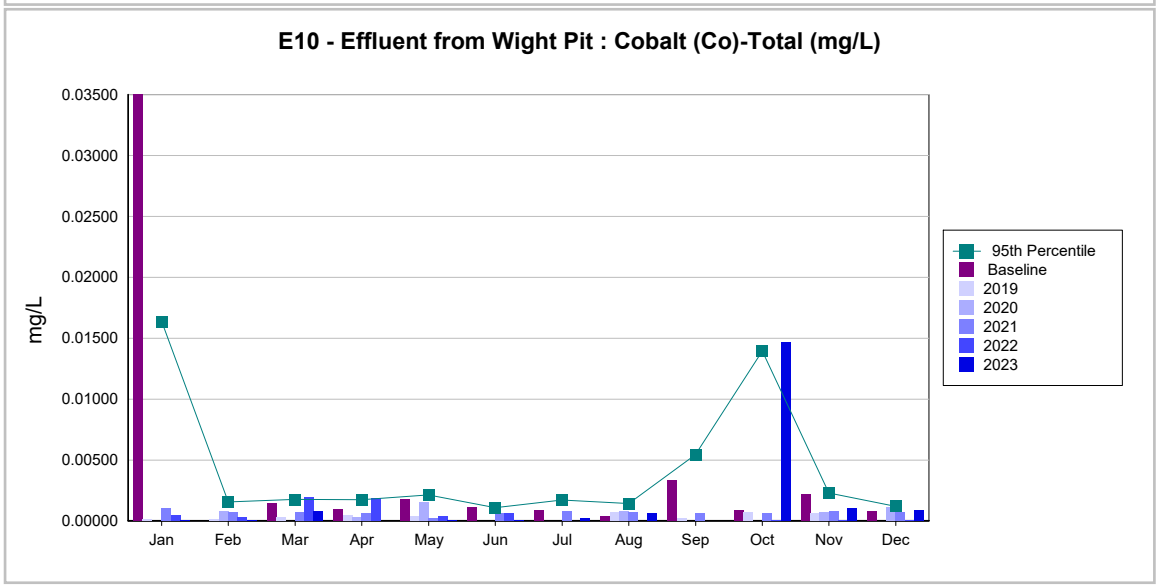
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







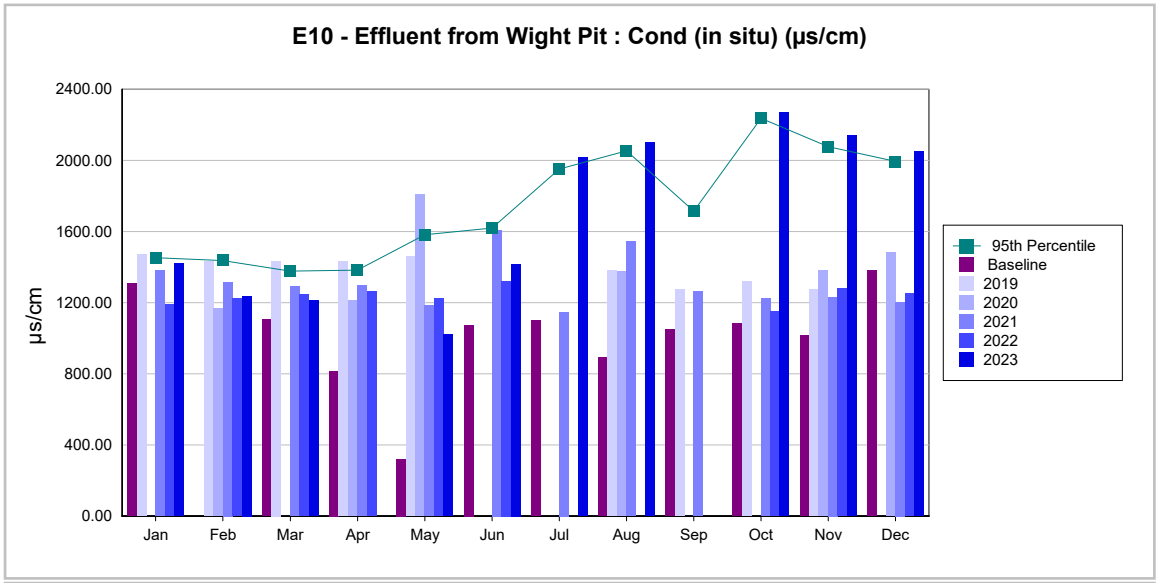
Water Quality Report

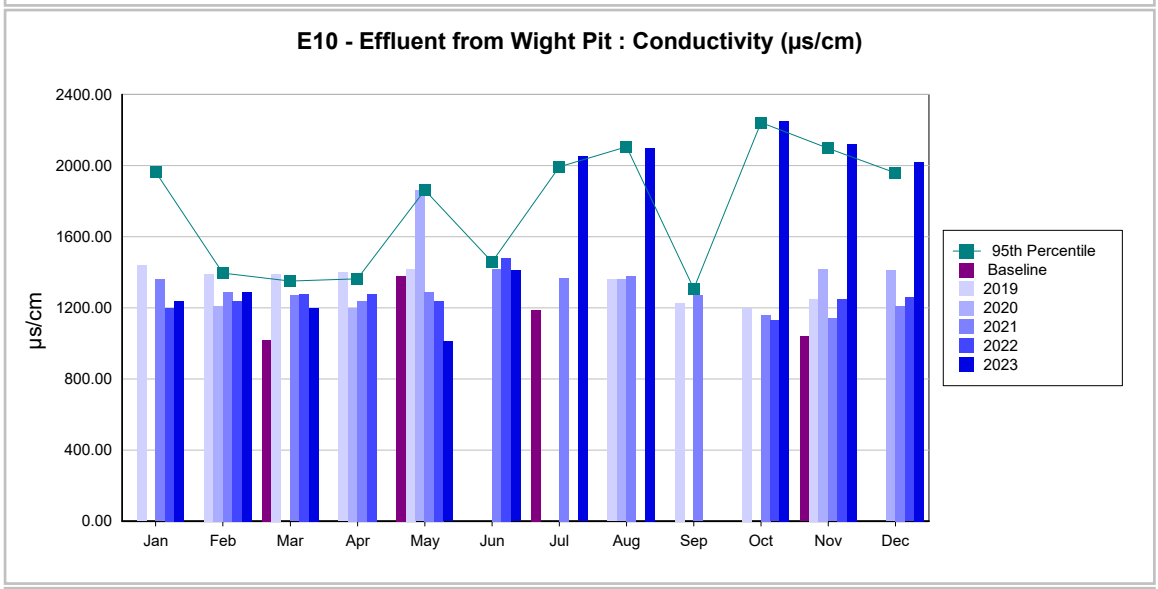
Annual Report Drainage Water

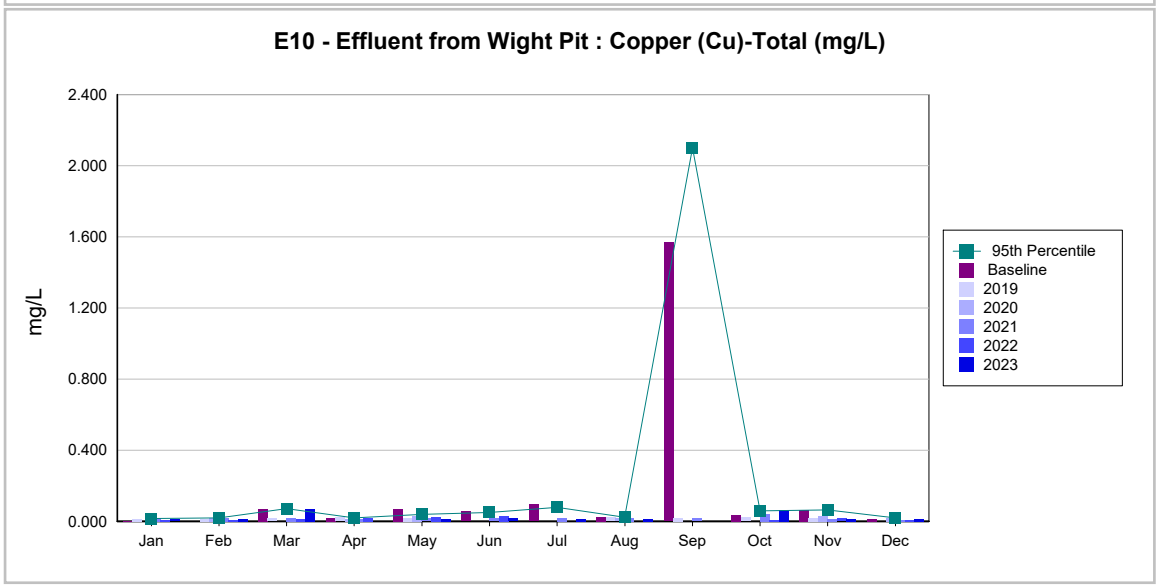
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

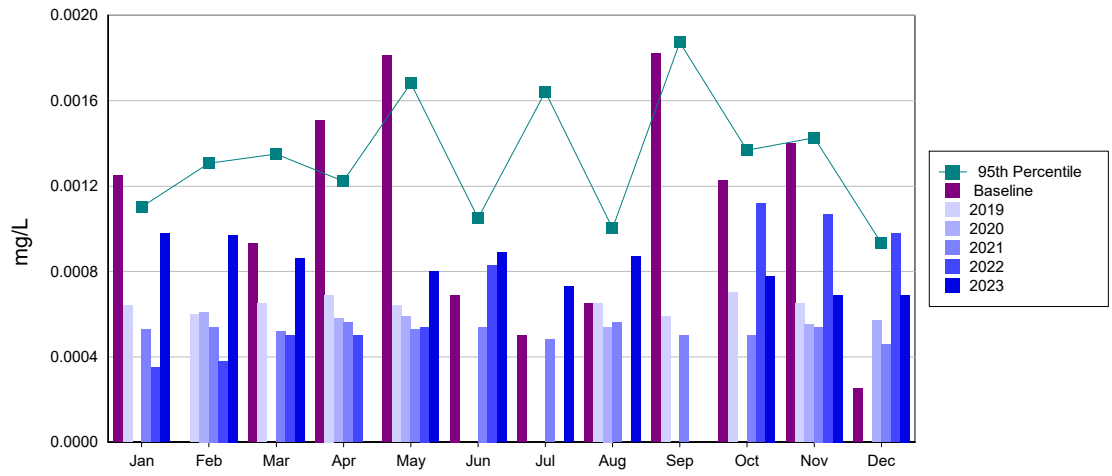
Annual Report Drainage Water

Mount Polley

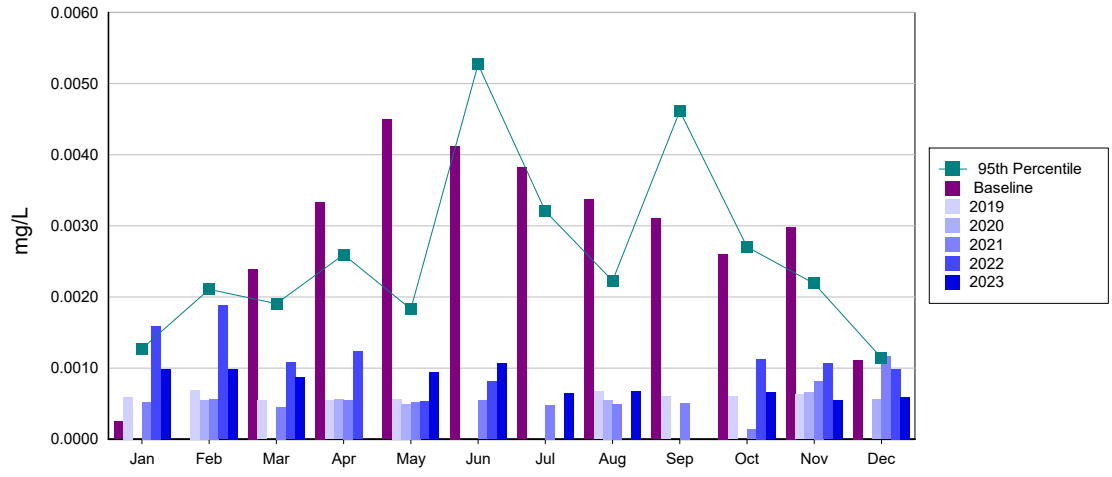
Mining Corporation

IMPERIAL METALS CORPORATION

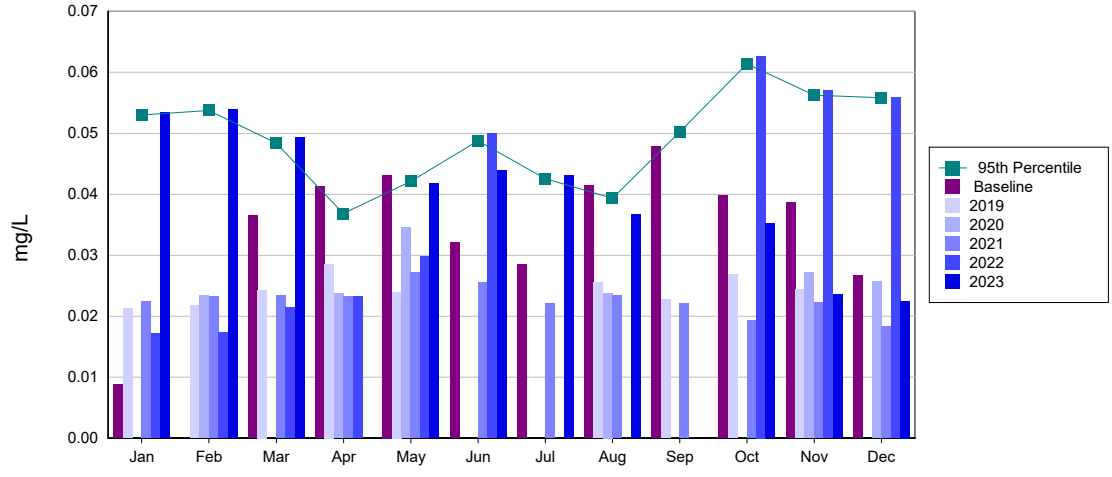
E10 - Effluent from Wight Pit : Diss-Antimony (Sb) (mg/L)



E10 - Effluent from Wight Pit : Diss-Arsenic (As) (mg/L)



E10 - Effluent from Wight Pit : Diss-Barium (Ba) (mg/L)



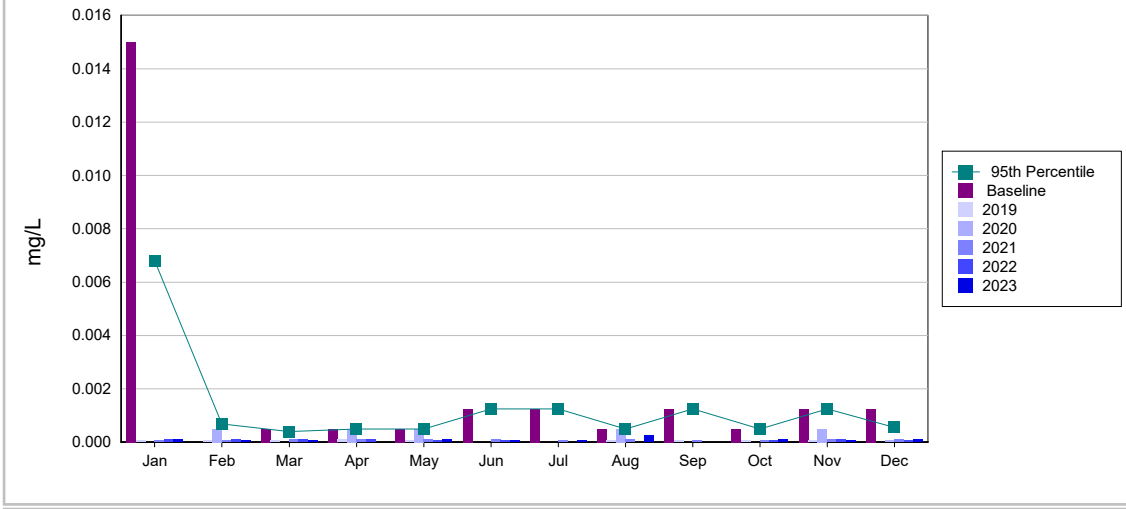
Water Quality Report

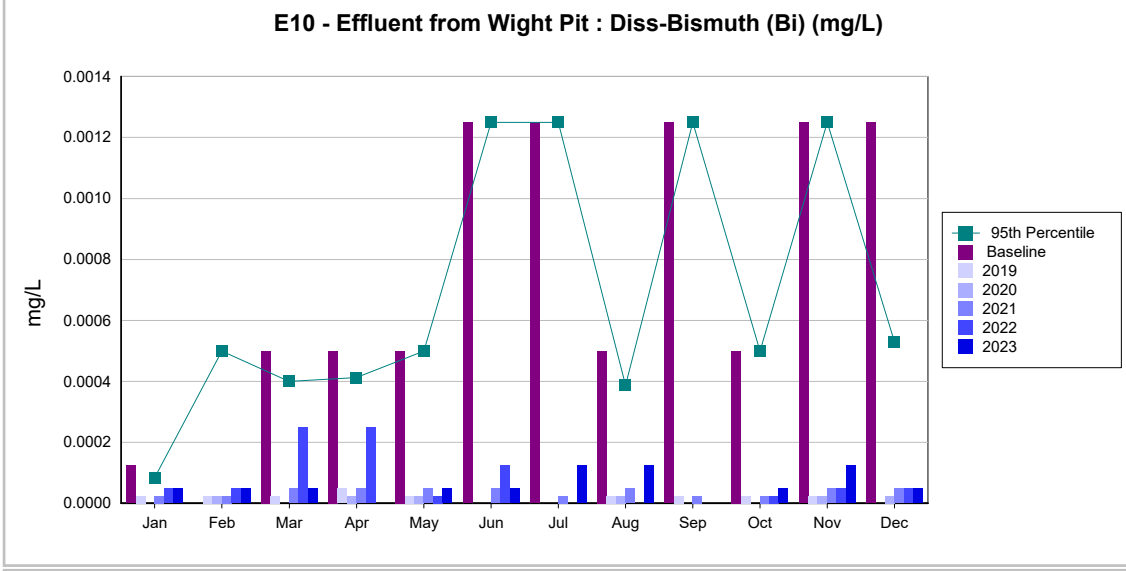
Annual Report Drainage Water

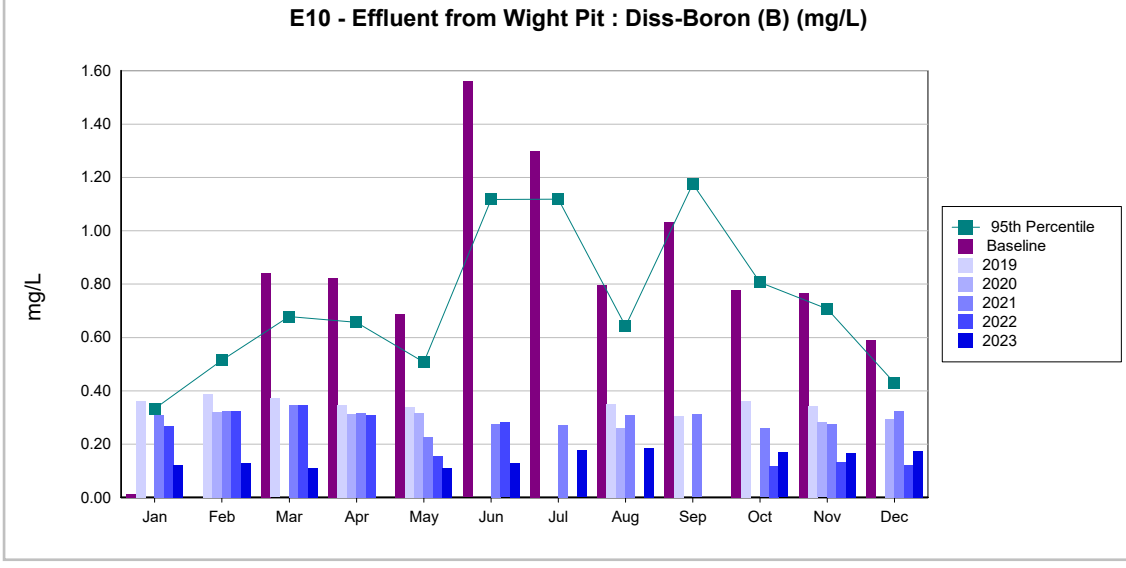
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







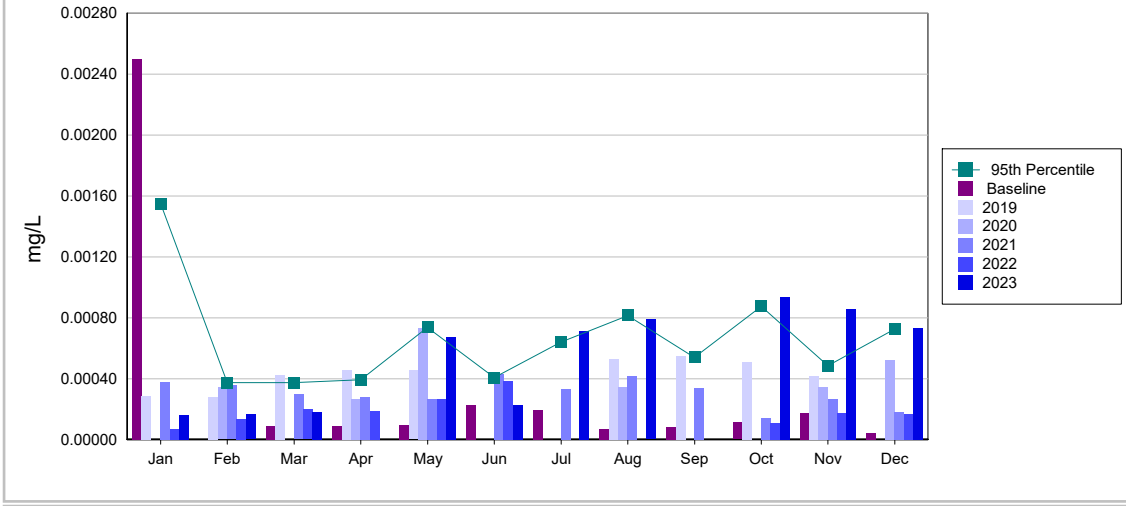
Water Quality Report

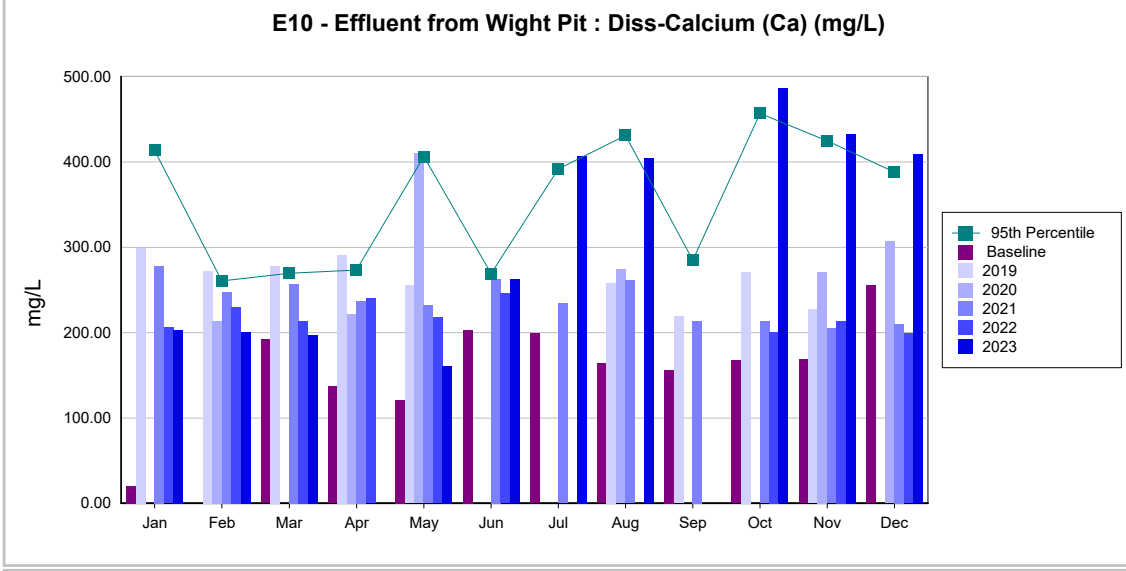
Annual Report Drainage Water

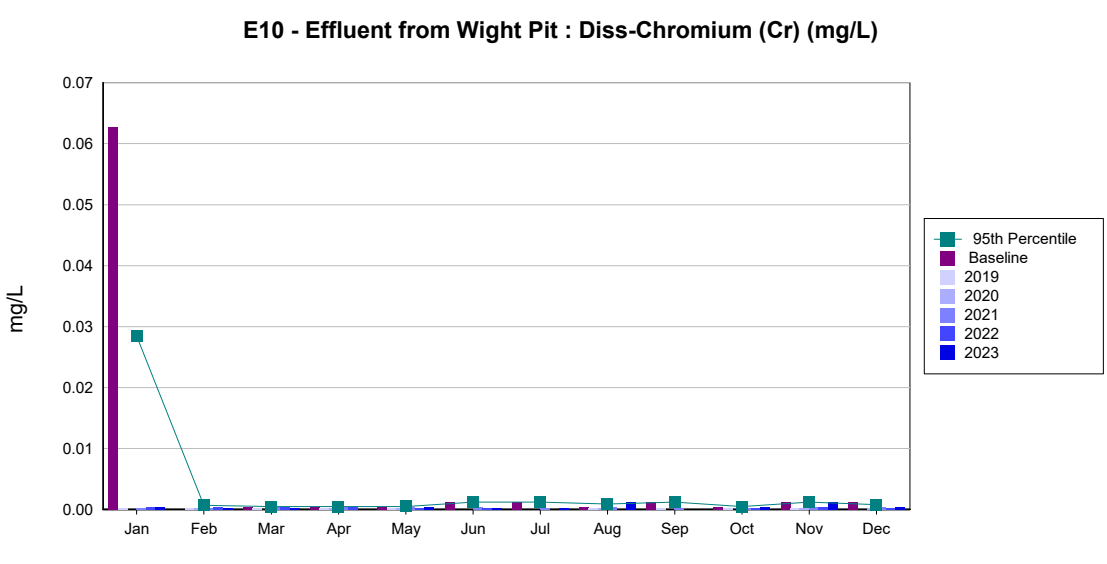
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







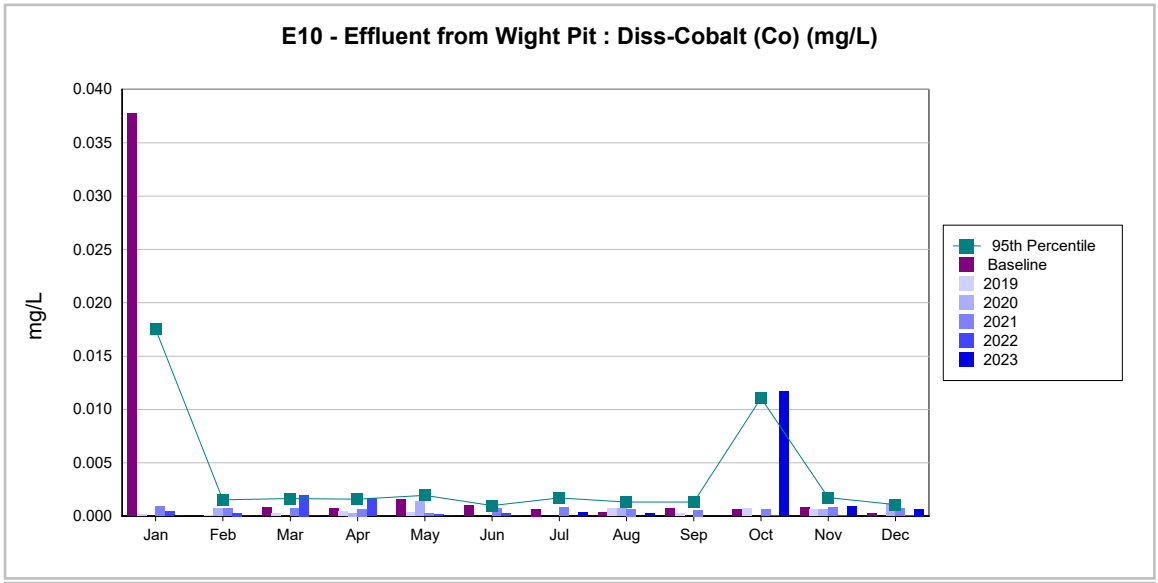
Water Quality Report

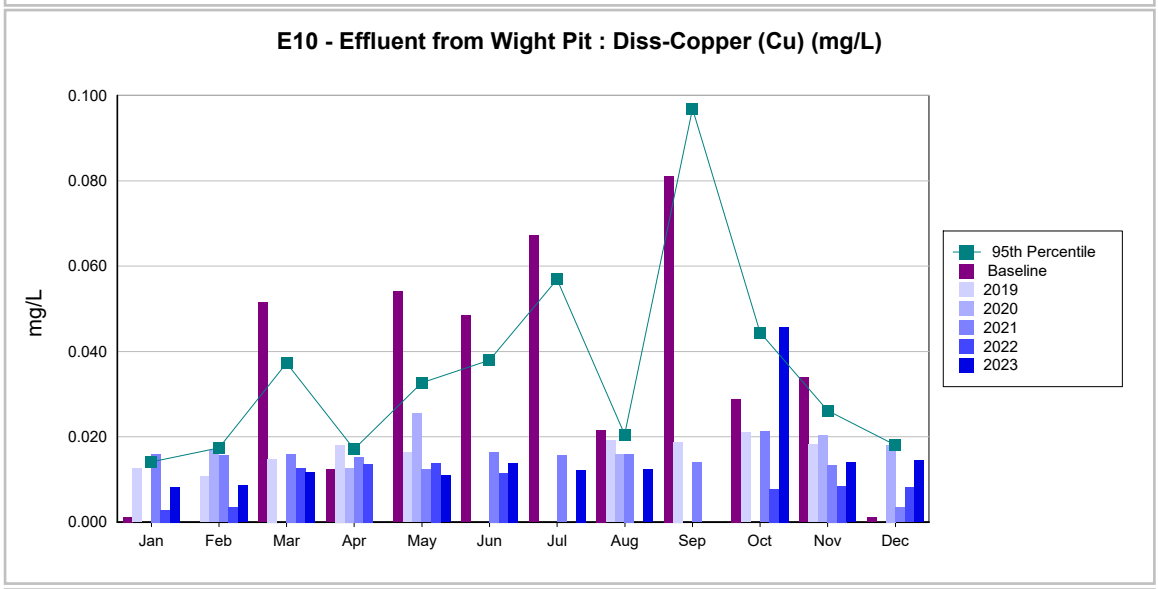
Annual Report Drainage Water

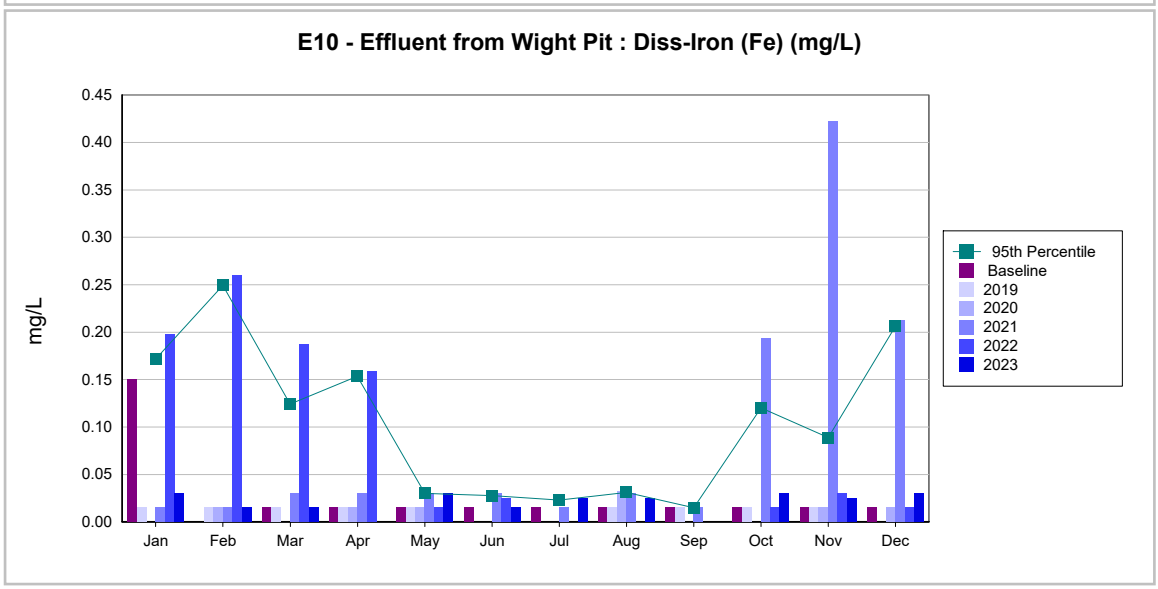
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







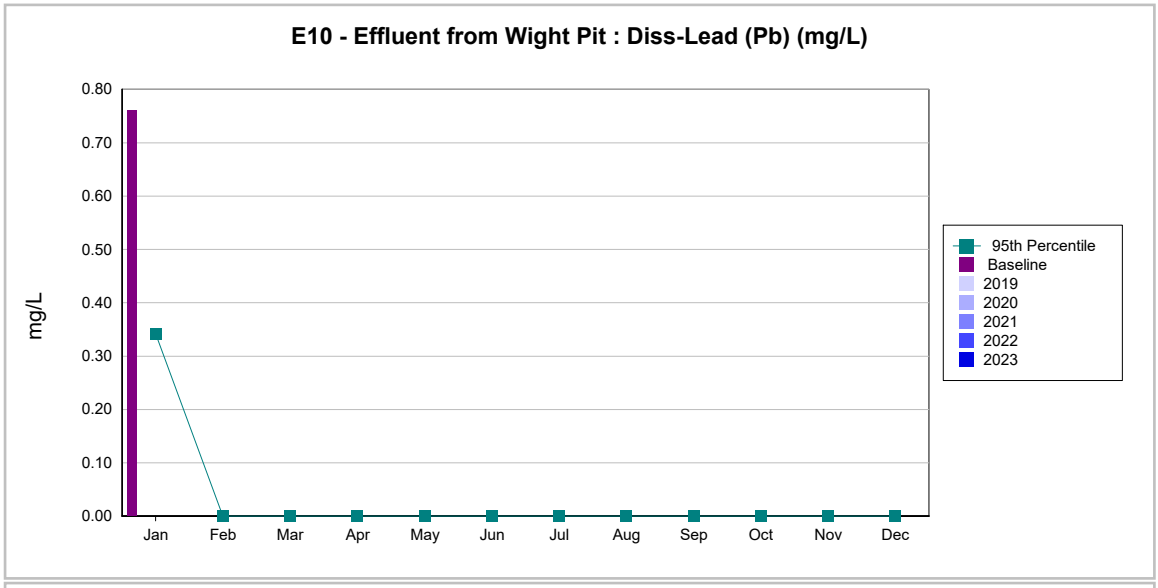
Water Quality Report

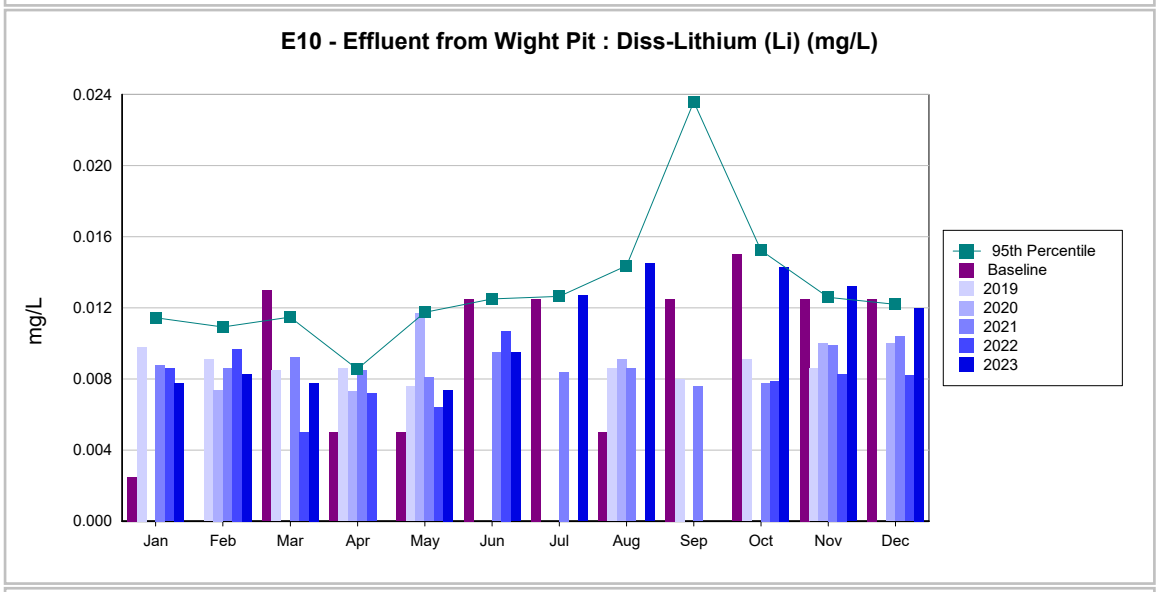
Annual Report Drainage Water

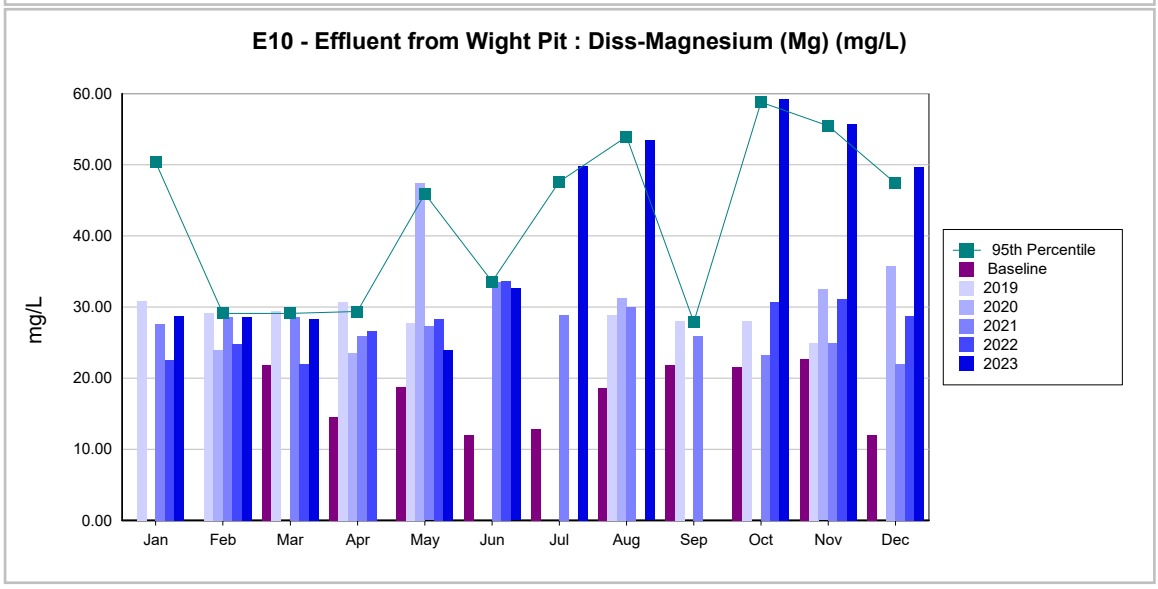
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







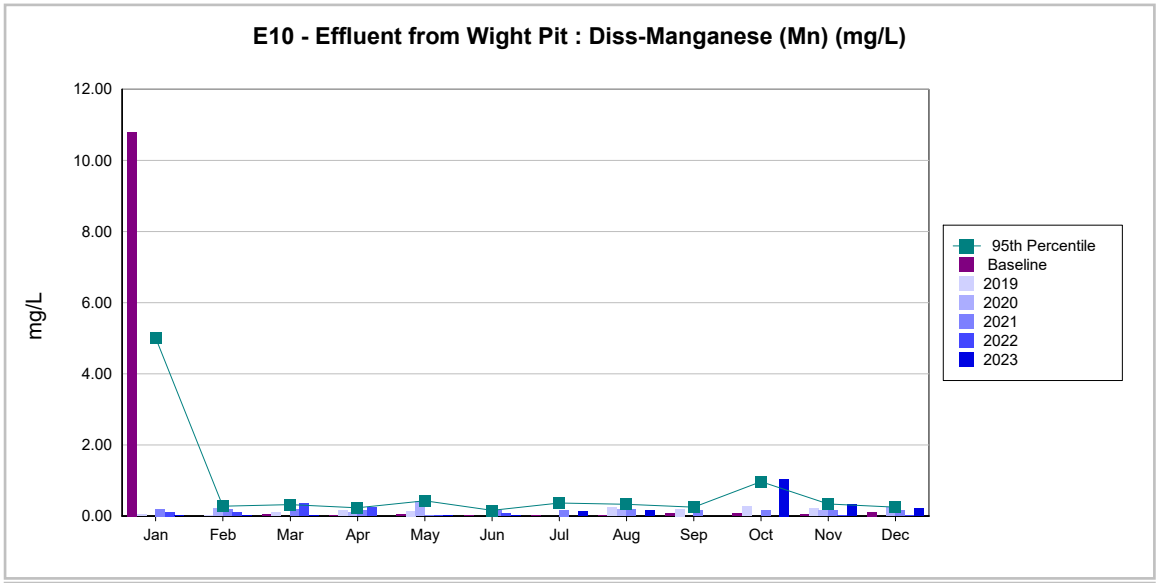
Water Quality Report

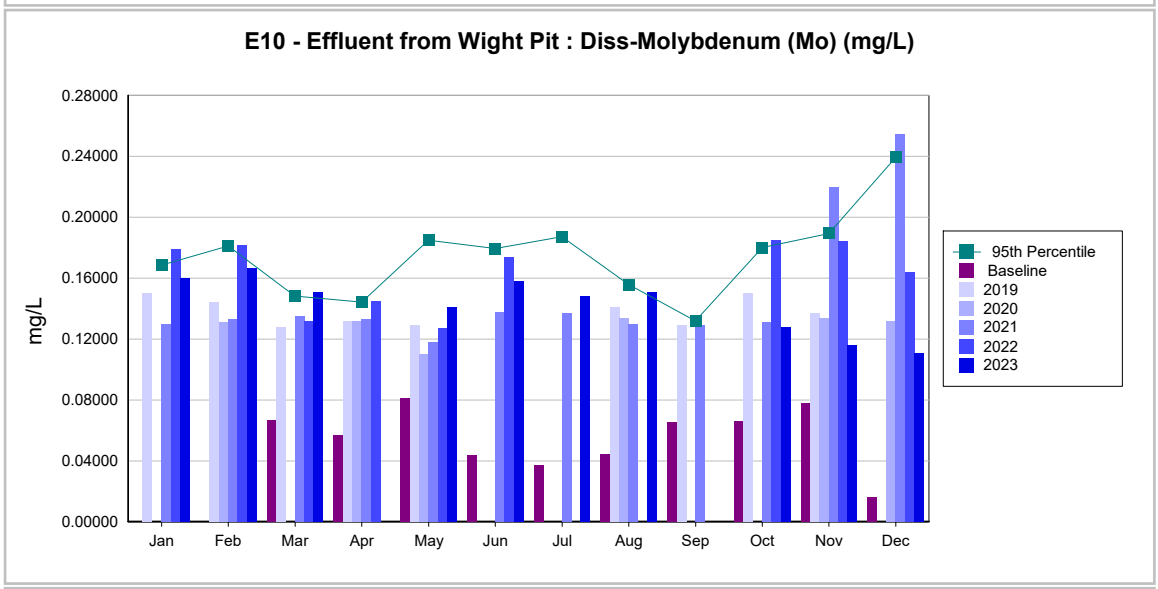
Annual Report Drainage Water

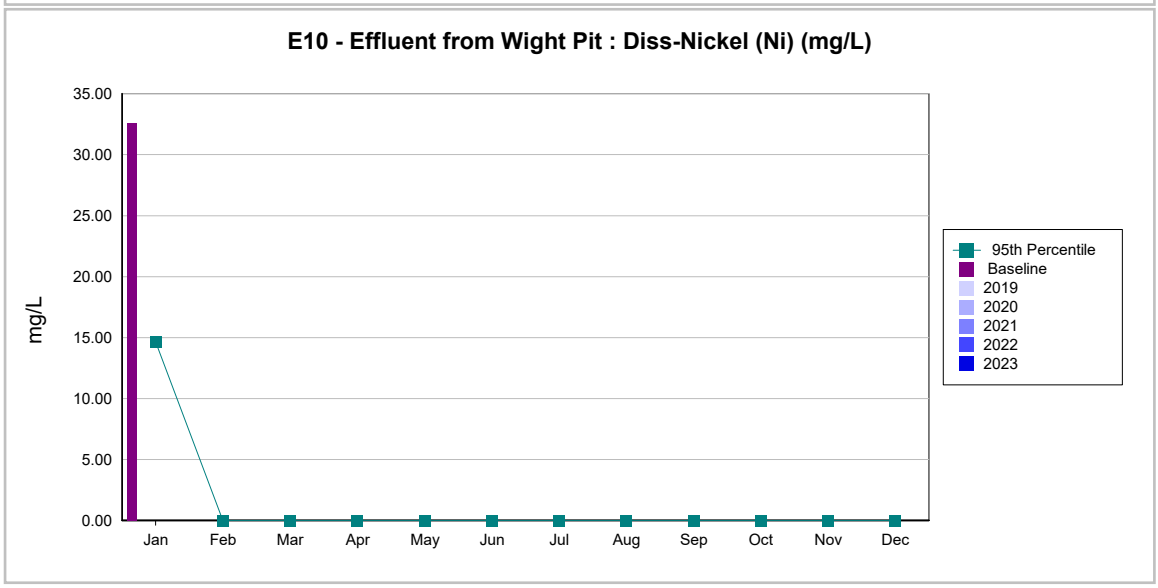
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

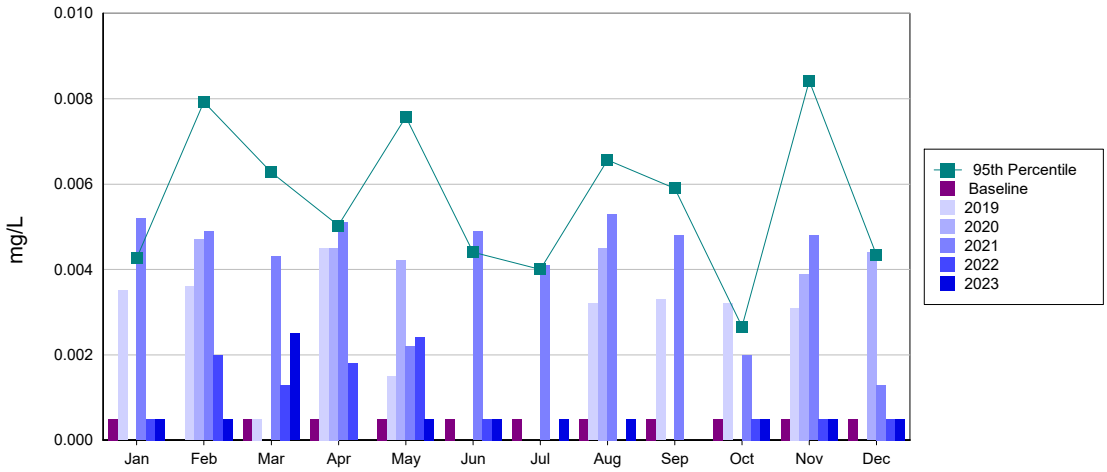
Annual Report Drainage Water

Mount Polley

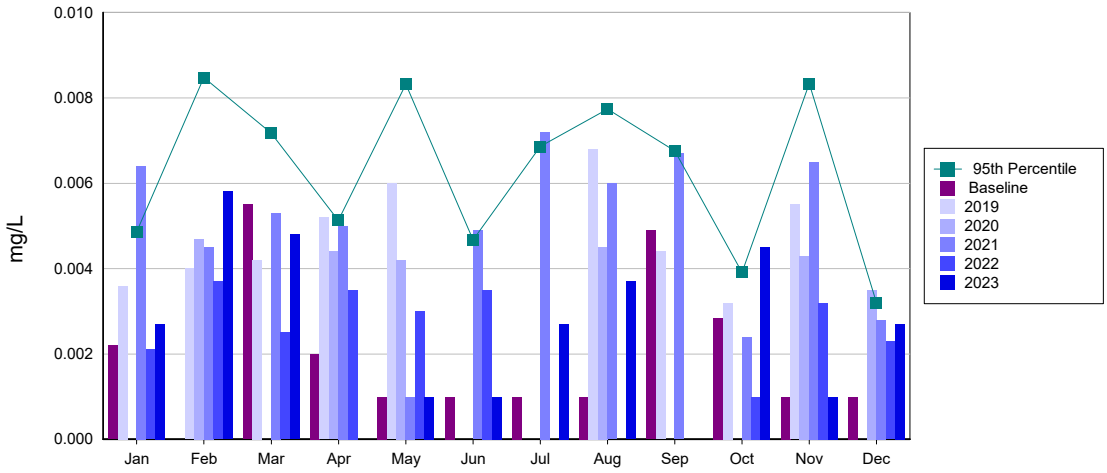
Mining Corporation

IMPERIAL METALS CORPORATION

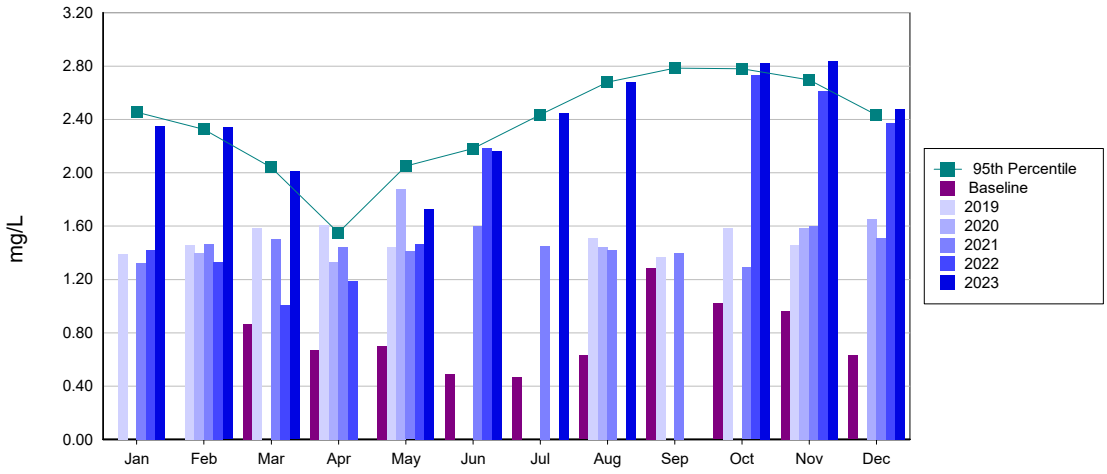
E10 - Effluent from Wight Pit : Diss-Orthophosphate (mg/L)



E10 - Effluent from Wight Pit : Diss-Phosphorus (mg/L)



E10 - Effluent from Wight Pit : Diss-Potassium (K) (mg/L)



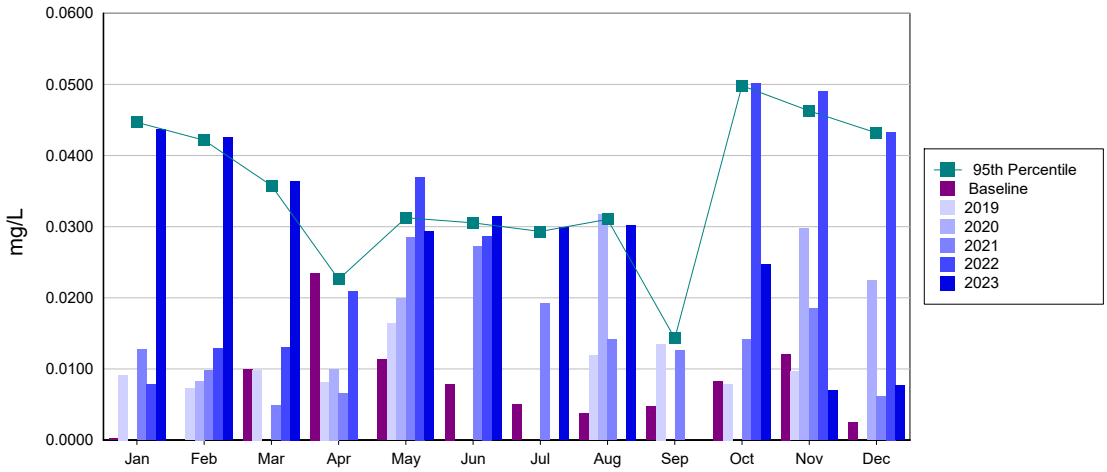
Water Quality Report

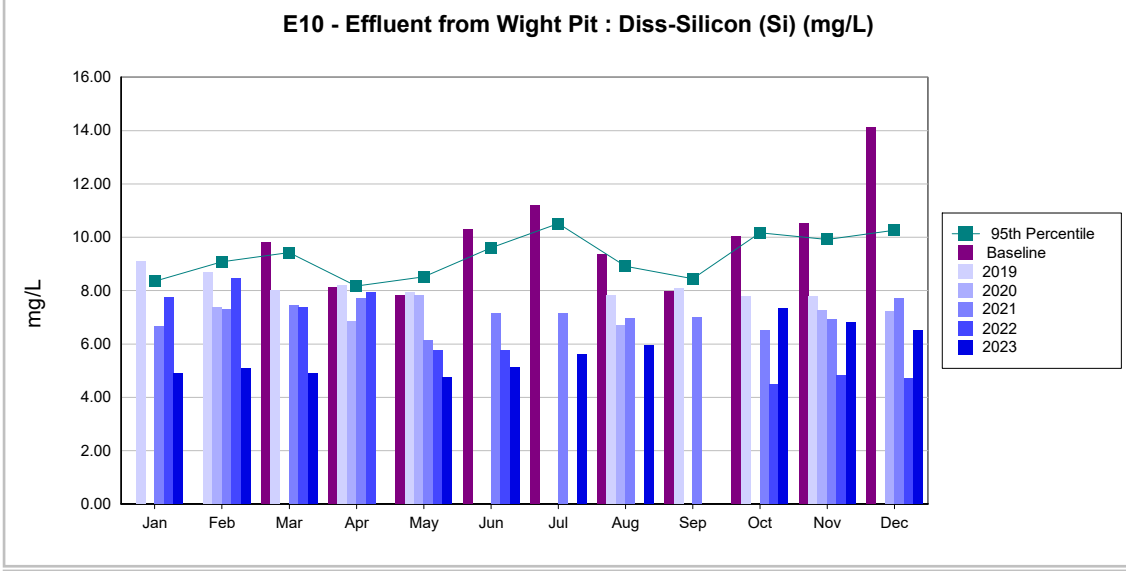
Annual Report Drainage Water

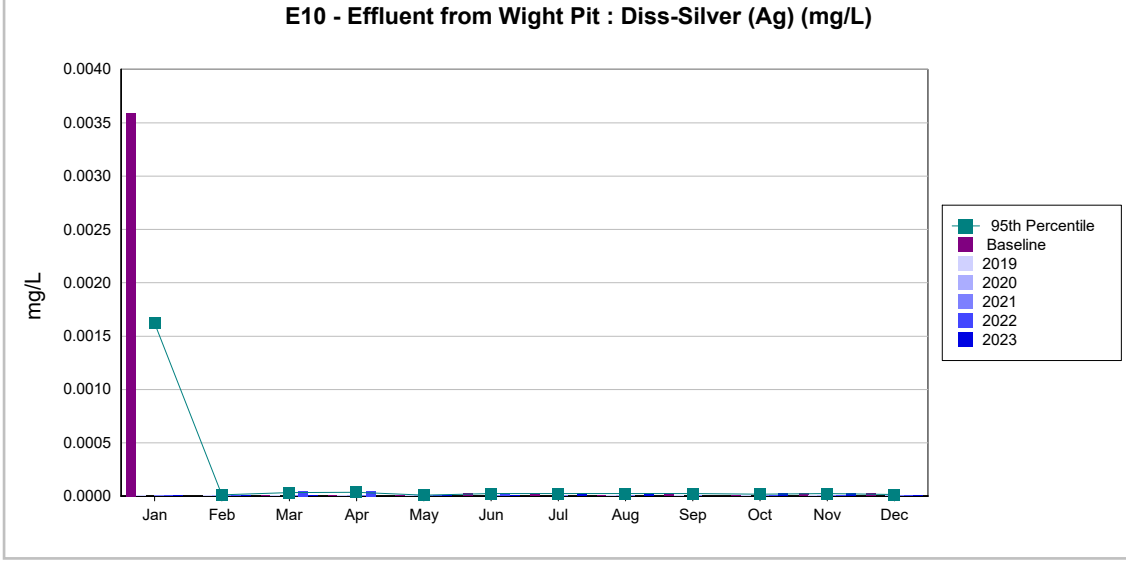
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







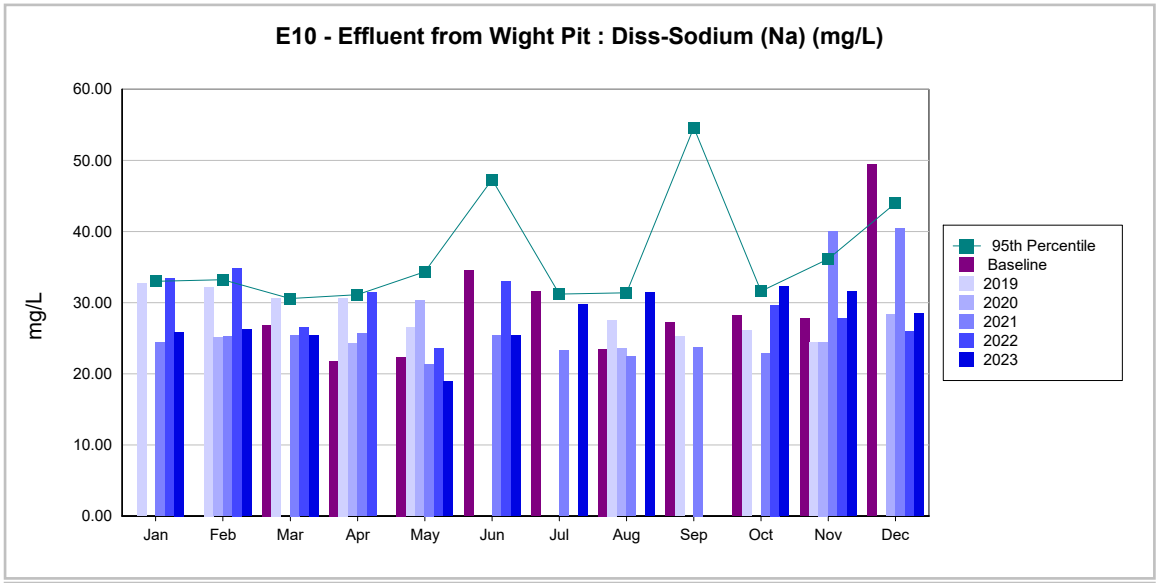
Water Quality Report

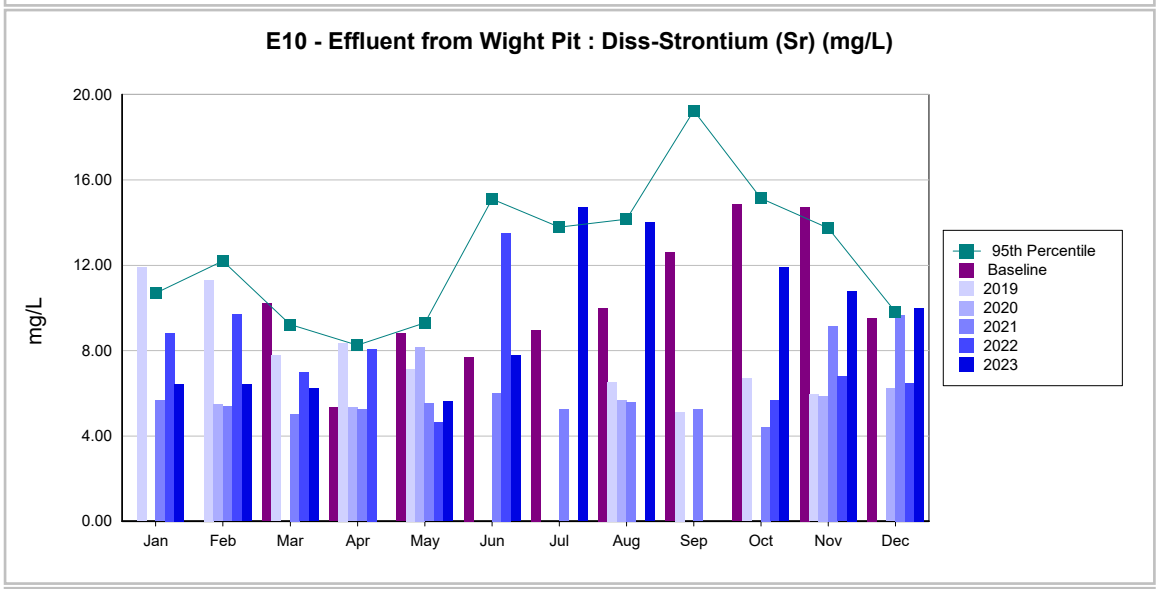
Annual Report Drainage Water

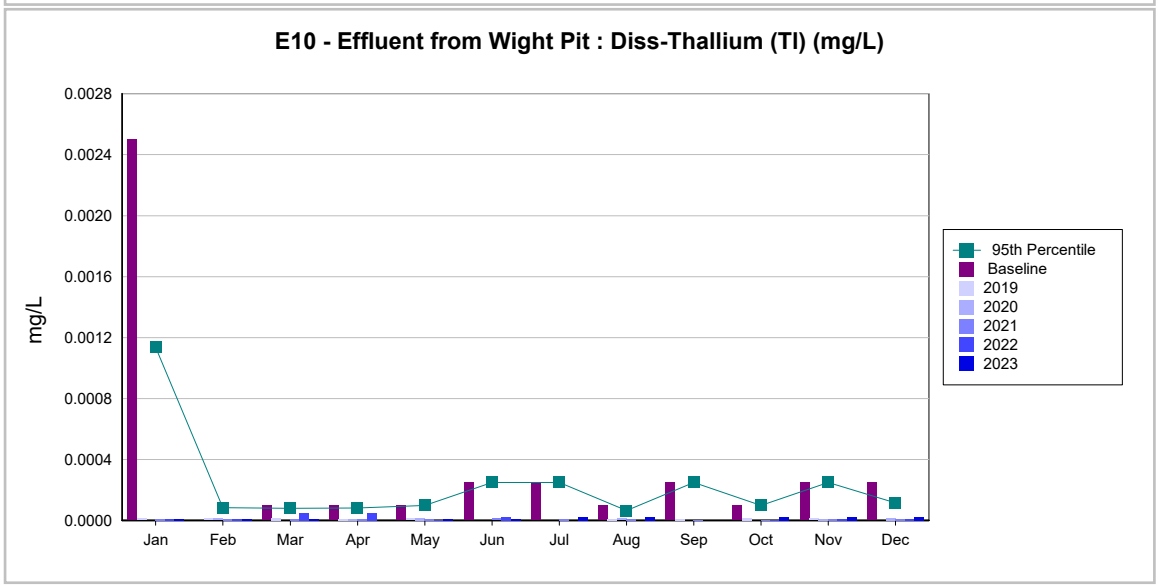
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







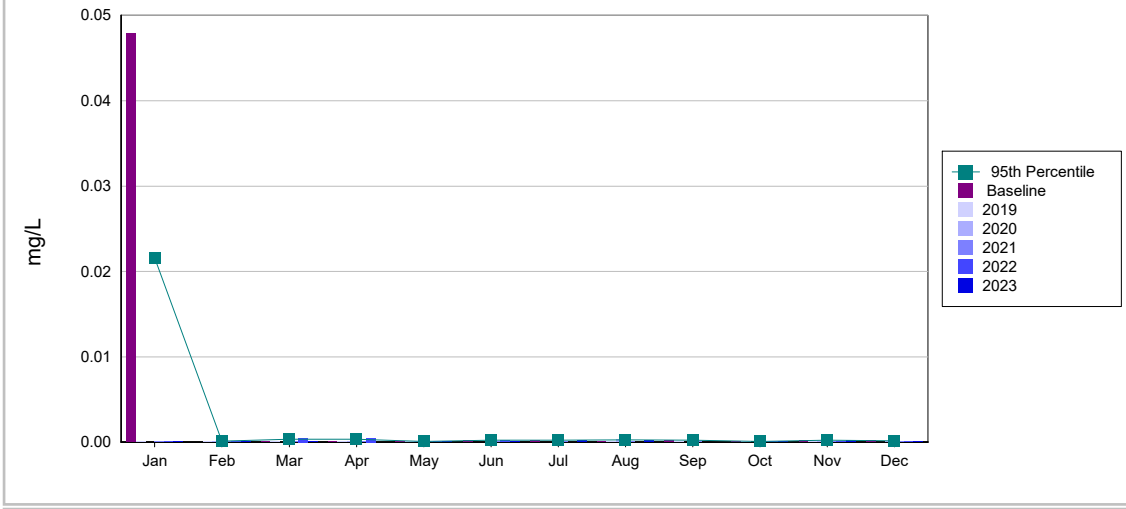
Water Quality Report

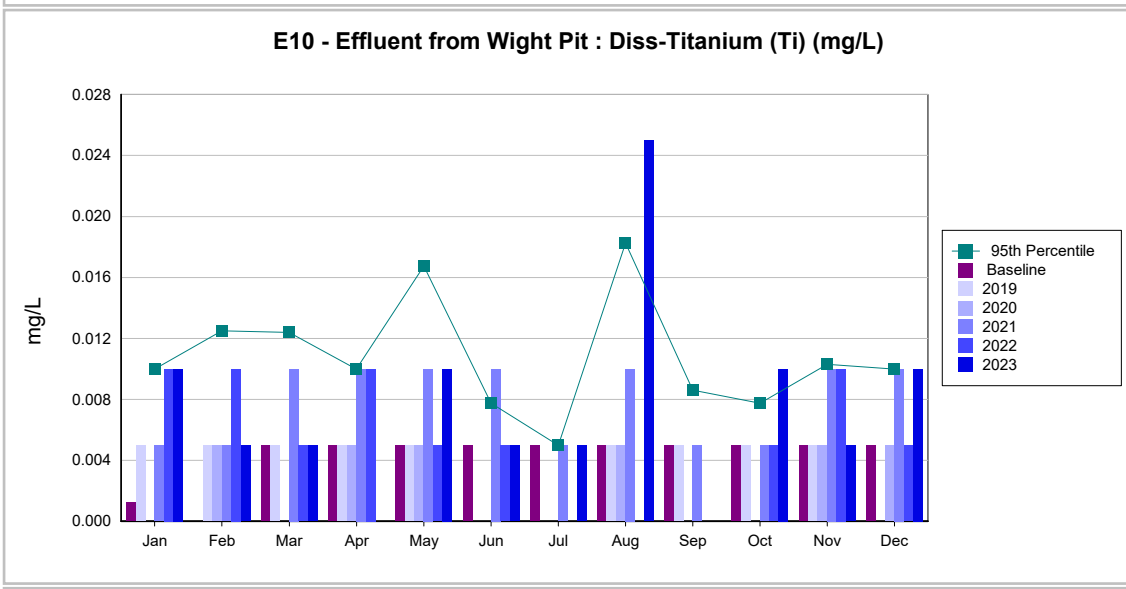
Annual Report Drainage Water

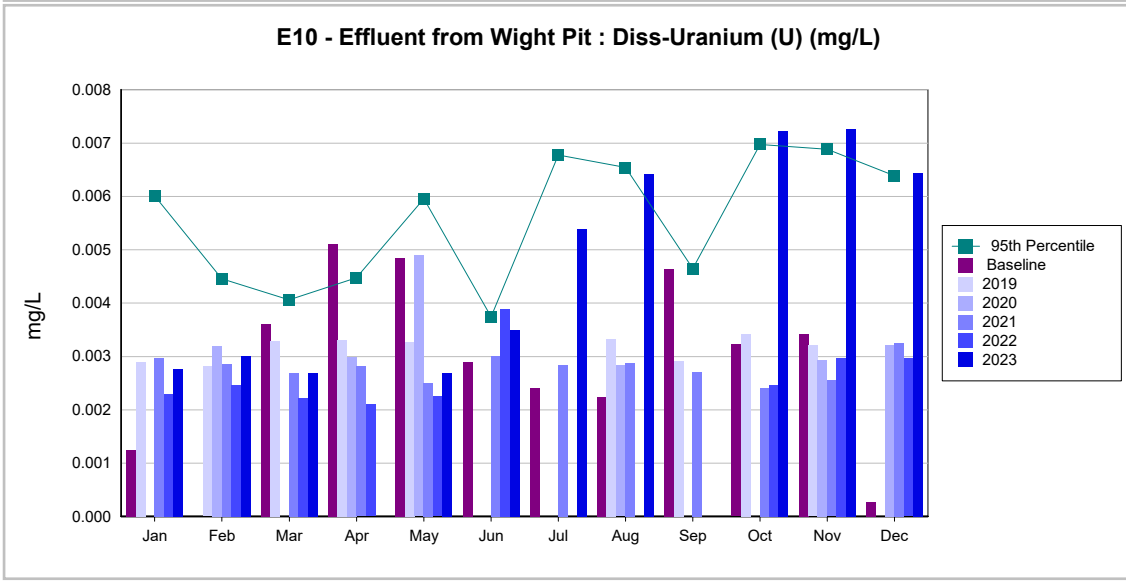
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







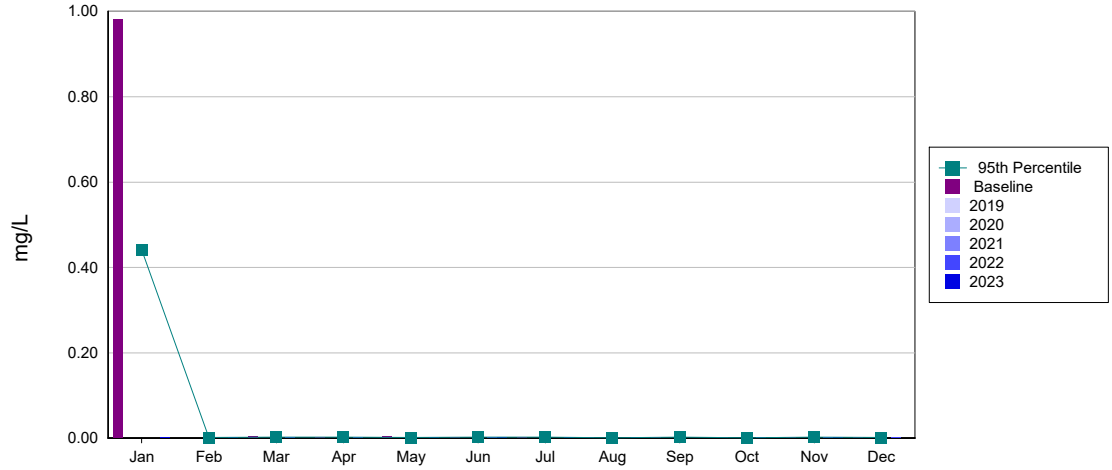
Water Quality Report

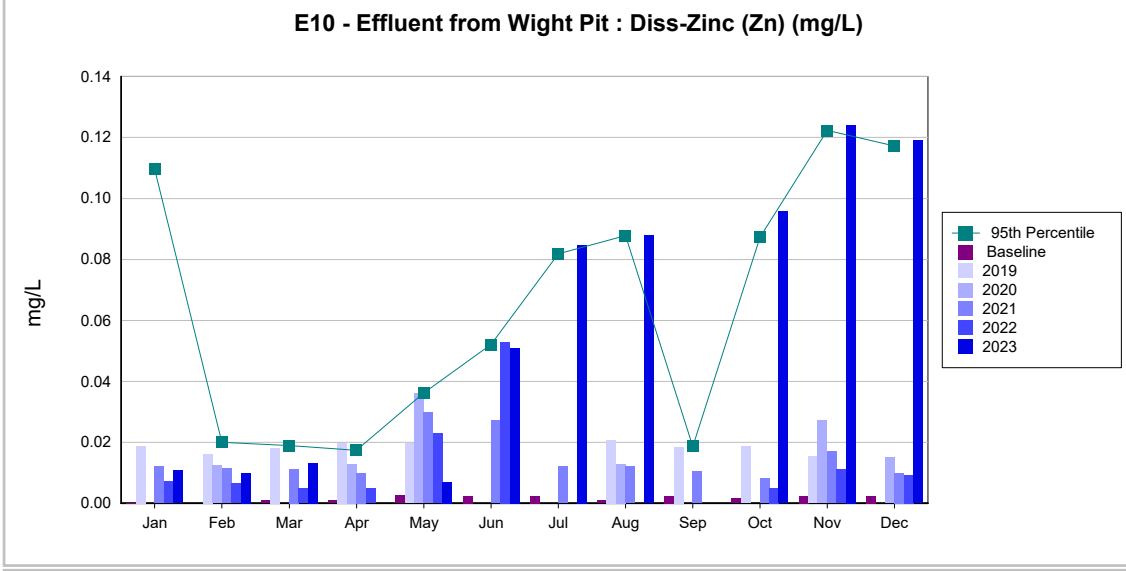
Annual Report Drainage Water

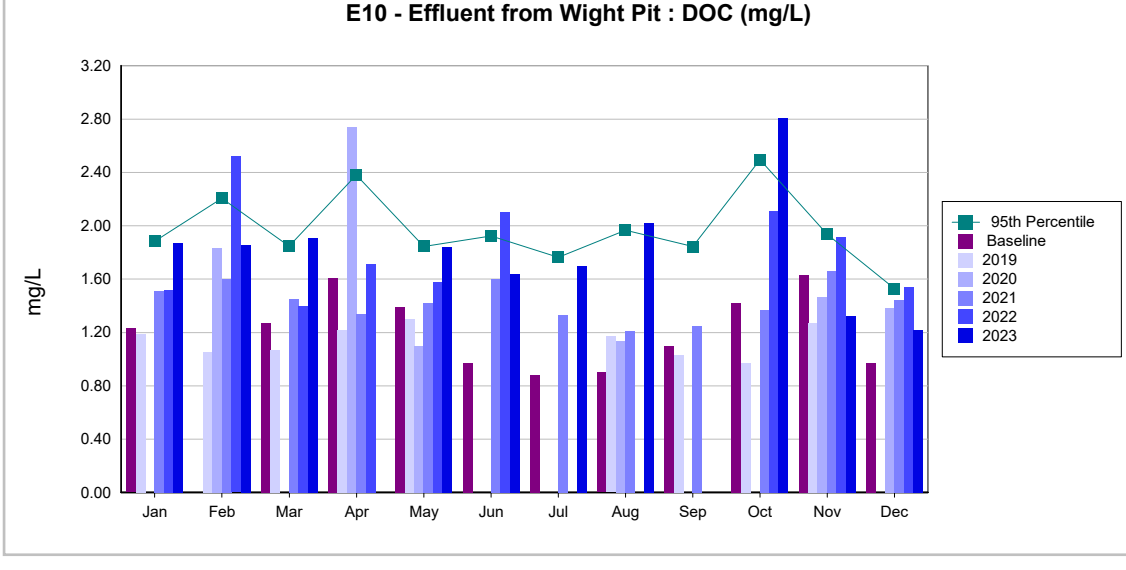
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







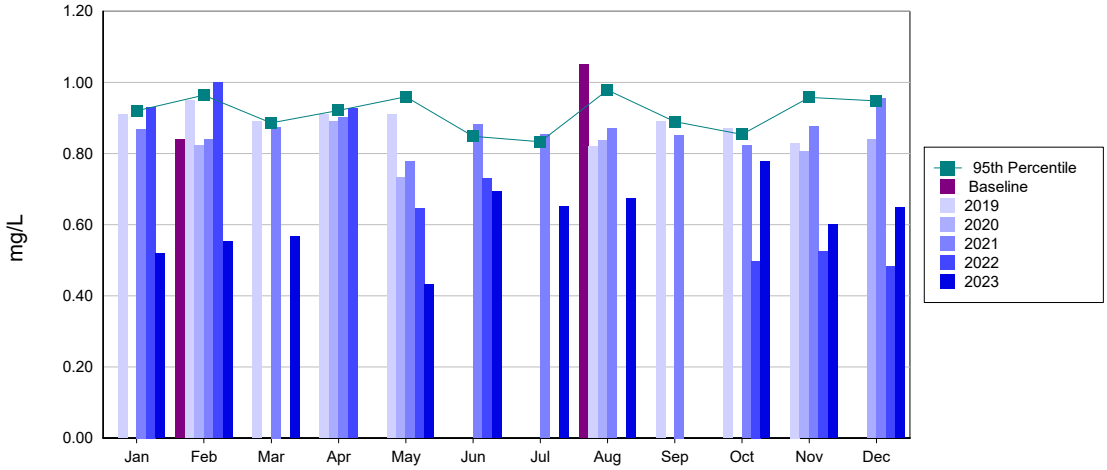
Water Quality Report

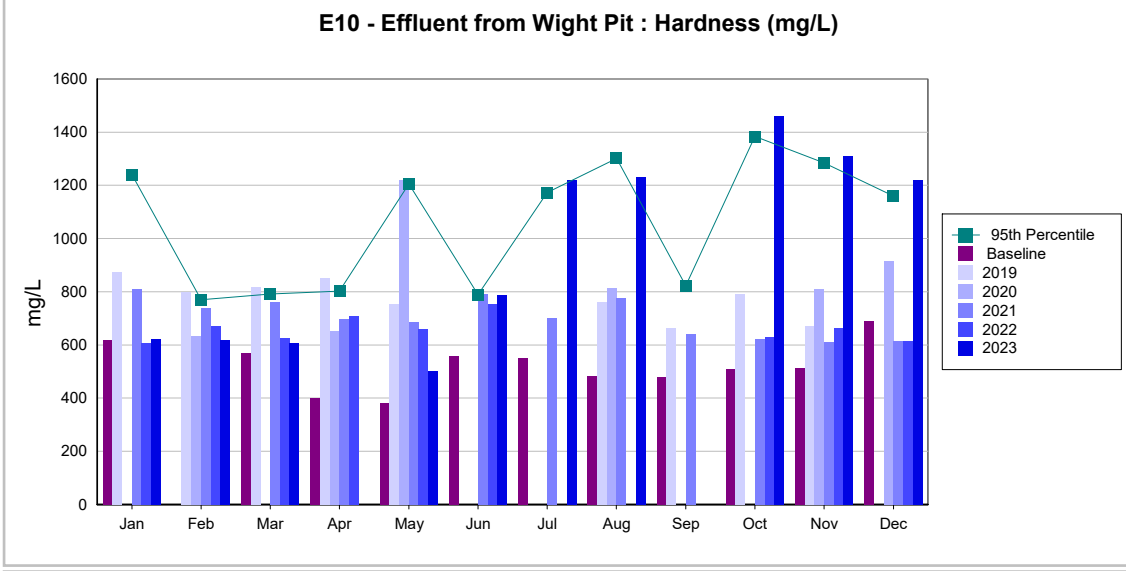
Annual Report Drainage Water

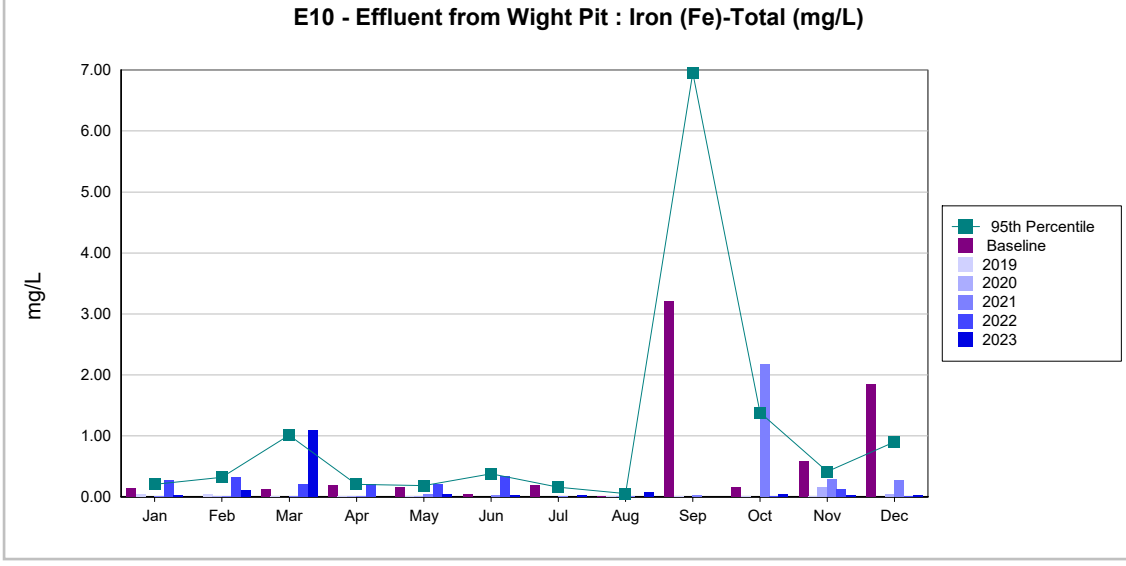
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







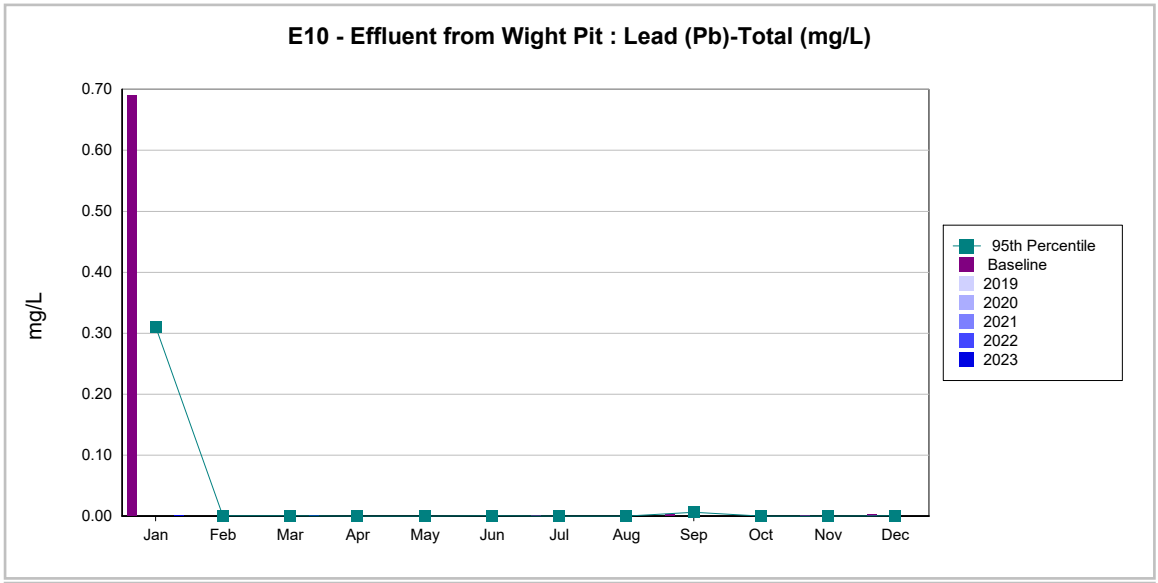
Water Quality Report

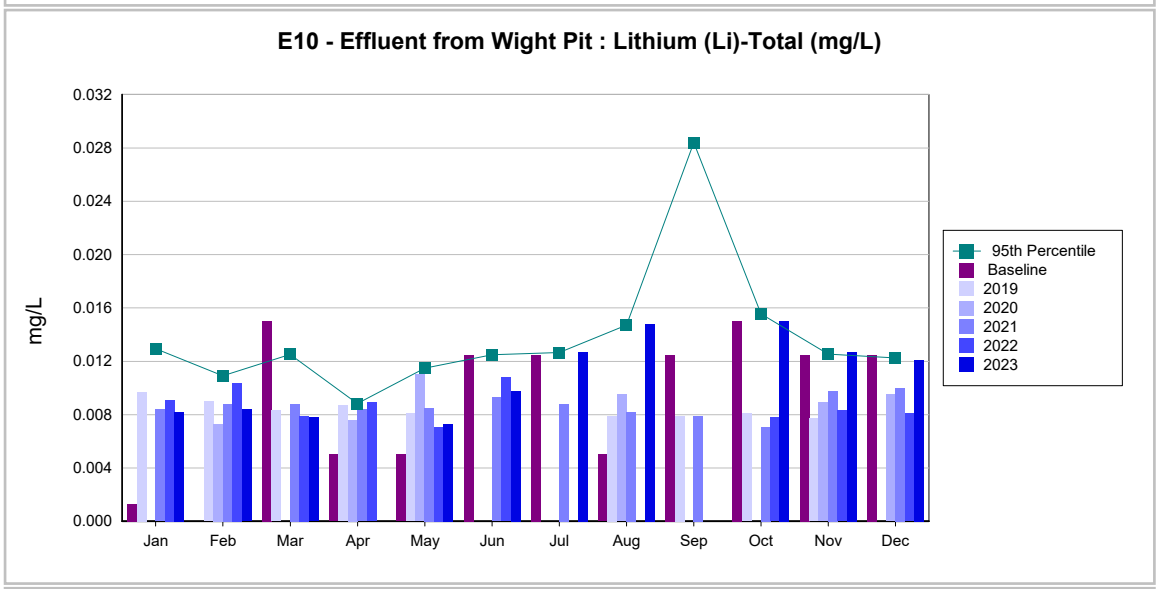
Annual Report Drainage Water

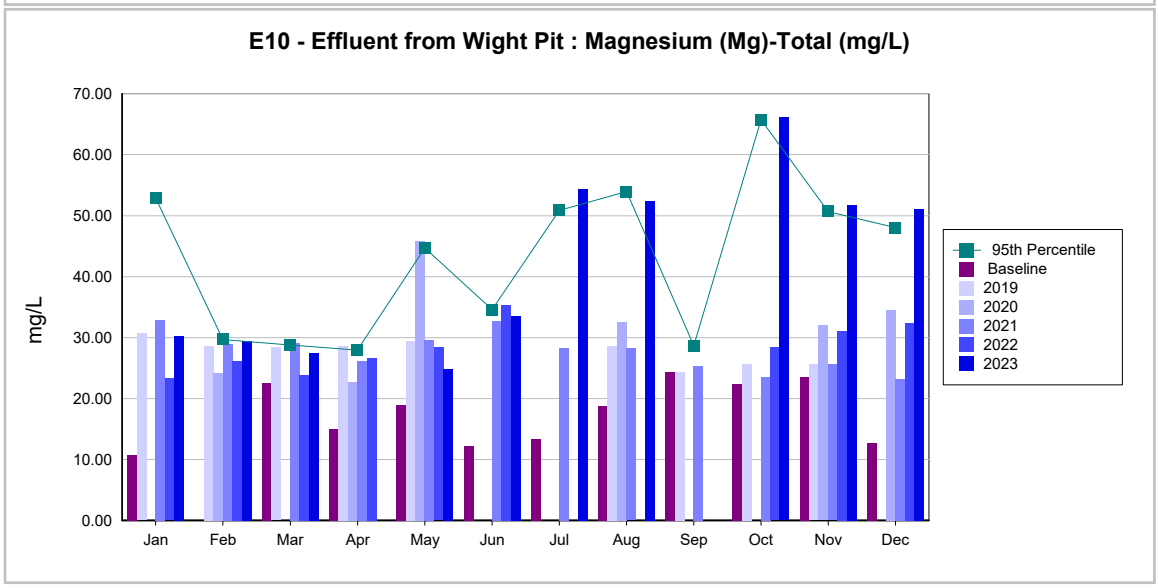
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







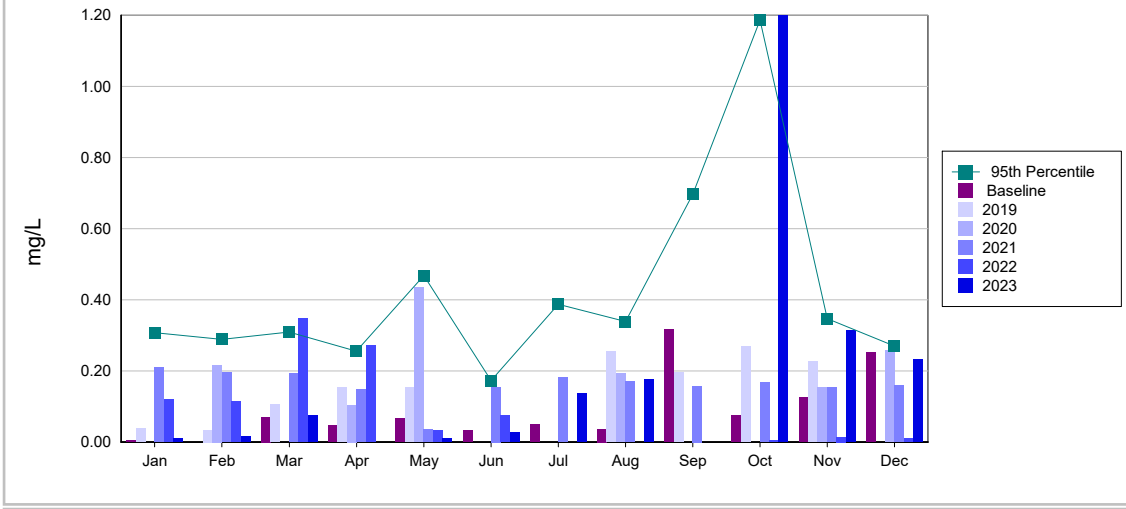
Water Quality Report

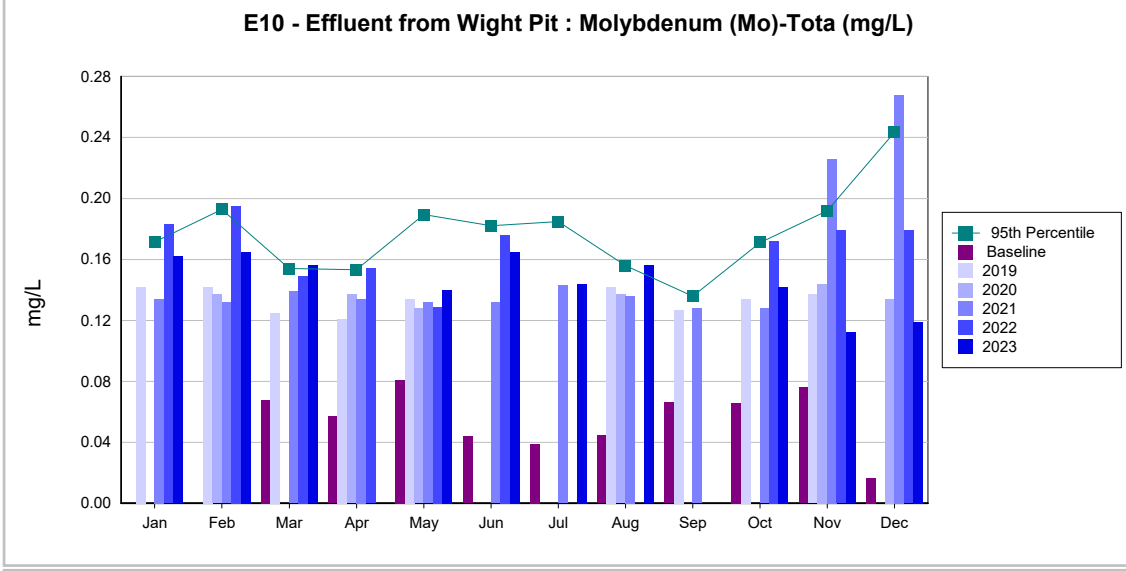
Annual Report Drainage Water

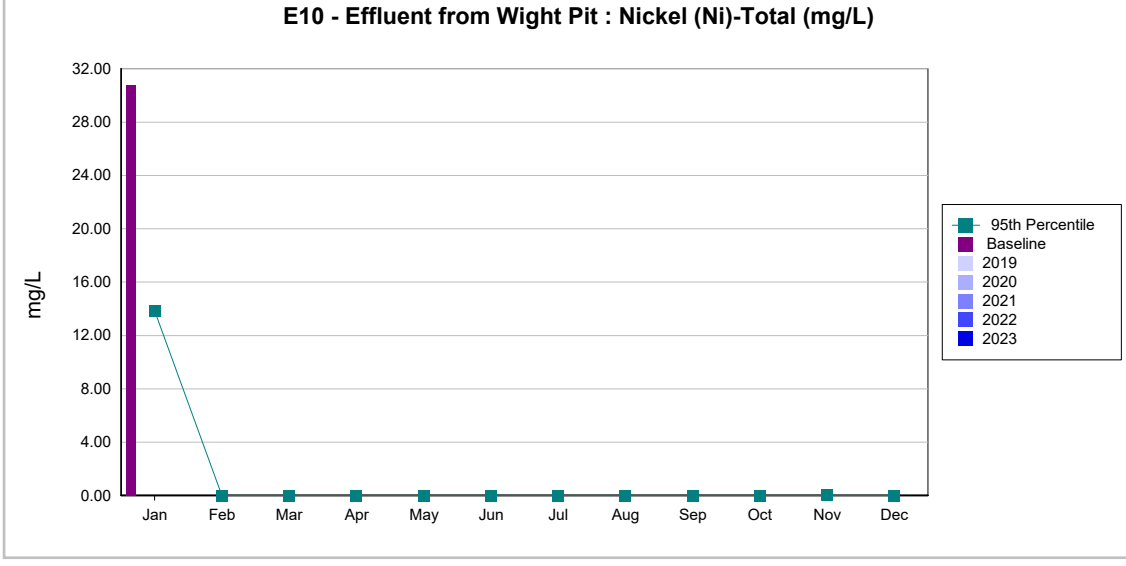
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







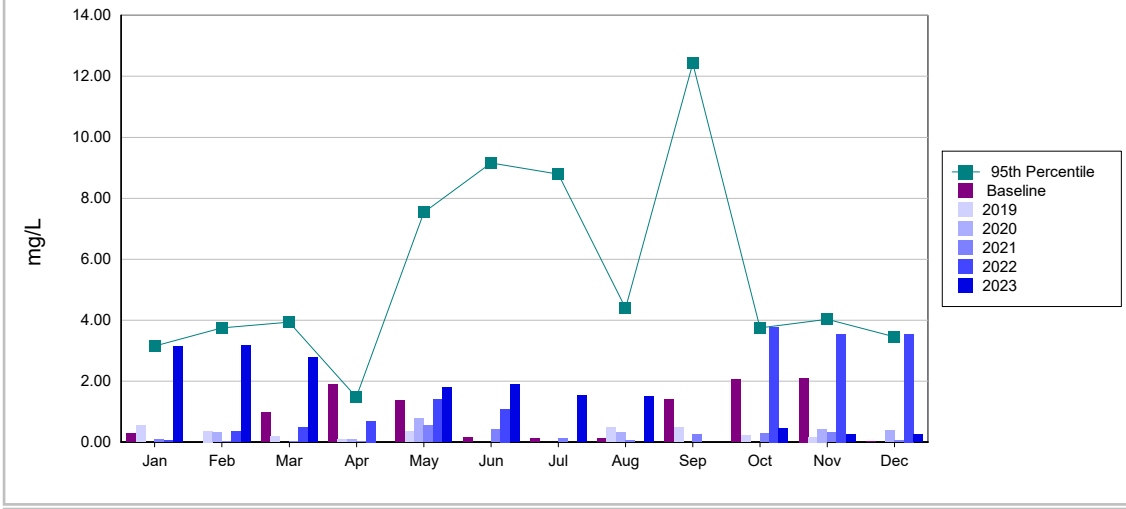
Water Quality Report

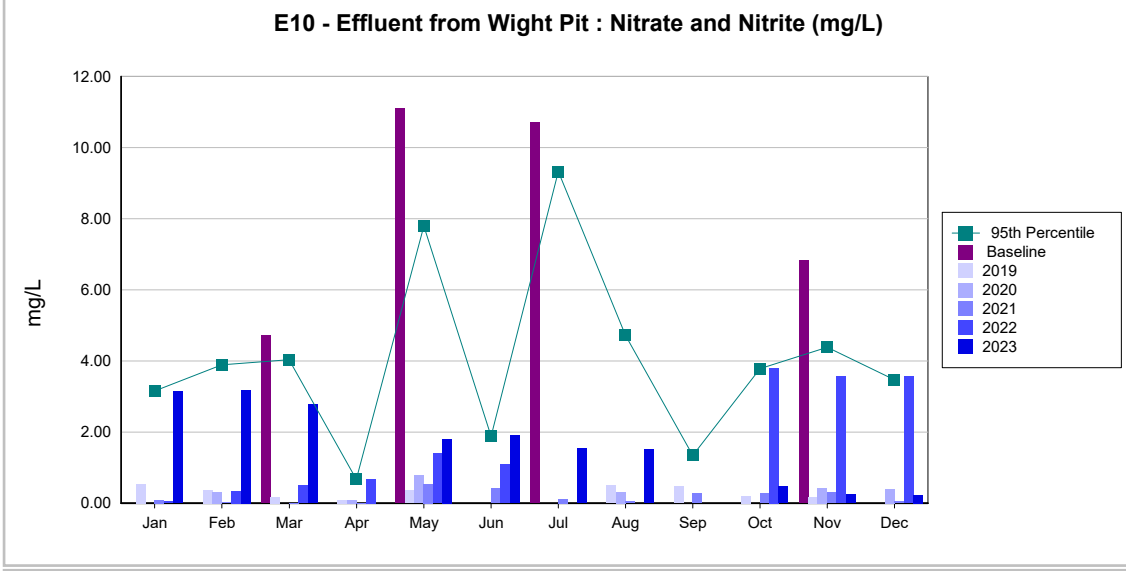
Annual Report Drainage Water

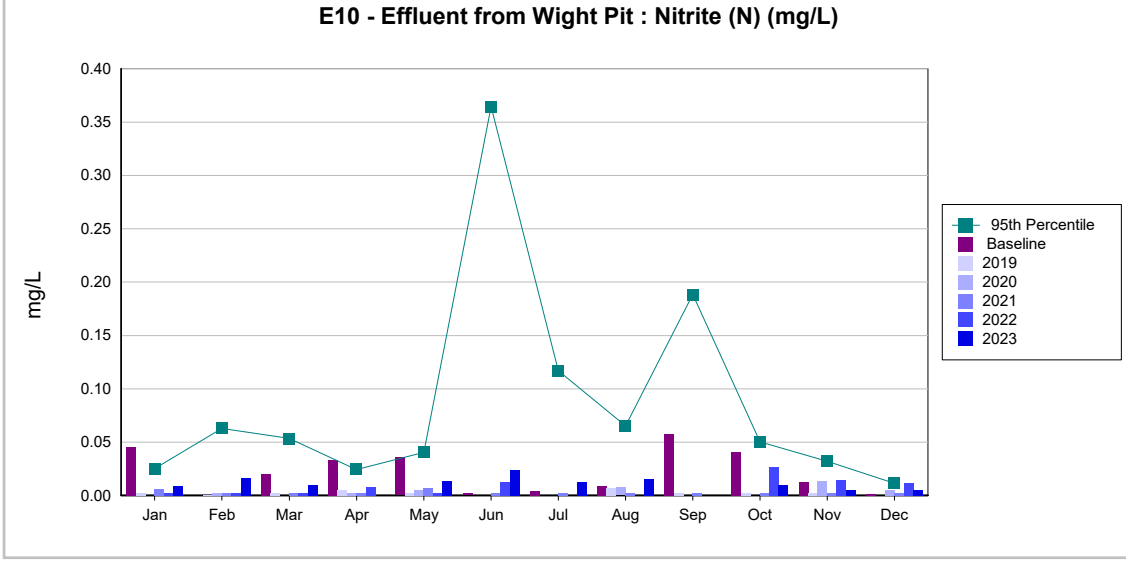
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







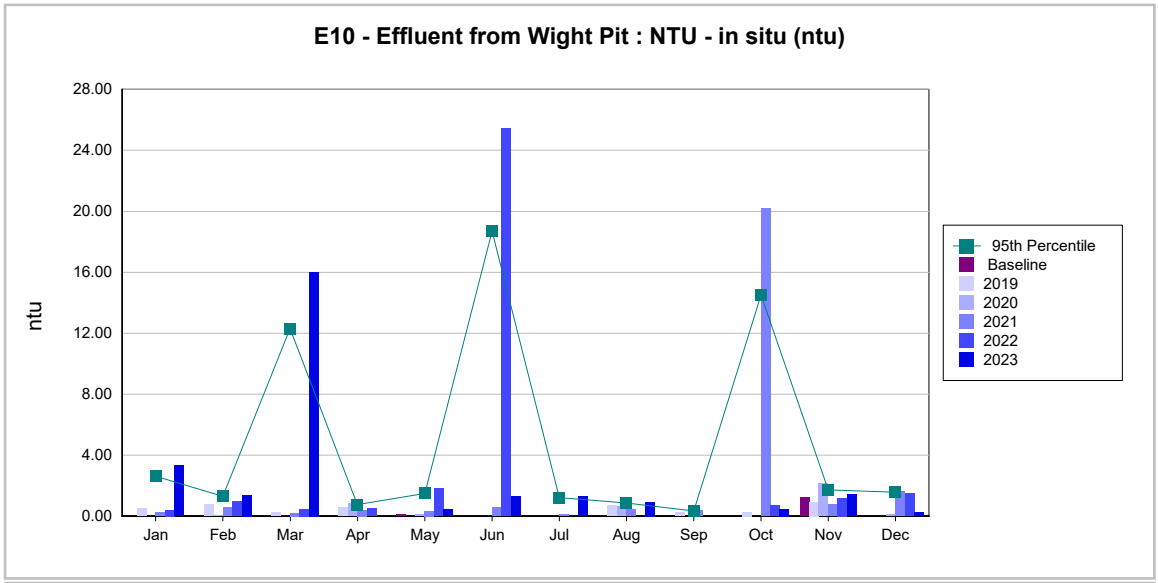
Water Quality Report

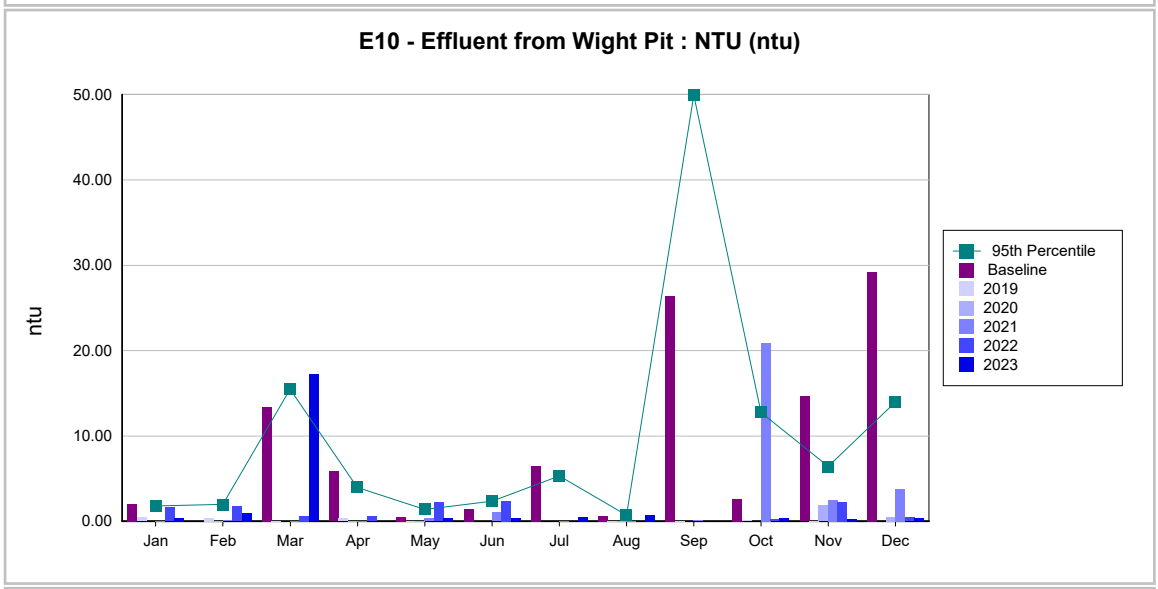
Annual Report Drainage Water

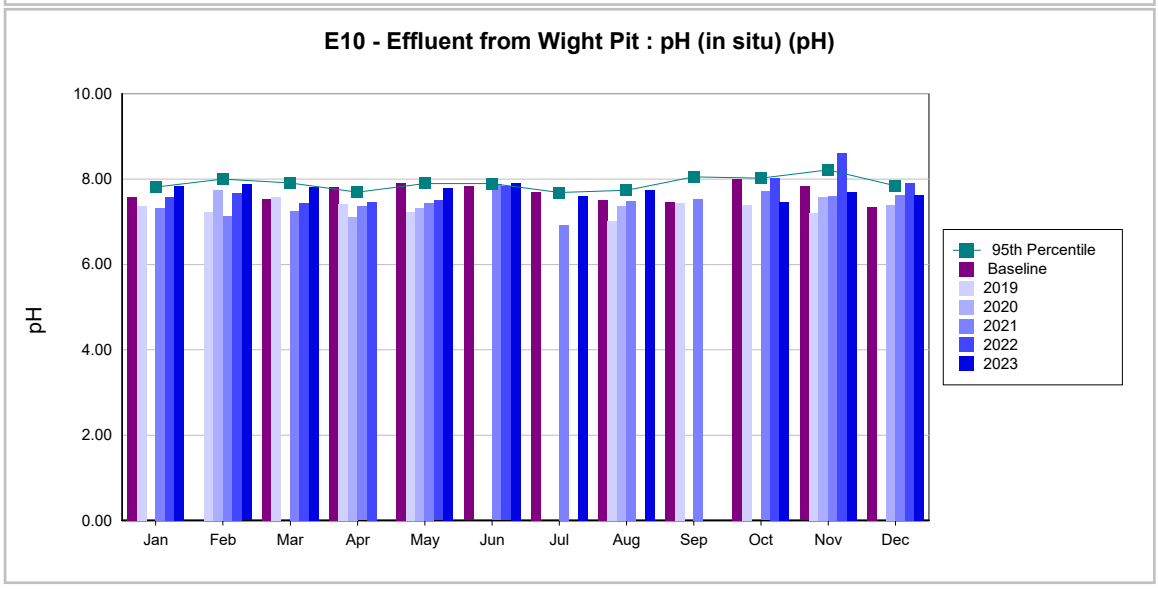
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







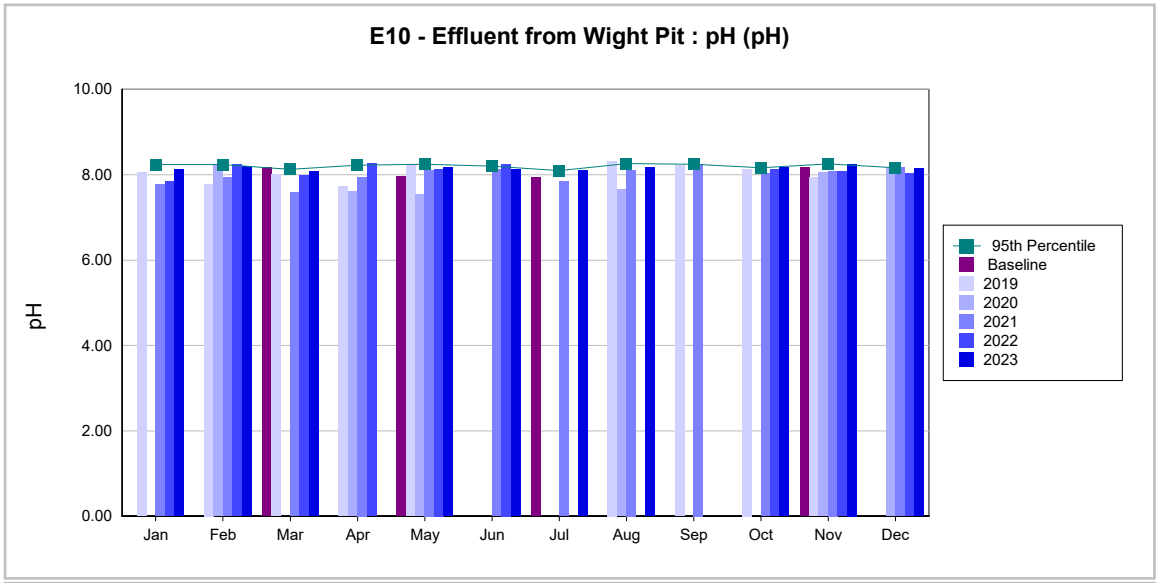
Water Quality Report

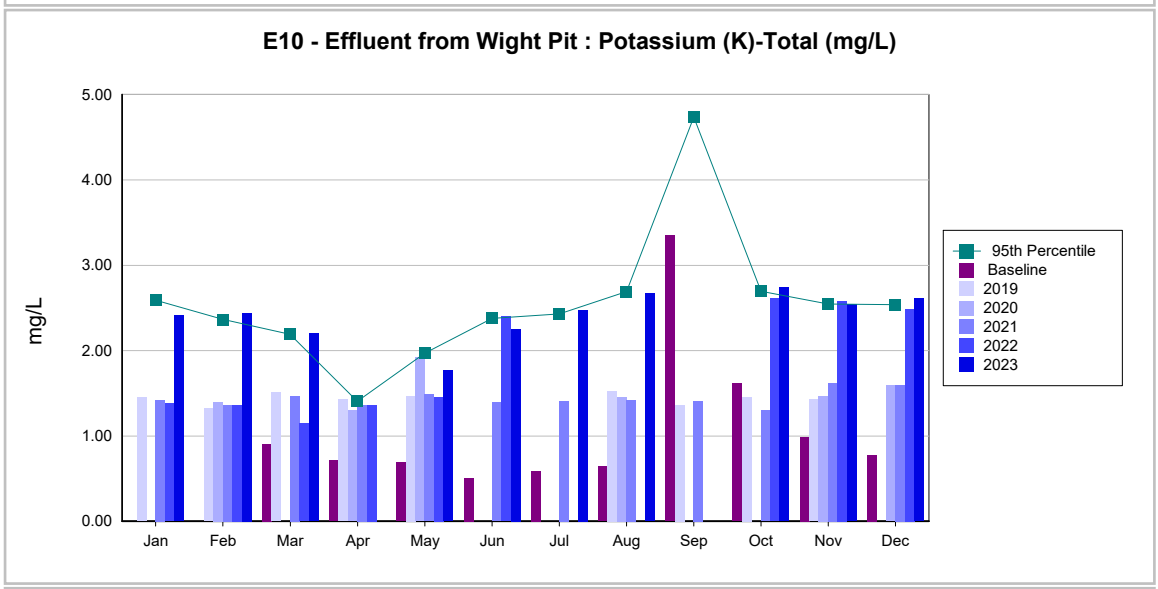
Annual Report Drainage Water

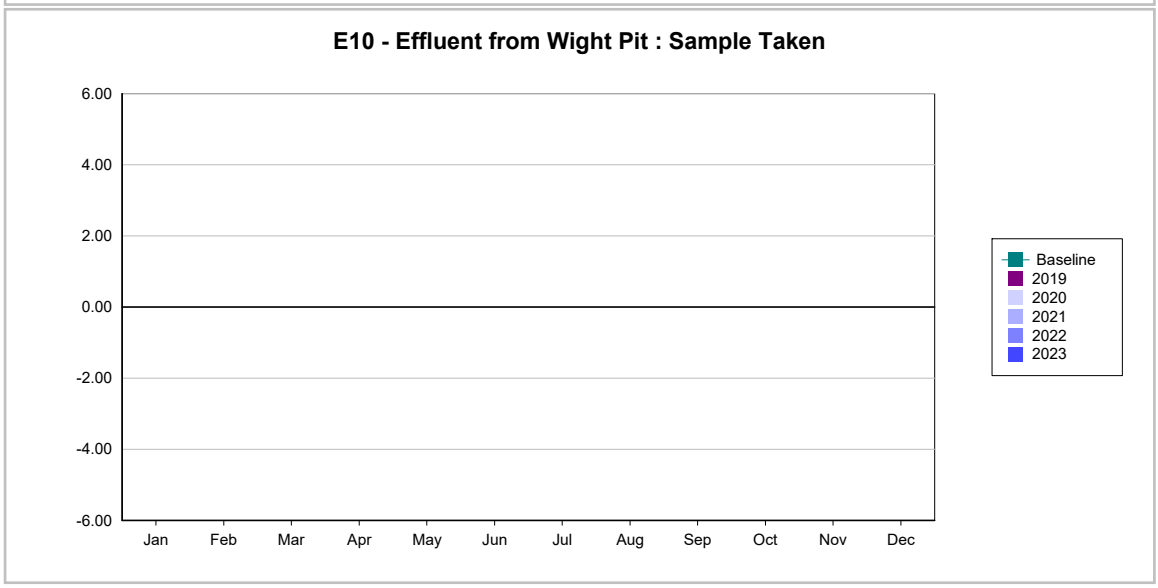
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







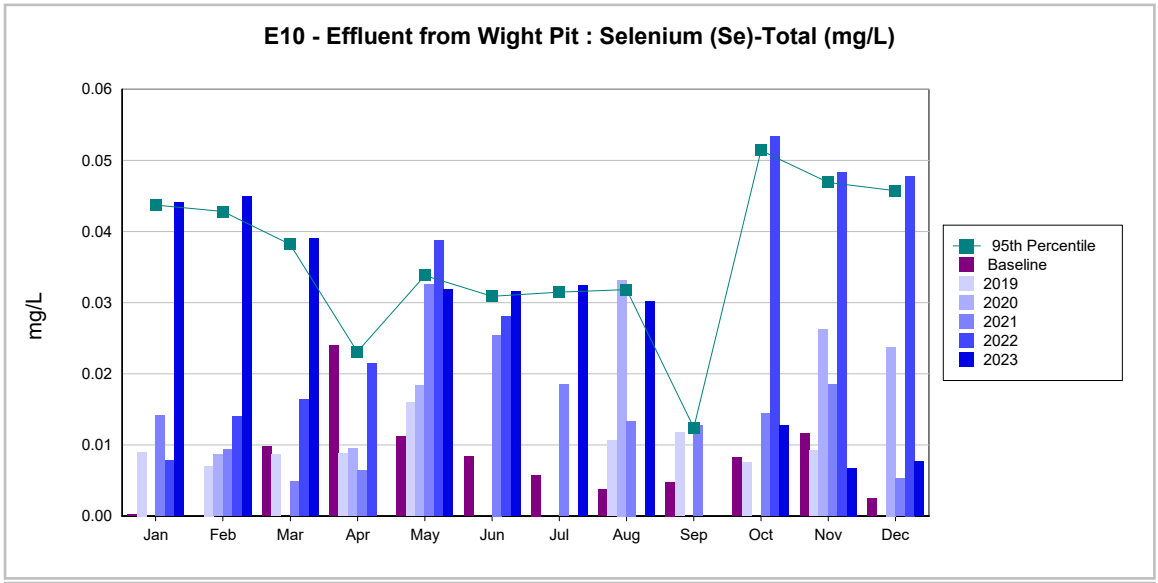
Water Quality Report

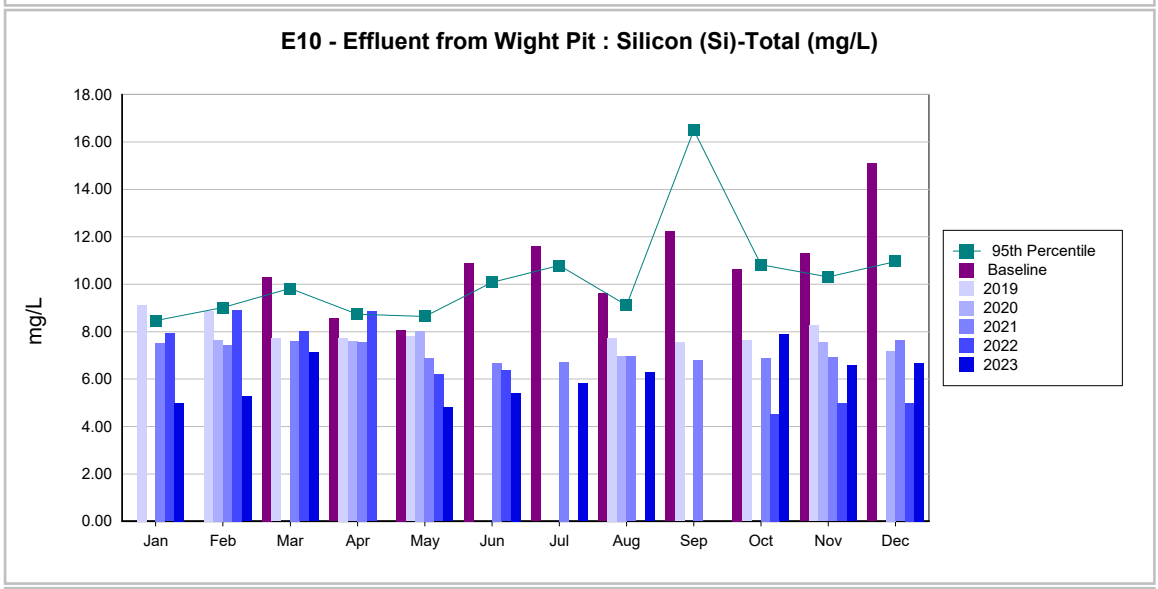
Annual Report Drainage Water

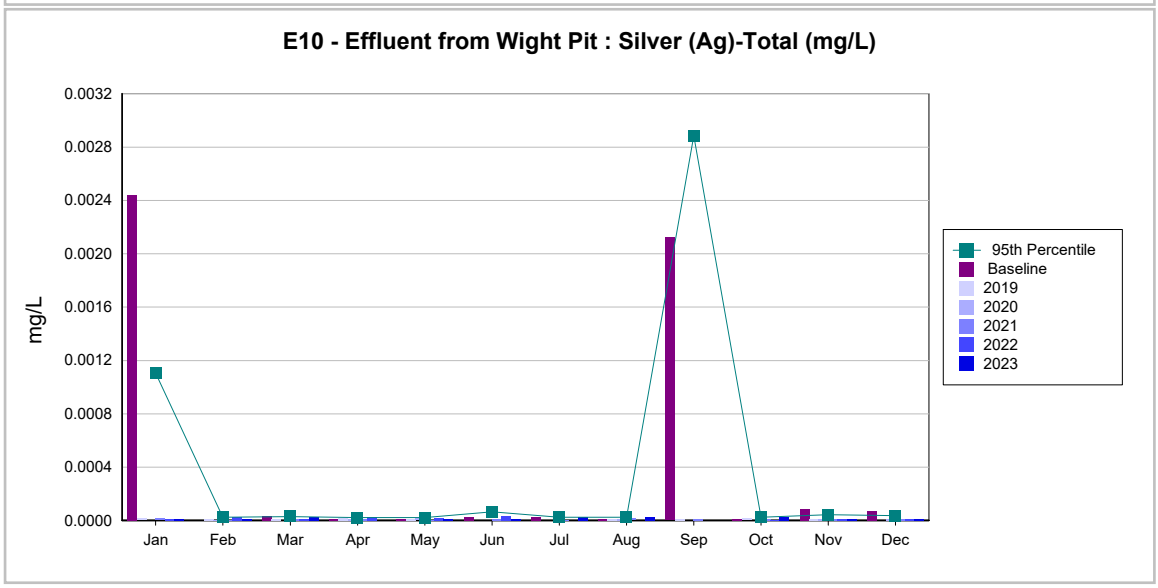
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

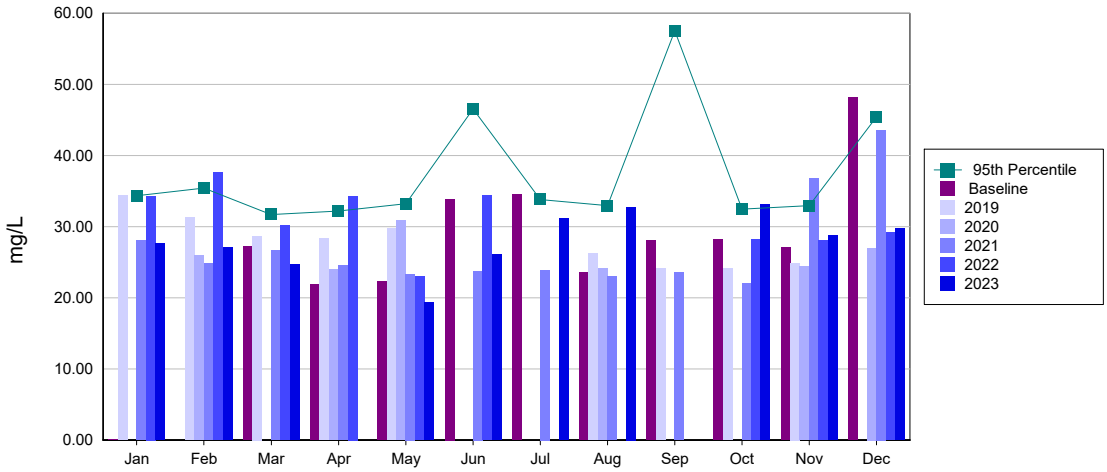
Annual Report Drainage Water

Mount Polley

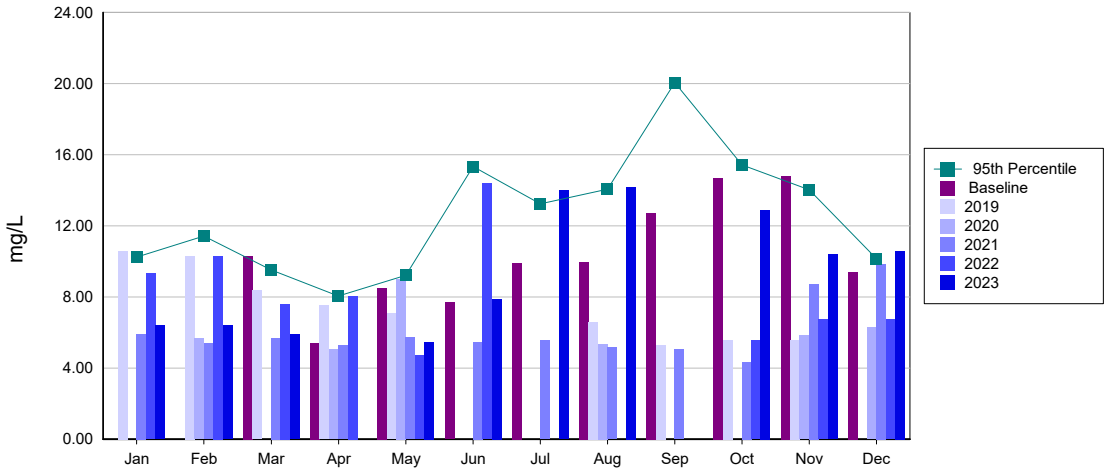
Mining Corporation

IMPERIAL METALS CORPORATION

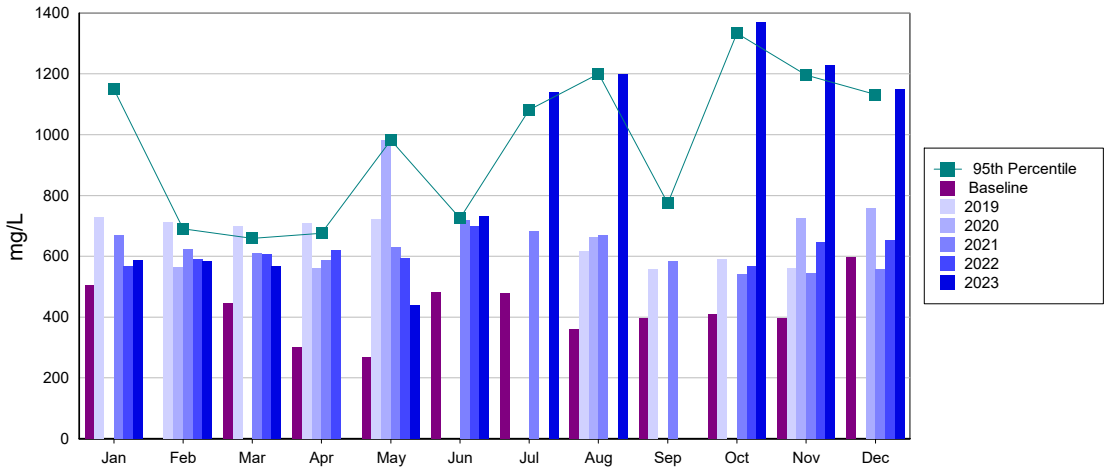
E10 - Effluent from Wight Pit : Sodium (Na)-Total (mg/L)



E10 - Effluent from Wight Pit : Strontium (Sr)-Total (mg/L)



E10 - Effluent from Wight Pit : Sulphate (mg/L)



Water Quality Report

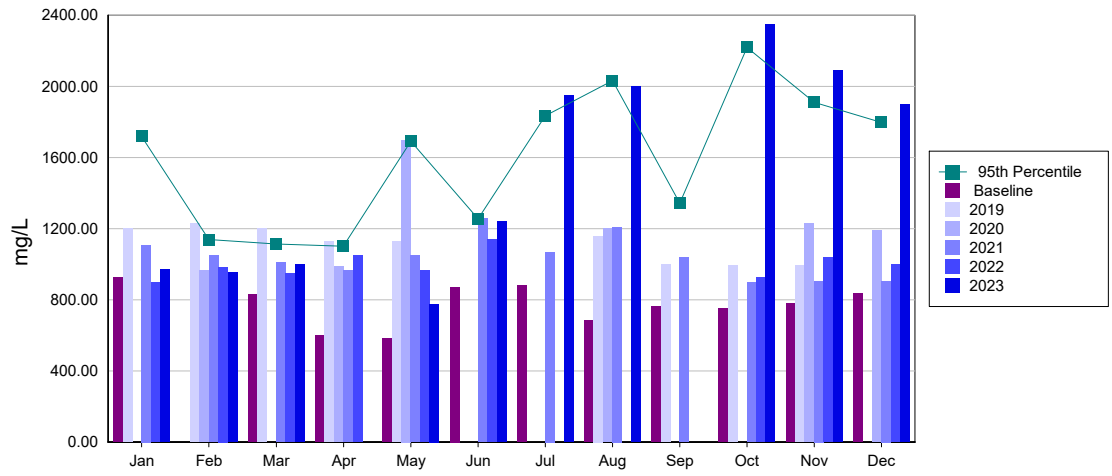
Annual Report Drainage Water

Mount Polley

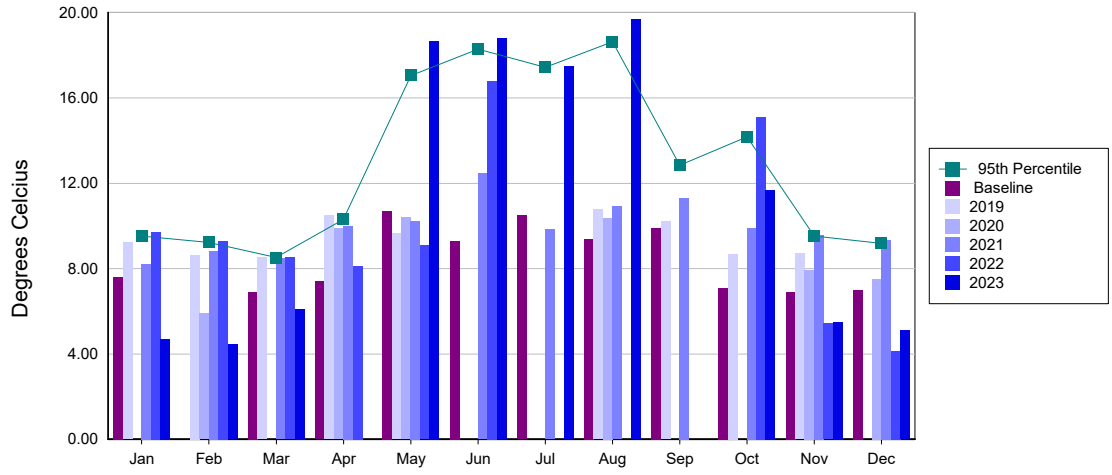
Mining Corporation

IMPERIAL METALS CORPORATION

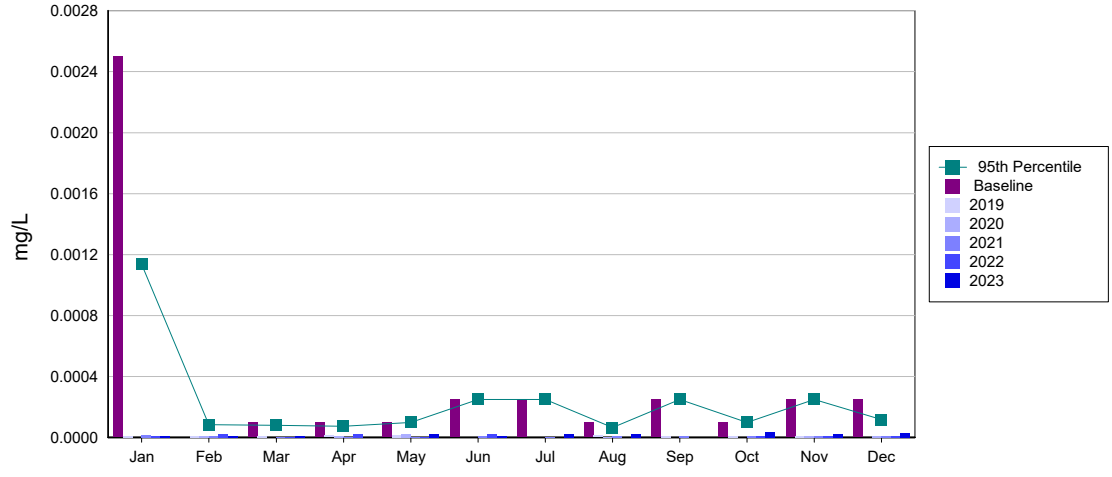
E10 - Effluent from Wight Pit : TDS (mg/L)



E10 - Effluent from Wight Pit : Temp (in situ) (Degrees Celcius)



E10 - Effluent from Wight Pit : Thallium (Tl)-Total (mg/L)



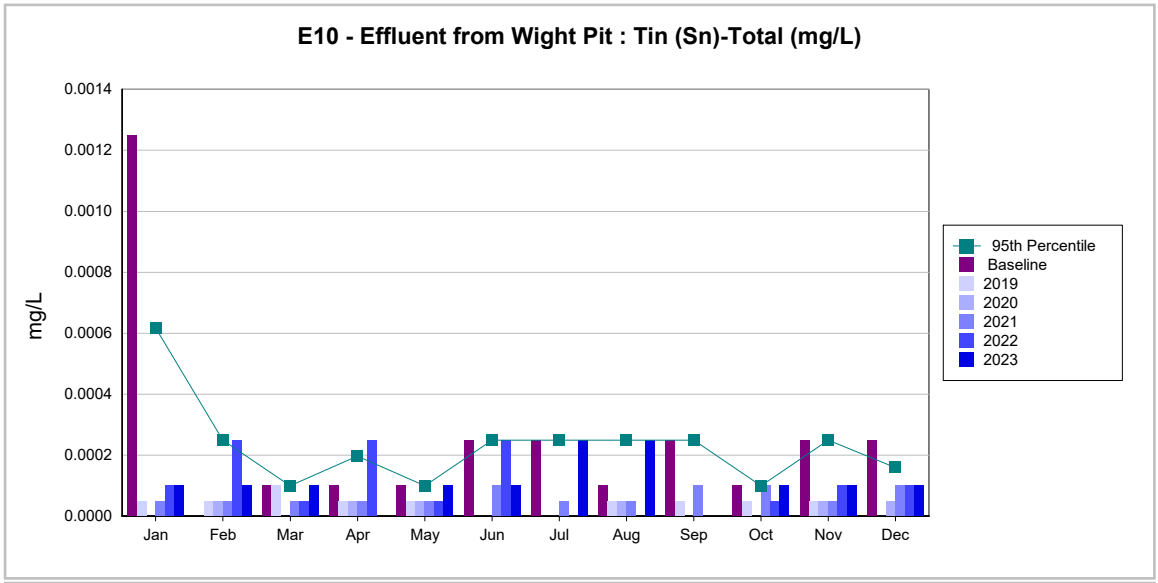
Water Quality Report

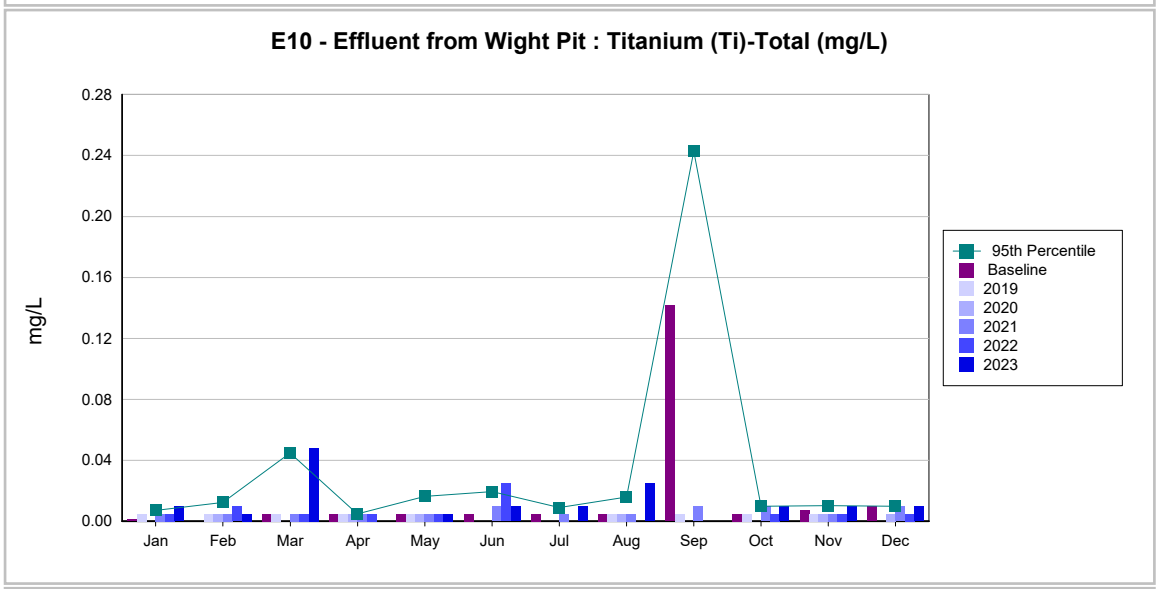
Annual Report Drainage Water

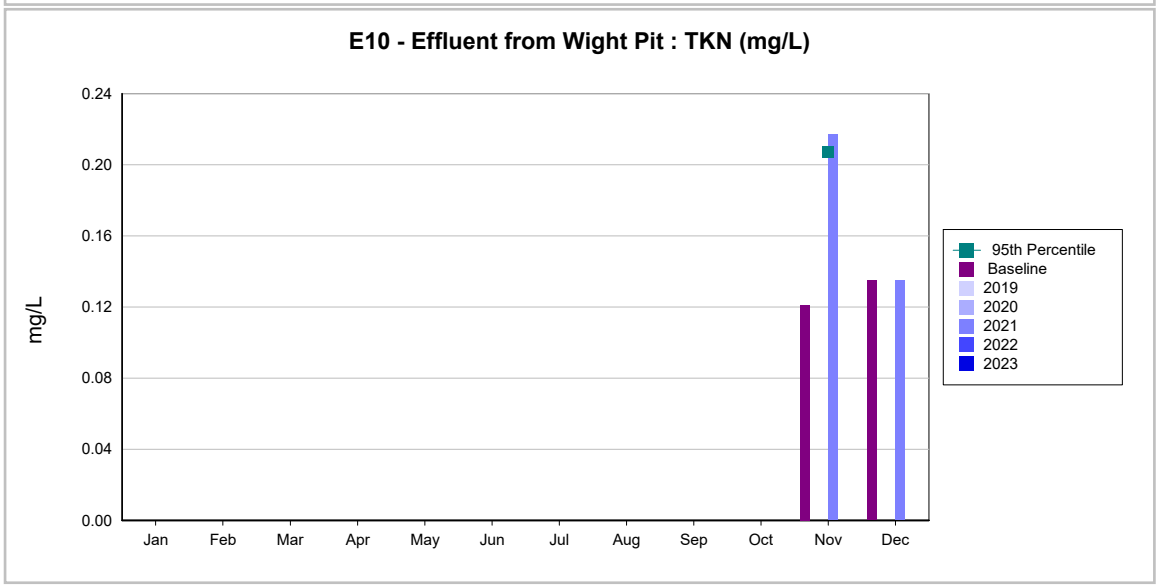
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







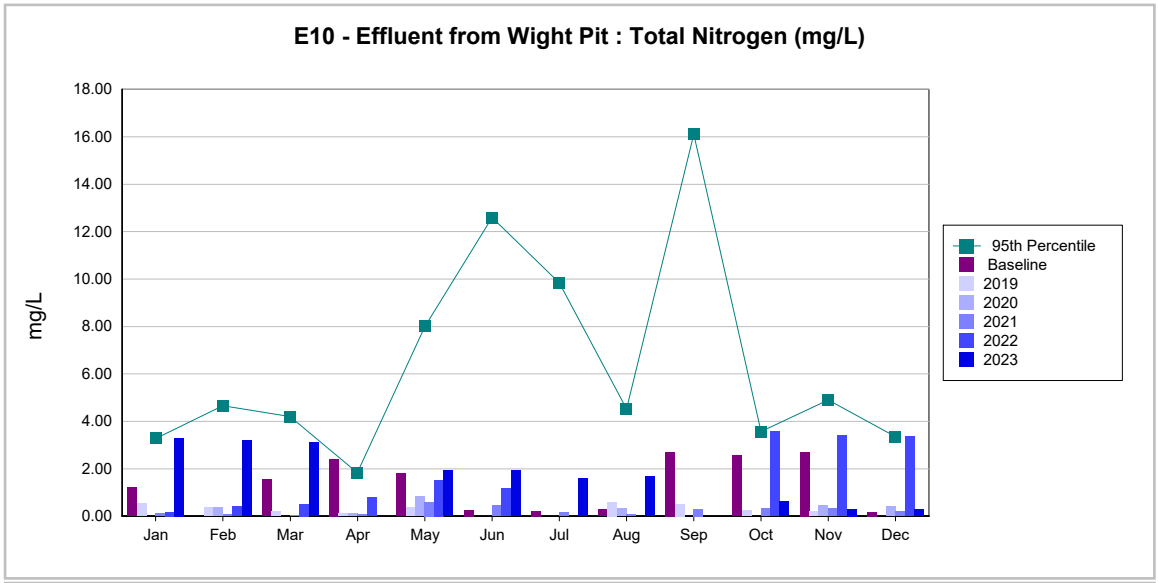
Water Quality Report

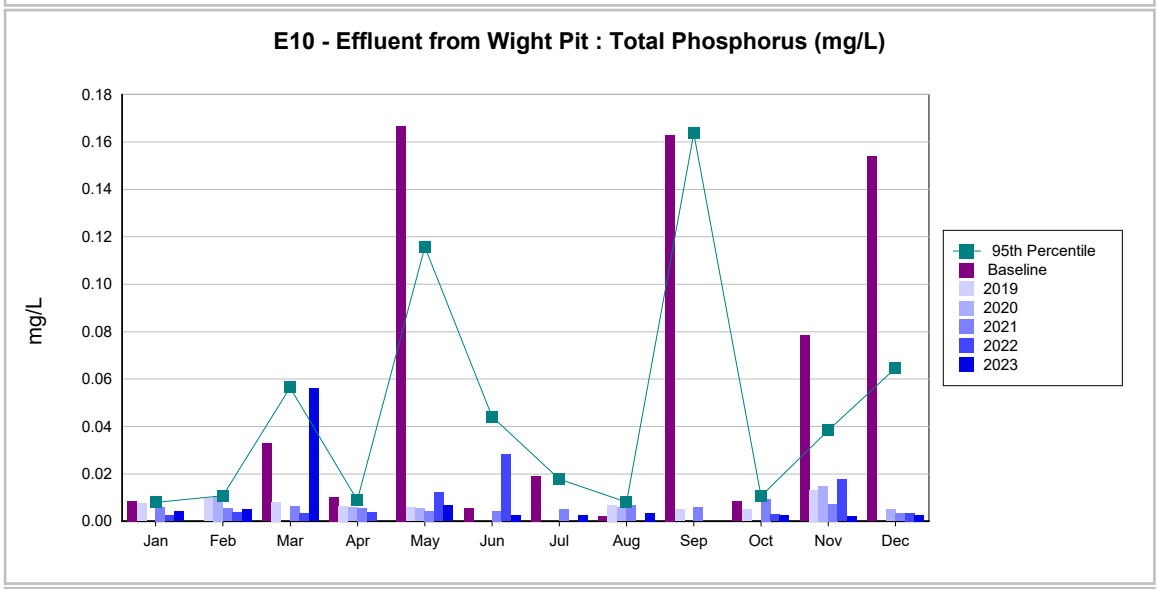
Annual Report Drainage Water

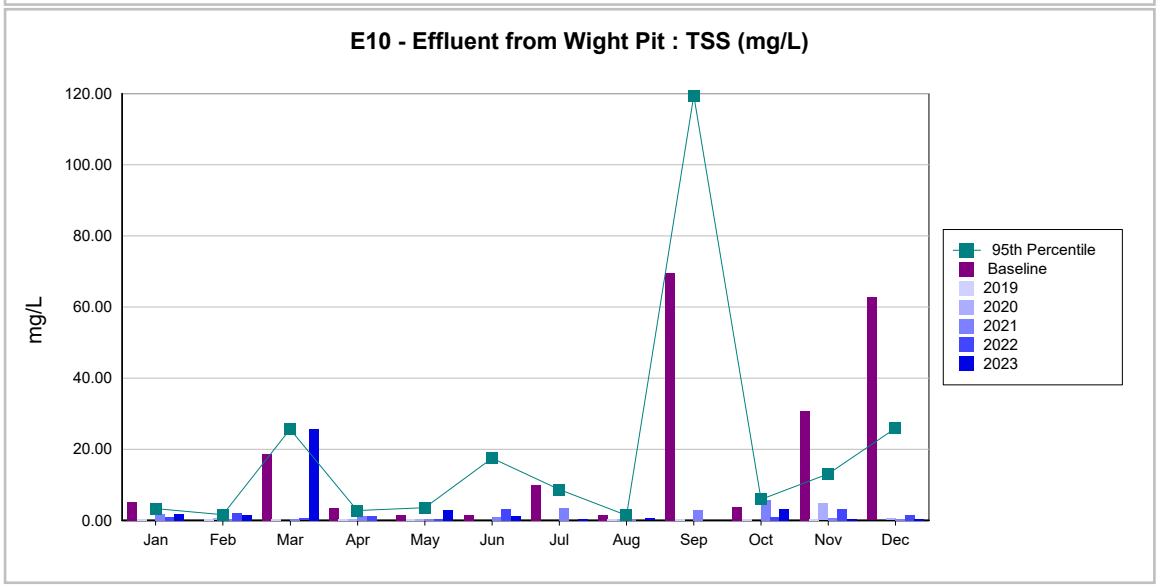
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







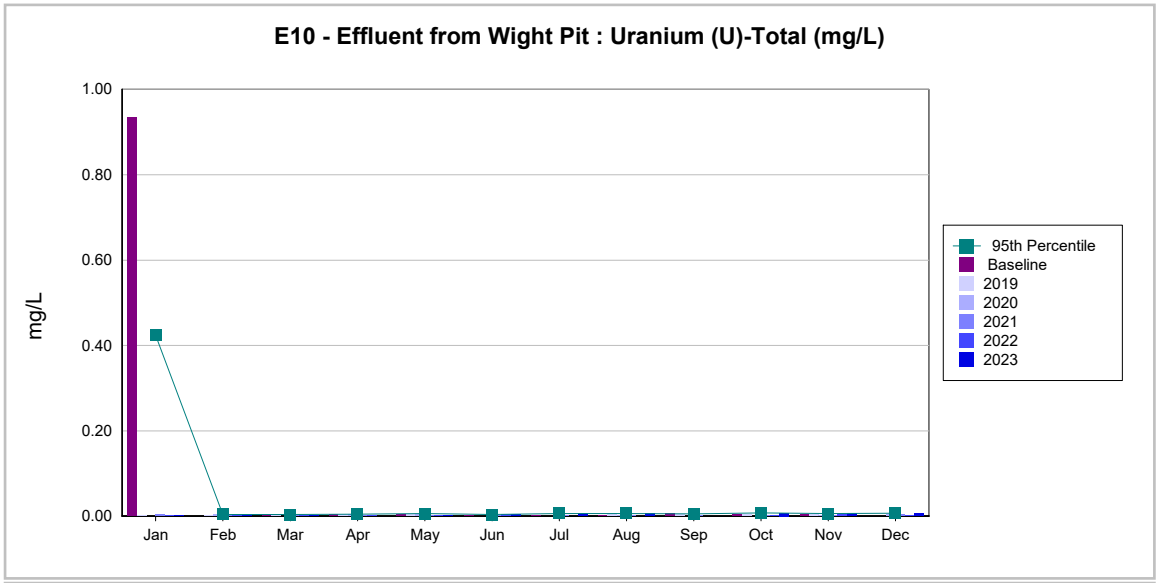
Water Quality Report

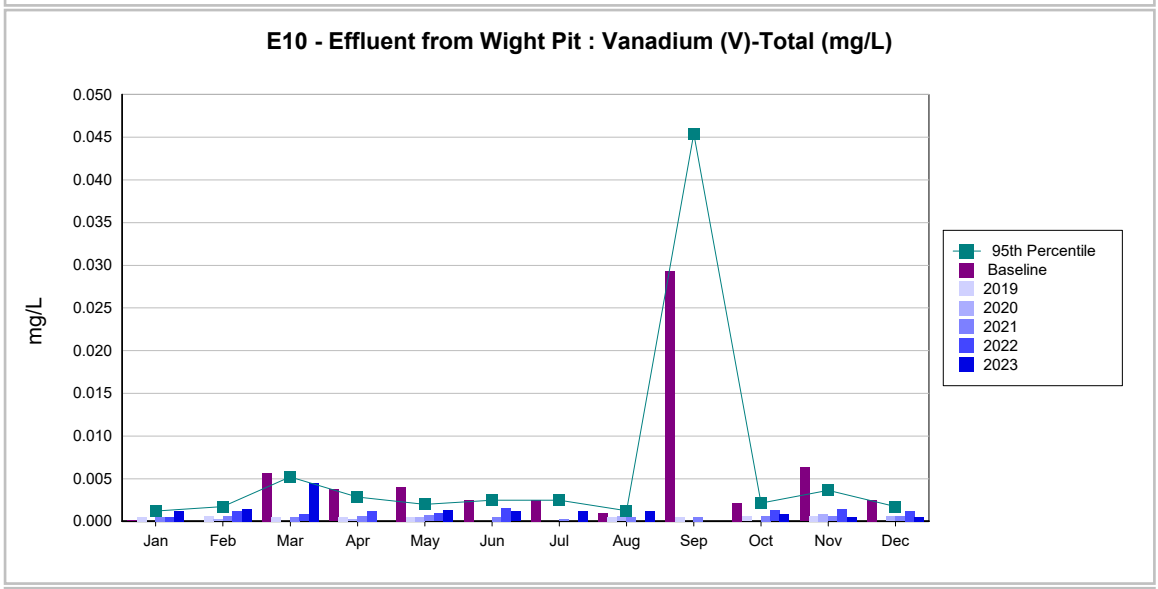
Annual Report Drainage Water

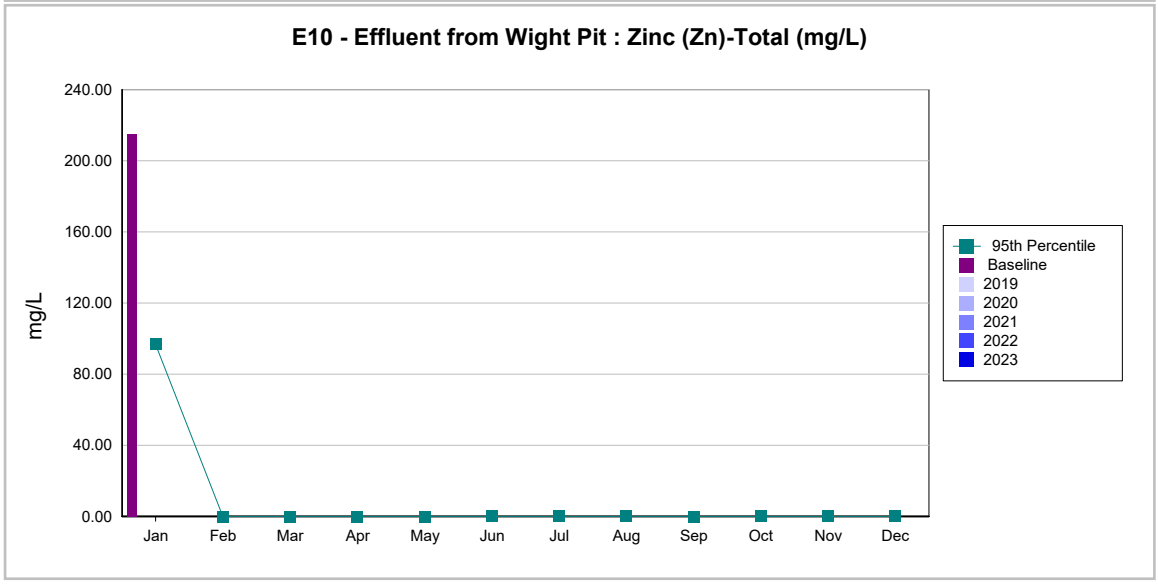
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







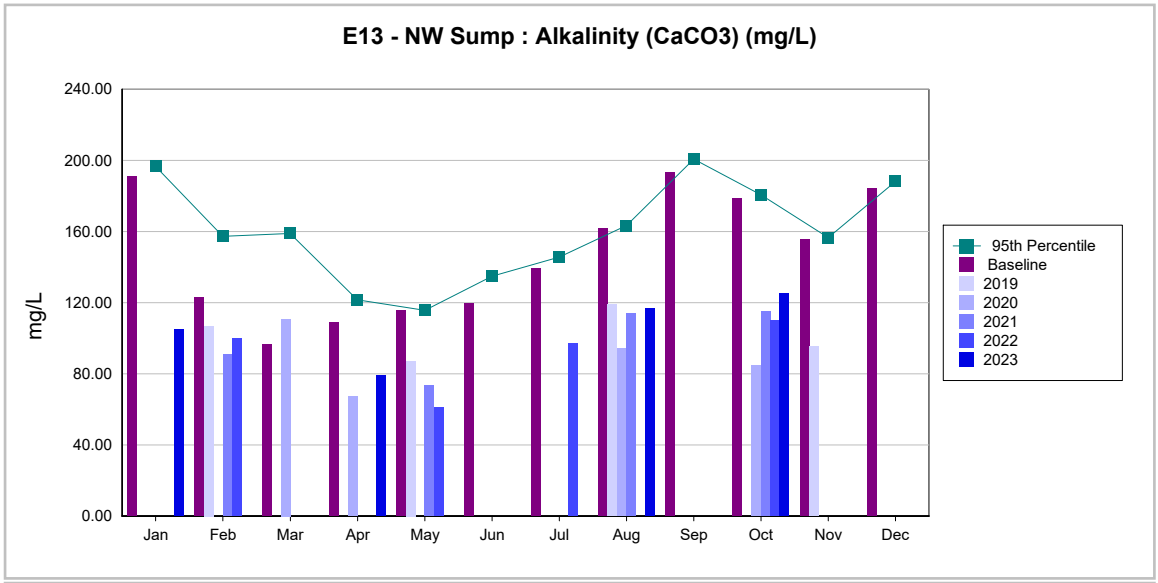
Water Quality Report

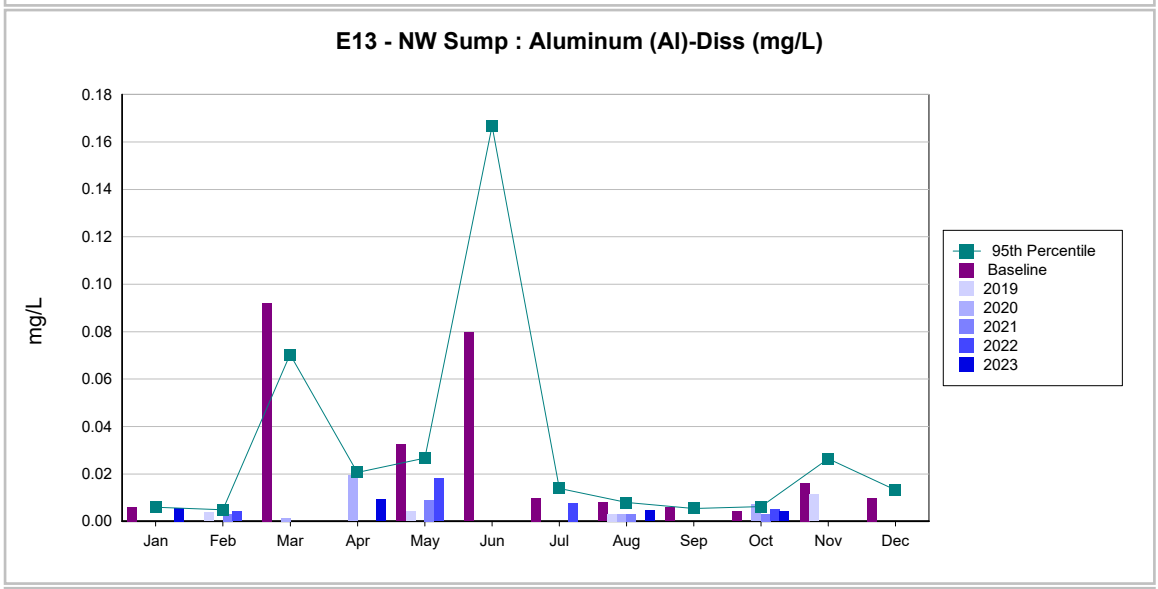
Annual Report Drainage Water

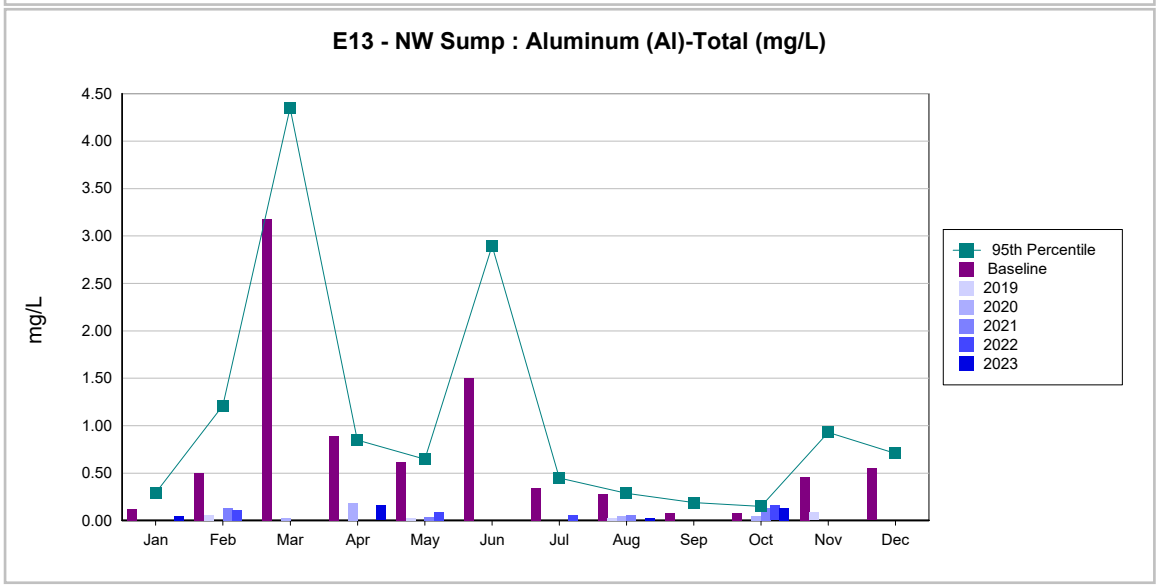
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







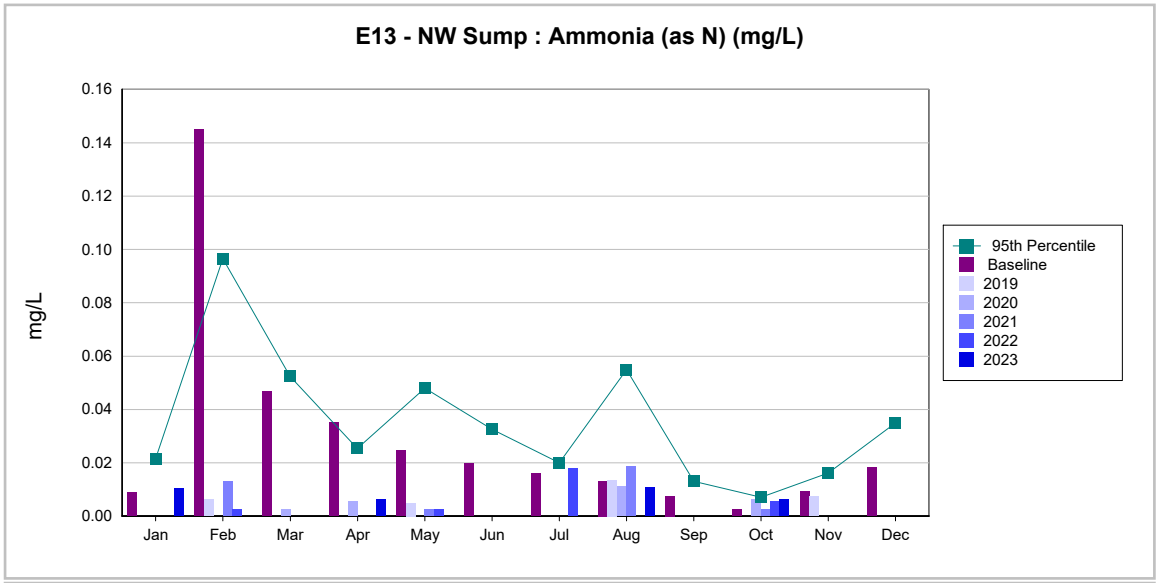
Water Quality Report

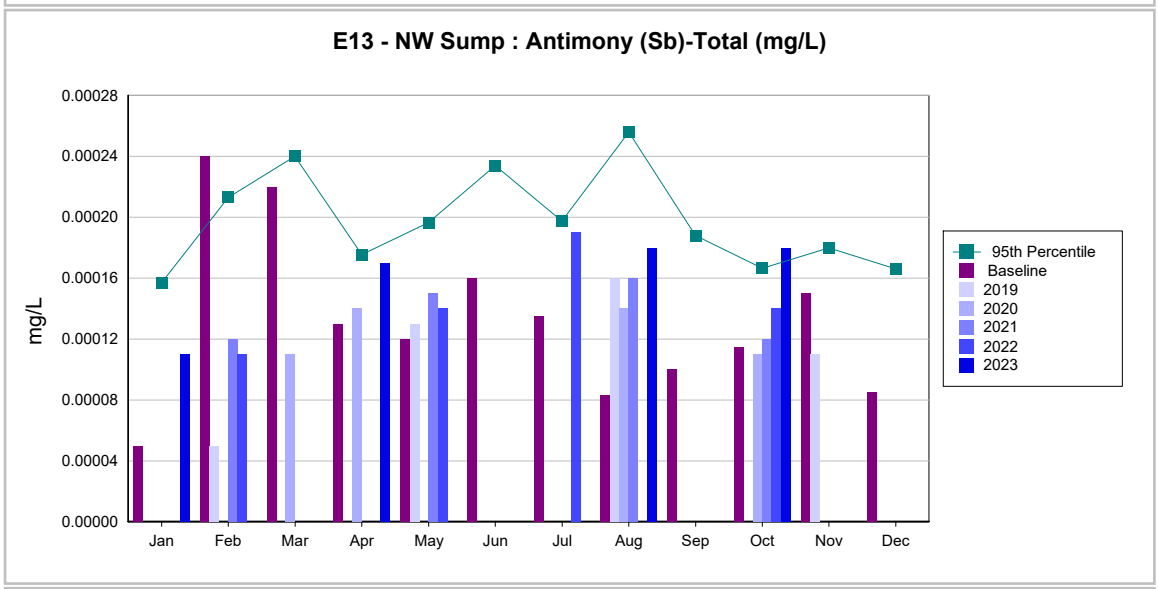
Annual Report Drainage Water

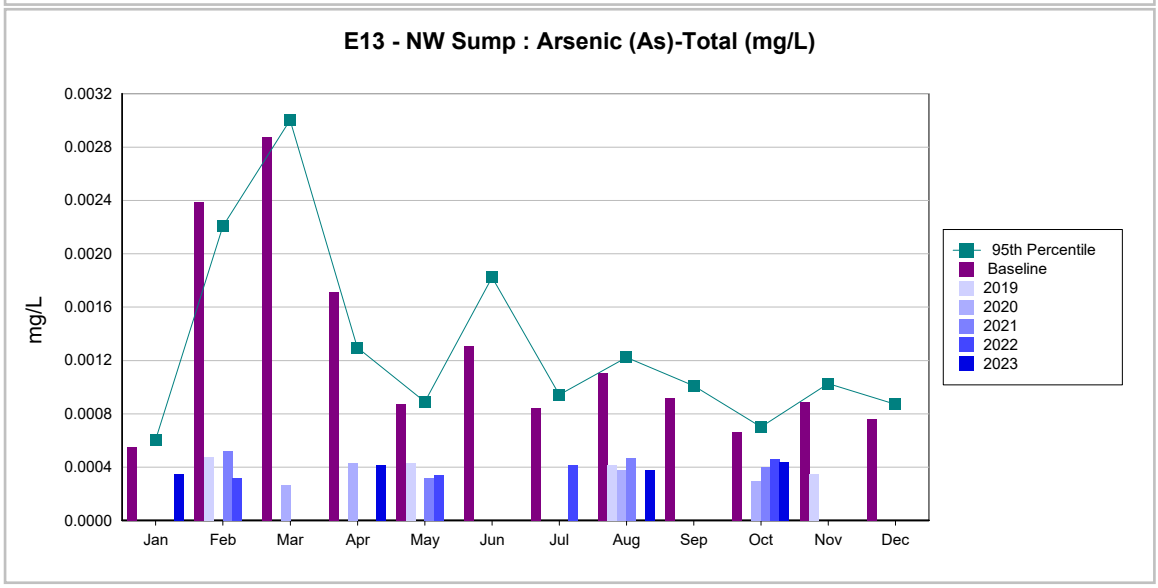
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







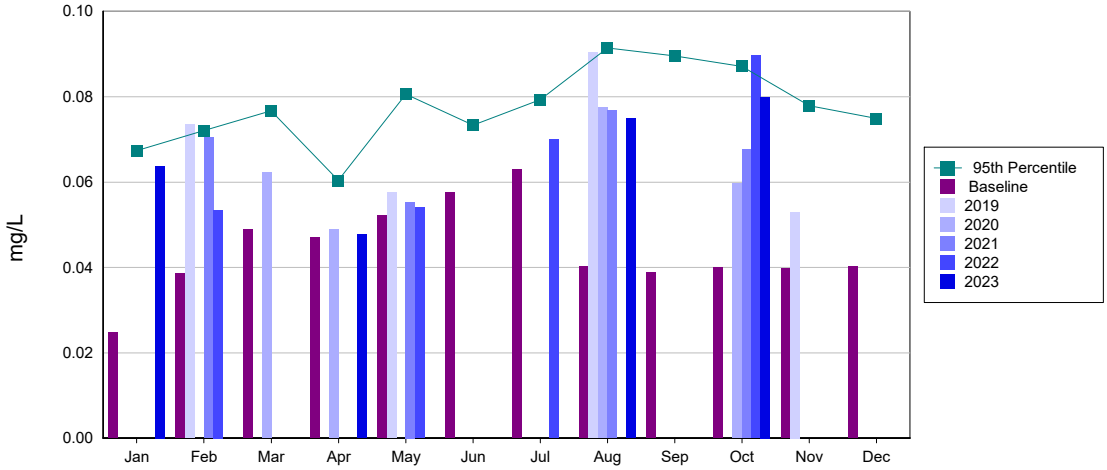
Water Quality Report

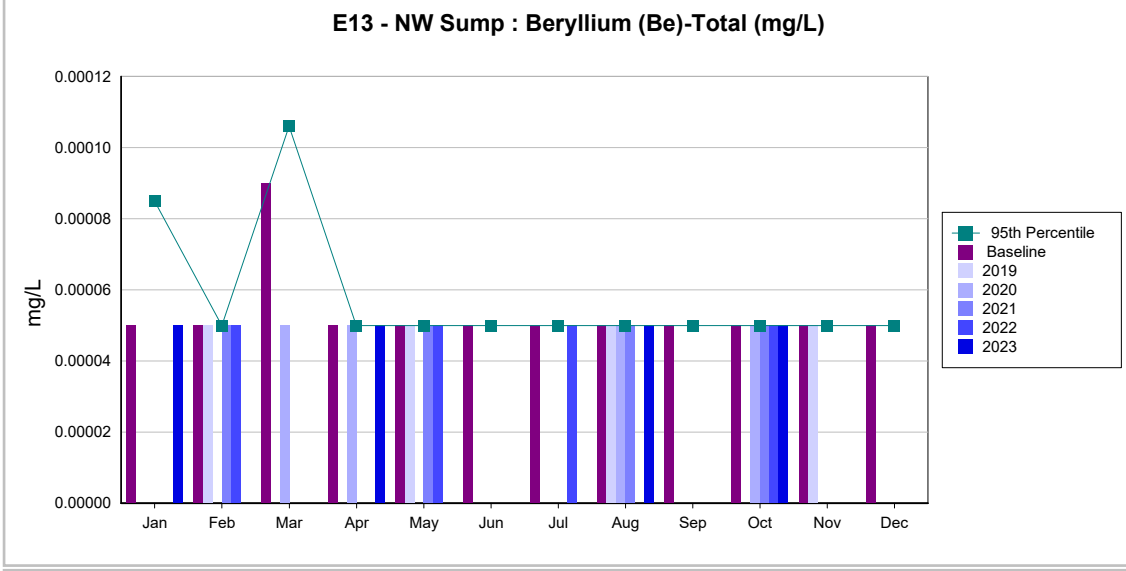
Annual Report Drainage Water

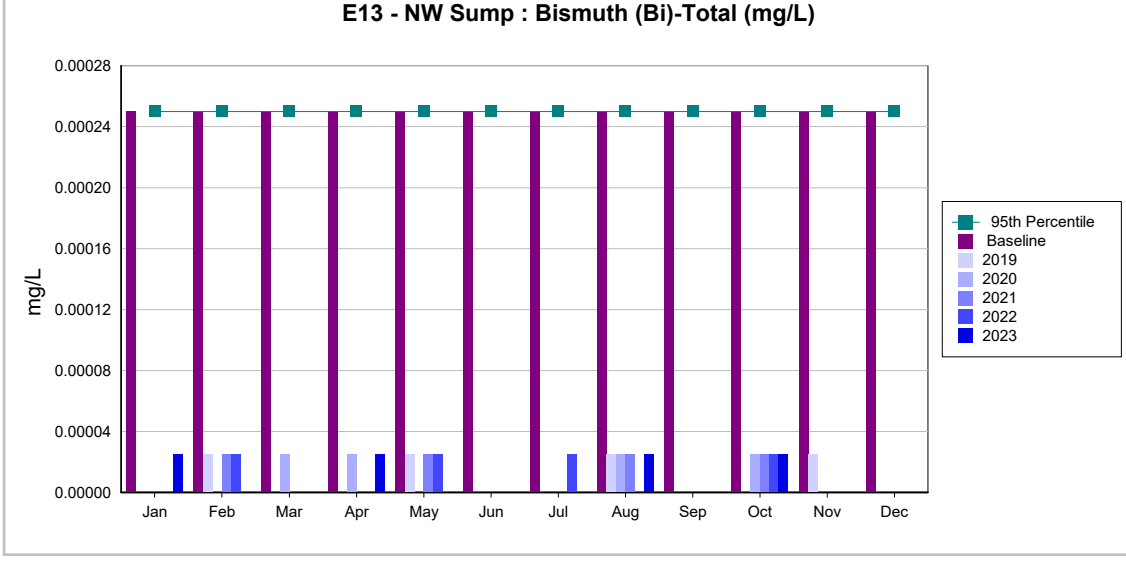
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







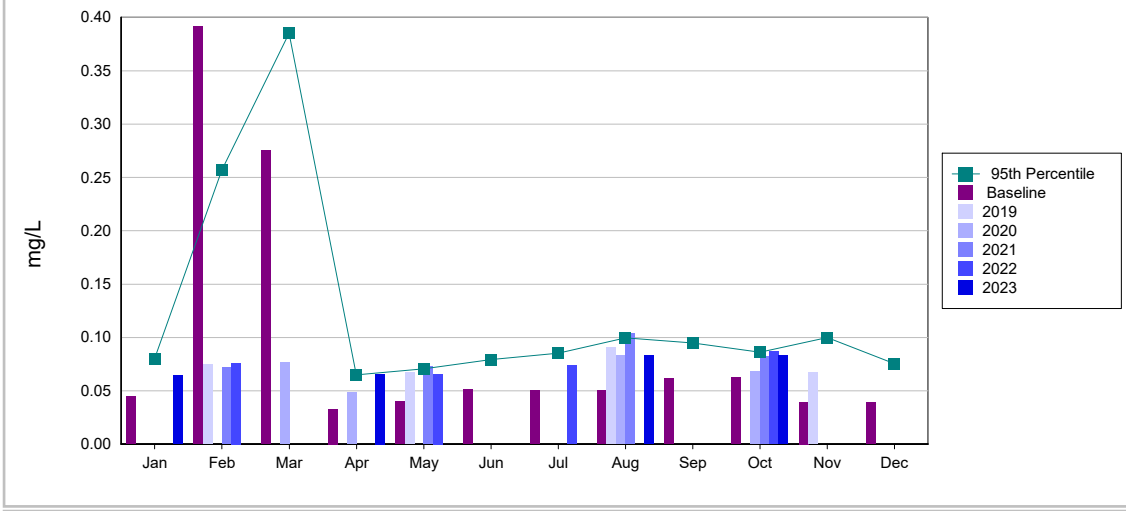
Water Quality Report

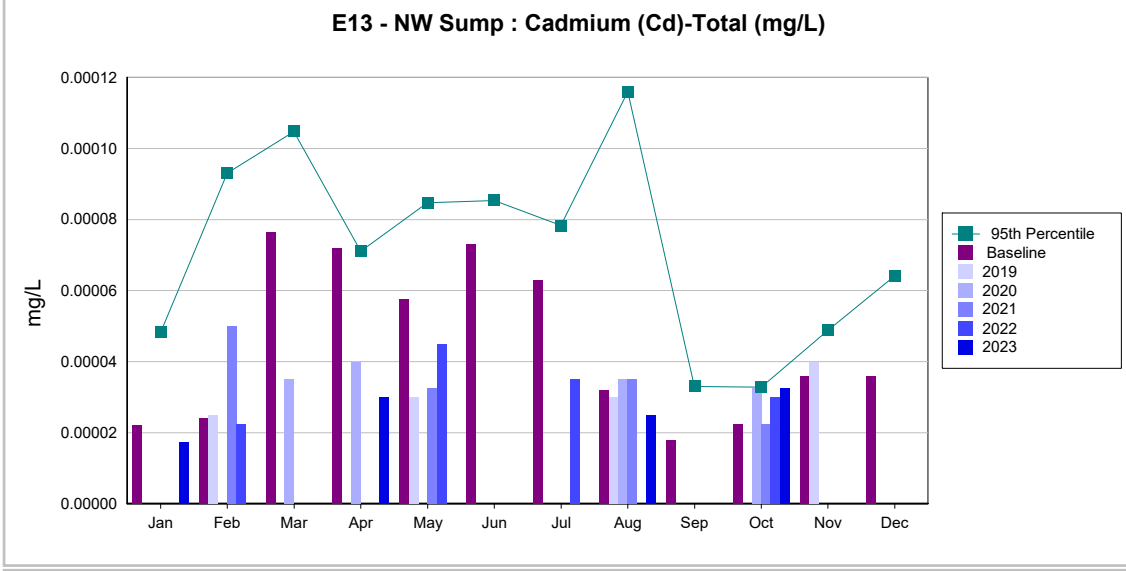
Annual Report Drainage Water

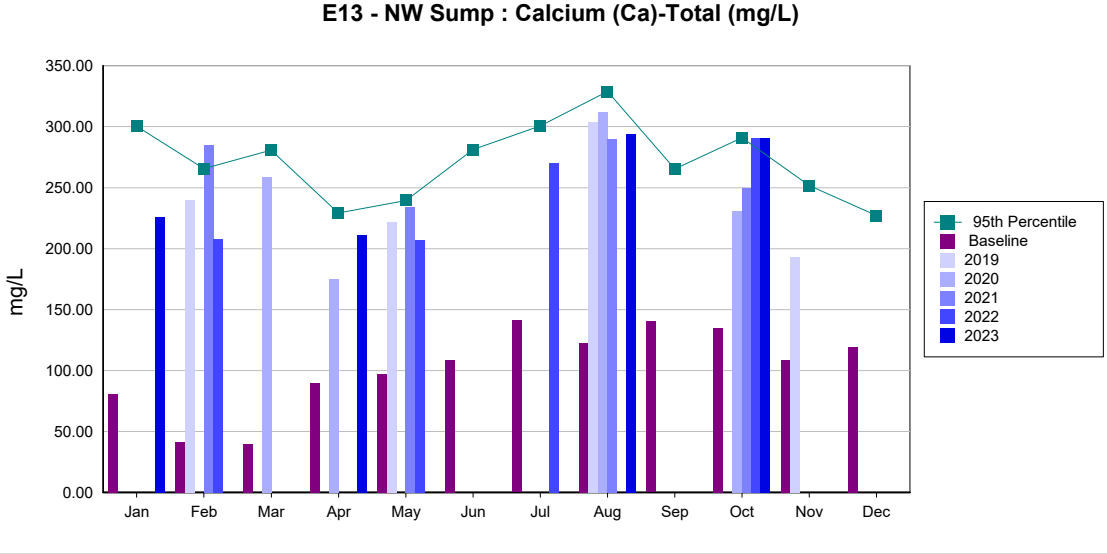
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







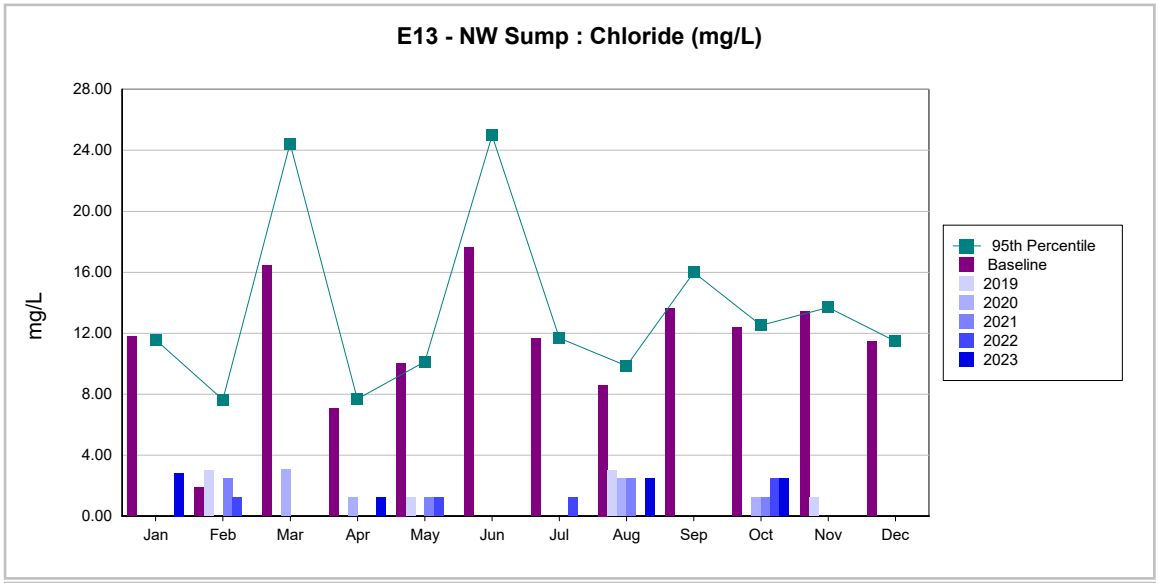
Water Quality Report

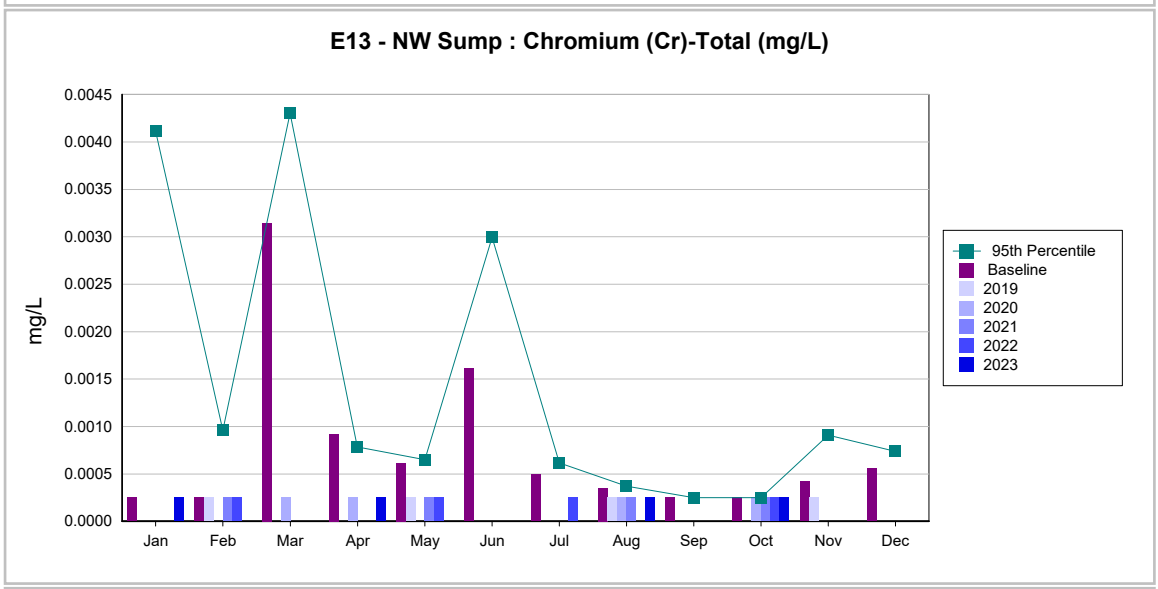
Annual Report Drainage Water

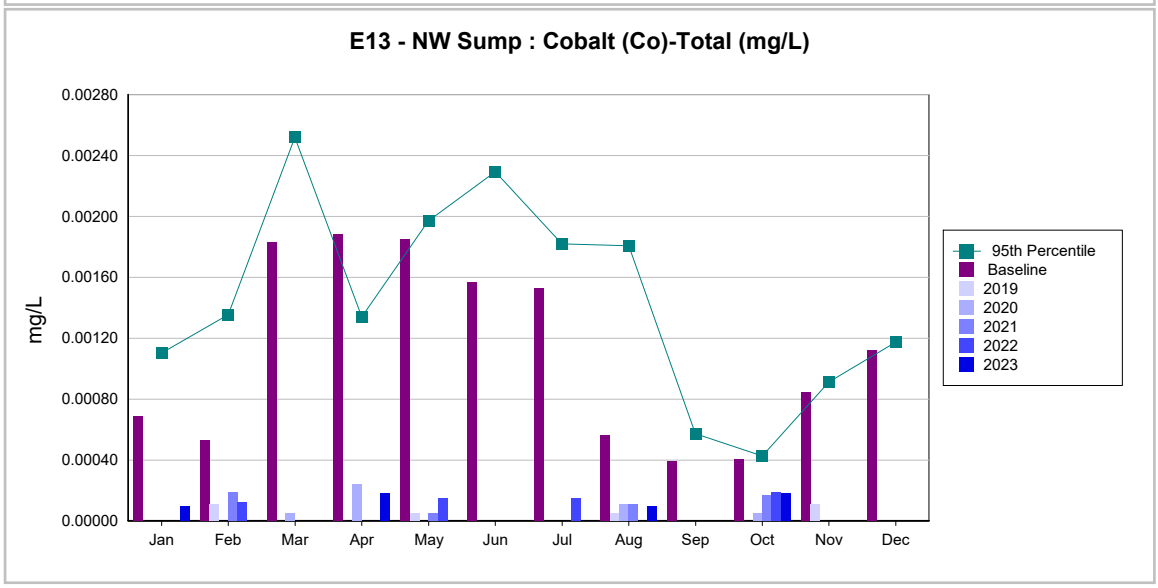
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







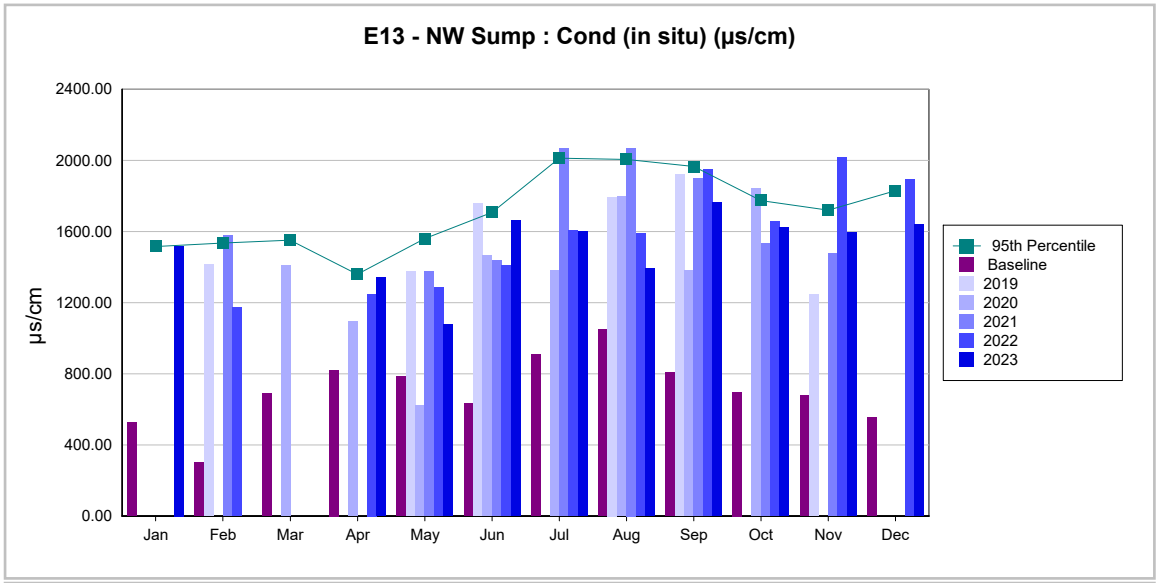
Water Quality Report

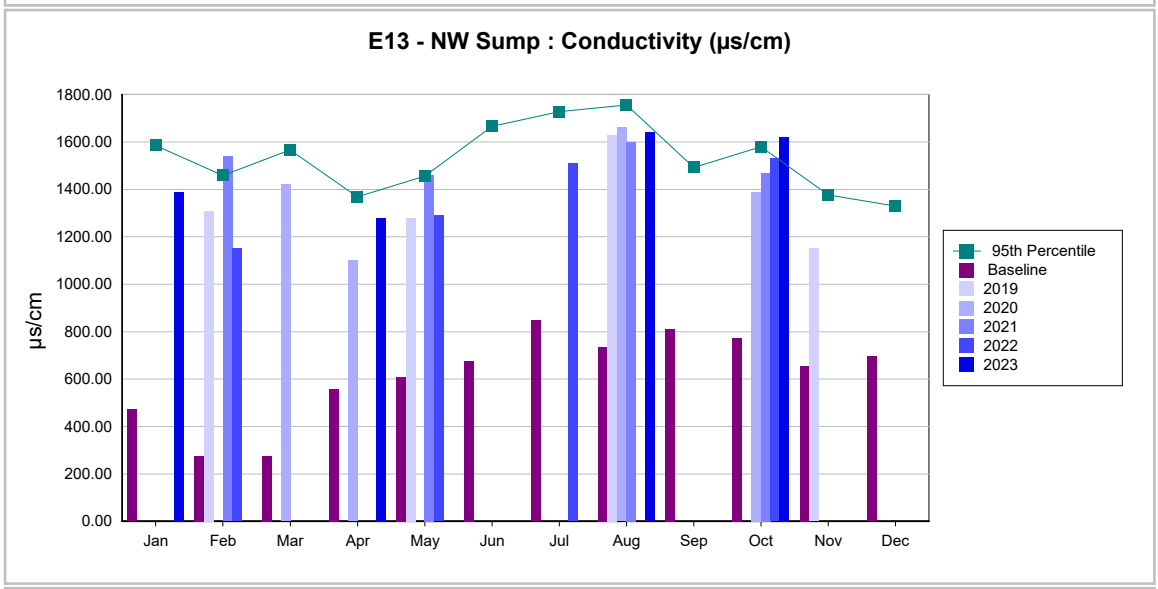
Annual Report Drainage Water

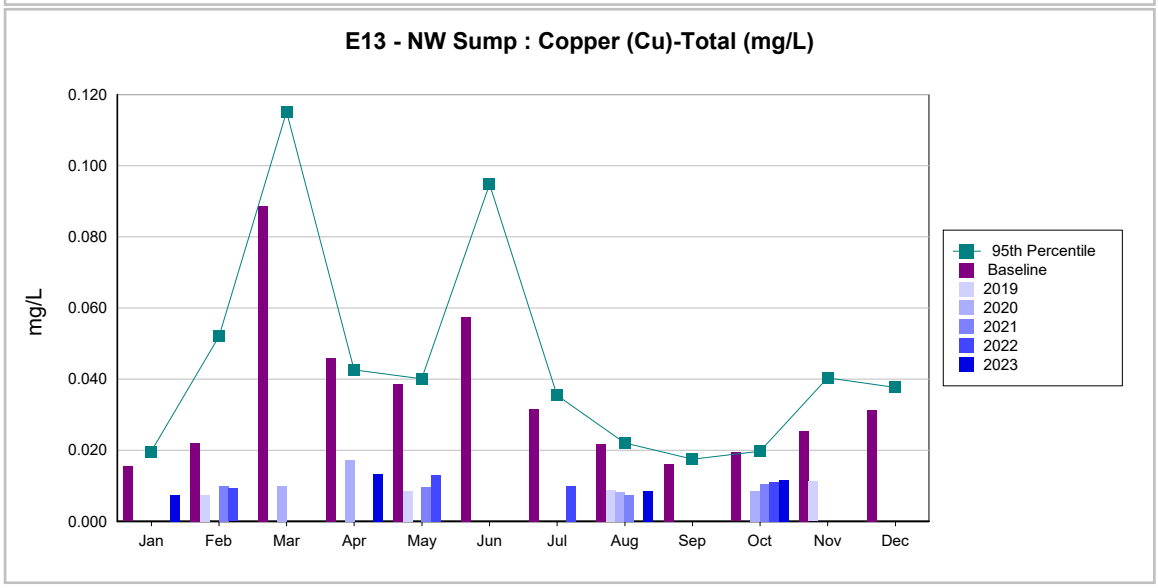
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







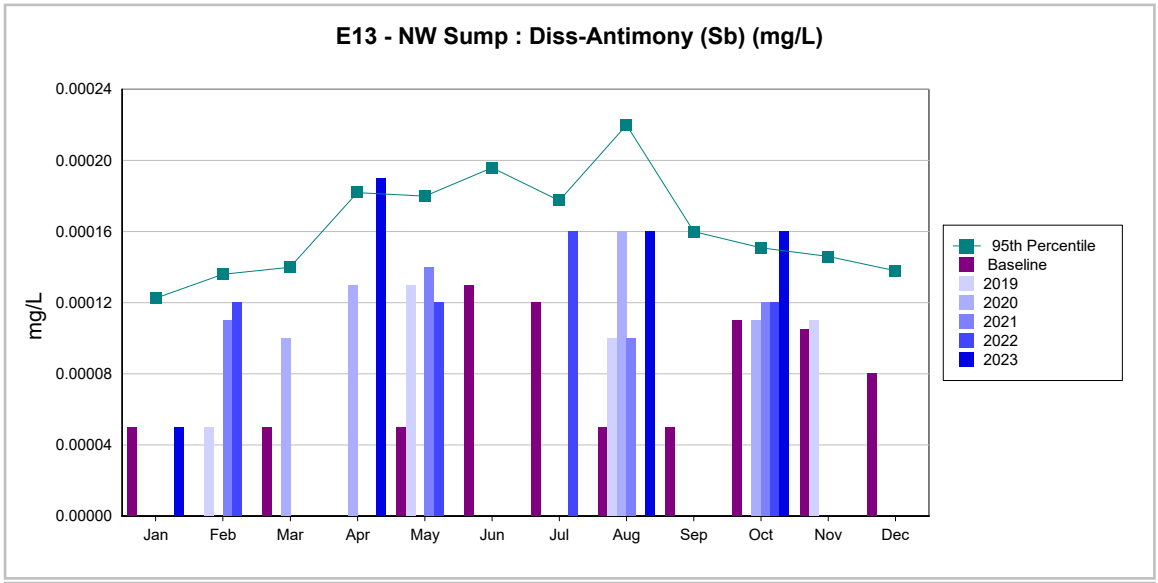
Water Quality Report

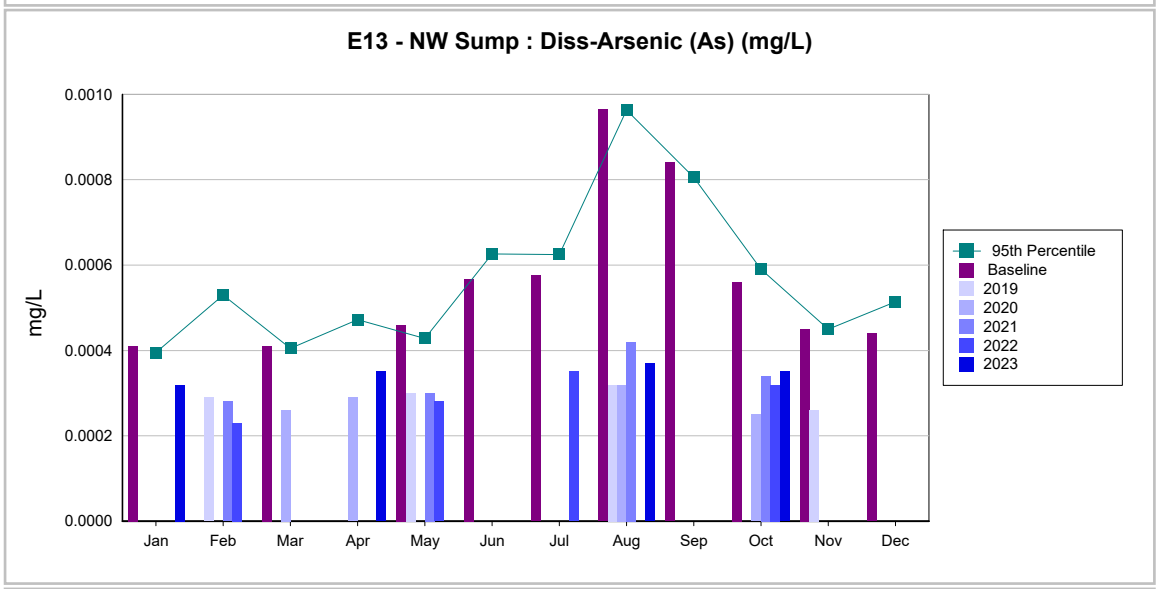
Annual Report Drainage Water

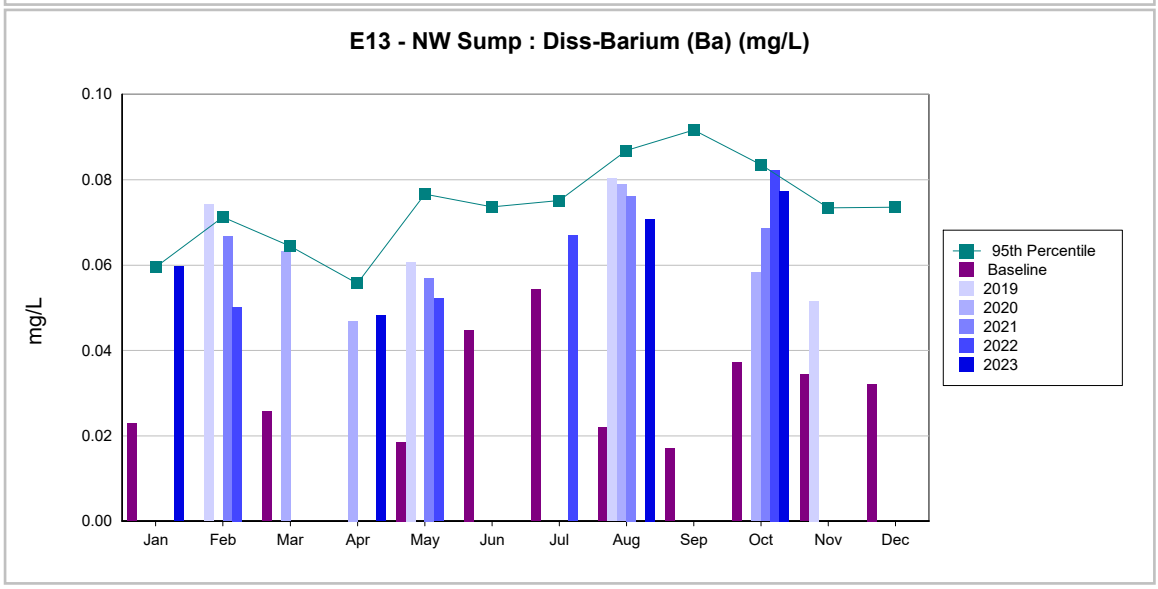
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







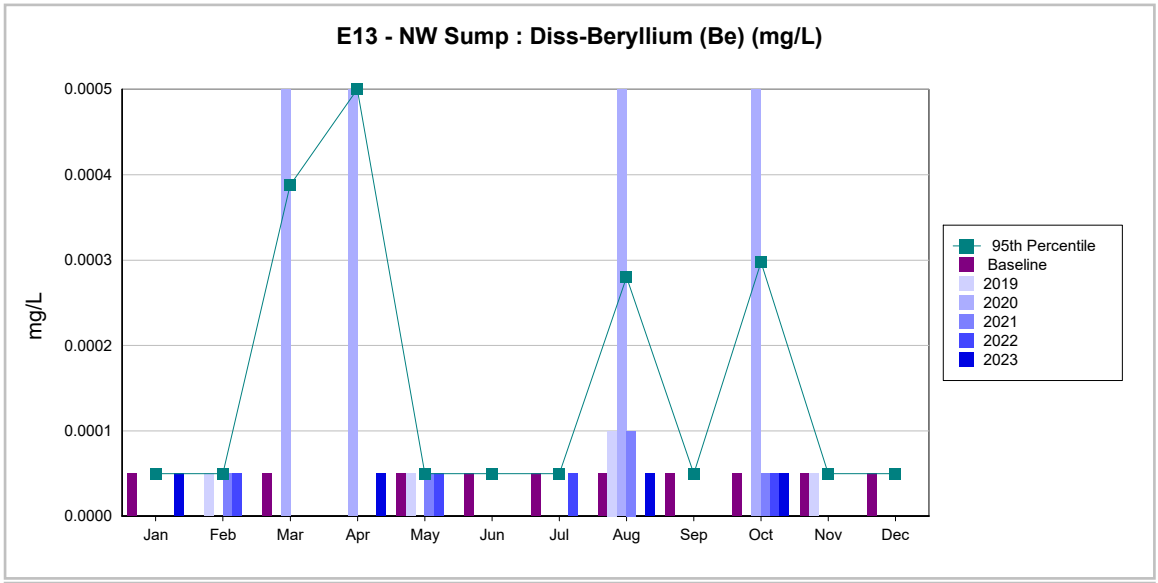
Water Quality Report

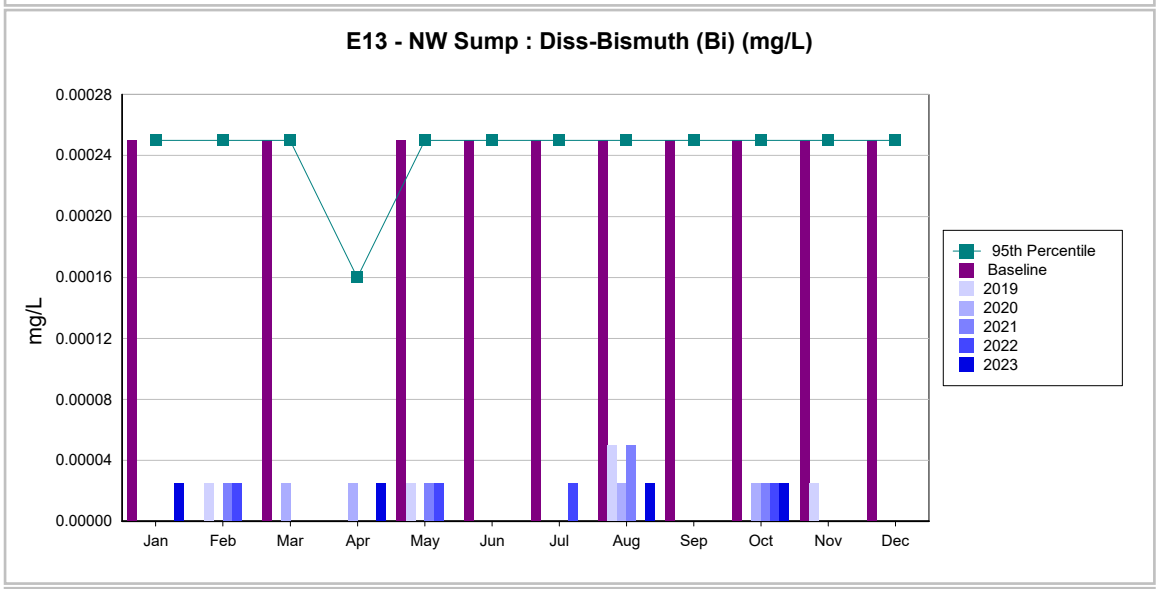
Annual Report Drainage Water

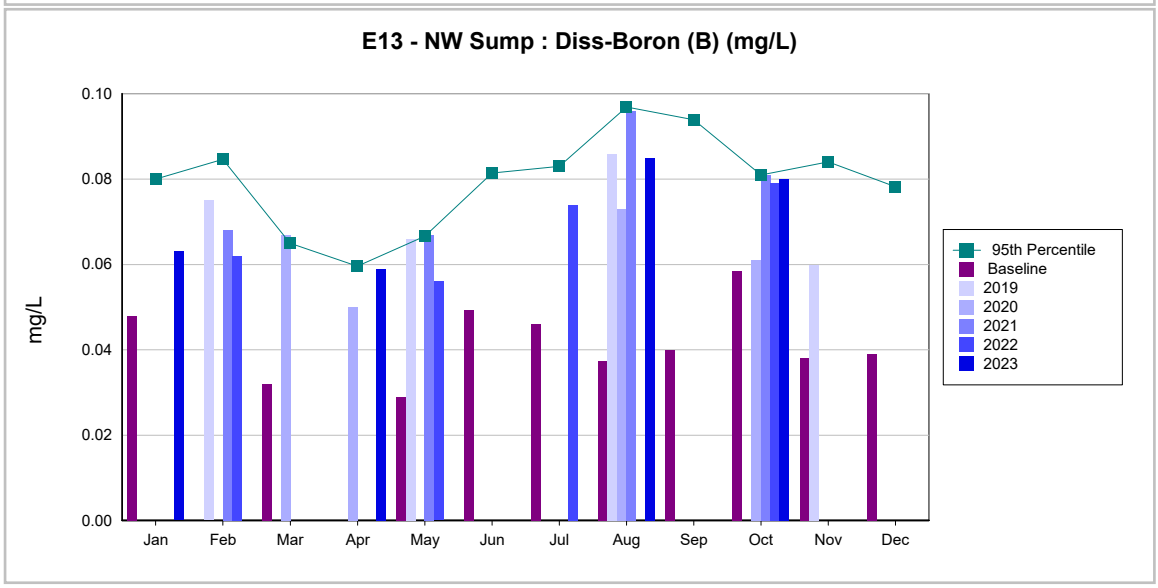
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







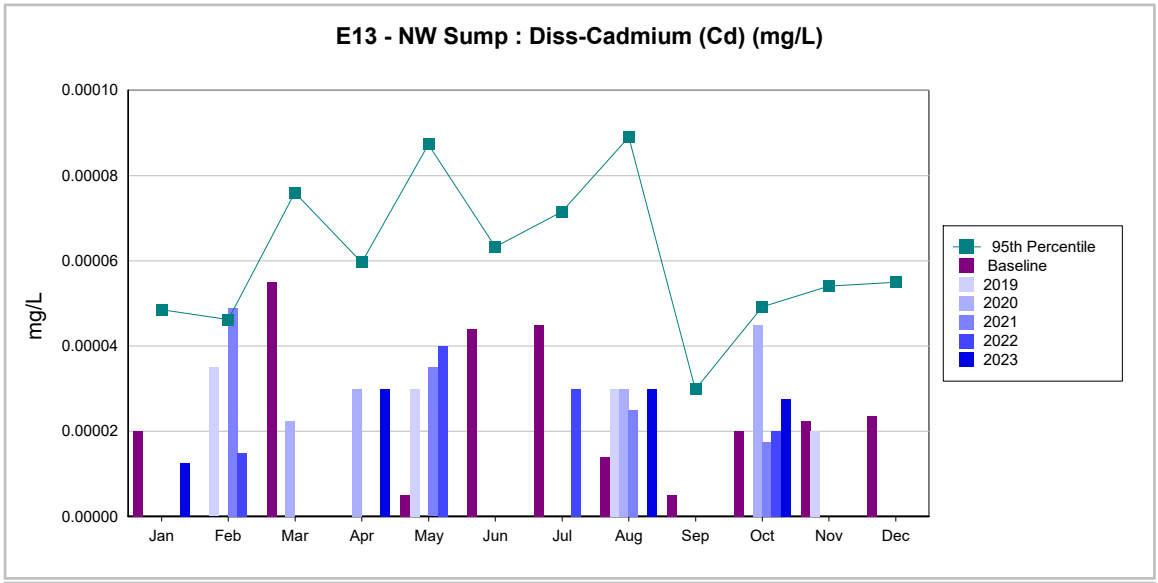
Water Quality Report

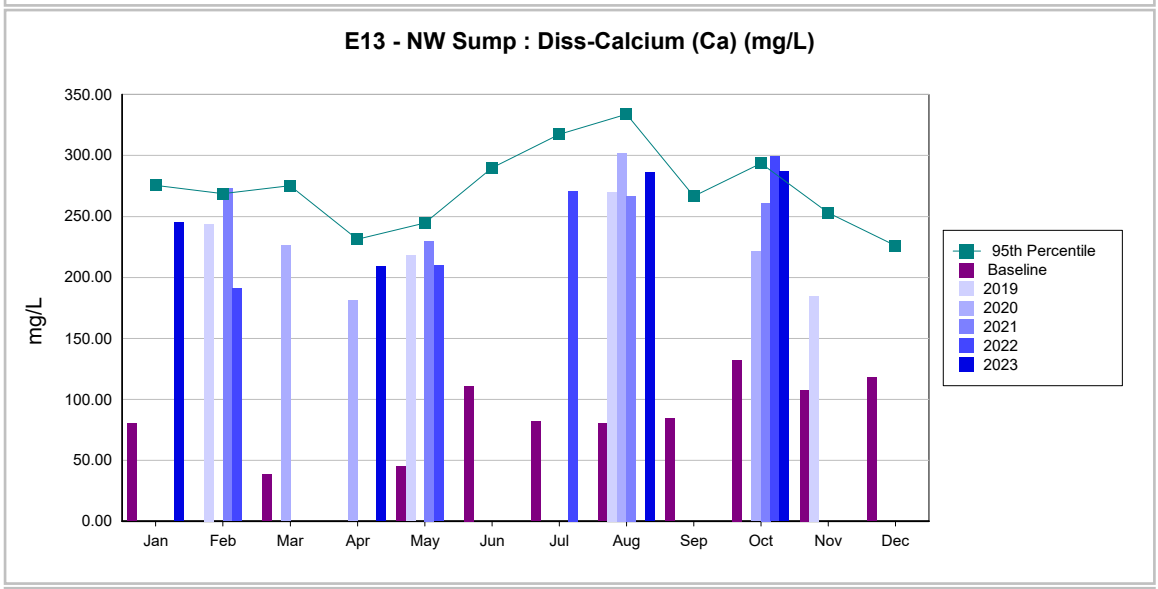
Annual Report Drainage Water

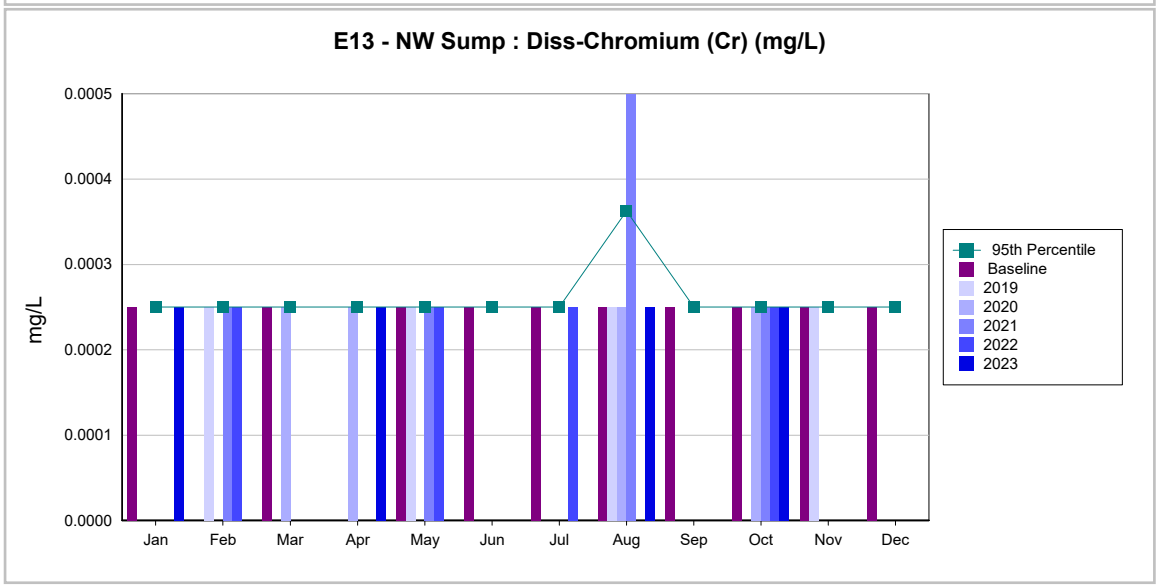
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







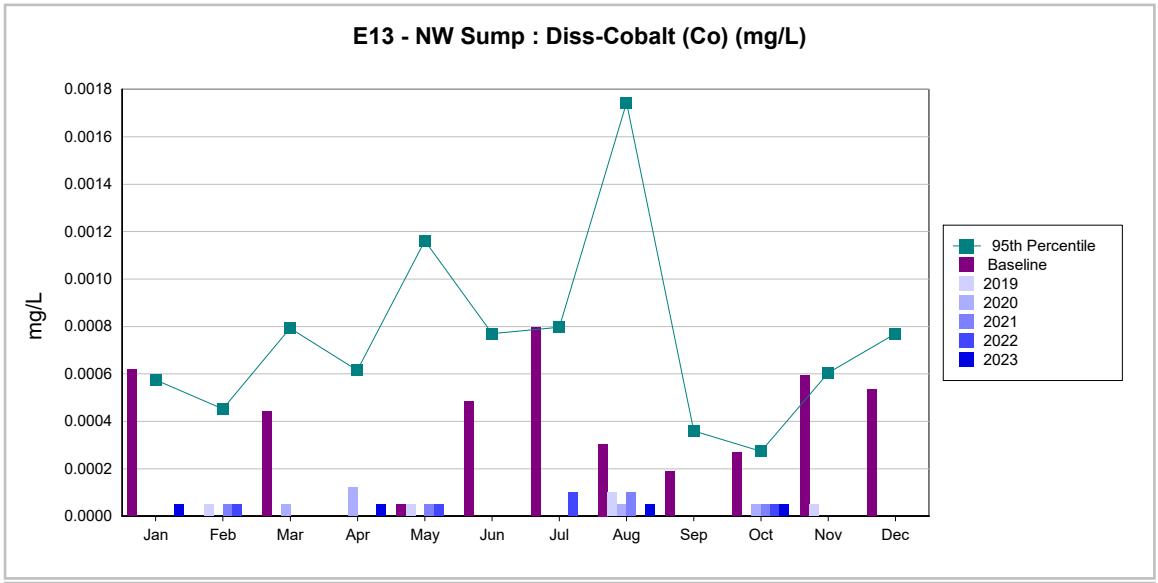
Water Quality Report

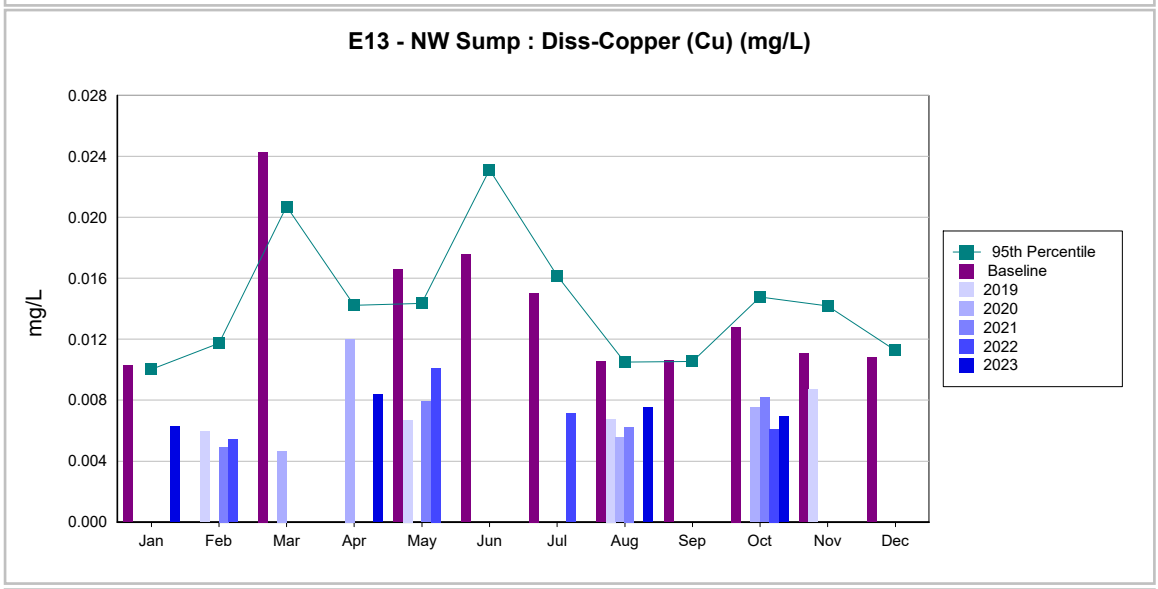
Annual Report Drainage Water

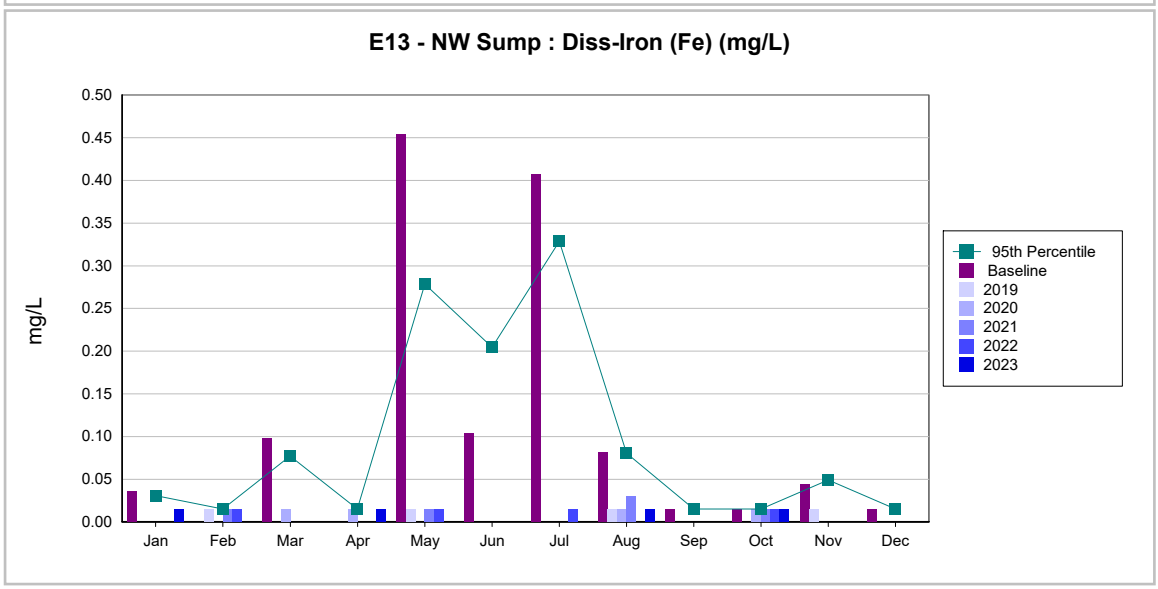
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







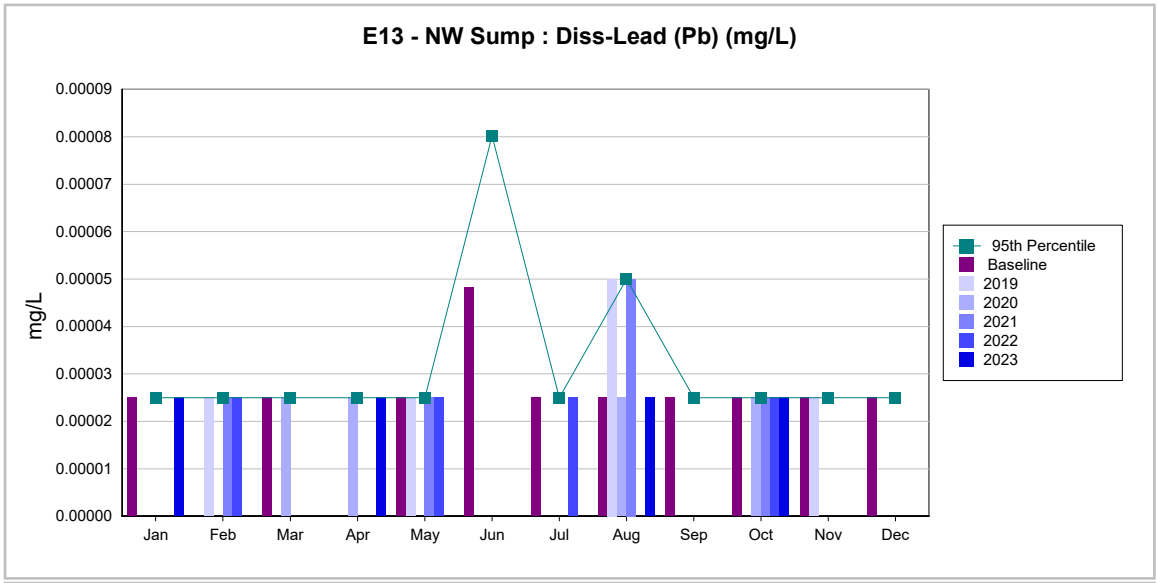
Water Quality Report

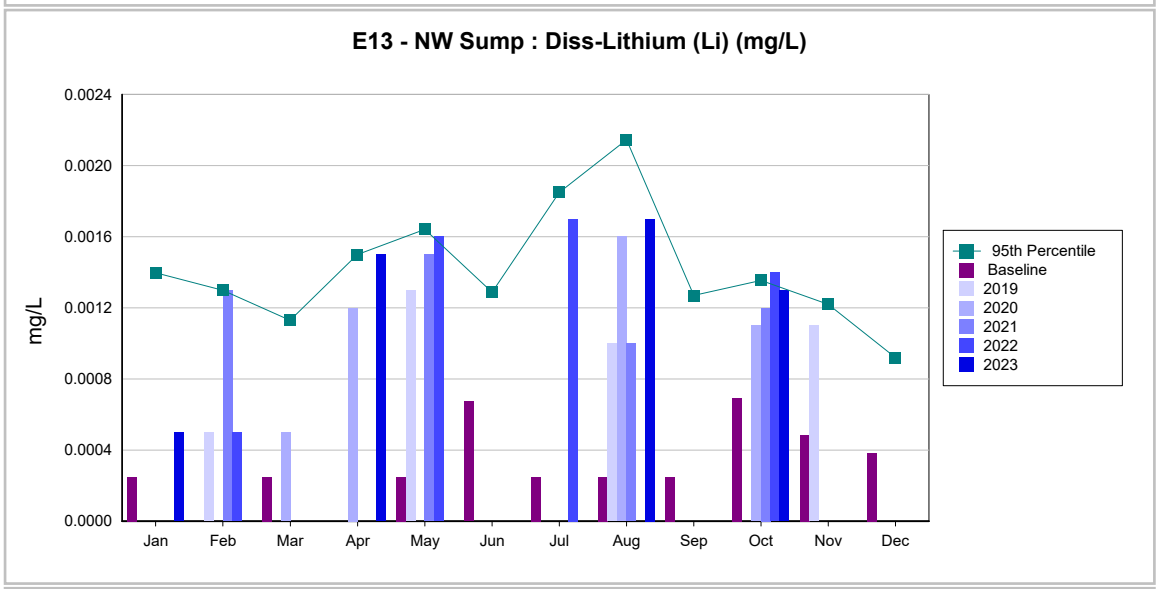
Annual Report Drainage Water

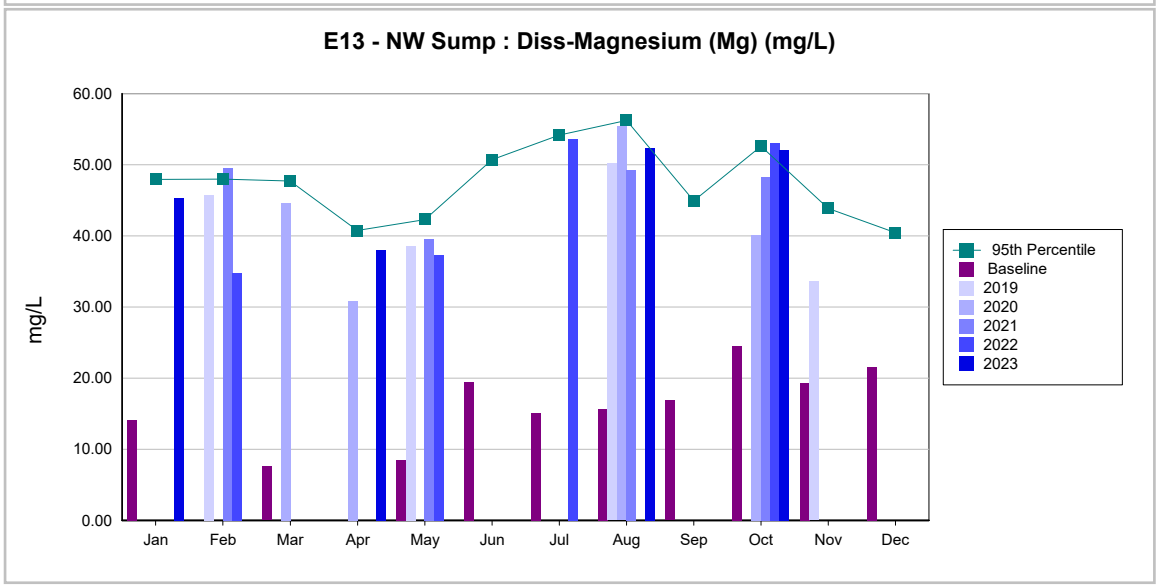
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







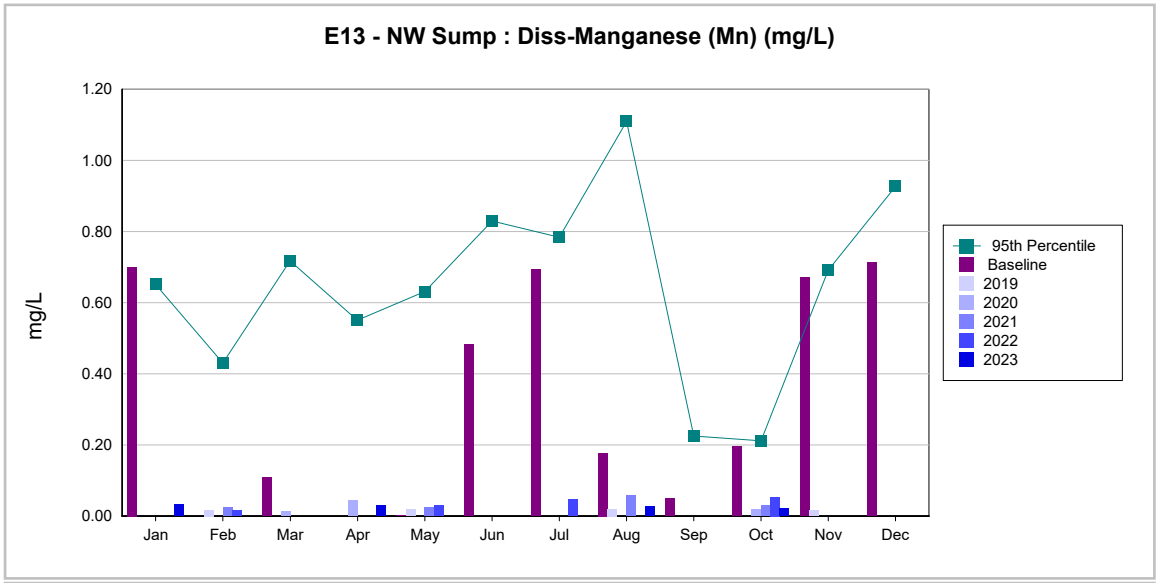
Water Quality Report

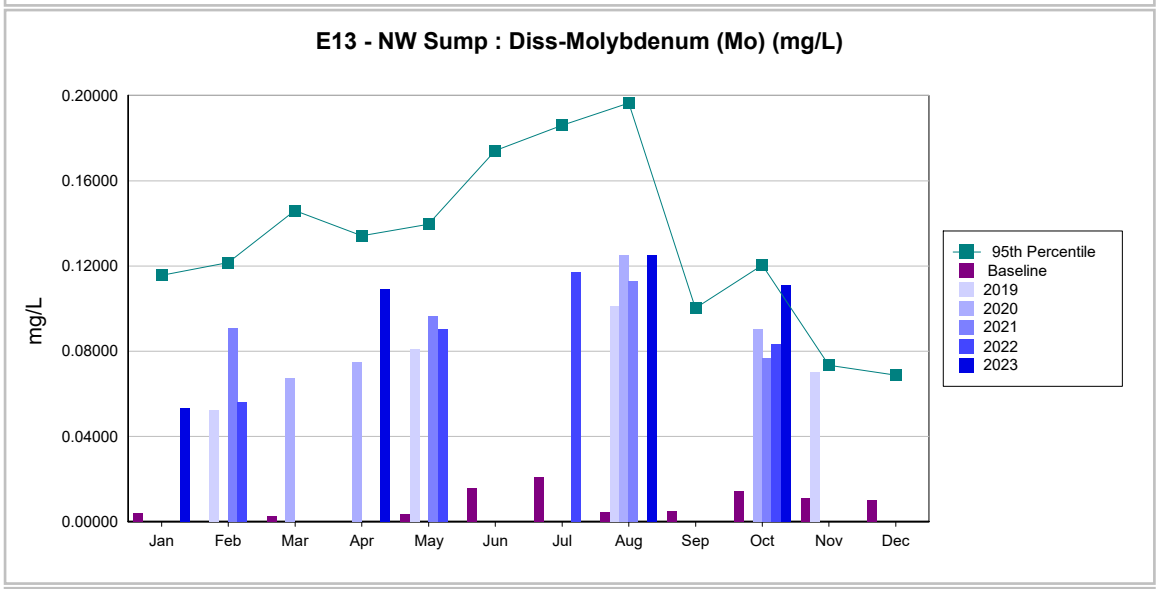
Annual Report Drainage Water

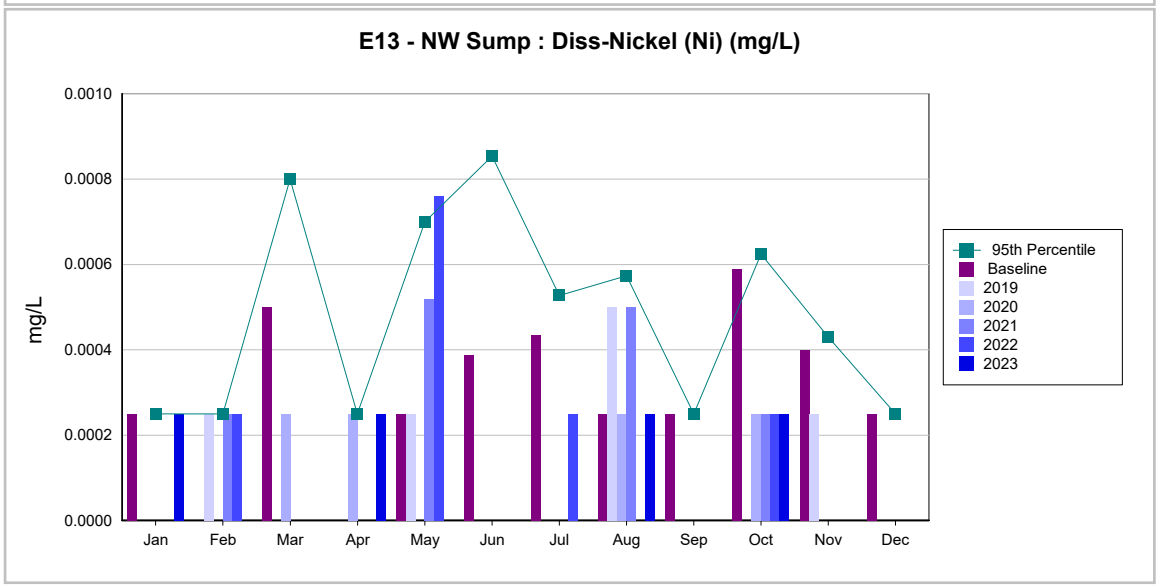
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







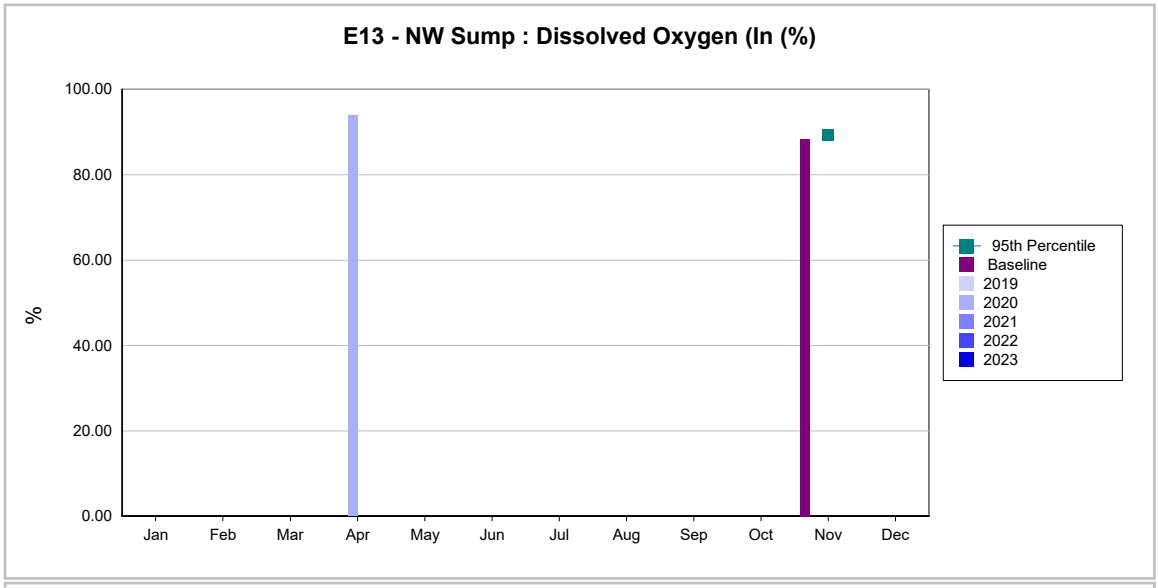
Water Quality Report

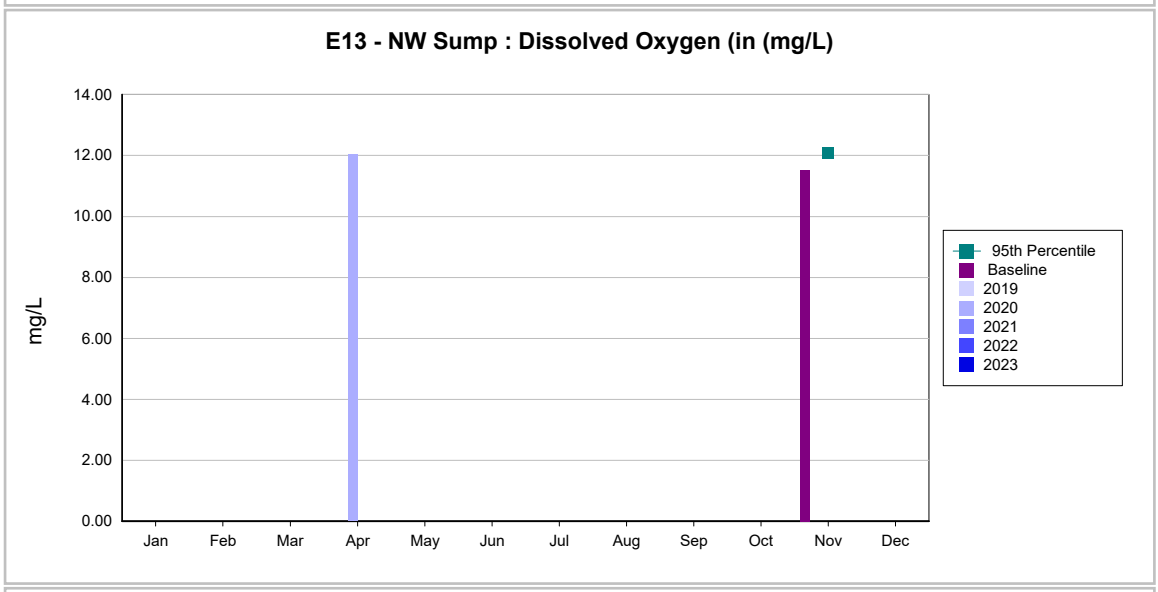
Annual Report Drainage Water

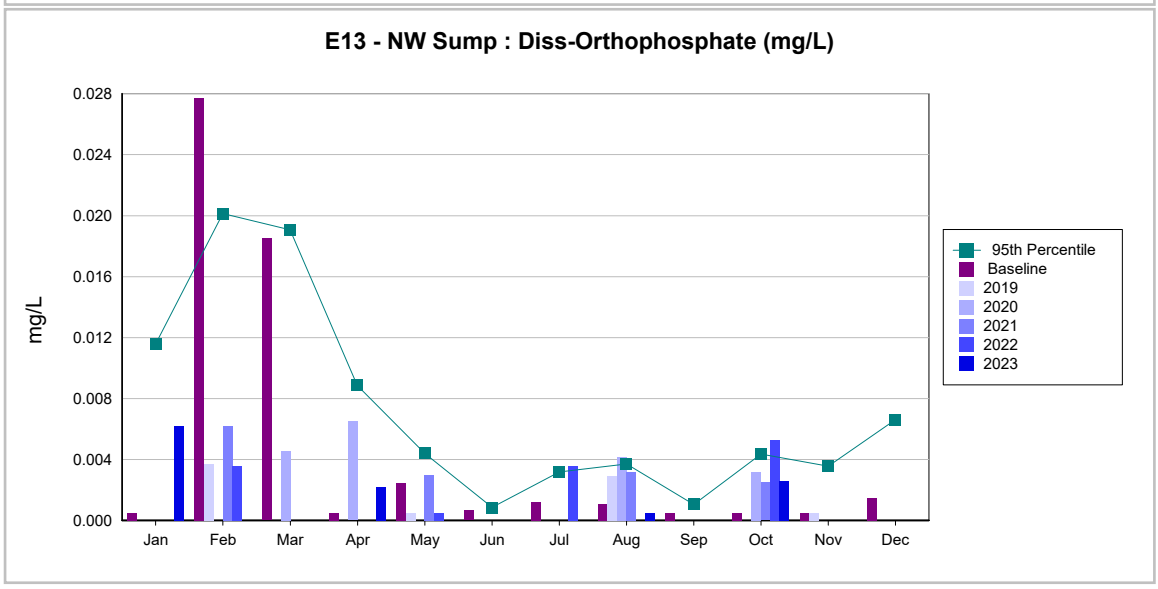
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







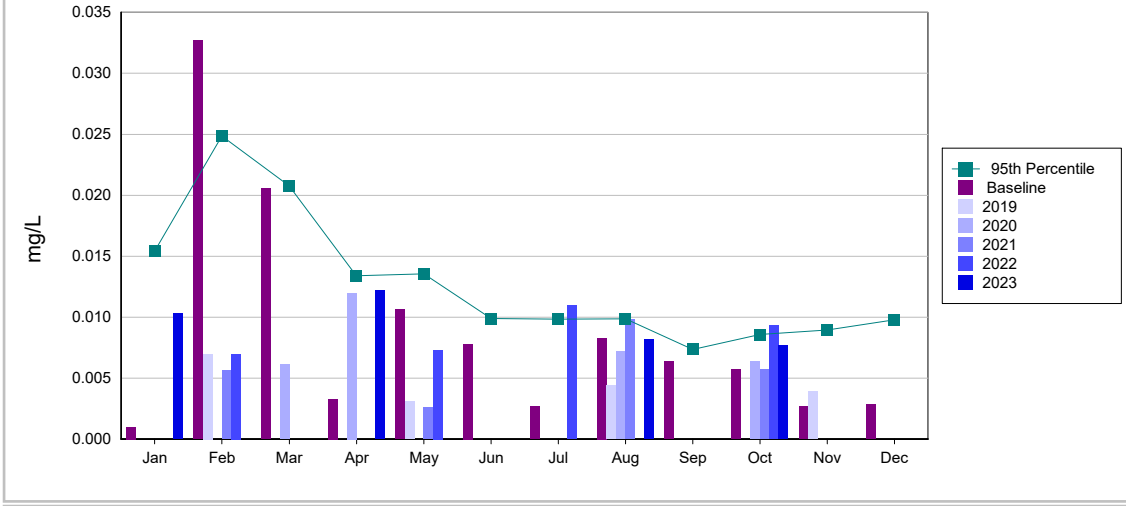
Water Quality Report

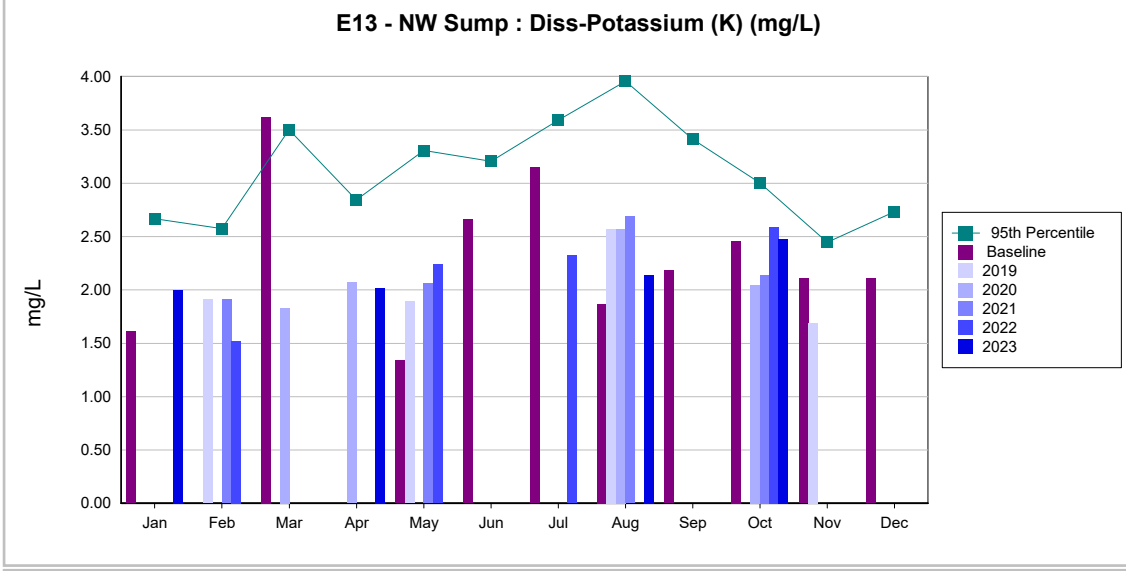
Annual Report Drainage Water

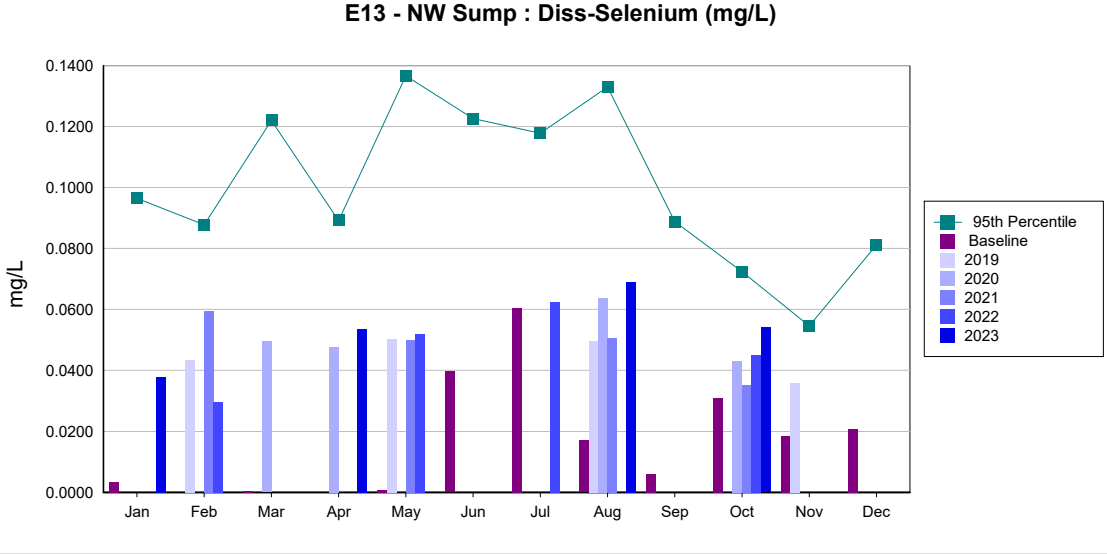
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







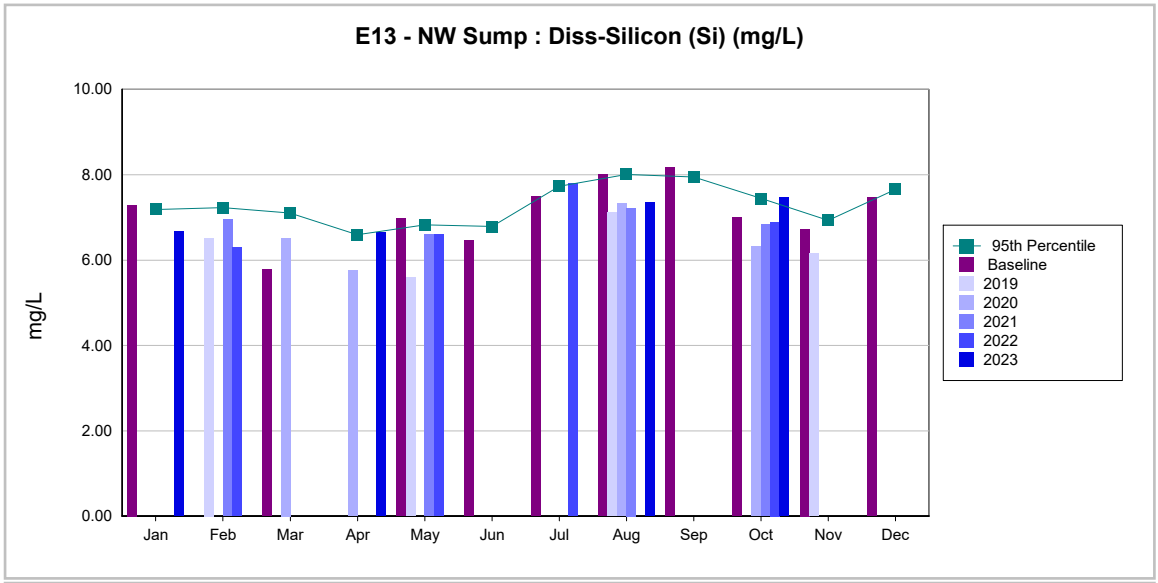
Water Quality Report

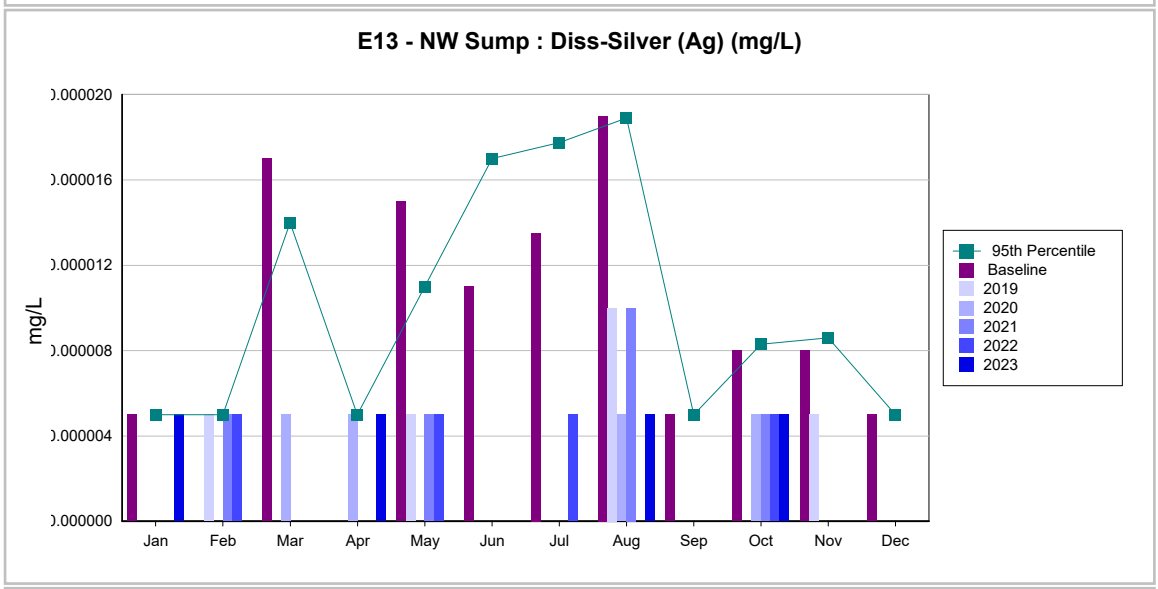
Annual Report Drainage Water

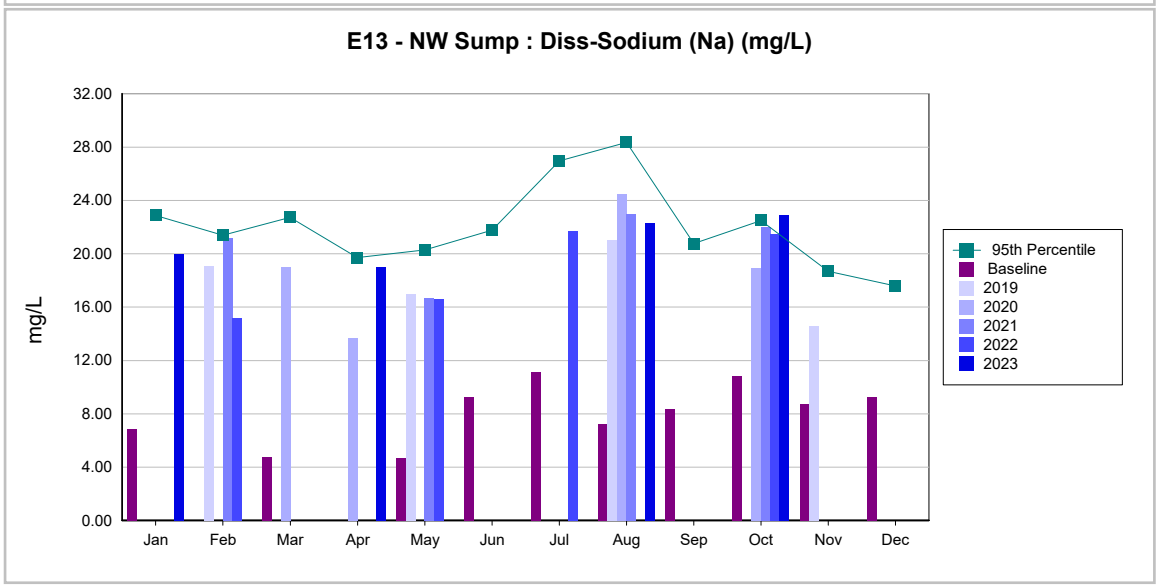
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







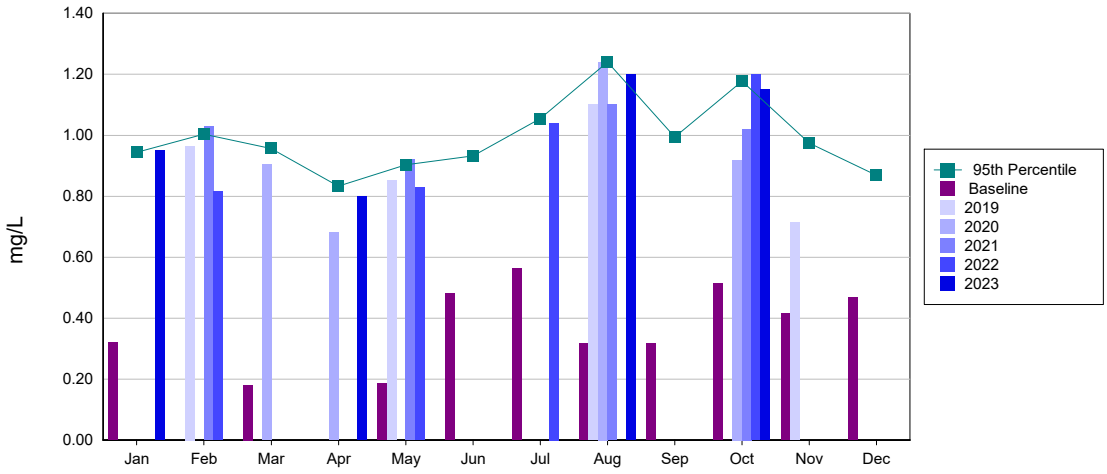
Water Quality Report

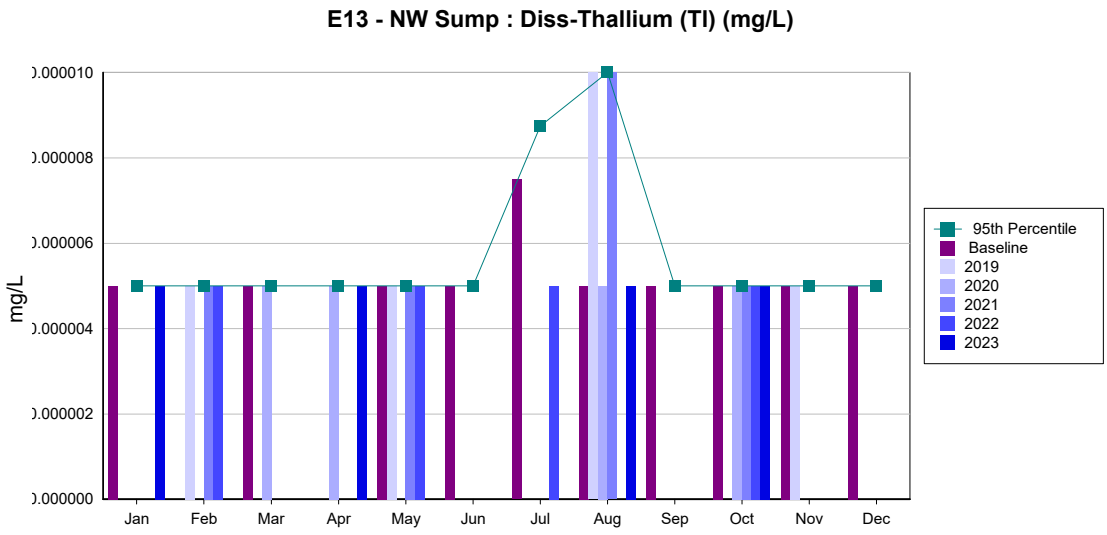
Annual Report Drainage Water

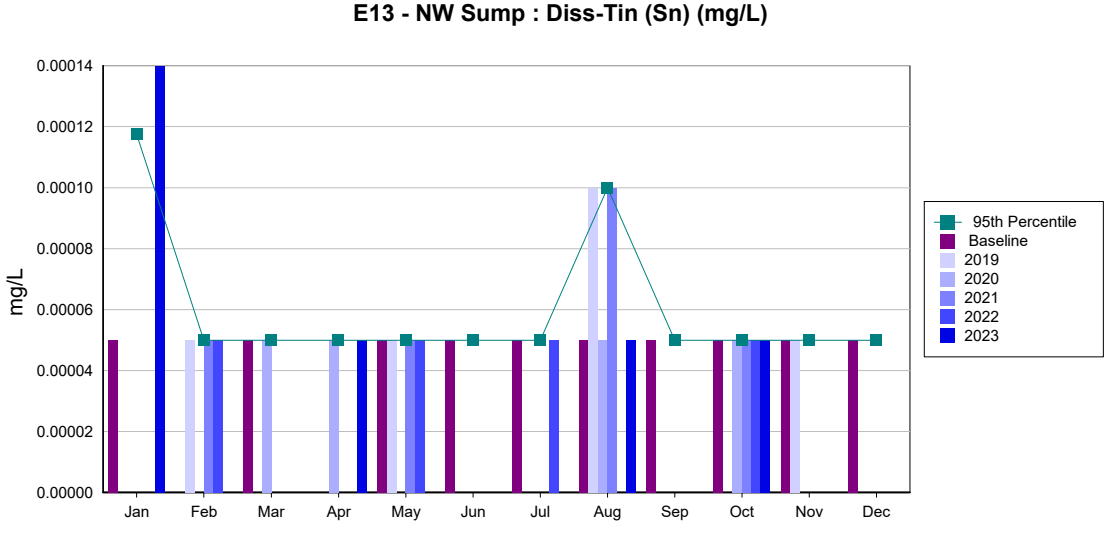
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







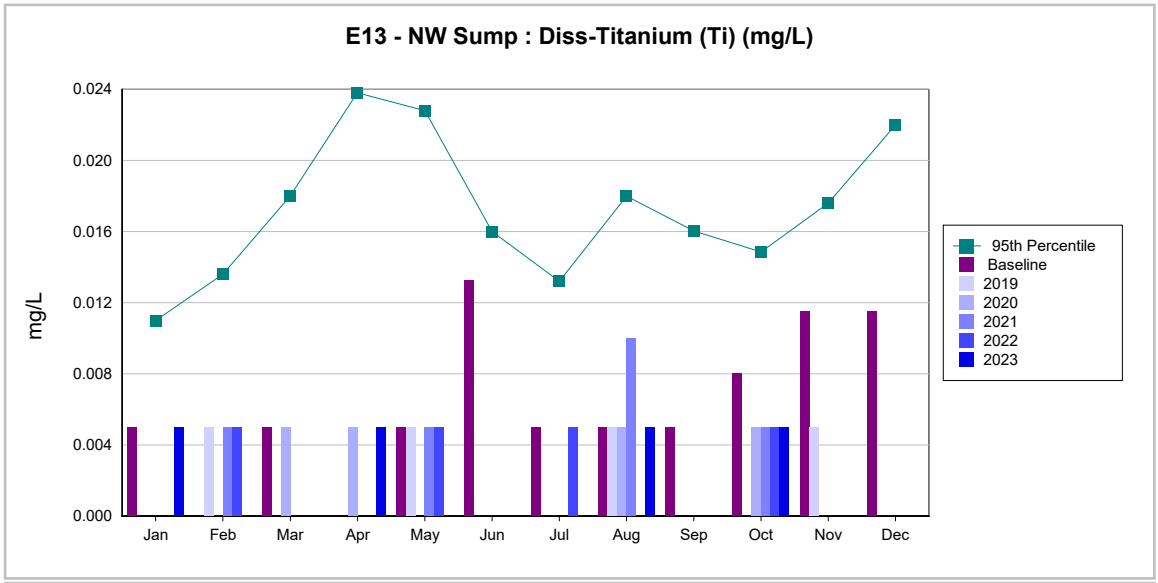
Water Quality Report

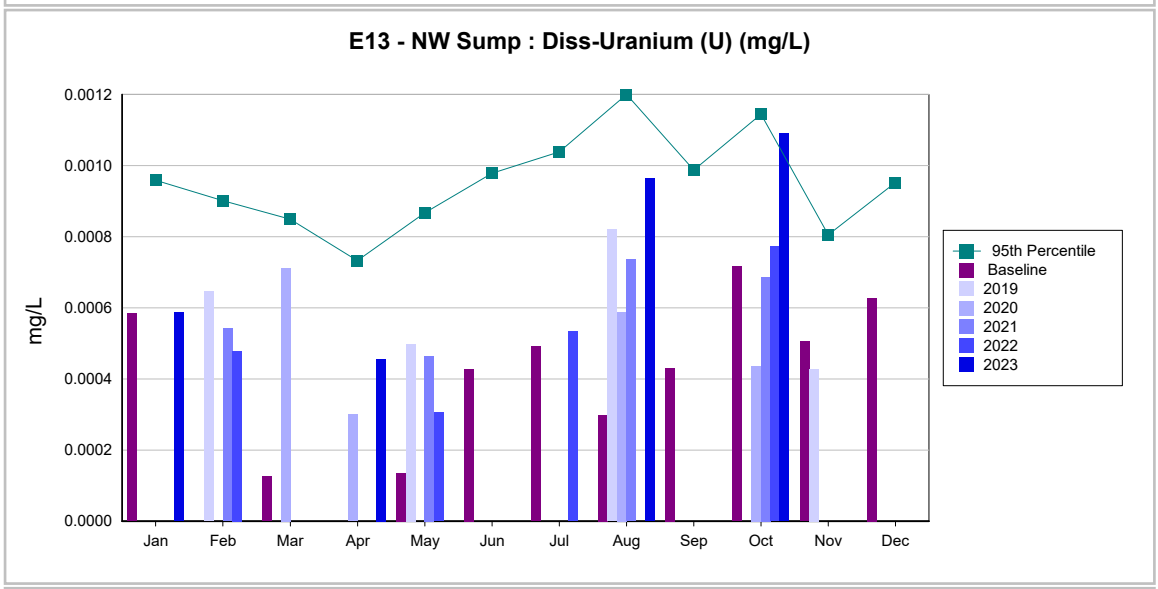
Annual Report Drainage Water

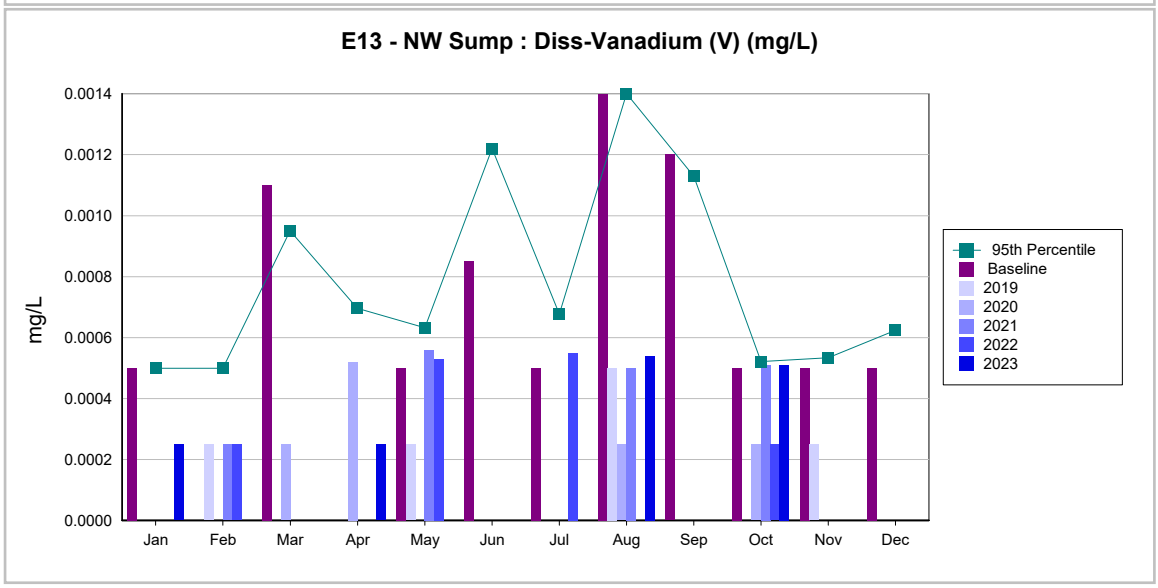
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







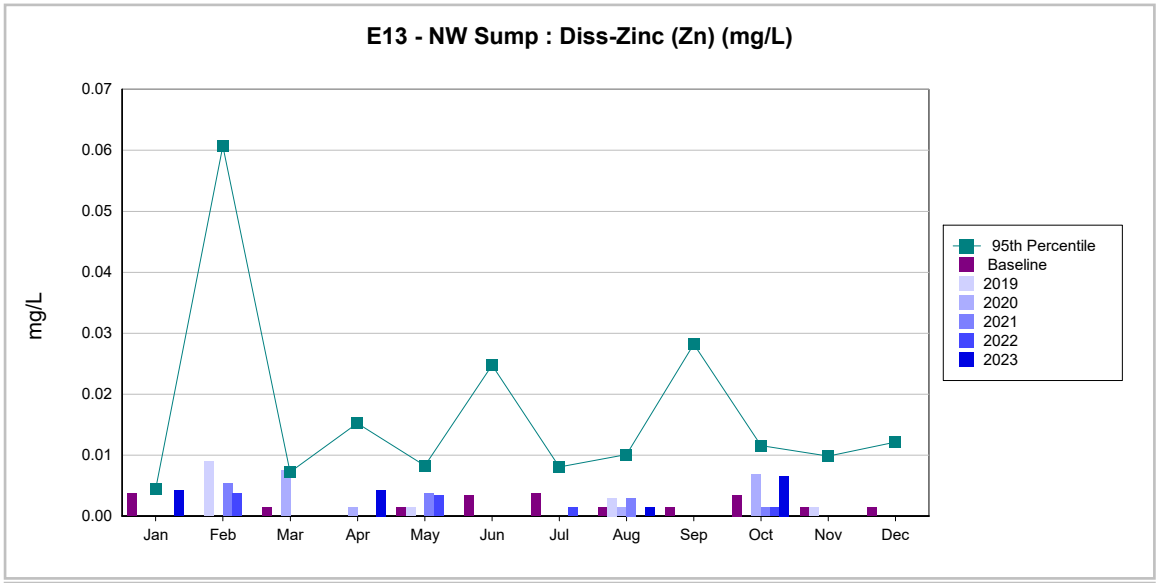
Water Quality Report

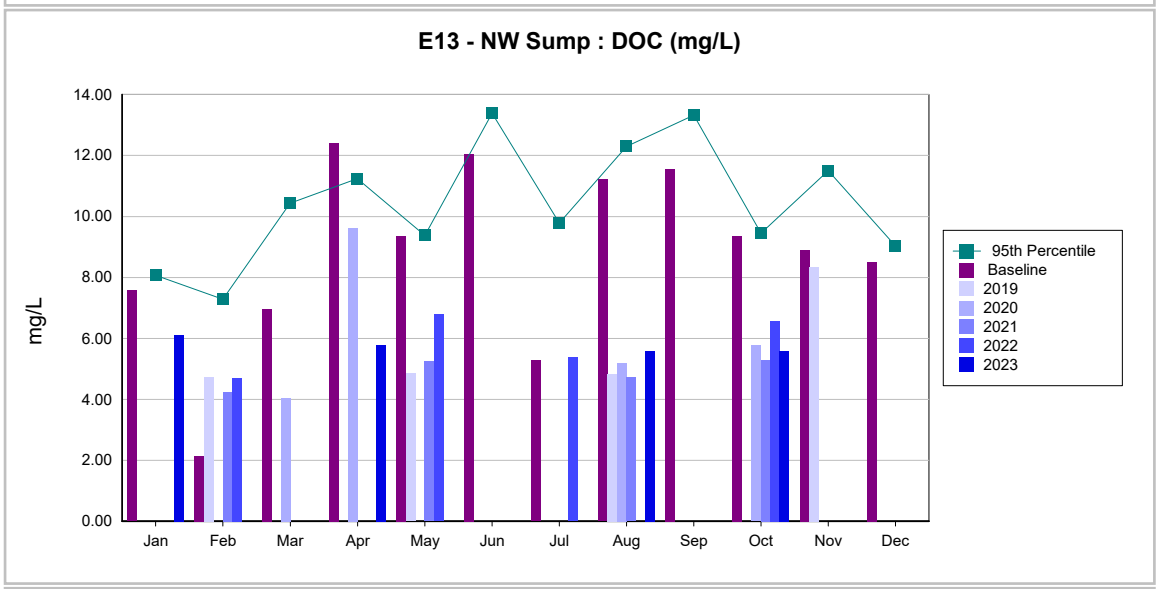
Annual Report Drainage Water

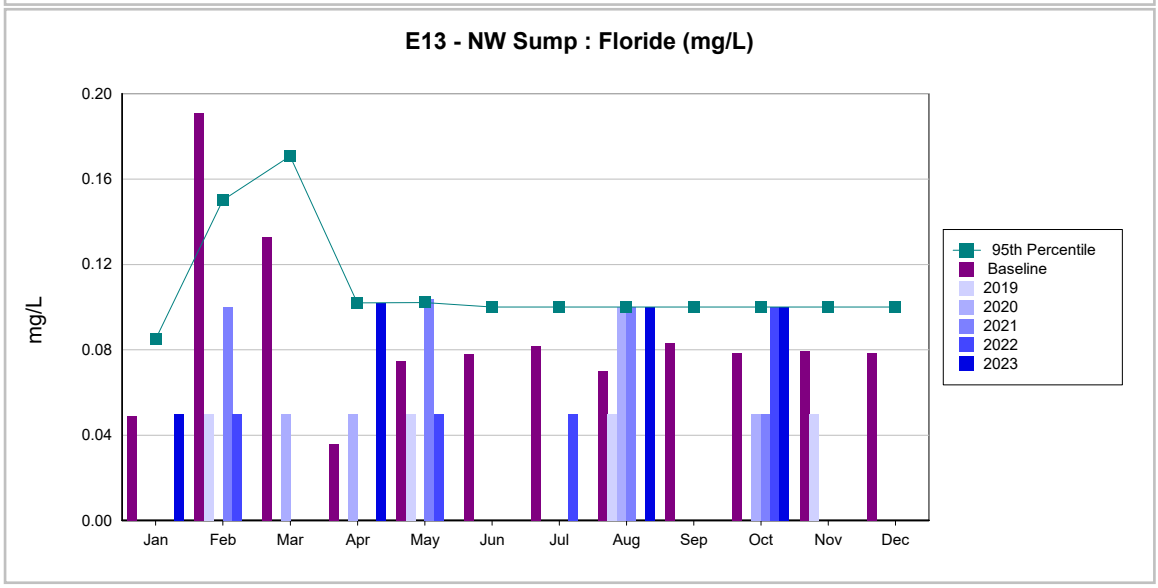
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







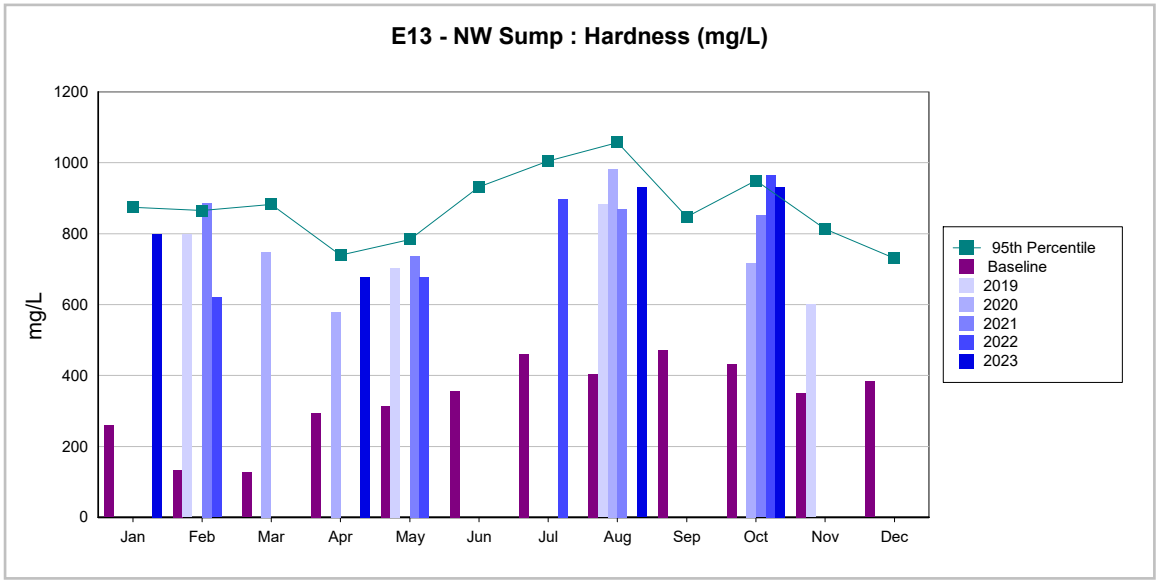
Water Quality Report

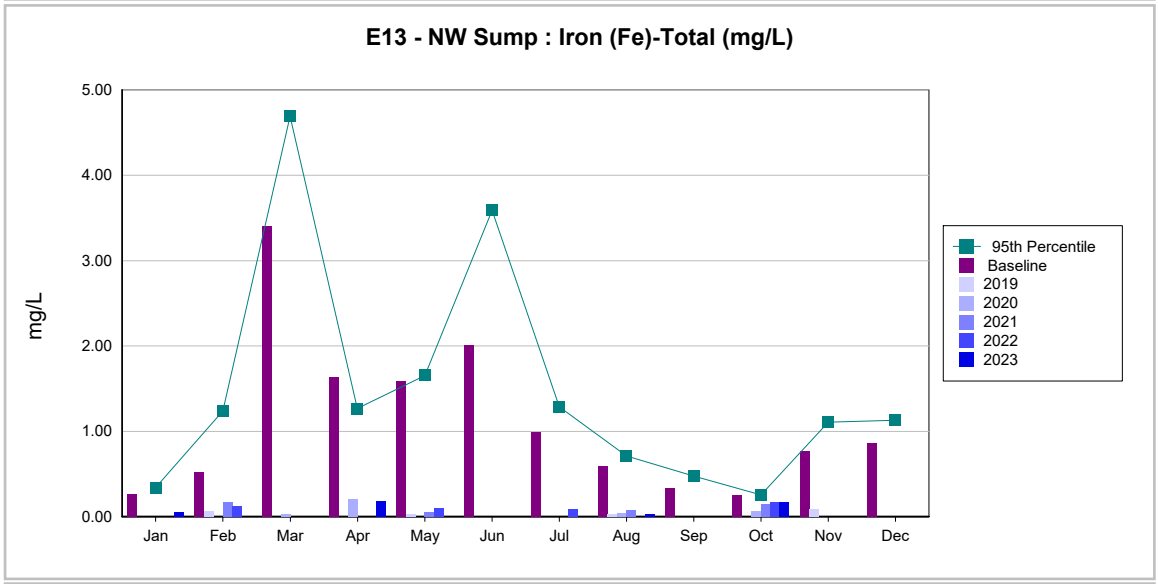
Annual Report Drainage Water

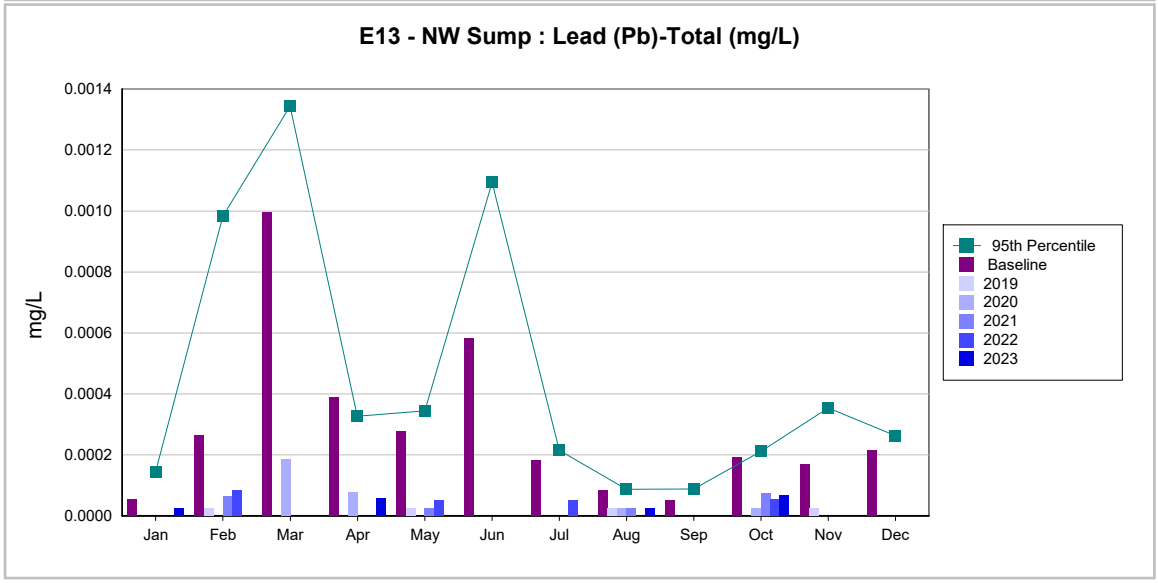
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







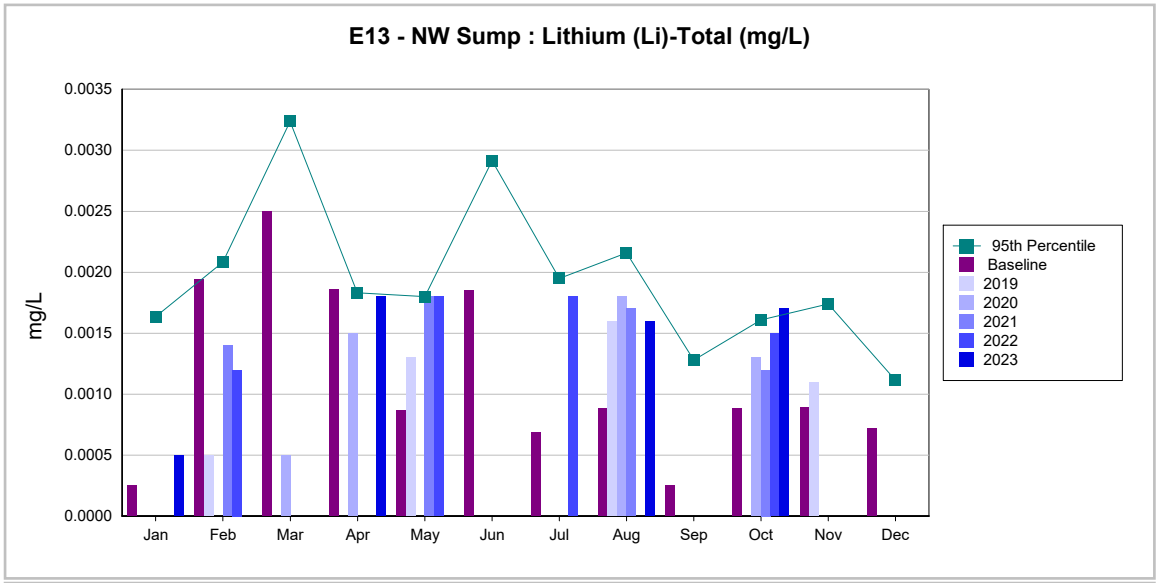
Water Quality Report

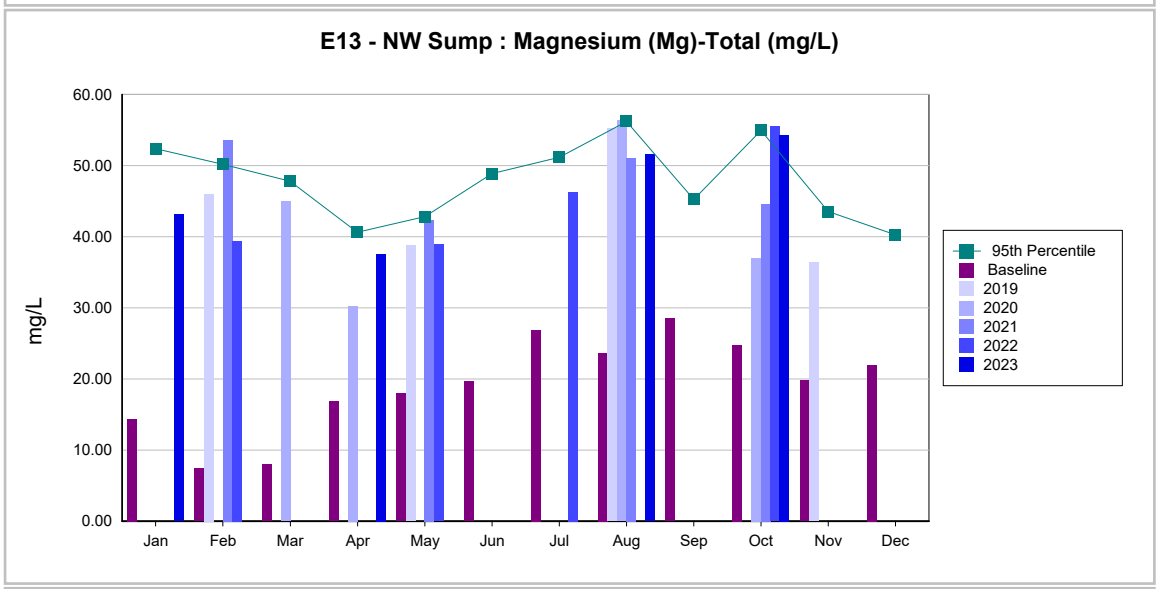
Annual Report Drainage Water

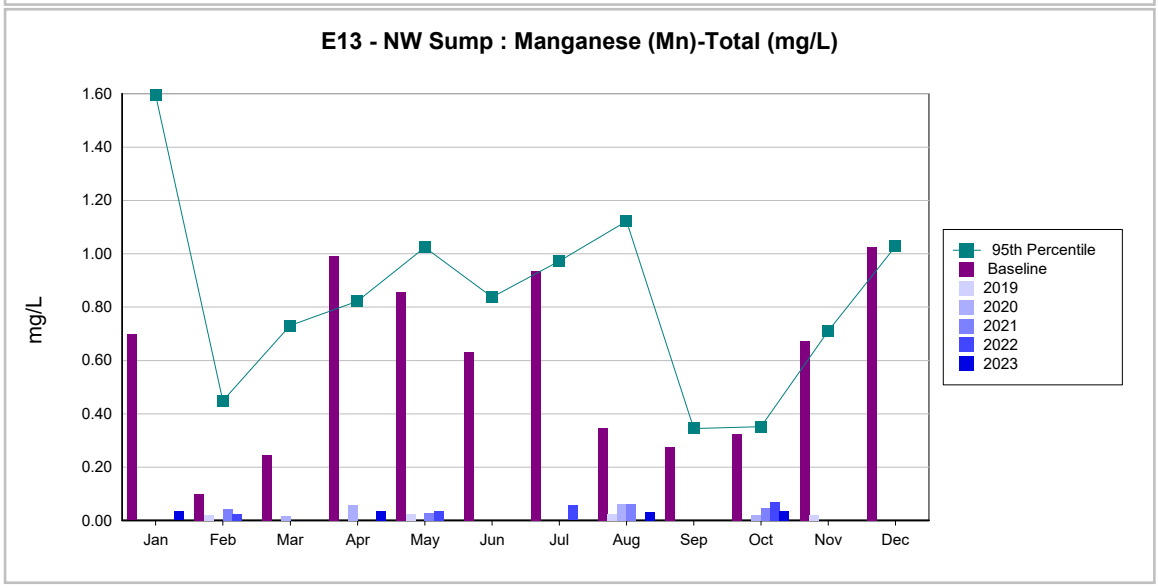
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







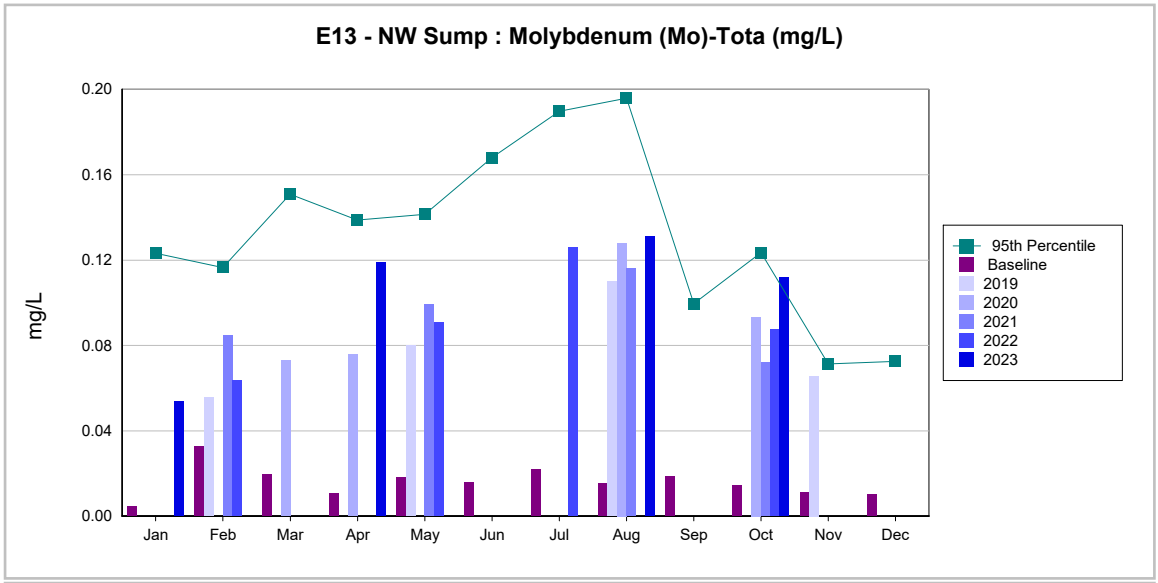
Water Quality Report

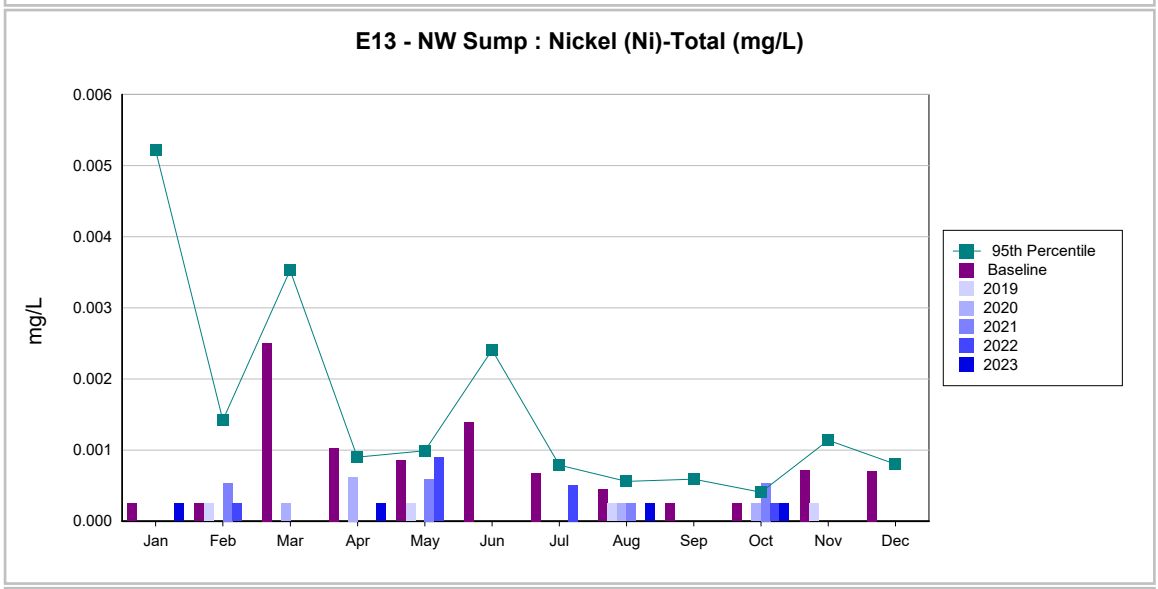
Annual Report Drainage Water

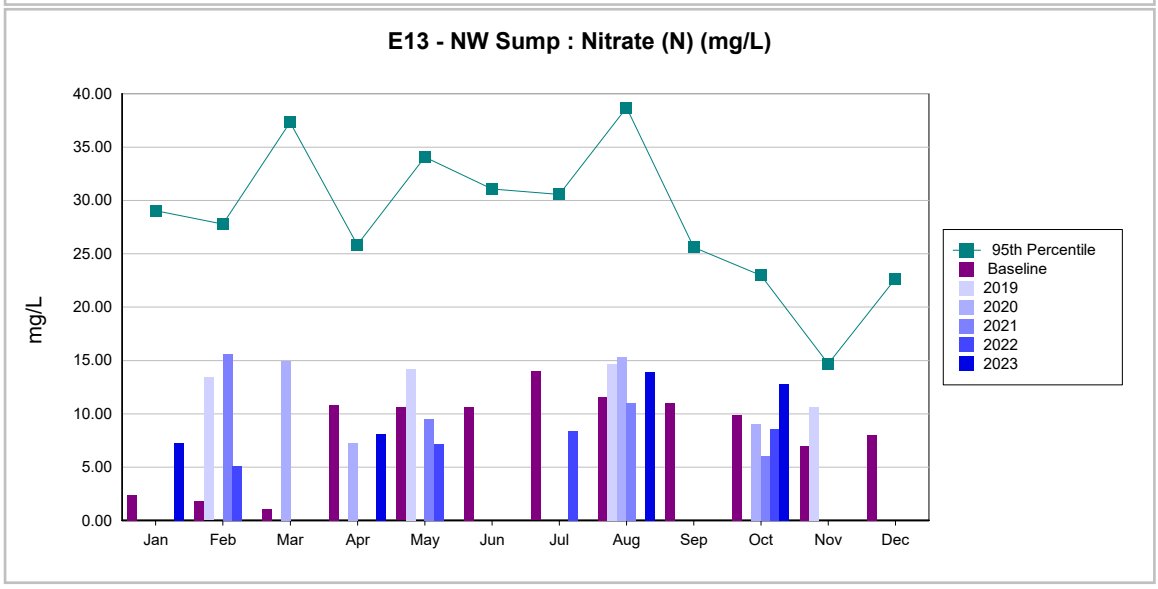
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







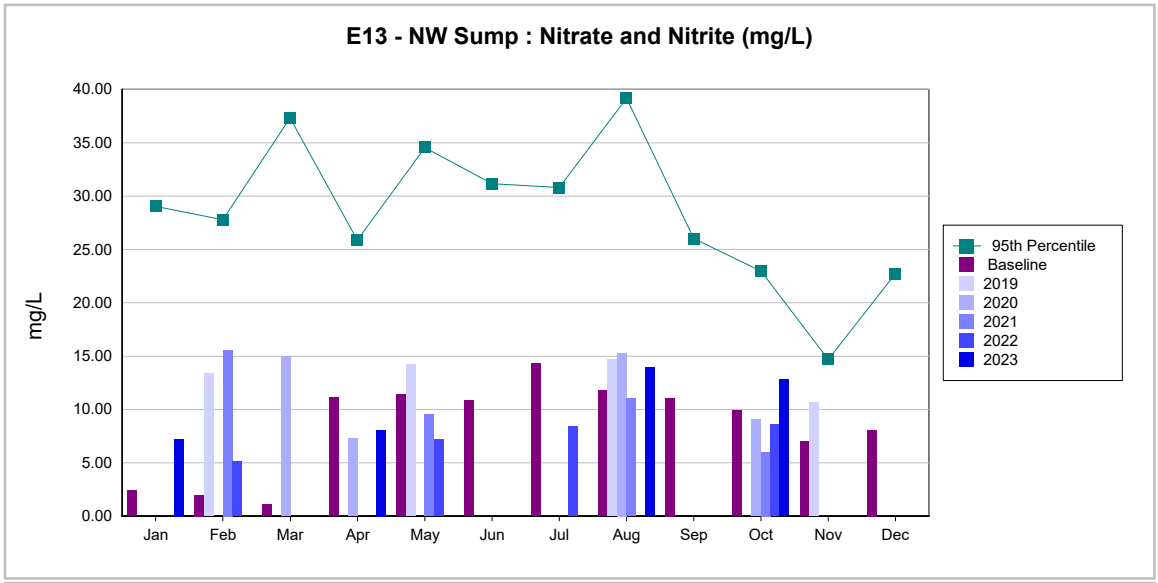
Water Quality Report

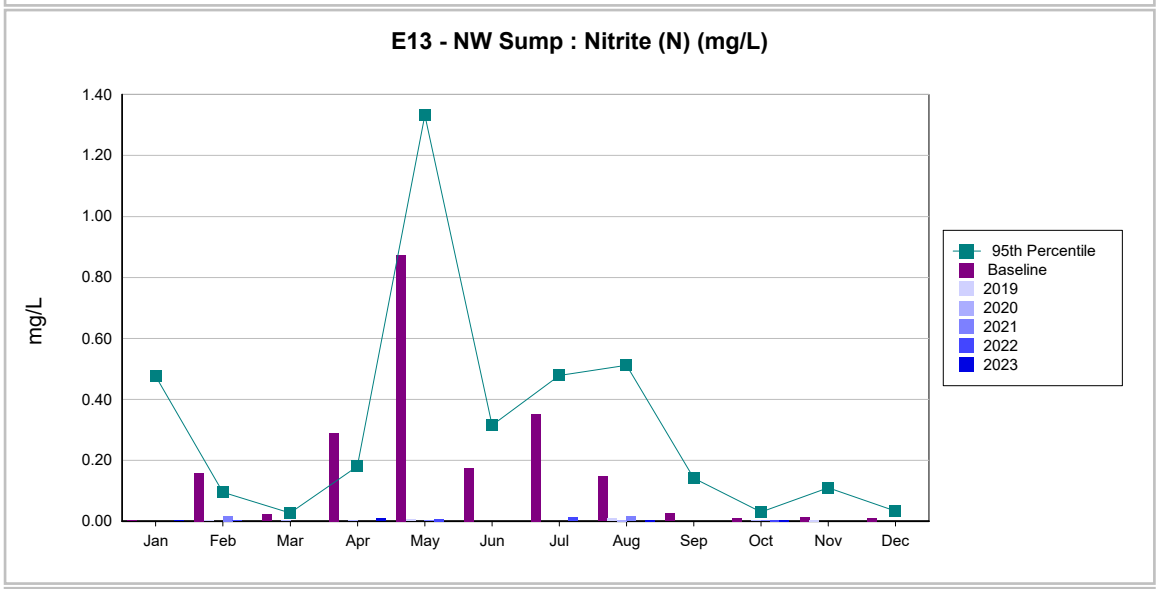
Annual Report Drainage Water

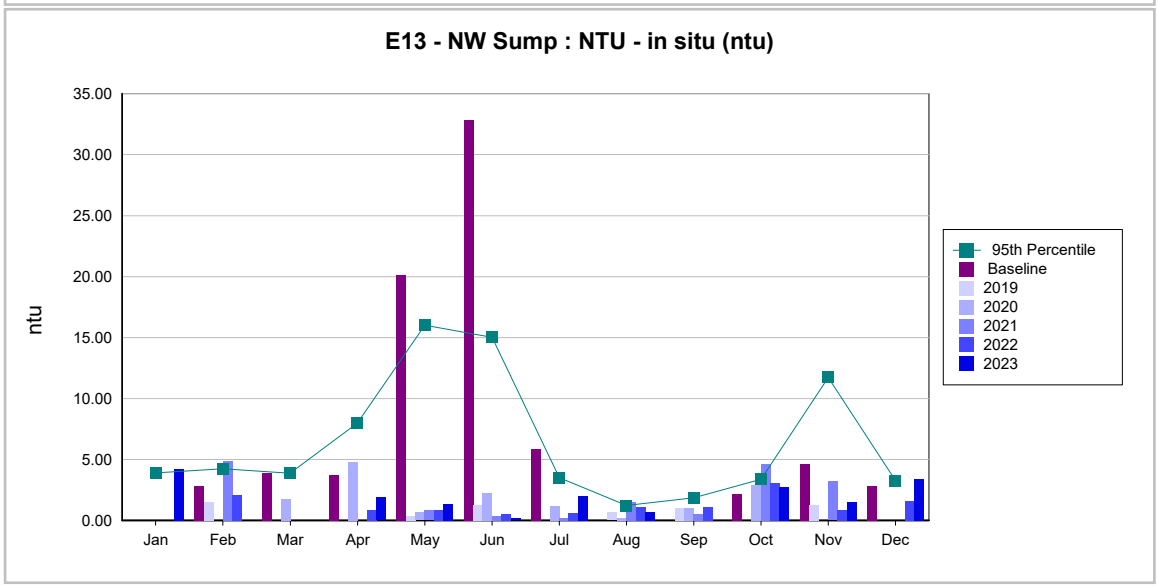
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







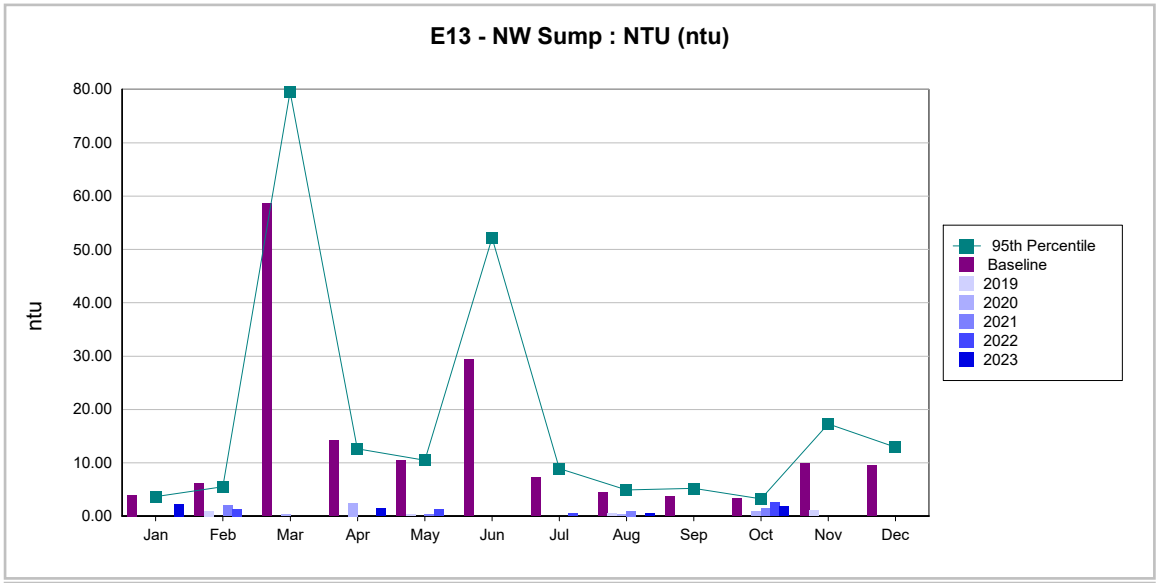
Water Quality Report

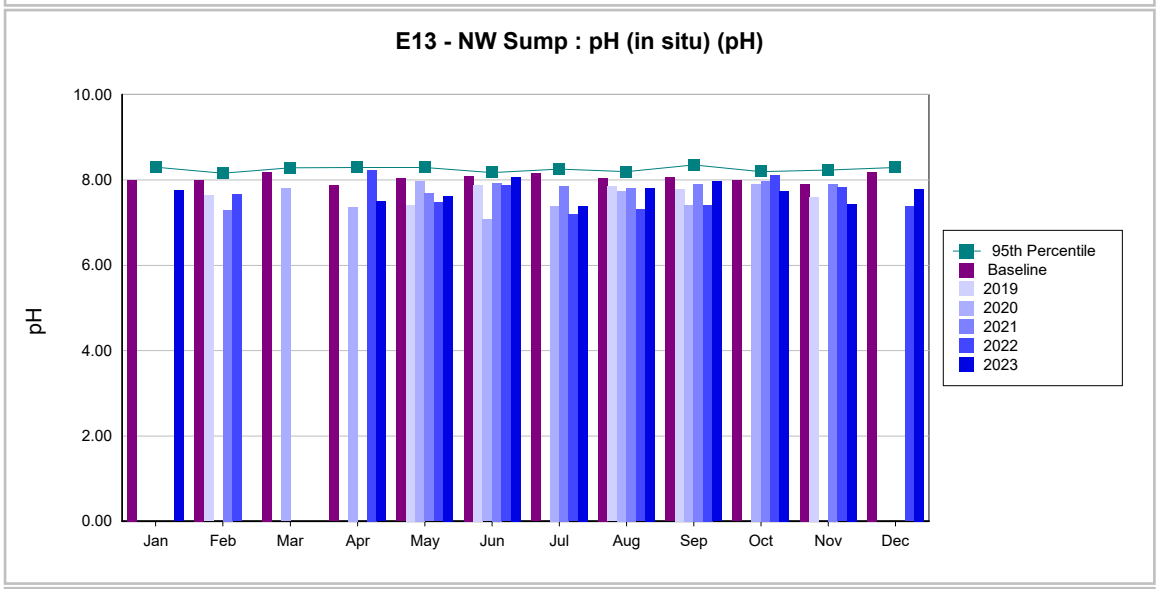
Annual Report Drainage Water

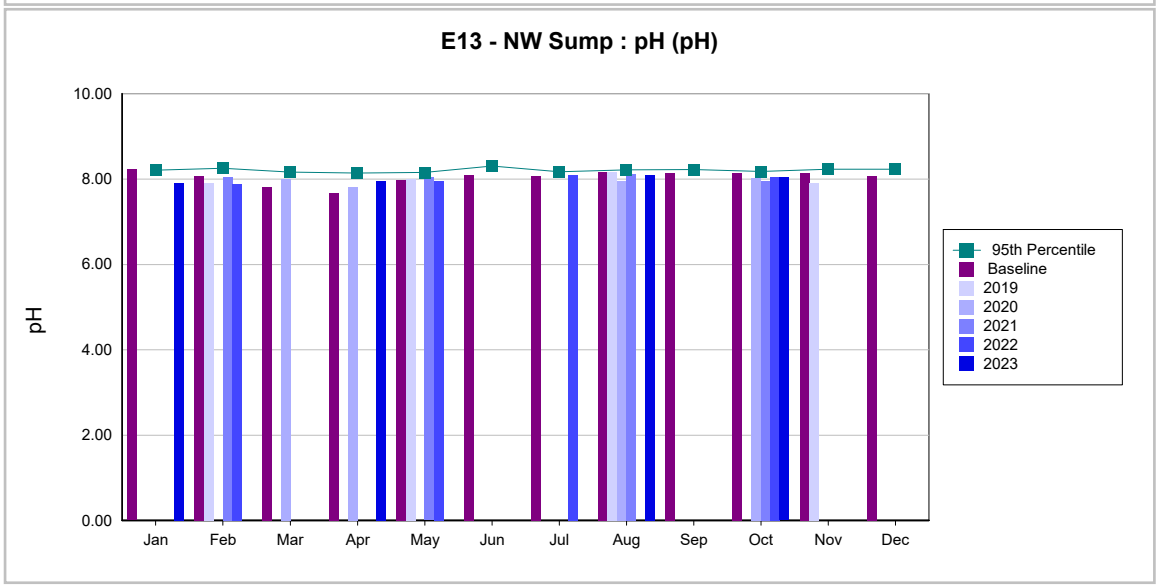
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







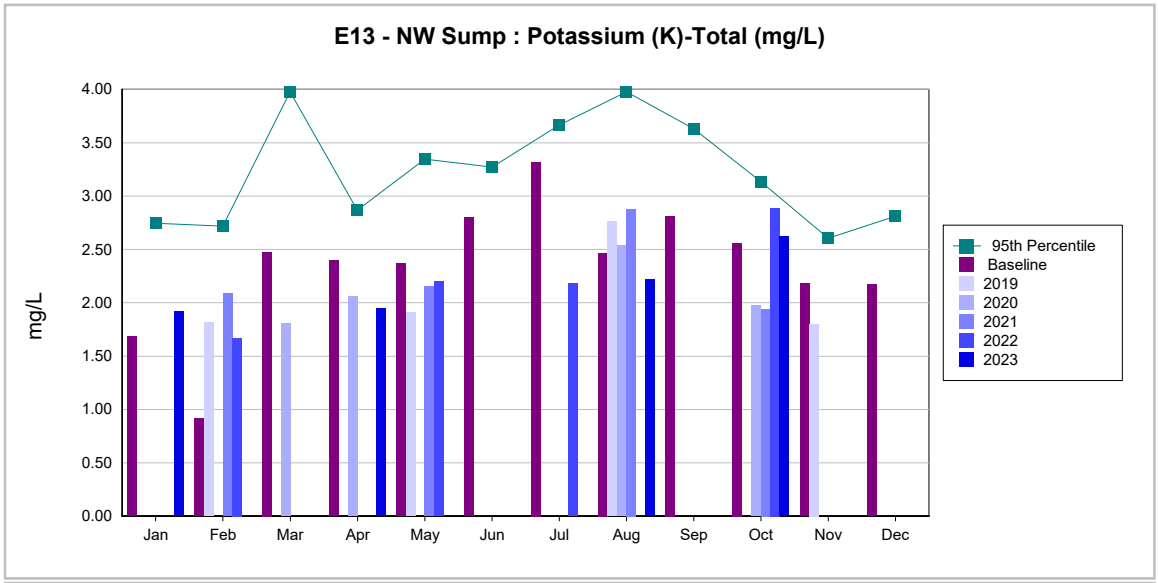
Water Quality Report

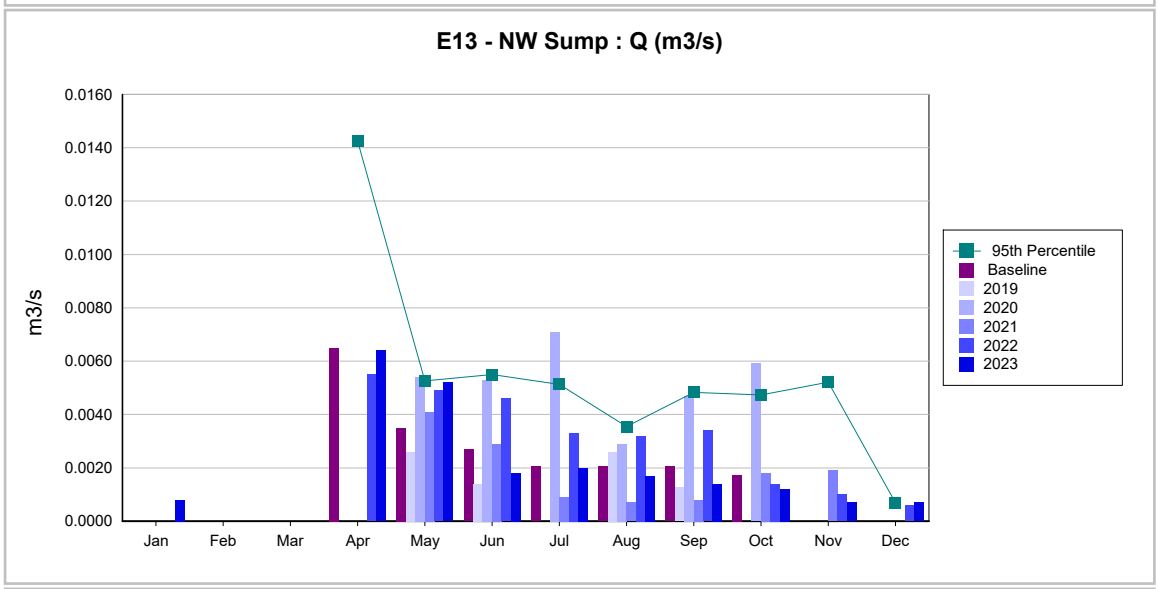
Annual Report Drainage Water

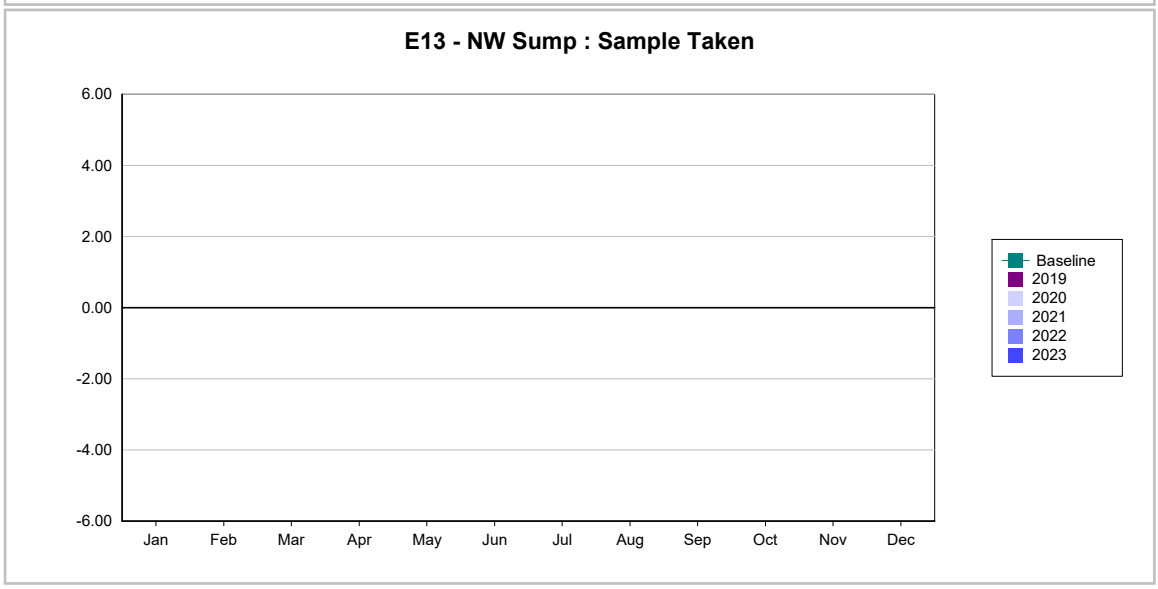
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







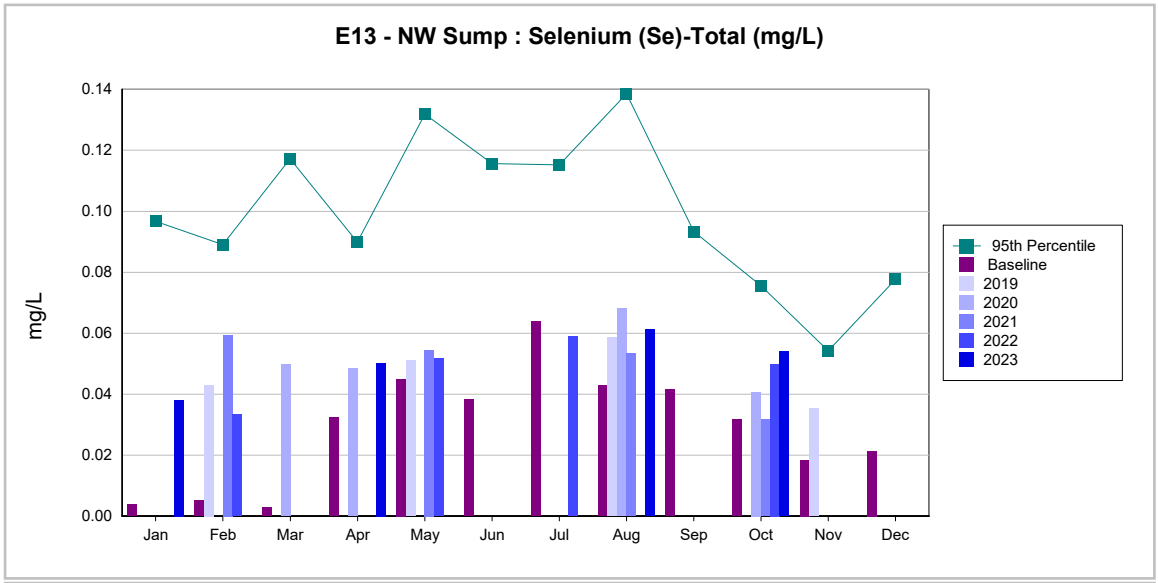
Water Quality Report

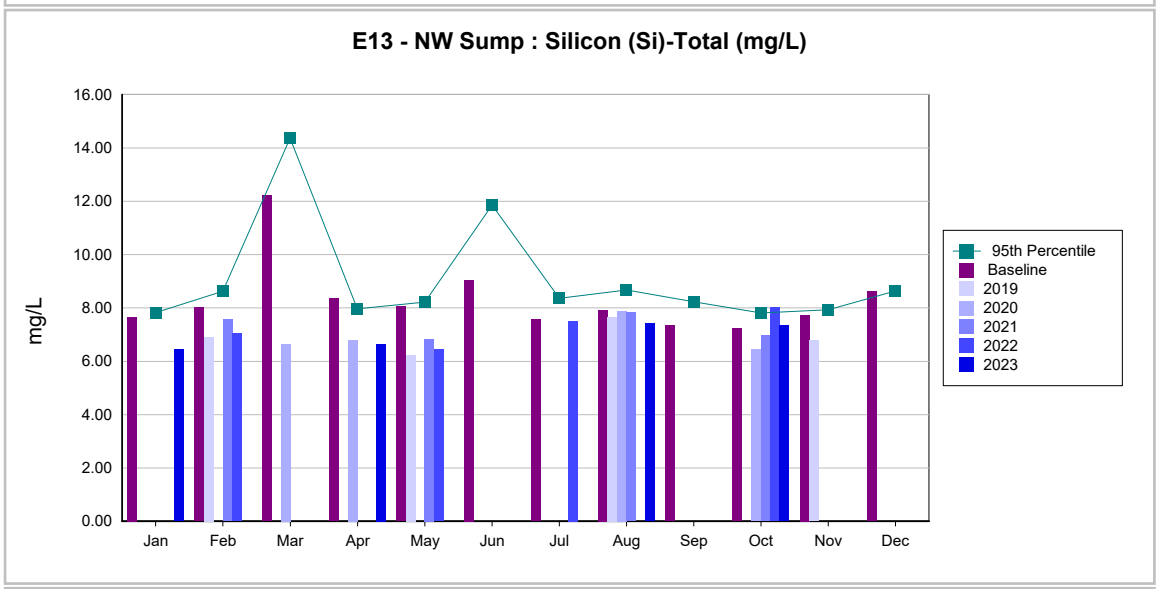
Annual Report Drainage Water

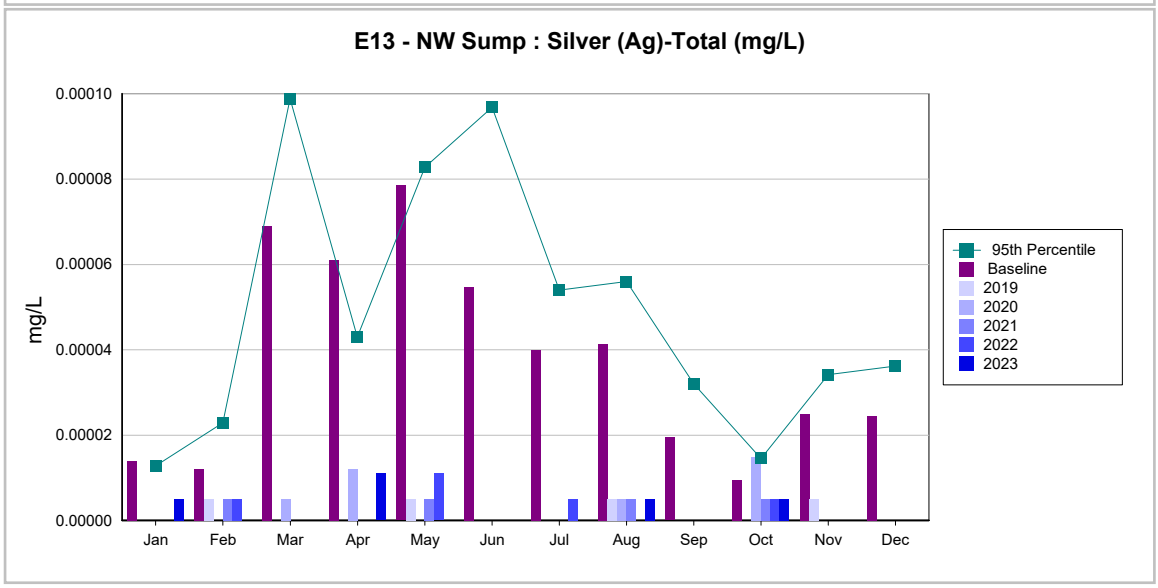
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







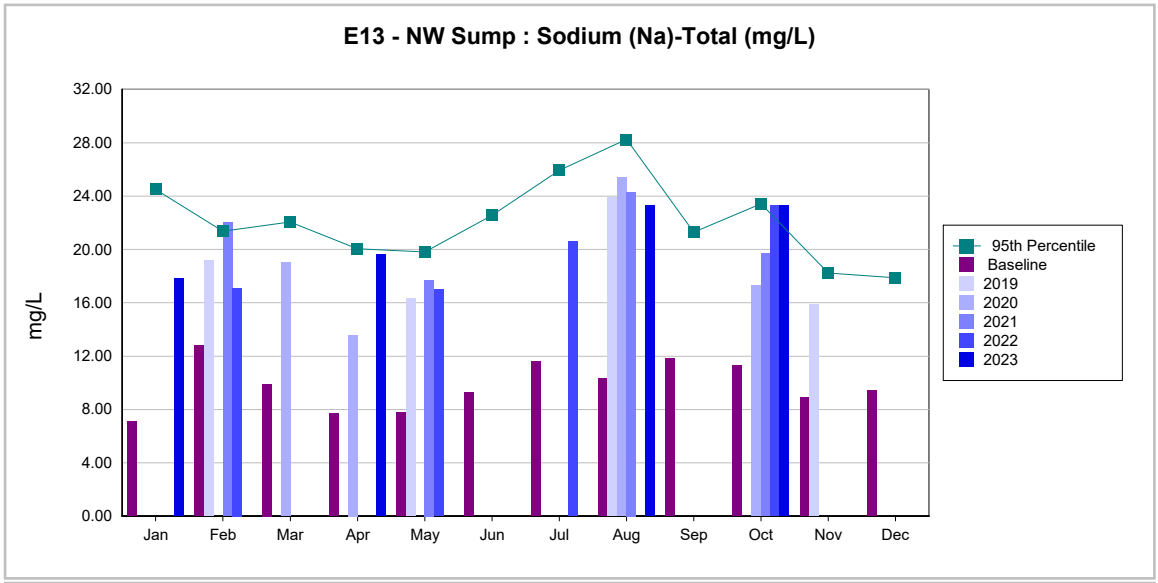
Water Quality Report

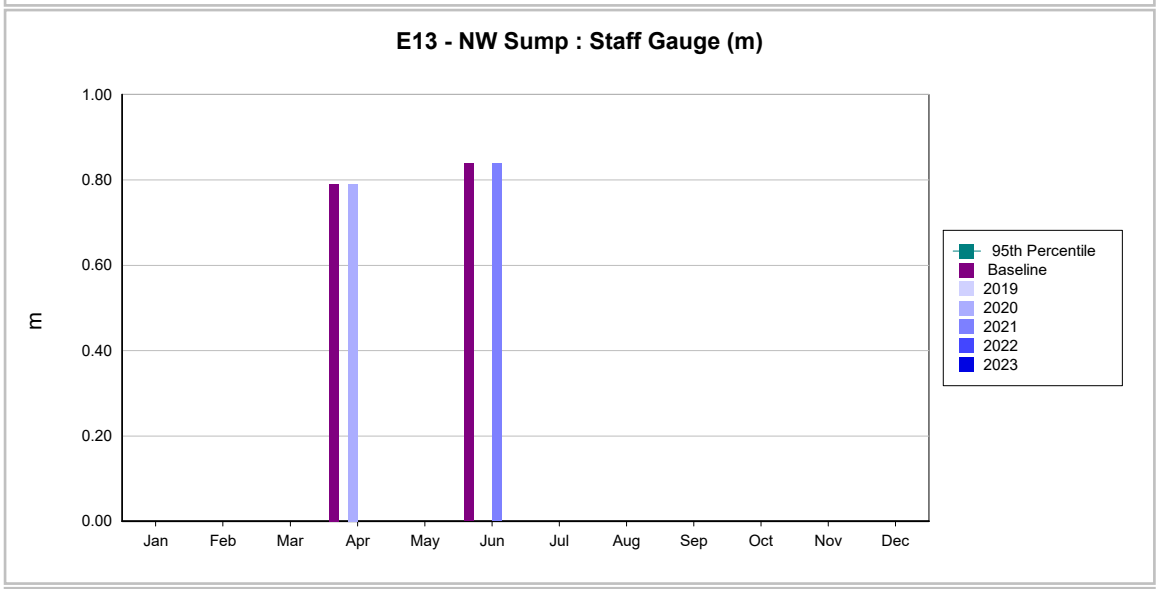
Annual Report Drainage Water

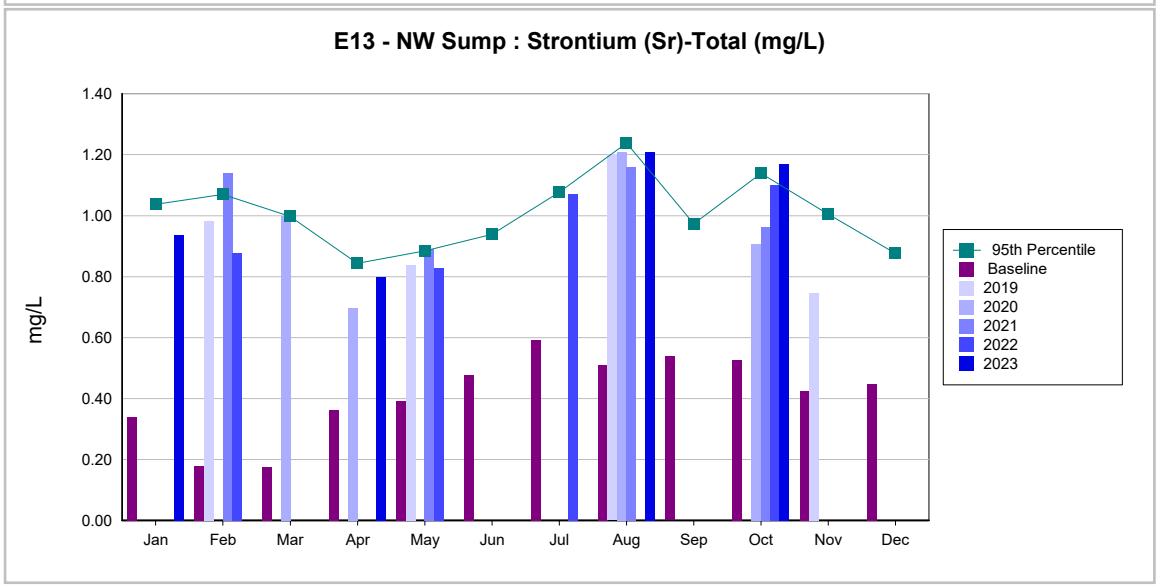
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







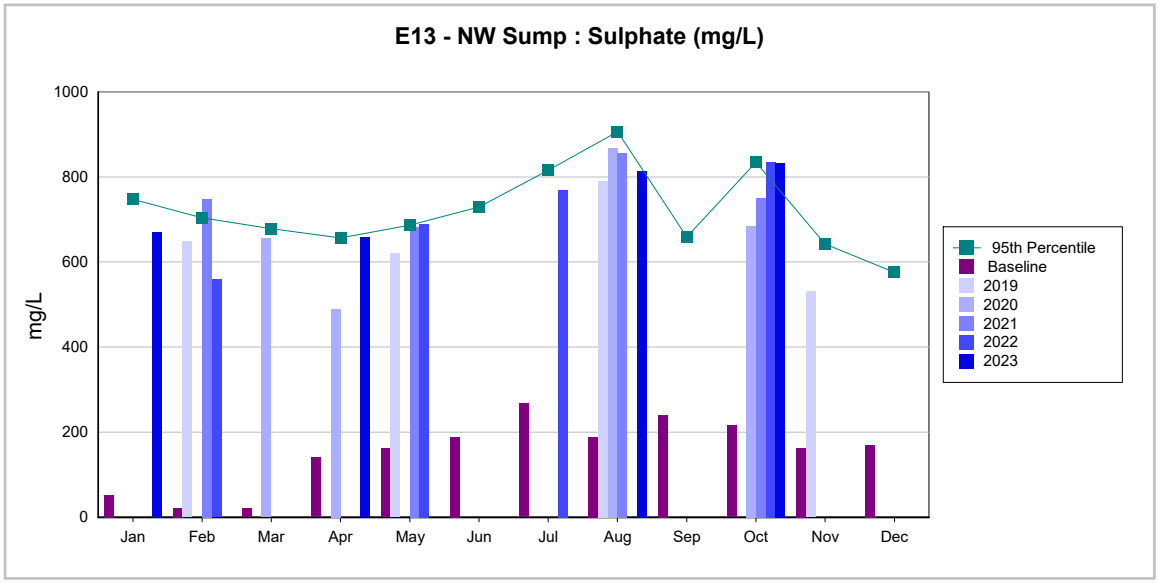
Water Quality Report

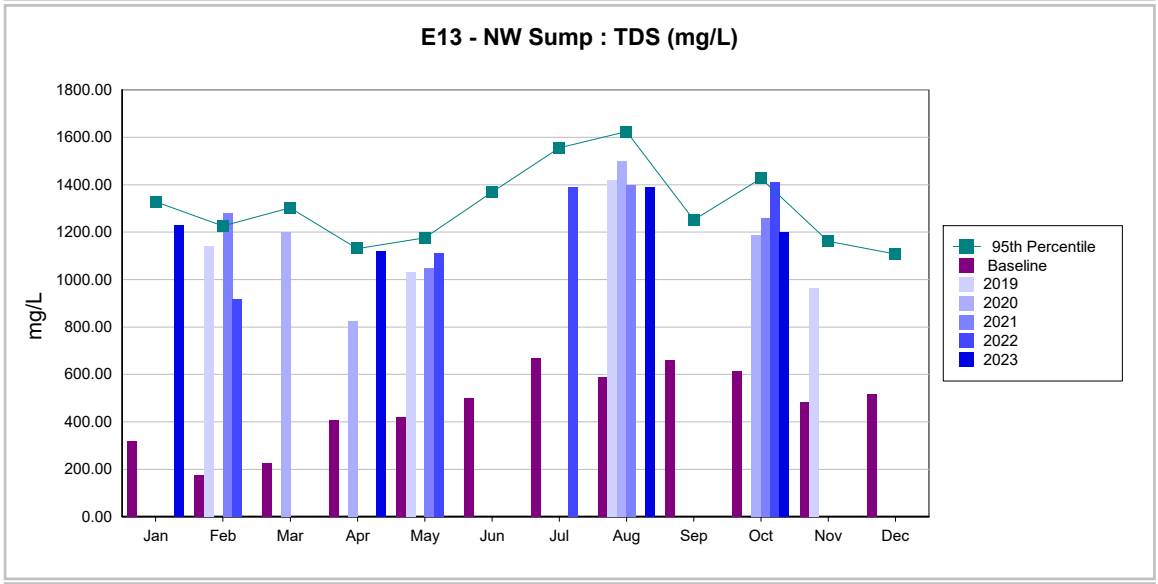
Annual Report Drainage Water

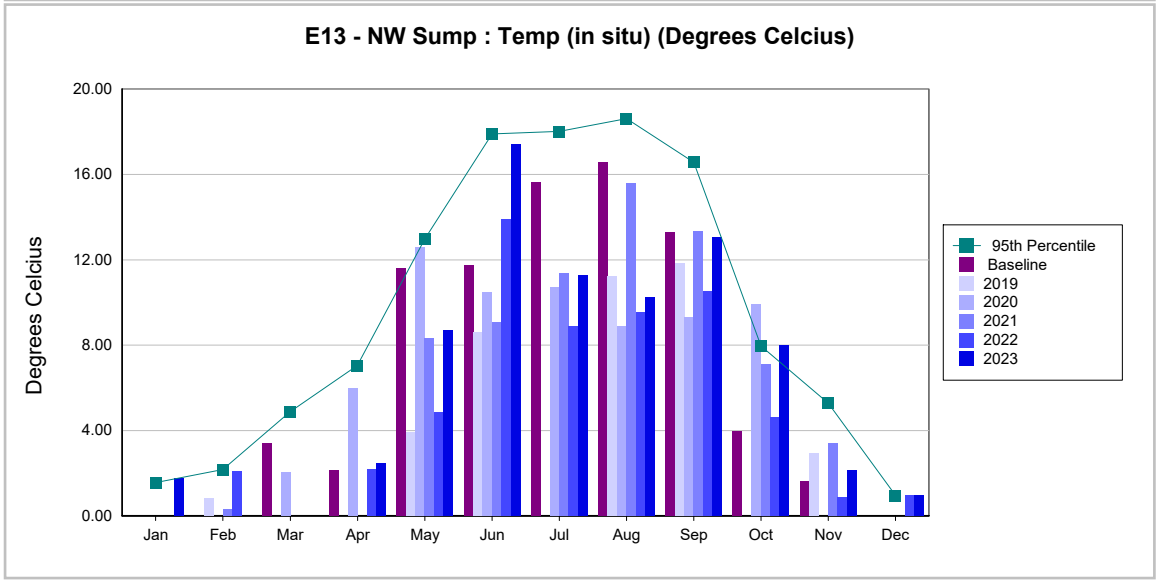
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







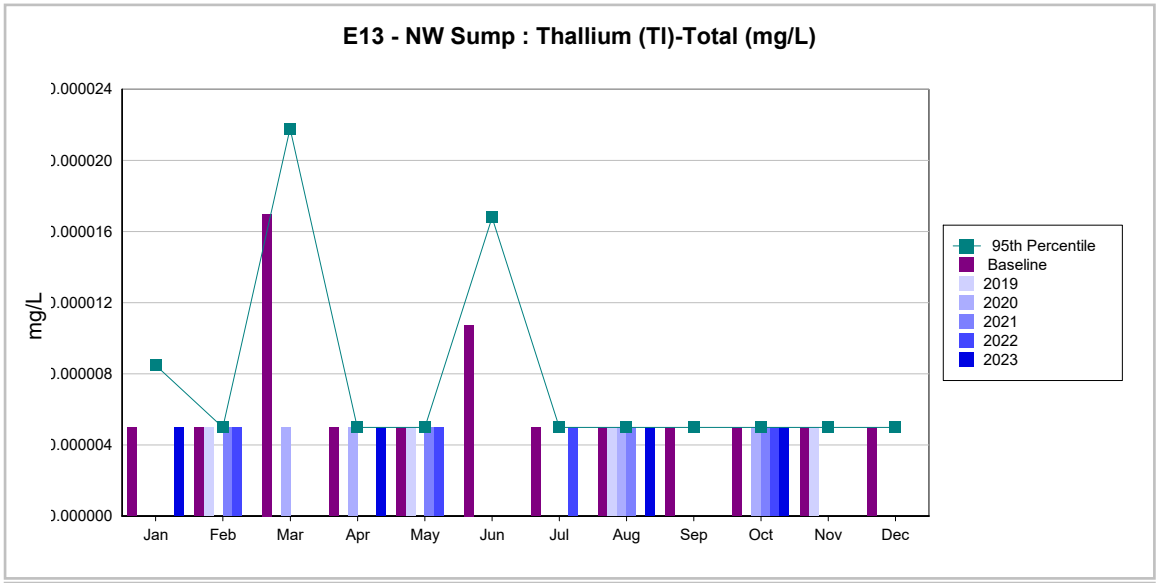
Water Quality Report

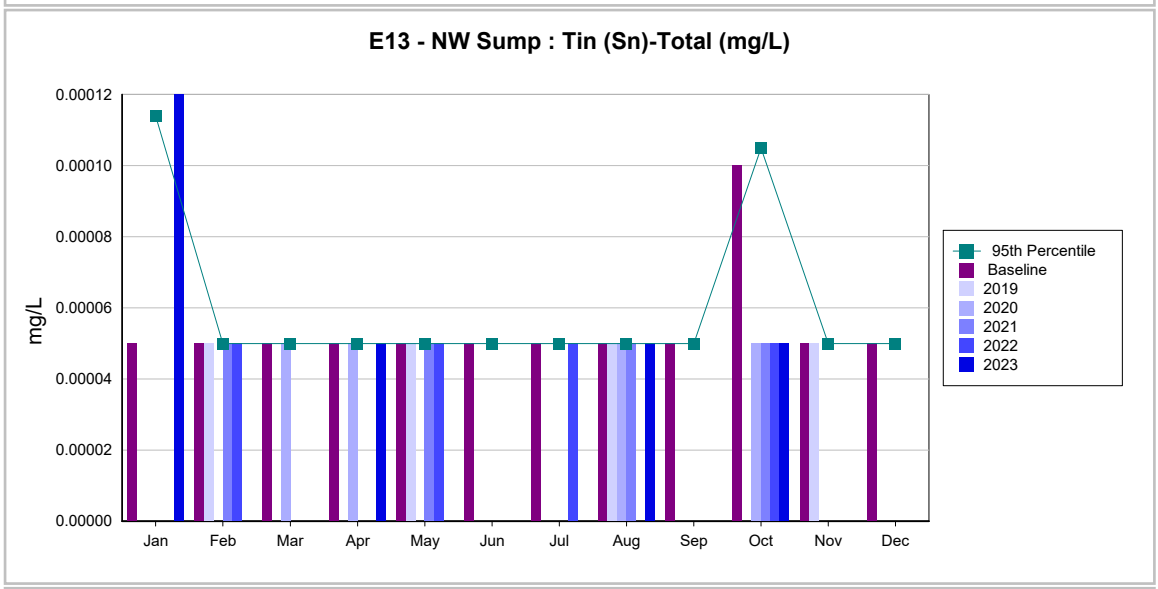
Annual Report Drainage Water

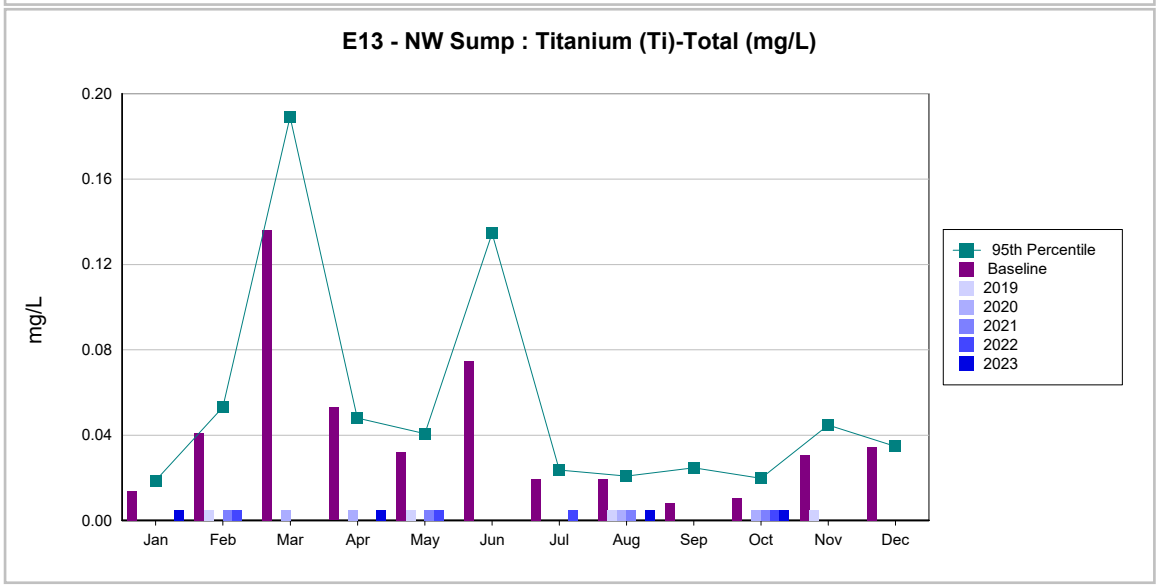
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







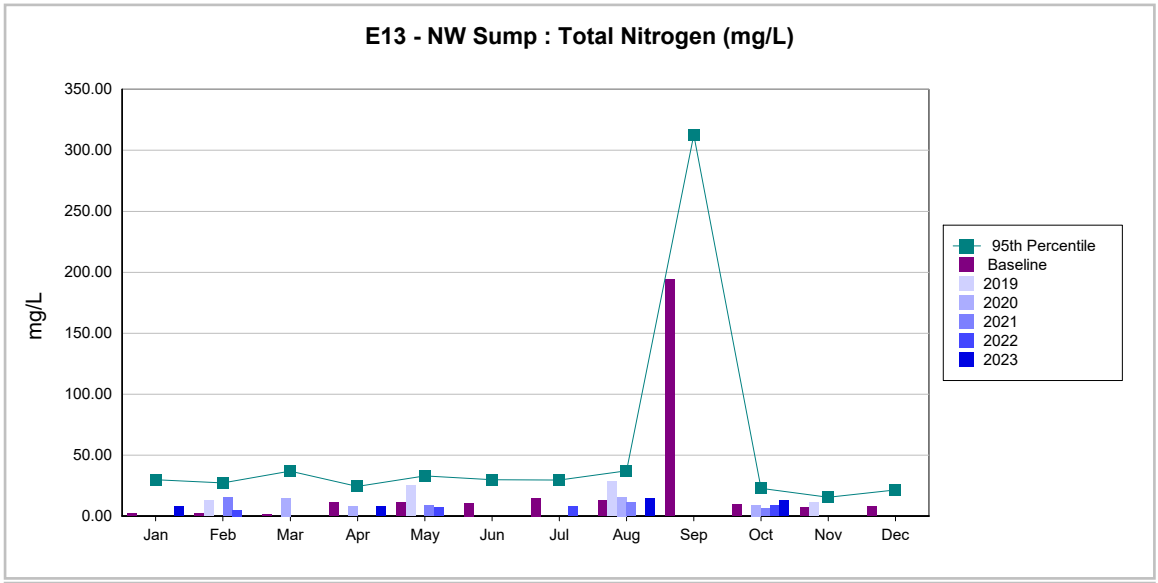
Water Quality Report

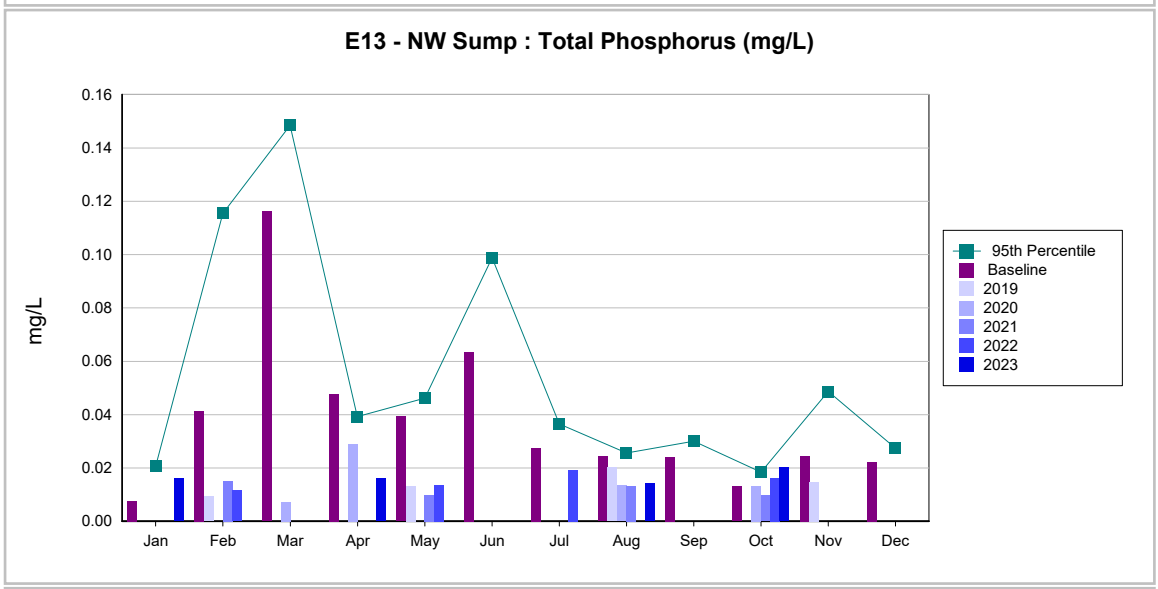
Annual Report Drainage Water

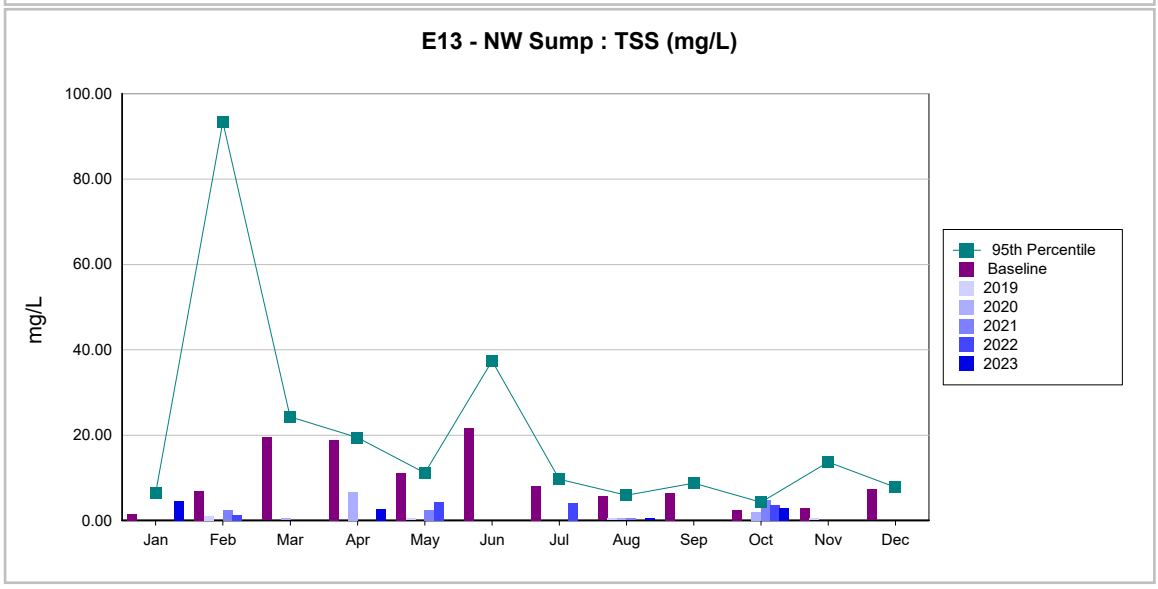
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







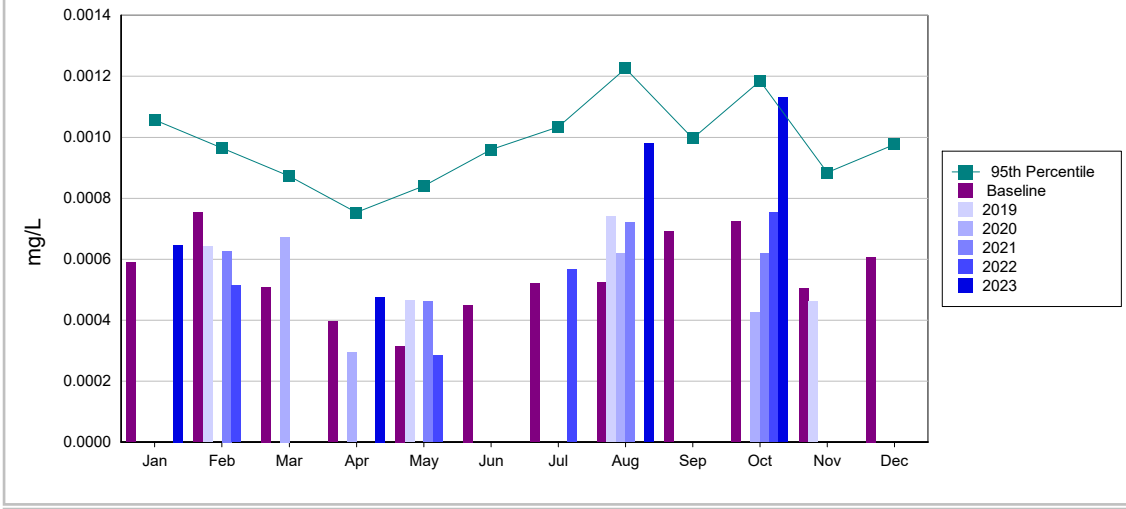
Water Quality Report

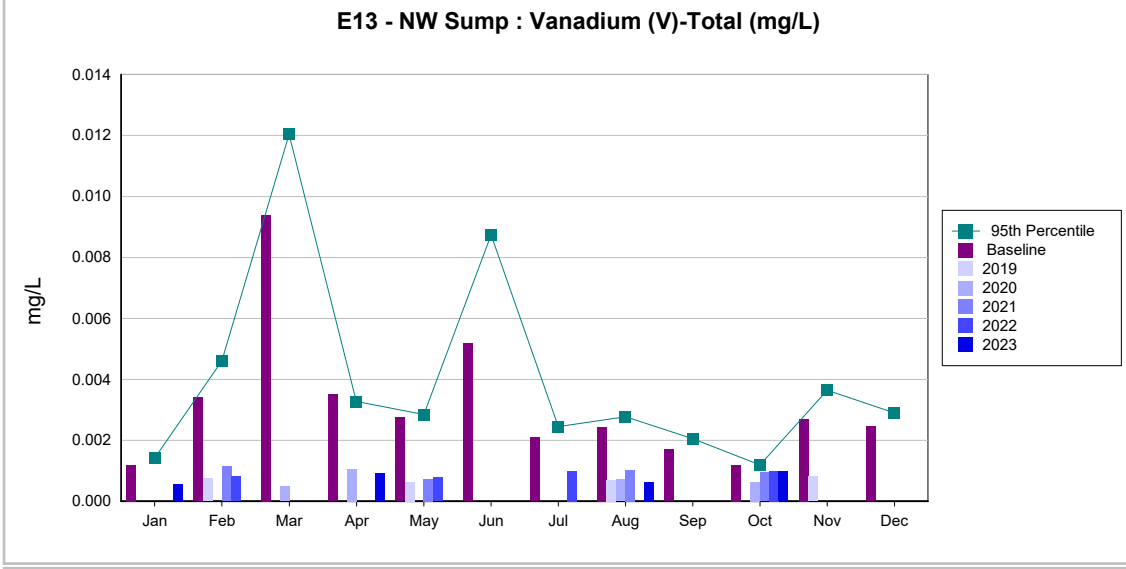
Annual Report Drainage Water

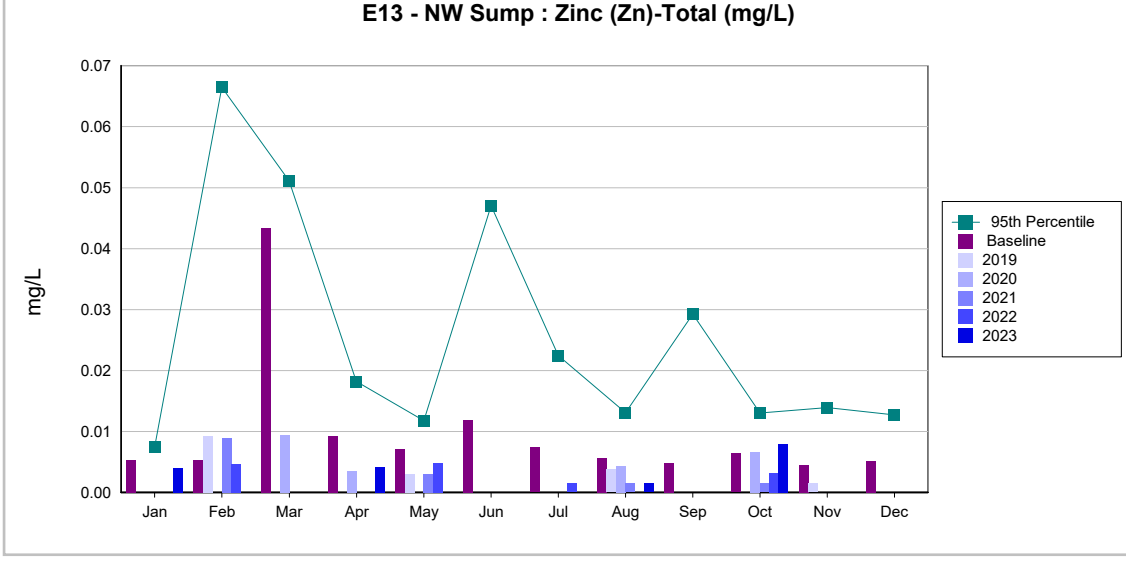
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







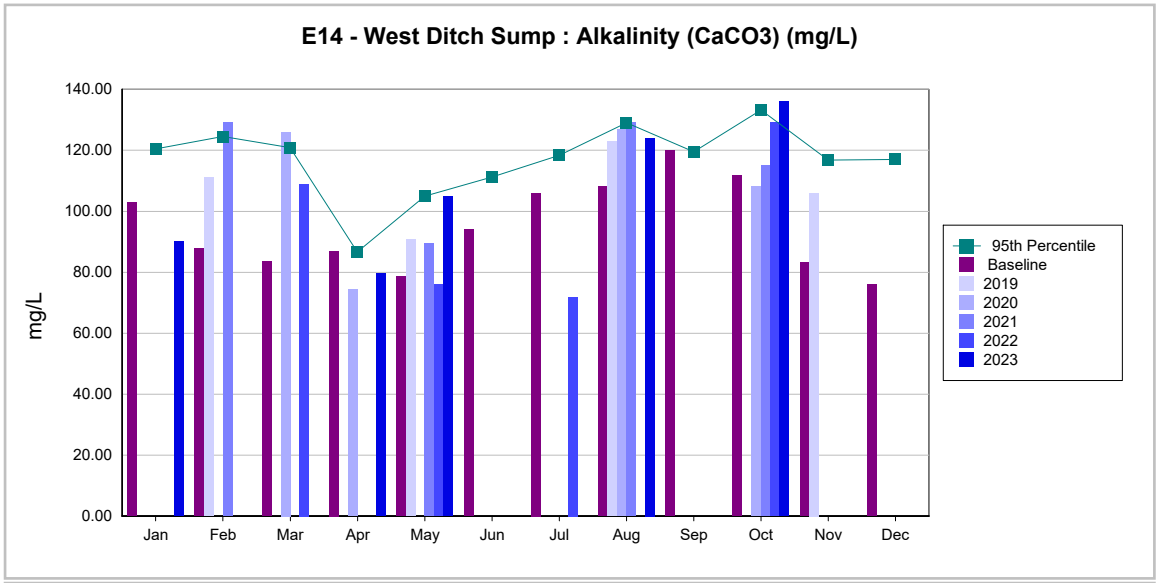
Water Quality Report

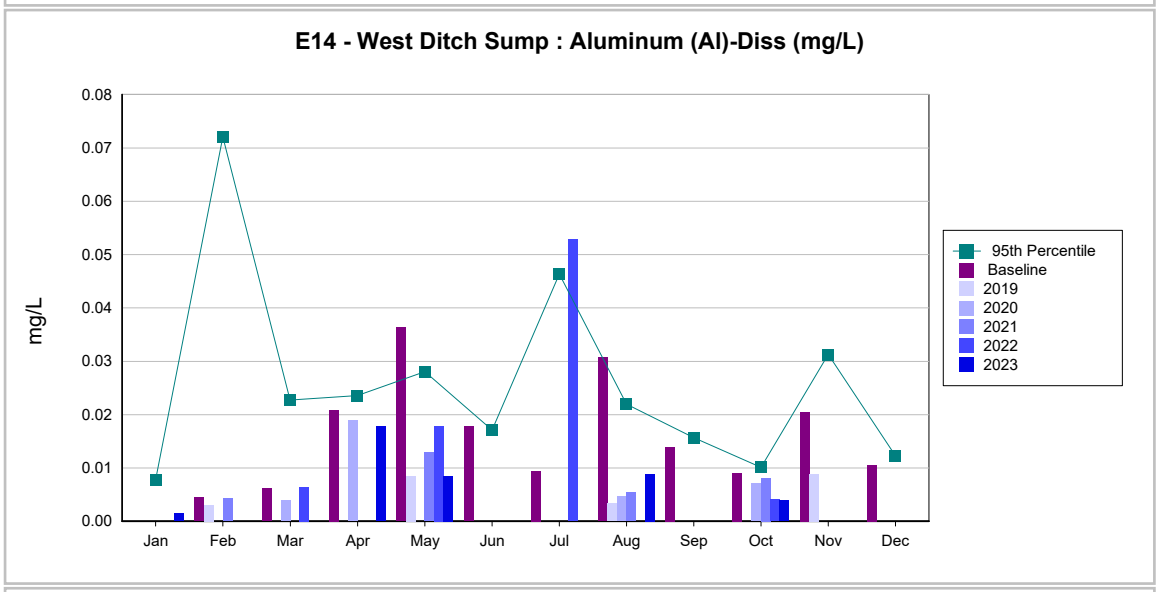
Annual Report Drainage Water

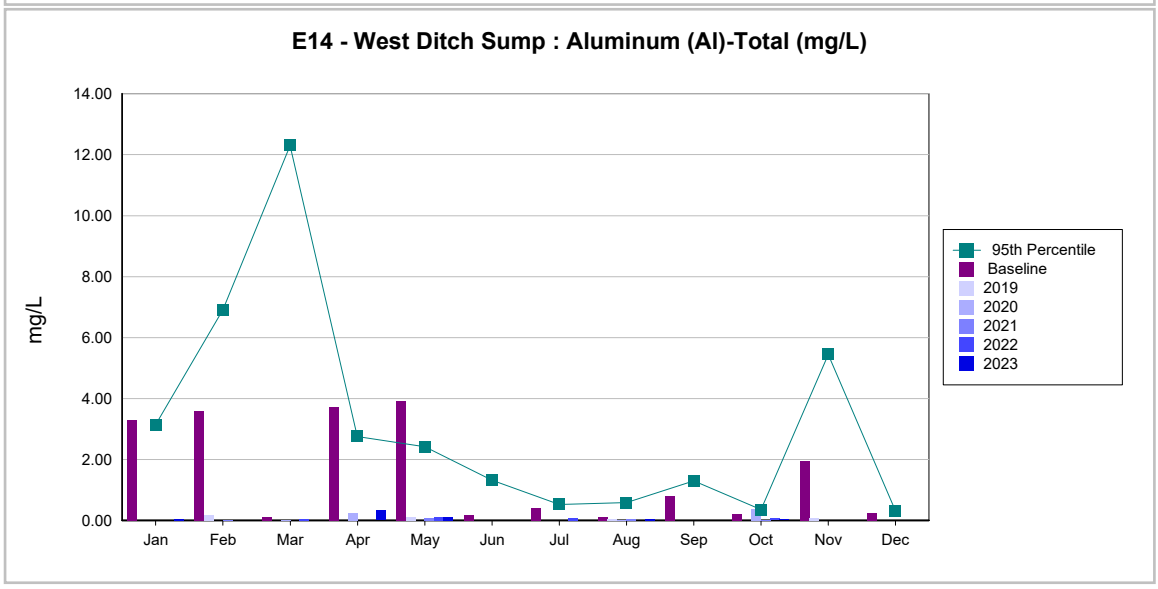
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







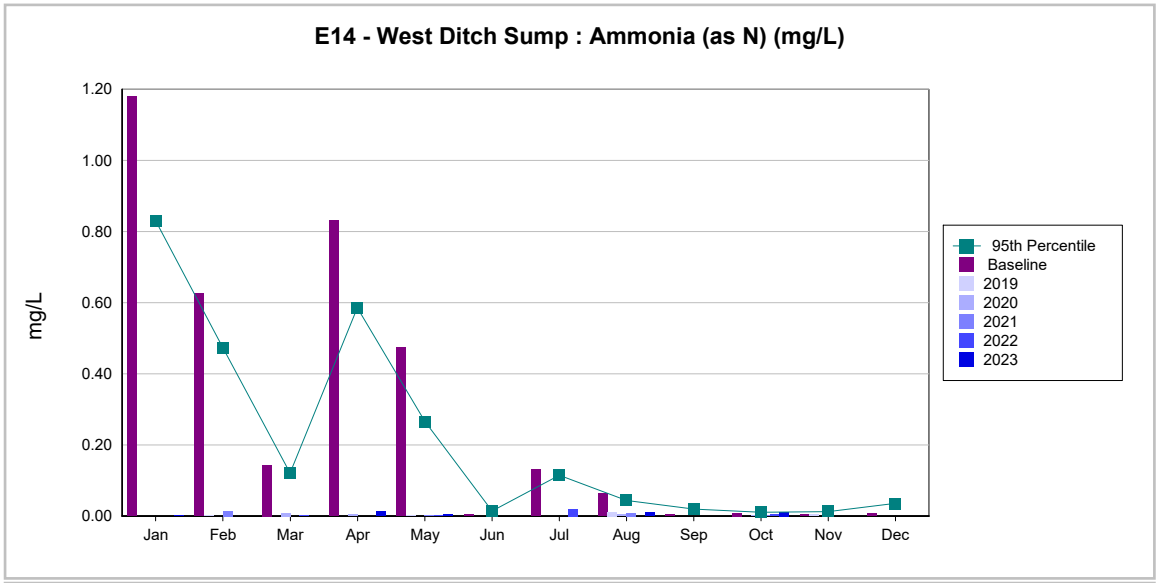
Water Quality Report

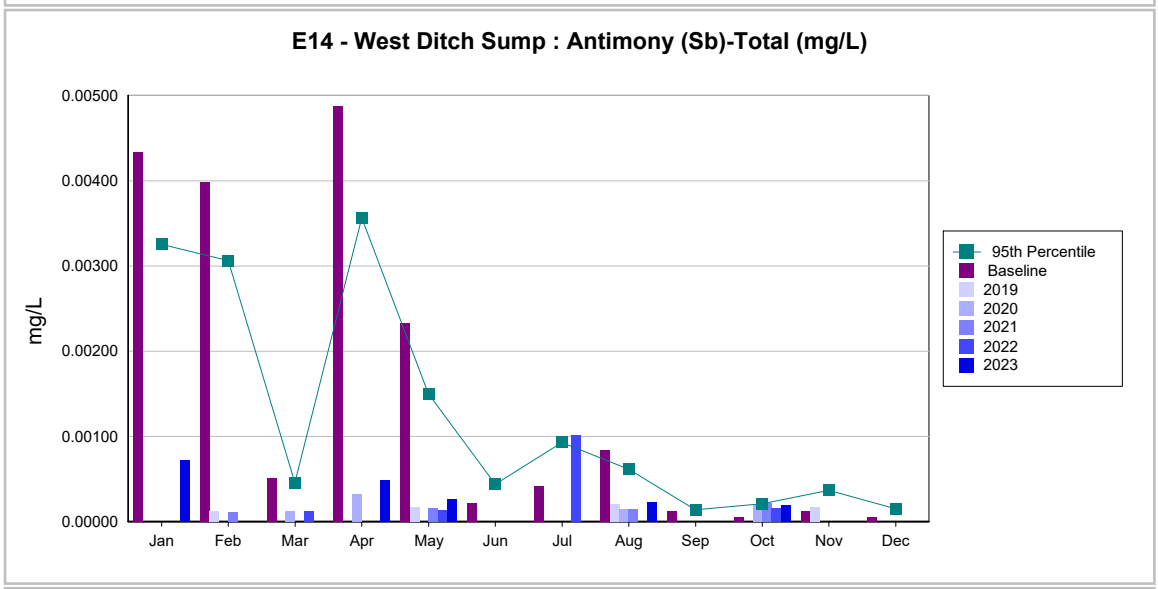
Annual Report Drainage Water

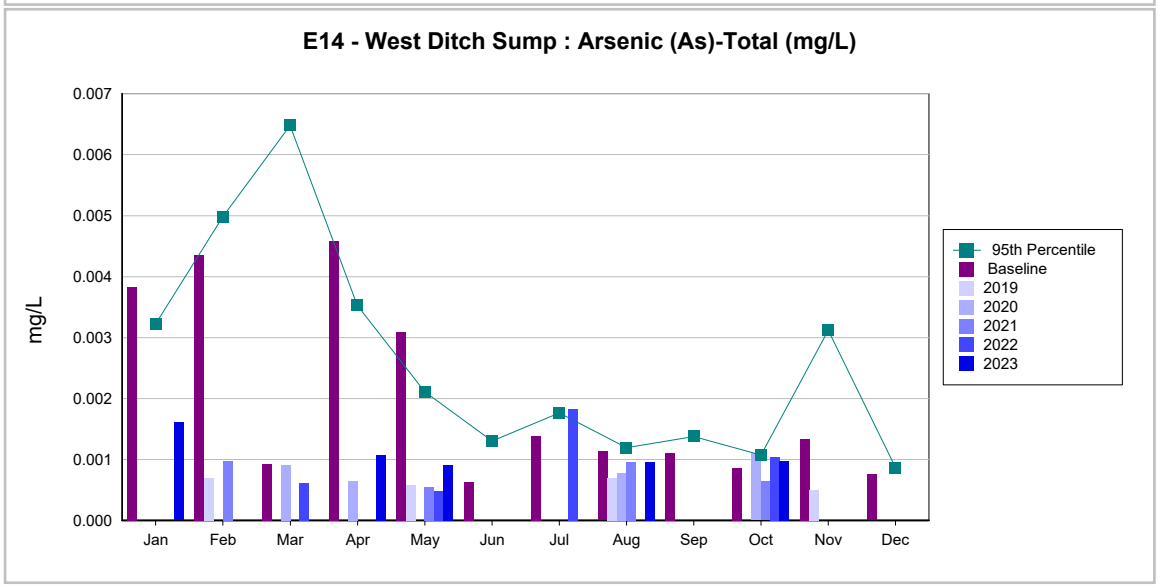
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







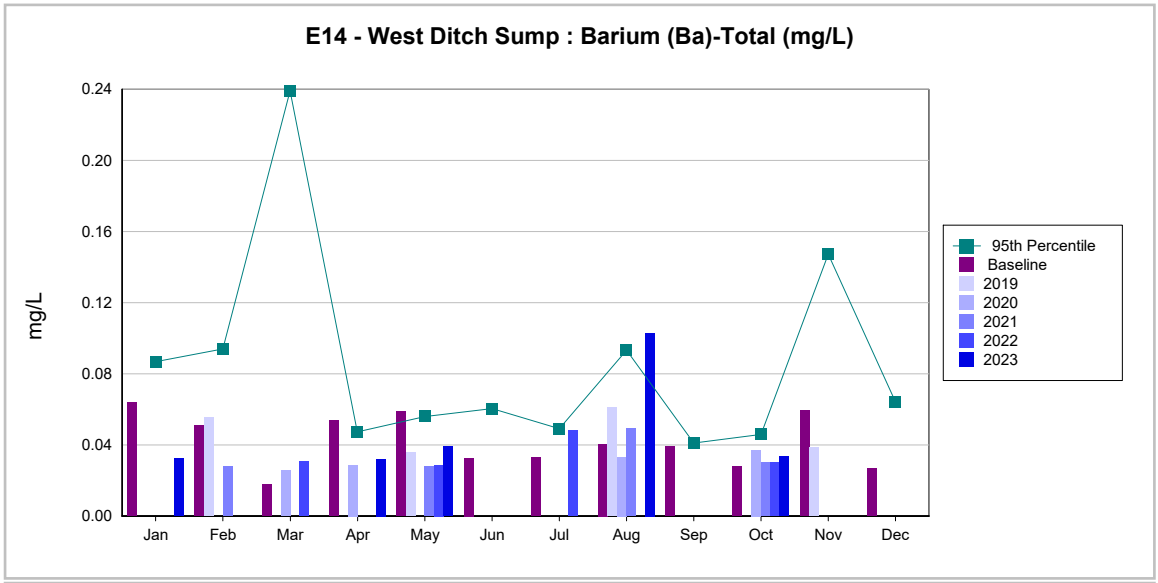
Water Quality Report

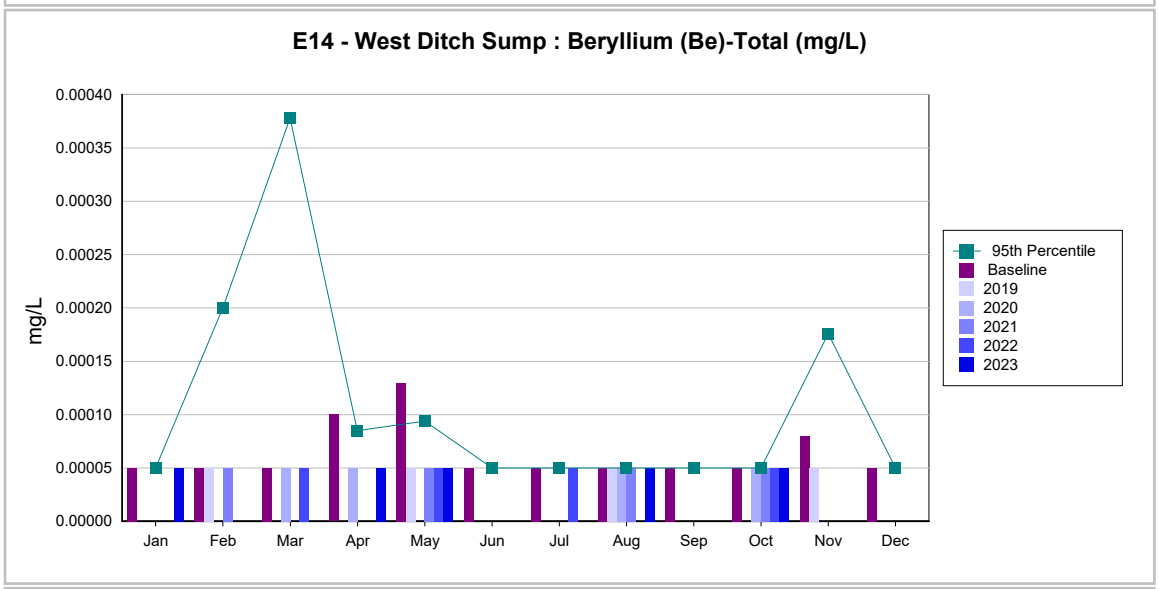
Annual Report Drainage Water

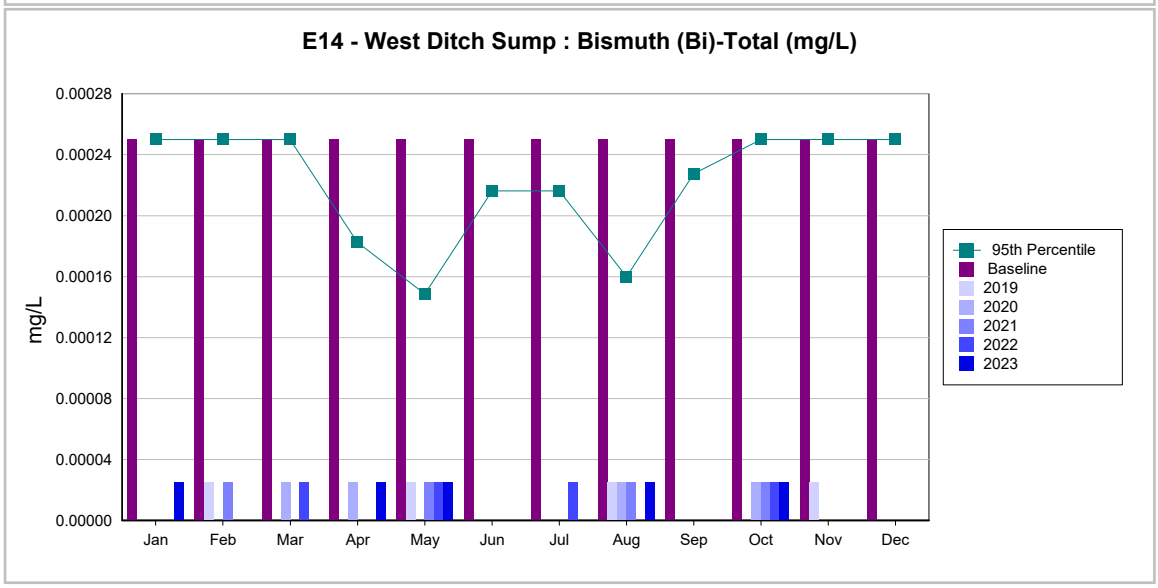
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







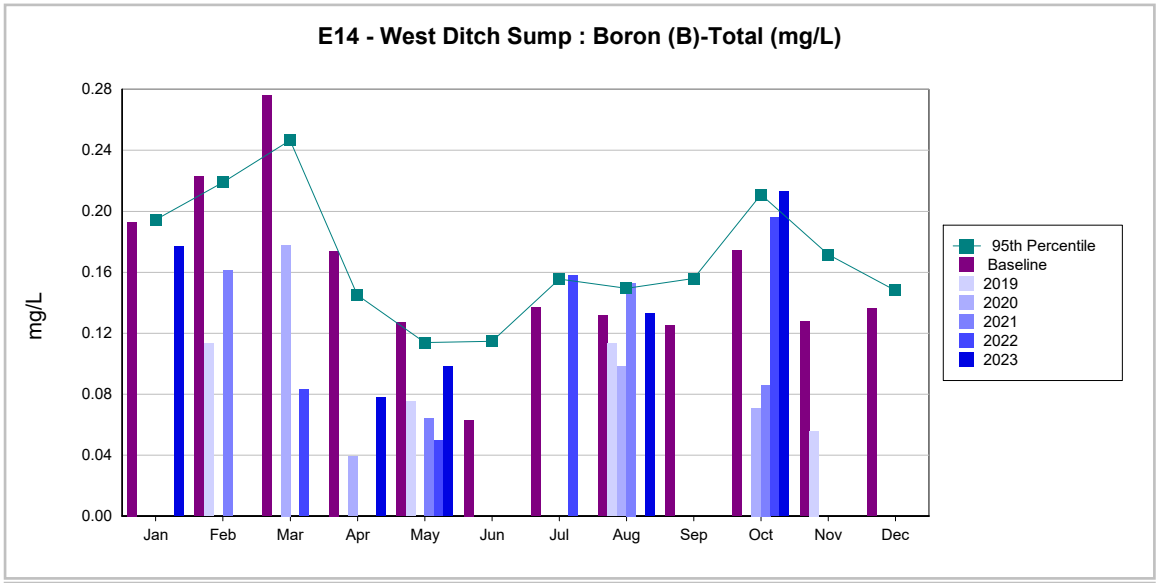
Water Quality Report

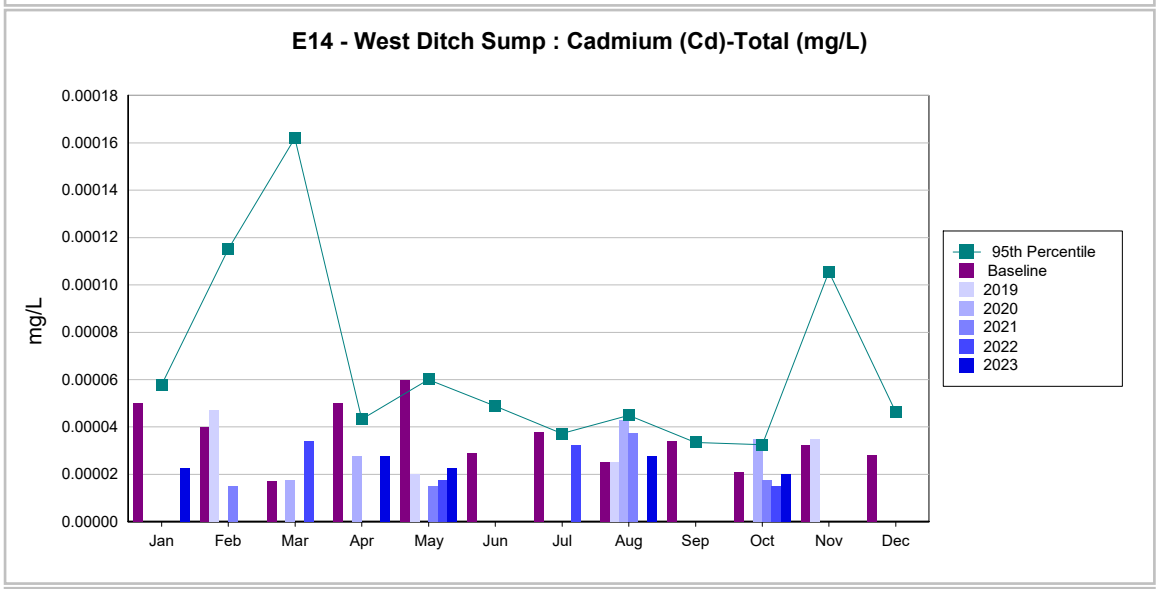
Annual Report Drainage Water

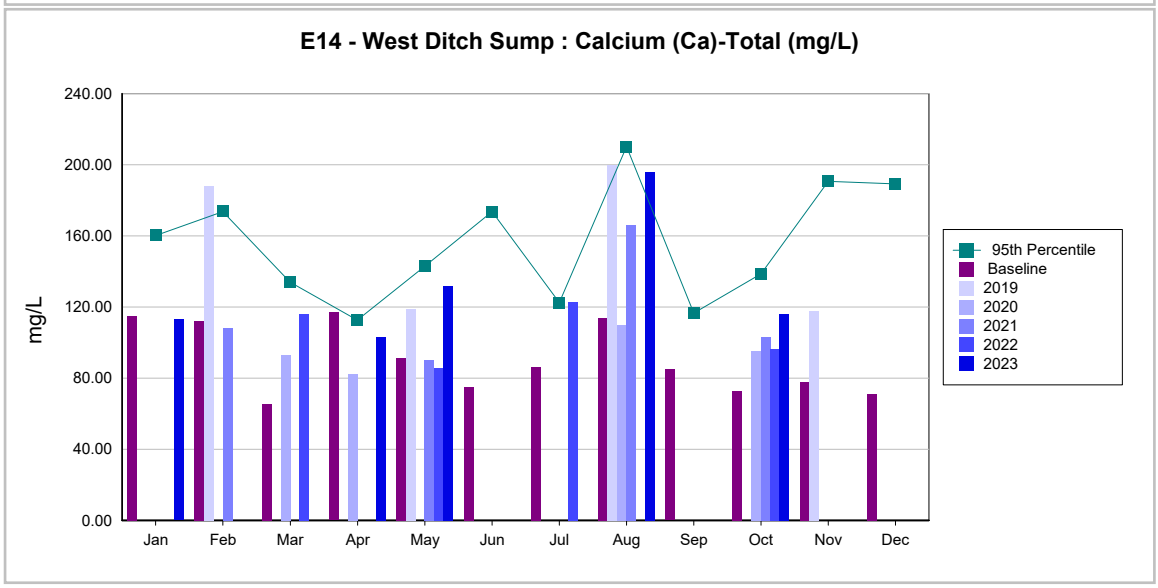
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







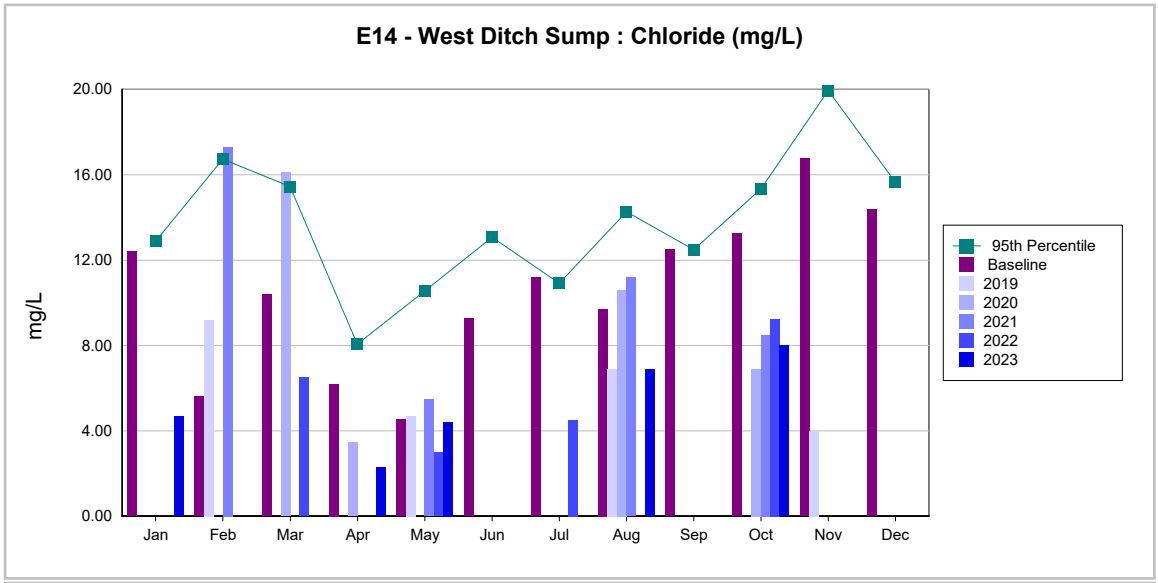
Water Quality Report

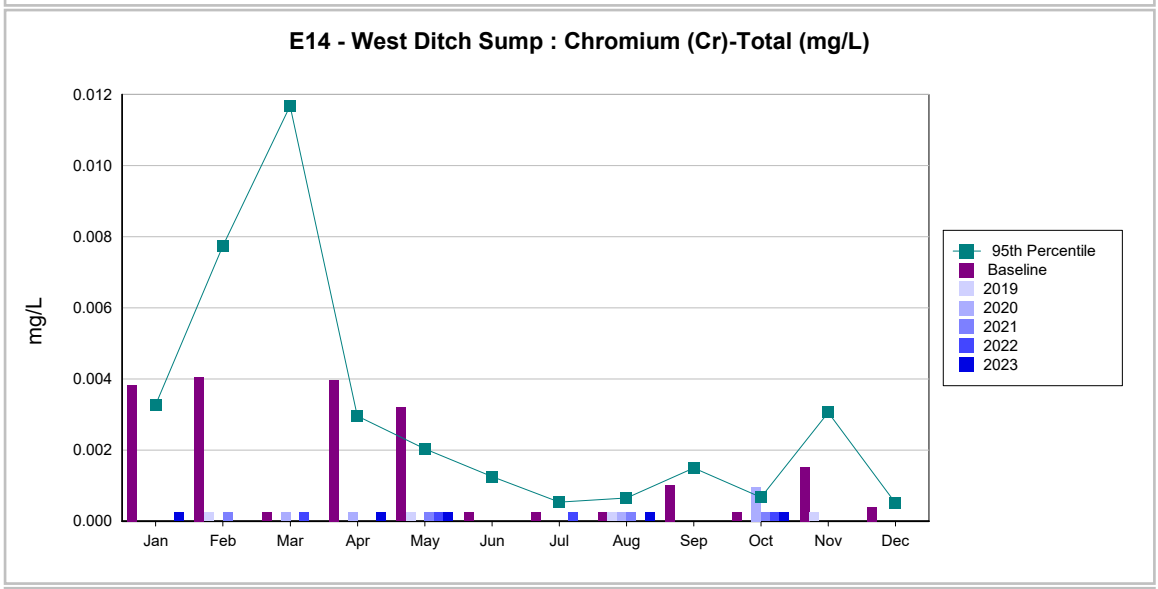
Annual Report Drainage Water

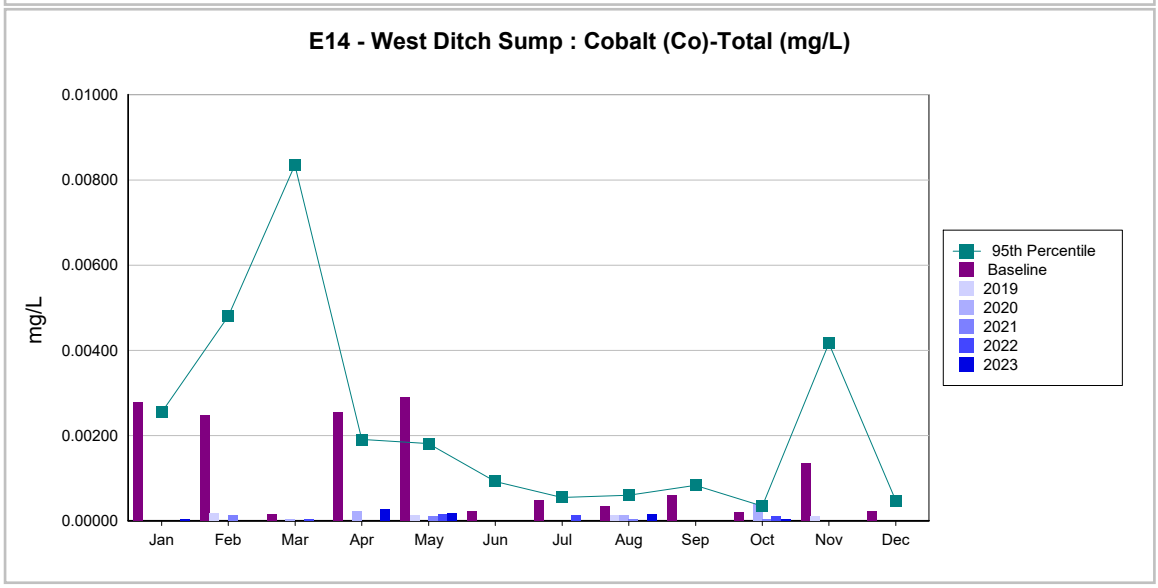
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







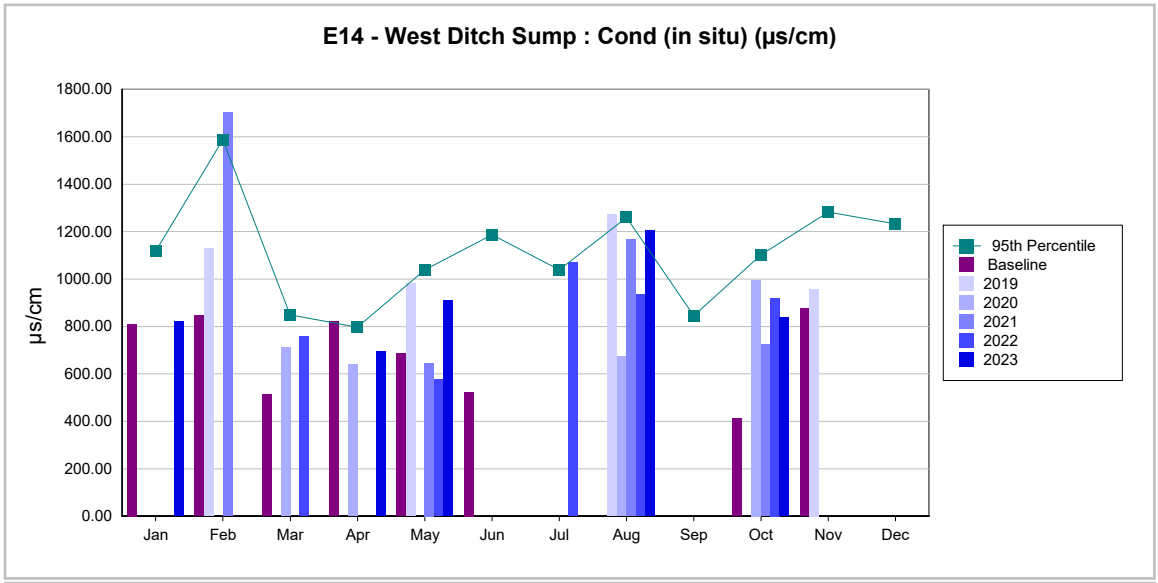
Water Quality Report

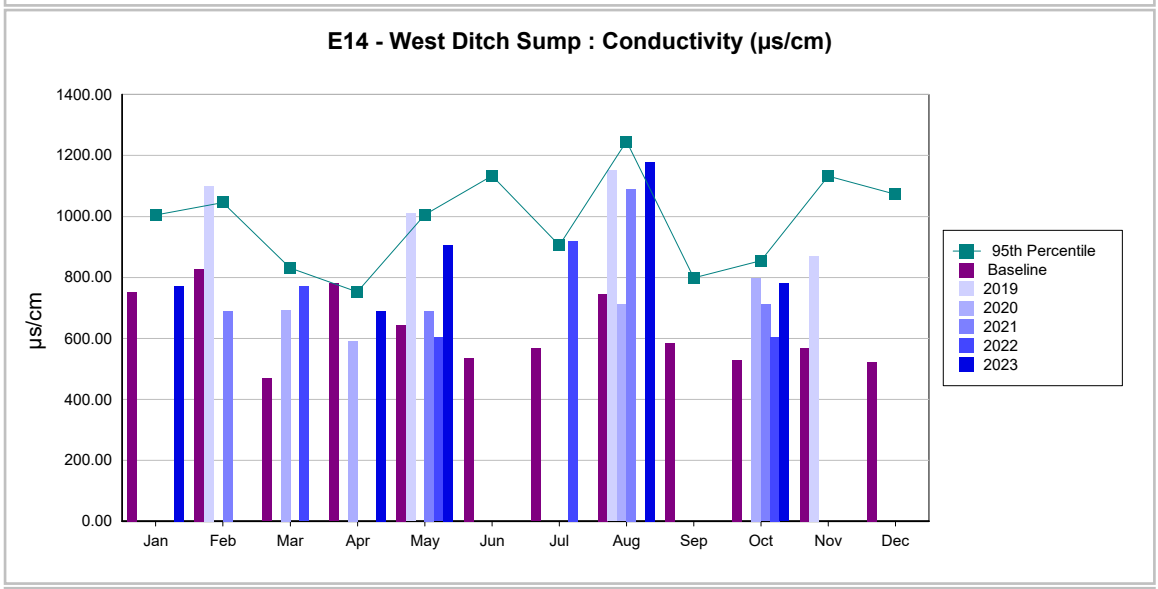
Annual Report Drainage Water

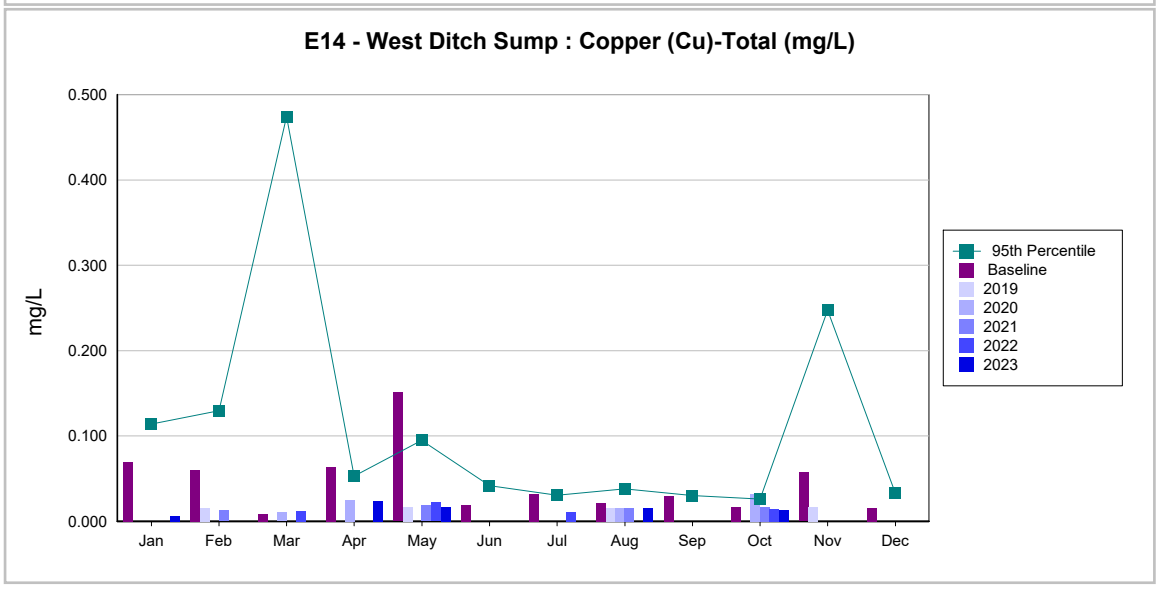
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







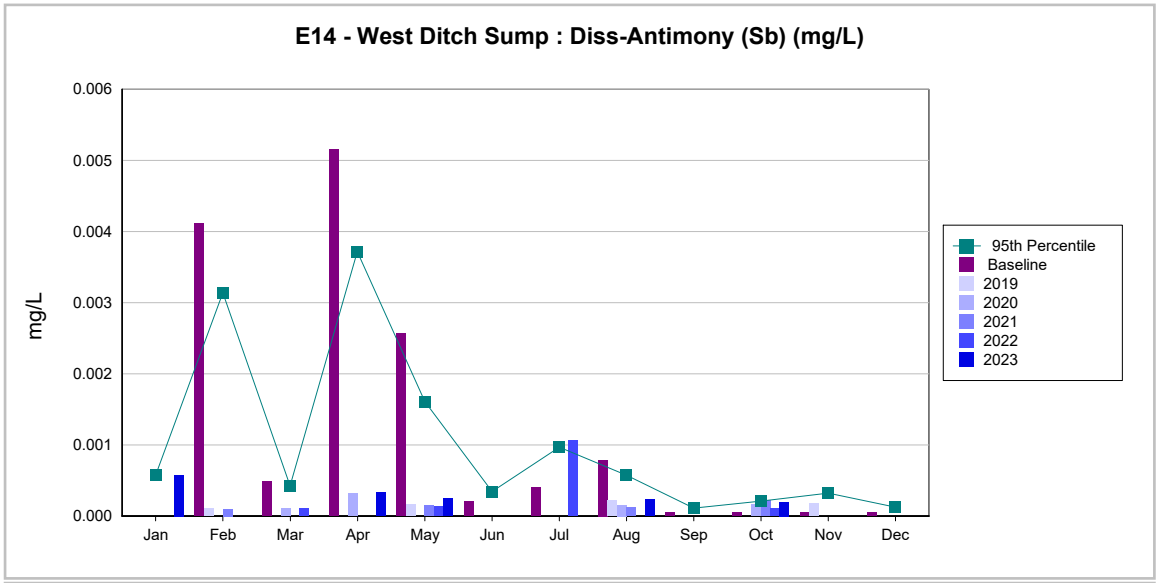
Water Quality Report

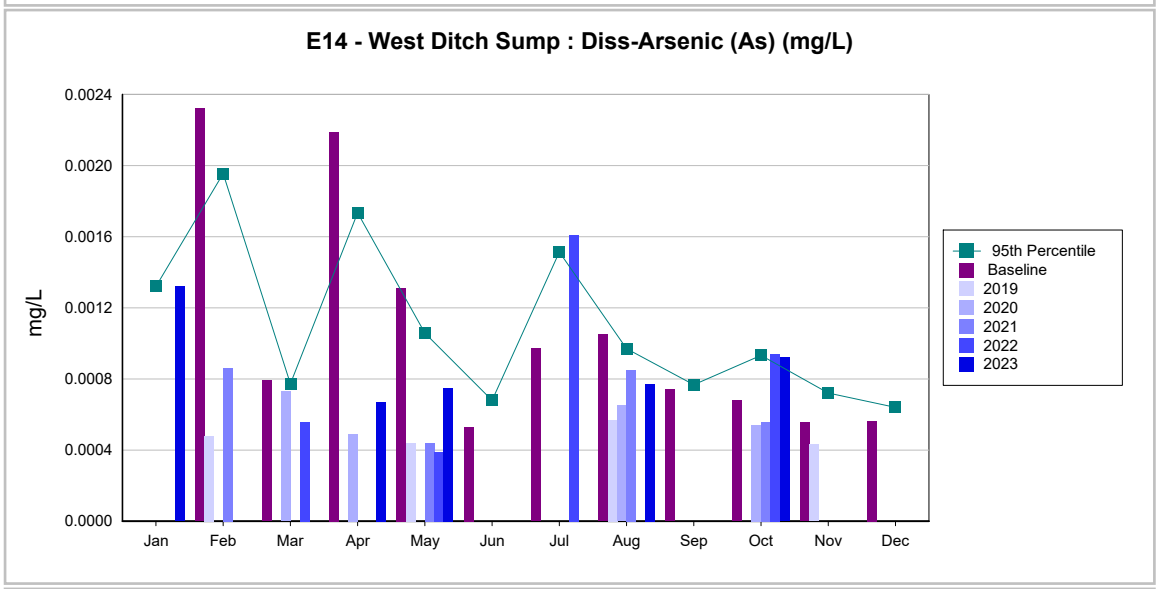
Annual Report Drainage Water

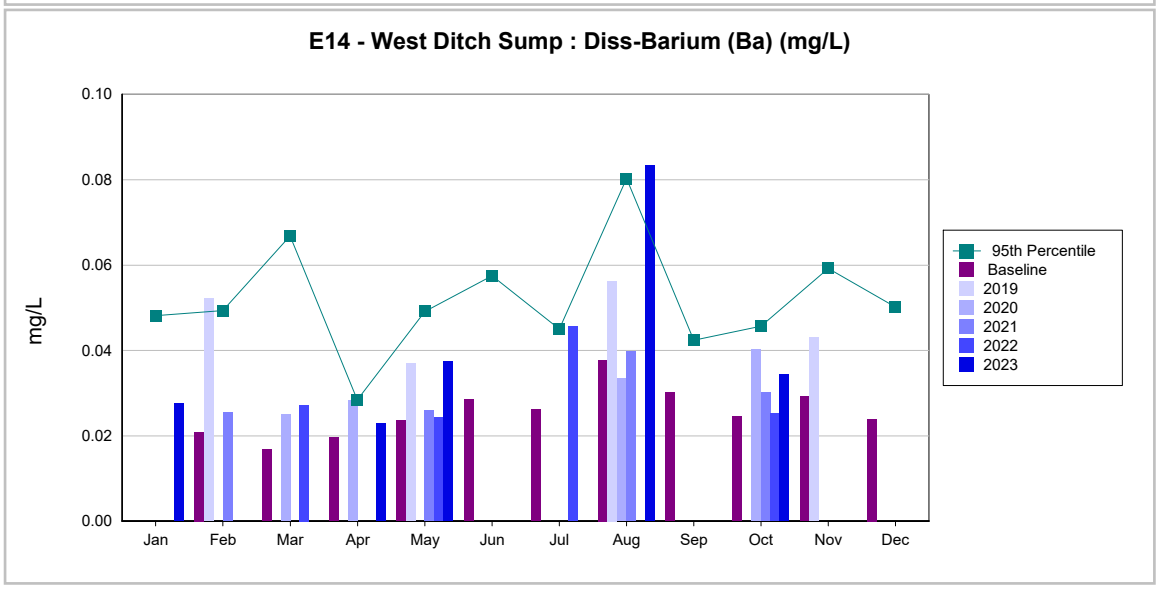
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







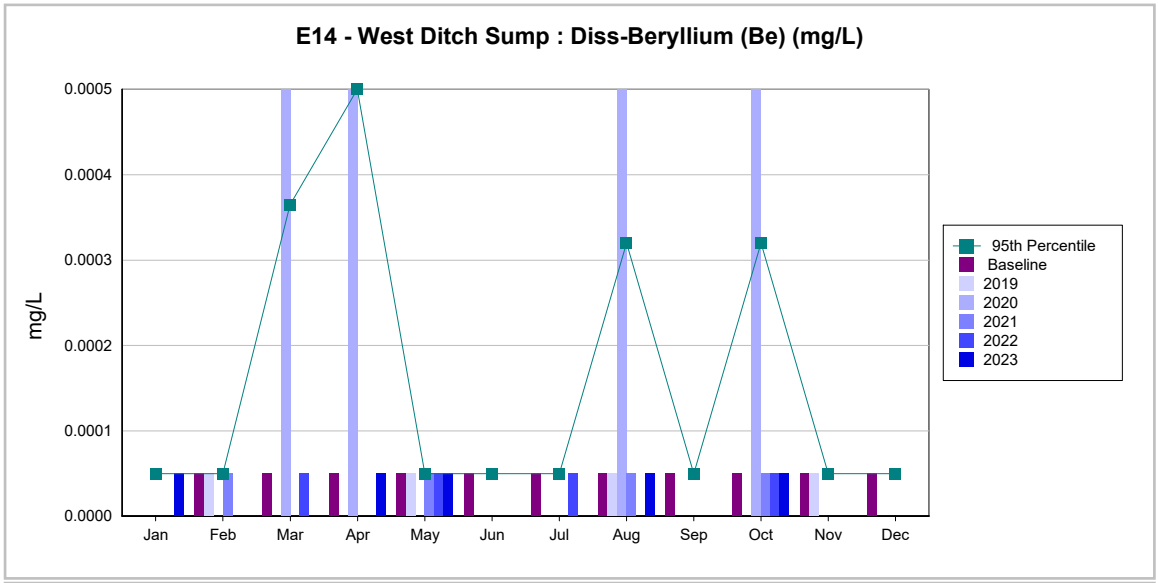
Water Quality Report

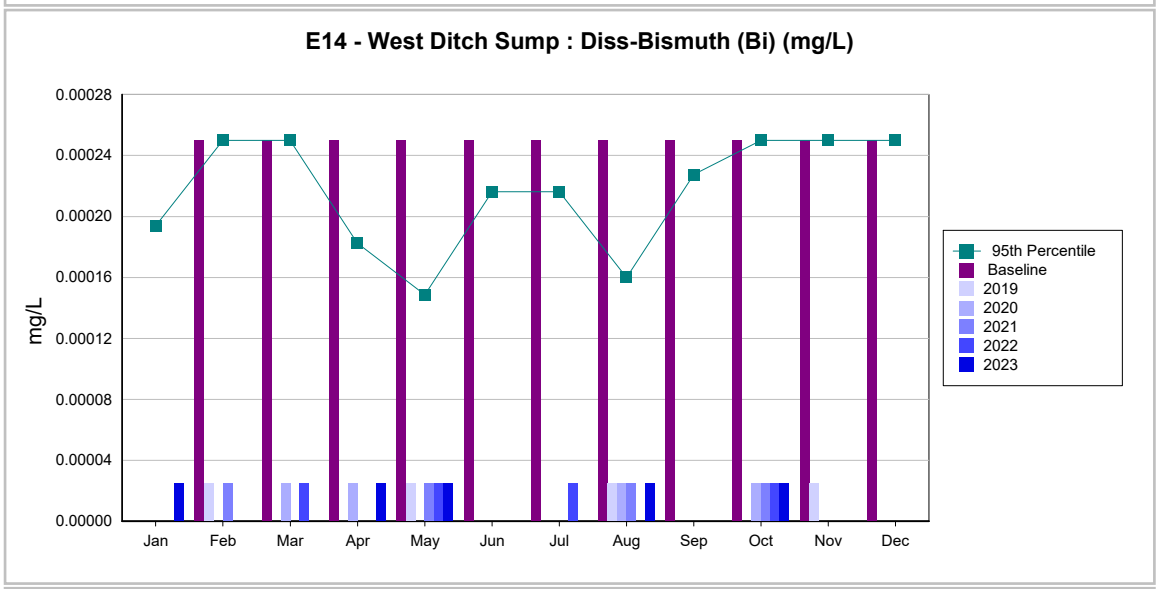
Annual Report Drainage Water

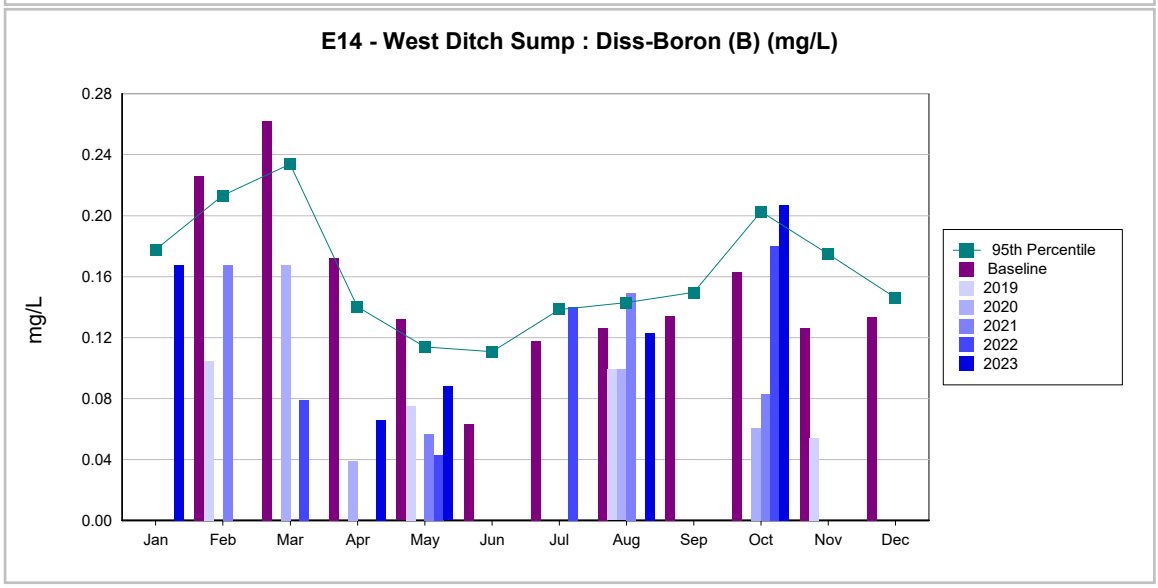
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

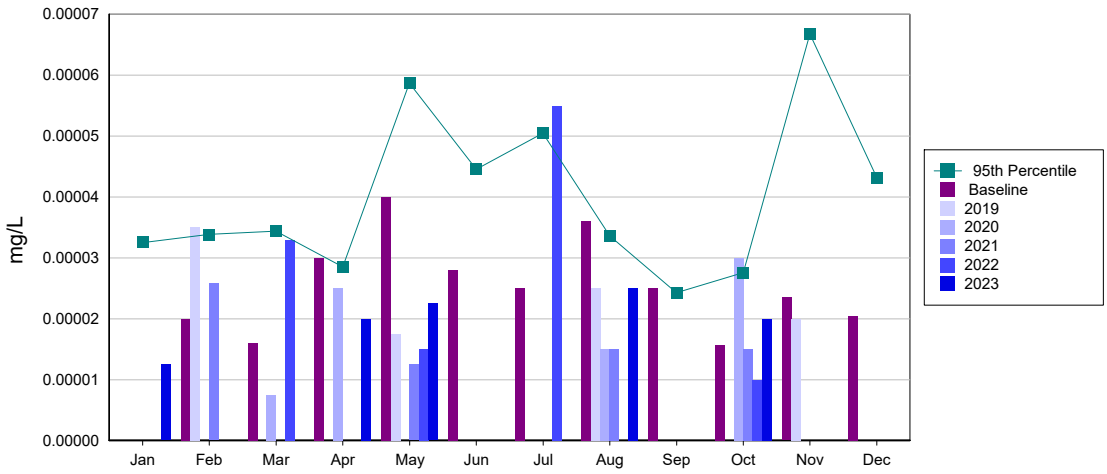
Annual Report Drainage Water

Mount Polley

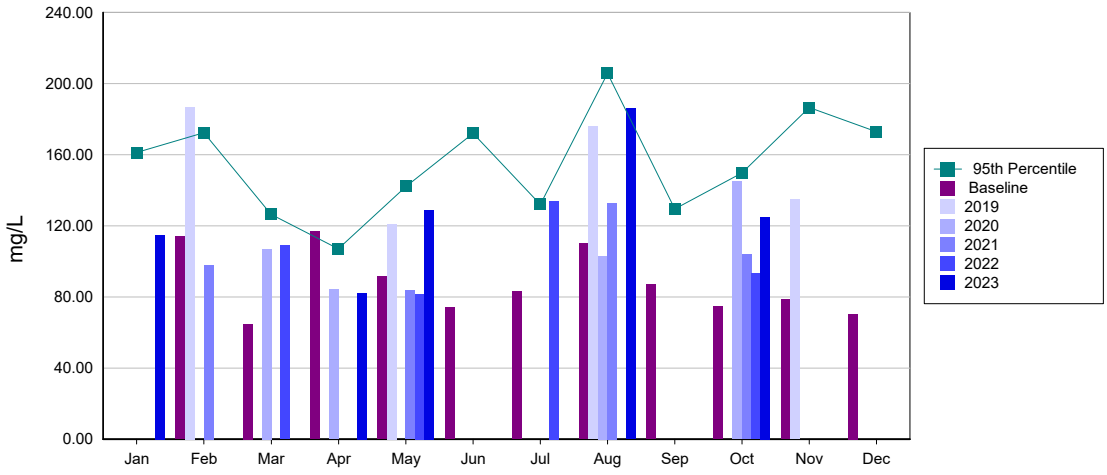
Mining Corporation

IMPERIAL METALS CORPORATION

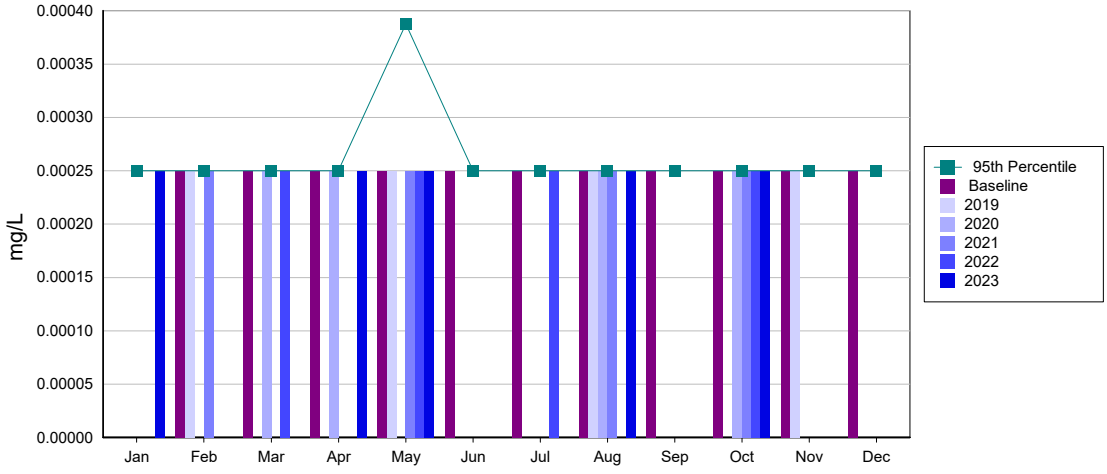
E14 - West Ditch Sump : Diss-Cadmium (Cd) (mg/L)



E14 - West Ditch Sump : Diss-Calcium (Ca) (mg/L)



E14 - West Ditch Sump : Diss-Chromium (Cr) (mg/L)



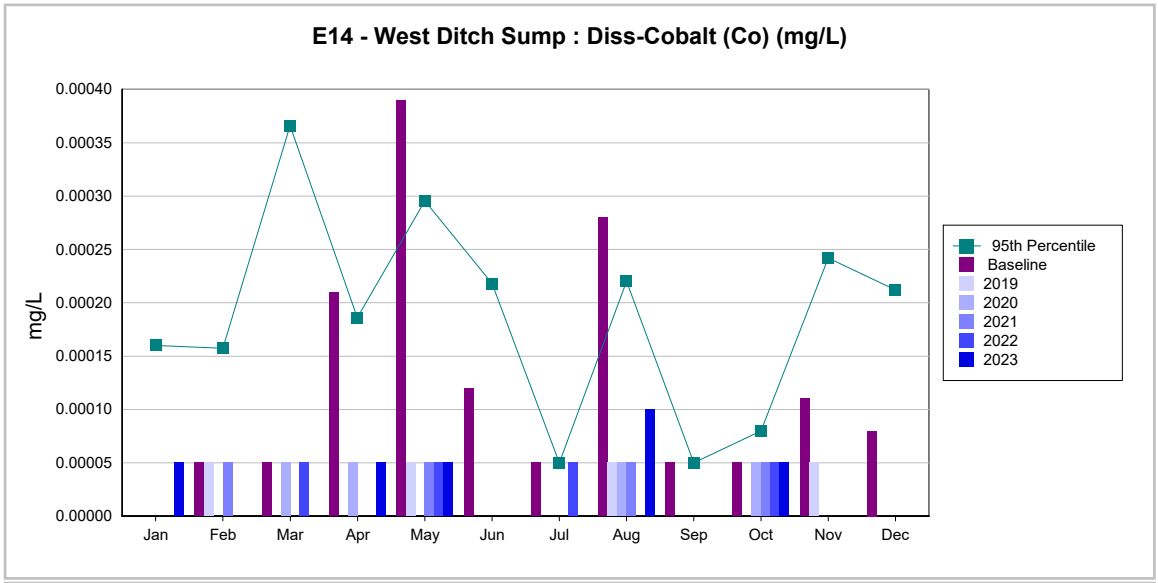
Water Quality Report

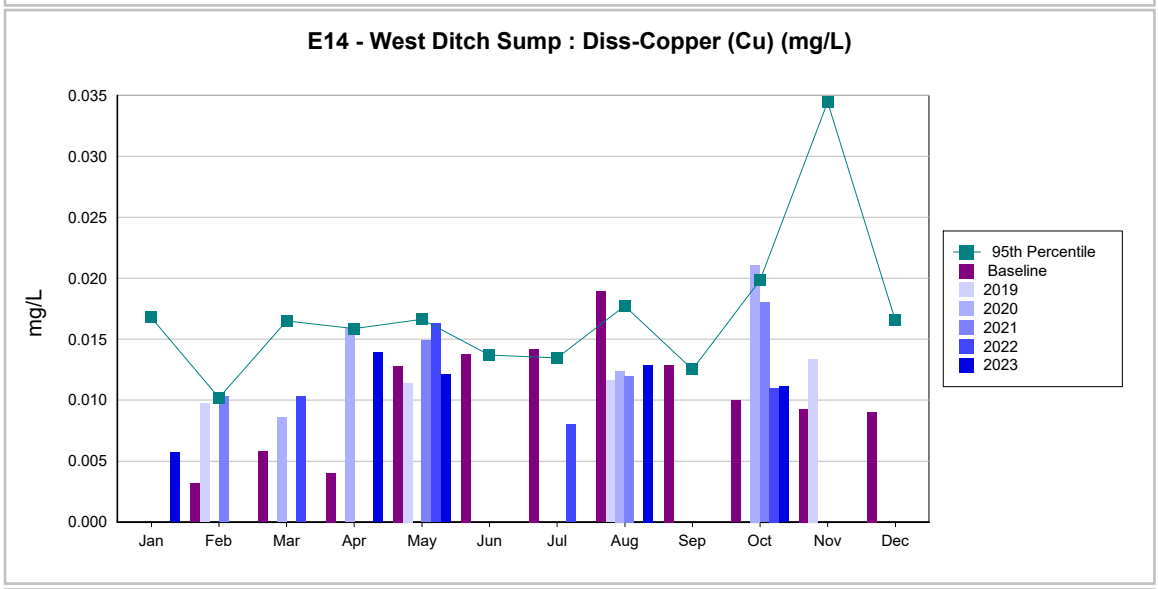
Annual Report Drainage Water

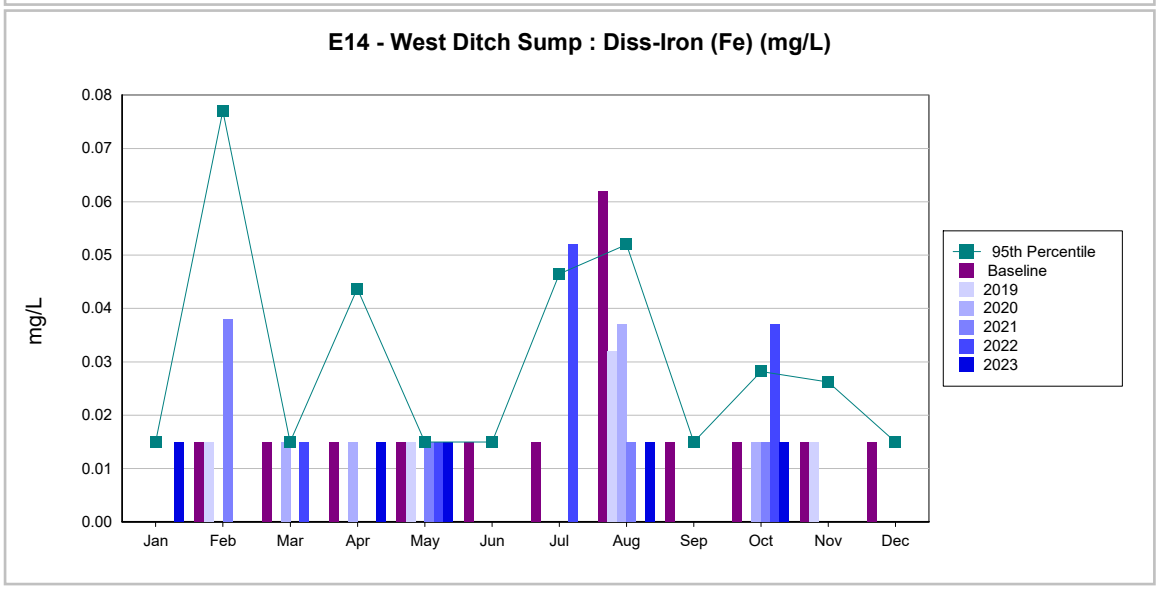
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







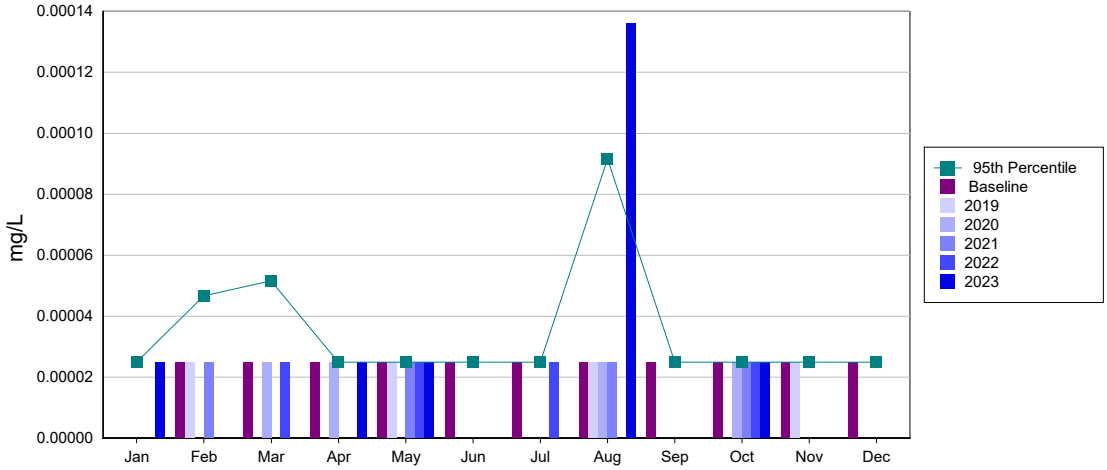
Water Quality Report

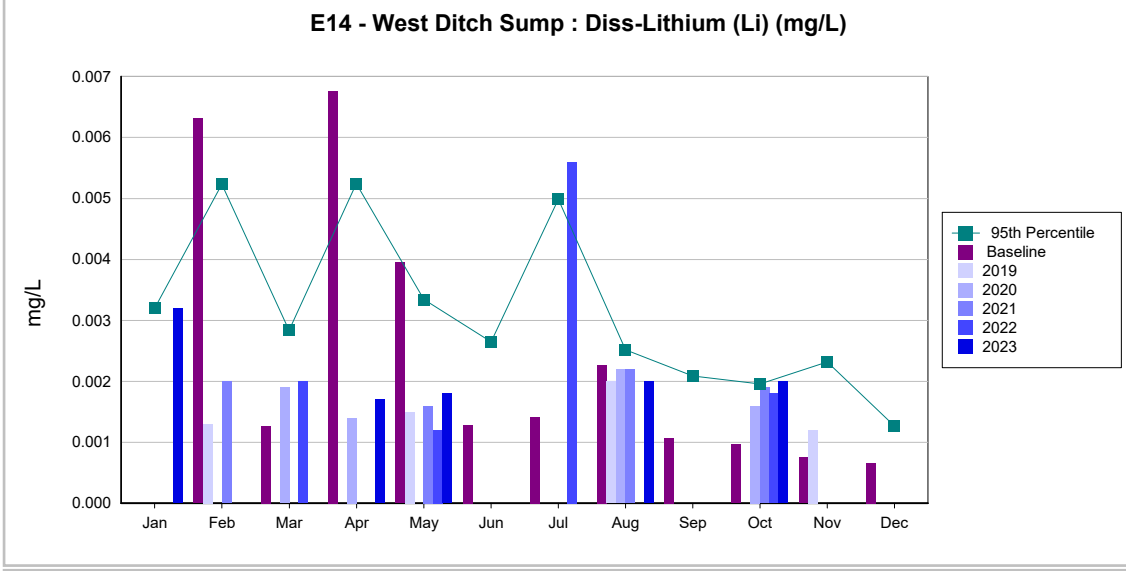
Annual Report Drainage Water

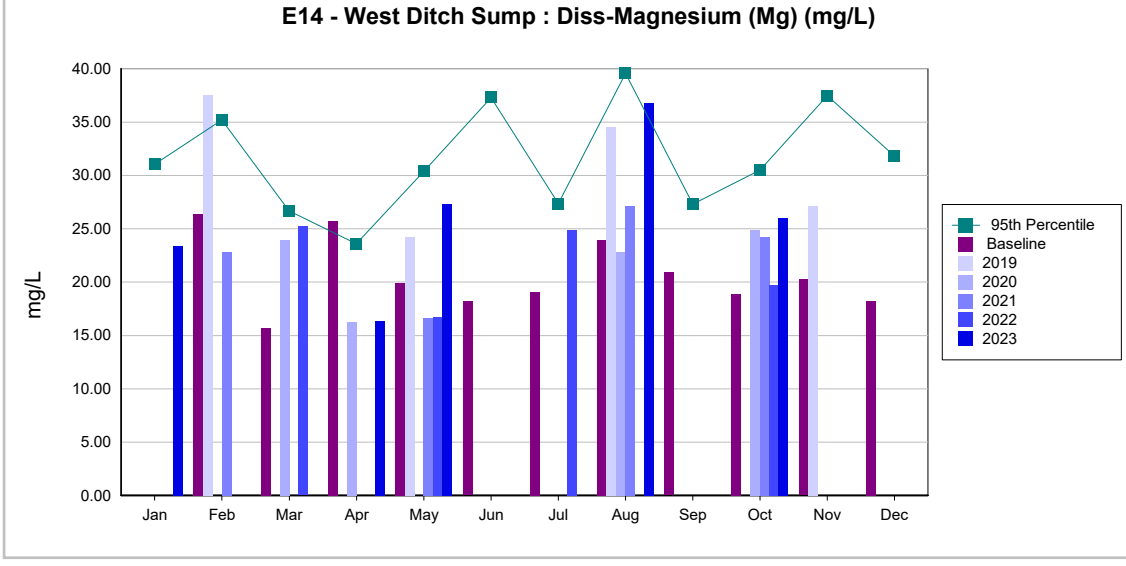
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







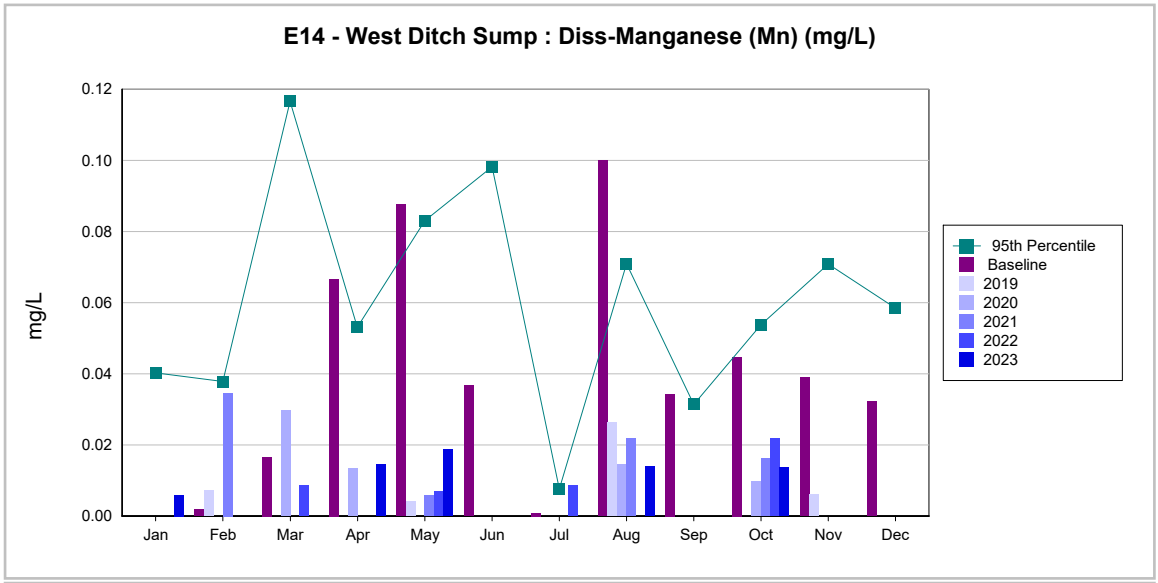
Water Quality Report

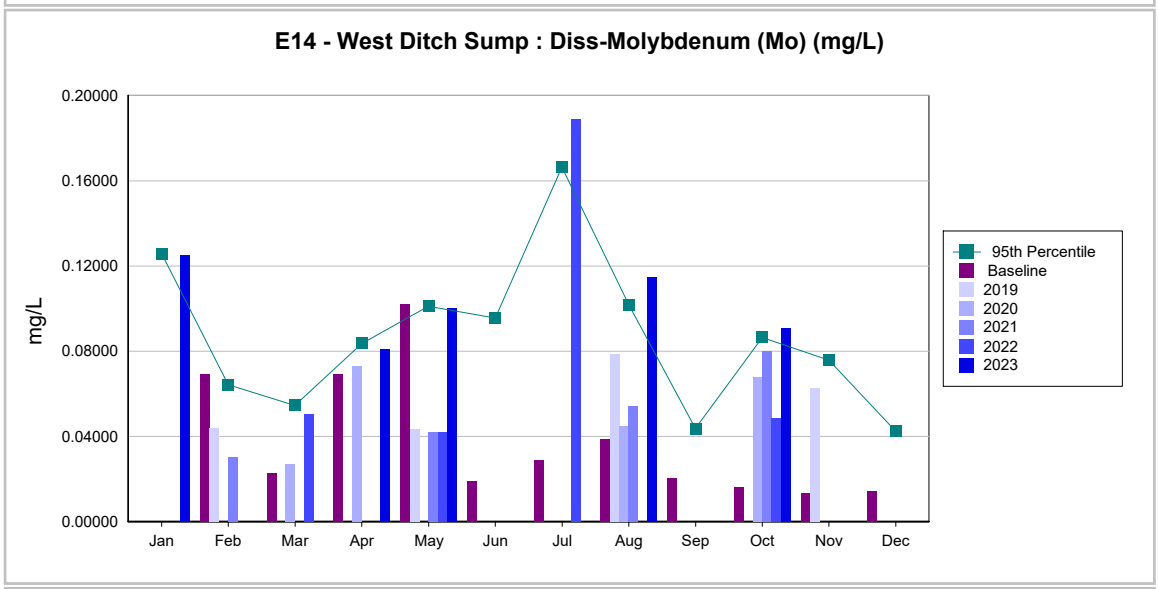
Annual Report Drainage Water

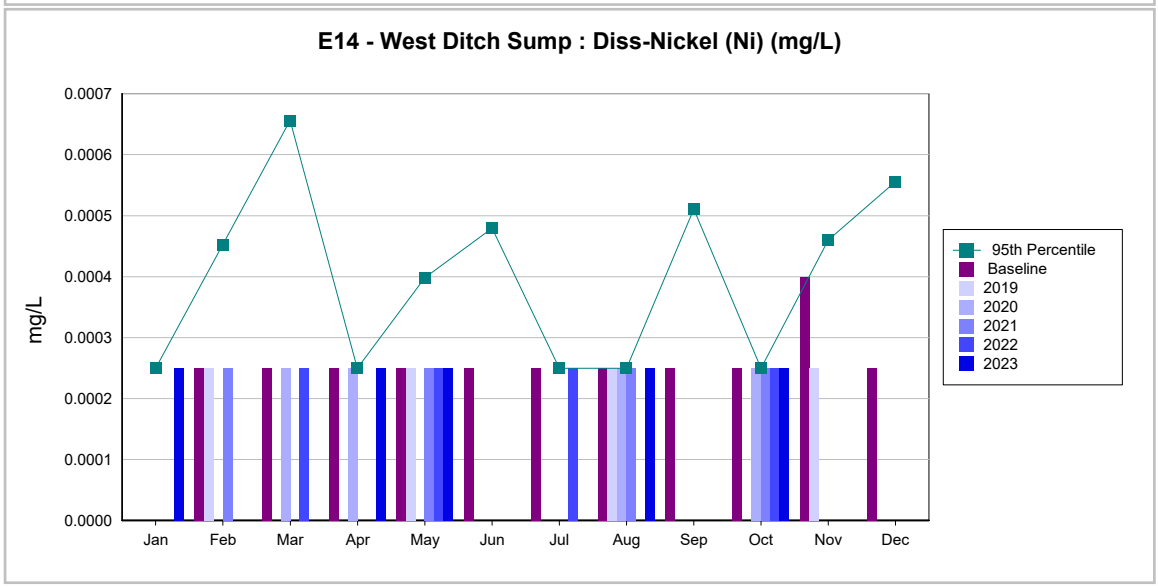
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







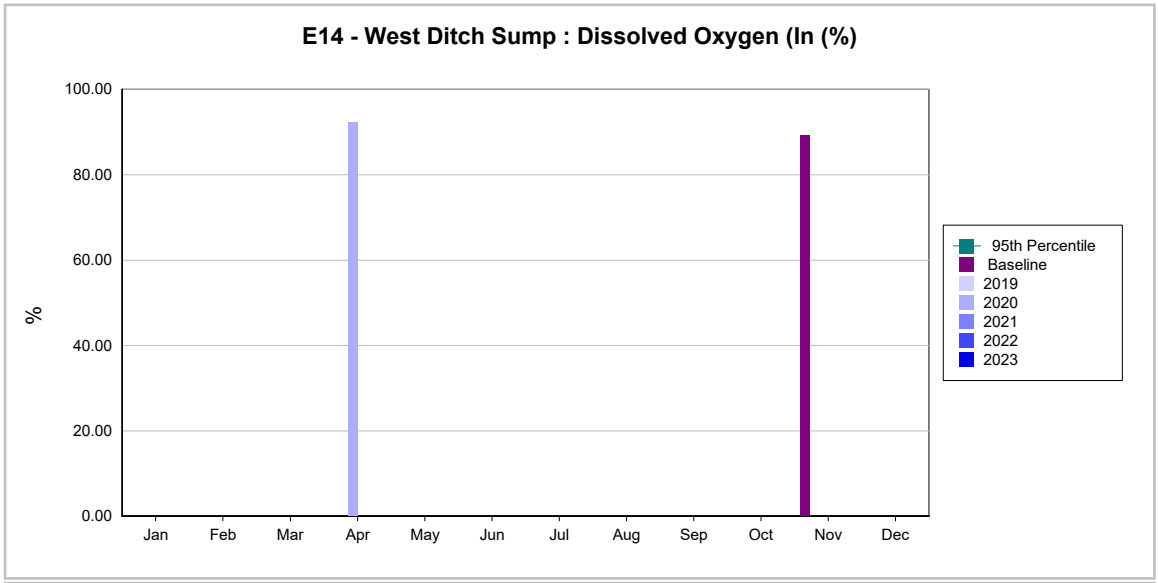
Water Quality Report

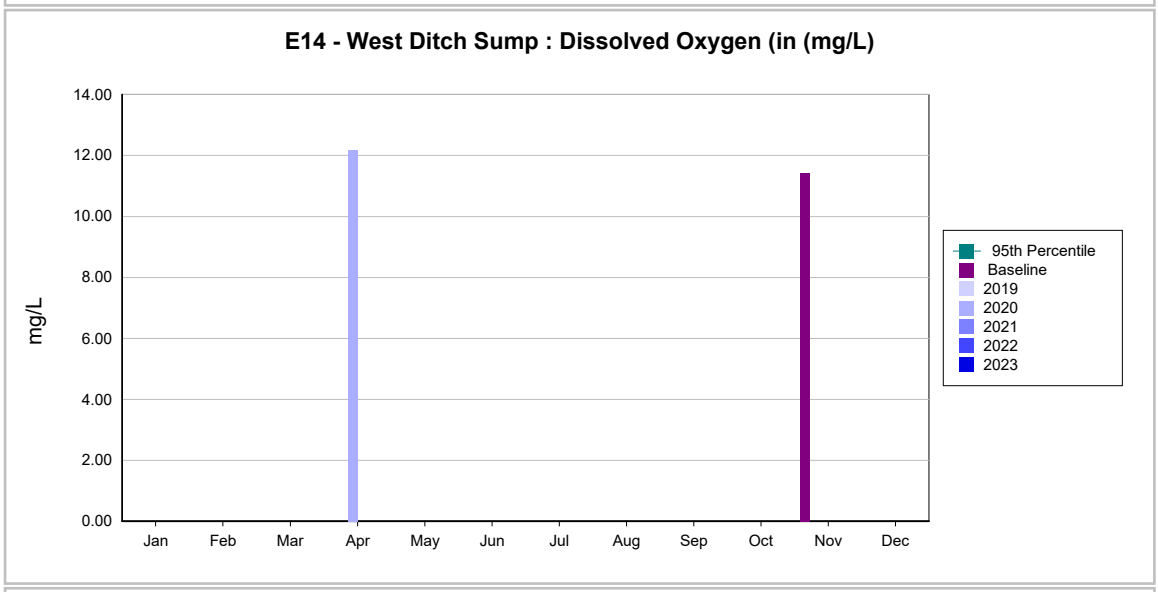
Annual Report Drainage Water

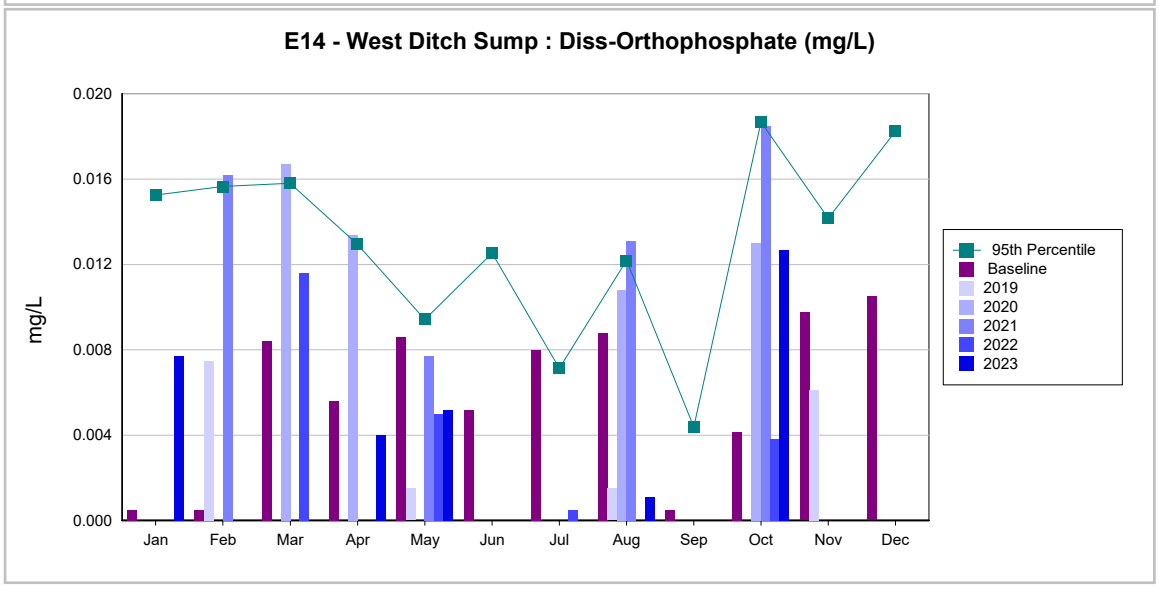
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







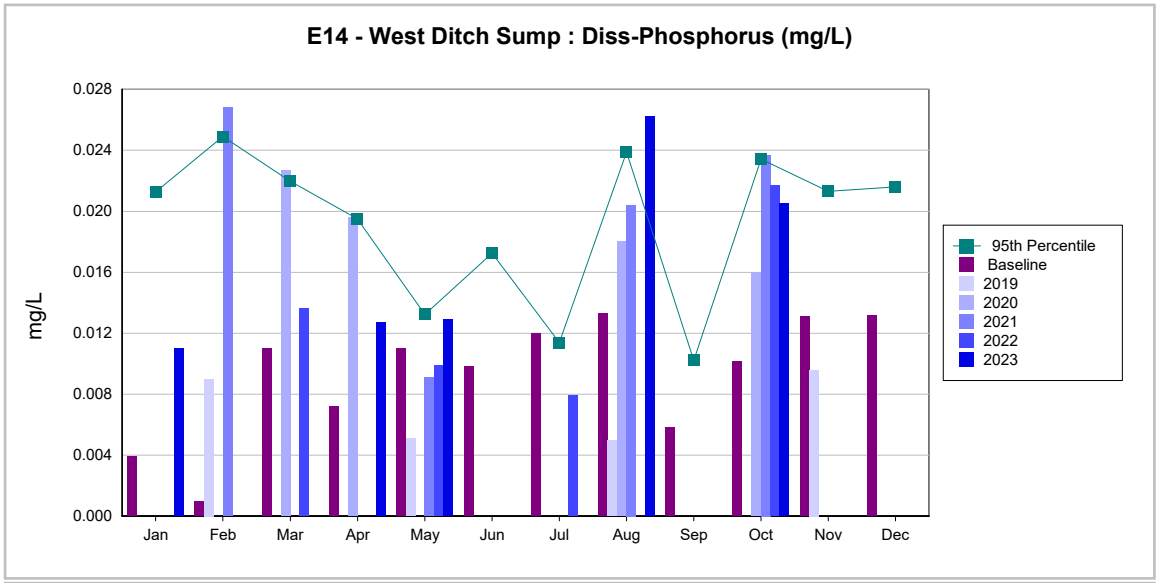
Water Quality Report

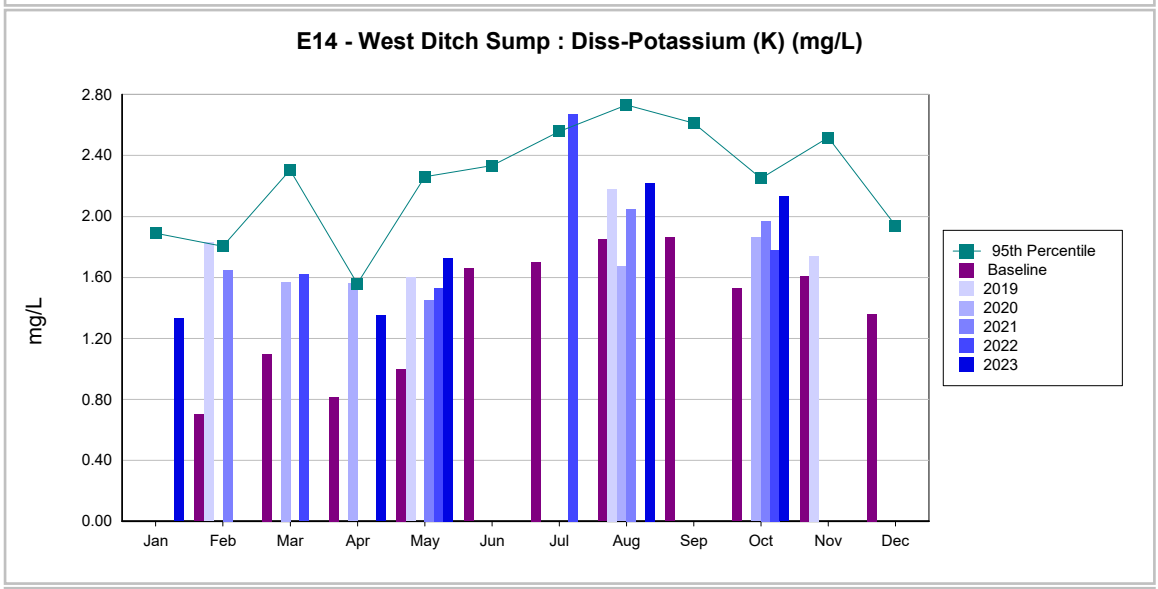
Annual Report Drainage Water

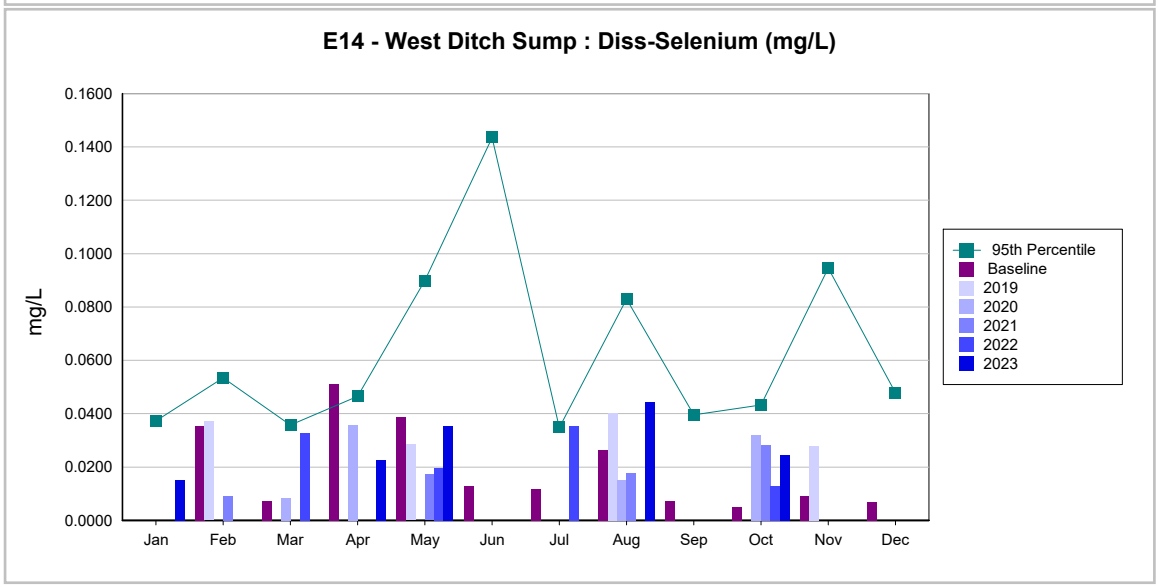
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







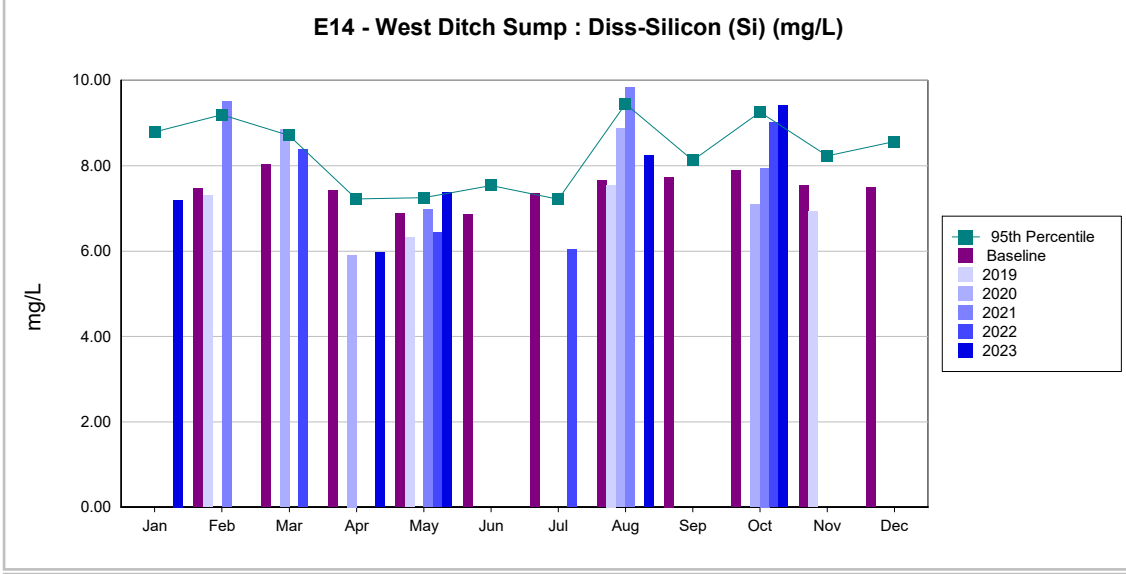
Water Quality Report

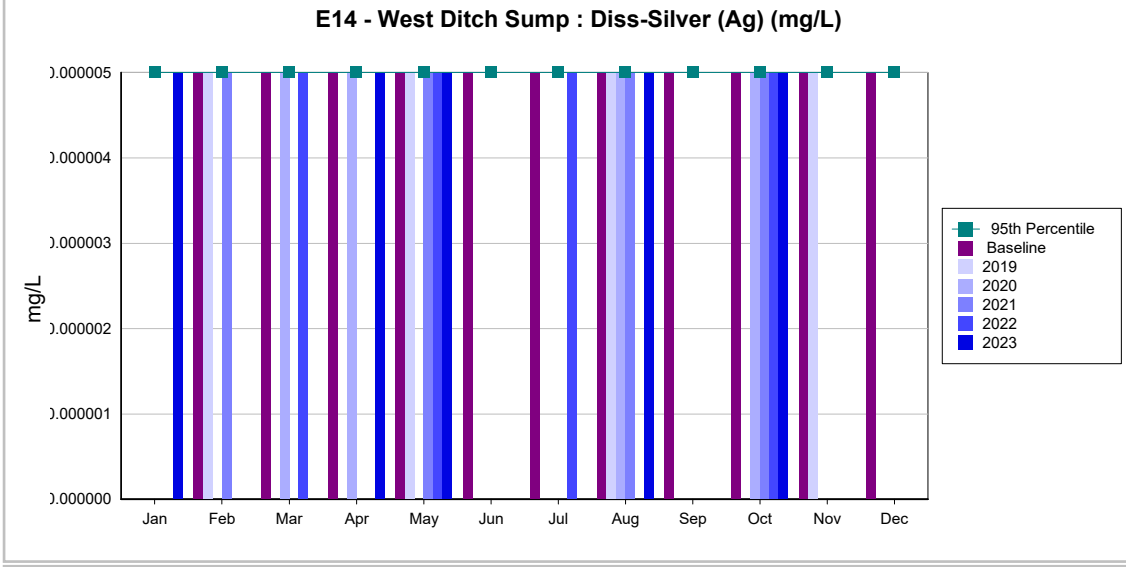
Annual Report Drainage Water

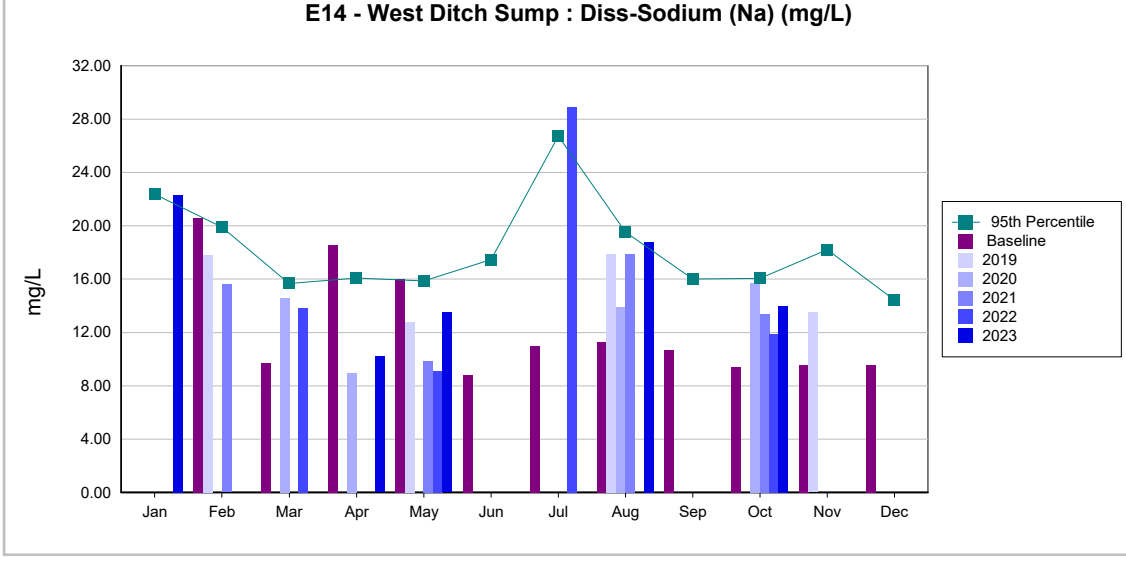
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







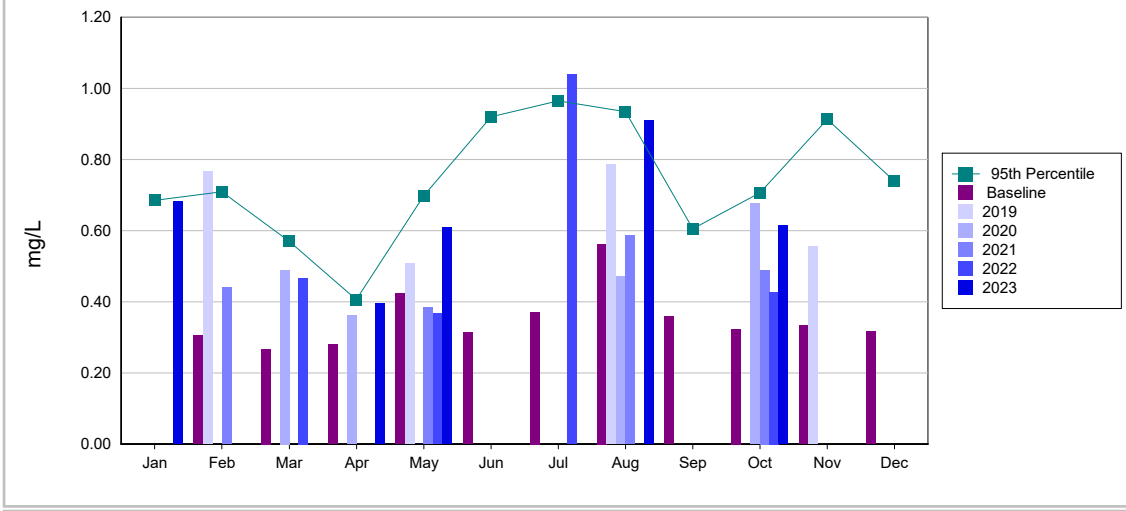
Water Quality Report

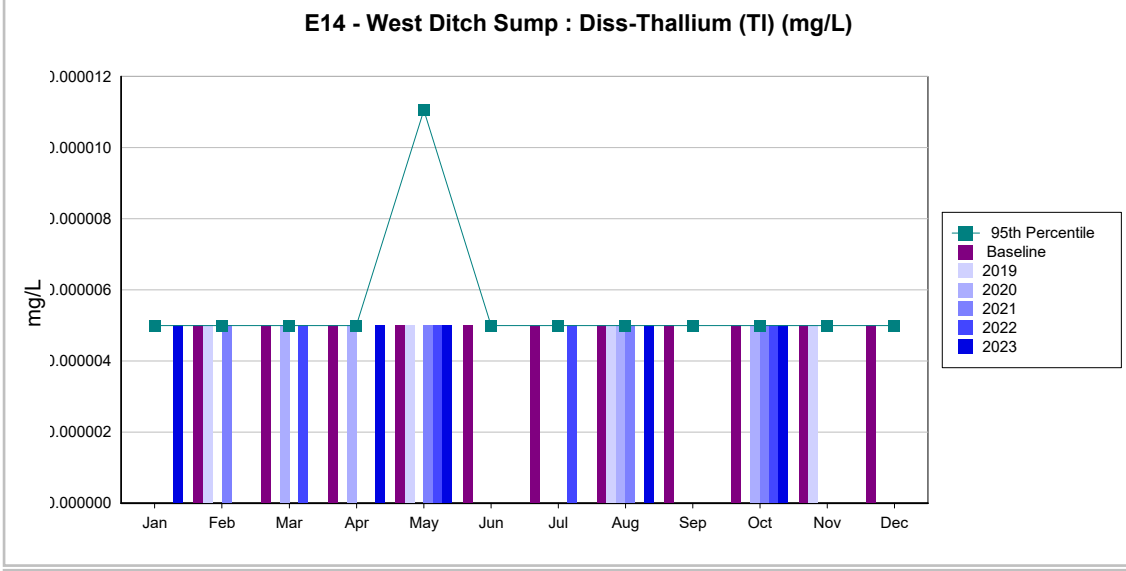
Annual Report Drainage Water

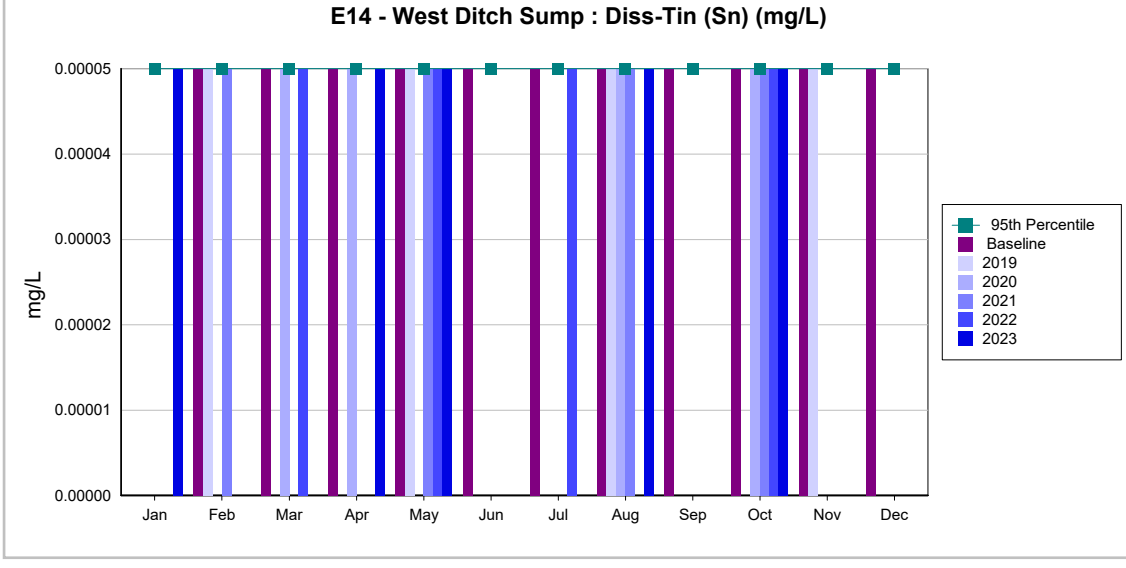
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







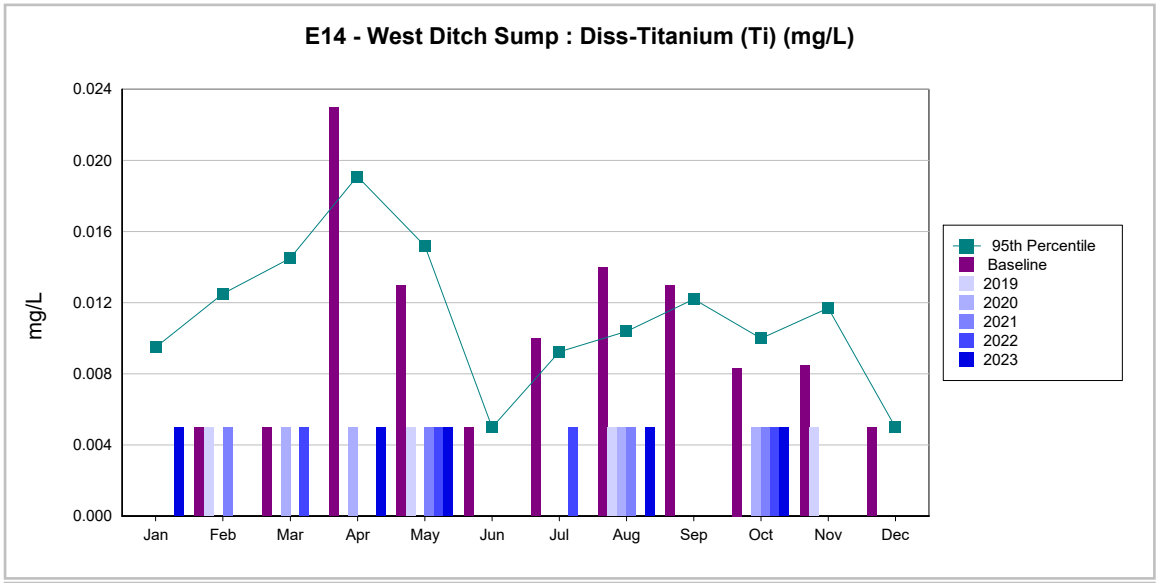
Water Quality Report

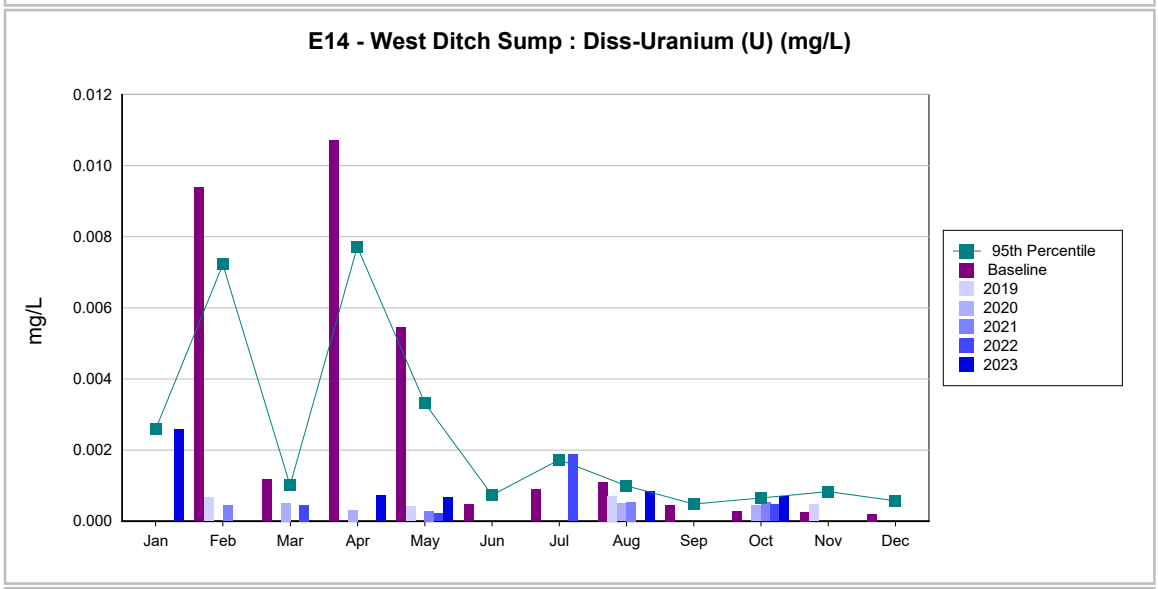
Annual Report Drainage Water

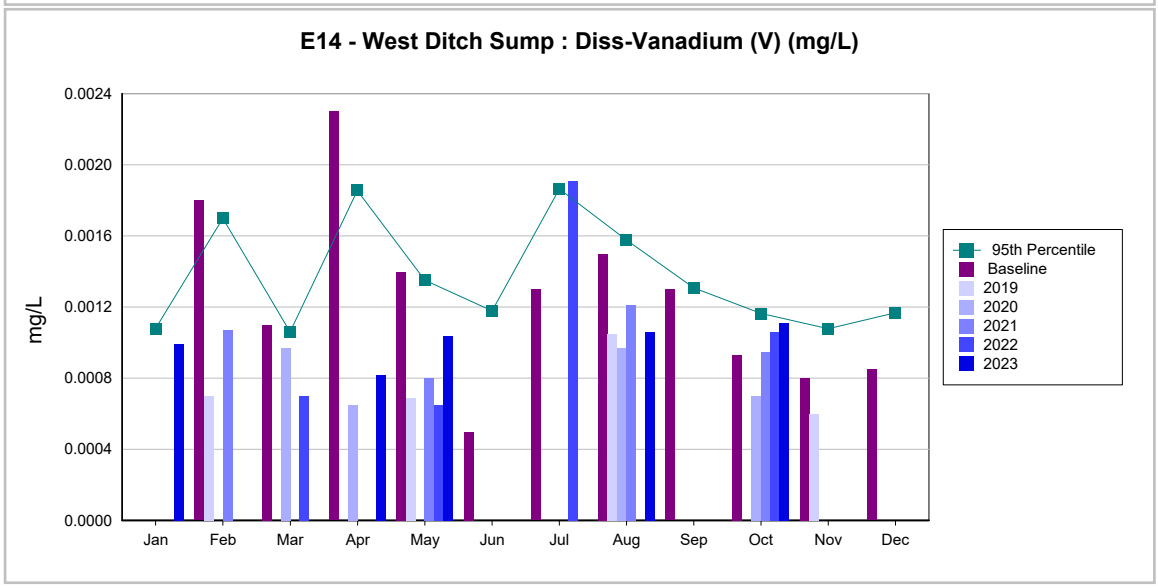
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







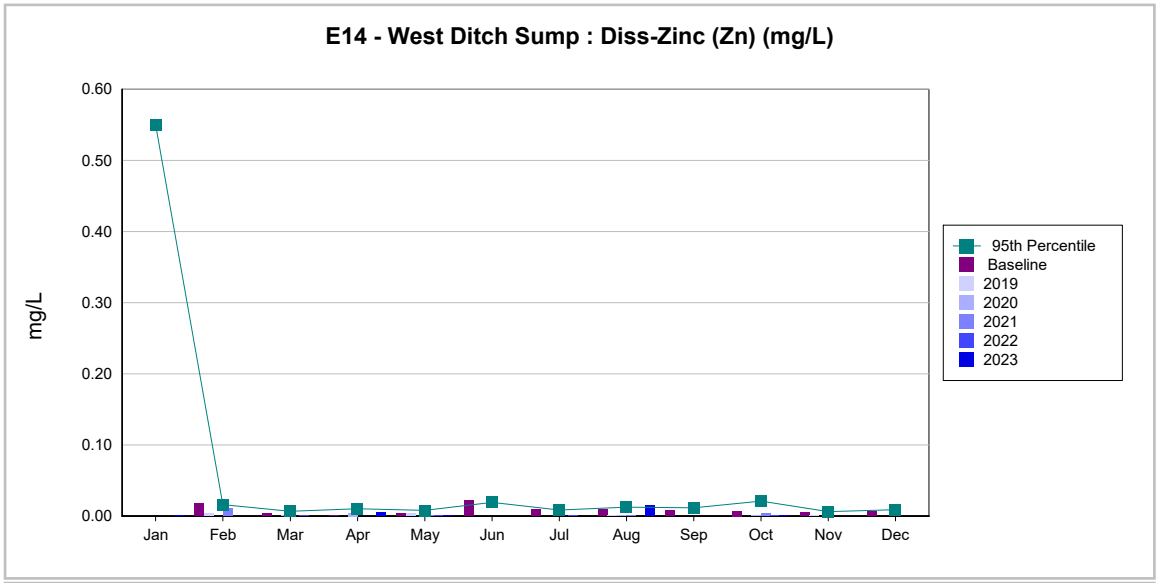
Water Quality Report

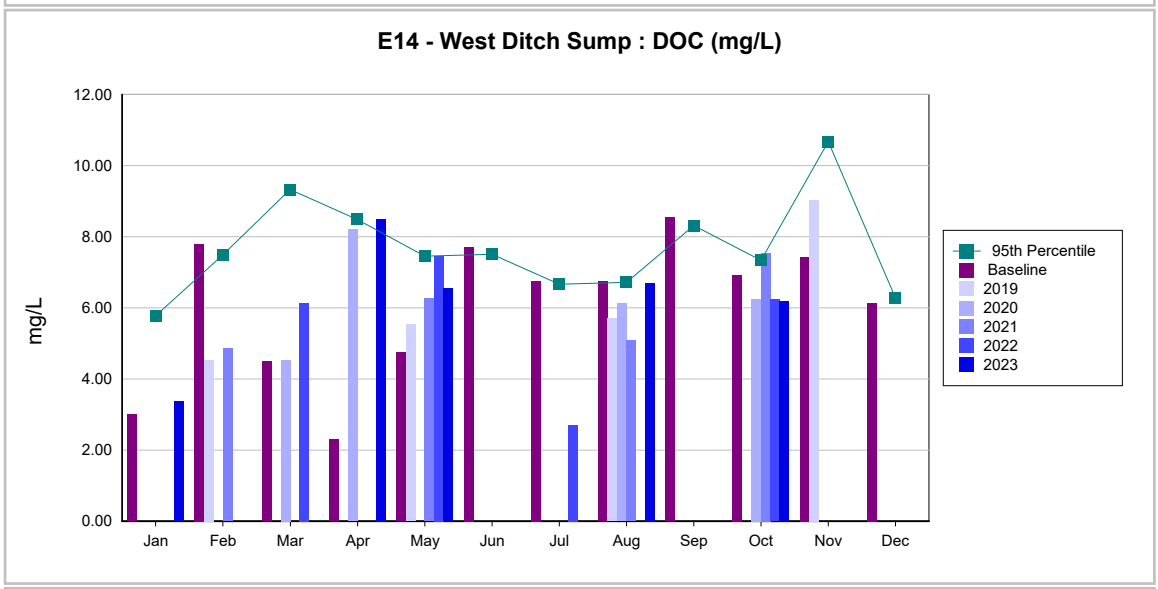
Annual Report Drainage Water

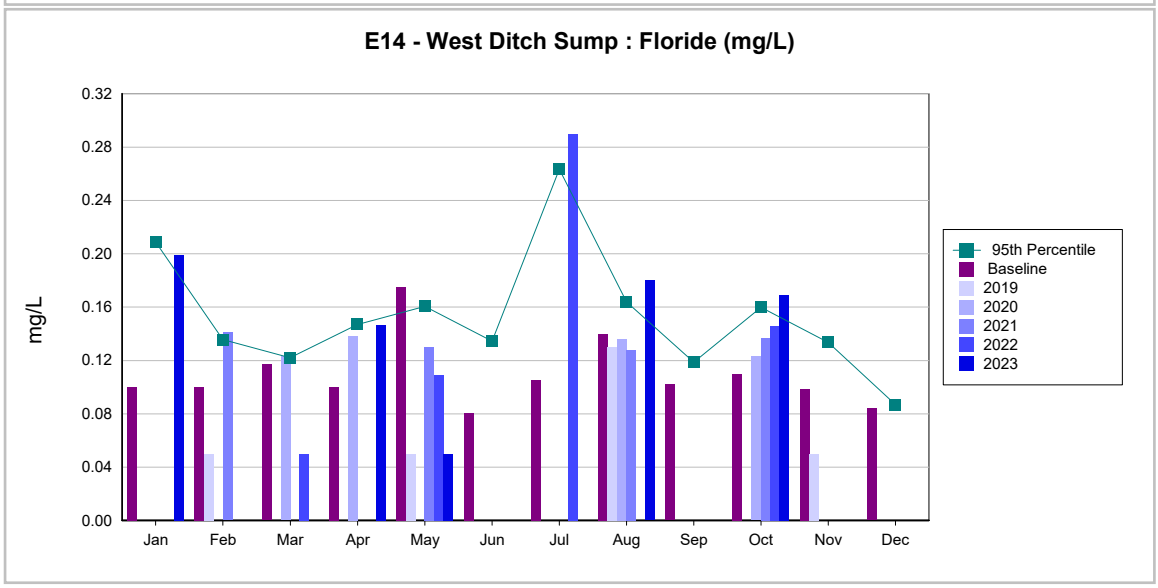
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







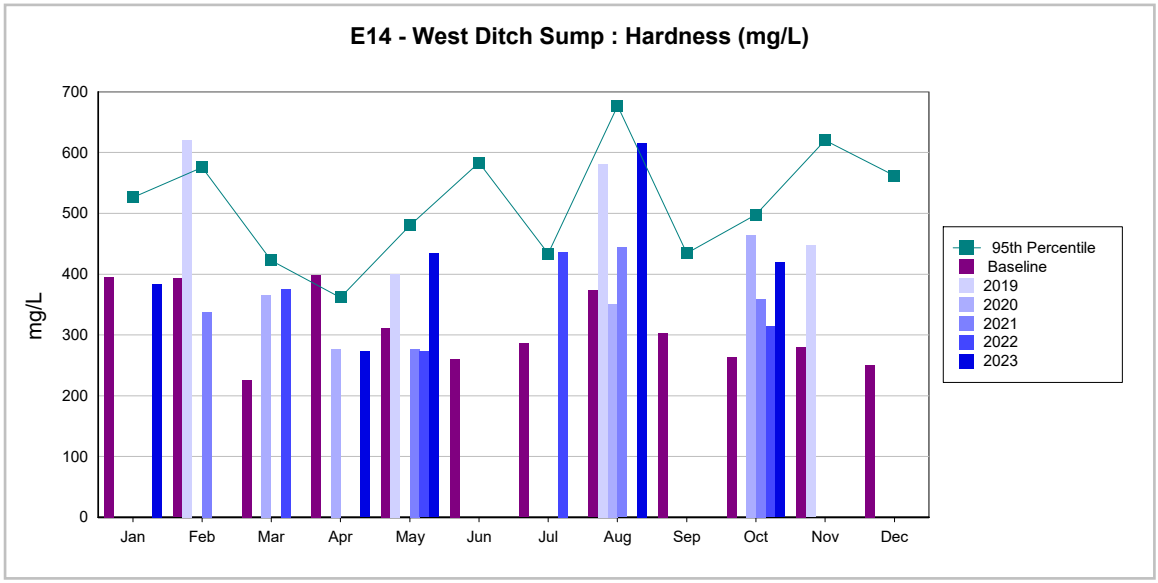
Water Quality Report

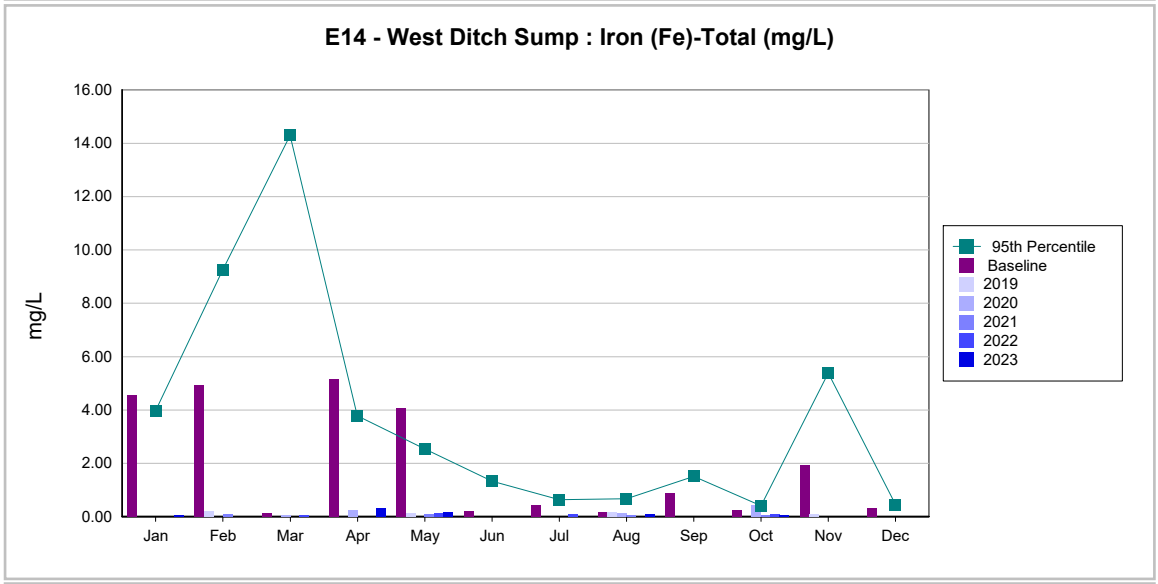
Annual Report Drainage Water

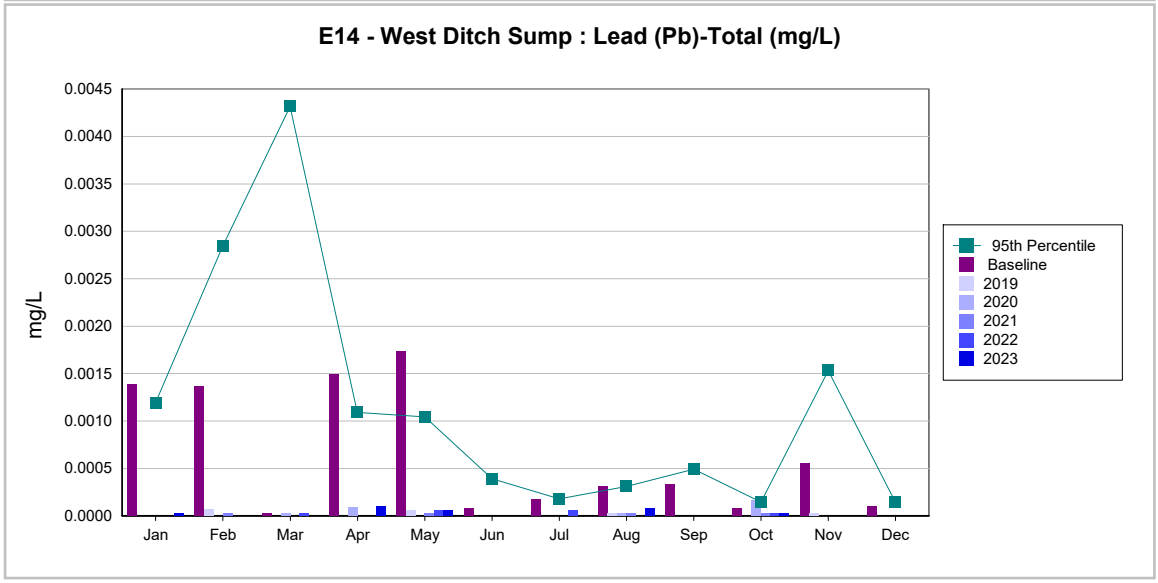
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







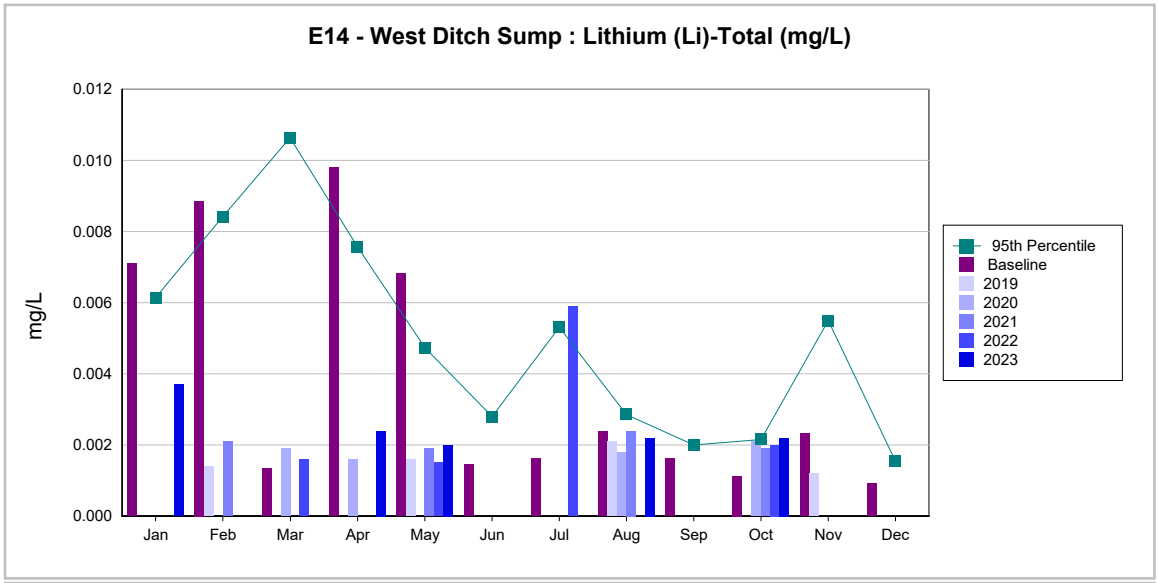
Water Quality Report

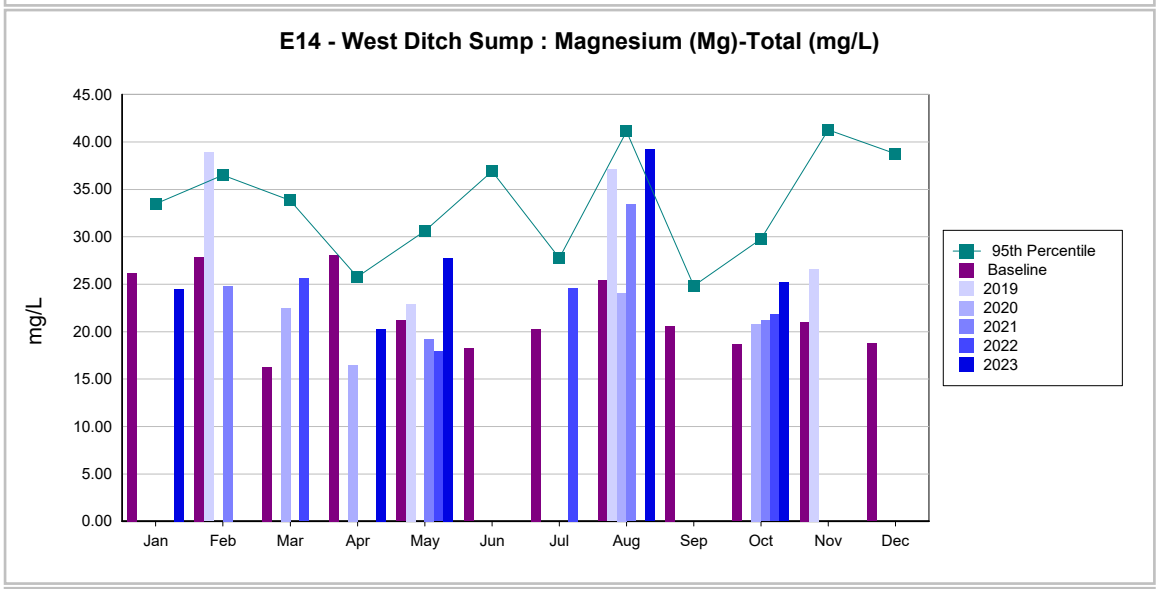
Annual Report Drainage Water

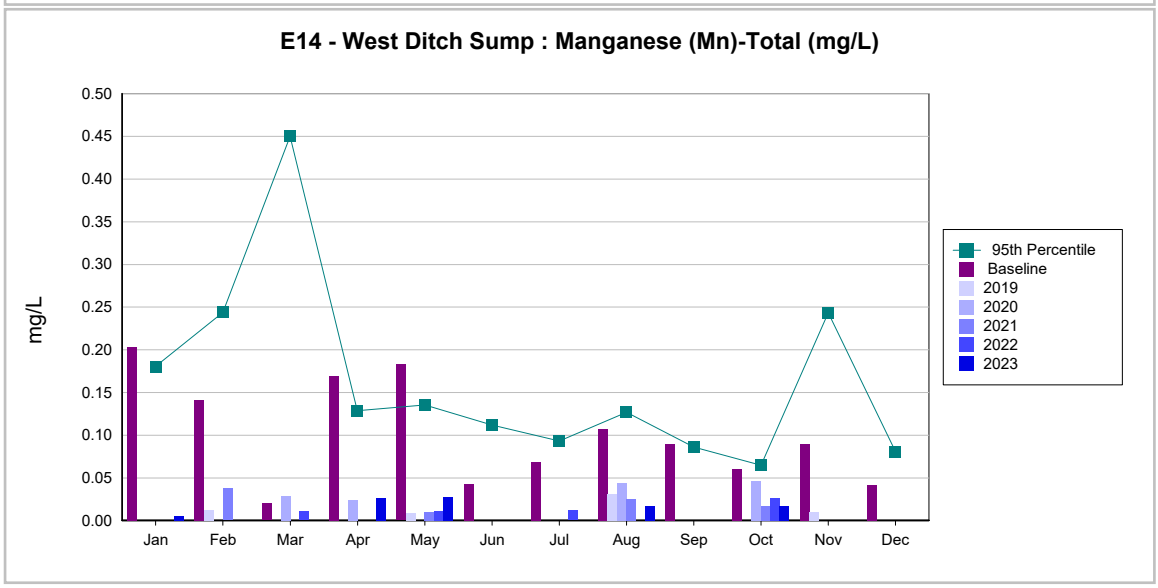
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







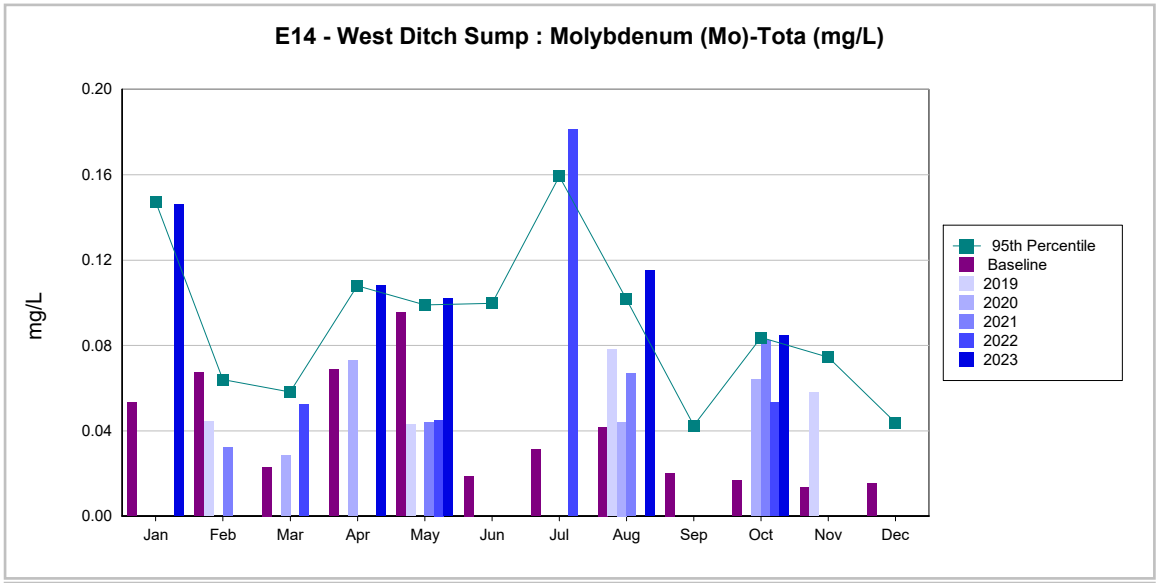
Water Quality Report

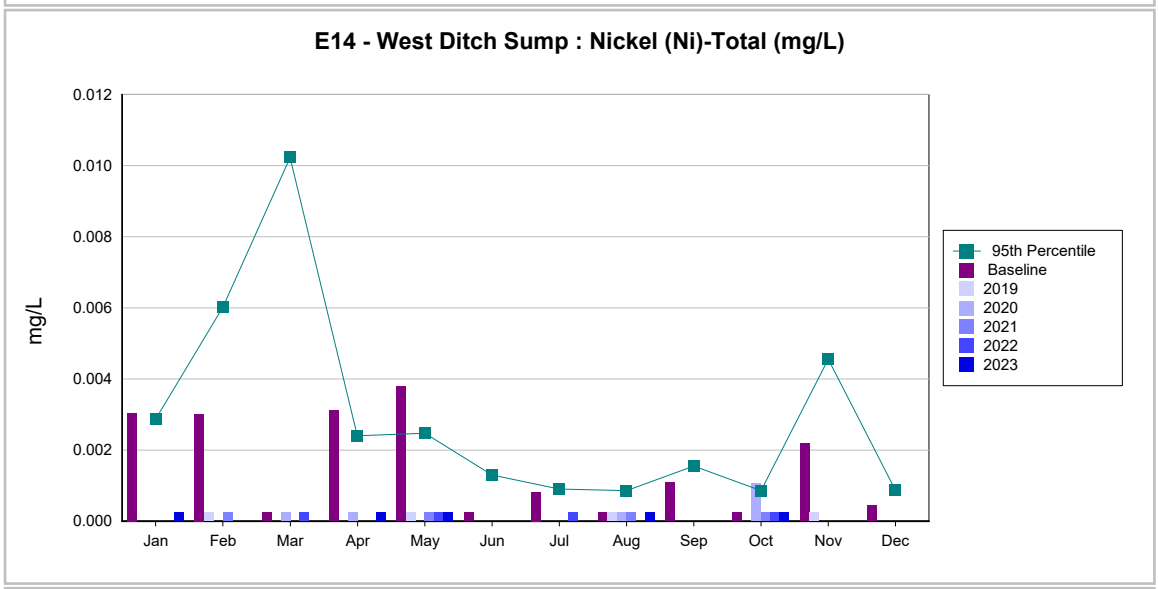
Annual Report Drainage Water

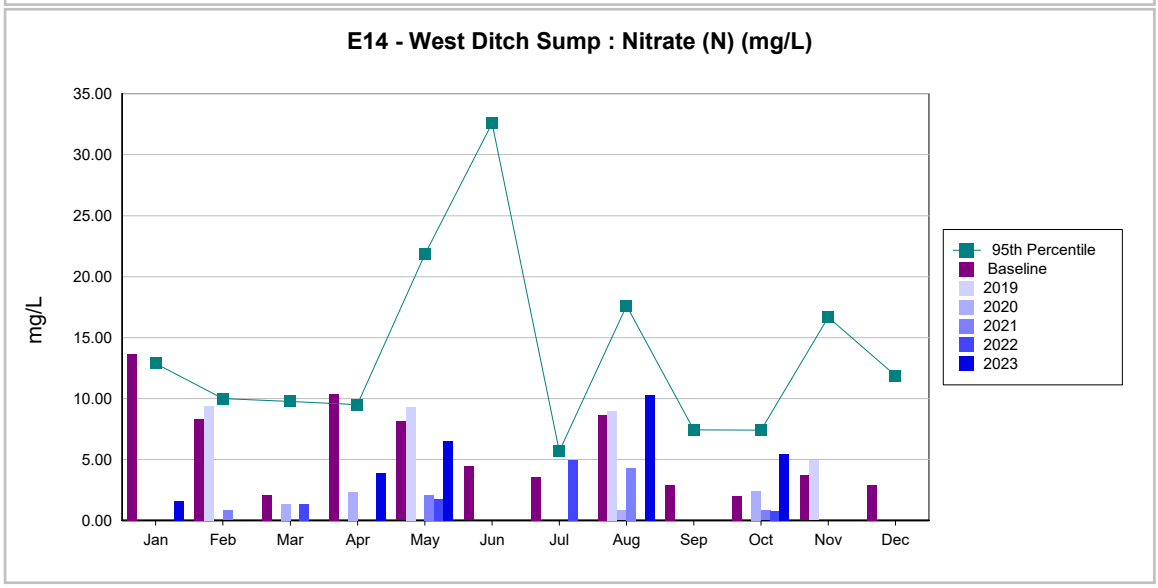
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







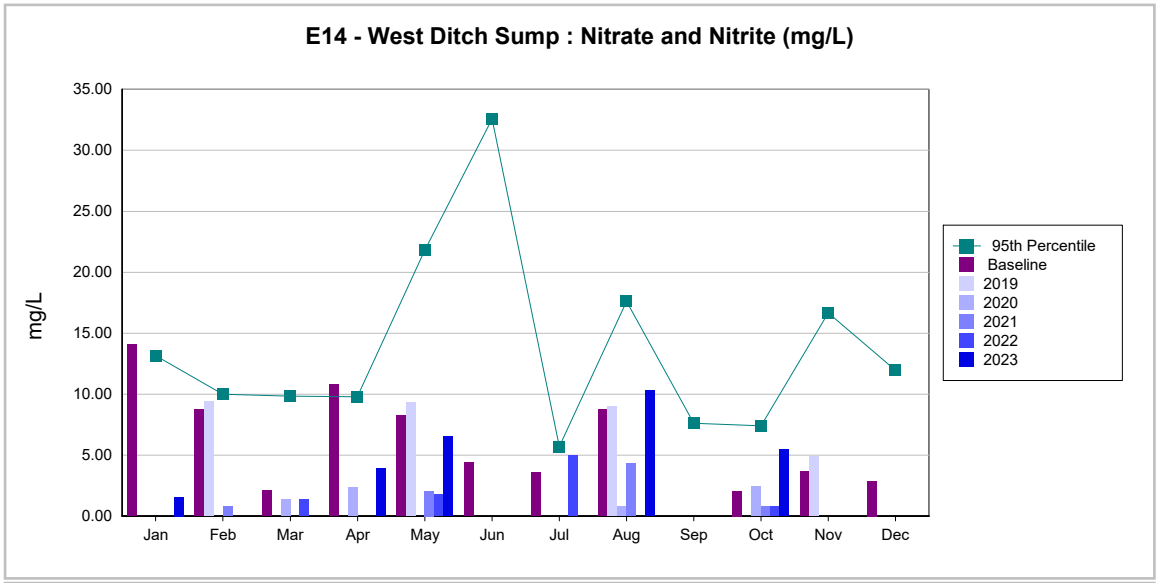
Water Quality Report

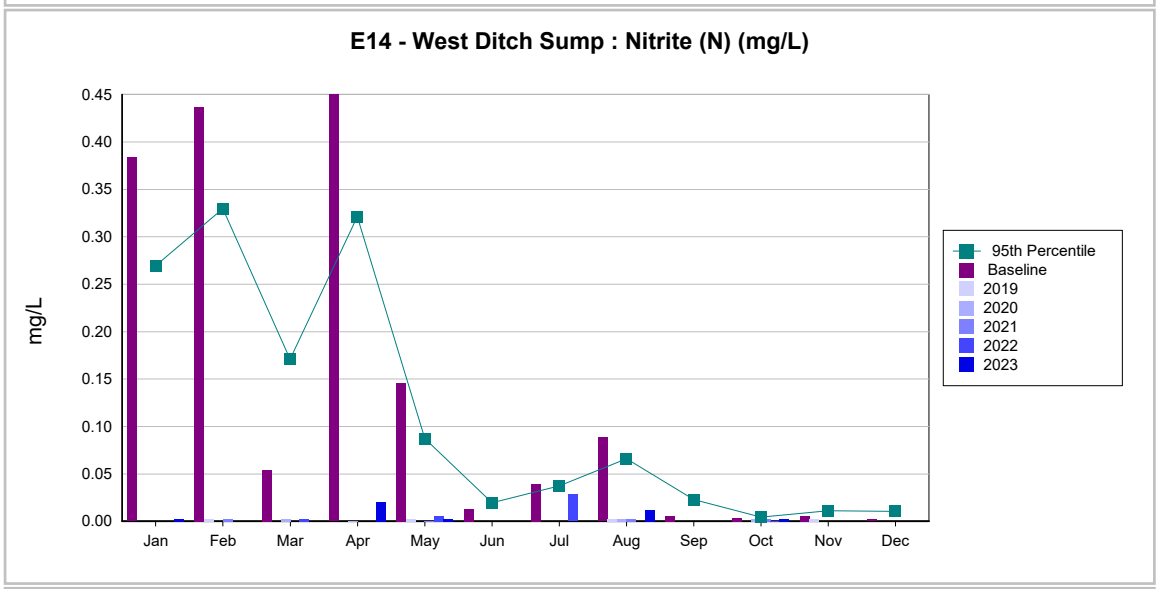
Annual Report Drainage Water

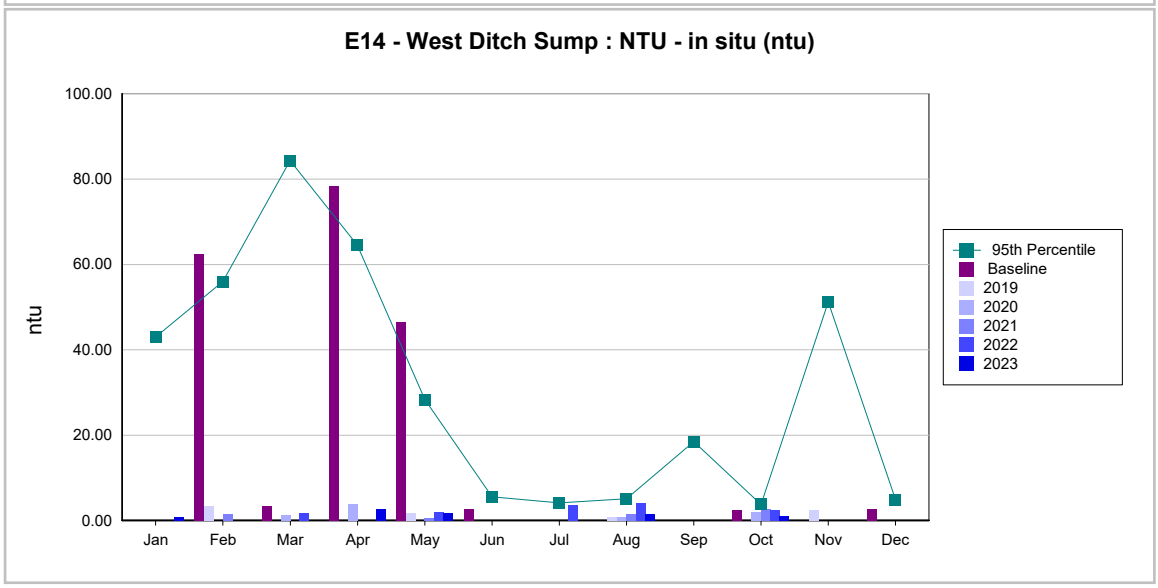
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







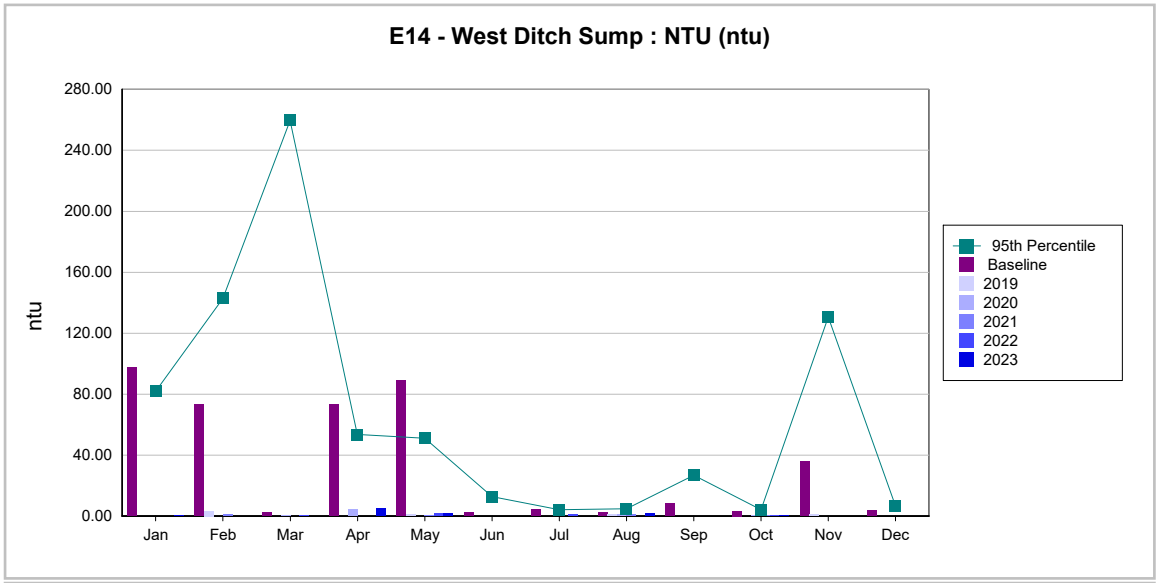
Water Quality Report

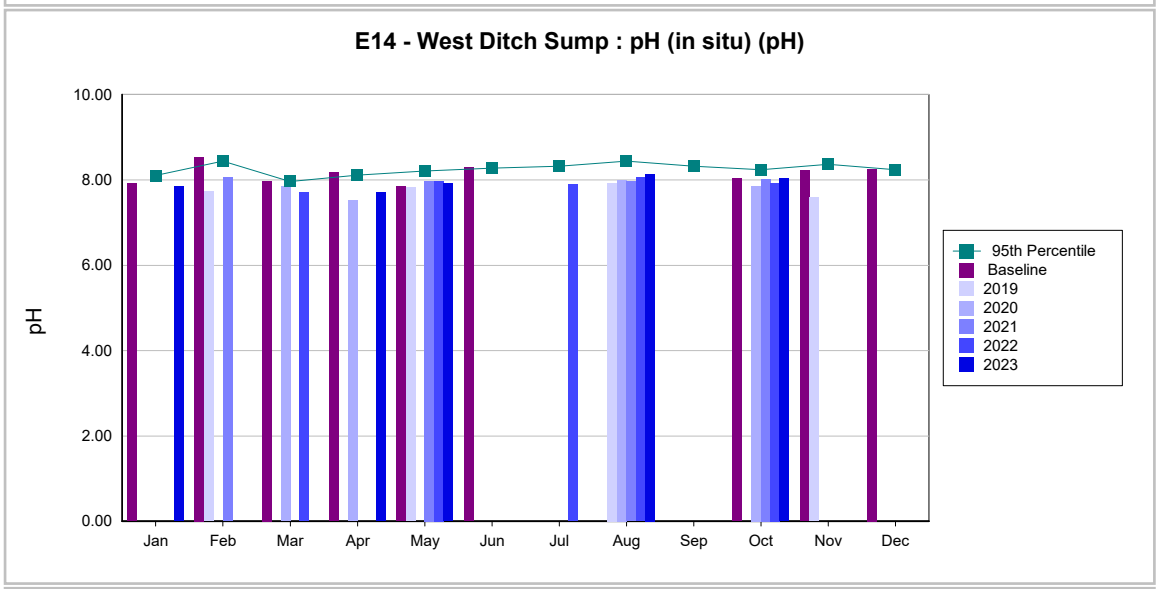
Annual Report Drainage Water

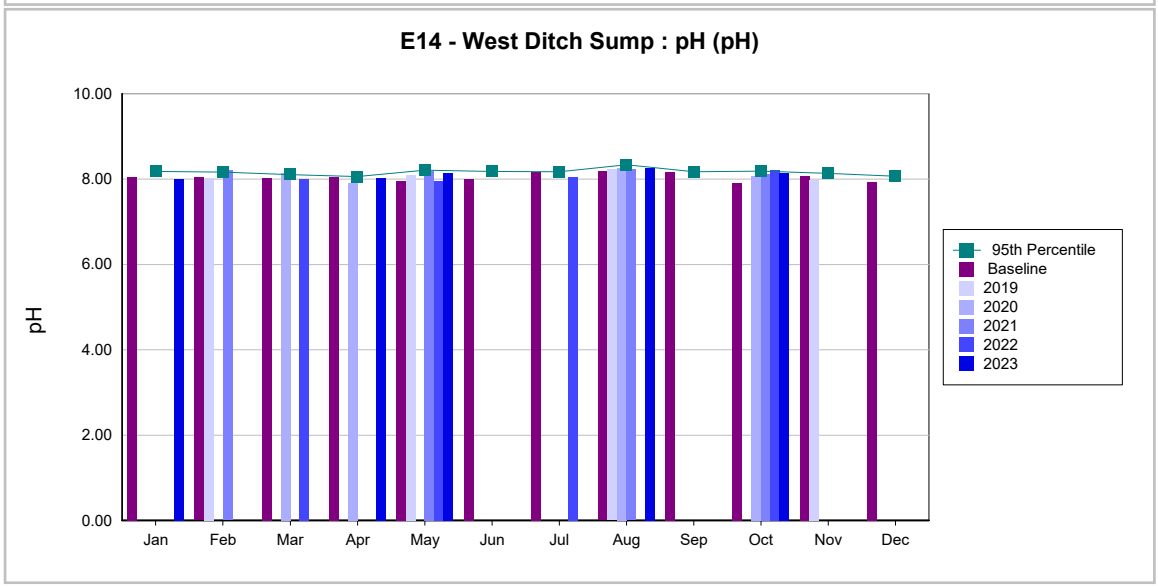
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







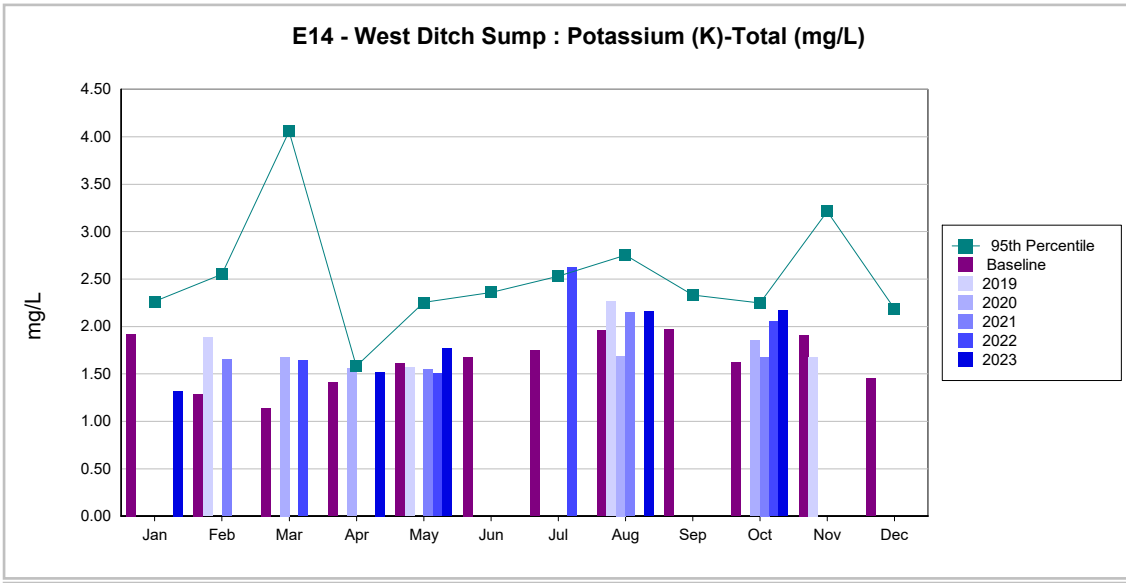
Water Quality Report

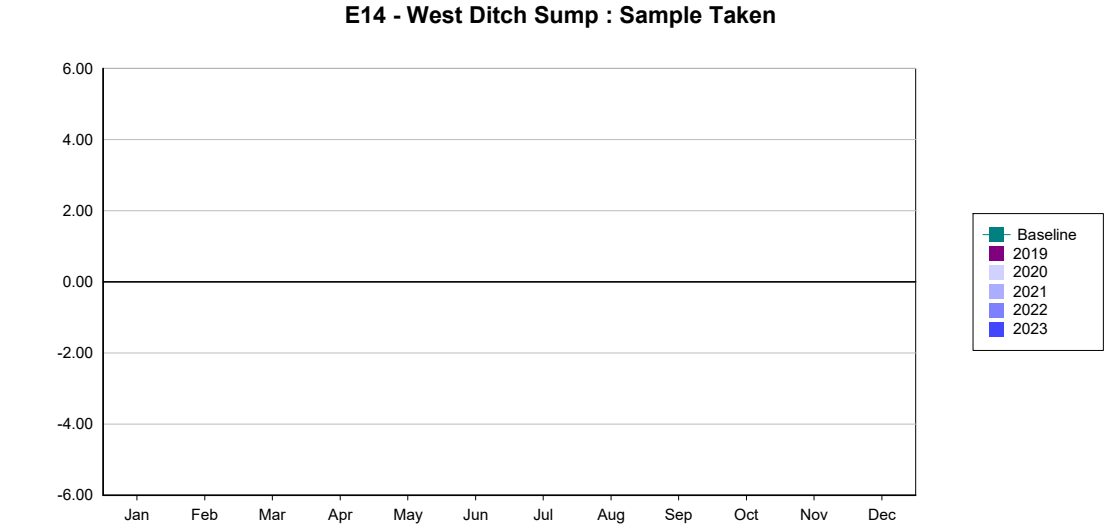
Annual Report Drainage Water

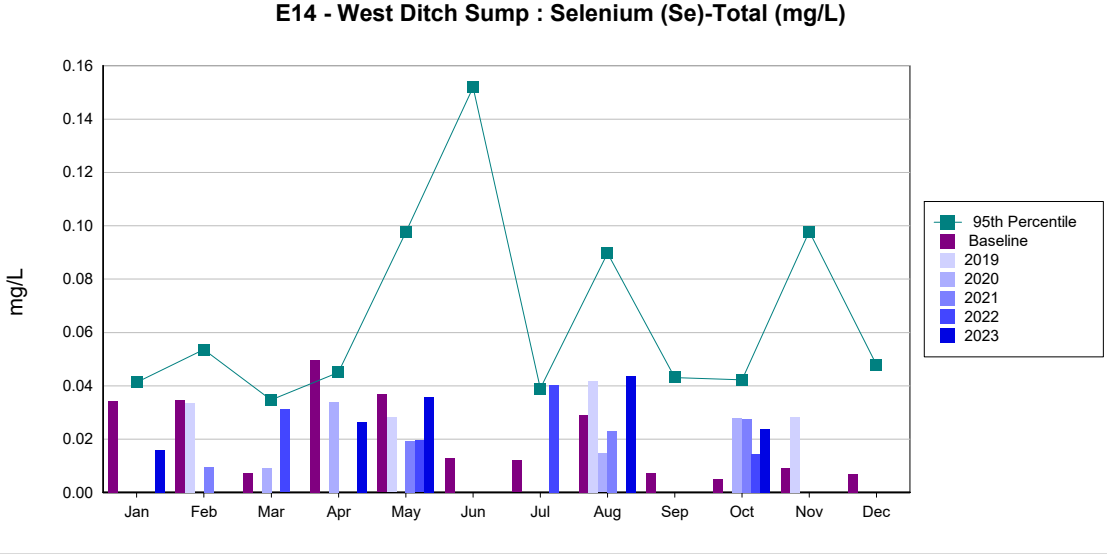
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







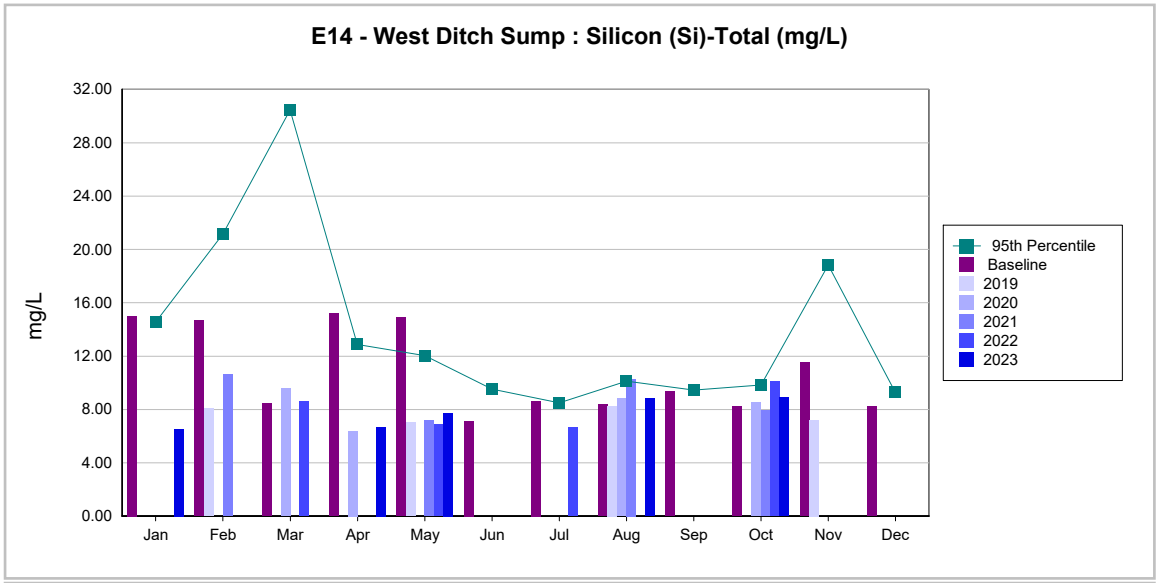
Water Quality Report

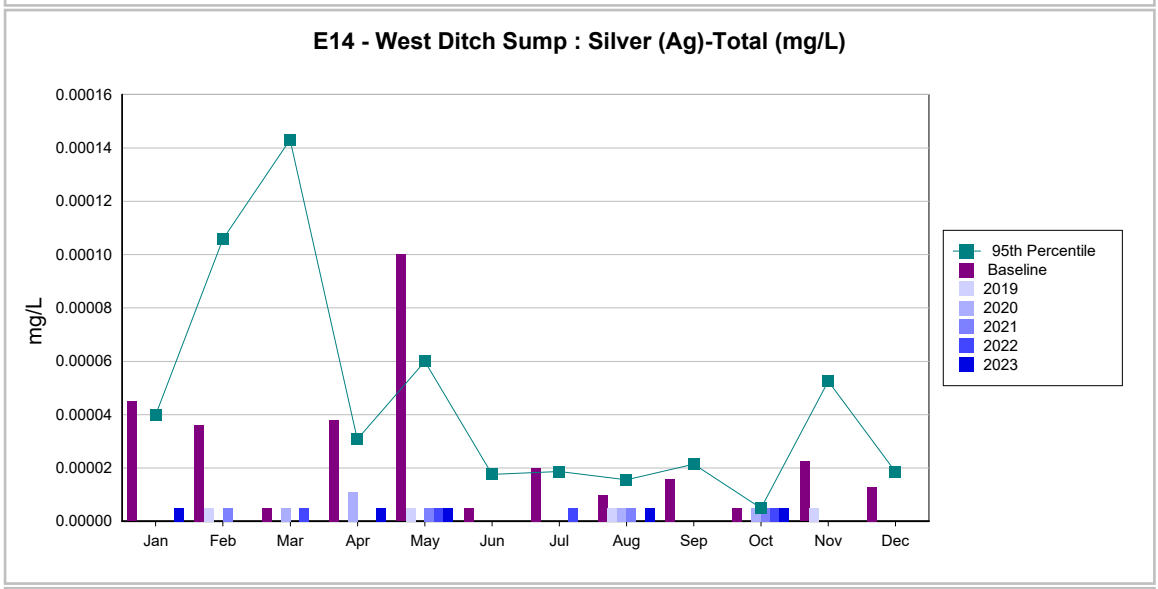
Annual Report Drainage Water

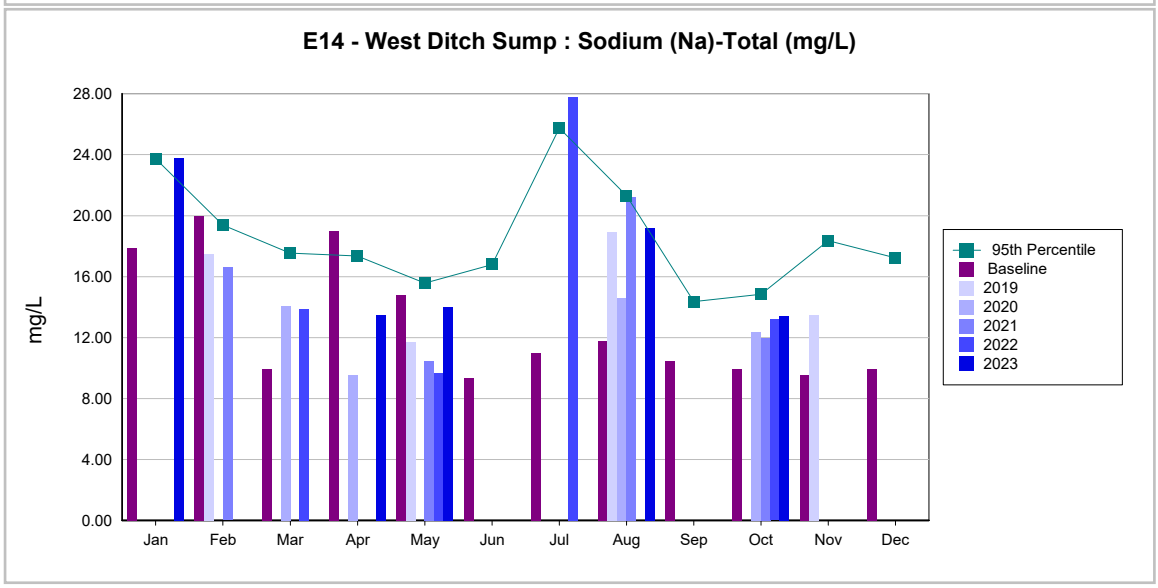
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







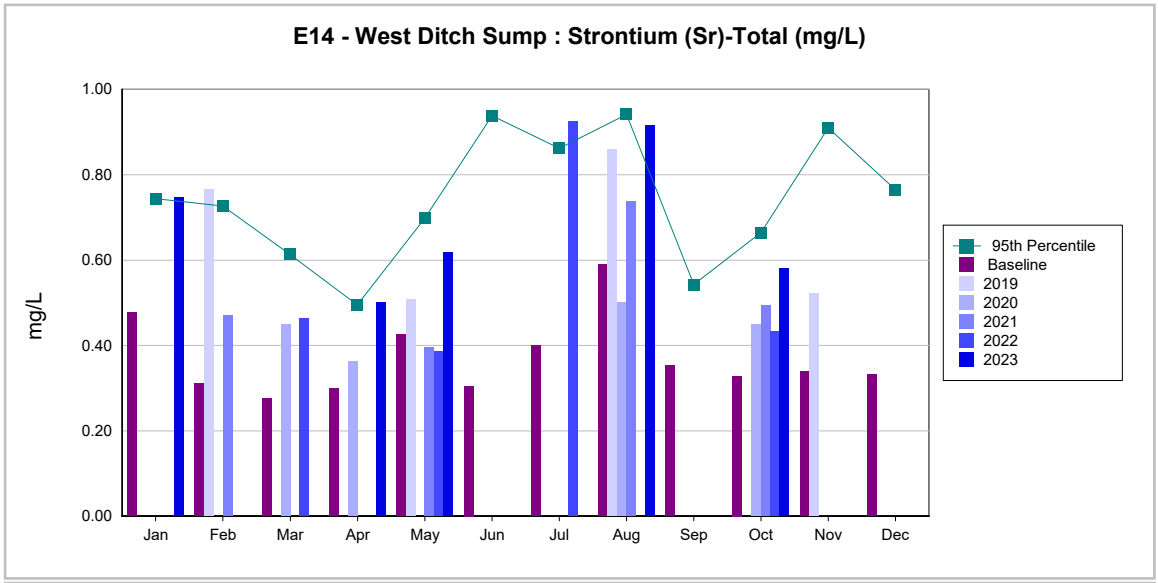
Water Quality Report

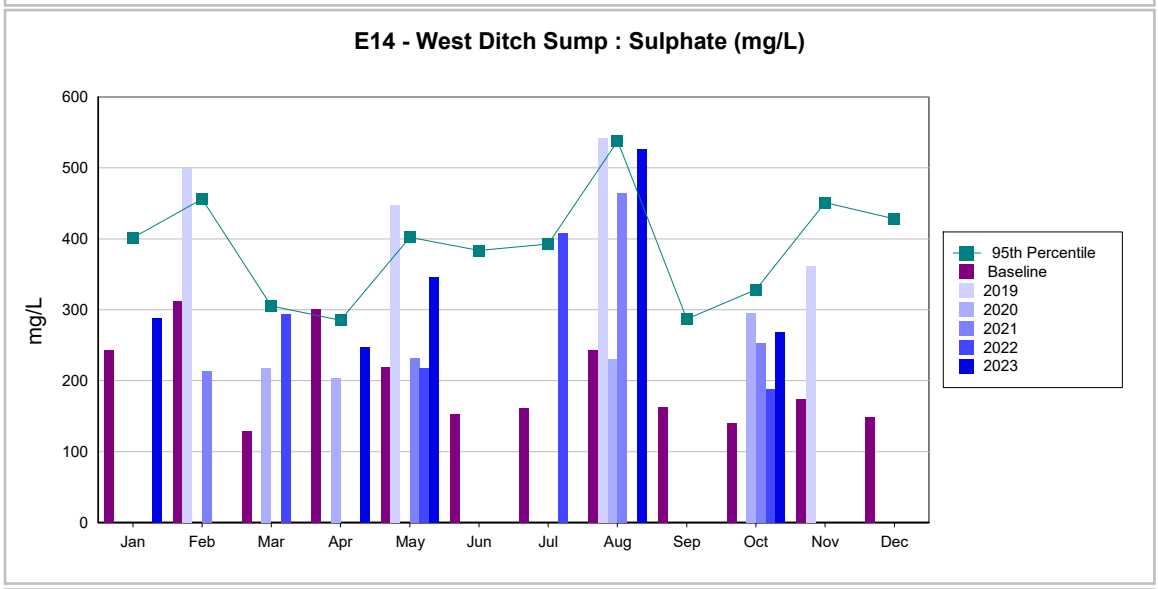
Annual Report Drainage Water

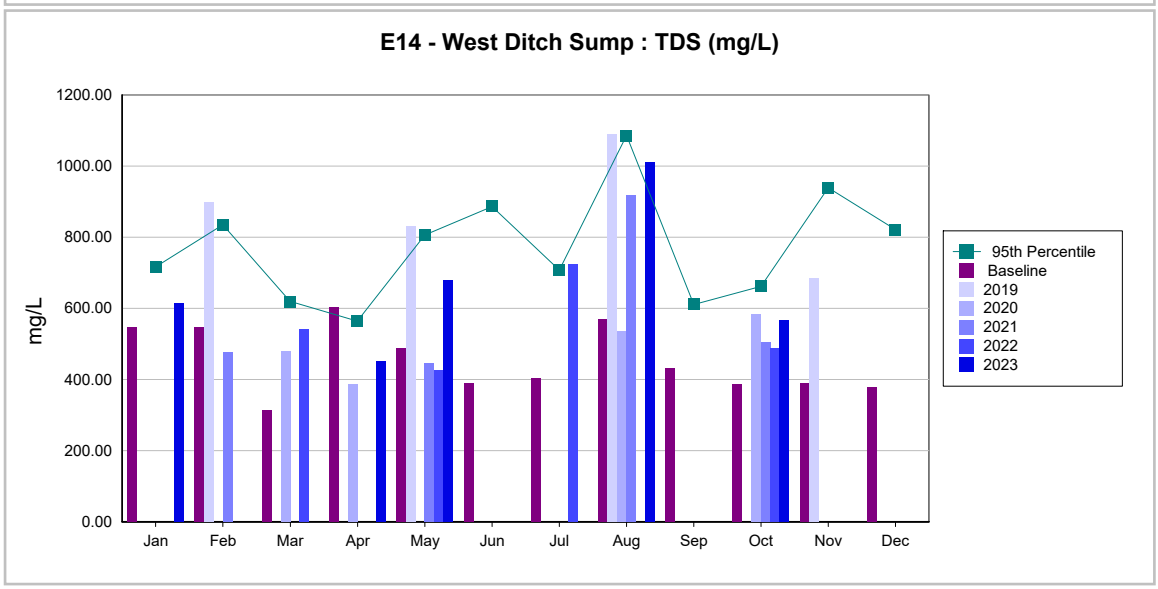
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







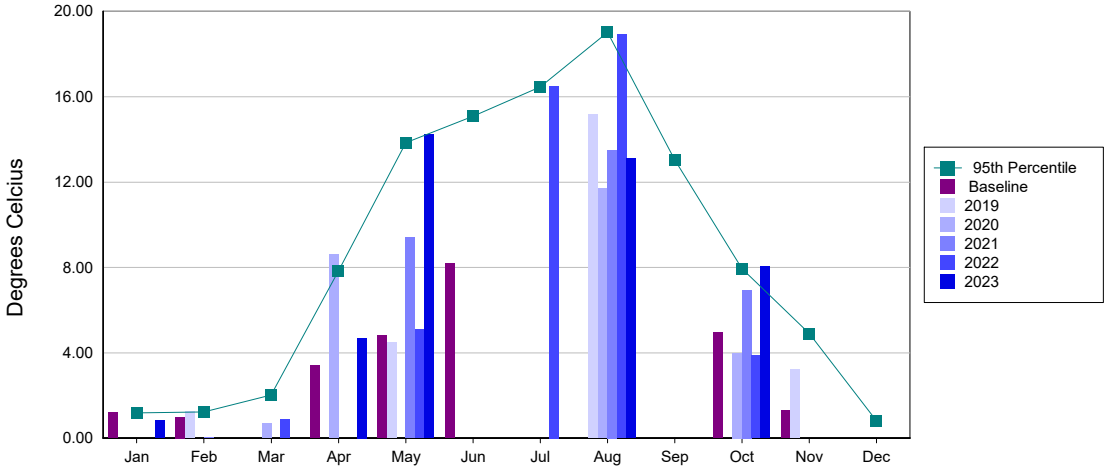
Water Quality Report

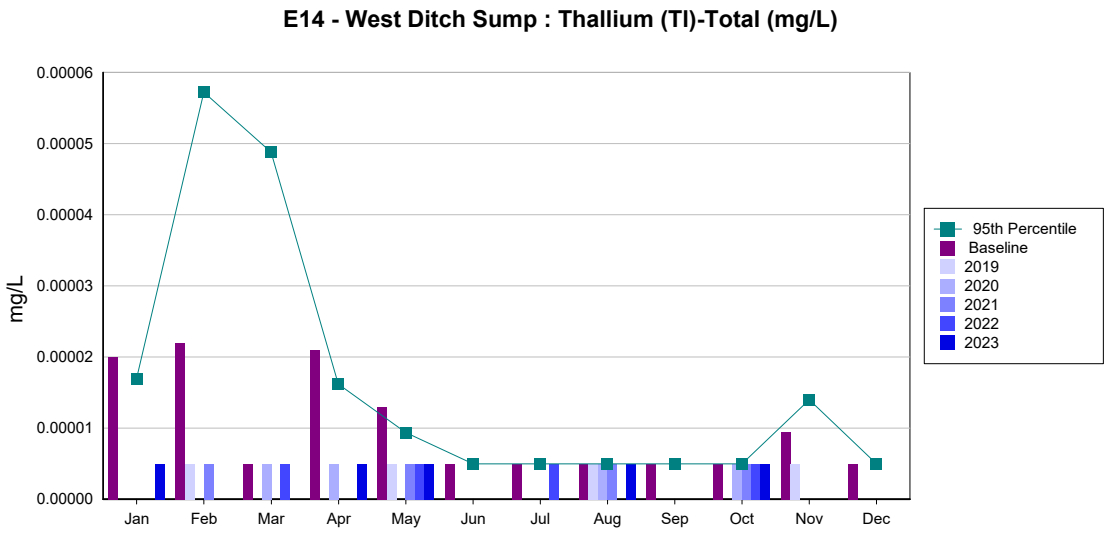
Annual Report Drainage Water

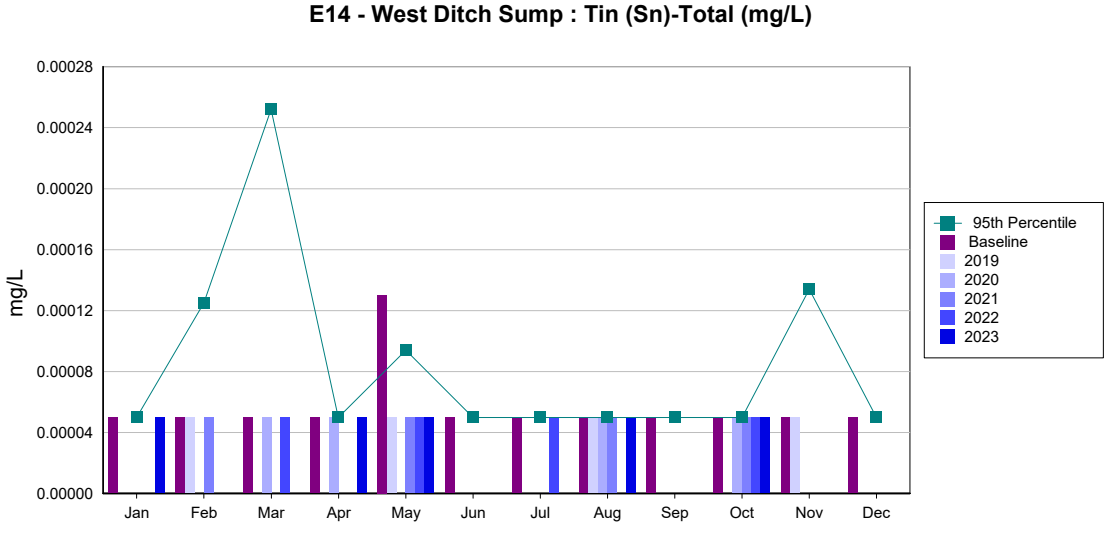
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







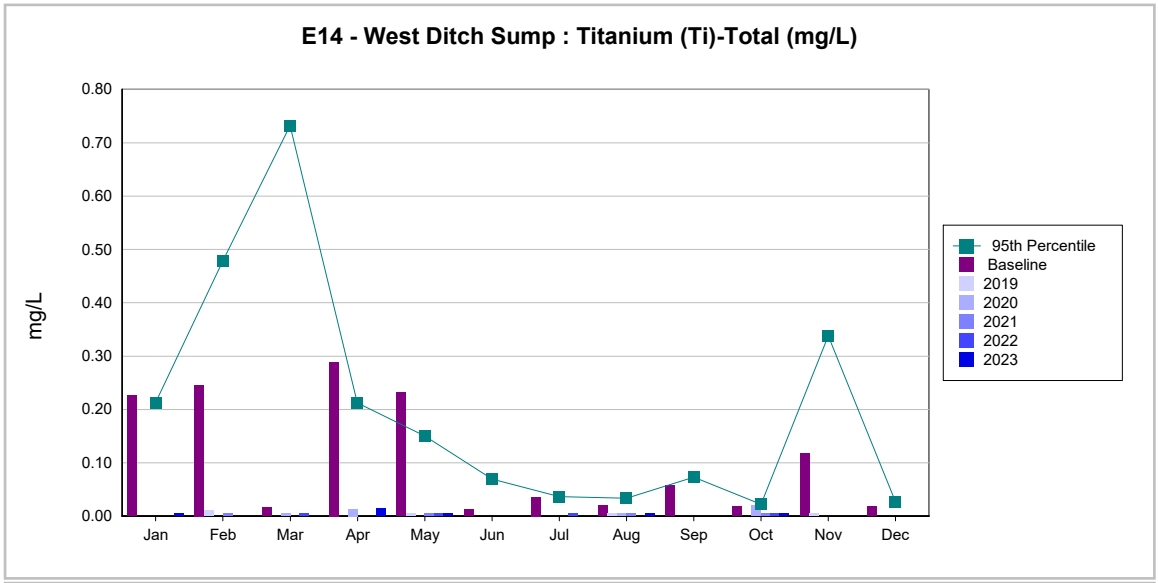
Water Quality Report

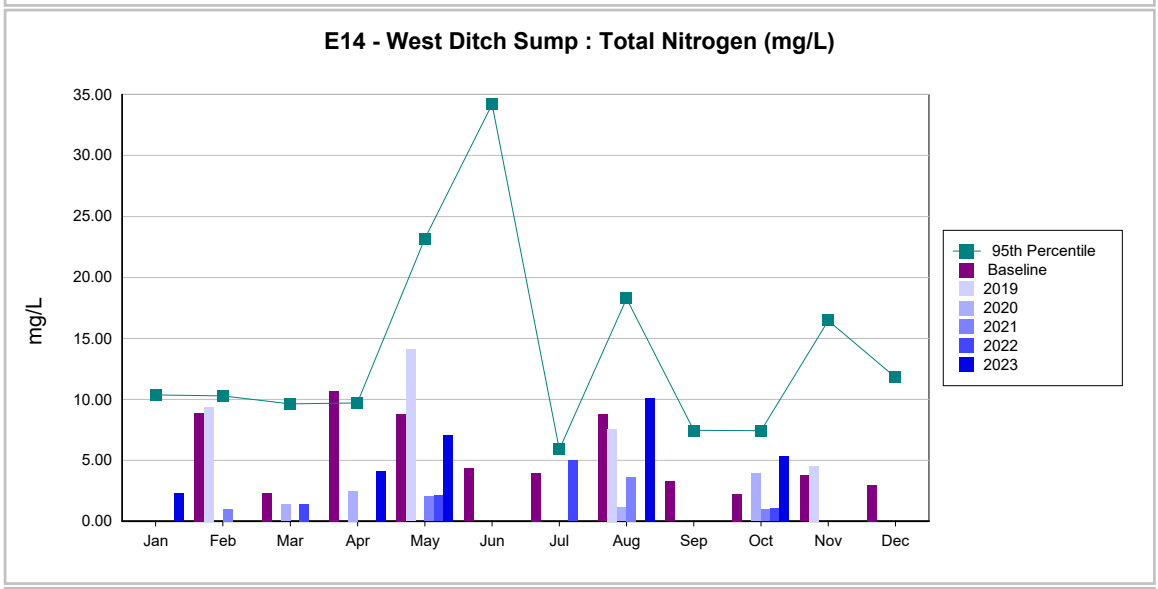
Annual Report Drainage Water

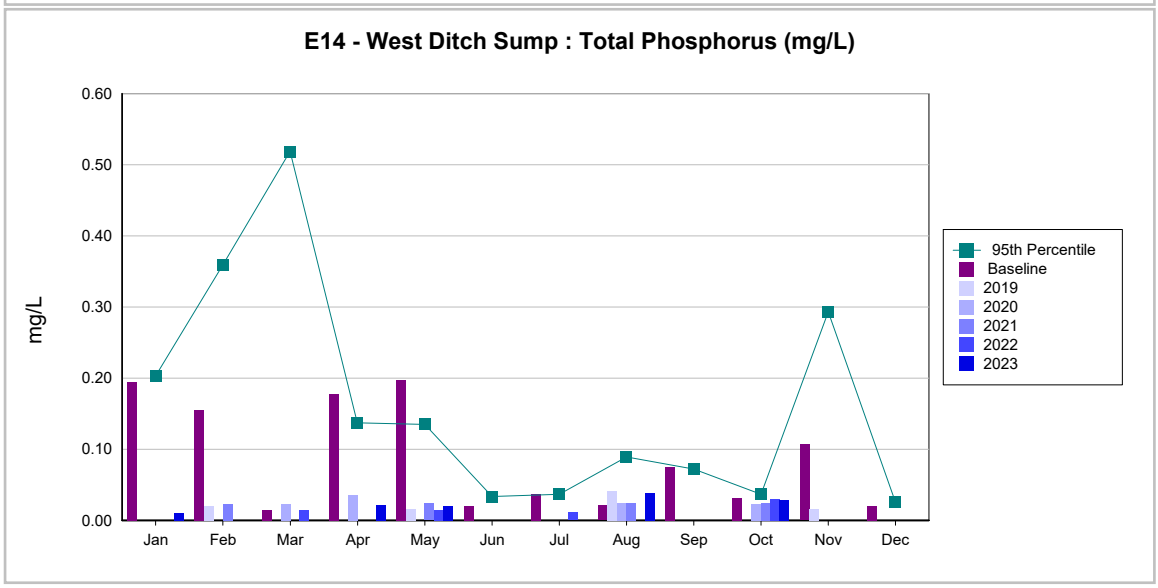
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







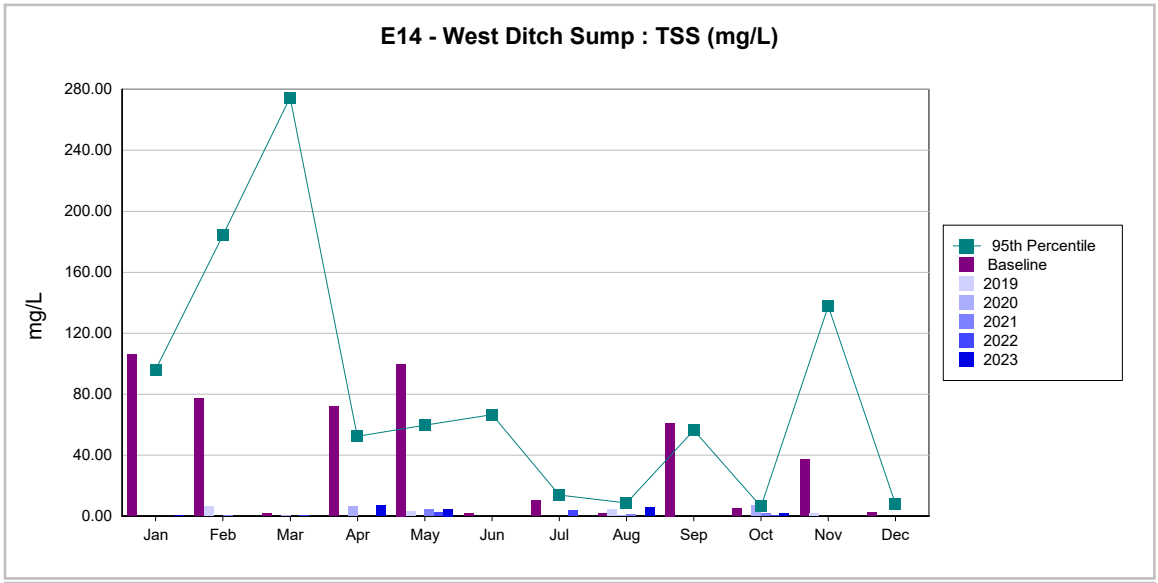
Water Quality Report

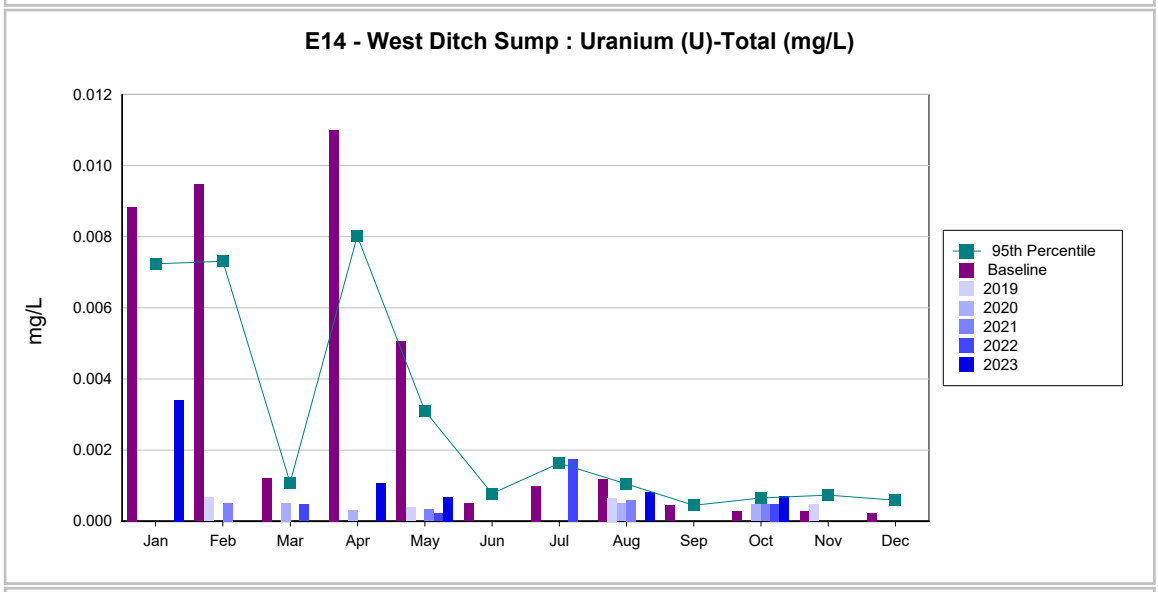
Annual Report Drainage Water

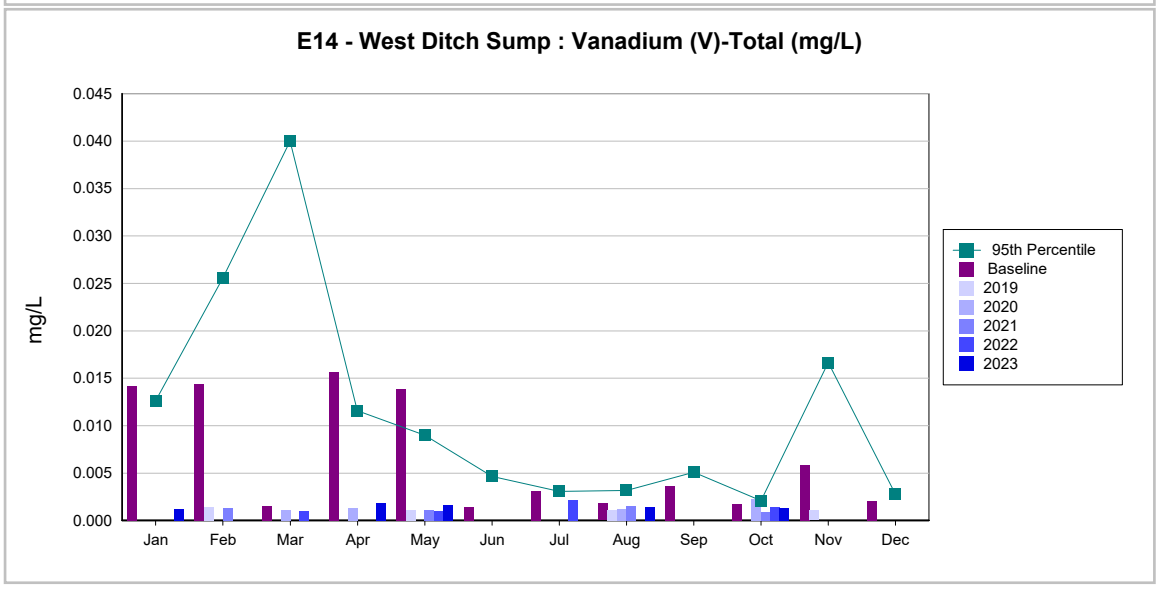
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

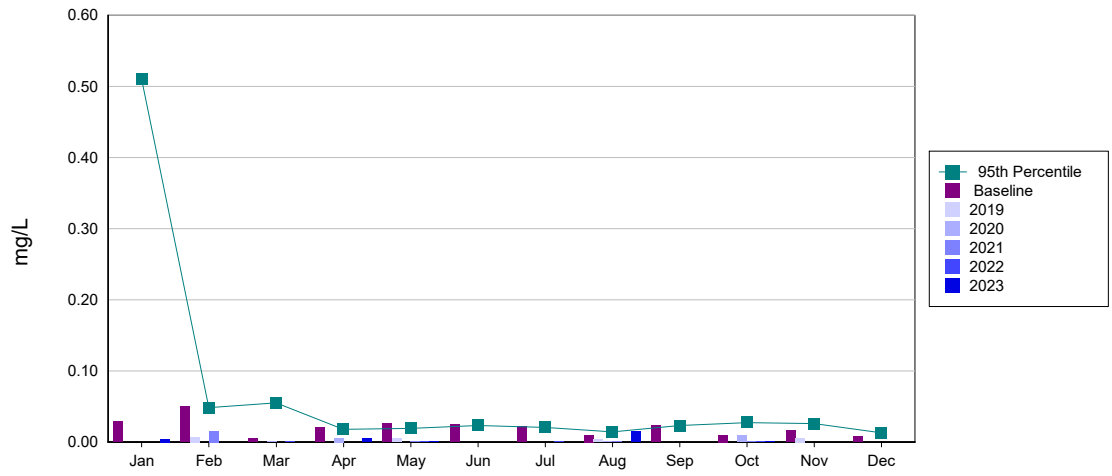
Annual Report Drainage Water

Mount Polley

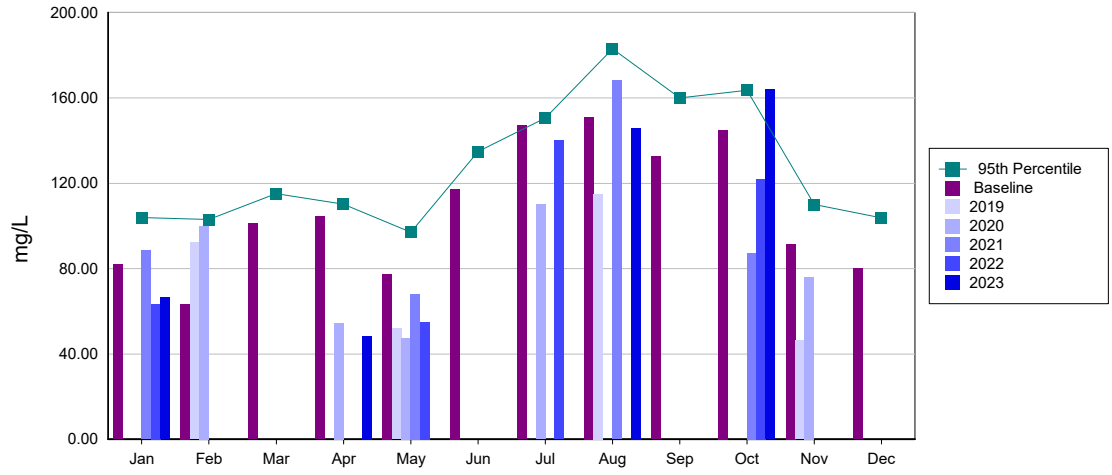
Mining Corporation

IMPERIAL METALS CORPORATION

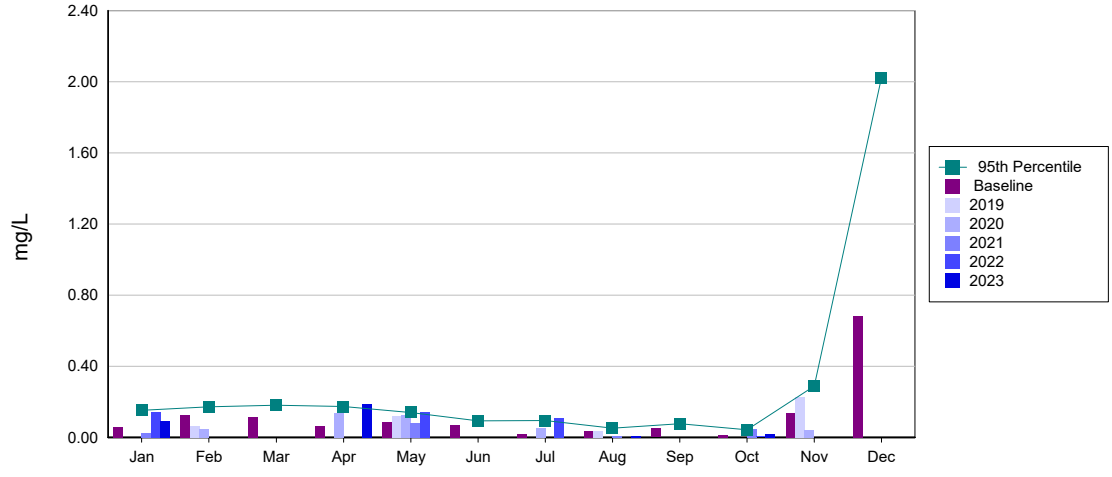
E14 - West Ditch Sump : Zinc (Zn)-Total (mg/L)



E15 - Sump at Bootjack Culvert : Alkalinity (CaCO3) (mg/L)



E15 - Sump at Bootjack Culvert : Aluminum (Al)-Diss (mg/L)



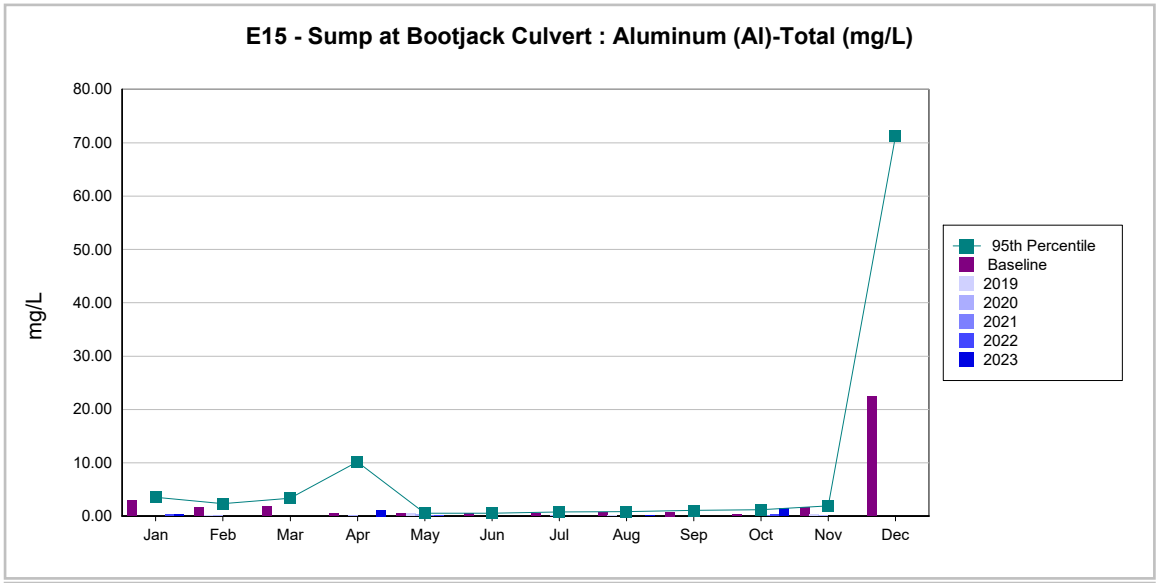
Water Quality Report

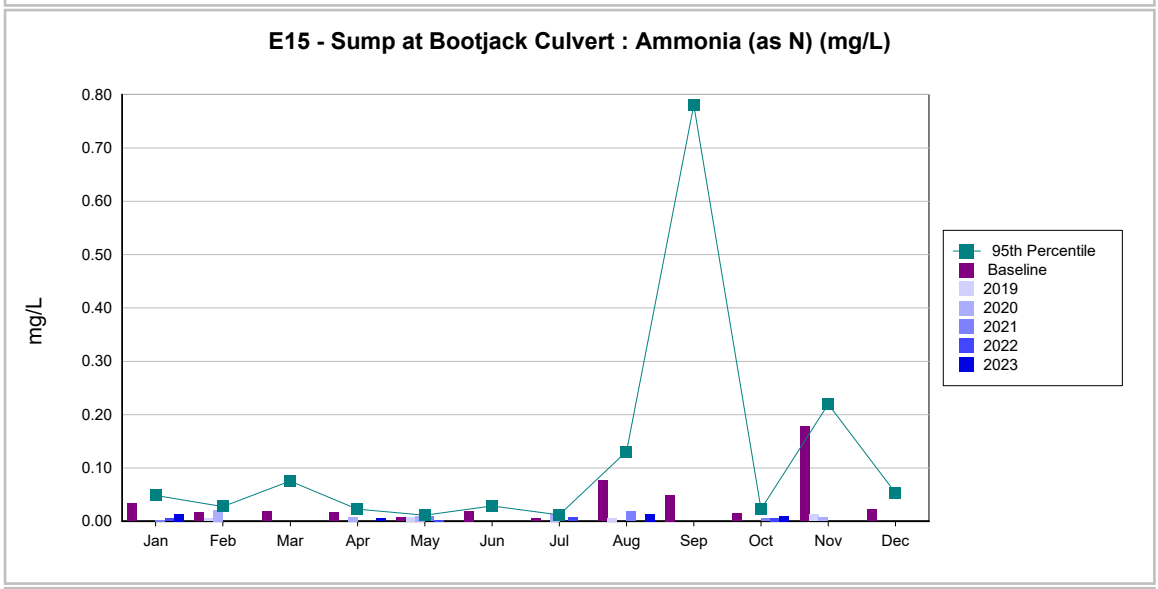
Annual Report Drainage Water

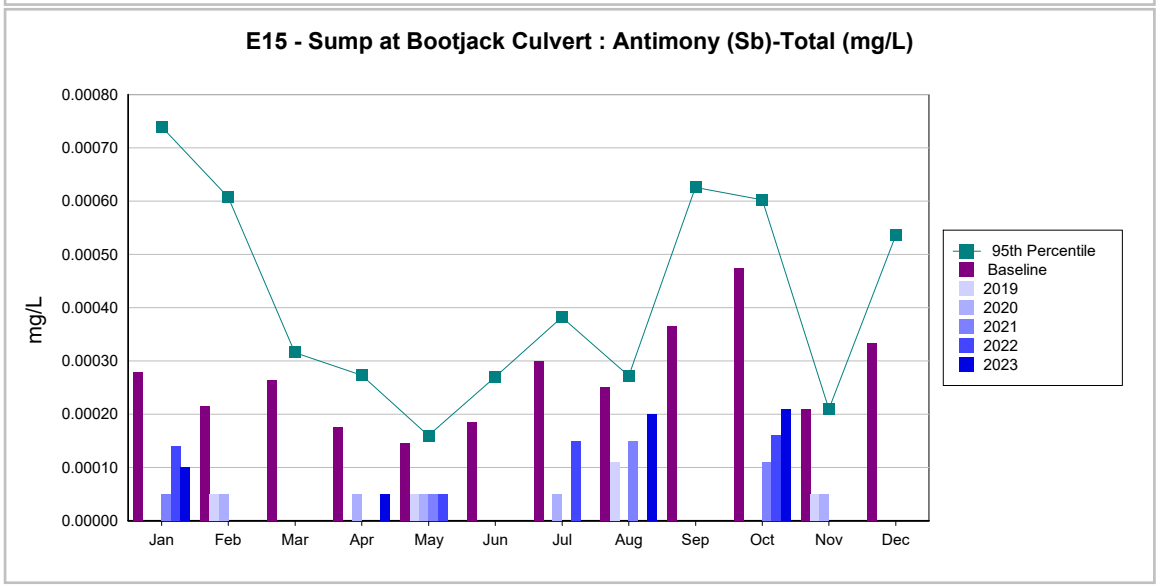
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







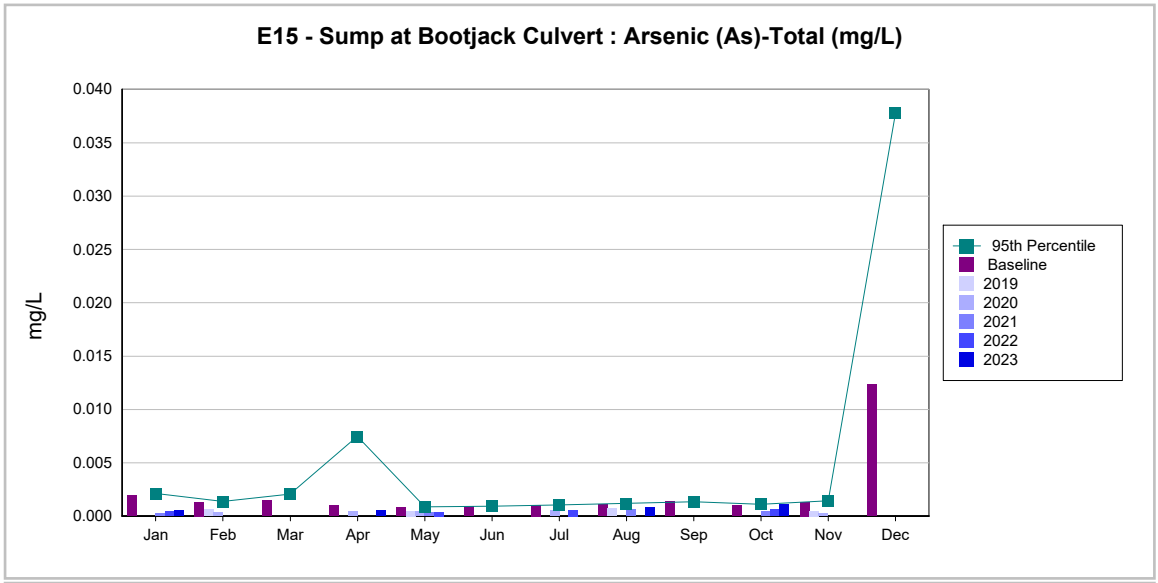
Water Quality Report

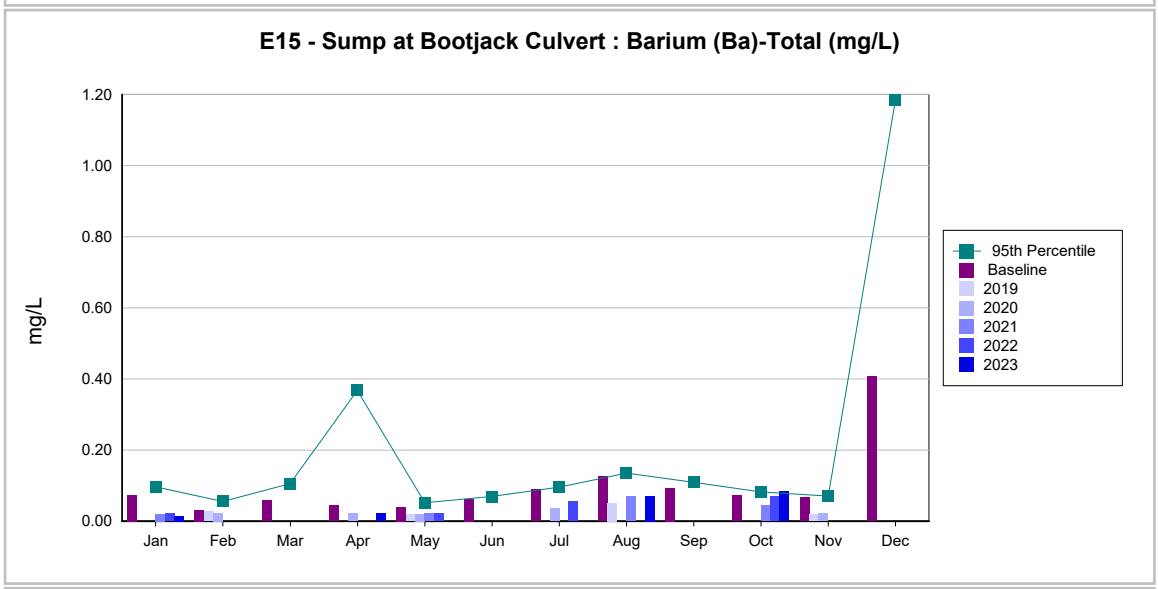
Annual Report Drainage Water

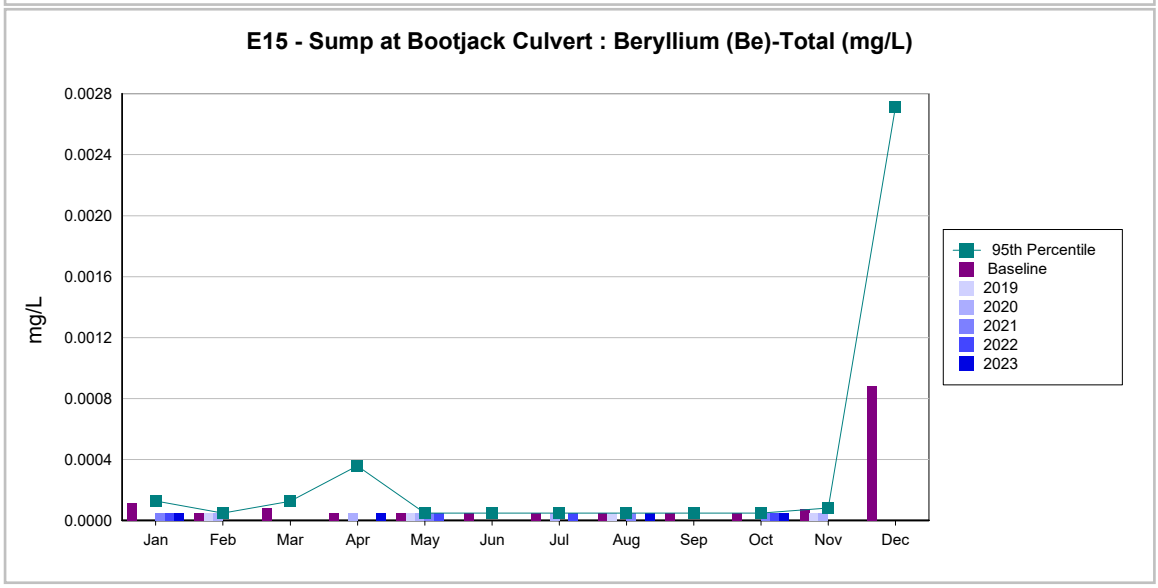
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







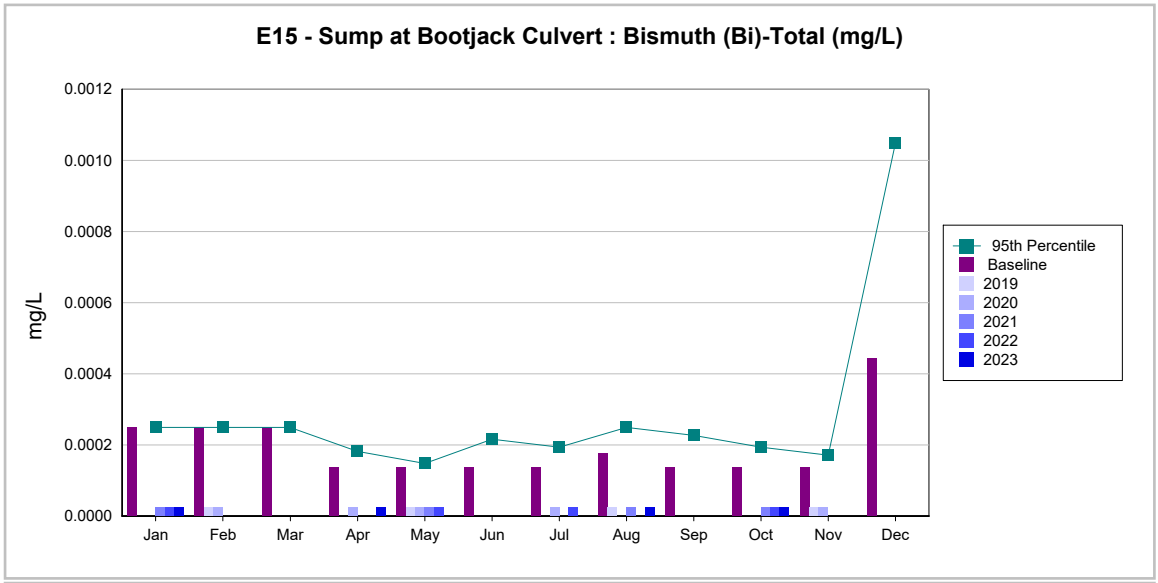
Water Quality Report

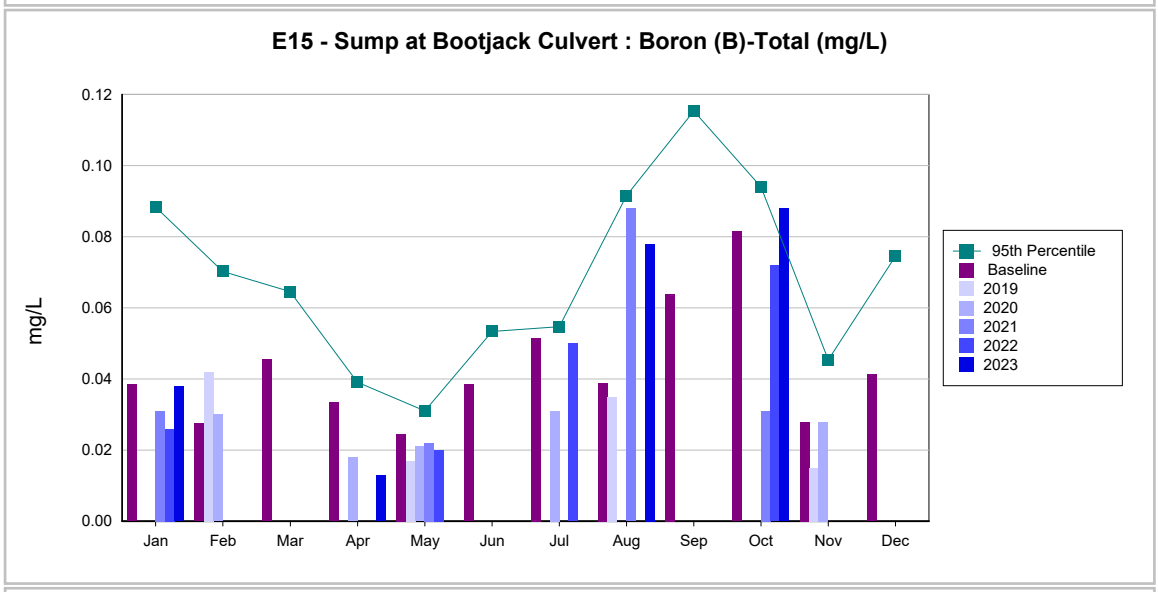
Annual Report Drainage Water

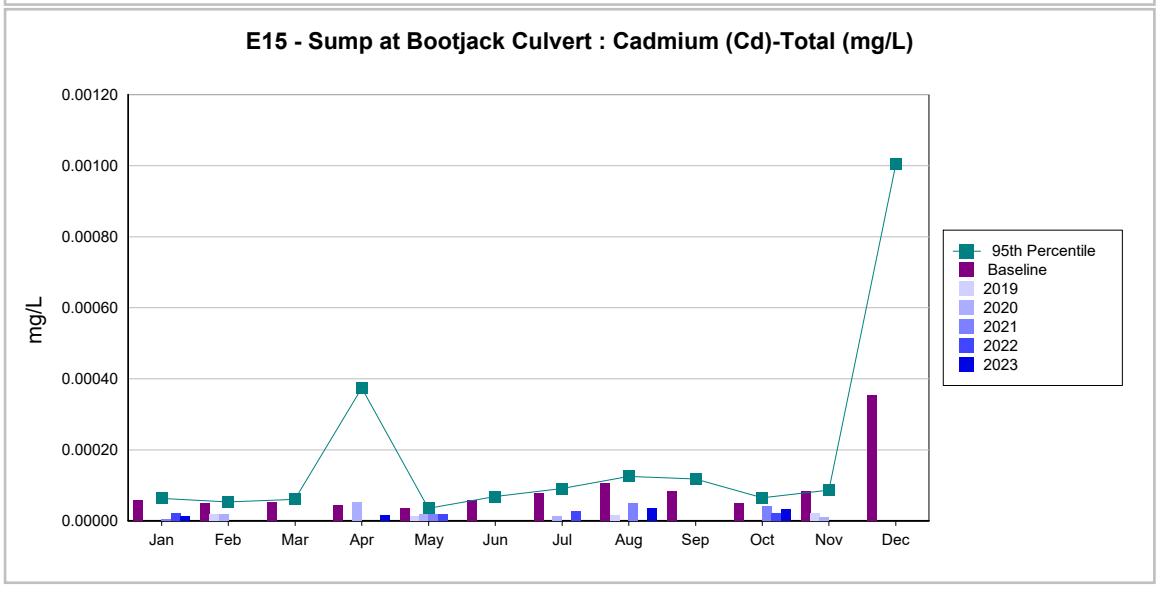
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







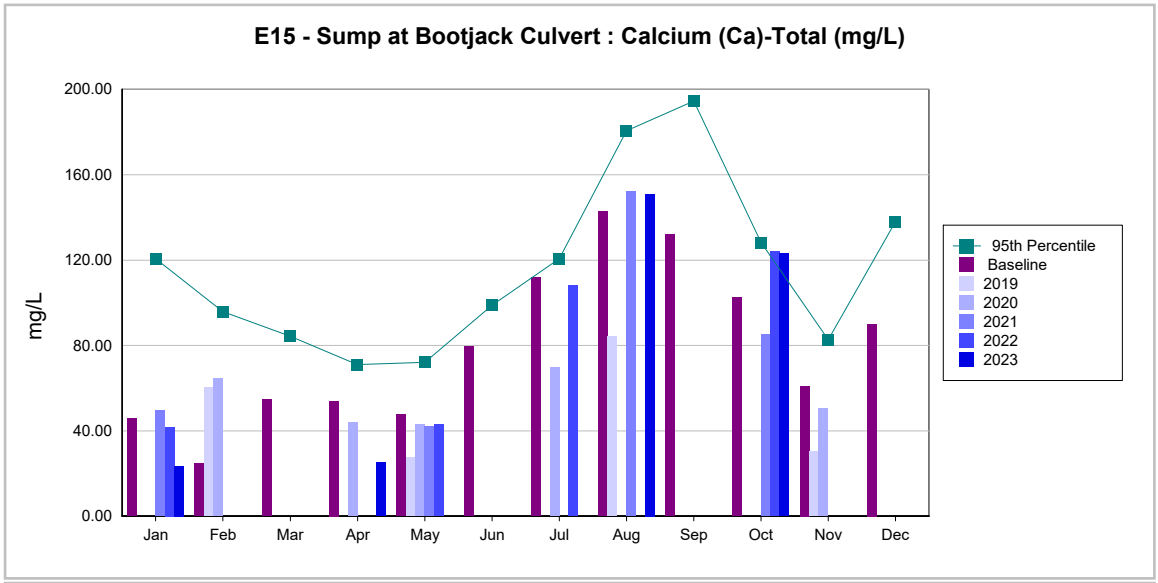
Water Quality Report

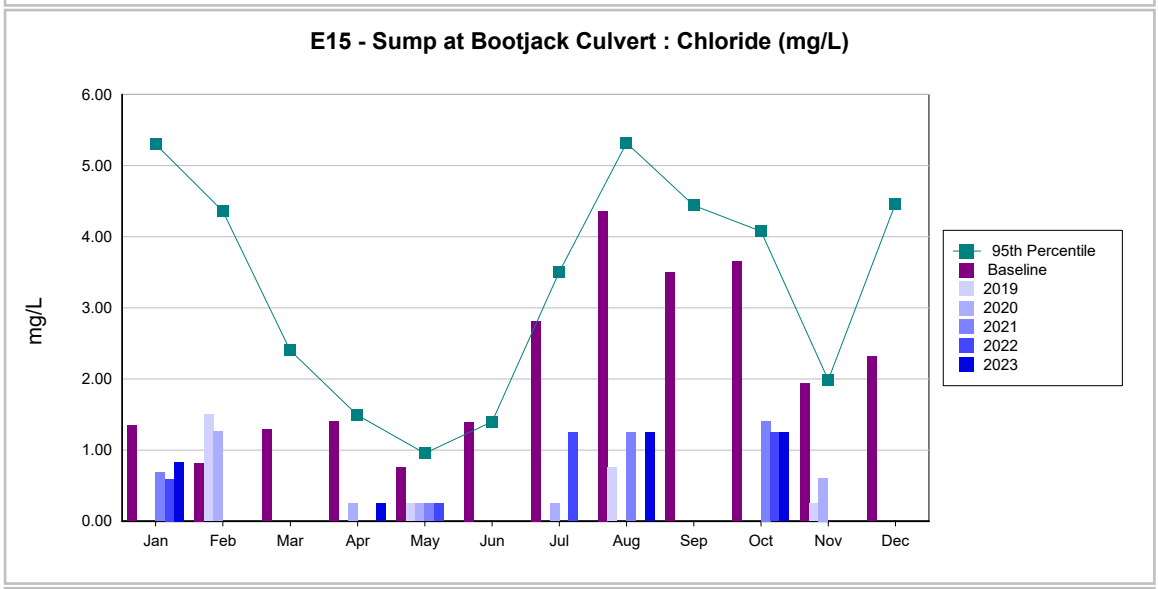
Annual Report Drainage Water

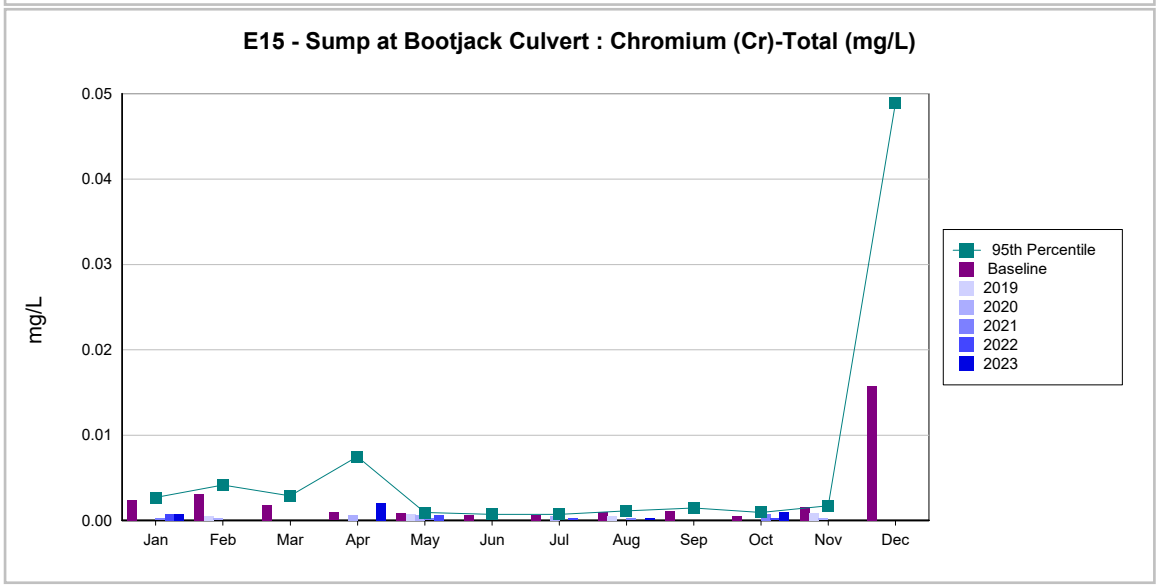
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







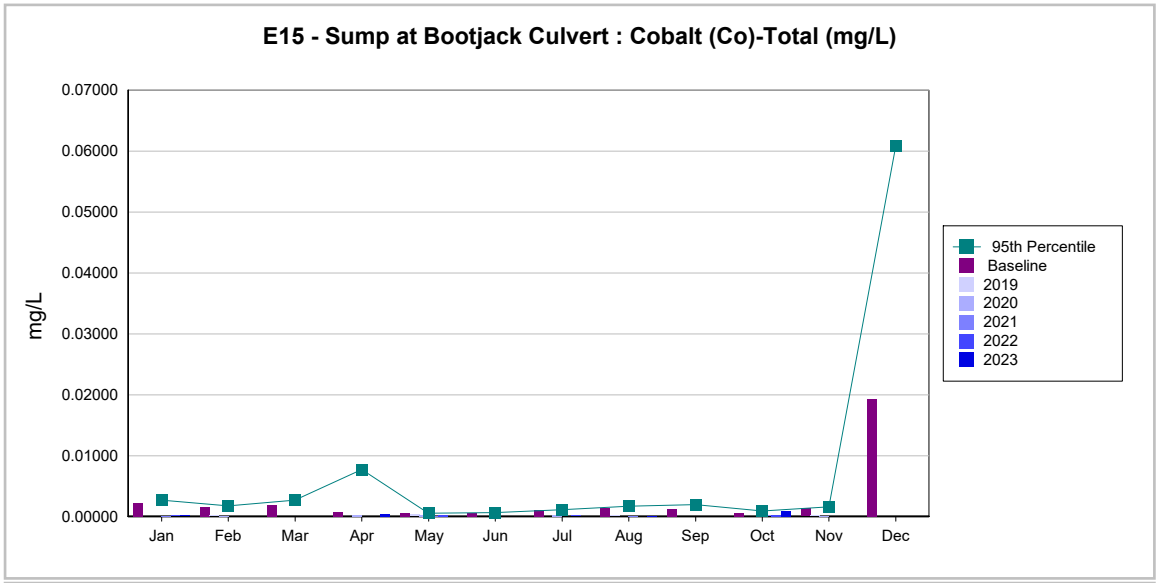
Water Quality Report

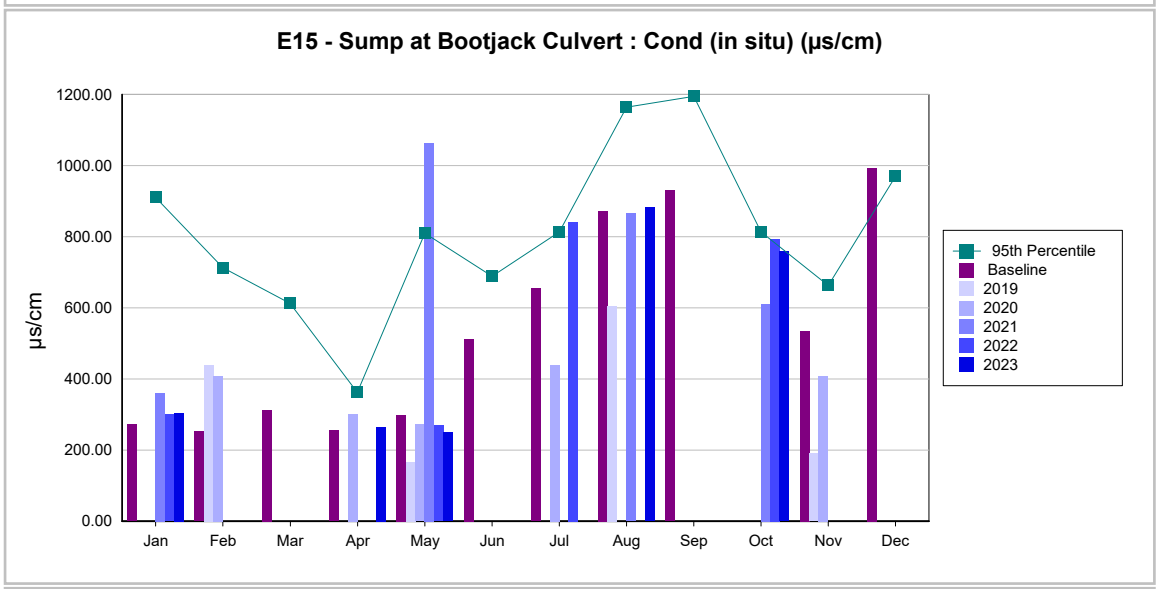
Annual Report Drainage Water

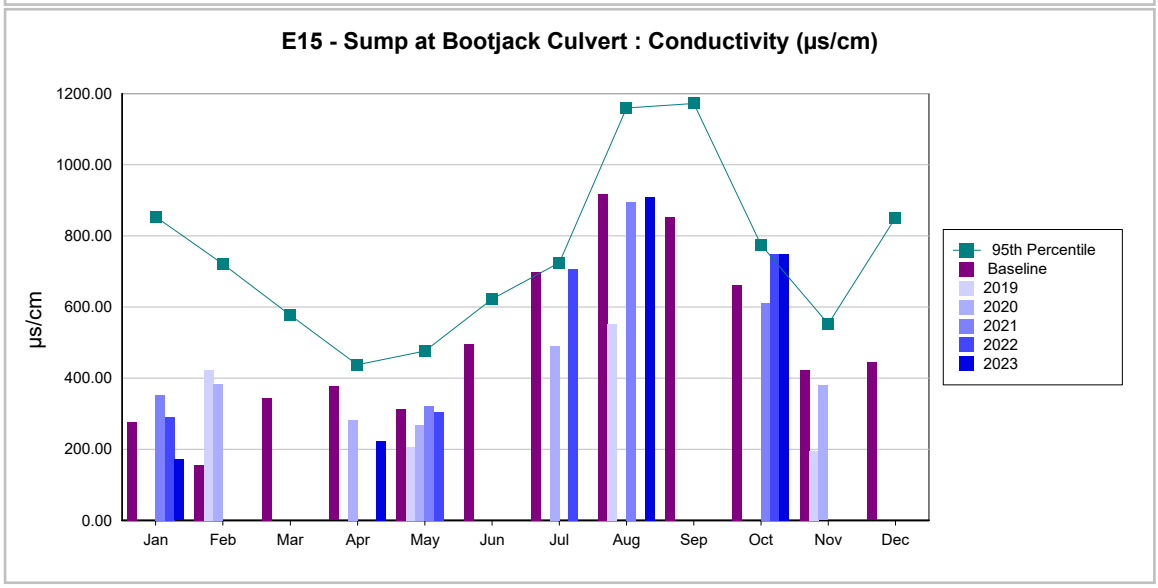
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







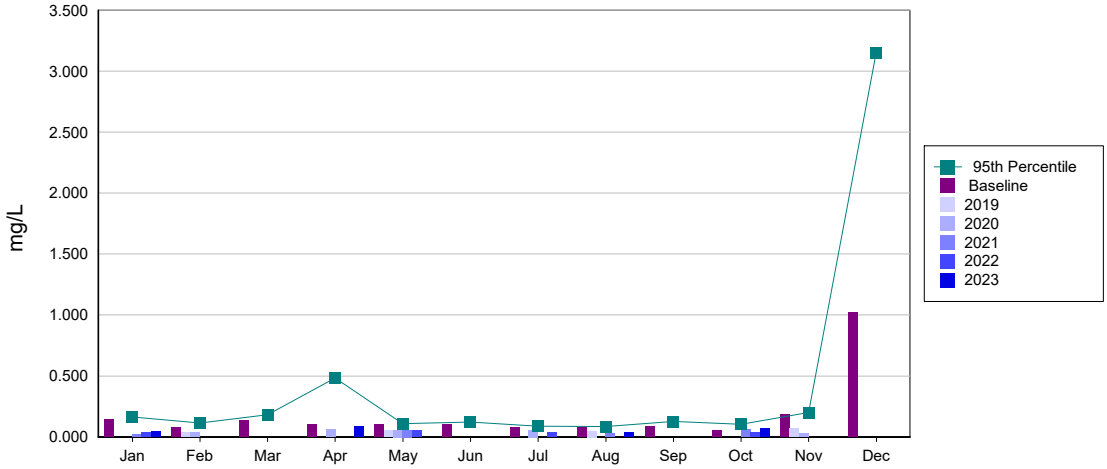
Water Quality Report

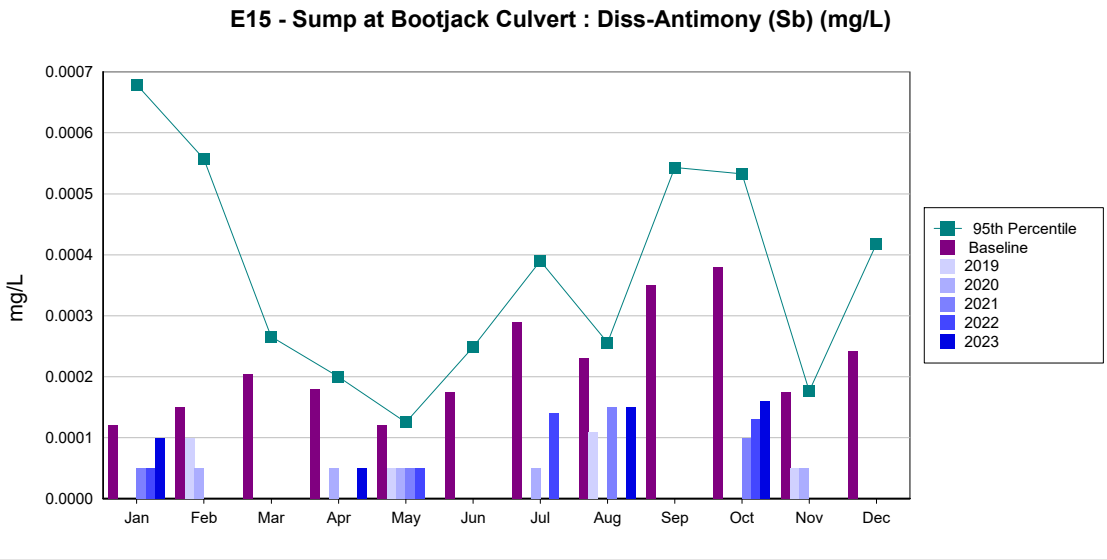
Annual Report Drainage Water

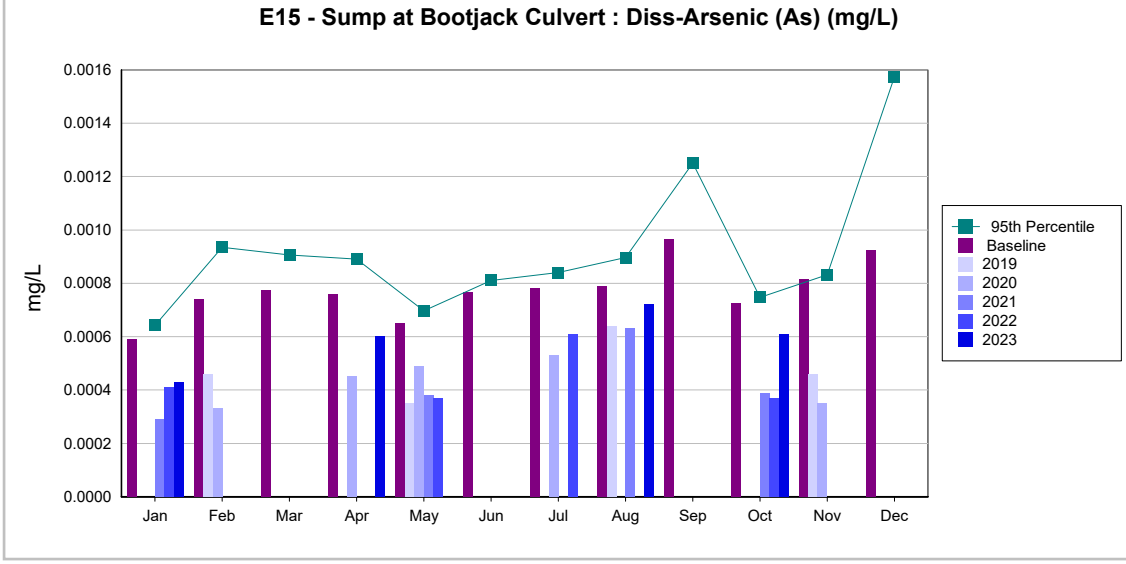
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







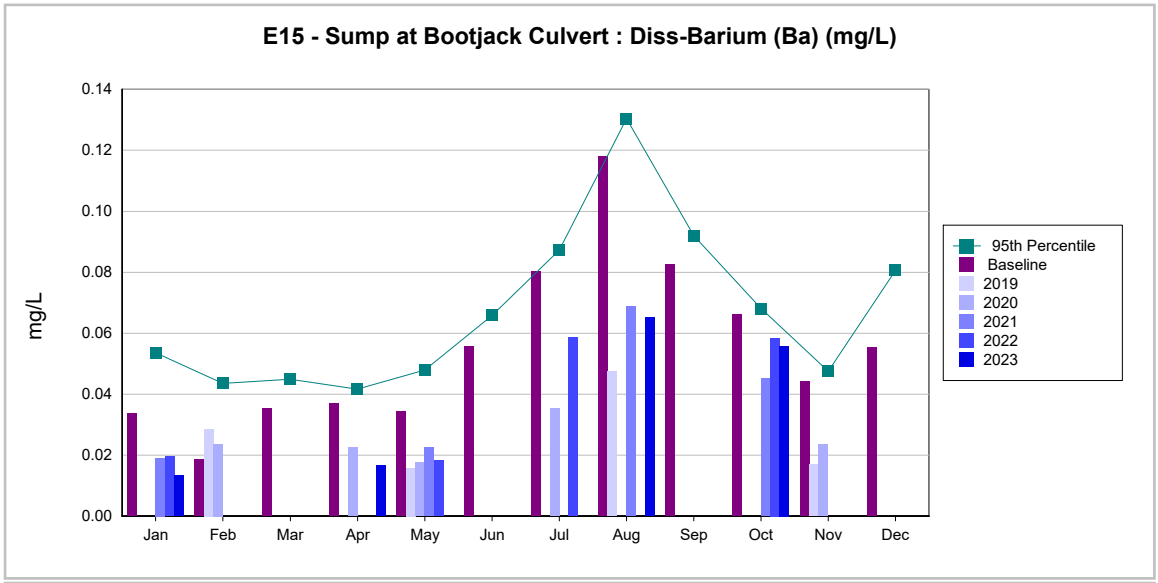
Water Quality Report

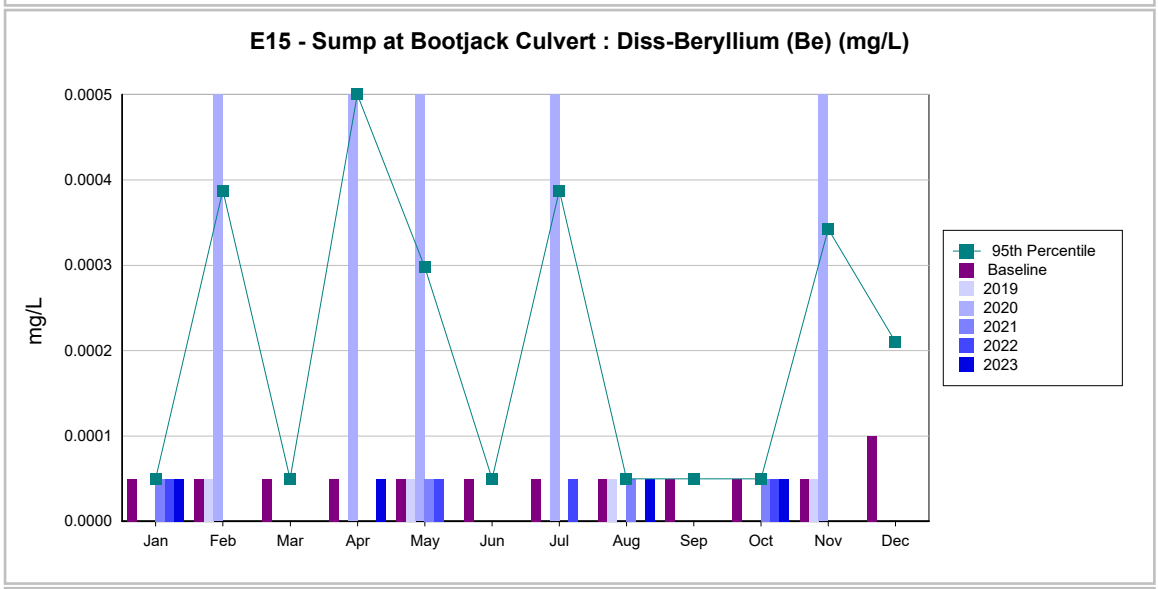
Annual Report Drainage Water

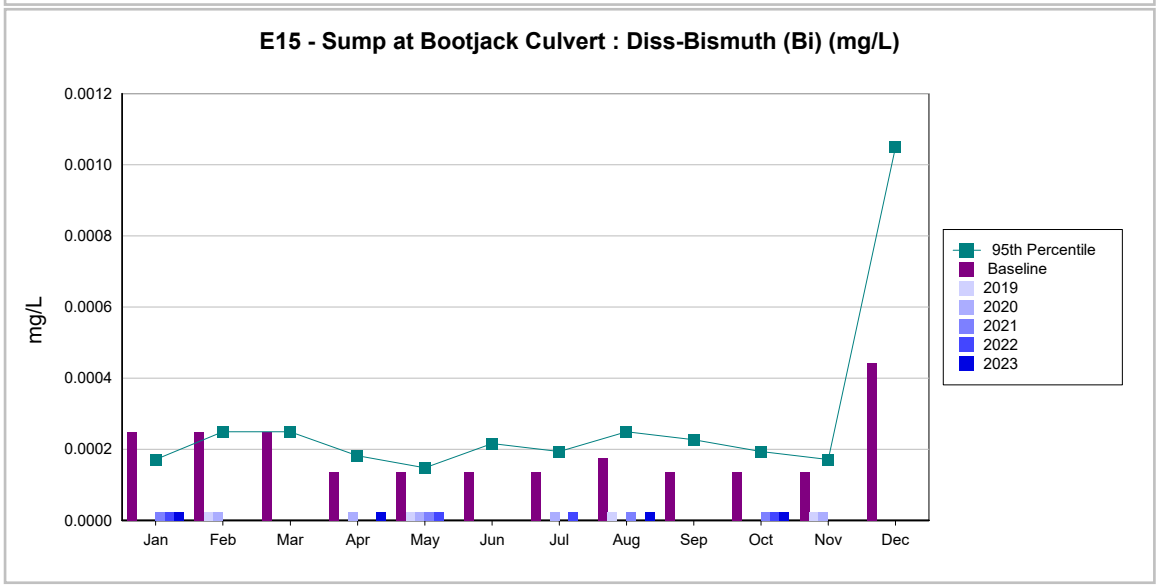
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







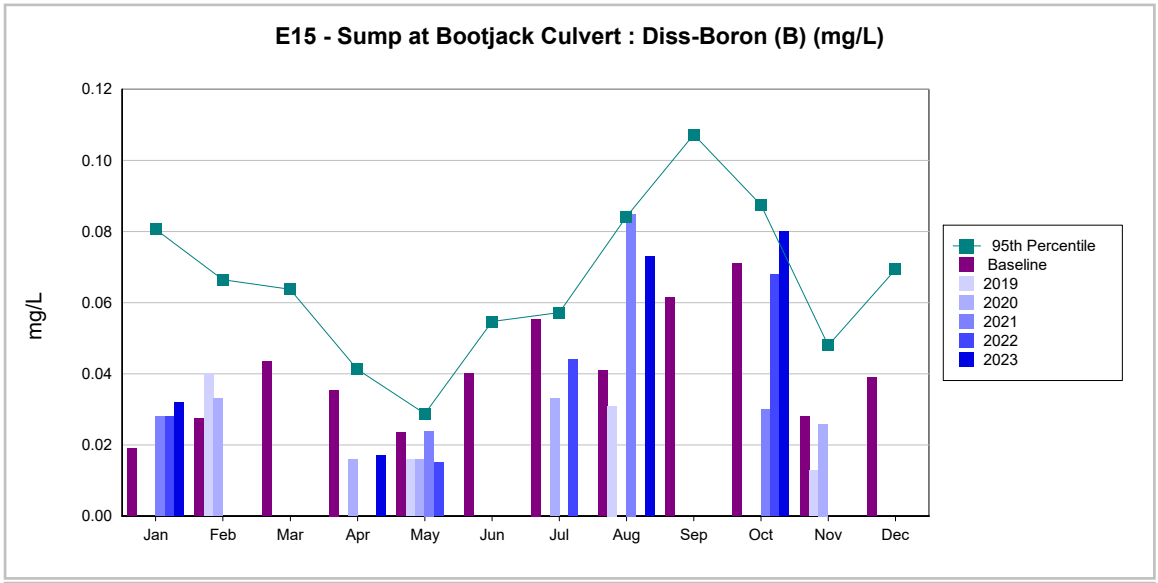
Water Quality Report

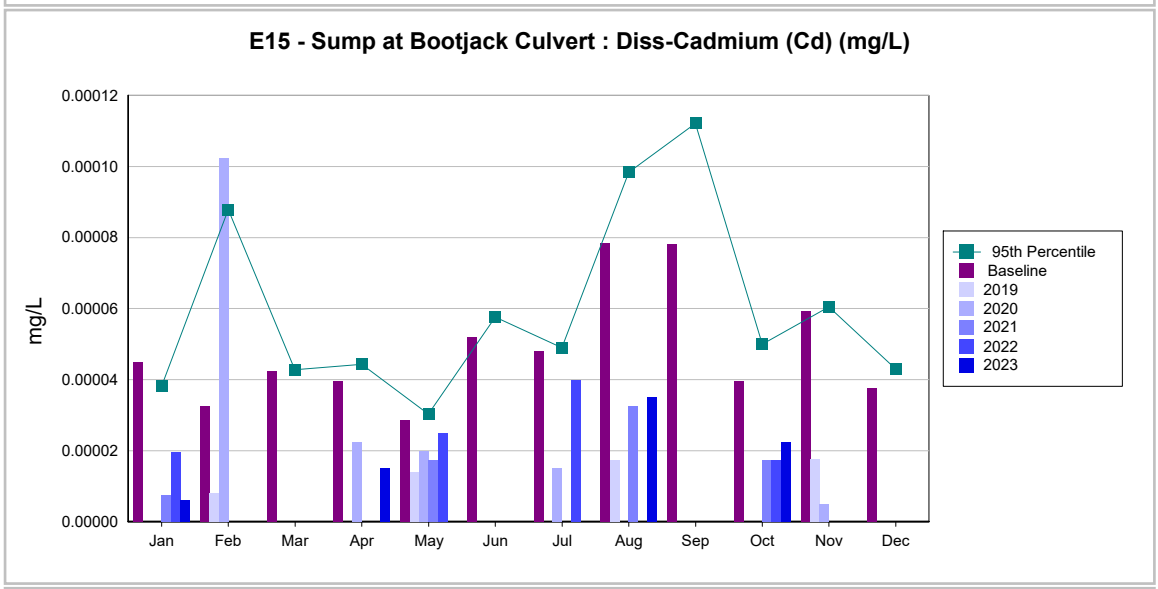
Annual Report Drainage Water

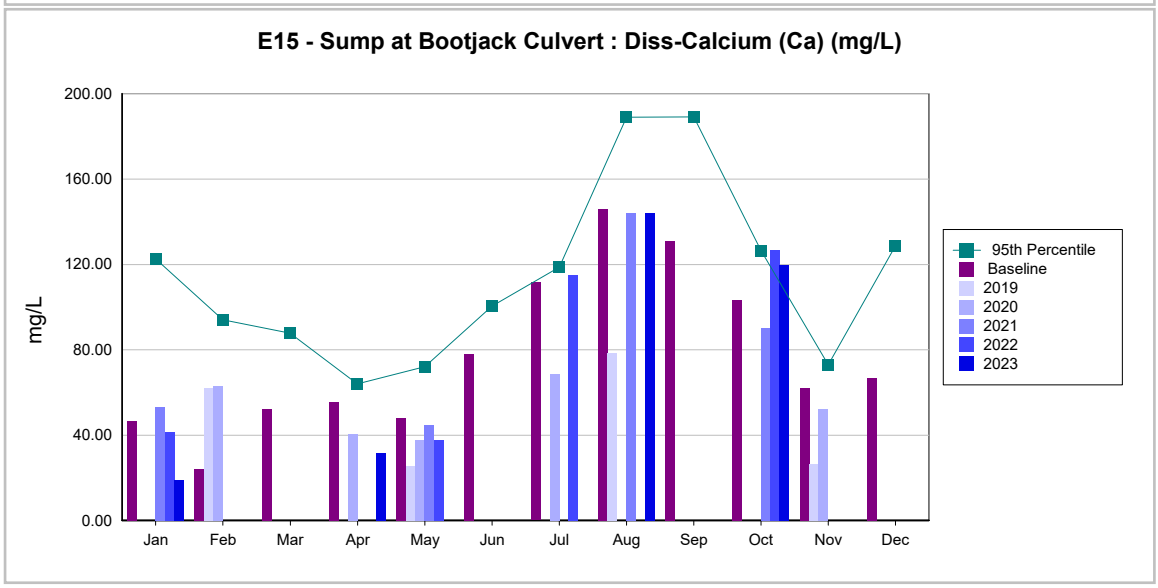
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







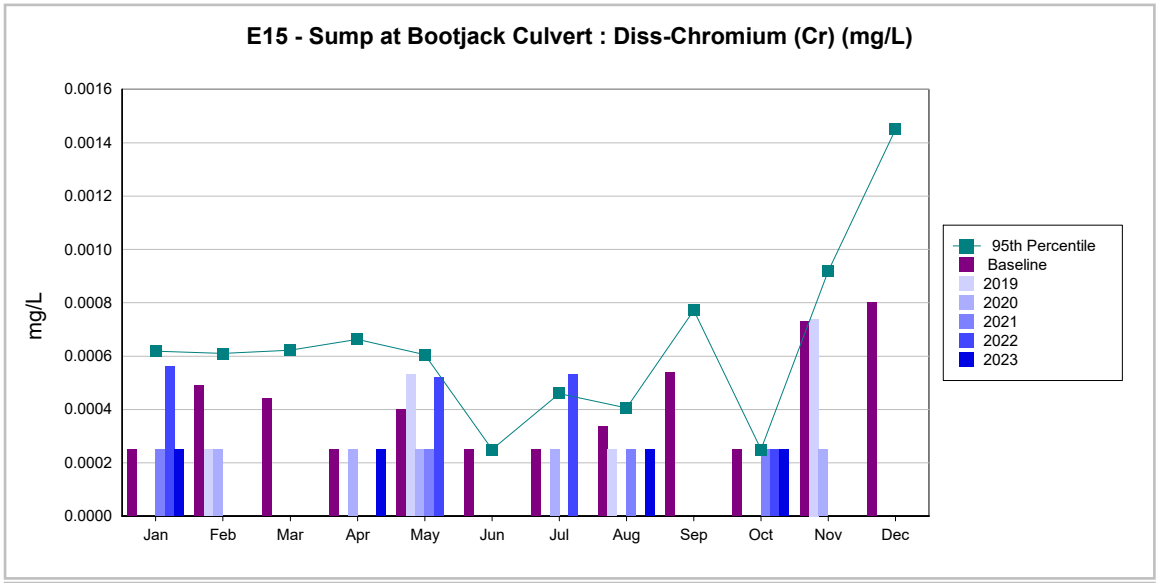
Water Quality Report

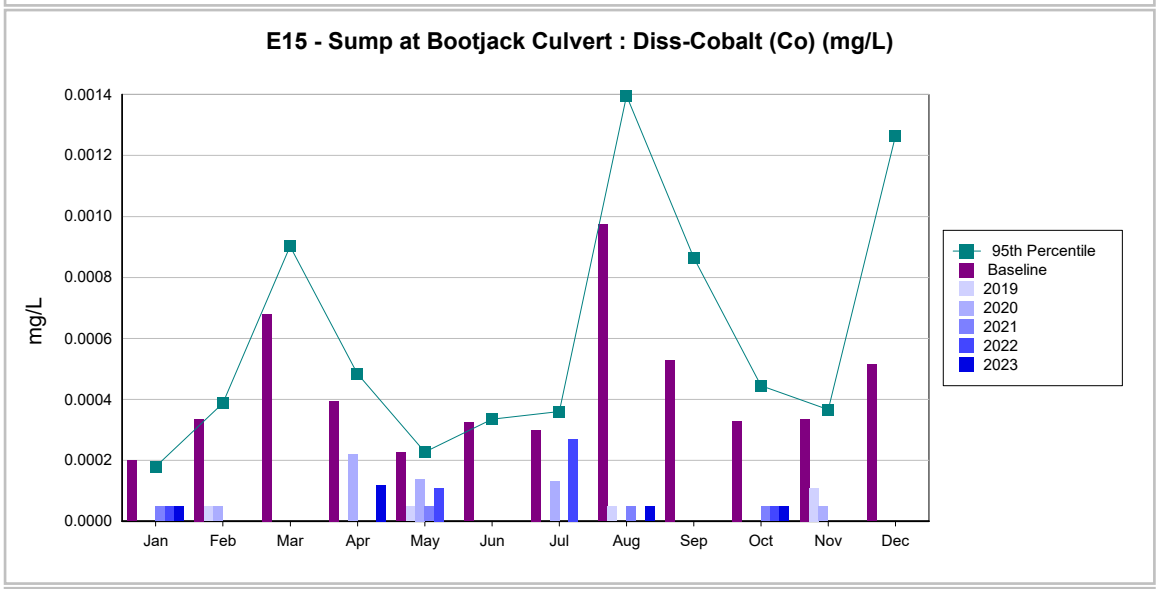
Annual Report Drainage Water

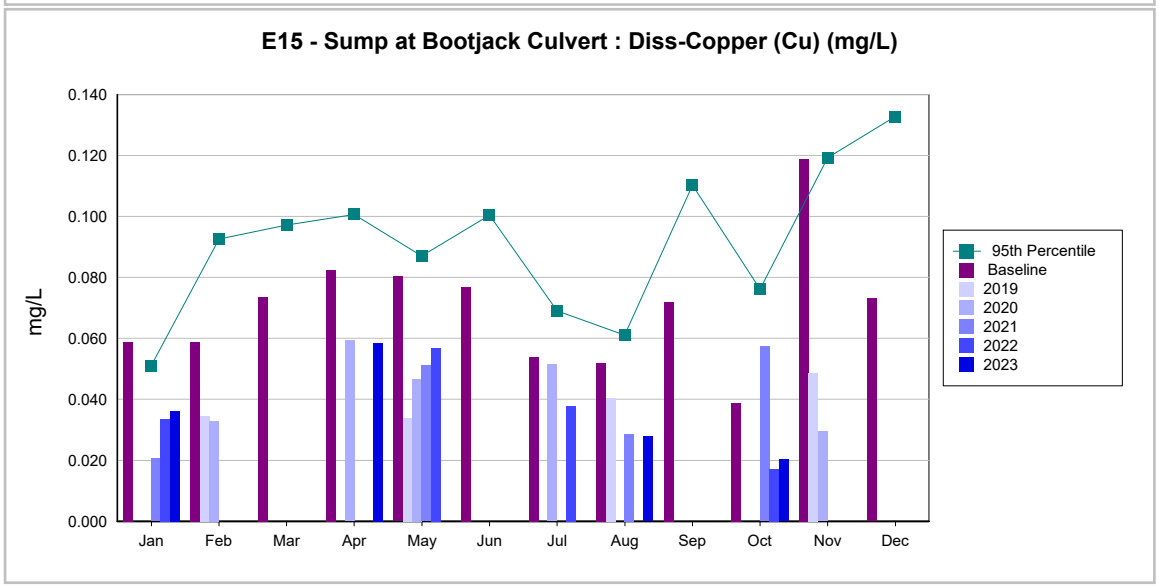
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







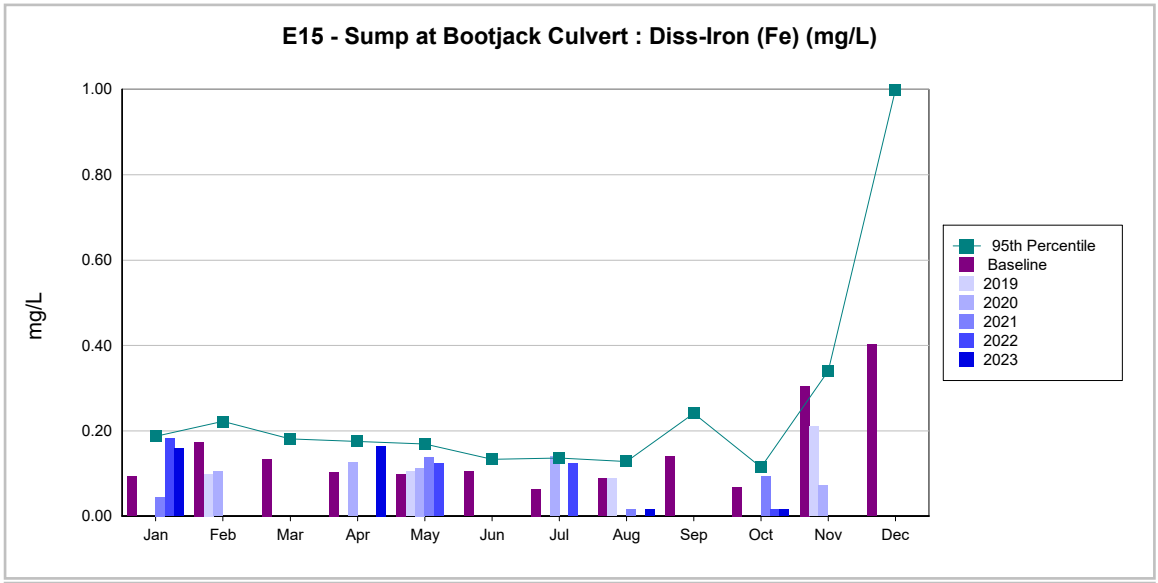
Water Quality Report

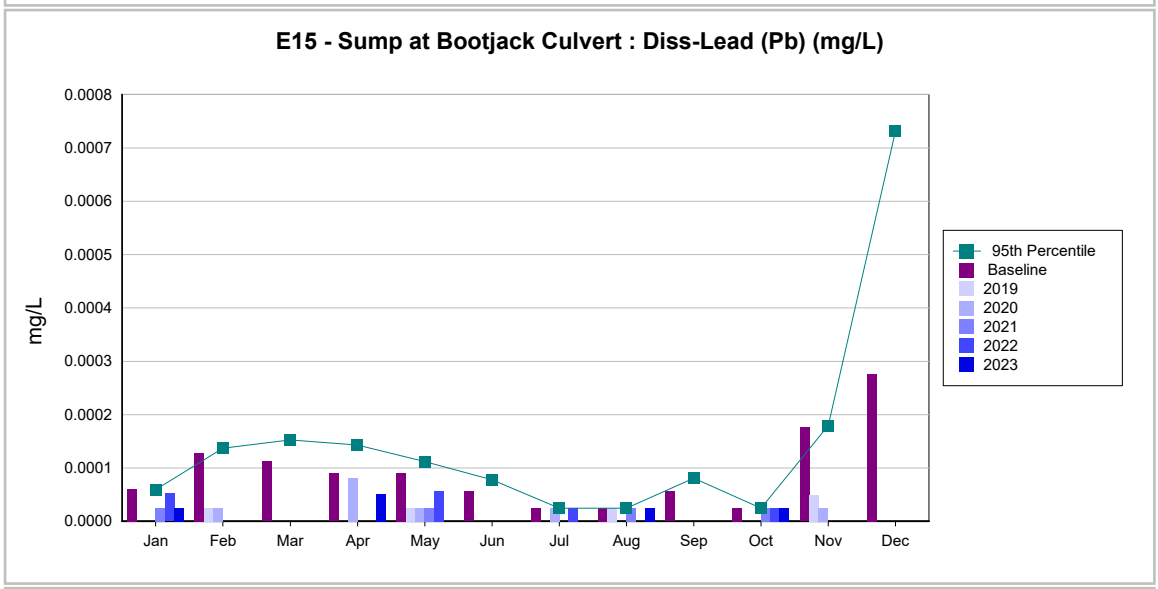
Annual Report Drainage Water

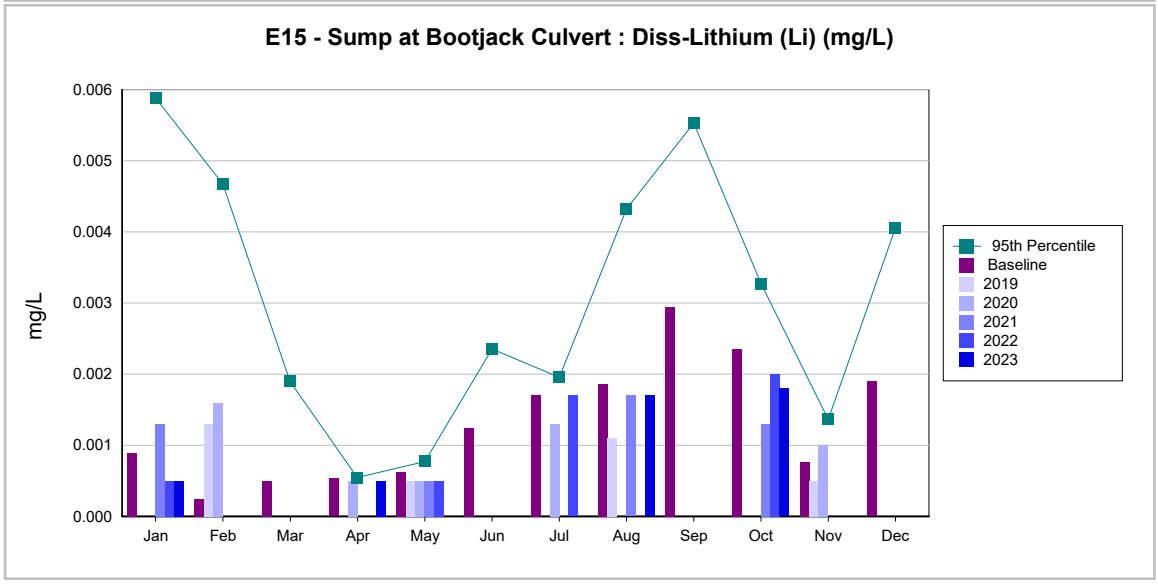
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







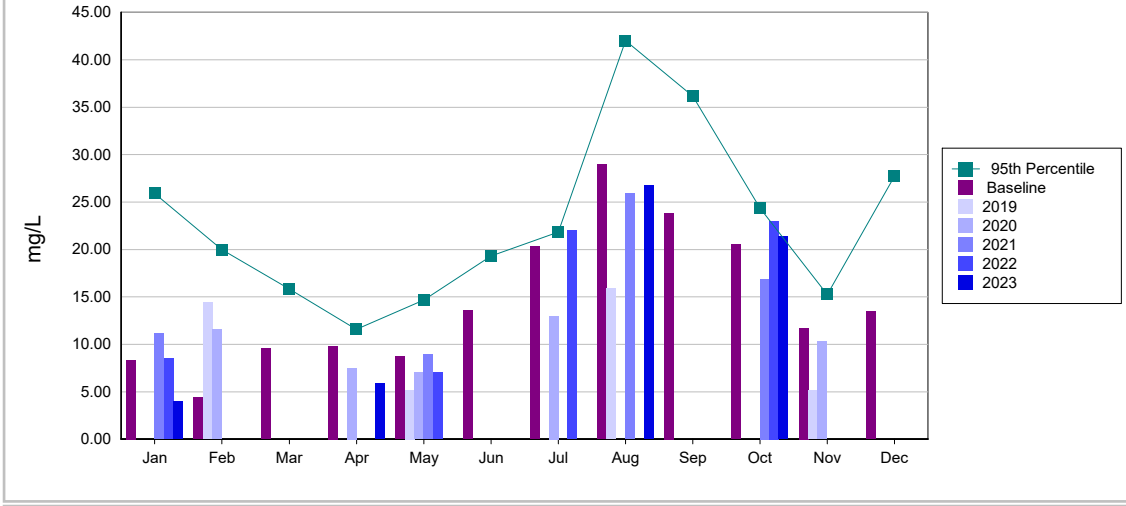
Water Quality Report

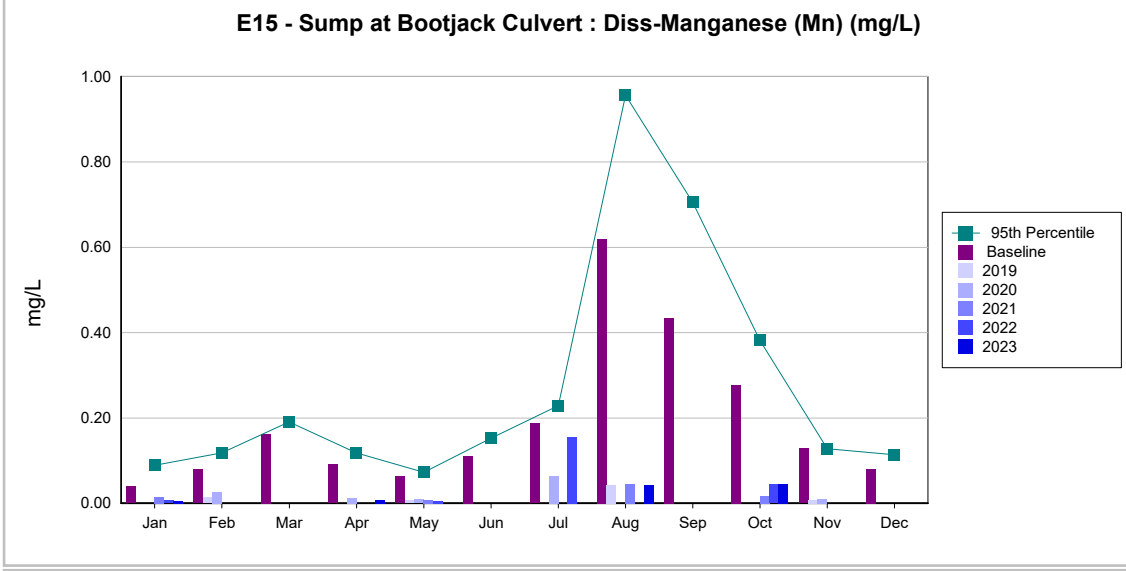
Annual Report Drainage Water

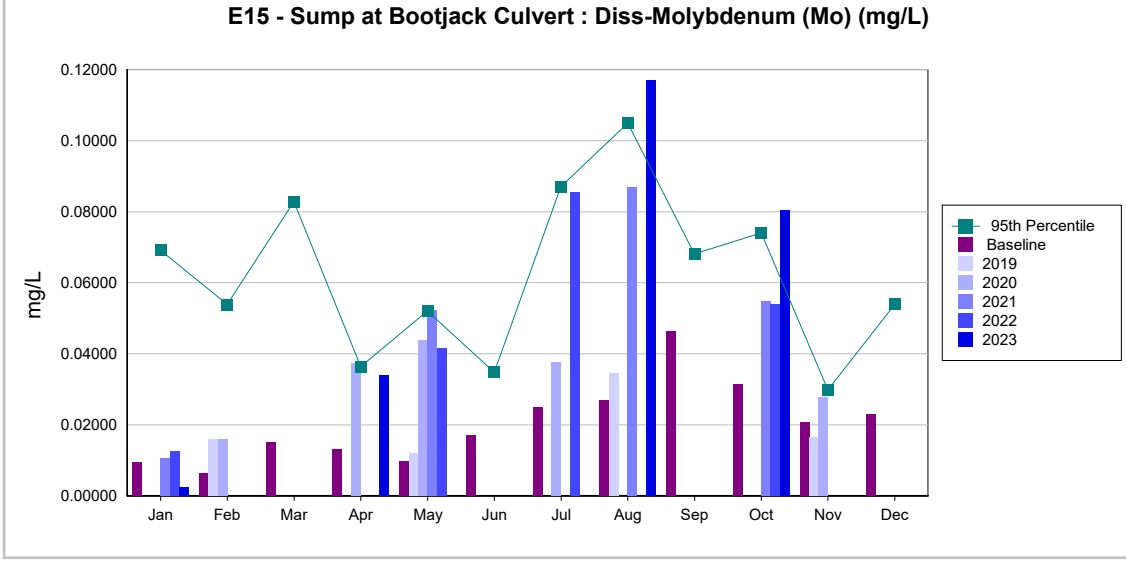
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







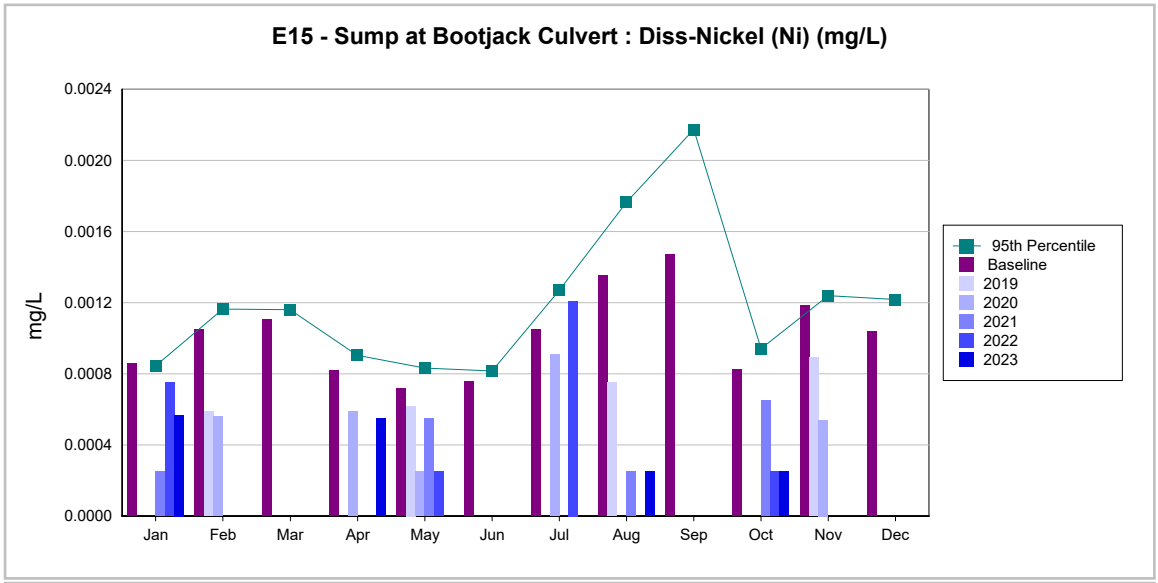
Water Quality Report

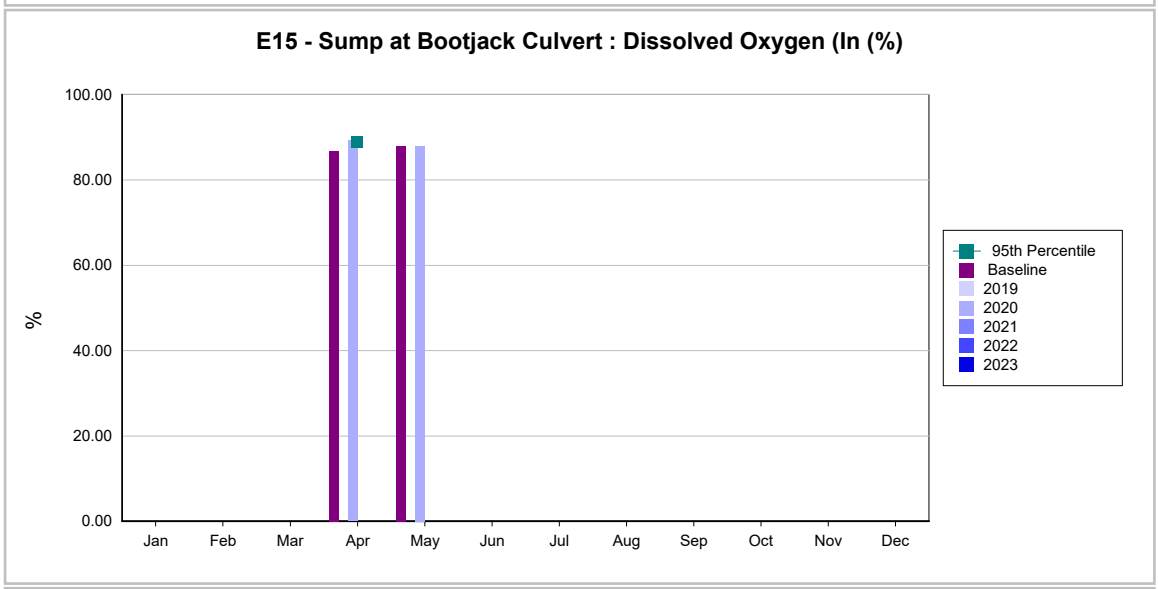
Annual Report Drainage Water

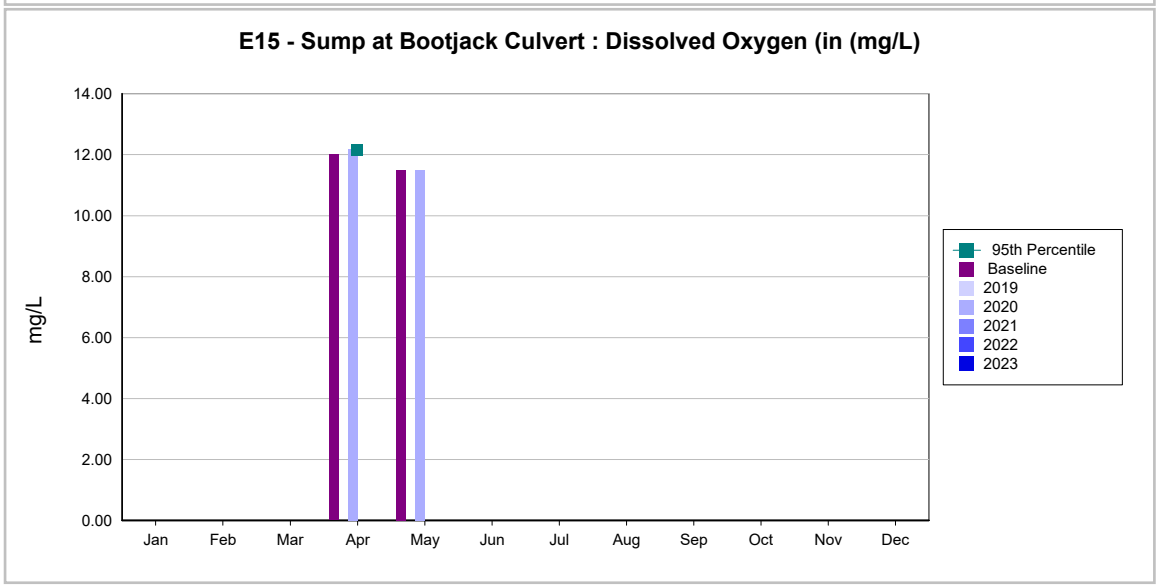
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







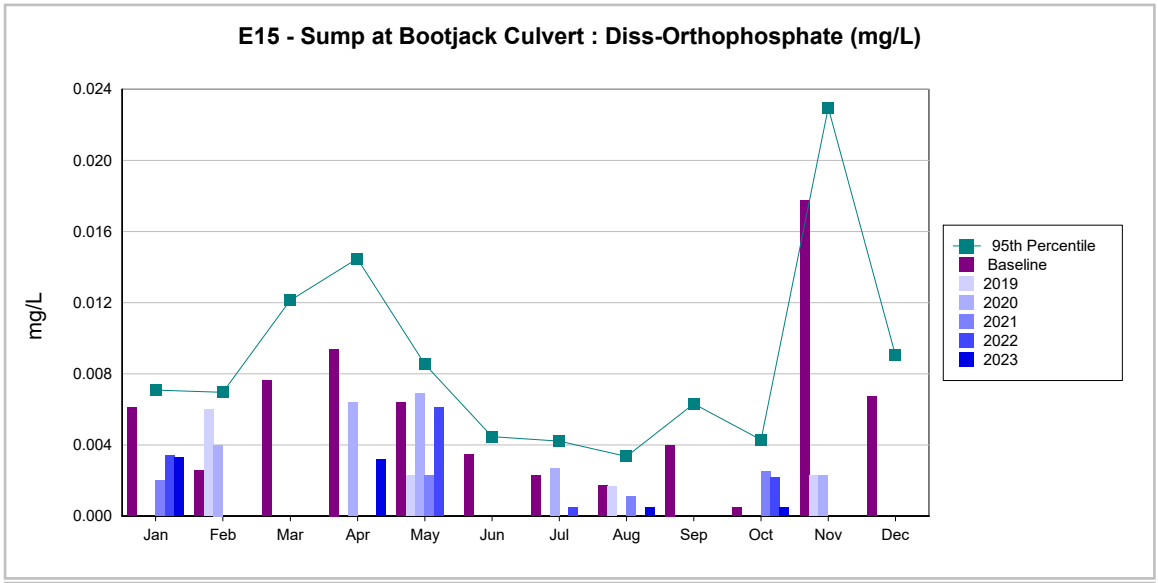
Water Quality Report

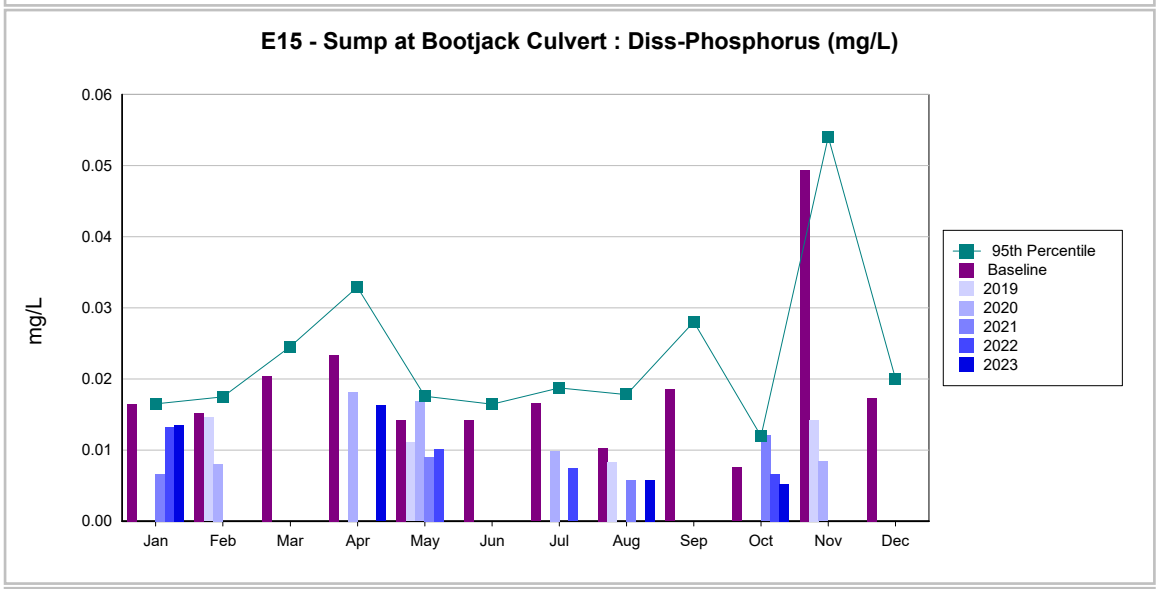
Annual Report Drainage Water

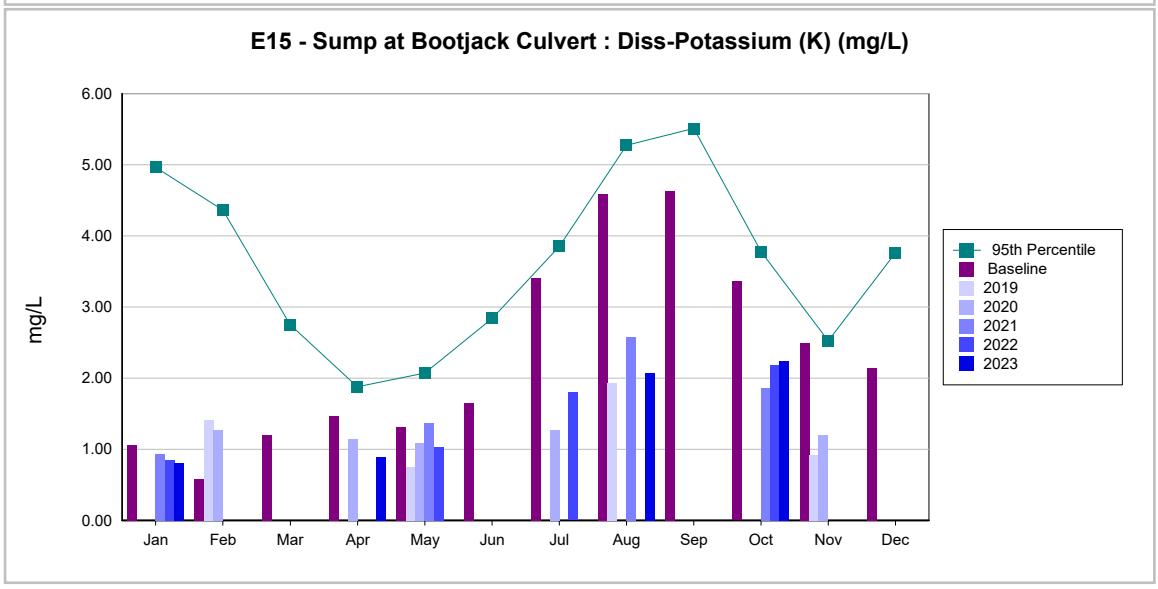
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

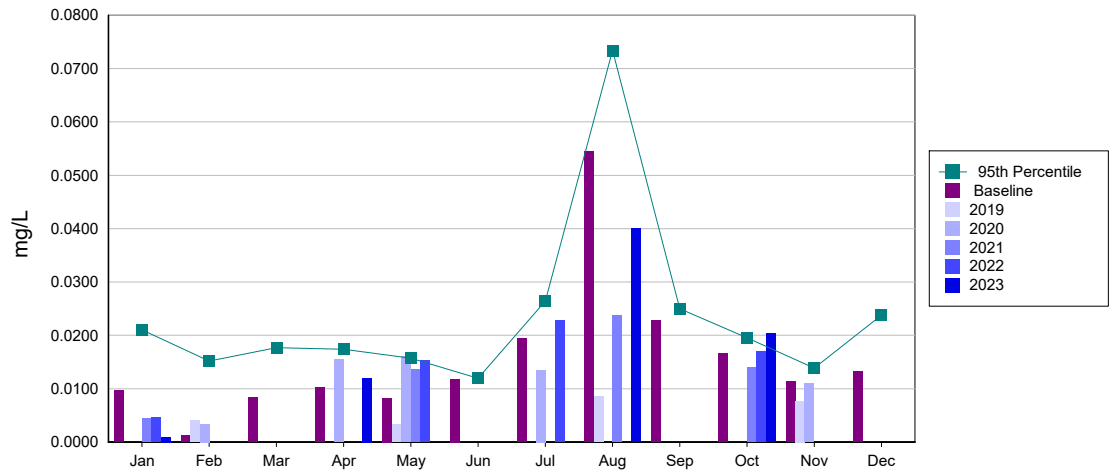
Annual Report Drainage Water

Mount Polley

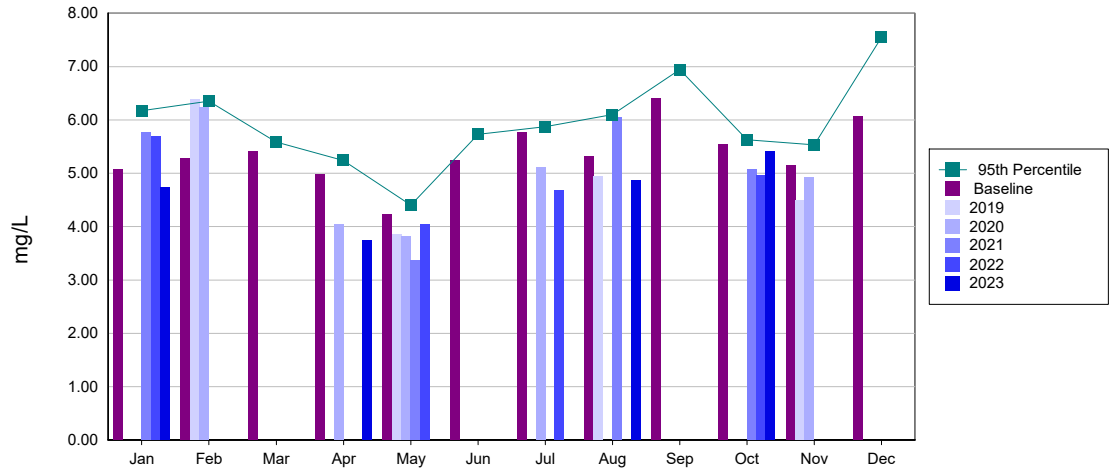
Mining Corporation

IMPERIAL METALS CORPORATION

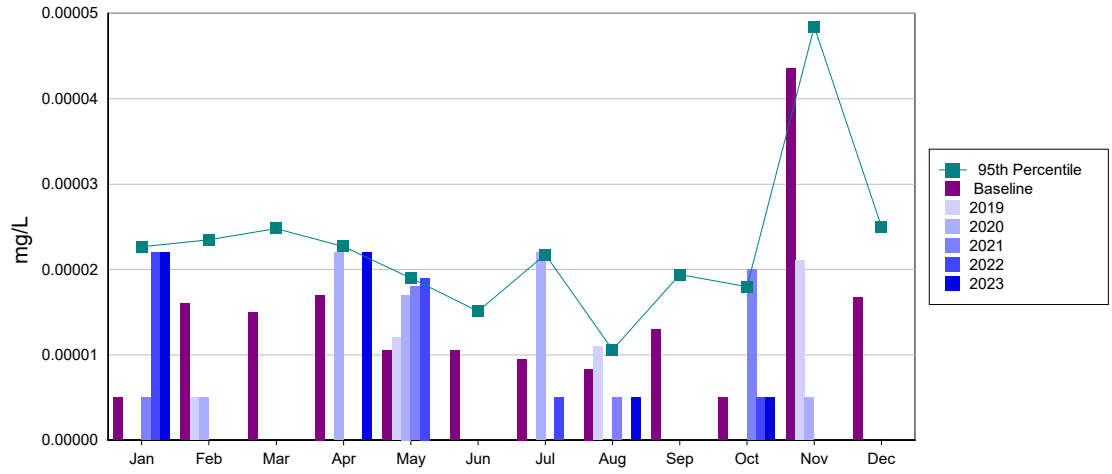
E15 - Sump at Bootjack Culvert : Diss-Selenium (mg/L)



E15 - Sump at Bootjack Culvert : Diss-Silicon (Si) (mg/L)



E15 - Sump at Bootjack Culvert : Diss-Silver (Ag) (mg/L)



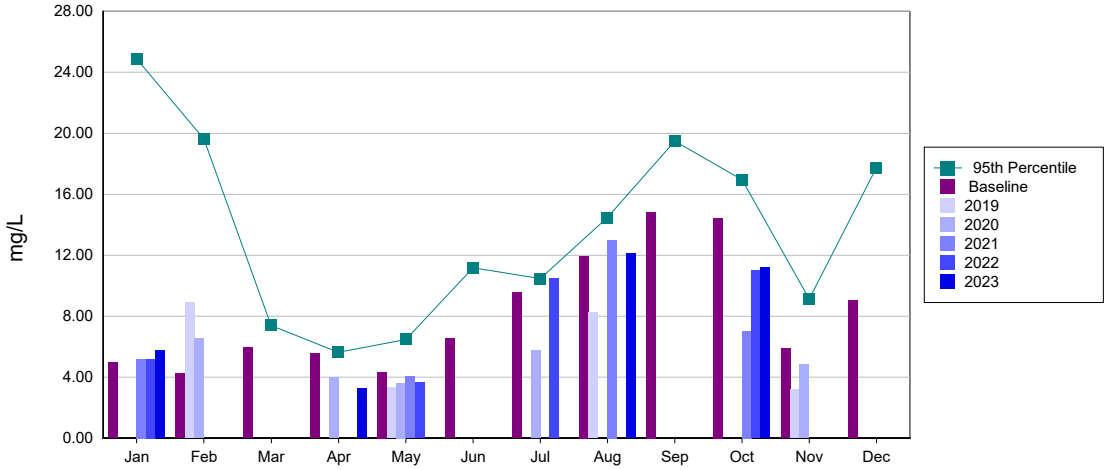
Water Quality Report

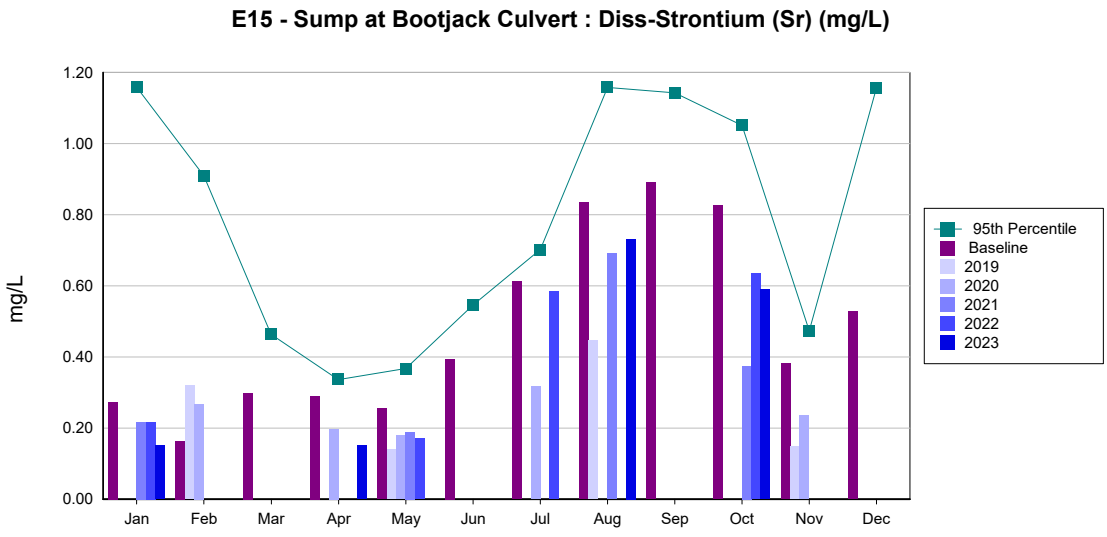
Annual Report Drainage Water

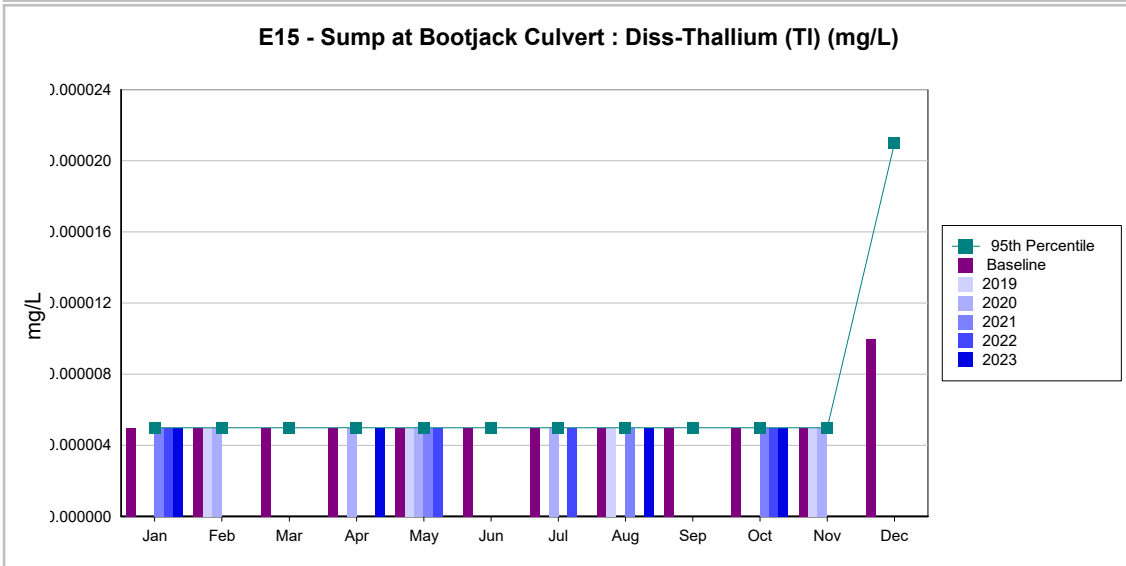
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







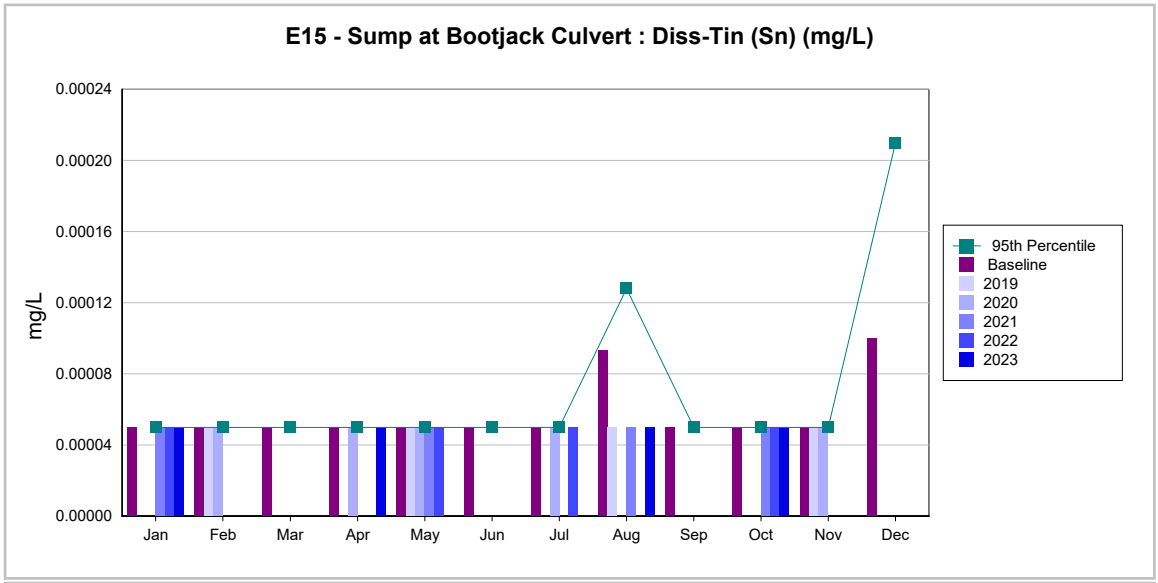
Water Quality Report

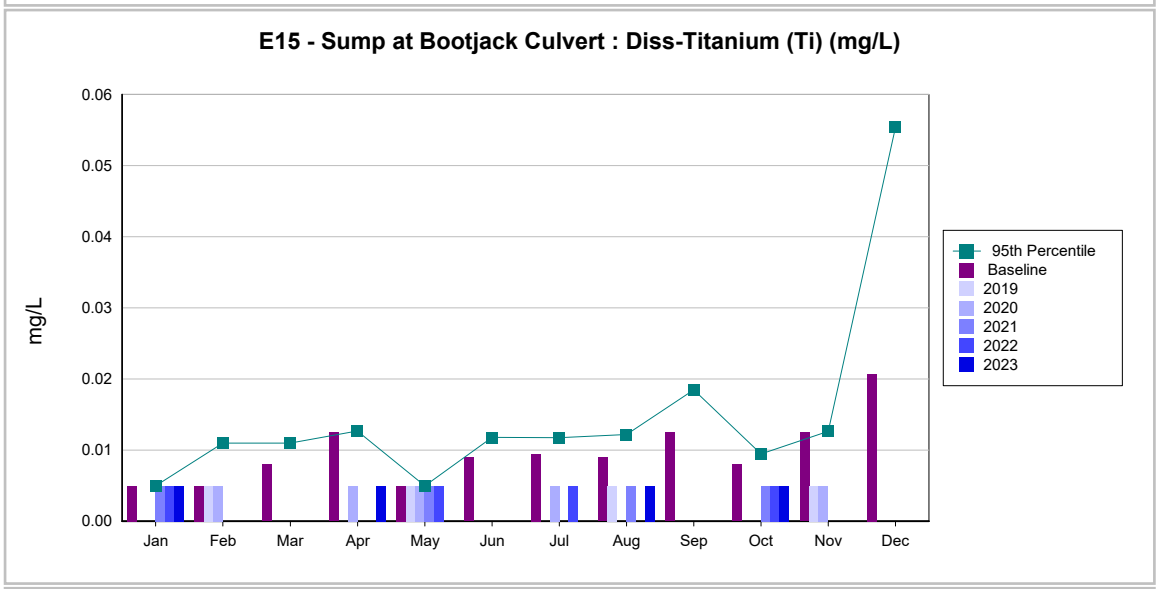
Annual Report Drainage Water

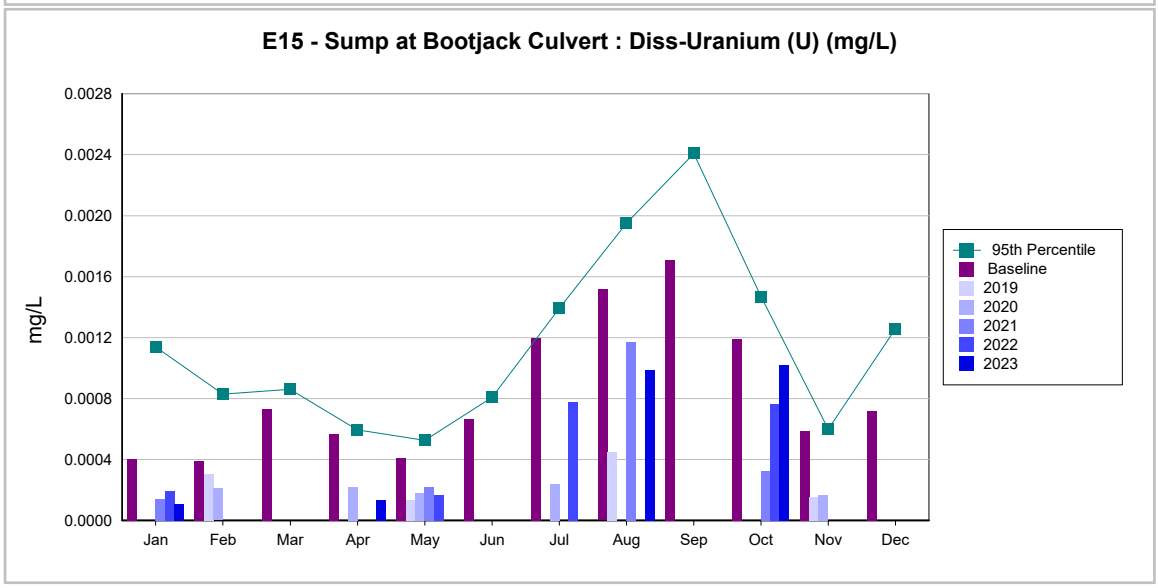
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







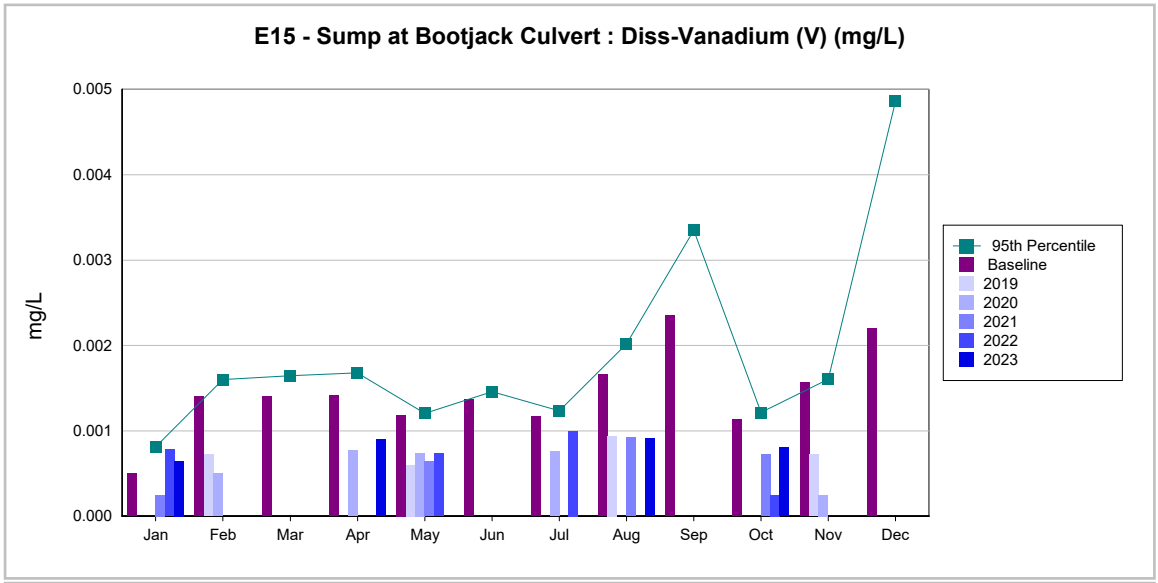
Water Quality Report

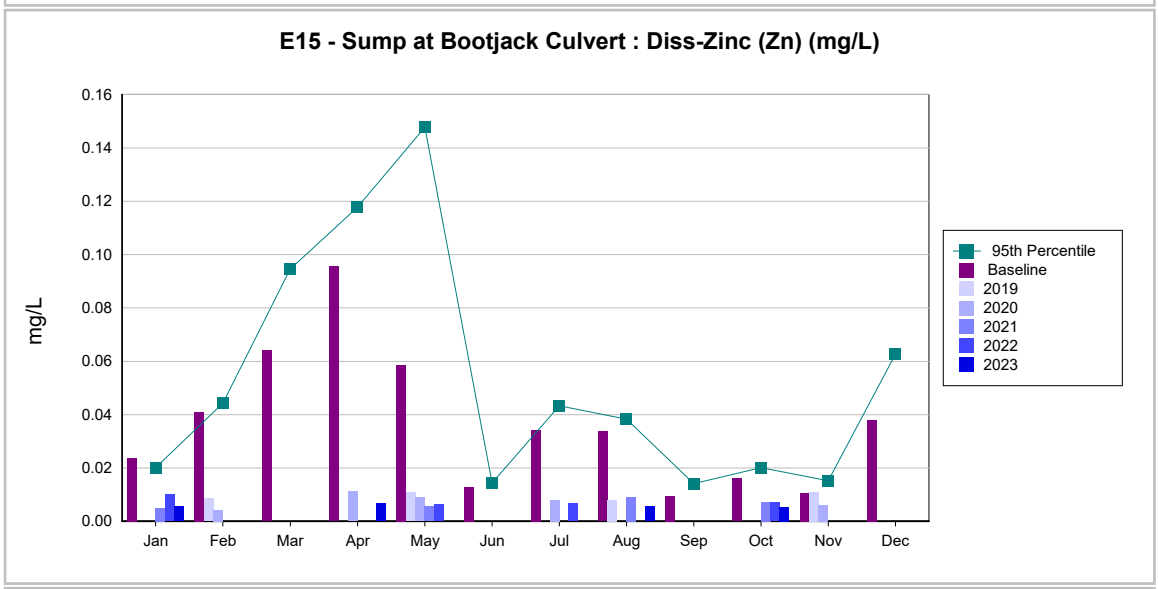
Annual Report Drainage Water

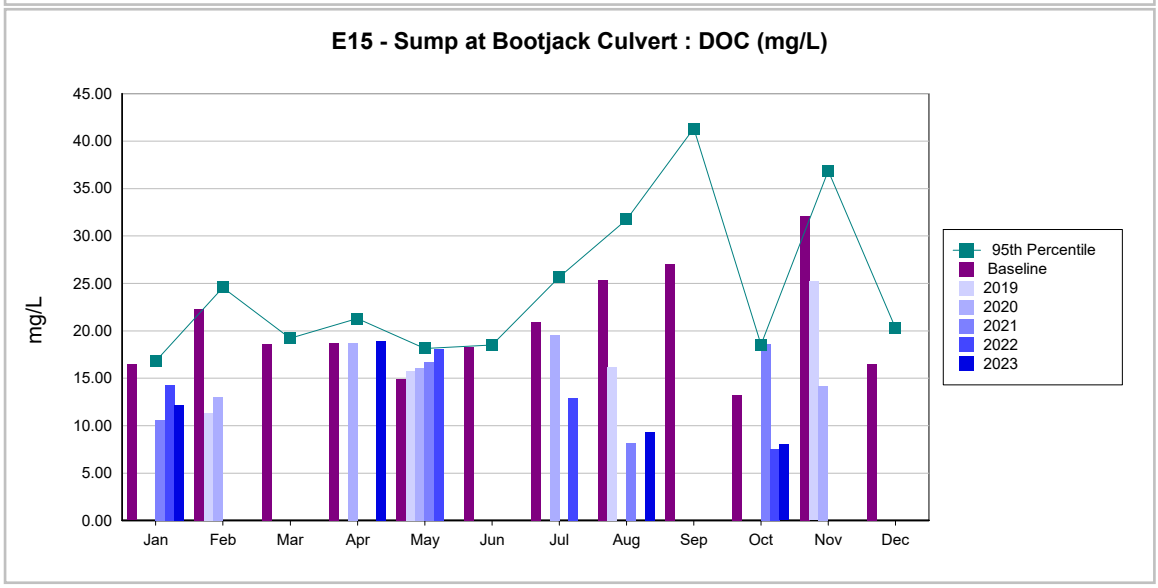
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

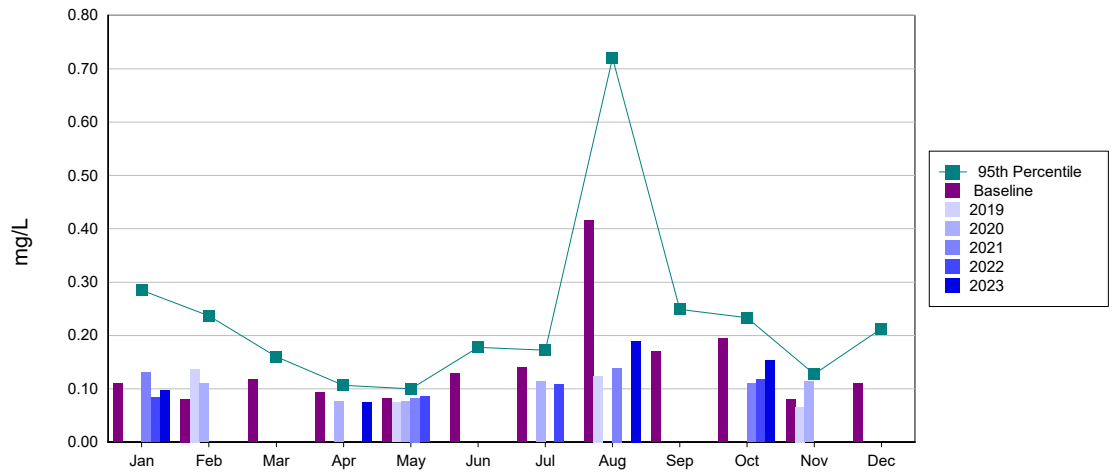
Annual Report Drainage Water

Mount Polley

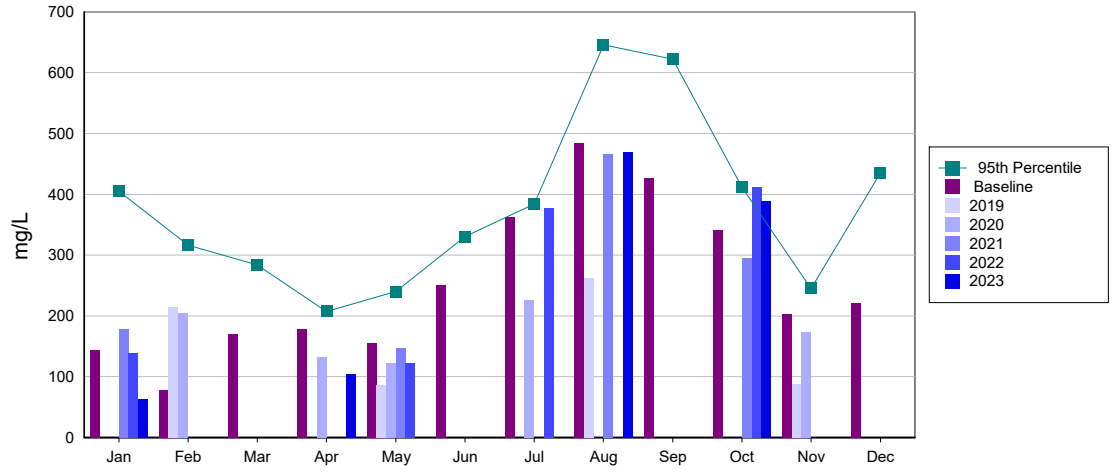
Mining Corporation

IMPERIAL METALS CORPORATION

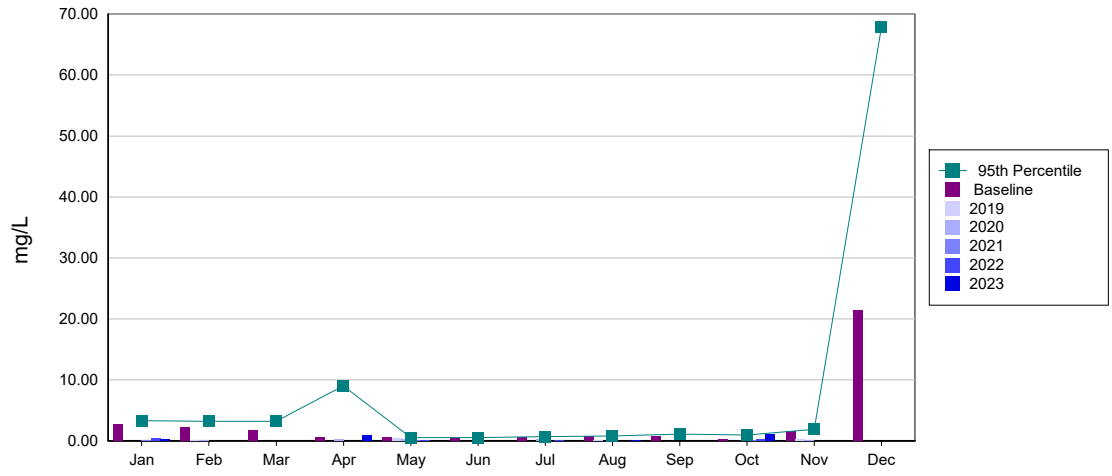
E15 - Sump at Bootjack Culvert : Floride (mg/L)



E15 - Sump at Bootjack Culvert : Hardness (mg/L)



E15 - Sump at Bootjack Culvert : Iron (Fe)-Total (mg/L)



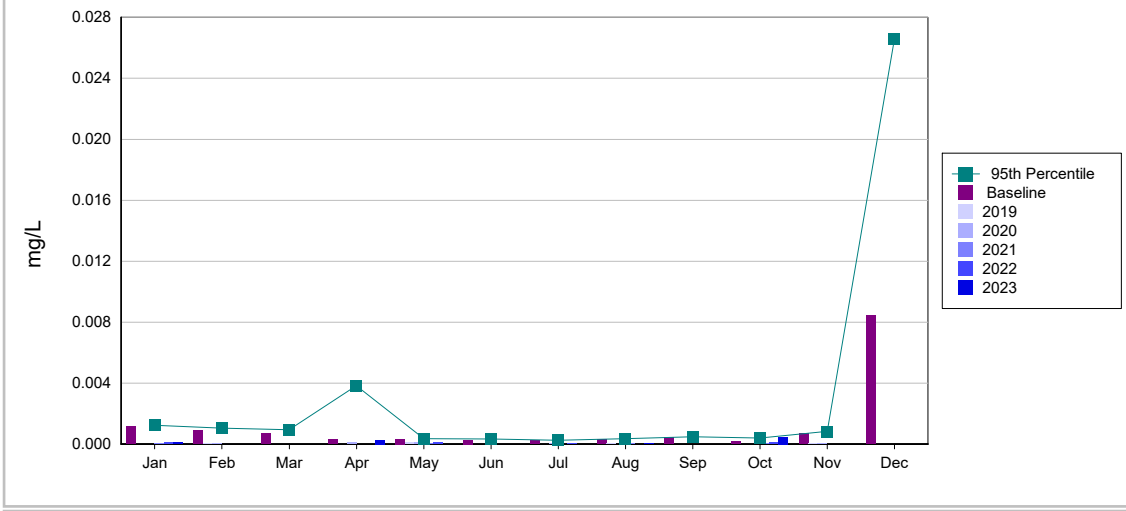
Water Quality Report

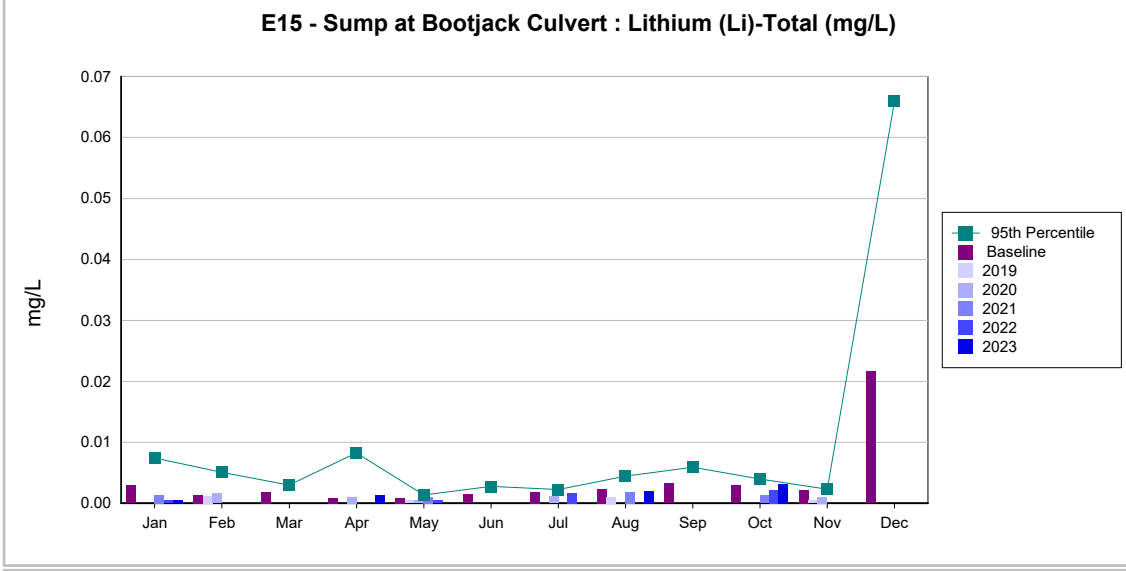
Annual Report Drainage Water

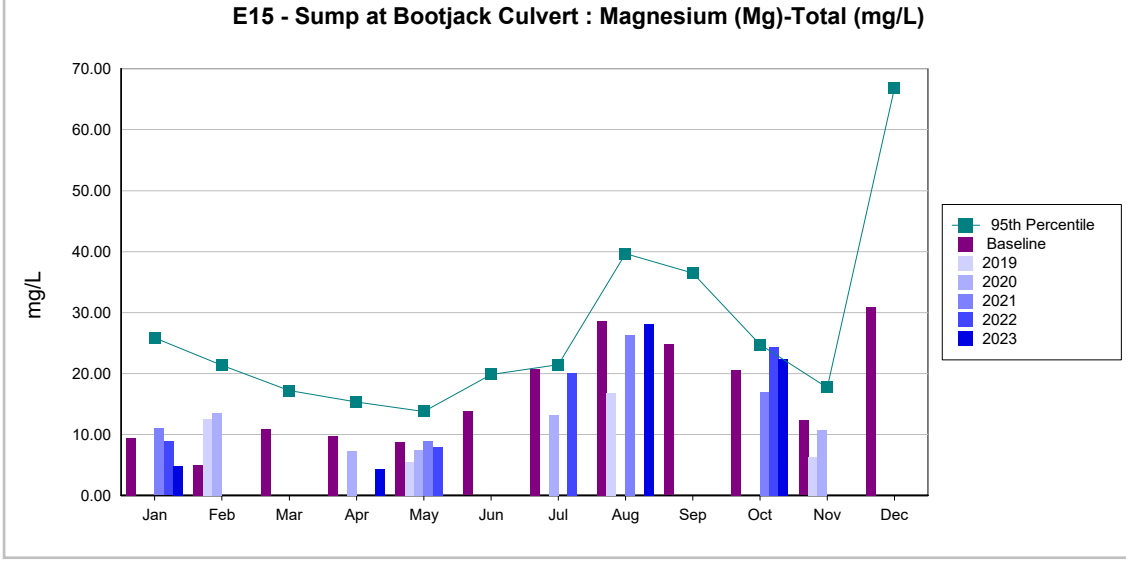
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







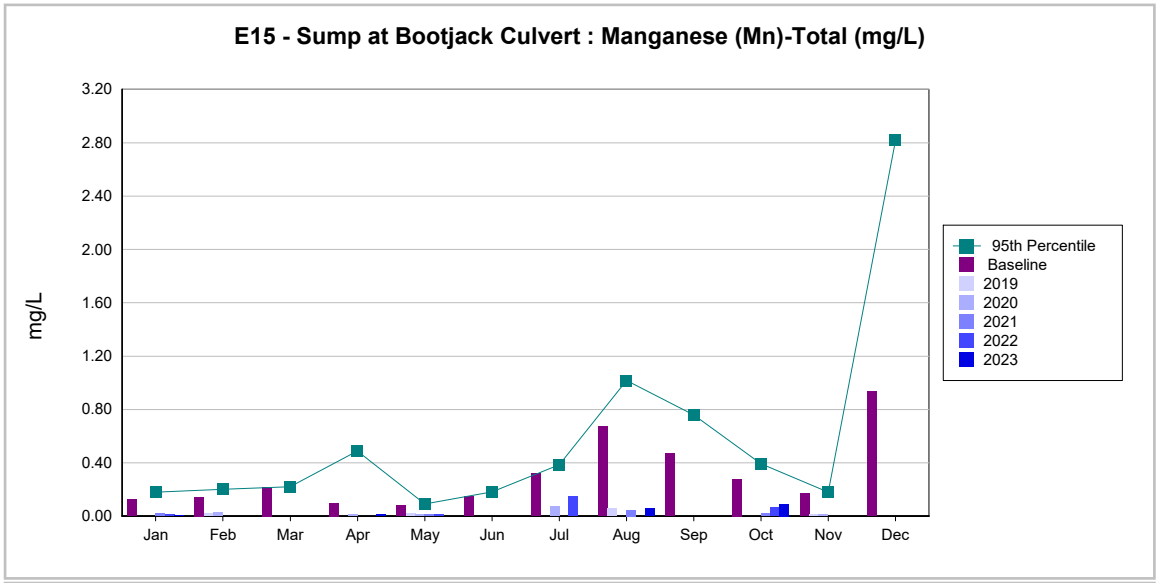
Water Quality Report

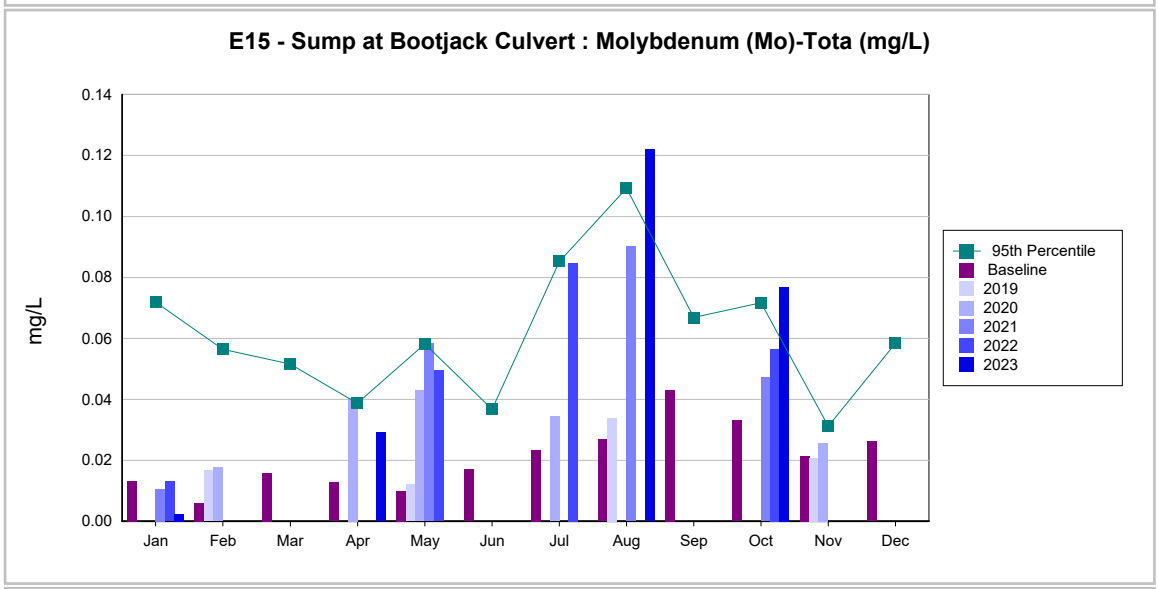
Annual Report Drainage Water

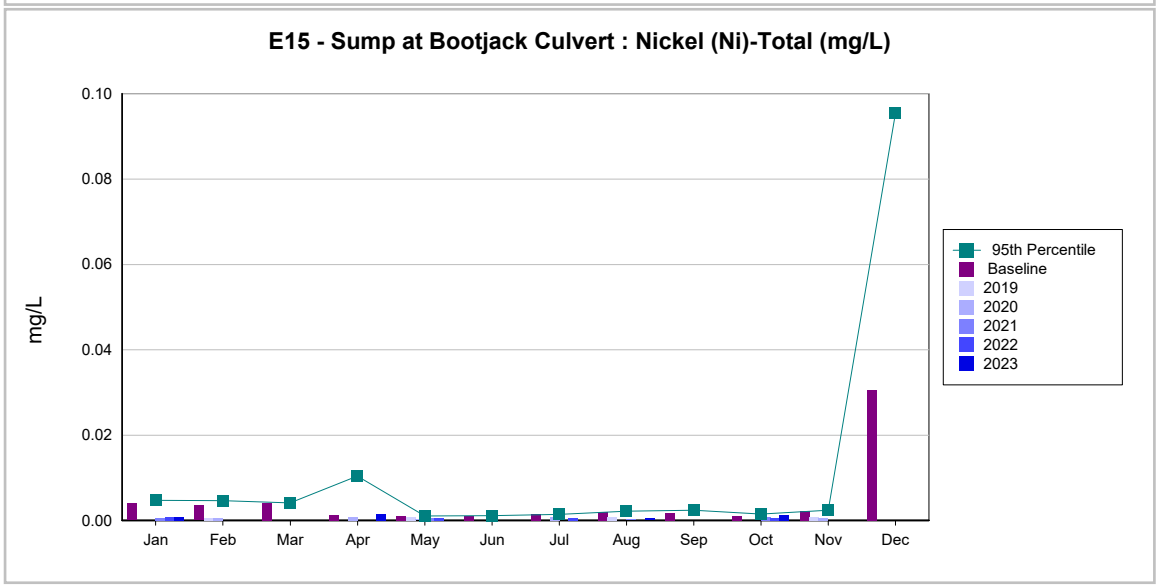
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







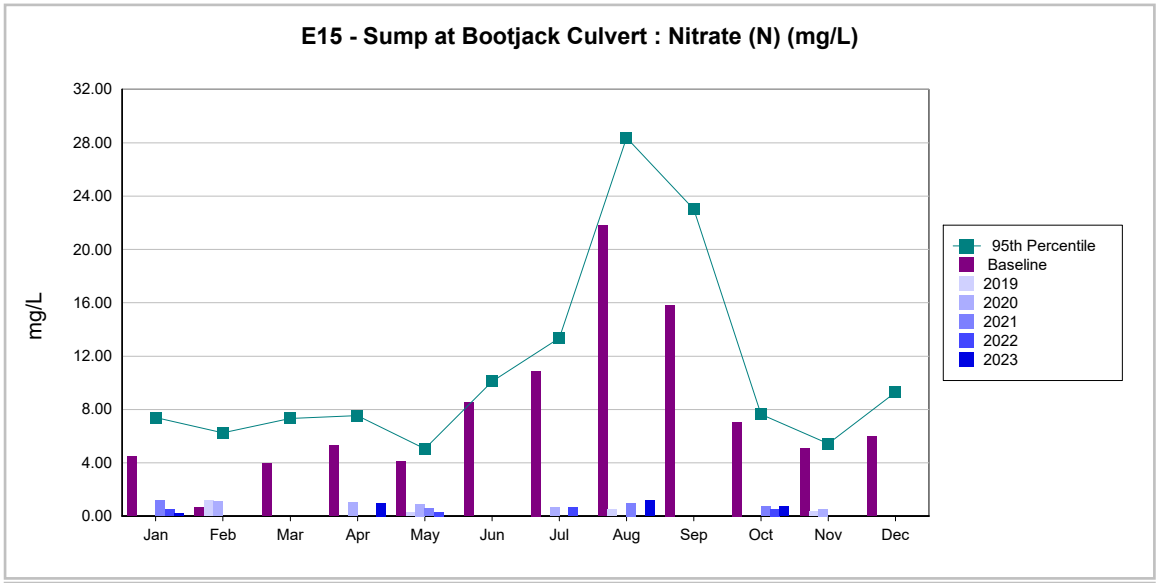
Water Quality Report

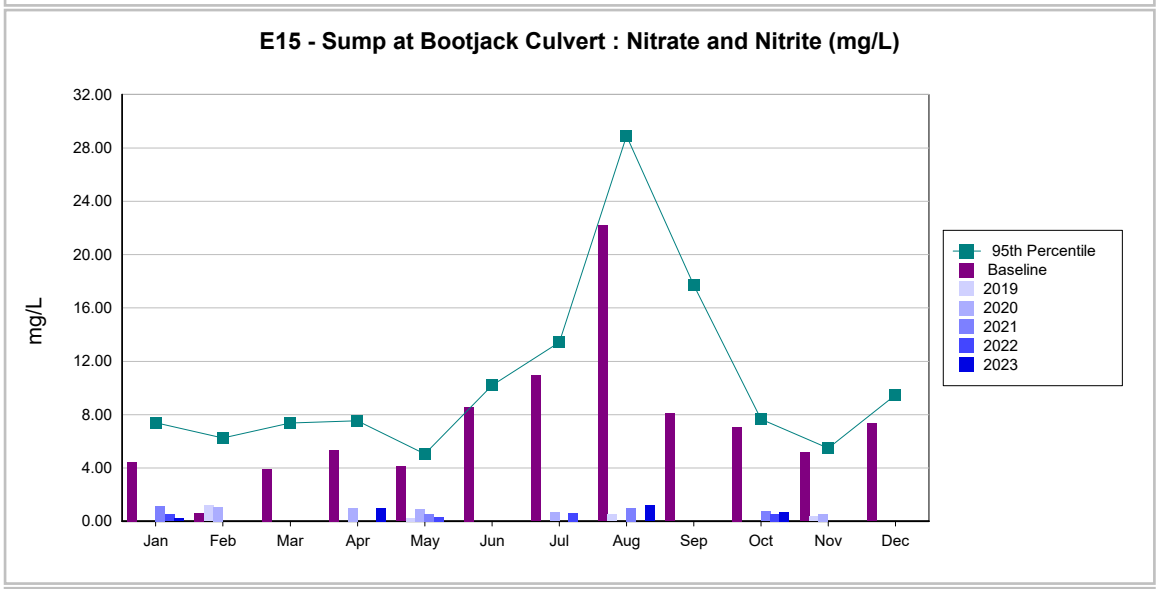
Annual Report Drainage Water

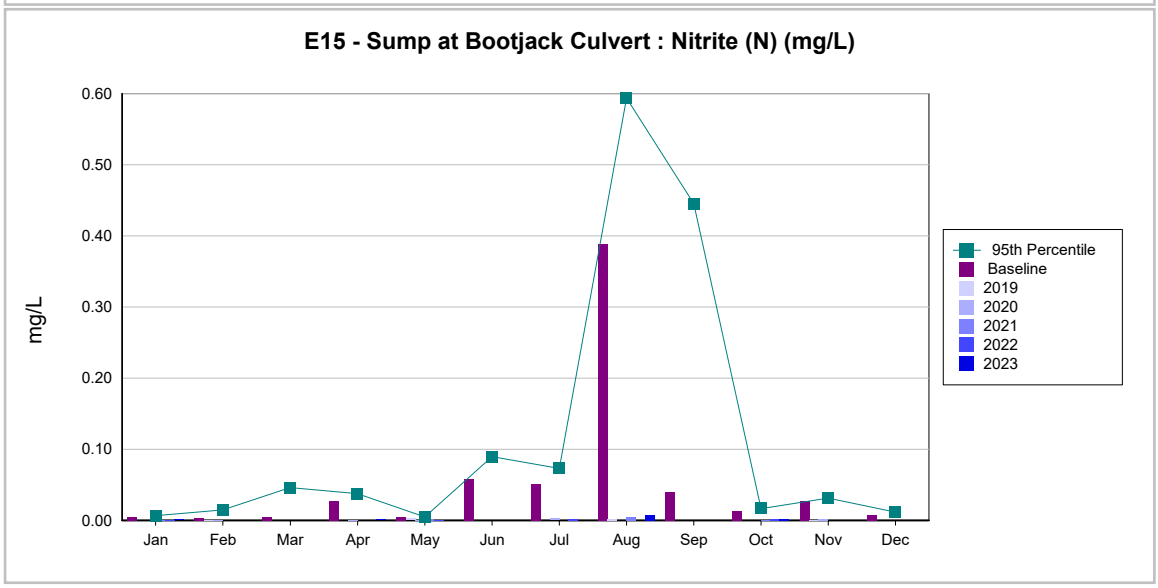
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







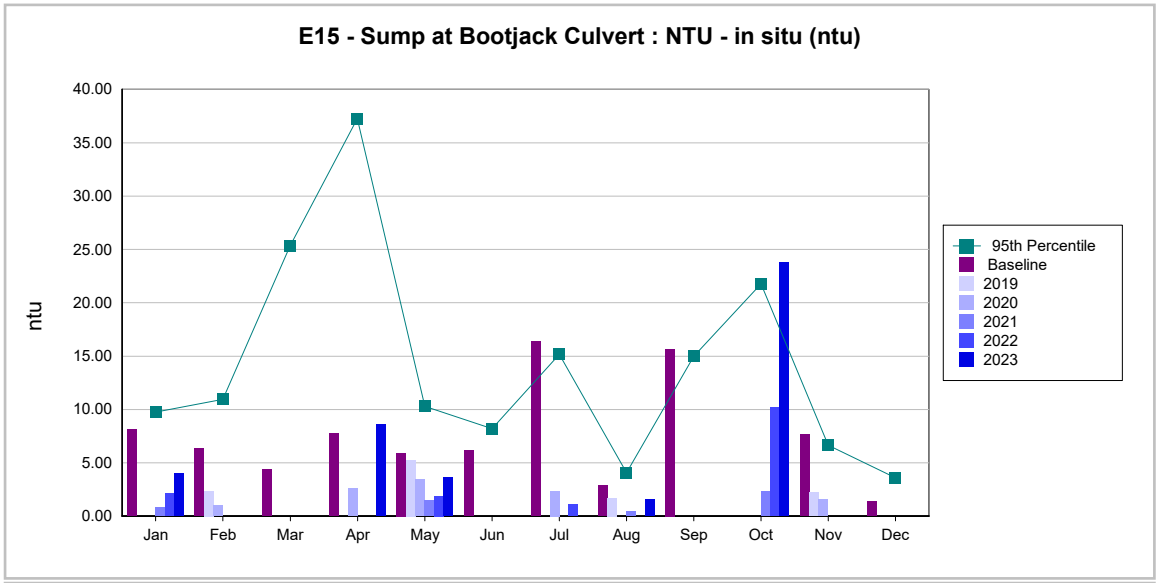
Water Quality Report

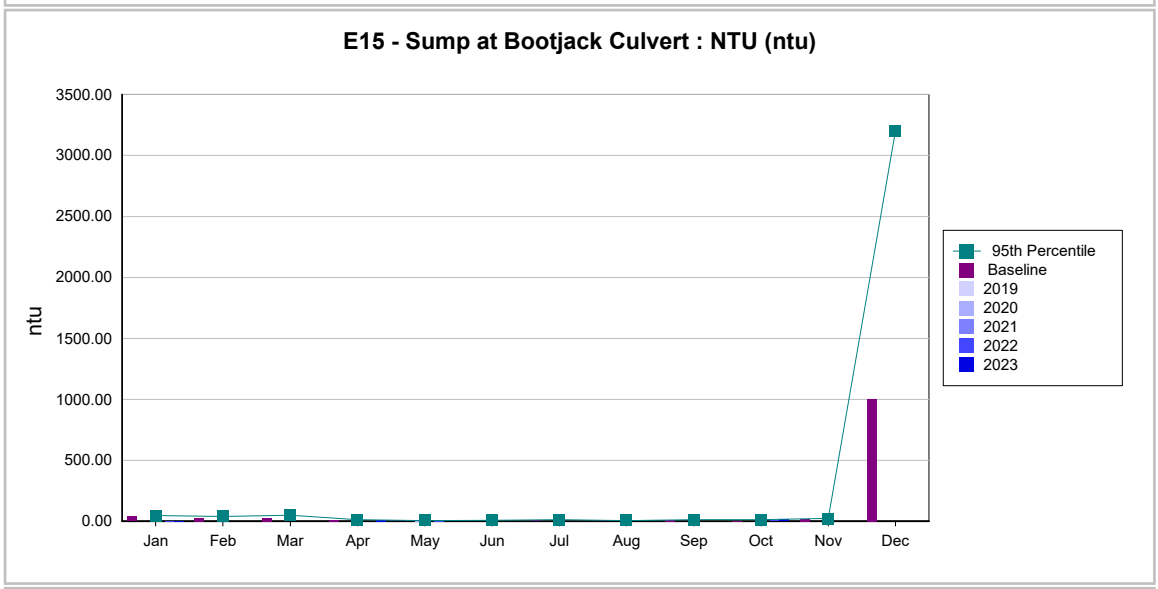
Annual Report Drainage Water

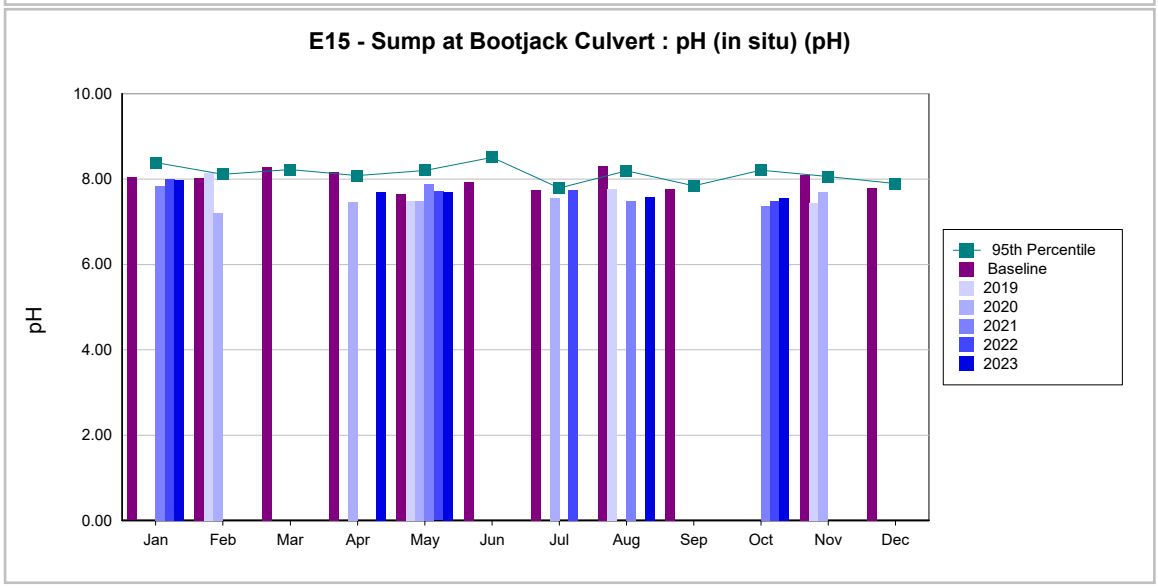
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







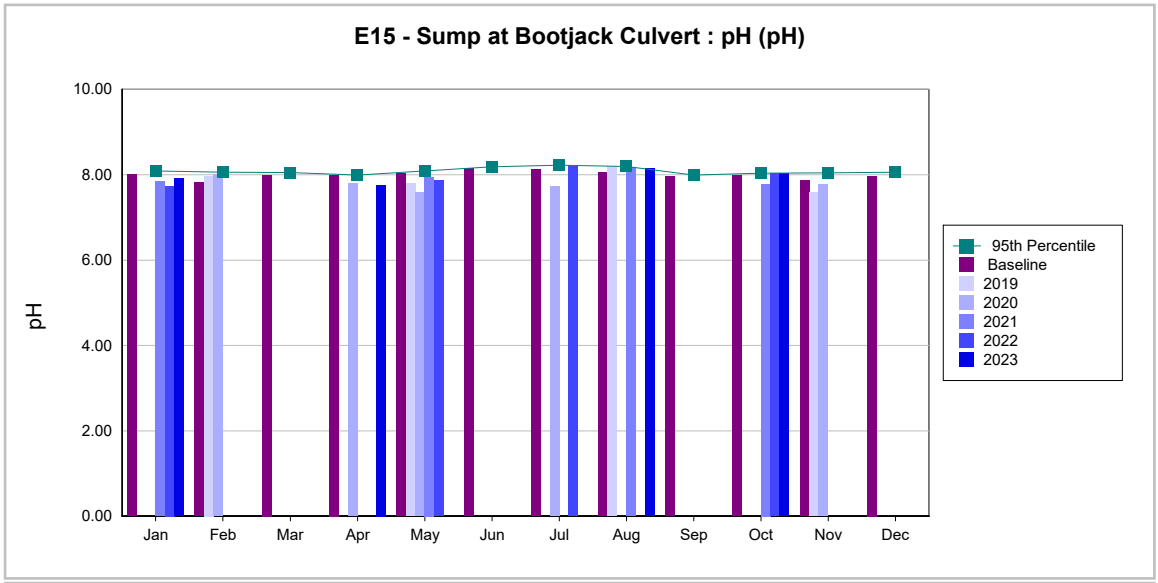
Water Quality Report

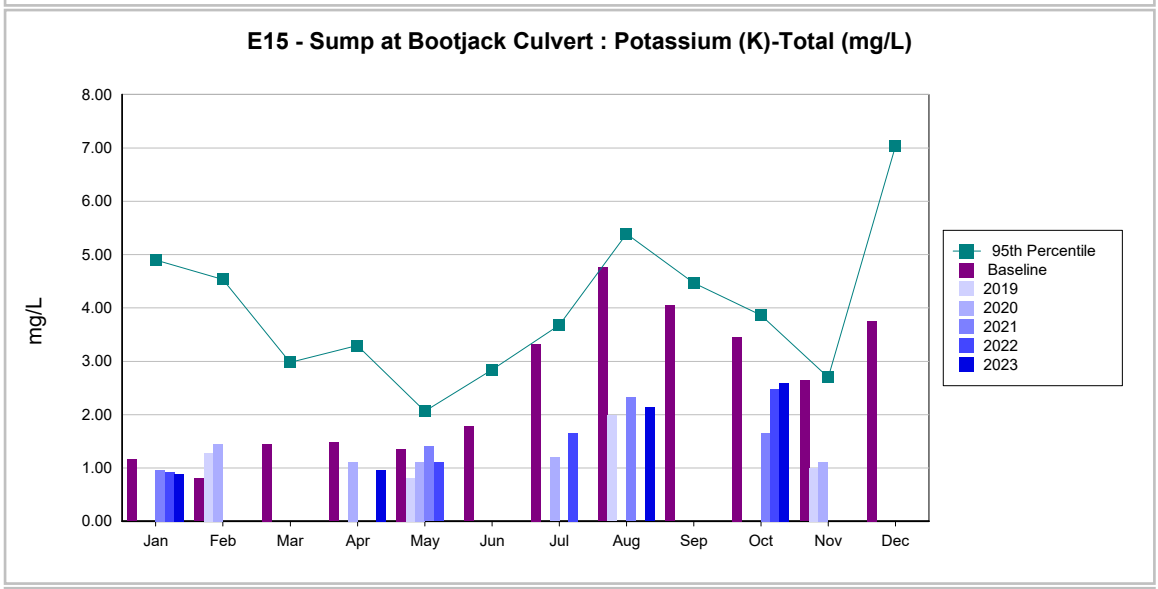
Annual Report Drainage Water

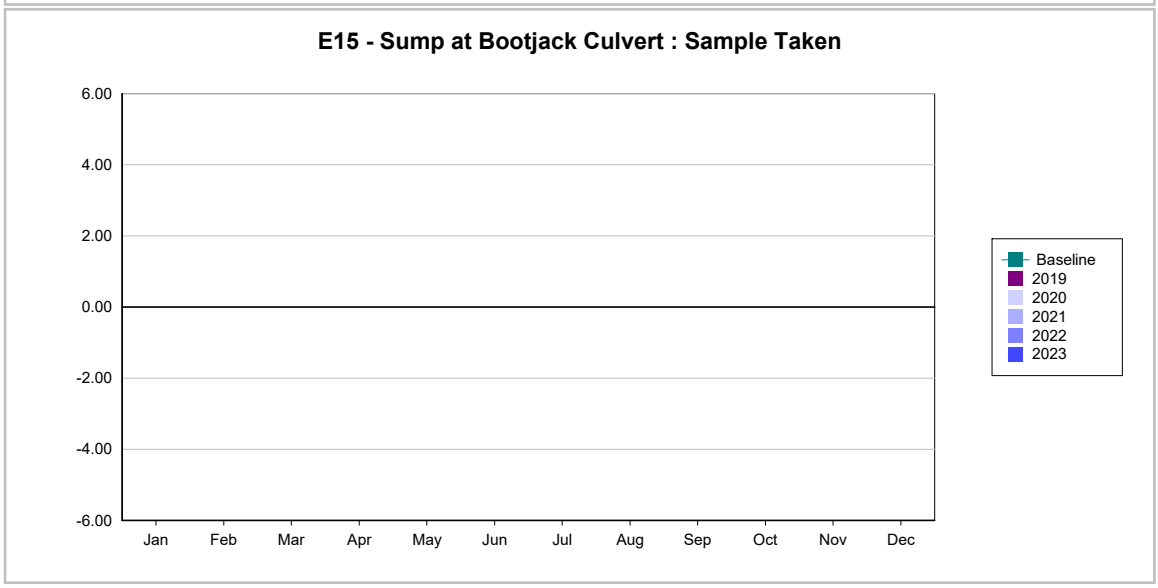
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







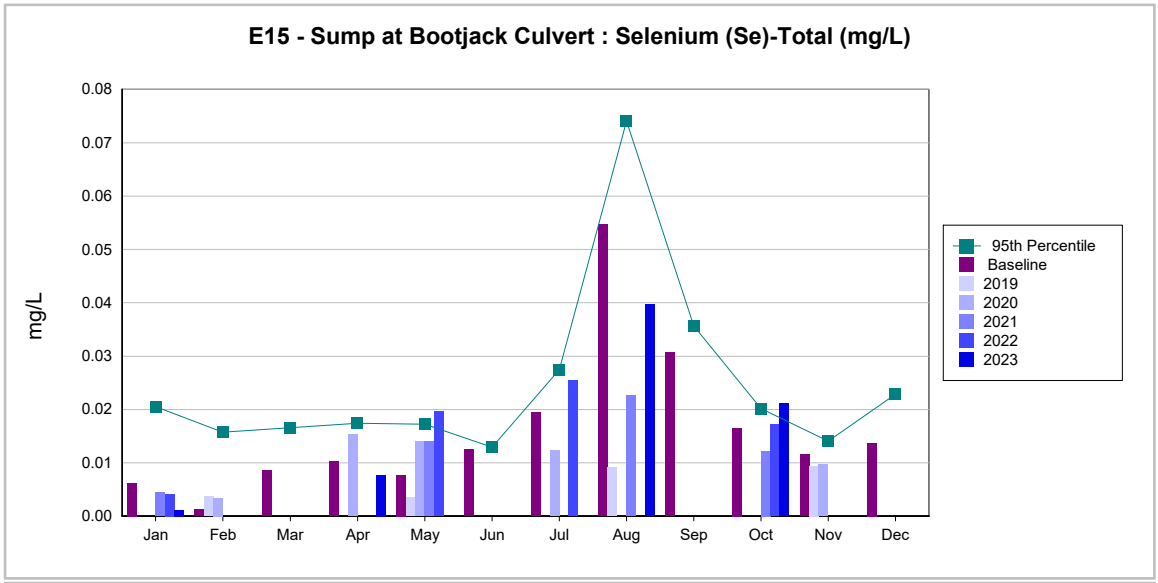
Water Quality Report

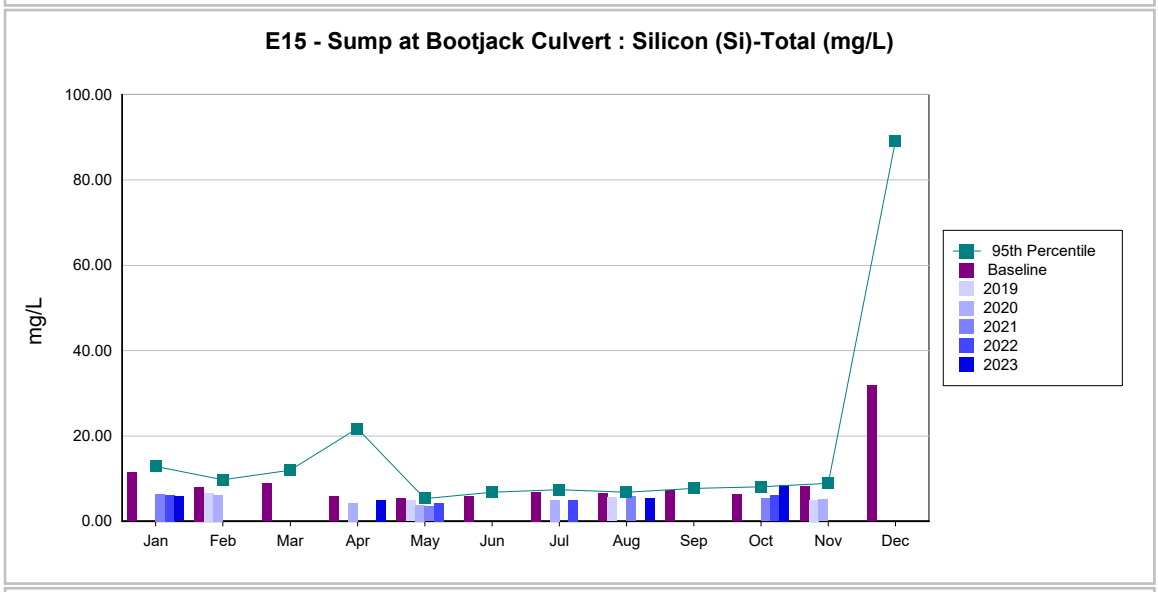
Annual Report Drainage Water

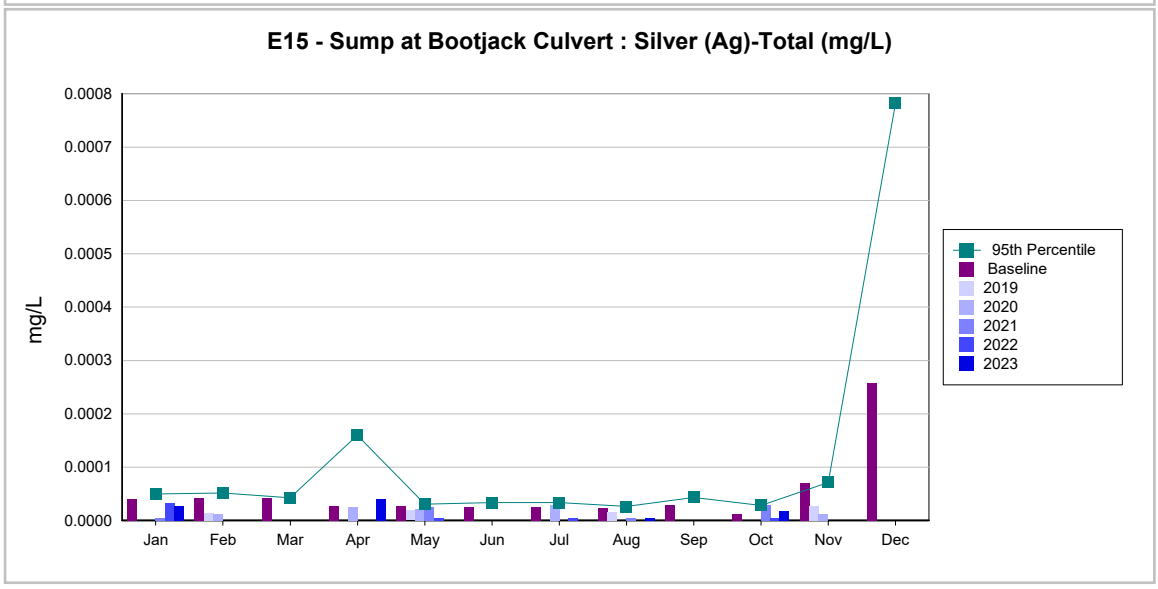
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

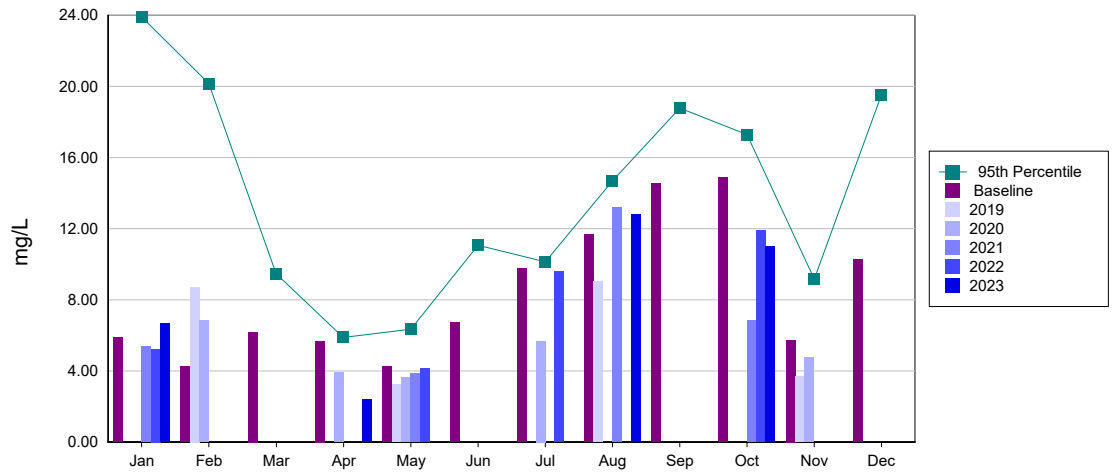
Annual Report Drainage Water

Mount Polley

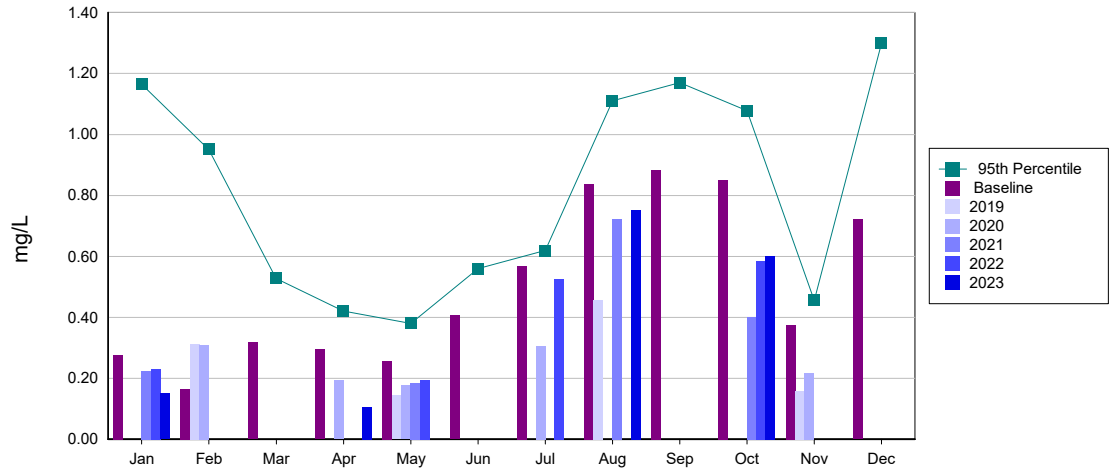
Mining Corporation

IMPERIAL METALS CORPORATION

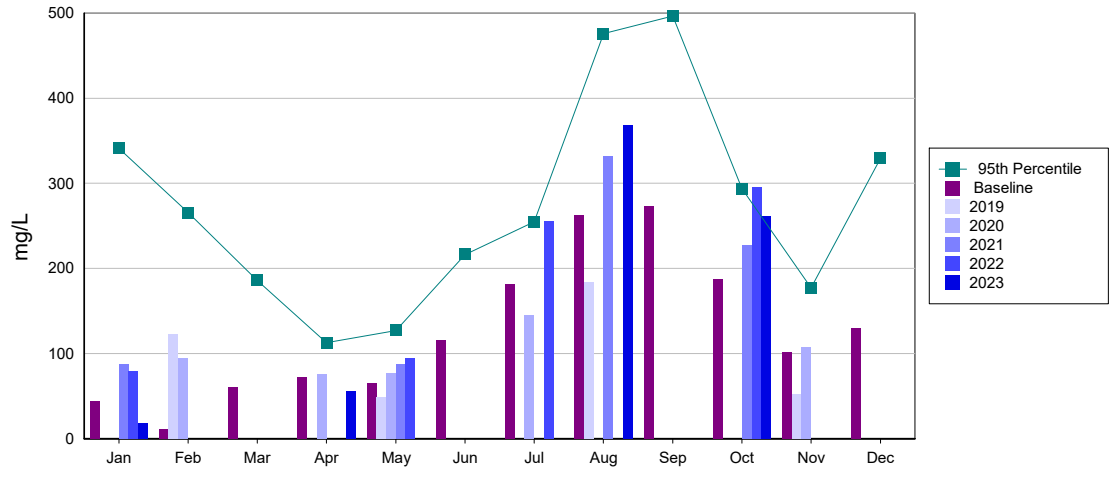
E15 - Sump at Bootjack Culvert : Sodium (Na)-Total (mg/L)



E15 - Sump at Bootjack Culvert : Strontium (Sr)-Total (mg/L)



E15 - Sump at Bootjack Culvert : Sulphate (mg/L)



Water Quality Report

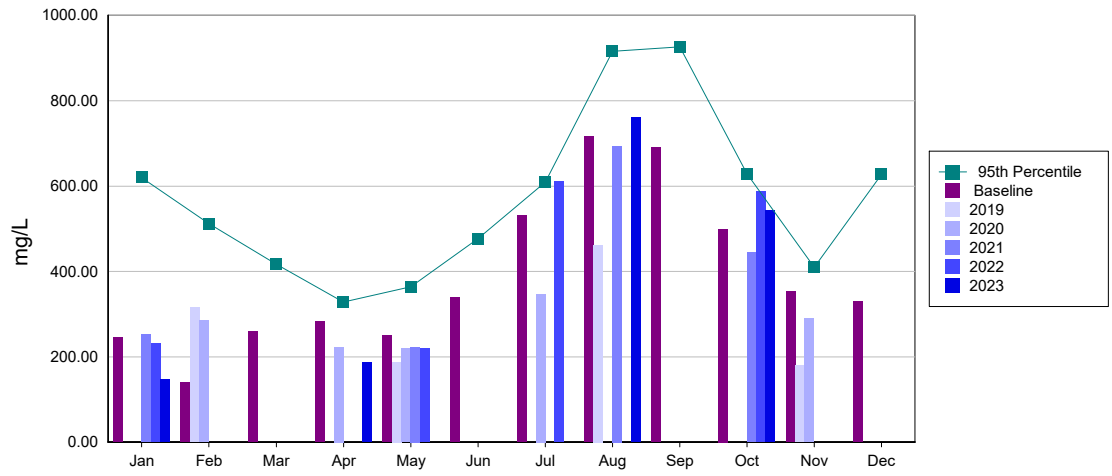
Annual Report Drainage Water

Mount Polley

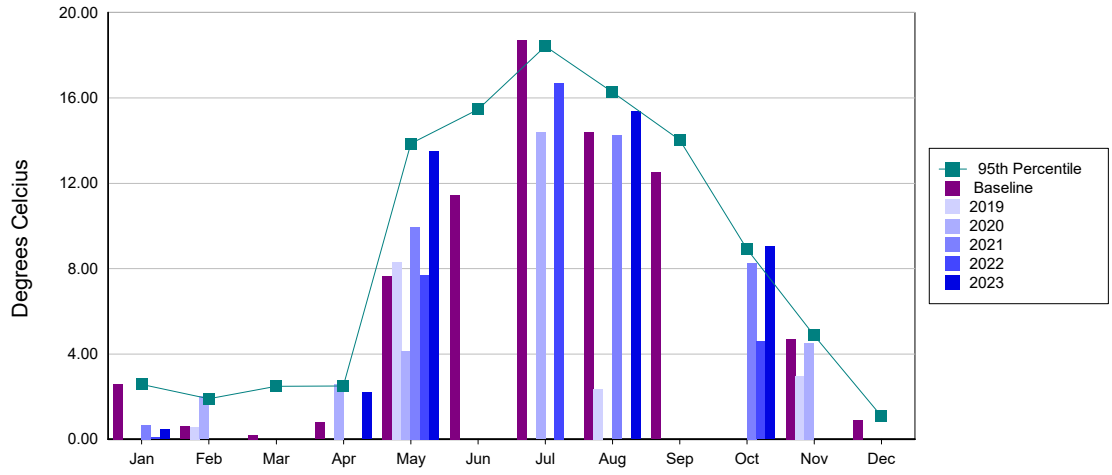
Mining Corporation

IMPERIAL METALS CORPORATION

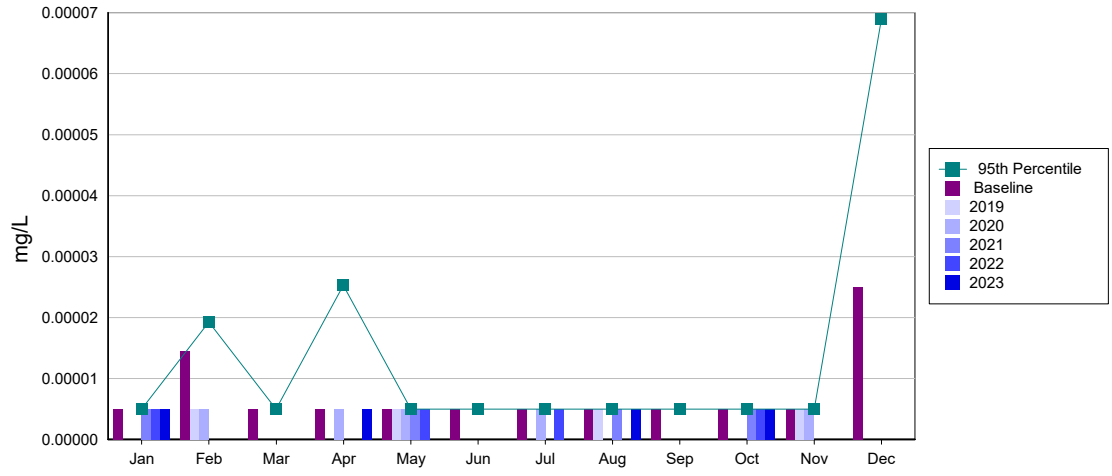
E15 - Sump at Bootjack Culvert : TDS (mg/L)



E15 - Sump at Bootjack Culvert : Temp (in situ) (Degrees Celcius)



E15 - Sump at Bootjack Culvert : Thallium (Tl)-Total (mg/L)



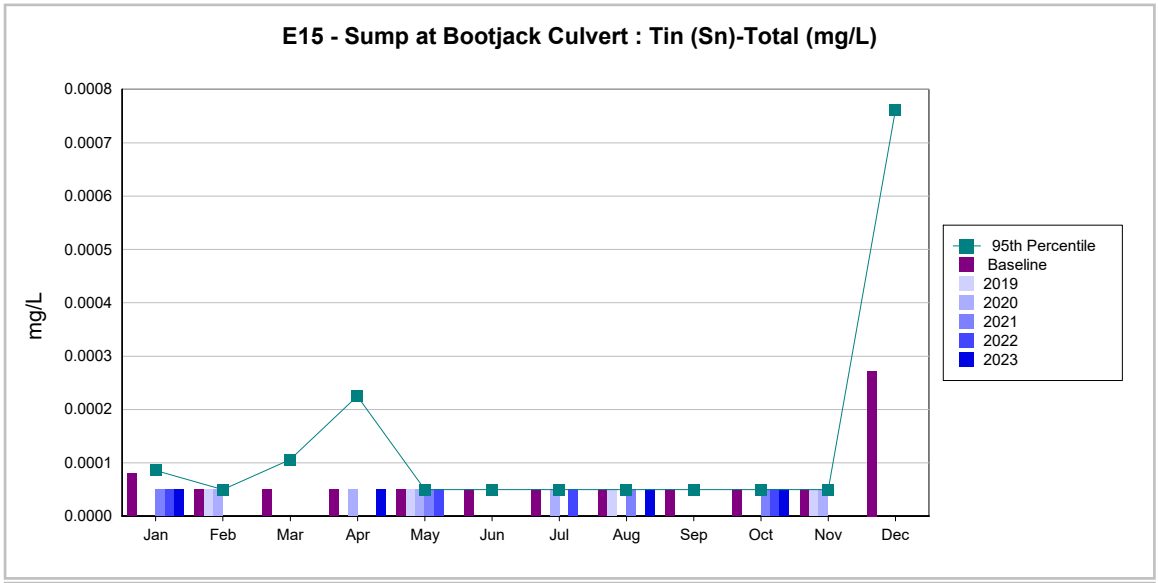
Water Quality Report

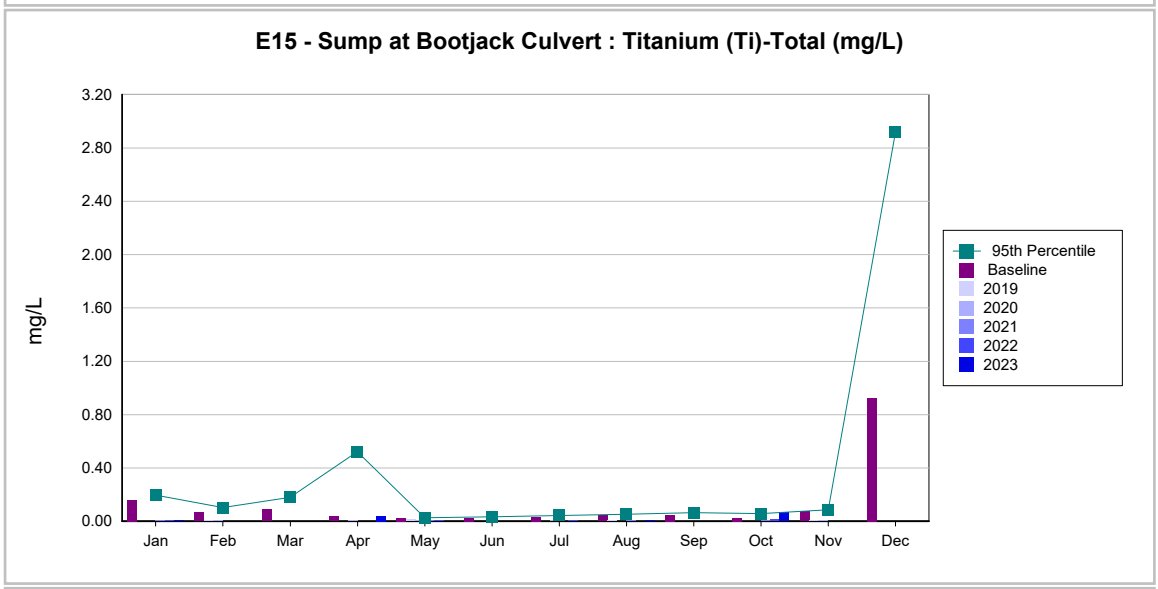
Annual Report Drainage Water

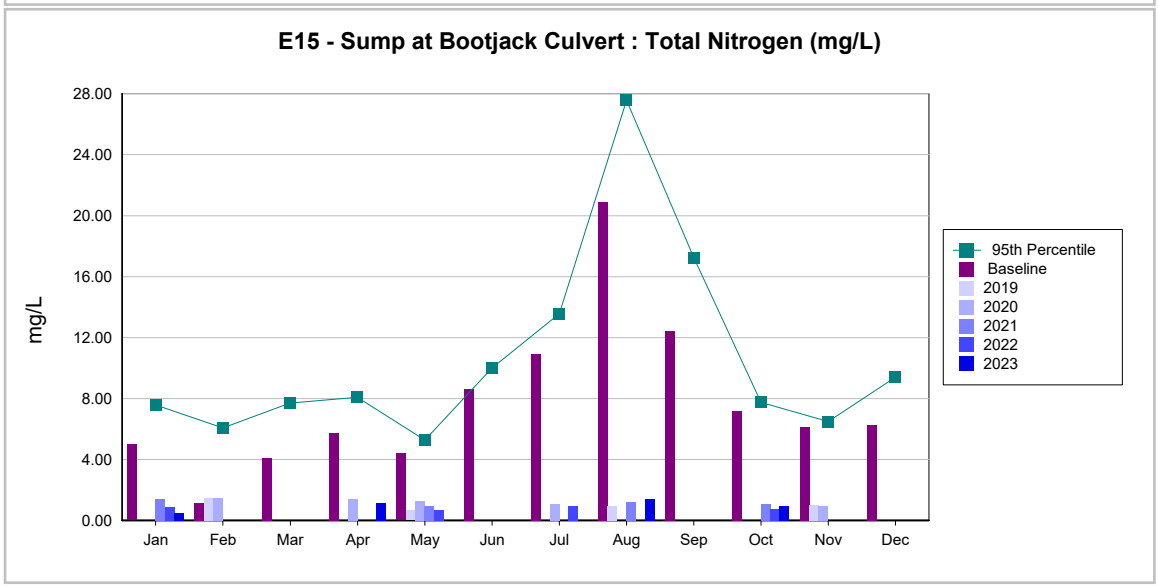
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







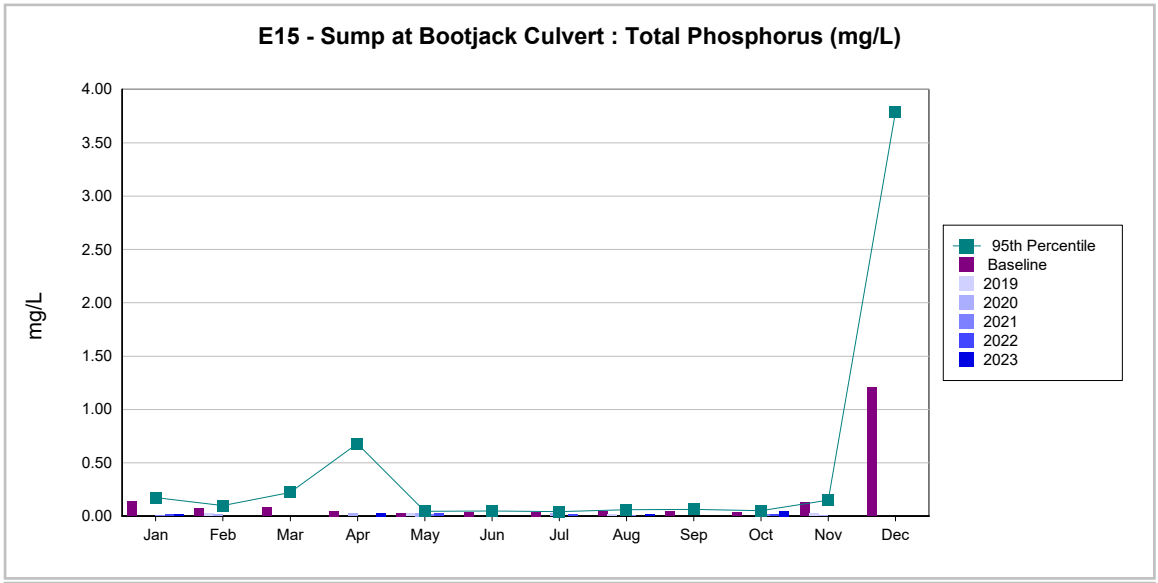
Water Quality Report

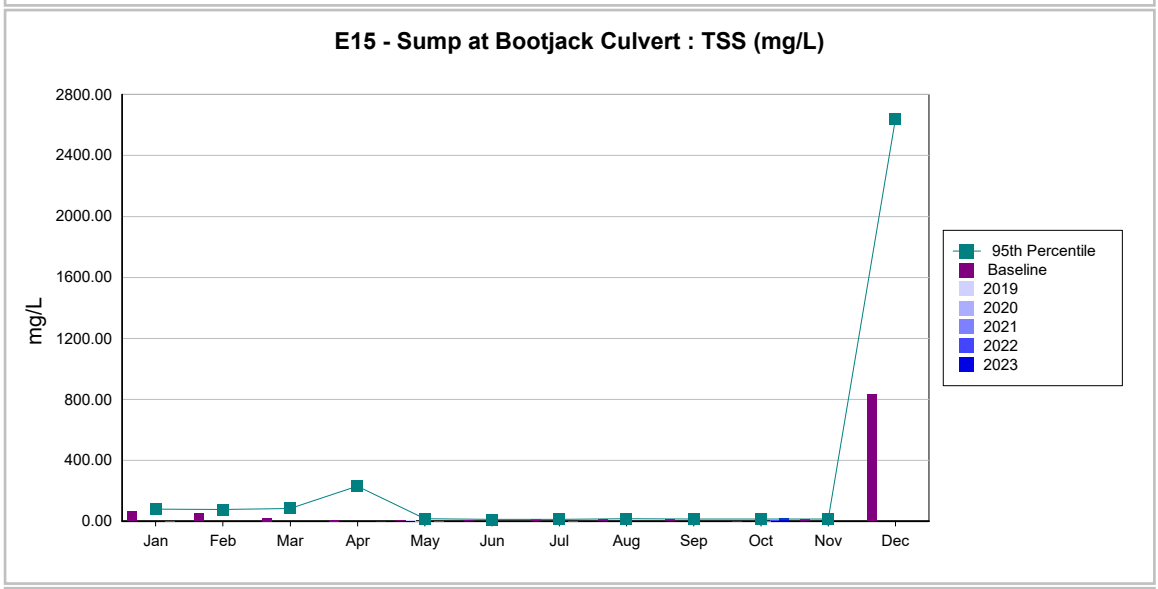
Annual Report Drainage Water

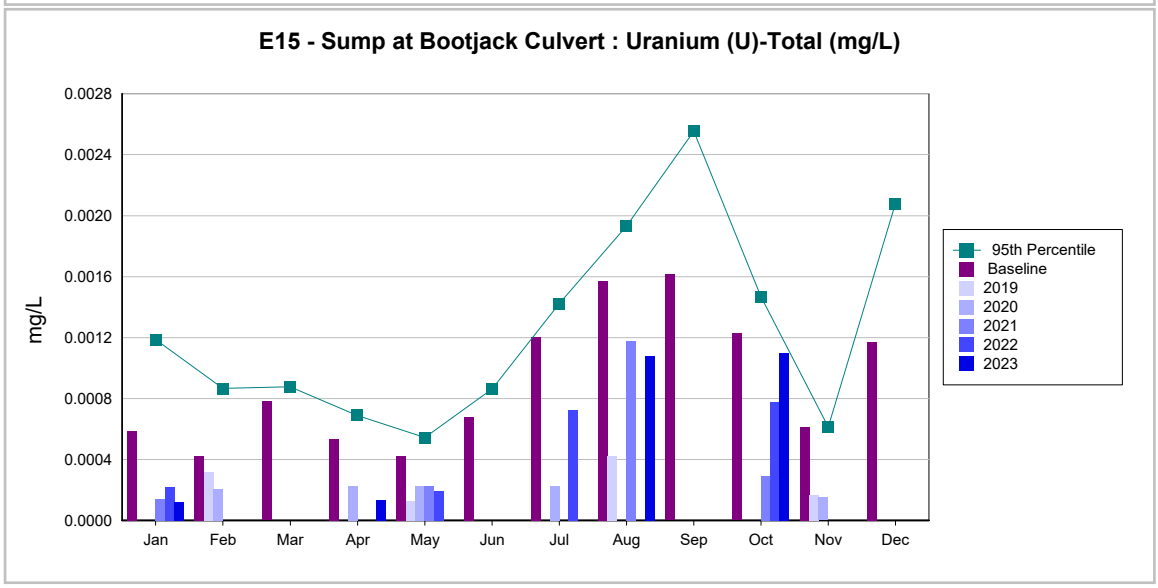
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







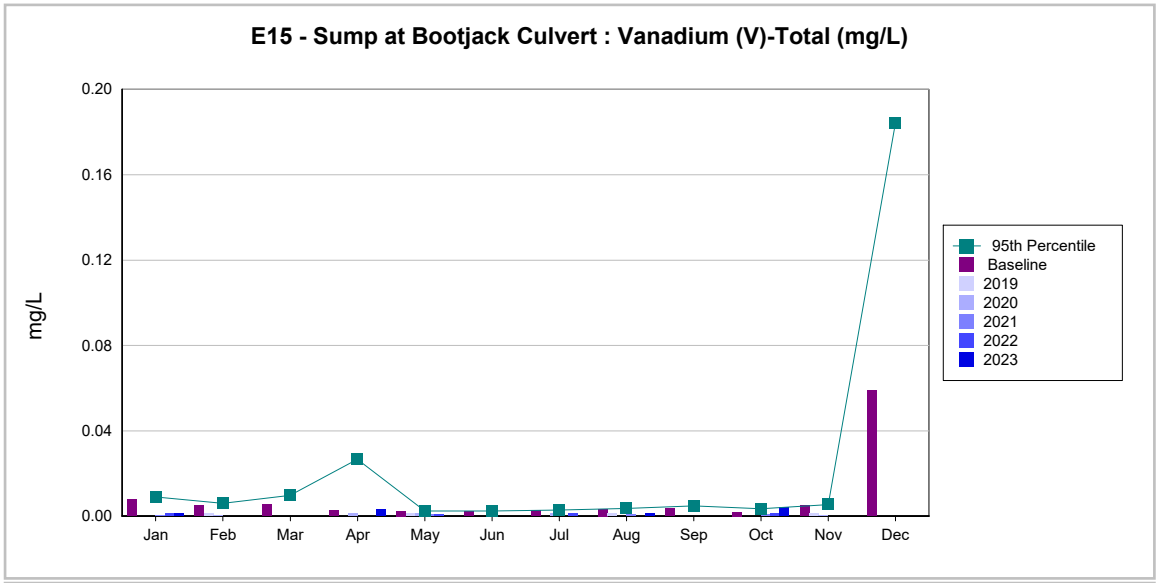
Water Quality Report

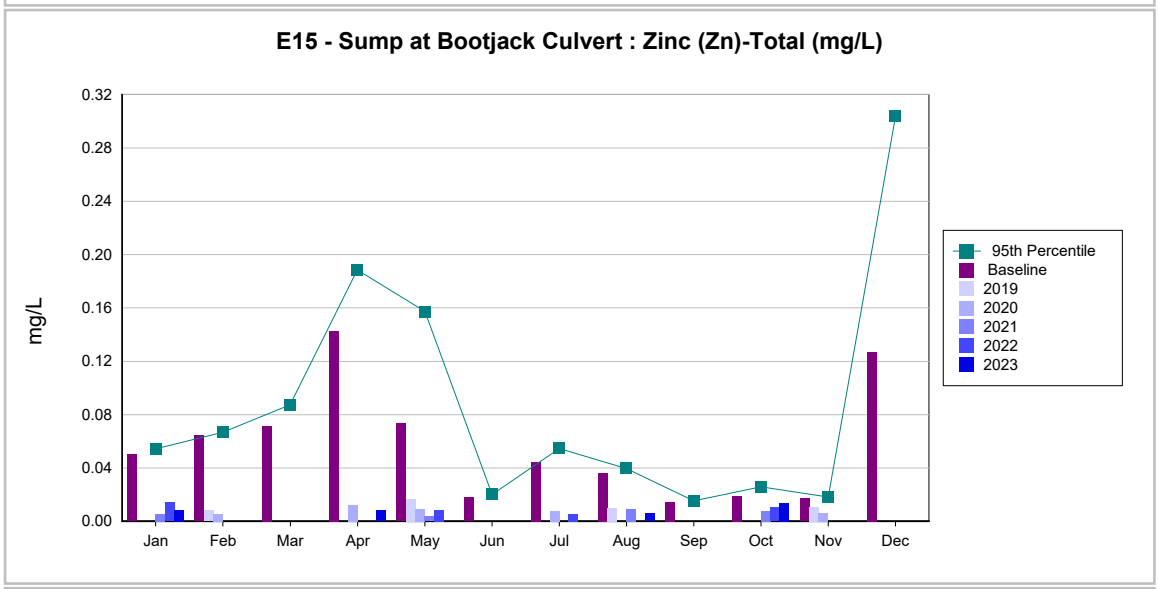
Annual Report Drainage Water

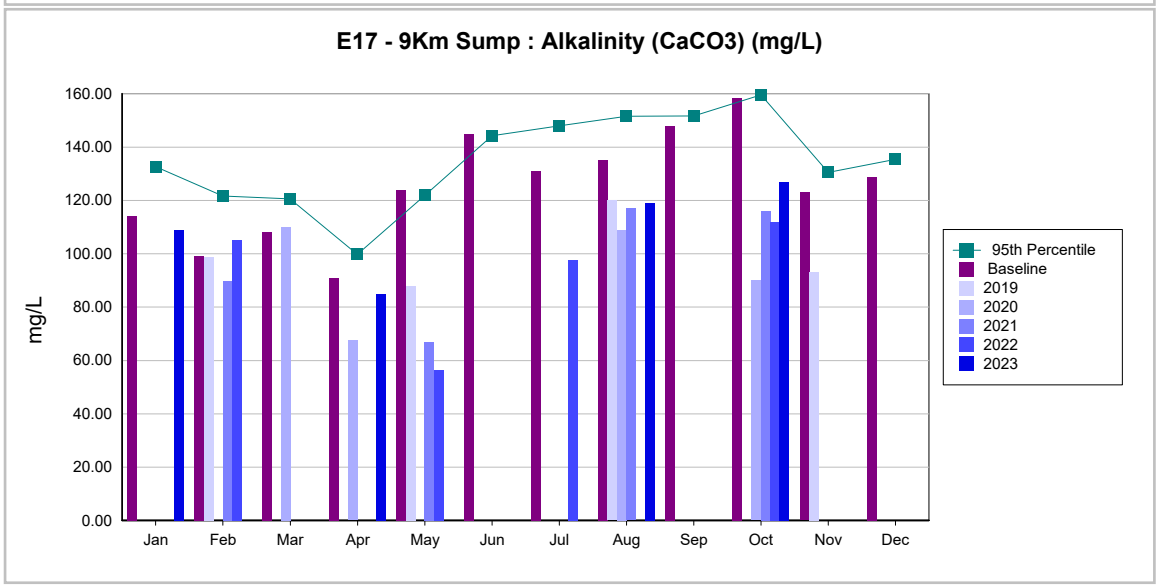
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







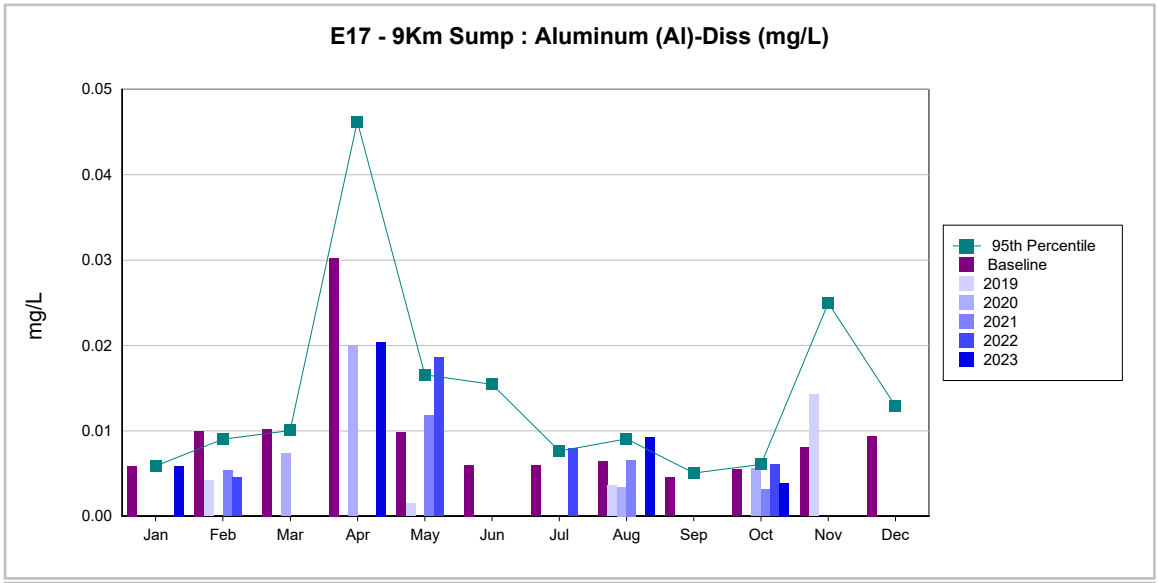
Water Quality Report

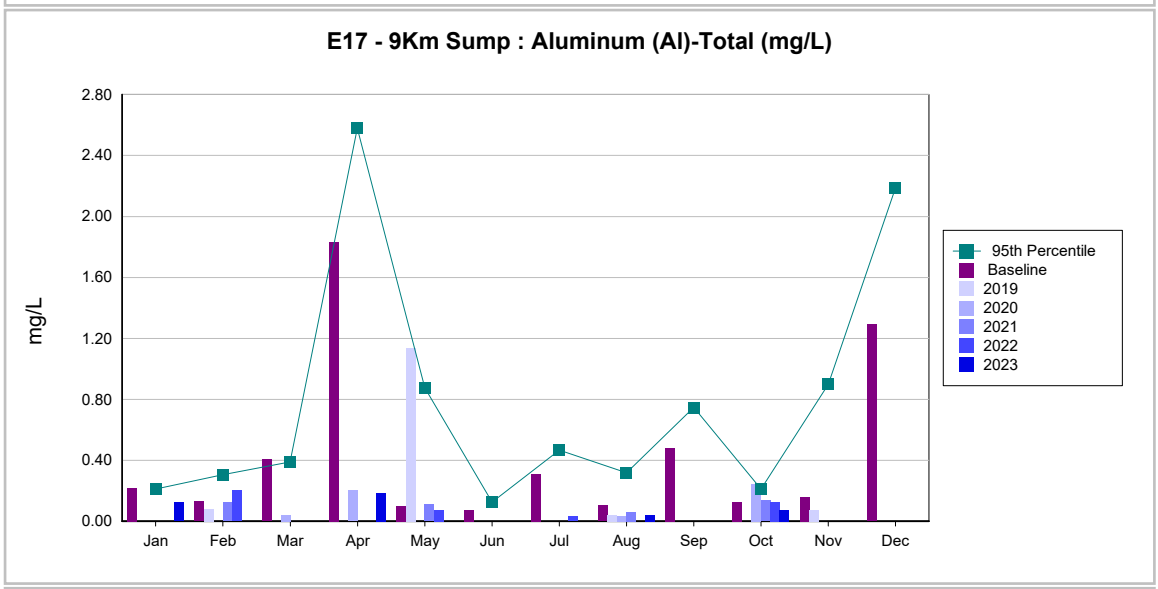
Annual Report Drainage Water

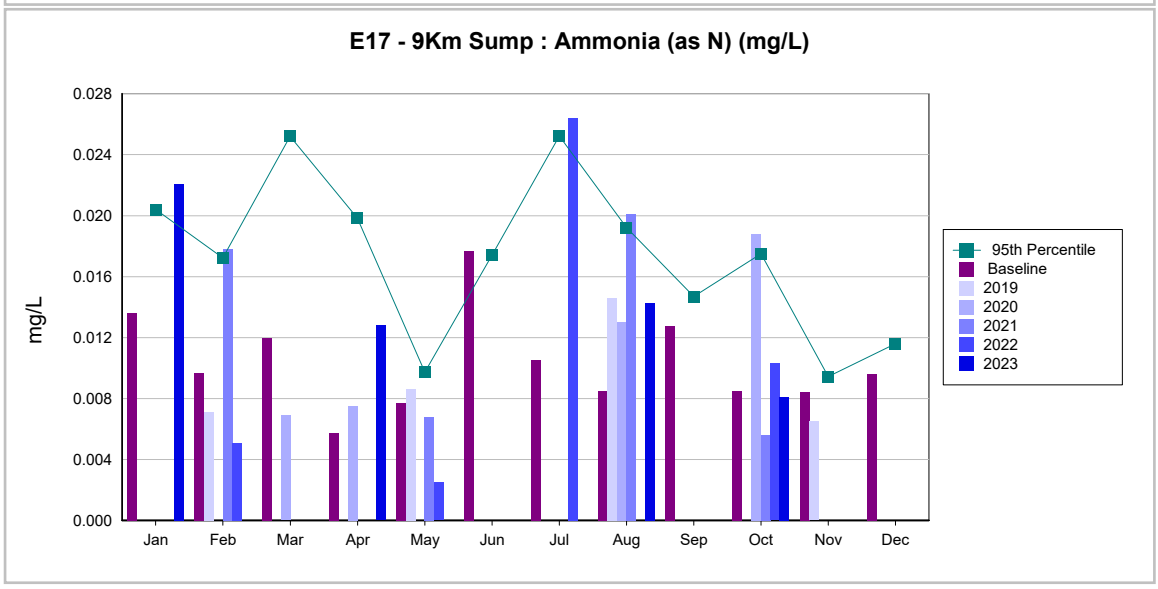
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







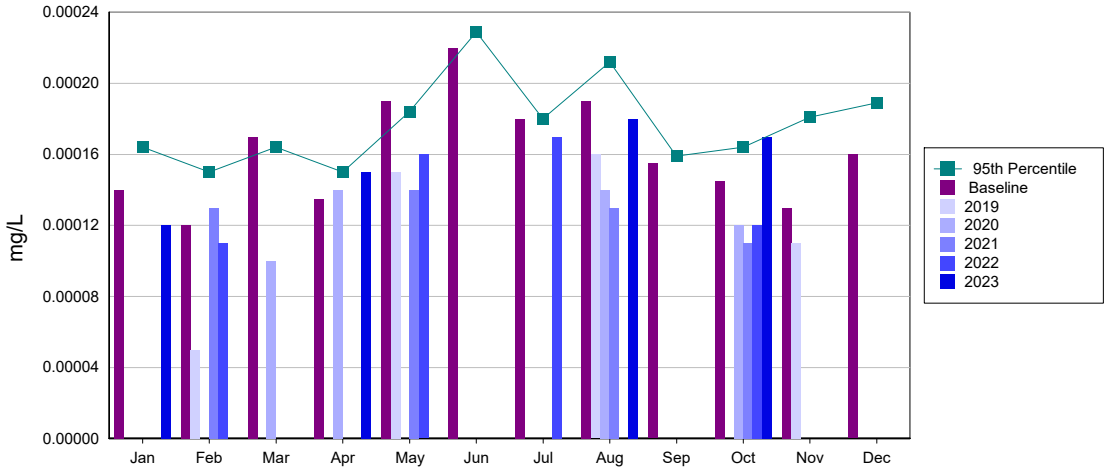
Water Quality Report

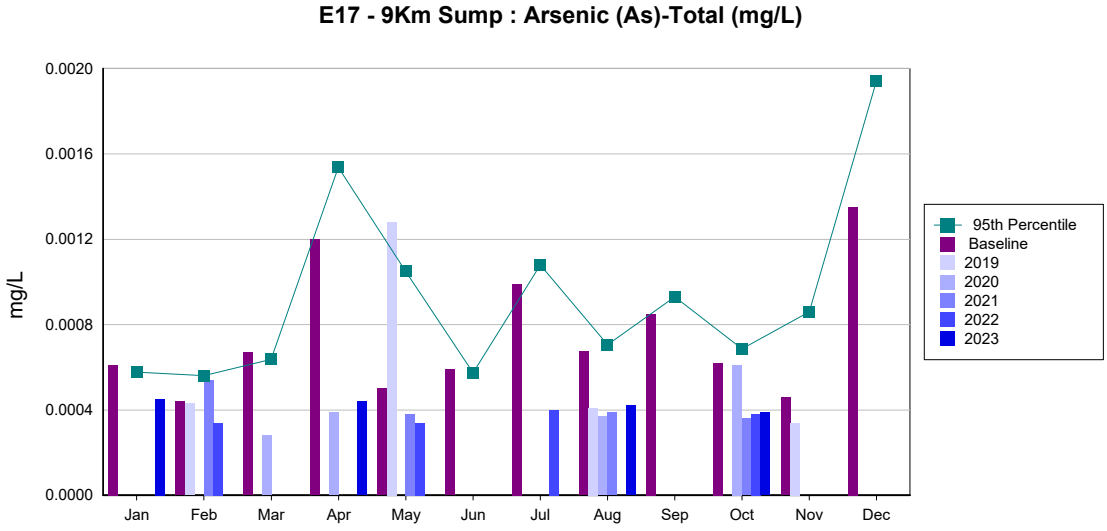
Annual Report Drainage Water

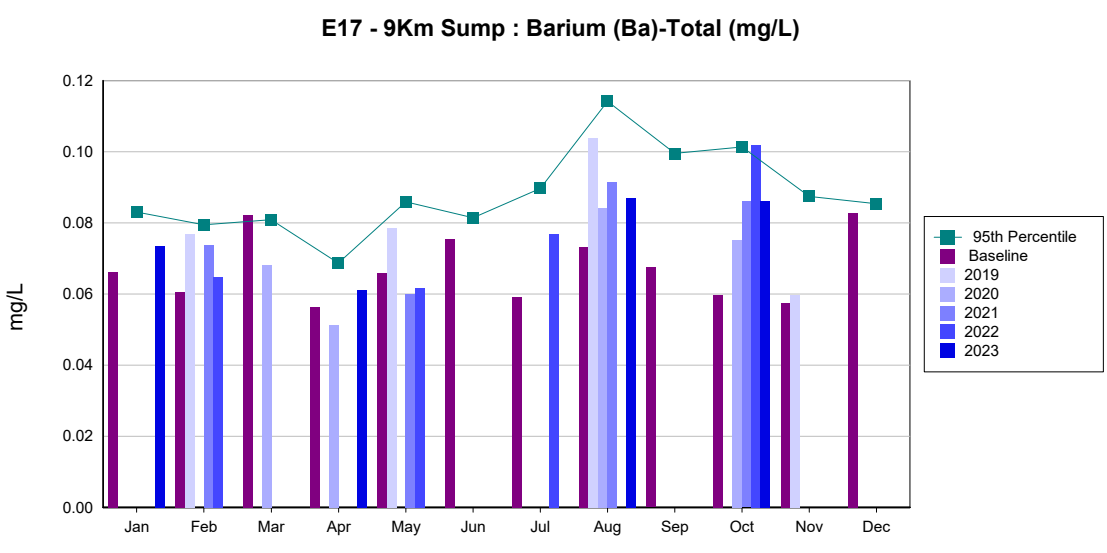
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







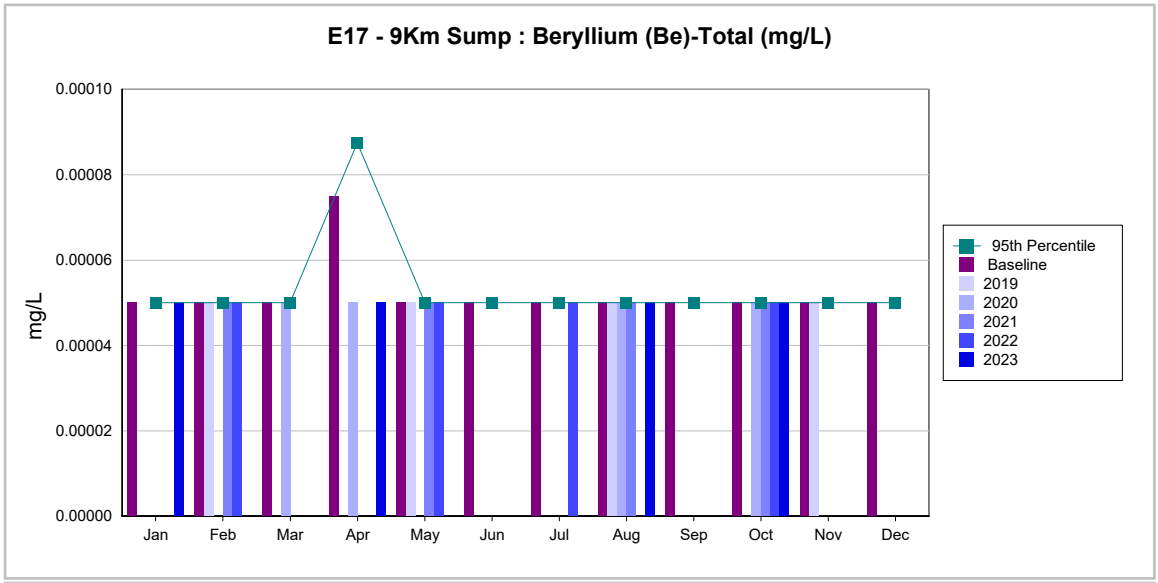
Water Quality Report

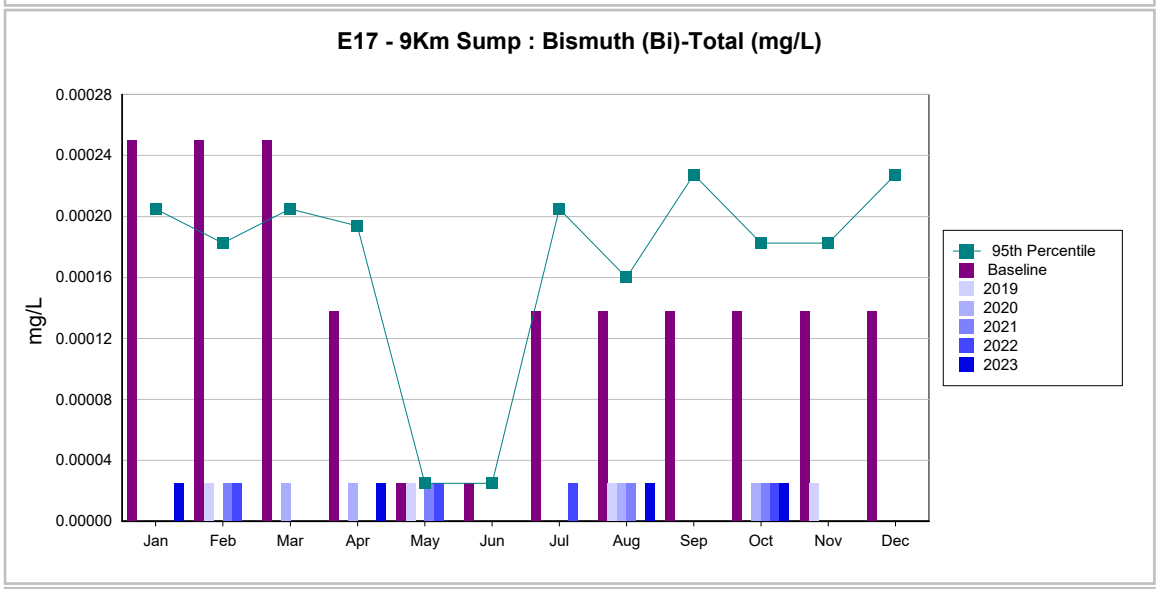
Annual Report Drainage Water

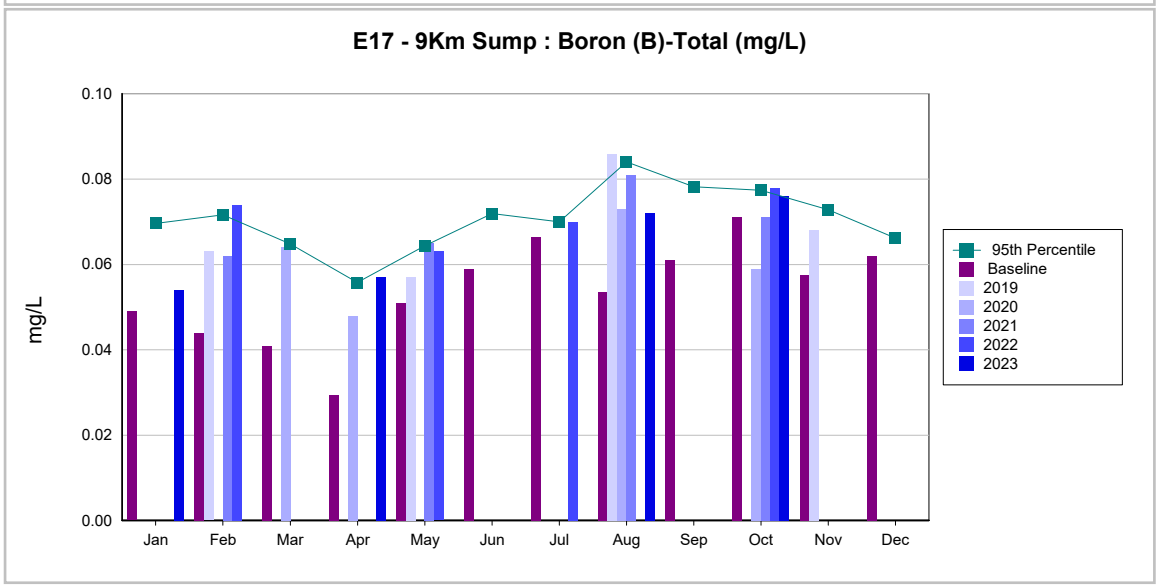
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







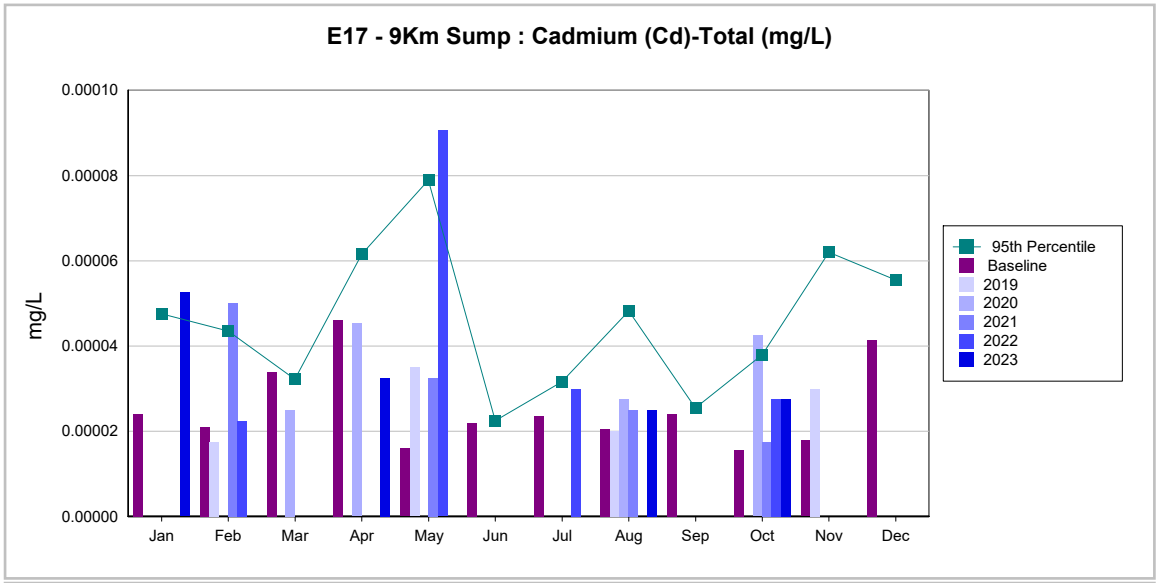
Water Quality Report

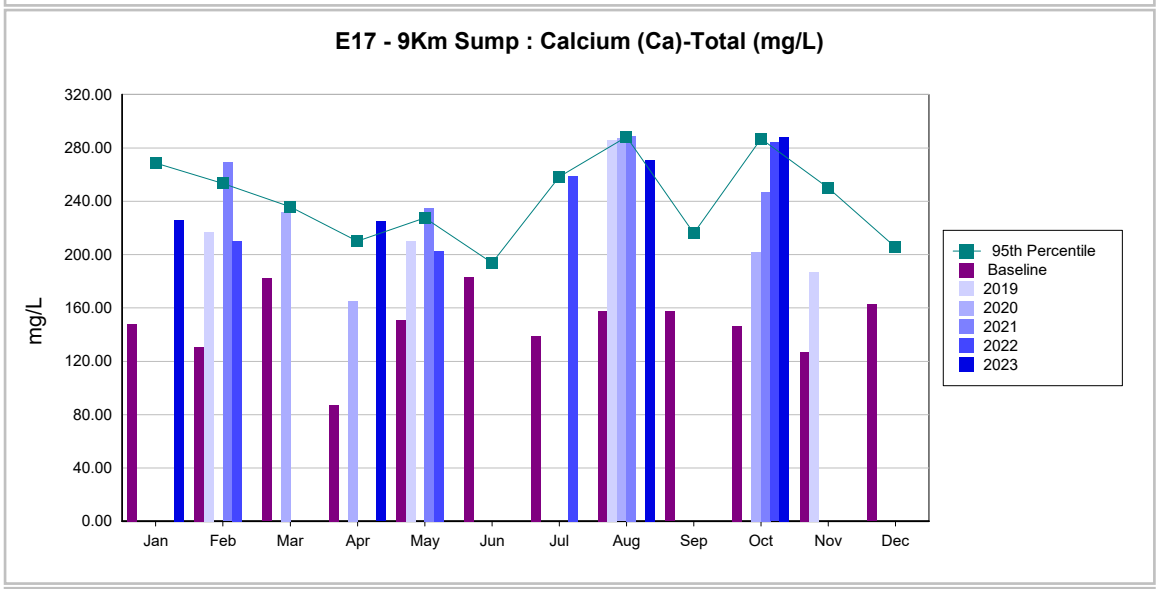
Annual Report Drainage Water

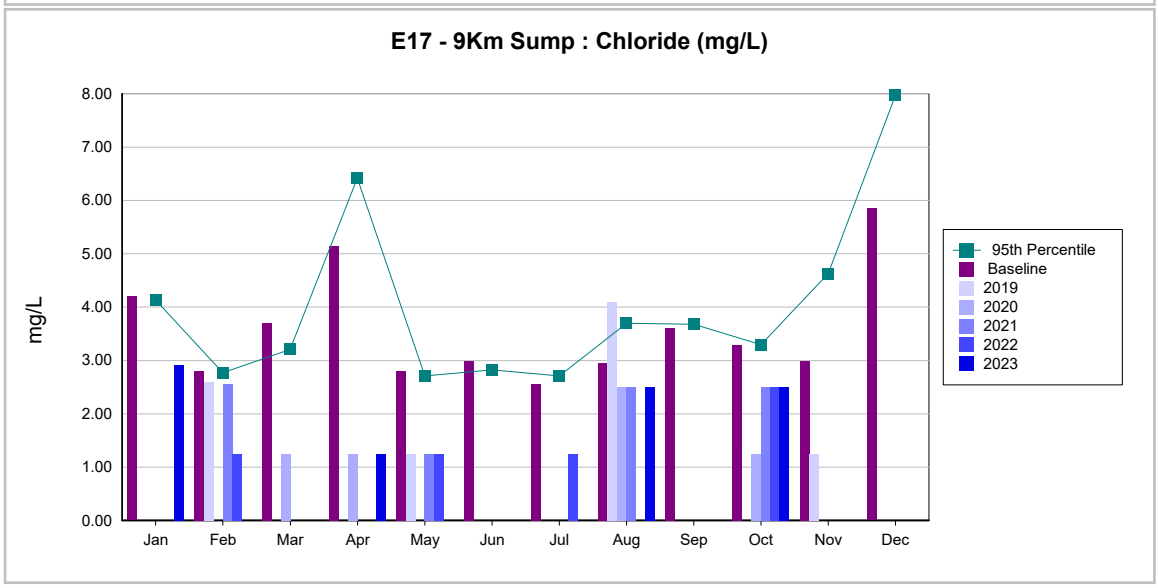
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







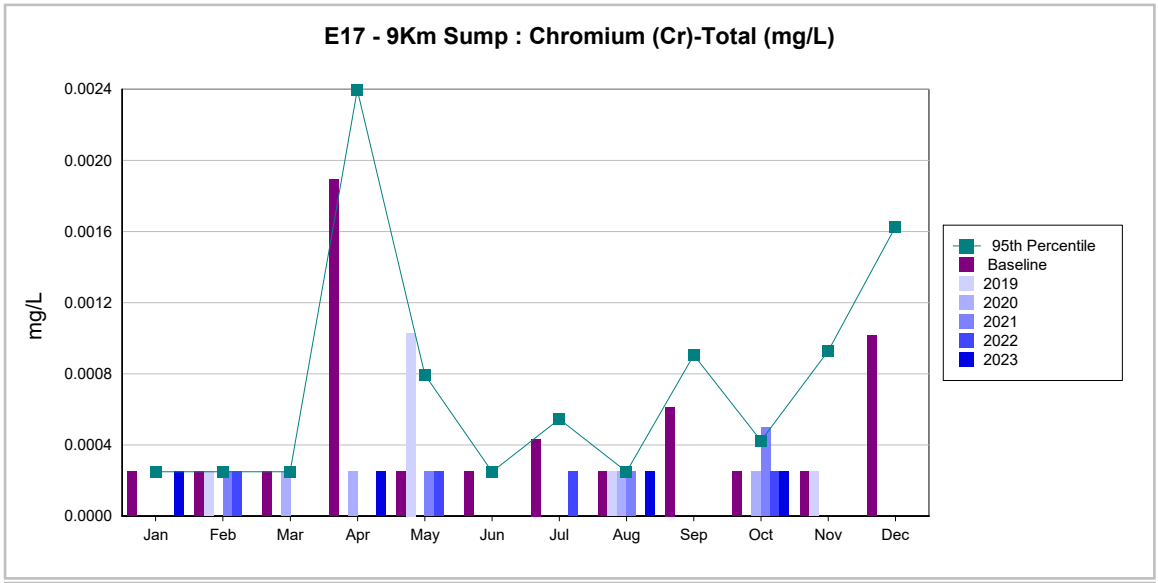
Water Quality Report

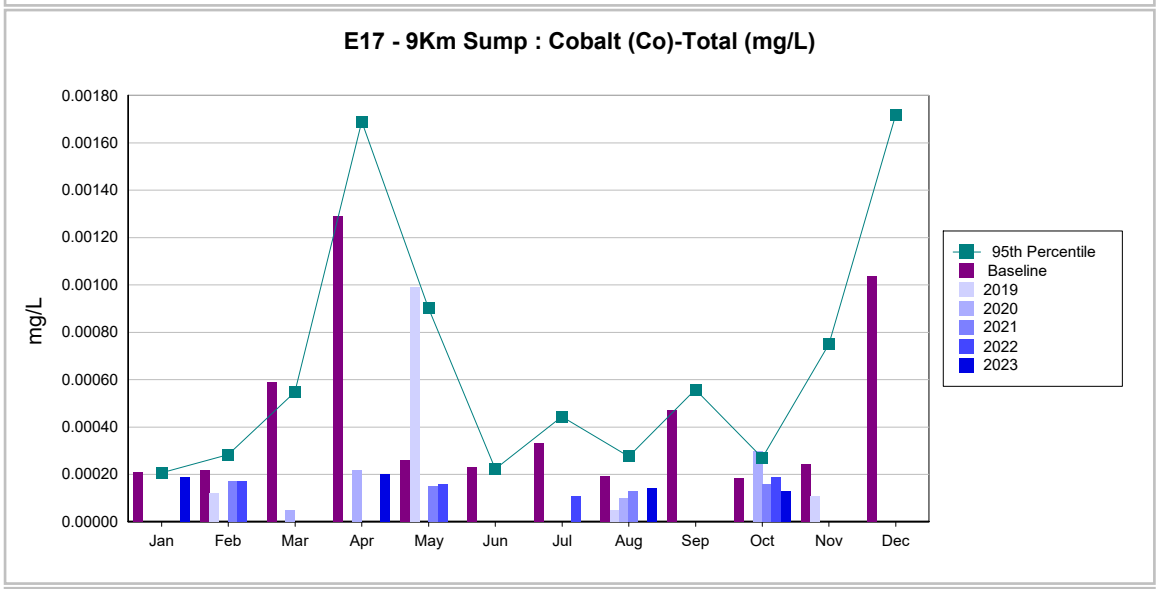
Annual Report Drainage Water

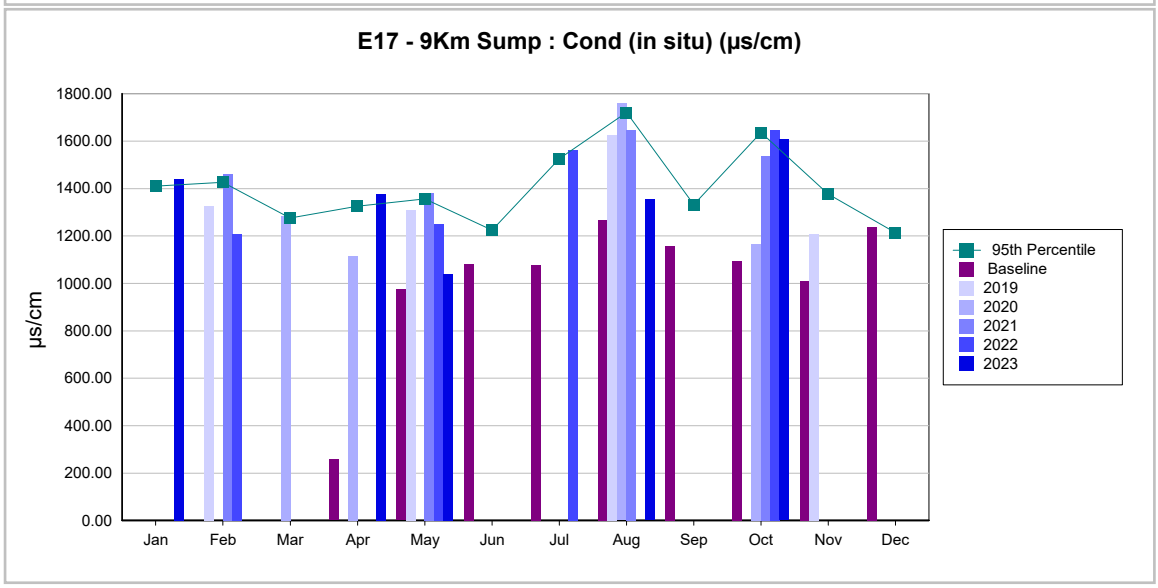
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







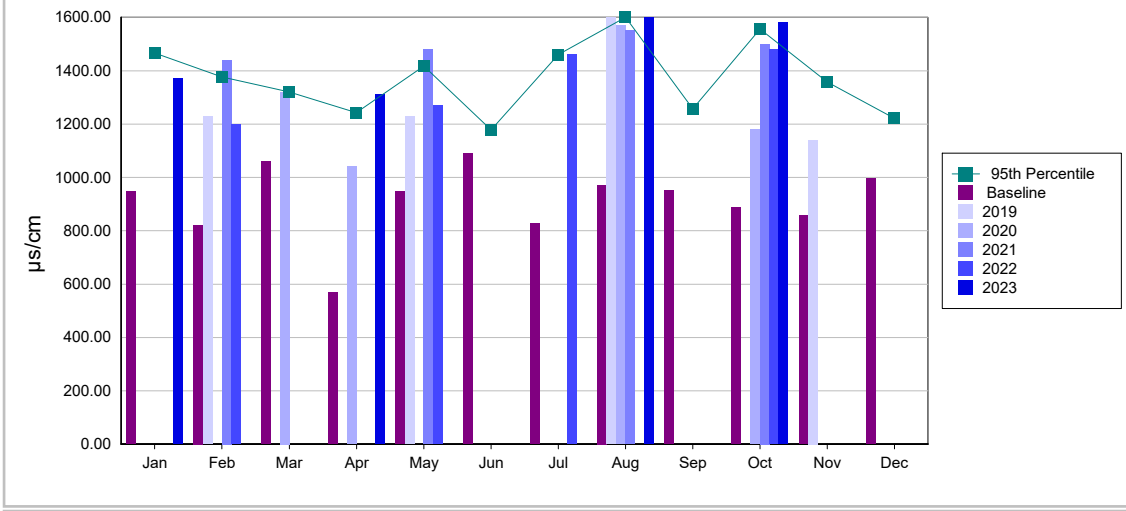
Water Quality Report

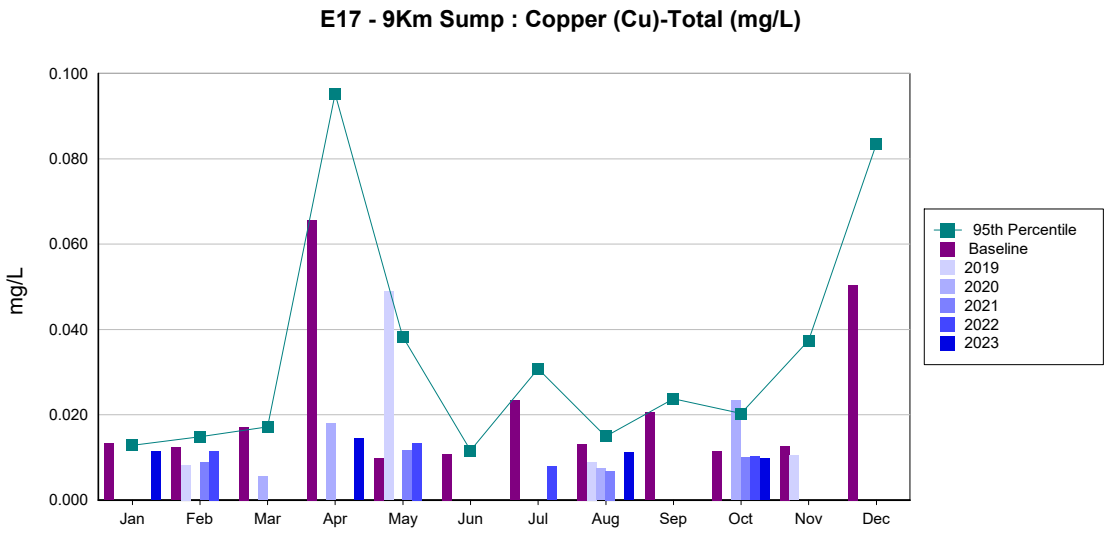
Annual Report Drainage Water

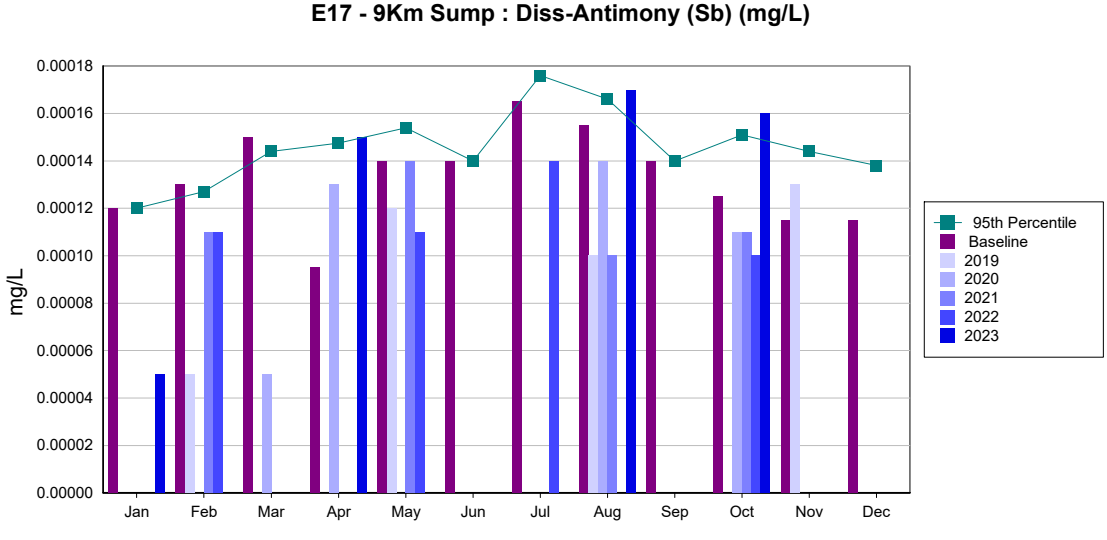
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







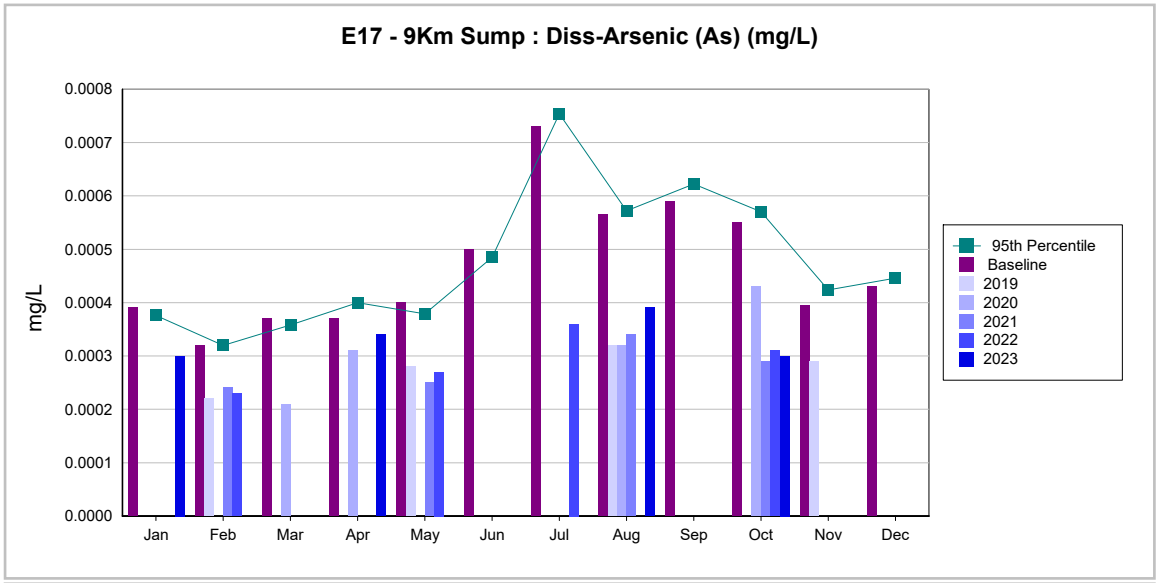
Water Quality Report

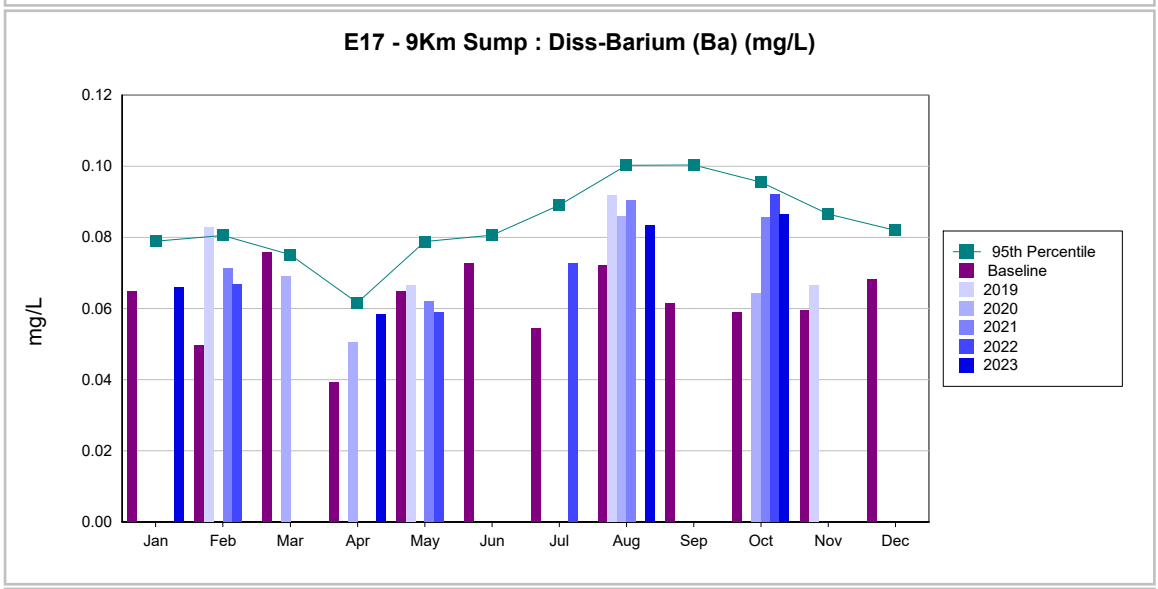
Annual Report Drainage Water

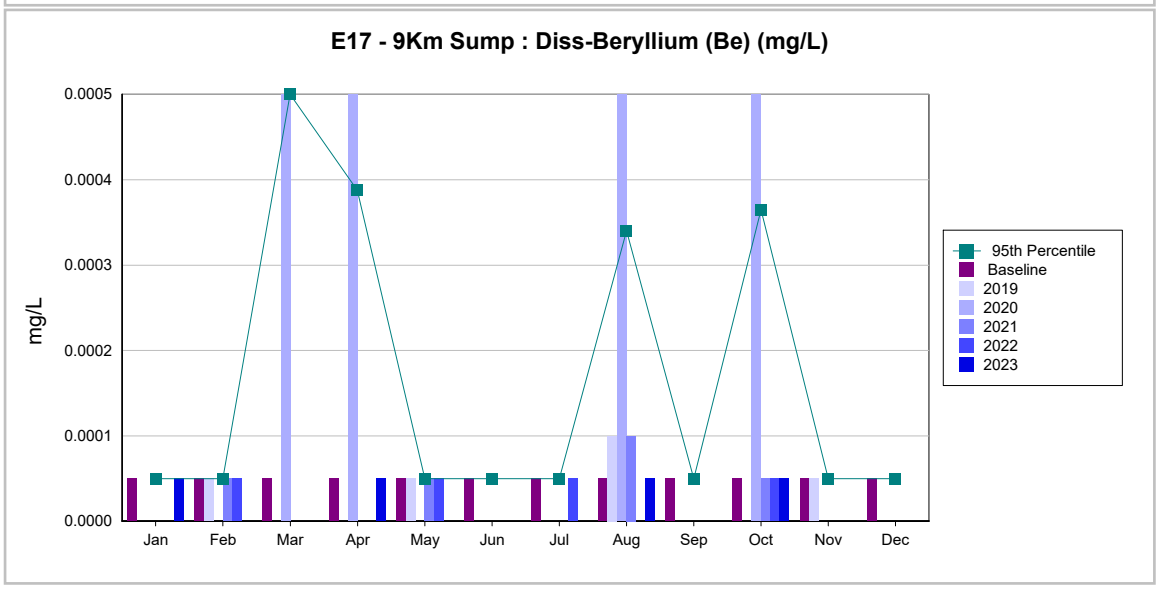
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







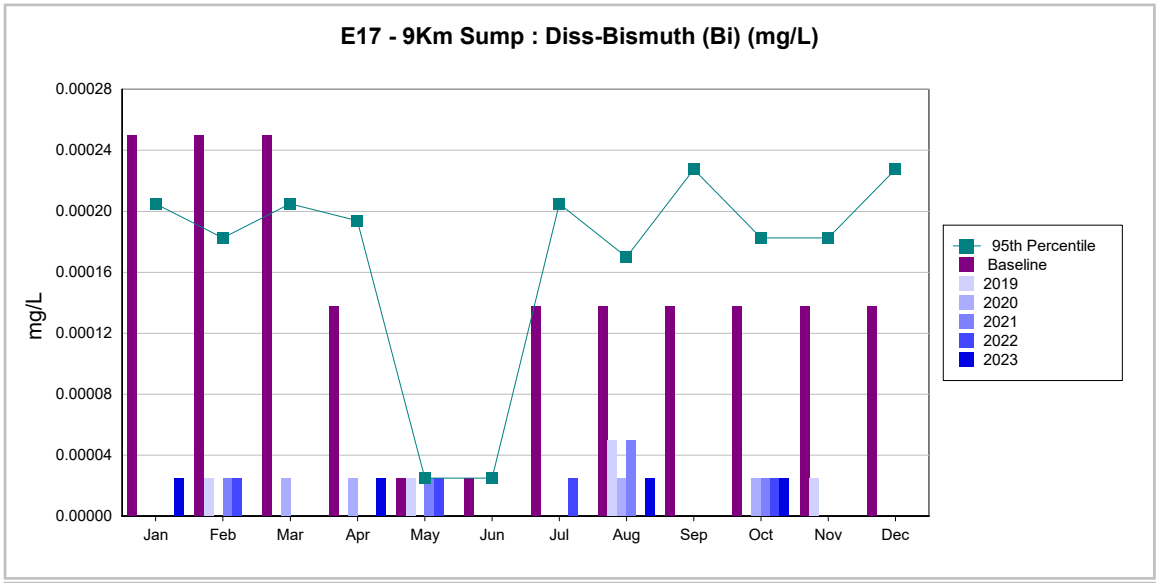
Water Quality Report

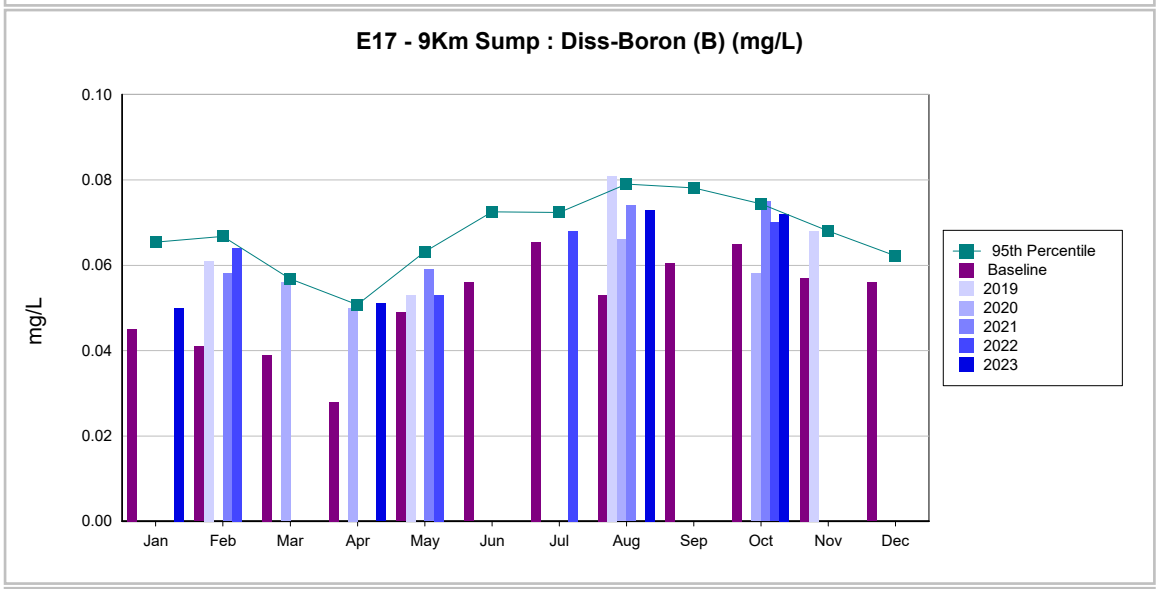
Annual Report Drainage Water

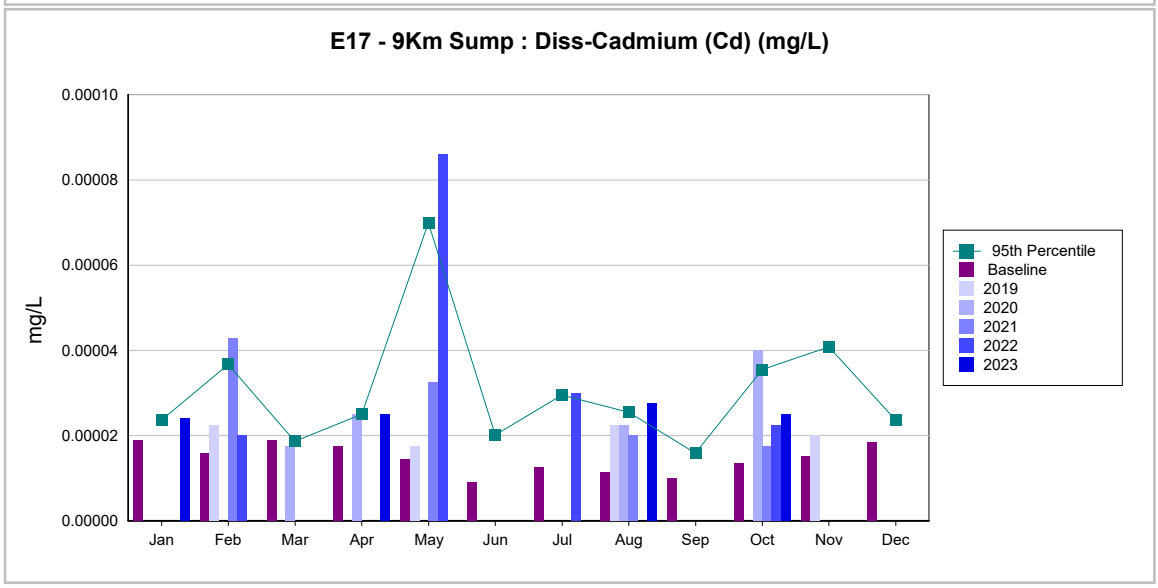
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







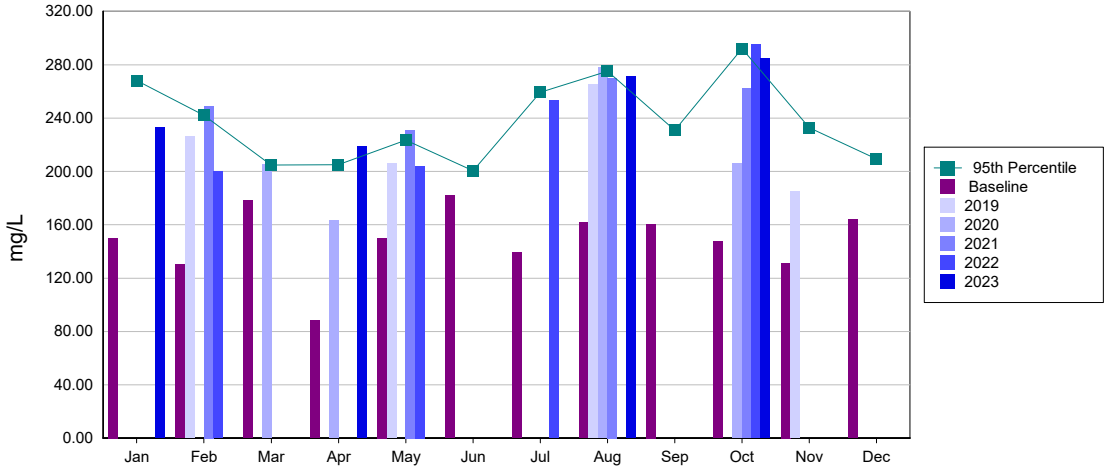
Water Quality Report

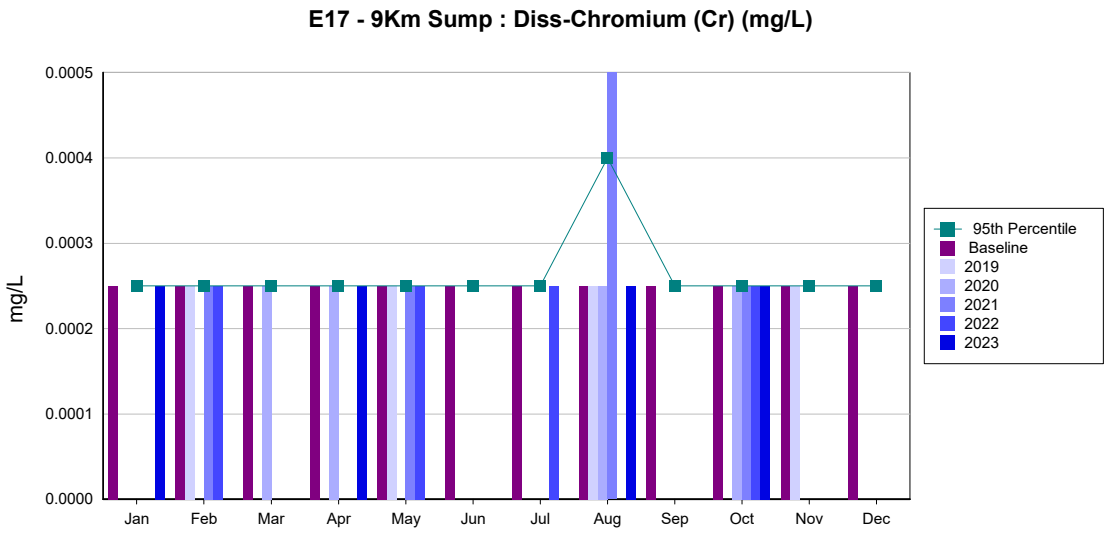
Annual Report Drainage Water

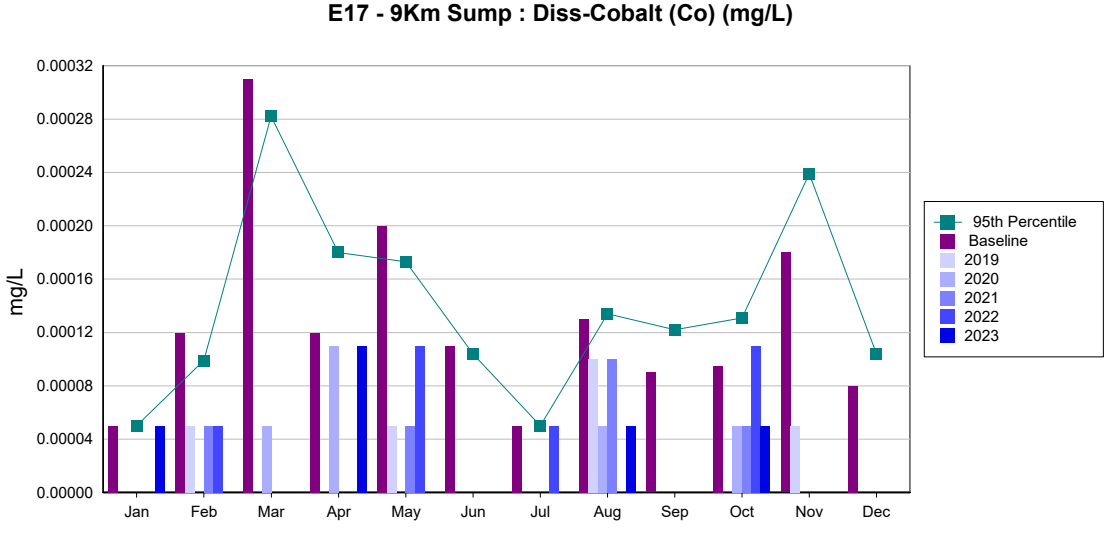
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







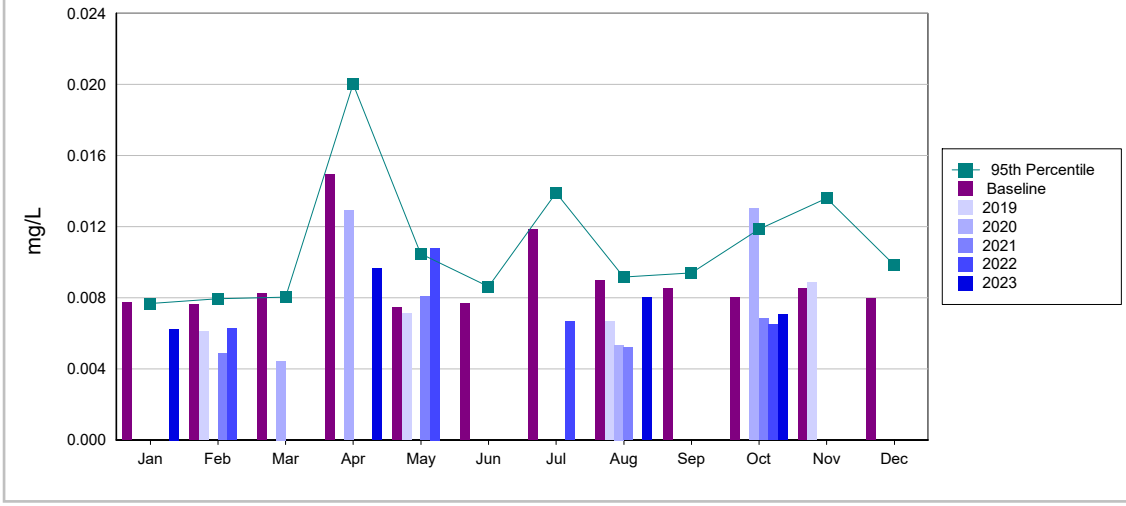
Water Quality Report

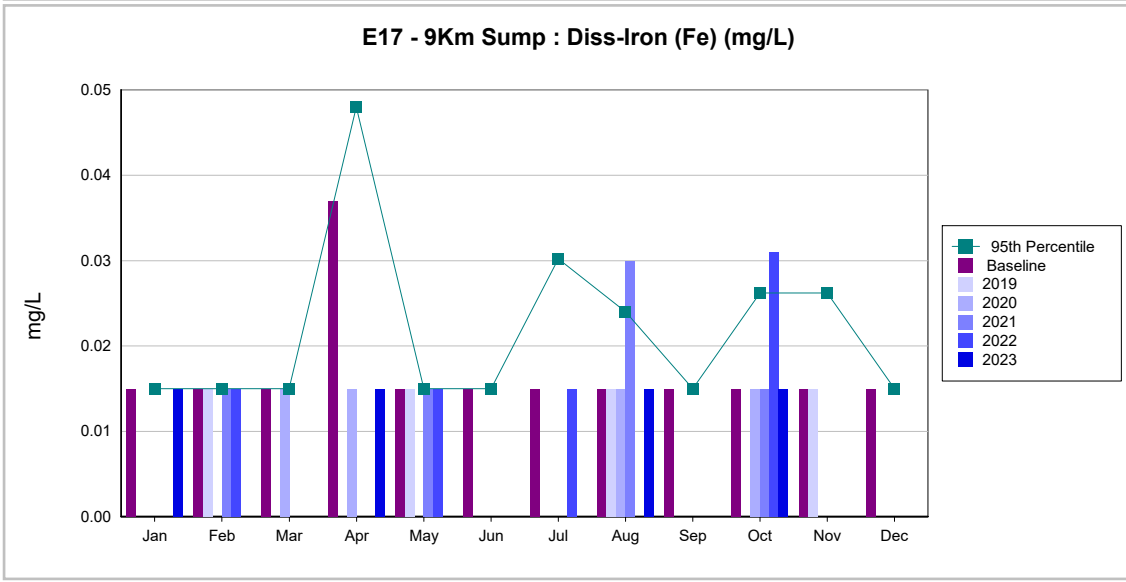
Annual Report Drainage Water

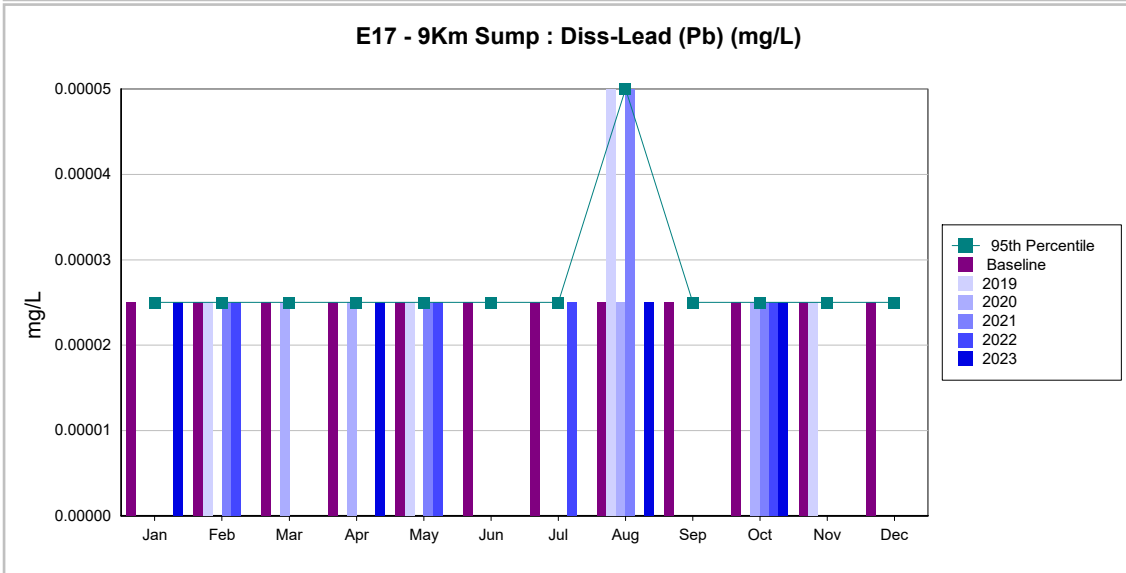
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







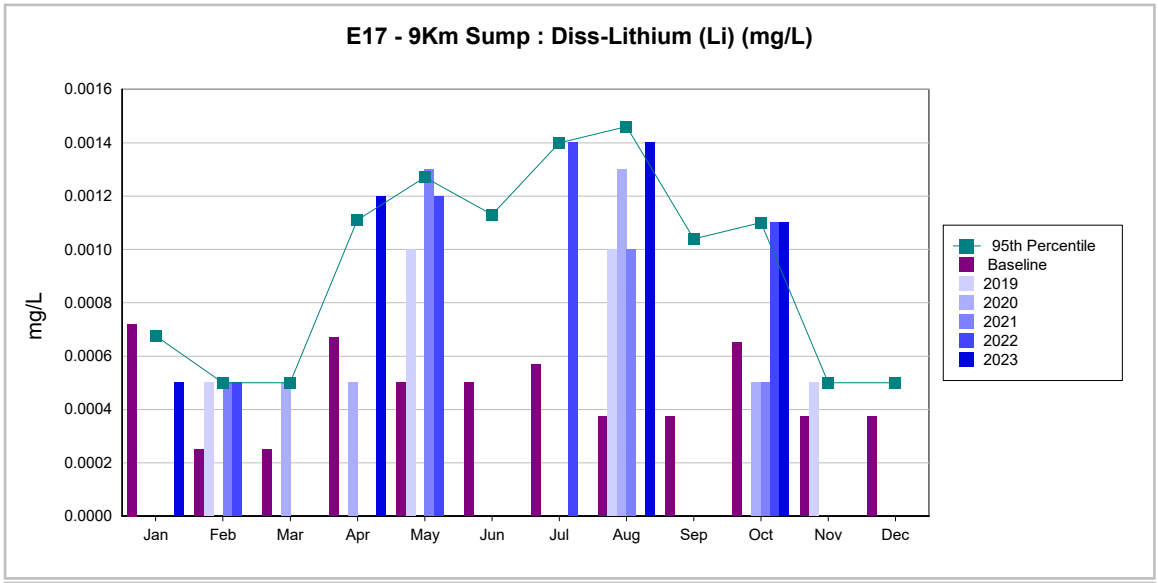
Water Quality Report

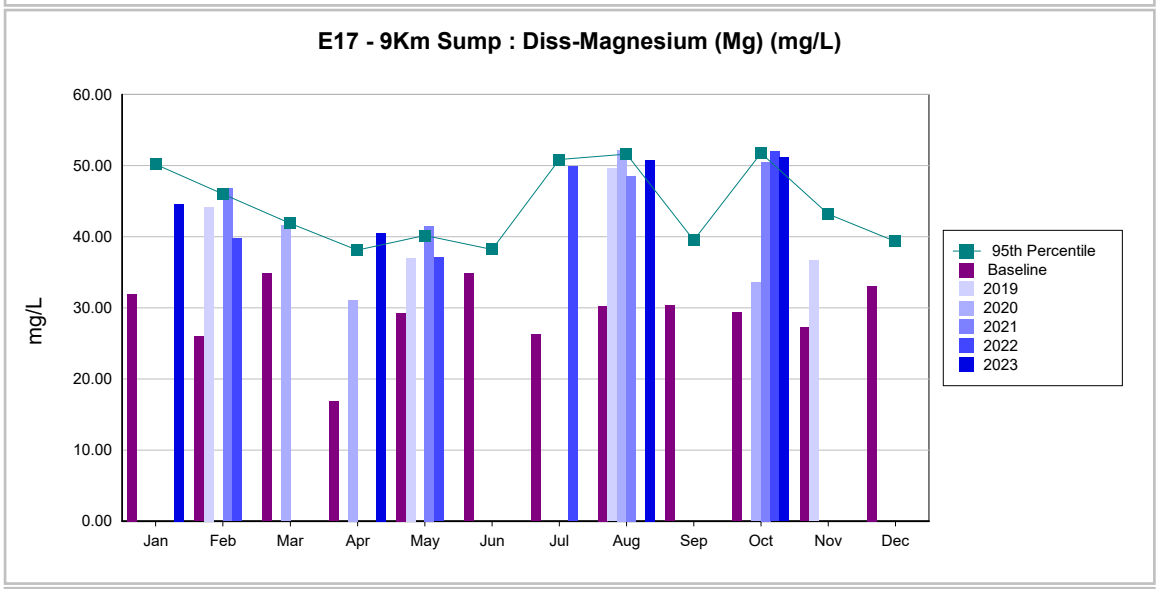
Annual Report Drainage Water

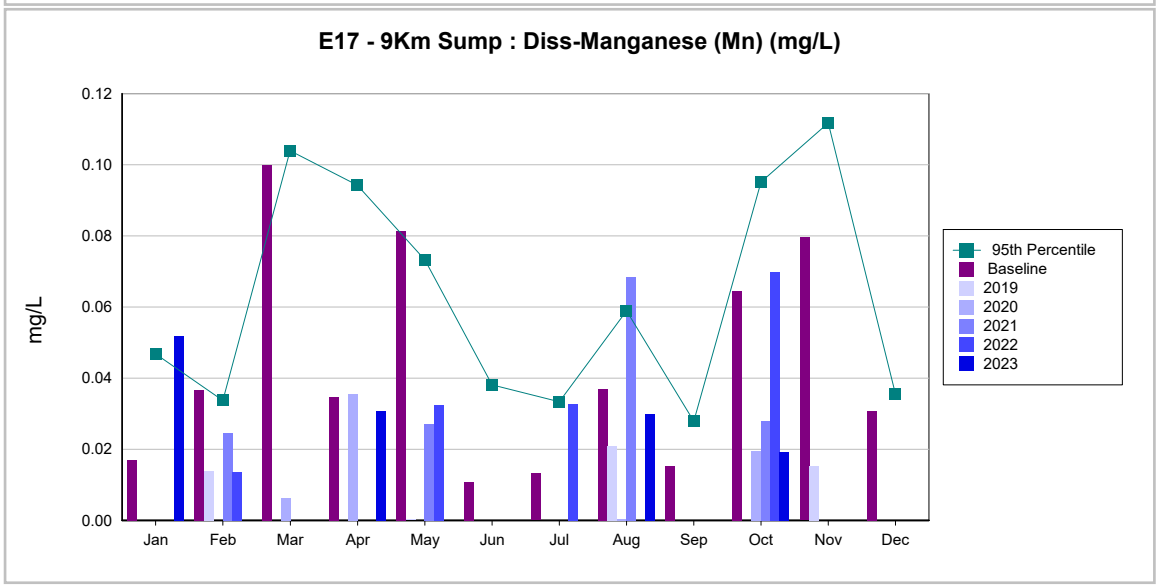
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







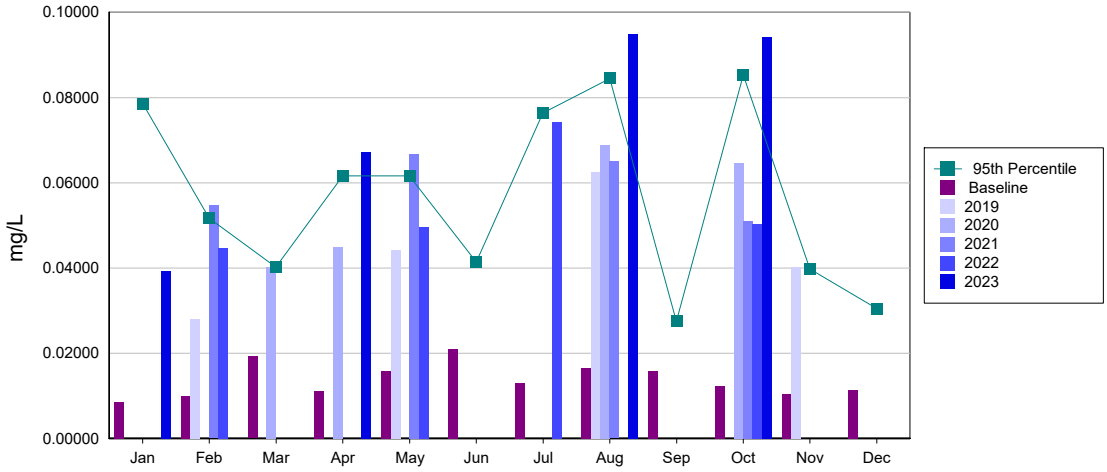
Water Quality Report

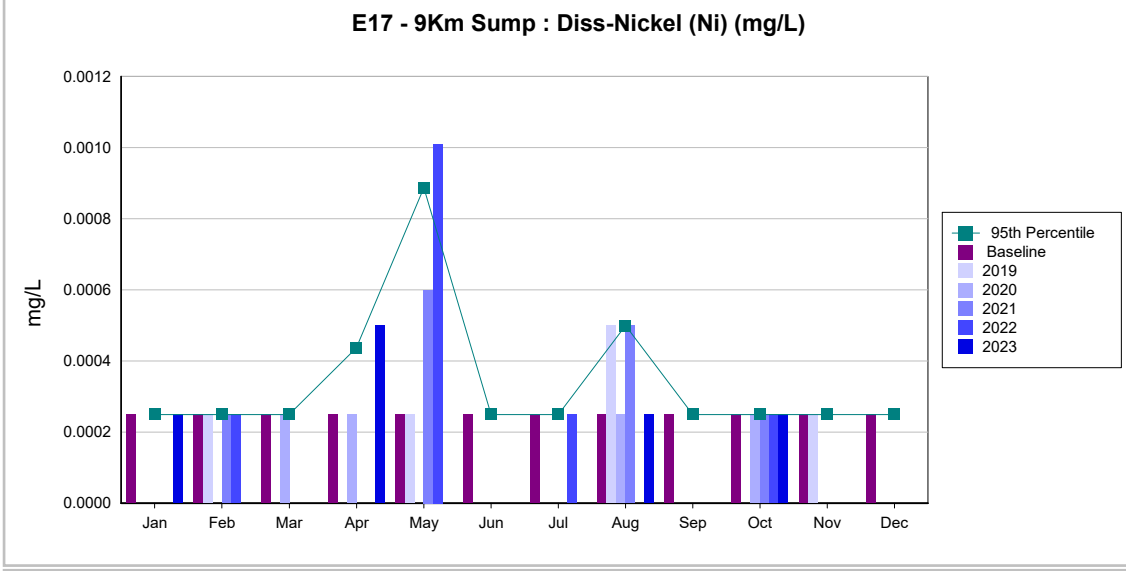
Annual Report Drainage Water

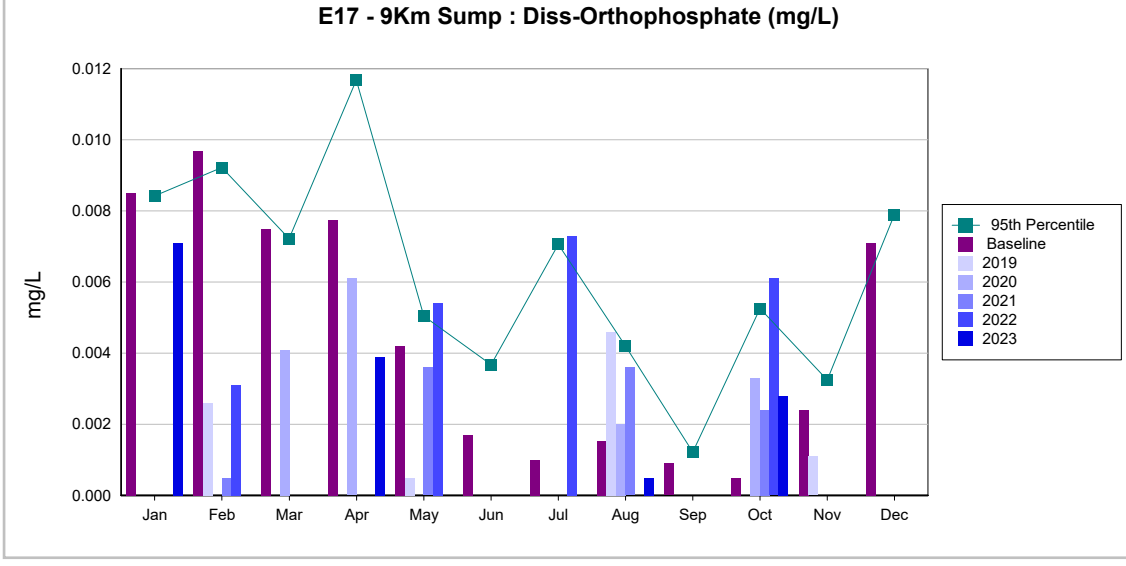
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







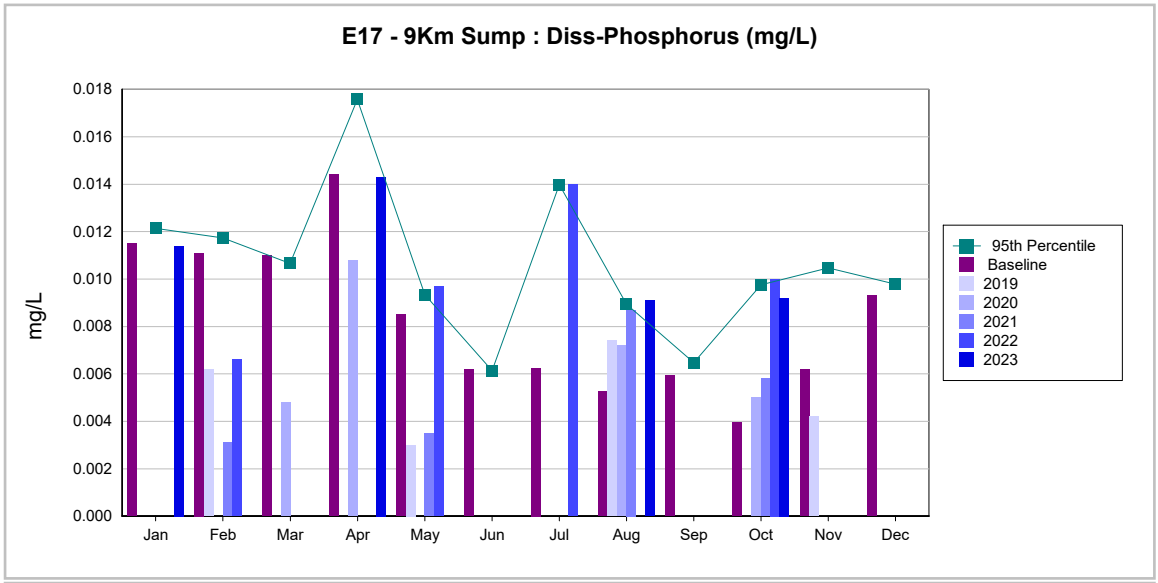
Water Quality Report

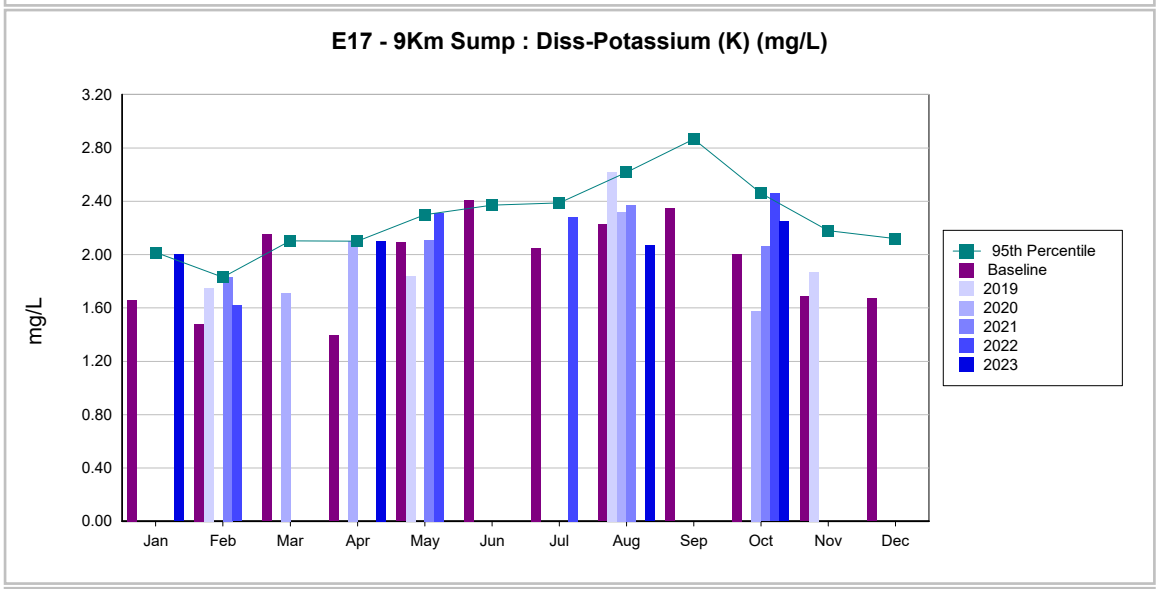
Annual Report Drainage Water

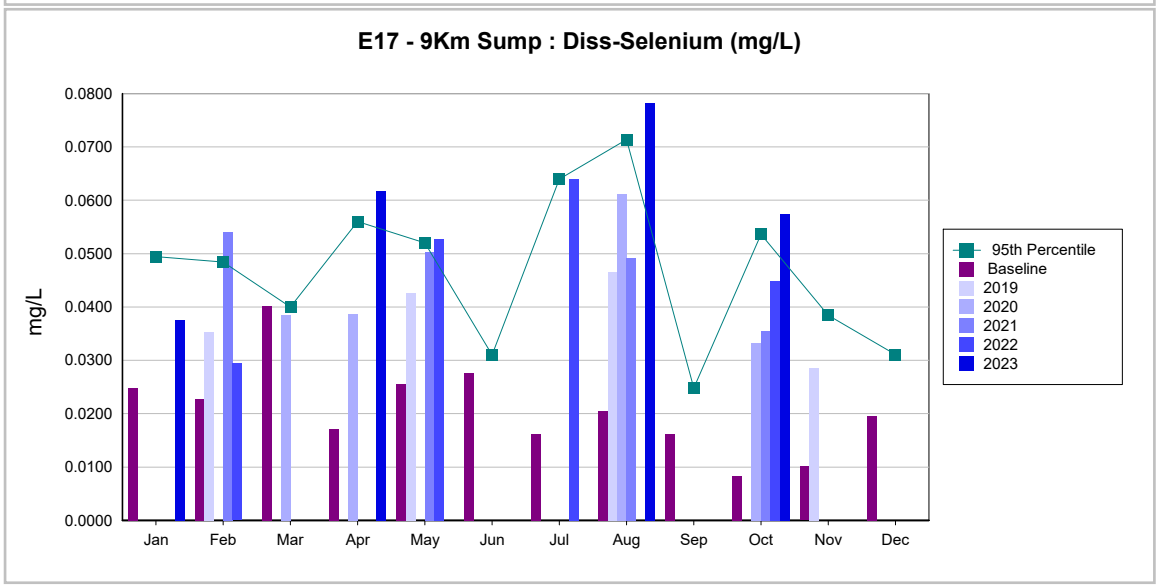
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







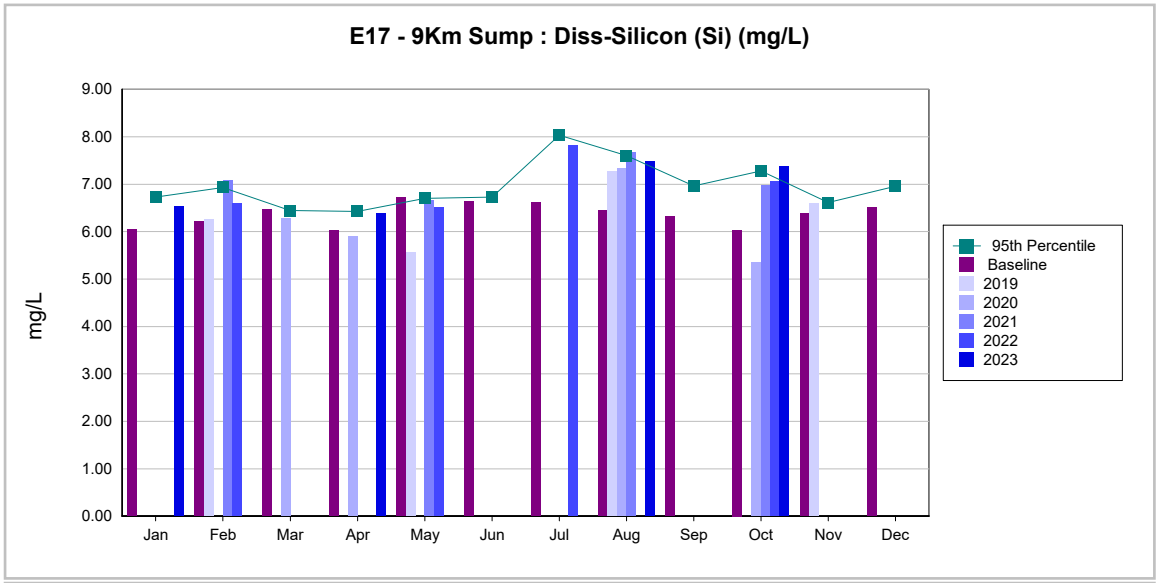
Water Quality Report

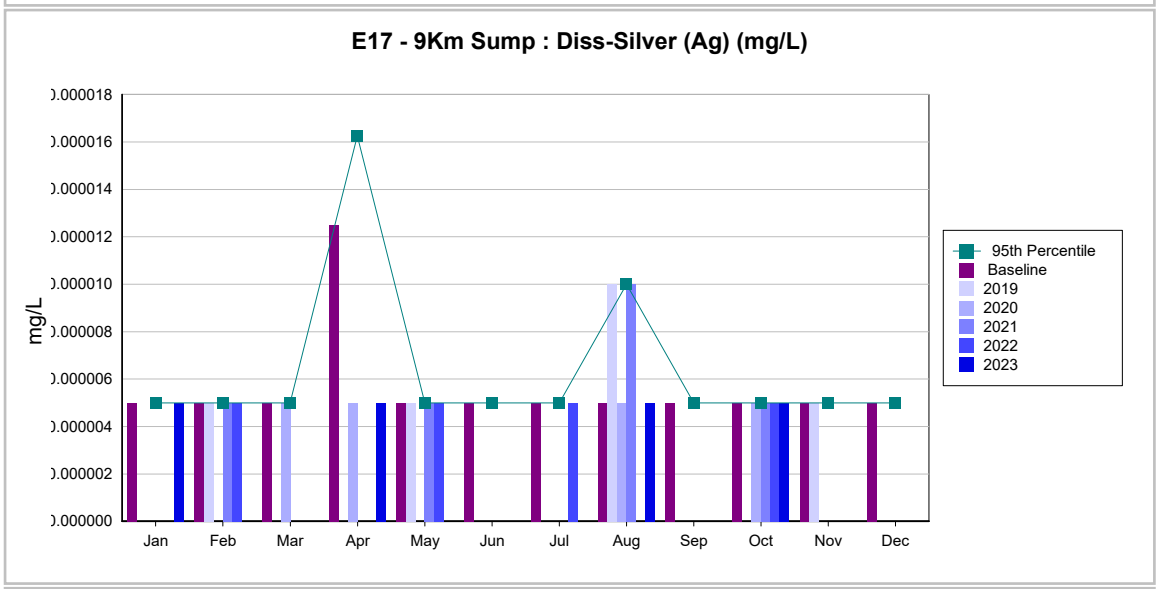
Annual Report Drainage Water

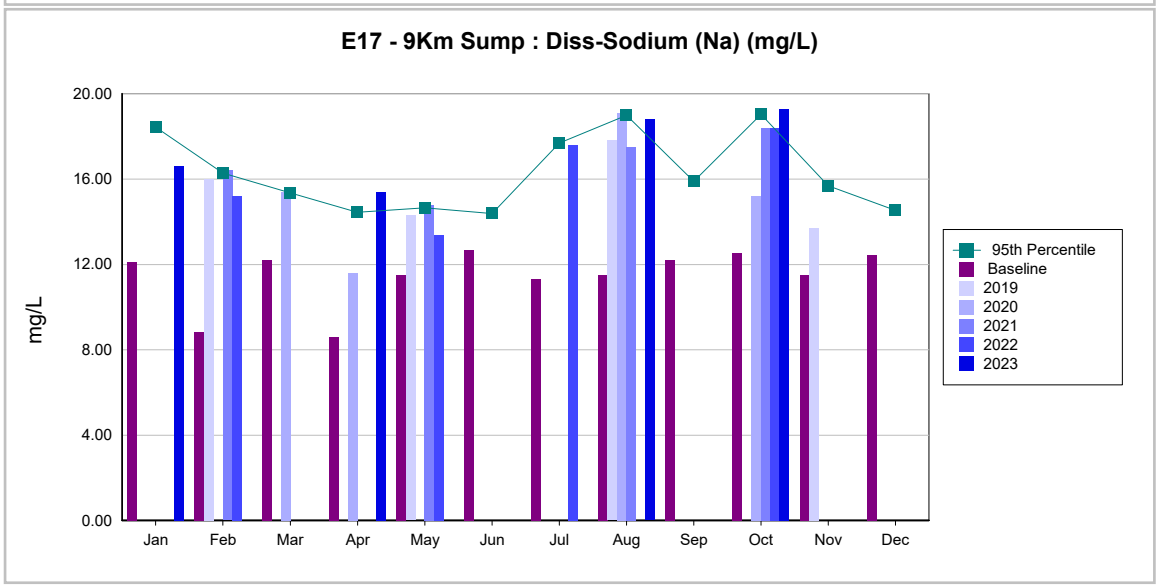
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







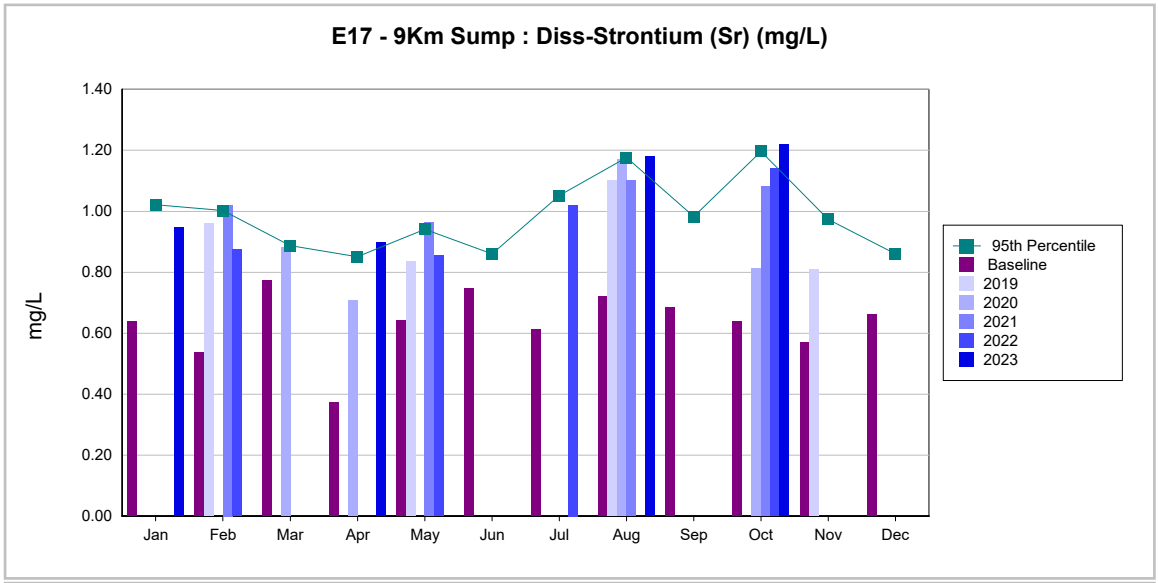
Water Quality Report

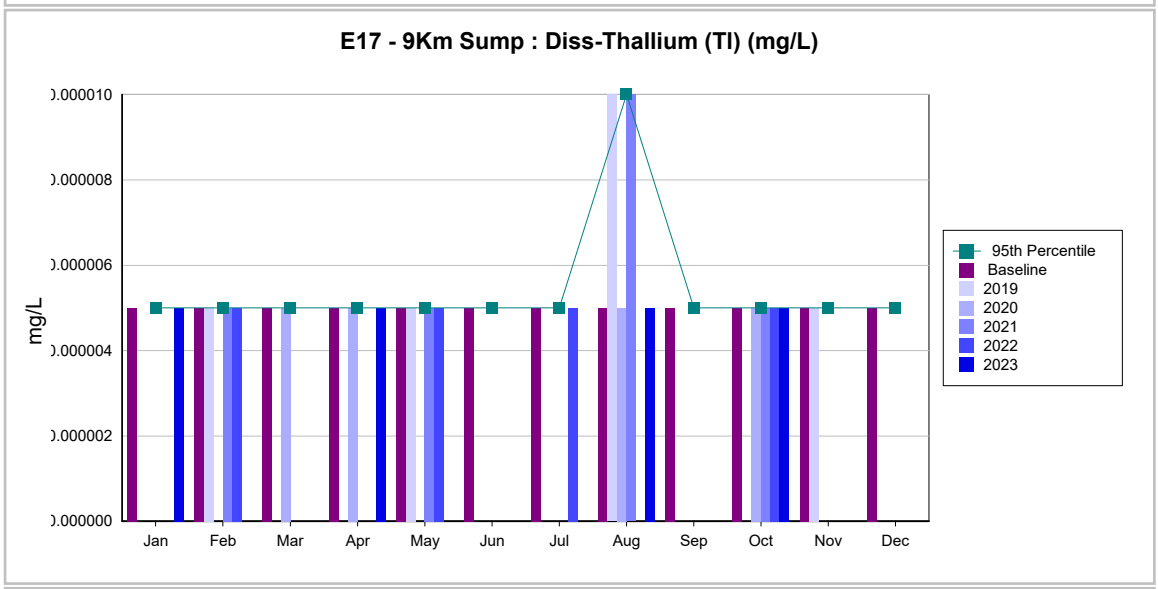
Annual Report Drainage Water

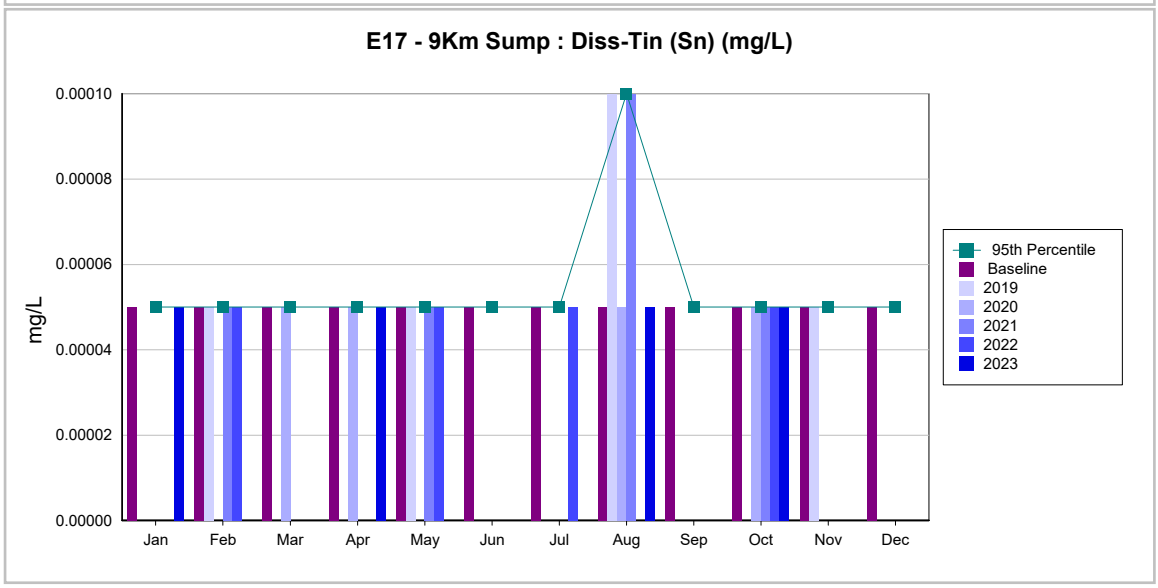
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







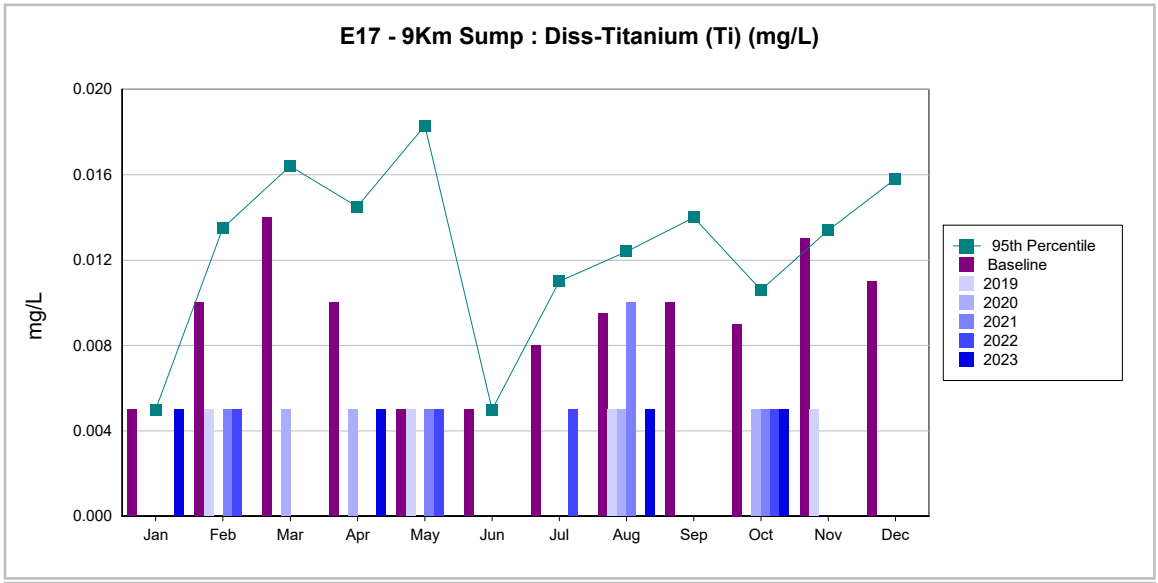
Water Quality Report

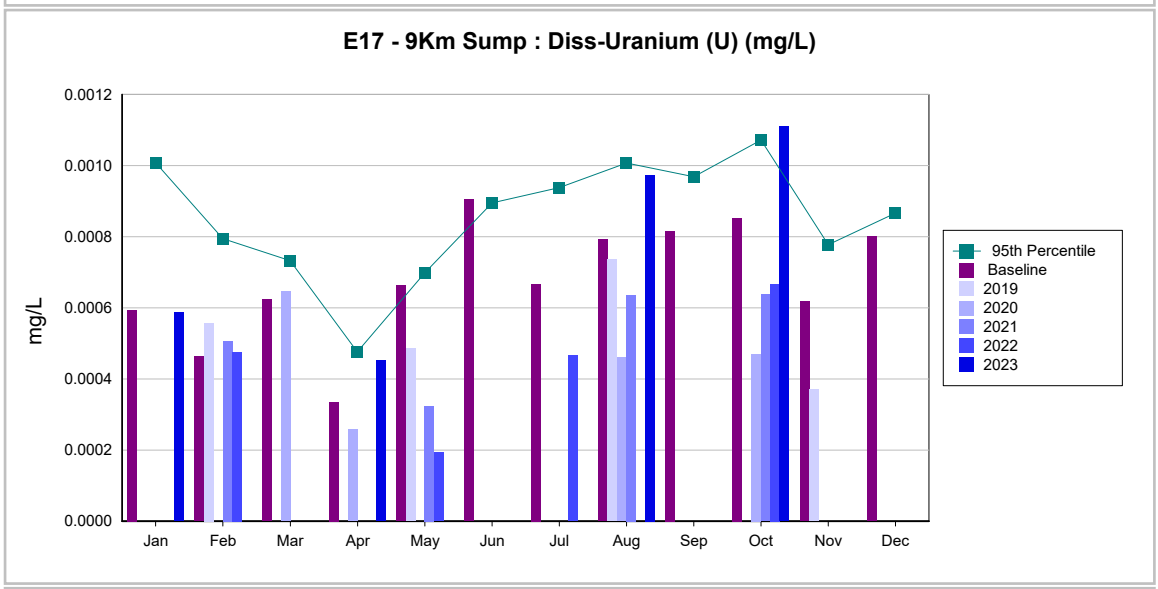
Annual Report Drainage Water

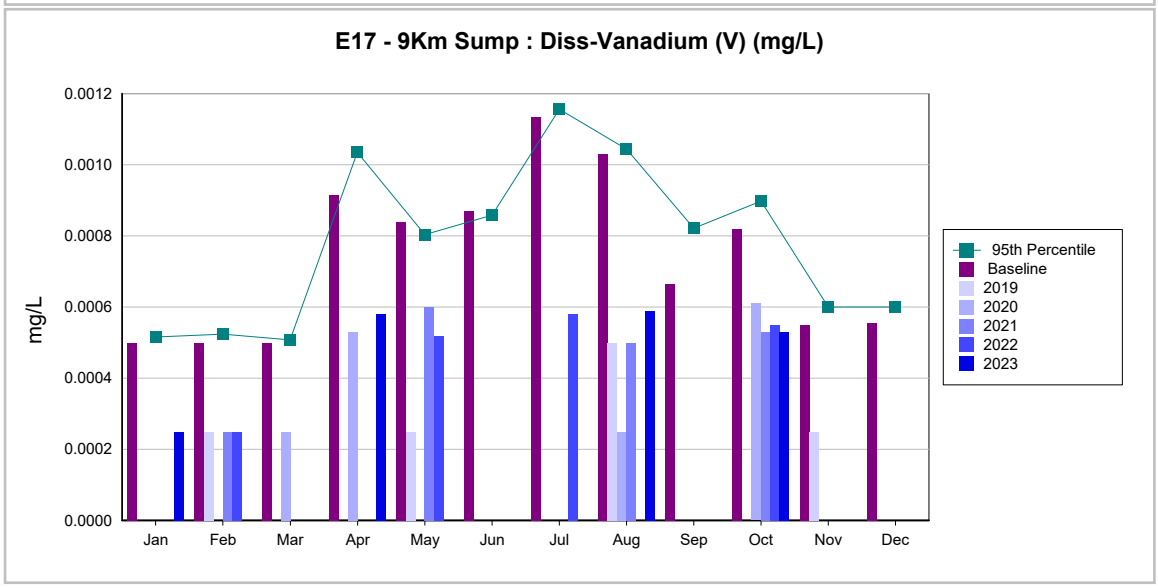
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







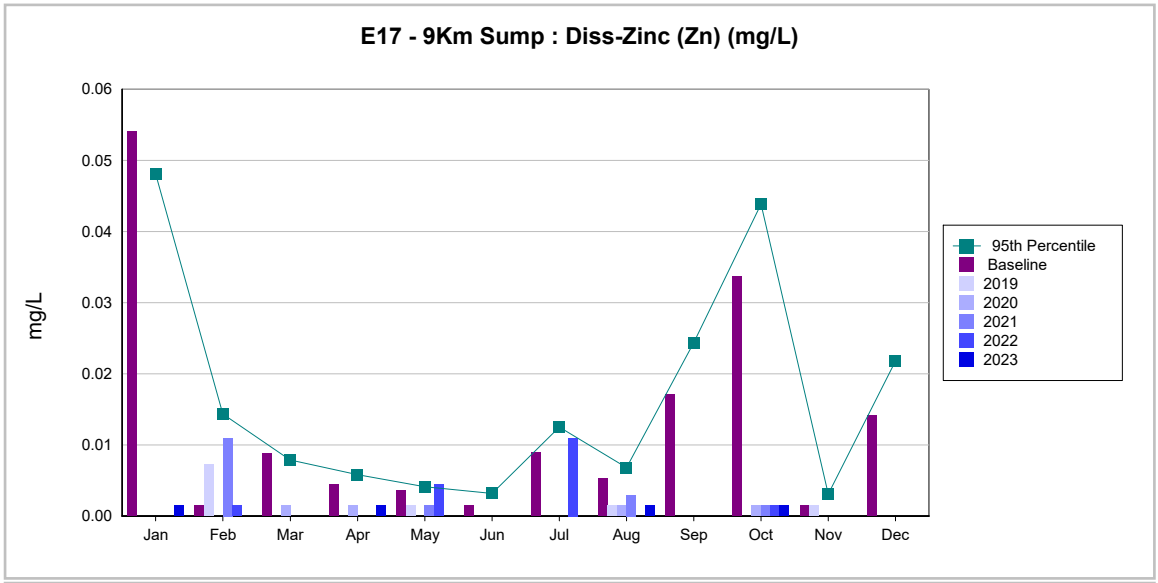
Water Quality Report

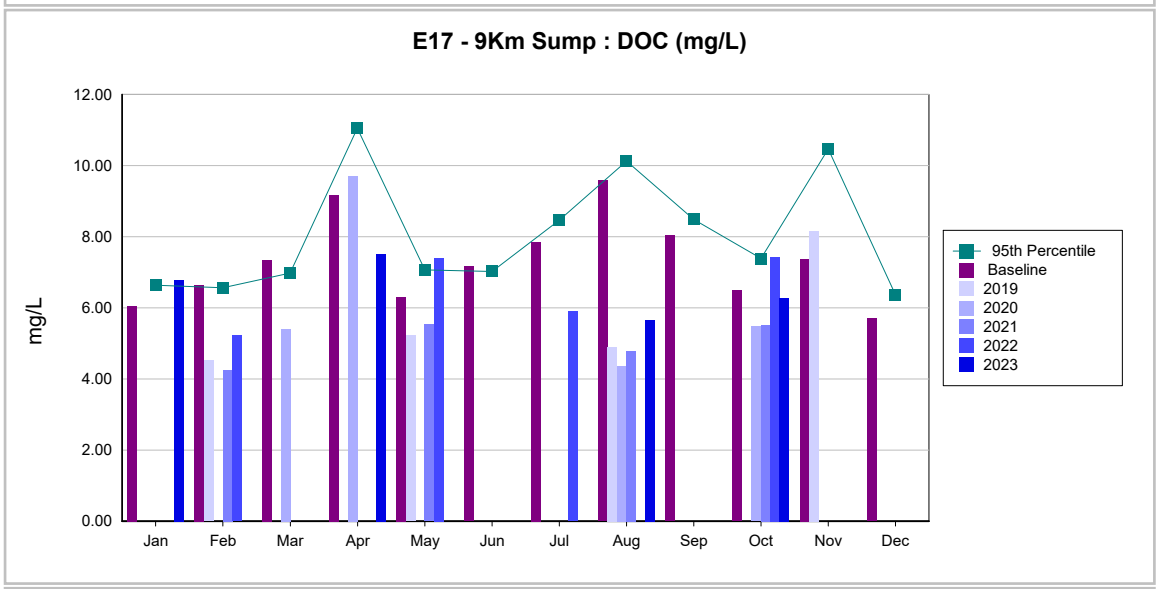
Annual Report Drainage Water

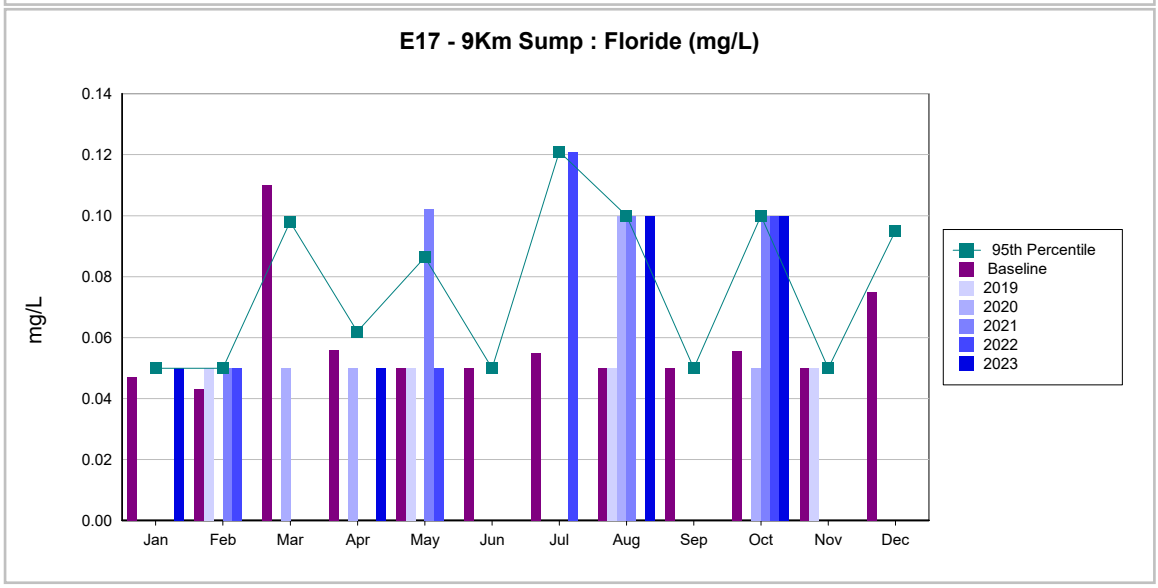
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







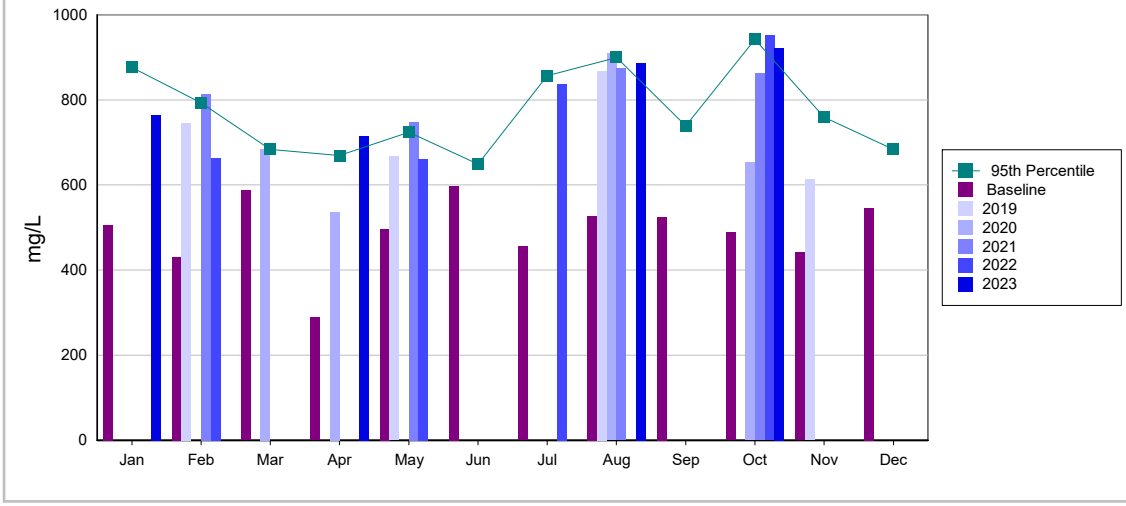
Water Quality Report

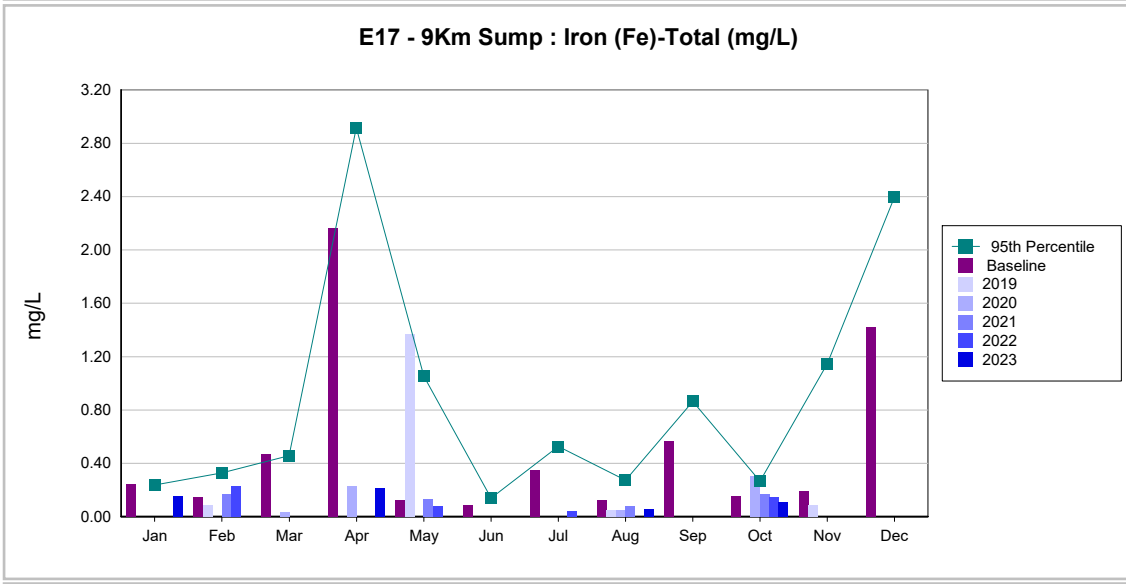
Annual Report Drainage Water

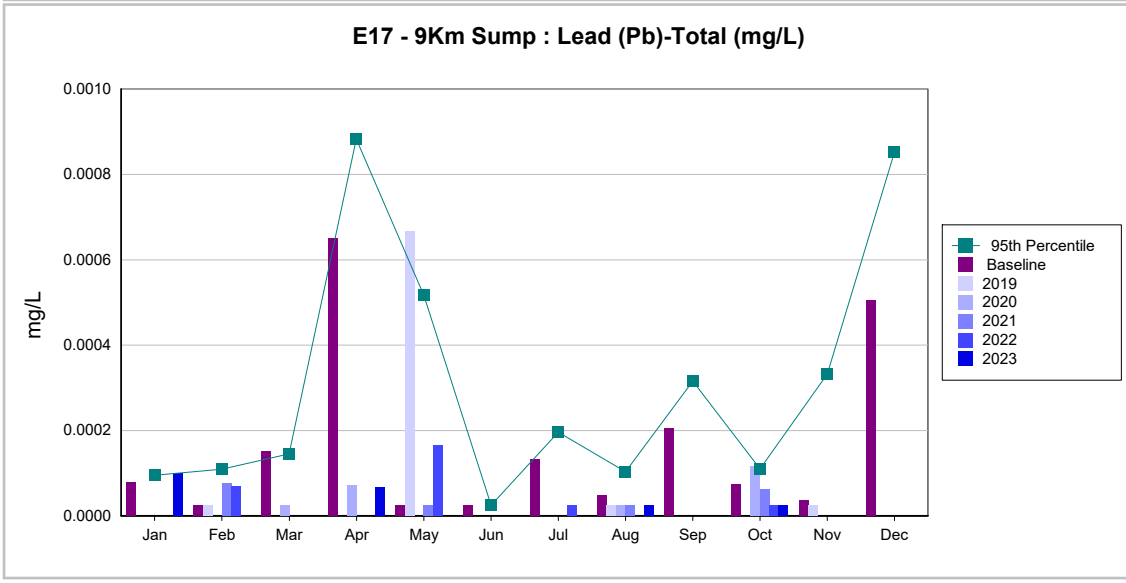
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







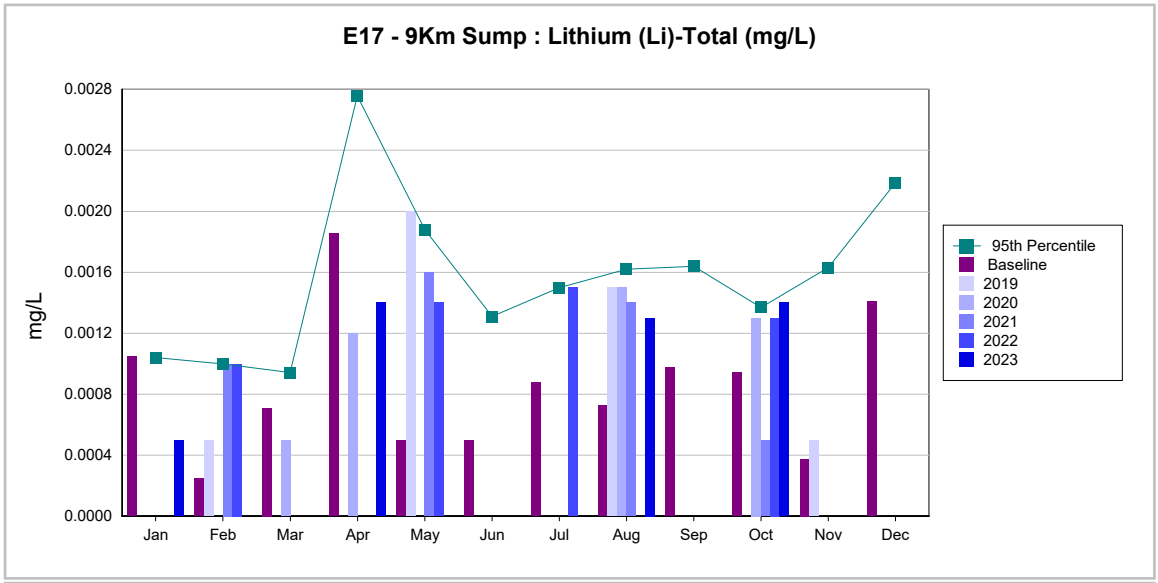
Water Quality Report

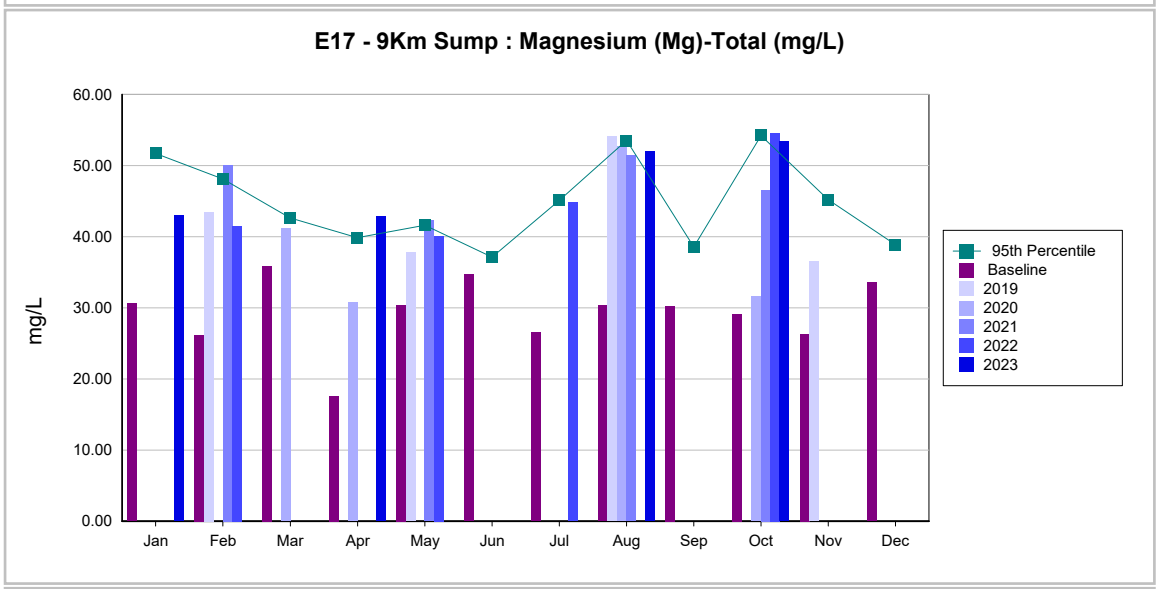
Annual Report Drainage Water

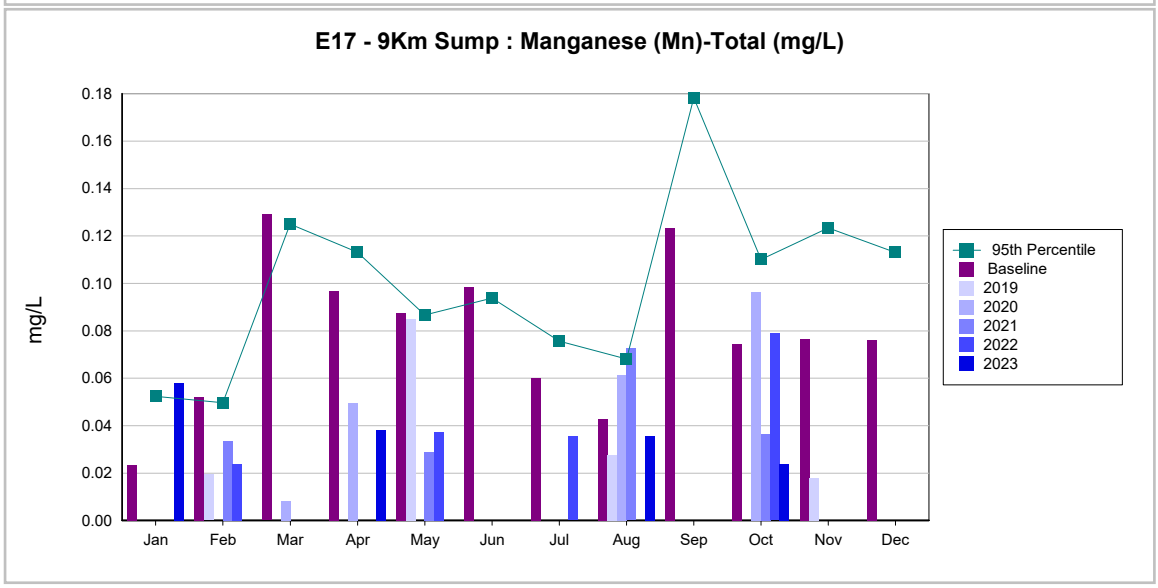
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







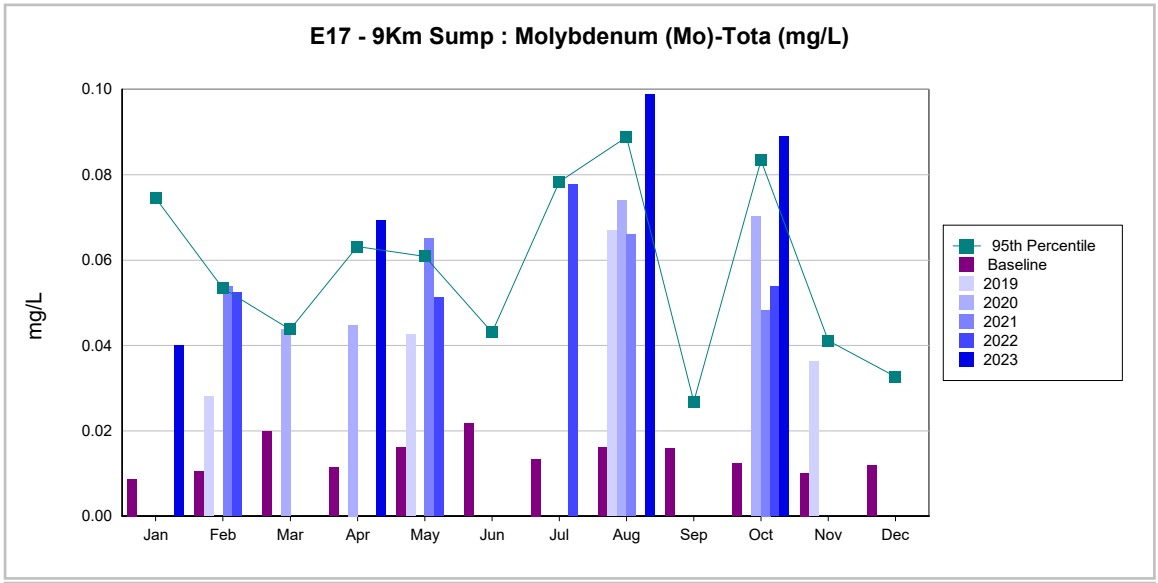
Water Quality Report

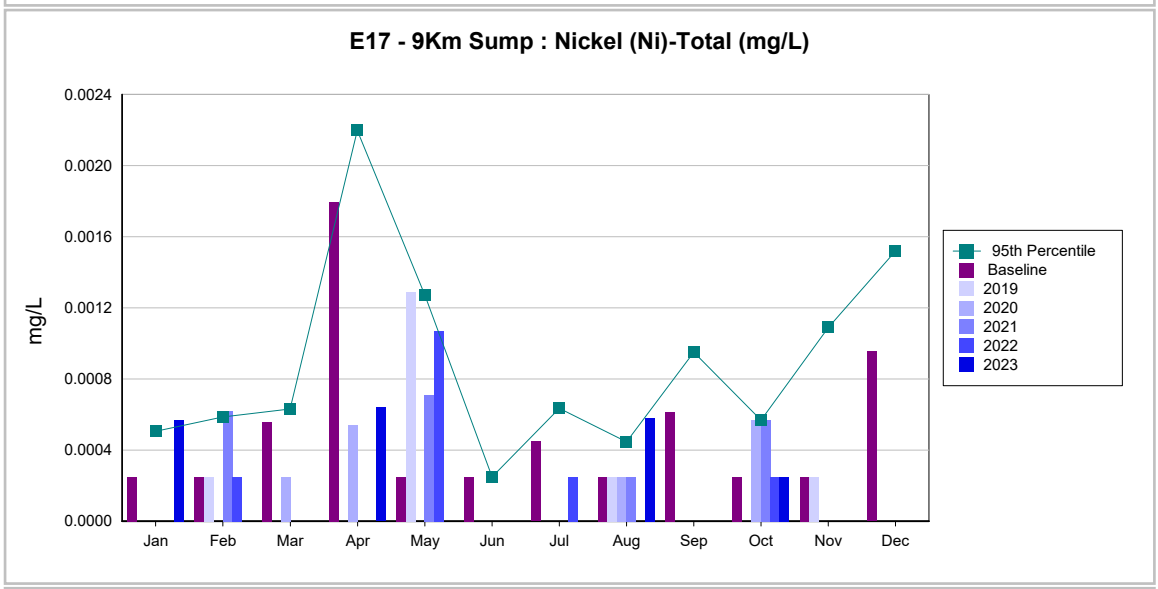
Annual Report Drainage Water

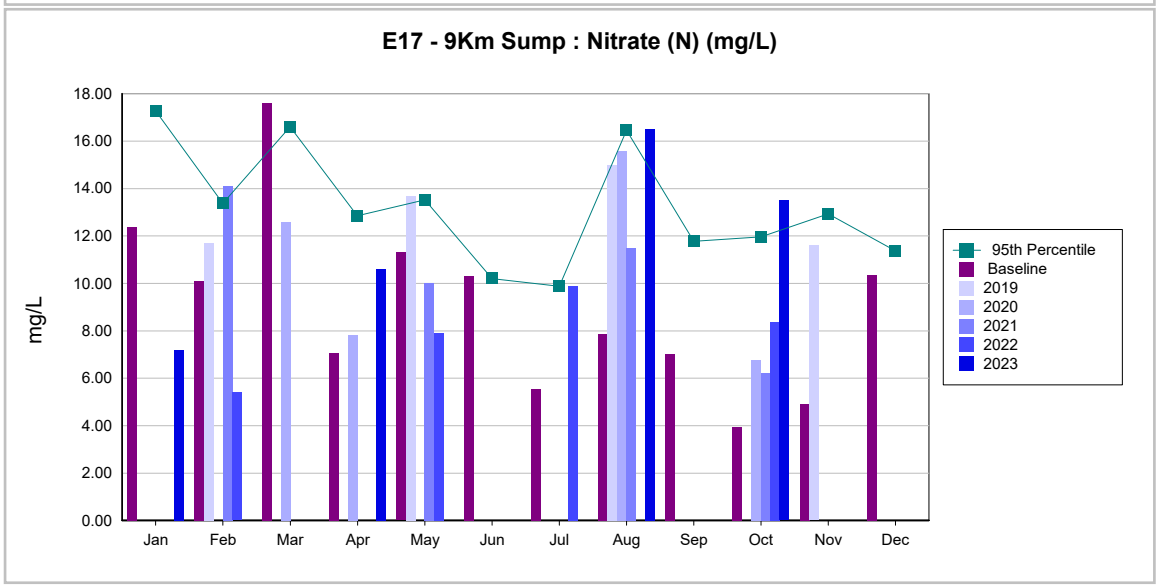
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







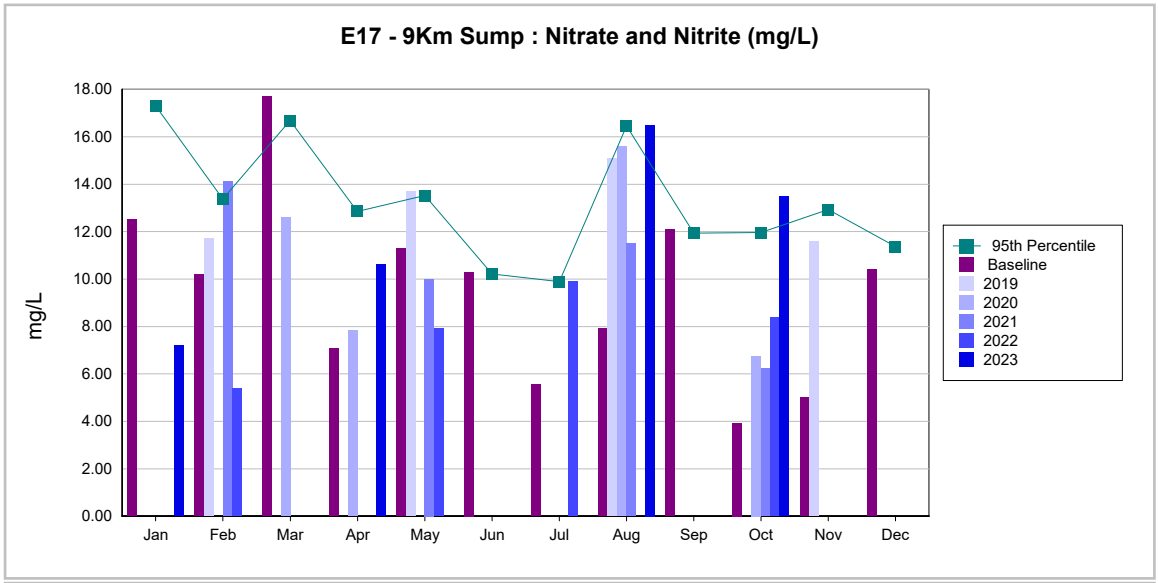
Water Quality Report

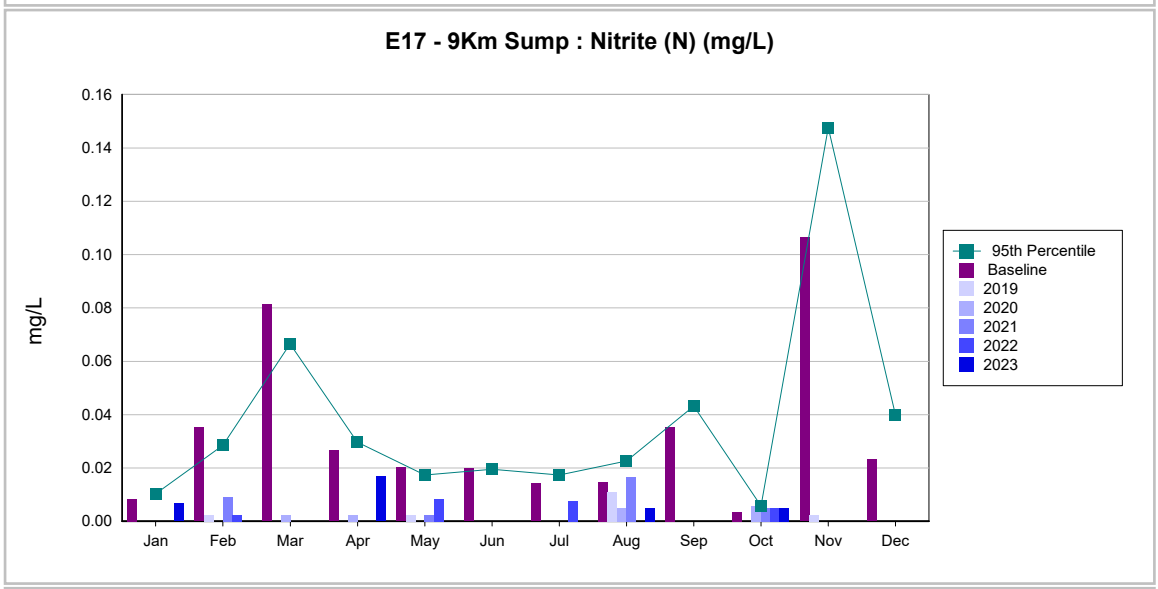
Annual Report Drainage Water

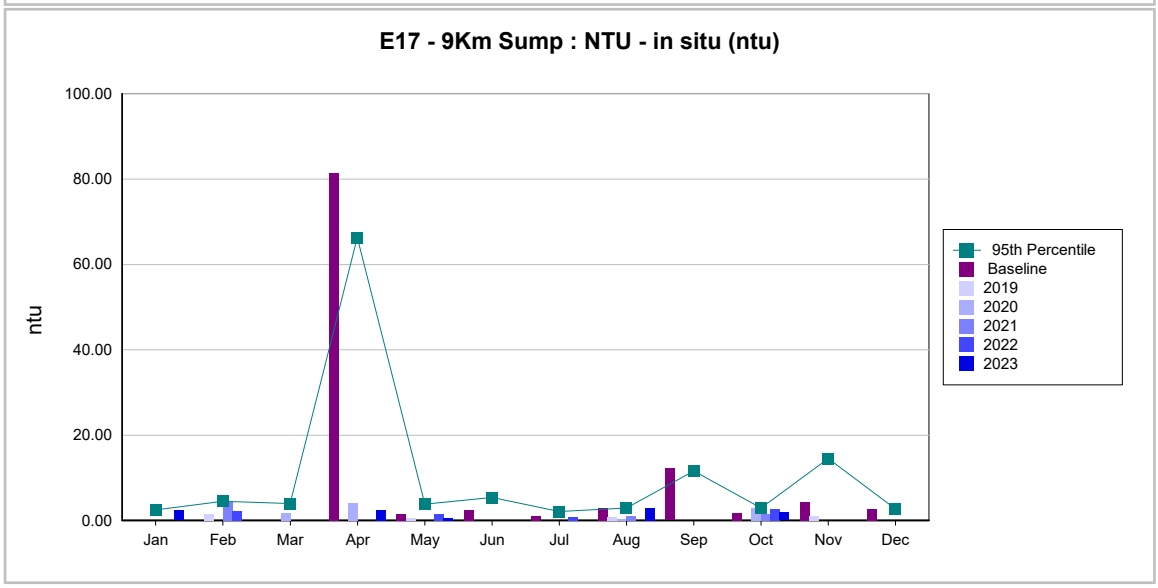
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







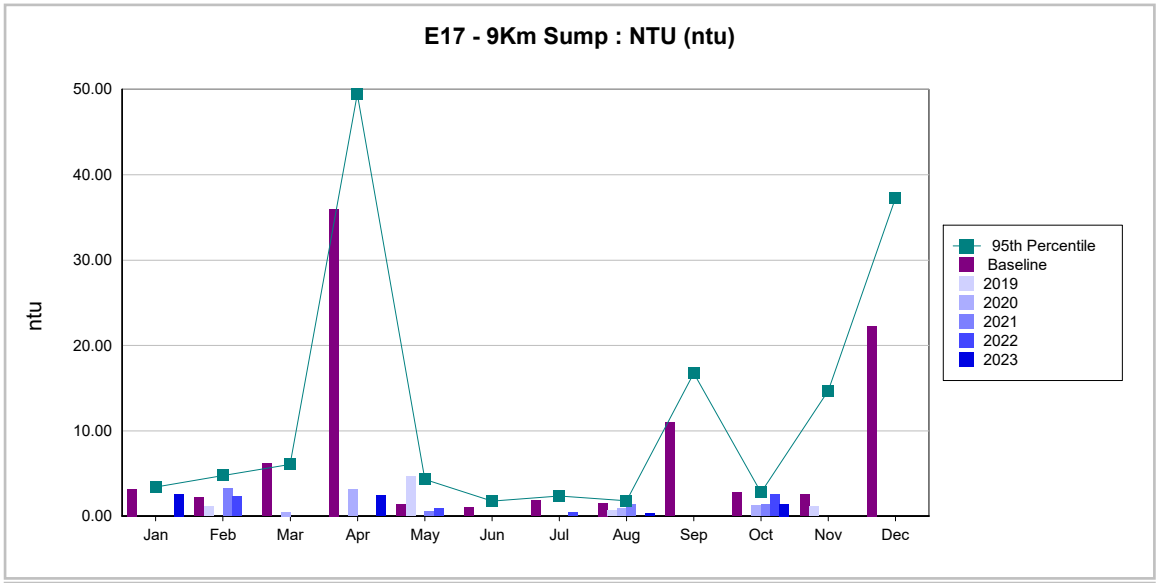
Water Quality Report

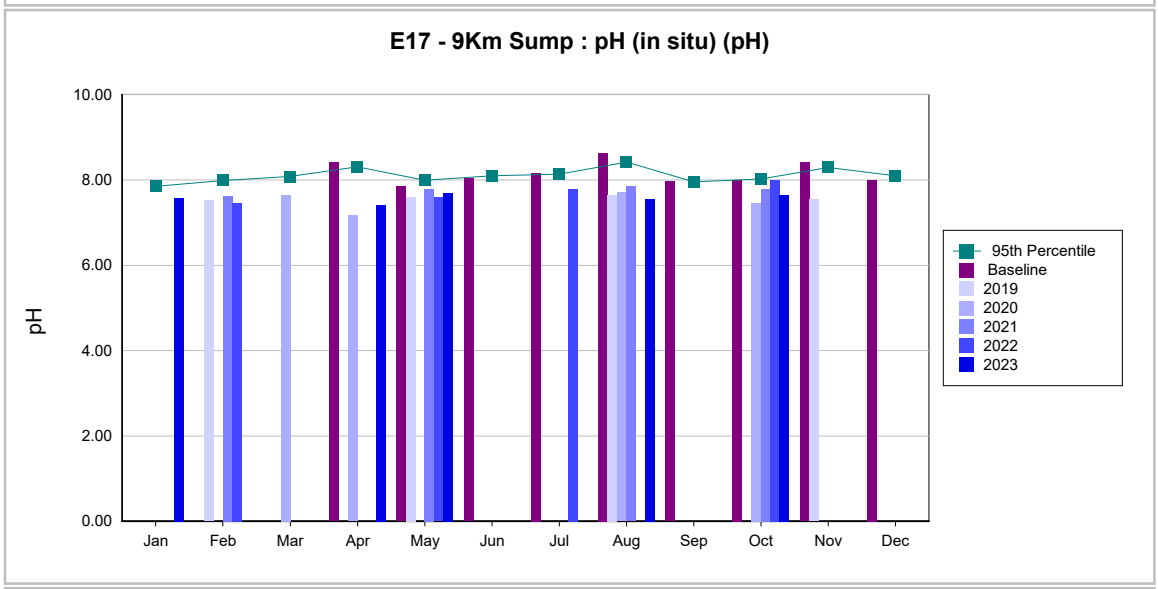
Annual Report Drainage Water

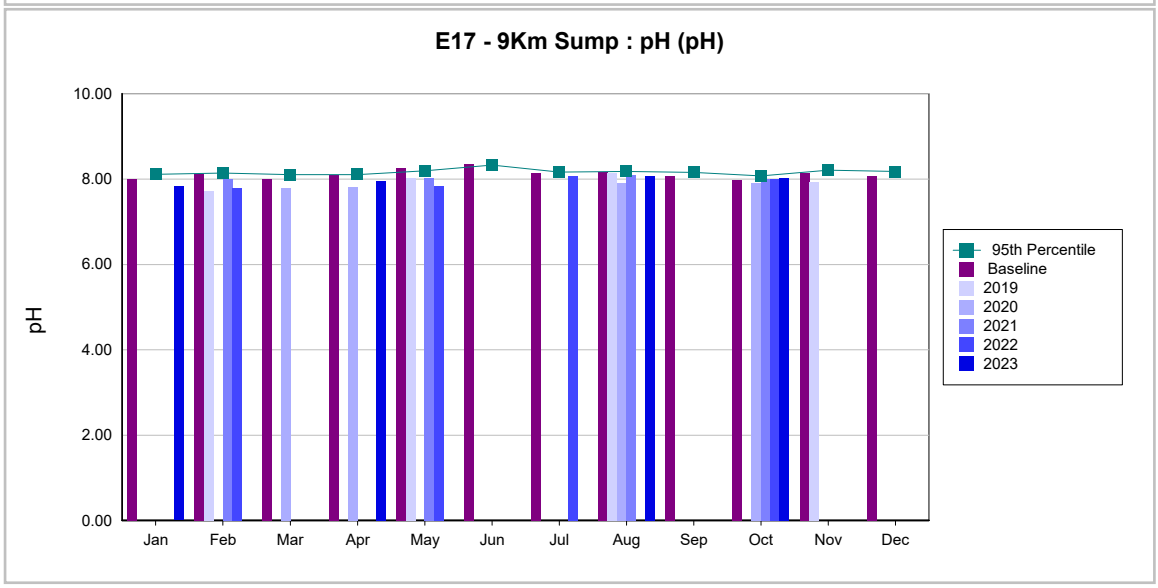
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







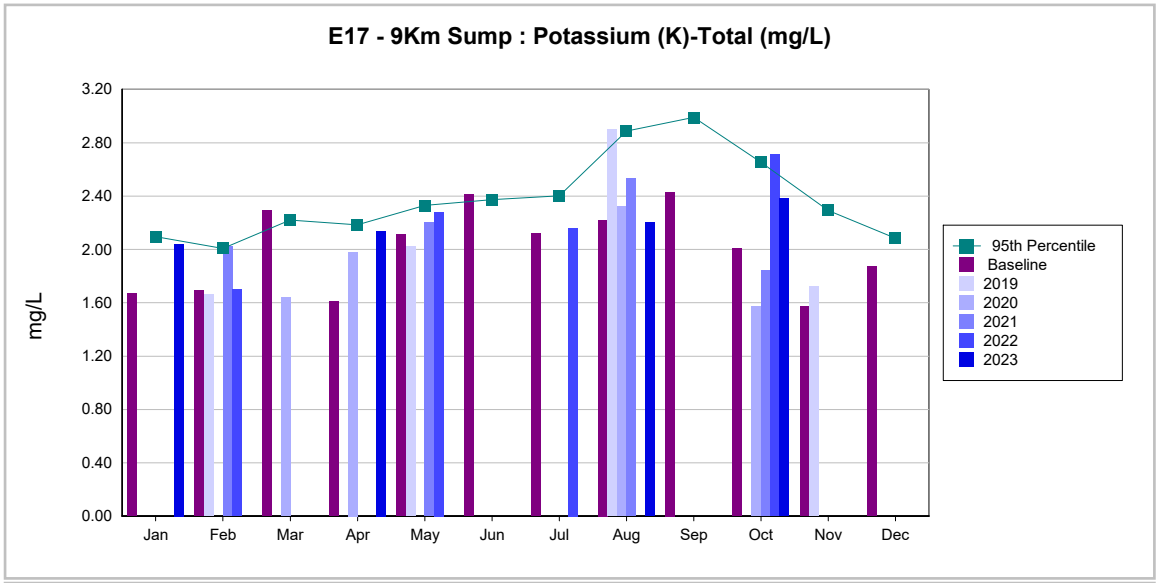
Water Quality Report

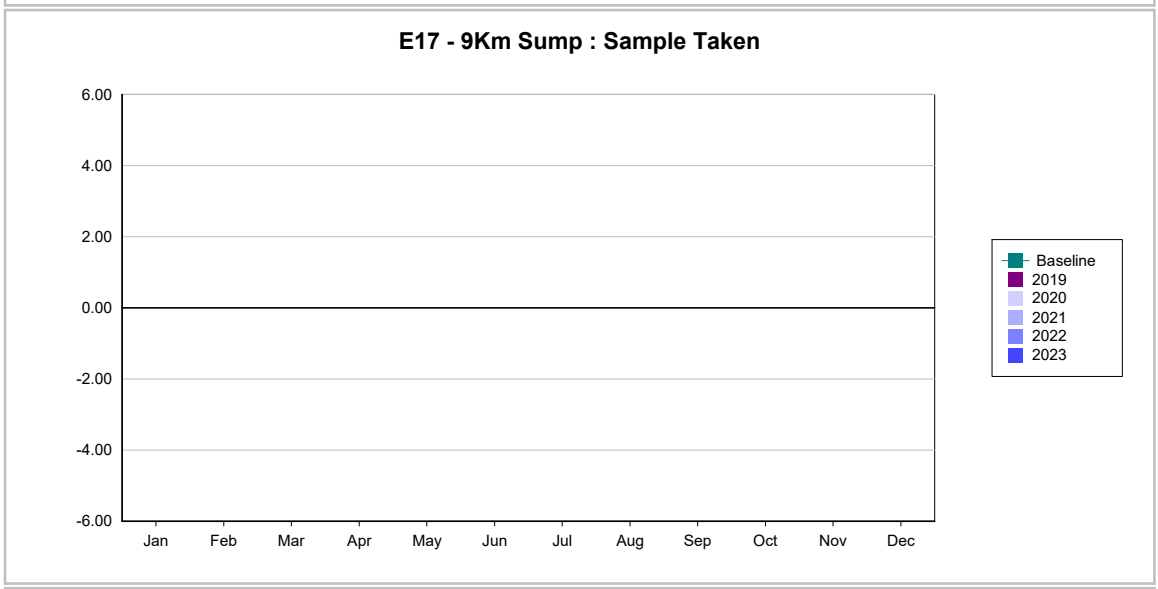
Annual Report Drainage Water

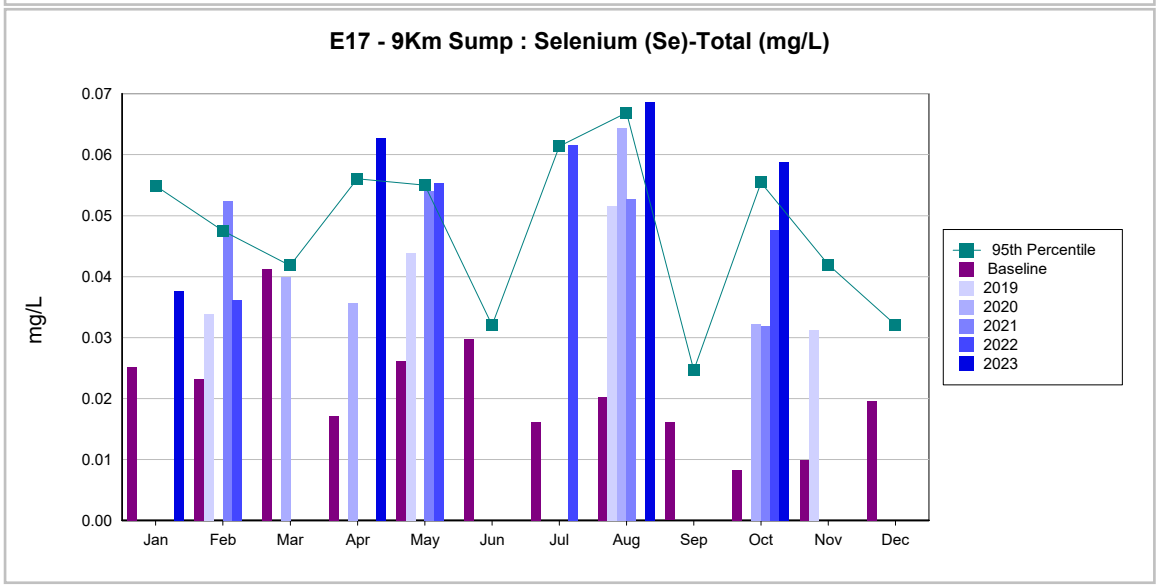
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







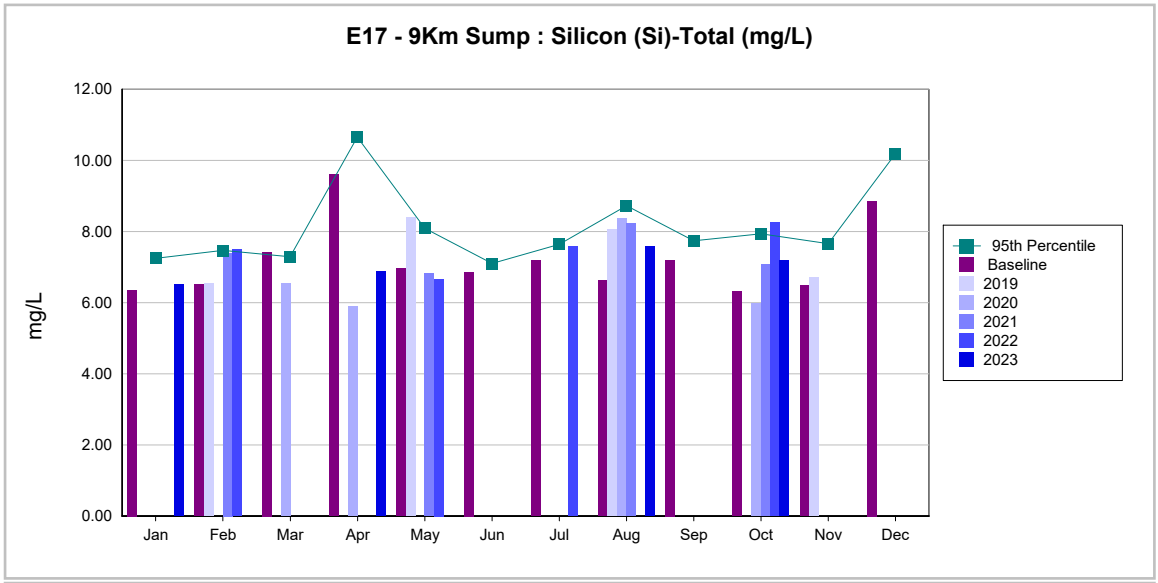
Water Quality Report

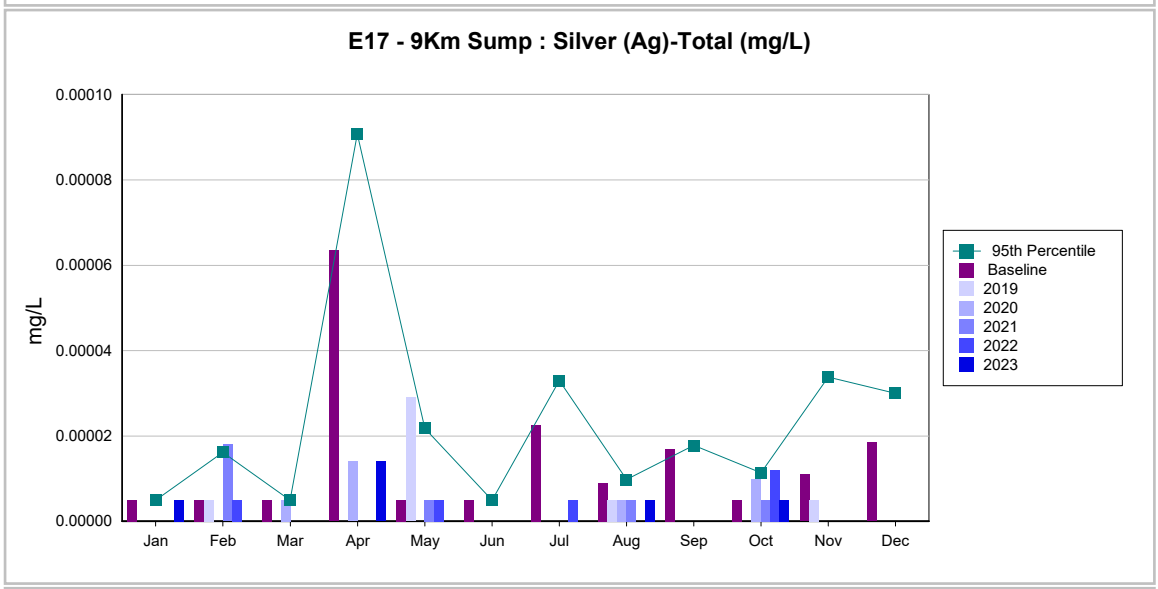
Annual Report Drainage Water

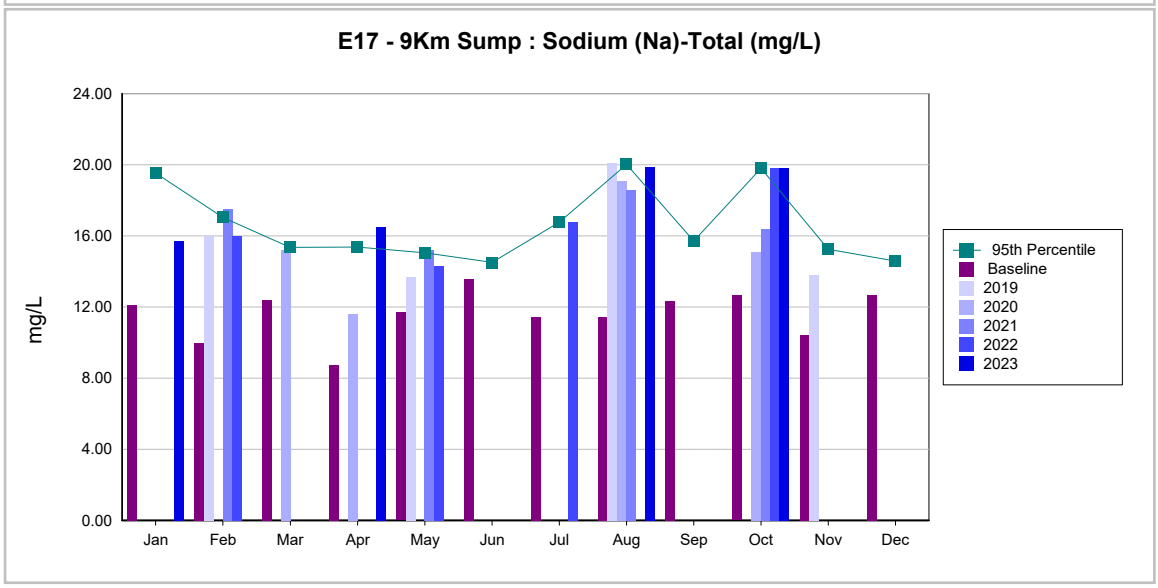
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

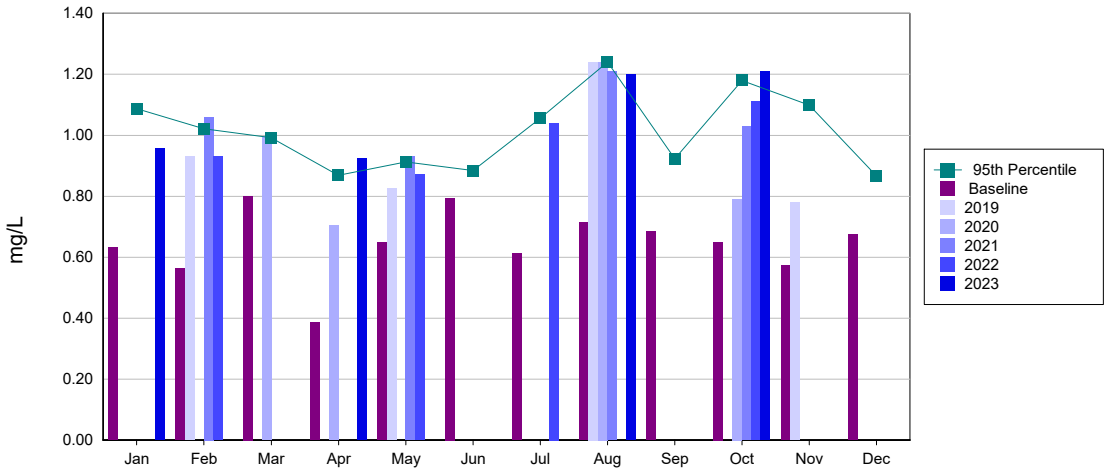
Annual Report Drainage Water

Mount Polley

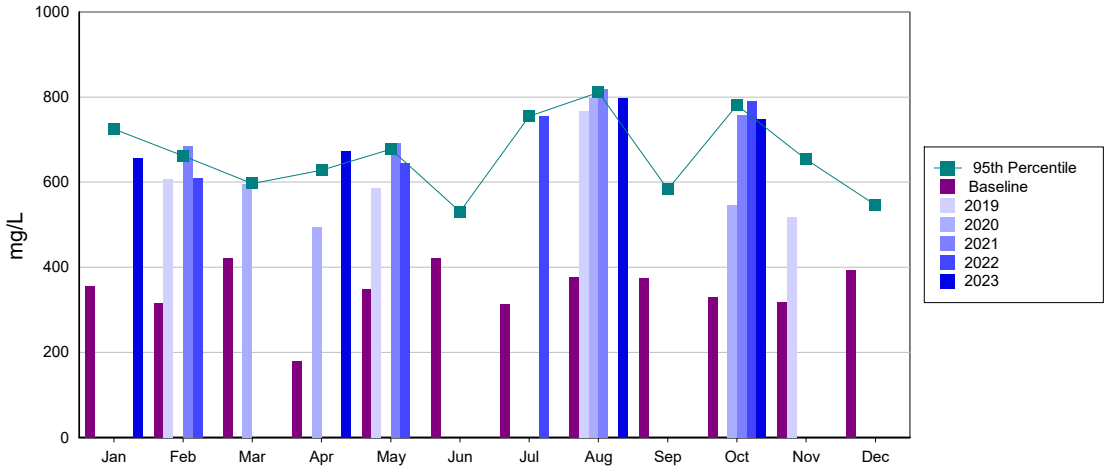
Mining Corporation

IMPERIAL METALS CORPORATION

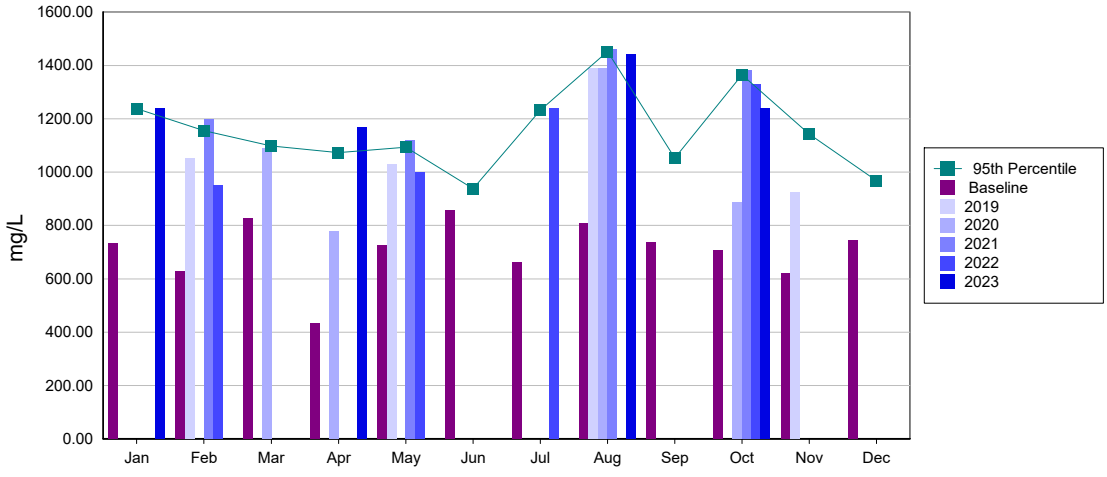
E17 - 9Km Sump : Strontium (Sr)-Total (mg/L)



E17 - 9Km Sump : Sulphate (mg/L)



E17 - 9Km Sump : TDS (mg/L)



Water Quality Report

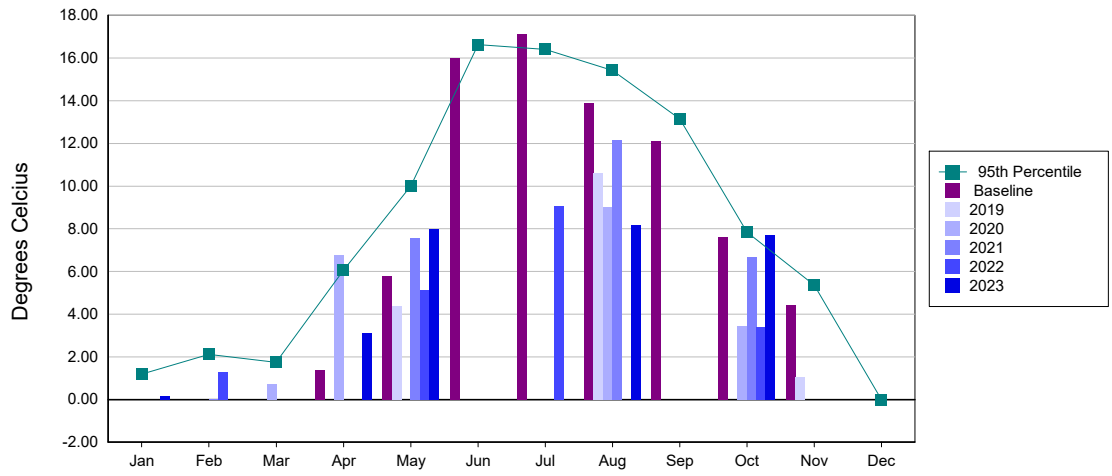
Annual Report Drainage Water

Mount Polley

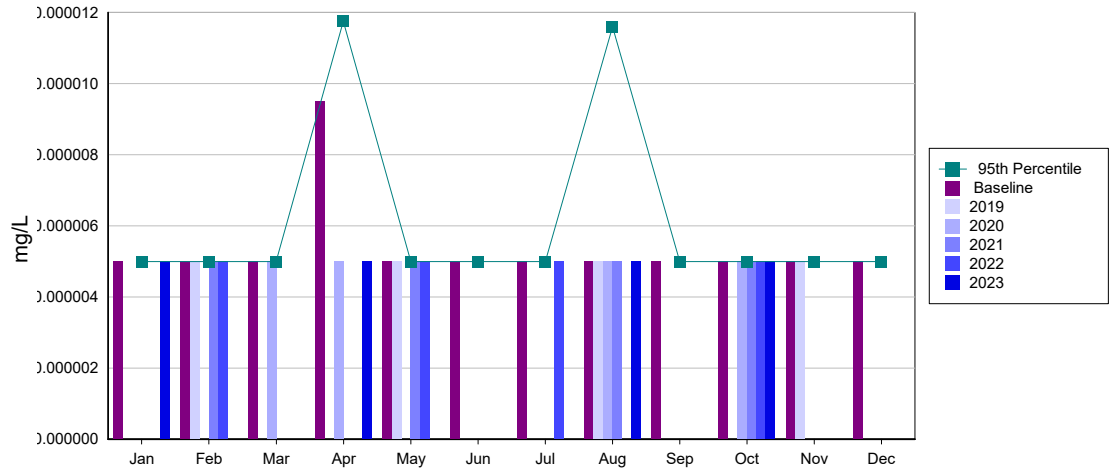
Mining Corporation

IMPERIAL METALS CORPORATION

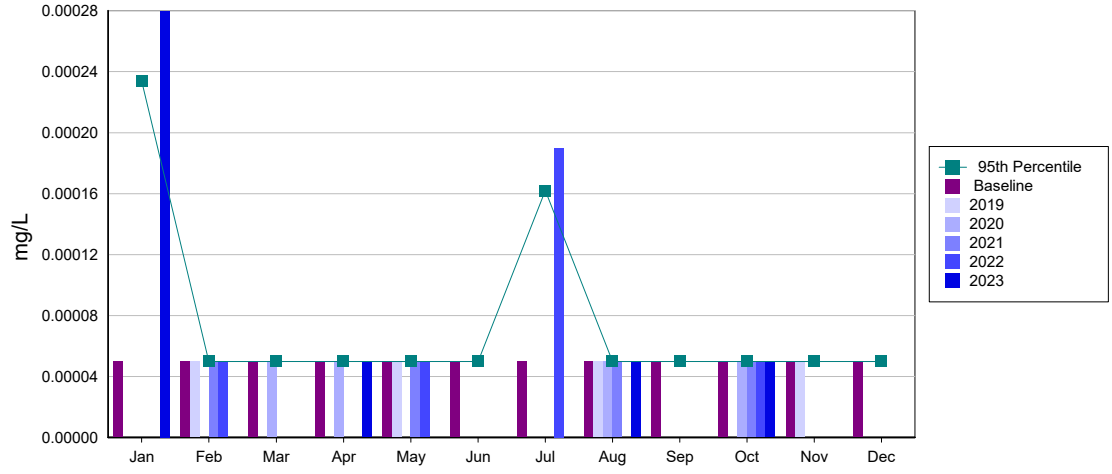
E17 - 9Km Sump : Temp (in situ) (Degrees Celcius)



E17 - 9Km Sump : Thallium (Tl)-Total (mg/L)



E17 - 9Km Sump : Tin (Sn)-Total (mg/L)



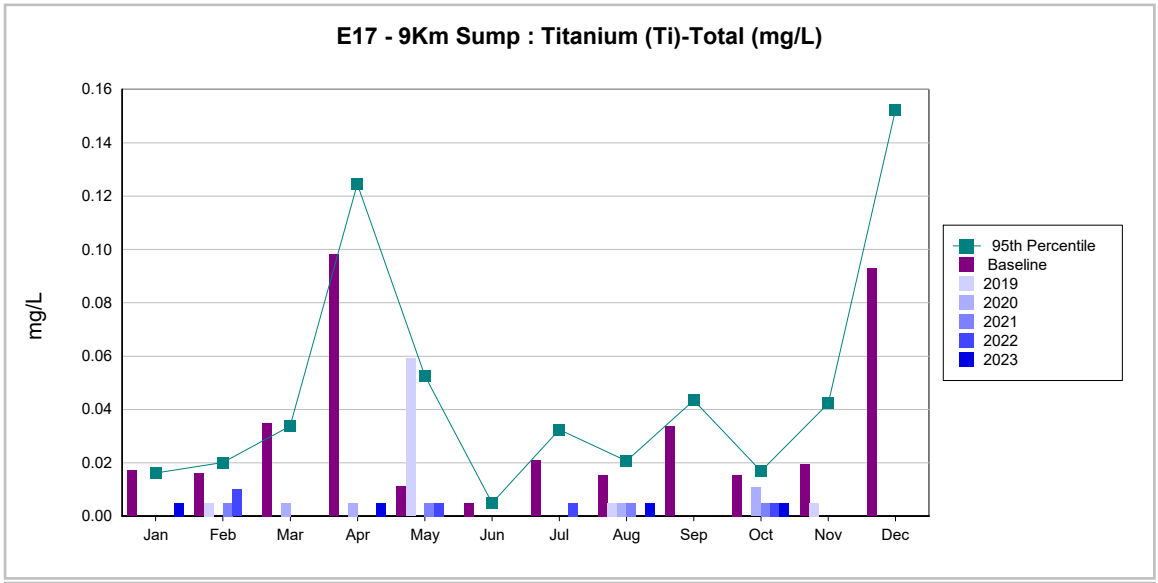
Water Quality Report

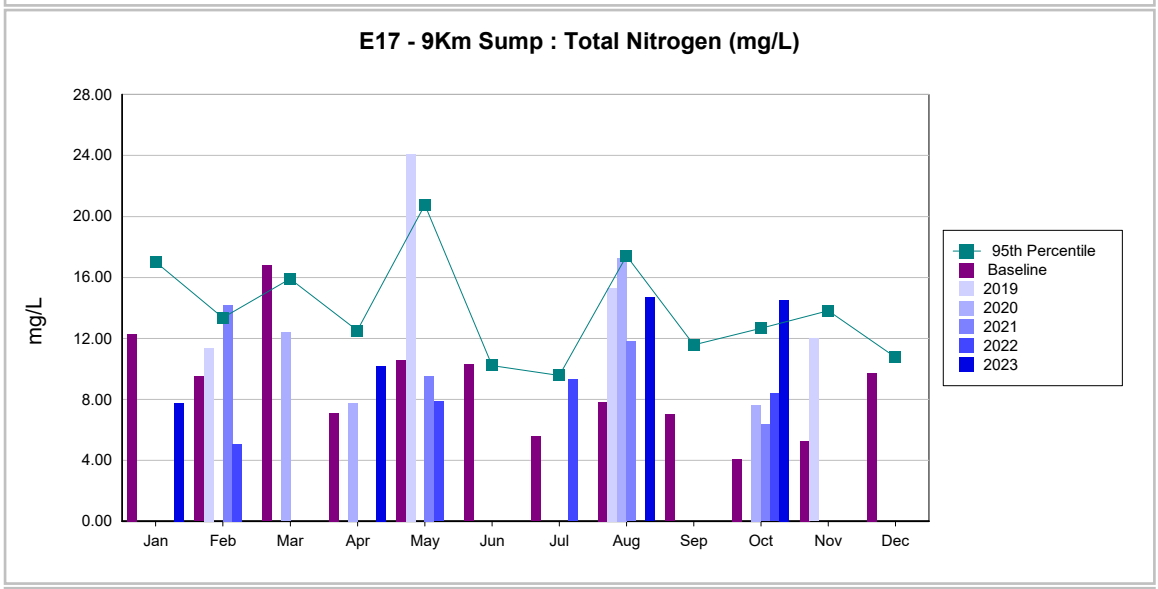
Annual Report Drainage Water

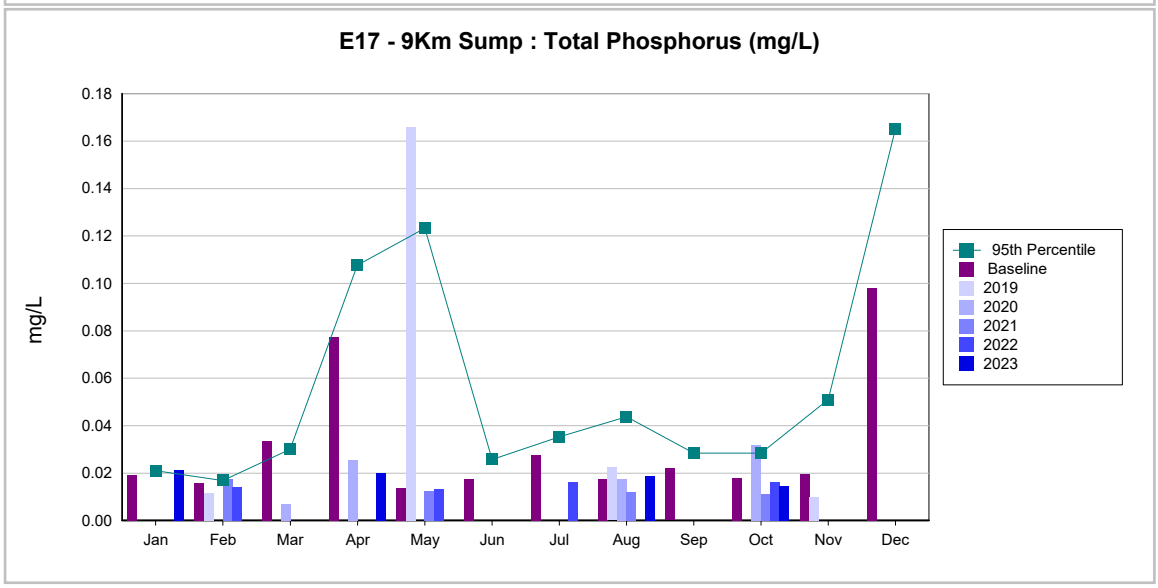
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







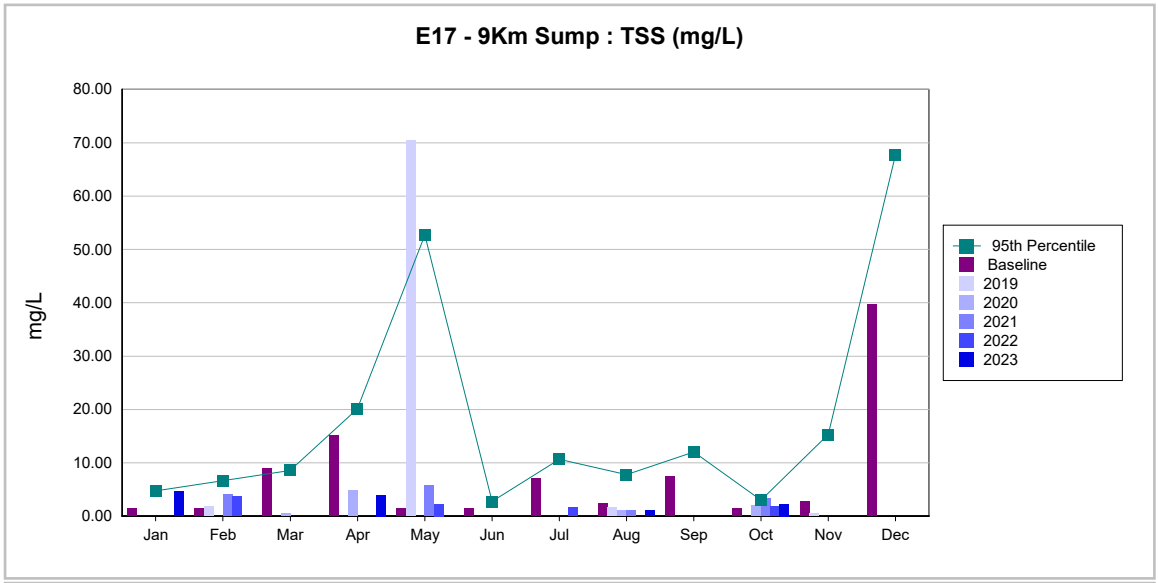
Water Quality Report

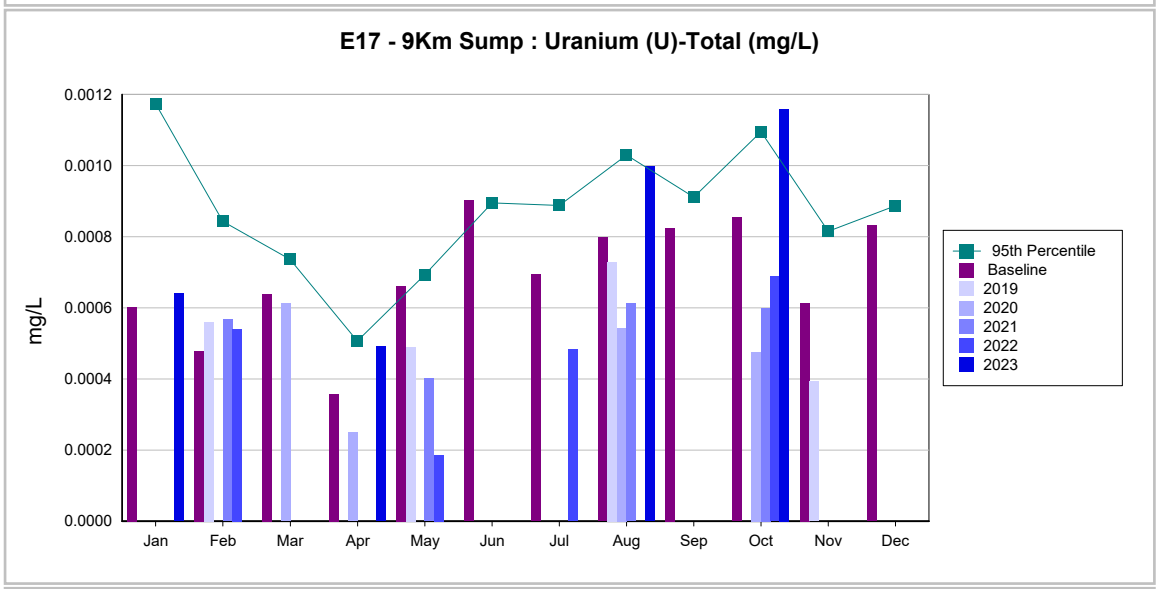
Annual Report Drainage Water

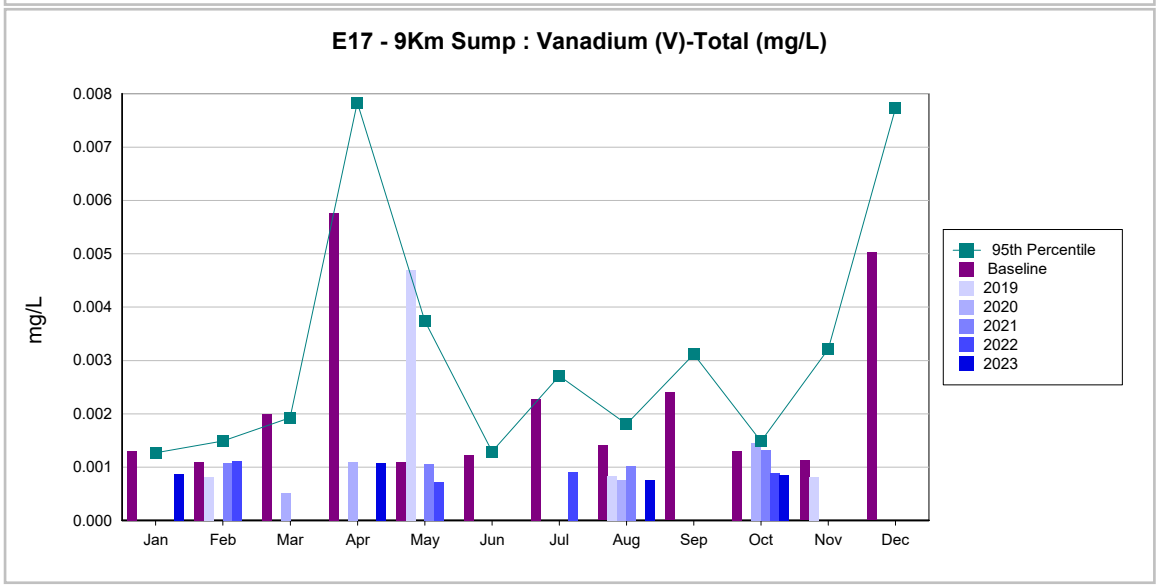
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







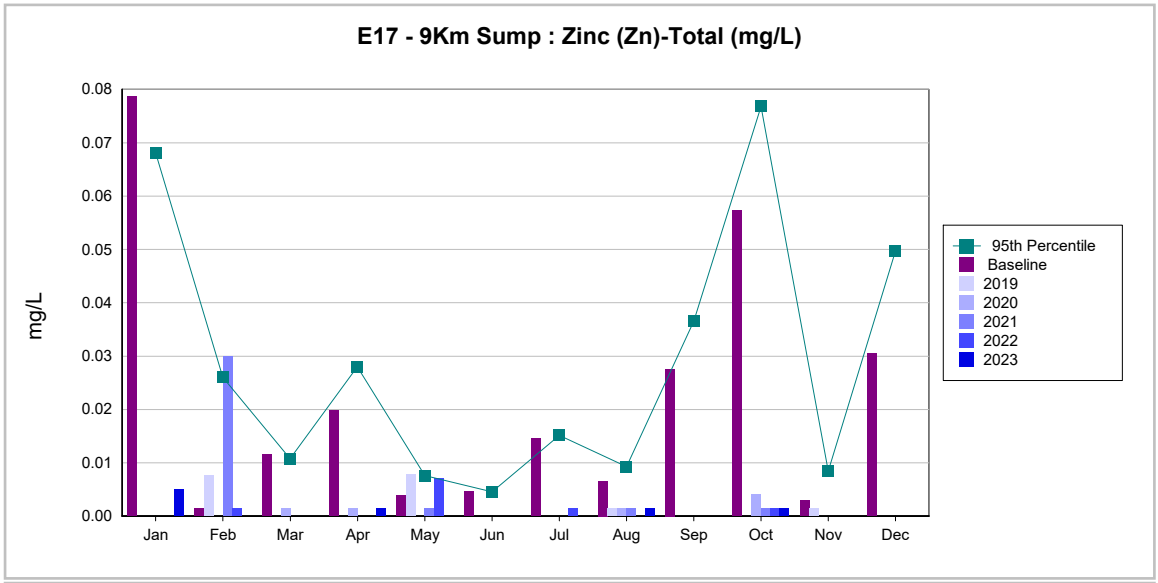
Water Quality Report

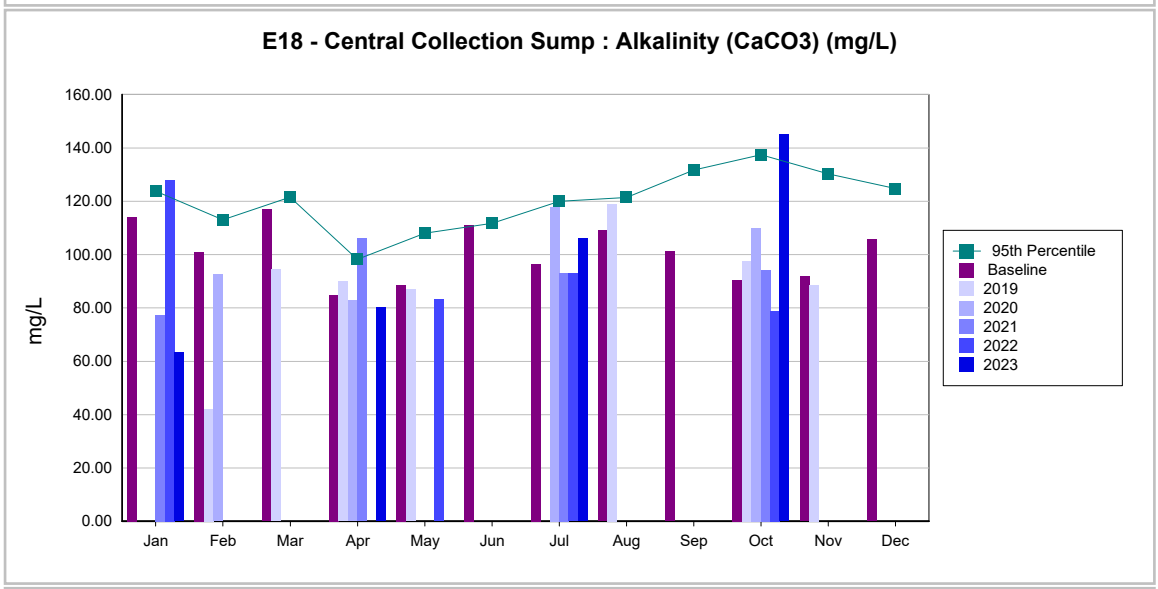
Annual Report Drainage Water

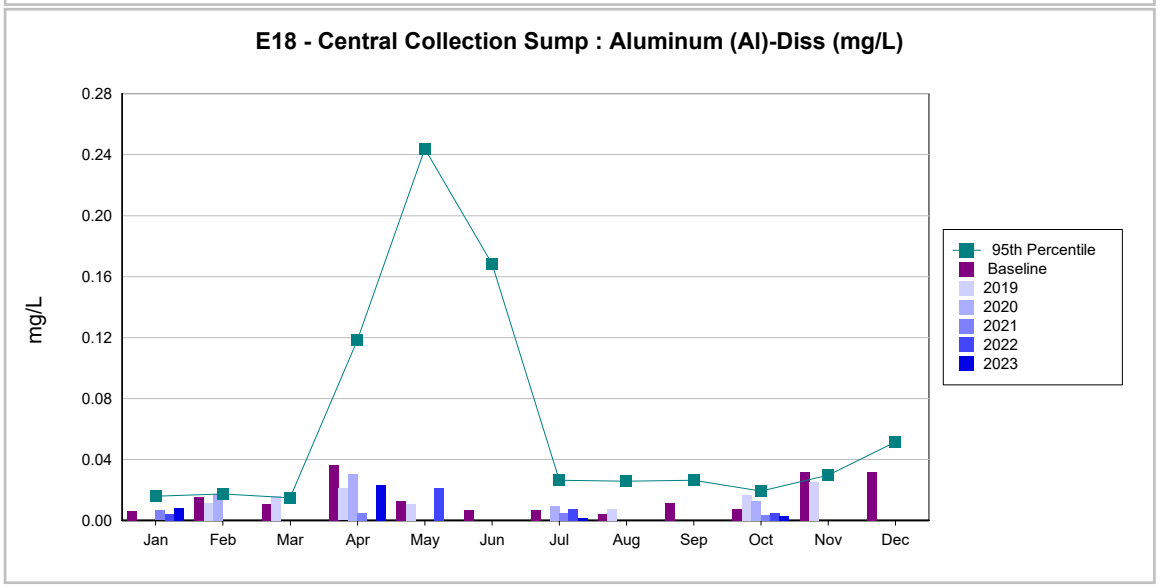
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

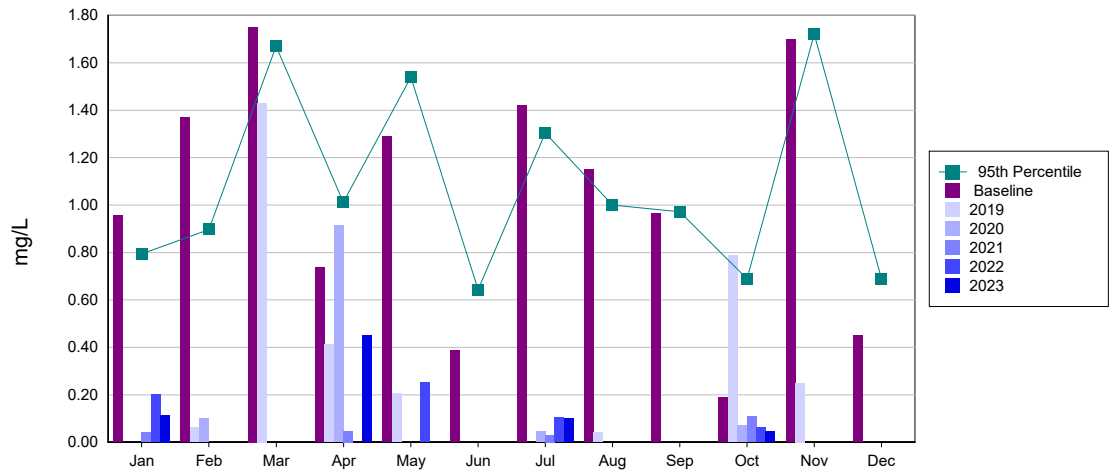
Annual Report Drainage Water

Mount Polley

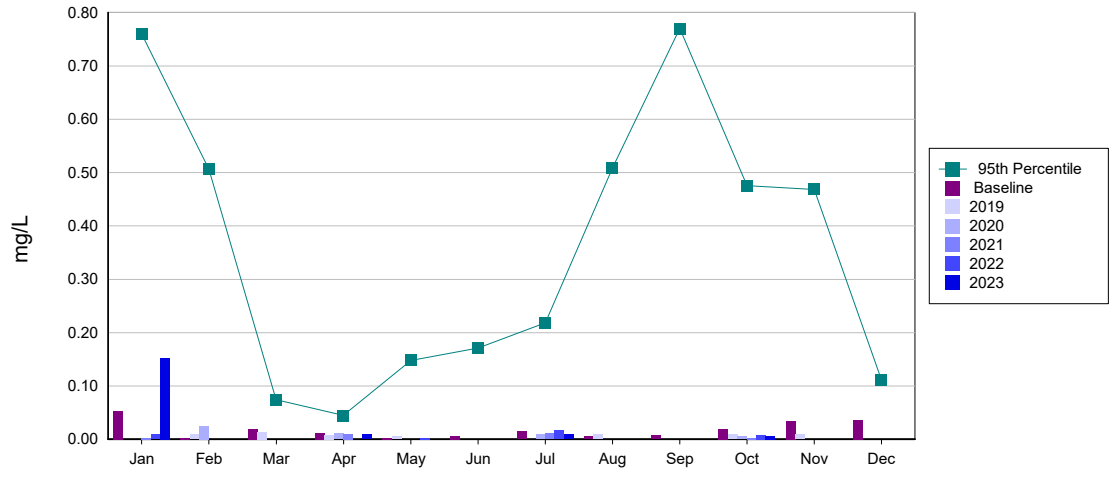
Mining Corporation

IMPERIAL METALS CORPORATION

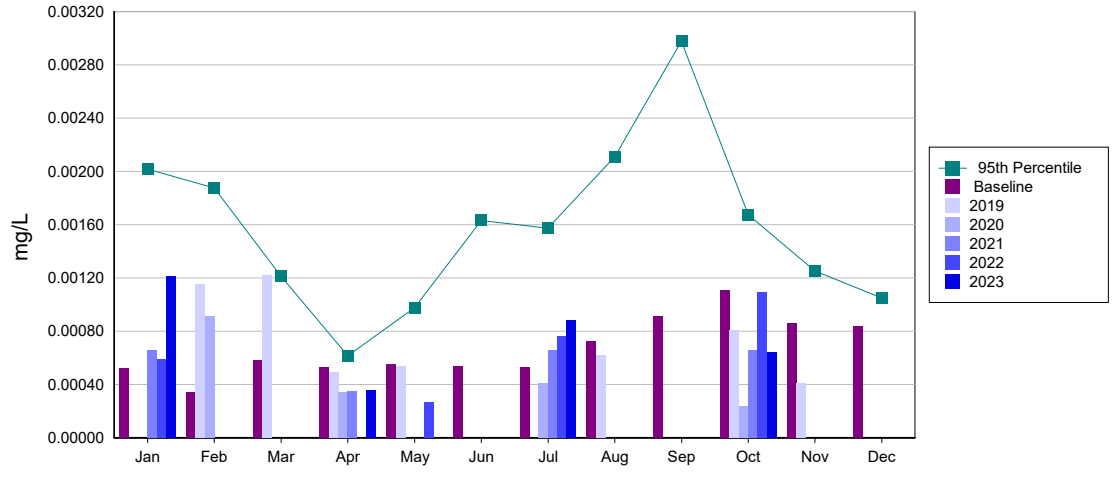
E18 - Central Collection Sump : Aluminum (Al)-Total (mg/L)



E18 - Central Collection Sump : Ammonia (as N) (mg/L)



E18 - Central Collection Sump : Antimony (Sb)-Total (mg/L)



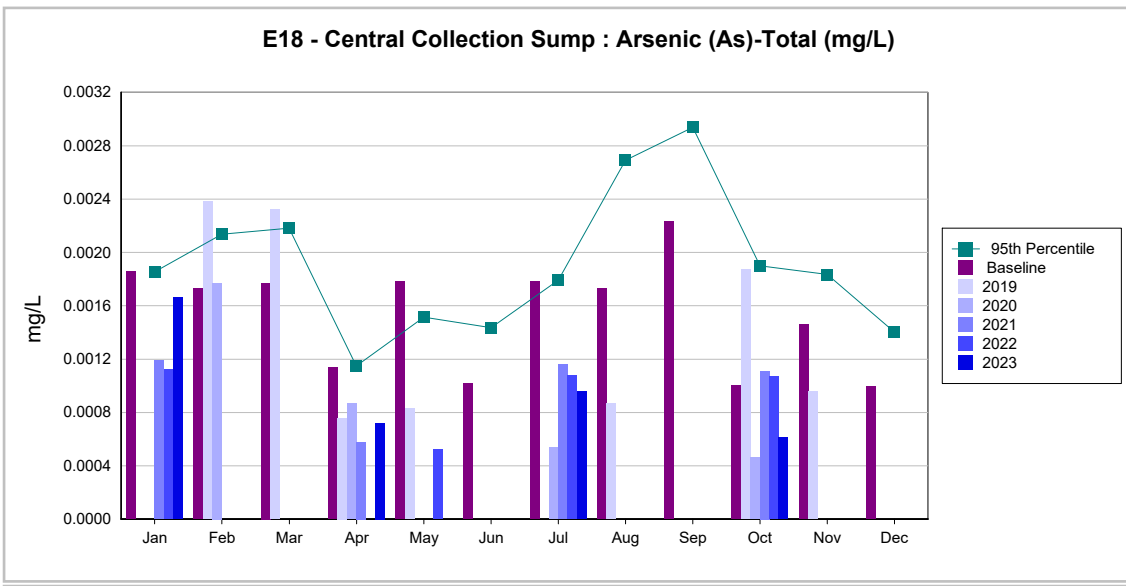
Water Quality Report

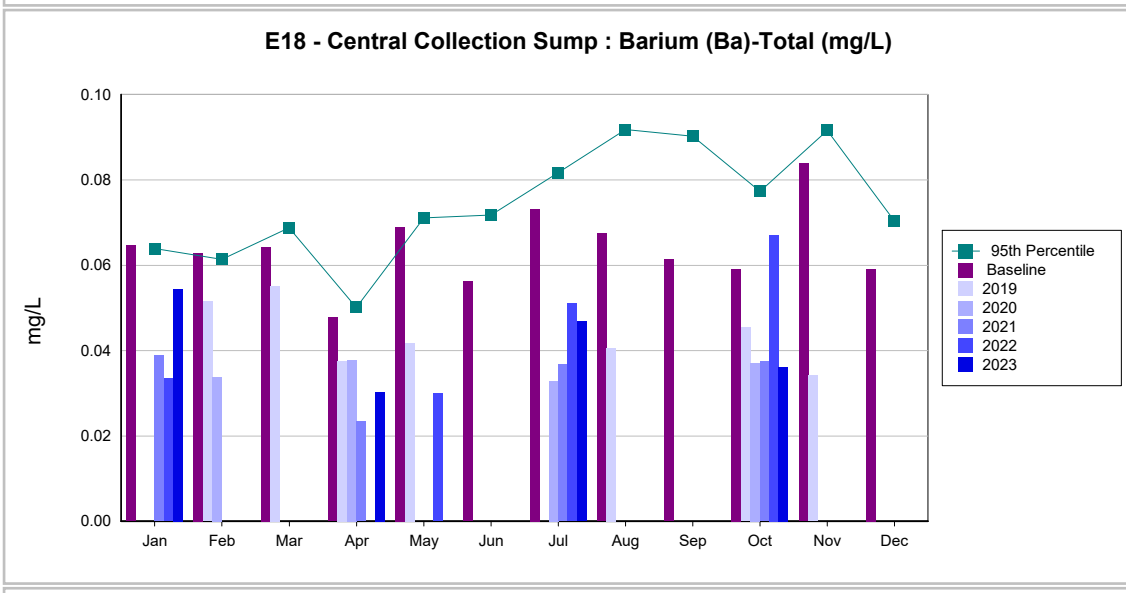
Annual Report Drainage Water

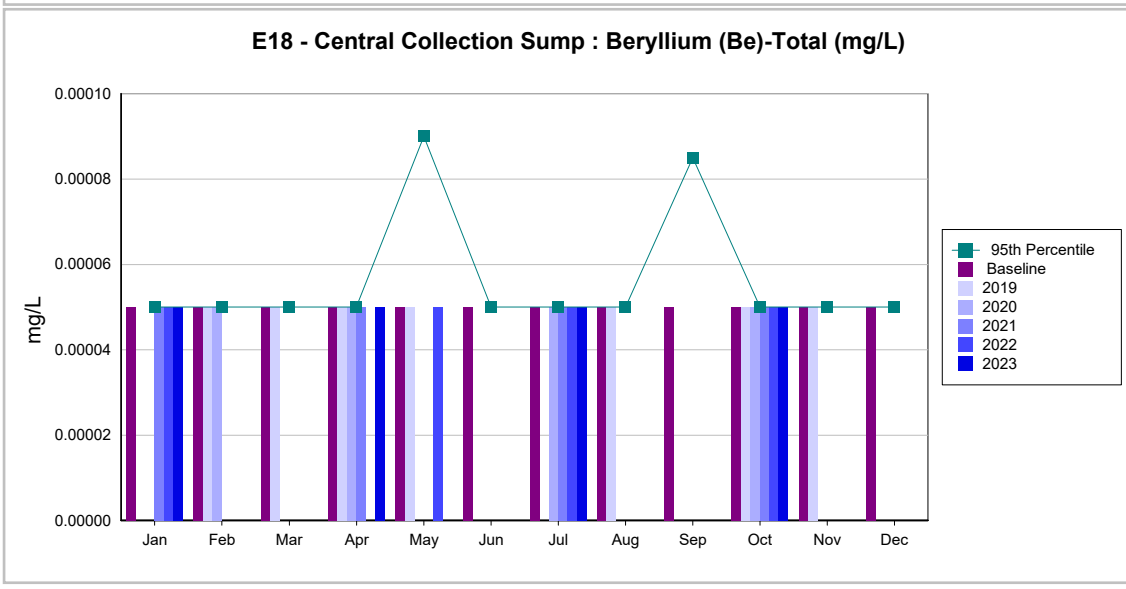
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

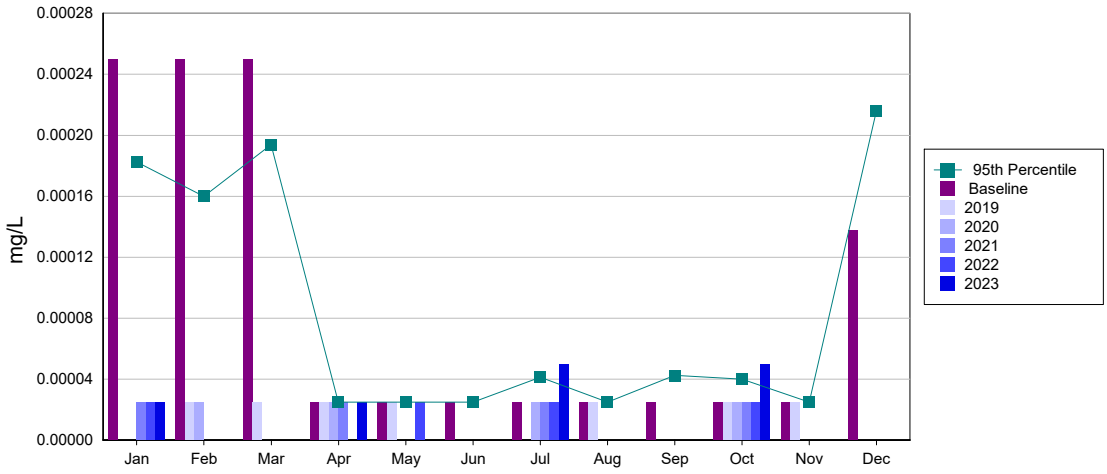
Annual Report Drainage Water

Mount Polley

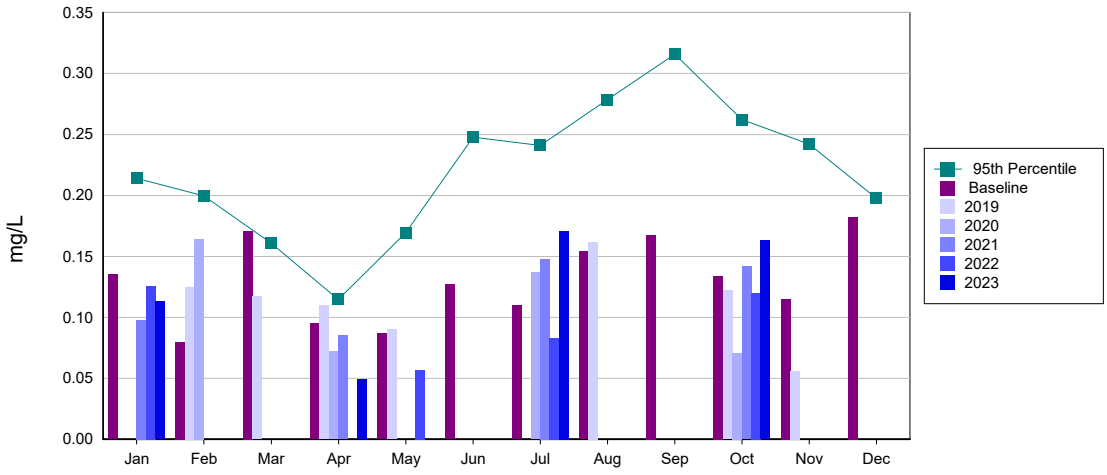
Mining Corporation

IMPERIAL METALS CORPORATION

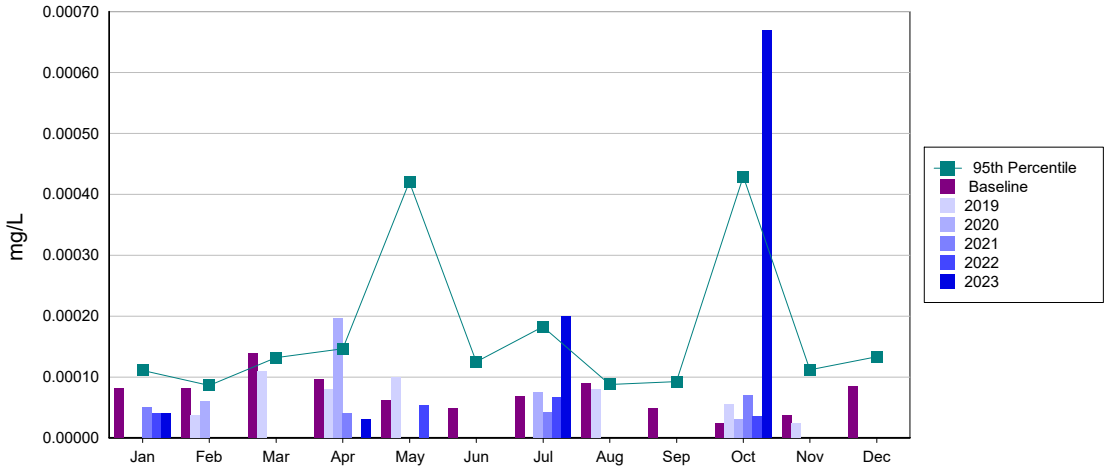
E18 - Central Collection Sump : Bismuth (Bi)-Total (mg/L)



E18 - Central Collection Sump : Boron (B)-Total (mg/L)



E18 - Central Collection Sump : Cadmium (Cd)-Total (mg/L)



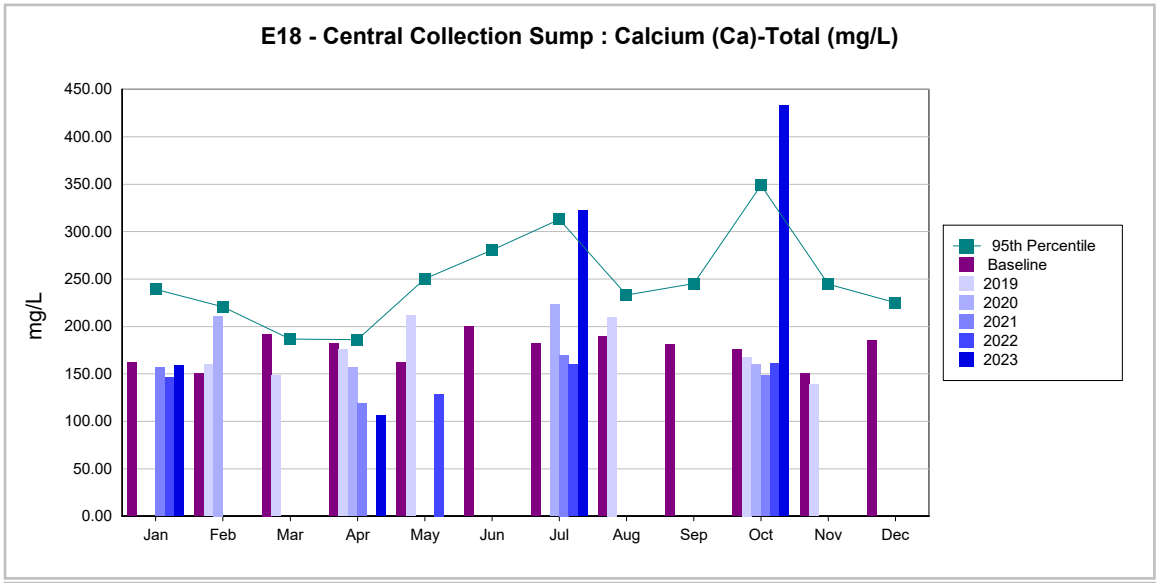
Water Quality Report

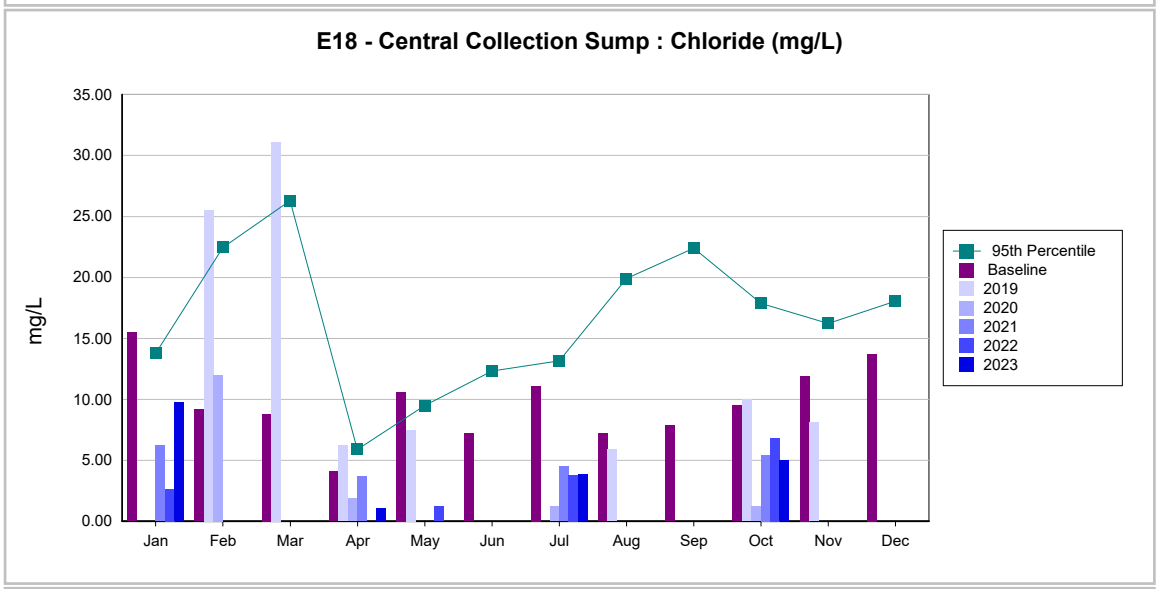
Annual Report Drainage Water

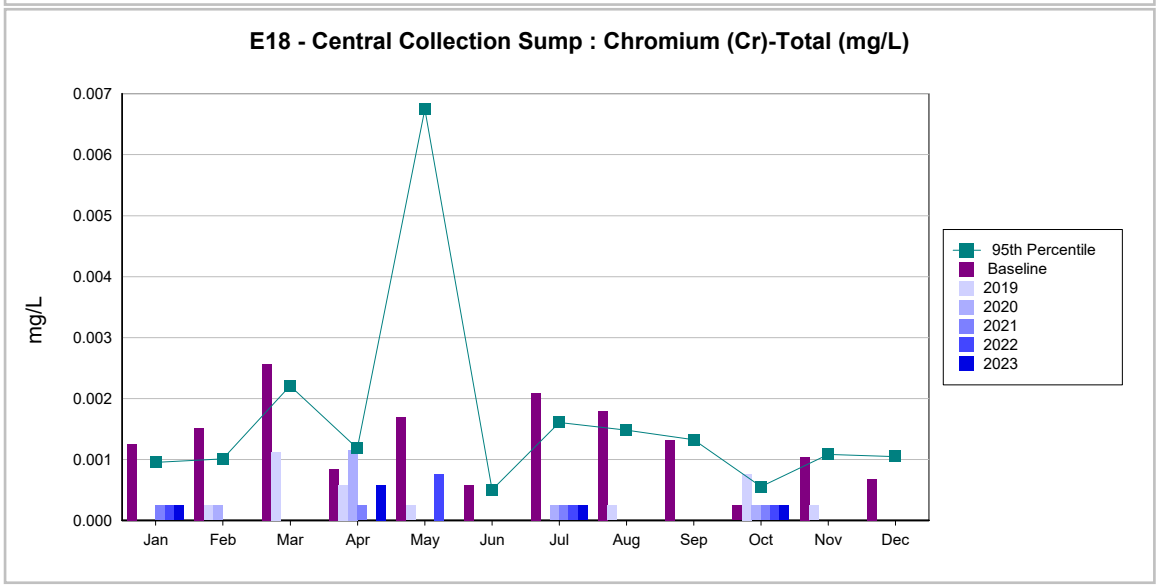
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







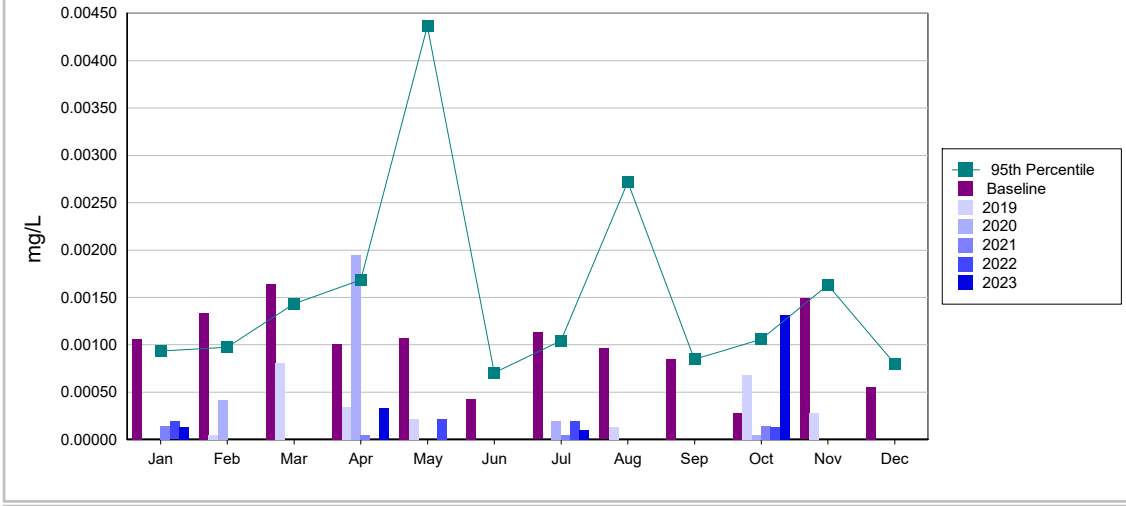
Water Quality Report

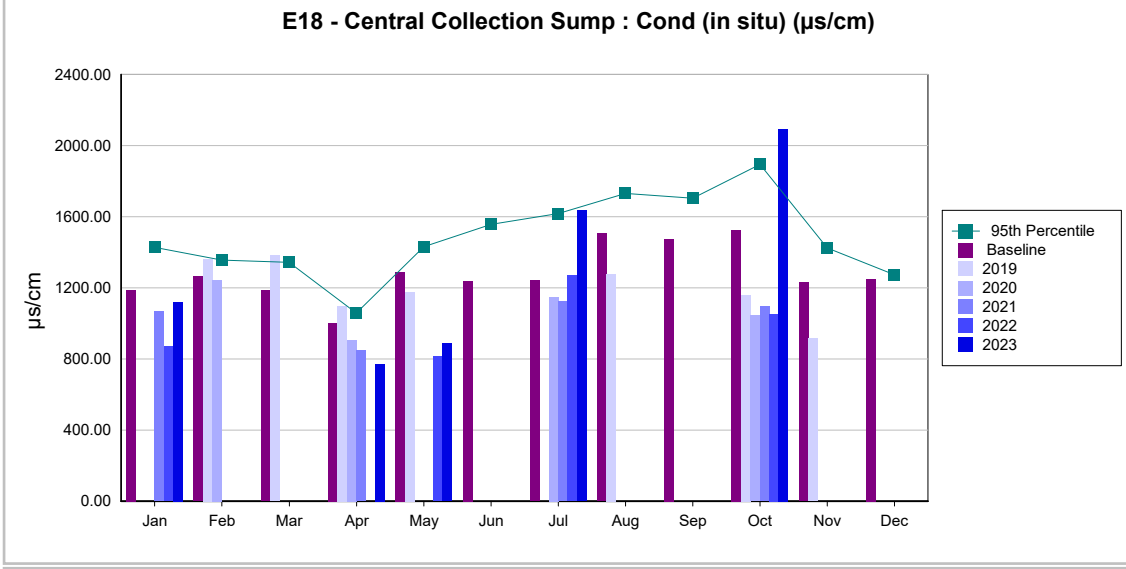
Annual Report Drainage Water

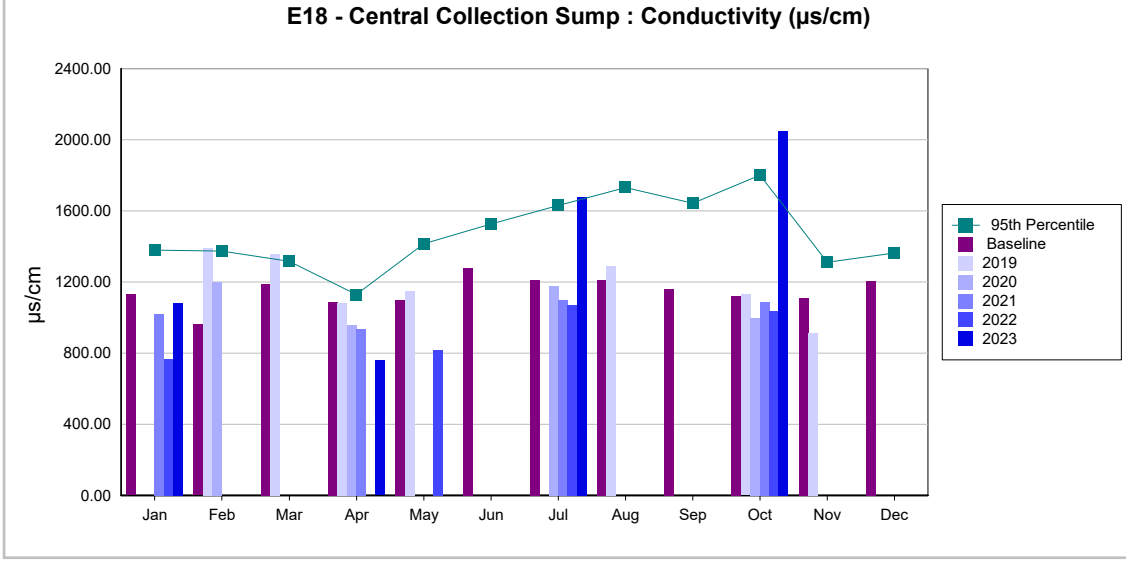
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







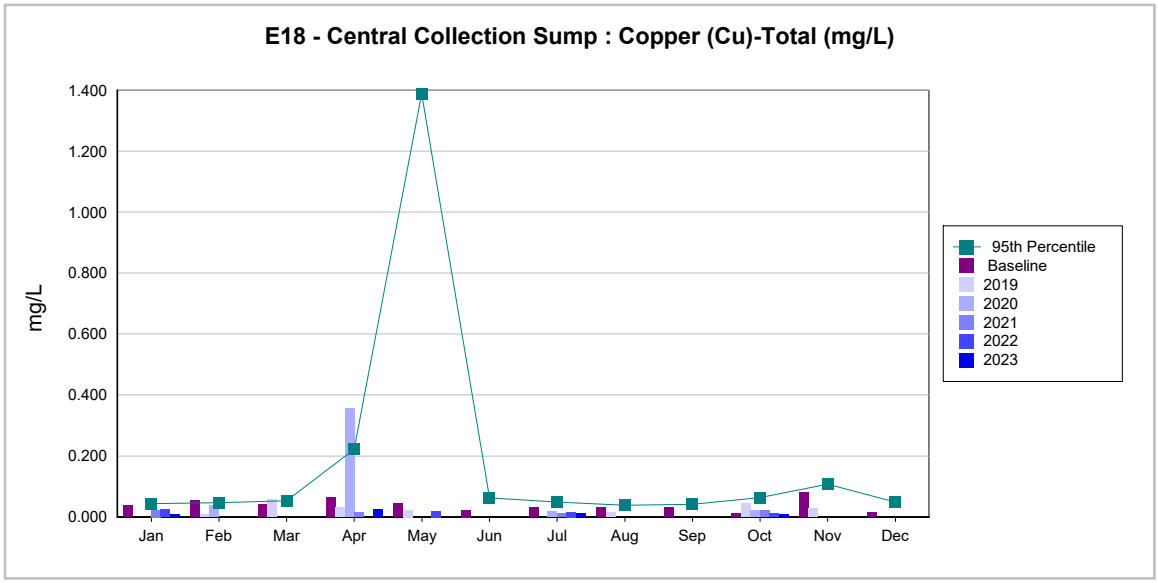
Water Quality Report

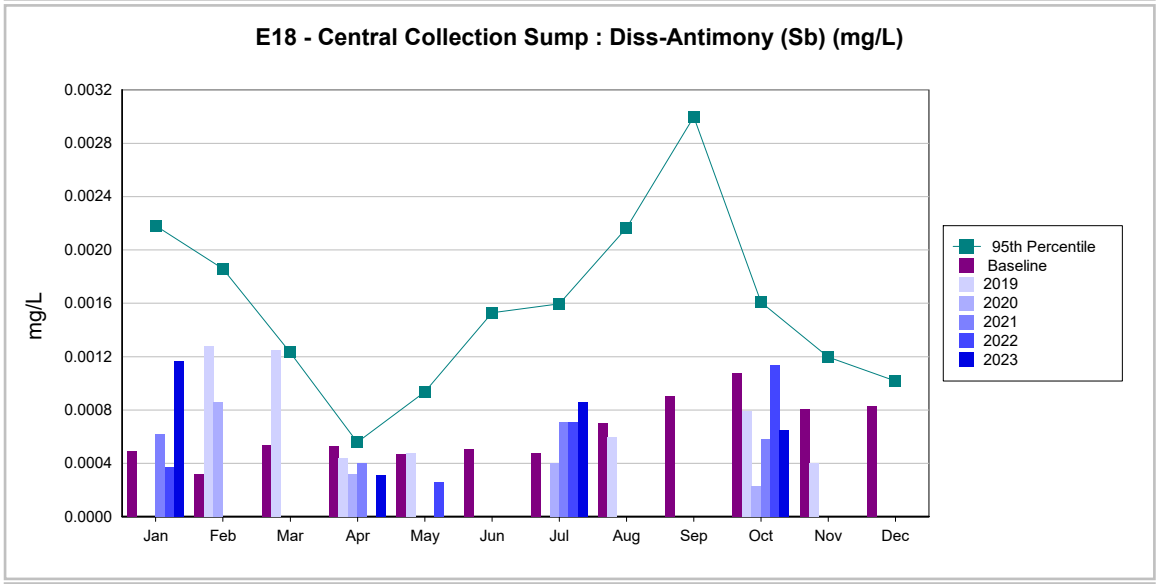
Annual Report Drainage Water

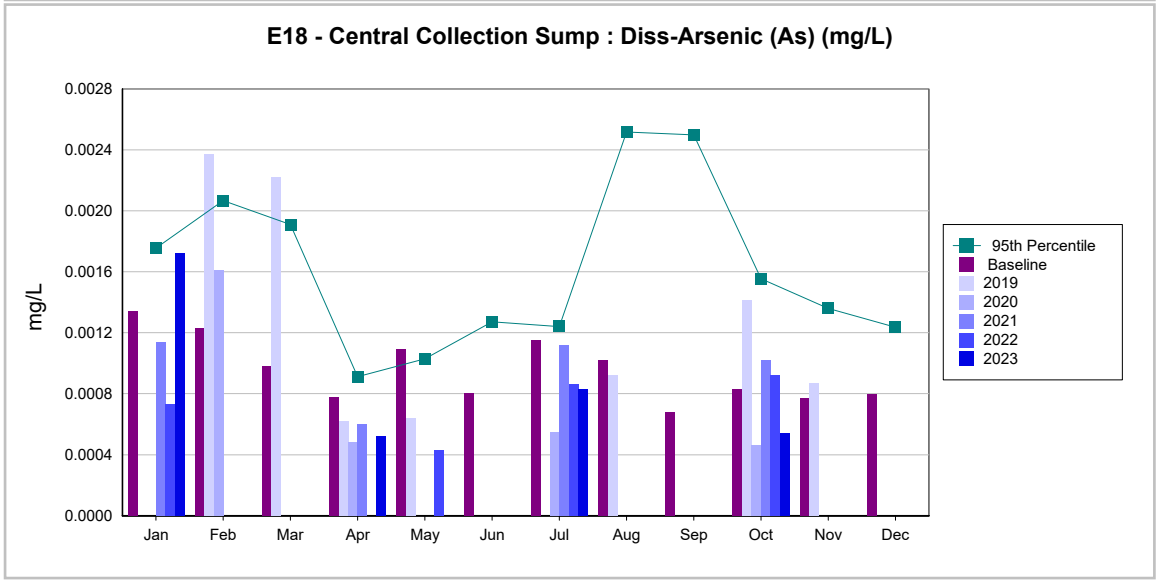
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







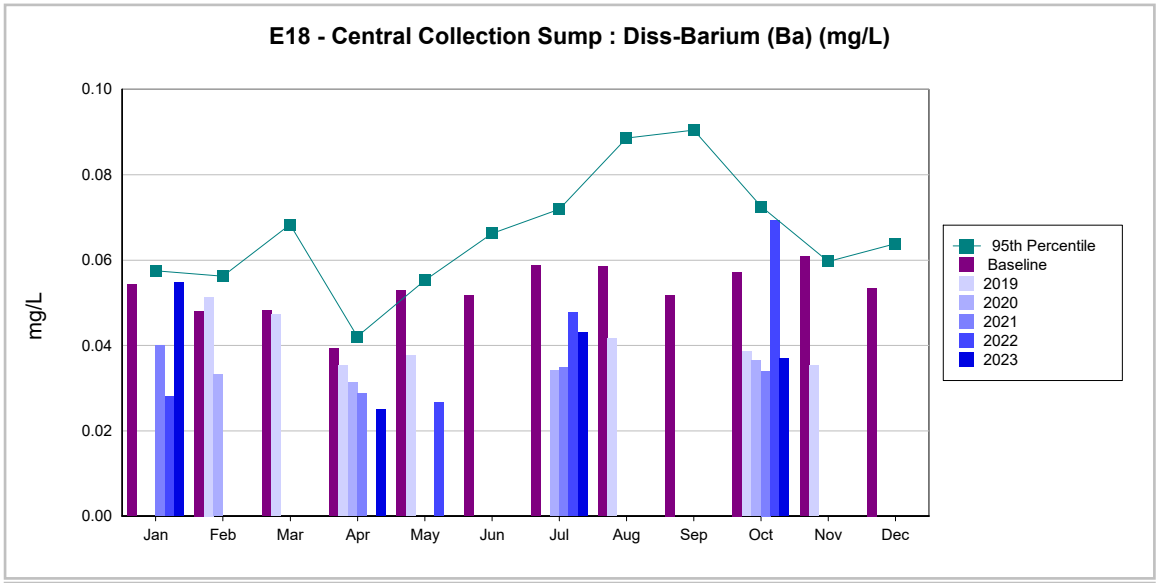
Water Quality Report

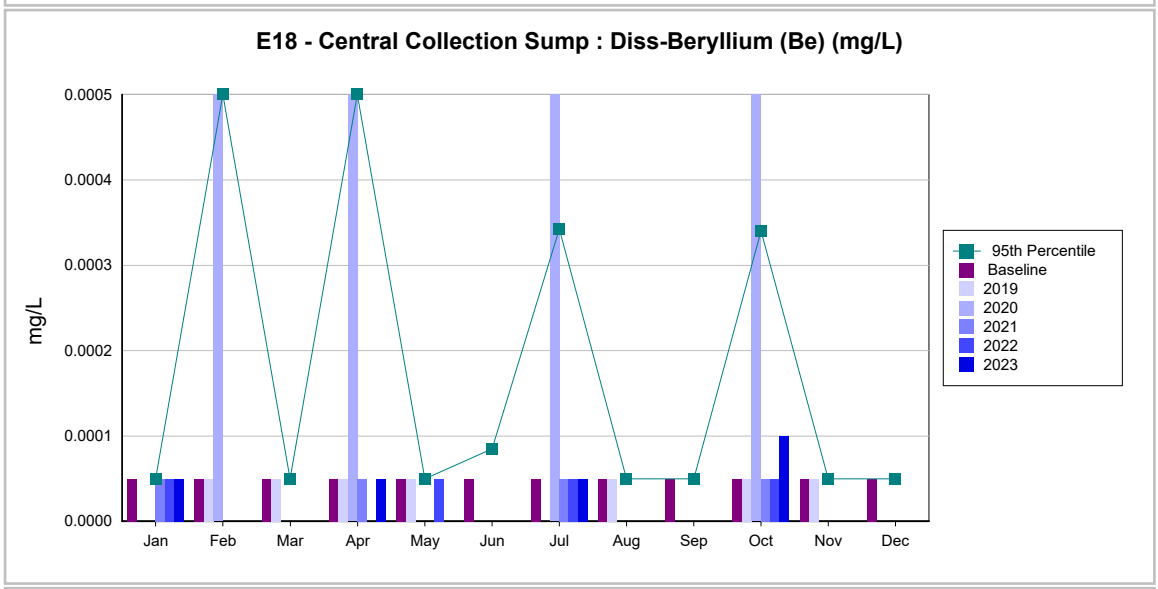
Annual Report Drainage Water

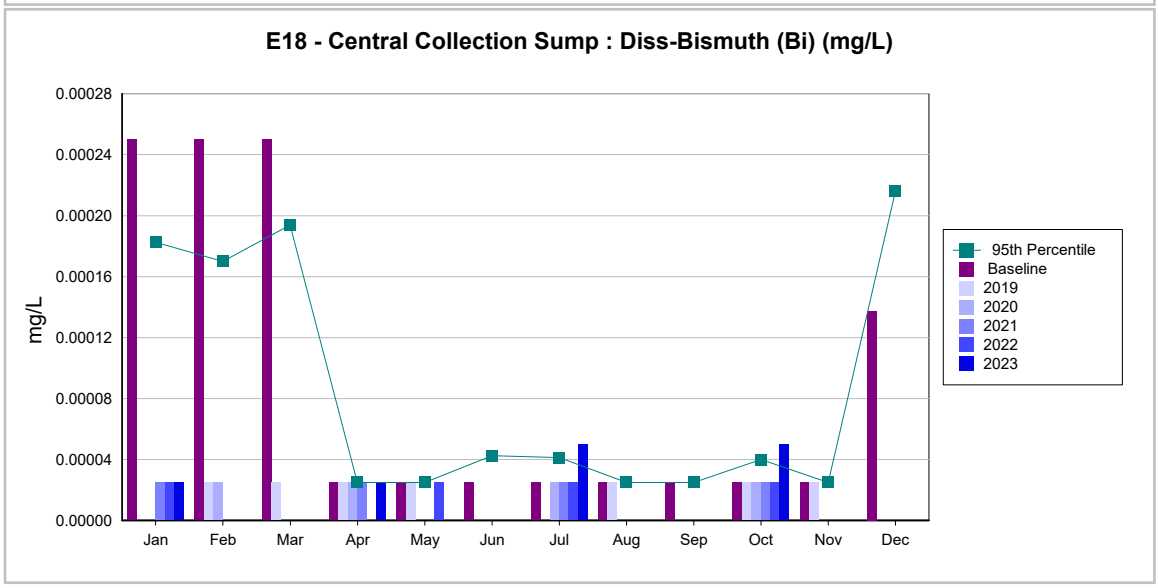
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







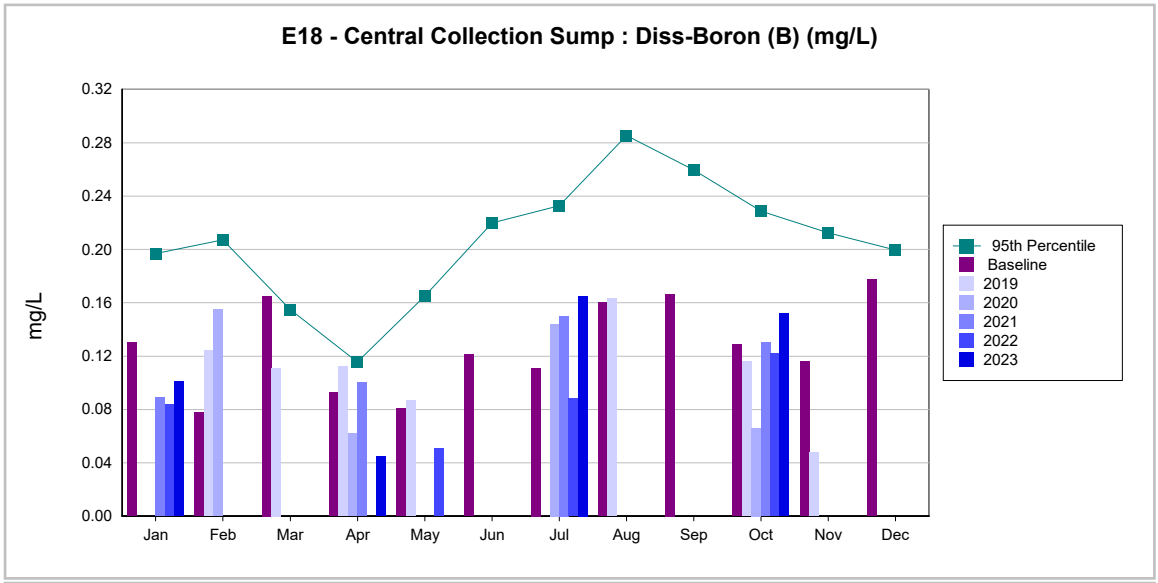
Water Quality Report

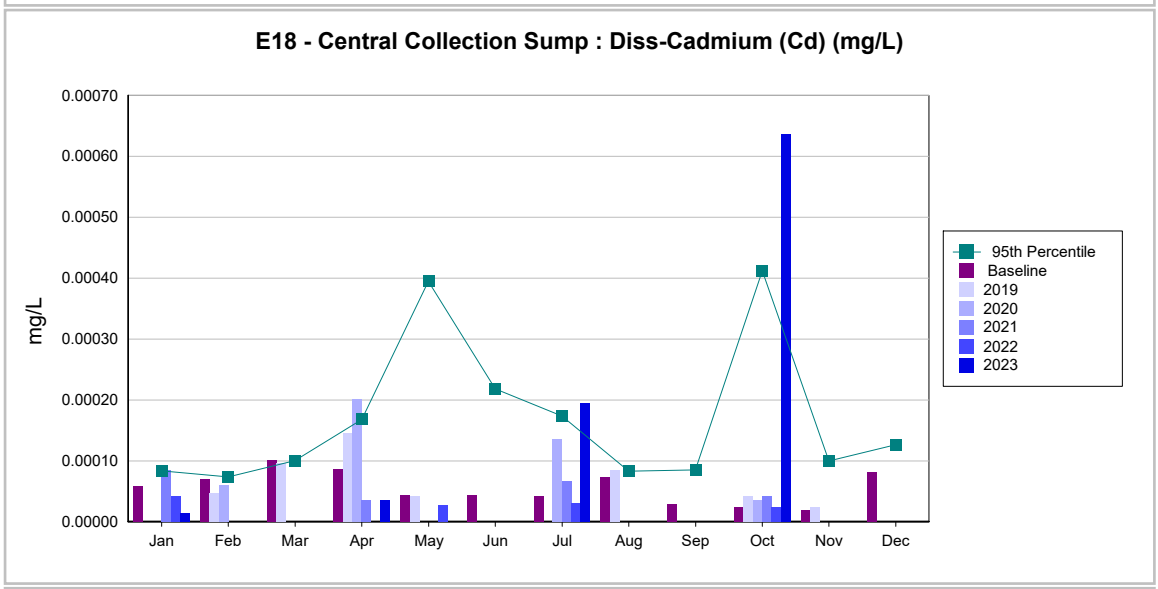
Annual Report Drainage Water

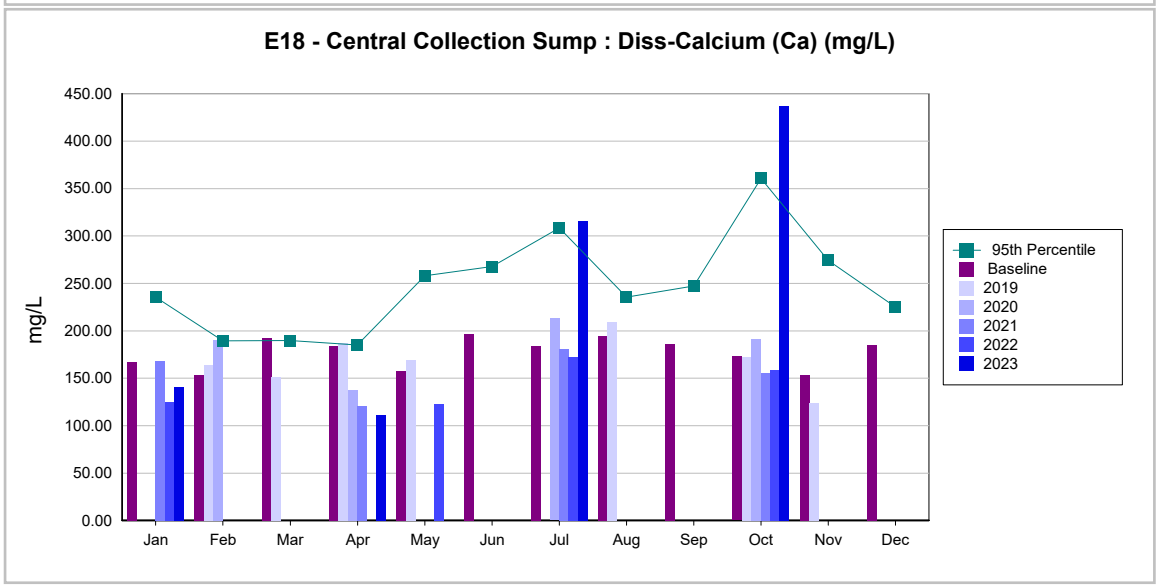
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







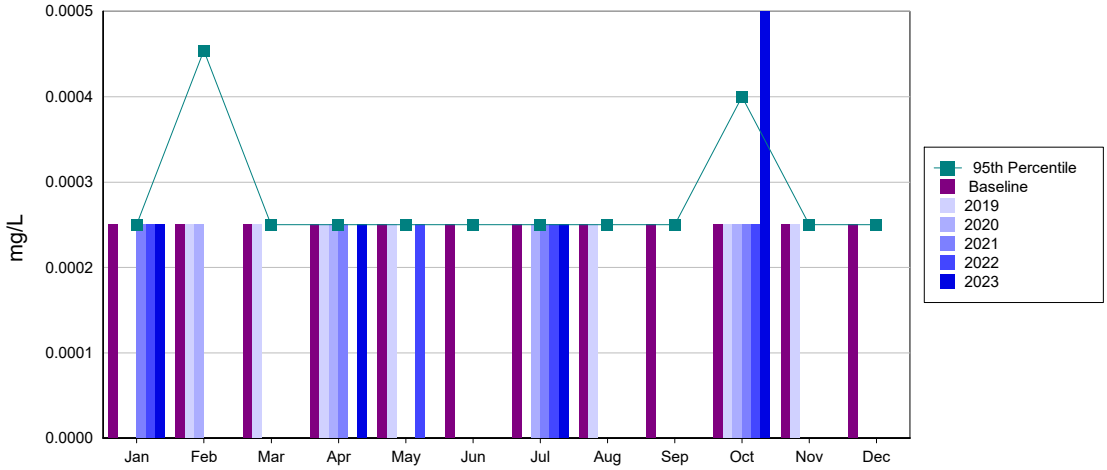
Water Quality Report

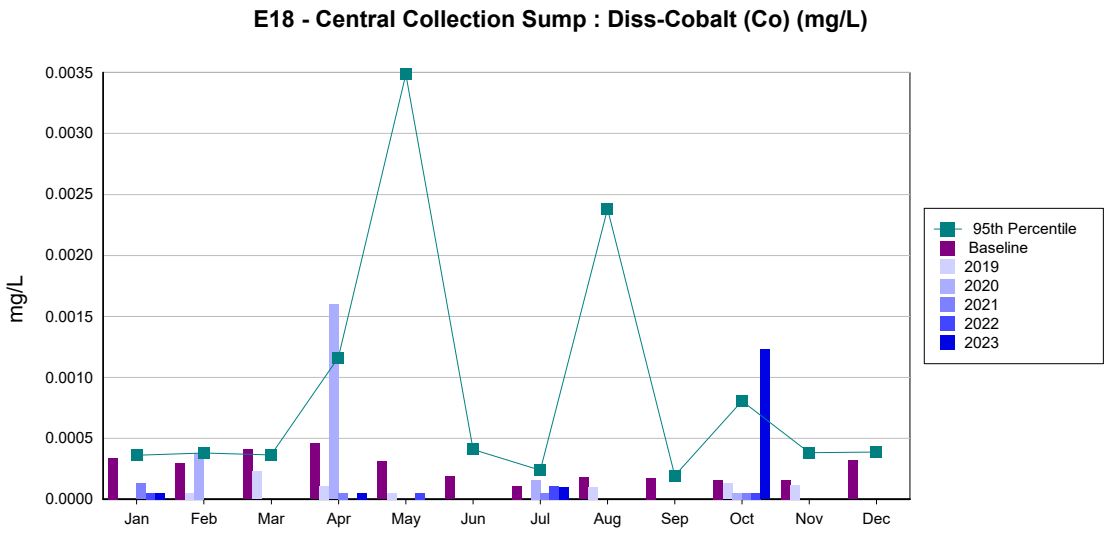
Annual Report Drainage Water

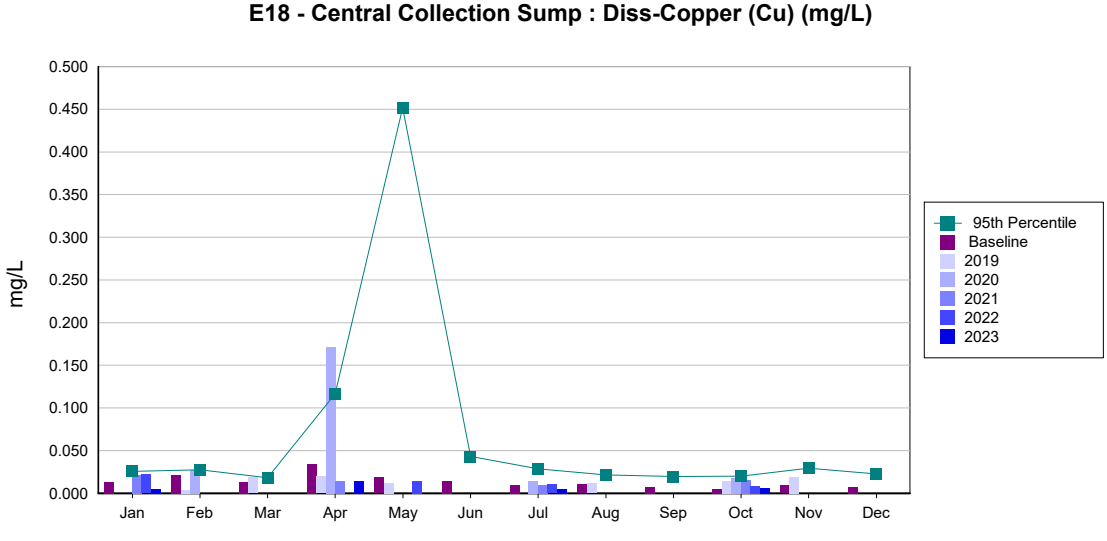
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







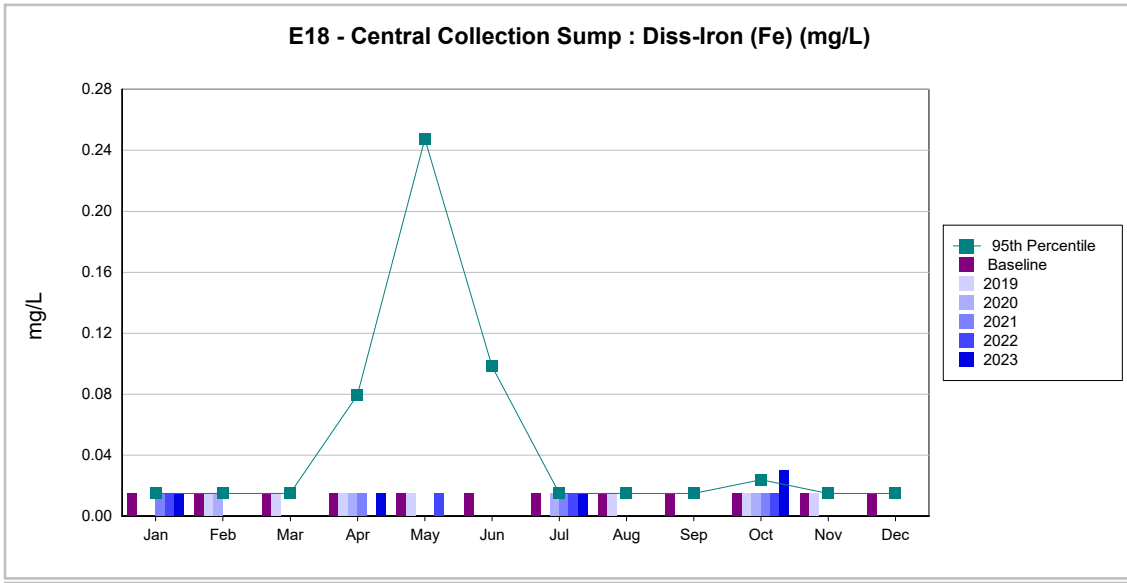
Water Quality Report

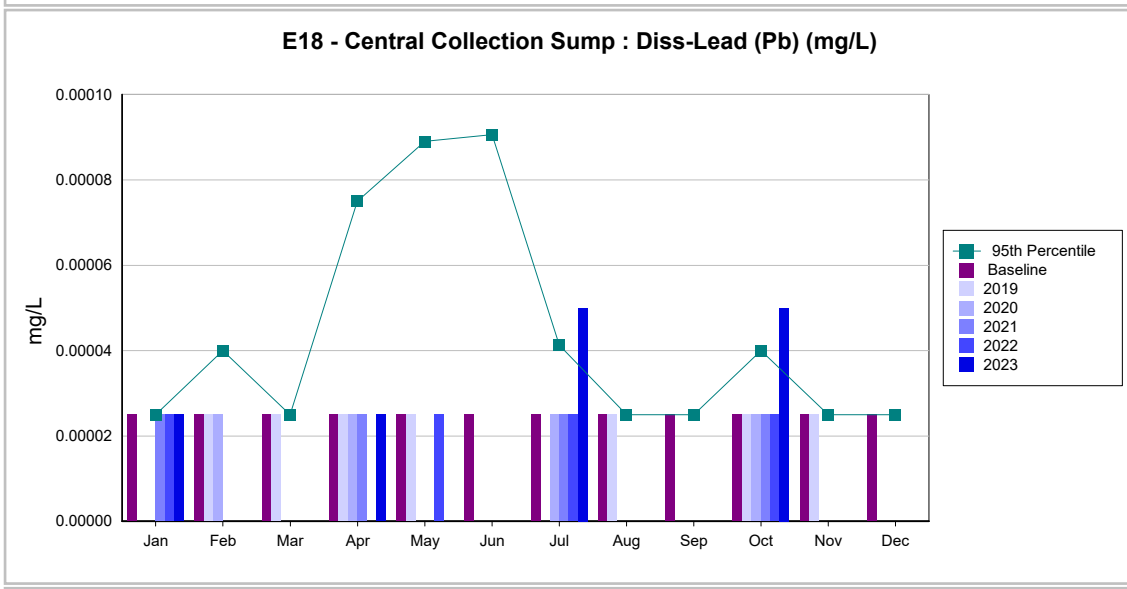
Annual Report Drainage Water

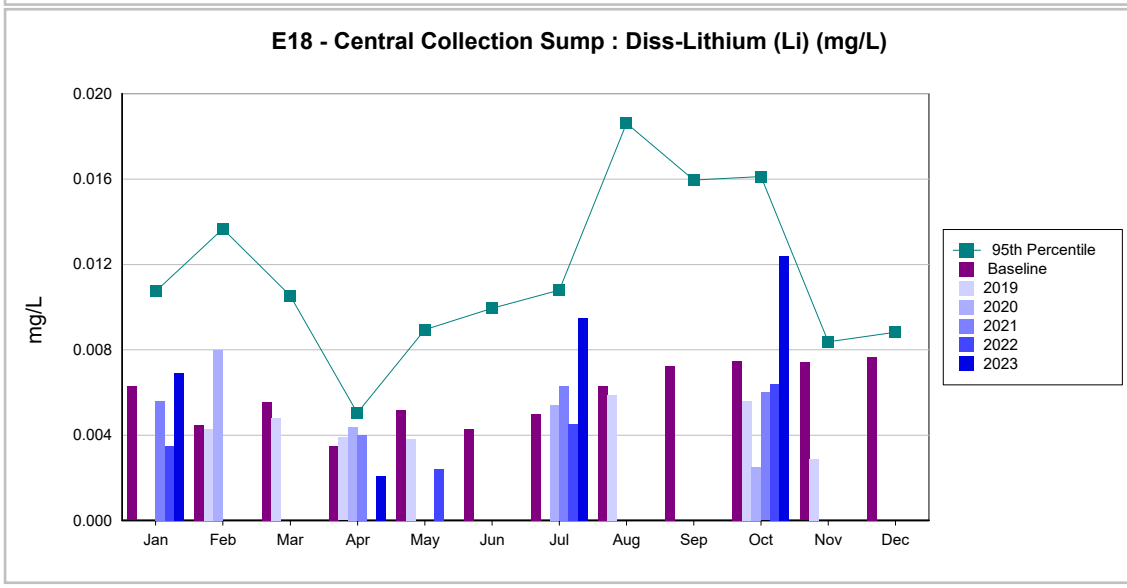
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

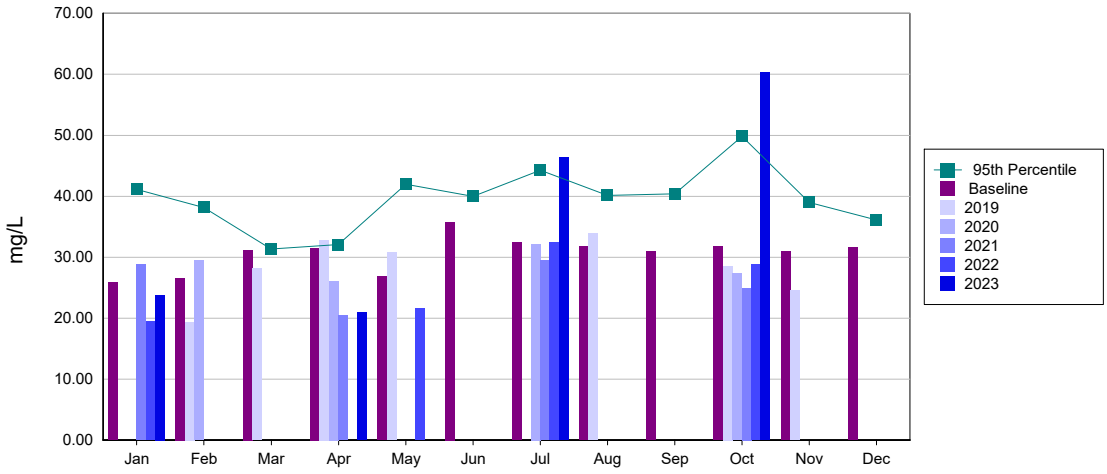
Annual Report Drainage Water

Mount Polley

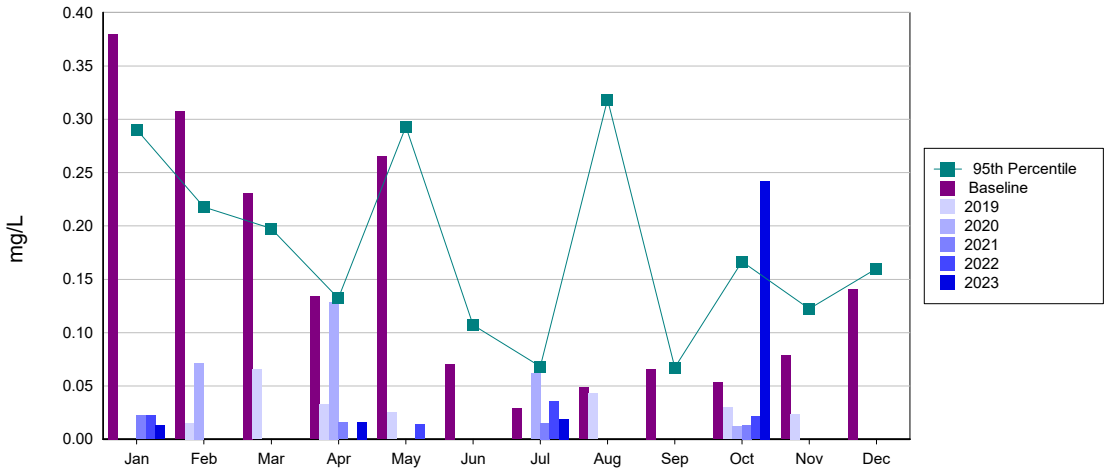
Mining Corporation

IMPERIAL METALS CORPORATION

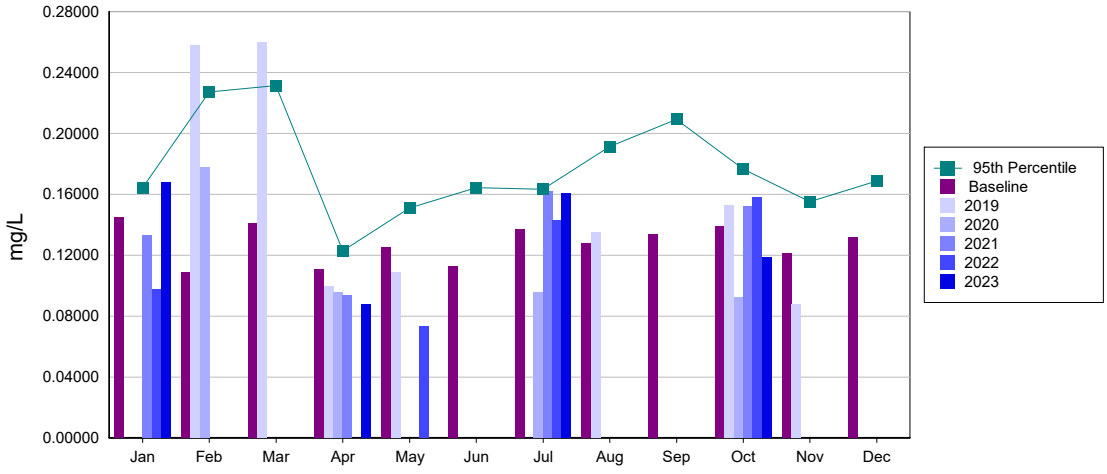
E18 - Central Collection Sump : Diss-Magnesium (Mg) (mg/L)



E18 - Central Collection Sump : Diss-Manganese (Mn) (mg/L)



E18 - Central Collection Sump : Diss-Molybdenum (Mo) (mg/L)



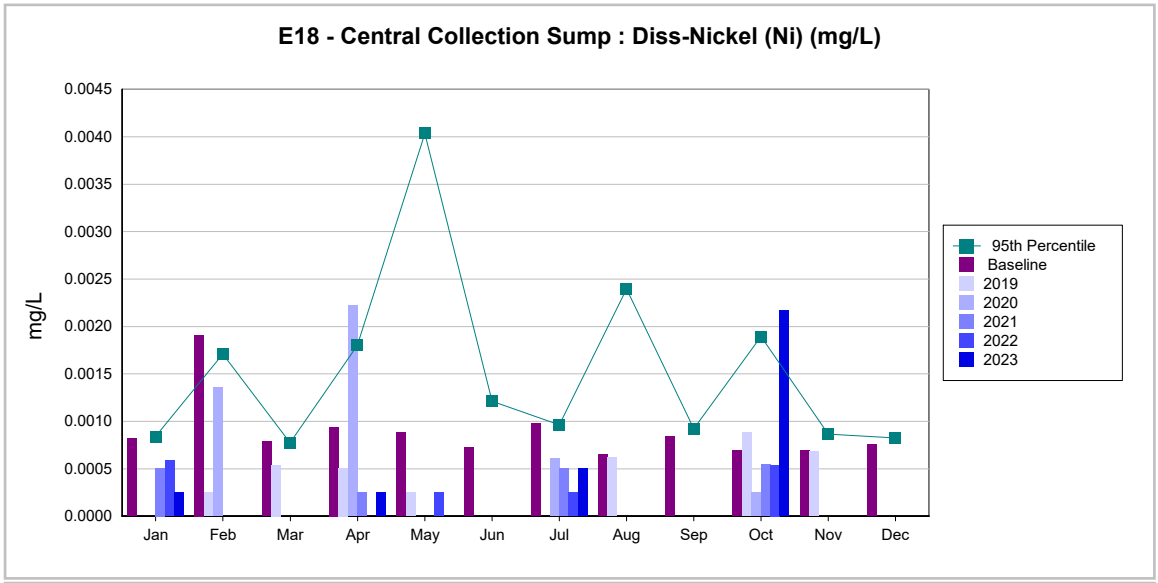
Water Quality Report

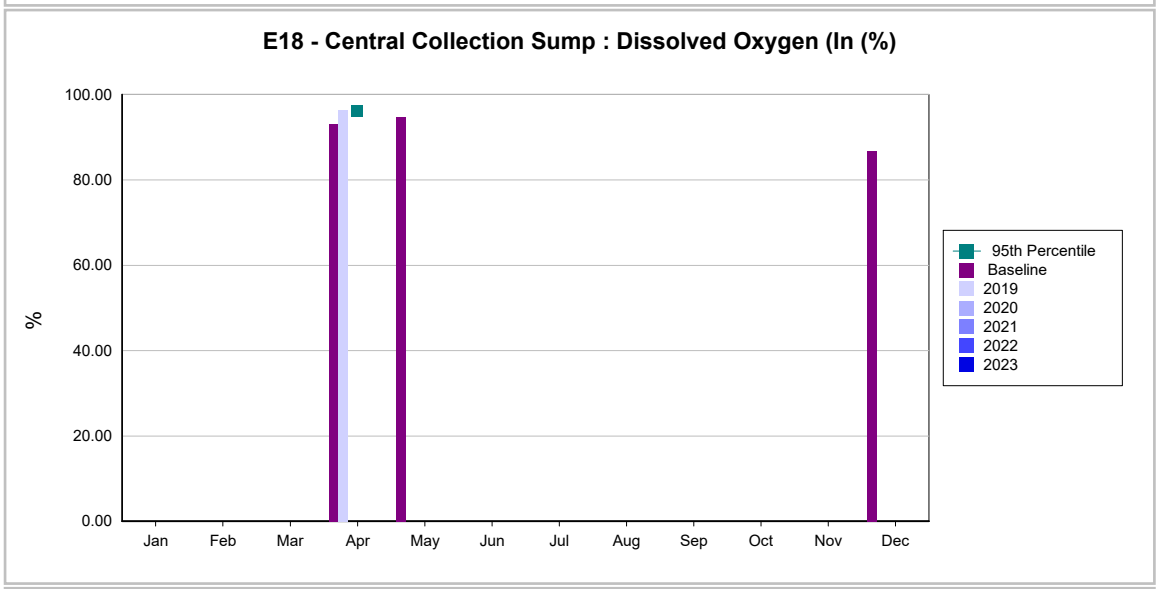
Annual Report Drainage Water

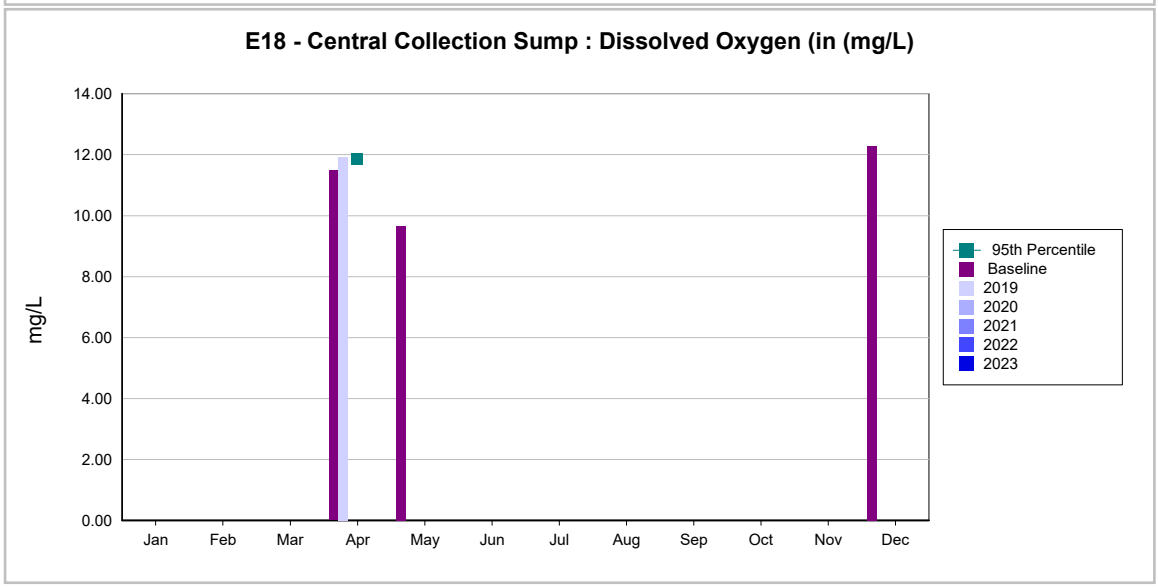
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

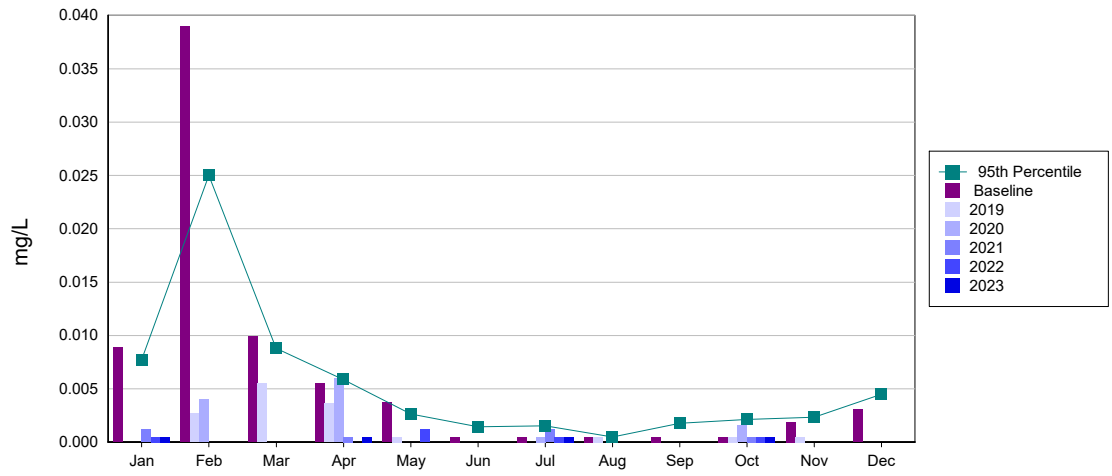
Annual Report Drainage Water

Mount Polley

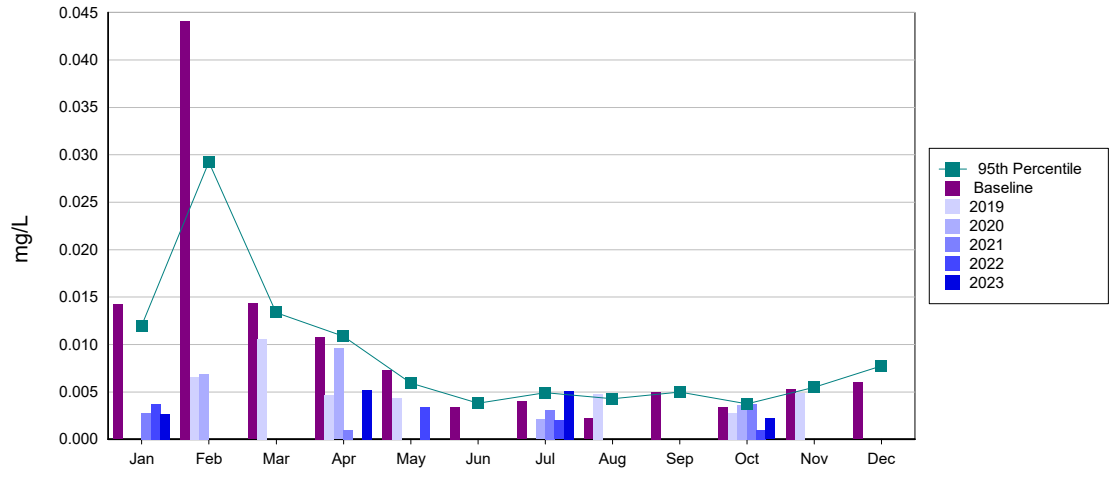
Mining Corporation

IMPERIAL METALS CORPORATION

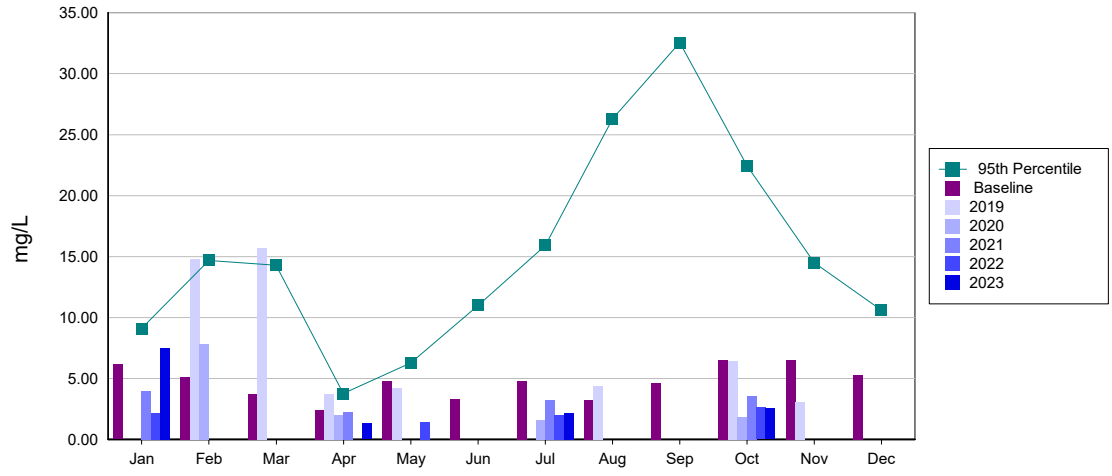
E18 - Central Collection Sump : Diss-Orthophosphate (mg/L)



E18 - Central Collection Sump : Diss-Phosphorus (mg/L)



E18 - Central Collection Sump : Diss-Potassium (K) (mg/L)



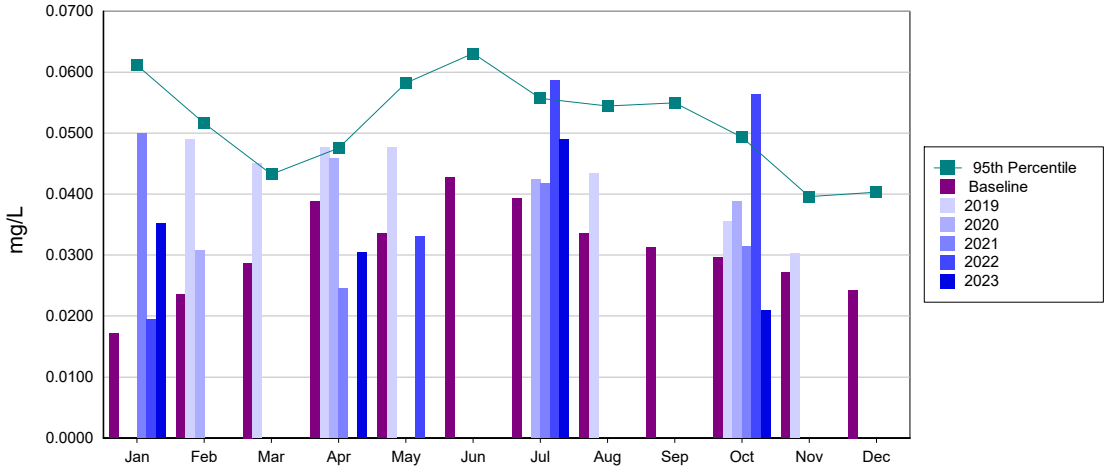
Water Quality Report

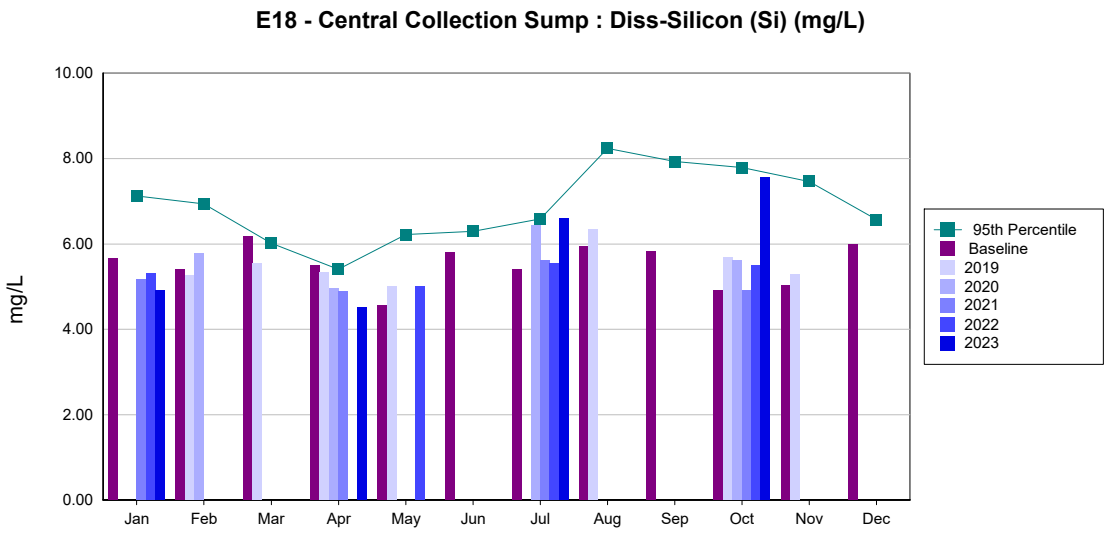
Annual Report Drainage Water

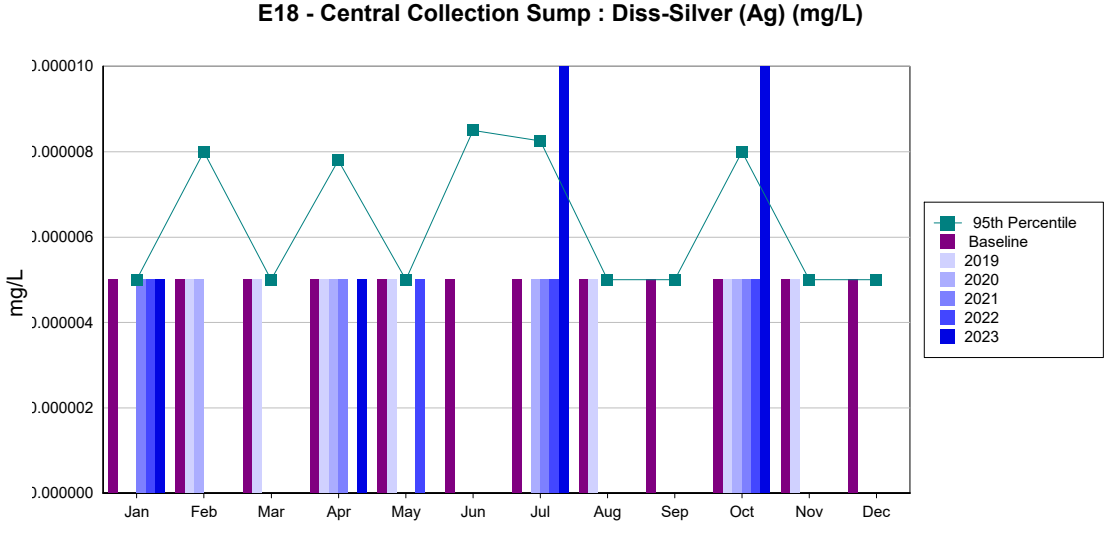
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







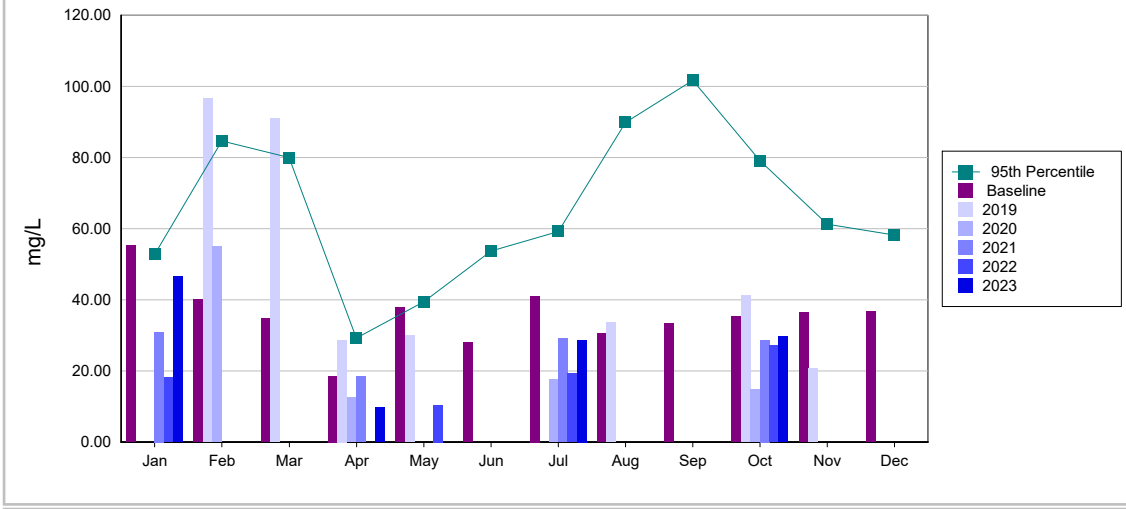
Water Quality Report

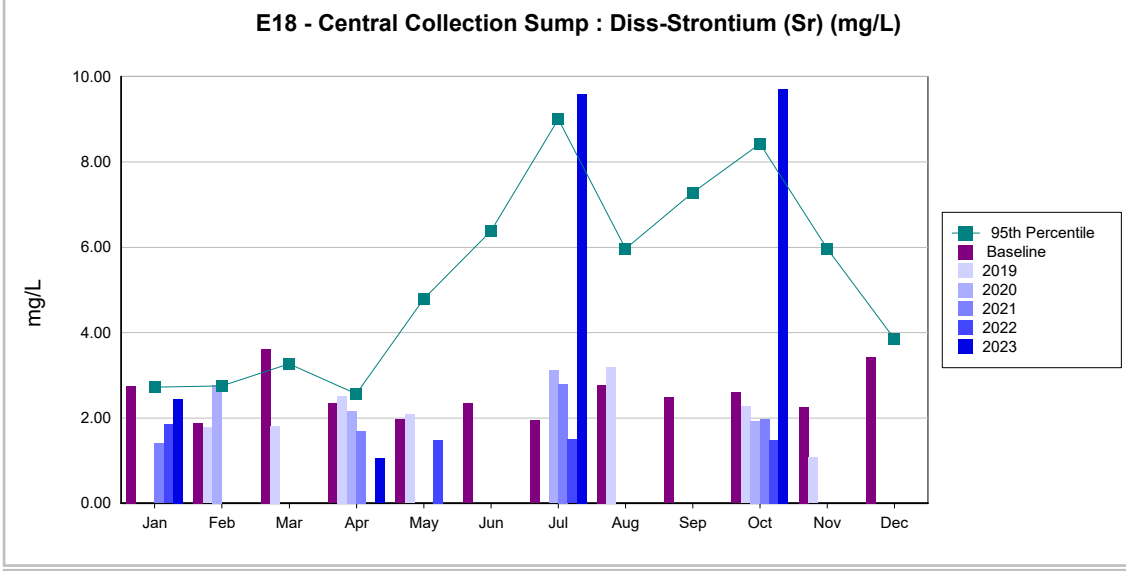
Annual Report Drainage Water

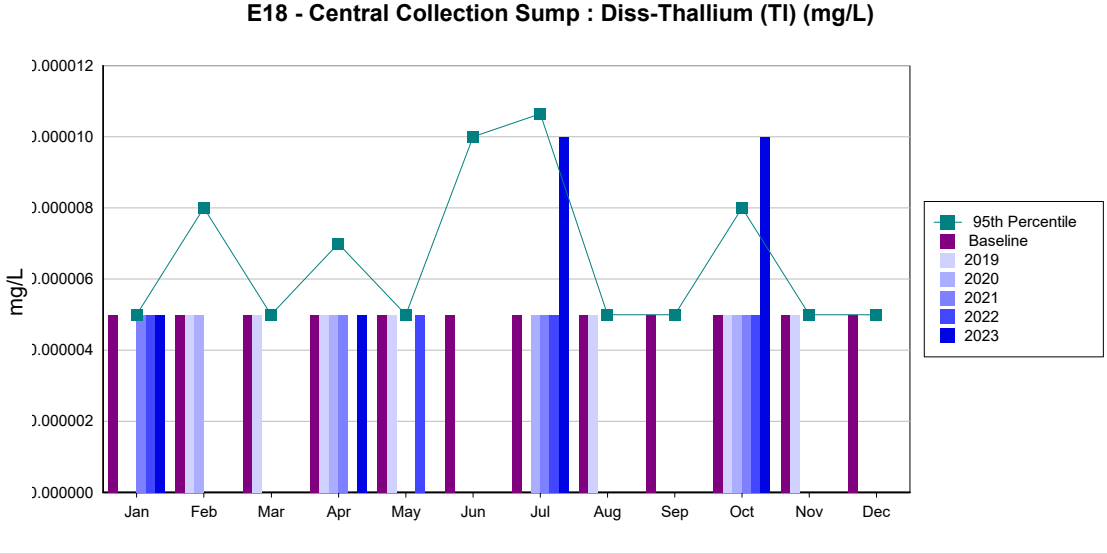
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







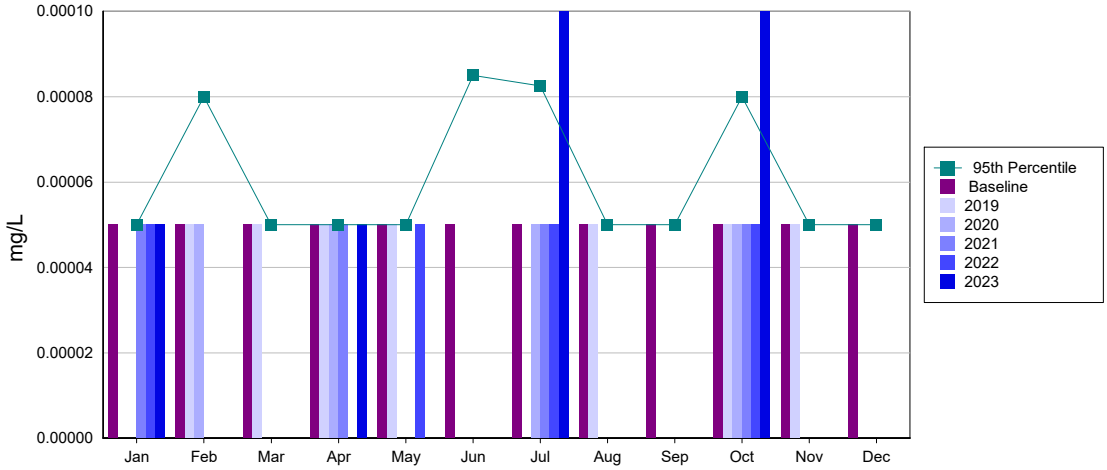
Water Quality Report

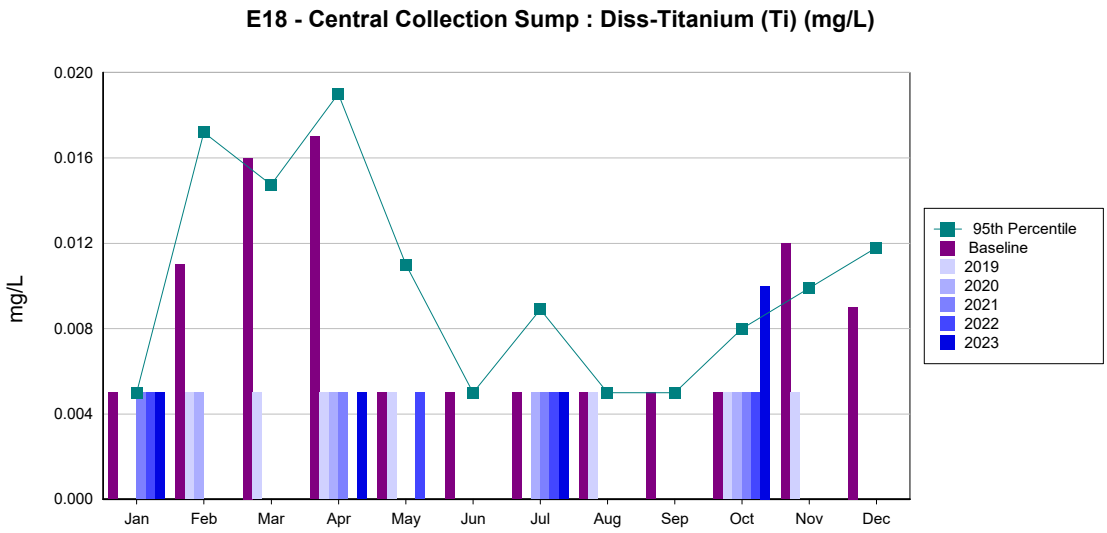
Annual Report Drainage Water

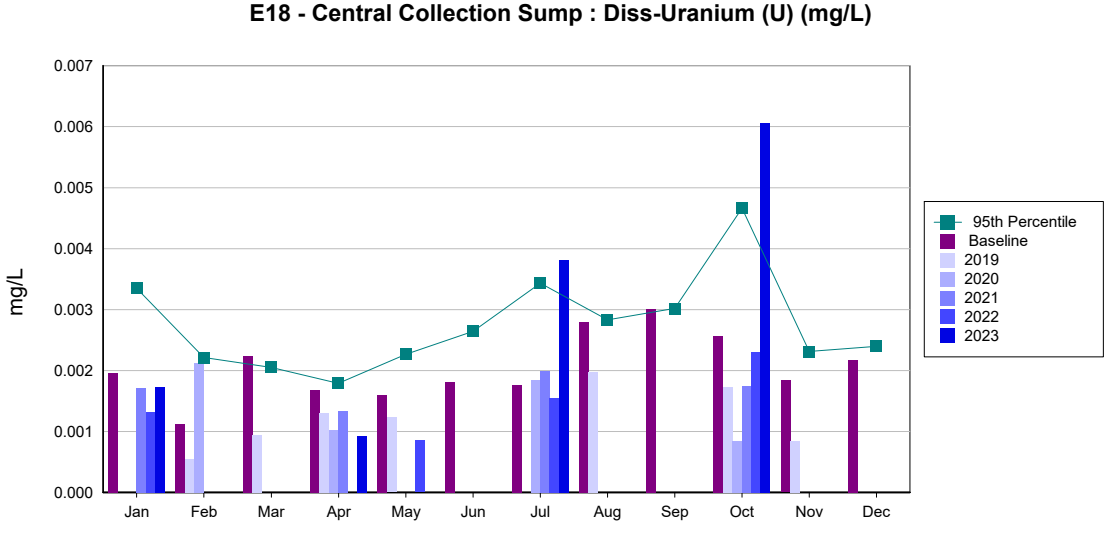
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

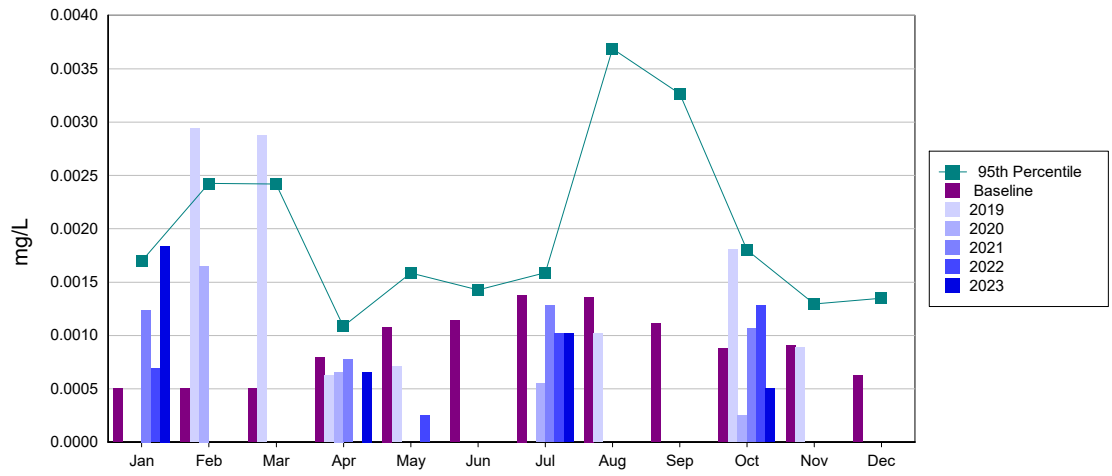
Annual Report Drainage Water

Mount Polley

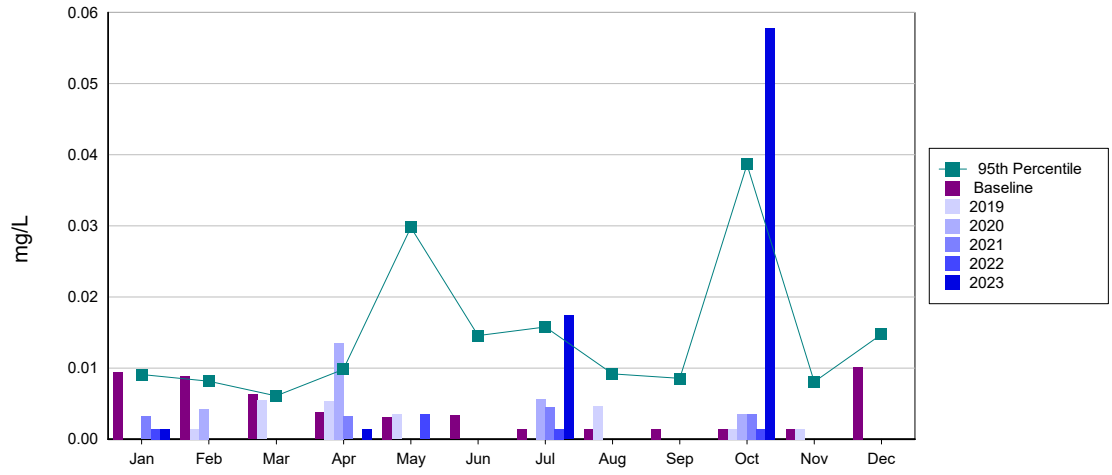
Mining Corporation

IMPERIAL METALS CORPORATION

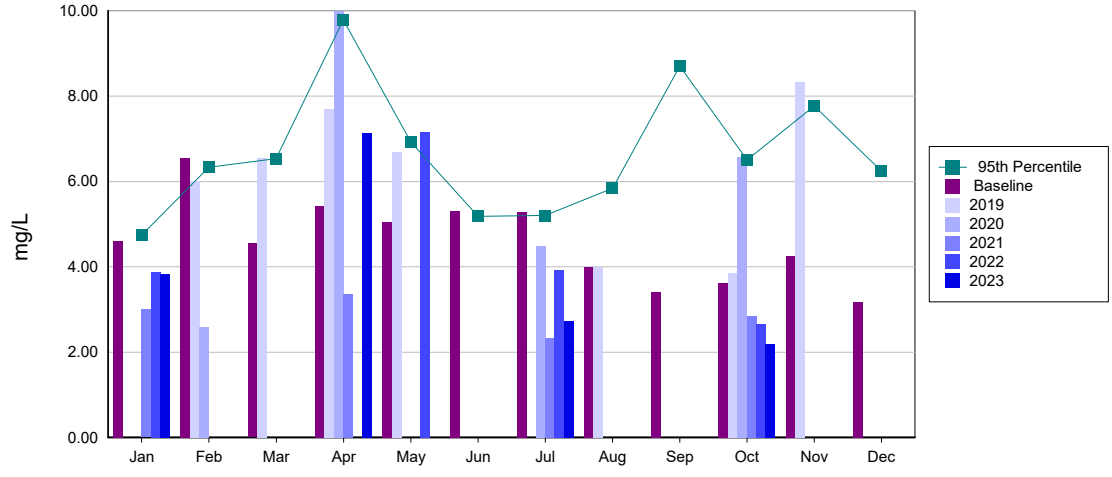
E18 - Central Collection Sump : Diss-Vanadium (V) (mg/L)



E18 - Central Collection Sump : Diss-Zinc (Zn) (mg/L)



E18 - Central Collection Sump : DOC (mg/L)



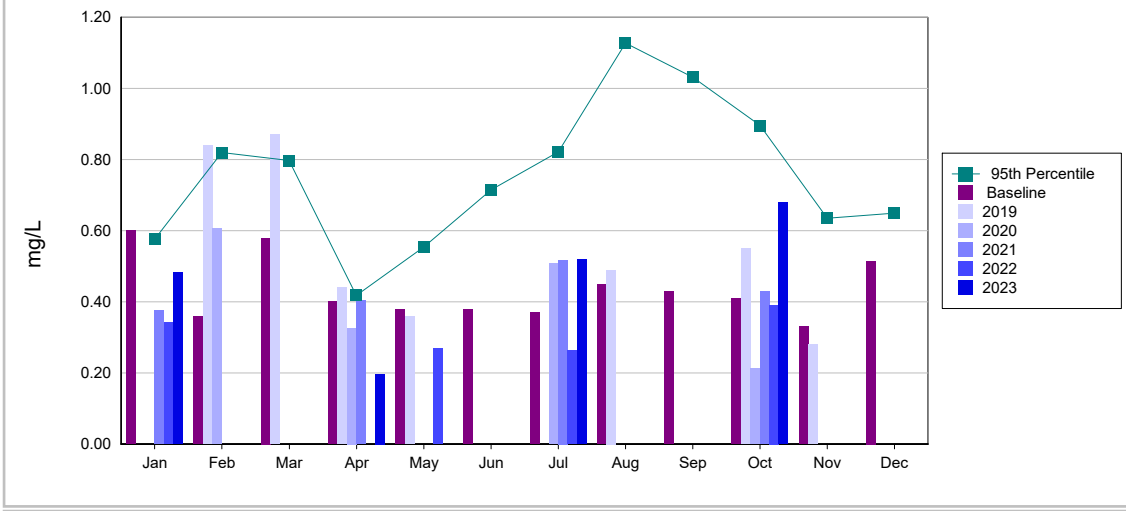
Water Quality Report

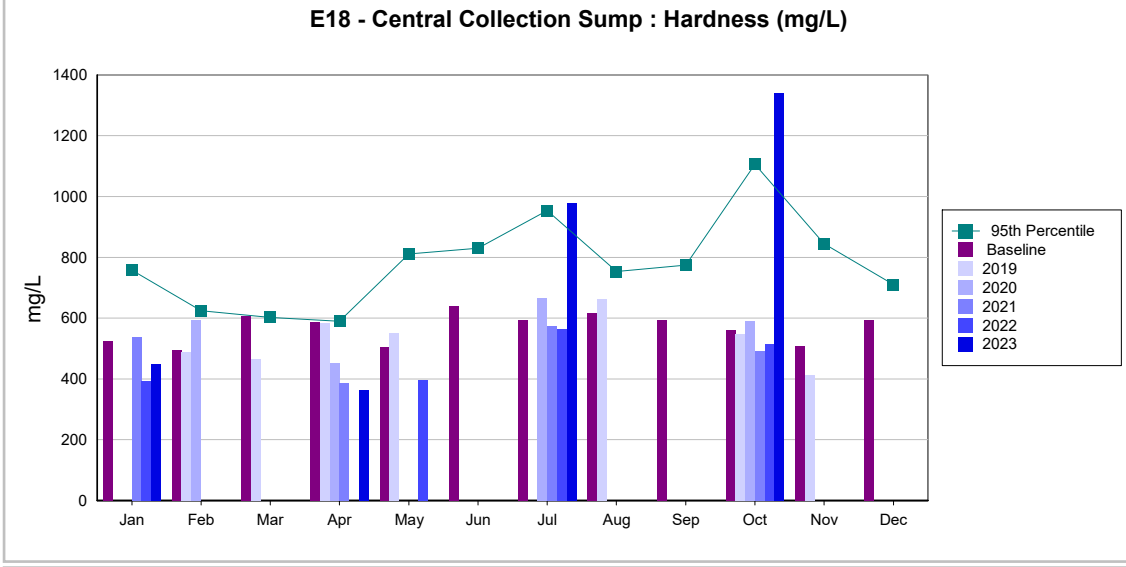
Annual Report Drainage Water

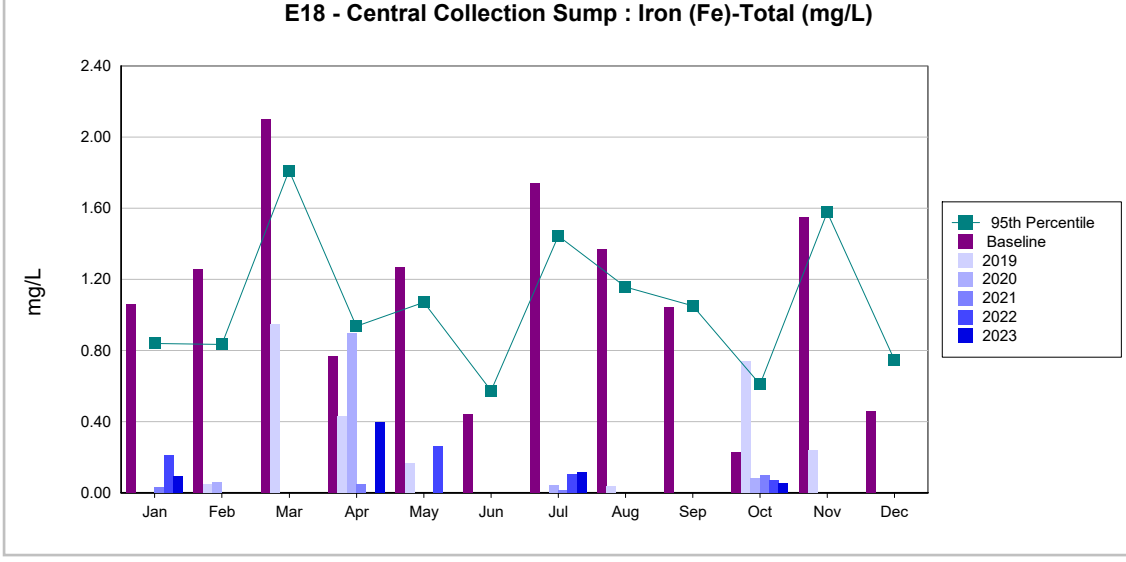
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







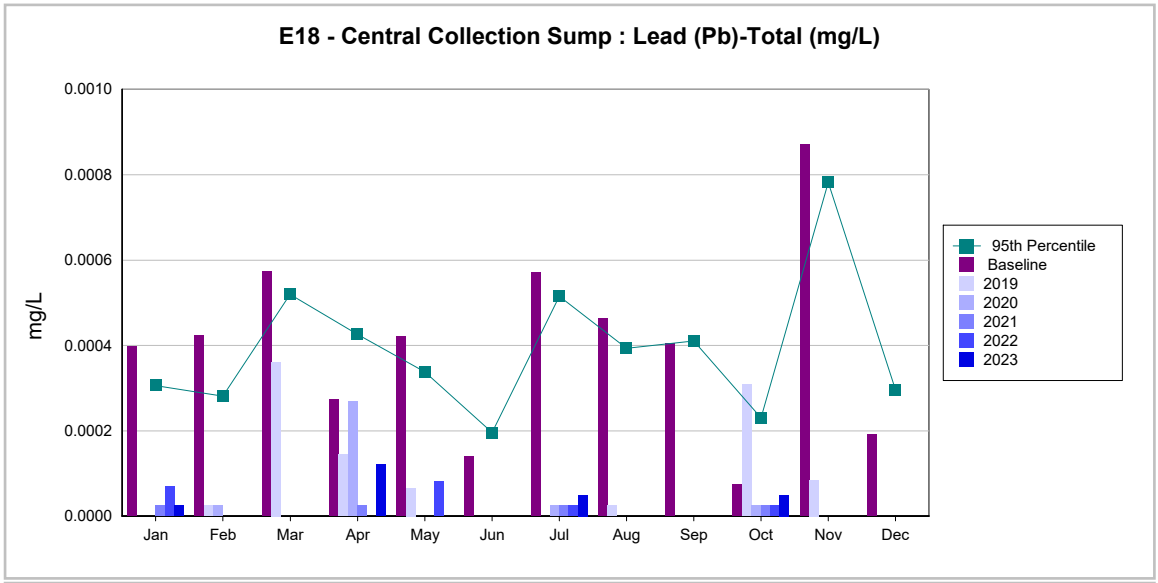
Water Quality Report

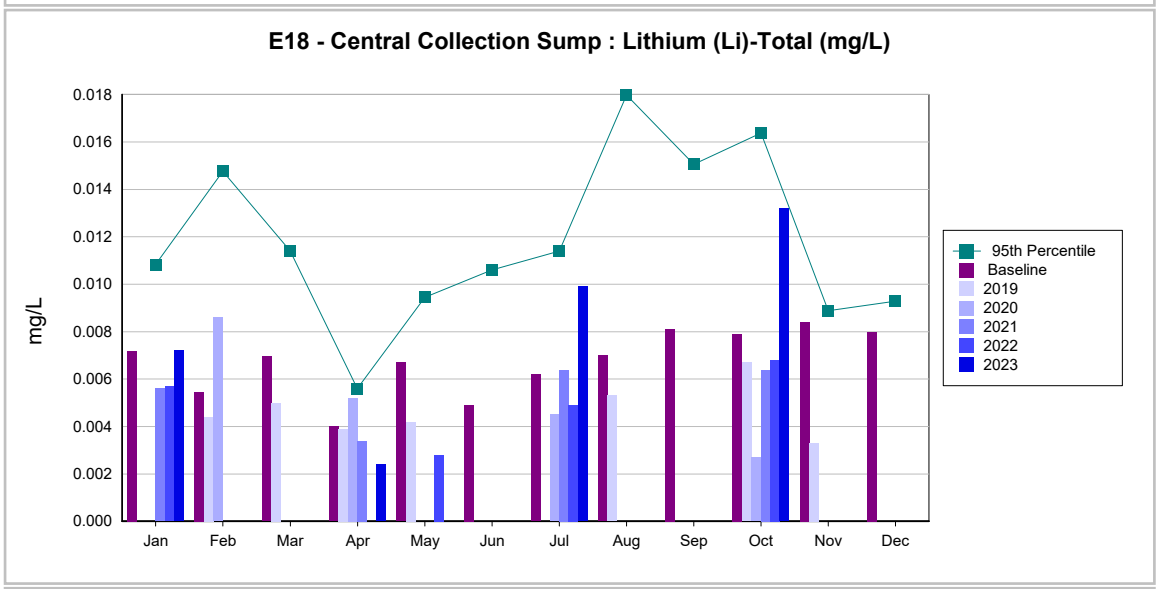
Annual Report Drainage Water

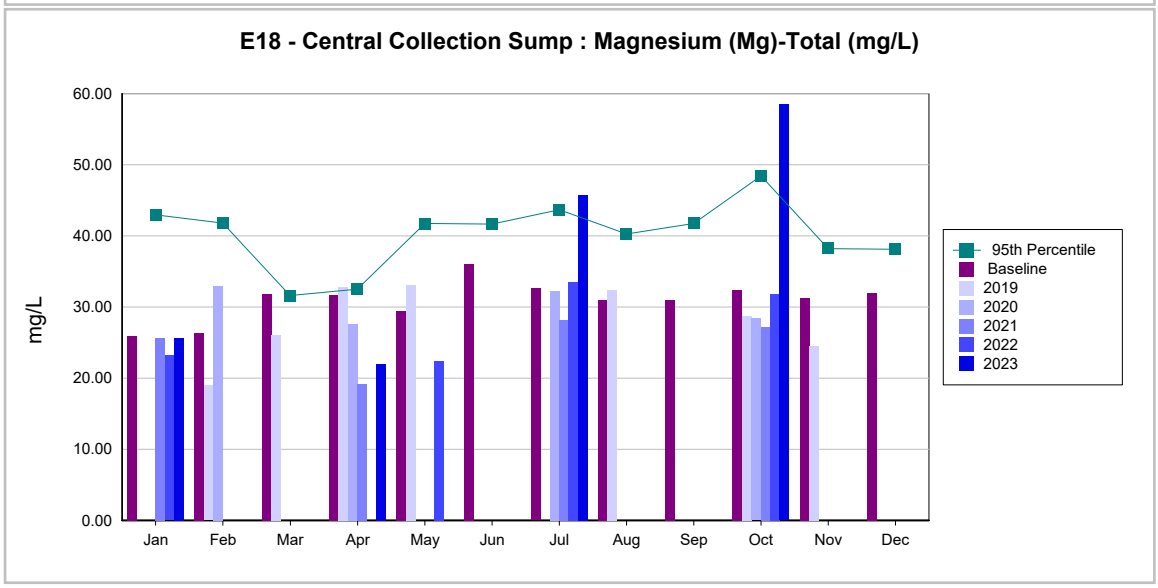
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

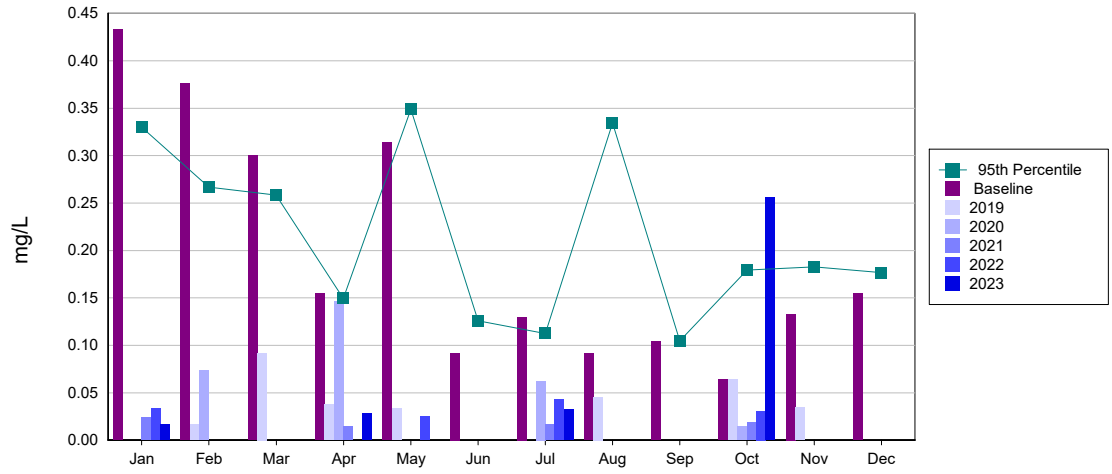
Annual Report Drainage Water

Mount Polley

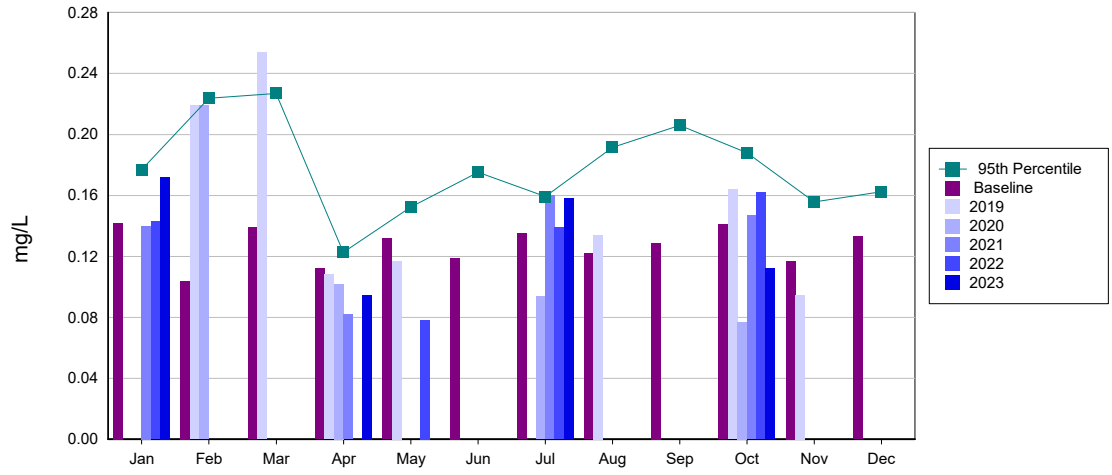
Mining Corporation

IMPERIAL METALS CORPORATION

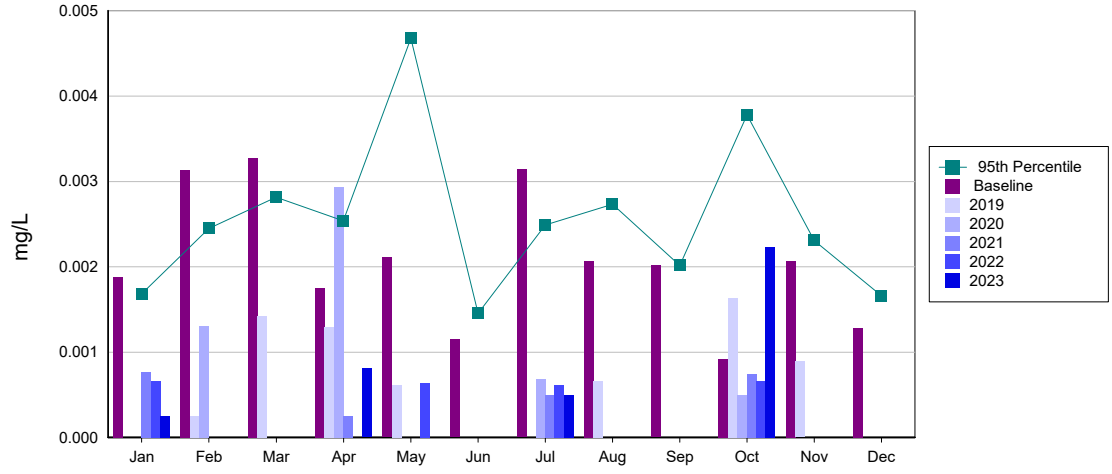
E18 - Central Collection Sump : Manganese (Mn)-Total (mg/L)



E18 - Central Collection Sump : Molybdenum (Mo)-Tota (mg/L)



E18 - Central Collection Sump : Nickel (Ni)-Total (mg/L)



Water Quality Report

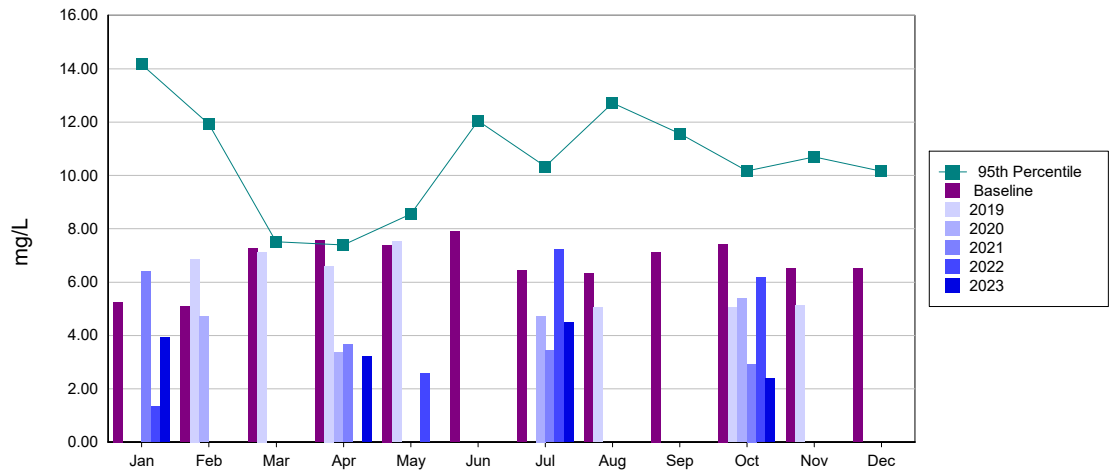
Annual Report Drainage Water

Mount Polley

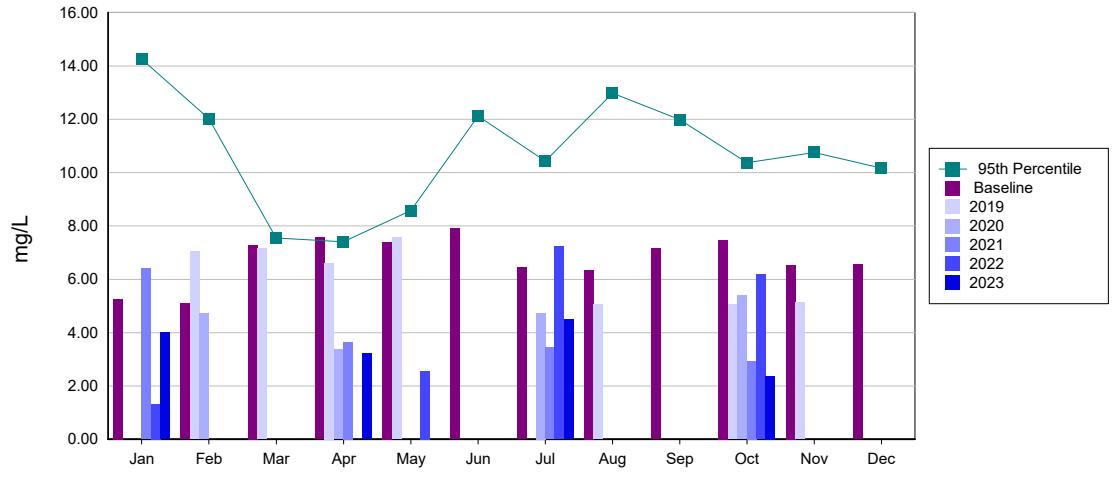
Mining Corporation

IMPERIAL METALS CORPORATION

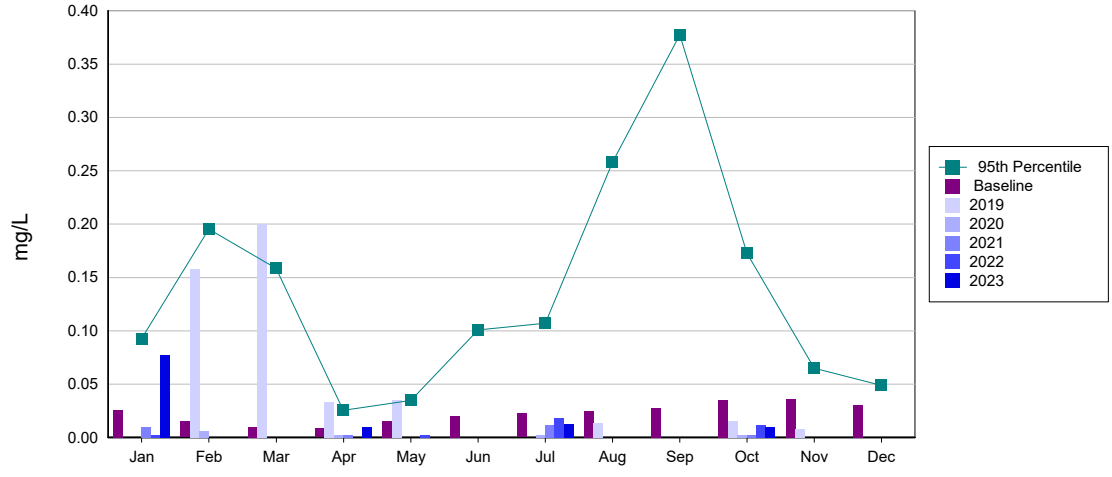
E18 - Central Collection Sump : Nitrate (N) (mg/L)



E18 - Central Collection Sump : Nitrate and Nitrite (mg/L)



E18 - Central Collection Sump : Nitrite (N) (mg/L)



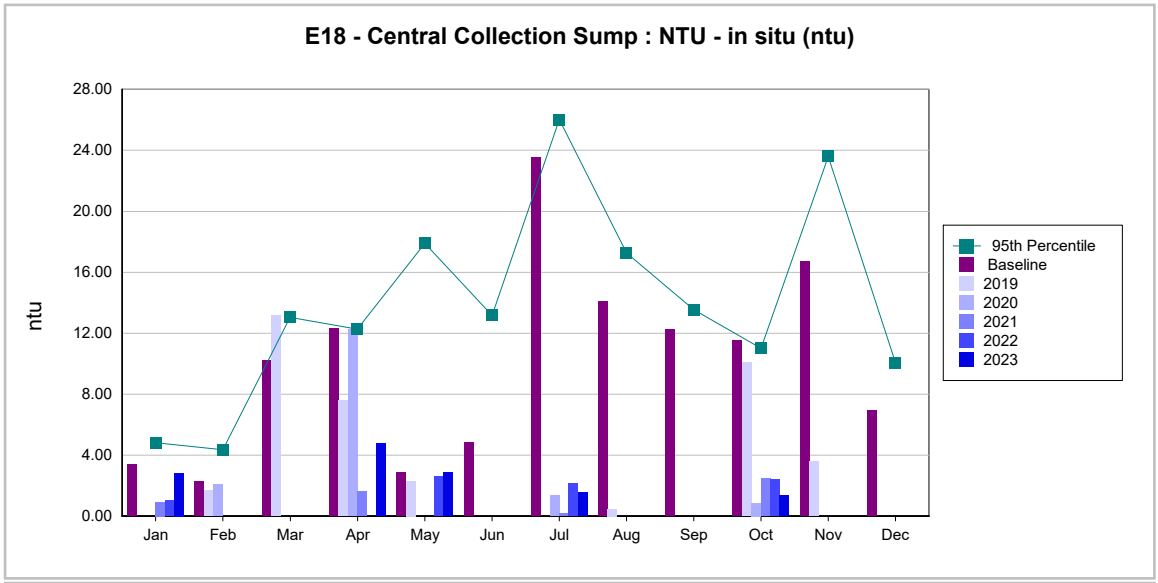
Water Quality Report

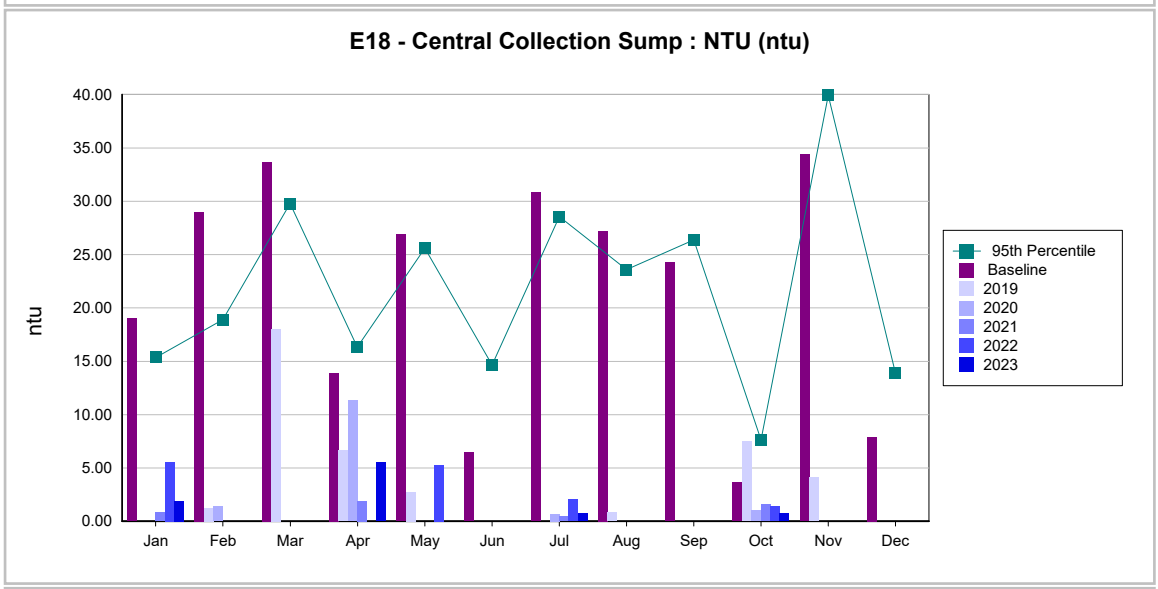
Annual Report Drainage Water

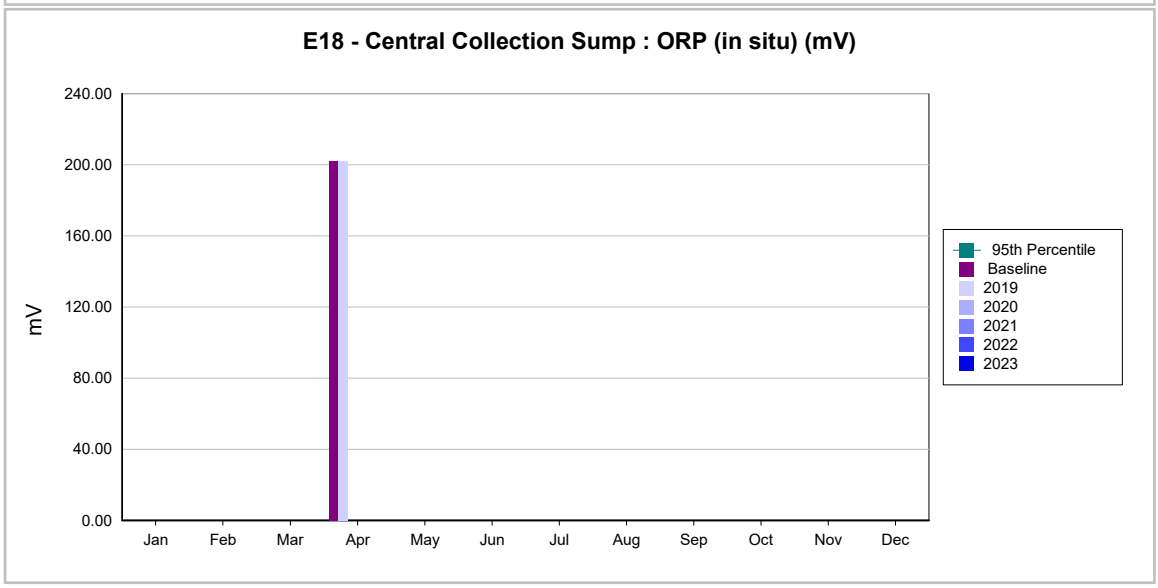
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







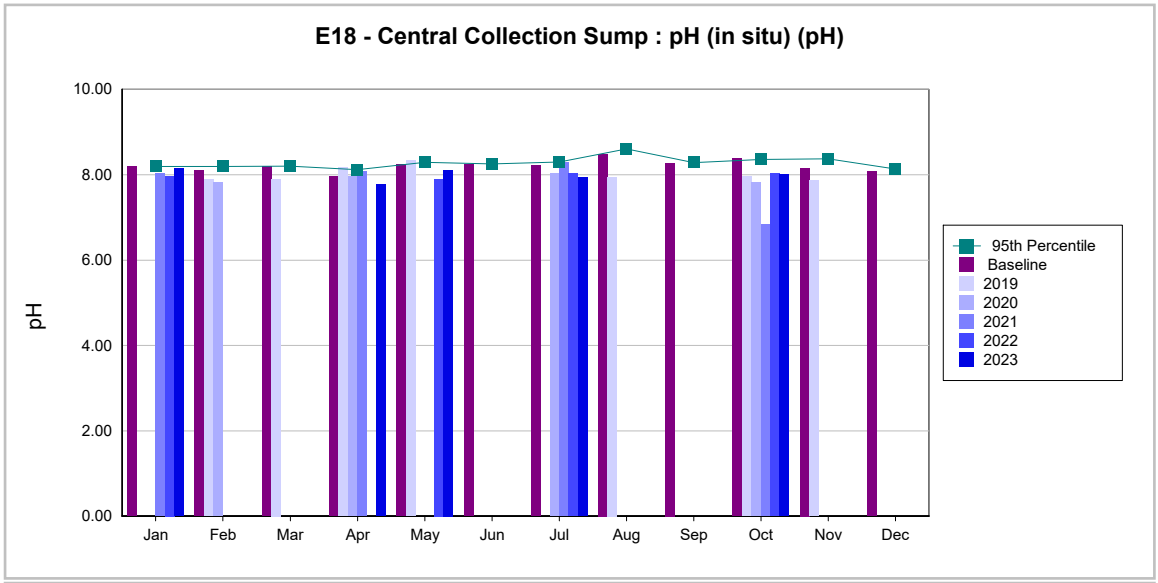
Water Quality Report

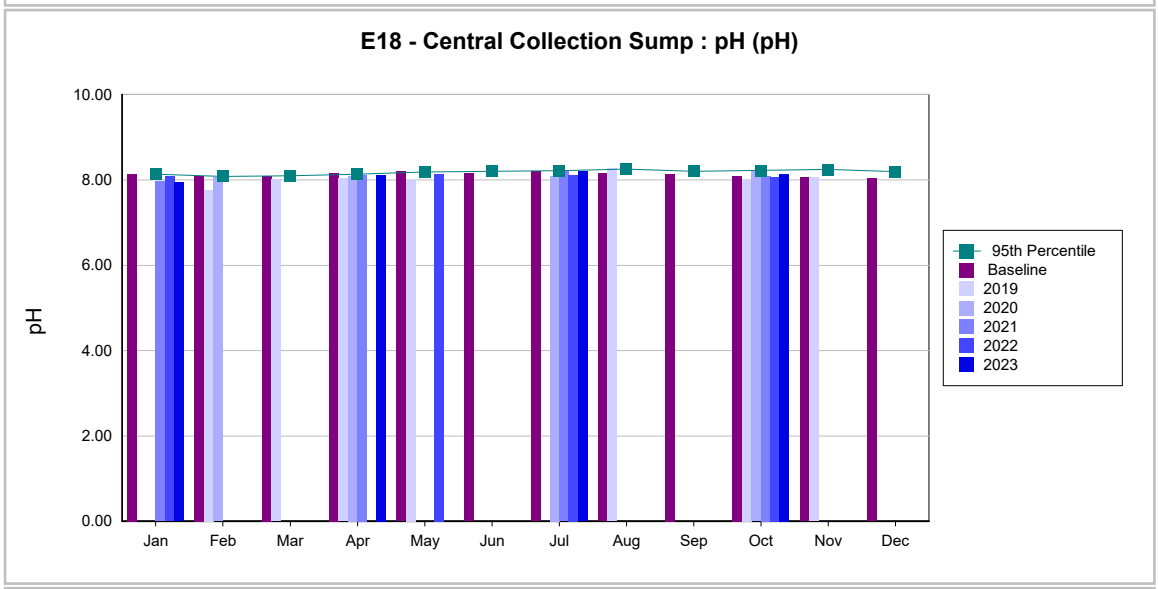
Annual Report Drainage Water

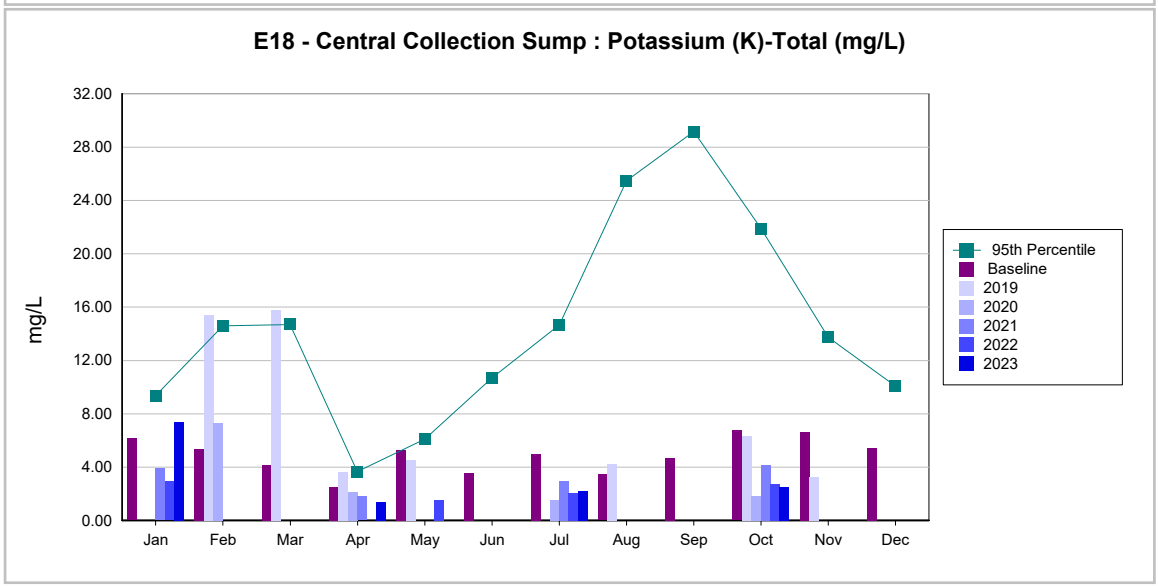
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

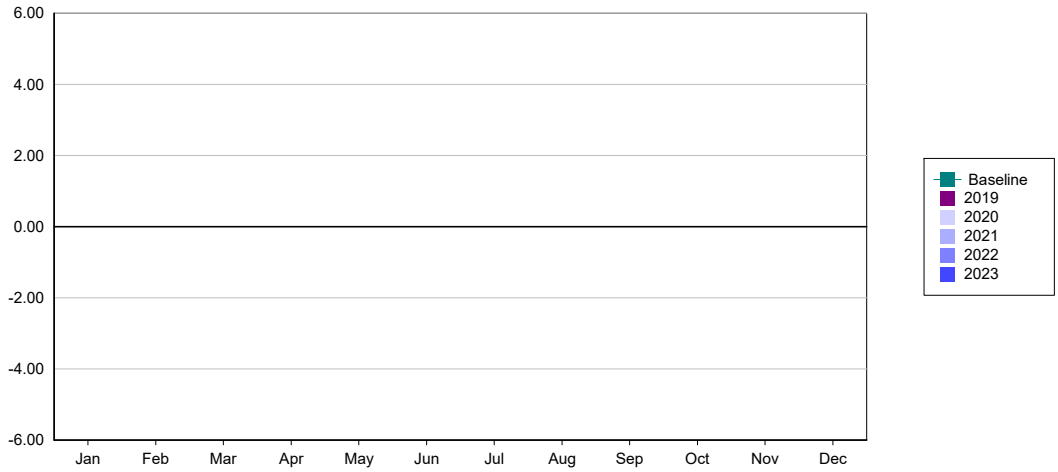
Annual Report Drainage Water

Mount Polley

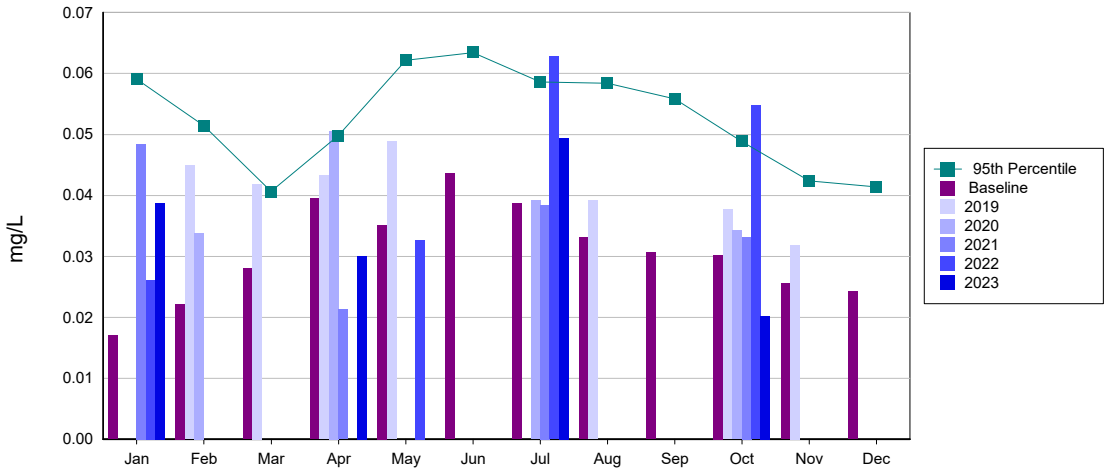
Mining Corporation

IMPERIAL METALS CORPORATION

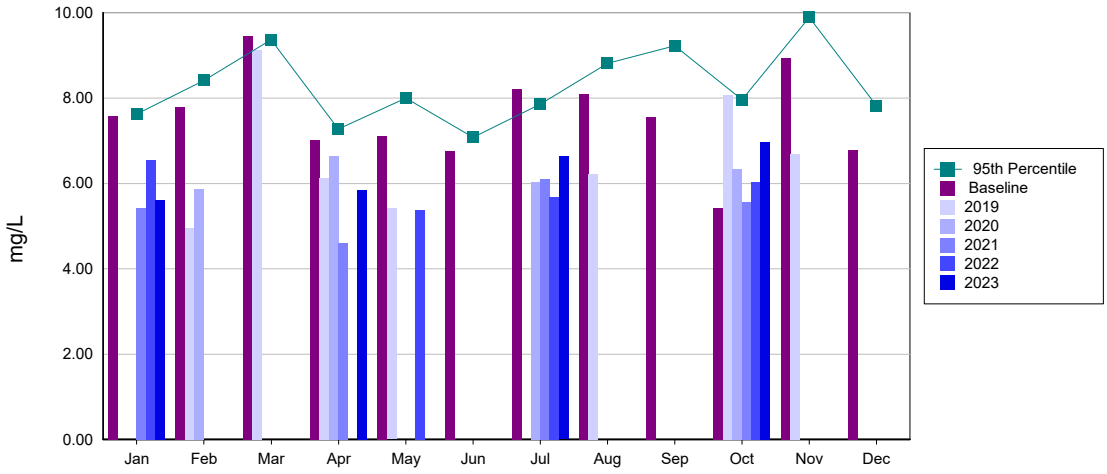
E18 - Central Collection Sump : Sample Taken



E18 - Central Collection Sump : Selenium (Se)-Total (mg/L)



E18 - Central Collection Sump : Silicon (Si)-Total (mg/L)



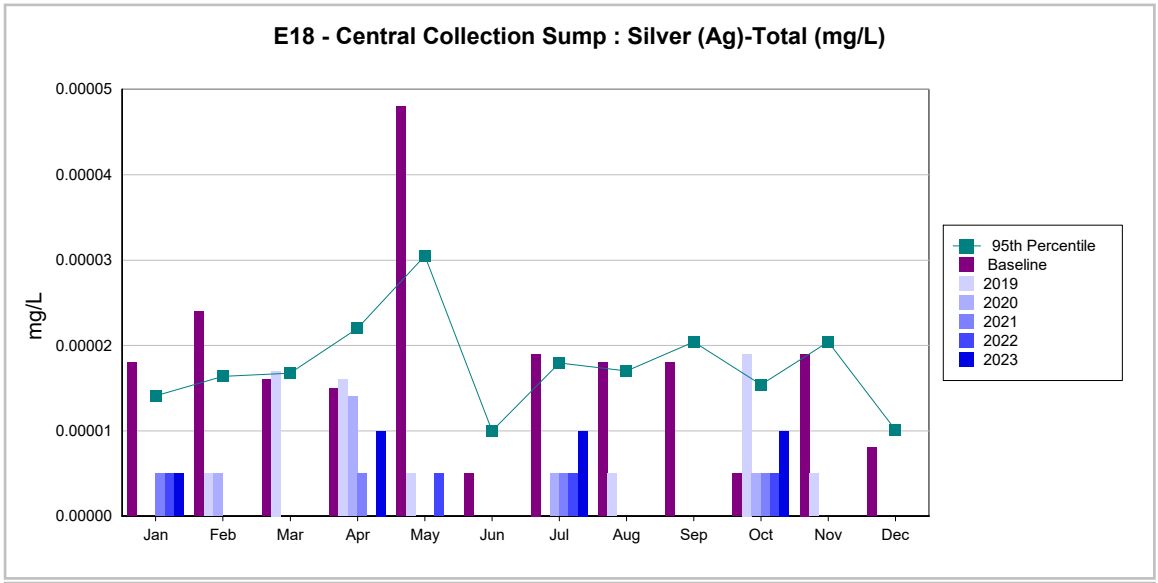
Water Quality Report

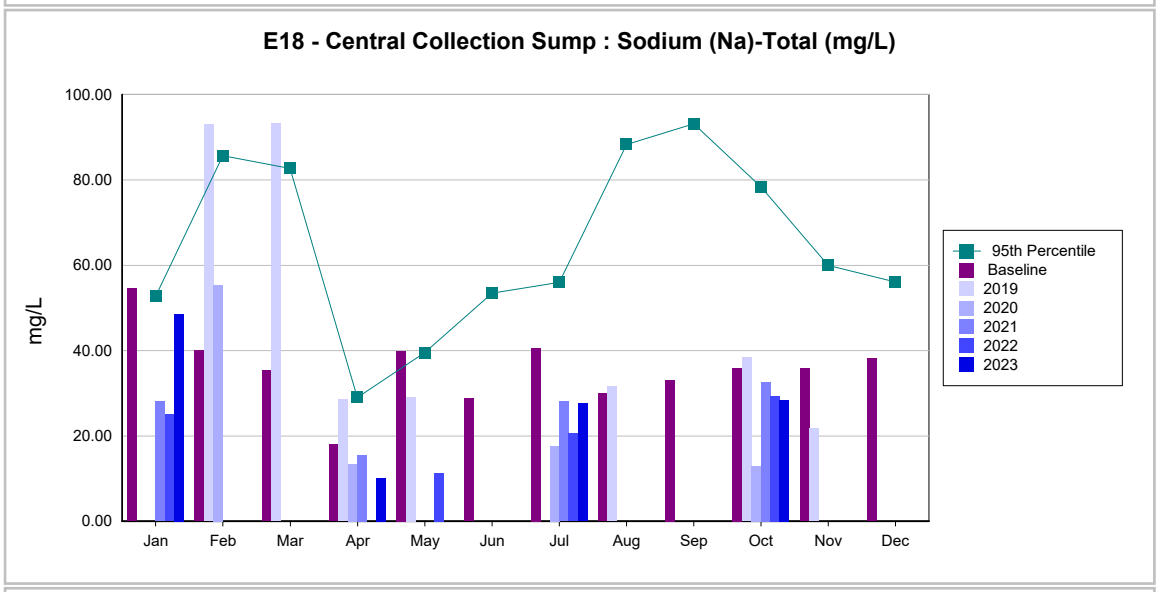
Annual Report Drainage Water

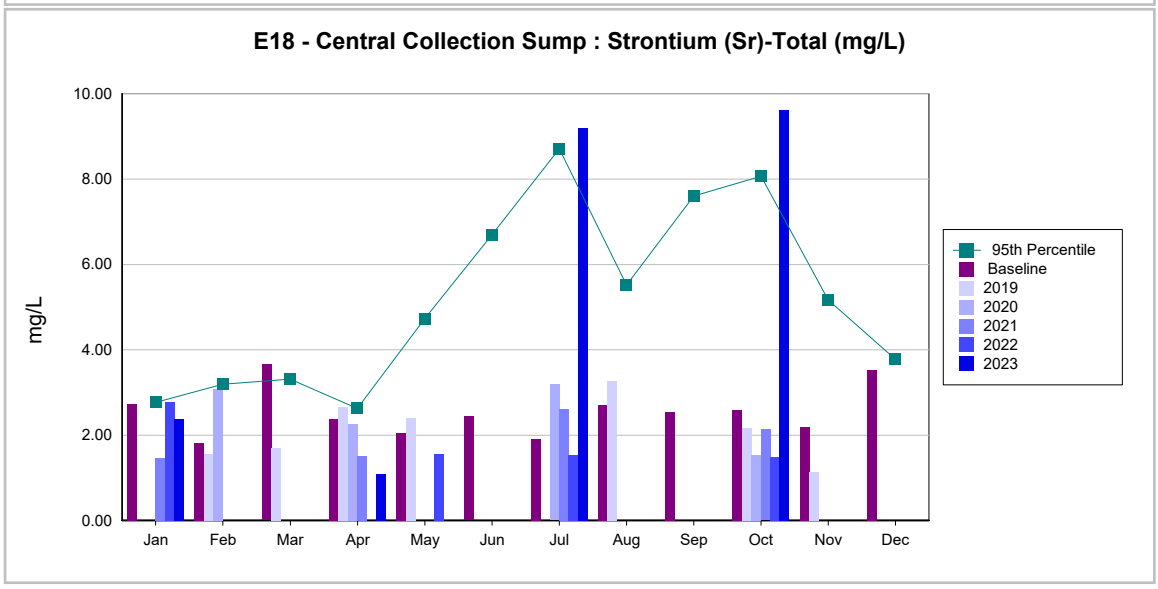
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

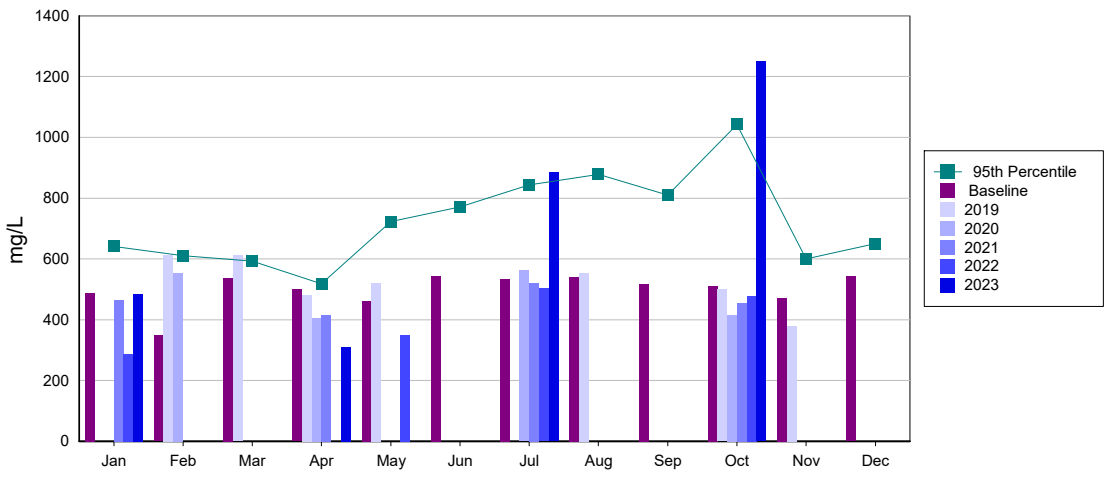
Annual Report Drainage Water

Mount Polley

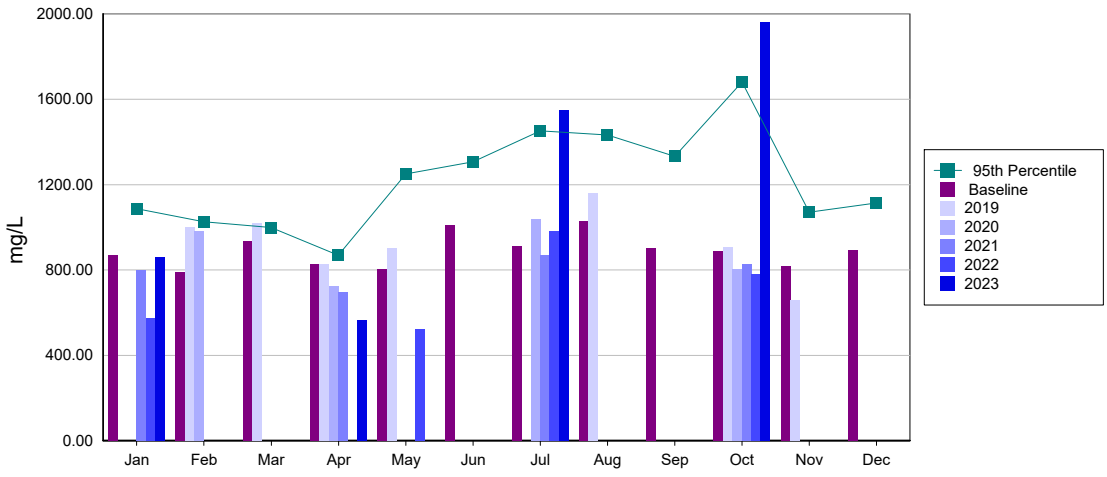
Mining Corporation

IMPERIAL METALS CORPORATION

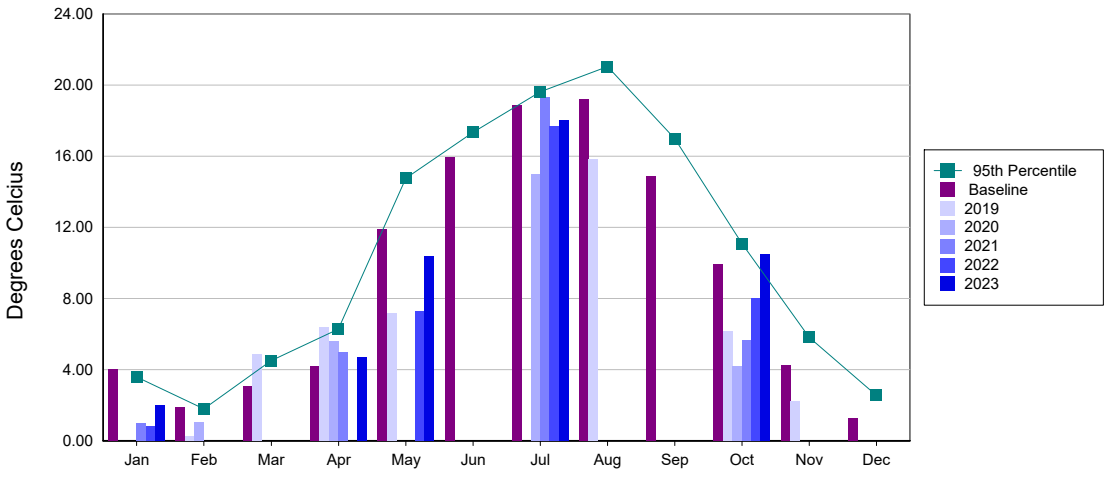
E18 - Central Collection Sump : Sulphate (mg/L)



E18 - Central Collection Sump : TDS (mg/L)



E18 - Central Collection Sump : Temp (in situ) (Degrees Celcius)



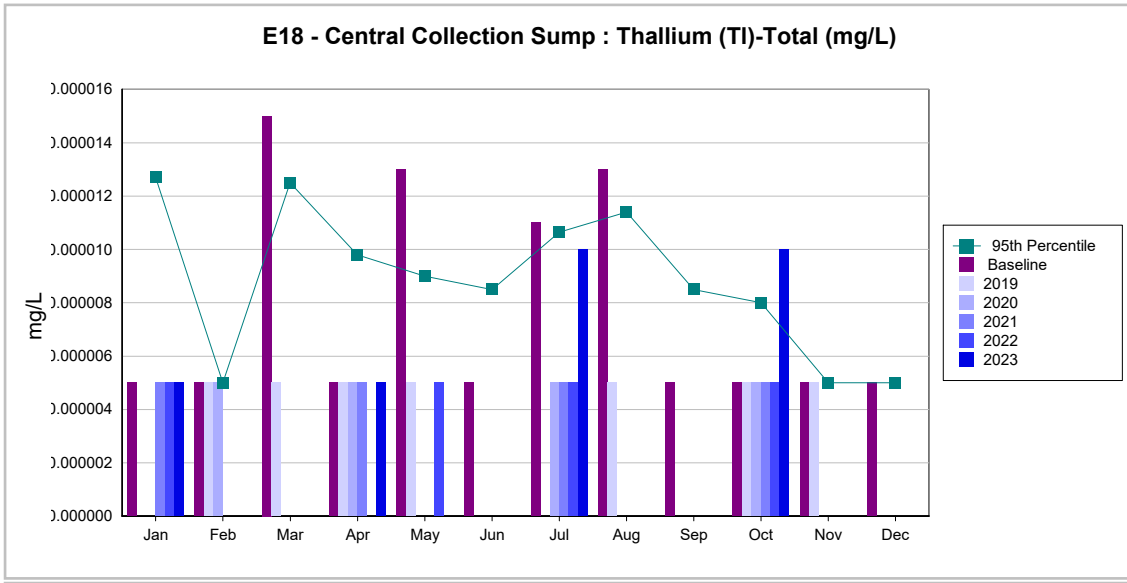
Water Quality Report

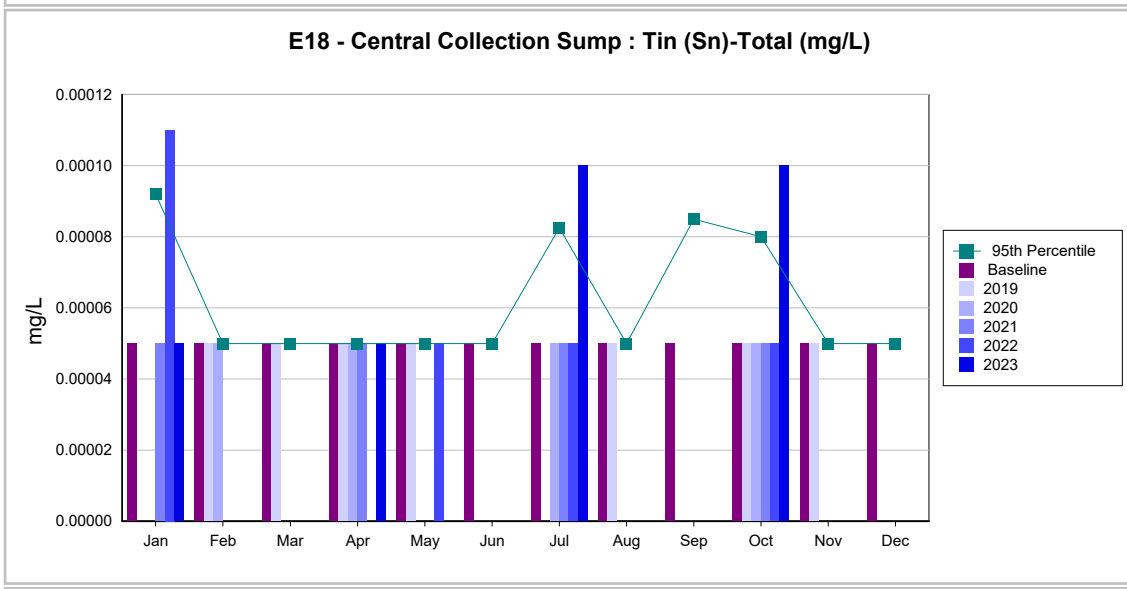
Annual Report Drainage Water

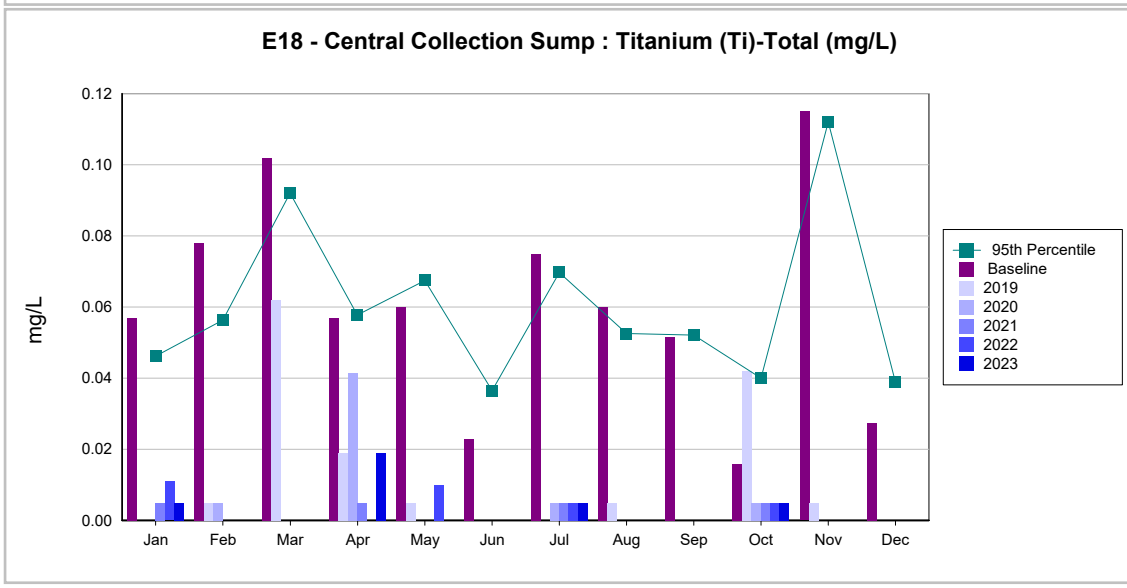
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







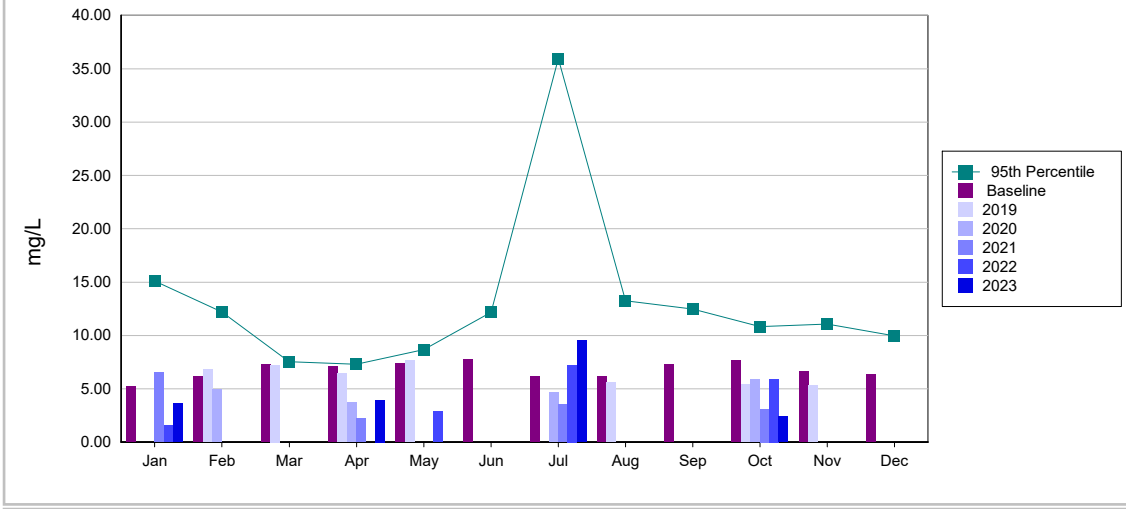
Water Quality Report

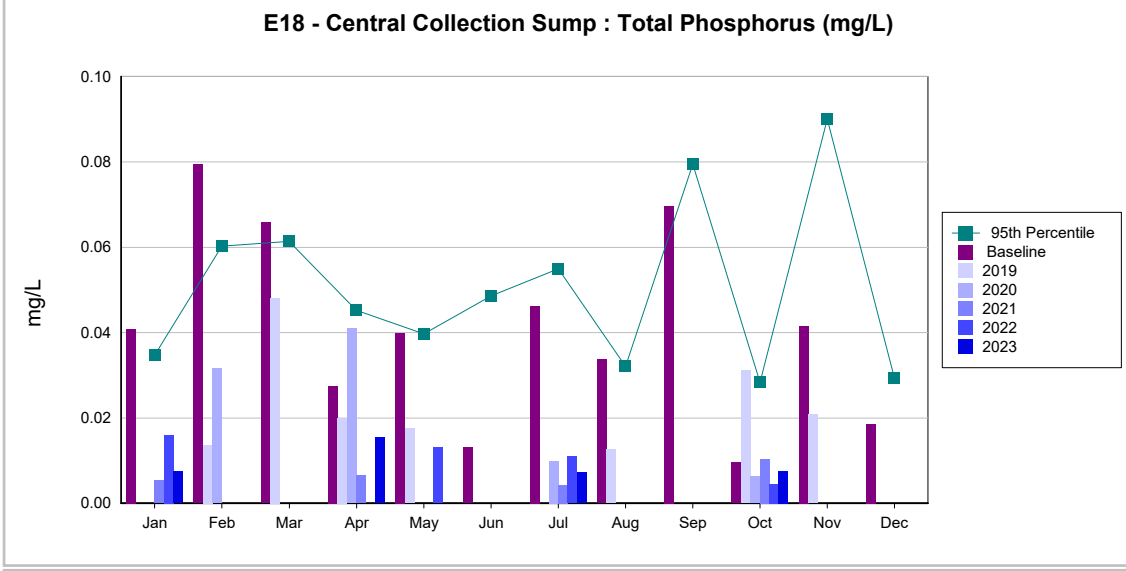
Annual Report Drainage Water

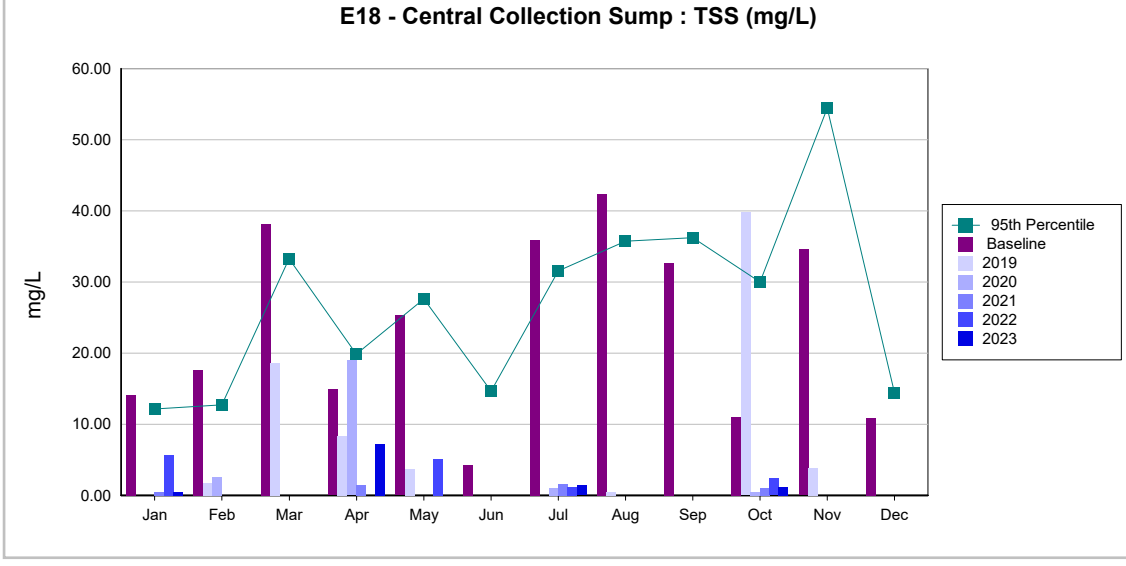
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







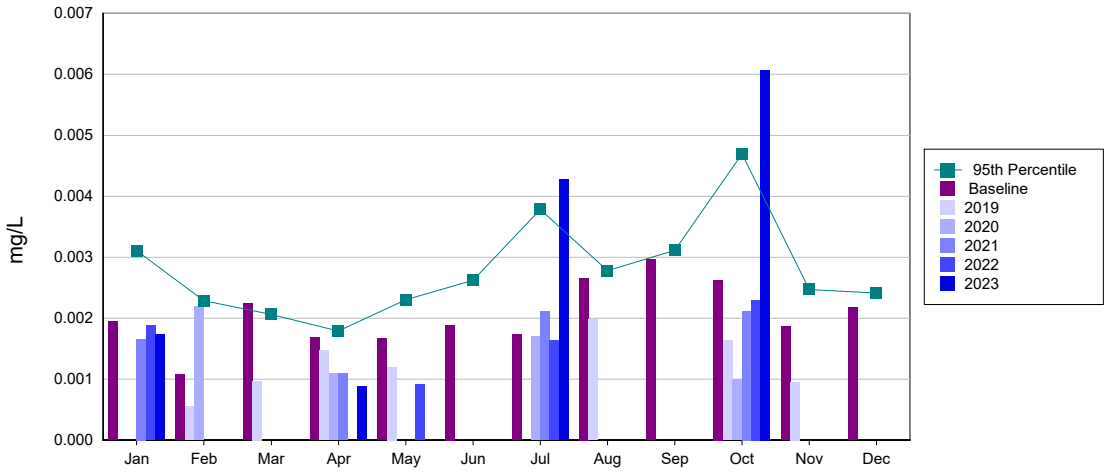
Water Quality Report

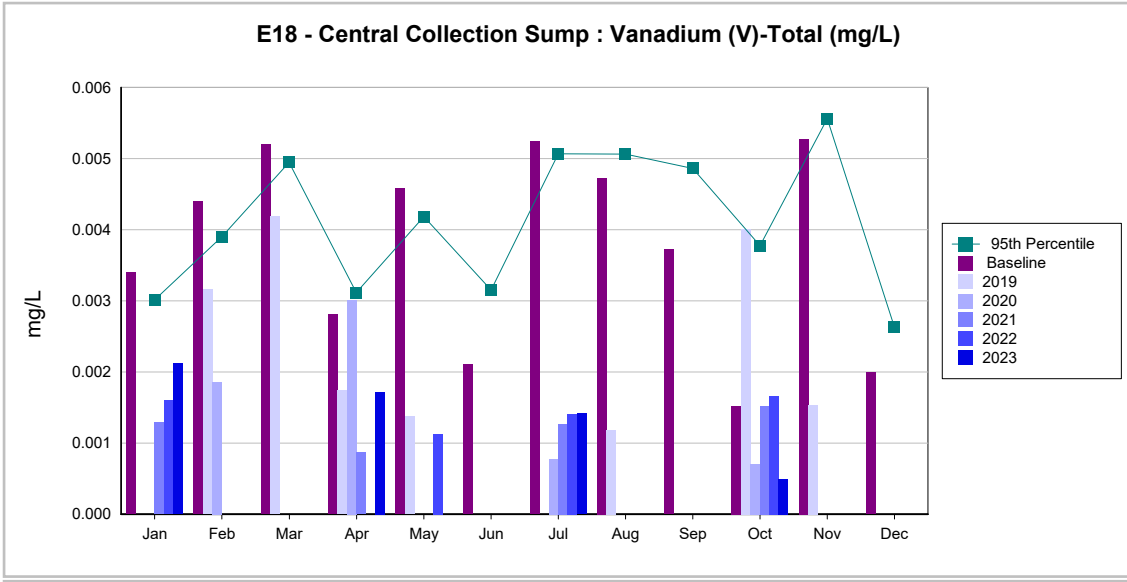
Annual Report Drainage Water

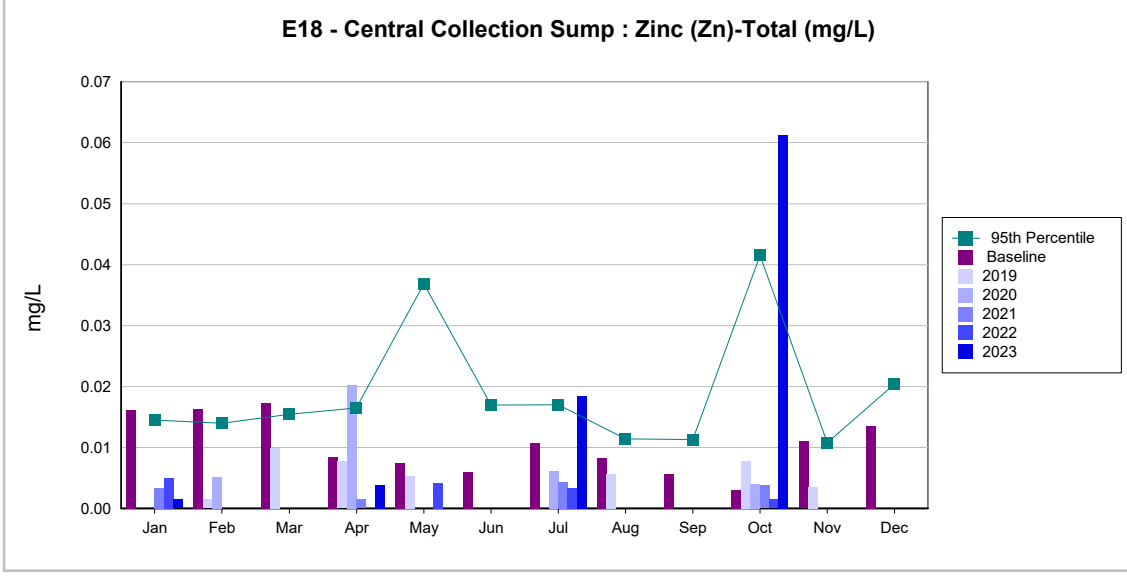
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

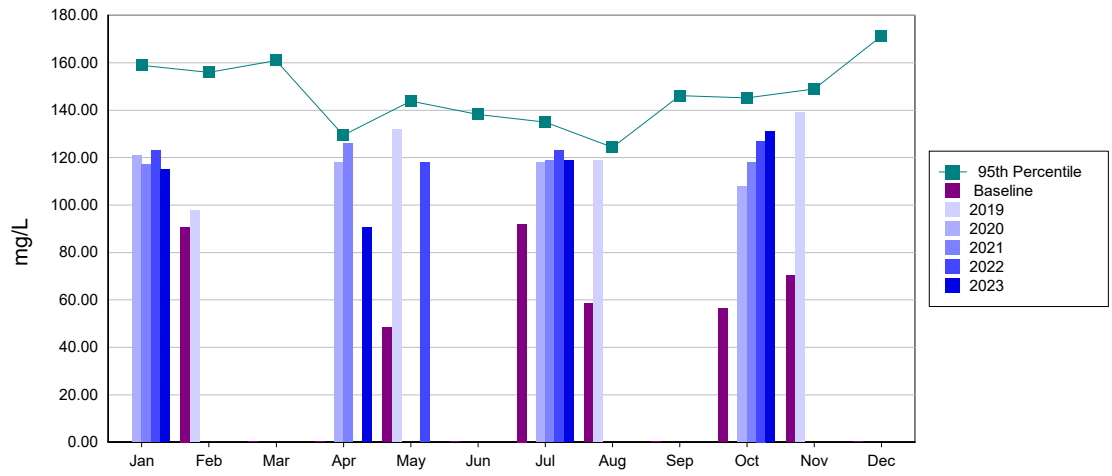
Annual Report Drainage Water

Mount Polley

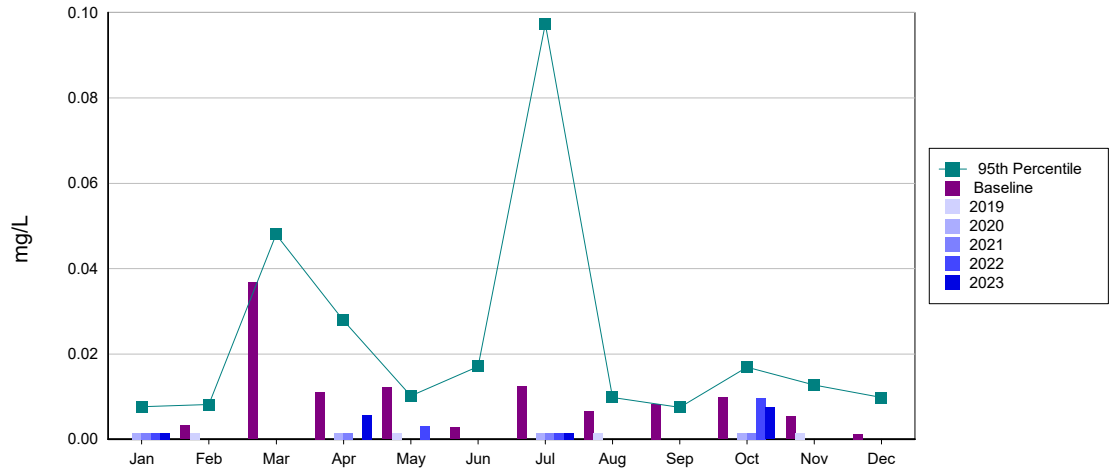
Mining Corporation

IMPERIAL METALS CORPORATION

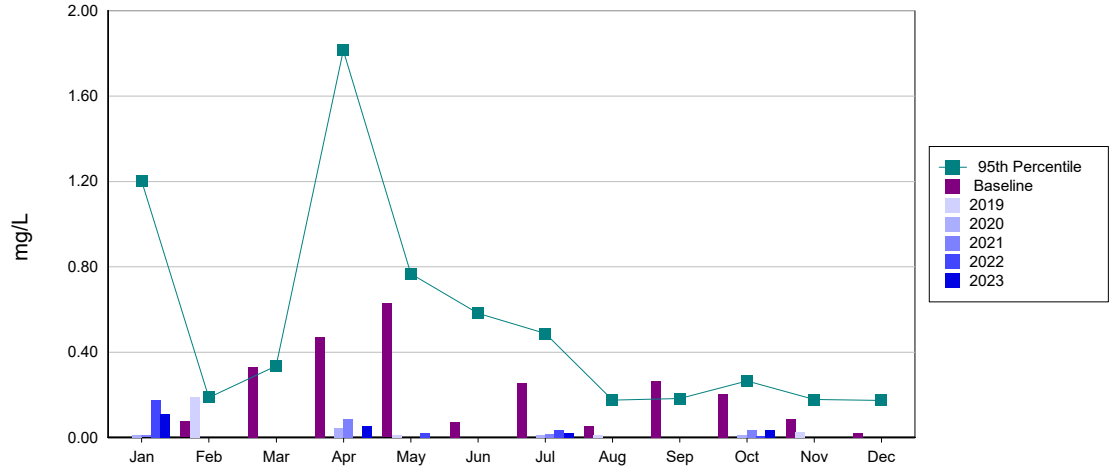
E4 - Main Embankment Seepage Pond : Alkalinity (CaCO3) (mg/L)



E4 - Main Embankment Seepage Pond : Aluminum (Al)-Diss (mg/L)



E4 - Main Embankment Seepage Pond : Aluminum (Al)-Total (mg/L)



Water Quality Report

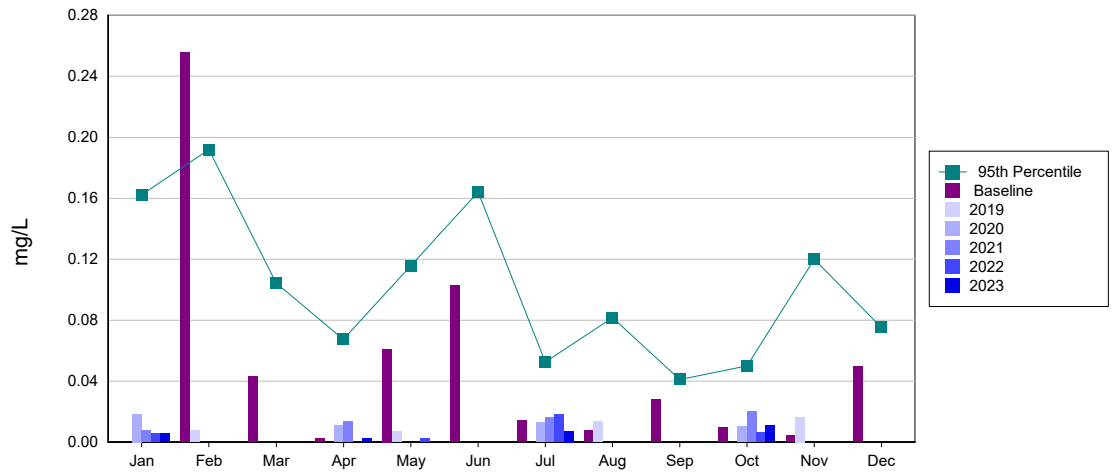
Annual Report Drainage Water

Mount Polley

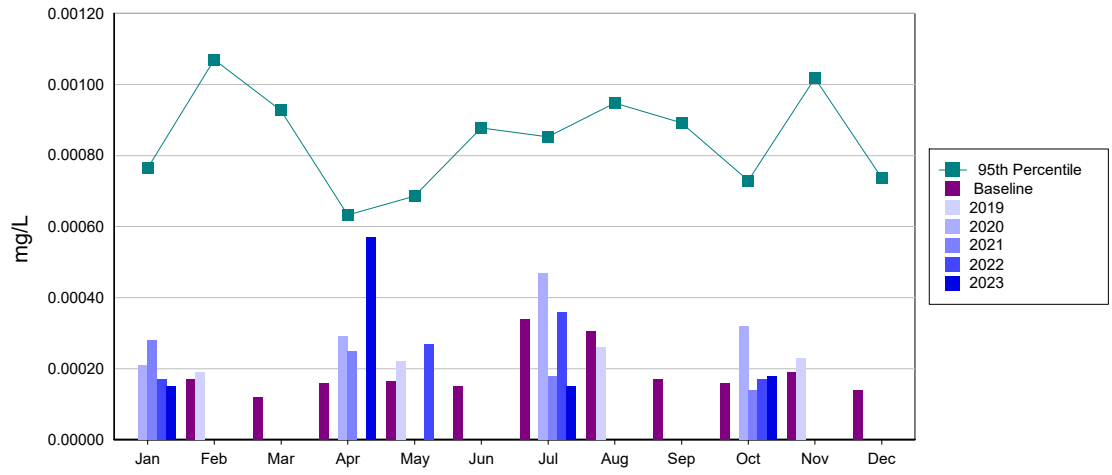
Mining Corporation

IMPERIAL METALS CORPORATION

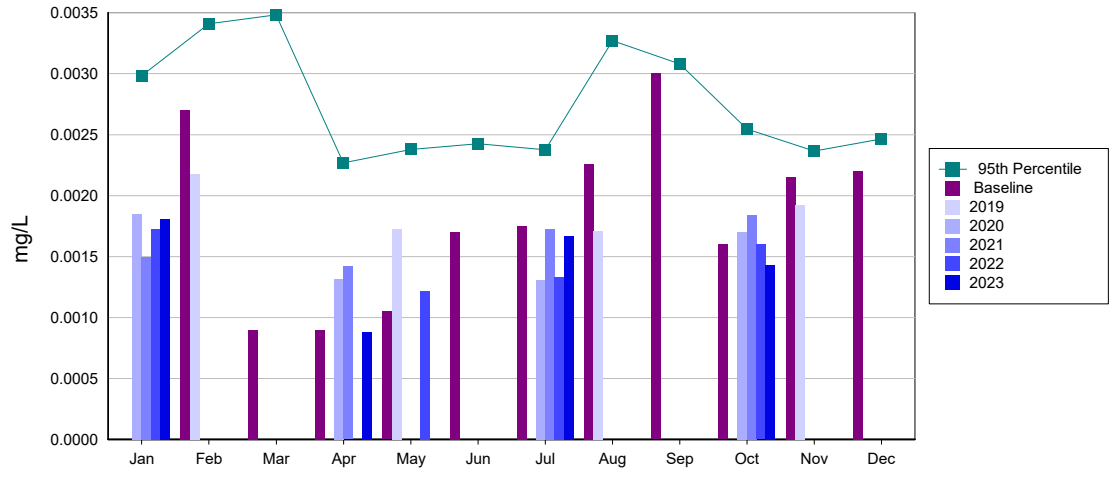
E4 - Main Embankment Seepage Pond : Ammonia (as N) (mg/L)



E4 - Main Embankment Seepage Pond : Antimony (Sb)-Total (mg/L)



E4 - Main Embankment Seepage Pond : Arsenic (As)-Total (mg/L)



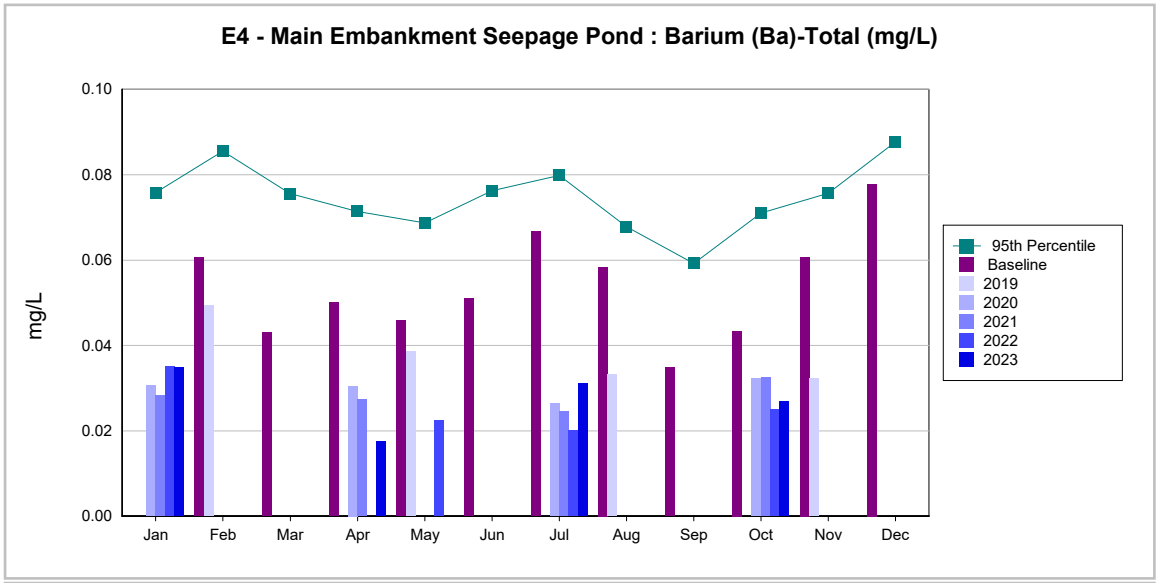
Water Quality Report

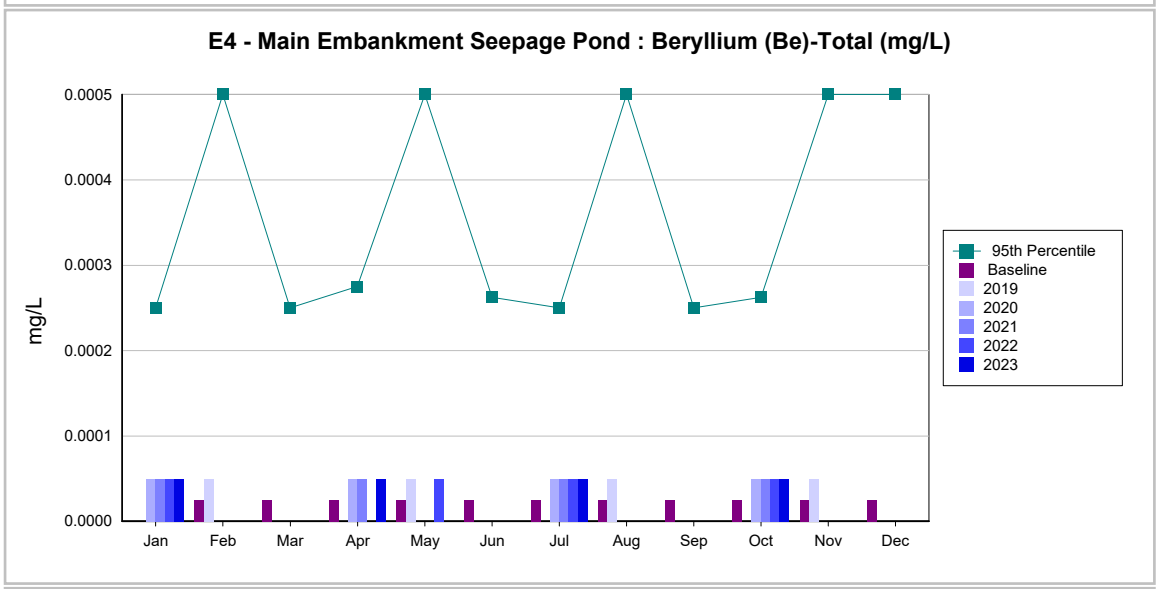
Annual Report Drainage Water

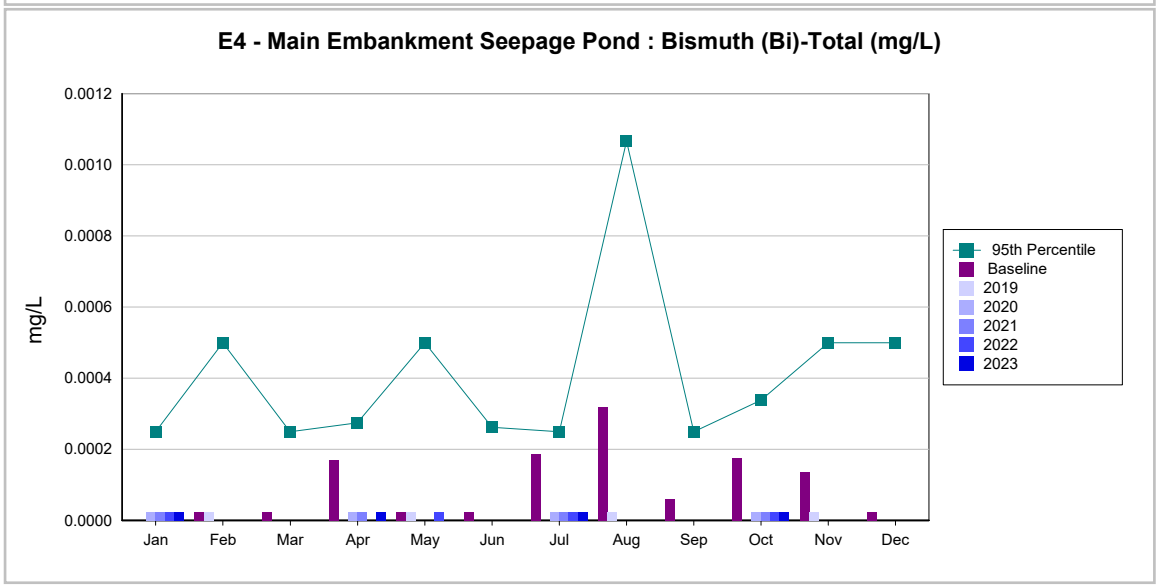
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







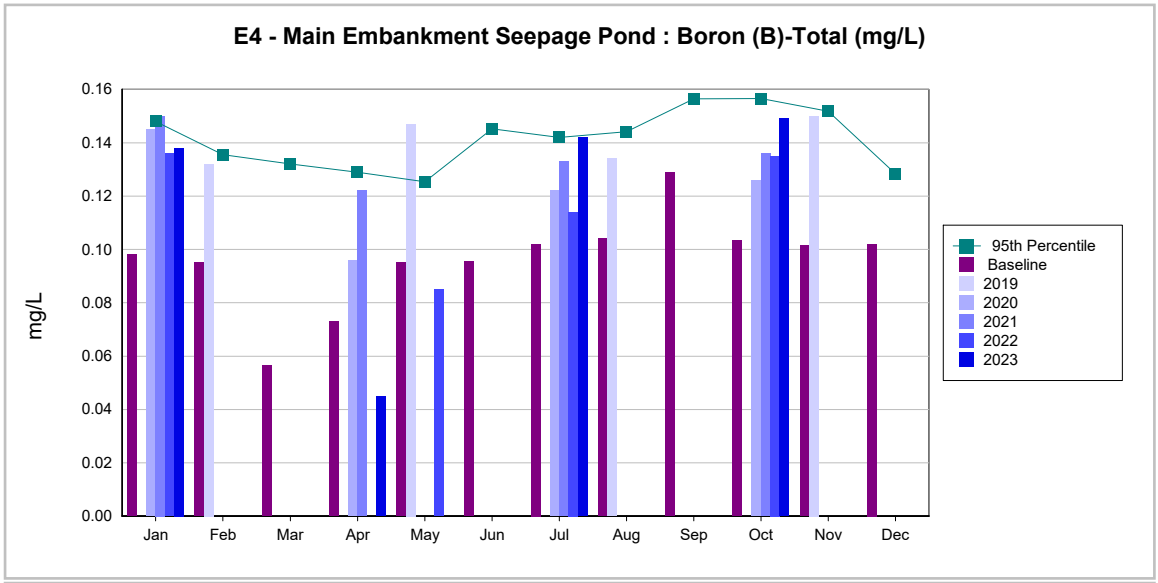
Water Quality Report

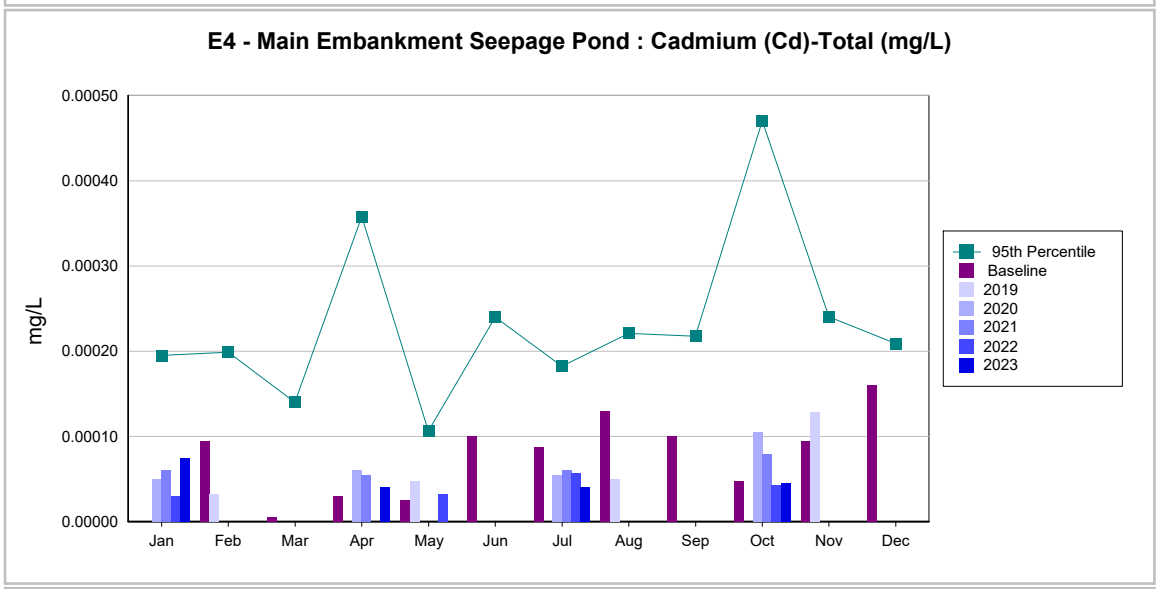
Annual Report Drainage Water

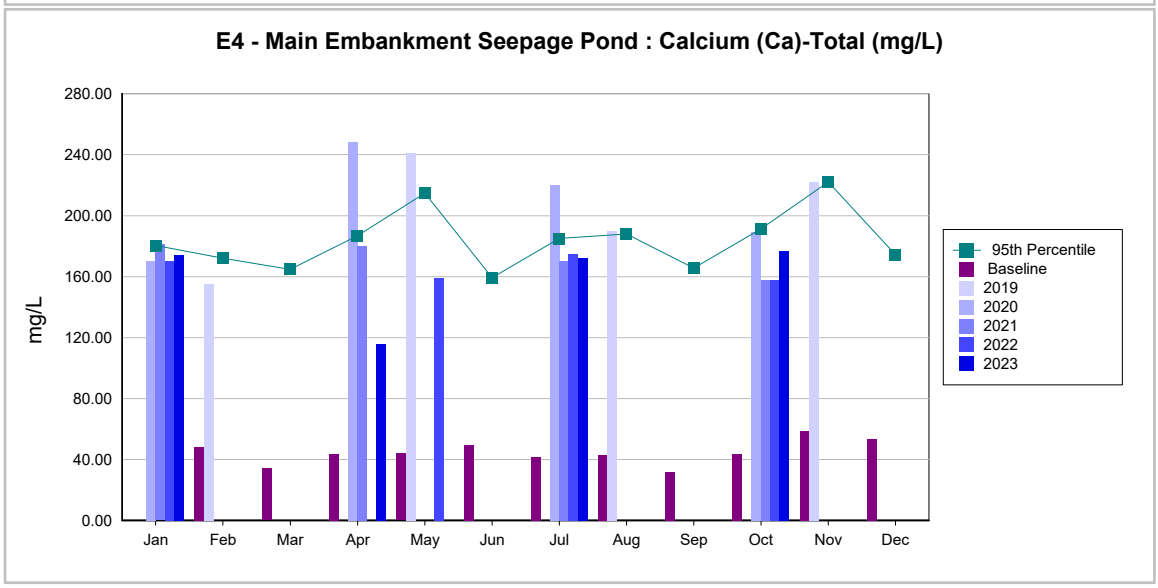
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







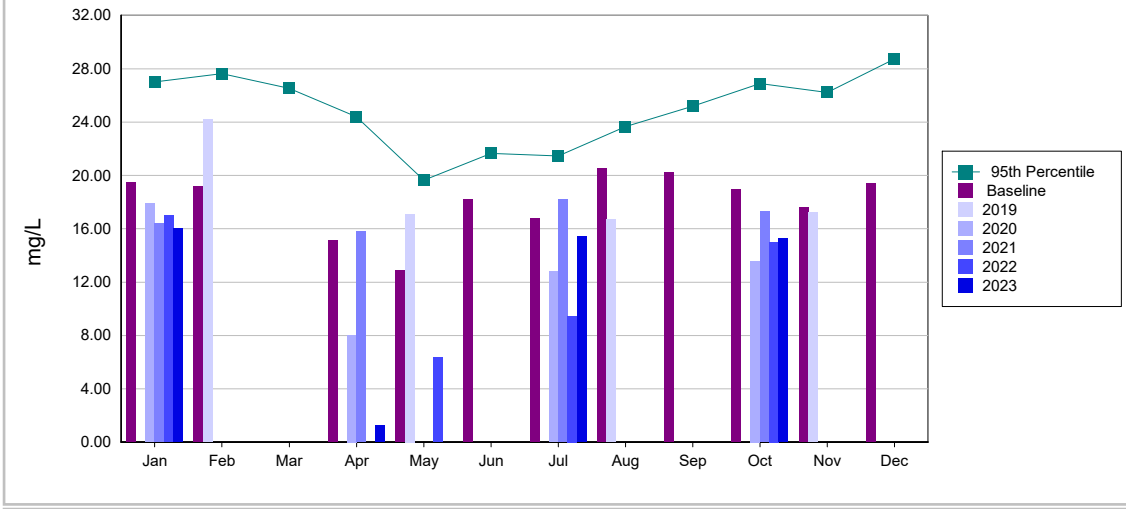
Water Quality Report

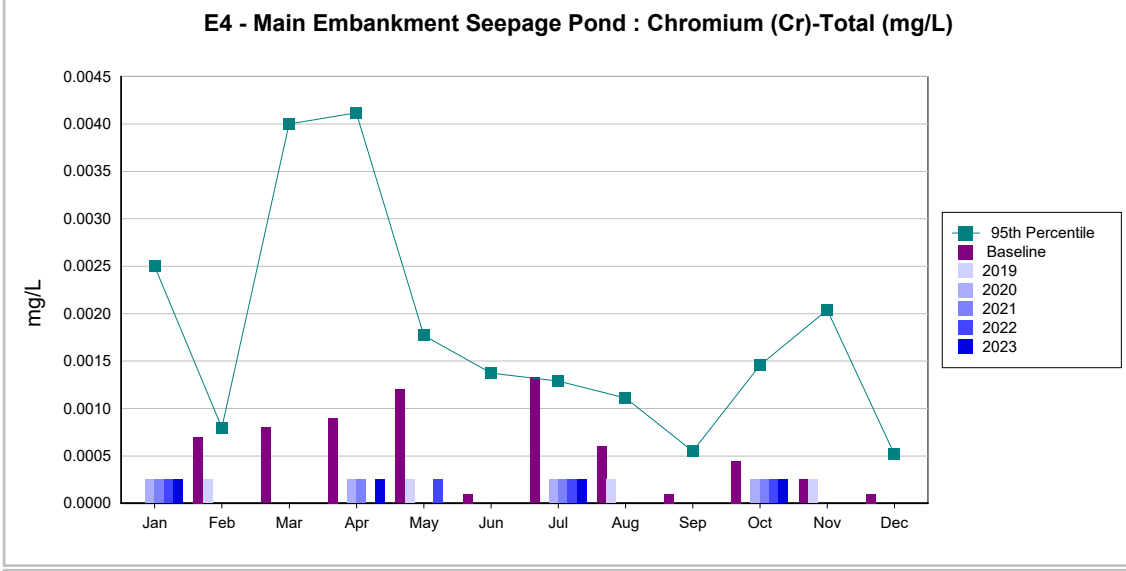
Annual Report Drainage Water

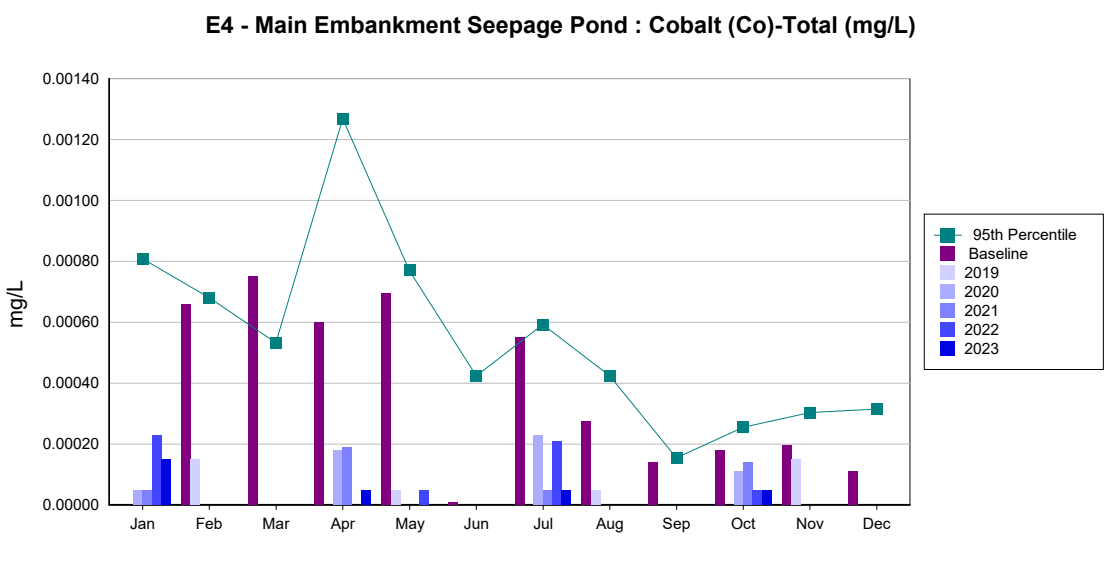
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

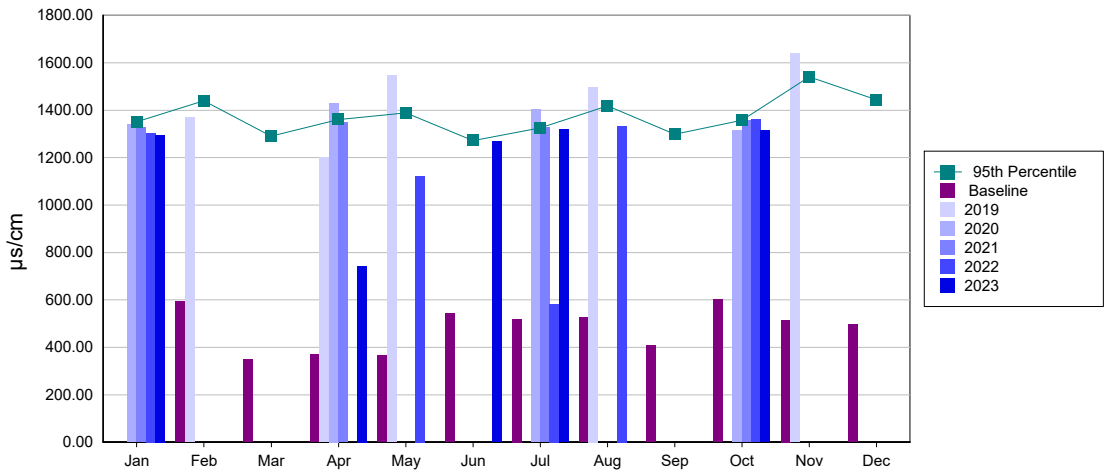
Annual Report Drainage Water

Mount Polley

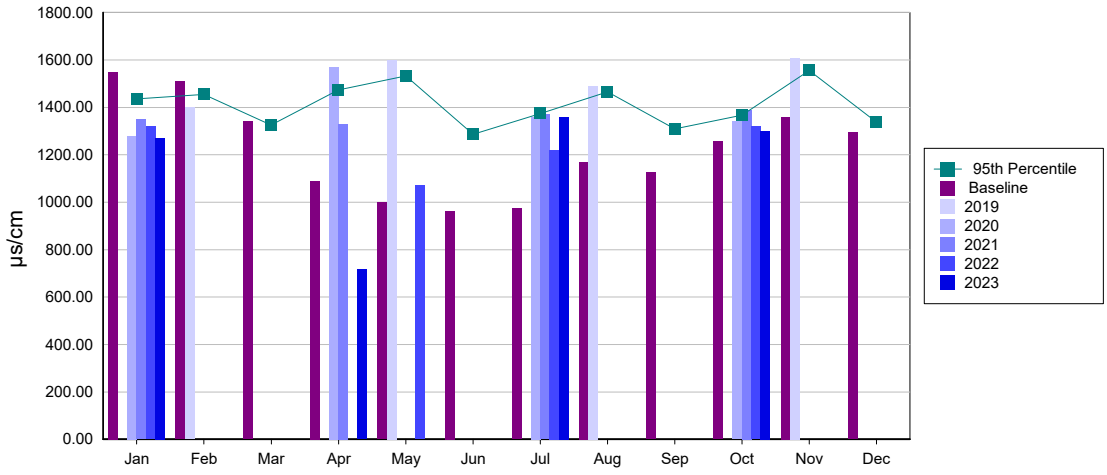
Mining Corporation

IMPERIAL METALS CORPORATION

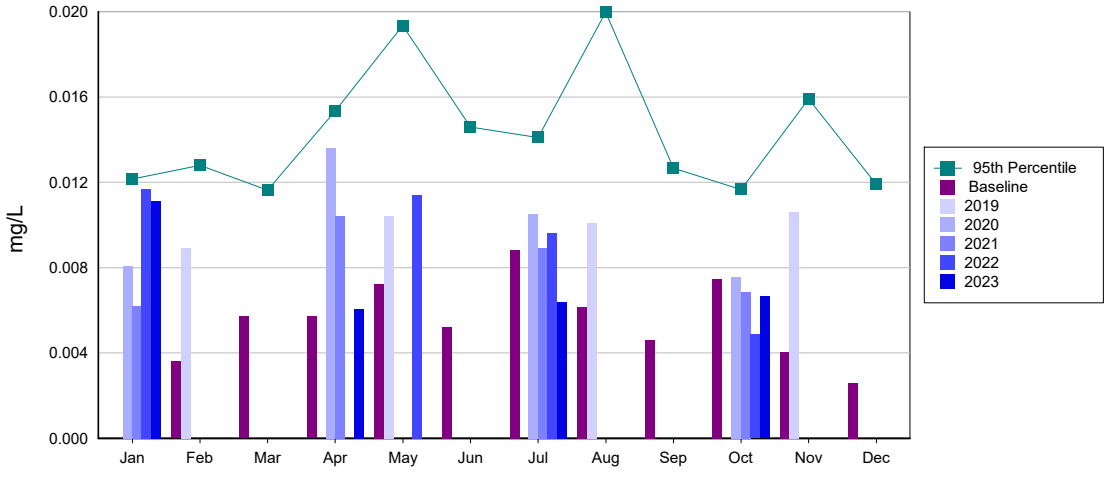
E4 - Main Embankment Seepage Pond : Cond (in situ) (µs/cm)



E4 - Main Embankment Seepage Pond : Conductivity (µs/cm)



E4 - Main Embankment Seepage Pond : Copper (Cu)-Total (mg/L)



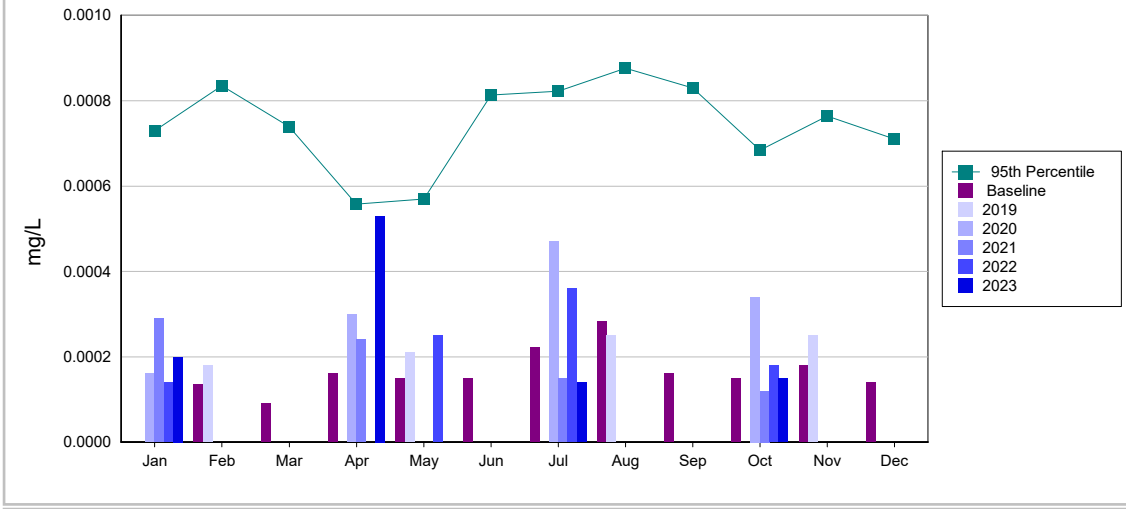
Water Quality Report

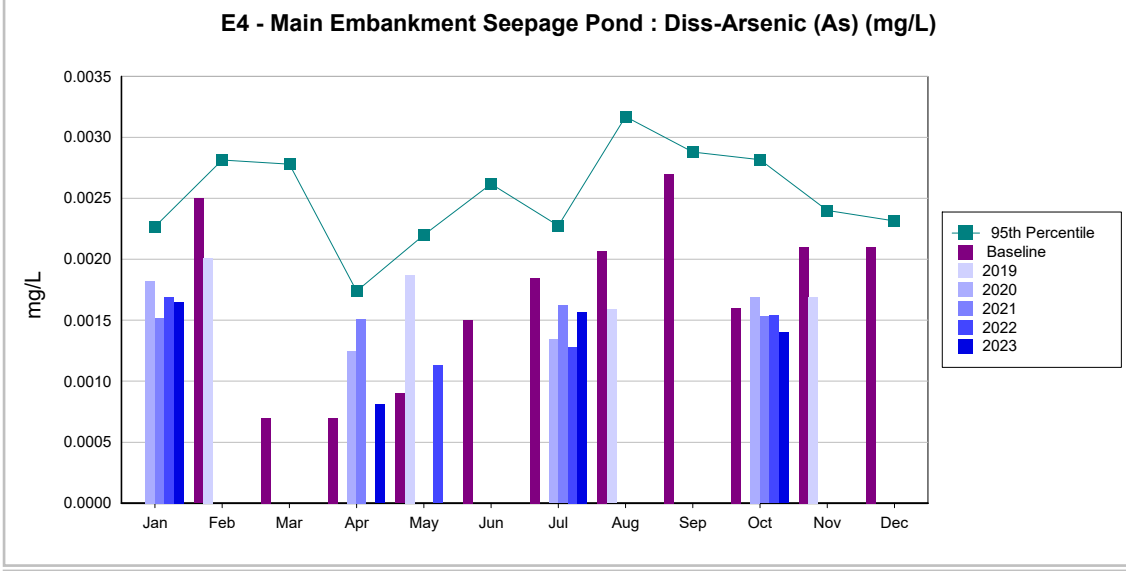
Annual Report Drainage Water

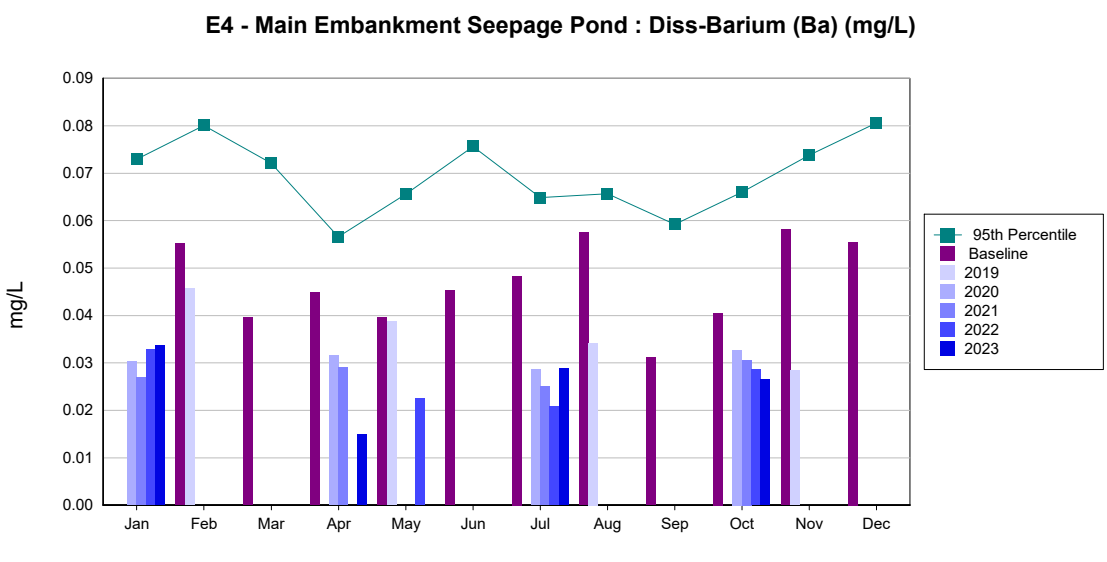
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







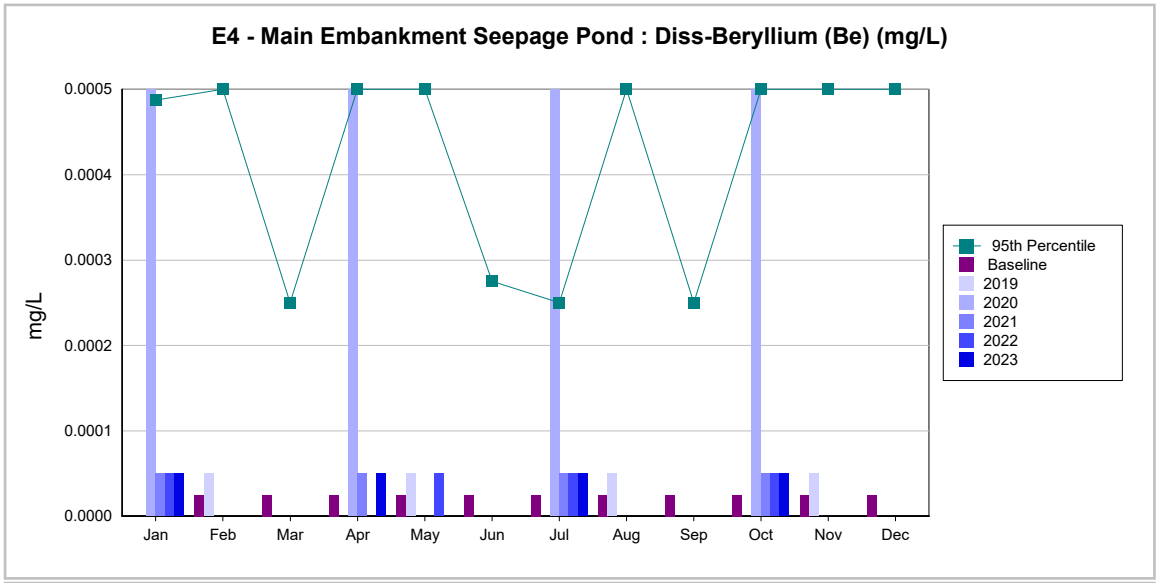
Water Quality Report

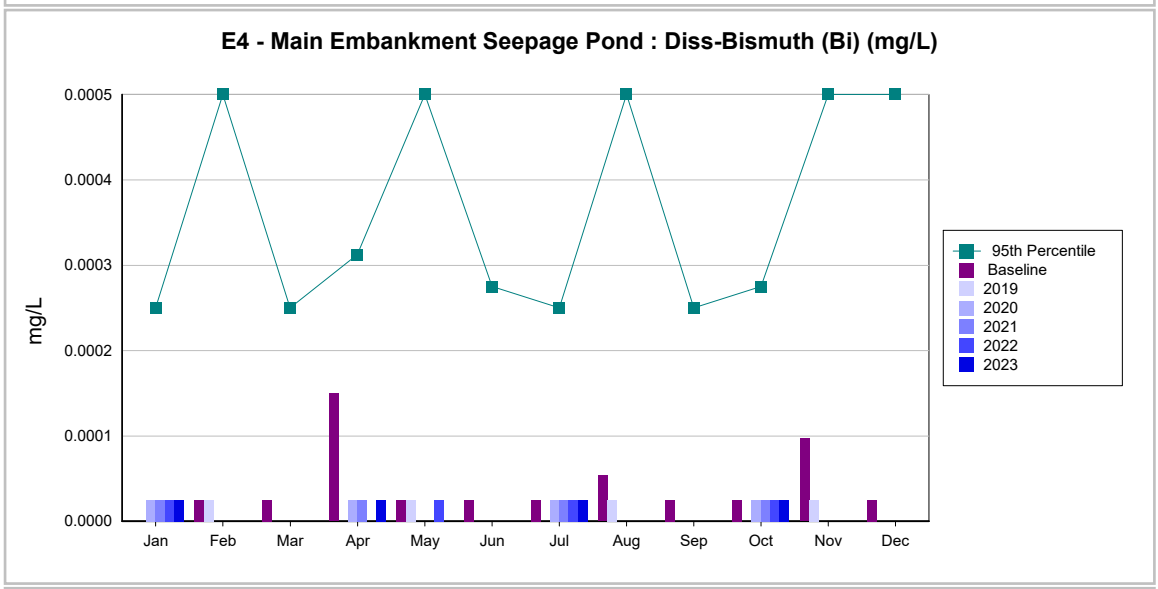
Annual Report Drainage Water

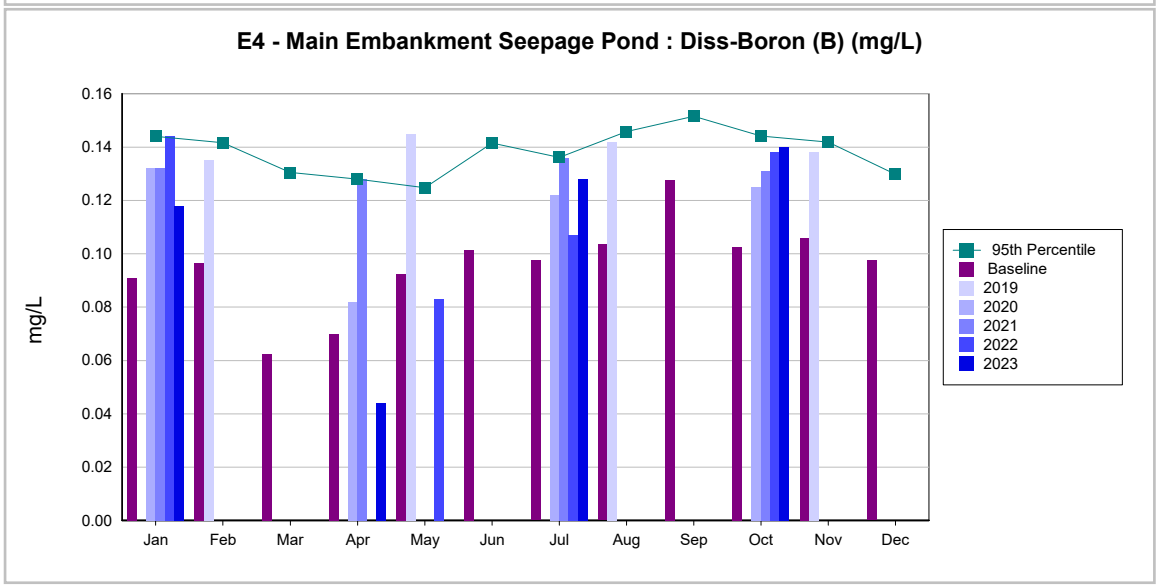
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

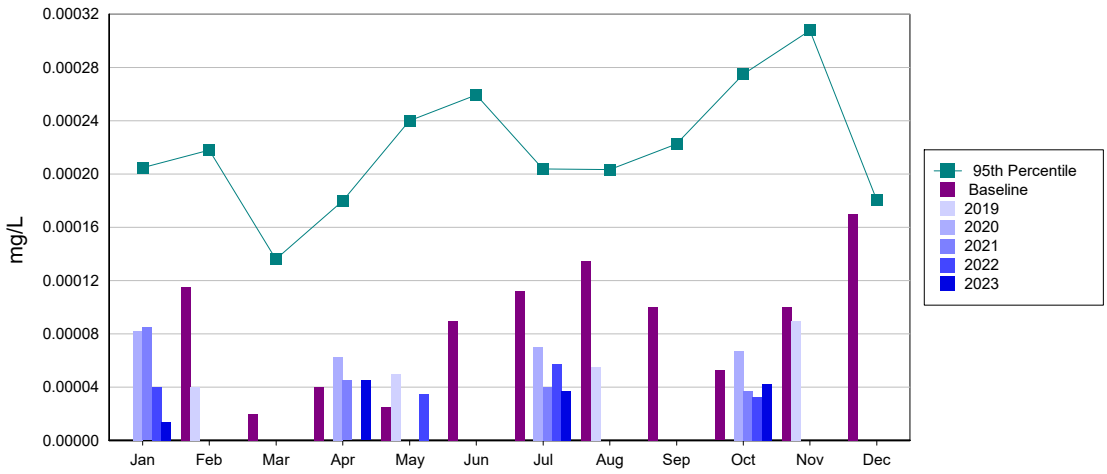
Annual Report Drainage Water

Mount Polley

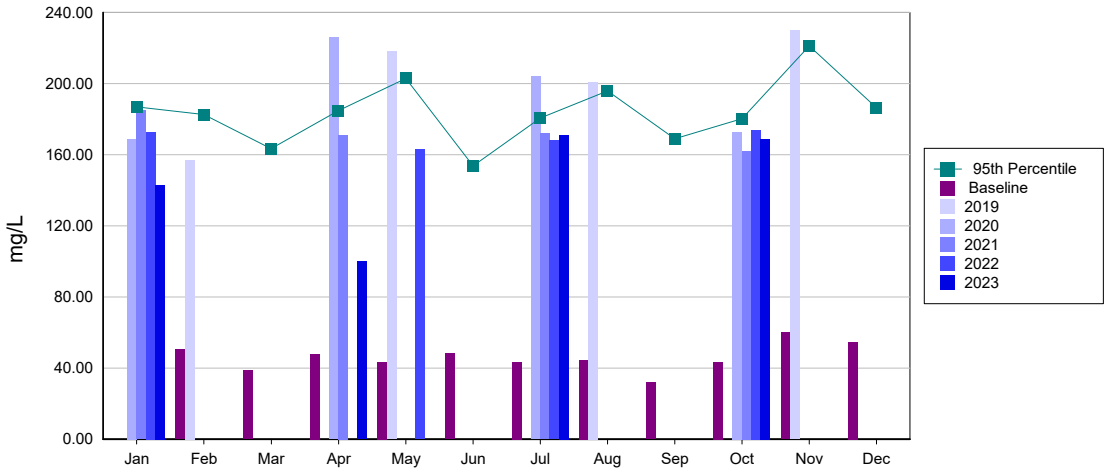
Mining Corporation

IMPERIAL METALS CORPORATION

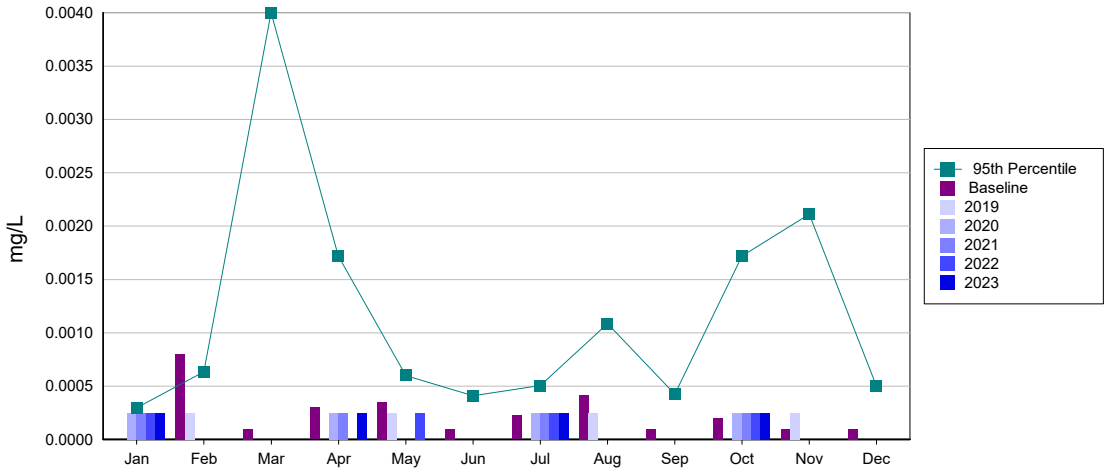
E4 - Main Embankment Seepage Pond : Diss-Cadmium (Cd) (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Calcium (Ca) (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Chromium (Cr) (mg/L)



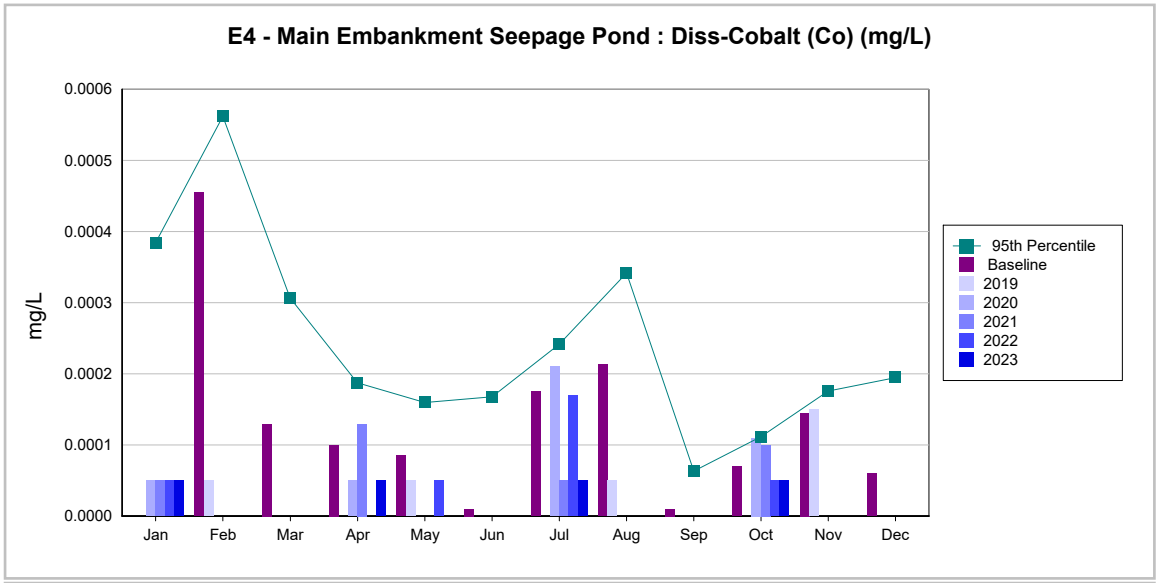
Water Quality Report

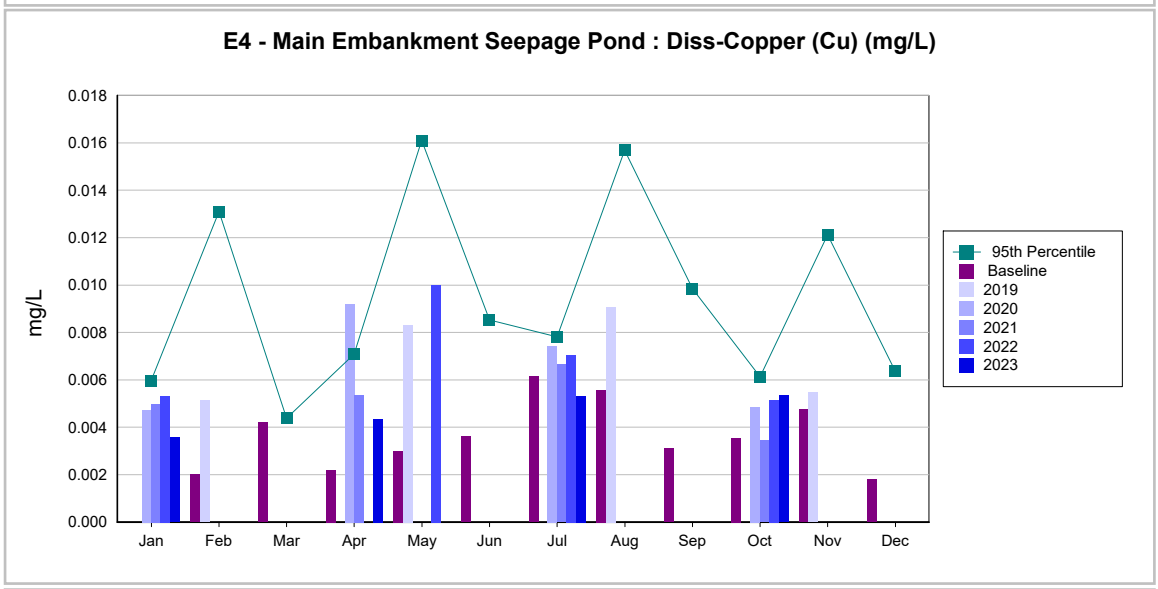
Annual Report Drainage Water

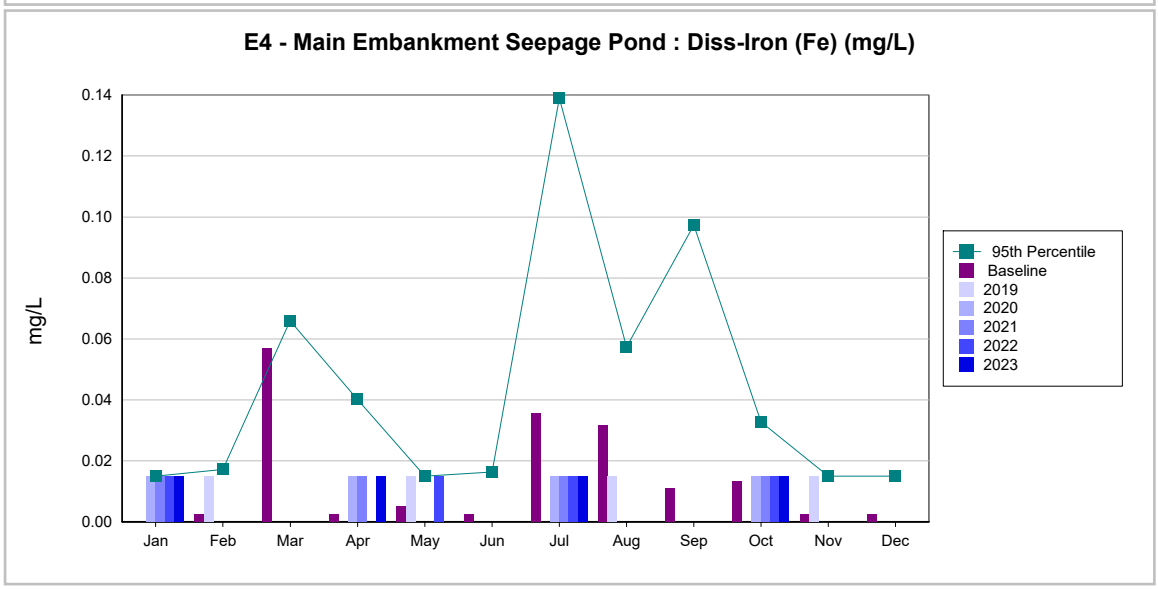
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







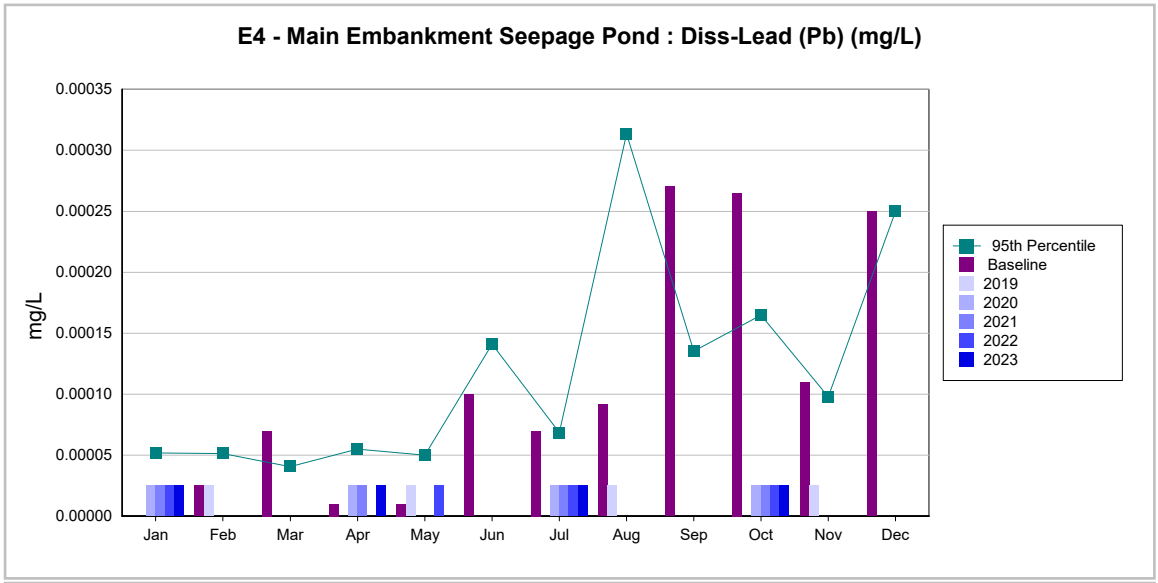
Water Quality Report

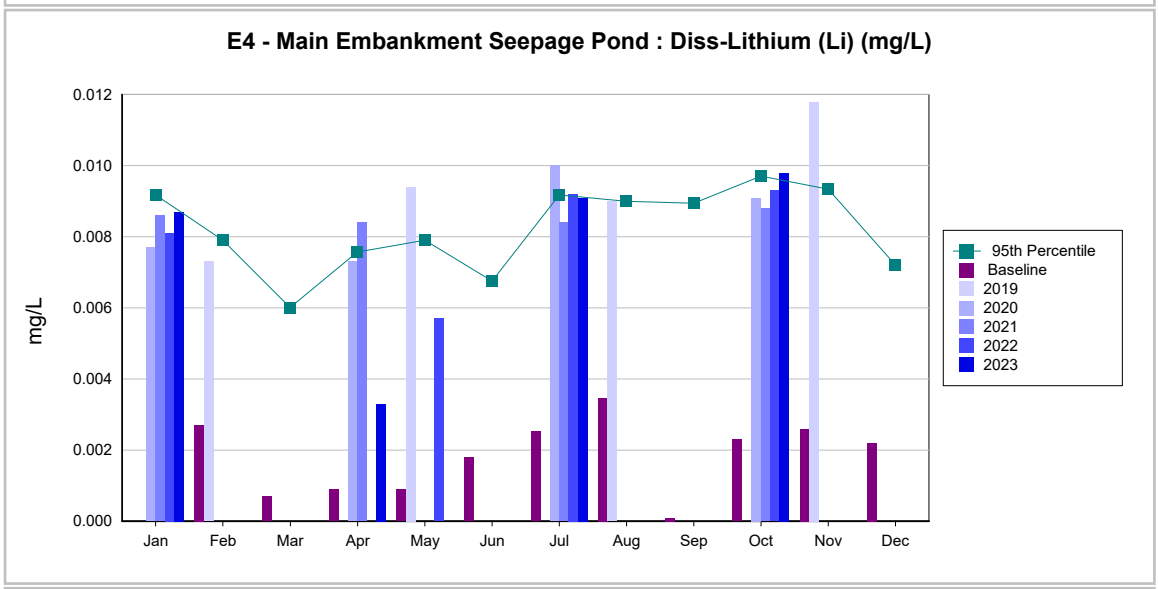
Annual Report Drainage Water

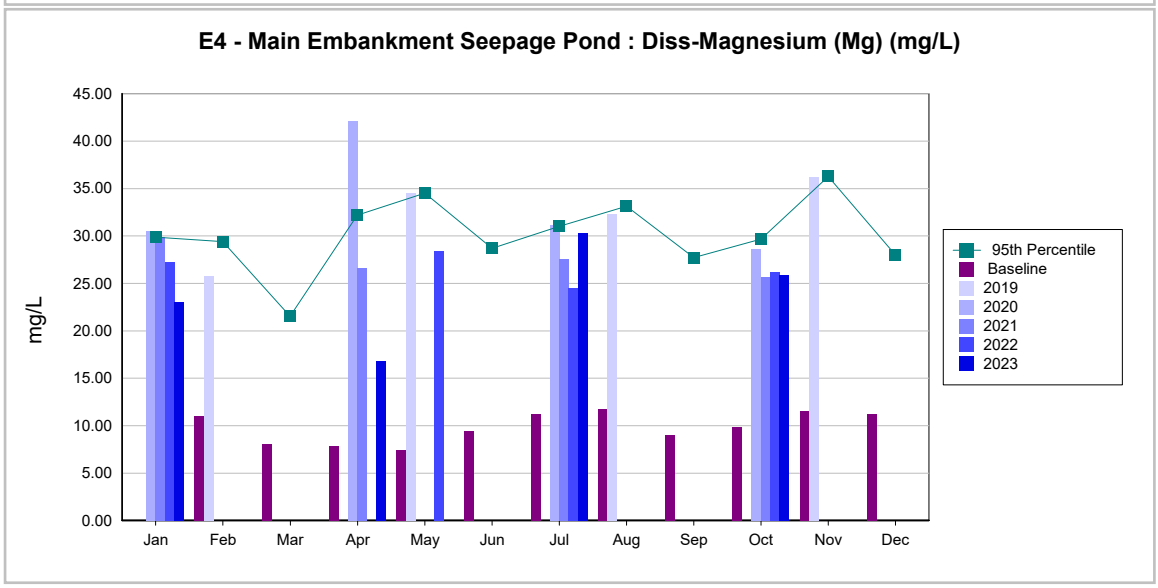
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







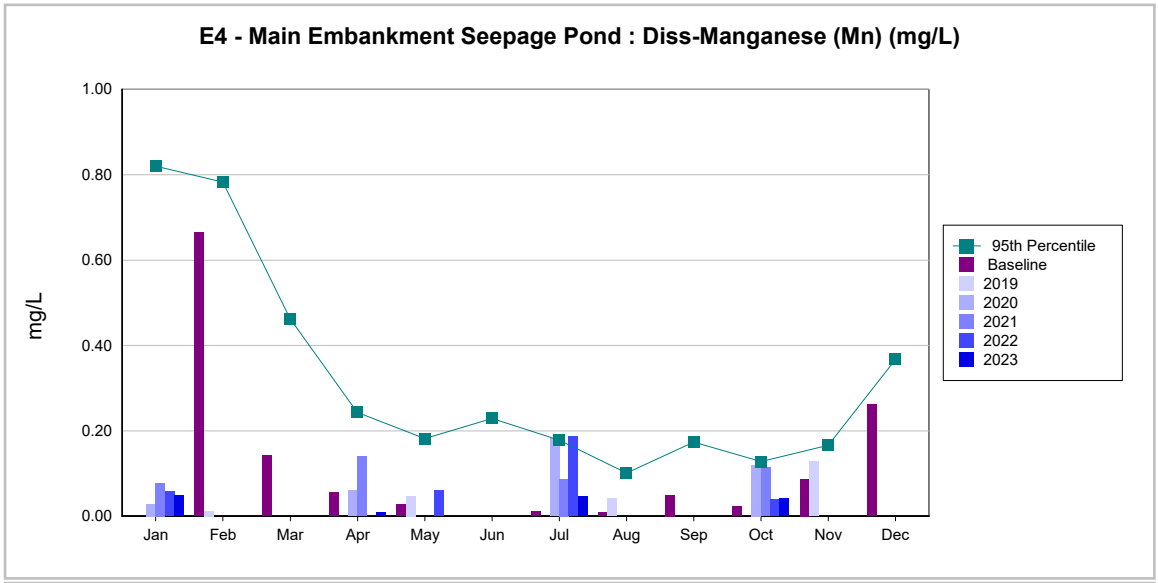
Water Quality Report

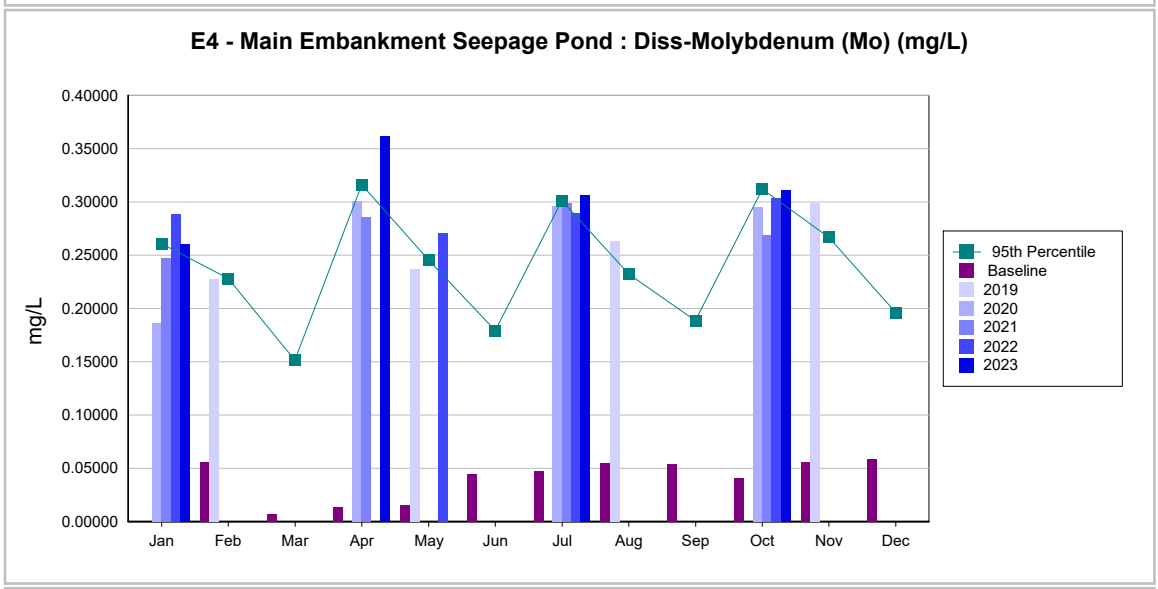
Annual Report Drainage Water

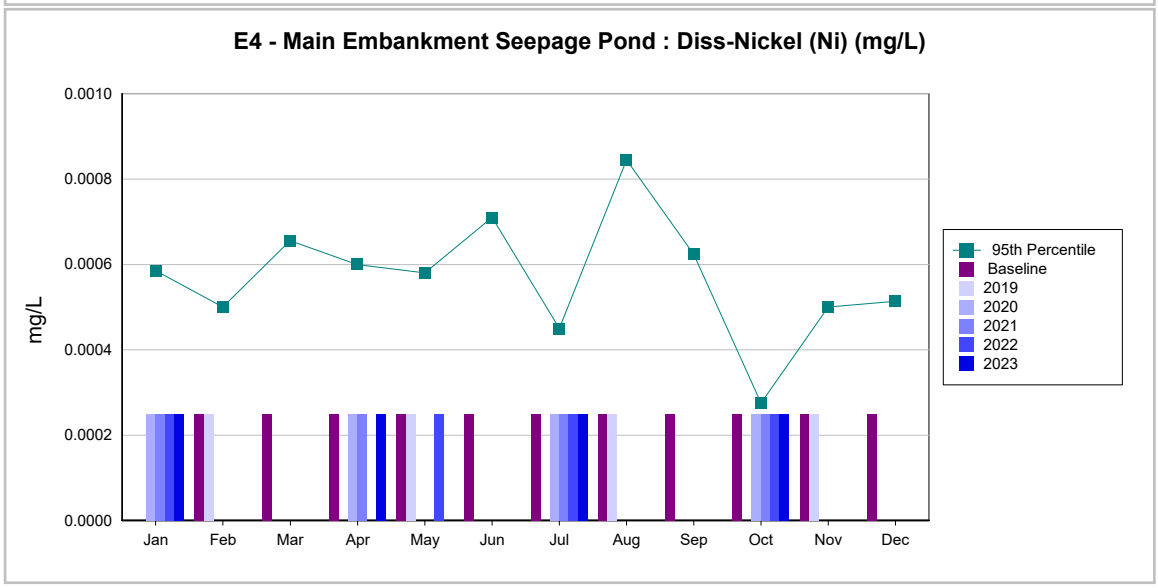
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

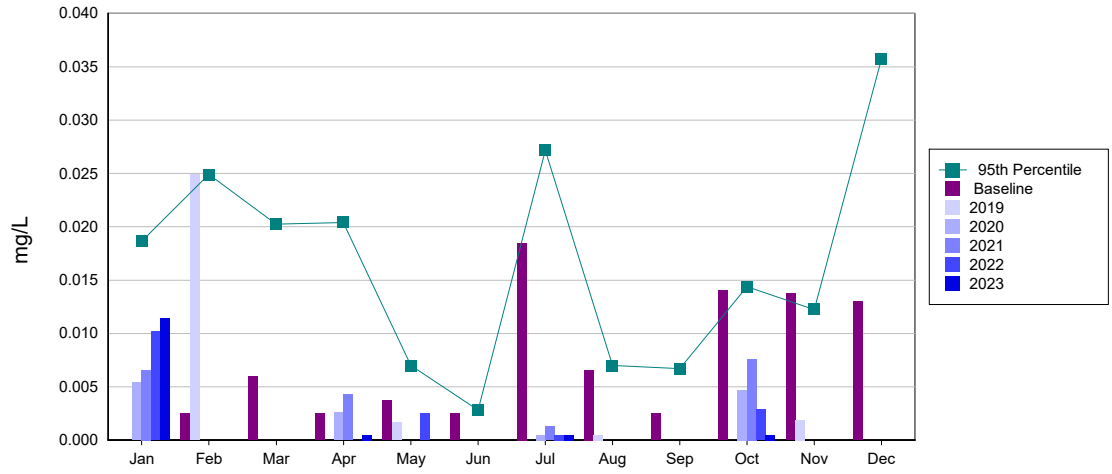
Annual Report Drainage Water

Mount Polley

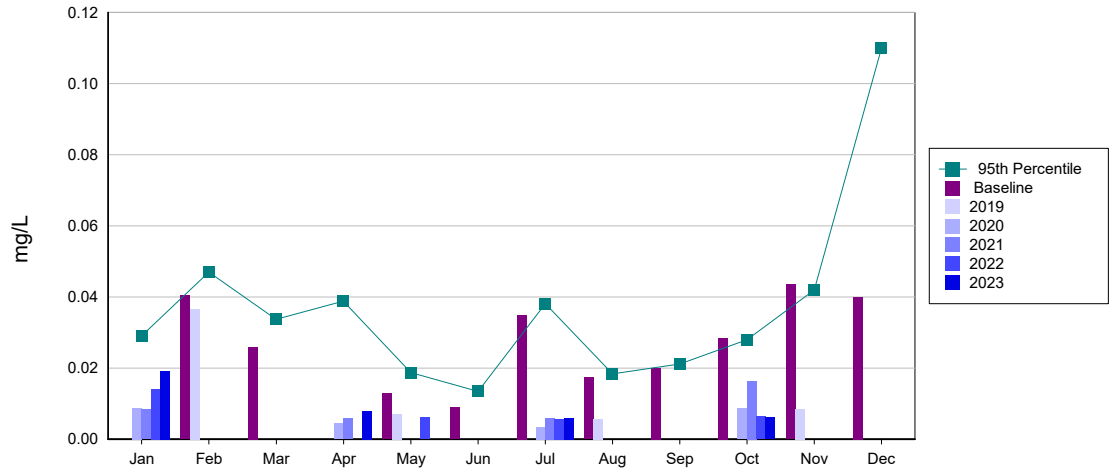
Mining Corporation

IMPERIAL METALS CORPORATION

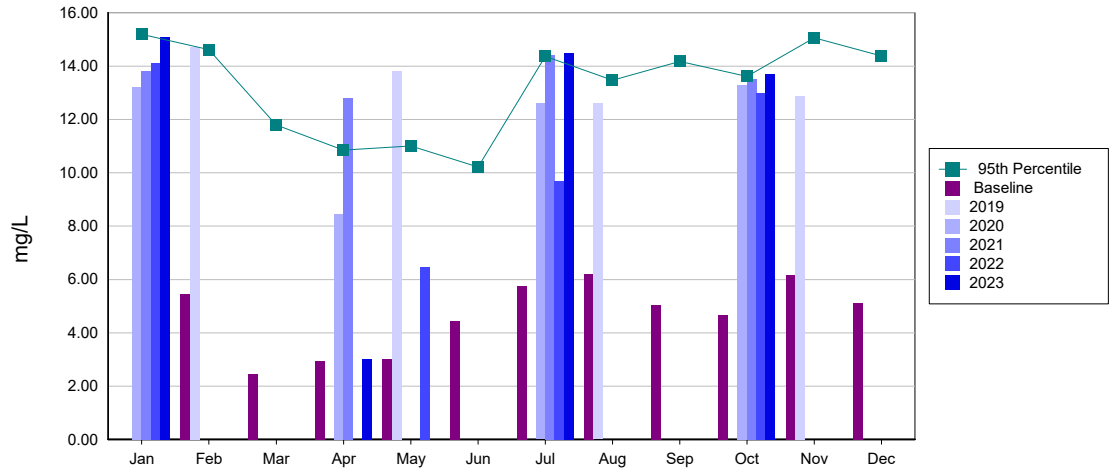
E4 - Main Embankment Seepage Pond : Diss-Orthophosphate (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Phosphorus (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Potassium (K) (mg/L)



Water Quality Report

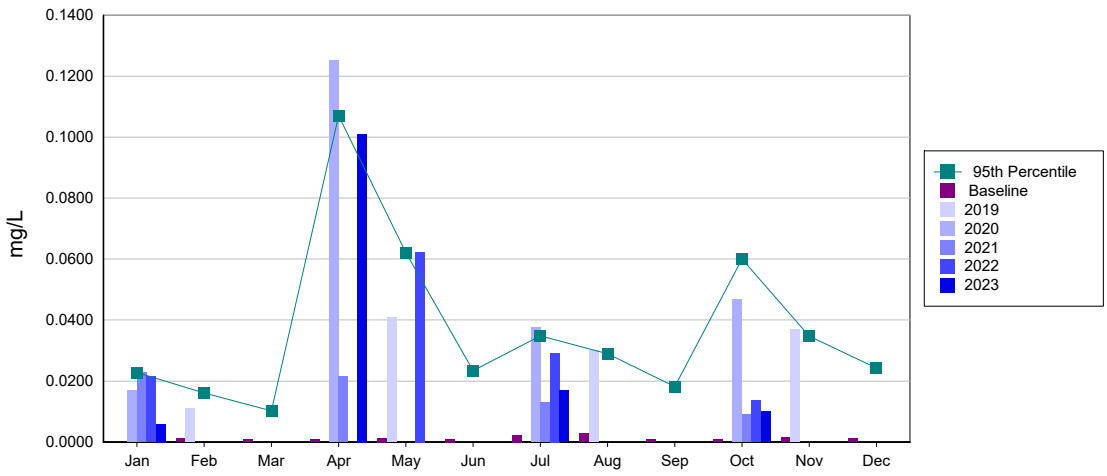
Annual Report Drainage Water

Mount Polley

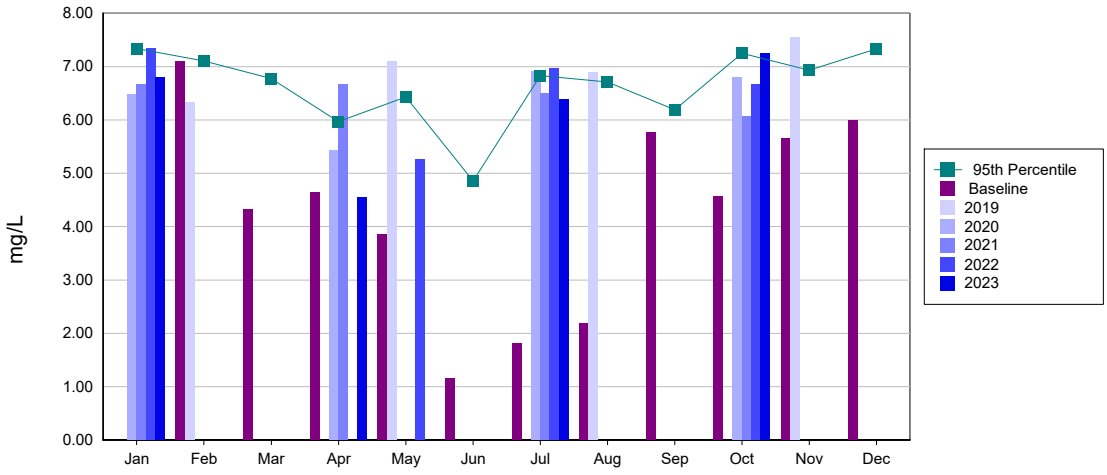
Mining Corporation

IMPERIAL METALS CORPORATION

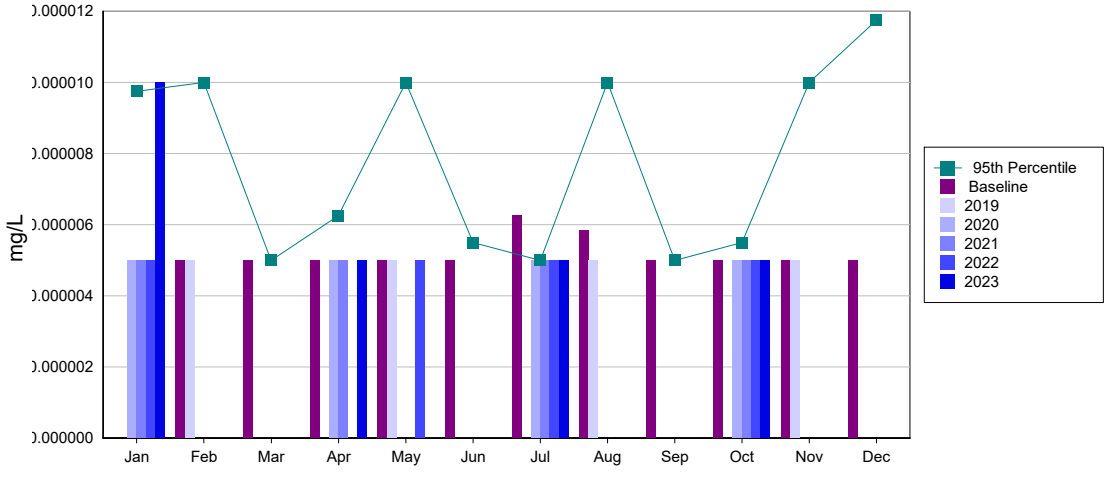
E4 - Main Embankment Seepage Pond : Diss-Selenium (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Silicon (Si) (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Silver (Ag) (mg/L)



Water Quality Report

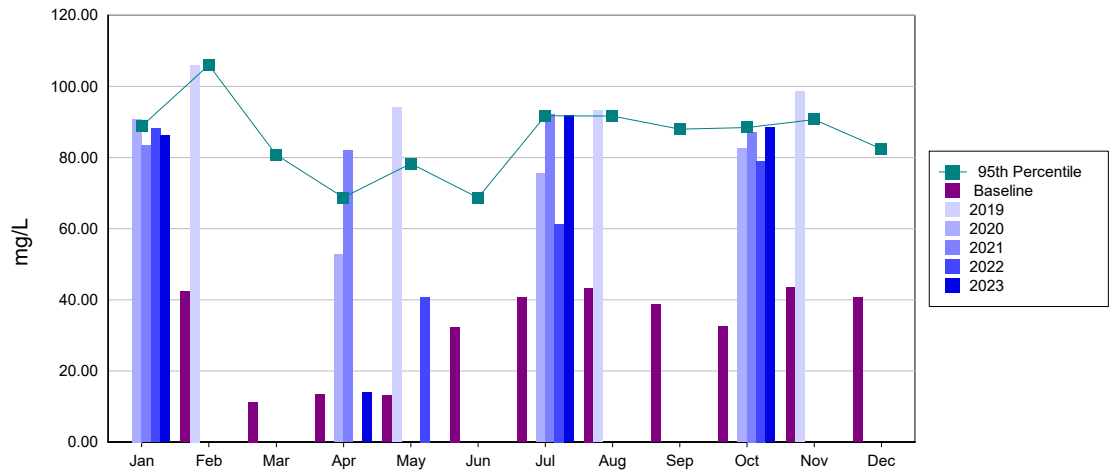
Annual Report Drainage Water

Mount Polley

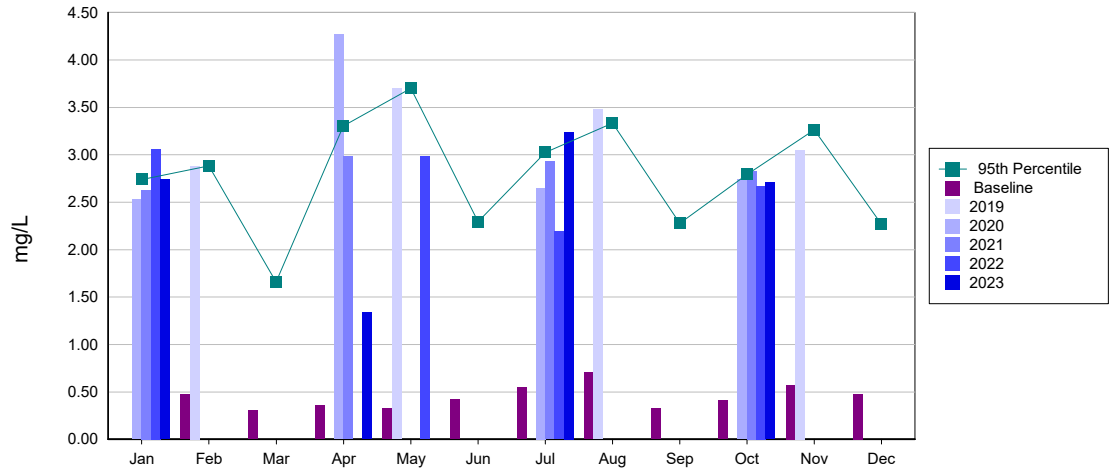
Mining Corporation

IMPERIAL METALS CORPORATION

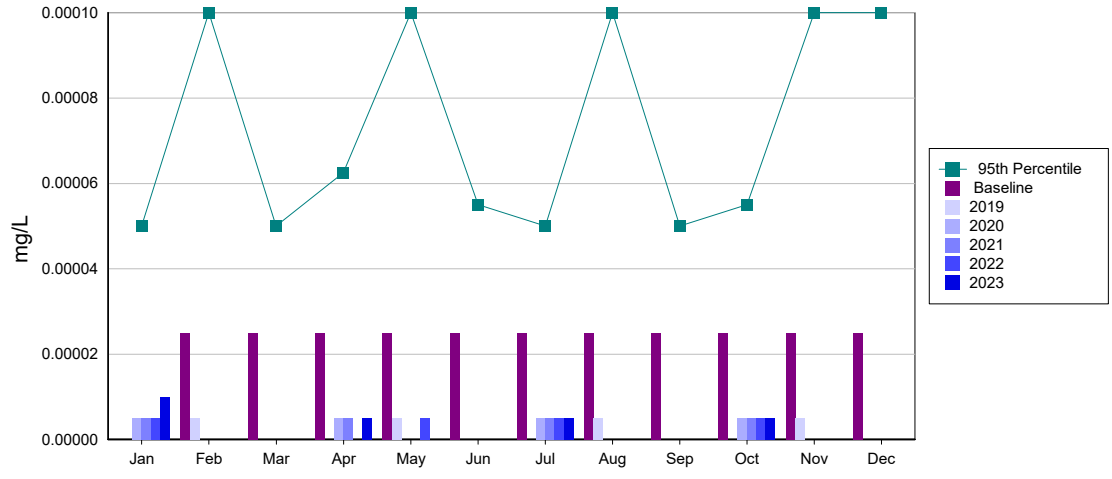
E4 - Main Embankment Seepage Pond : Diss-Sodium (Na) (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Strontium (Sr) (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Thallium (Tl) (mg/L)



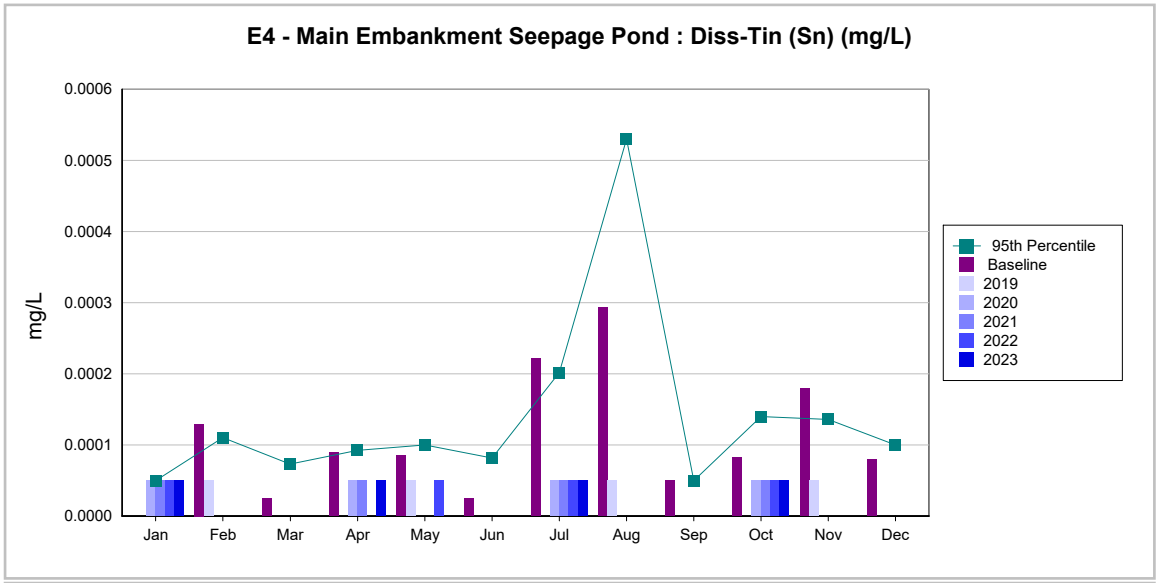
Water Quality Report

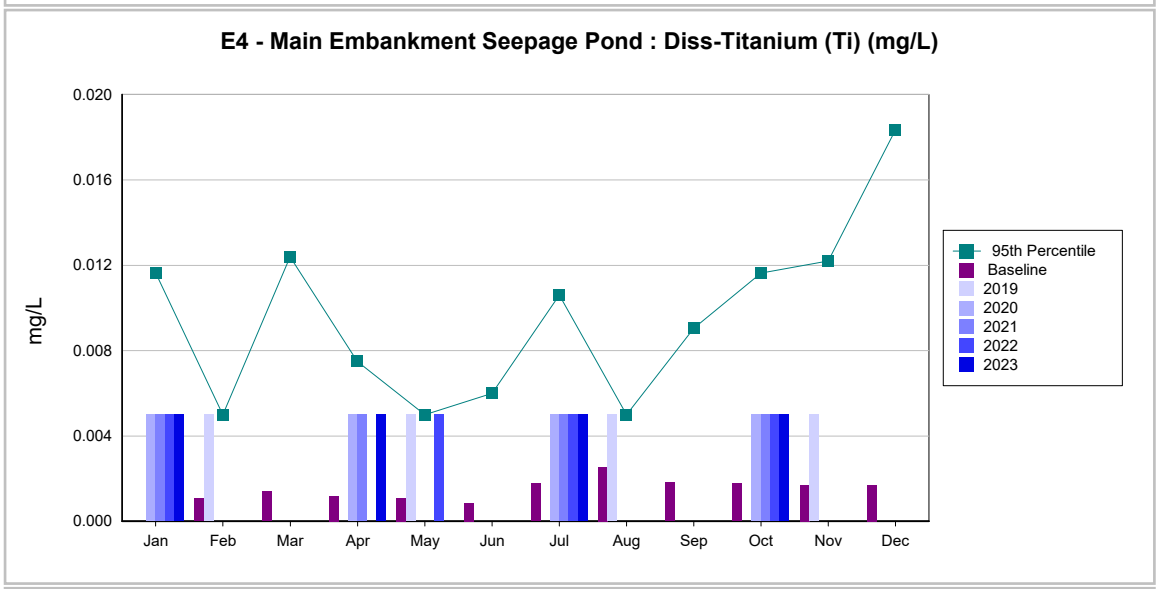
Annual Report Drainage Water

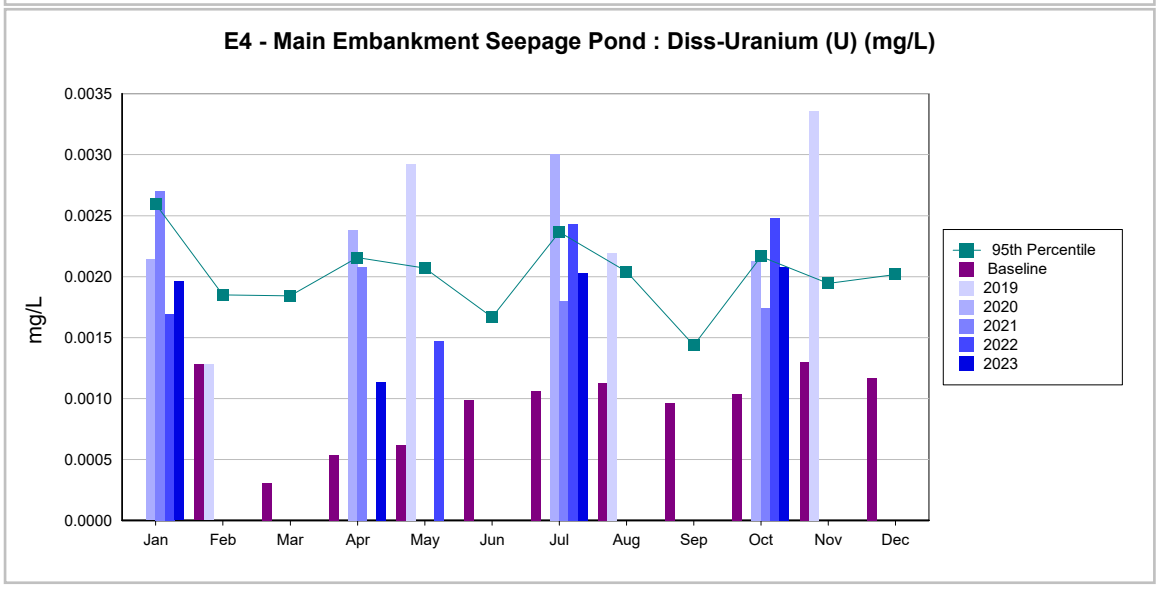
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

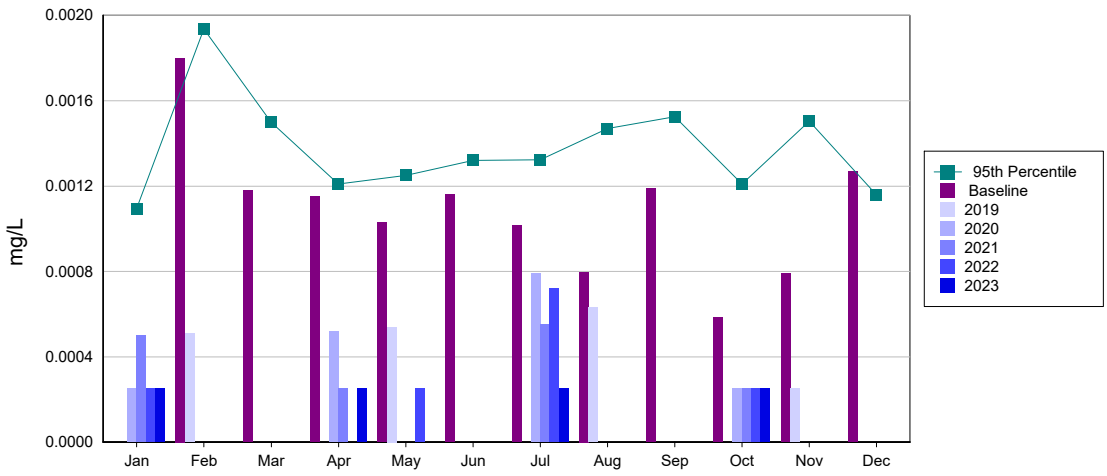
Annual Report Drainage Water

Mount Polley

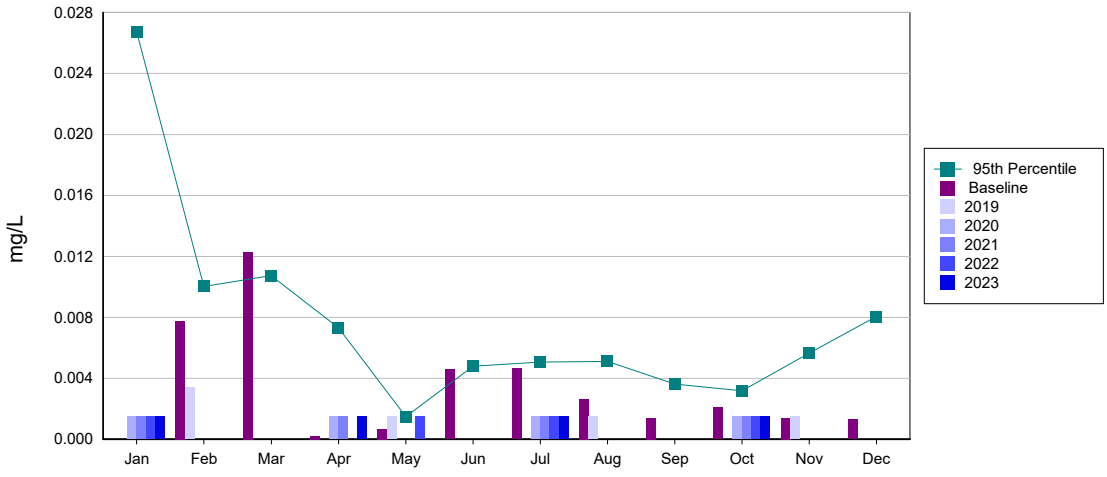
Mining Corporation

IMPERIAL METALS CORPORATION

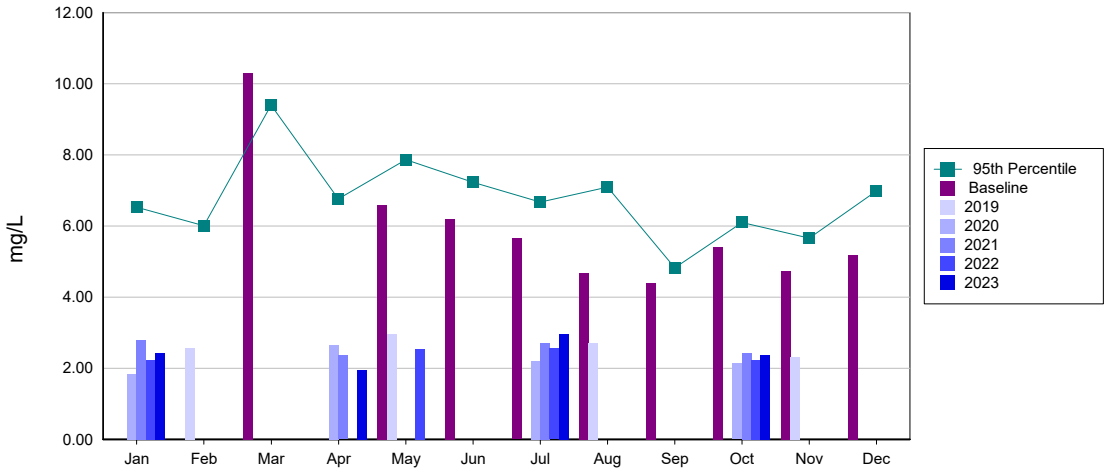
E4 - Main Embankment Seepage Pond : Diss-Vanadium (V) (mg/L)



E4 - Main Embankment Seepage Pond : Diss-Zinc (Zn) (mg/L)



E4 - Main Embankment Seepage Pond : DOC (mg/L)



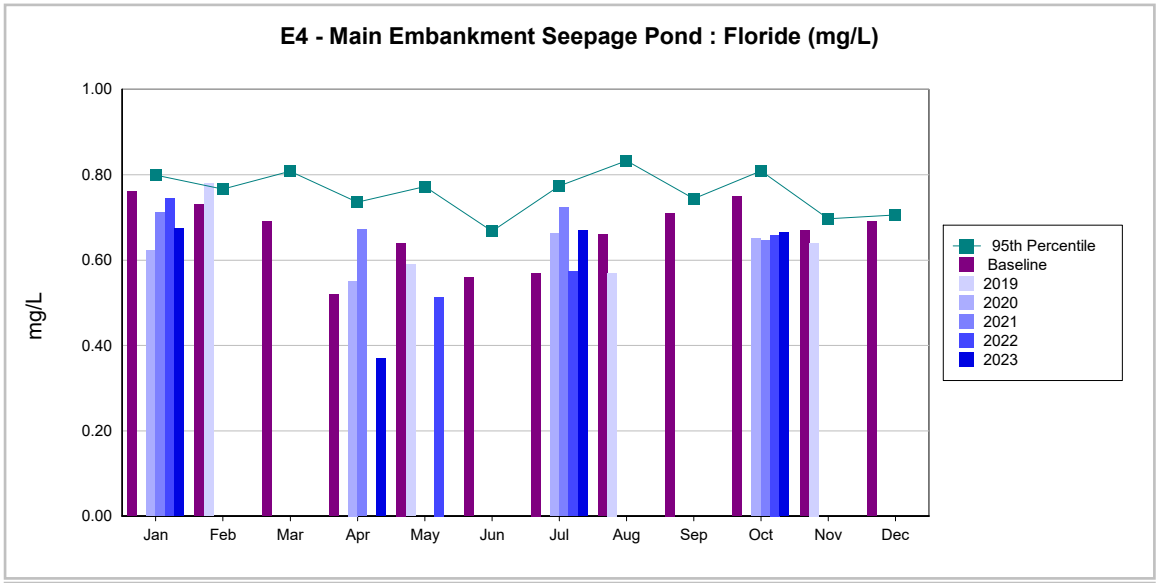
Water Quality Report

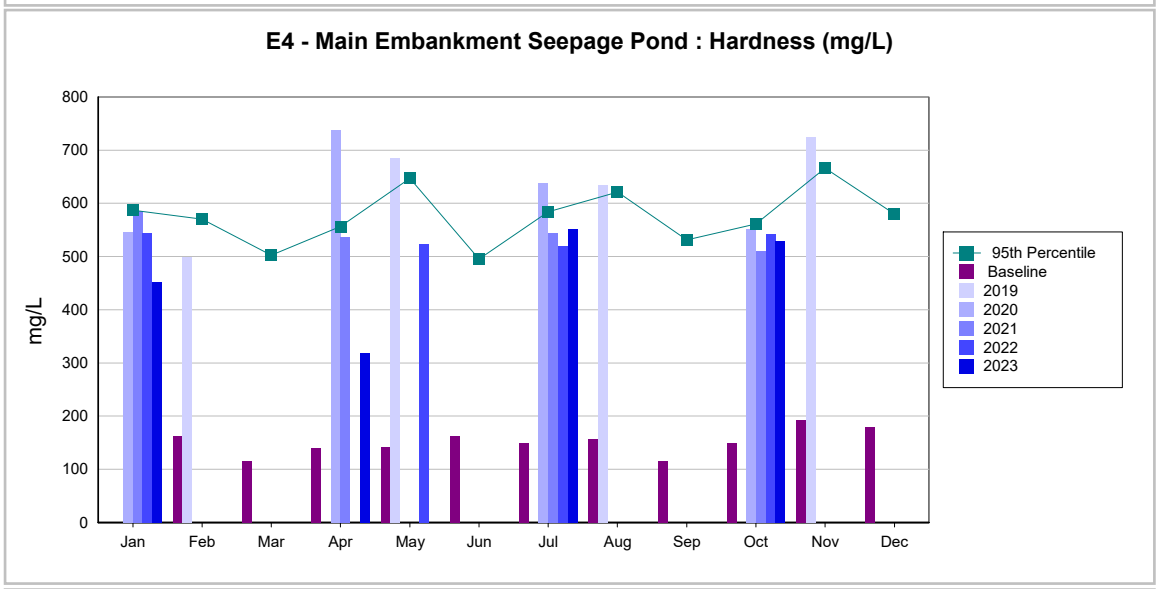
Annual Report Drainage Water

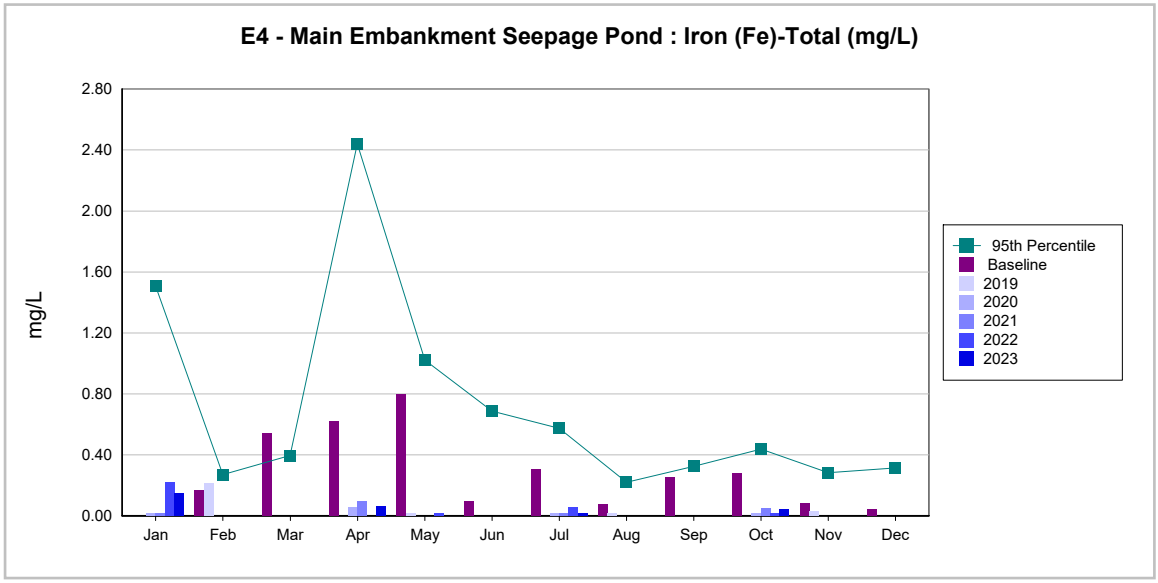
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







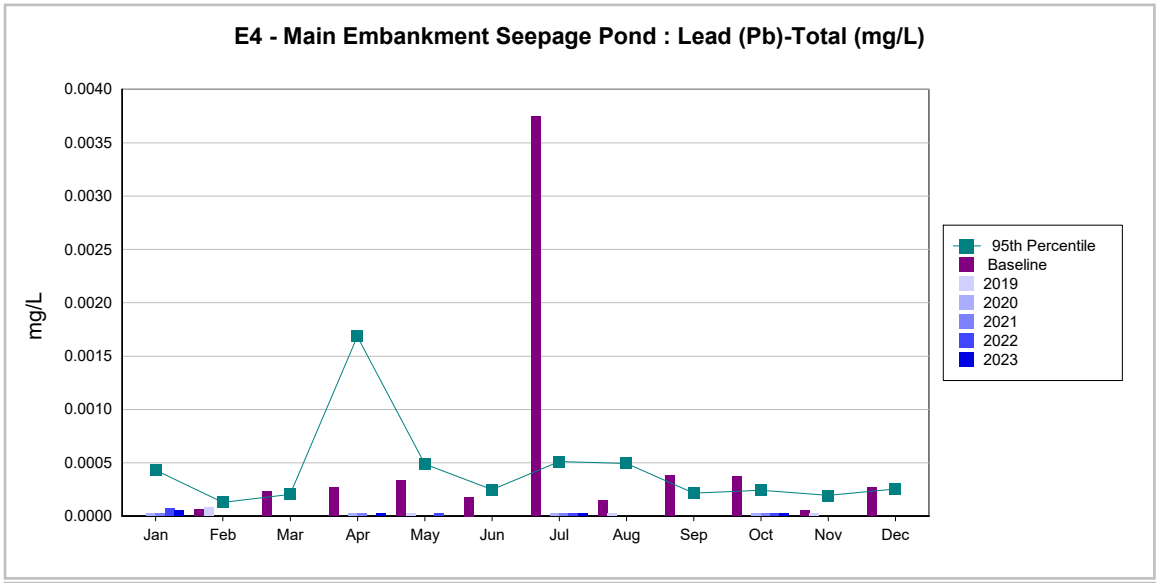
Water Quality Report

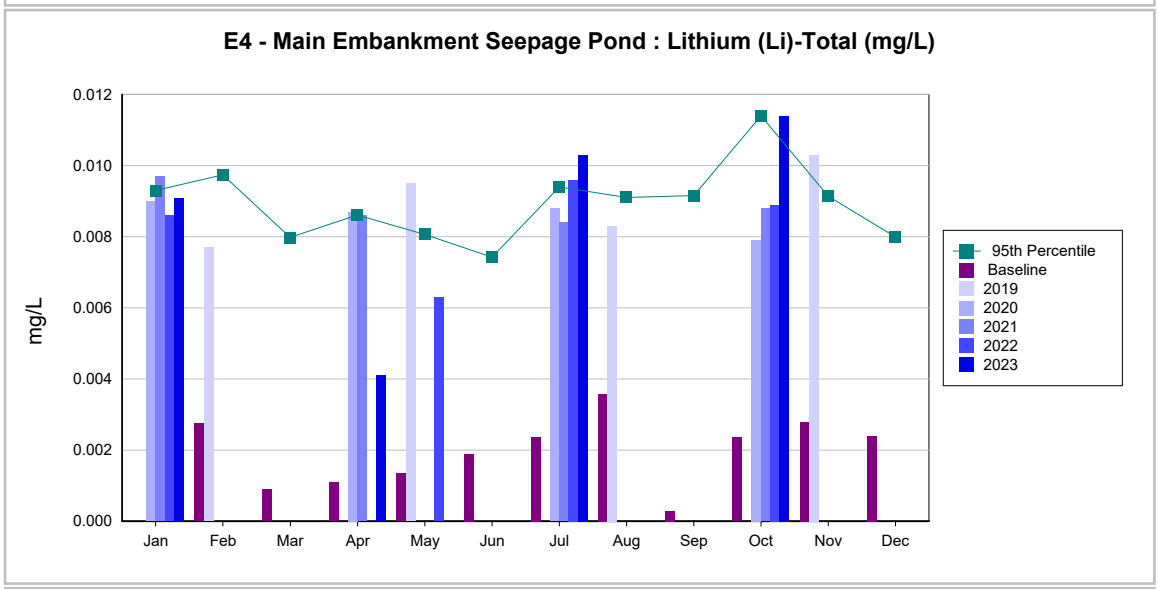
Annual Report Drainage Water

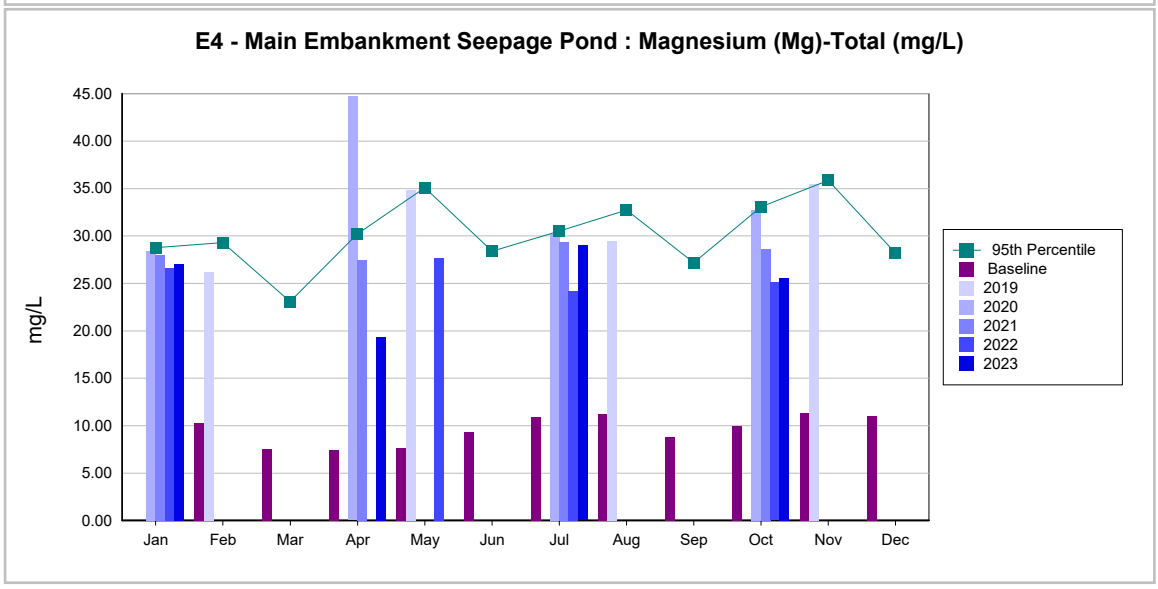
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







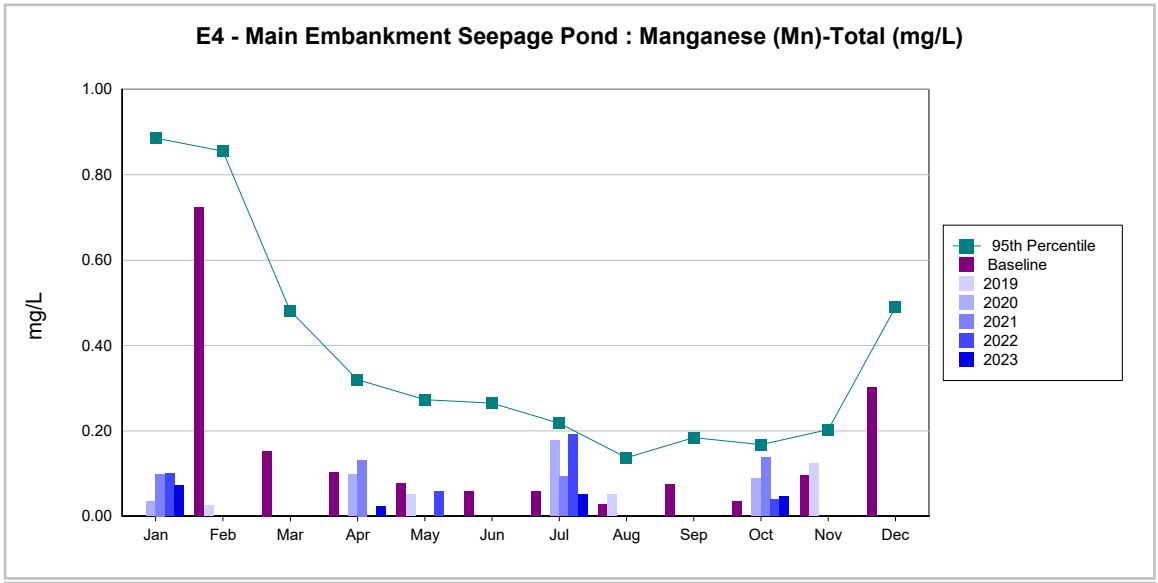
Water Quality Report

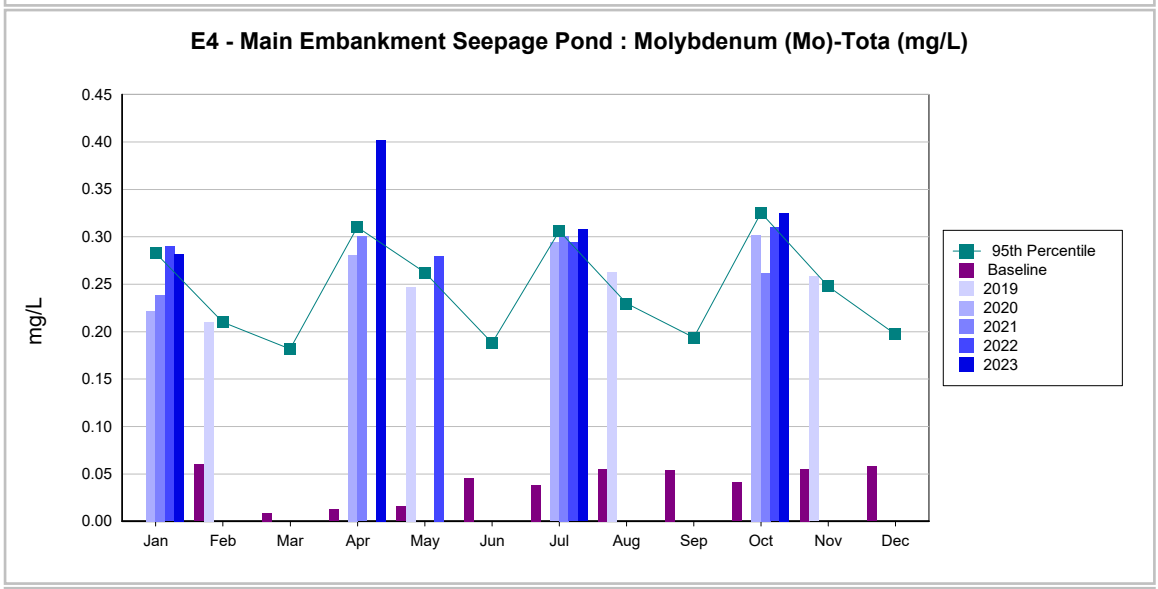
Annual Report Drainage Water

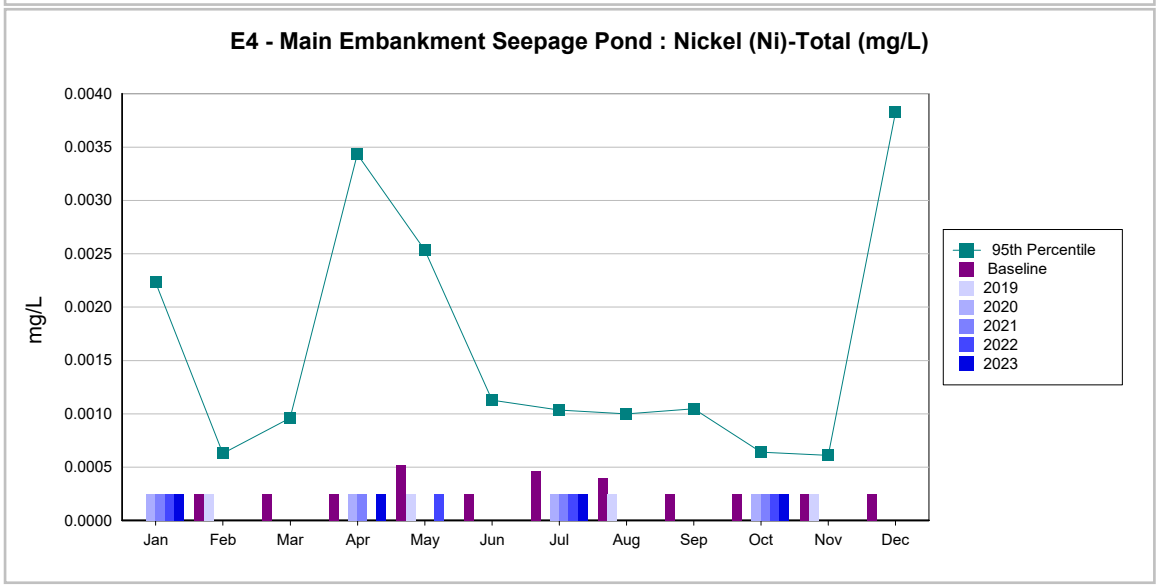
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







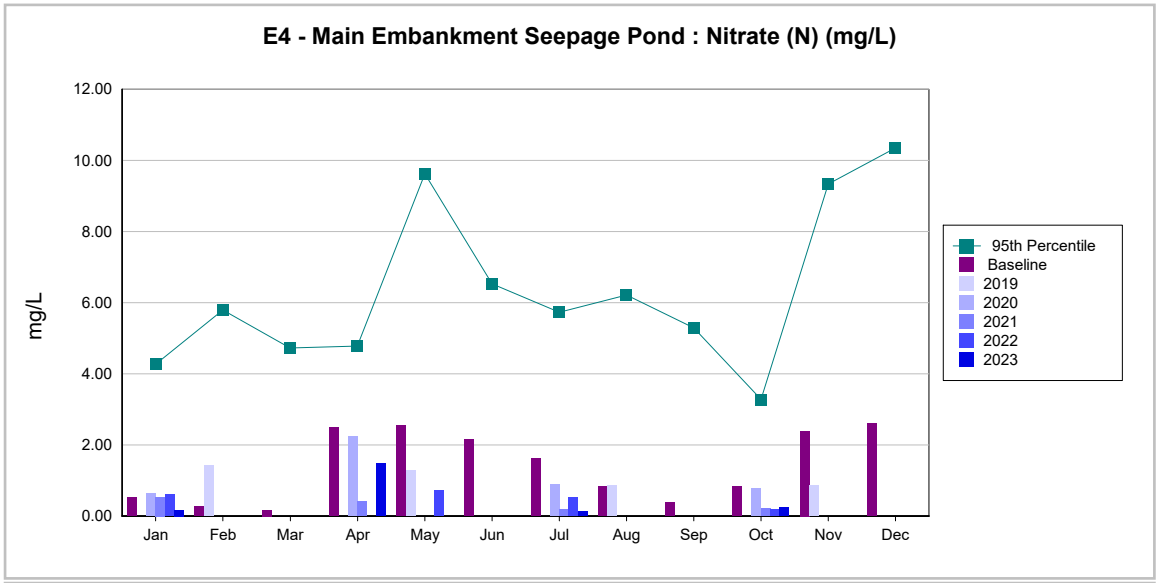
Water Quality Report

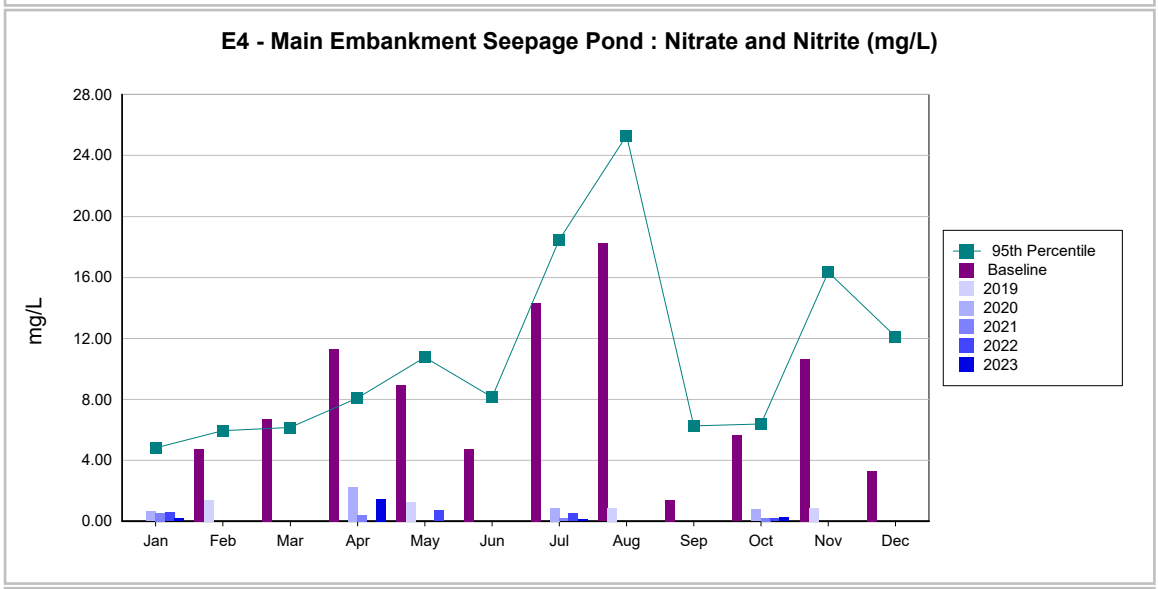
Annual Report Drainage Water

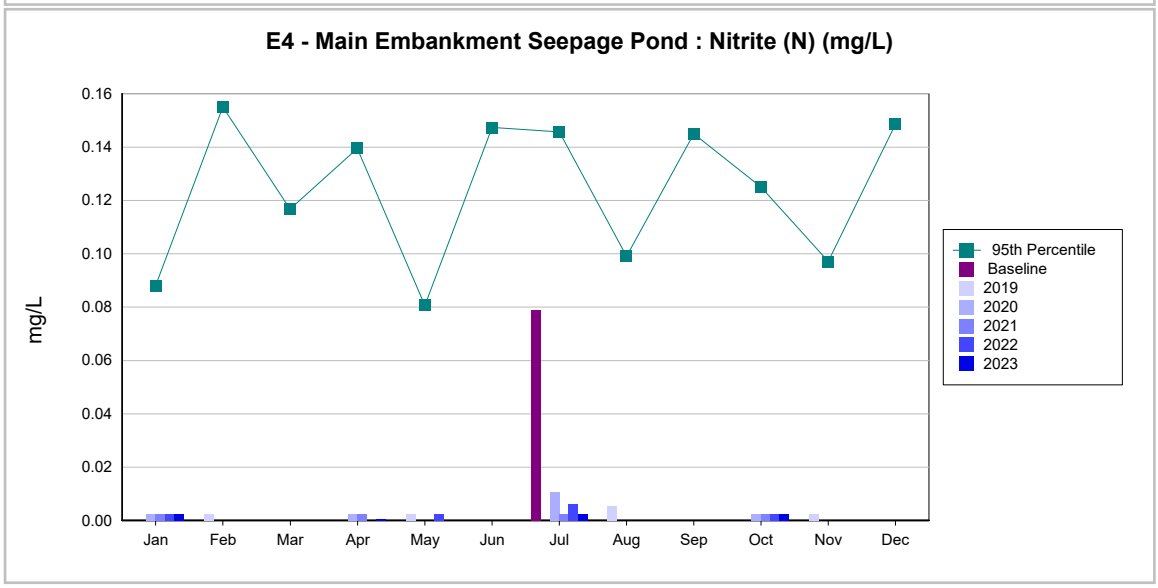
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







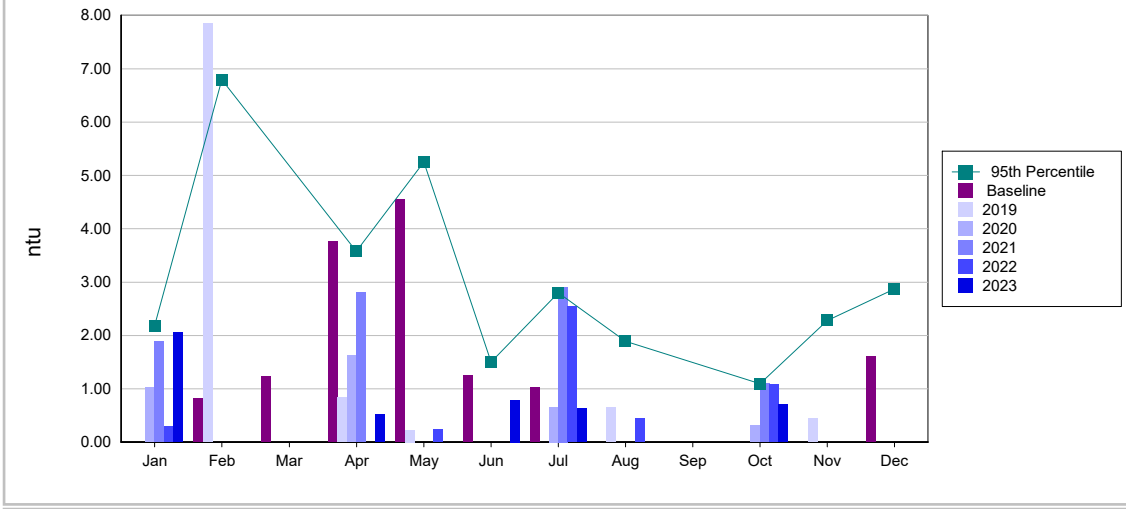
Water Quality Report

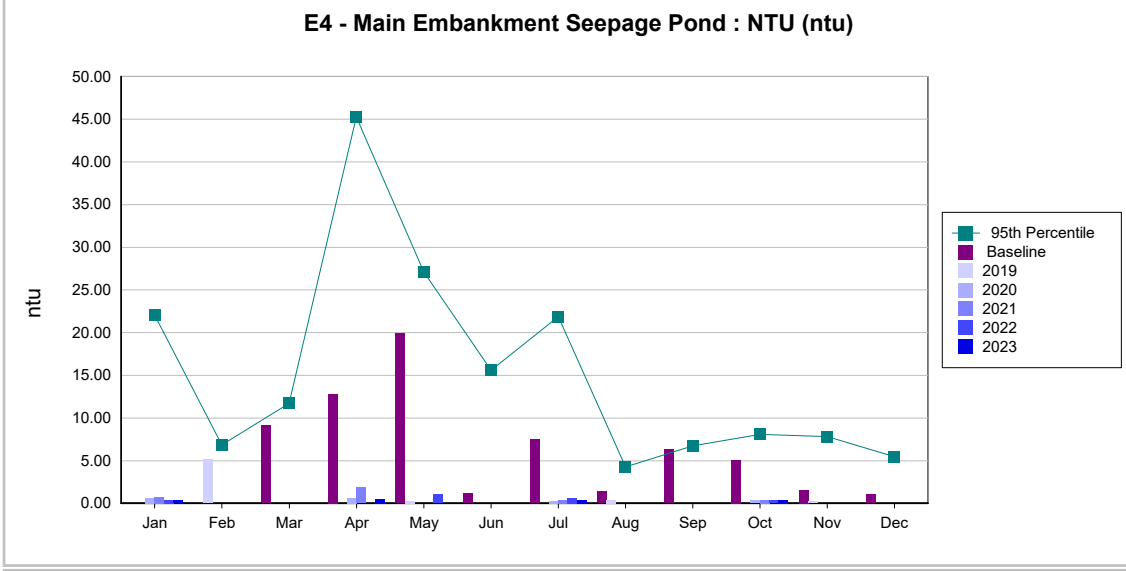
Annual Report Drainage Water

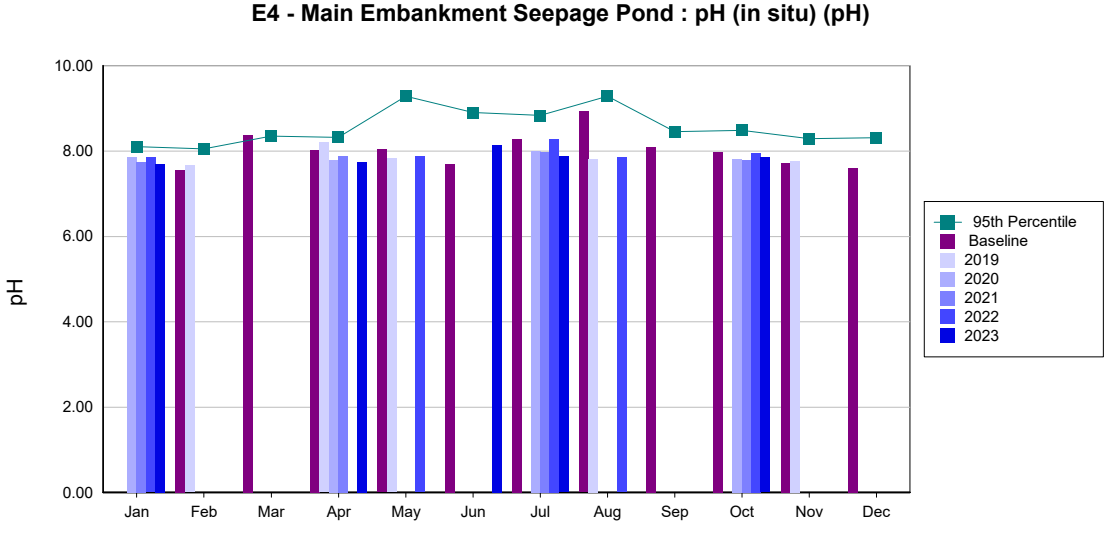
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







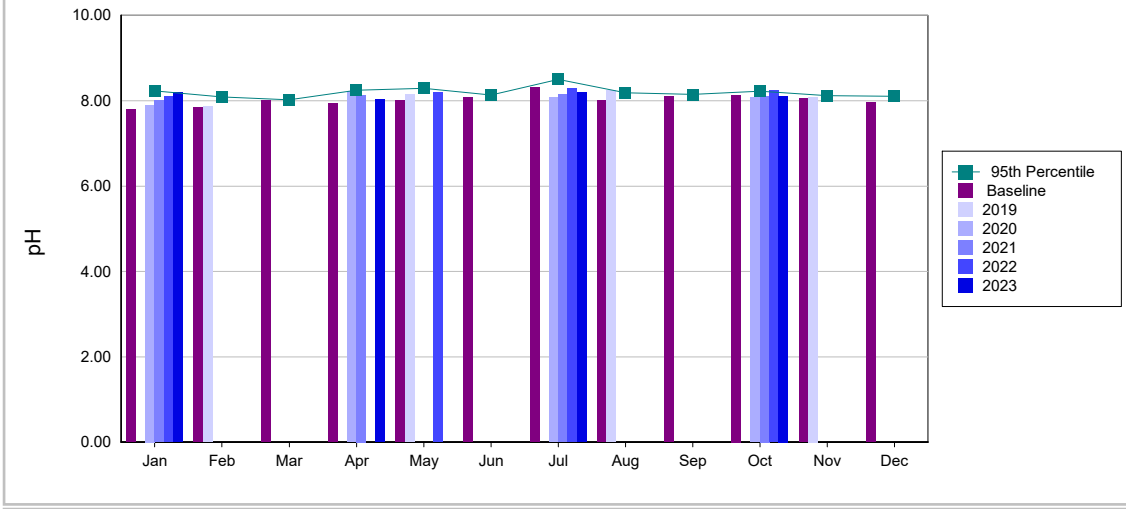
Water Quality Report

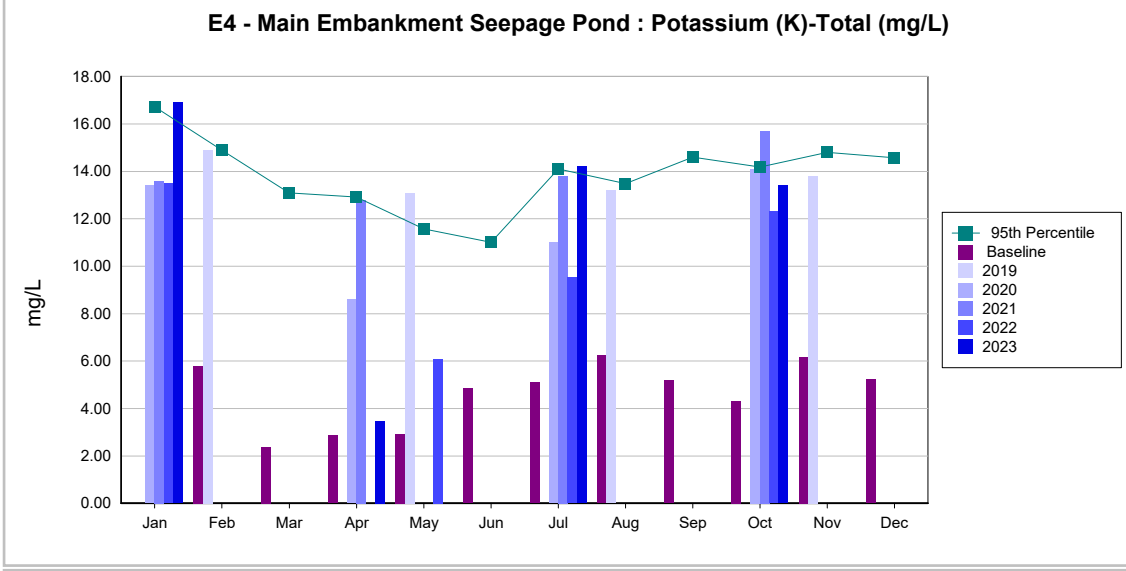
Annual Report Drainage Water

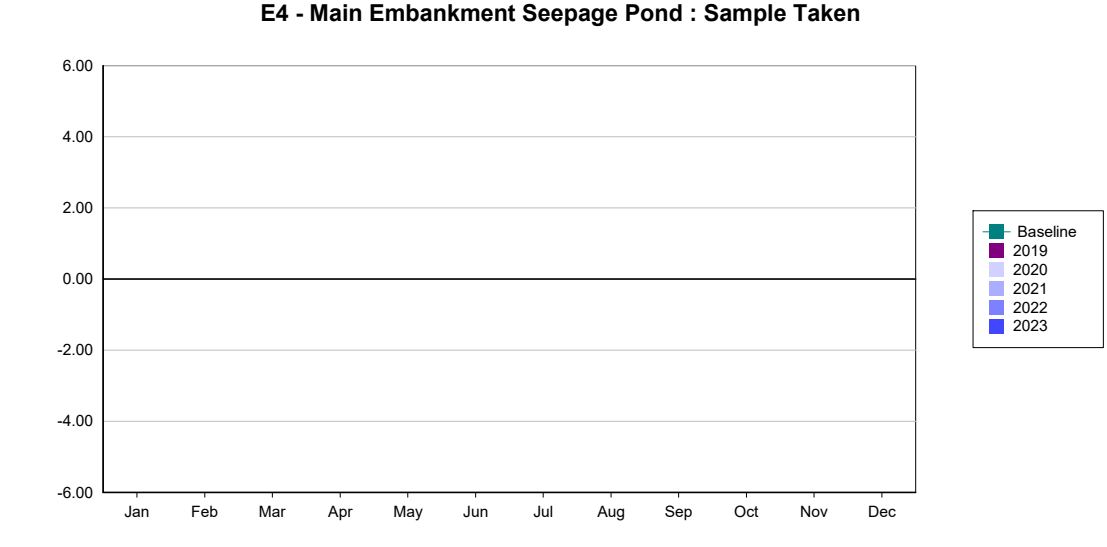
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

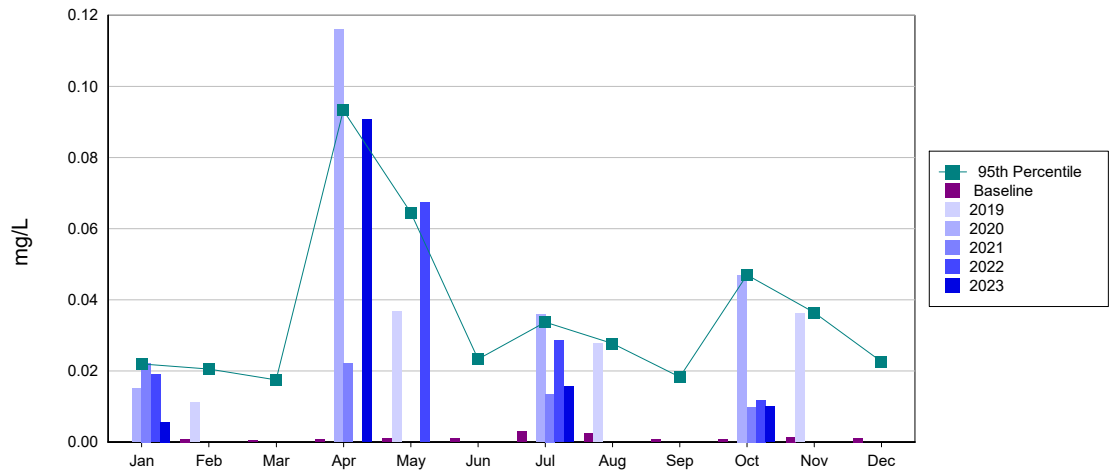
Annual Report Drainage Water

Mount Polley

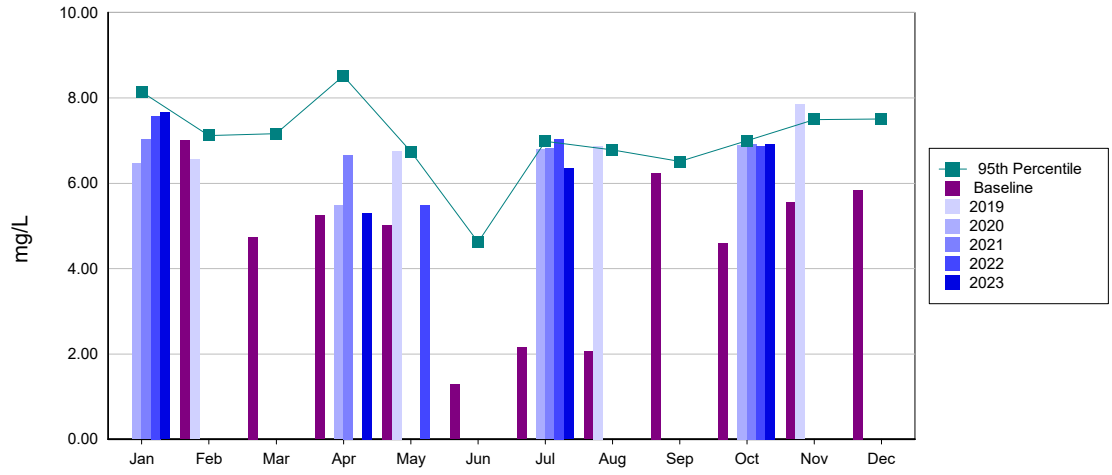
Mining Corporation

IMPERIAL METALS CORPORATION

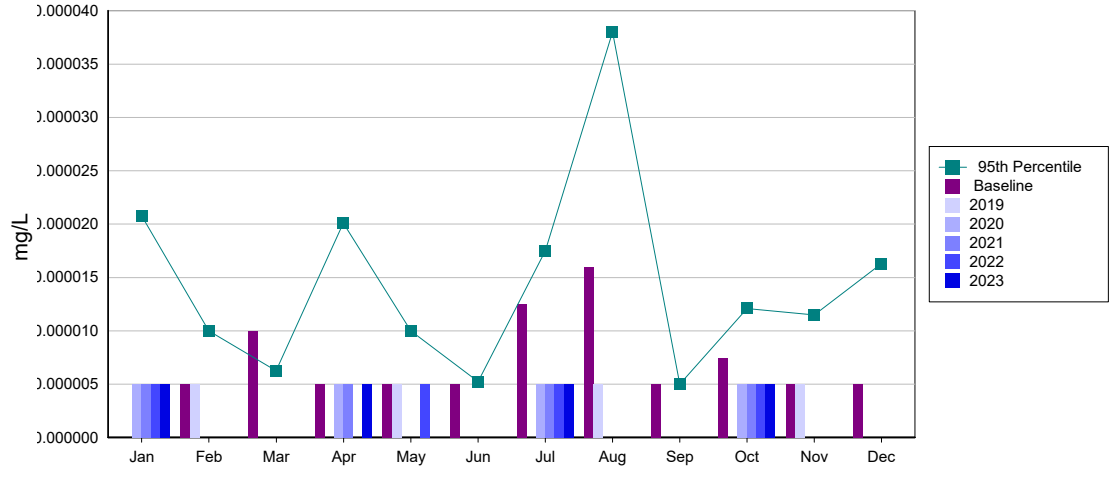
E4 - Main Embankment Seepage Pond : Selenium (Se)-Total (mg/L)



E4 - Main Embankment Seepage Pond : Silicon (Si)-Total (mg/L)



E4 - Main Embankment Seepage Pond : Silver (Ag)-Total (mg/L)



Water Quality Report

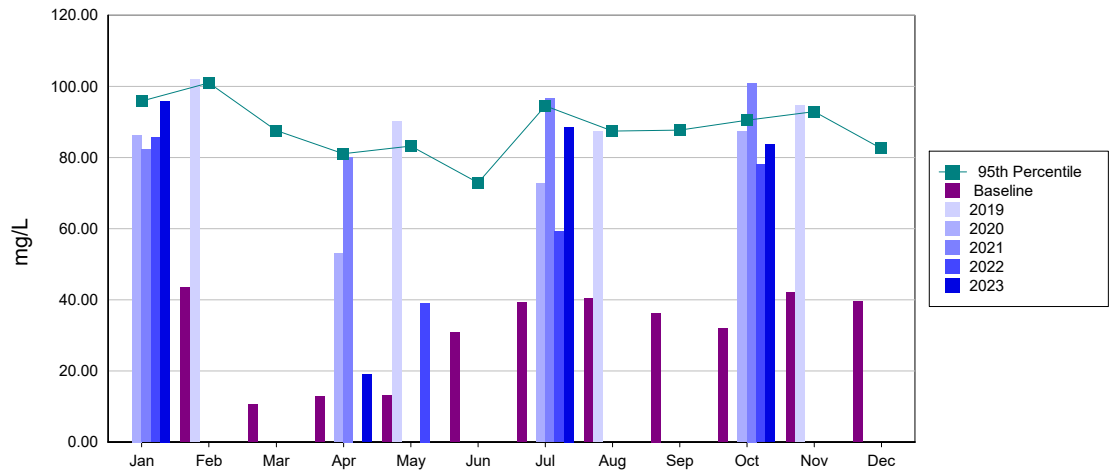
Annual Report Drainage Water

Mount Polley

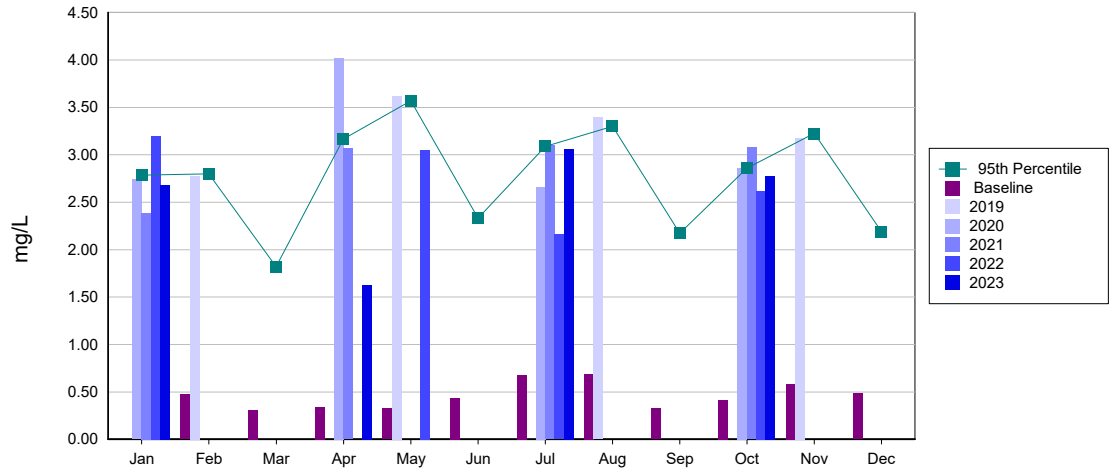
Mining Corporation

IMPERIAL METALS CORPORATION

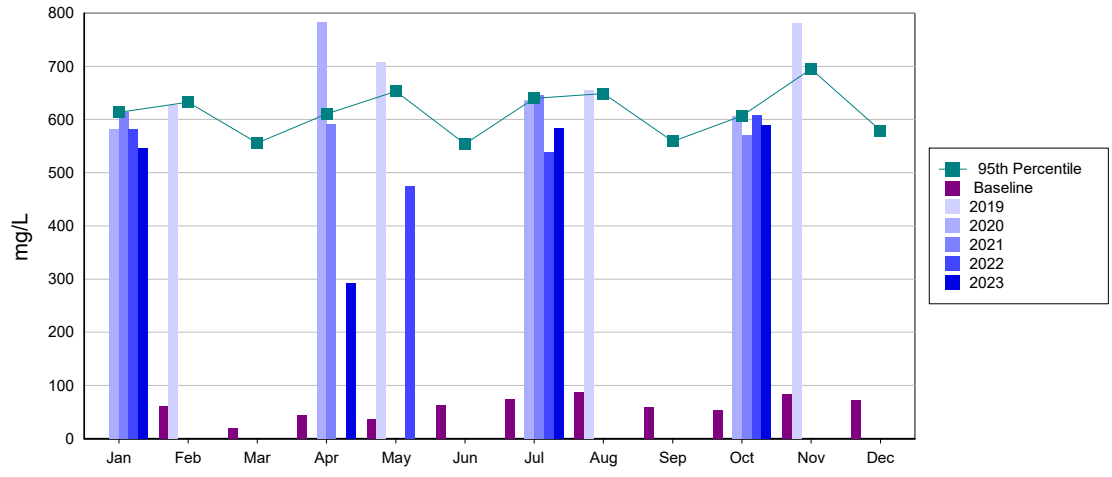
E4 - Main Embankment Seepage Pond : Sodium (Na)-Total (mg/L)



E4 - Main Embankment Seepage Pond : Strontium (Sr)-Total (mg/L)



E4 - Main Embankment Seepage Pond : Sulphate (mg/L)



Water Quality Report

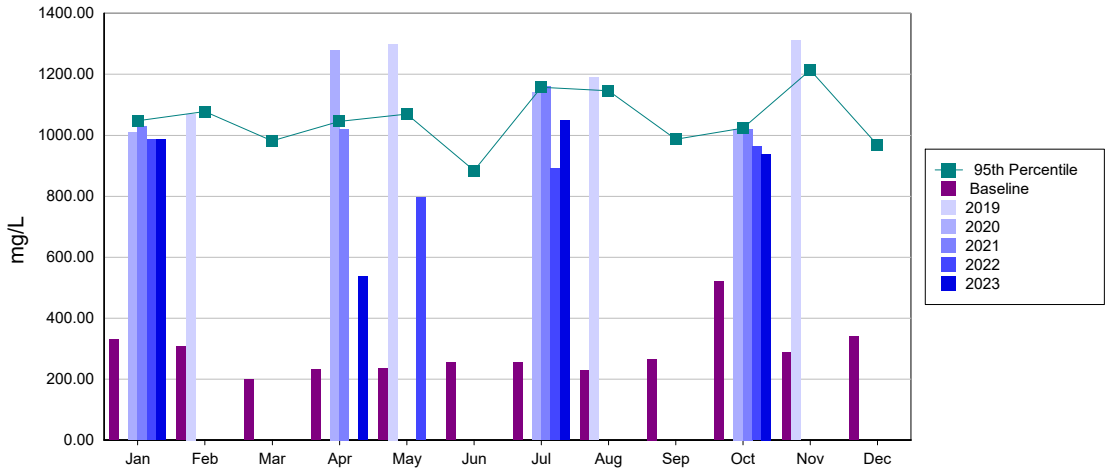
Annual Report Drainage Water

Mount Polley

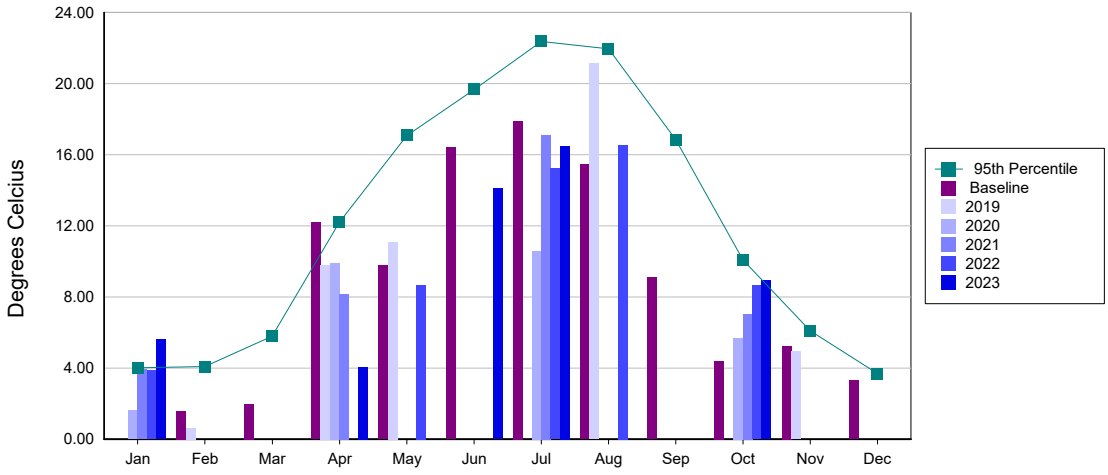
Mining Corporation

IMPERIAL METALS CORPORATION

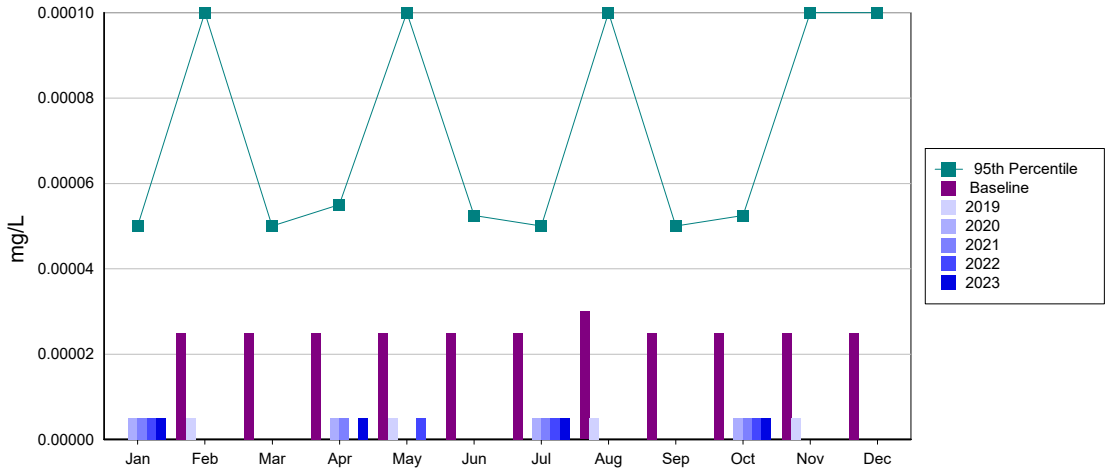
E4 - Main Embankment Seepage Pond : TDS (mg/L)



E4 - Main Embankment Seepage Pond : Temp (in situ) (Degrees Celcius)



E4 - Main Embankment Seepage Pond : Thallium (Tl)-Total (mg/L)



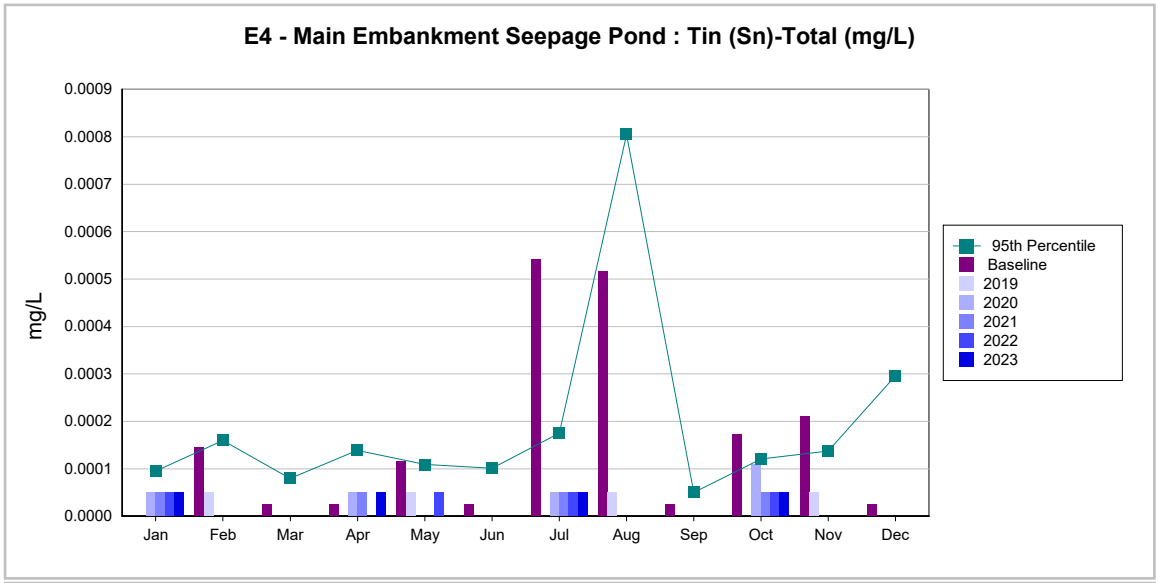
Water Quality Report

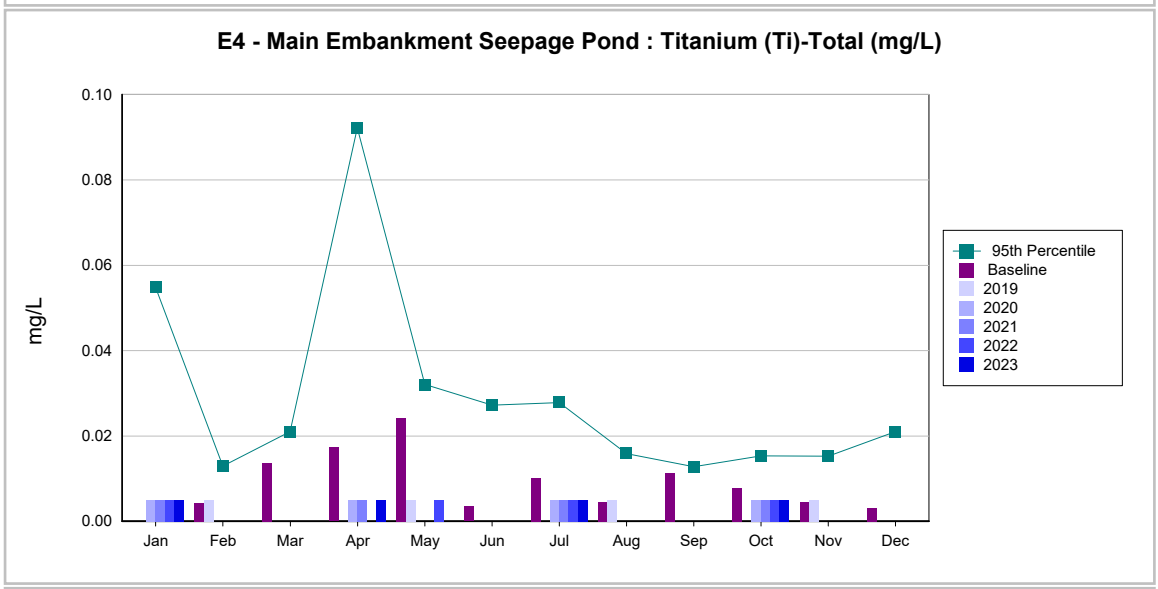
Annual Report Drainage Water

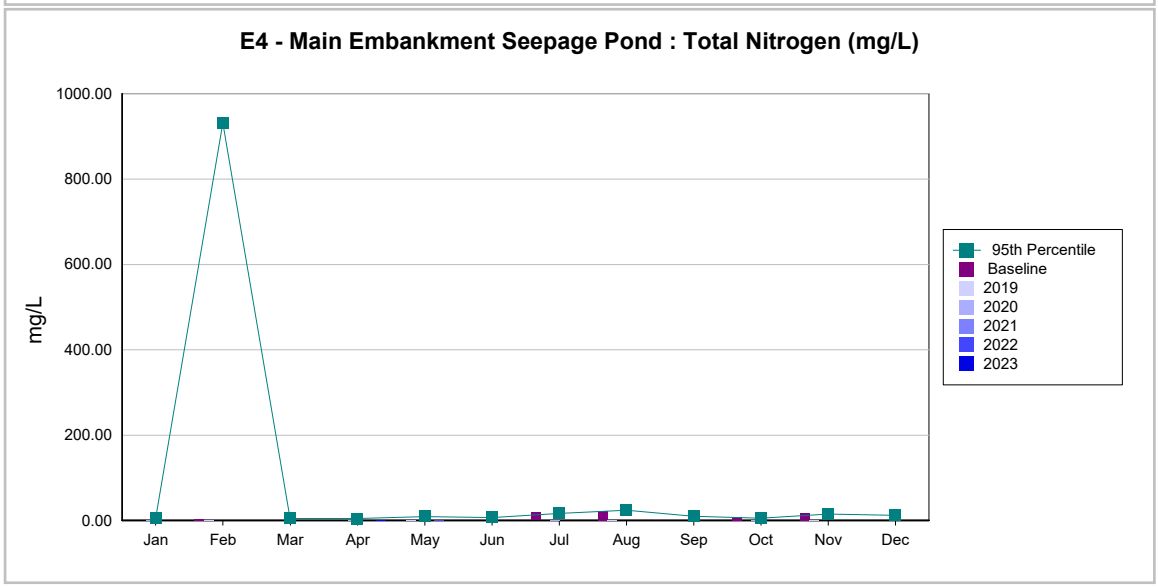
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

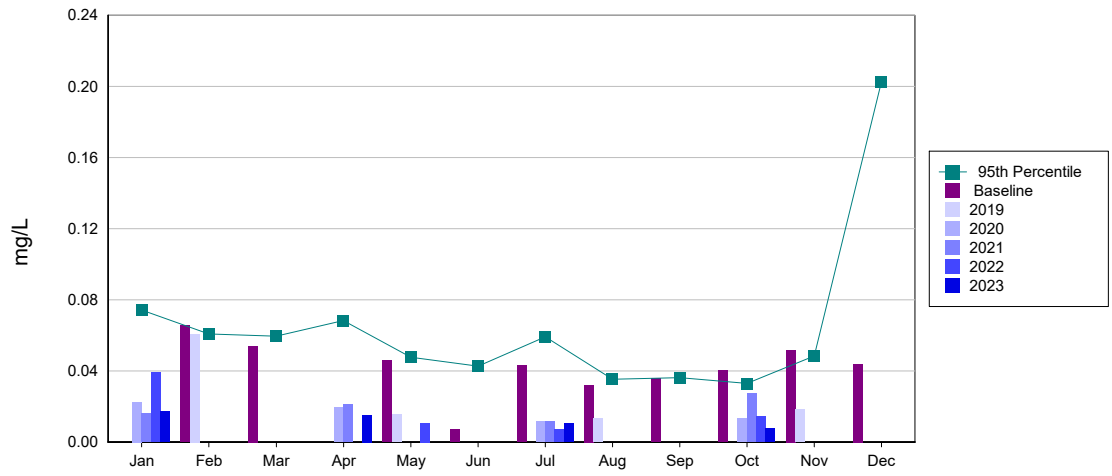
Annual Report Drainage Water

Mount Polley

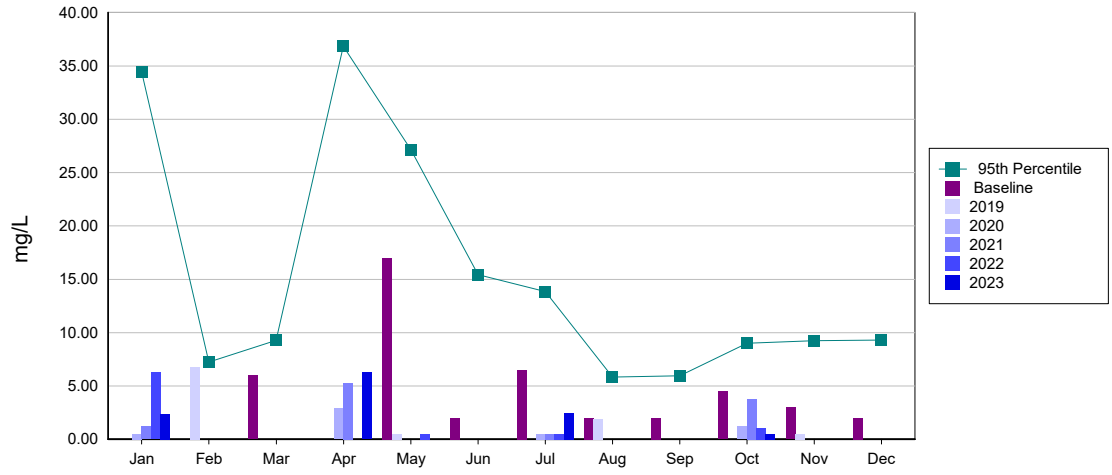
Mining Corporation

IMPERIAL METALS CORPORATION

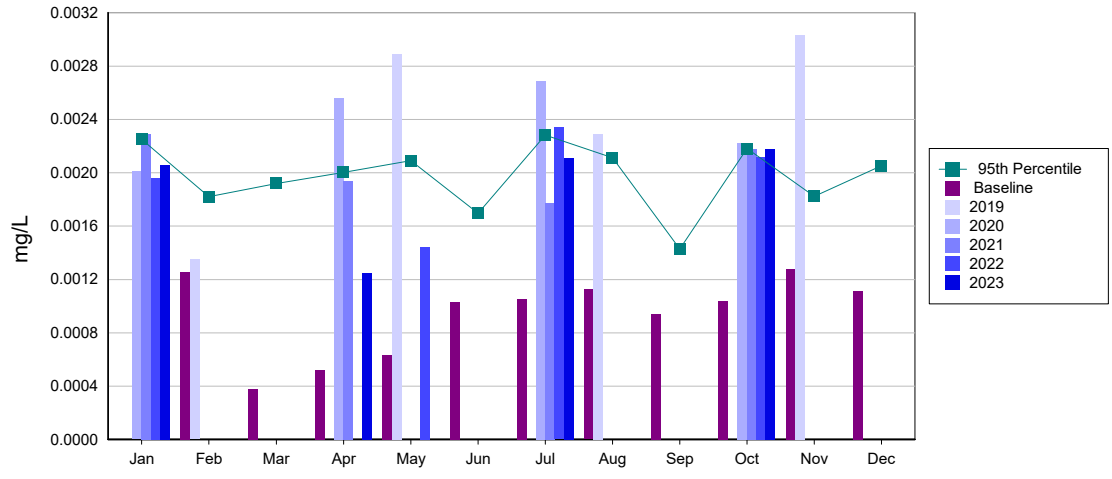
E4 - Main Embankment Seepage Pond : Total Phosphorus (mg/L)



E4 - Main Embankment Seepage Pond : TSS (mg/L)



E4 - Main Embankment Seepage Pond : Uranium (U)-Total (mg/L)



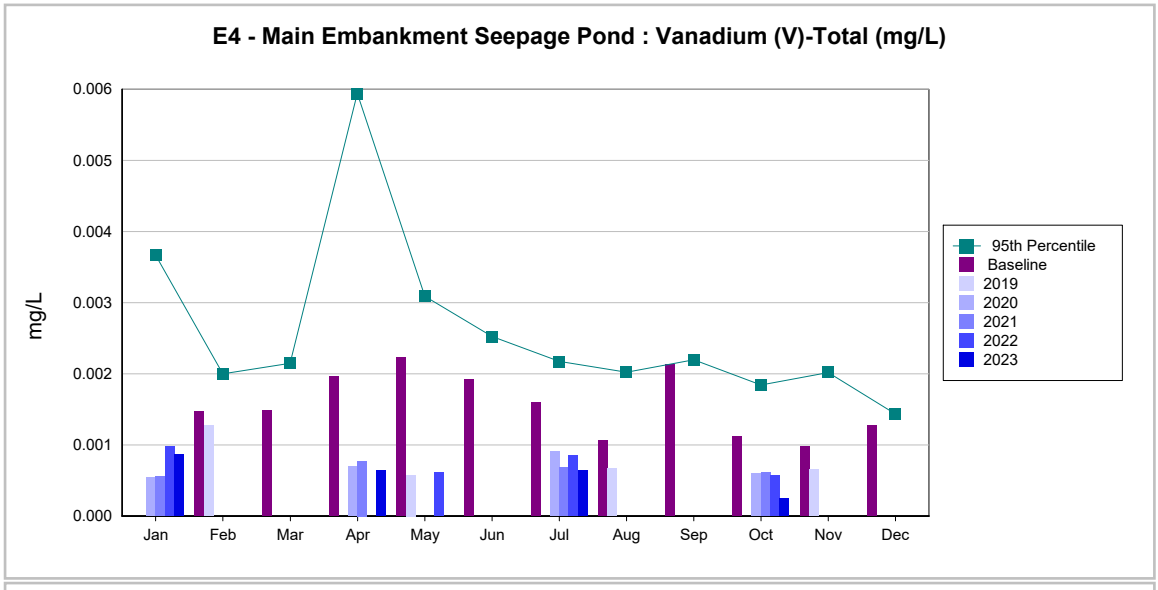
Water Quality Report

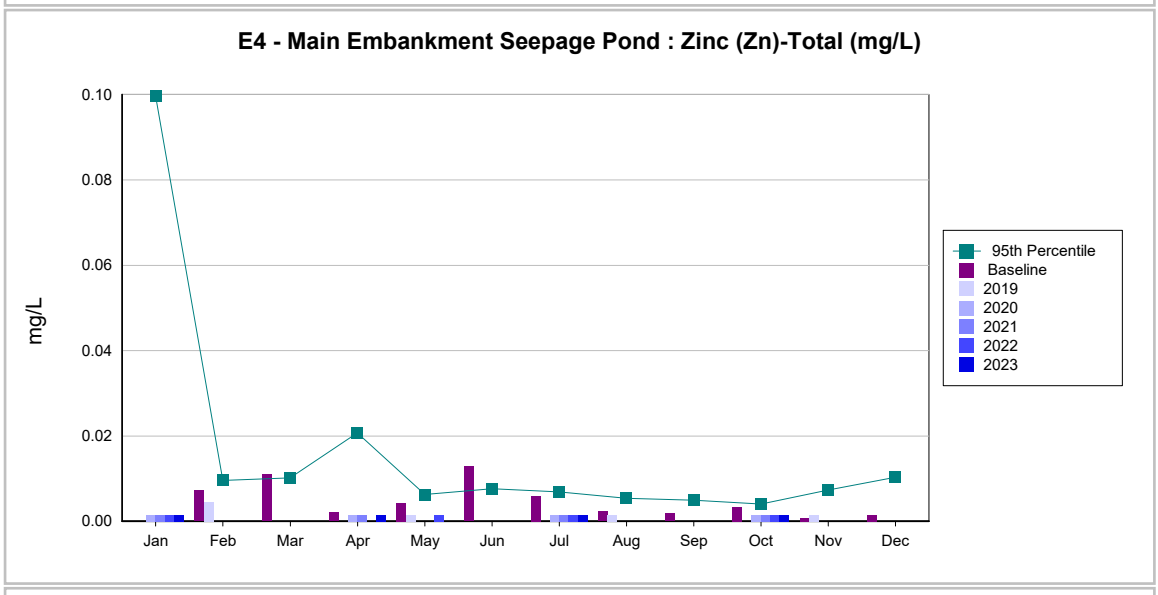
Annual Report Drainage Water

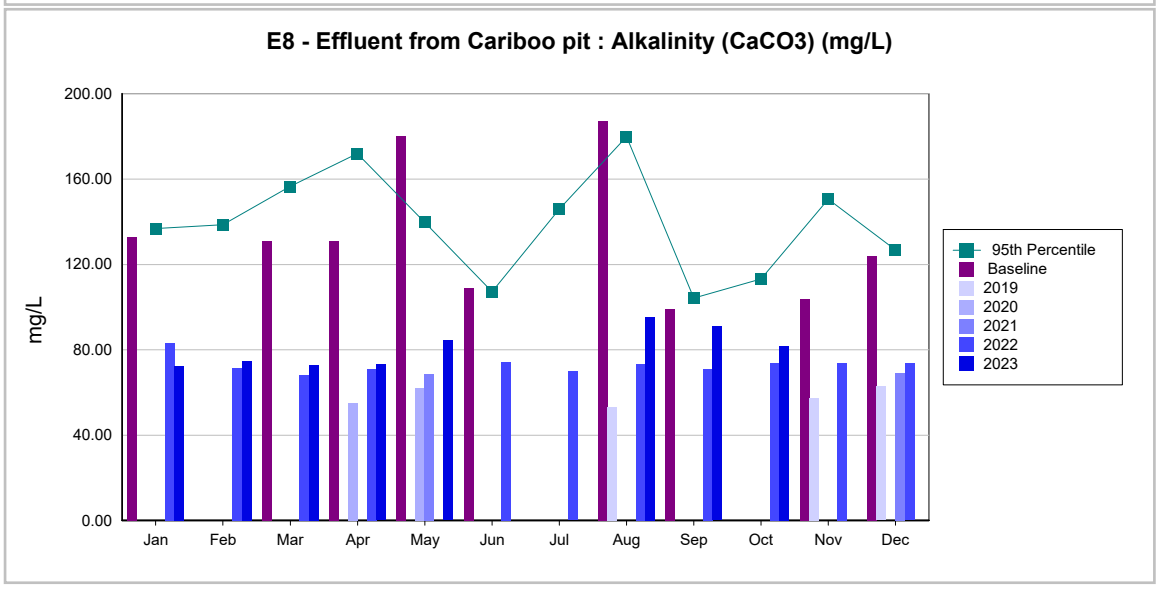
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







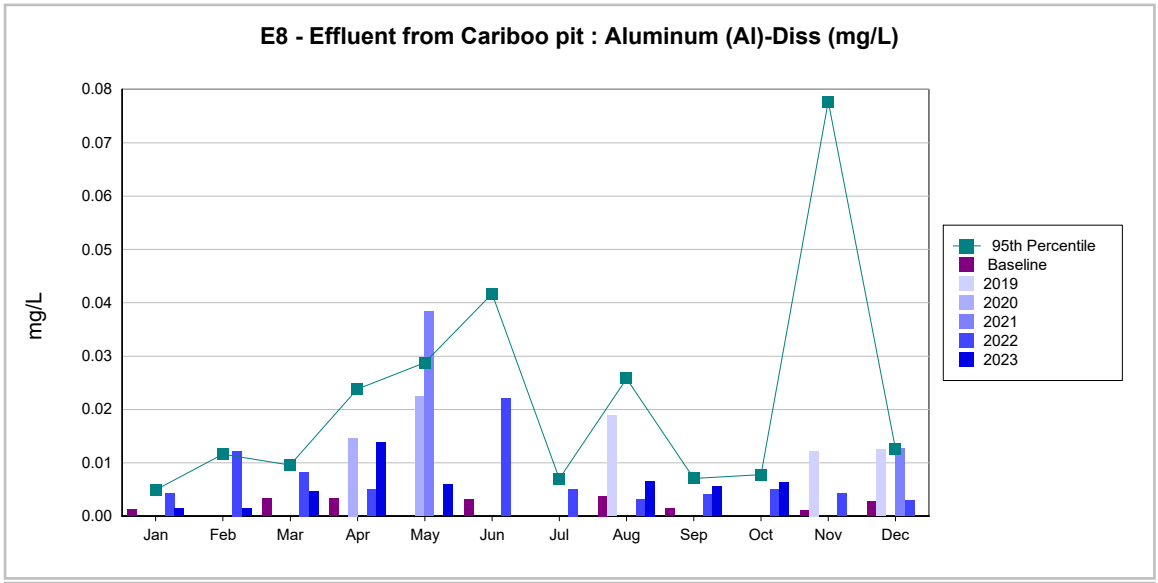
Water Quality Report

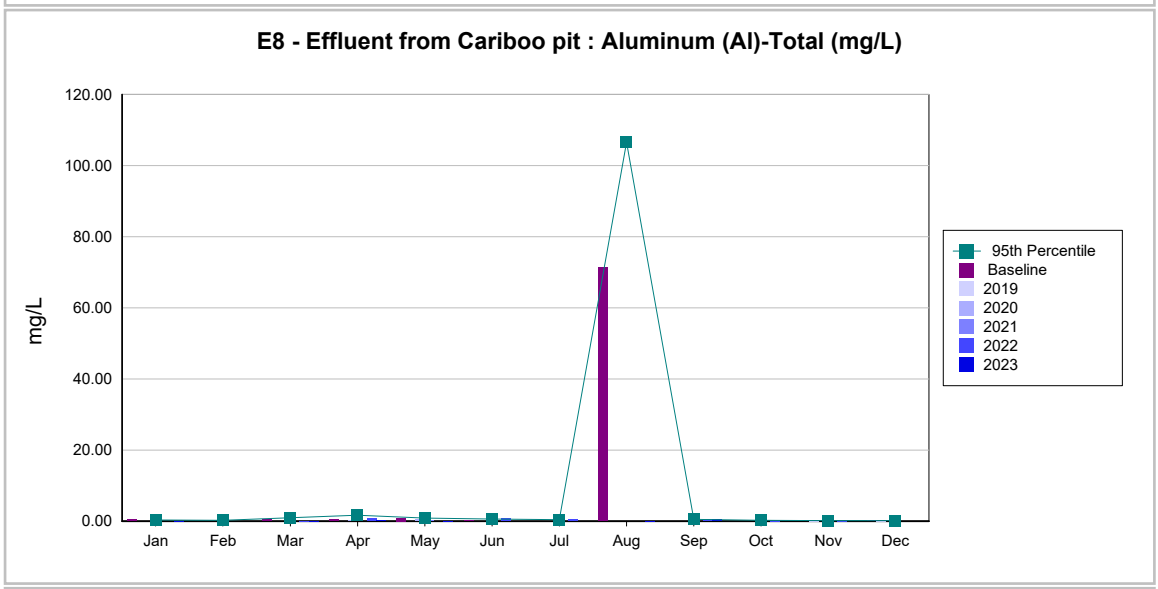
Annual Report Drainage Water

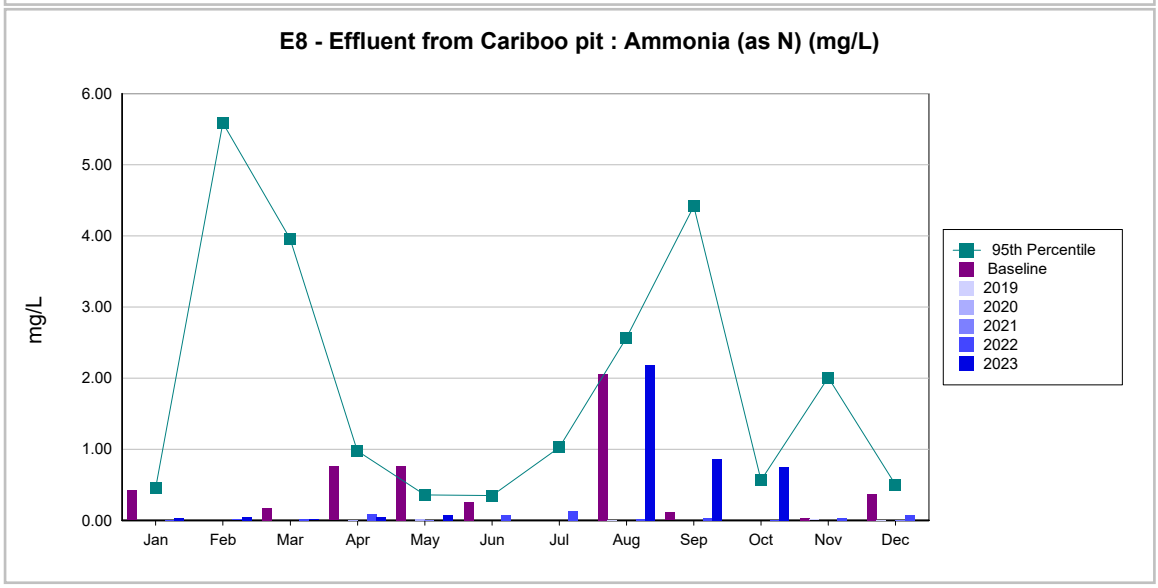
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







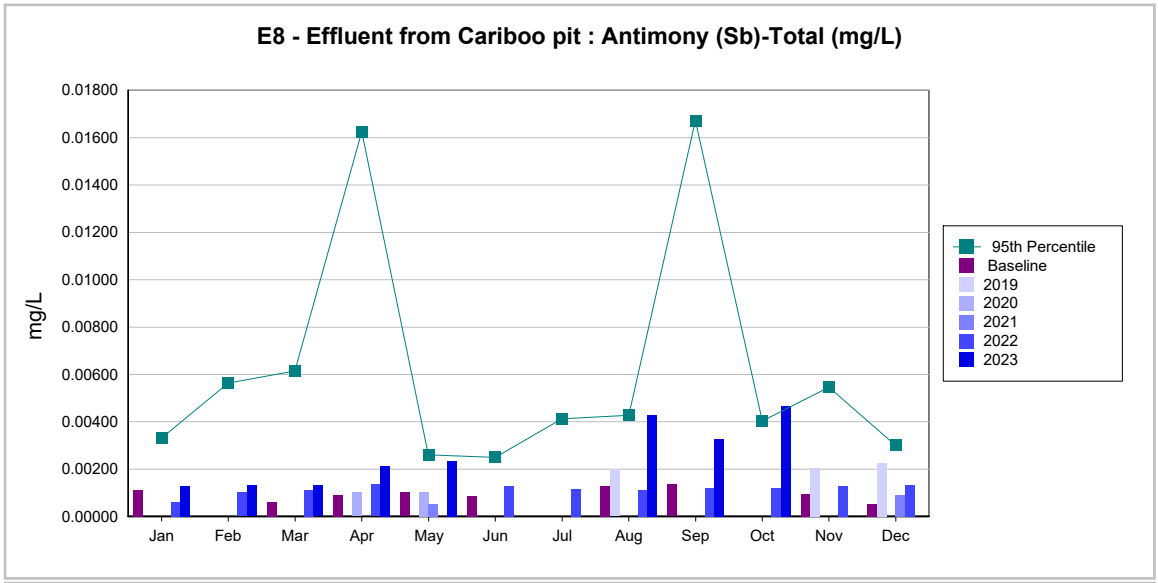
Water Quality Report

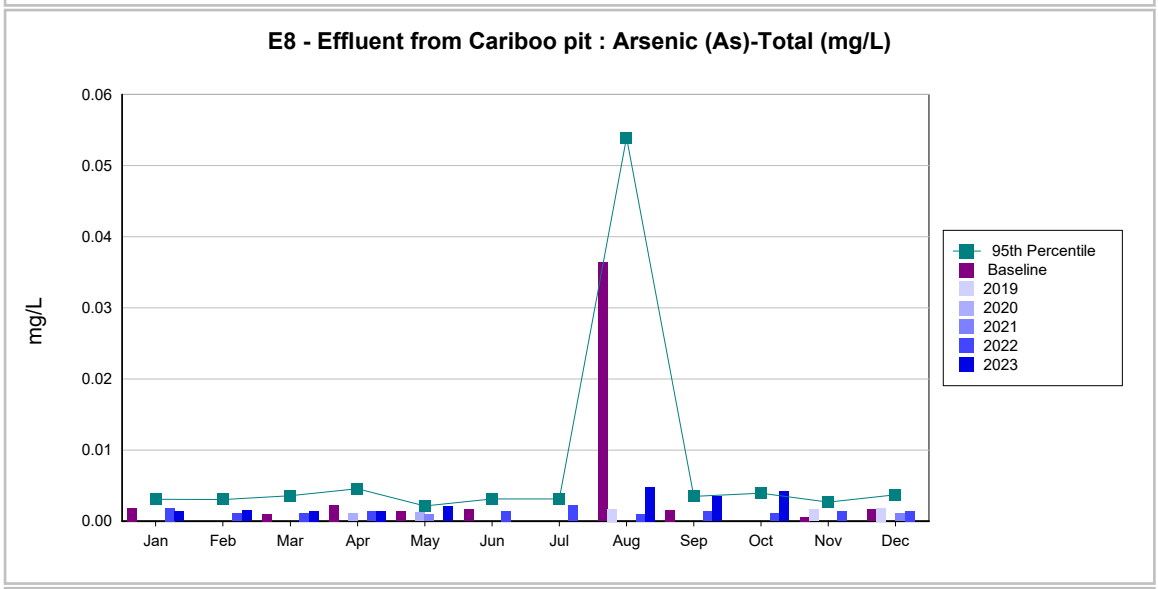
Annual Report Drainage Water

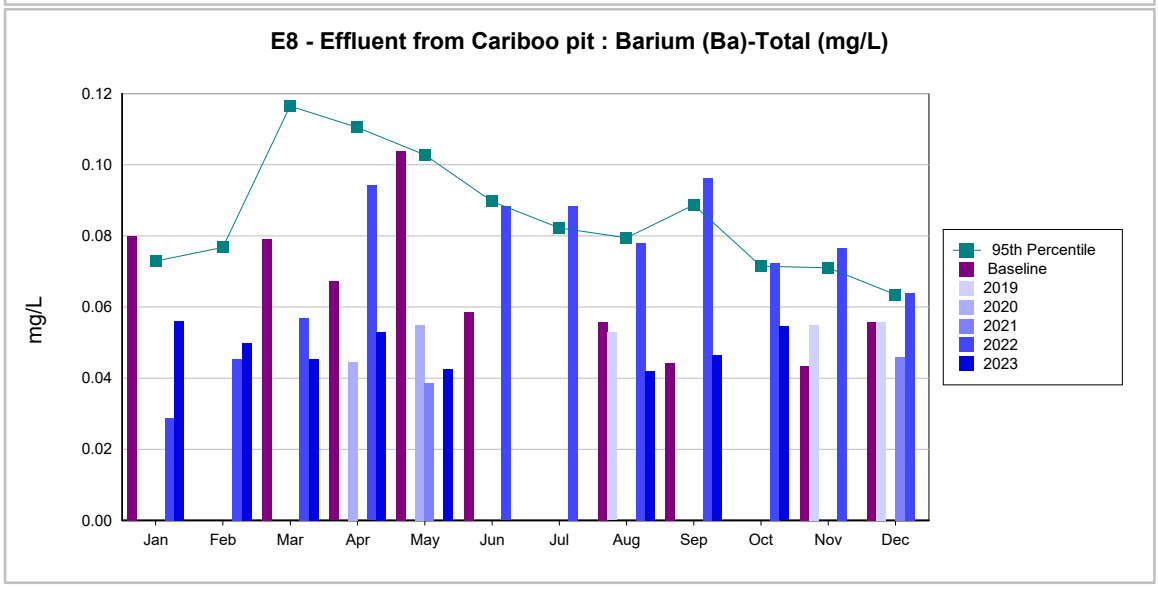
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







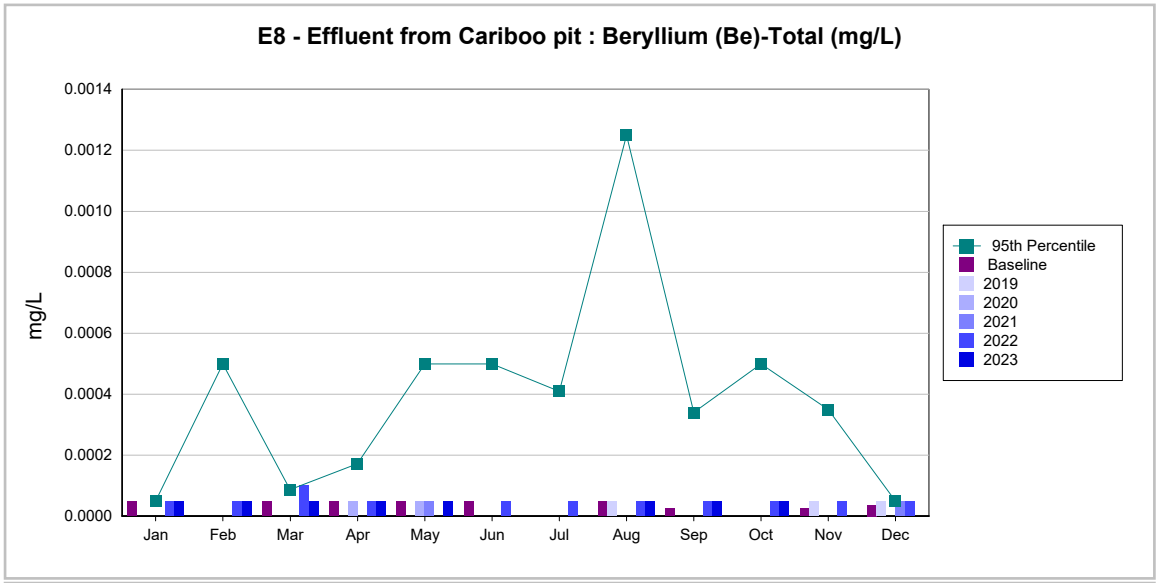
Water Quality Report

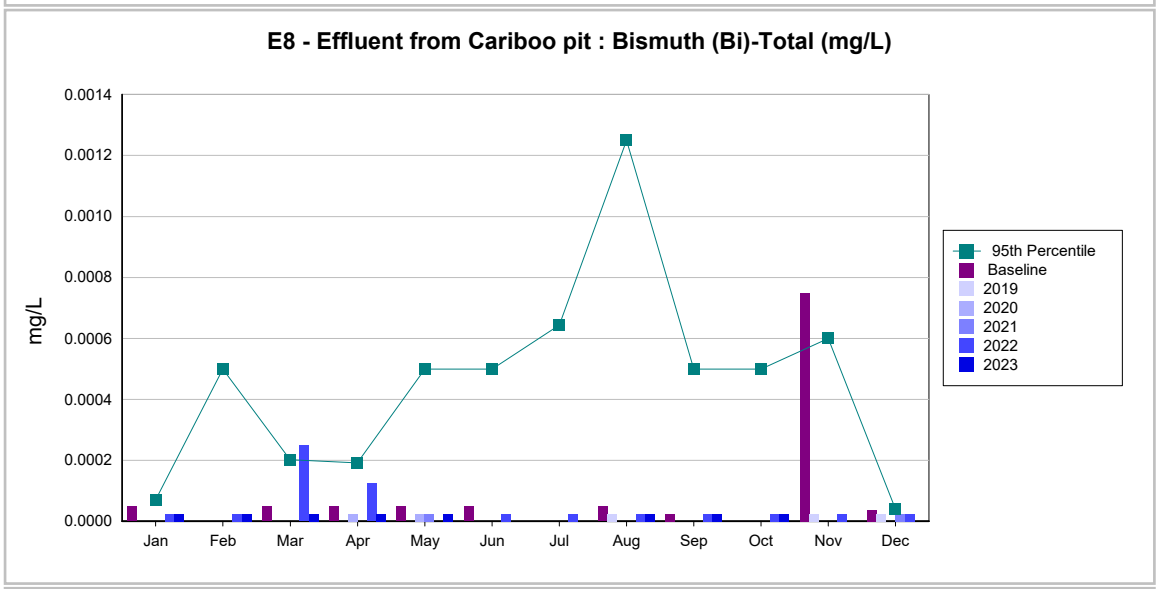
Annual Report Drainage Water

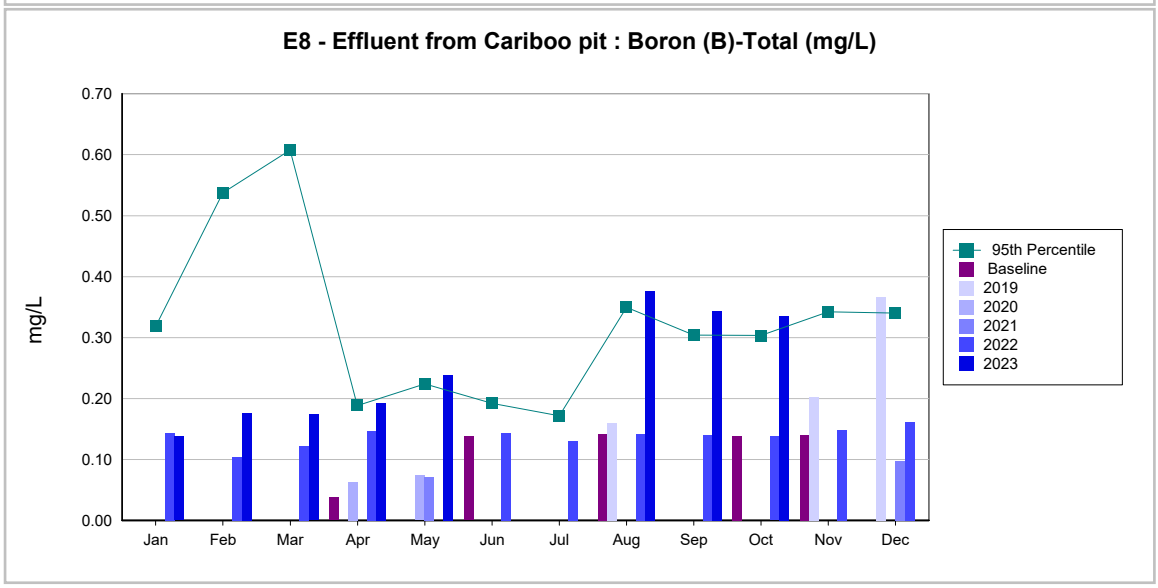
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







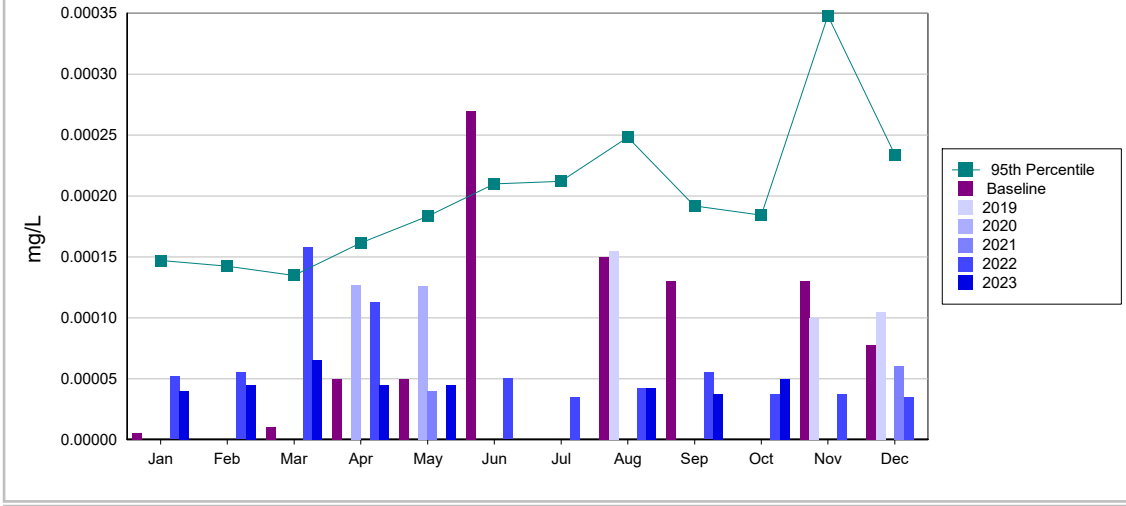
Water Quality Report

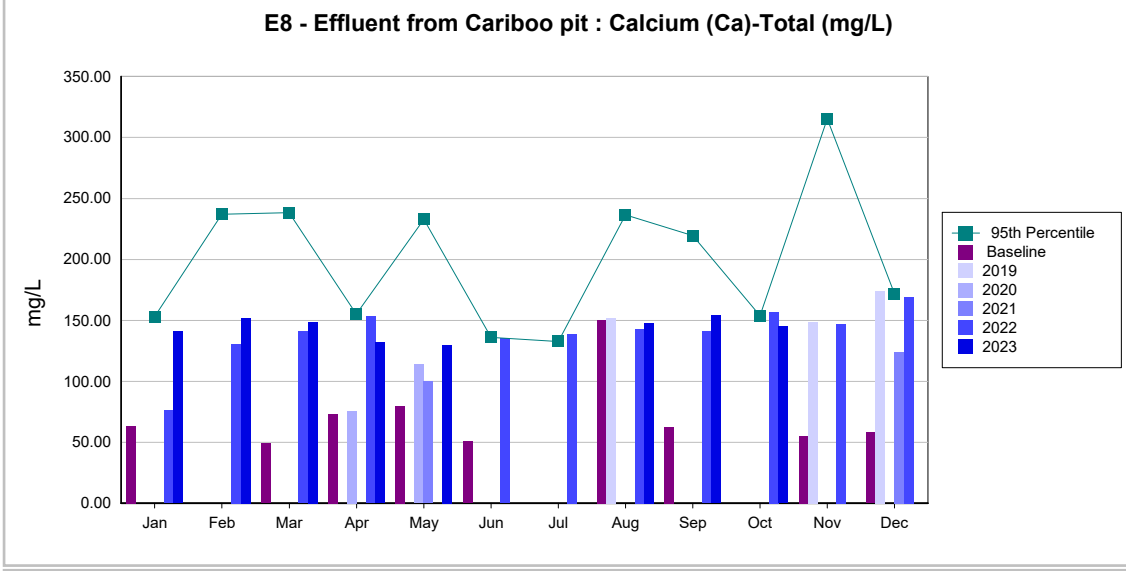
Annual Report Drainage Water

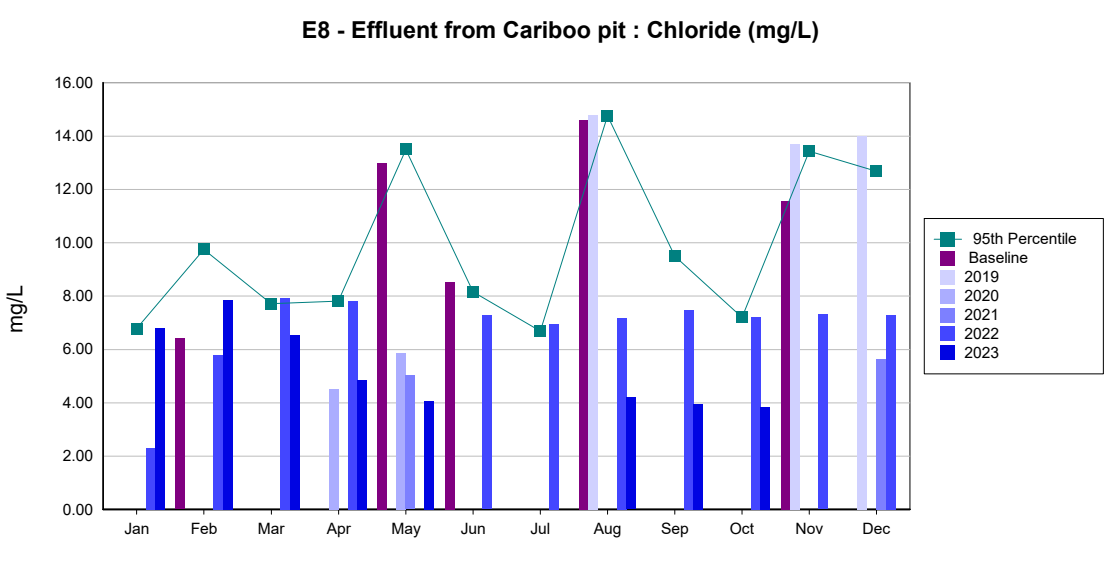
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

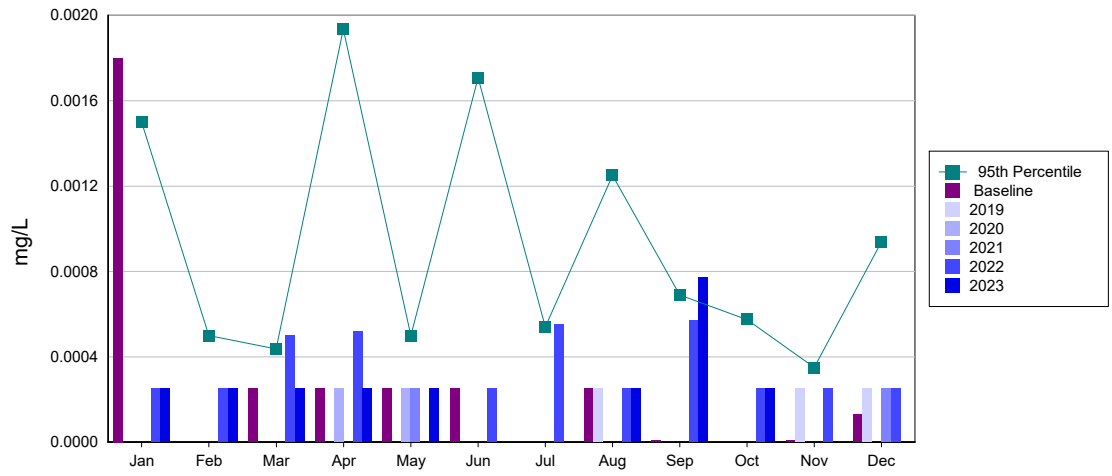
Annual Report Drainage Water

Mount Polley

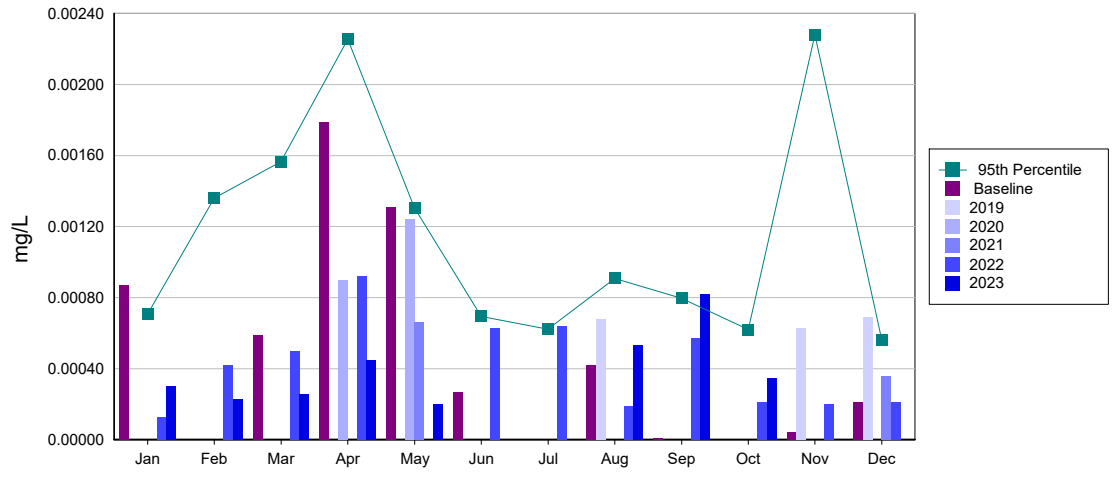
Mining Corporation

IMPERIAL METALS CORPORATION

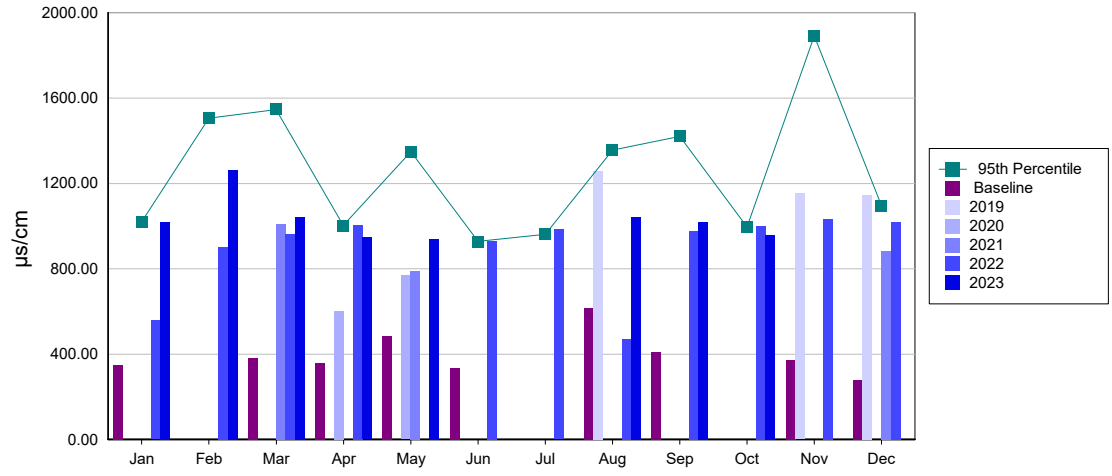
E8 - Effluent from Cariboo pit : Chromium (Cr)-Total (mg/L)



E8 - Effluent from Cariboo pit : Cobalt (Co)-Total (mg/L)



E8 - Effluent from Cariboo pit : Cond (in situ) (µs/cm)



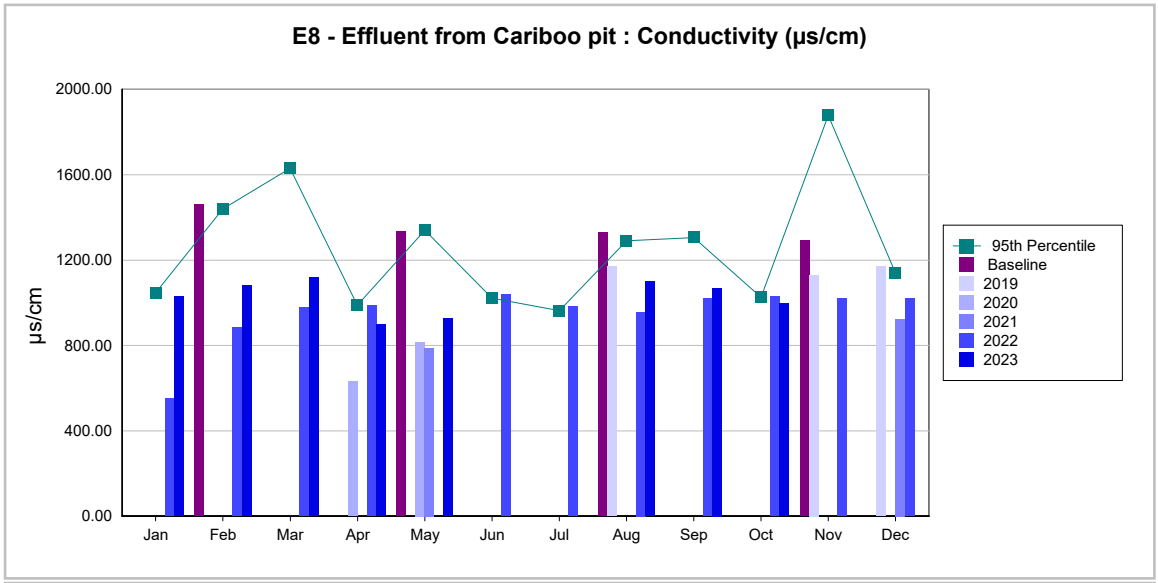
Water Quality Report

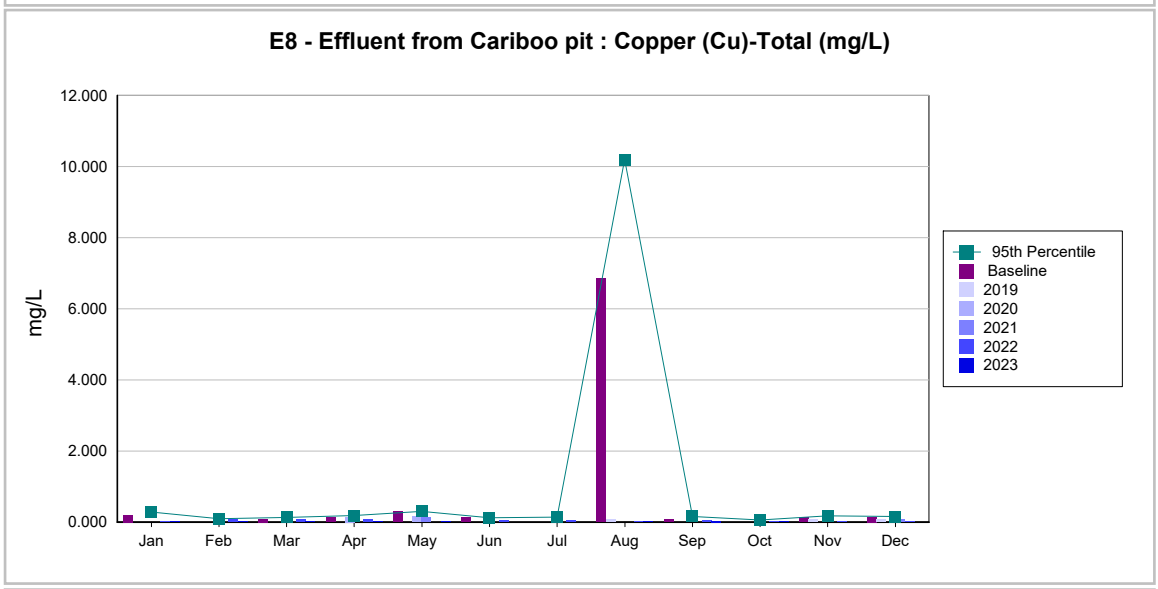
Annual Report Drainage Water

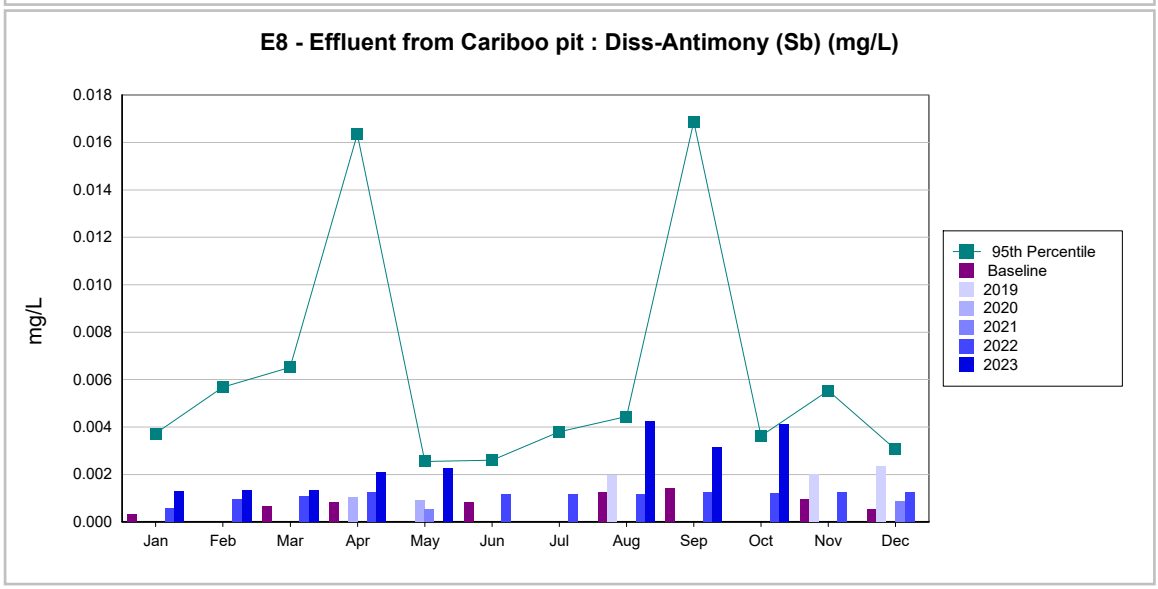
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

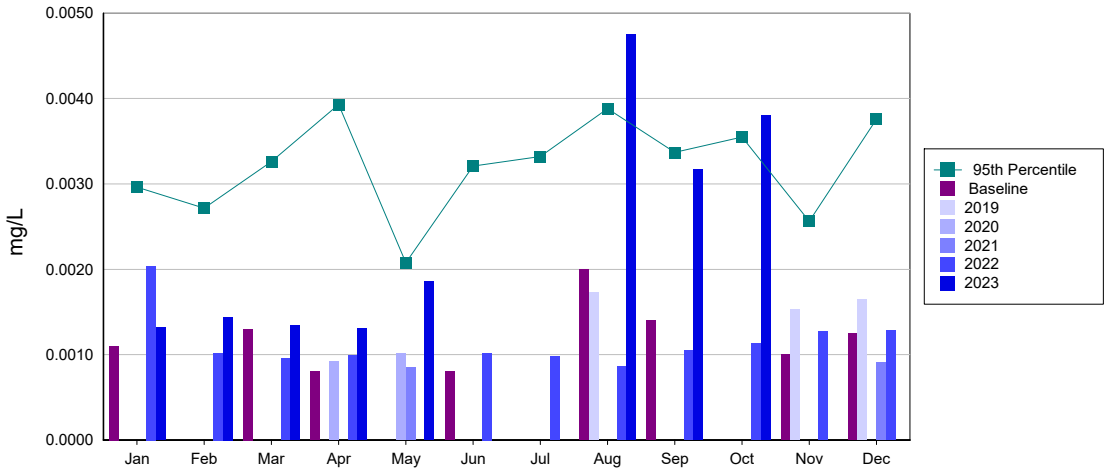
Annual Report Drainage Water

Mount Polley

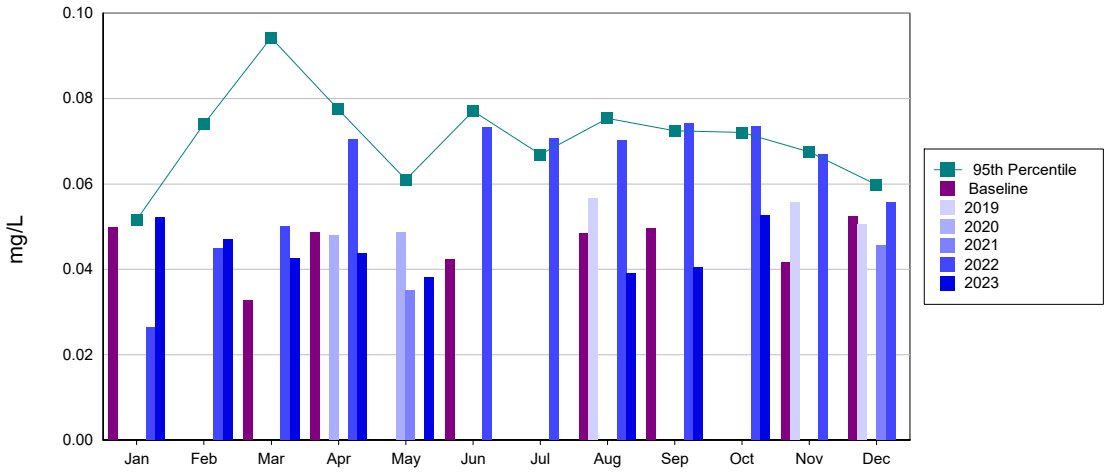
Mining Corporation

IMPERIAL METALS CORPORATION

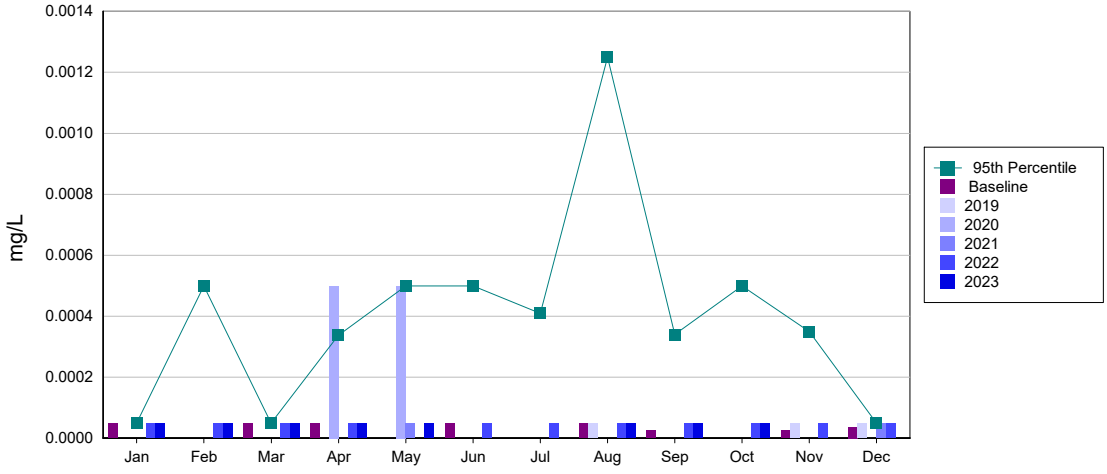
E8 - Effluent from Cariboo pit : Diss-Arsenic (As) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Barium (Ba) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Beryllium (Be) (mg/L)



Water Quality Report

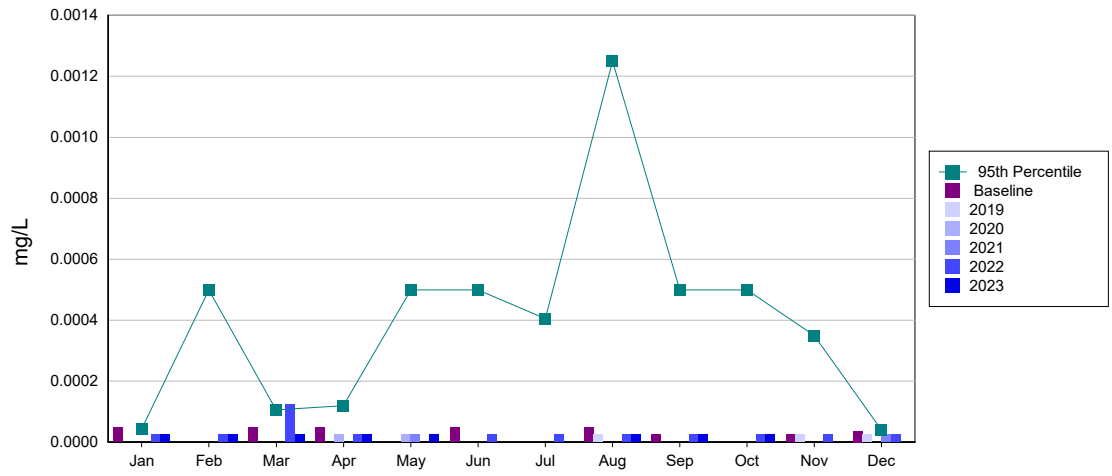
Annual Report Drainage Water

Mount Polley

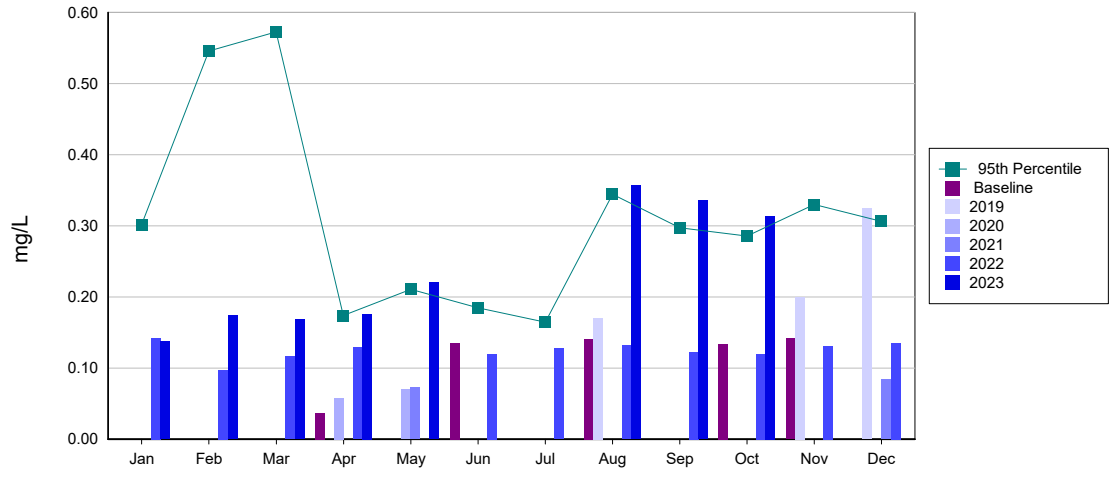
Mining Corporation

IMPERIAL METALS CORPORATION

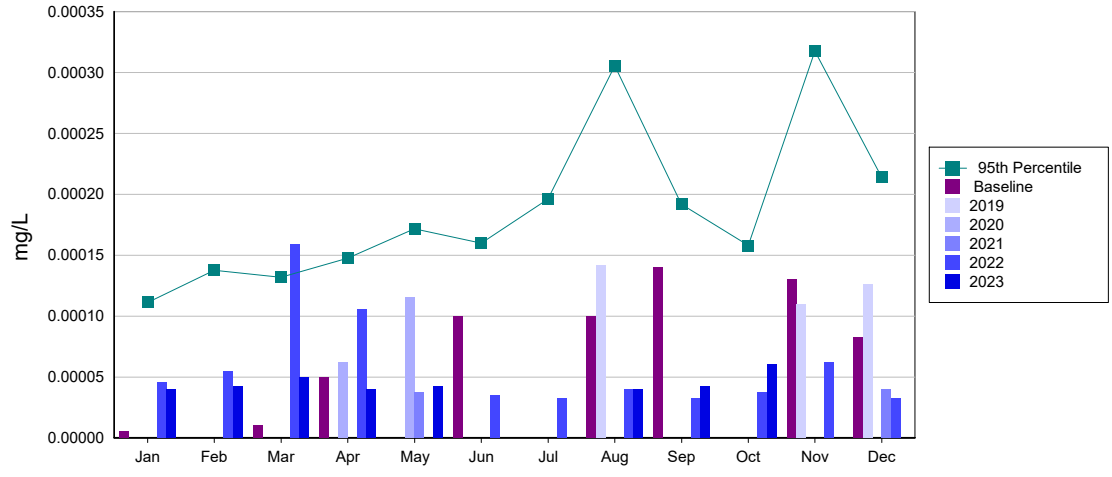
E8 - Effluent from Cariboo pit : Diss-Bismuth (Bi) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Boron (B) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Cadmium (Cd) (mg/L)



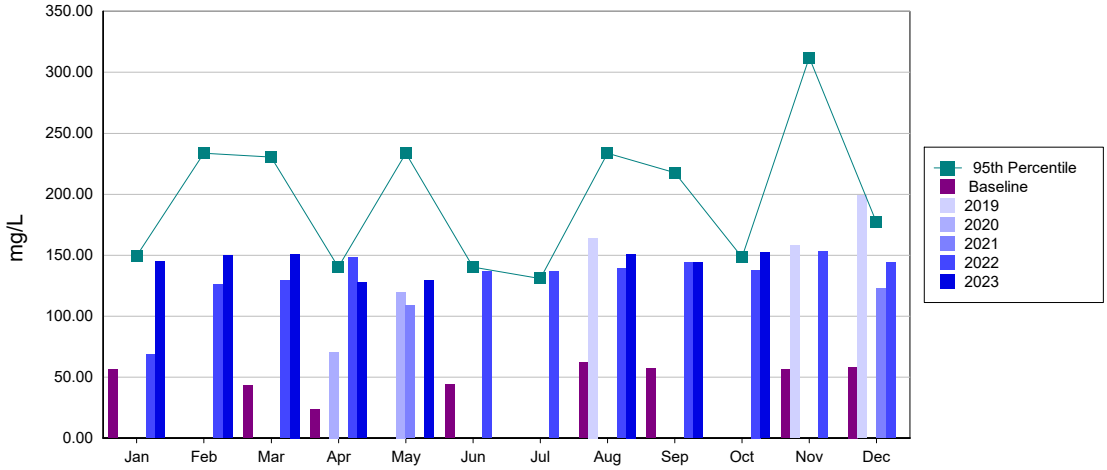
Water Quality Report

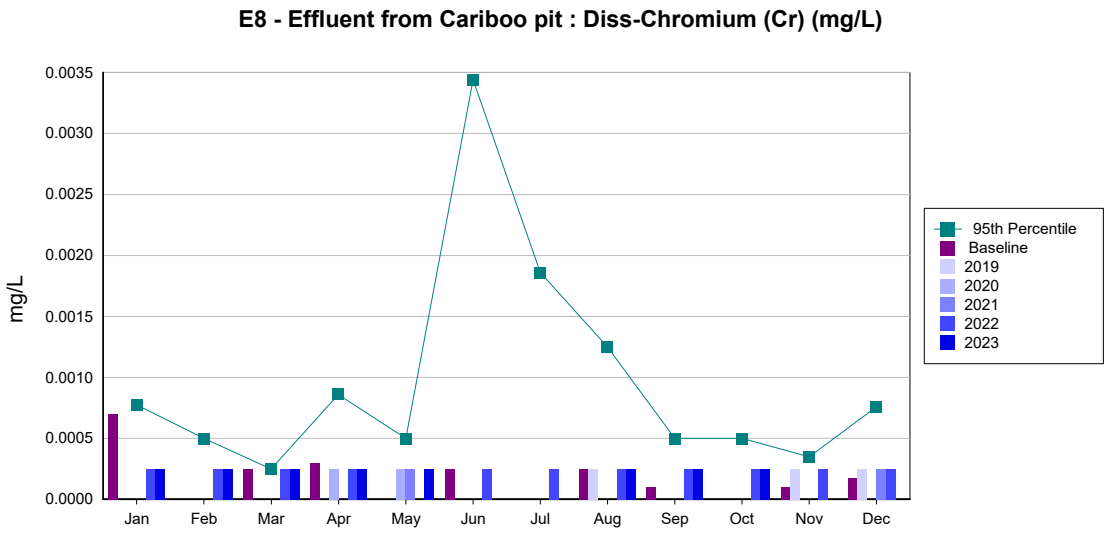
Annual Report Drainage Water

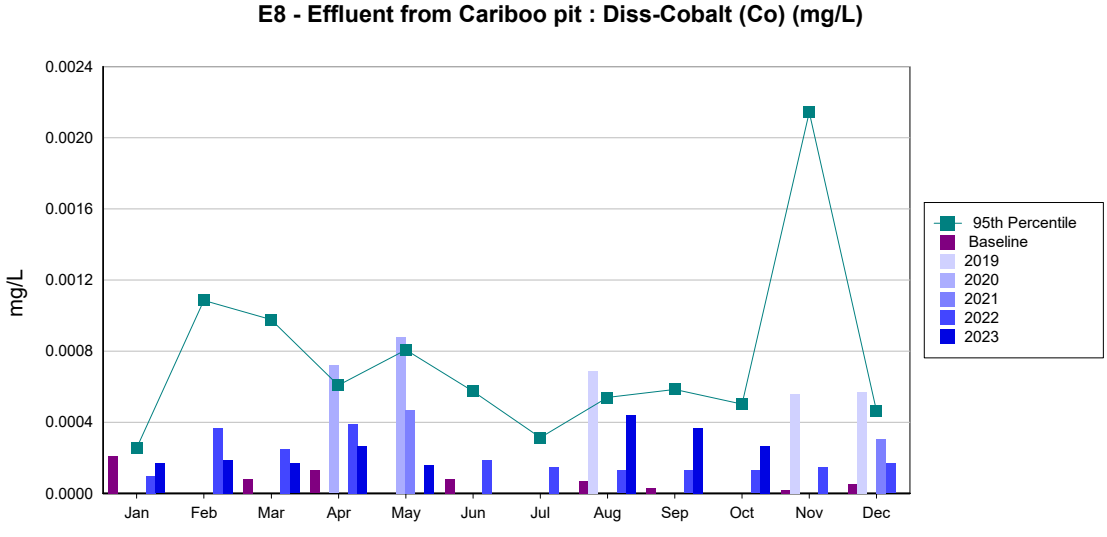
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







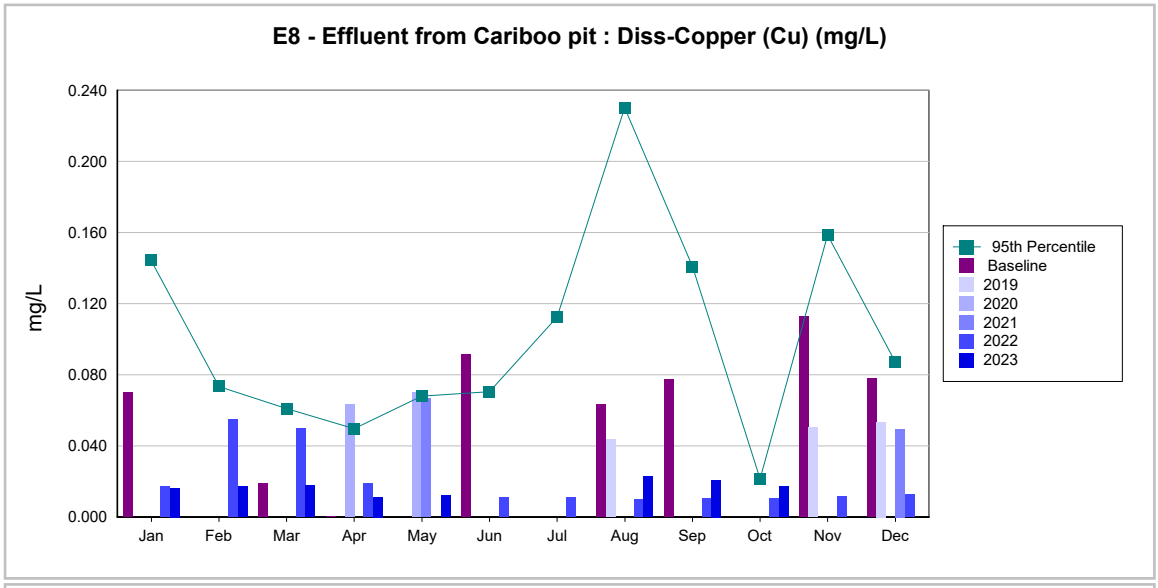
Water Quality Report

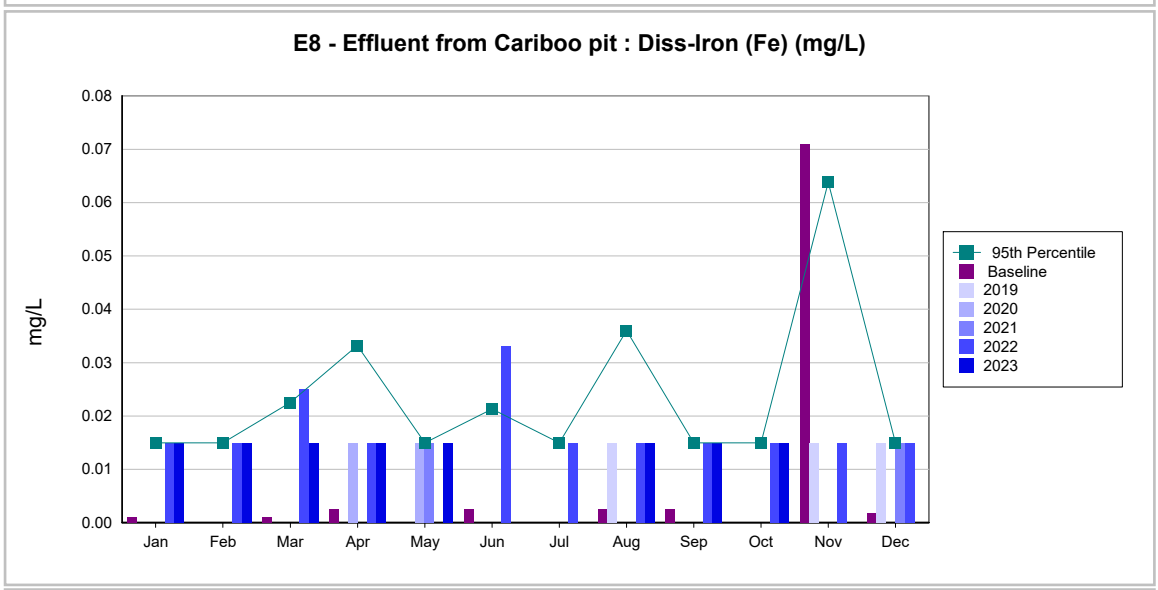
Annual Report Drainage Water

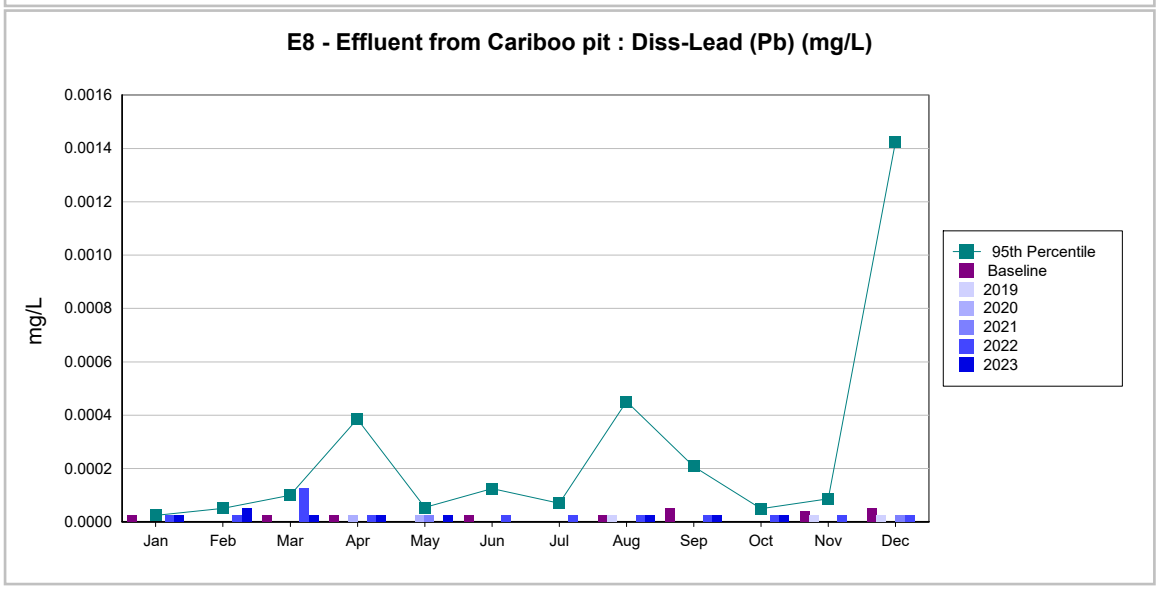
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







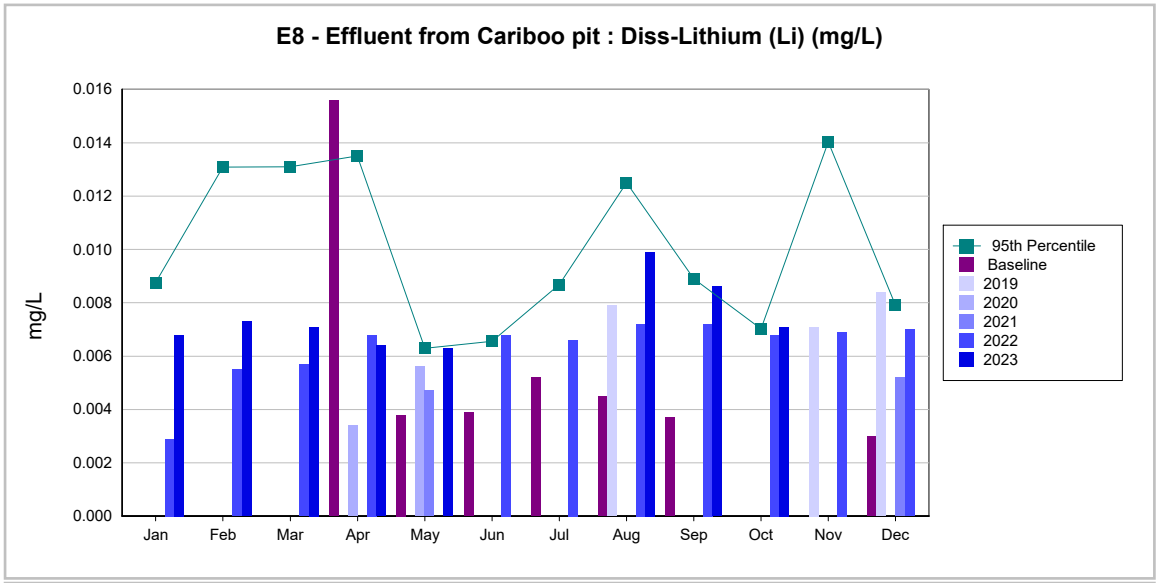
Water Quality Report

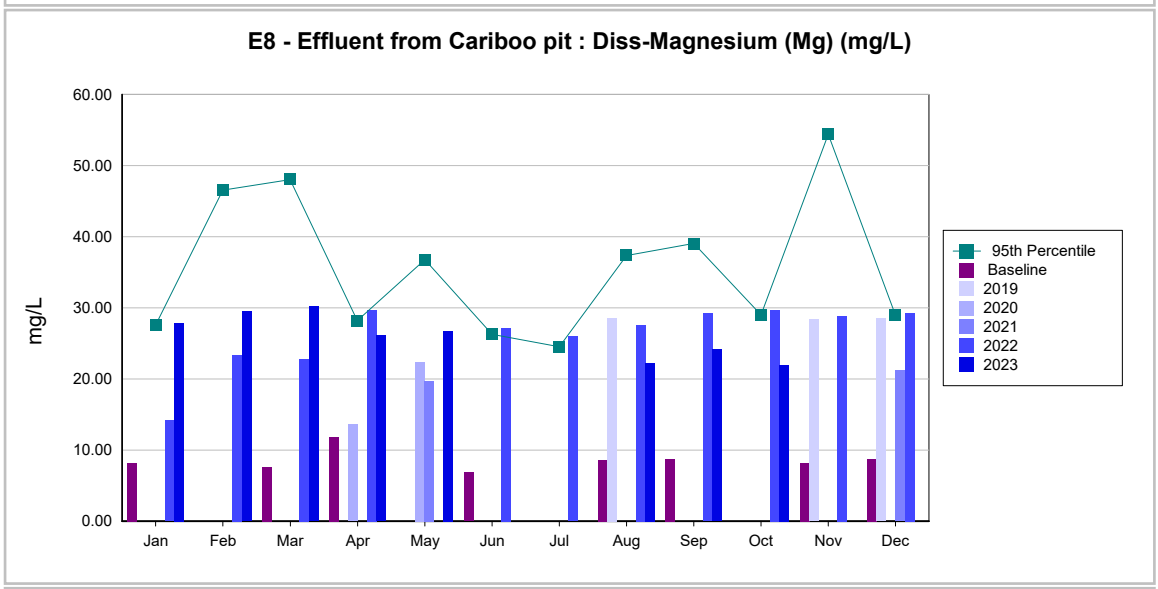
Annual Report Drainage Water

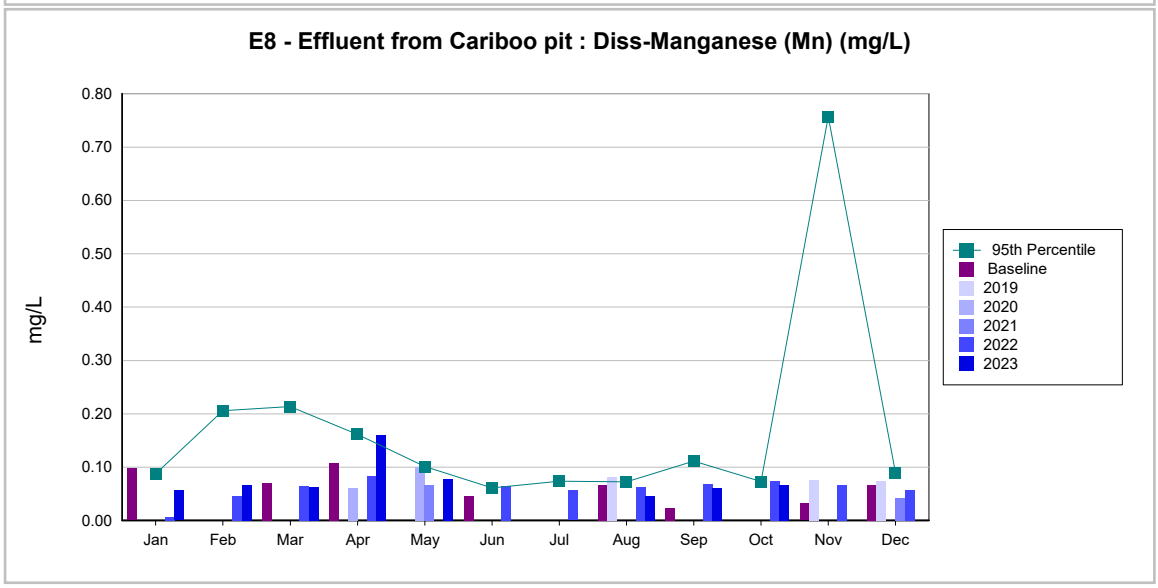
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

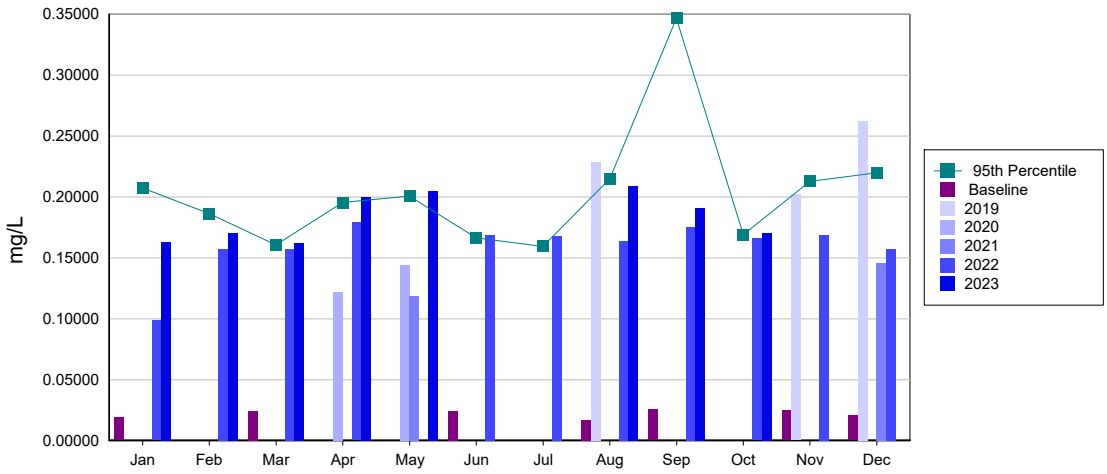
Annual Report Drainage Water

Mount Polley

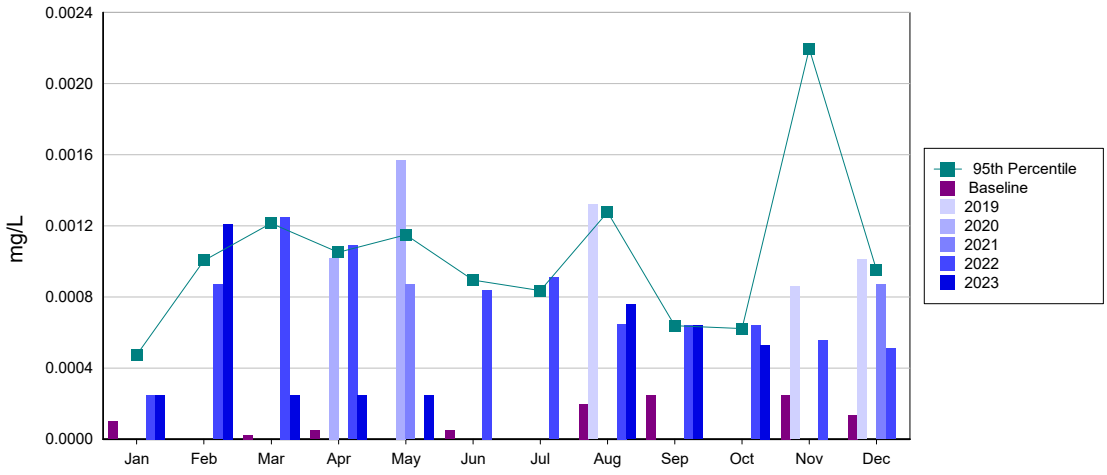
Mining Corporation

IMPERIAL METALS CORPORATION

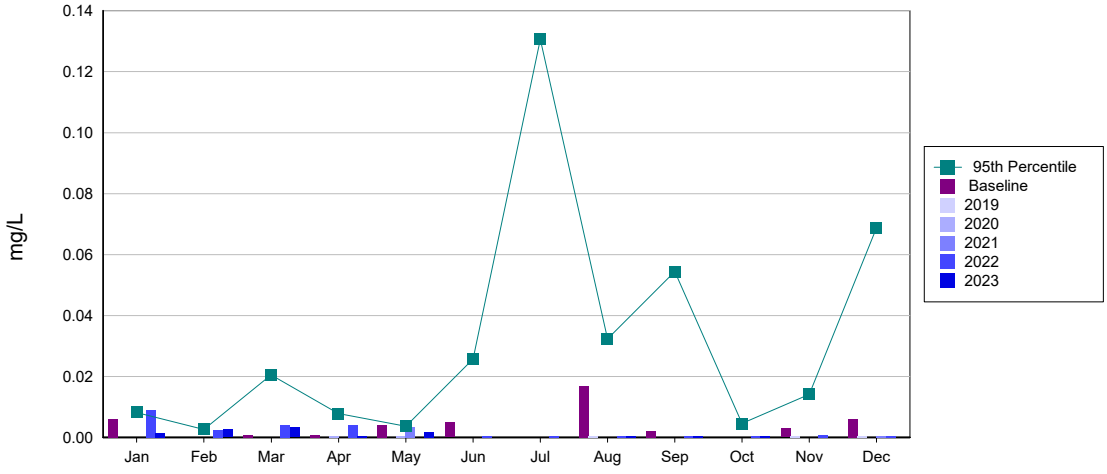
E8 - Effluent from Cariboo pit : Diss-Molybdenum (Mo) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Nickel (Ni) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Orthophosphate (mg/L)



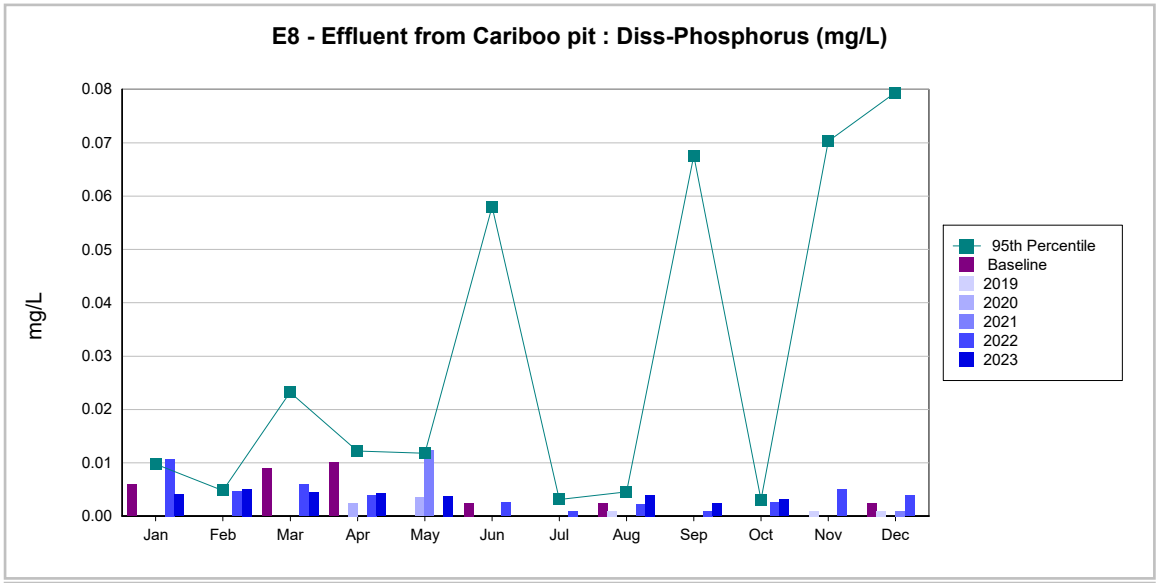
Water Quality Report

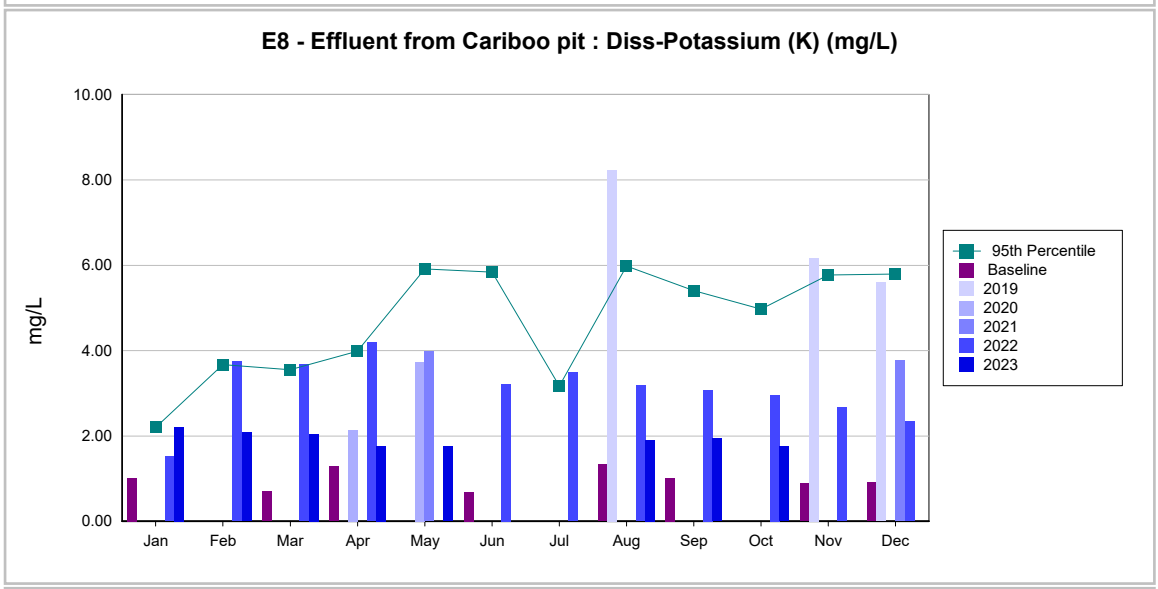
Annual Report Drainage Water

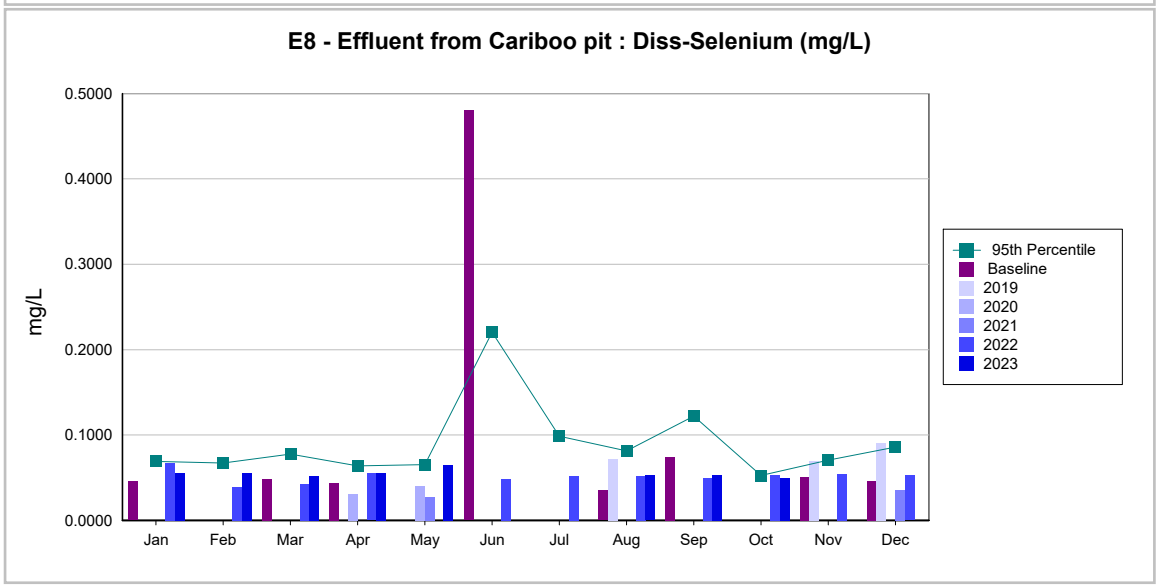
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

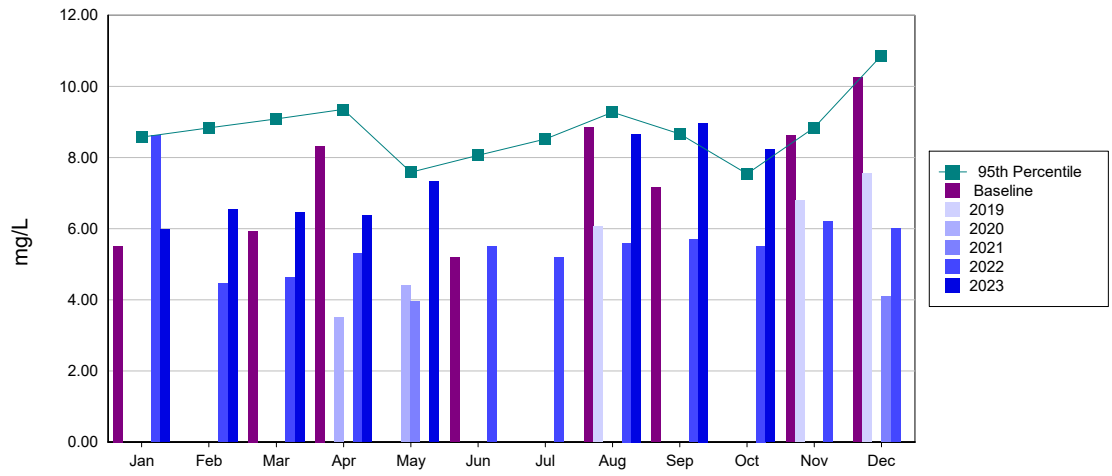
Annual Report Drainage Water

Mount Polley

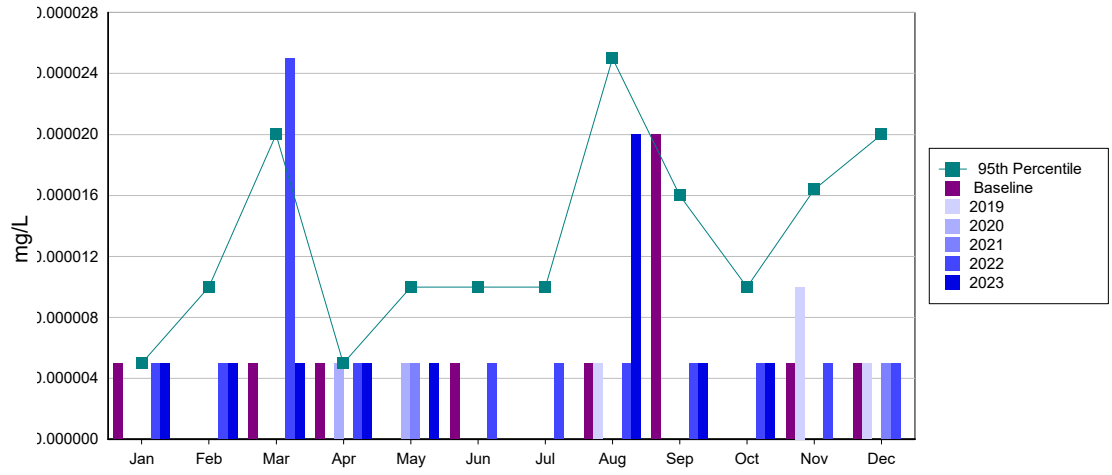
Mining Corporation

IMPERIAL METALS CORPORATION

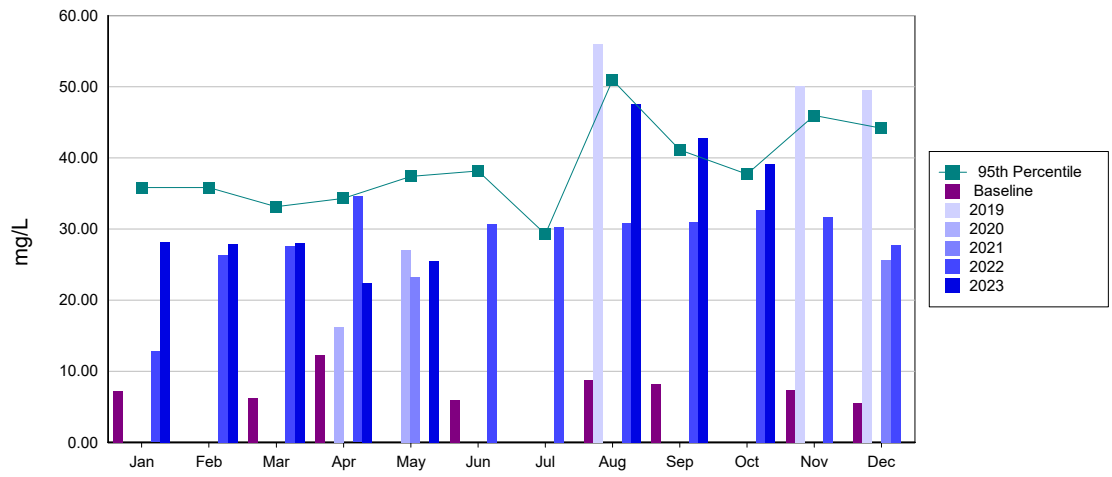
E8 - Effluent from Cariboo pit : Diss-Silicon (Si) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Silver (Ag) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Sodium (Na) (mg/L)



Water Quality Report

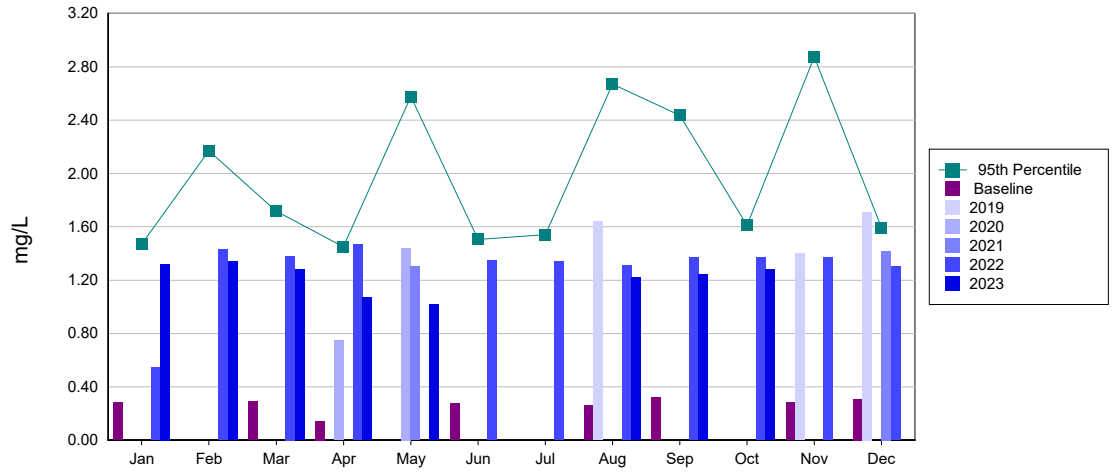
Annual Report Drainage Water

Mount Polley

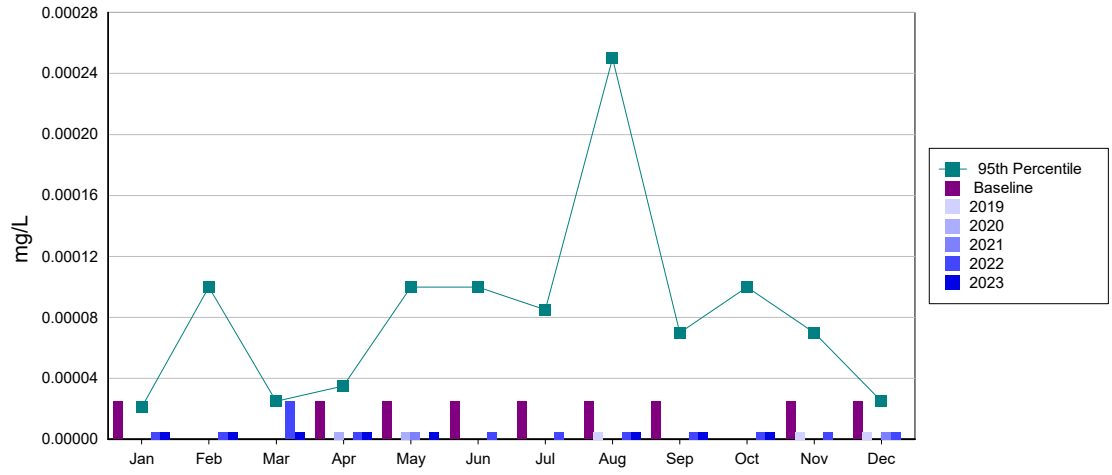
Mining Corporation

IMPERIAL METALS CORPORATION

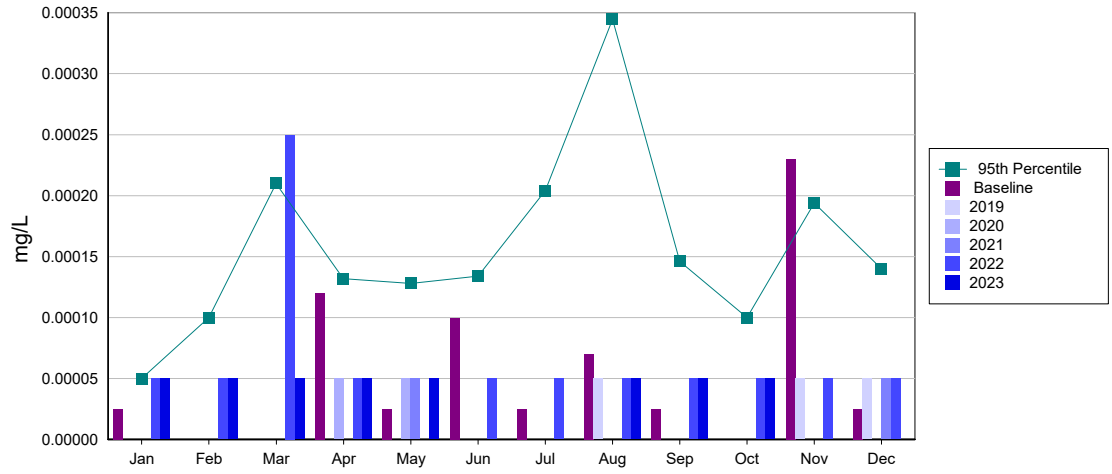
E8 - Effluent from Cariboo pit : Diss-Strontium (Sr) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Thallium (Tl) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Tin (Sn) (mg/L)



Water Quality Report

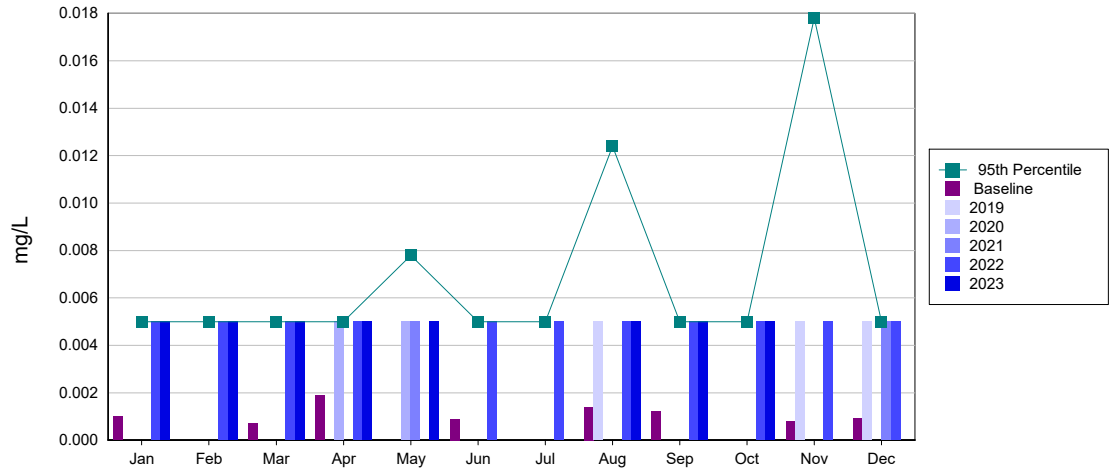
Annual Report Drainage Water

Mount Polley

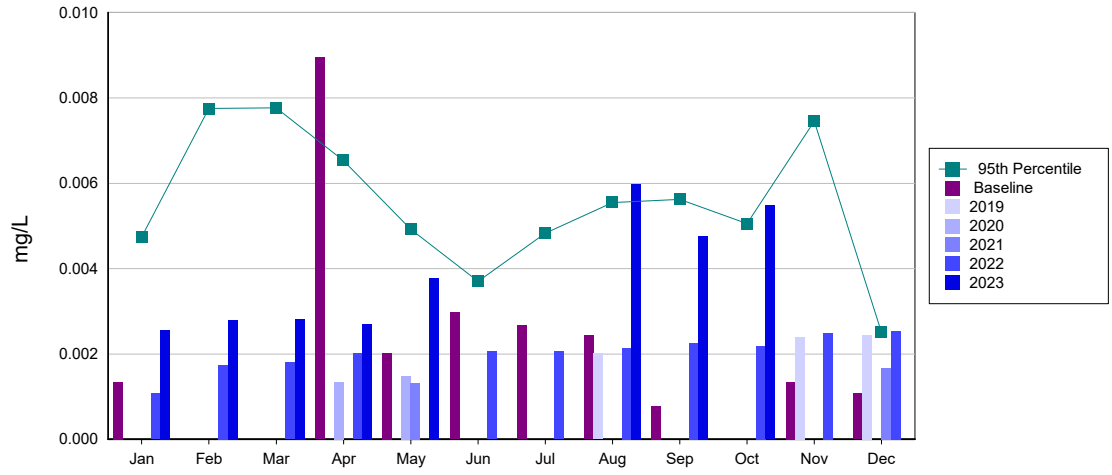
Mining Corporation

IMPERIAL METALS CORPORATION

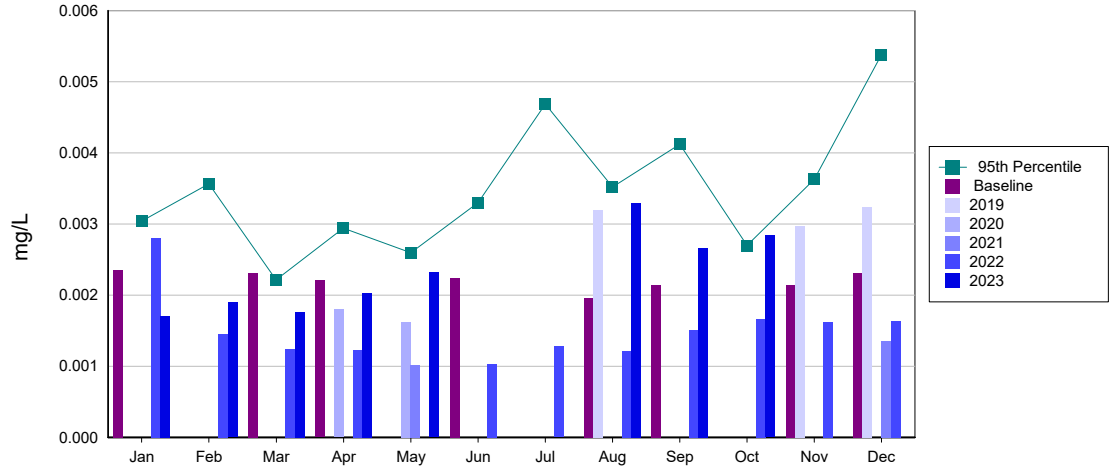
E8 - Effluent from Cariboo pit : Diss-Titanium (Ti) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Uranium (U) (mg/L)



E8 - Effluent from Cariboo pit : Diss-Vanadium (V) (mg/L)



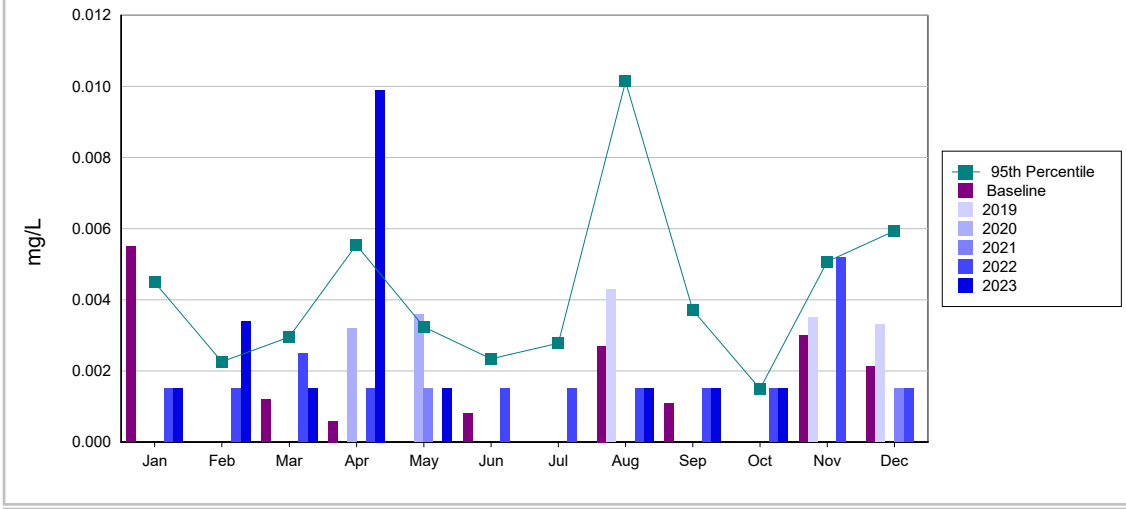
Water Quality Report

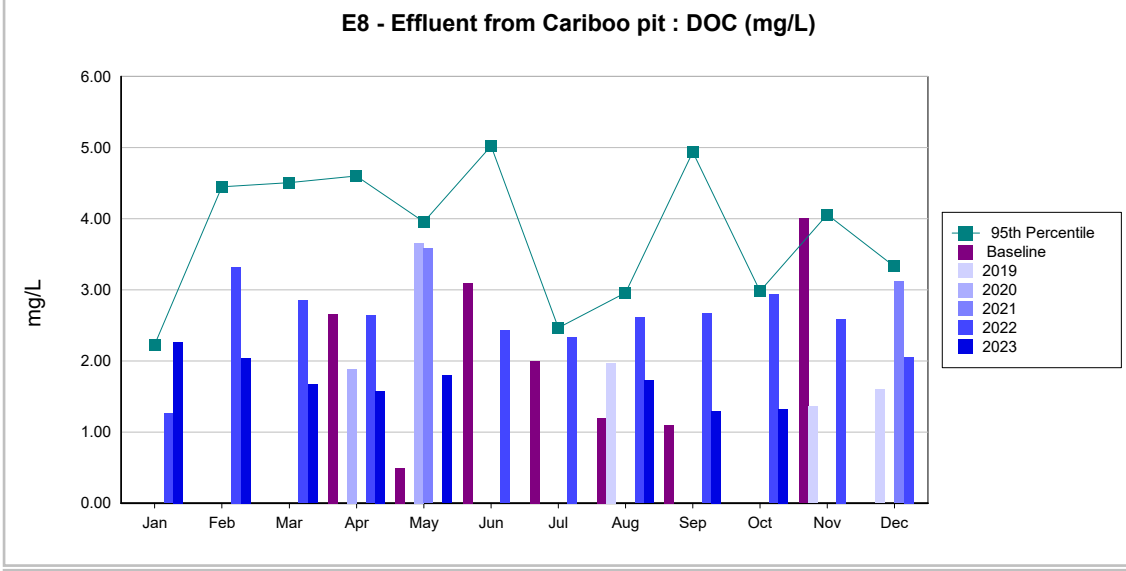
Annual Report Drainage Water

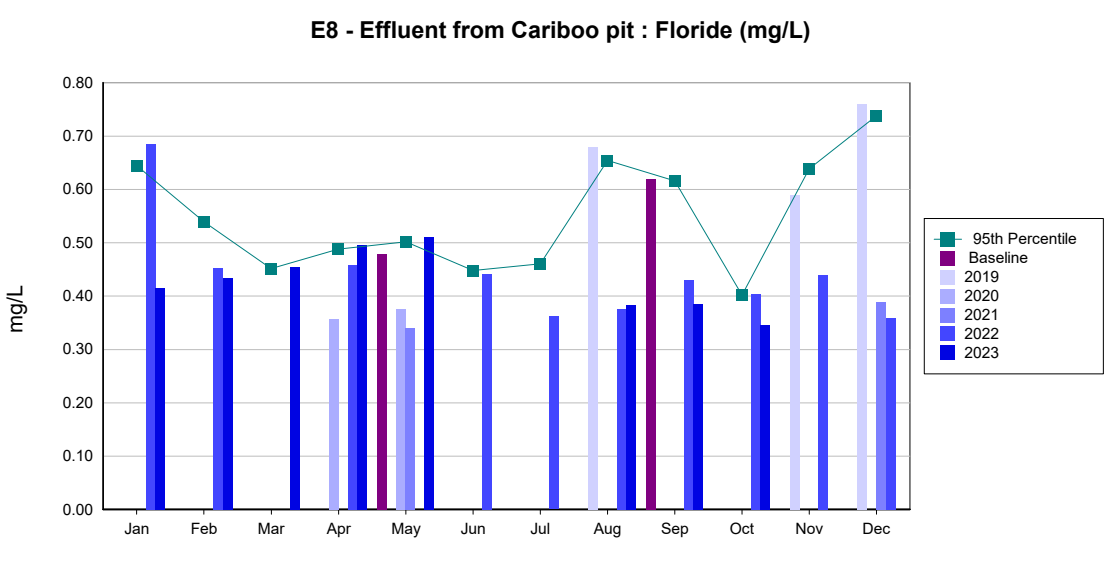
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

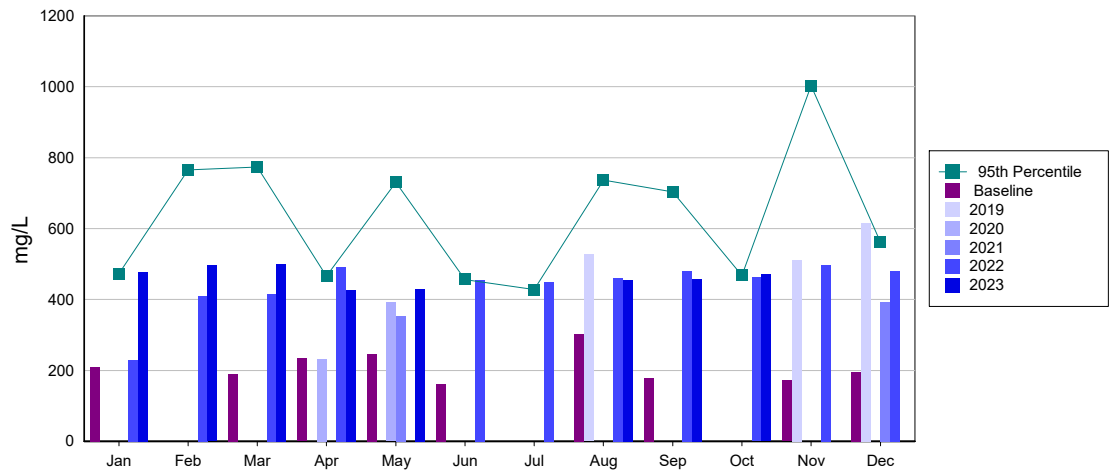
Annual Report Drainage Water

Mount Polley

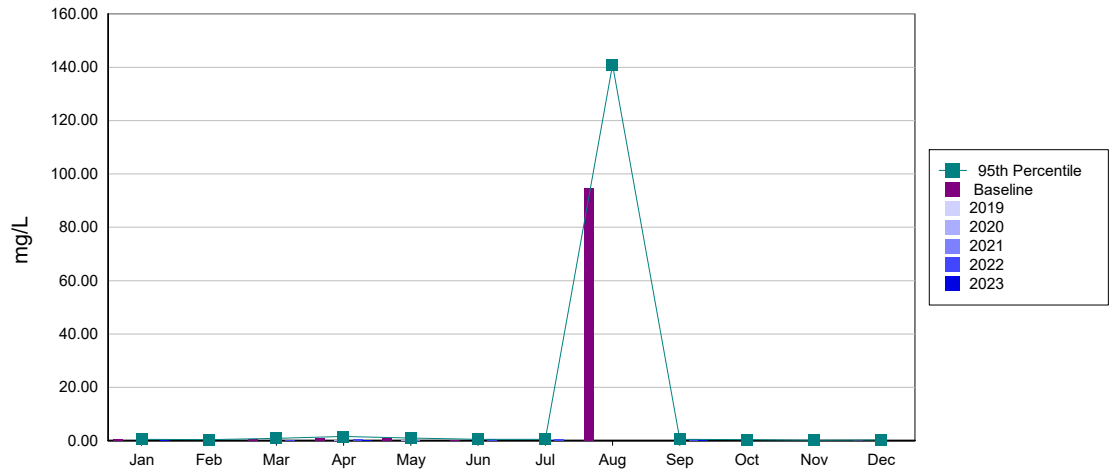
Mining Corporation

IMPERIAL METALS CORPORATION

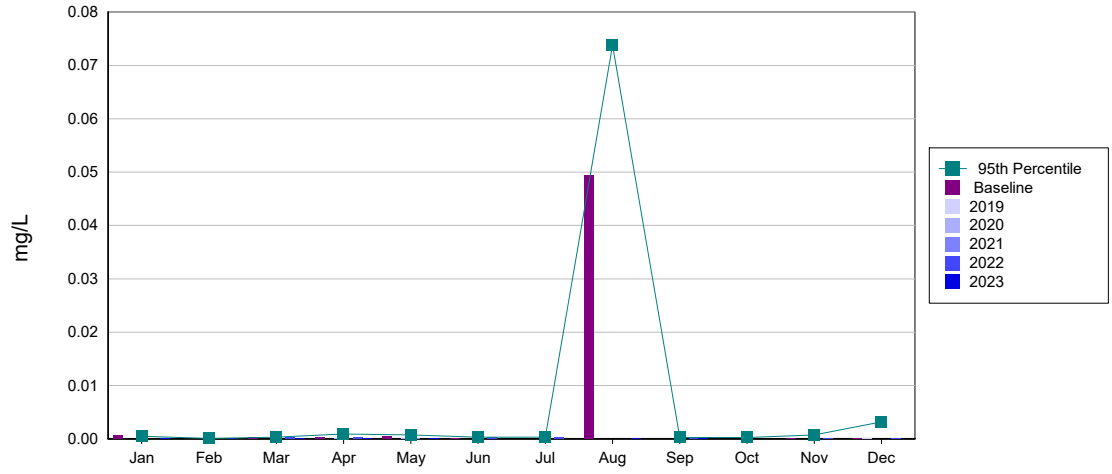
E8 - Effluent from Cariboo pit : Hardness (mg/L)



E8 - Effluent from Cariboo pit : Iron (Fe)-Total (mg/L)



E8 - Effluent from Cariboo pit : Lead (Pb)-Total (mg/L)



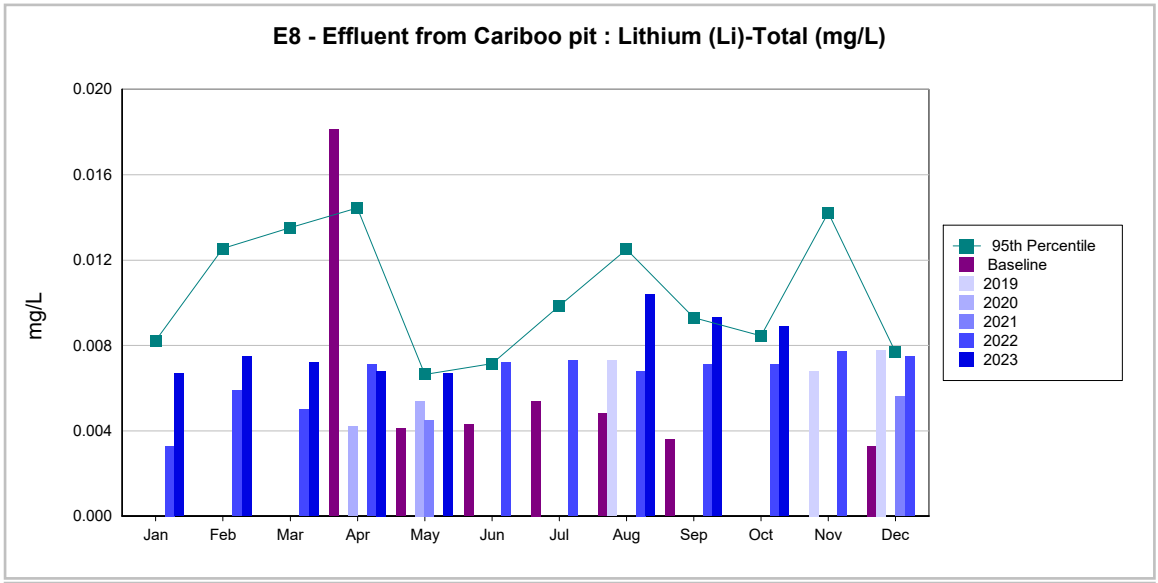
Water Quality Report

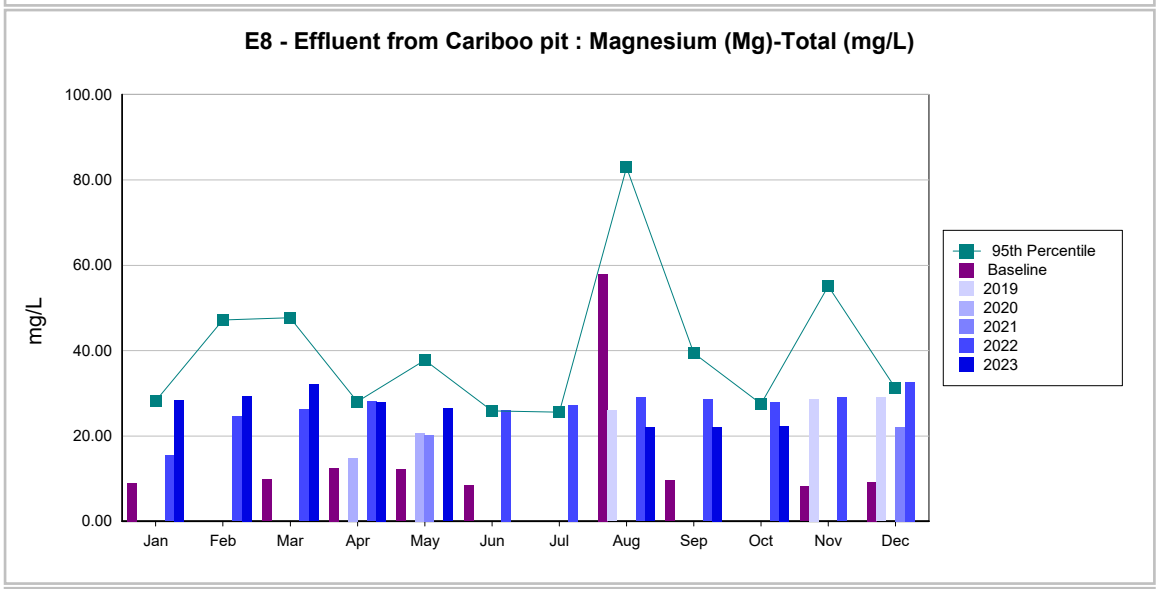
Annual Report Drainage Water

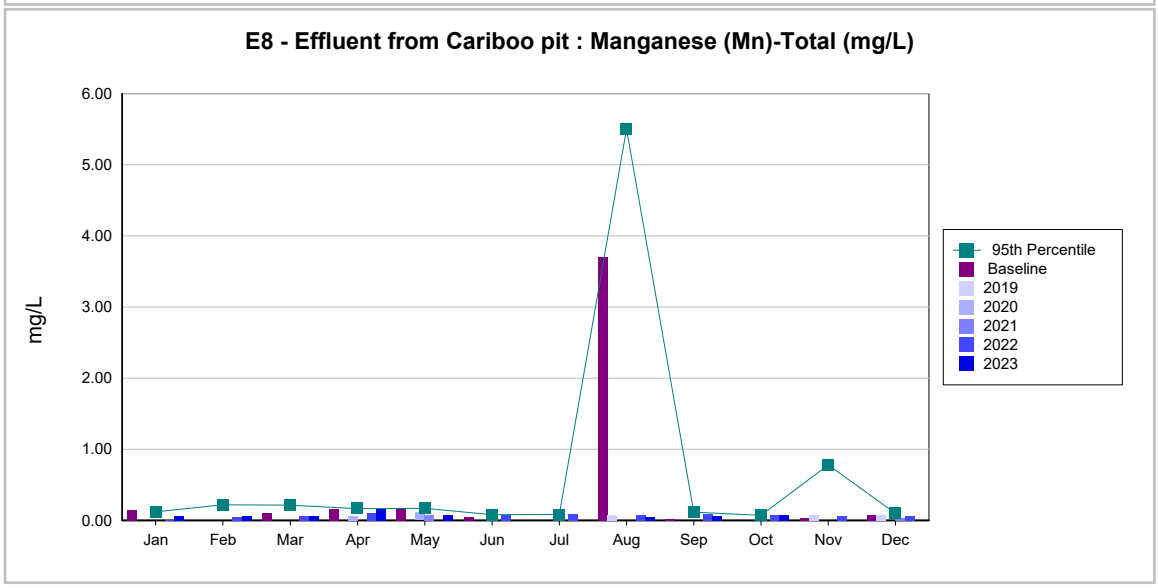
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

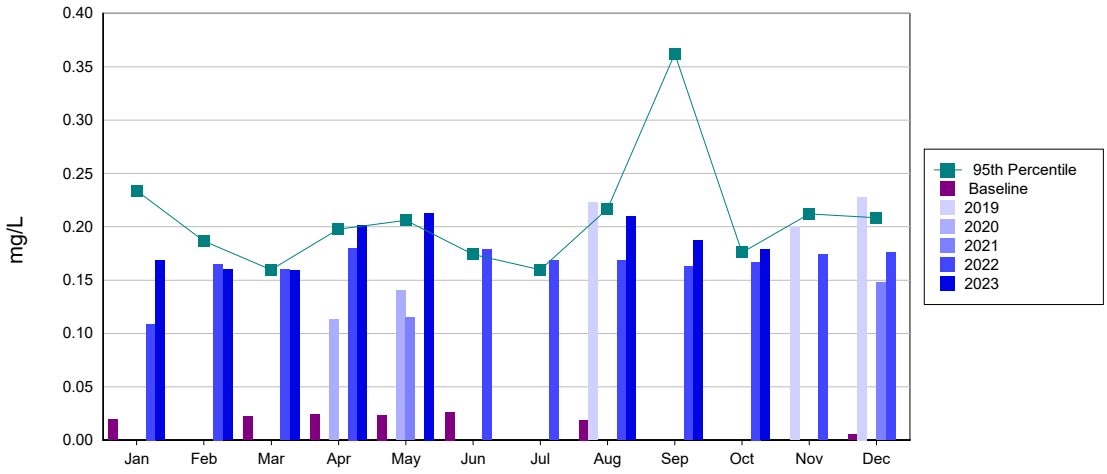
Annual Report Drainage Water

Mount Polley

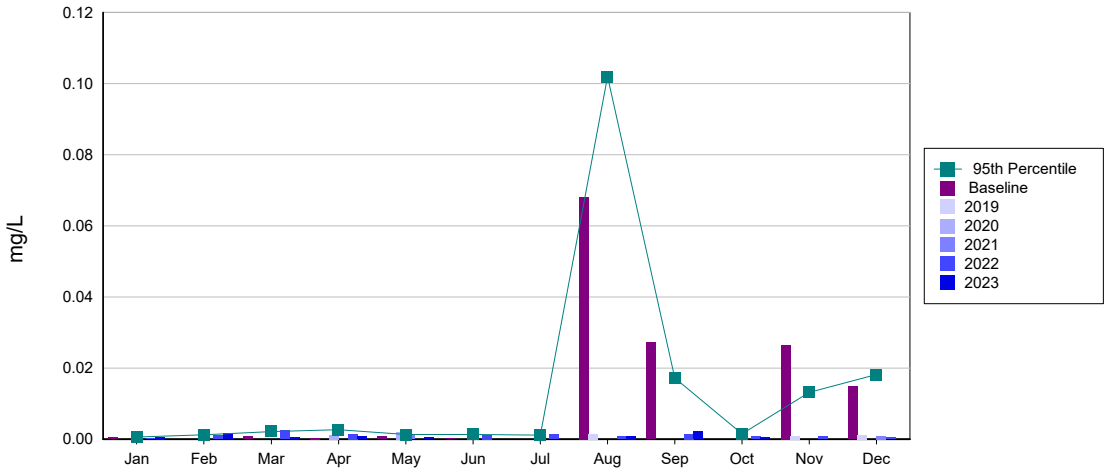
Mining Corporation

IMPERIAL METALS CORPORATION

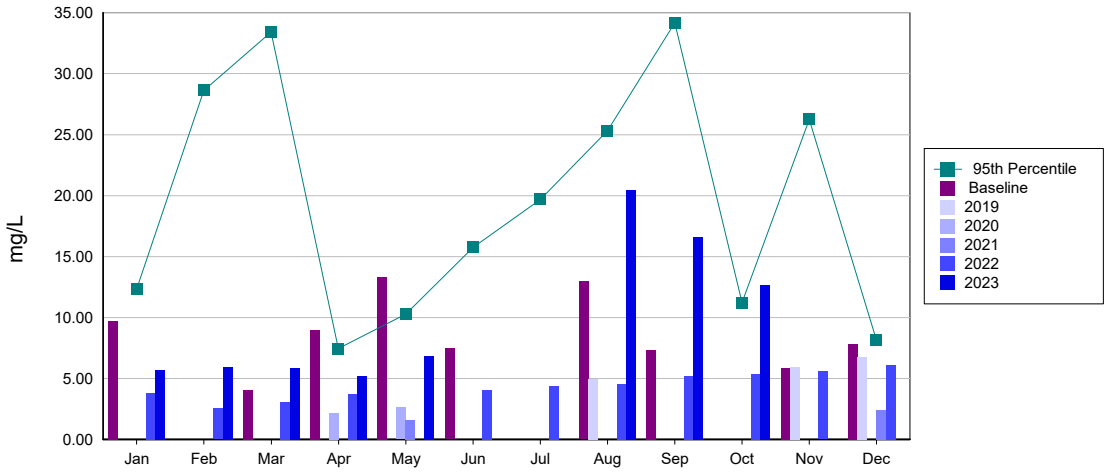
E8 - Effluent from Cariboo pit : Molybdenum (Mo)-Tota (mg/L)



E8 - Effluent from Cariboo pit : Nickel (Ni)-Total (mg/L)



E8 - Effluent from Cariboo pit : Nitrate (N) (mg/L)



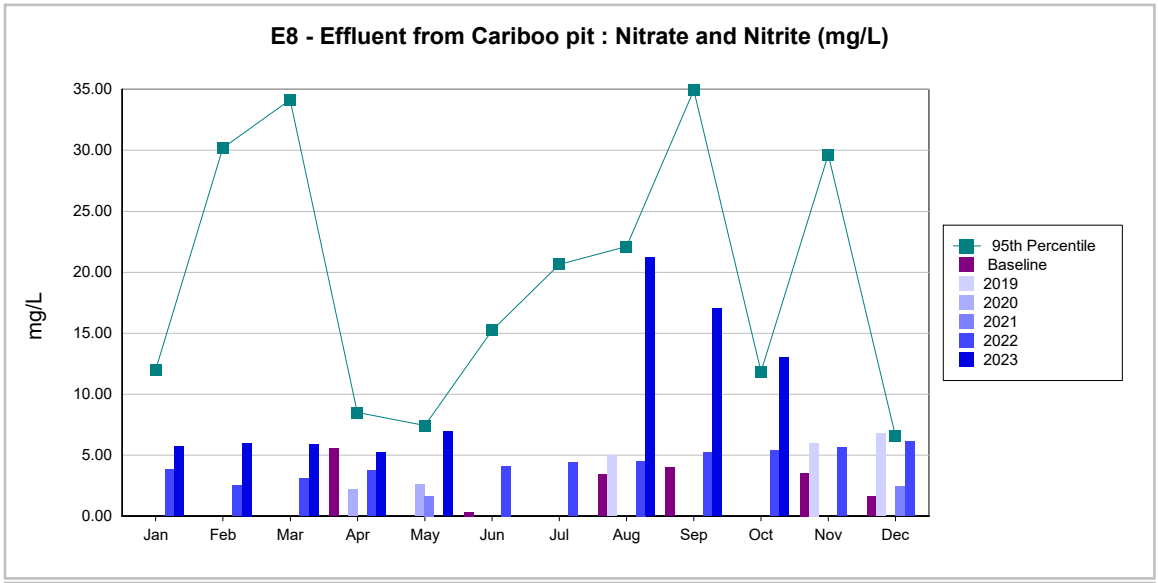
Water Quality Report

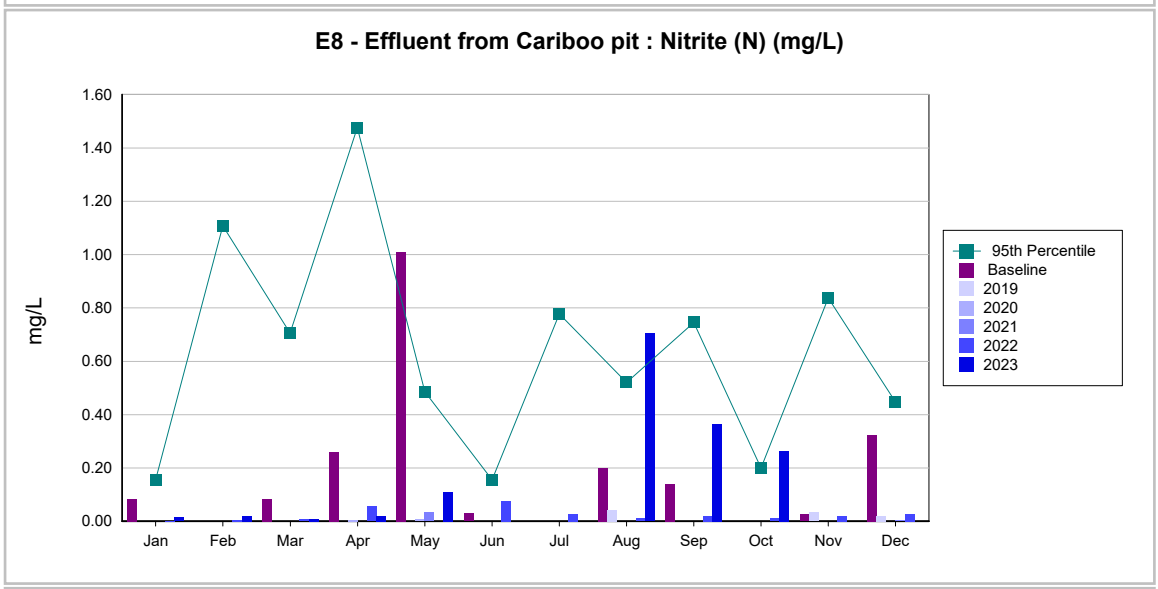
Annual Report Drainage Water

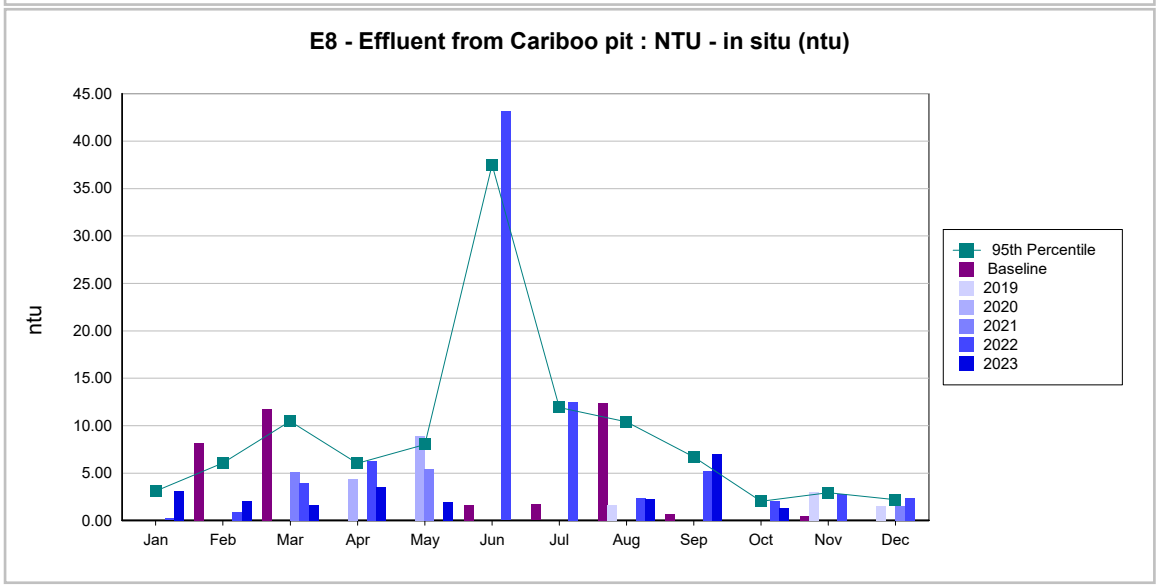
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







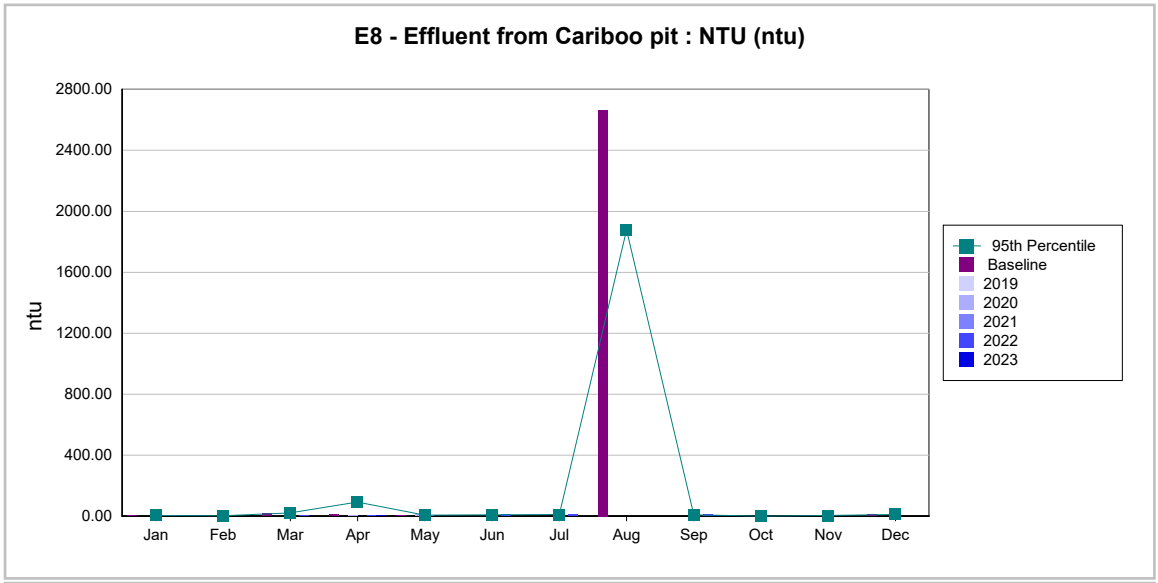
Water Quality Report

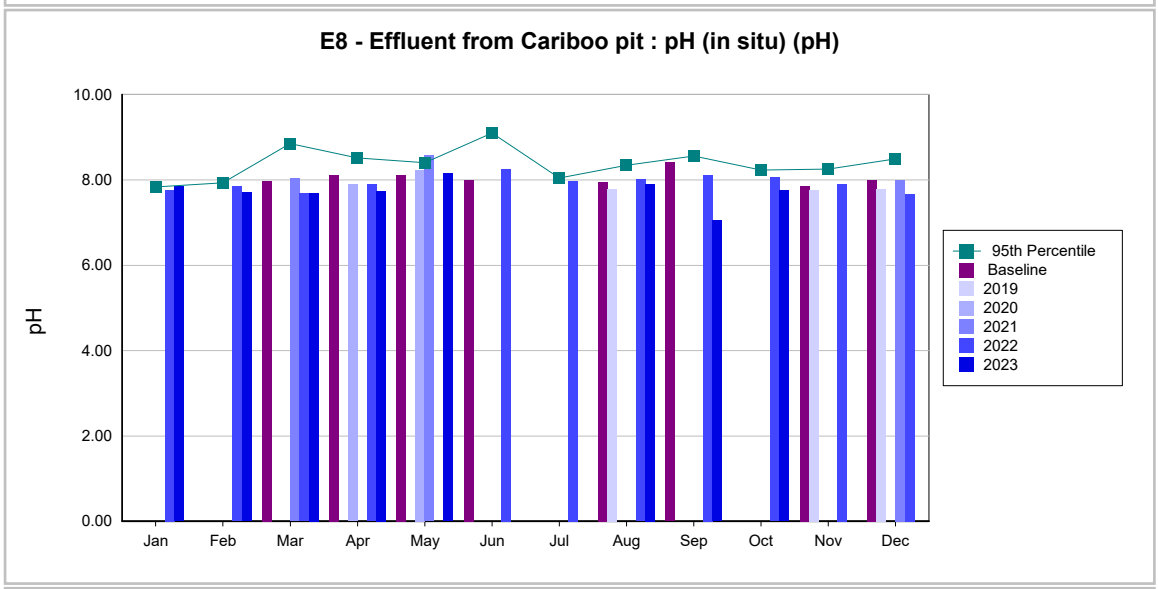
Annual Report Drainage Water

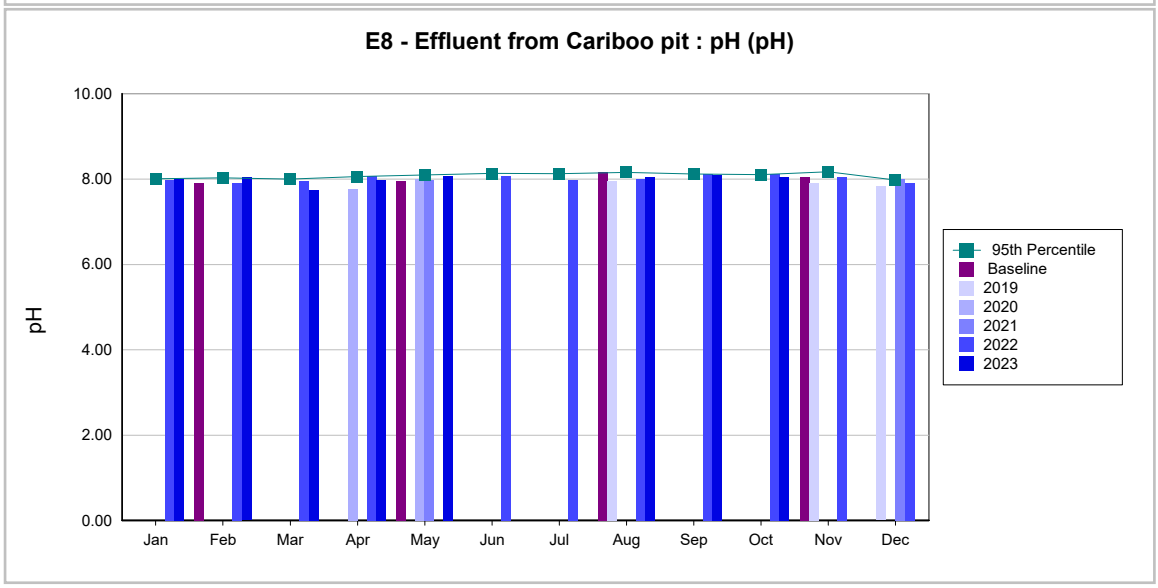
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

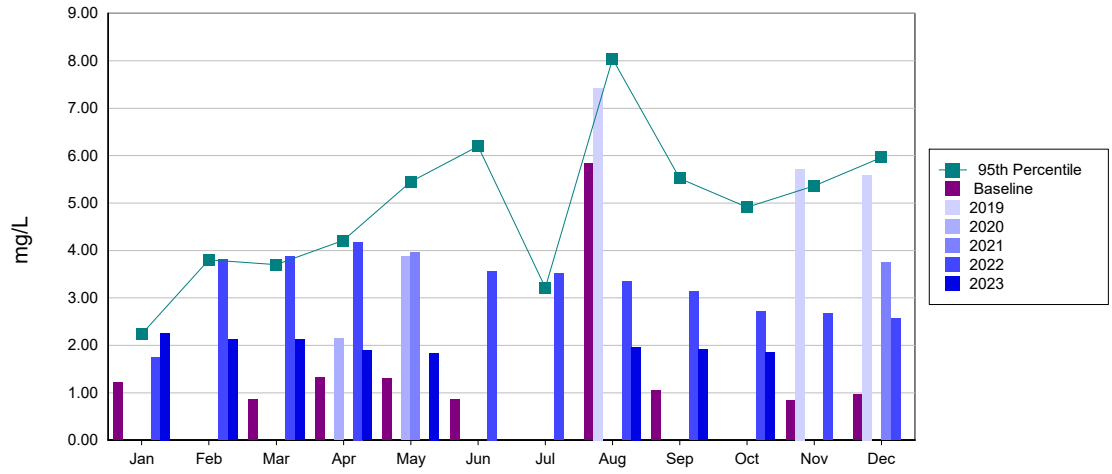
Annual Report Drainage Water

Mount Polley

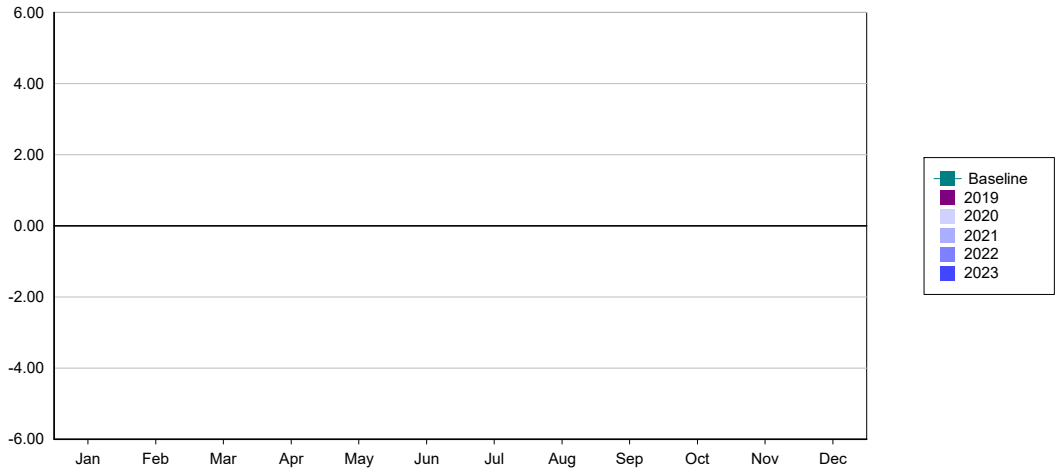
Mining Corporation

IMPERIAL METALS CORPORATION

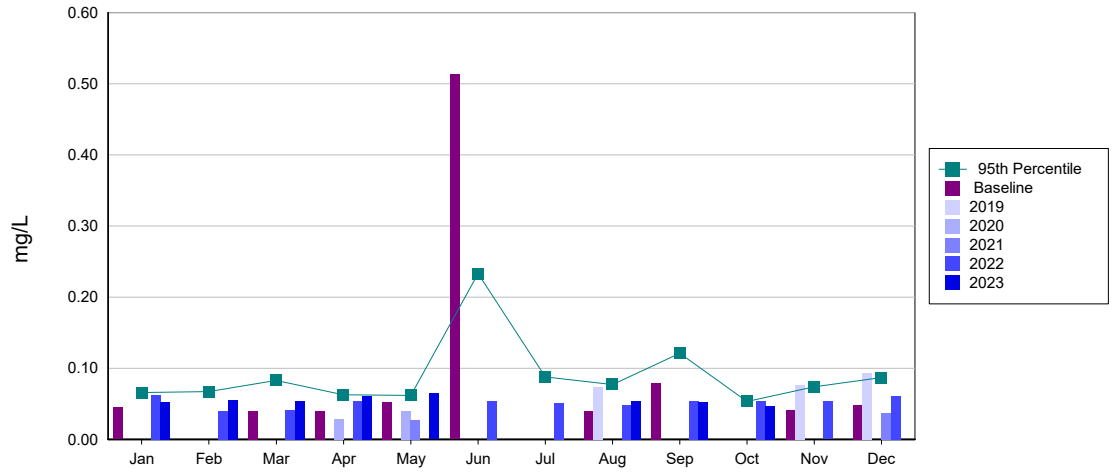
E8 - Effluent from Cariboo pit : Potassium (K)-Total (mg/L)



E8 - Effluent from Cariboo pit : Sample Taken



E8 - Effluent from Cariboo pit : Selenium (Se)-Total (mg/L)



Water Quality Report

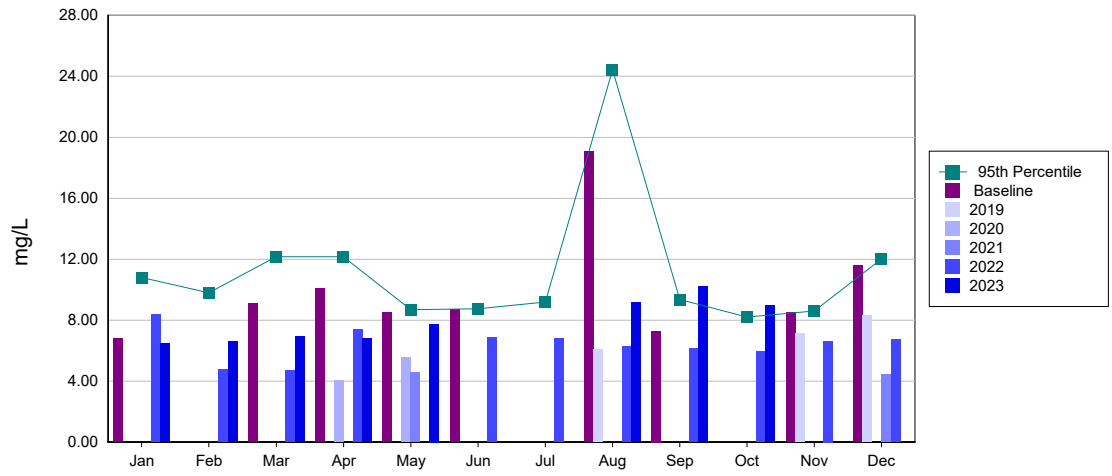
Annual Report Drainage Water

Mount Polley

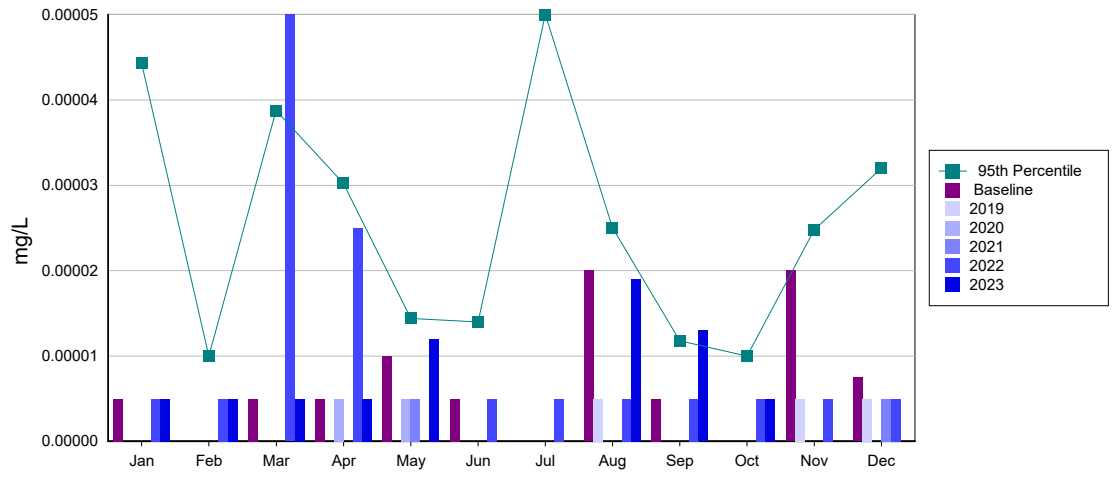
Mining Corporation

IMPERIAL METALS CORPORATION

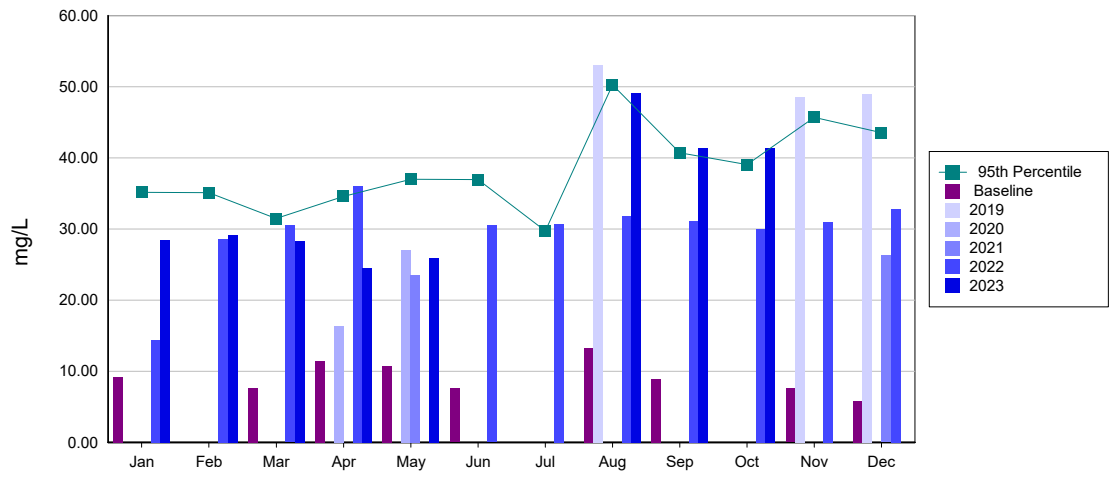
E8 - Effluent from Cariboo pit : Silicon (Si)-Total (mg/L)



E8 - Effluent from Cariboo pit : Silver (Ag)-Total (mg/L)



E8 - Effluent from Cariboo pit : Sodium (Na)-Total (mg/L)



Water Quality Report

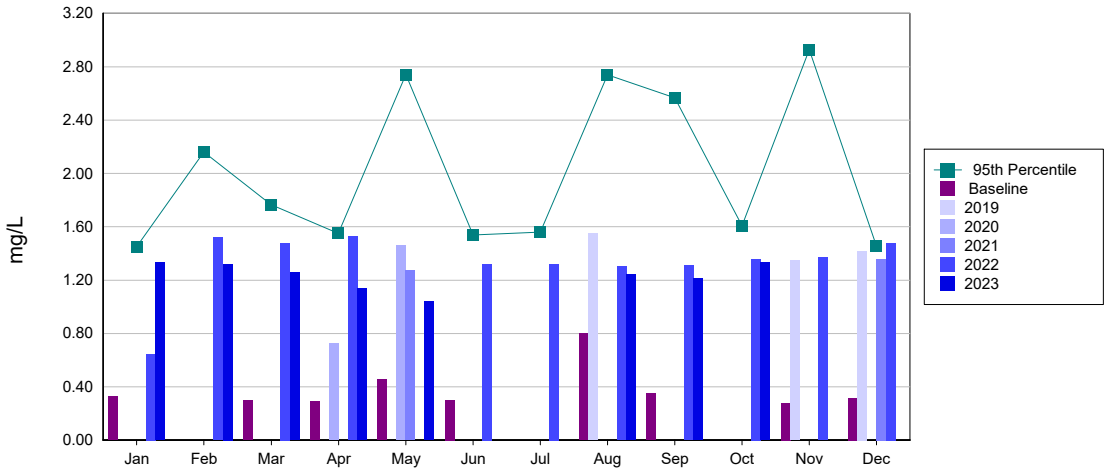
Annual Report Drainage Water

Mount Polley

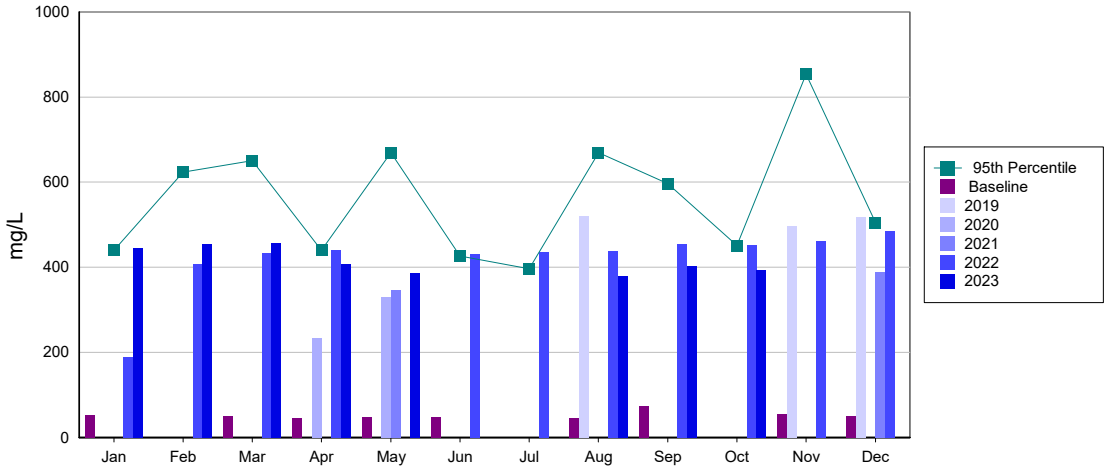
Mining Corporation

IMPERIAL METALS CORPORATION

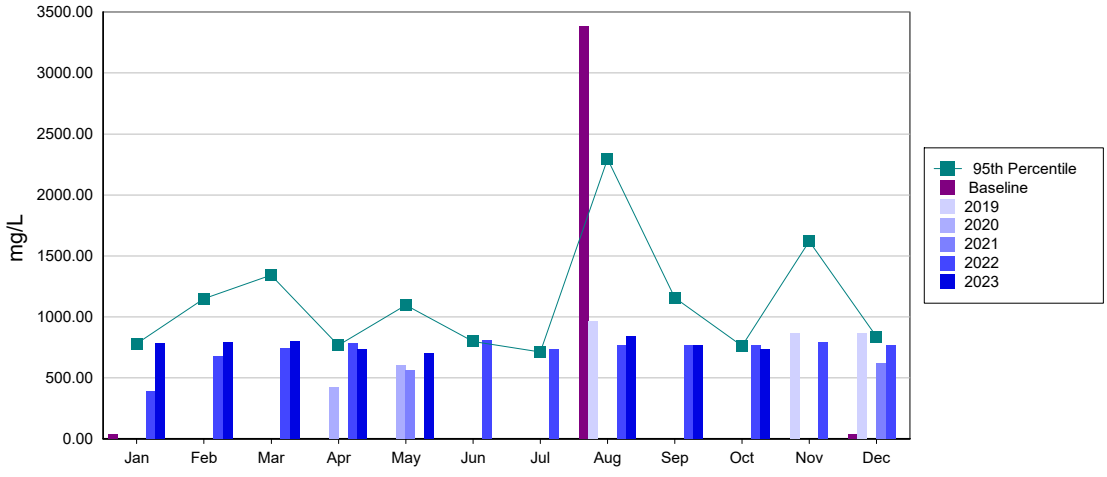
E8 - Effluent from Cariboo pit : Strontium (Sr)-Total (mg/L)



E8 - Effluent from Cariboo pit : Sulphate (mg/L)



E8 - Effluent from Cariboo pit : TDS (mg/L)



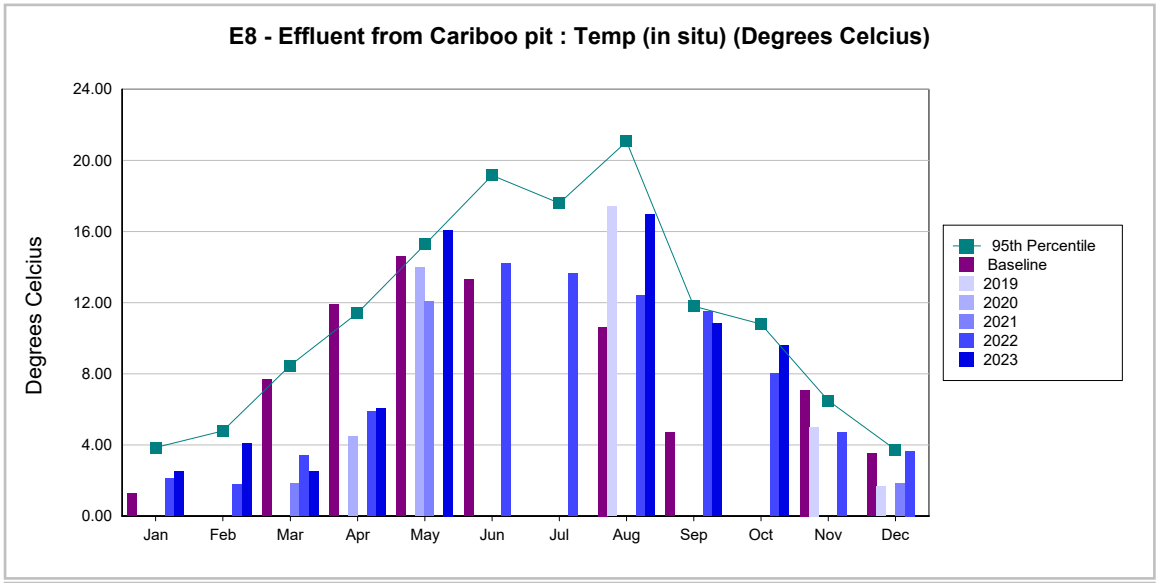
Water Quality Report

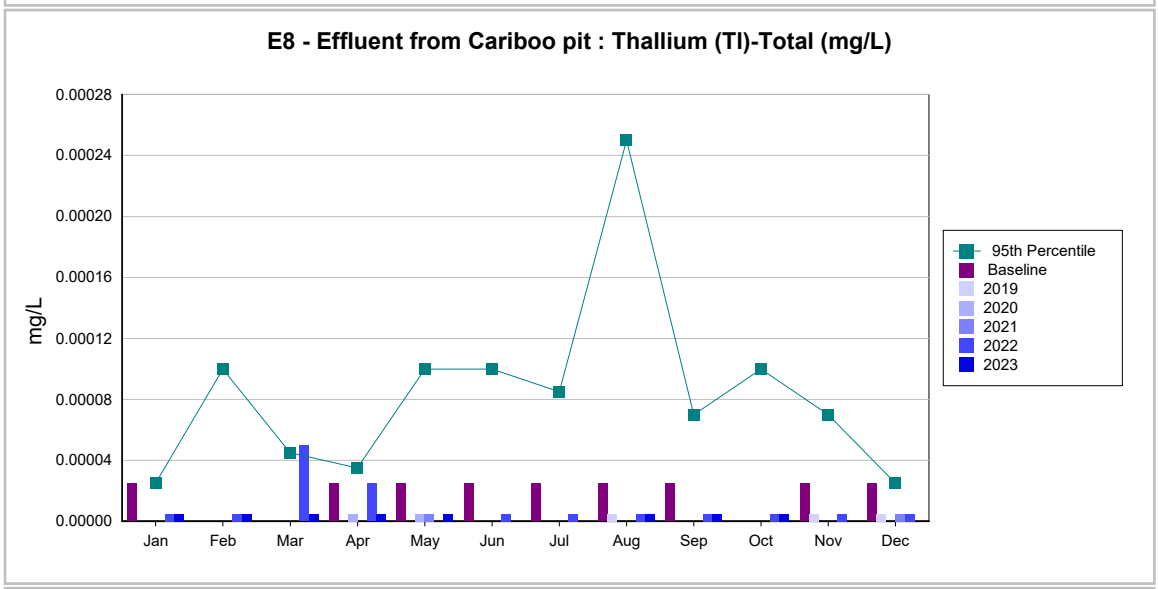
Annual Report Drainage Water

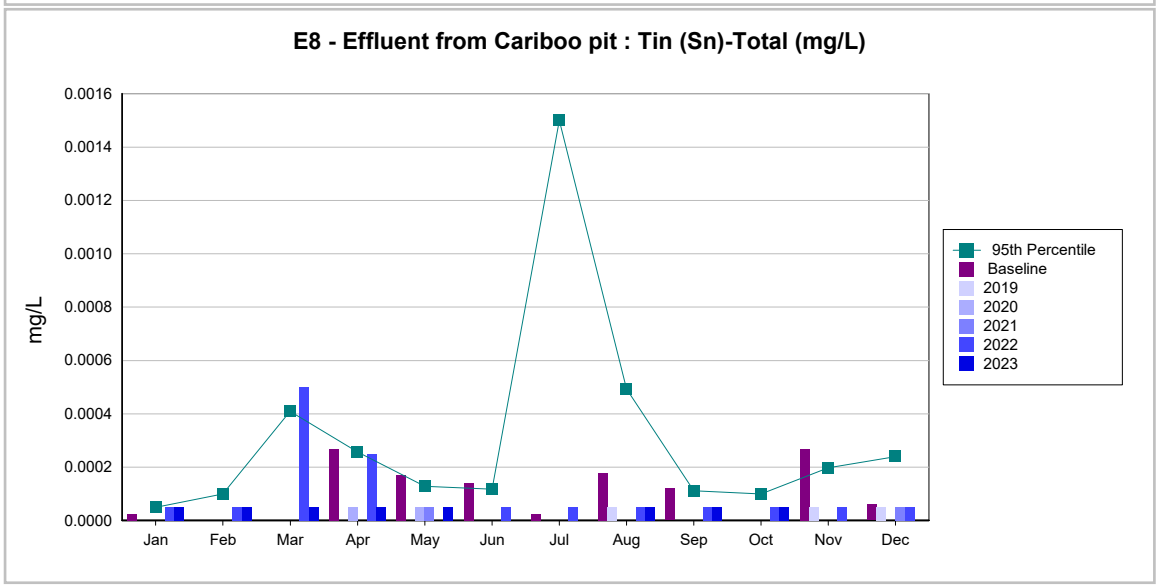
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







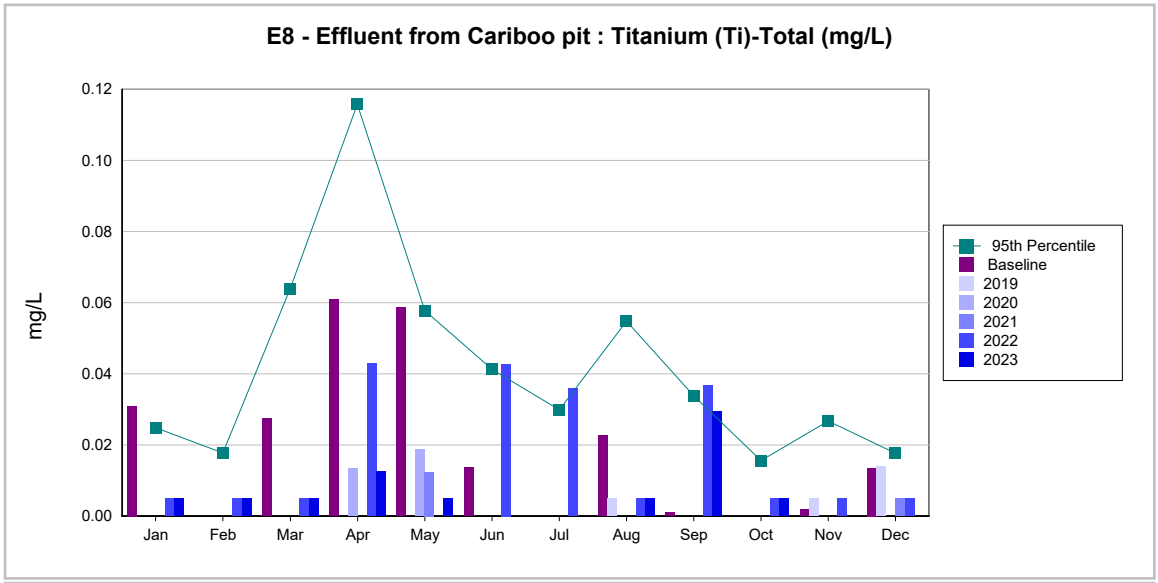
Water Quality Report

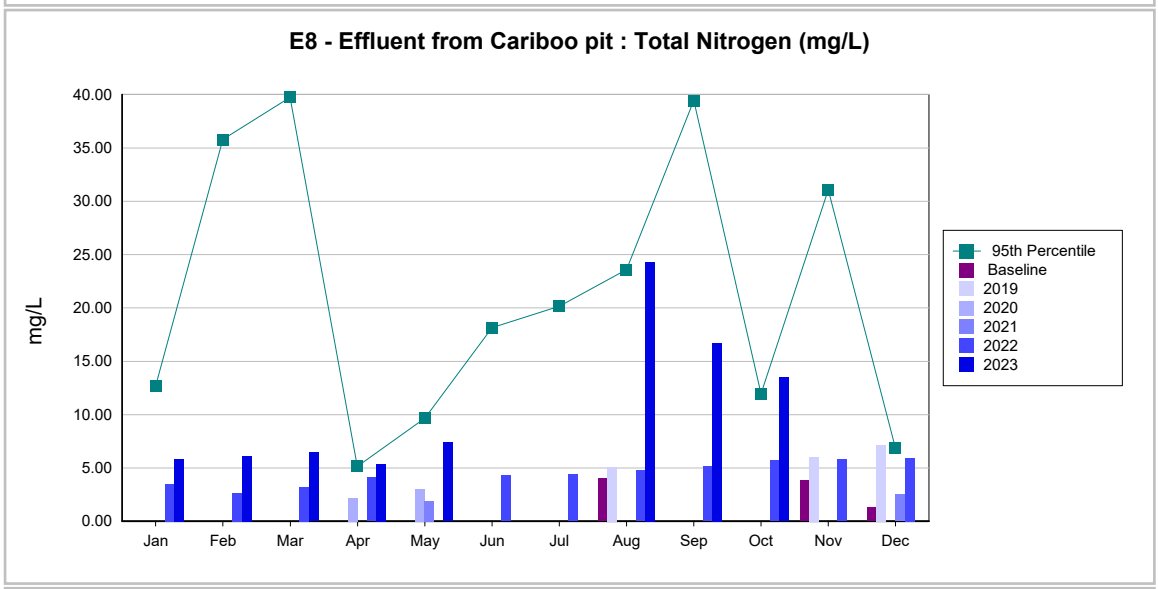
Annual Report Drainage Water

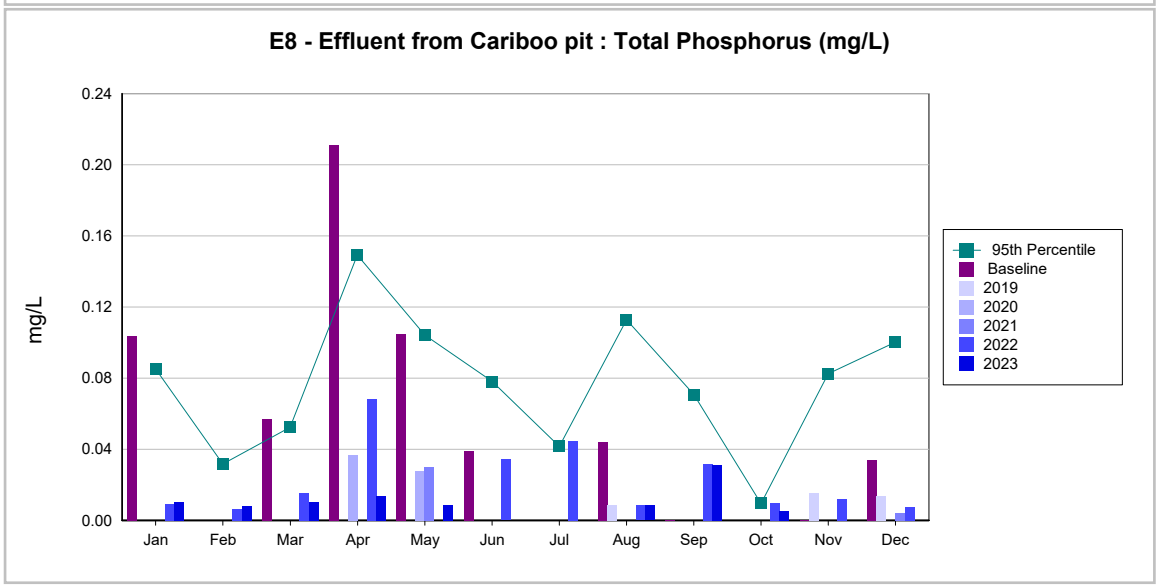
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







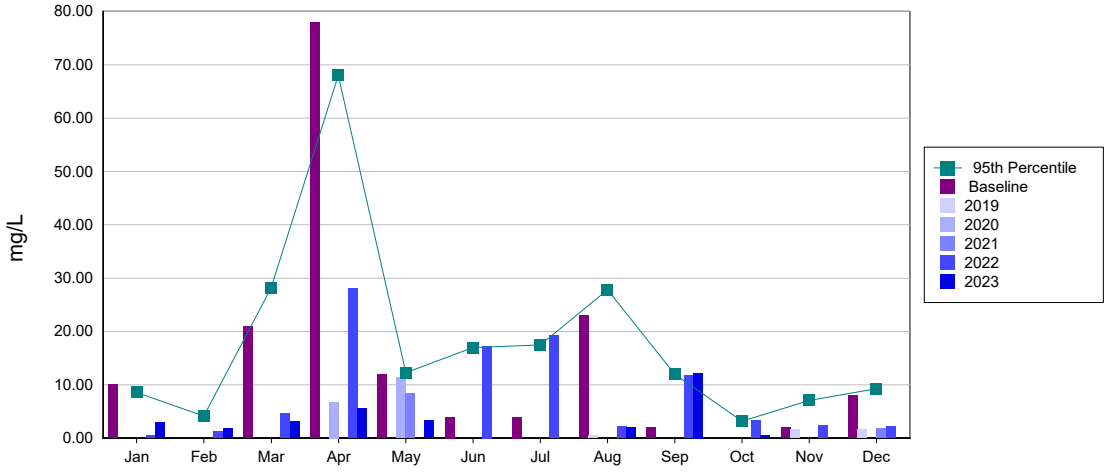
Water Quality Report

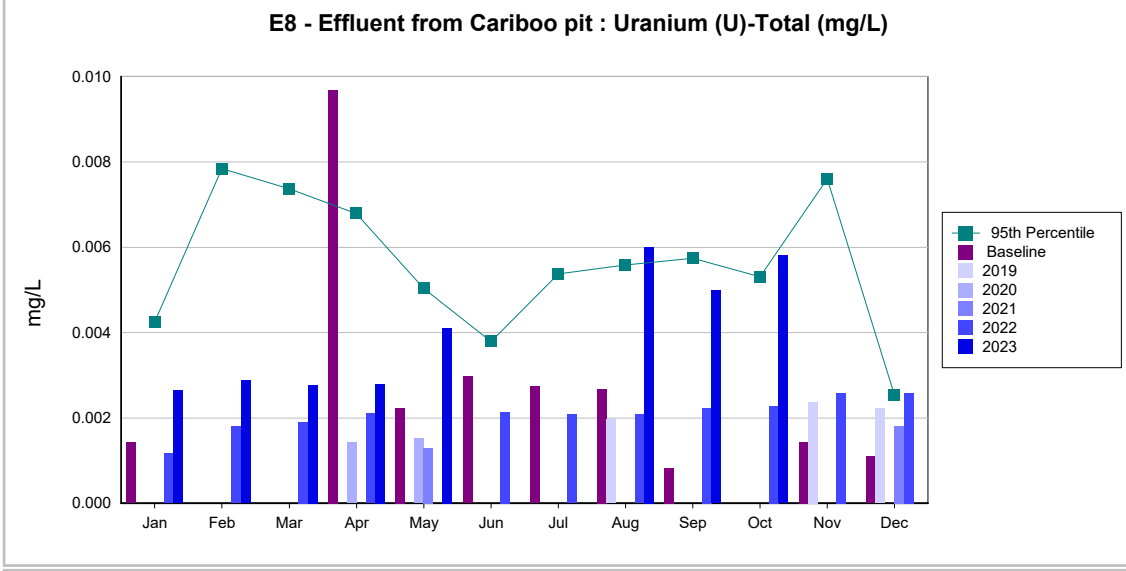
Annual Report Drainage Water

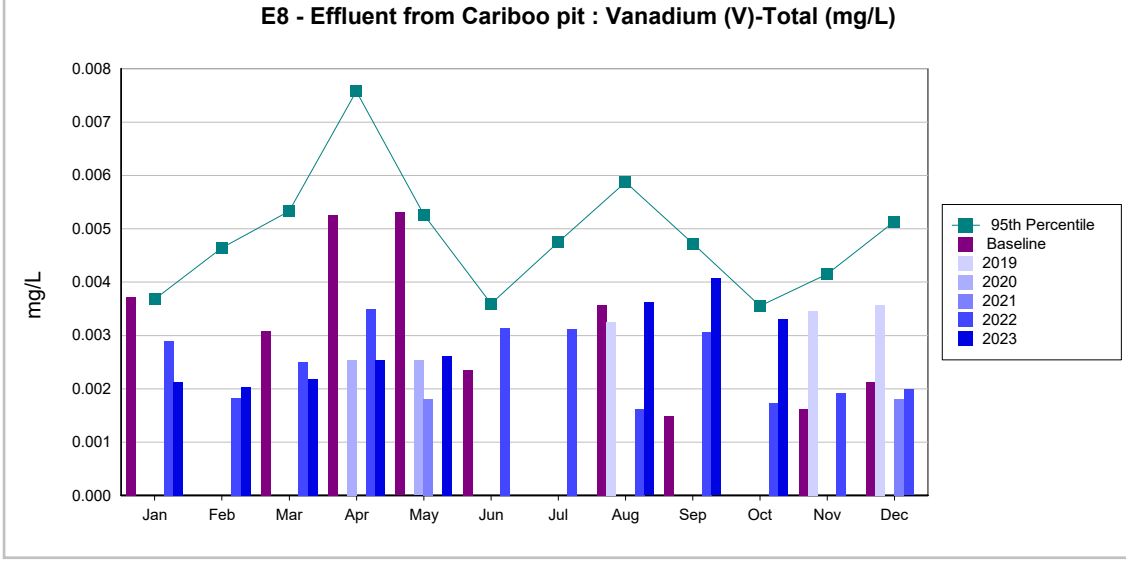
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

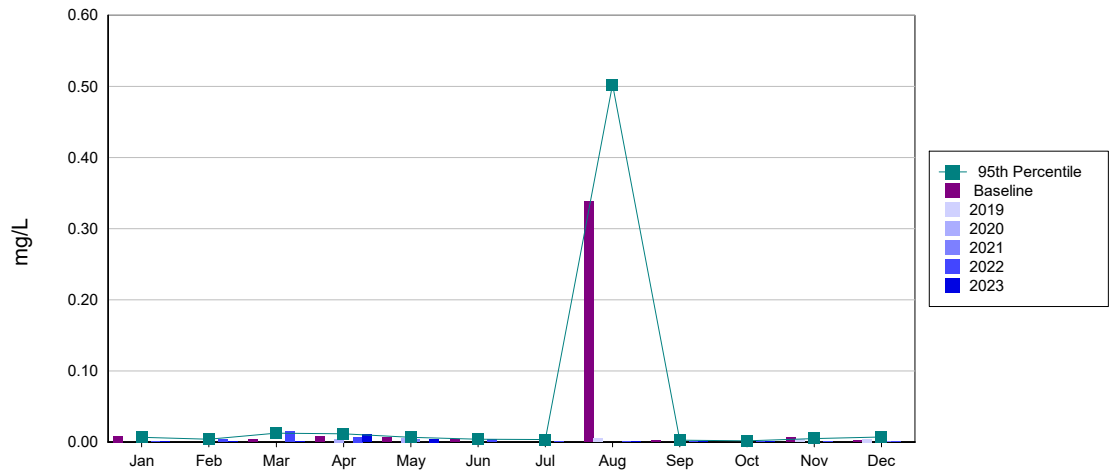
Annual Report Drainage Water

Mount Polley

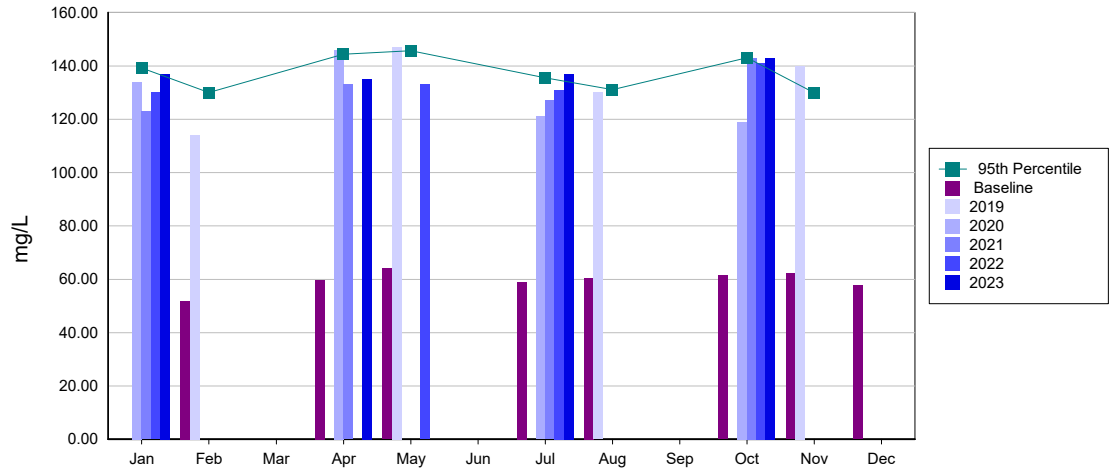
Mining Corporation

IMPERIAL METALS CORPORATION

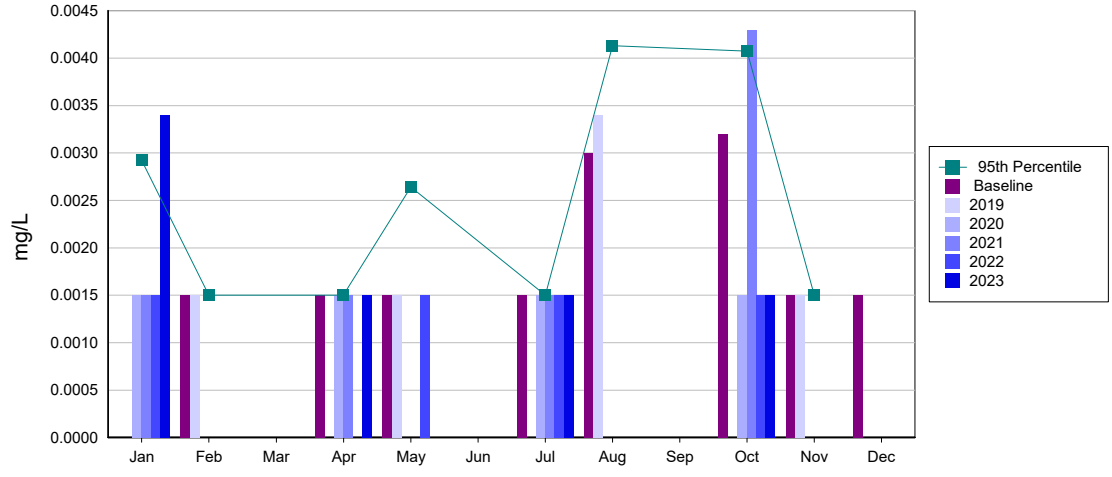
E8 - Effluent from Cariboo pit : Zinc (Zn)-Total (mg/L)



South Toe Drain : Alkalinity (CaCO3) (mg/L)



South Toe Drain : Aluminum (Al)-Diss (mg/L)



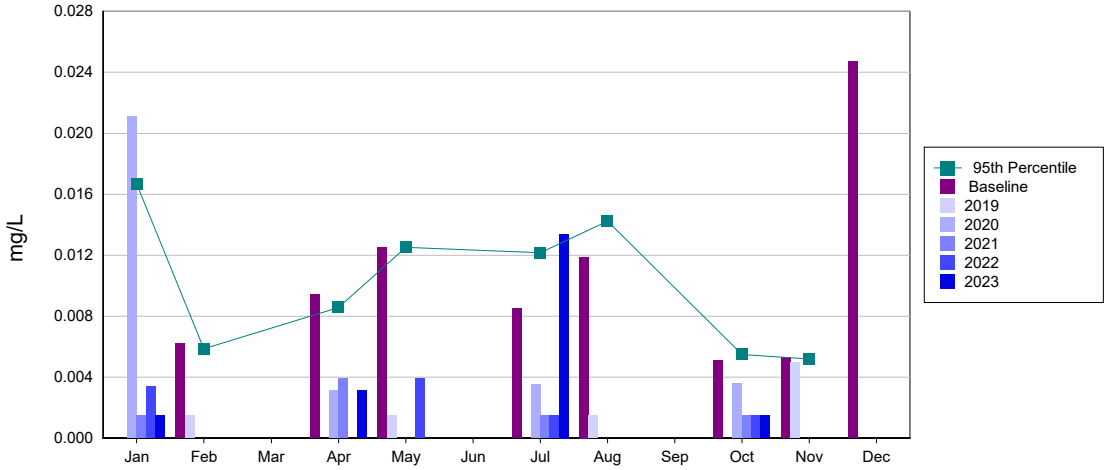
Water Quality Report

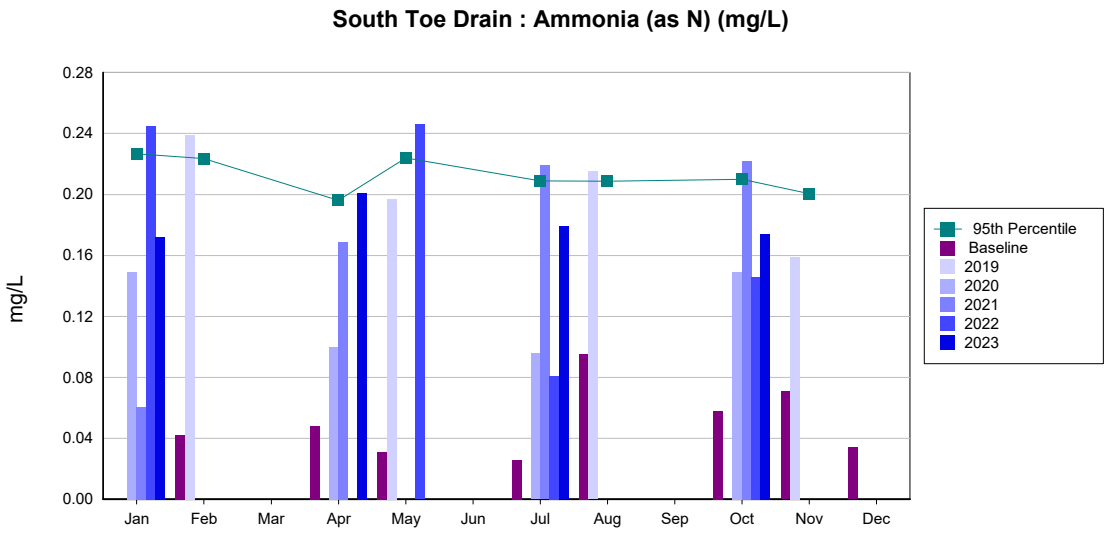
Annual Report Drainage Water

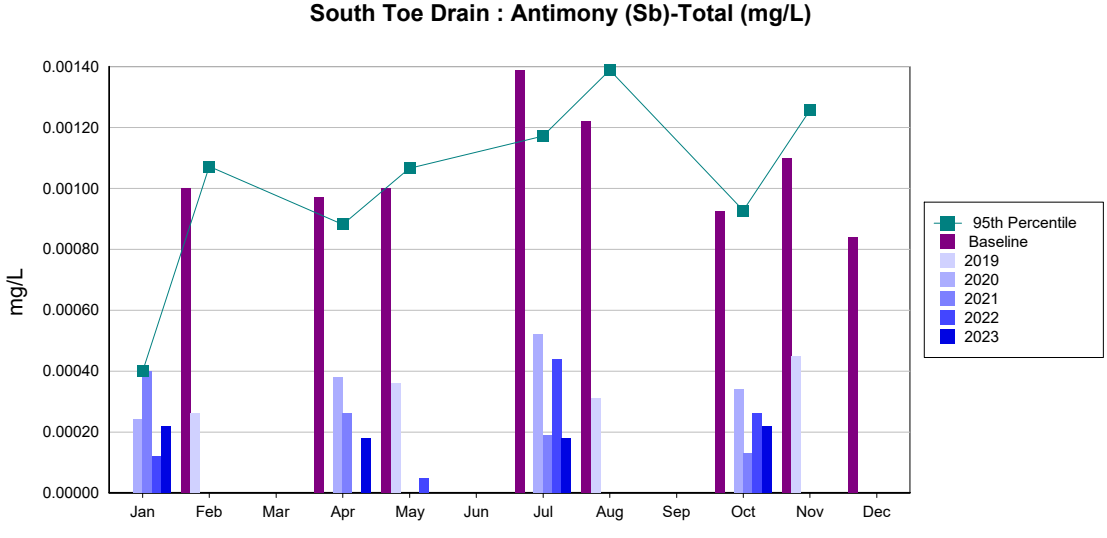
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







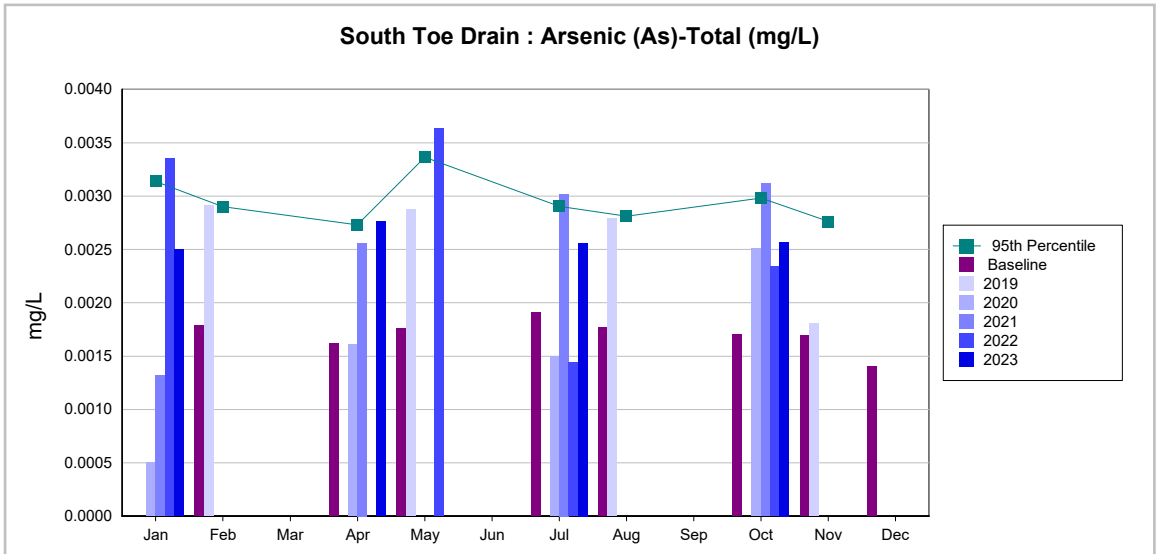
Water Quality Report

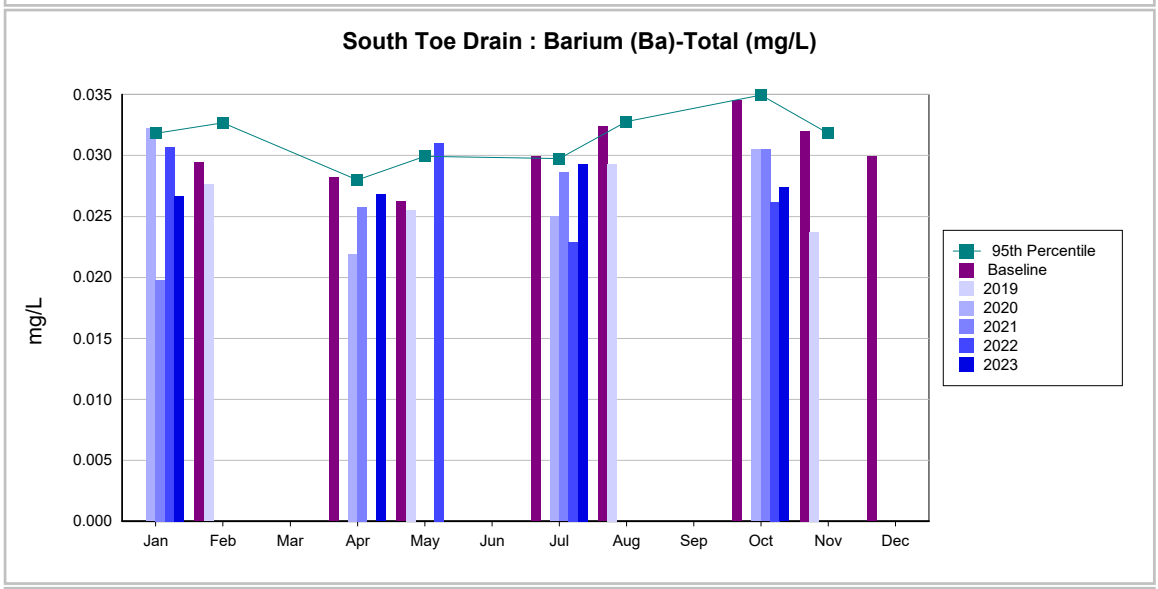
Annual Report Drainage Water

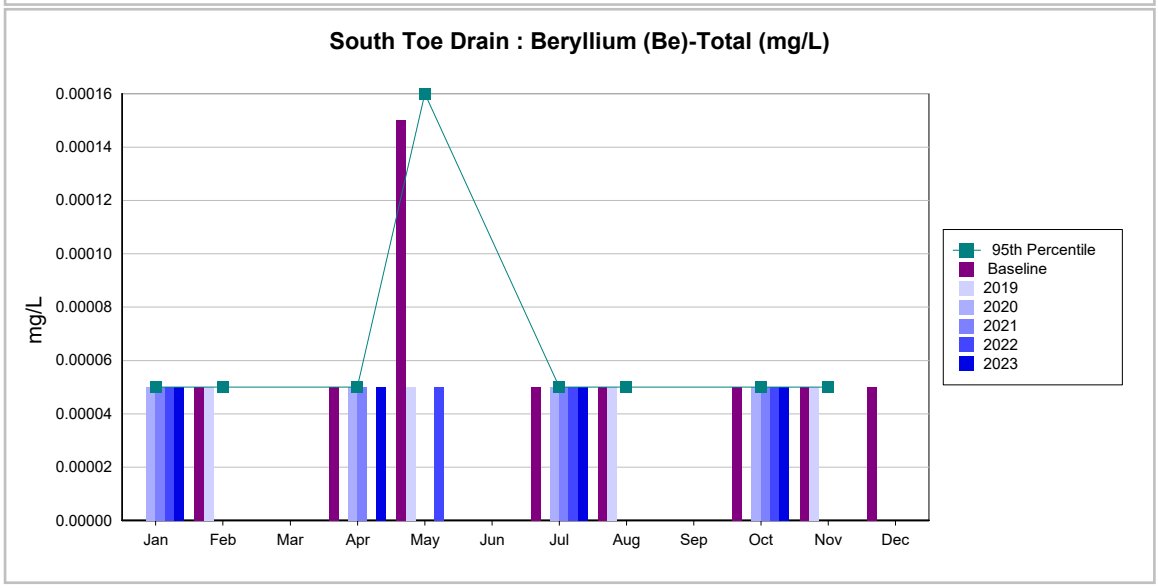
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







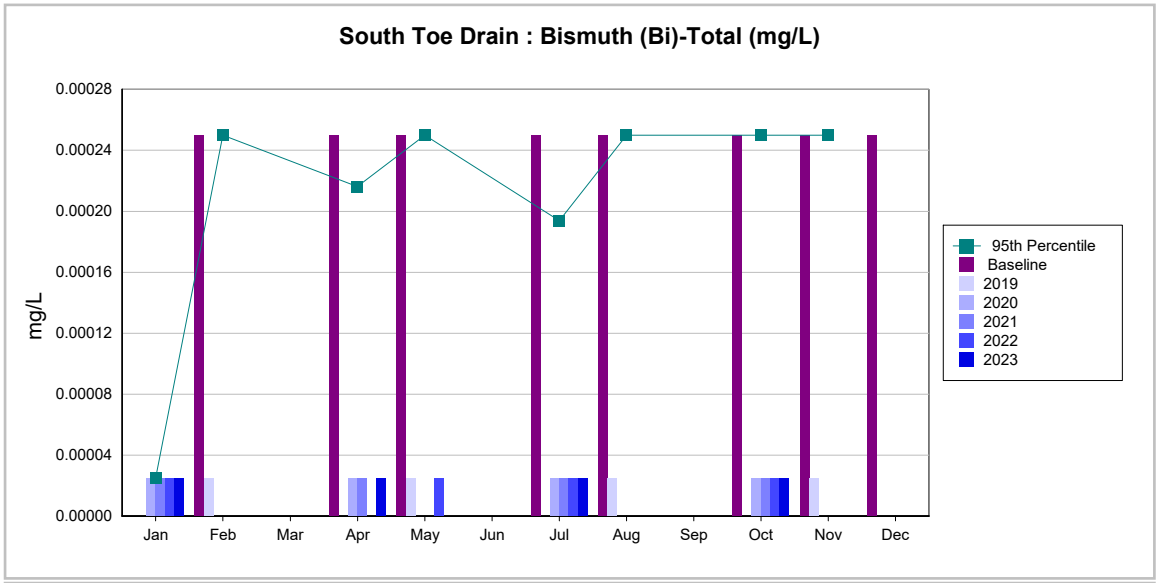
Water Quality Report

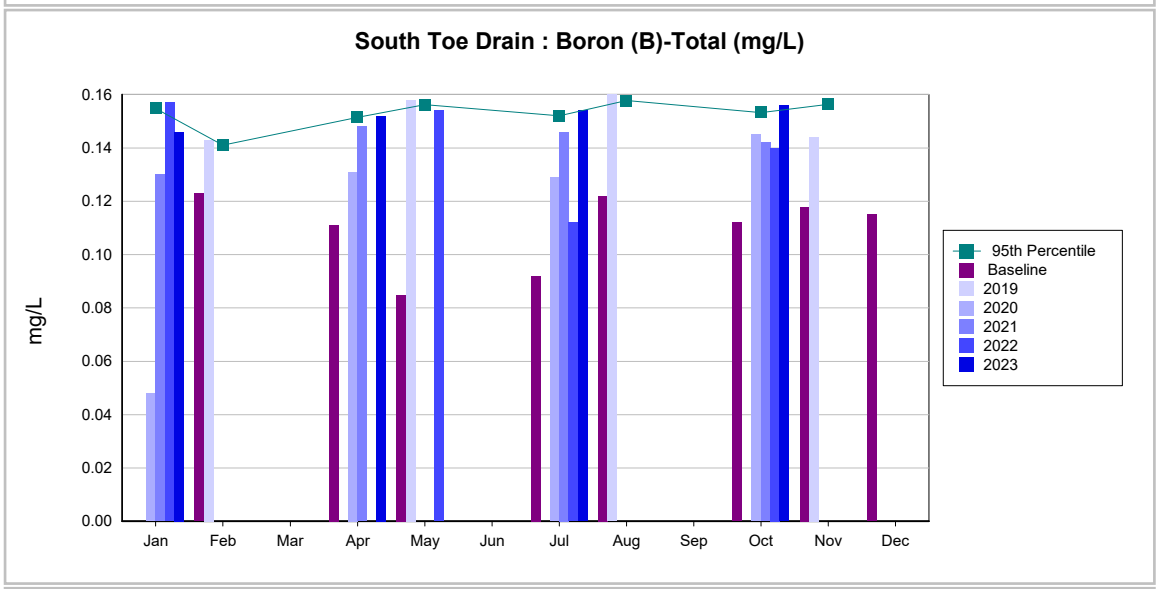
Annual Report Drainage Water

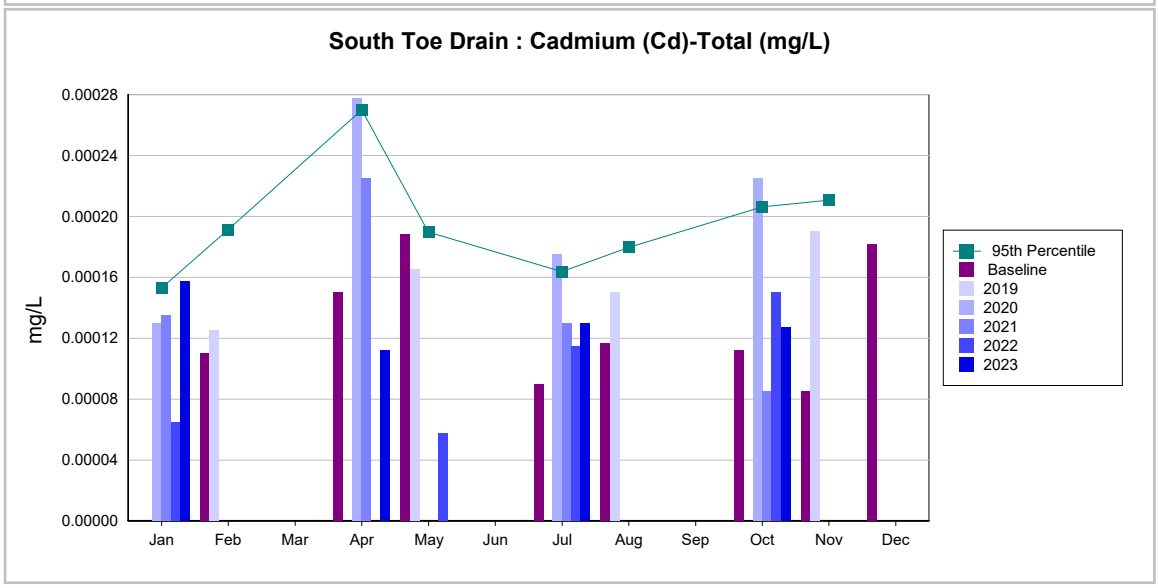
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







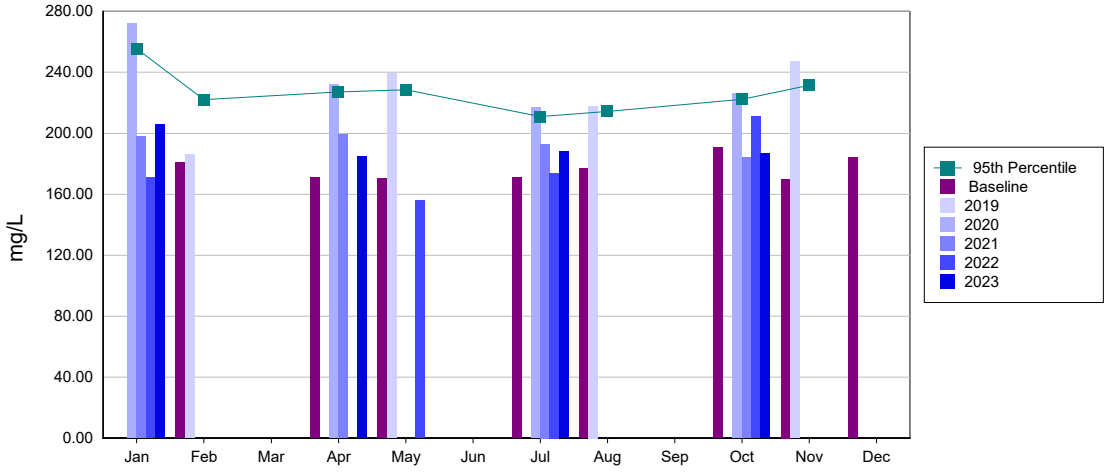
Water Quality Report

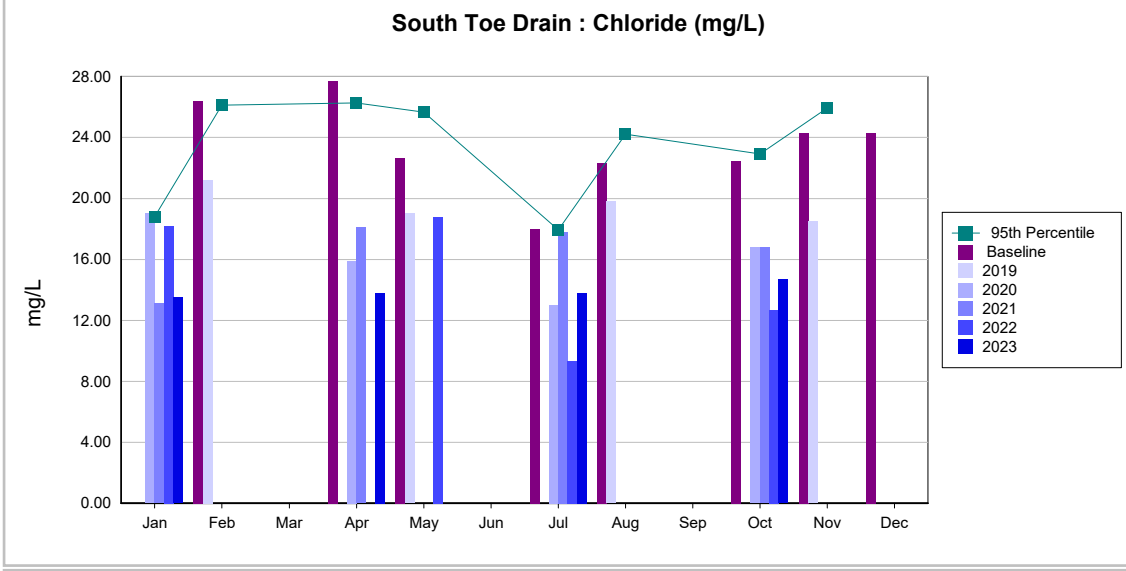
Annual Report Drainage Water

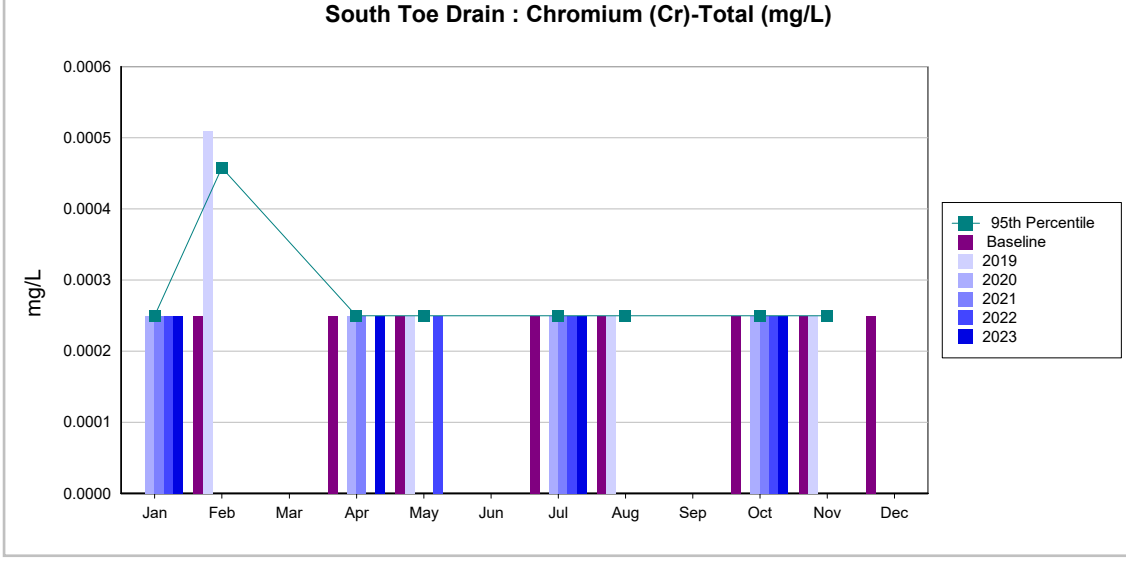
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







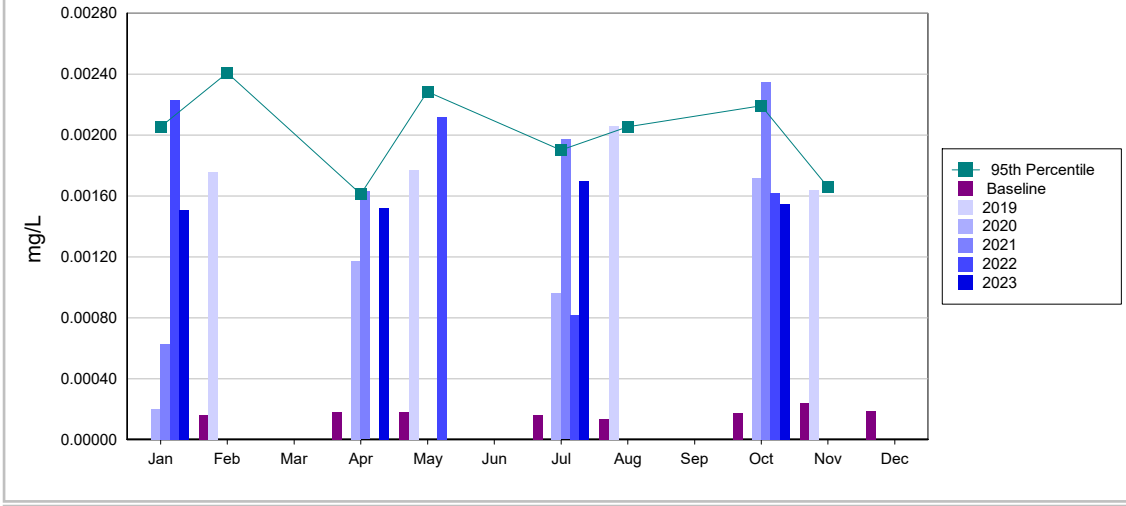
Water Quality Report

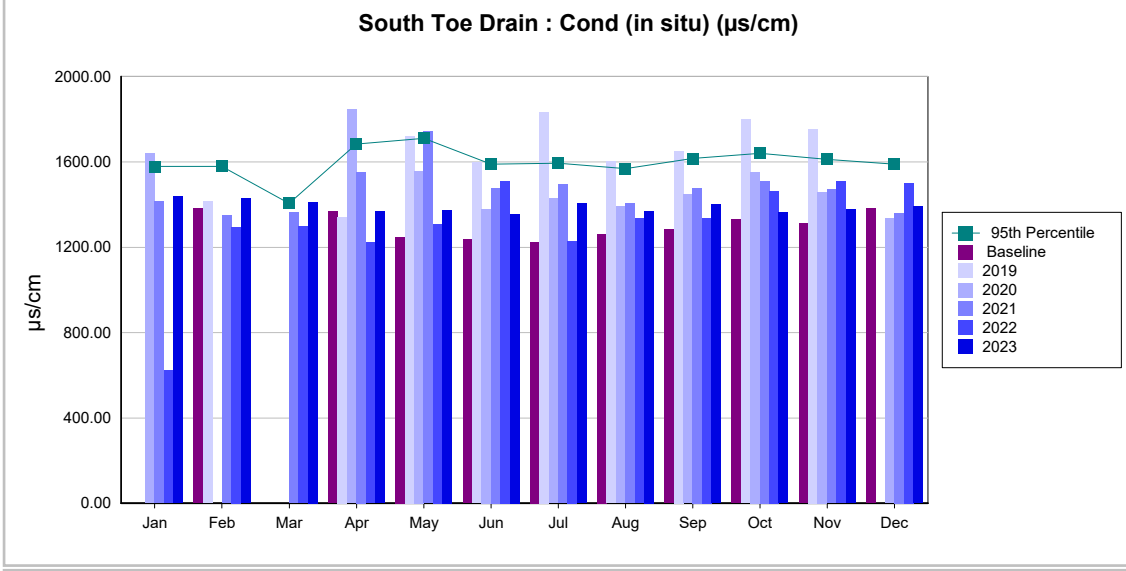
Annual Report Drainage Water

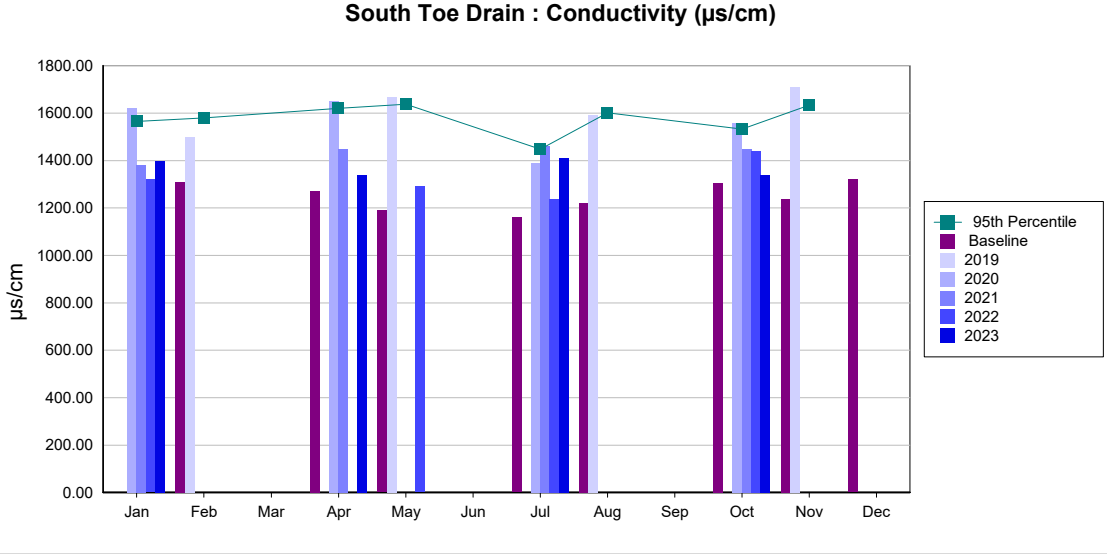
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







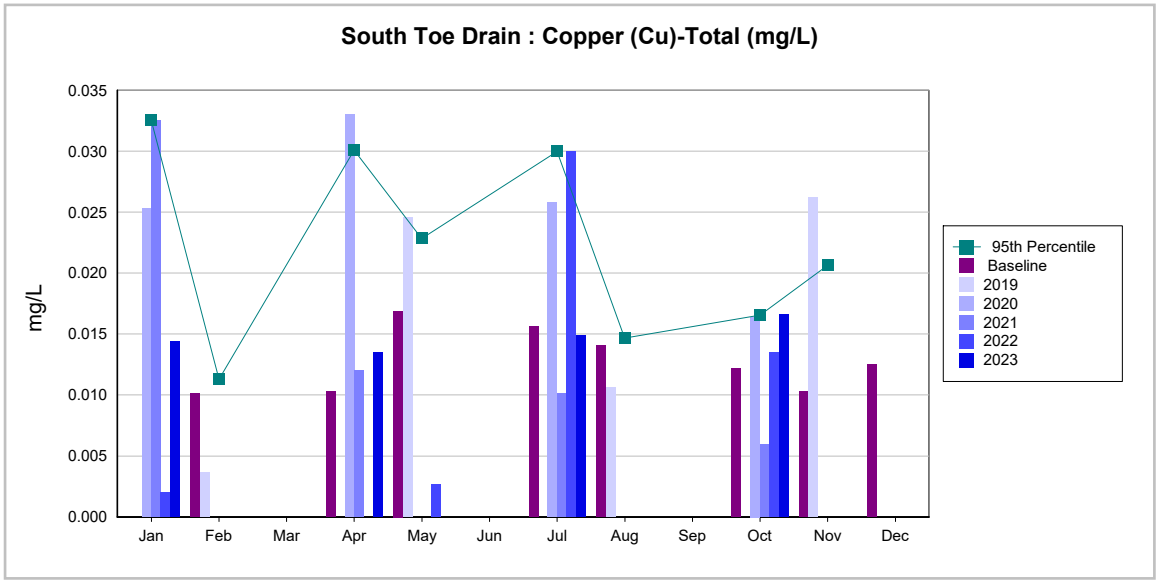
Water Quality Report

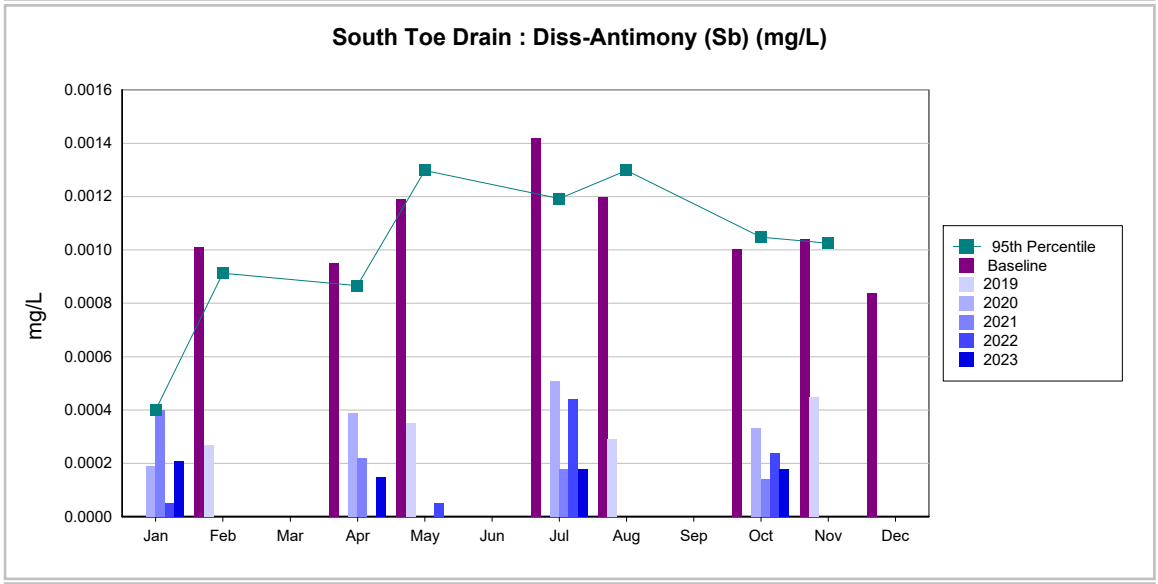
Annual Report Drainage Water

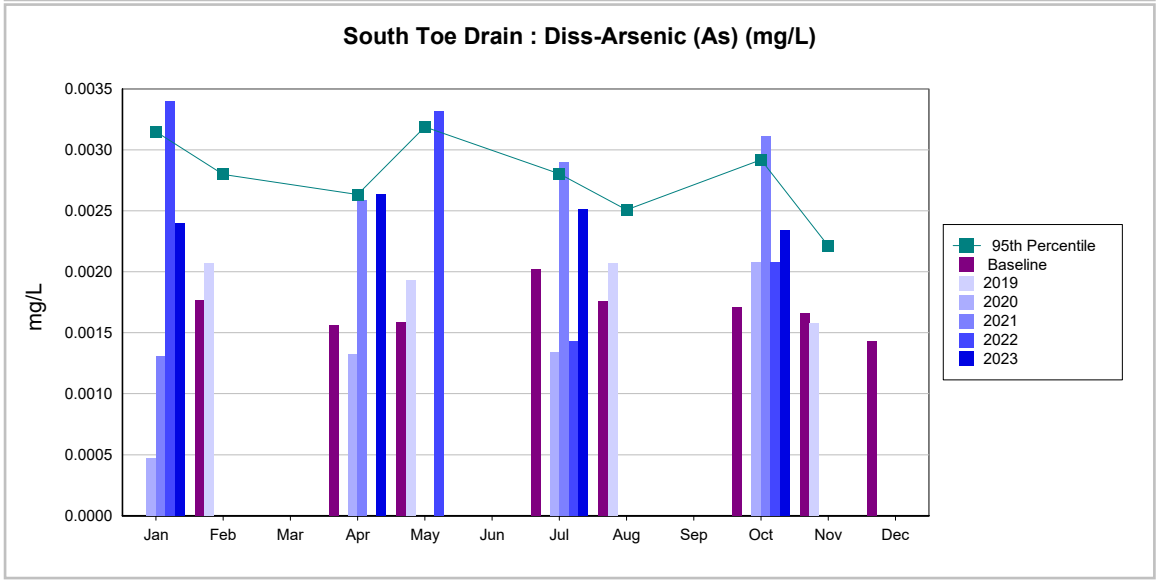
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







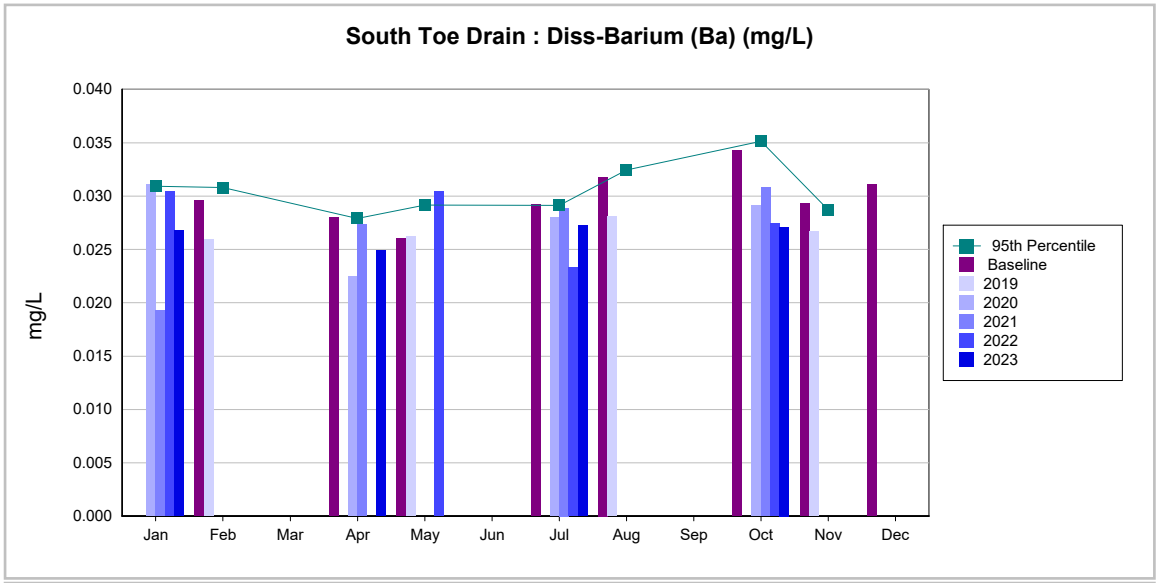
Water Quality Report

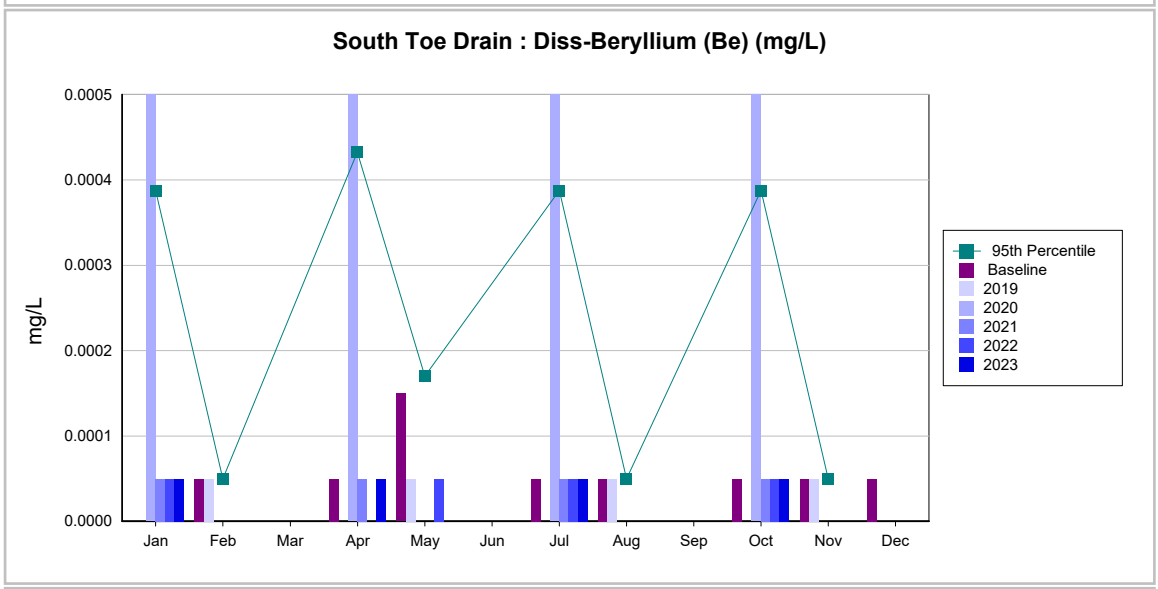
Annual Report Drainage Water

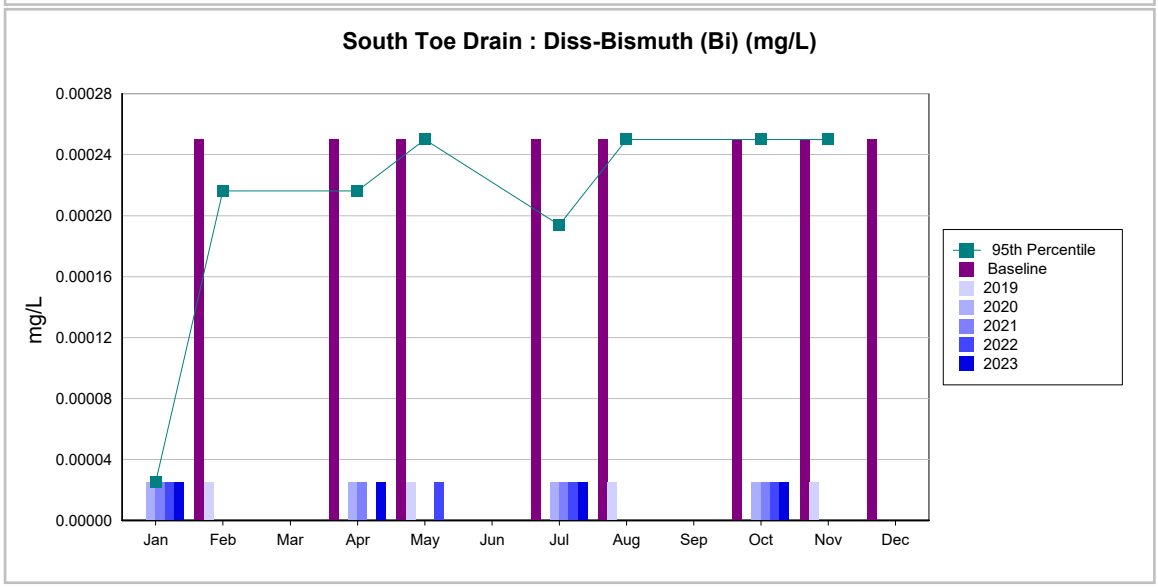
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







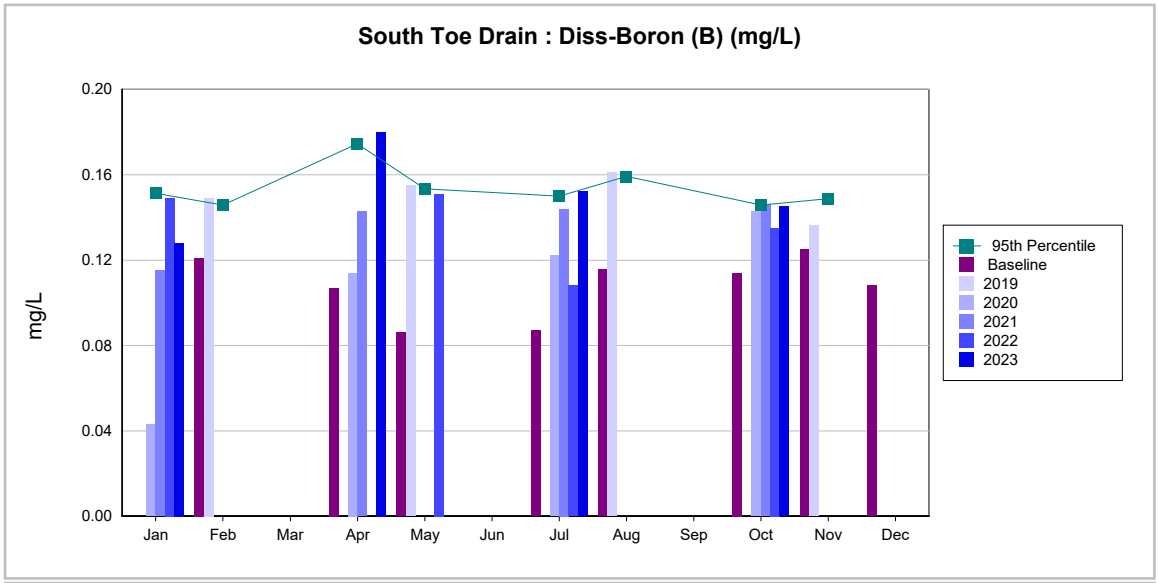
Water Quality Report

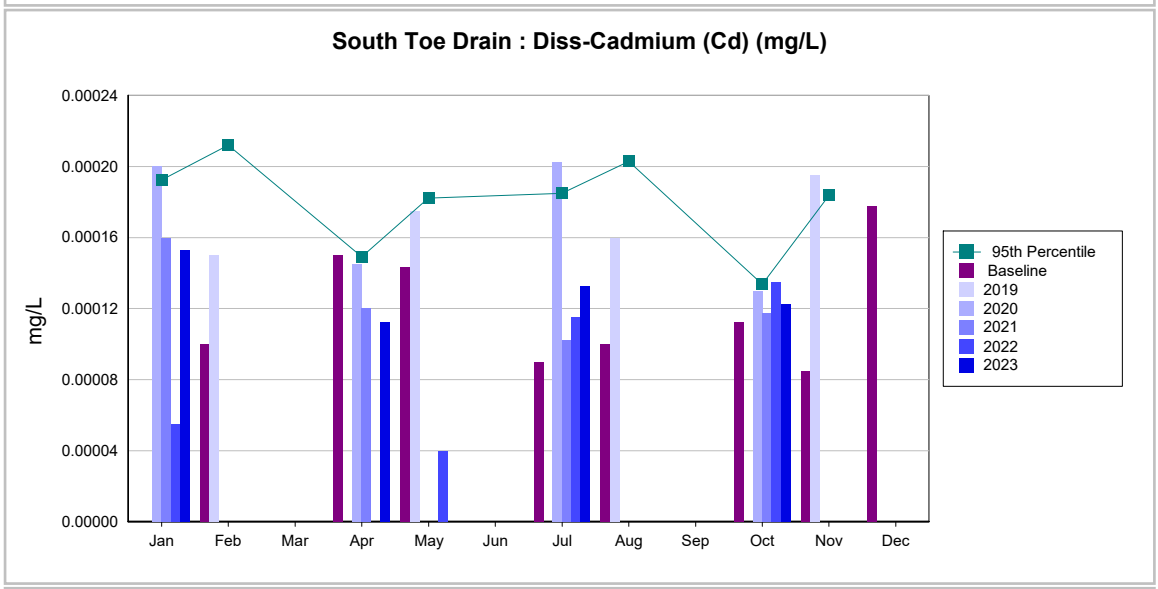
Annual Report Drainage Water

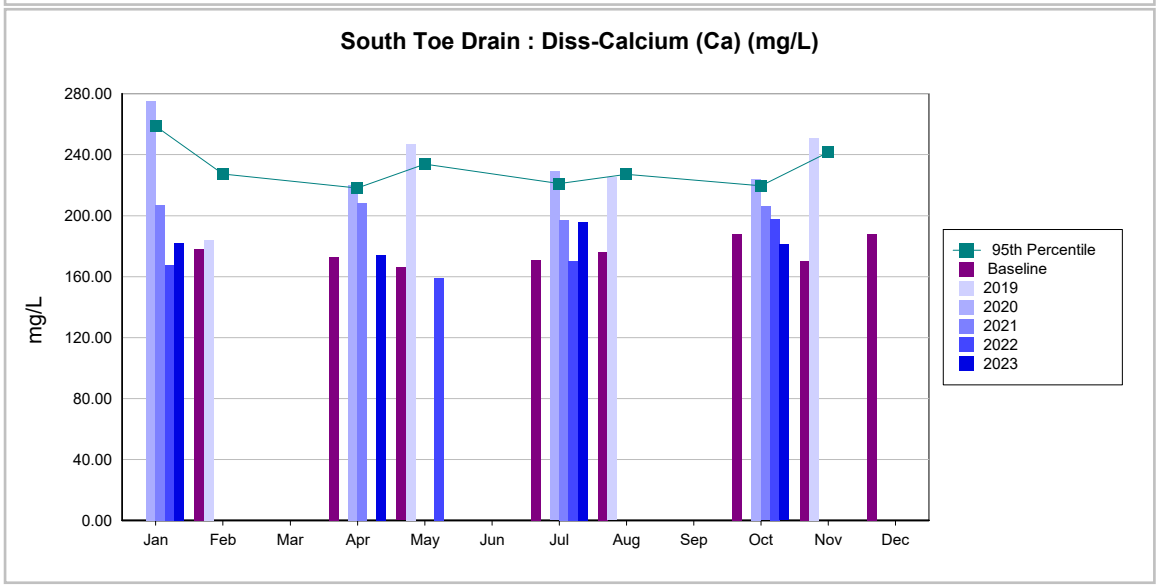
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







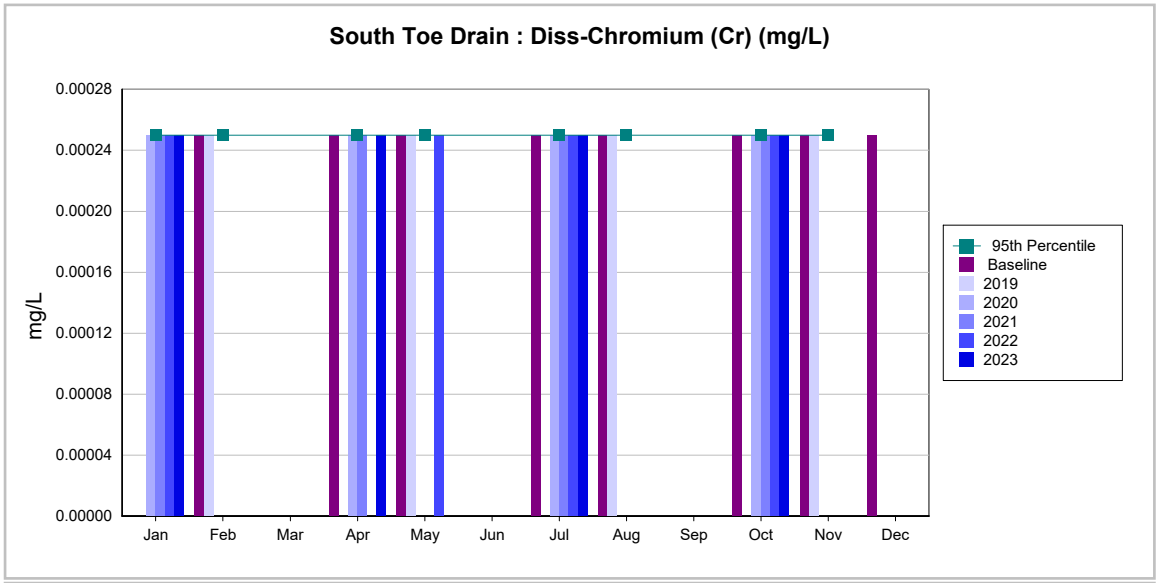
Water Quality Report

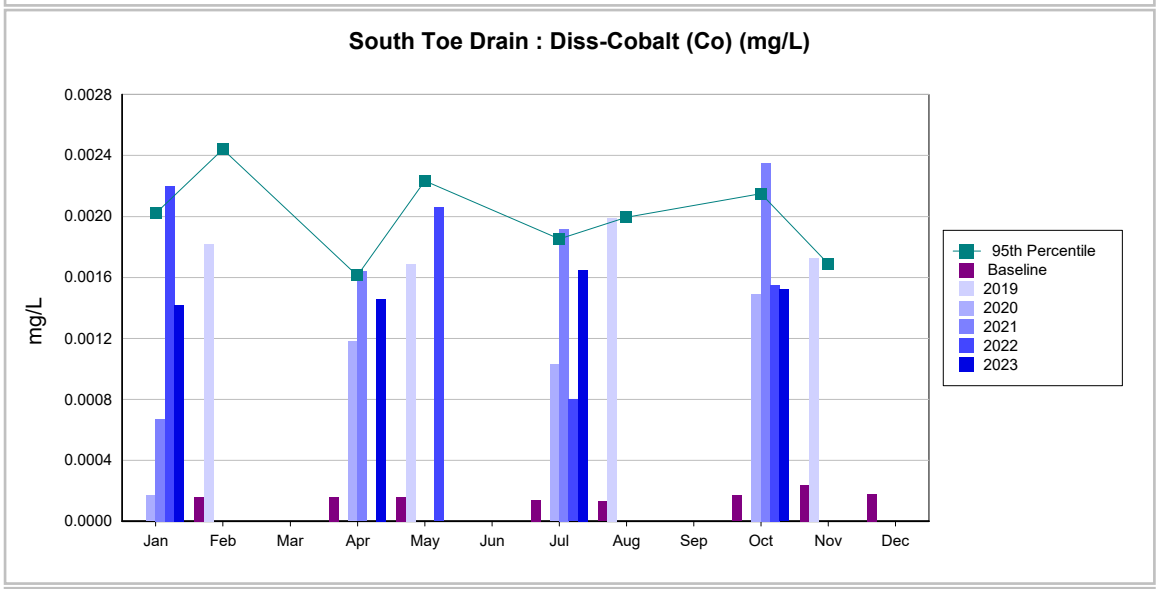
Annual Report Drainage Water

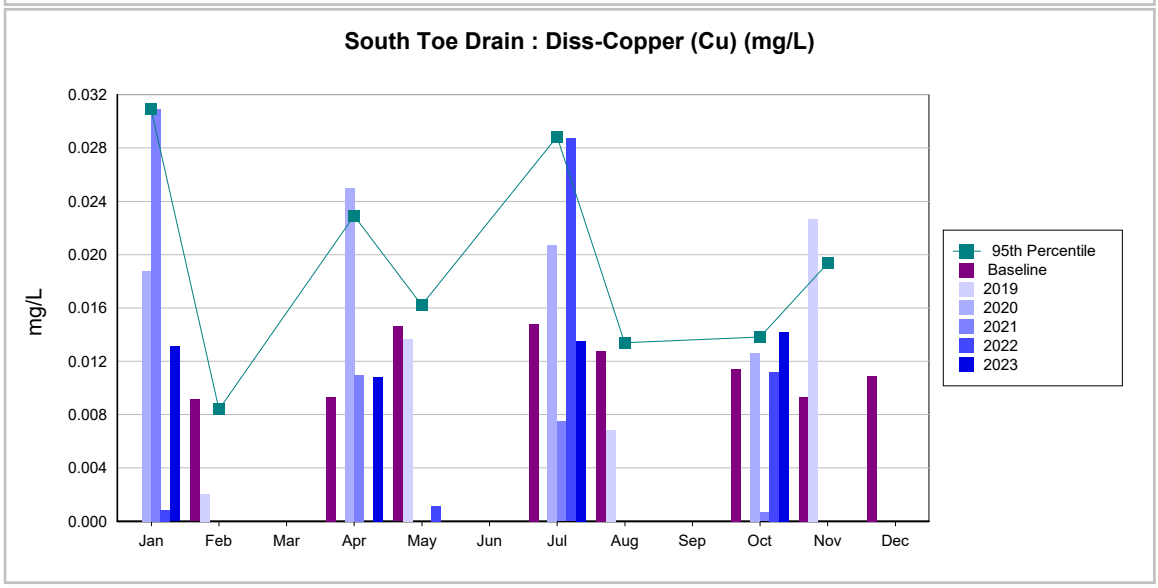
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







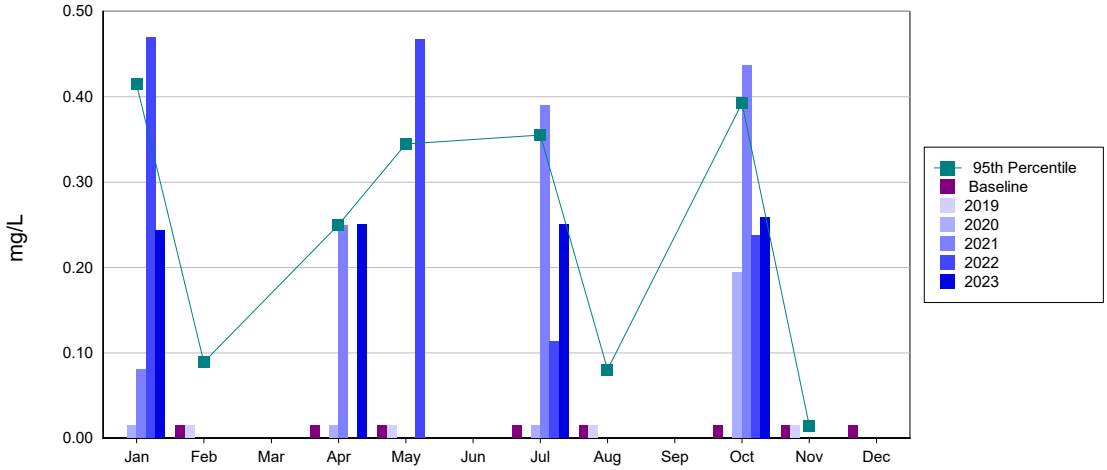
Water Quality Report

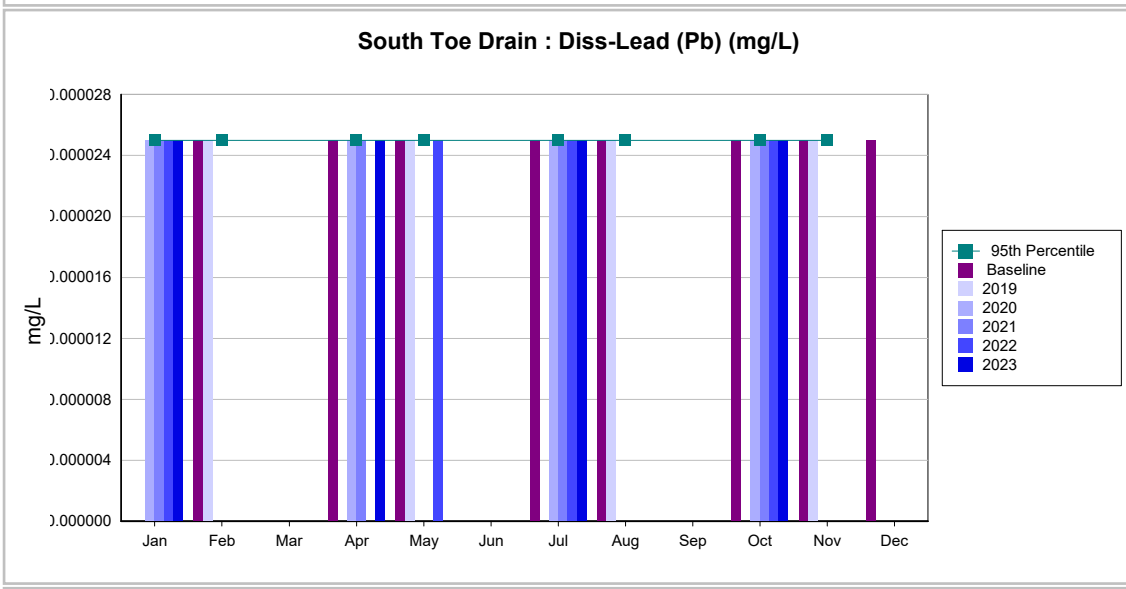
Annual Report Drainage Water

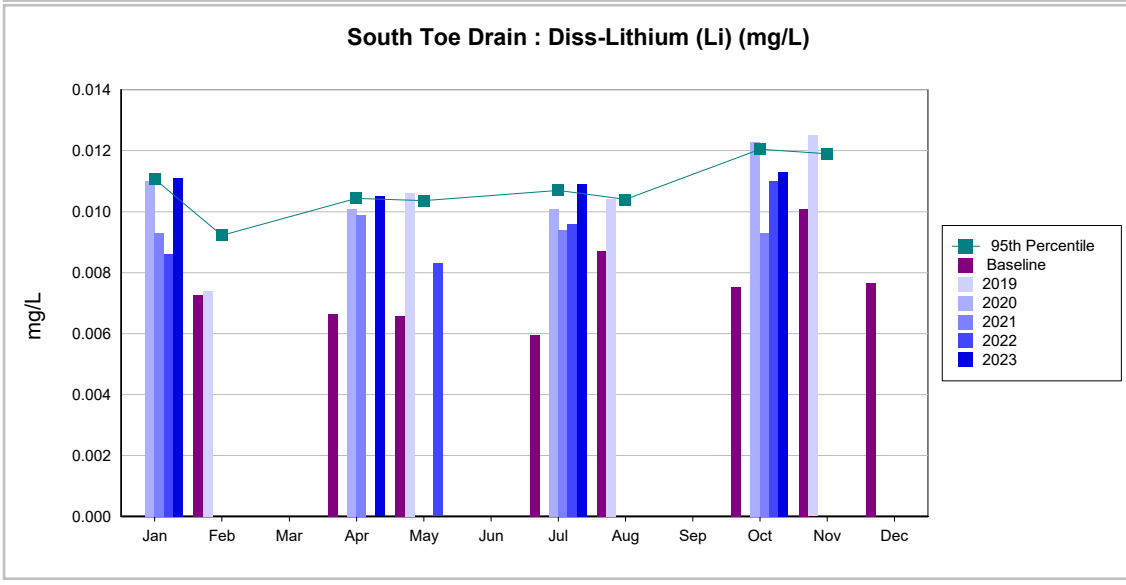
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







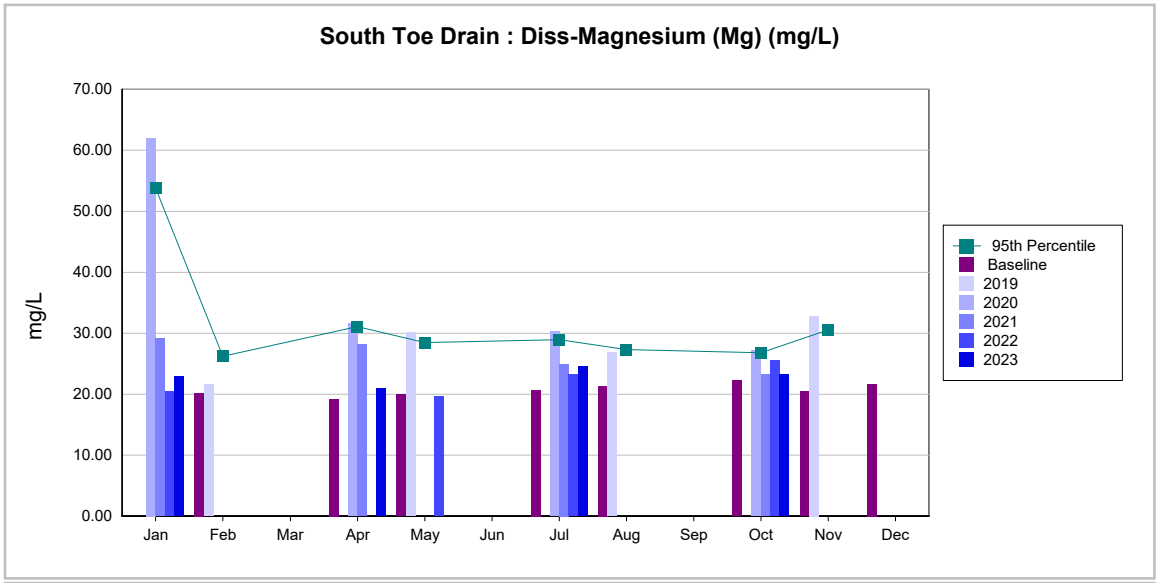
Water Quality Report

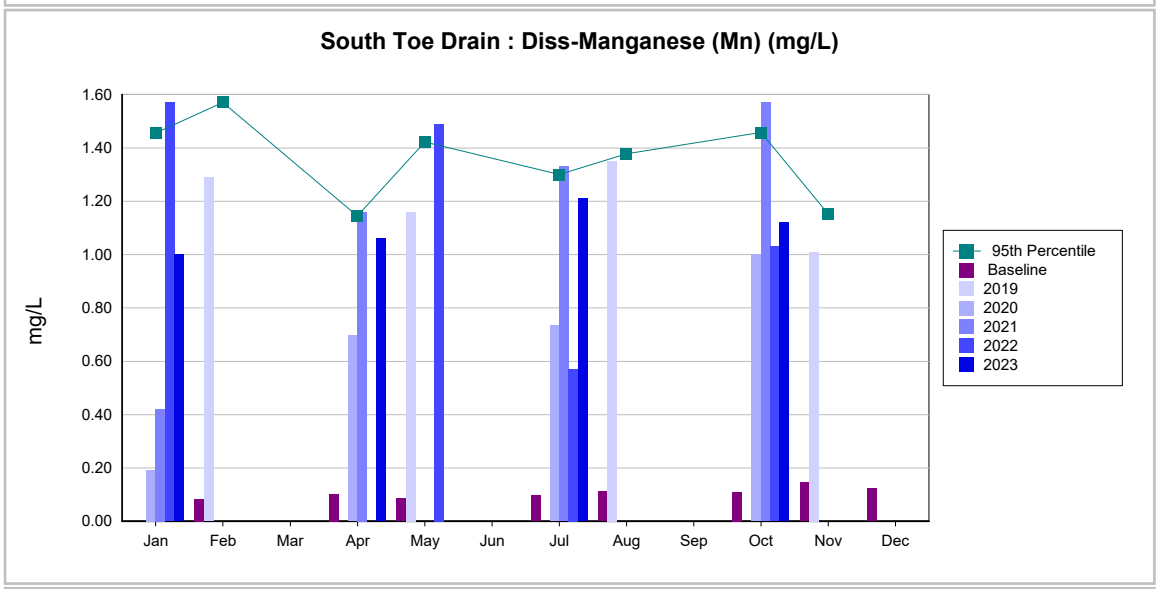
Annual Report Drainage Water

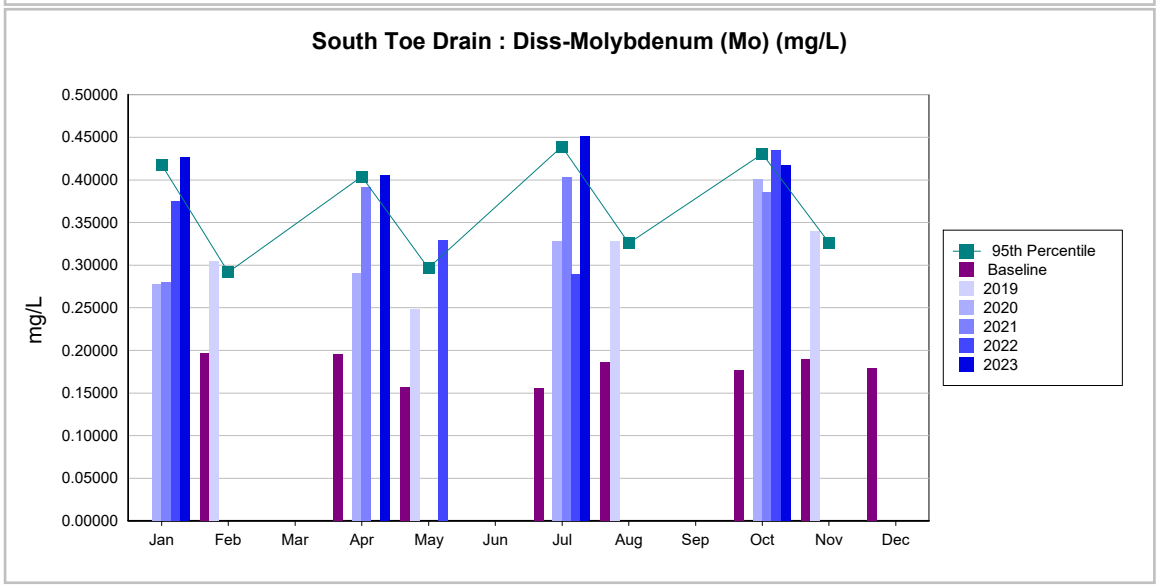
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







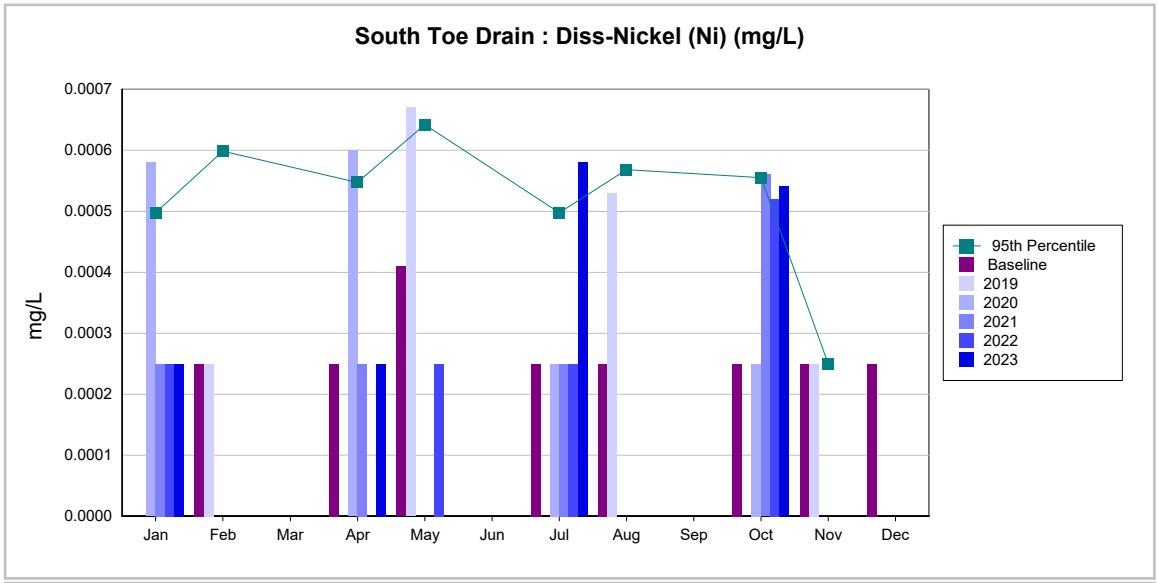
Water Quality Report

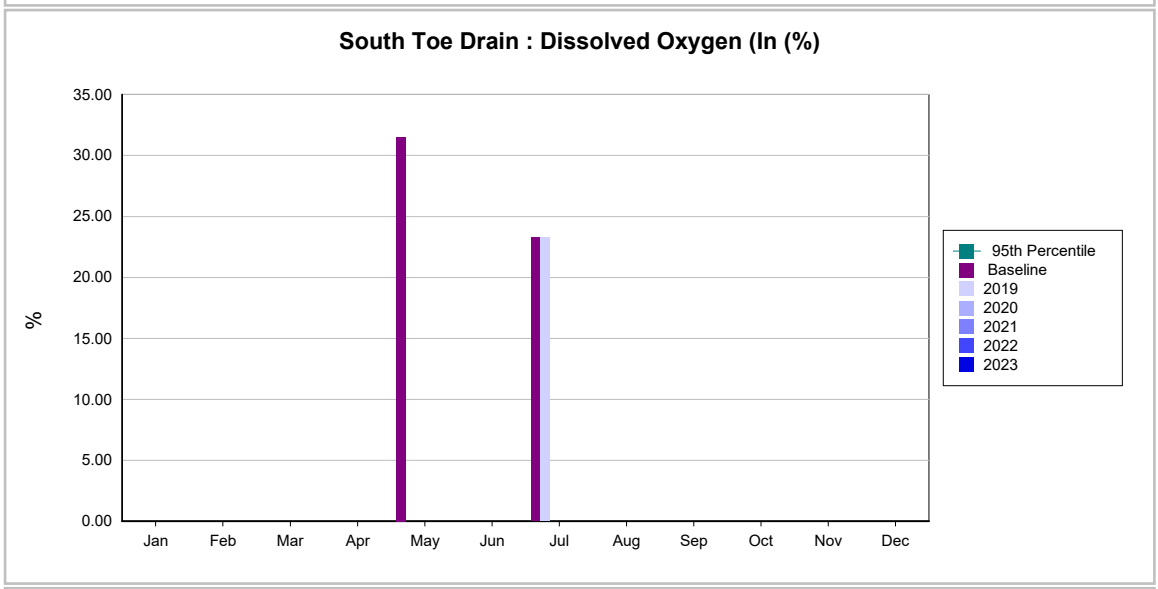
Annual Report Drainage Water

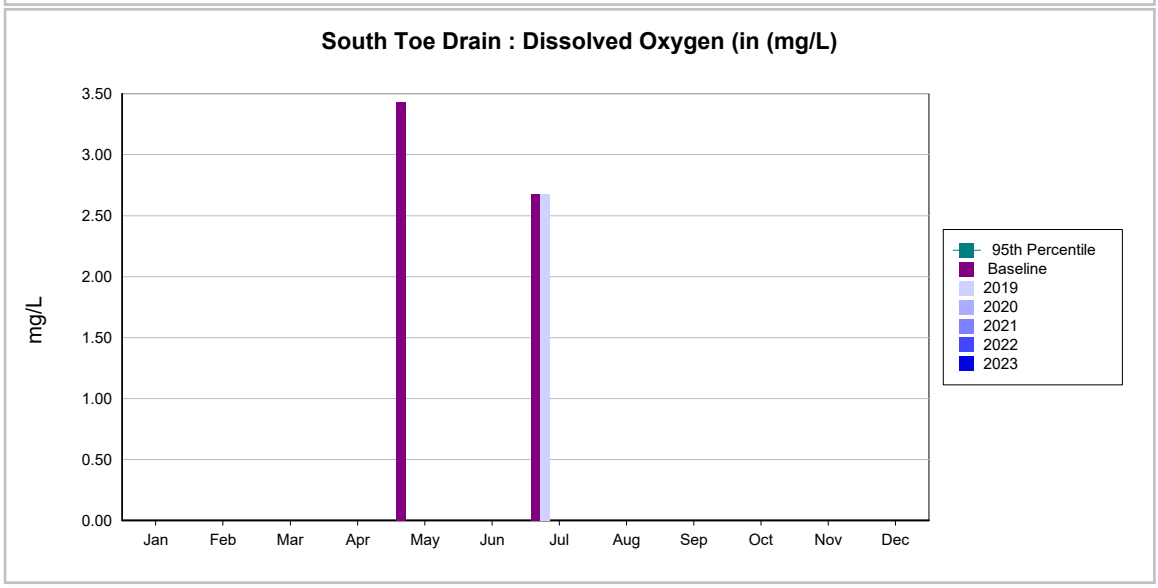
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







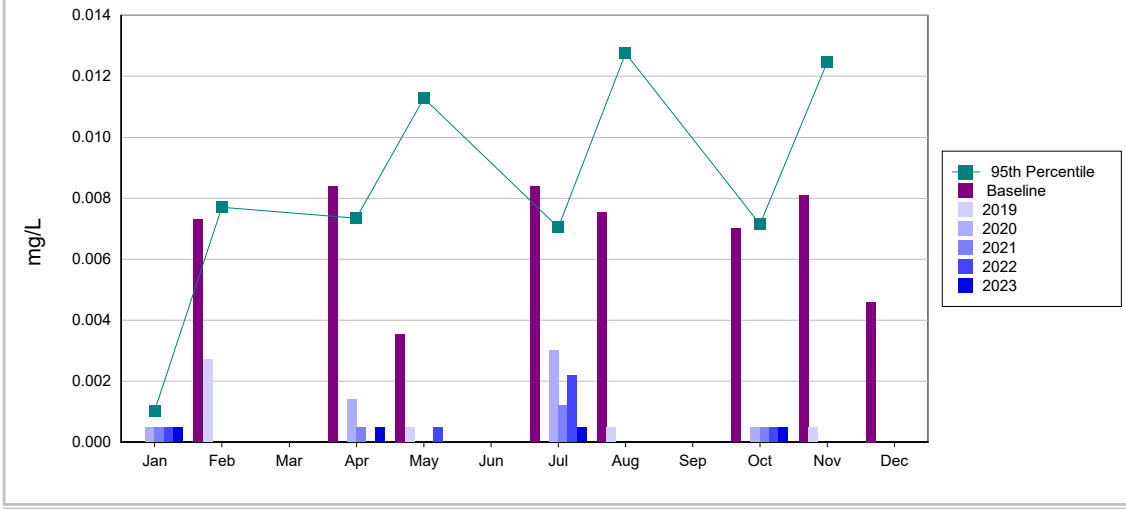
Water Quality Report

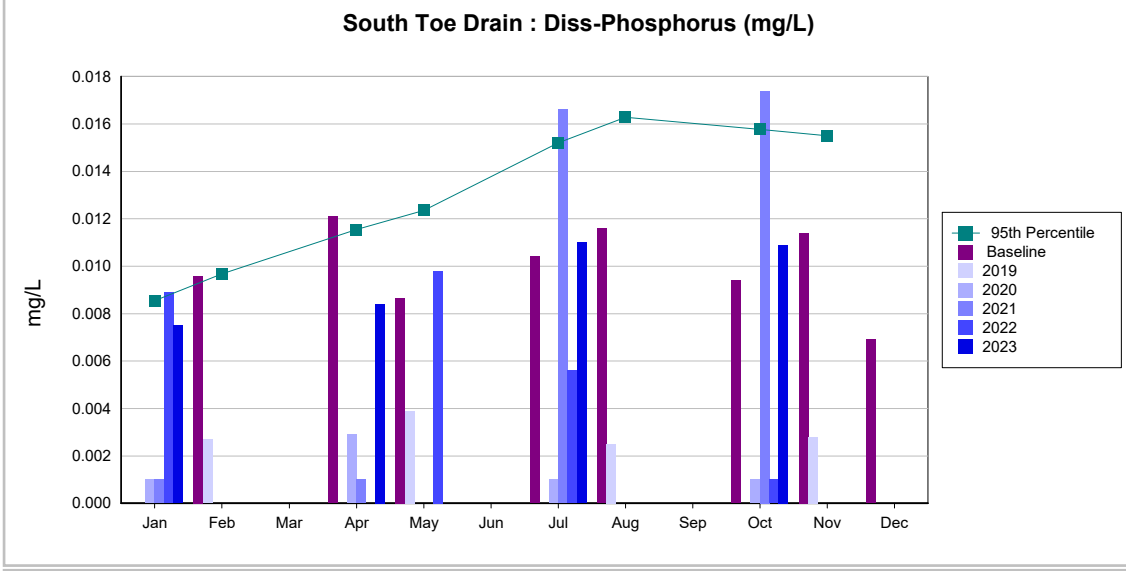
Annual Report Drainage Water

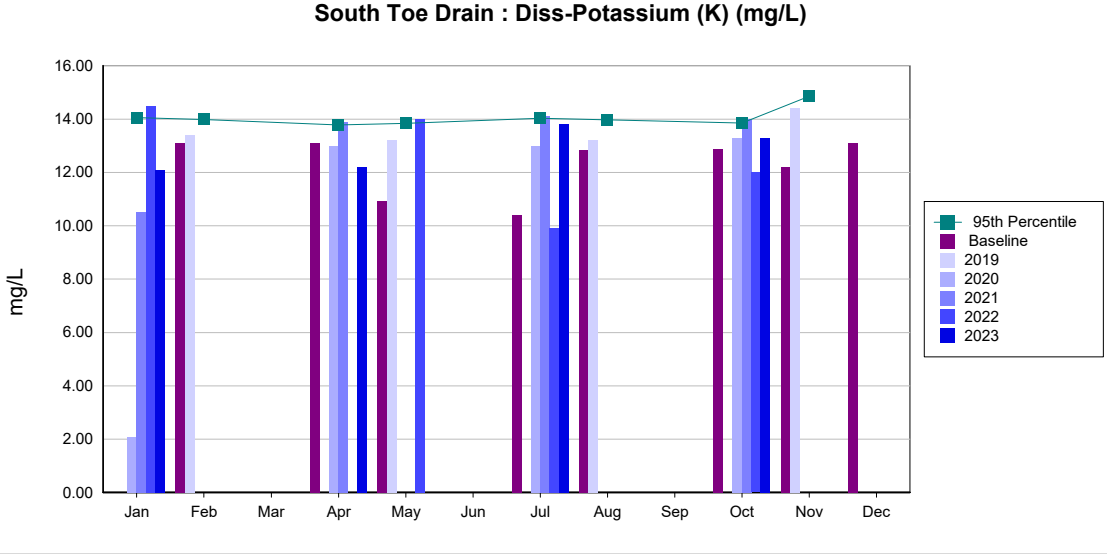
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







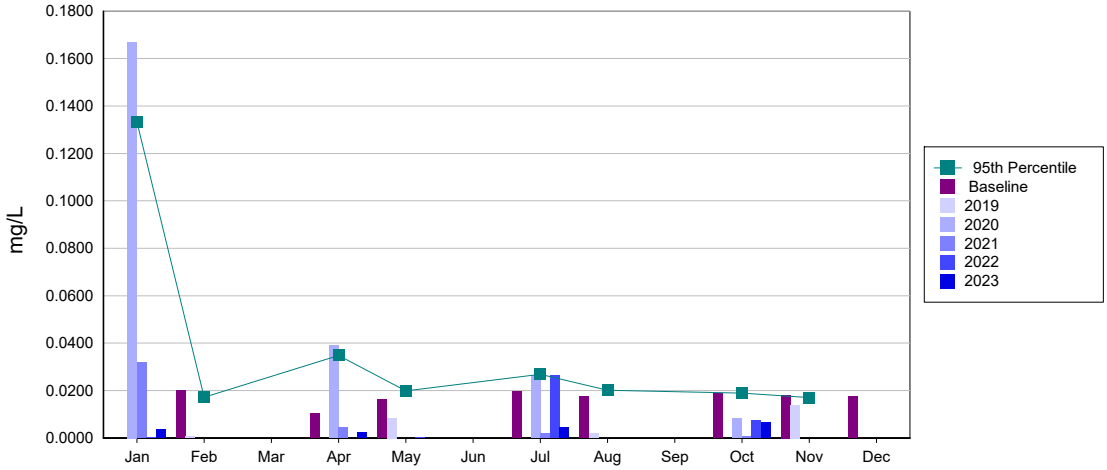
Water Quality Report

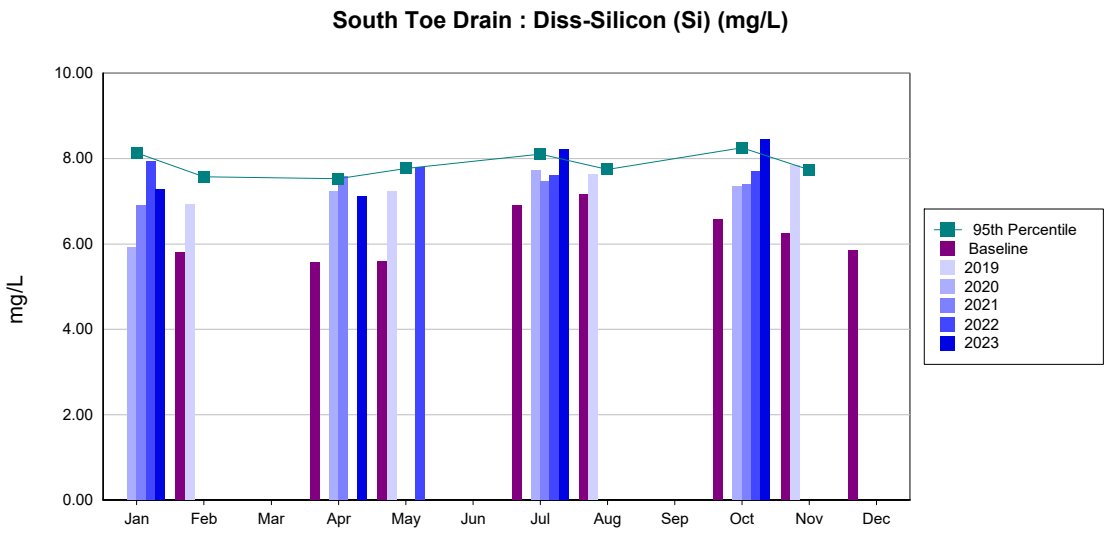
Annual Report Drainage Water

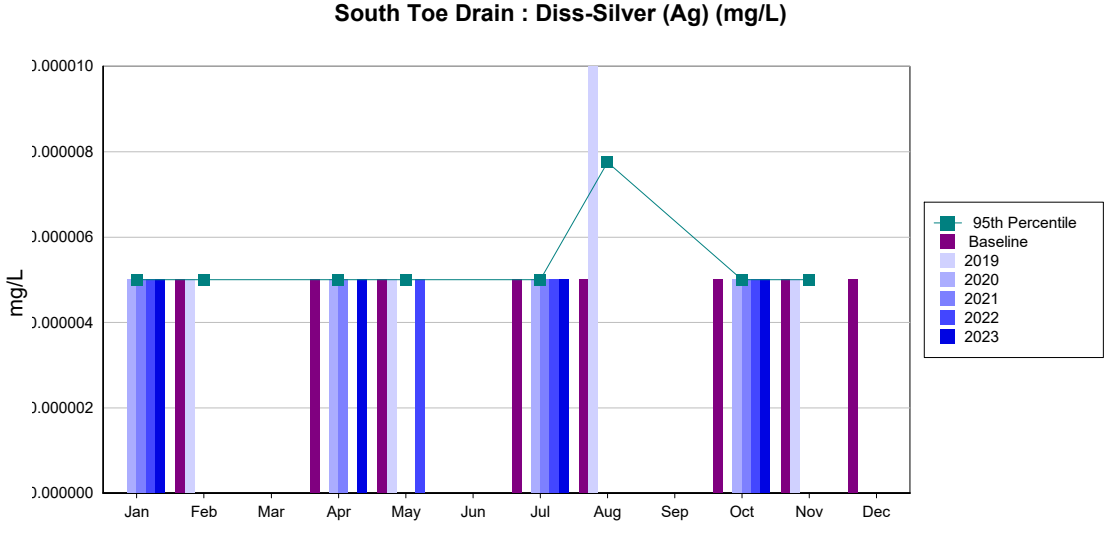
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







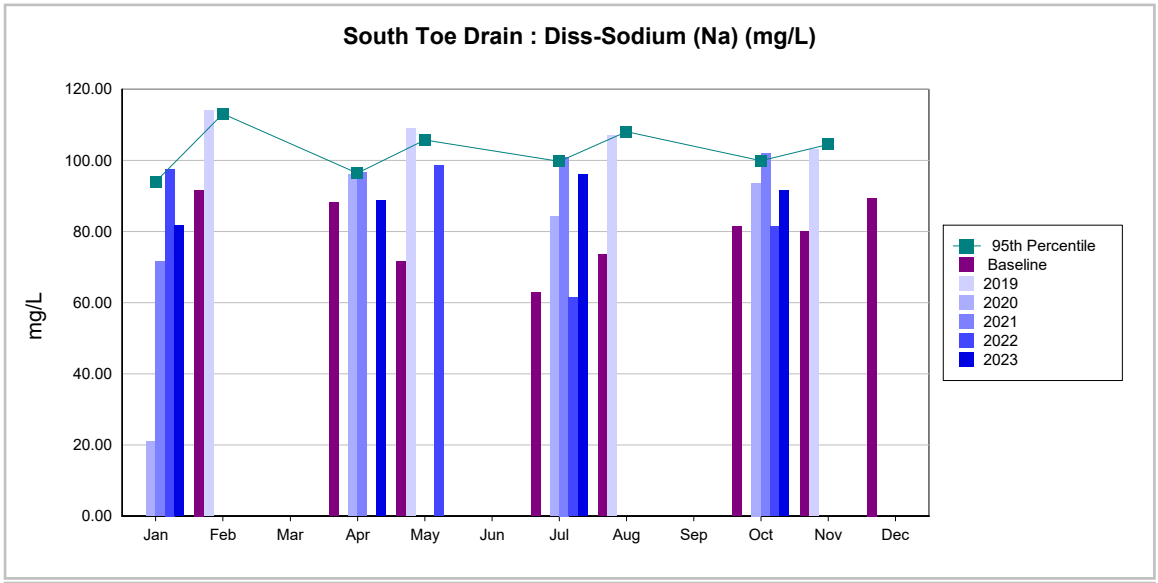
Water Quality Report

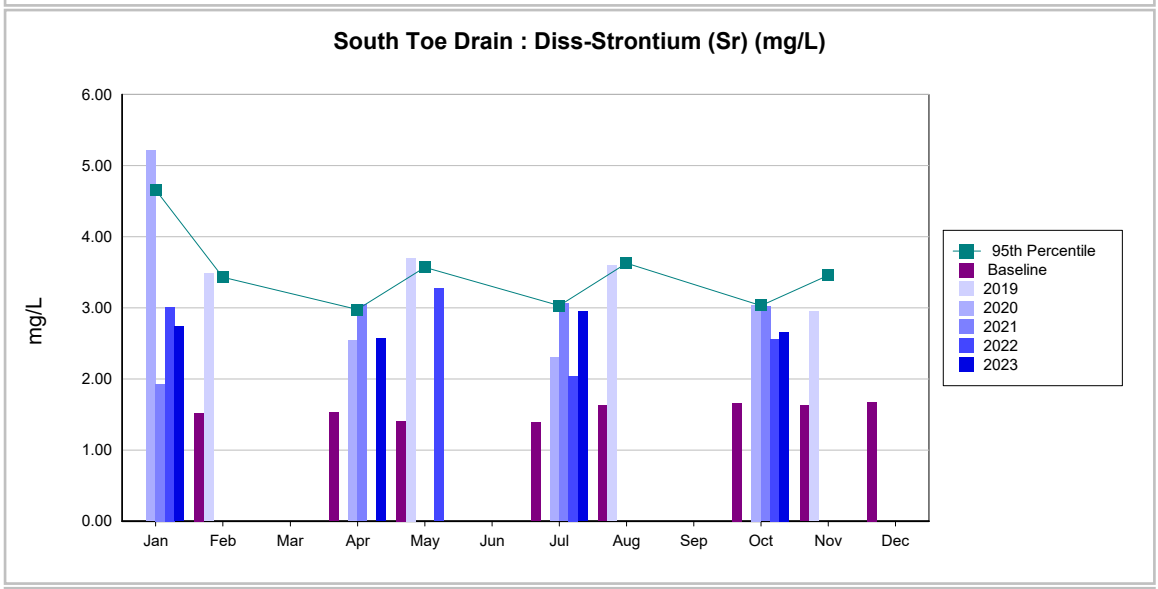
Annual Report Drainage Water

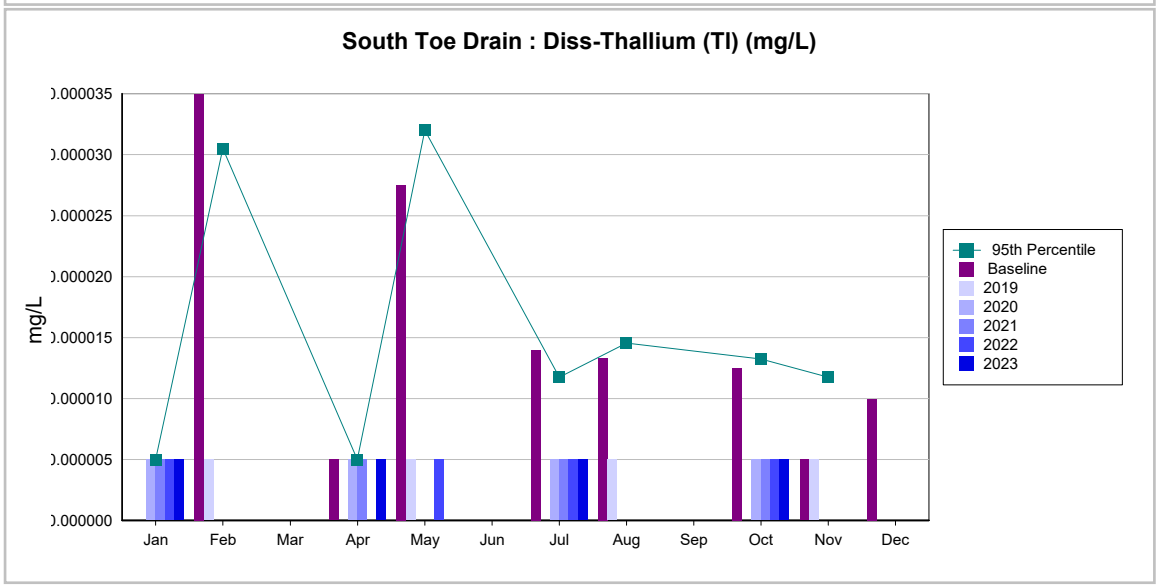
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







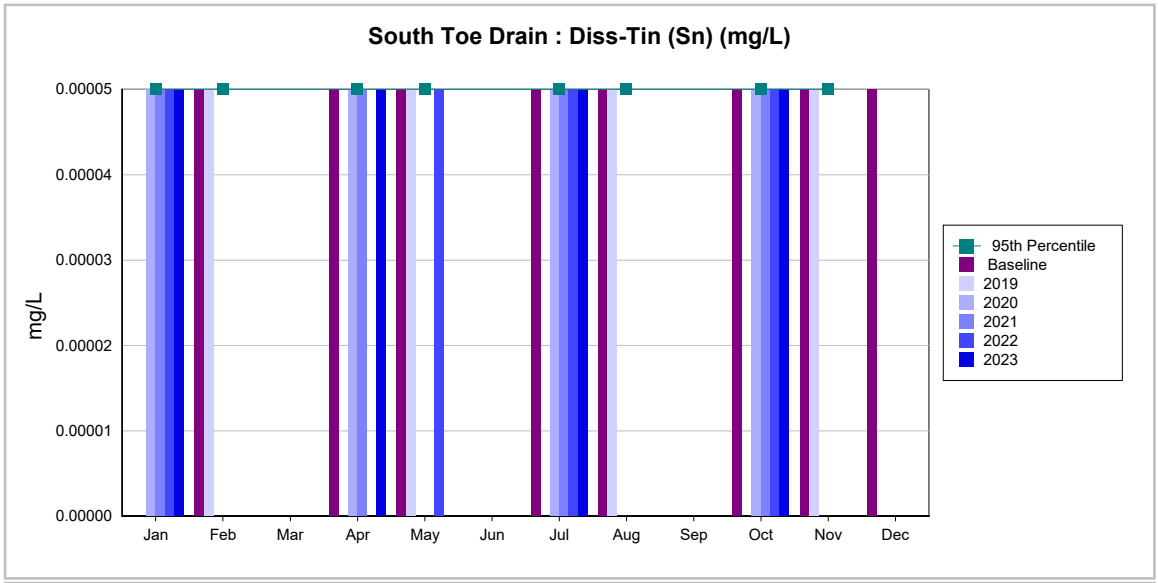
Water Quality Report

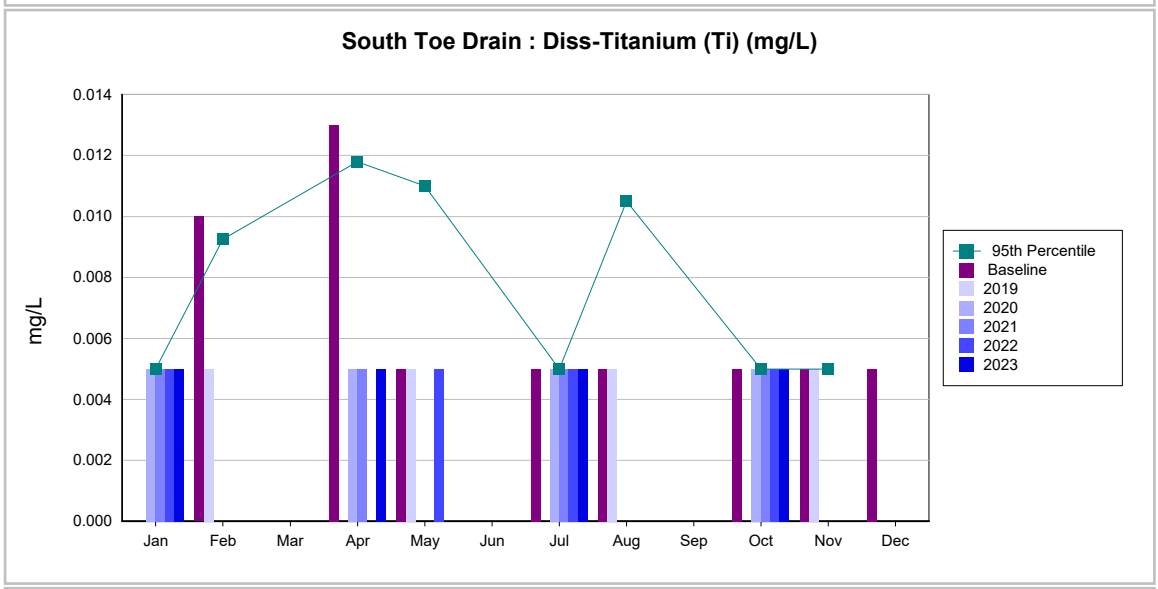
Annual Report Drainage Water

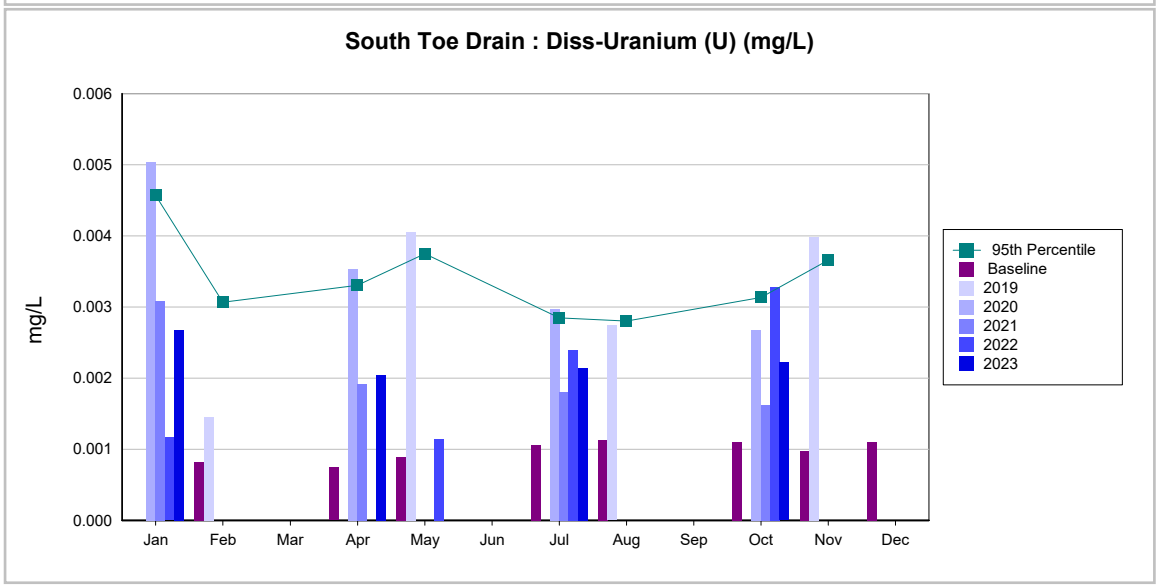
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







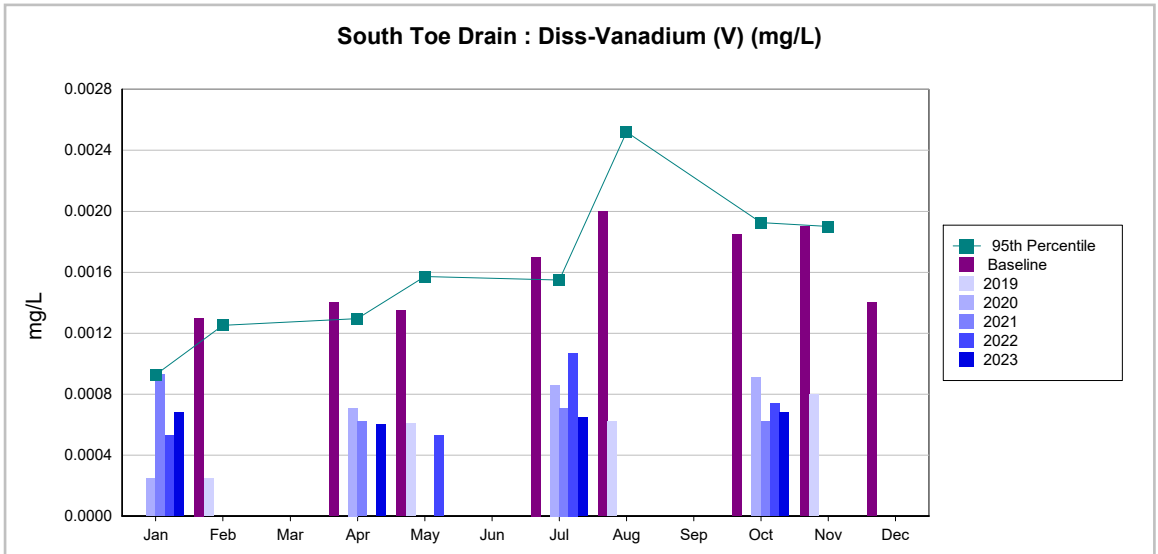
Water Quality Report

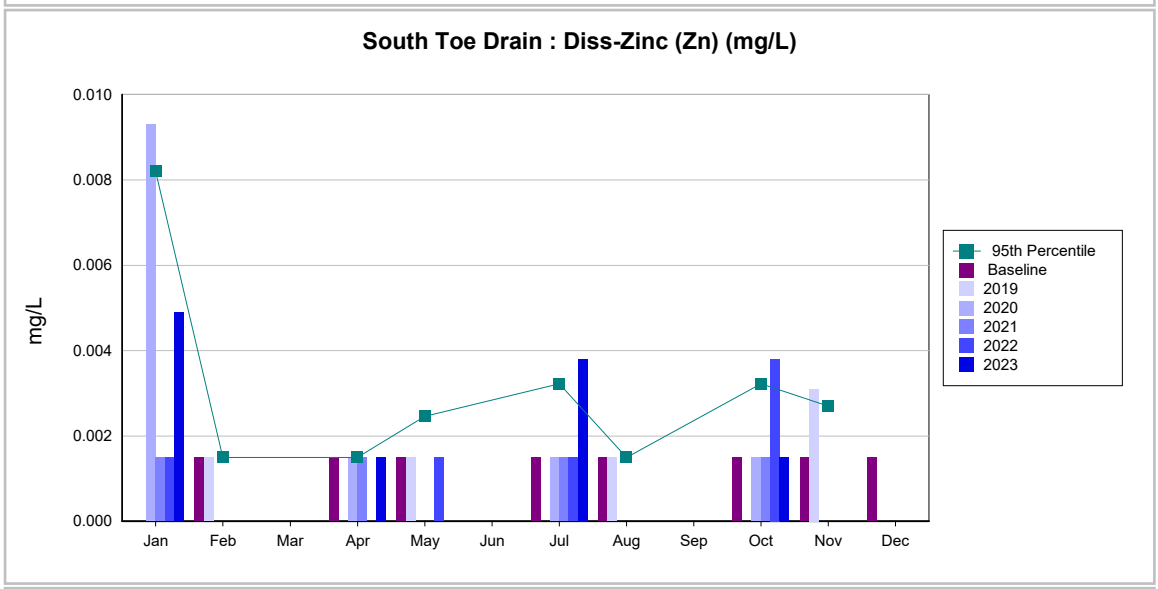
Annual Report Drainage Water

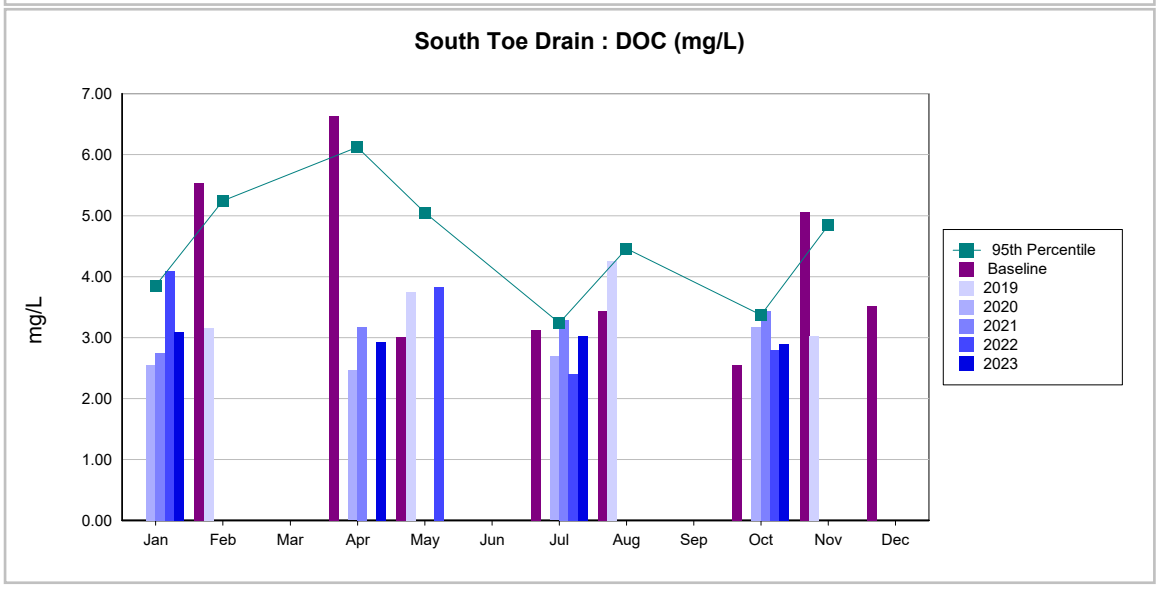
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







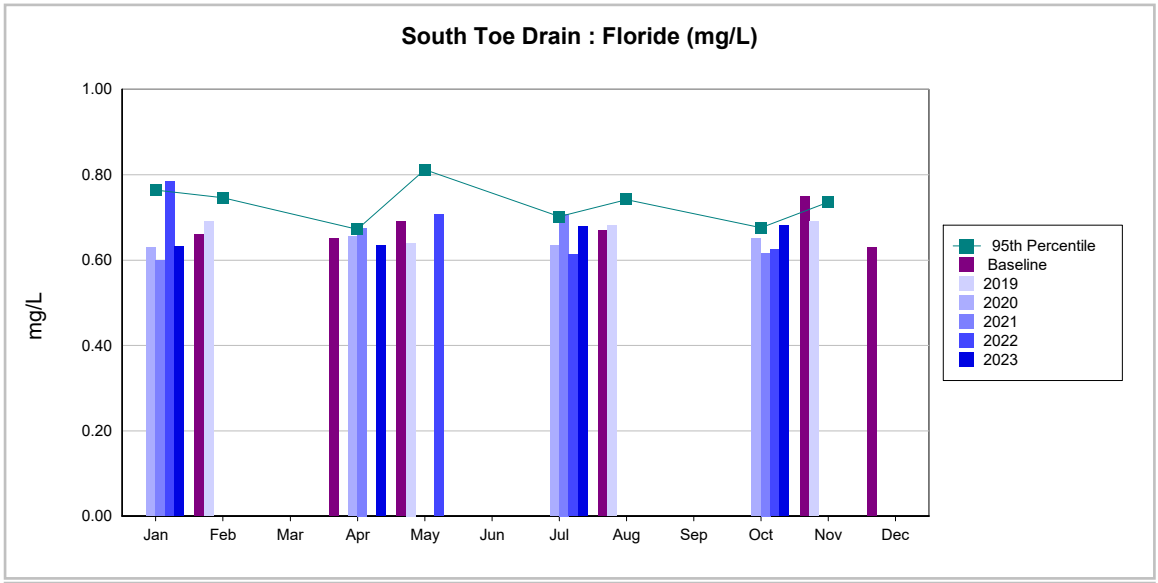
Water Quality Report

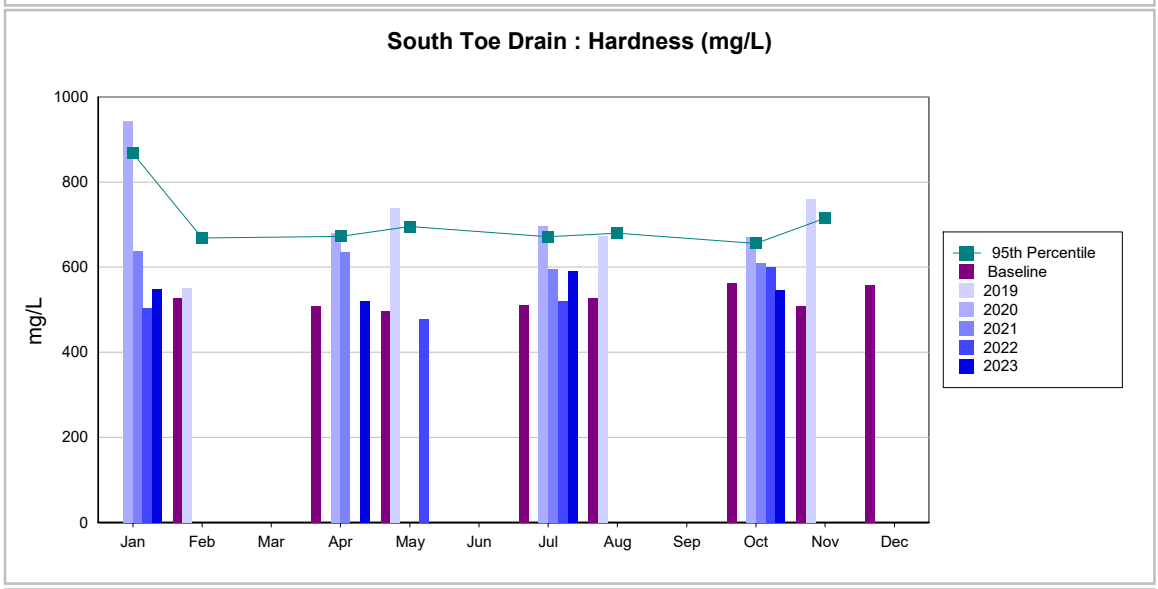
Annual Report Drainage Water

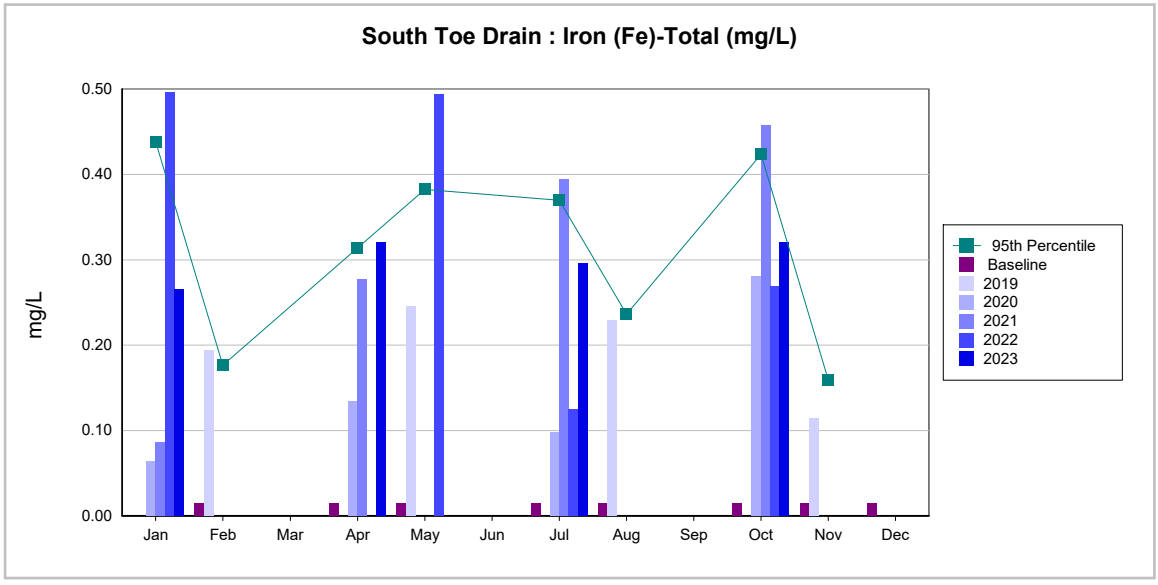
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







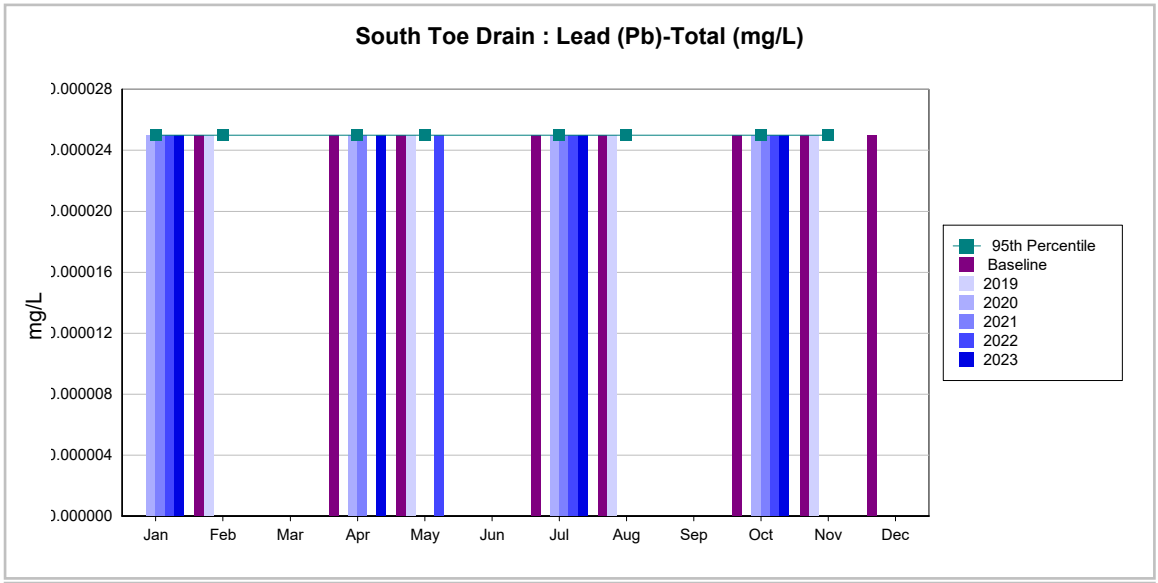
Water Quality Report

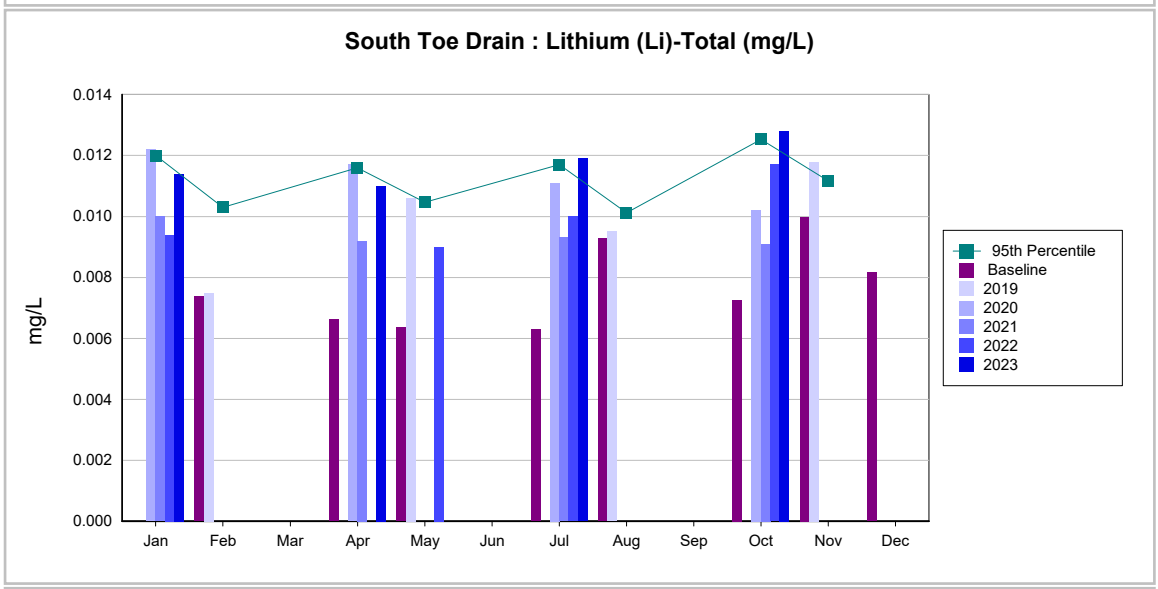
Annual Report Drainage Water

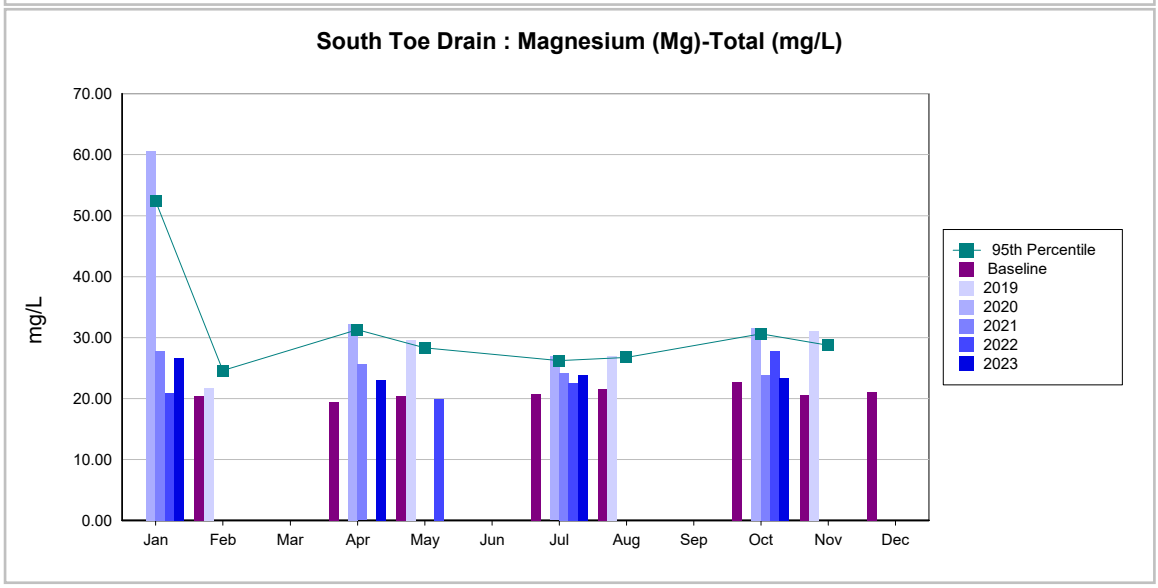
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







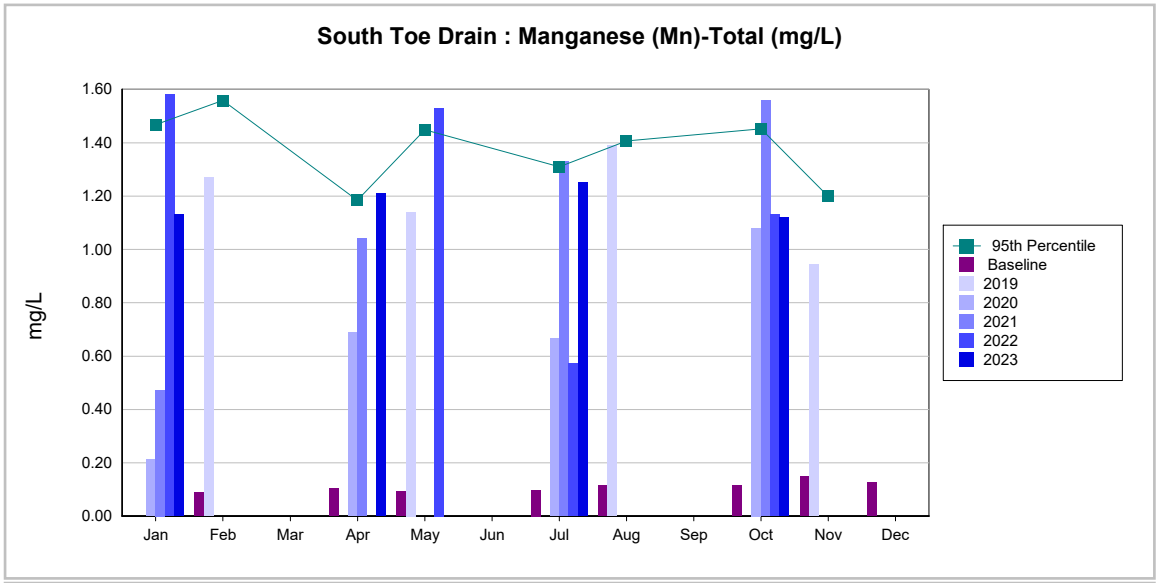
Water Quality Report

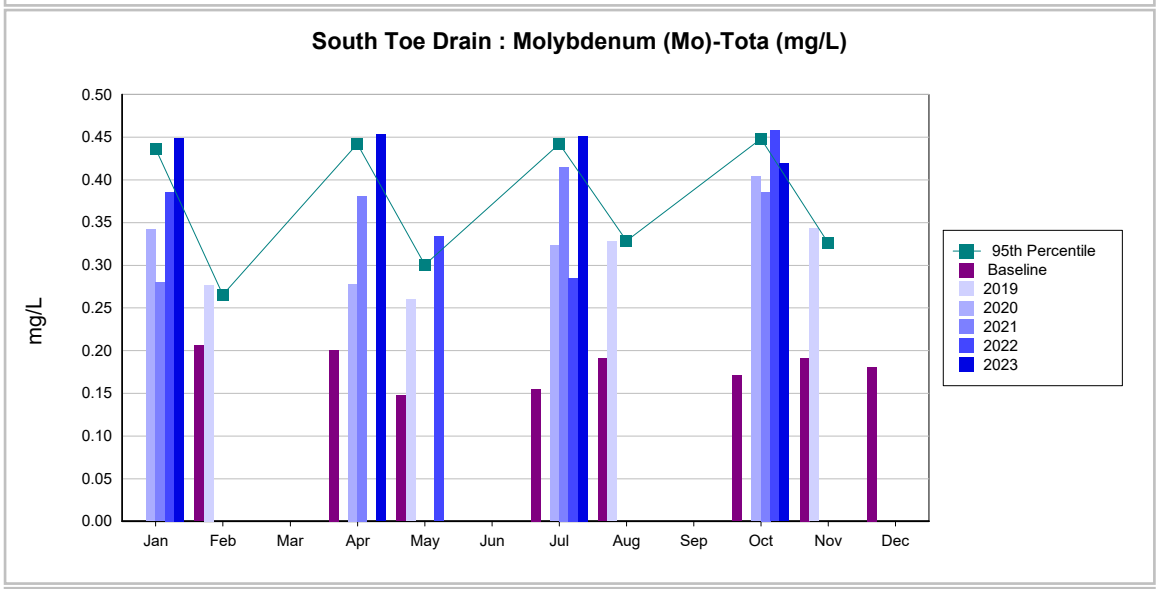
Annual Report Drainage Water

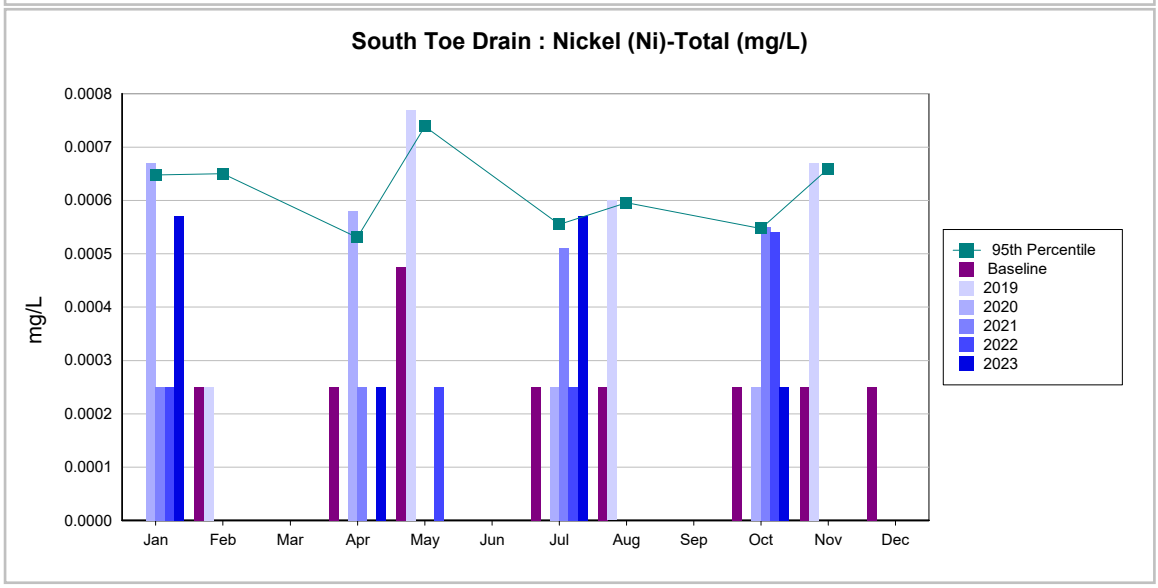
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







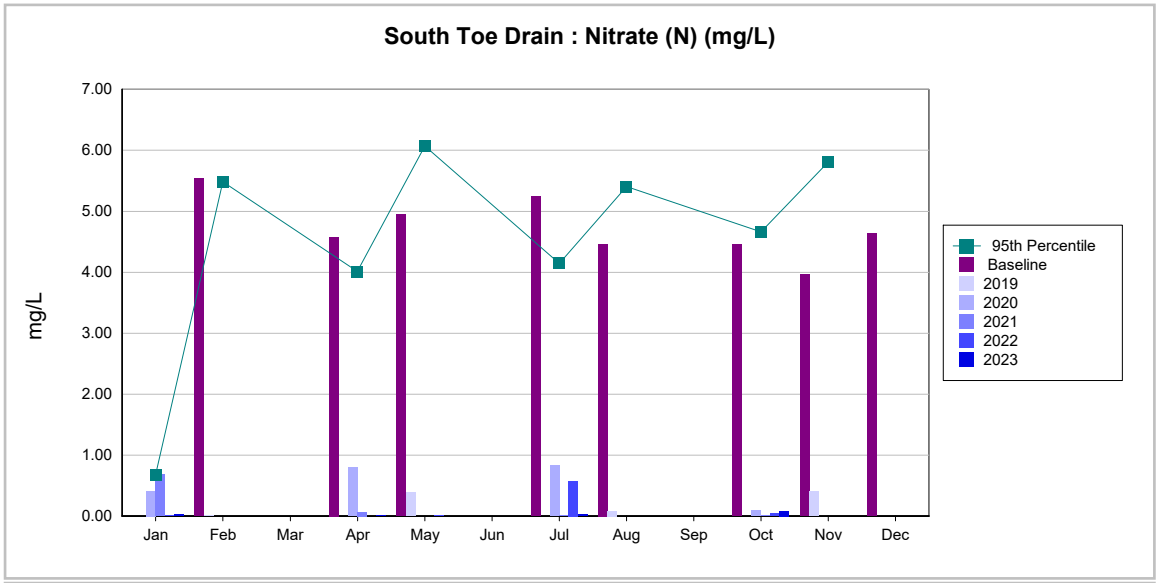
Water Quality Report

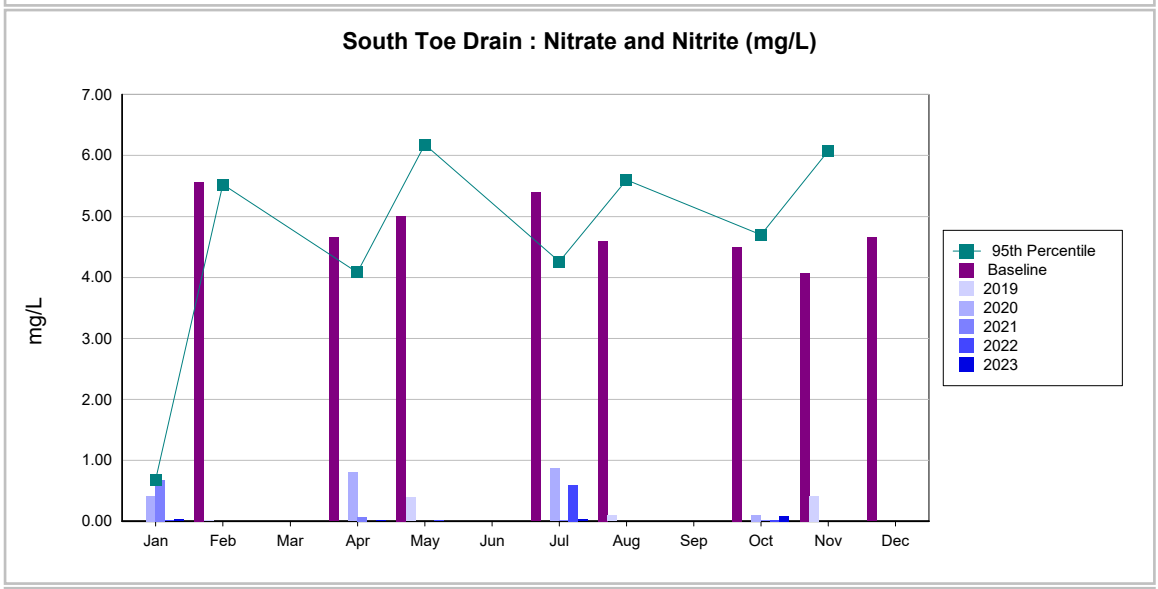
Annual Report Drainage Water

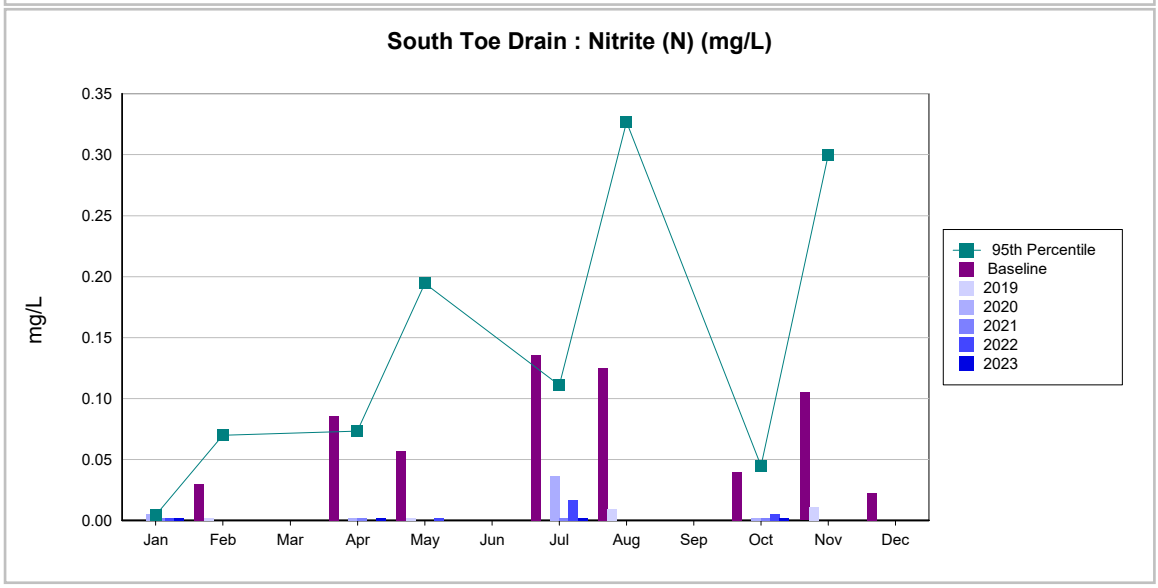
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







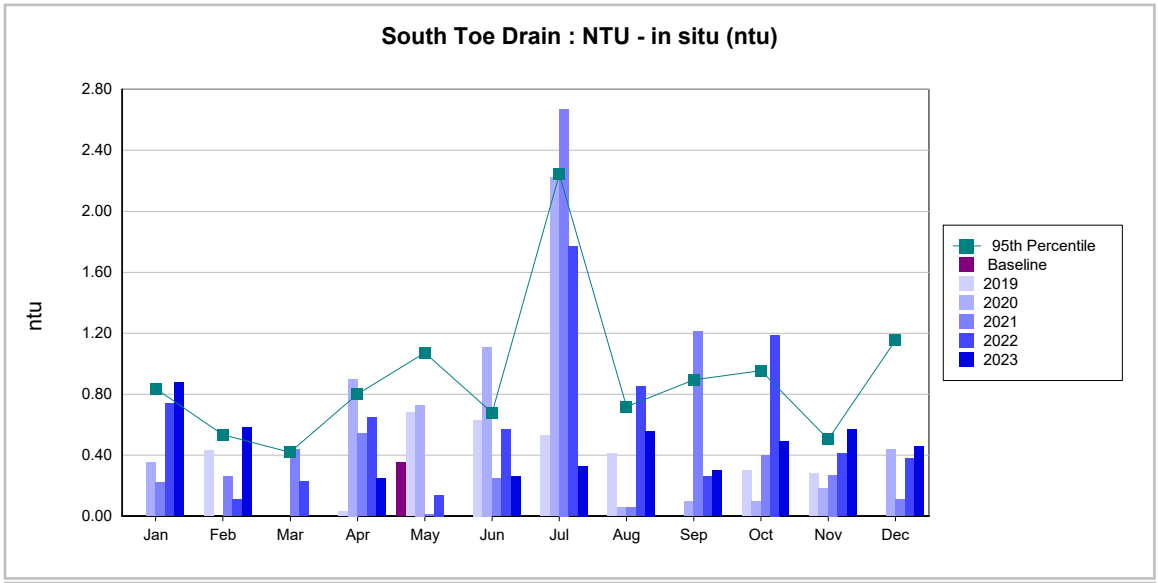
Water Quality Report

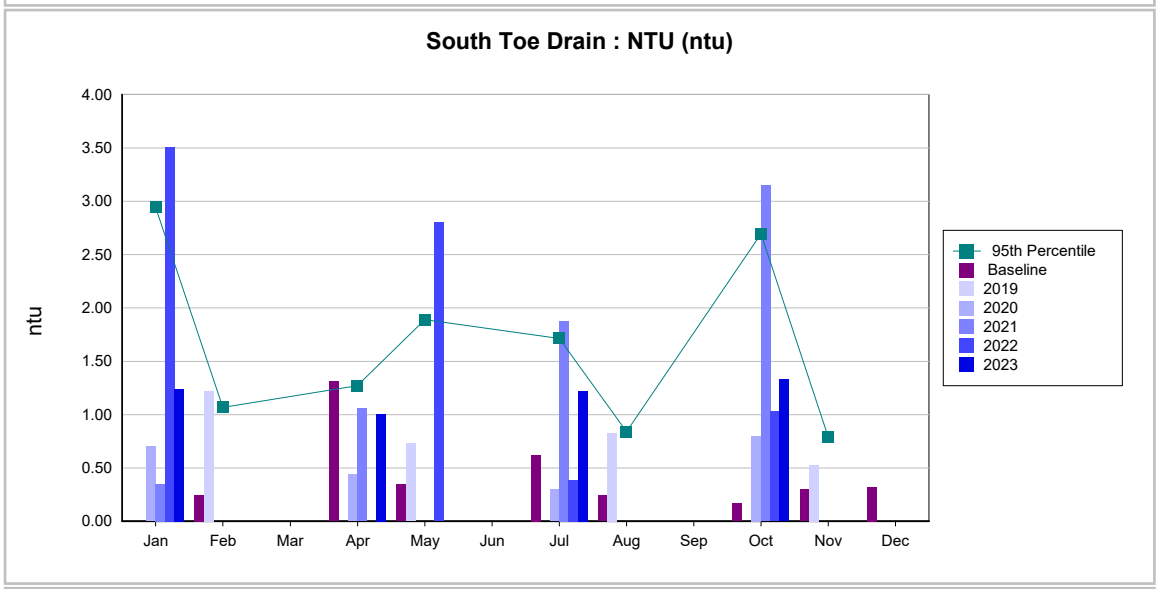
Annual Report Drainage Water

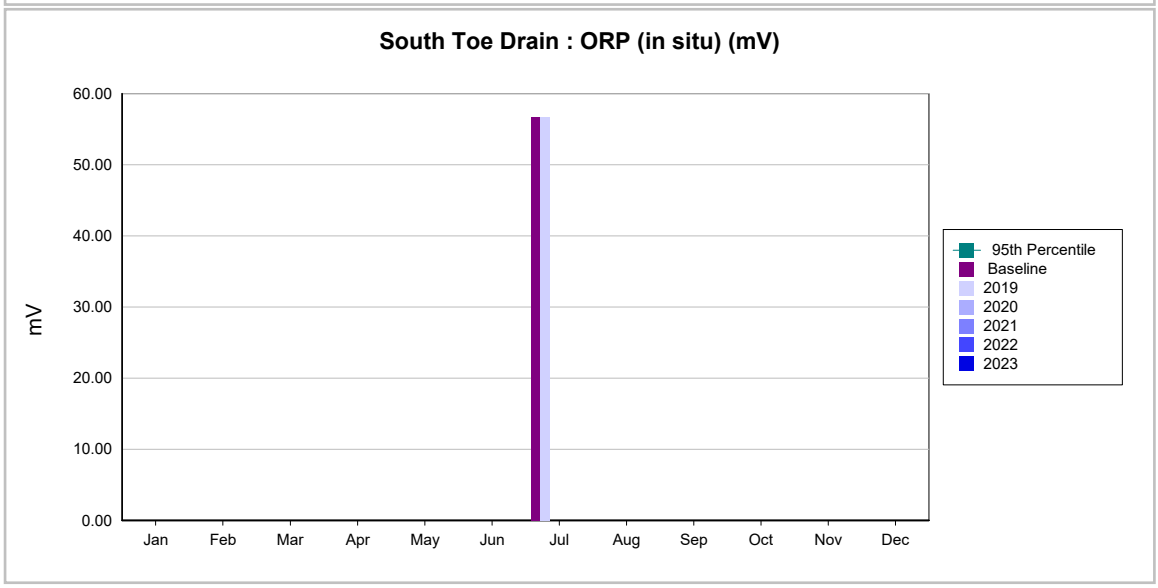
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







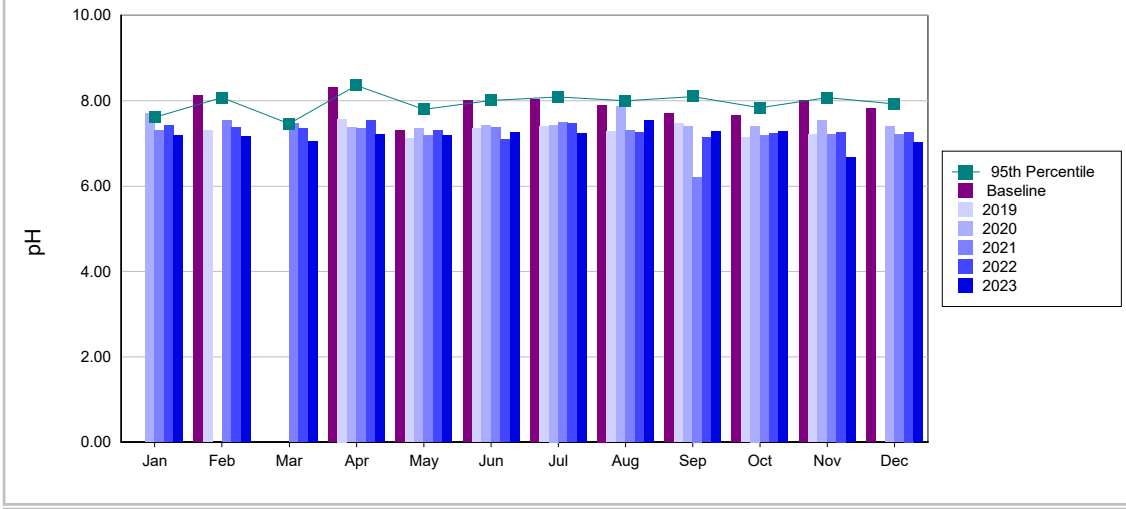
Water Quality Report

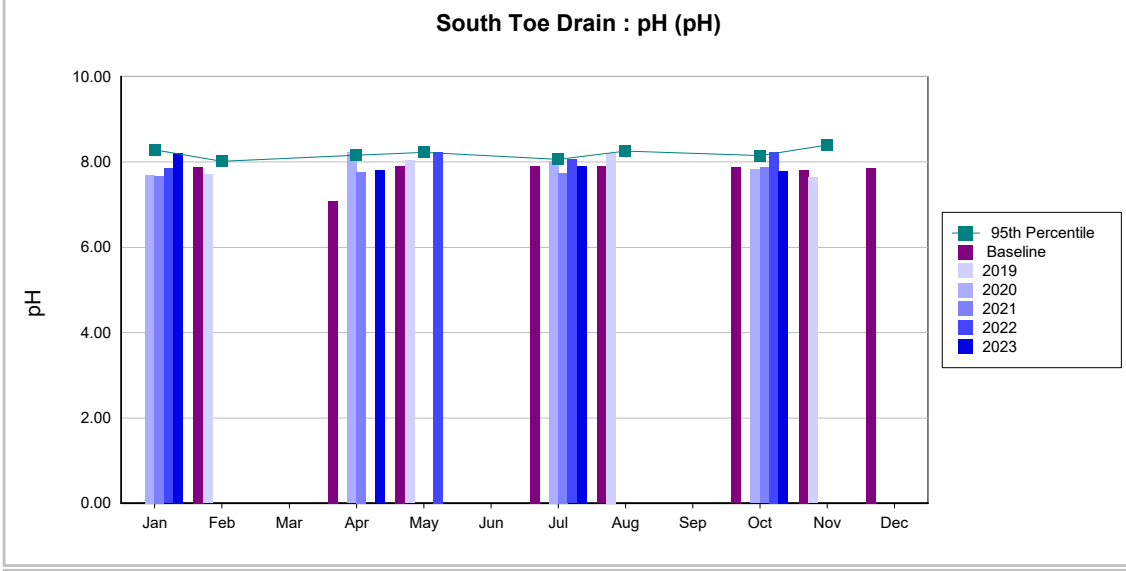
Annual Report Drainage Water

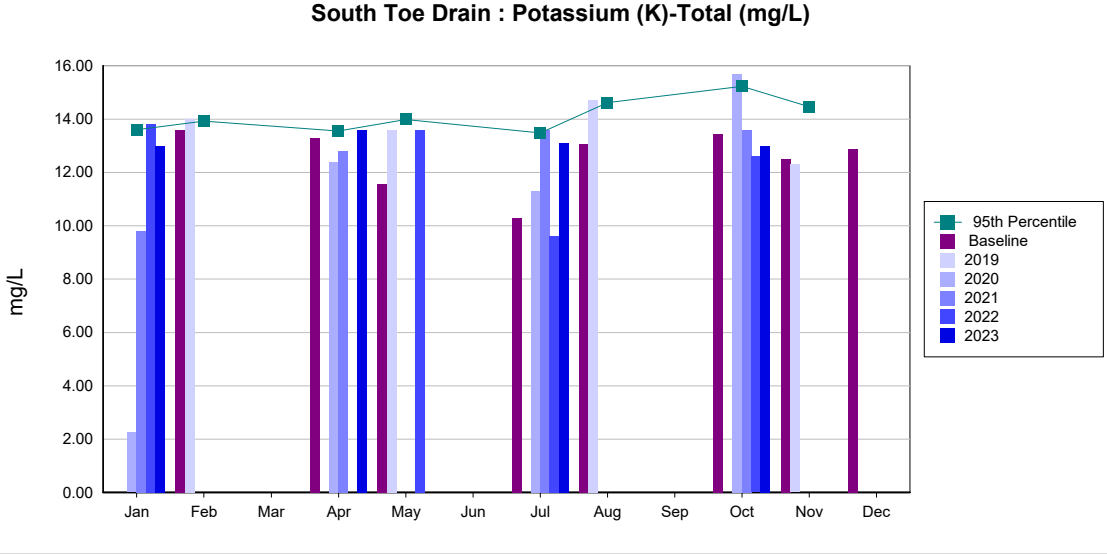
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







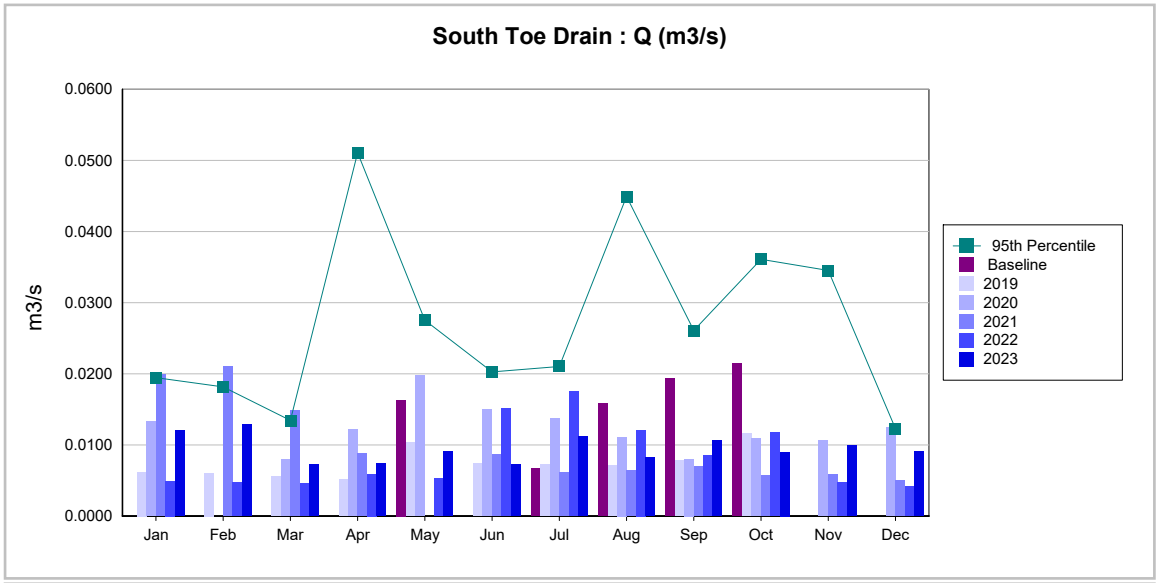
Water Quality Report

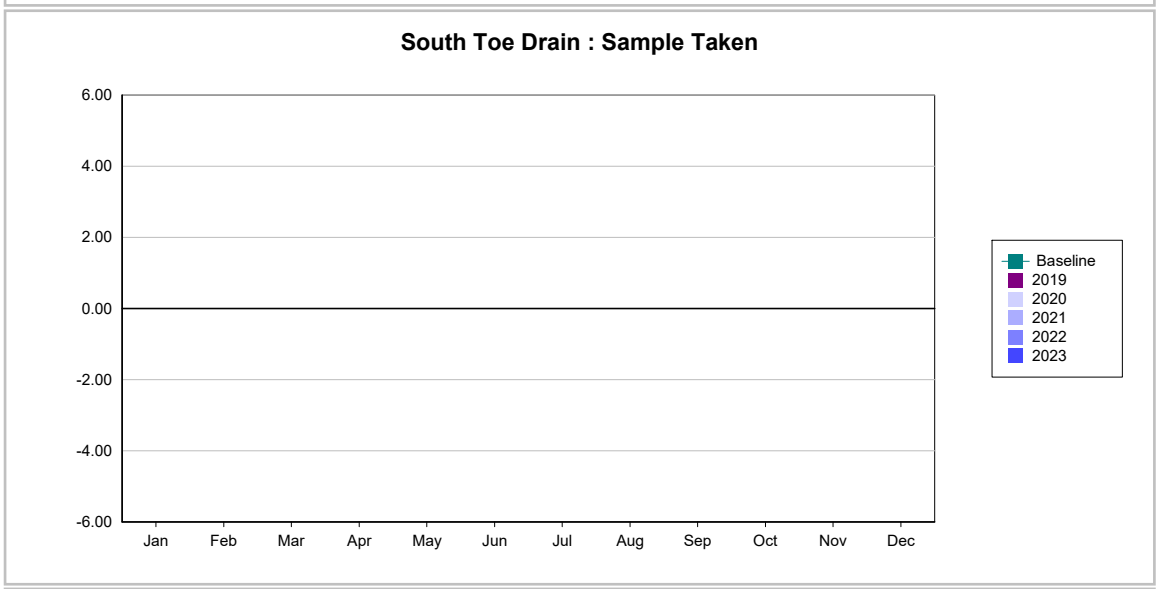
Annual Report Drainage Water

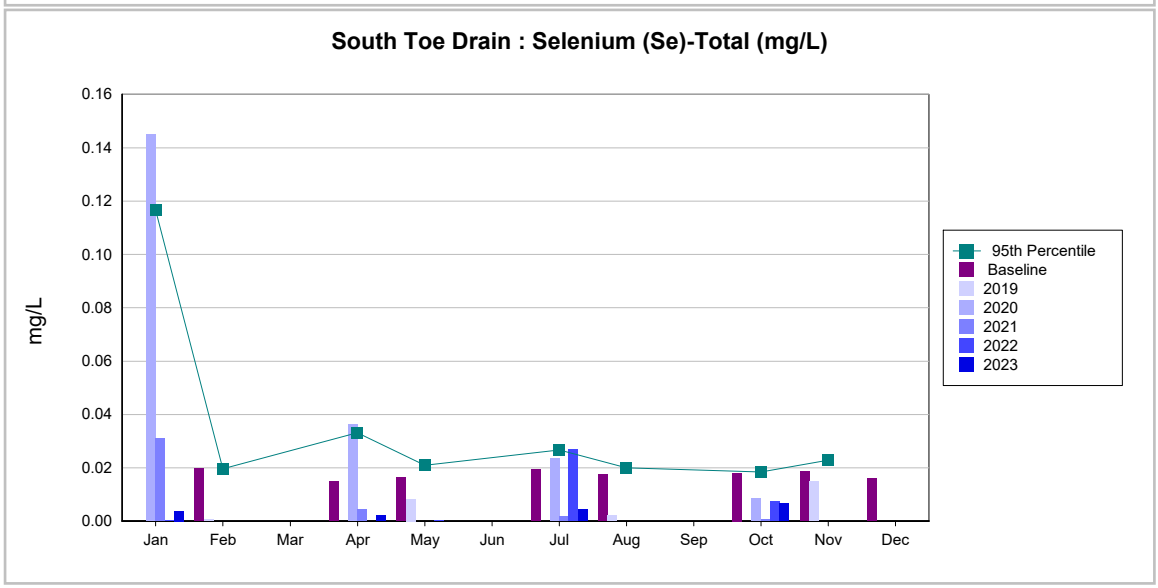
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







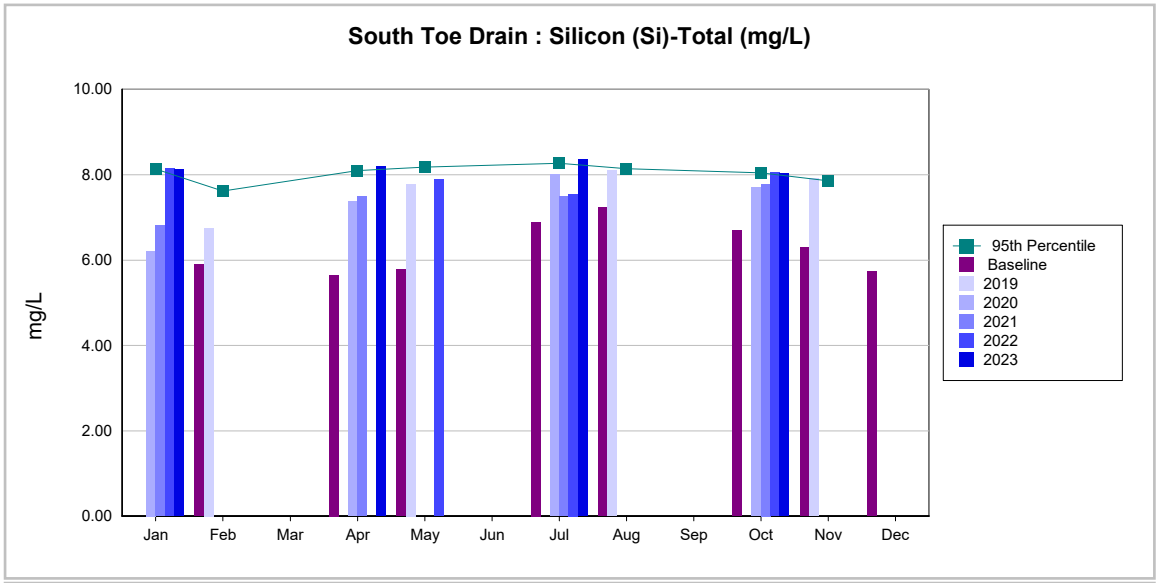
Water Quality Report

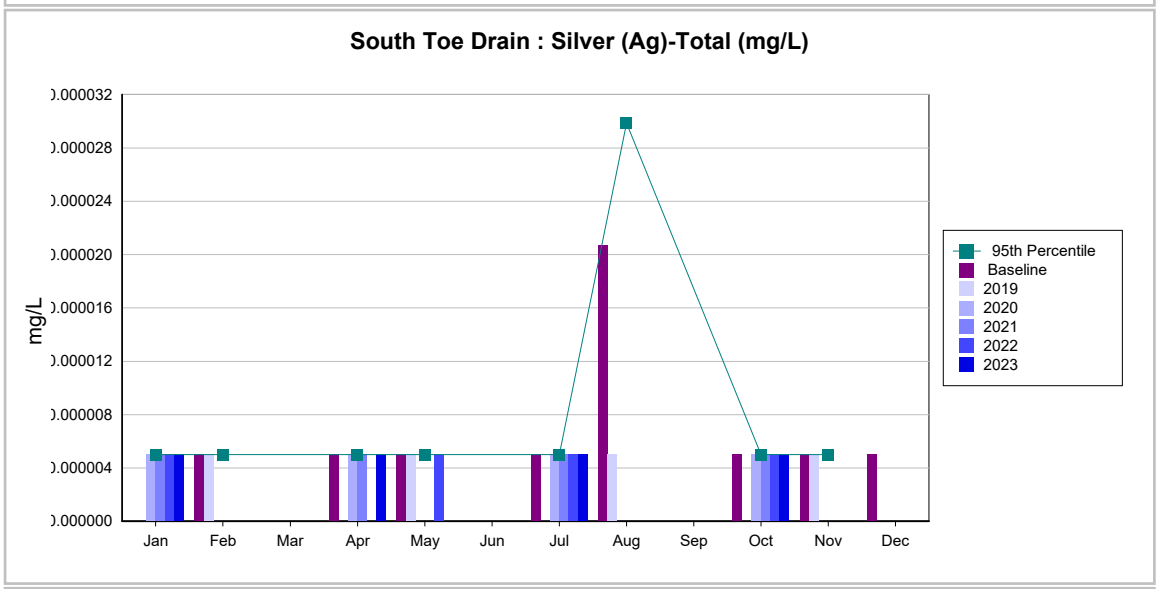
Annual Report Drainage Water

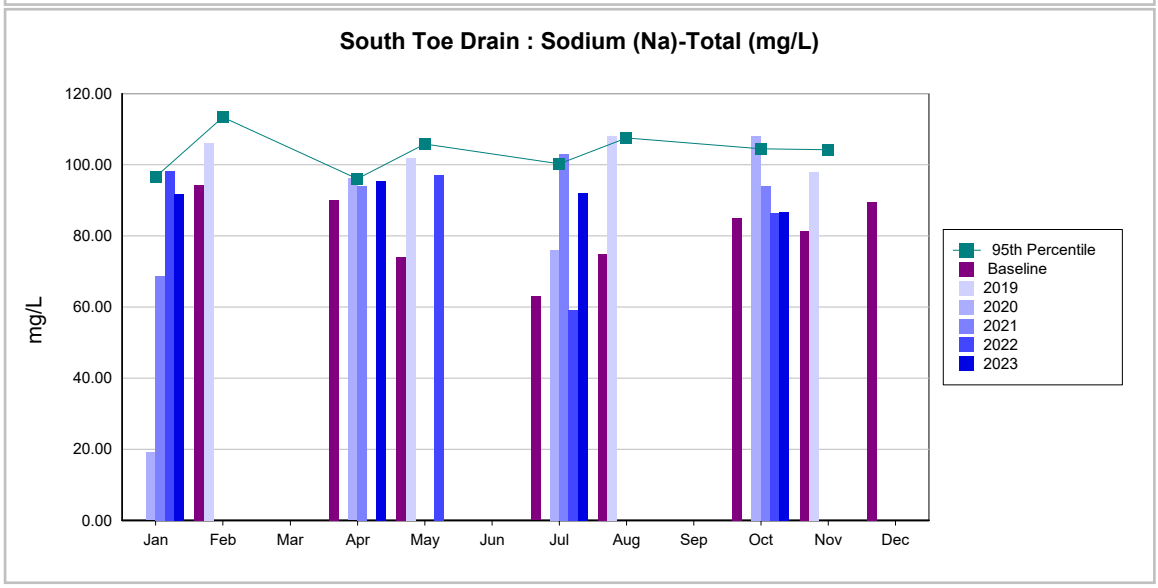
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







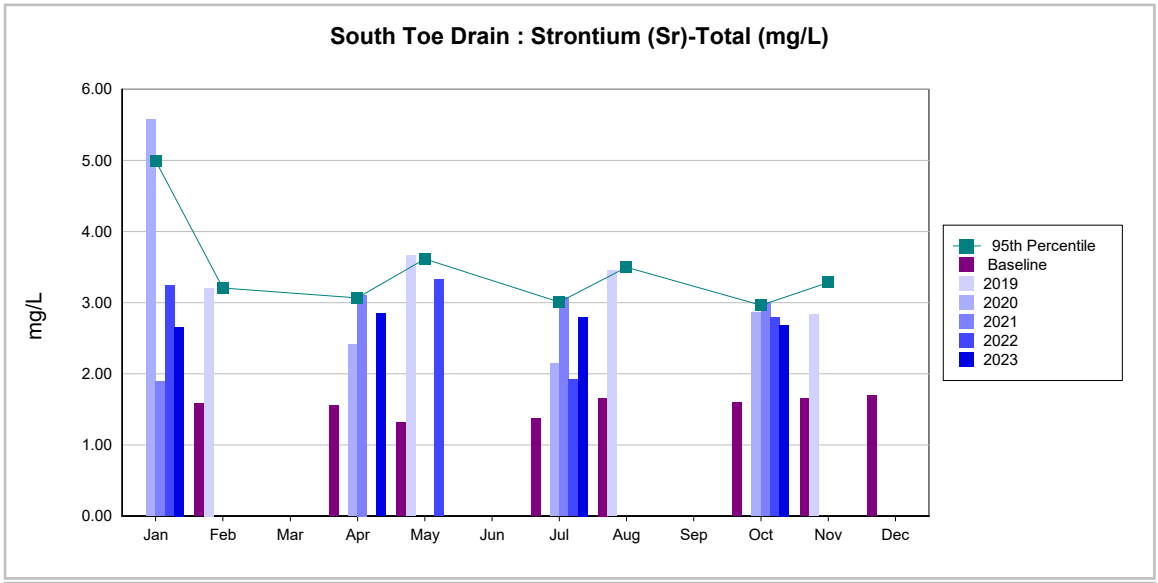
Water Quality Report

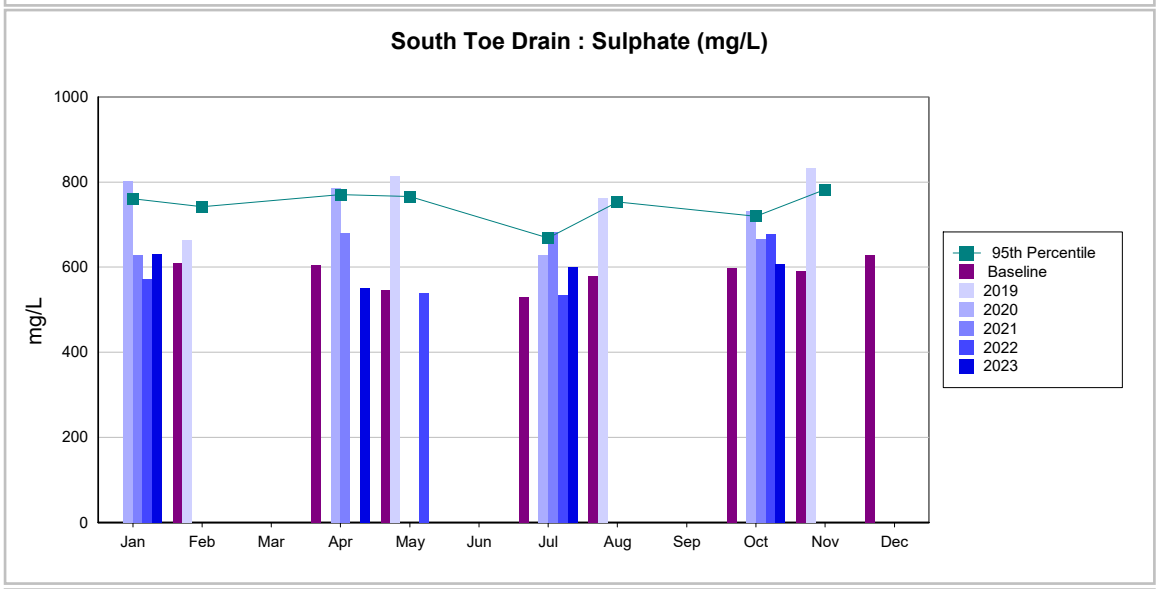
Annual Report Drainage Water

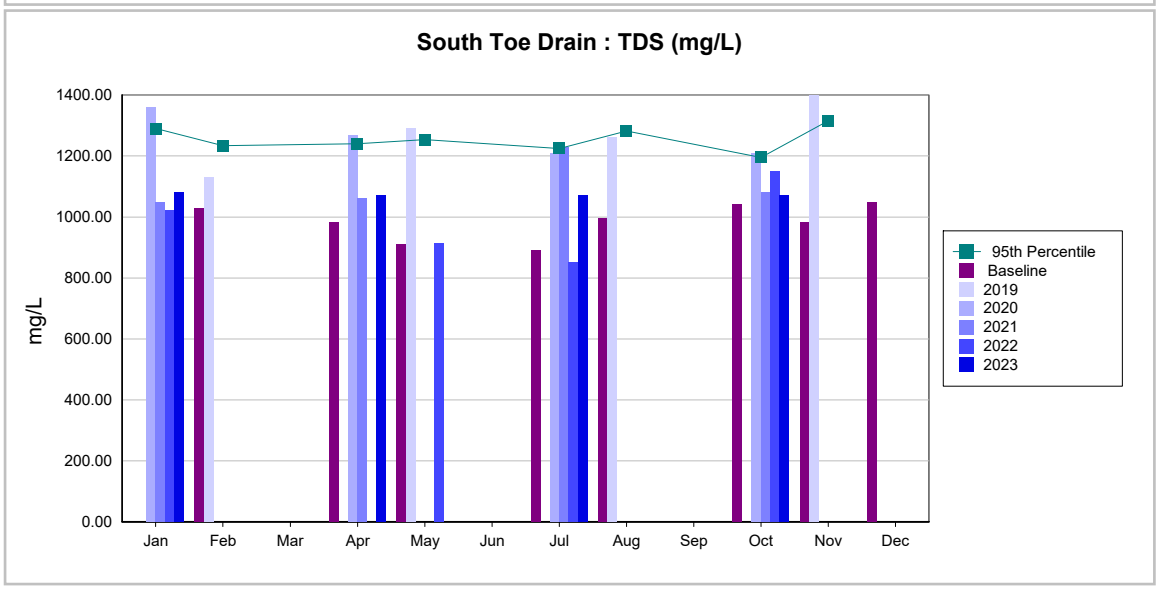
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







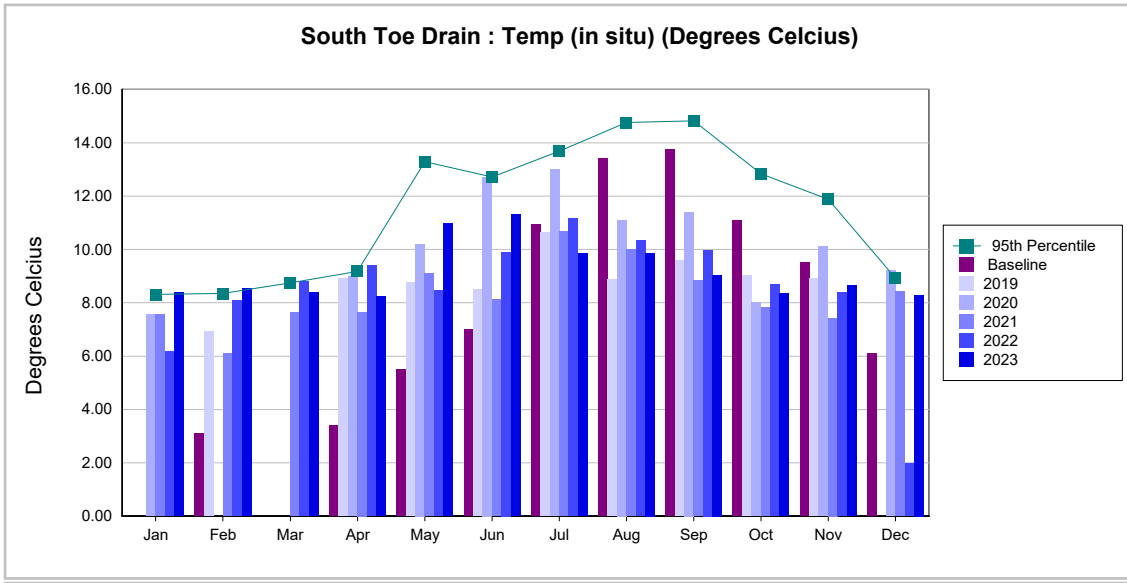
Water Quality Report

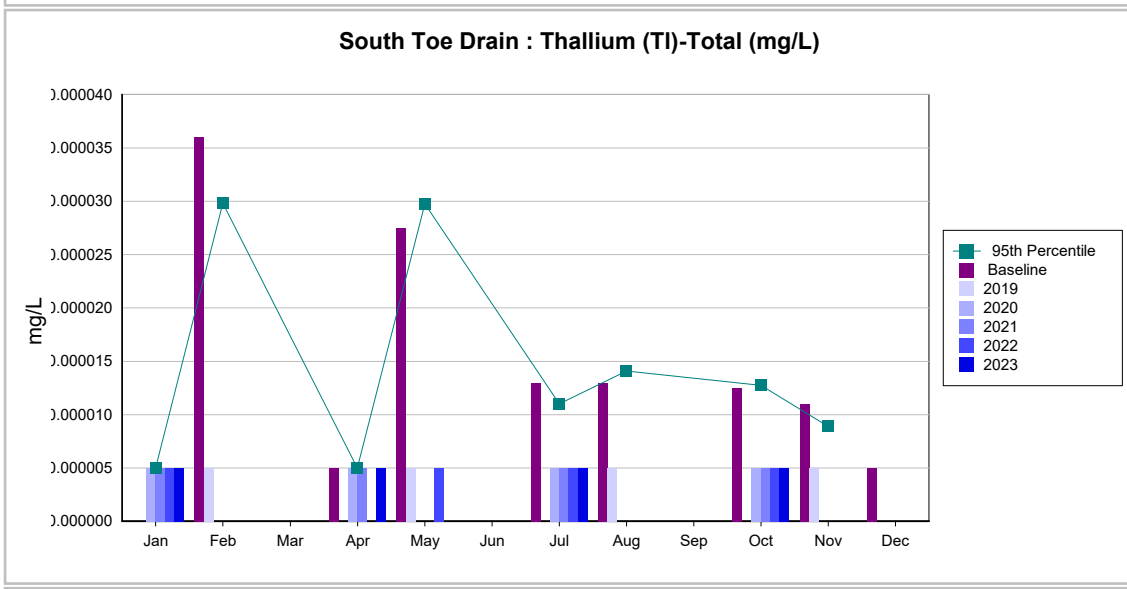
Annual Report Drainage Water

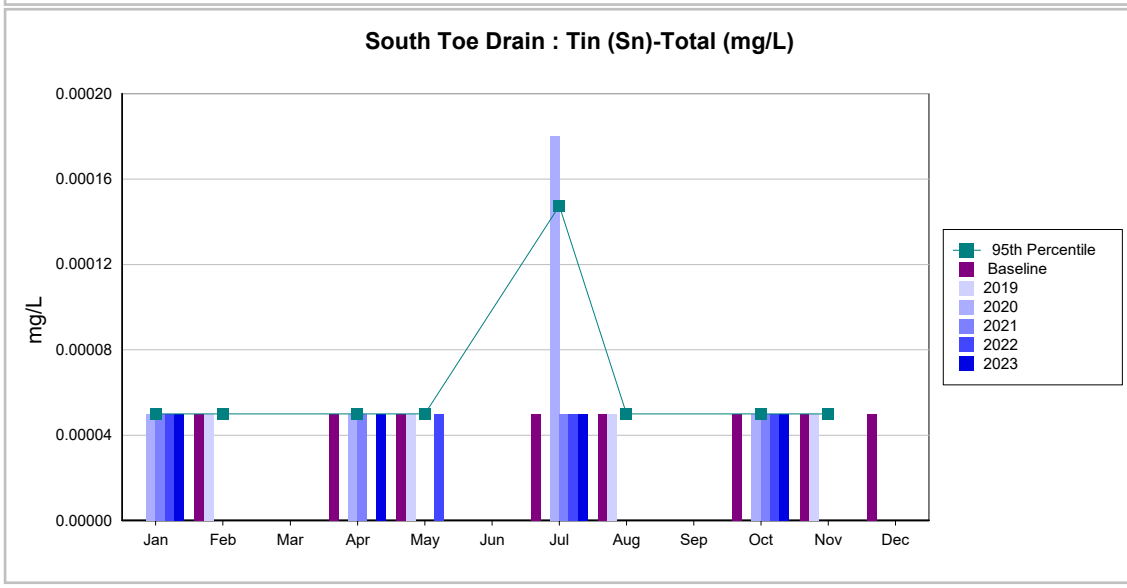
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







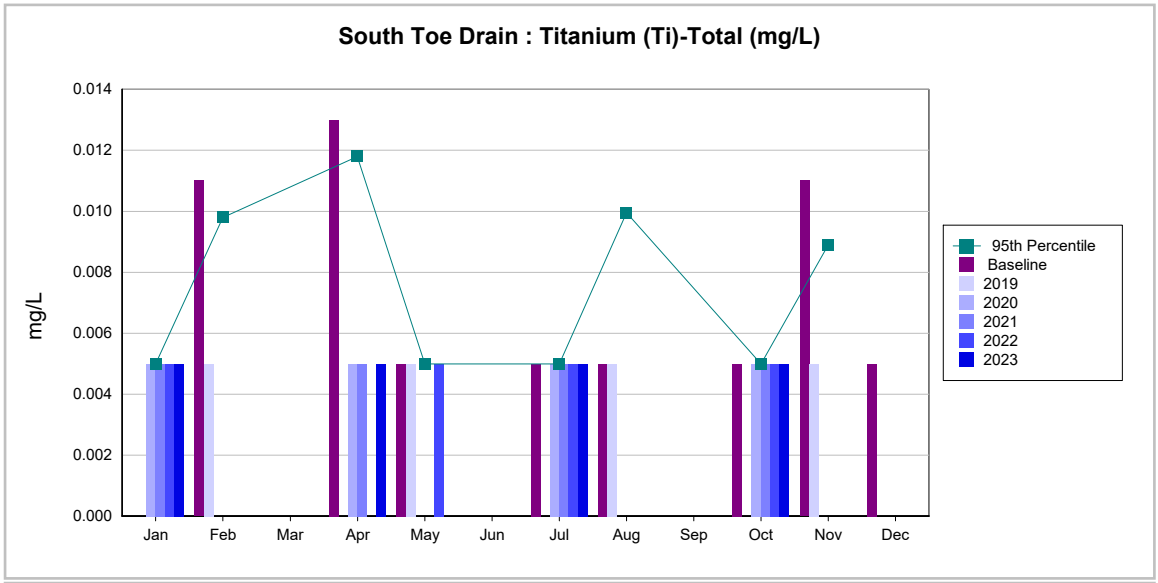
Water Quality Report

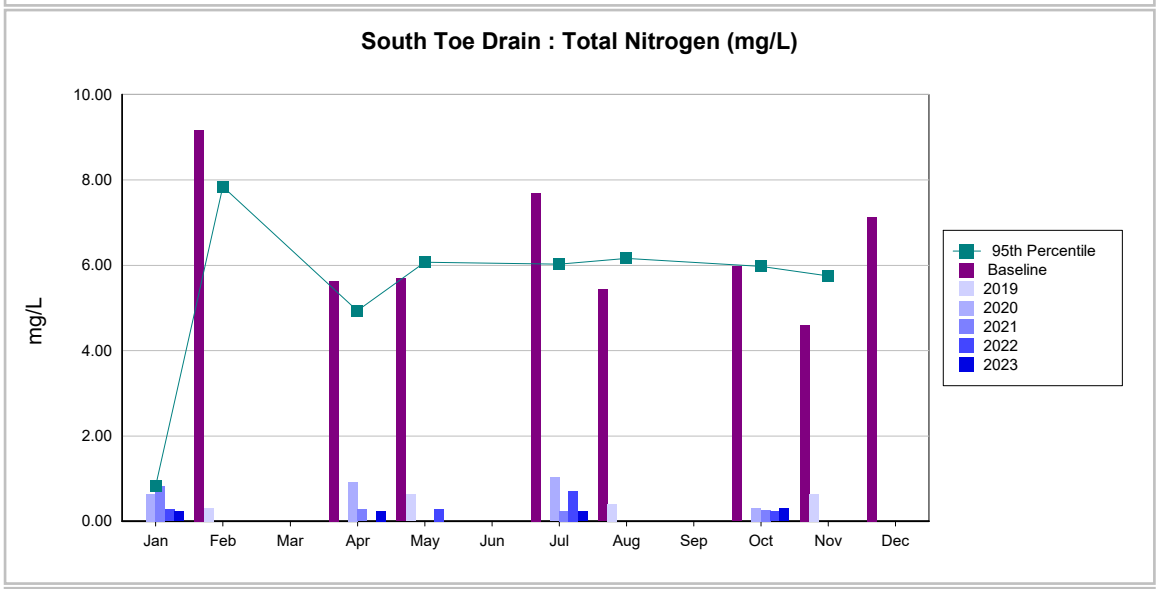
Annual Report Drainage Water

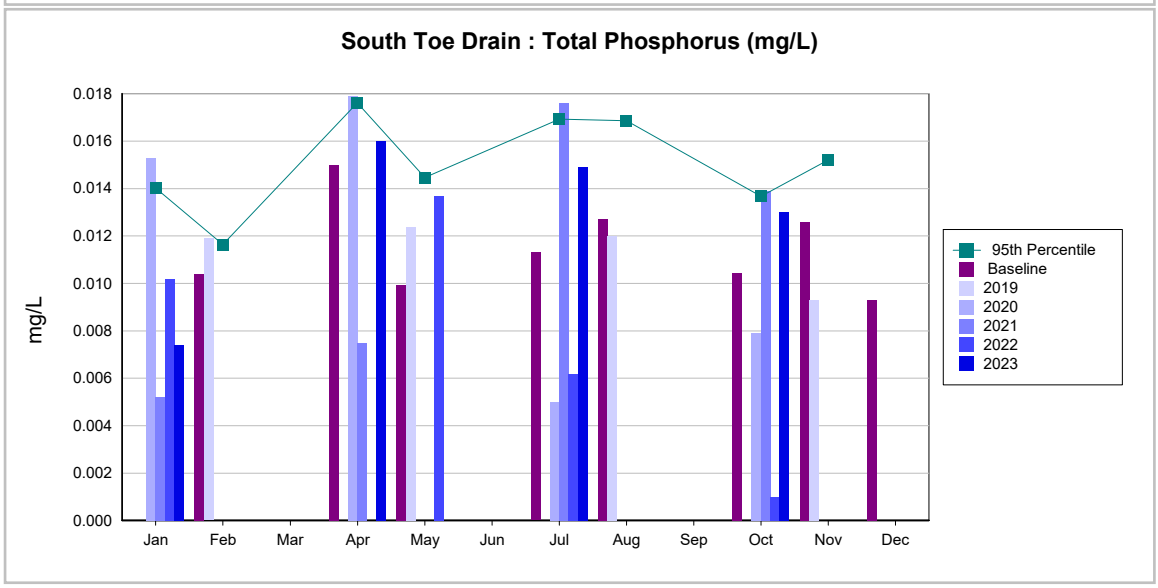
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







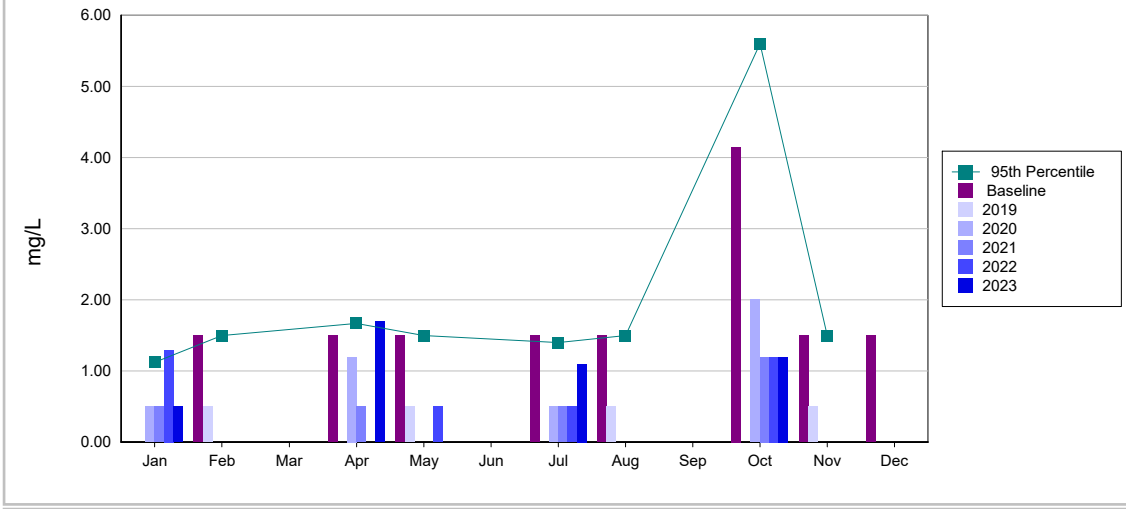
Water Quality Report

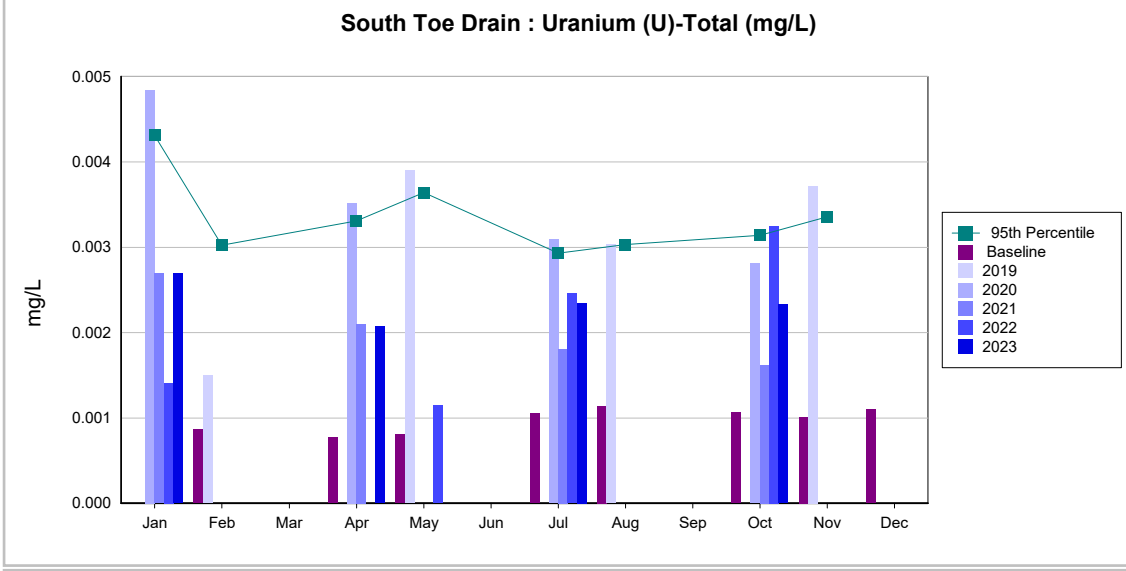
Annual Report Drainage Water

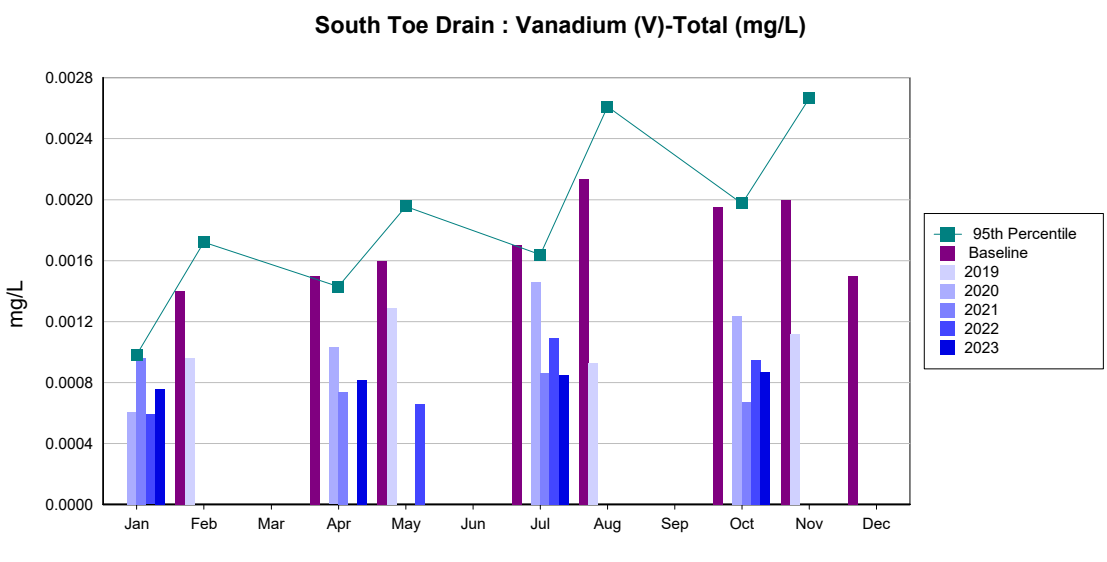
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







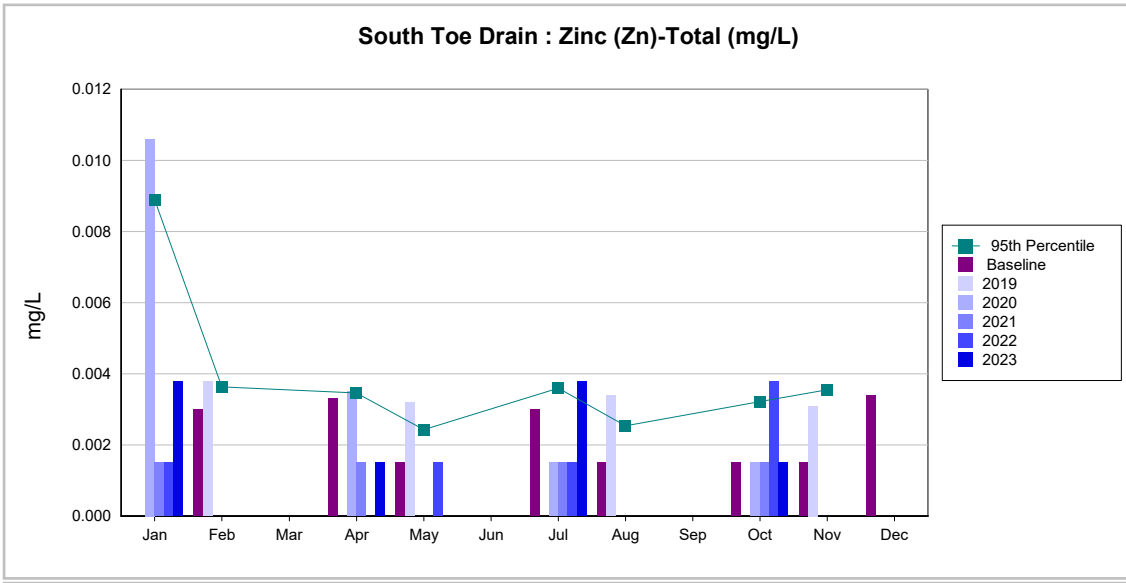
Water Quality Report

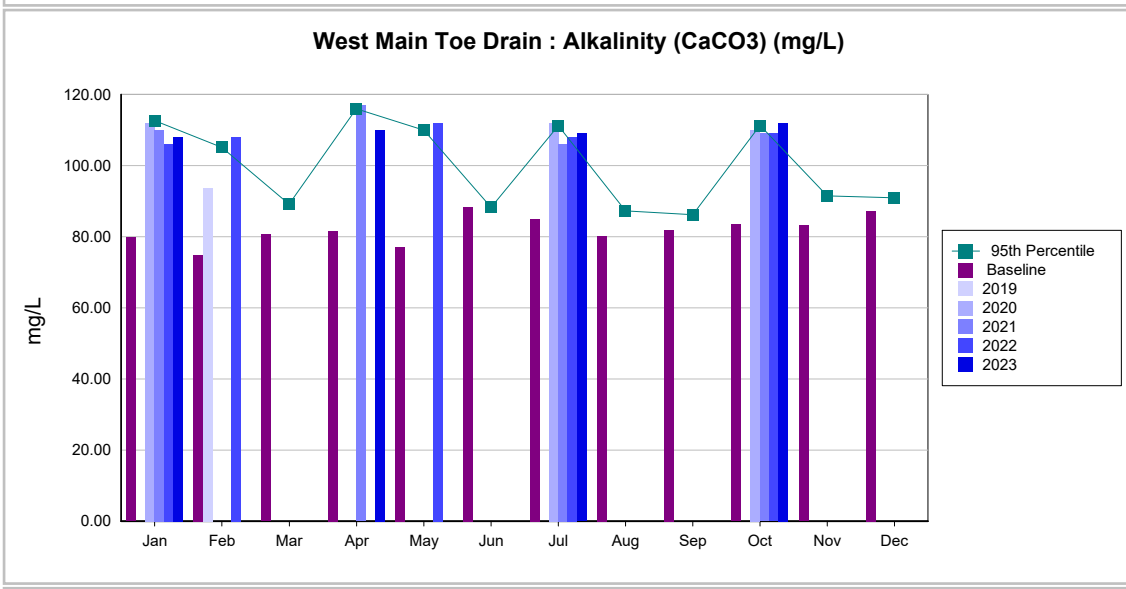
Annual Report Drainage Water

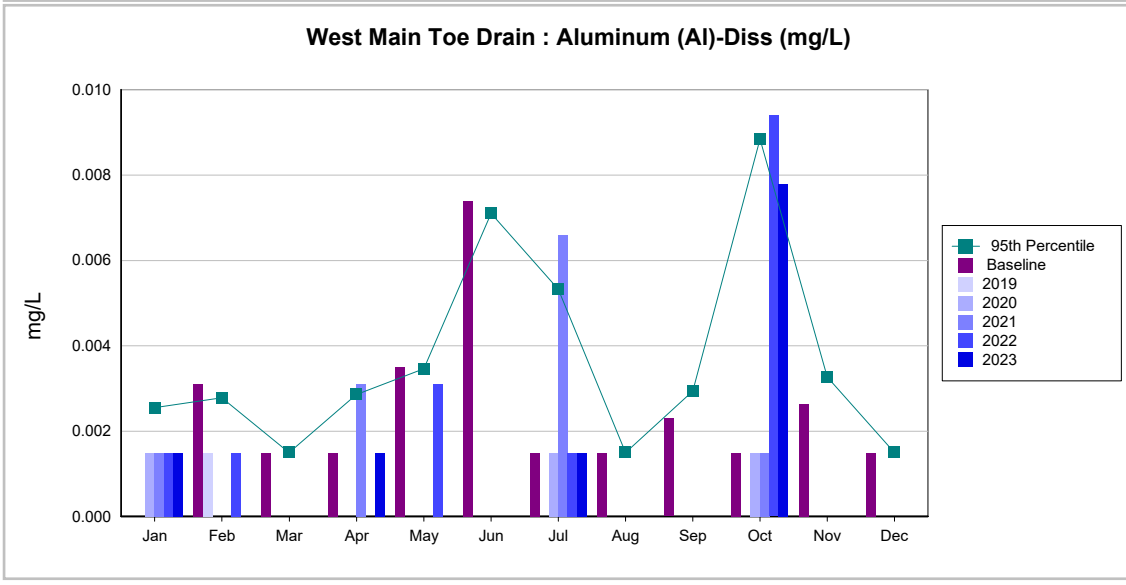
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







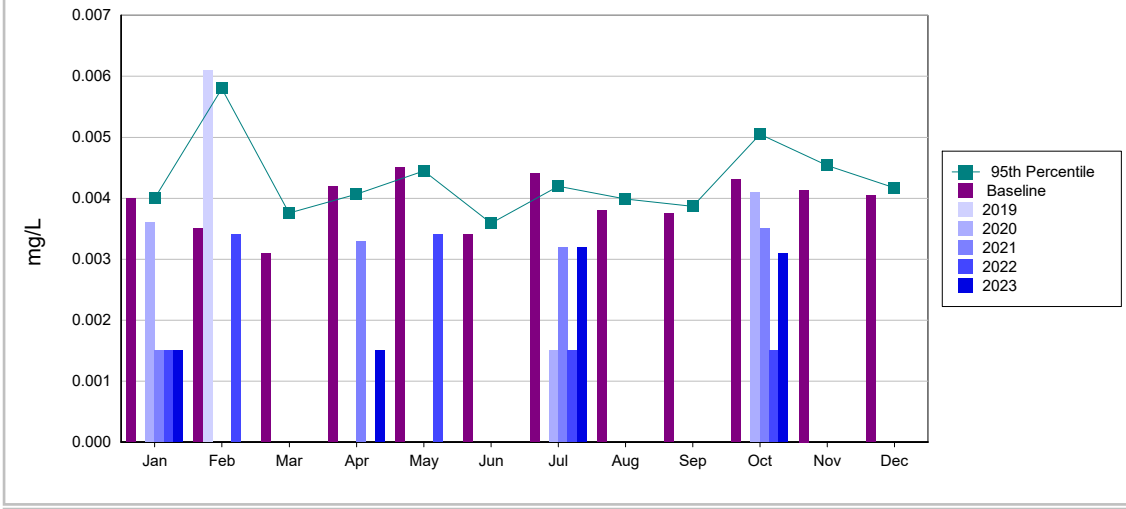
Water Quality Report

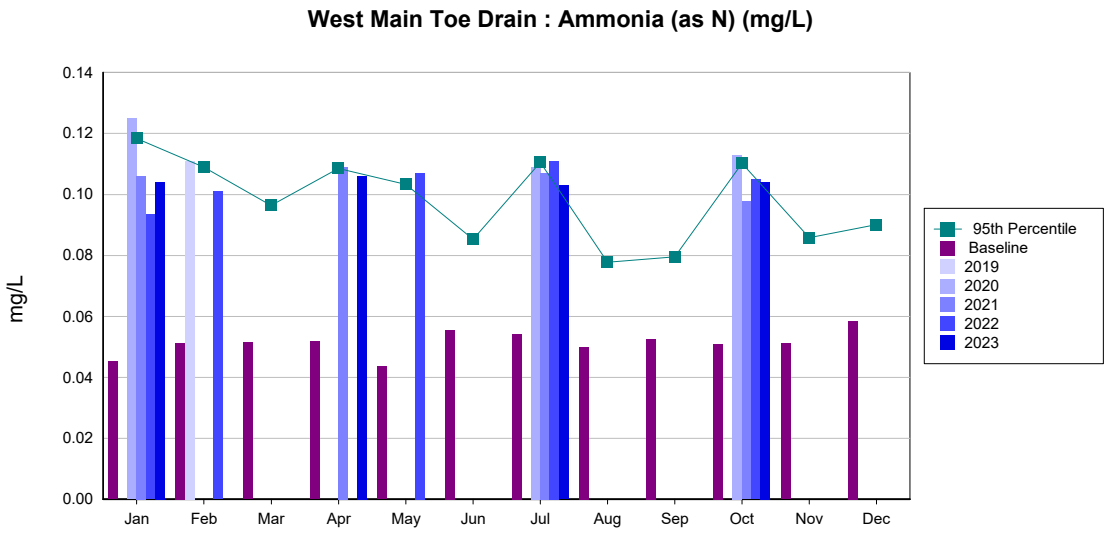
Annual Report Drainage Water

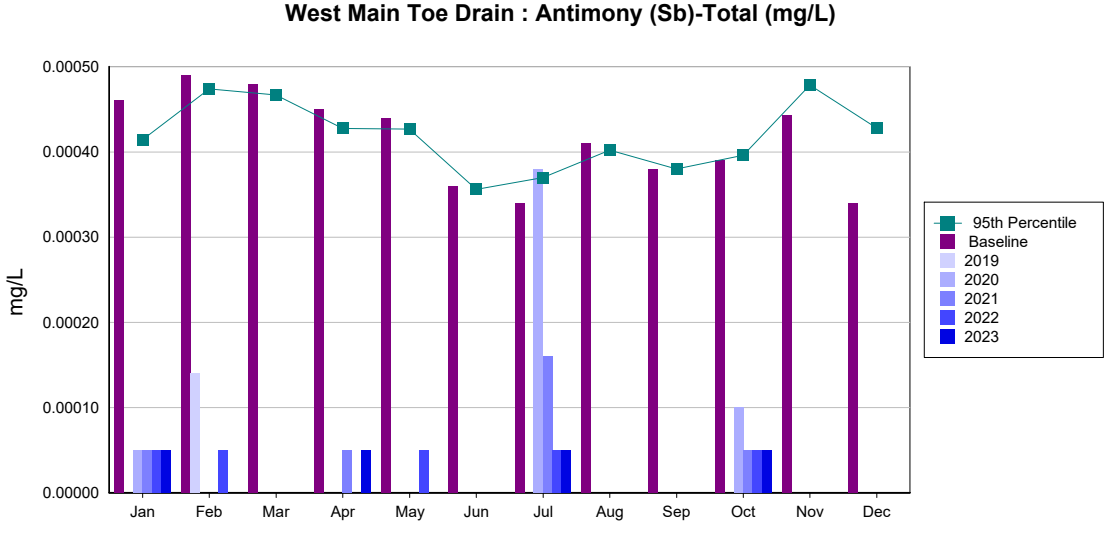
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







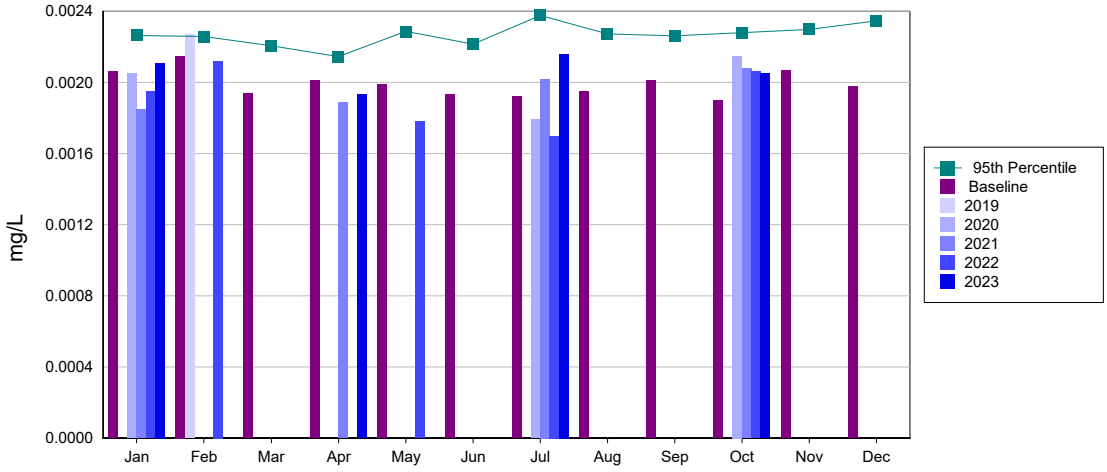
Water Quality Report

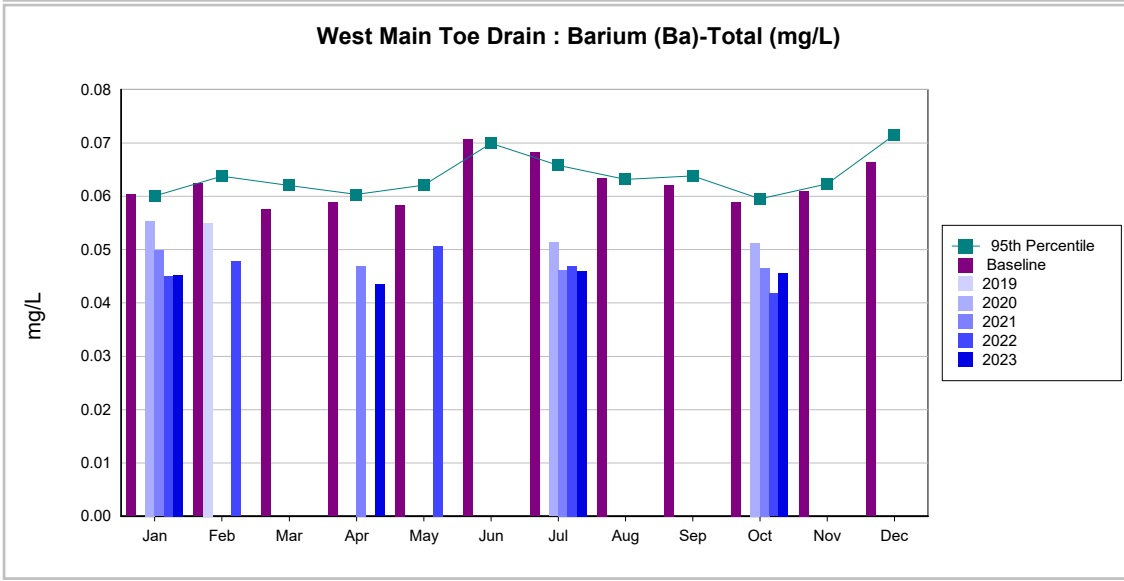
Annual Report Drainage Water

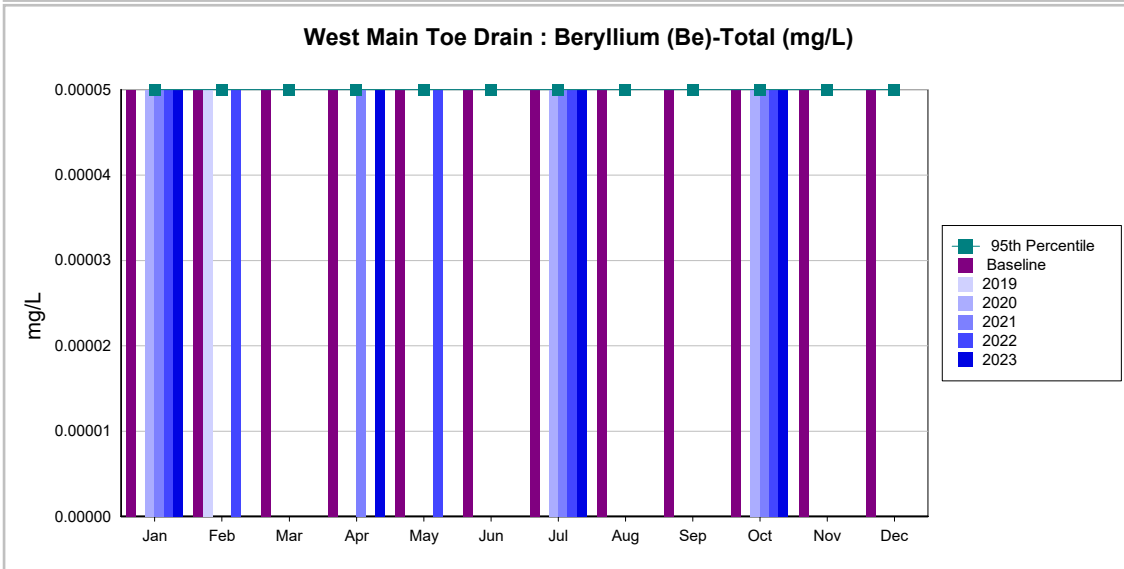
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







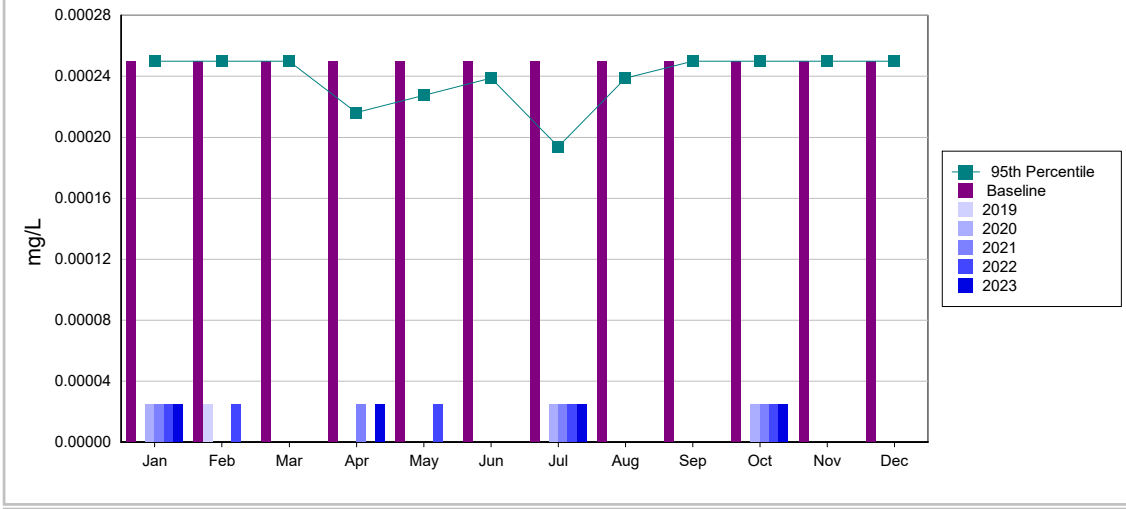
Water Quality Report

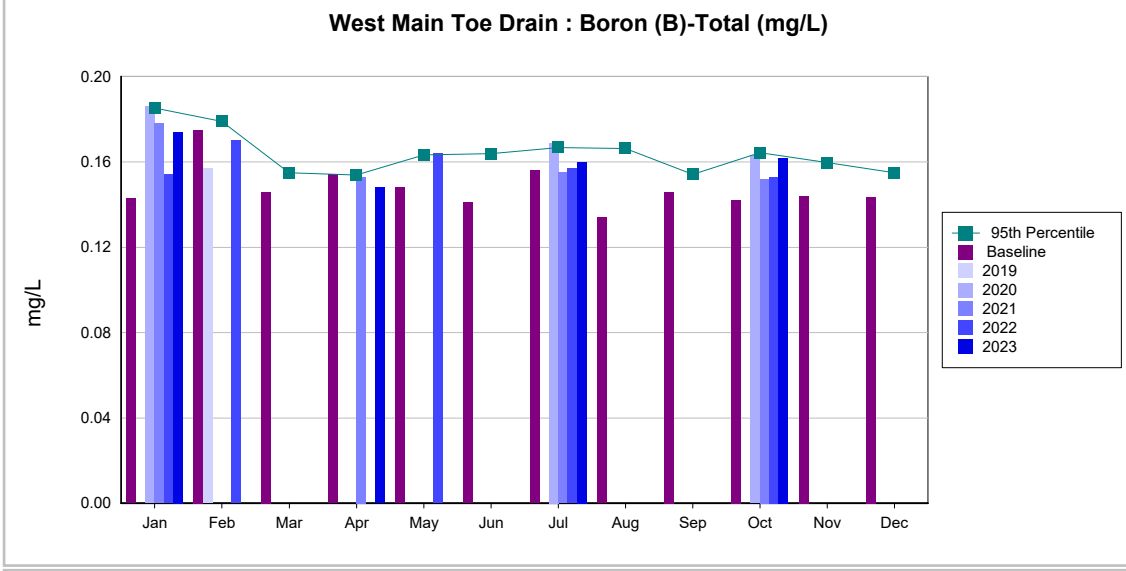
Annual Report Drainage Water

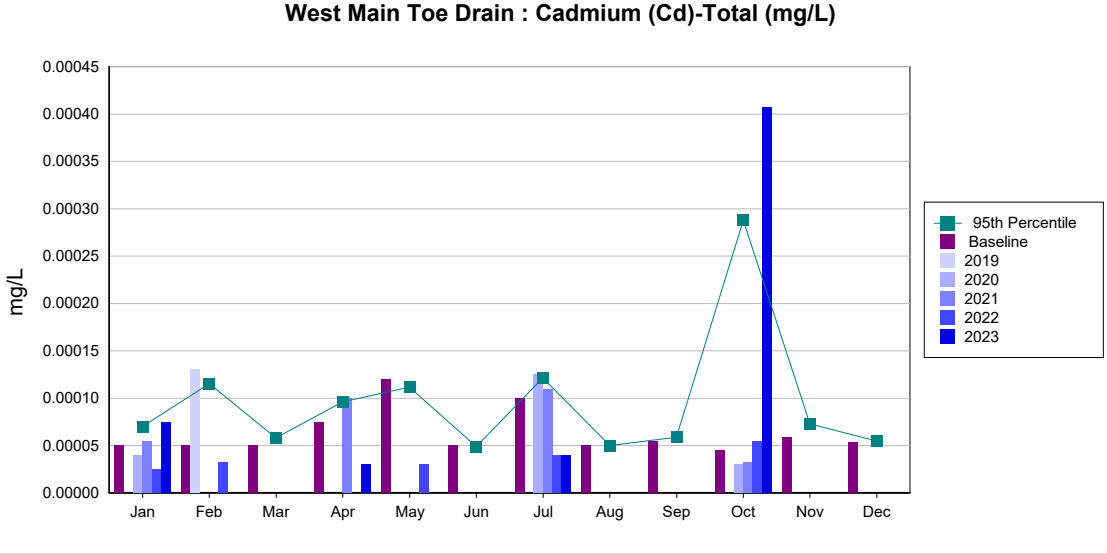
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







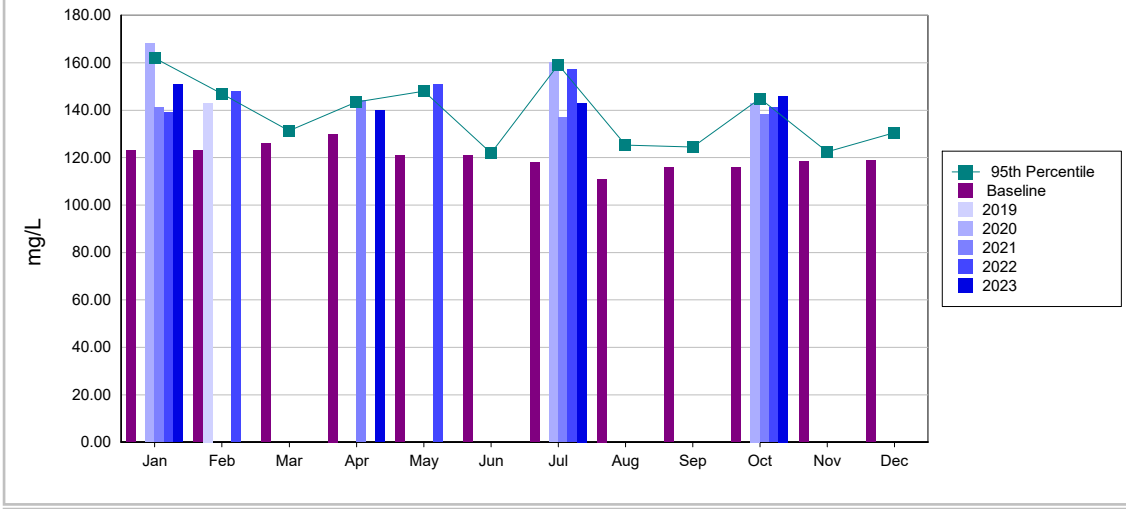
Water Quality Report

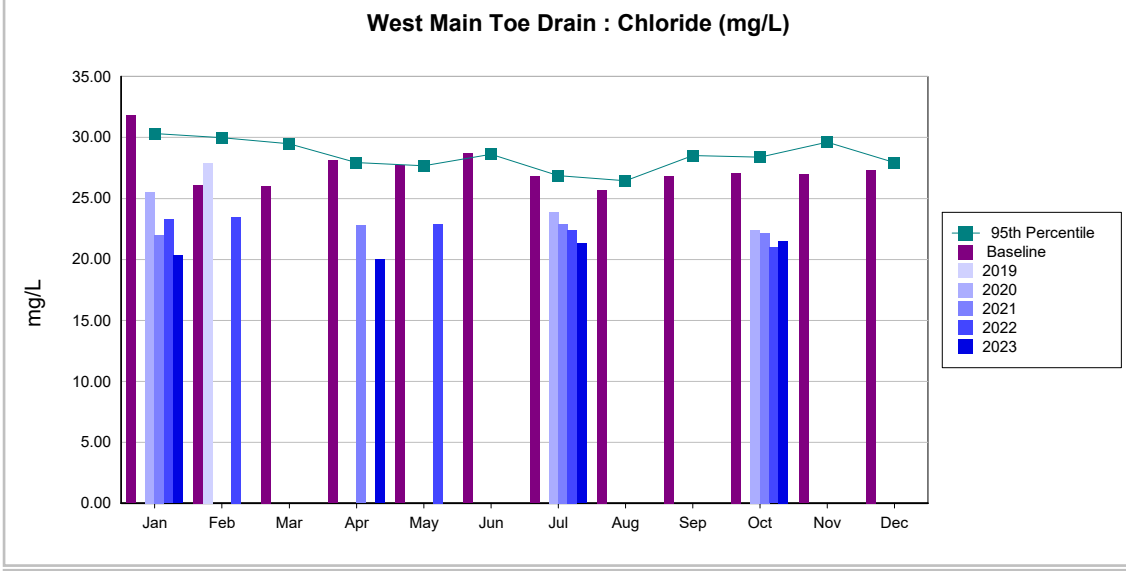
Annual Report Drainage Water

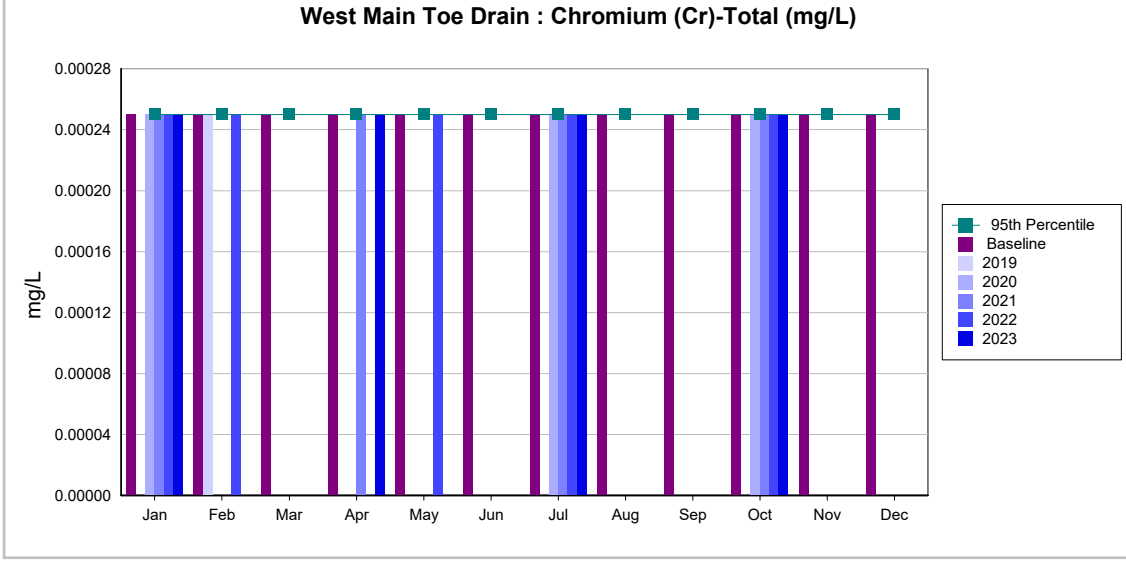
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







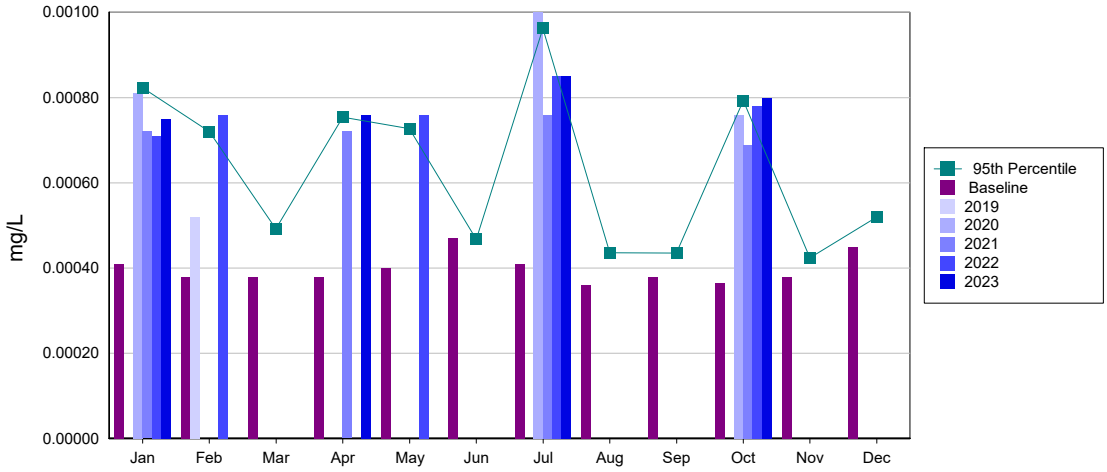
Water Quality Report

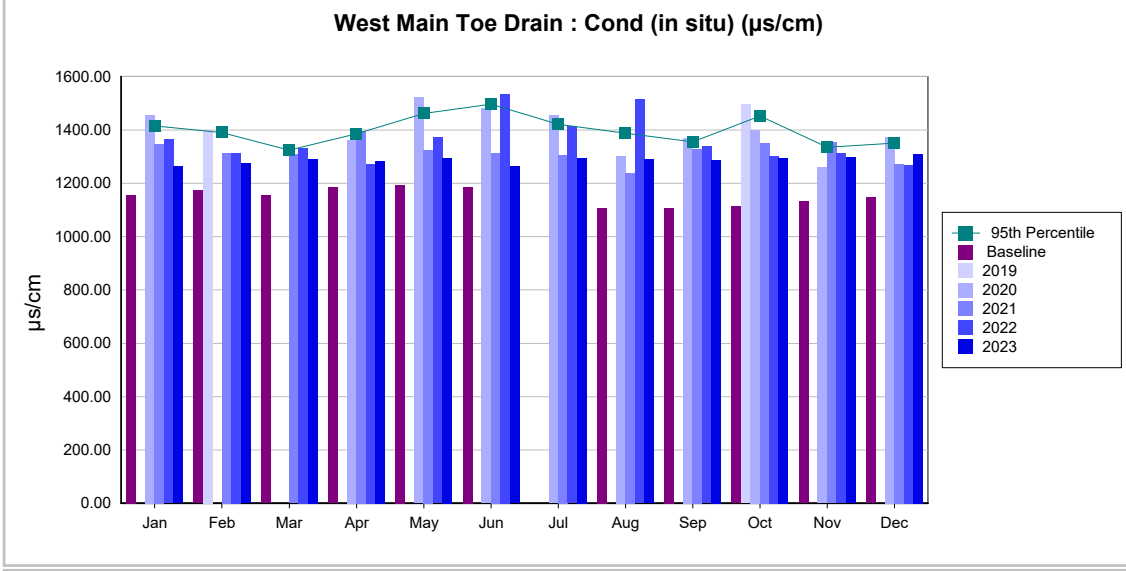
Annual Report Drainage Water

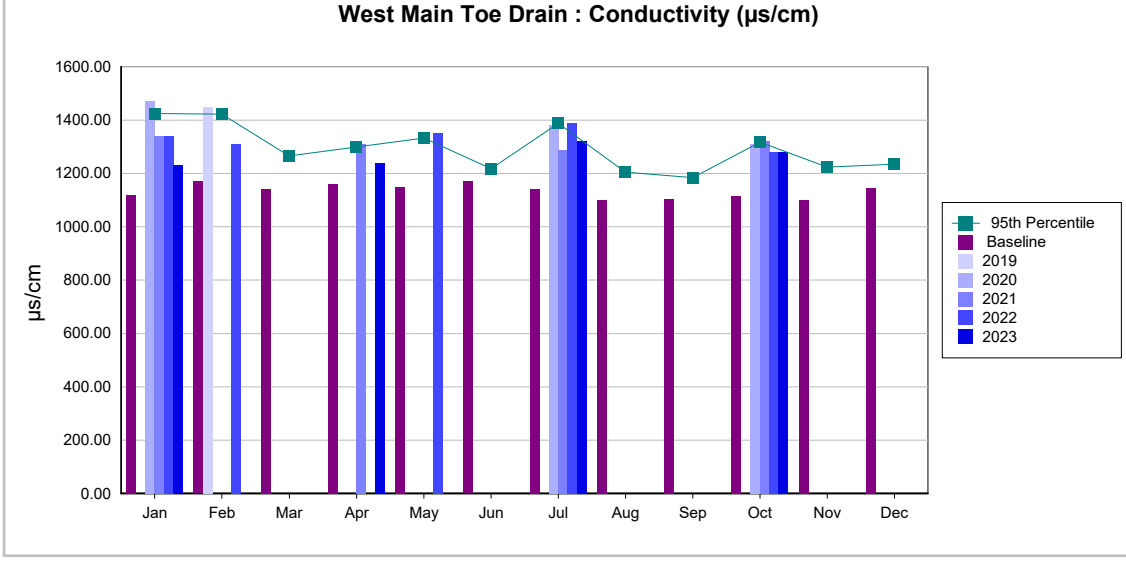
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







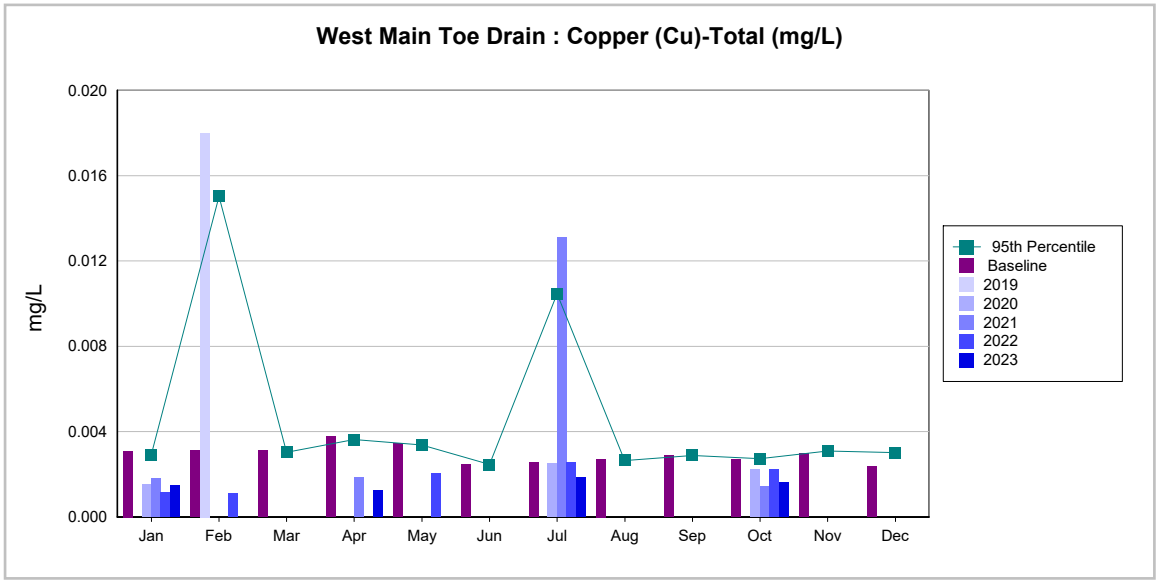
Water Quality Report

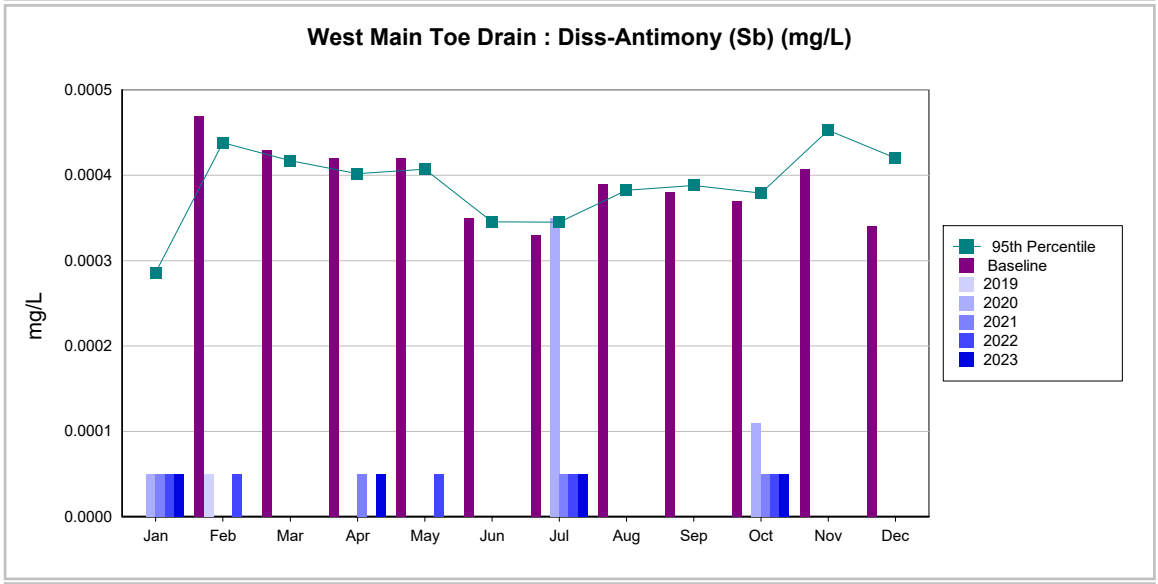
Annual Report Drainage Water

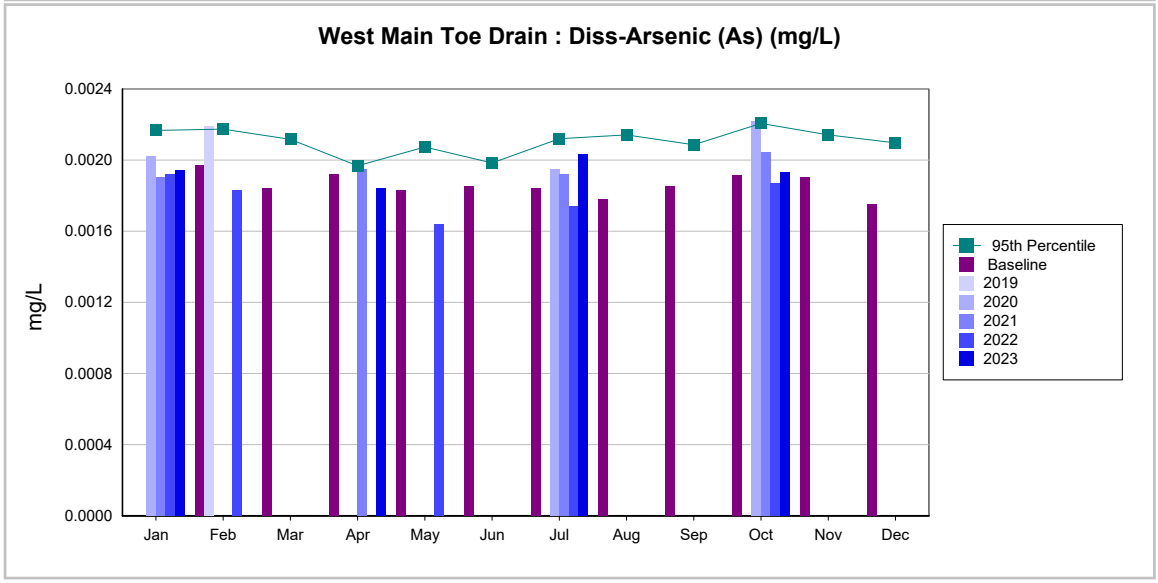
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







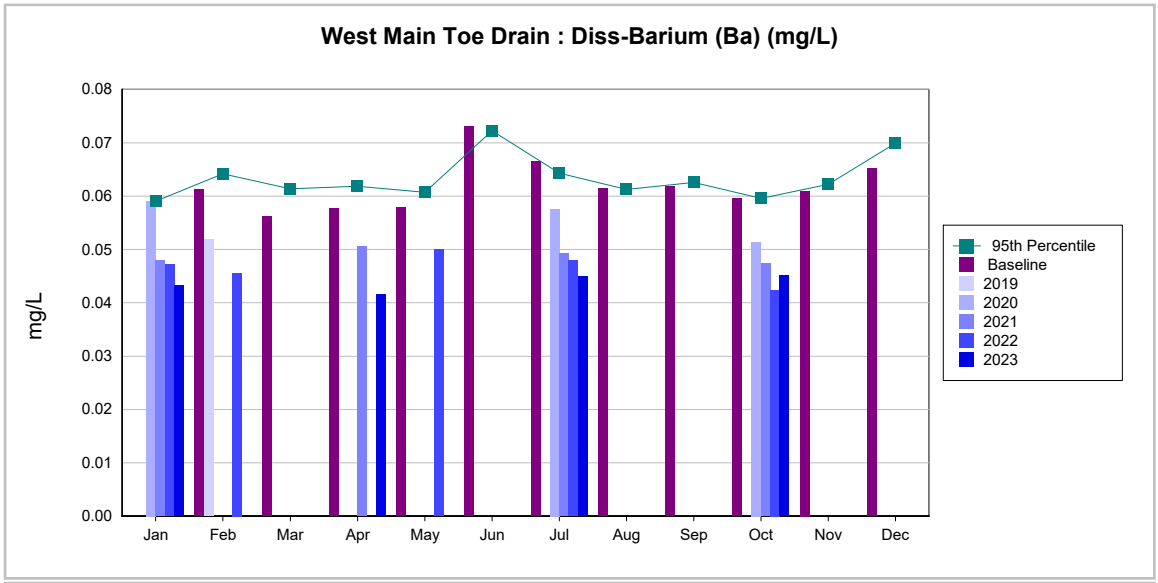
Water Quality Report

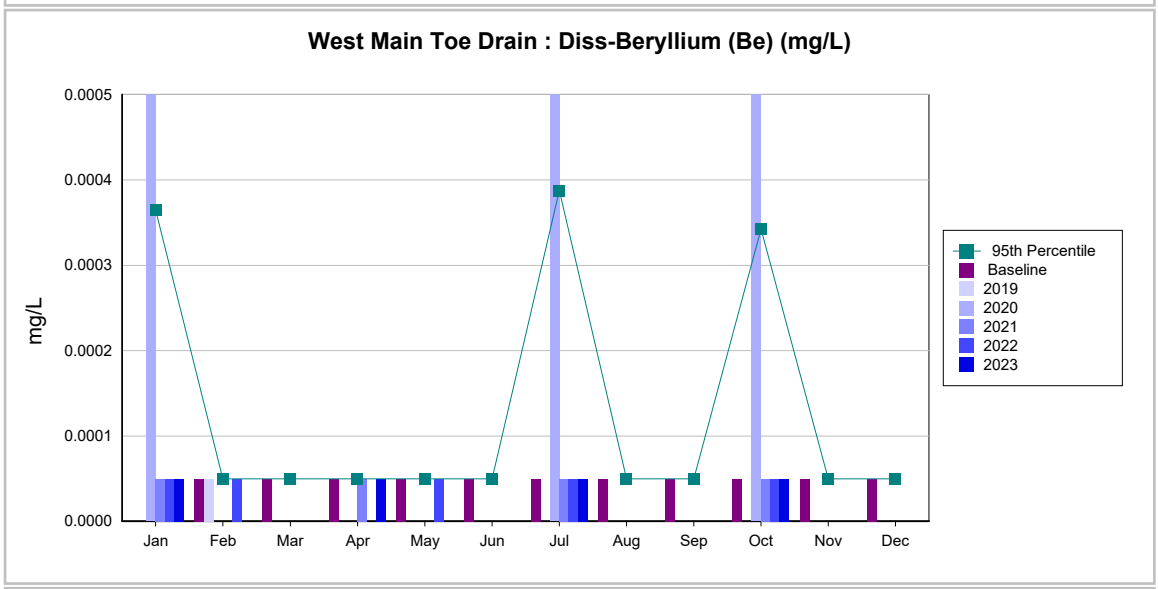
Annual Report Drainage Water

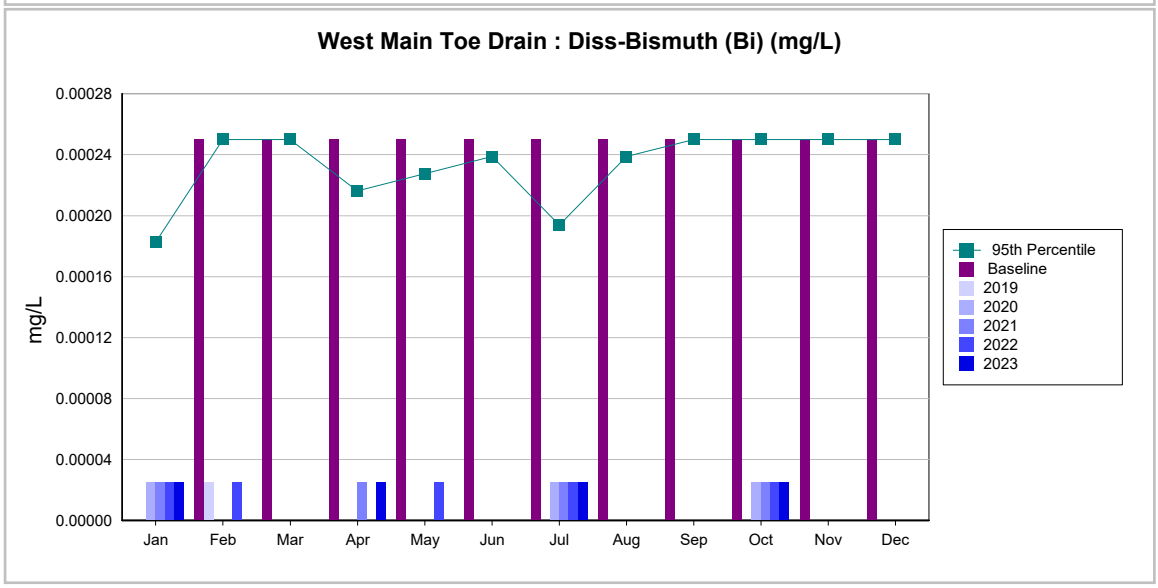
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







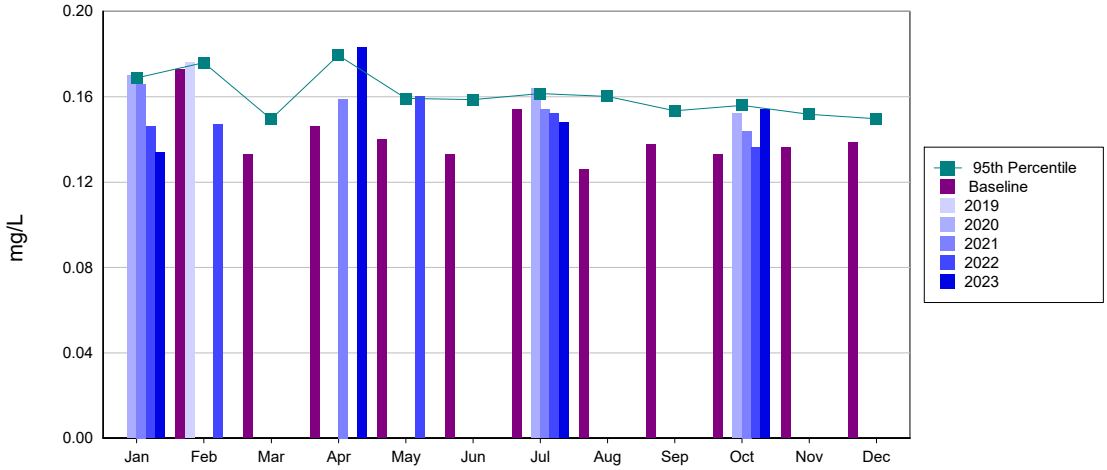
Water Quality Report

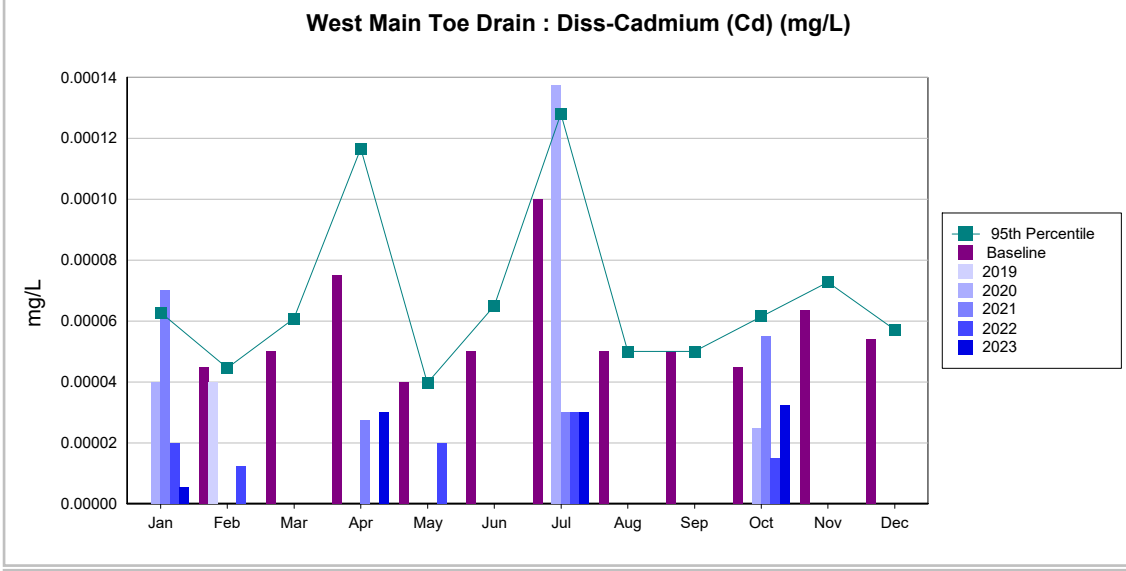
Annual Report Drainage Water

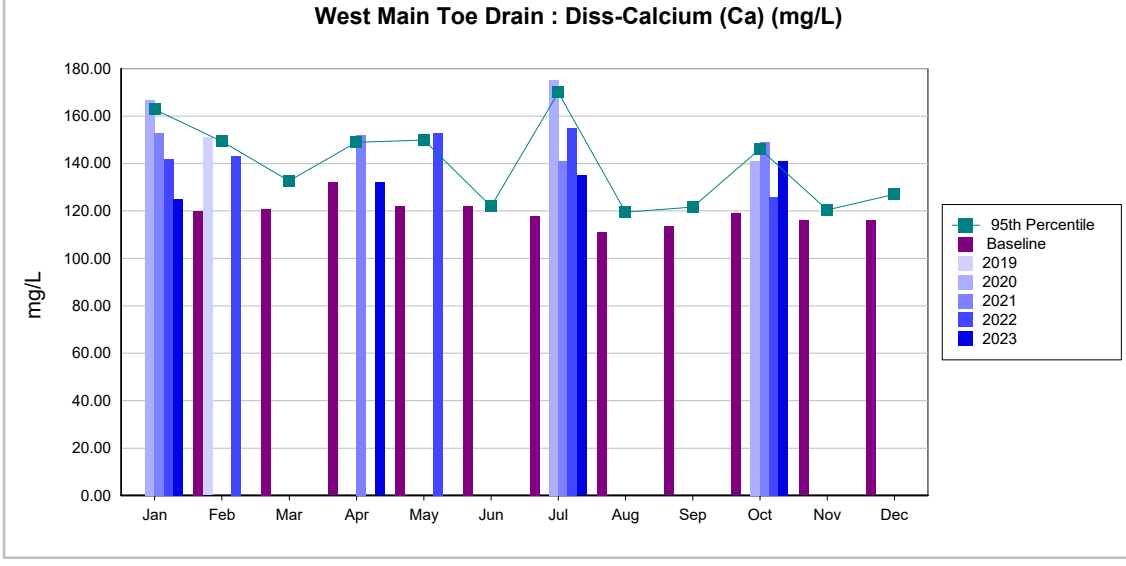
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







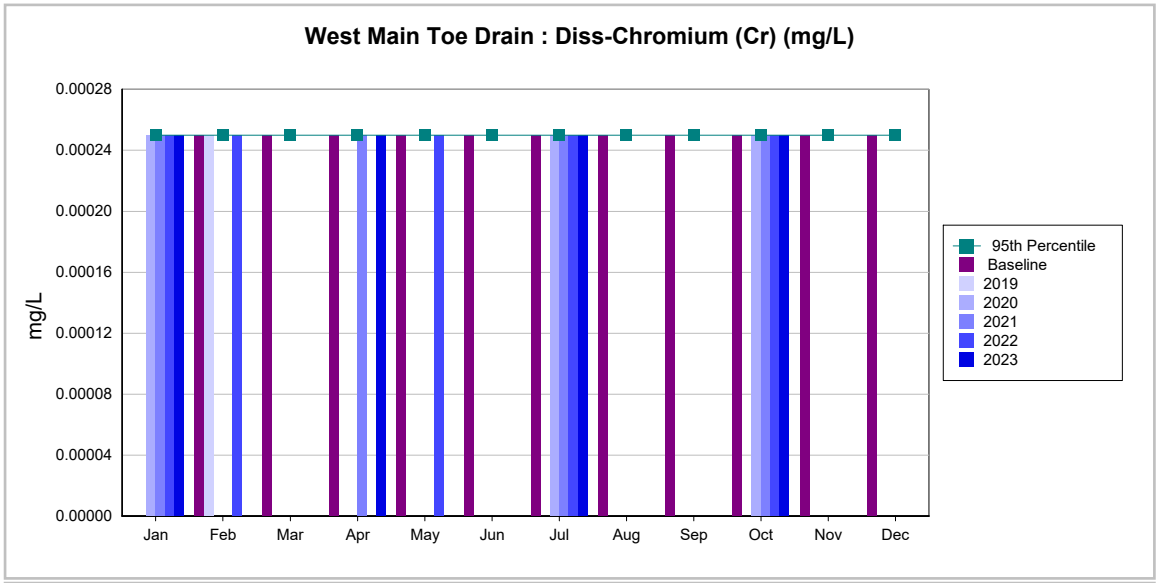
Water Quality Report

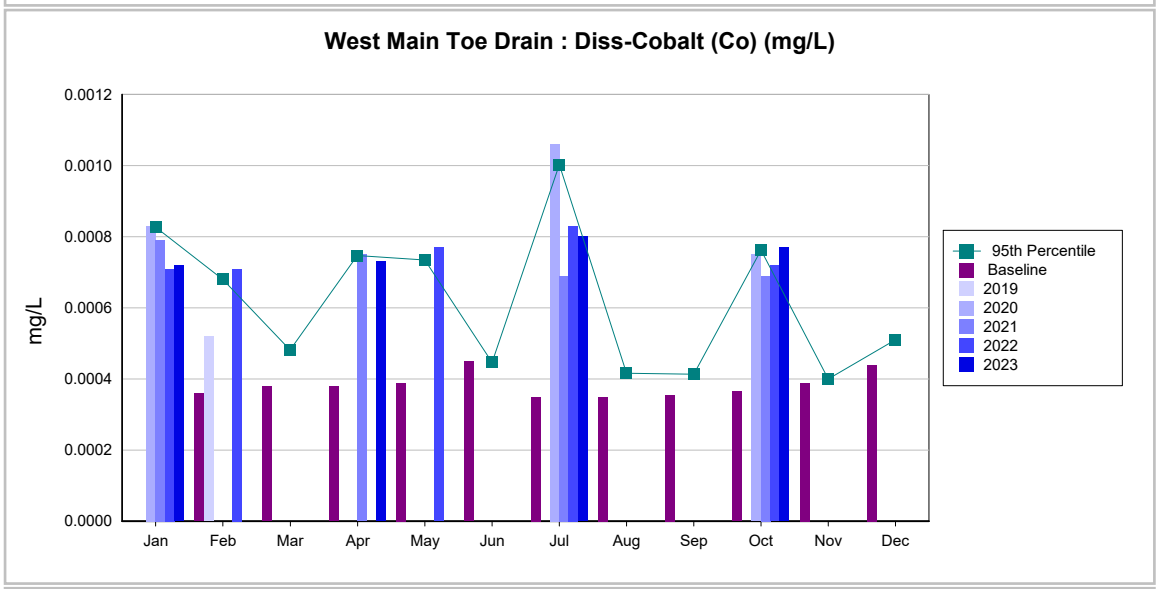
Annual Report Drainage Water

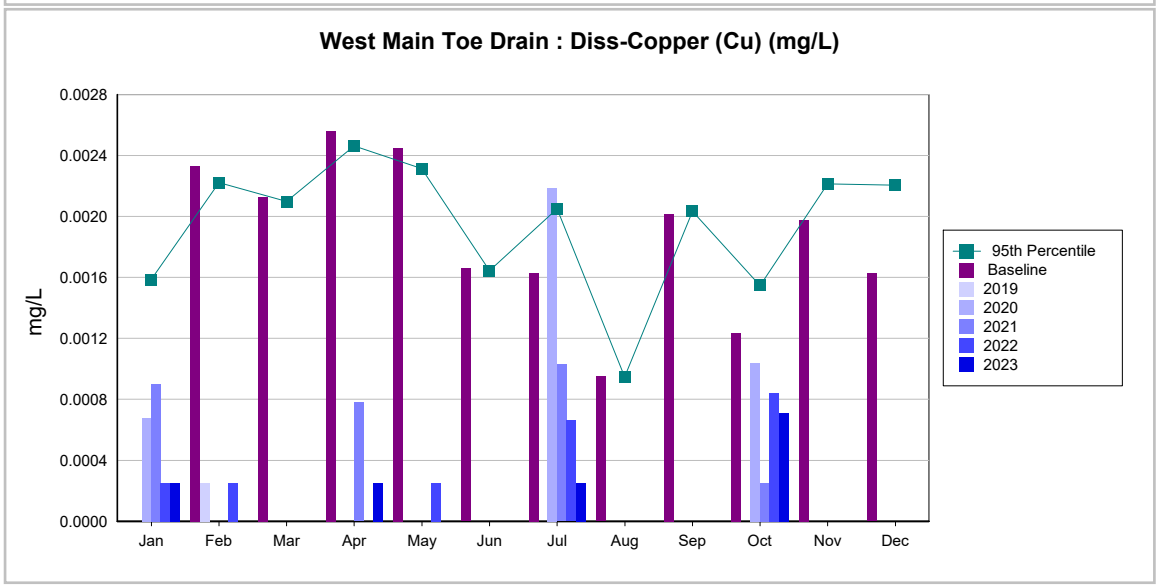
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







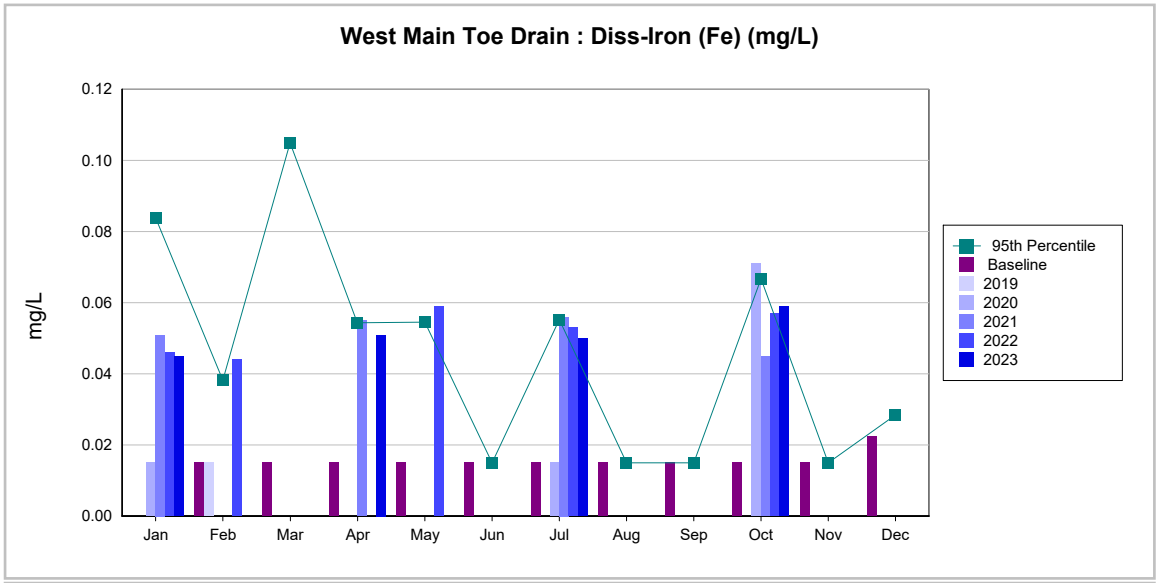
Water Quality Report

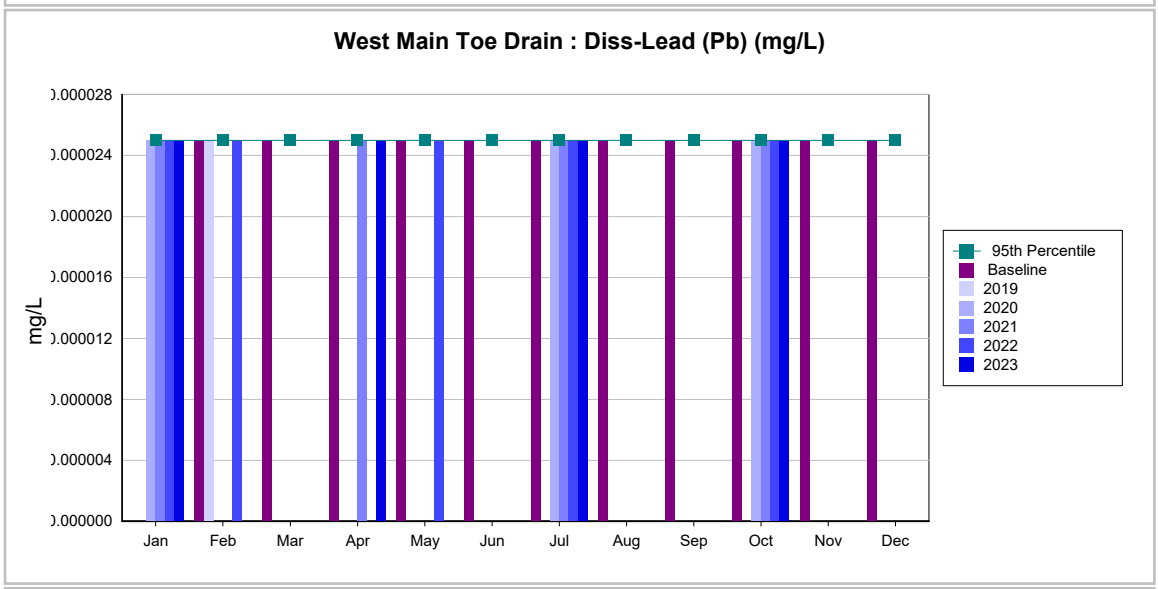
Annual Report Drainage Water

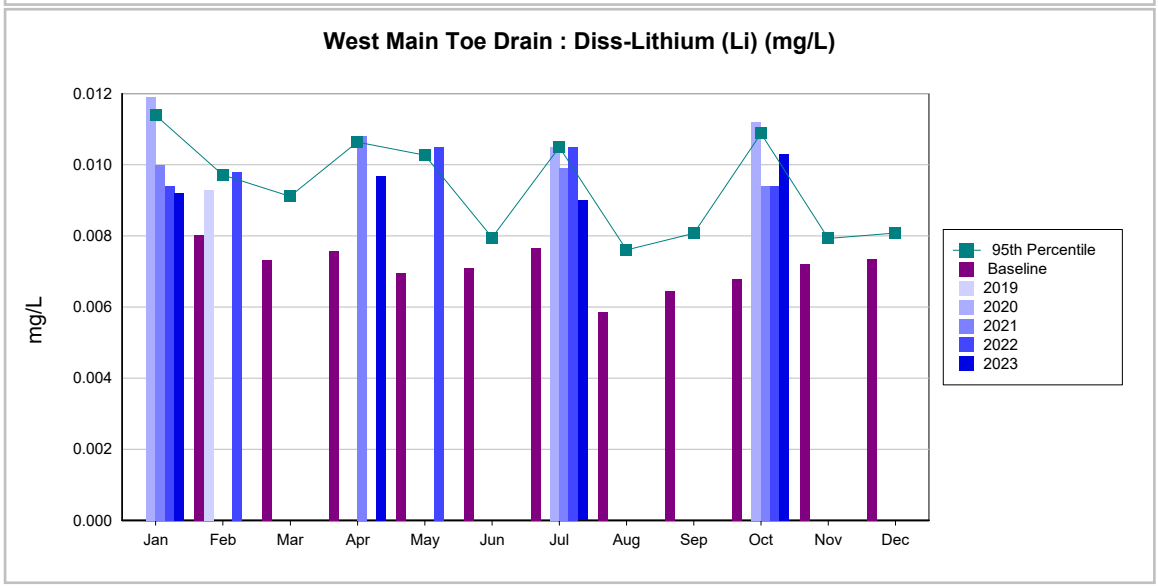
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







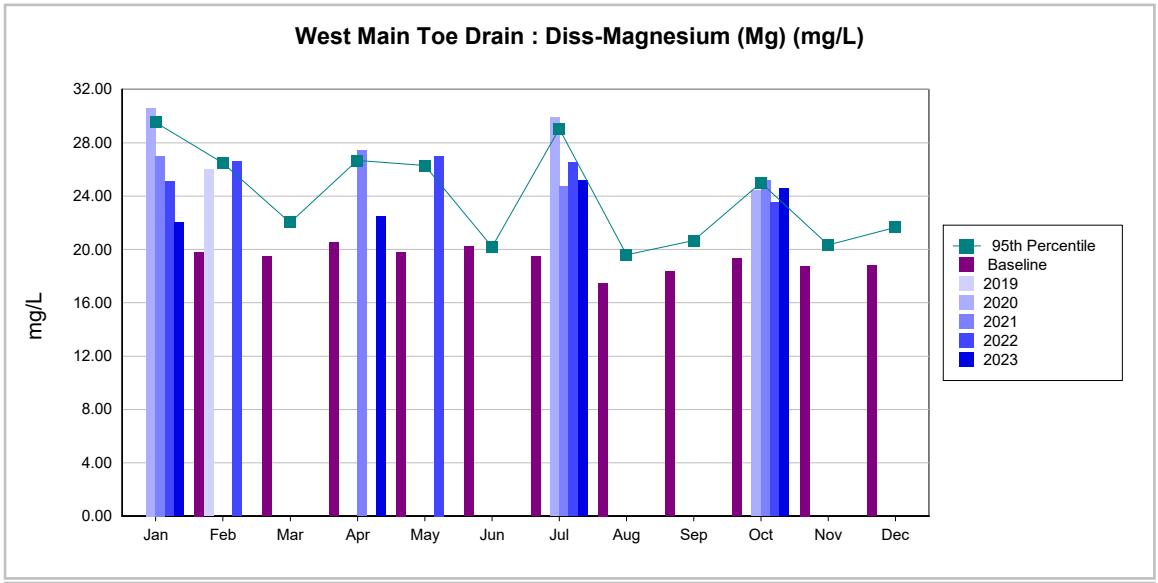
Water Quality Report

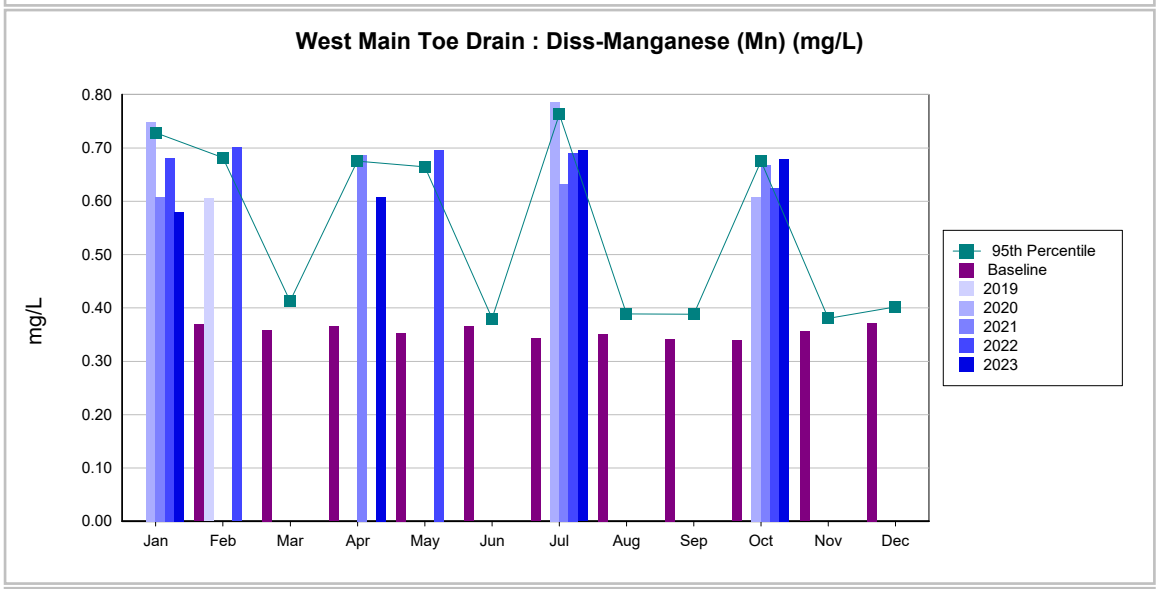
Annual Report Drainage Water

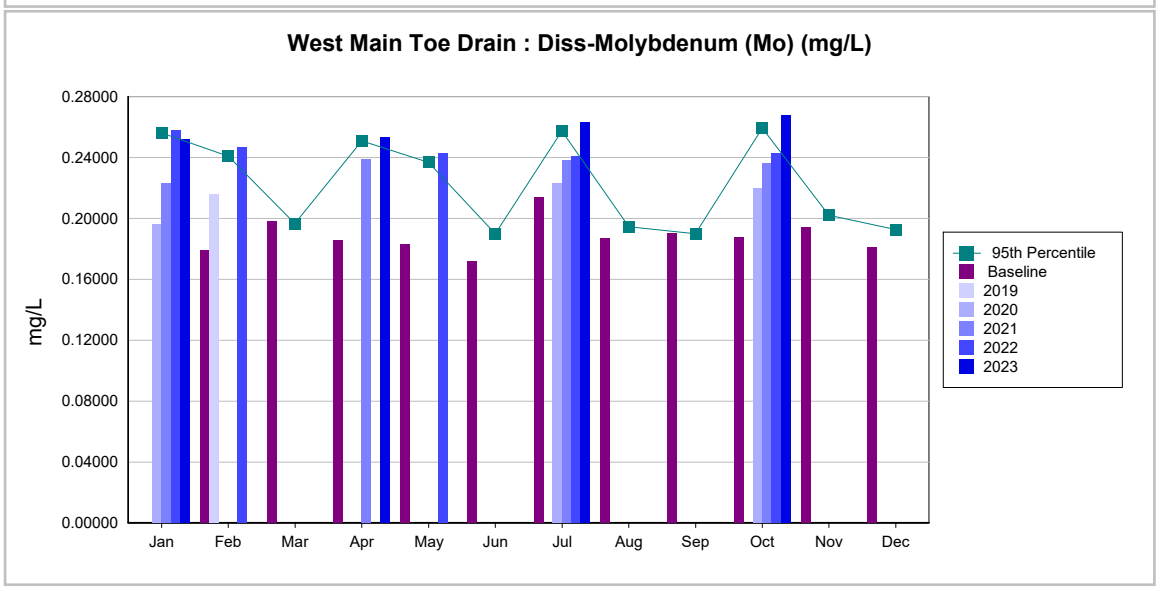
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







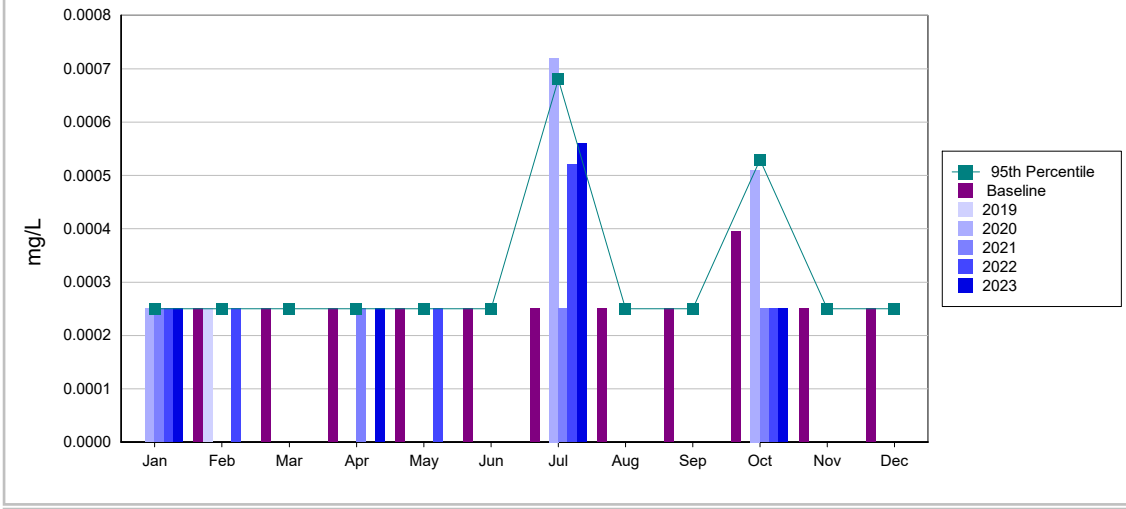
Water Quality Report

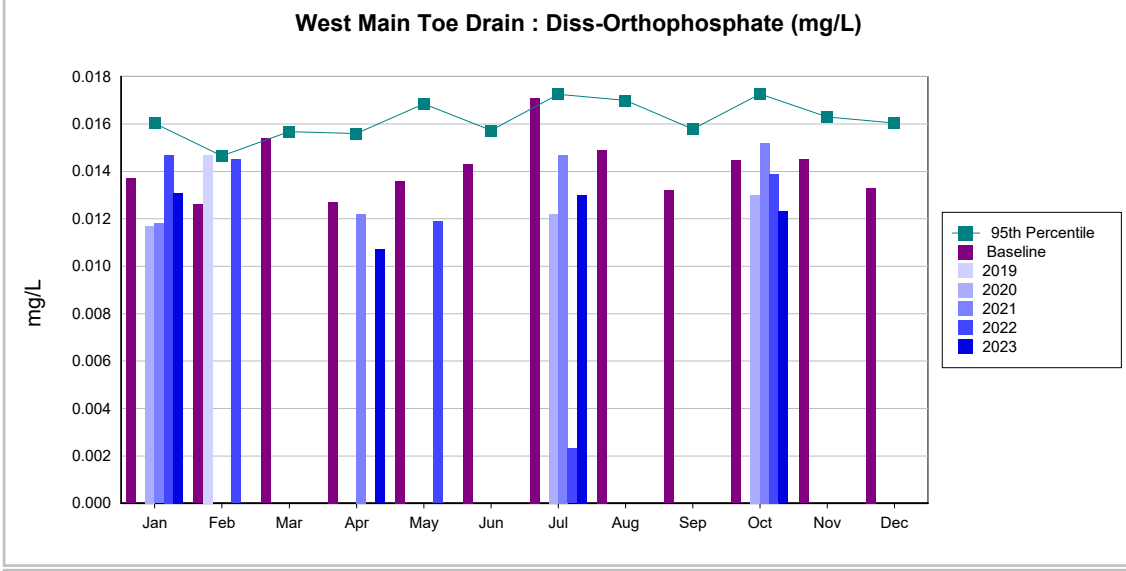
Annual Report Drainage Water

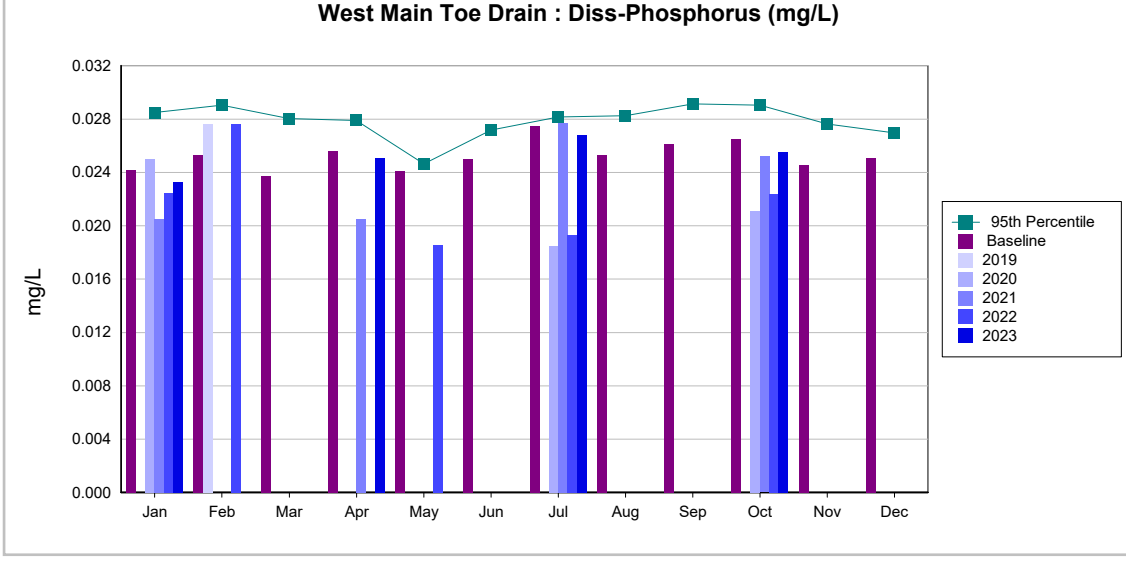
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







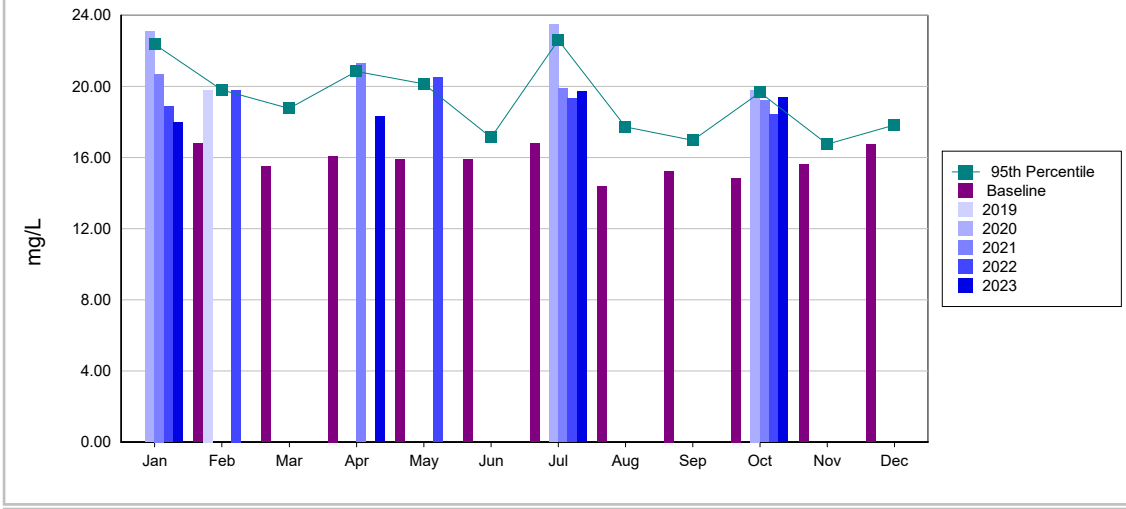
Water Quality Report

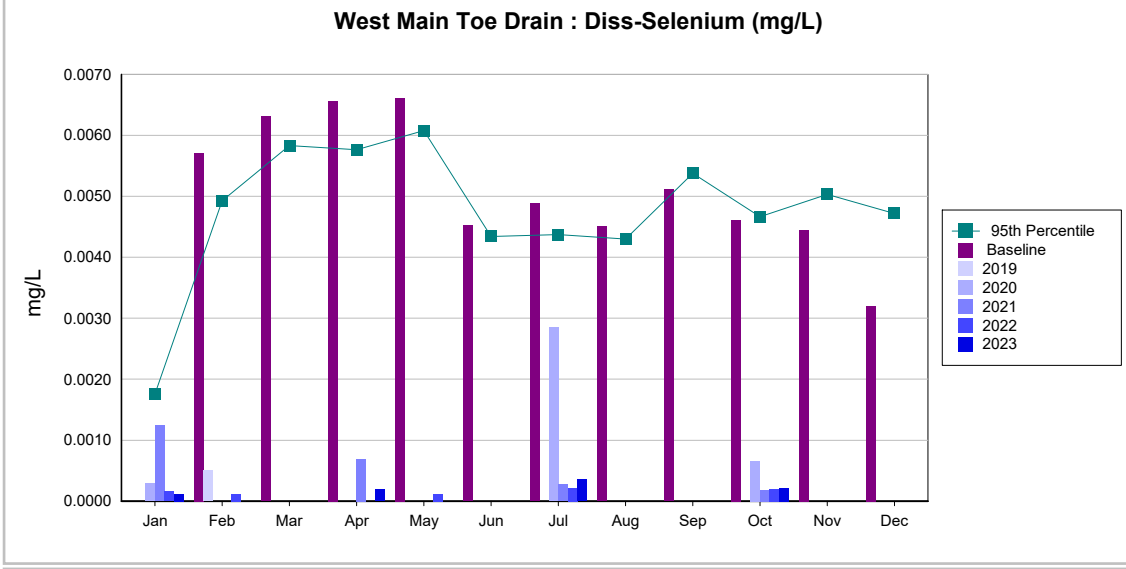
Annual Report Drainage Water

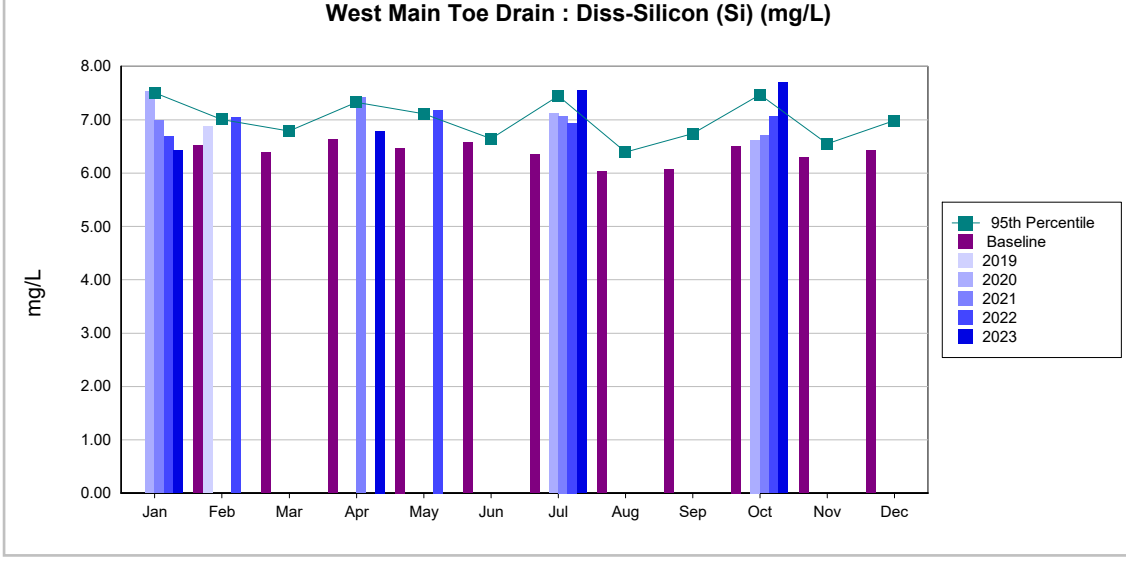
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







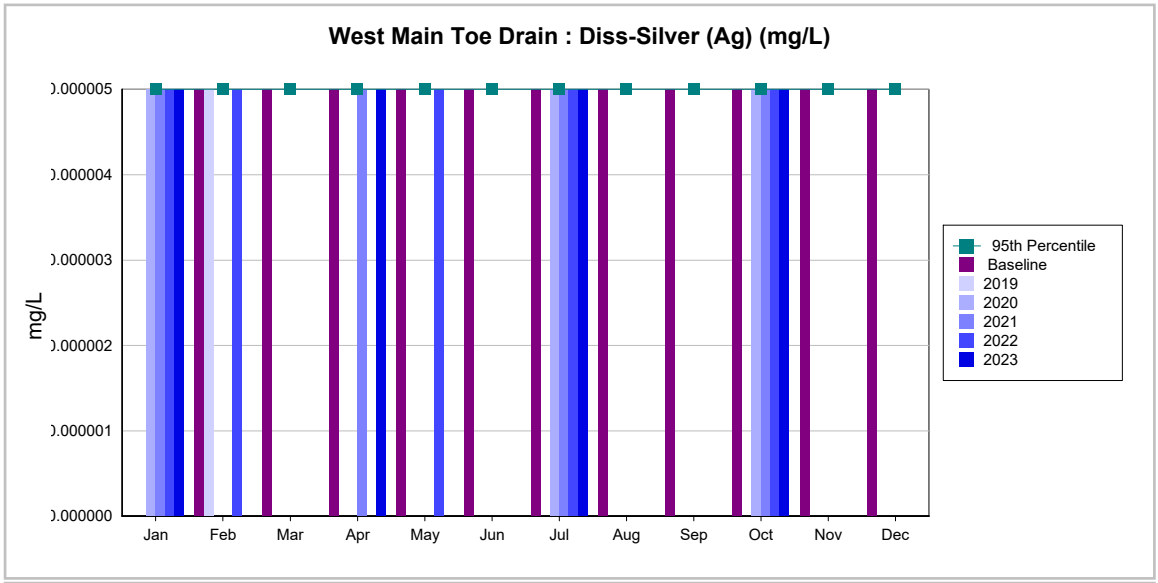
Water Quality Report

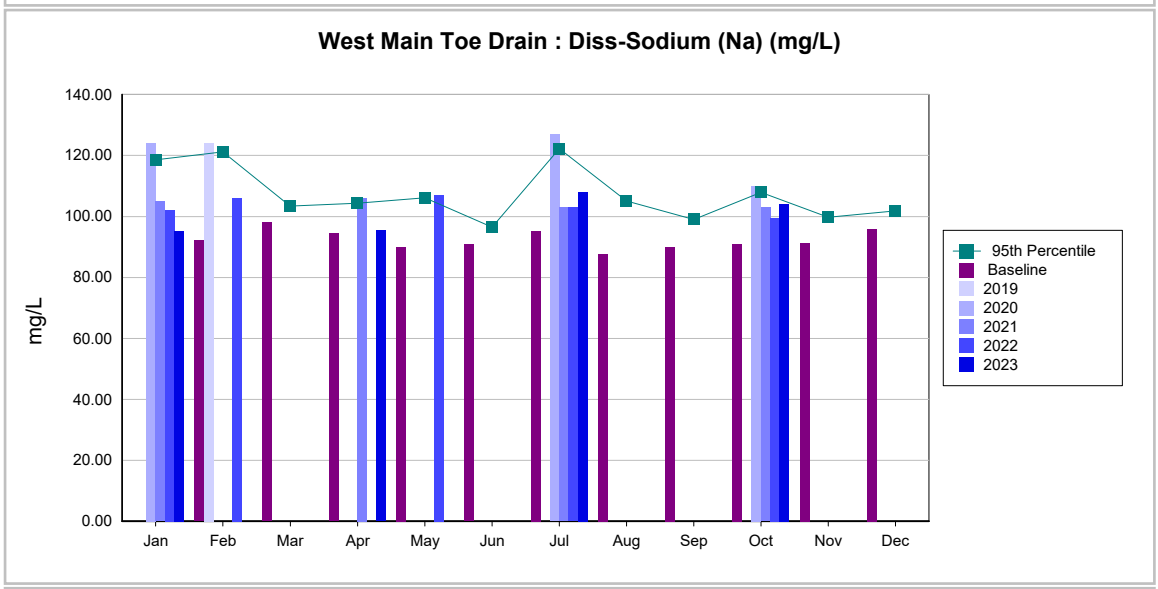
Annual Report Drainage Water

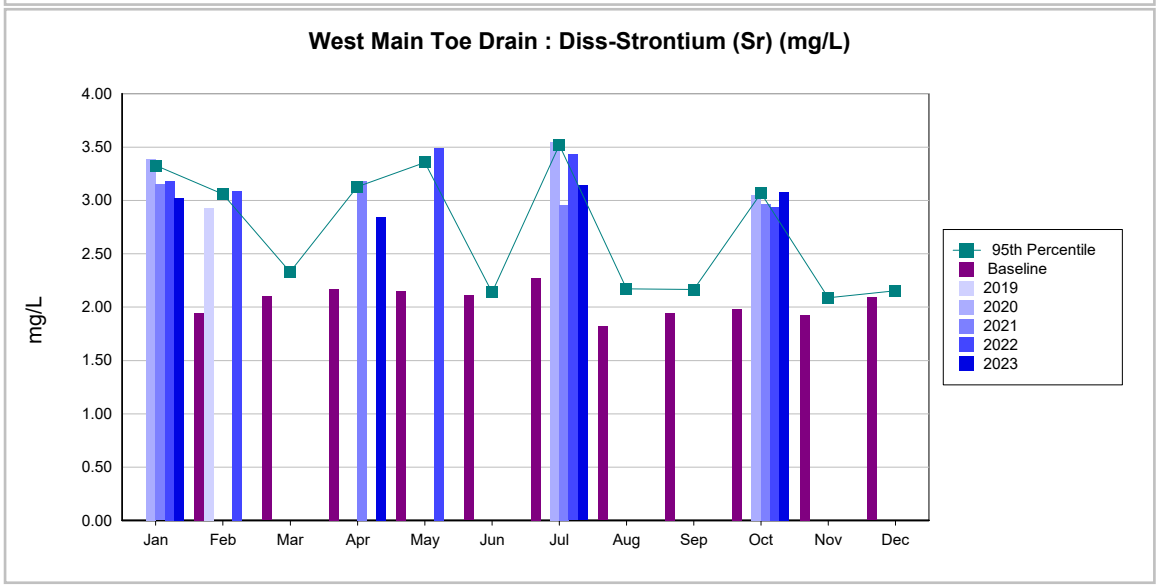
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







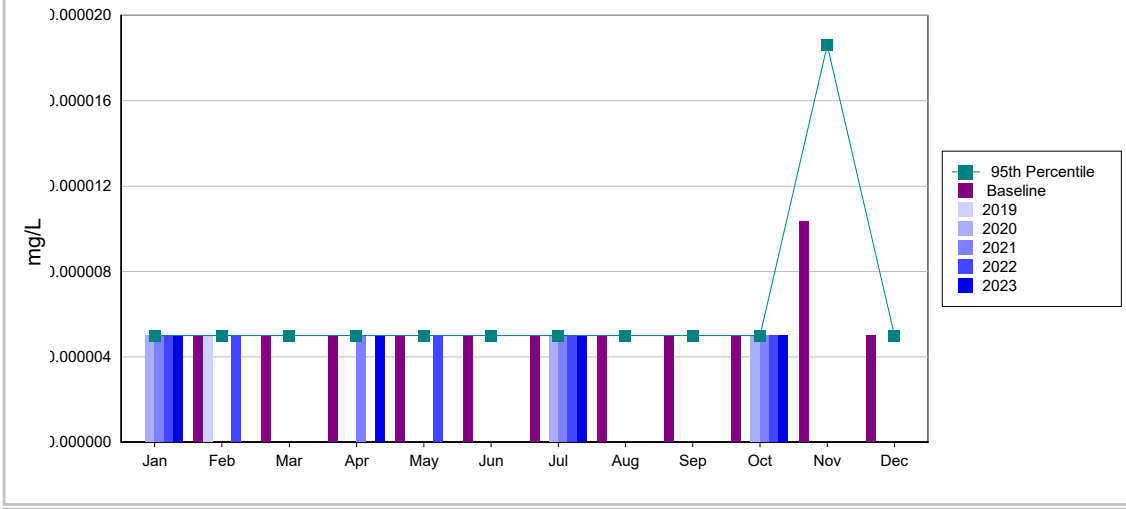
Water Quality Report

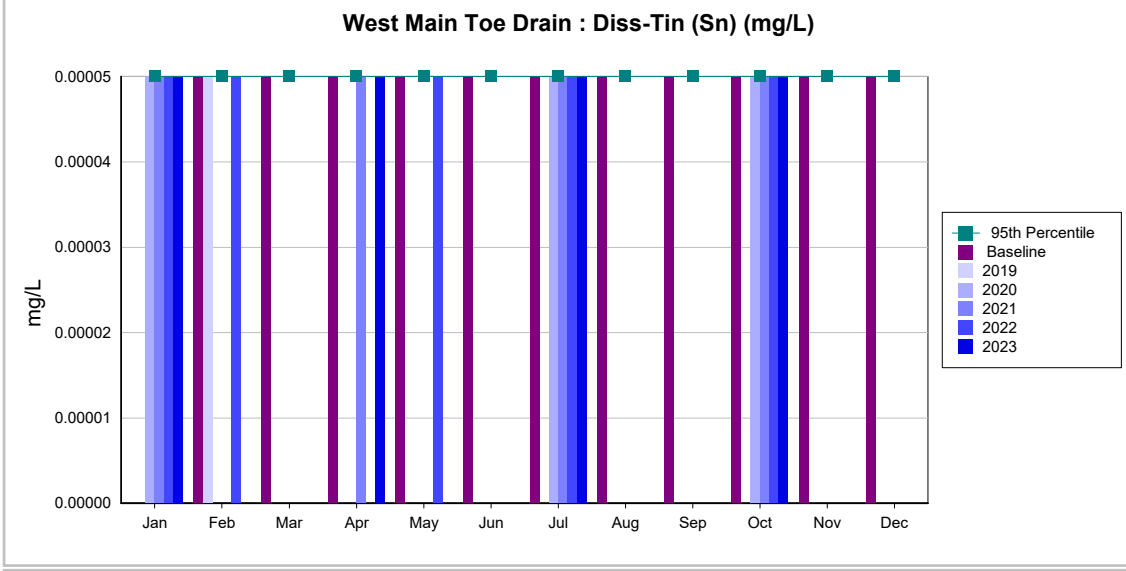
Annual Report Drainage Water

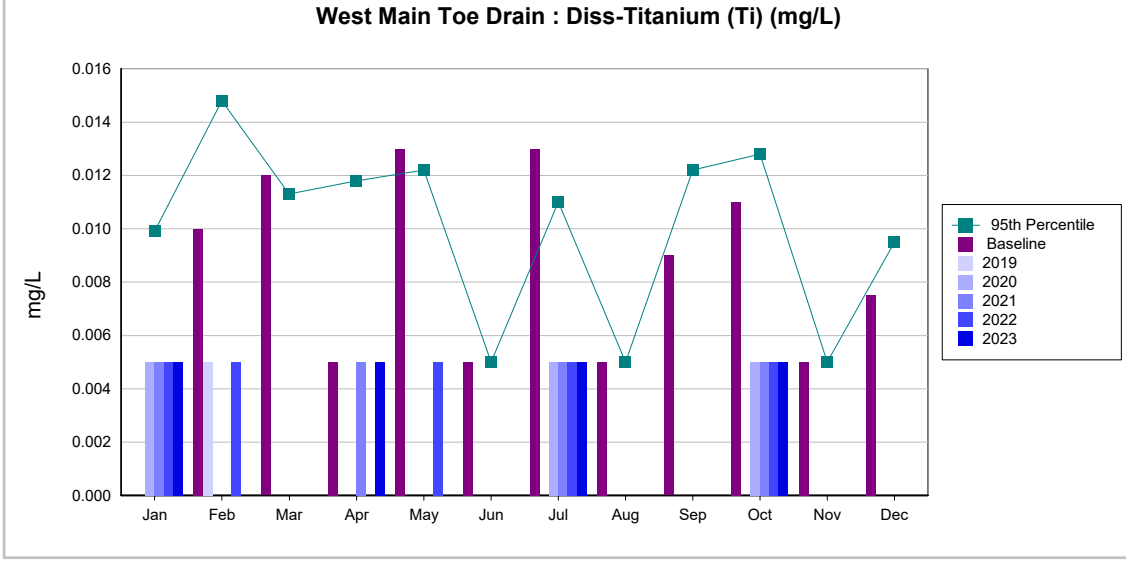
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







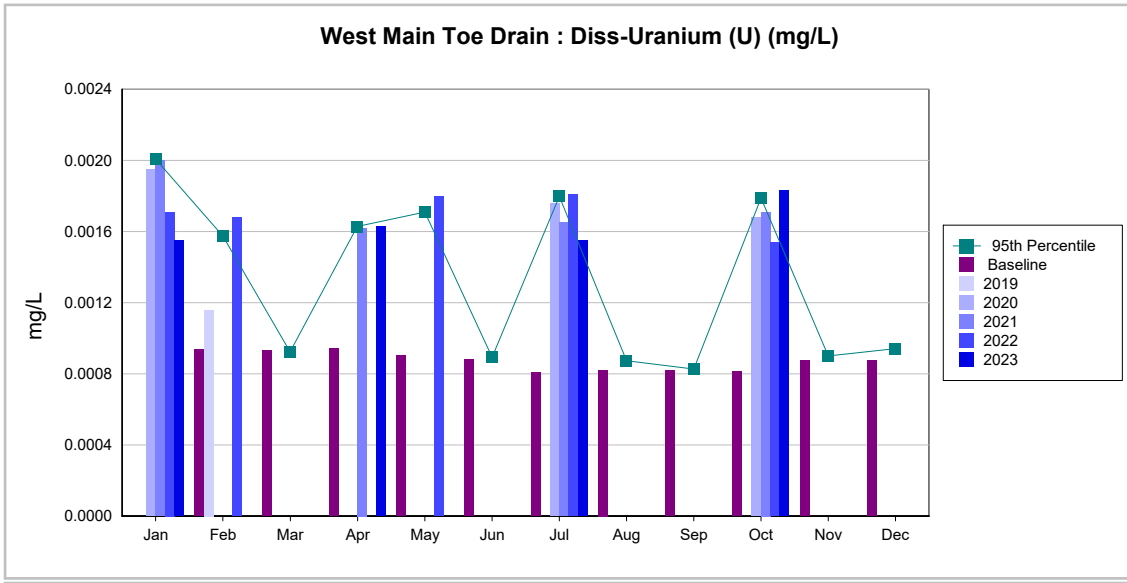
Water Quality Report

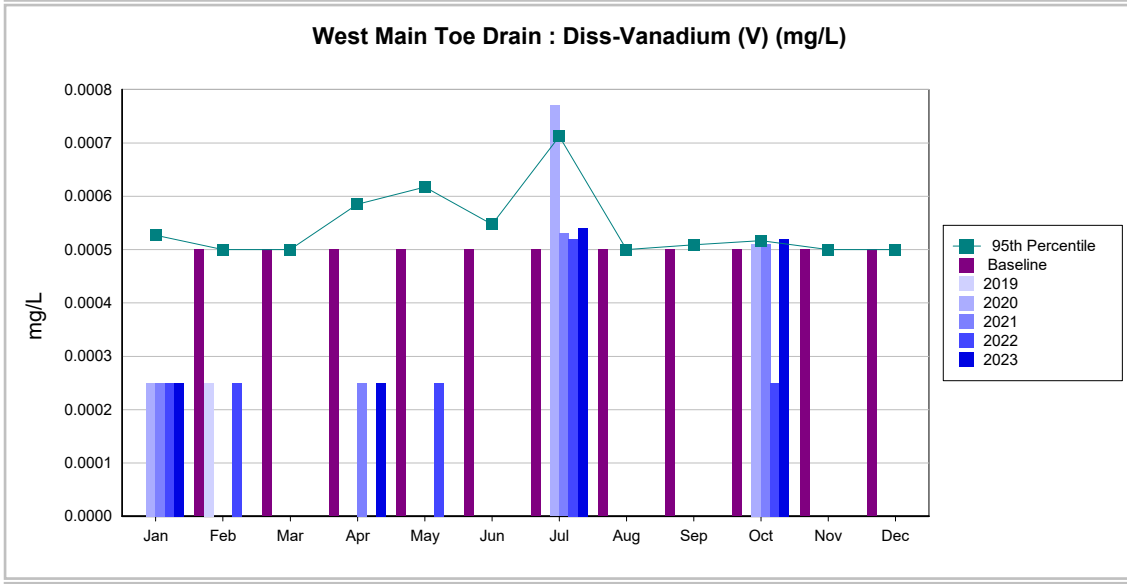
Annual Report Drainage Water

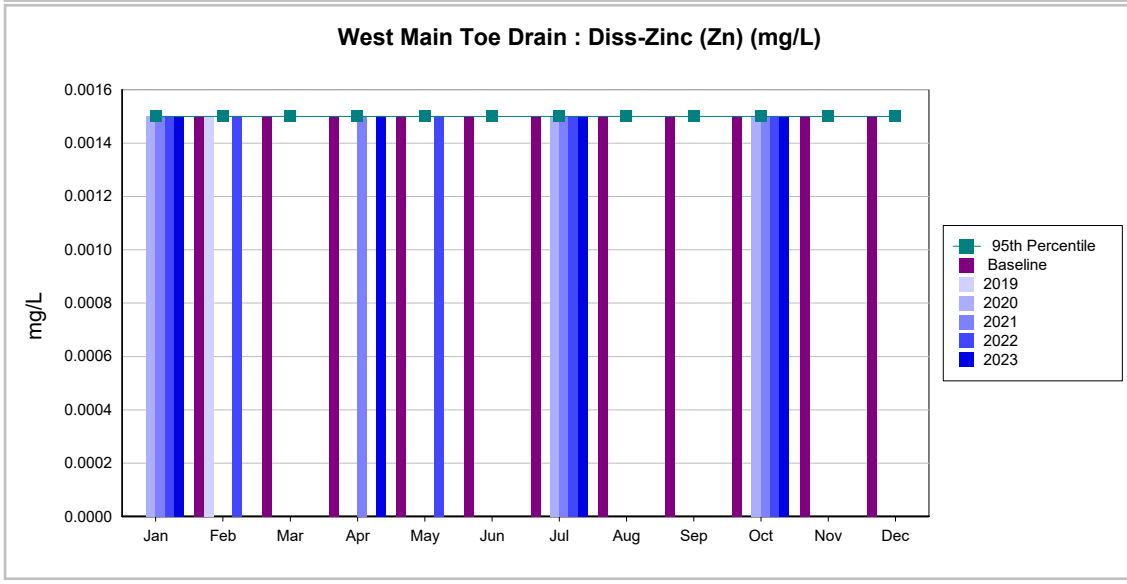
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







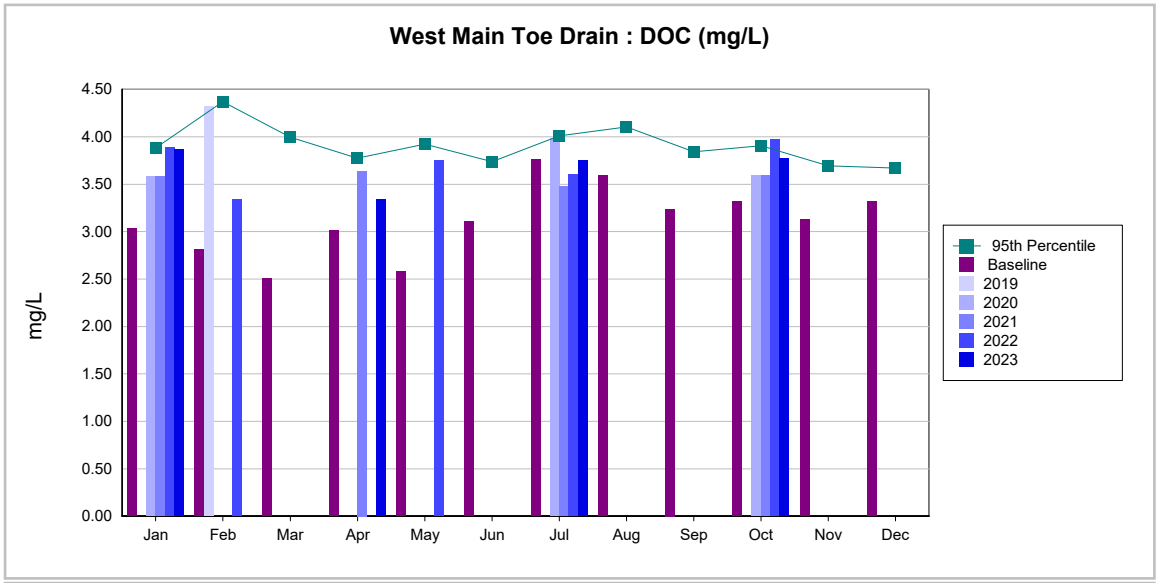
Water Quality Report

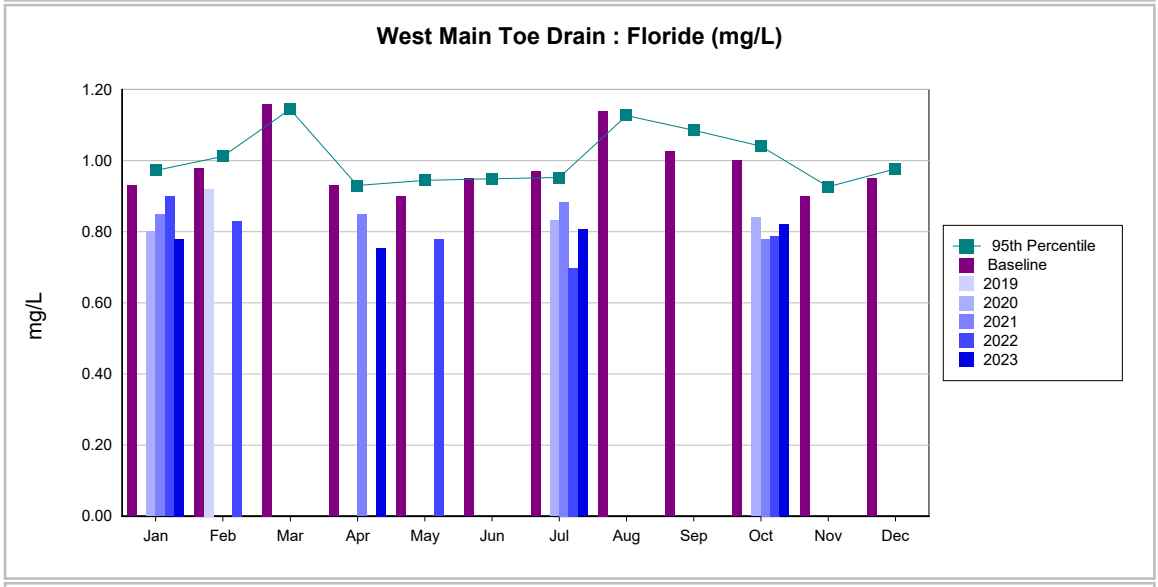
Annual Report Drainage Water

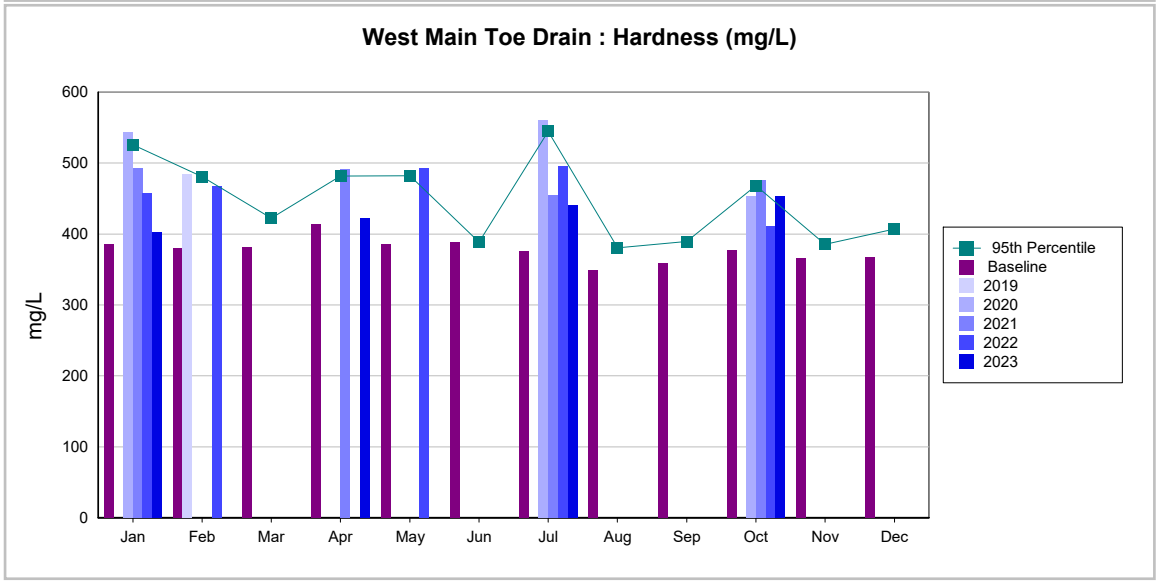
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







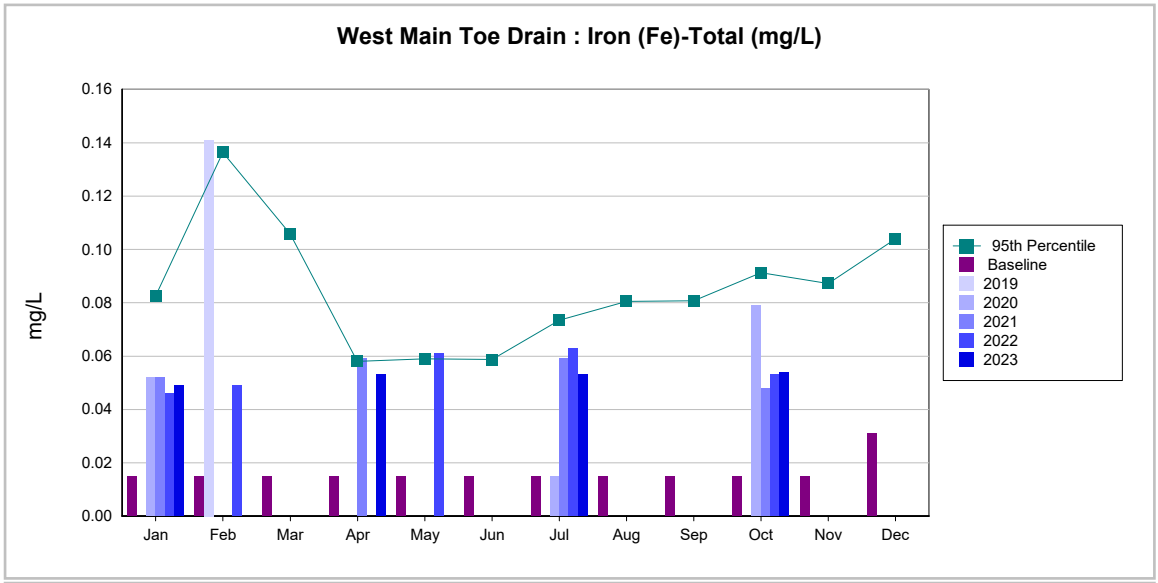
Water Quality Report

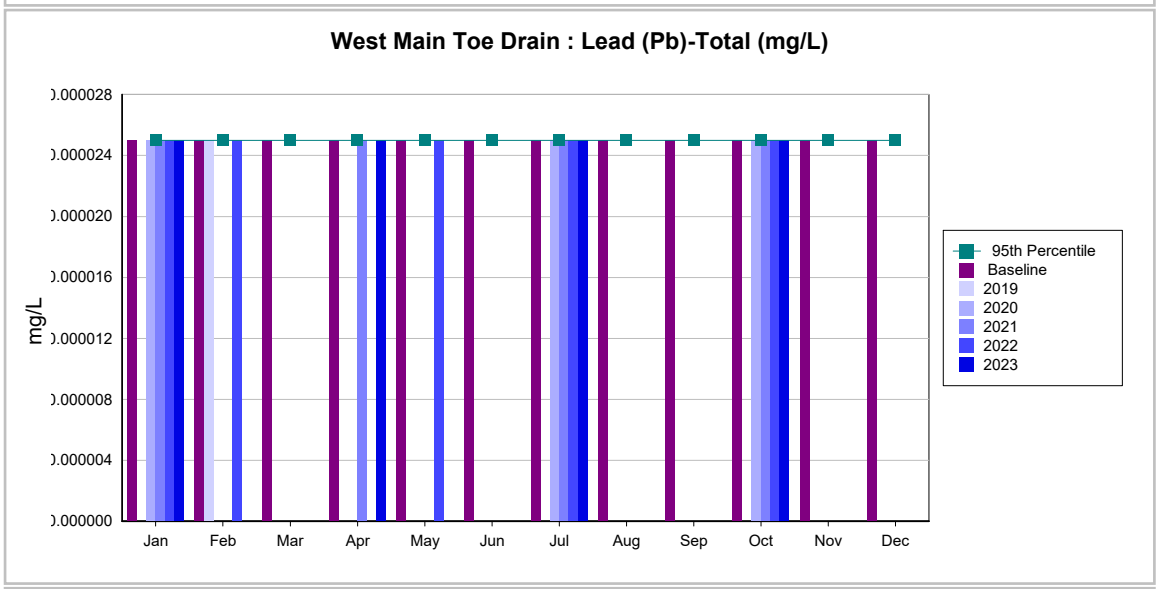
Annual Report Drainage Water

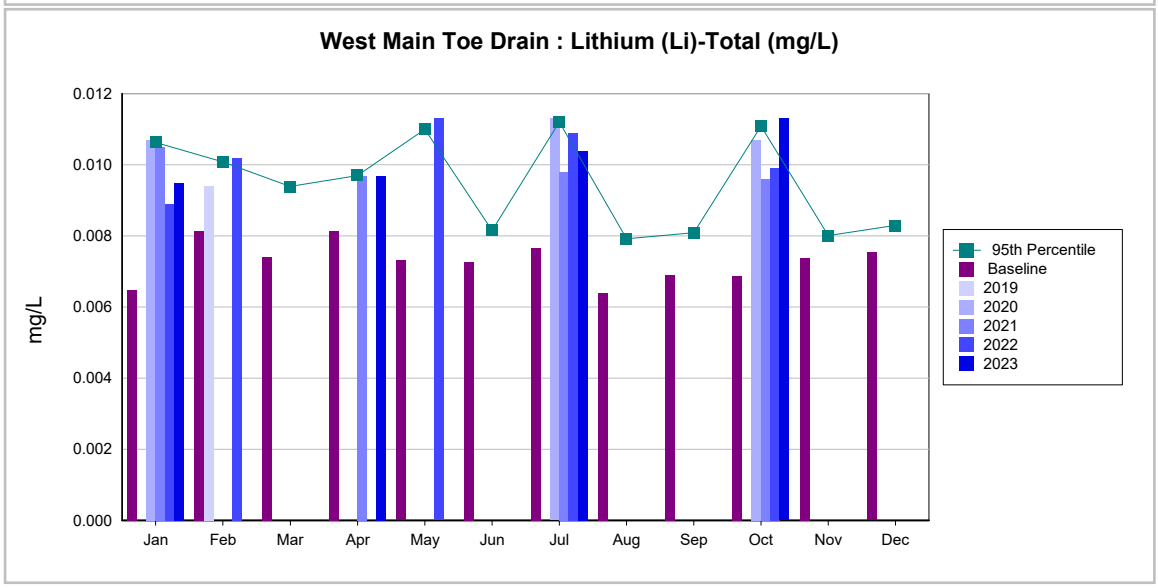
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







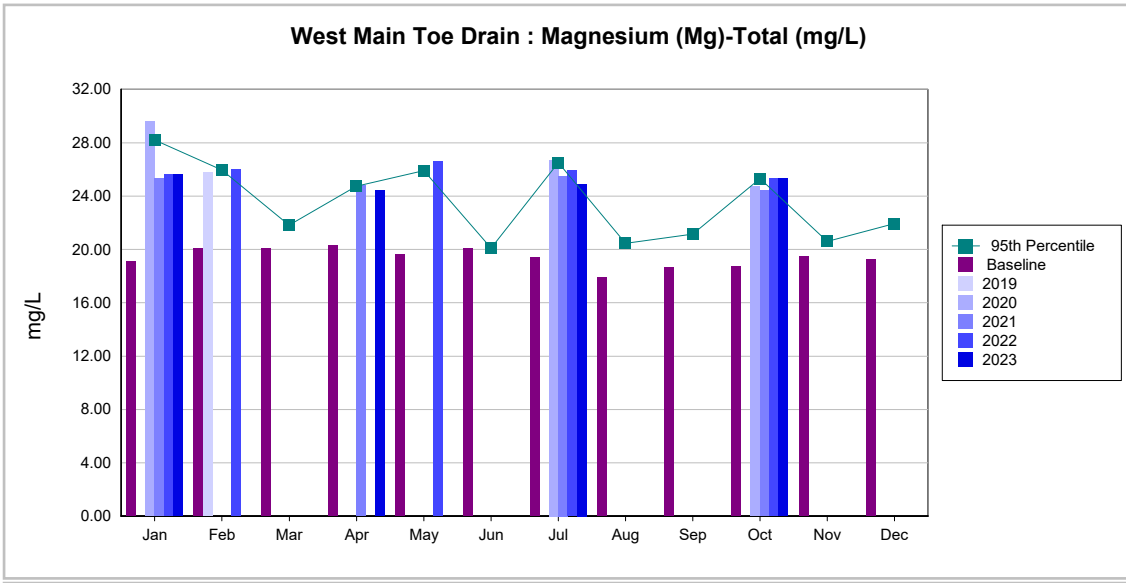
Water Quality Report

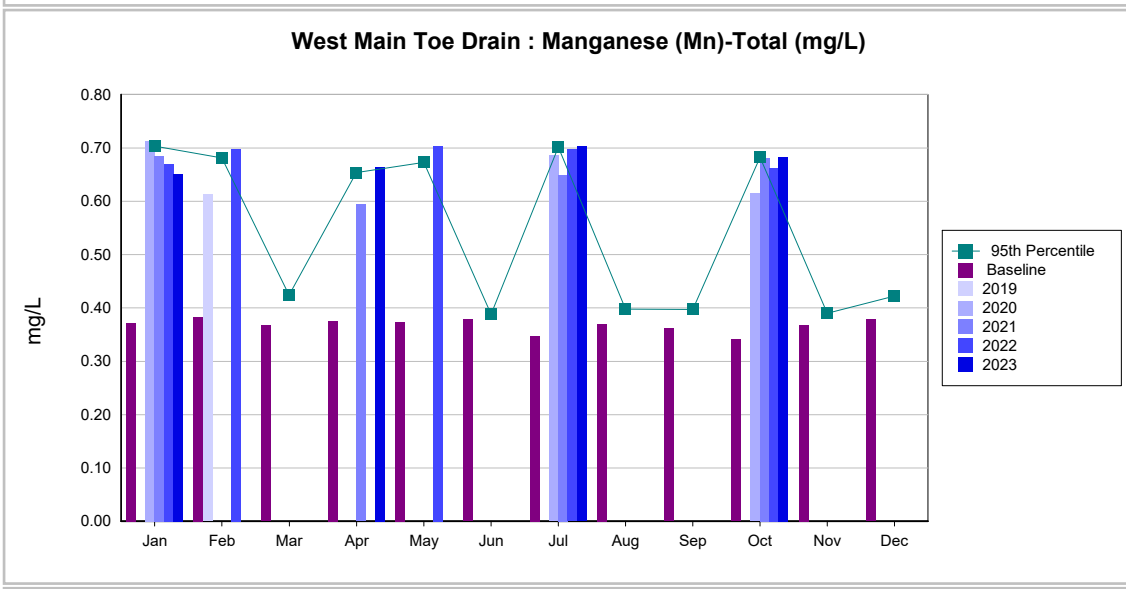
Annual Report Drainage Water

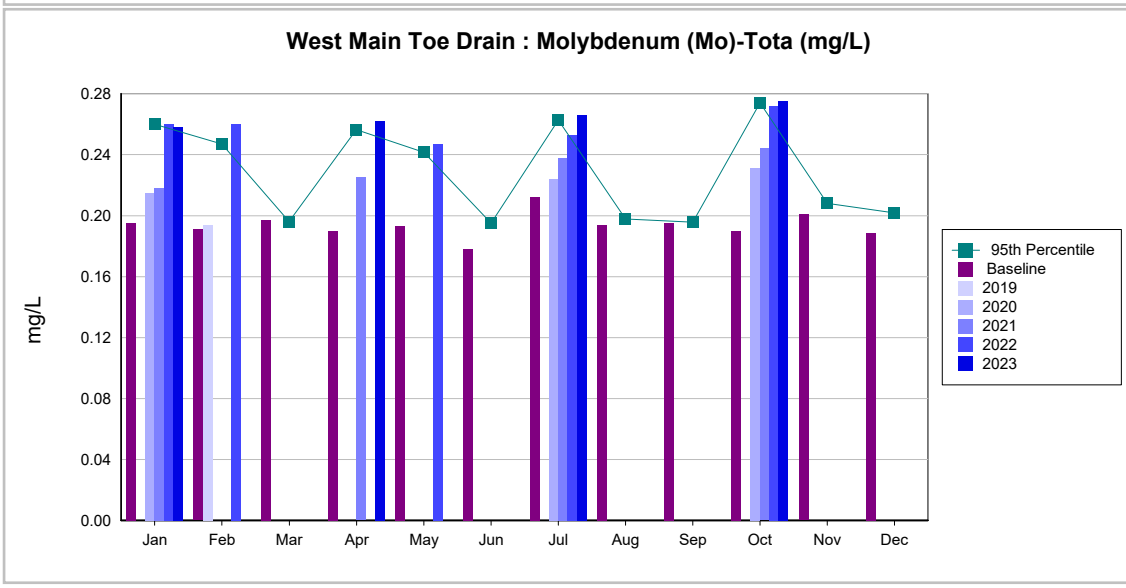
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







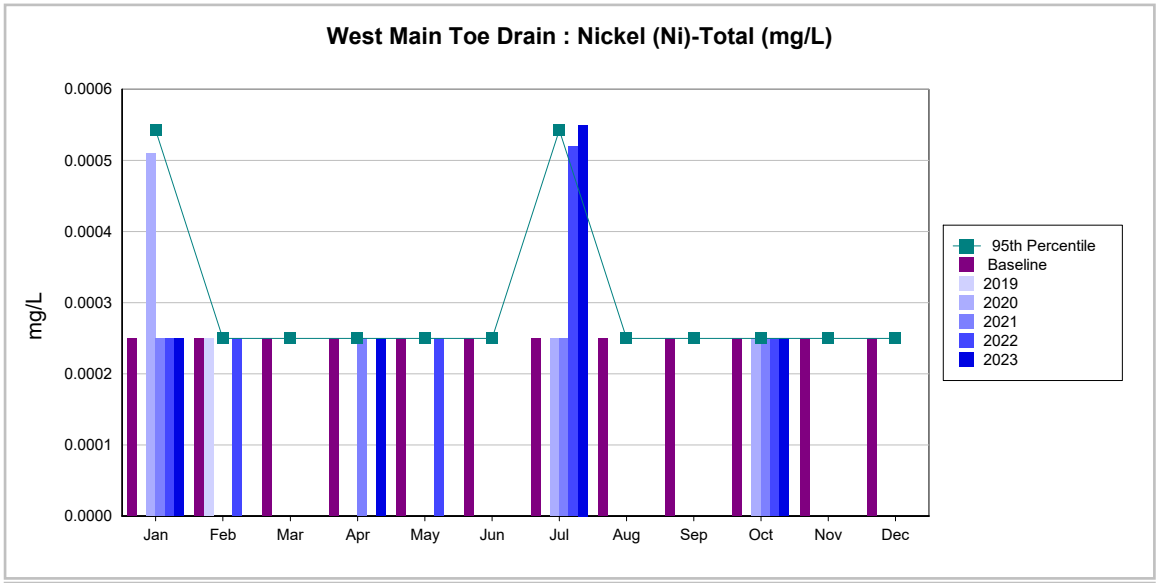
Water Quality Report

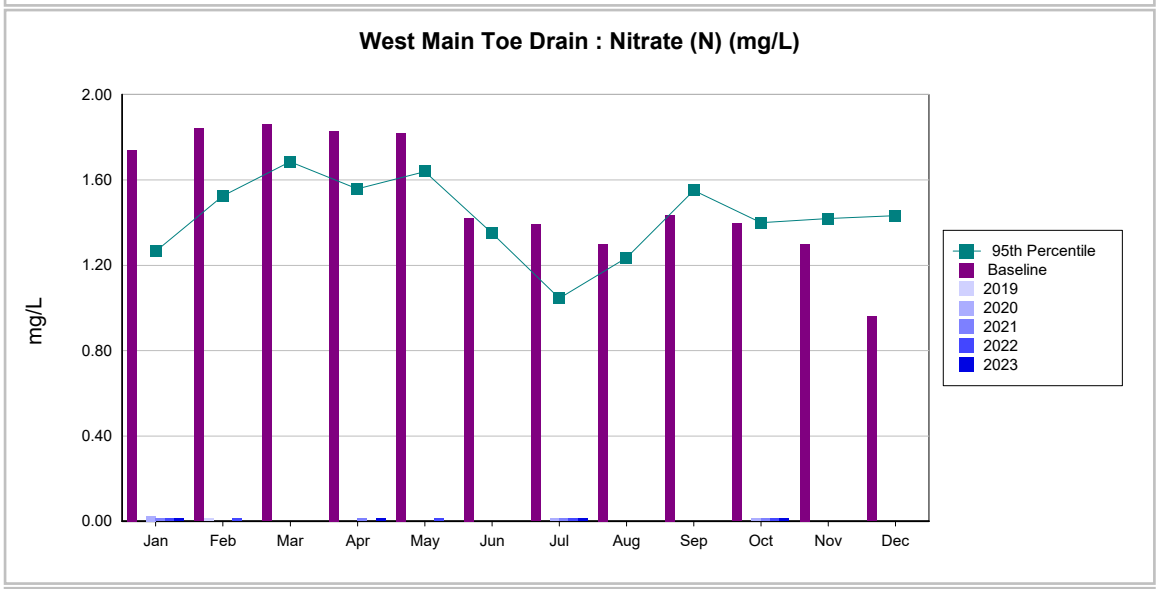
Annual Report Drainage Water

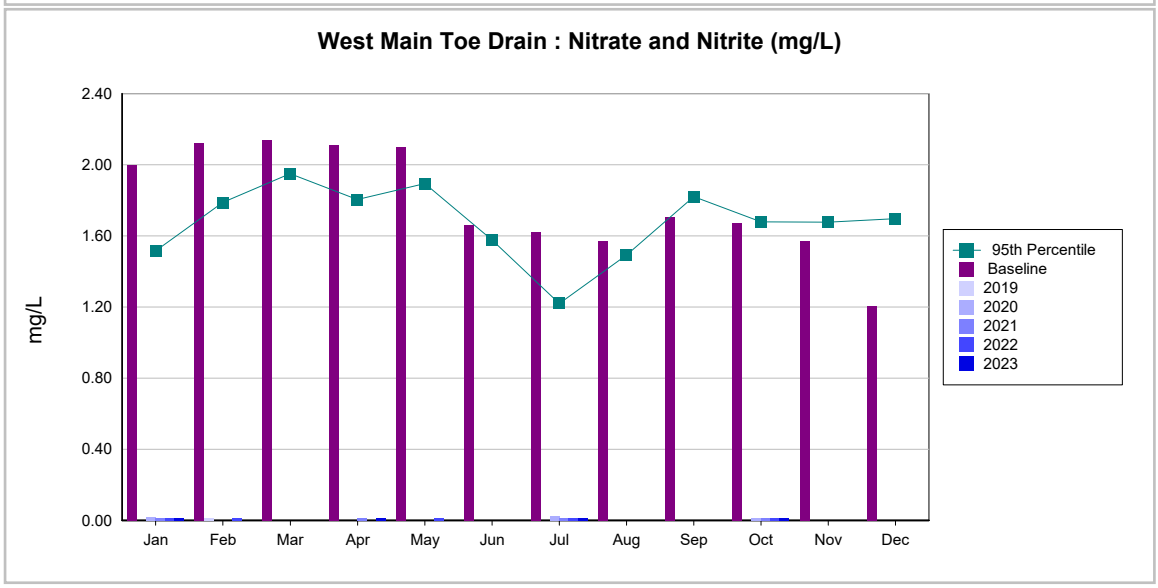
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







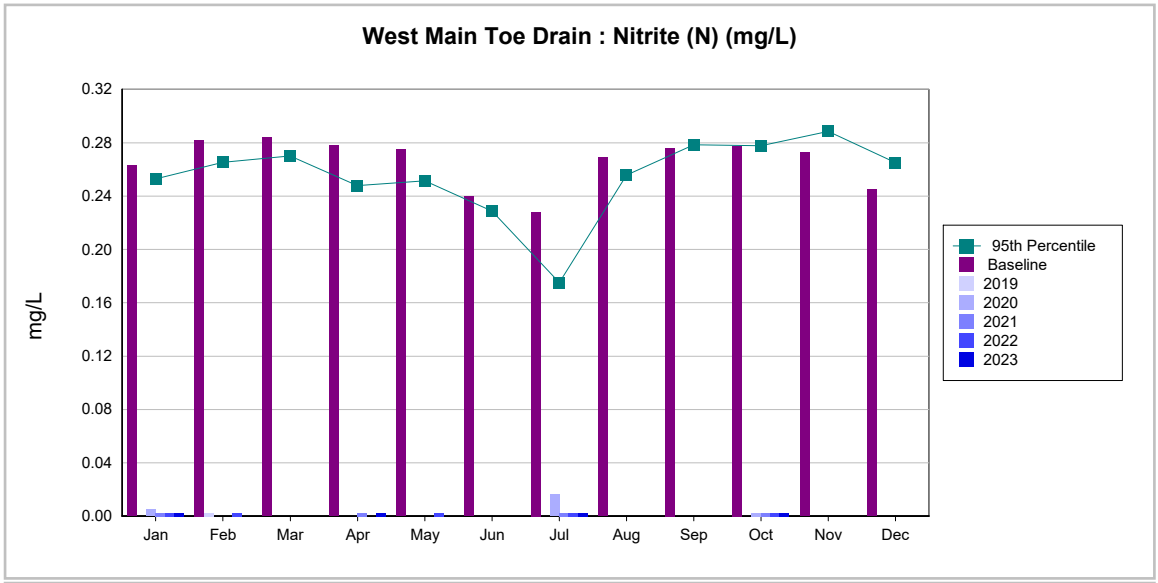
Water Quality Report

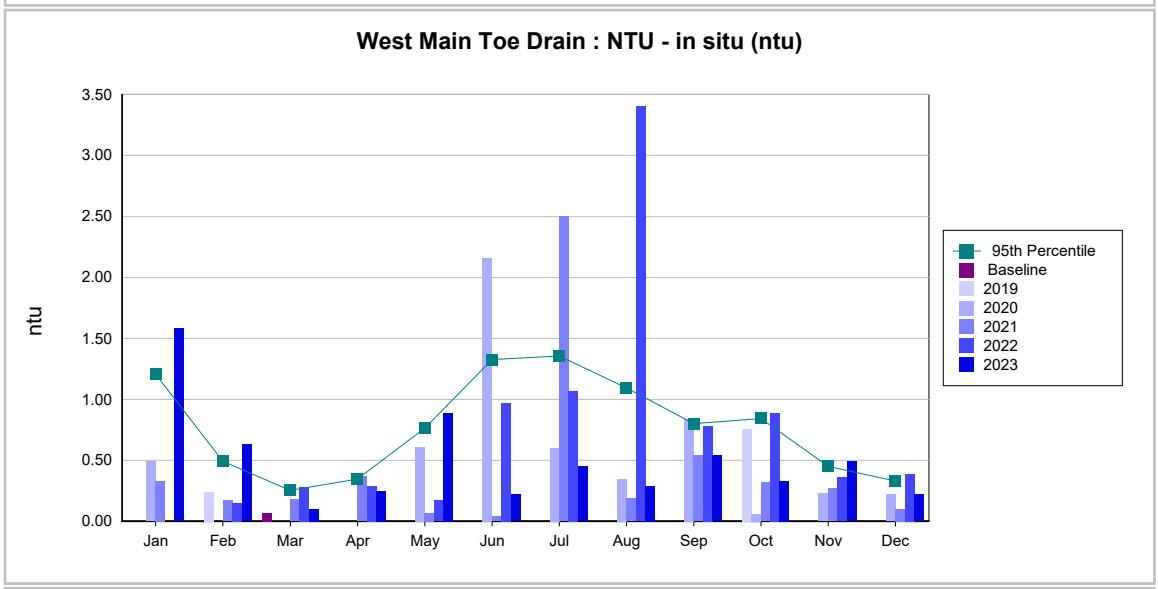
Annual Report Drainage Water

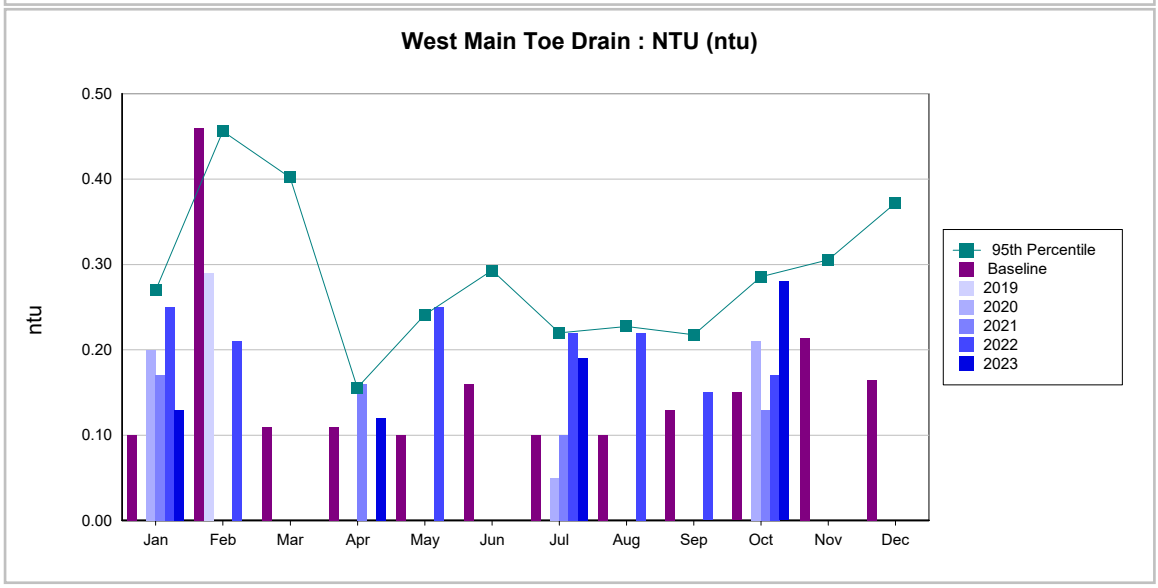
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







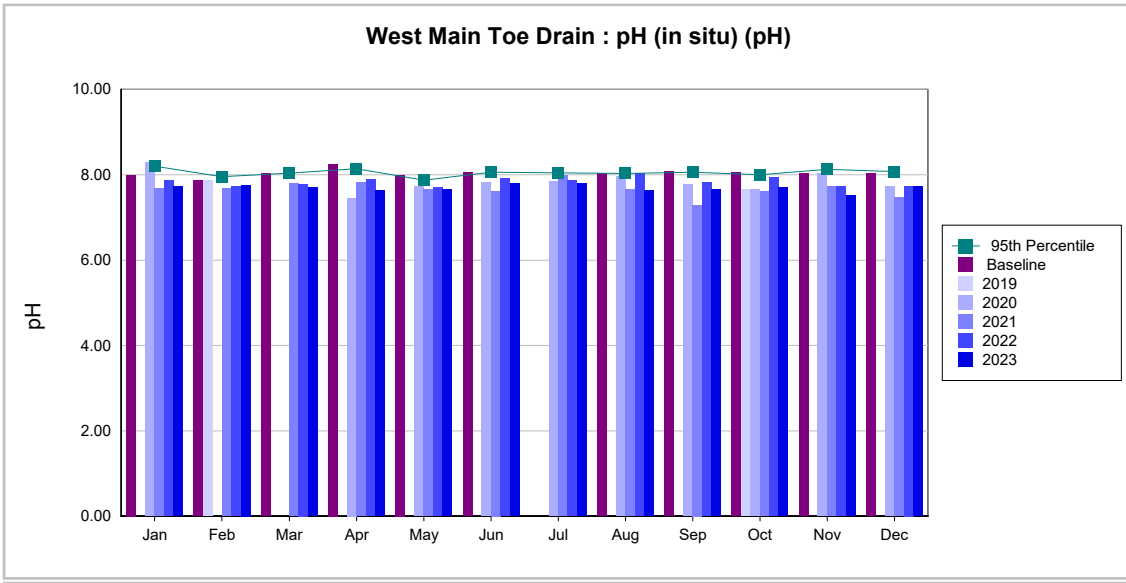
Water Quality Report

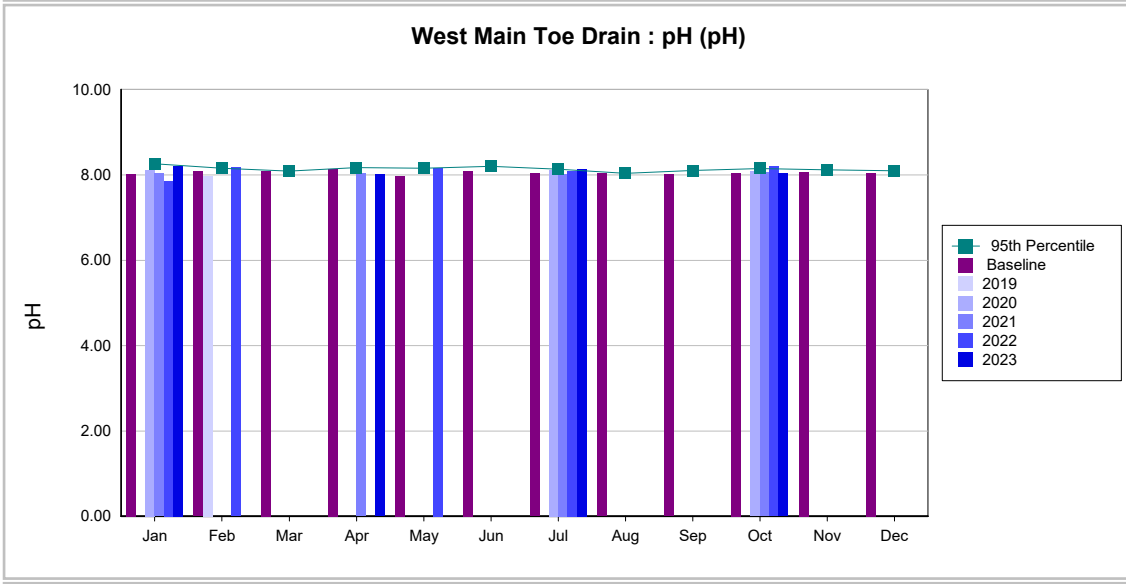
Annual Report Drainage Water

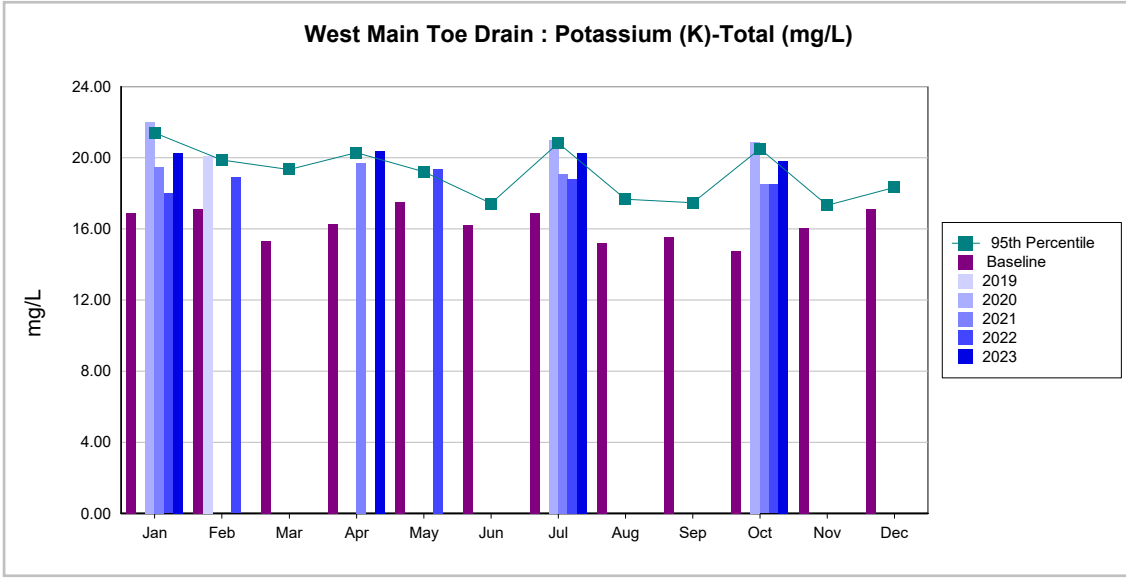
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







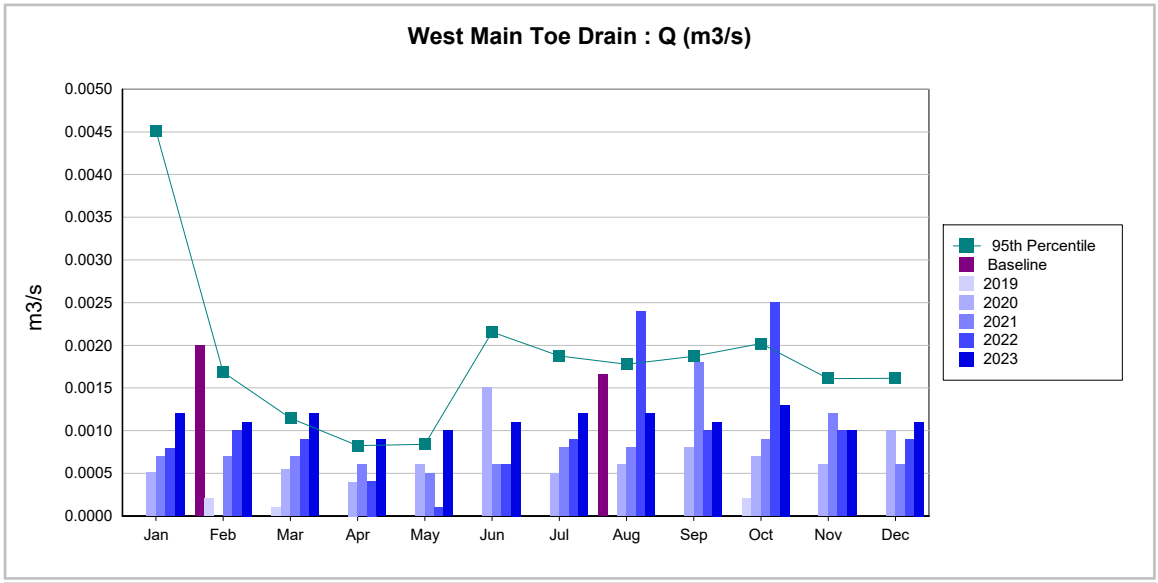
Water Quality Report

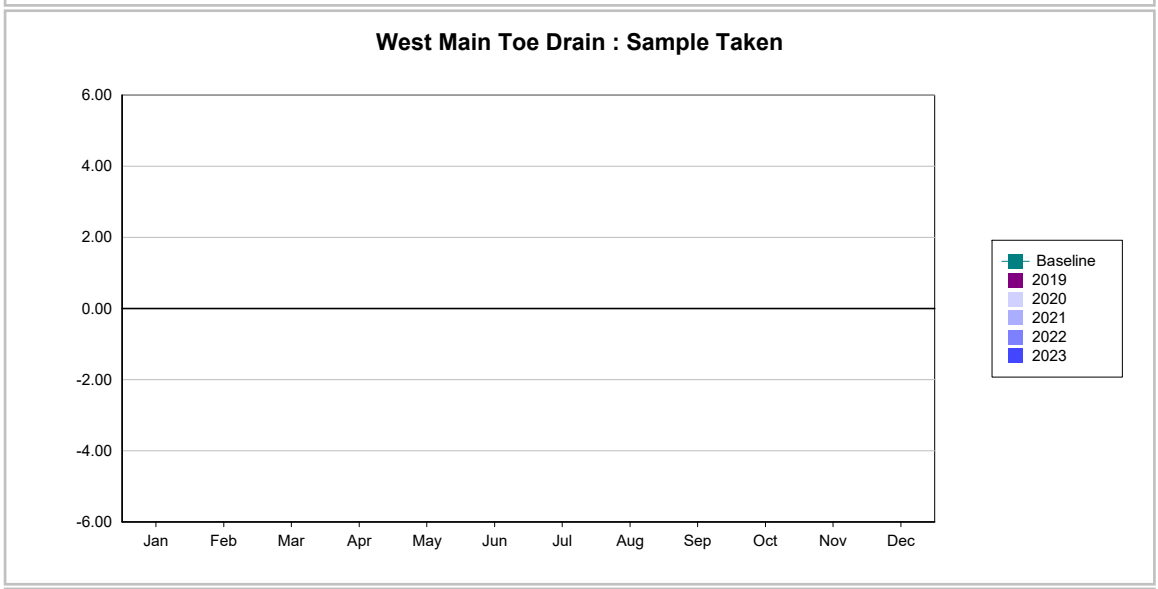
Annual Report Drainage Water

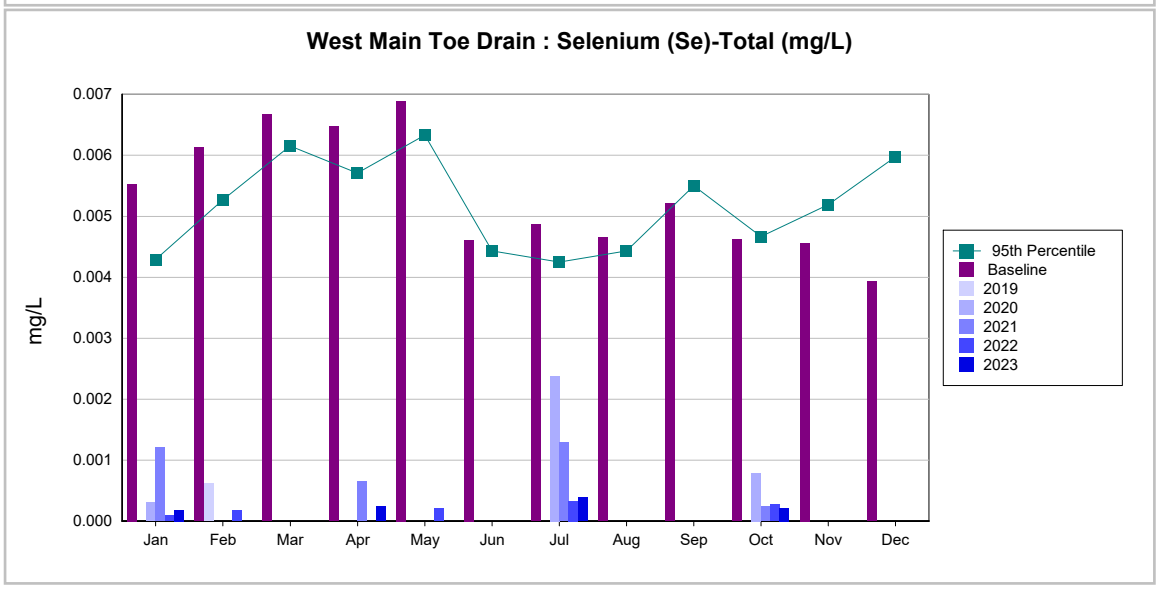
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







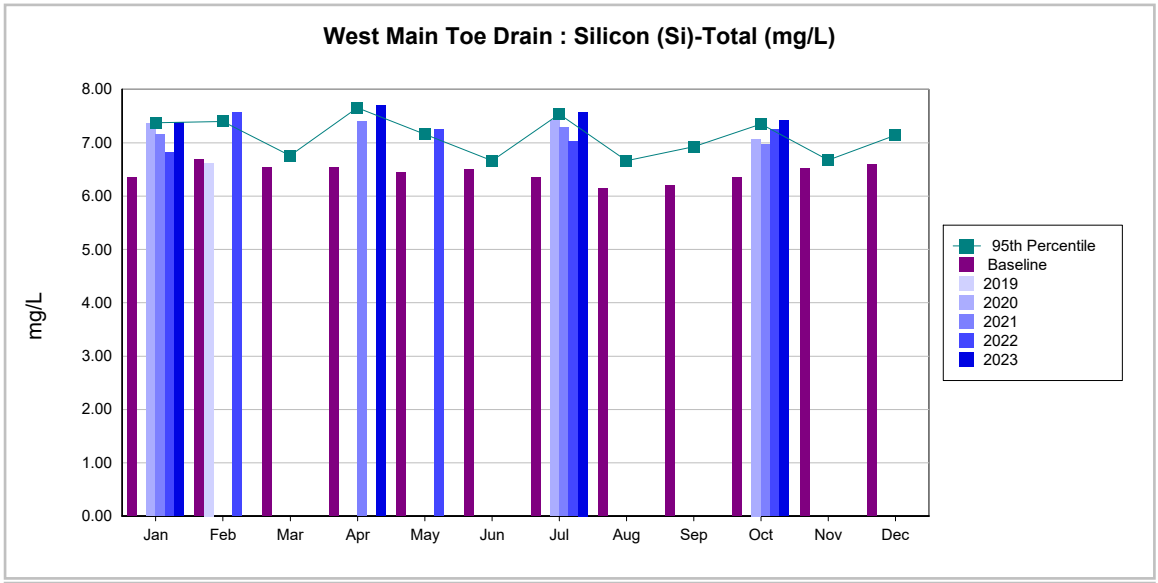
Water Quality Report

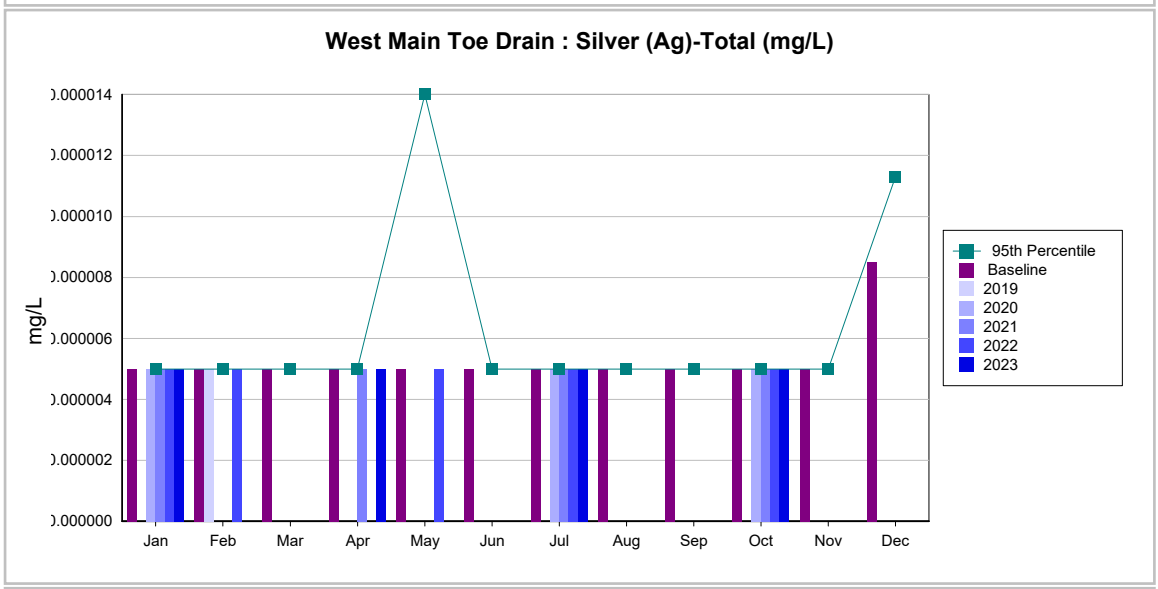
Annual Report Drainage Water

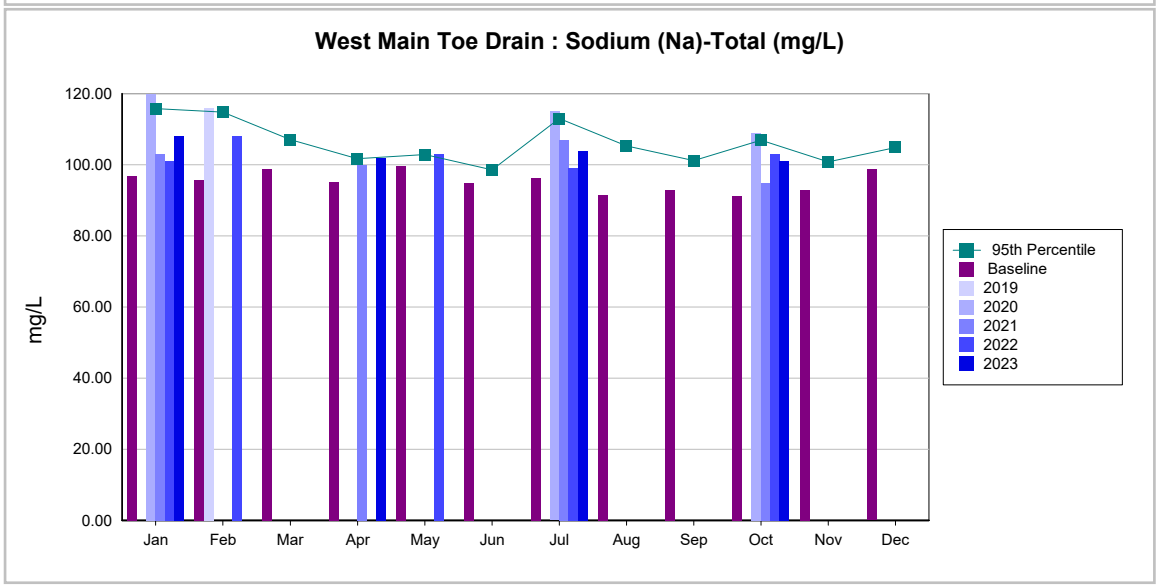
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







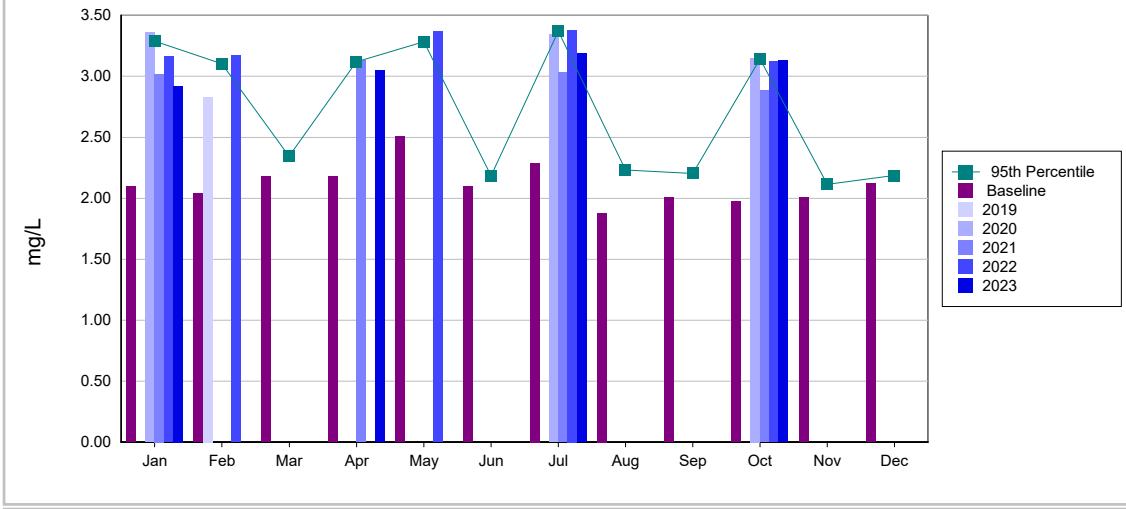
Water Quality Report

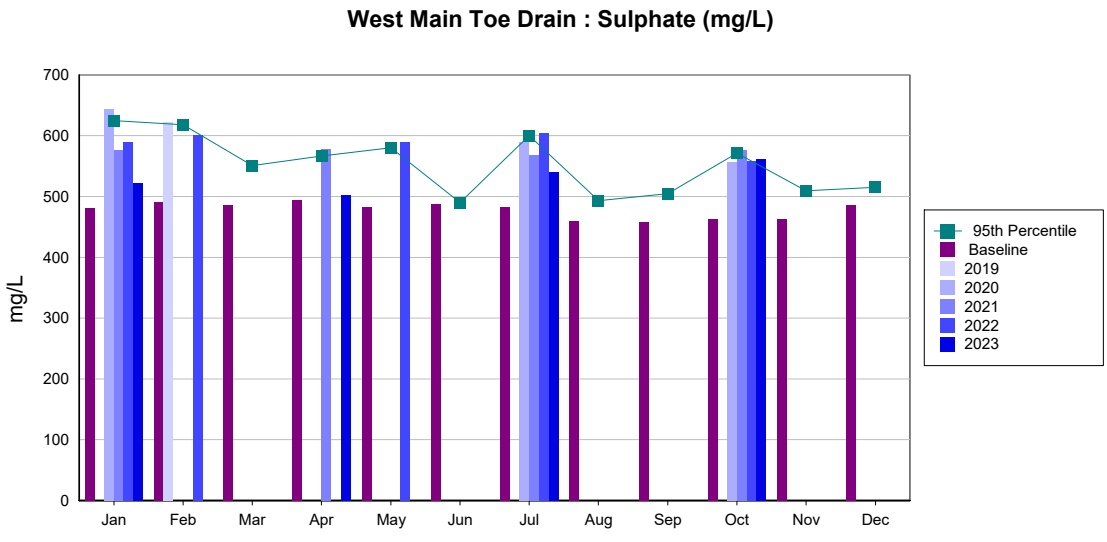
Annual Report Drainage Water

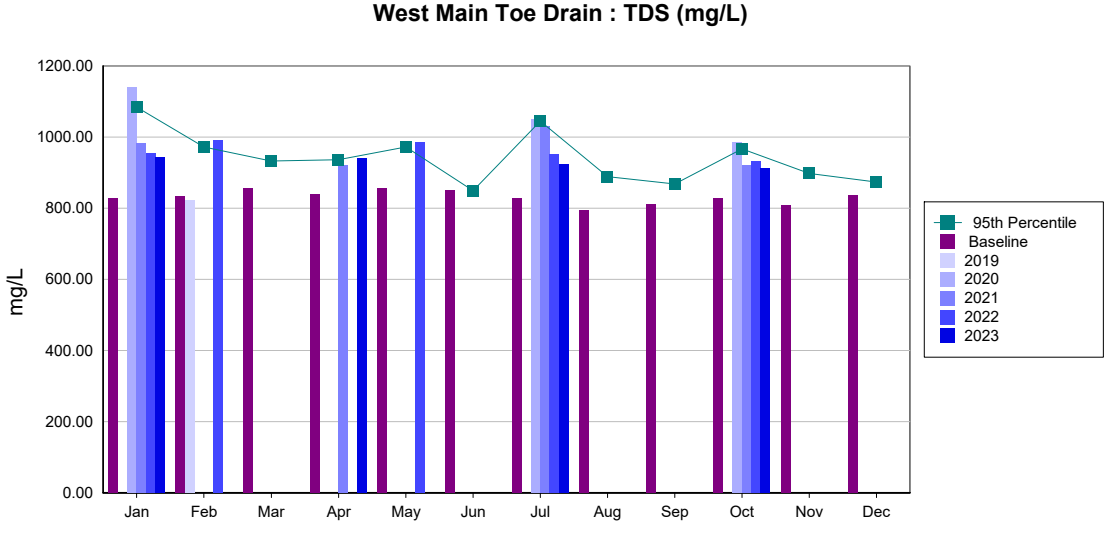
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







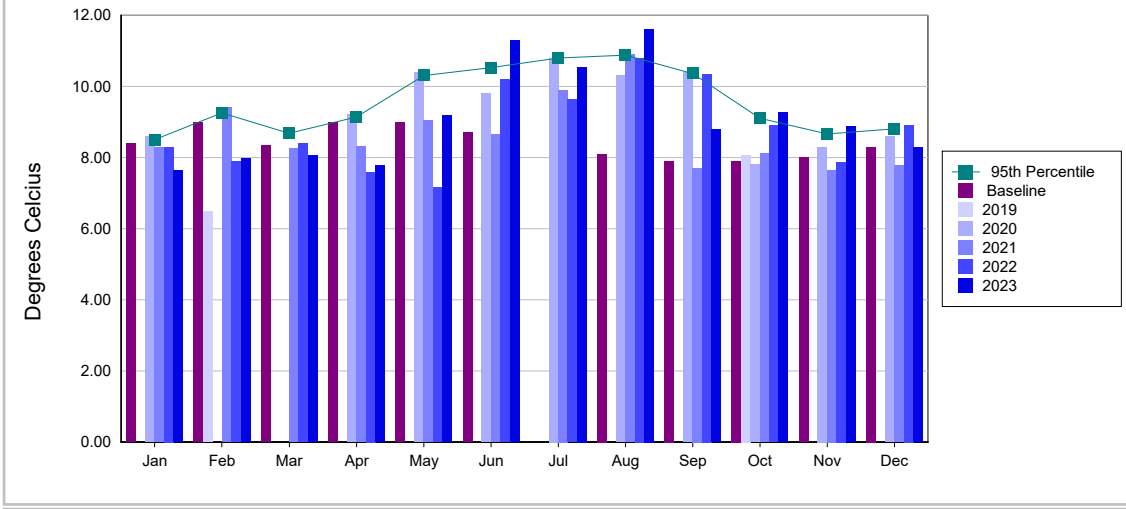
Water Quality Report

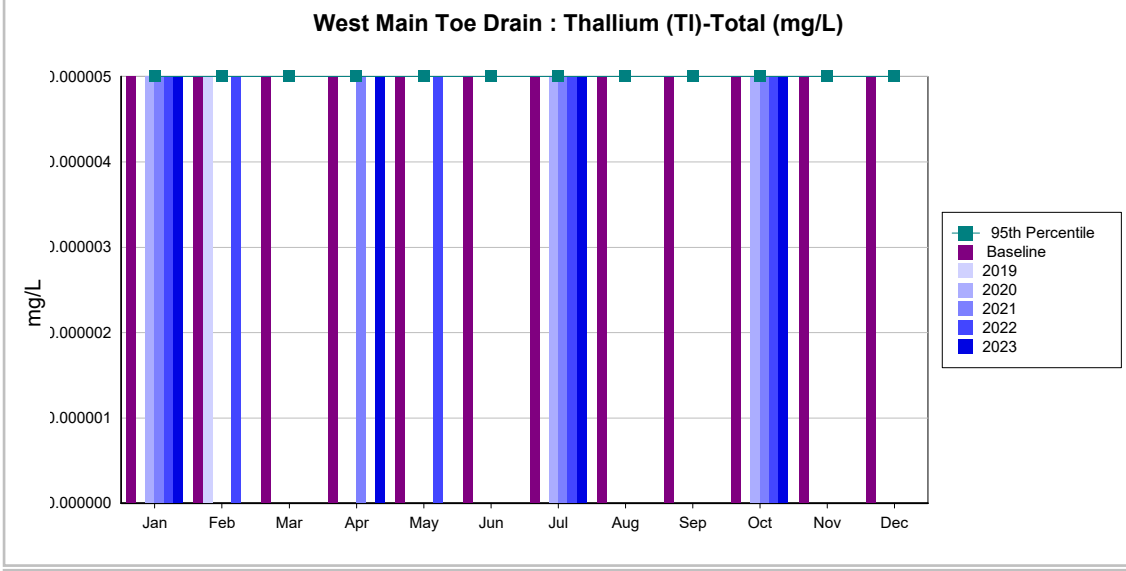
Annual Report Drainage Water

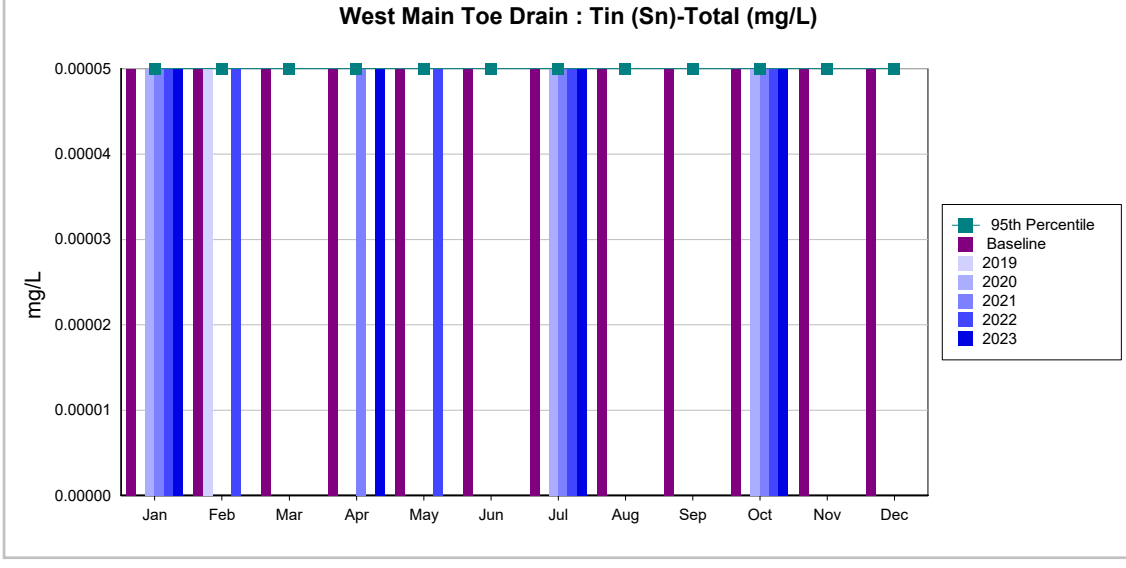
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







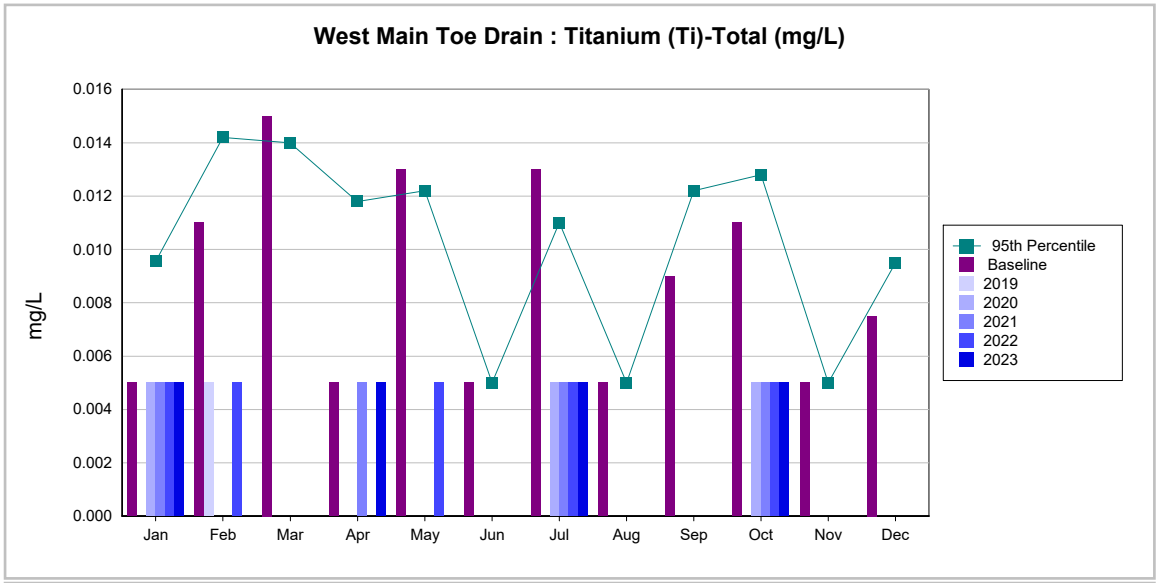
Water Quality Report

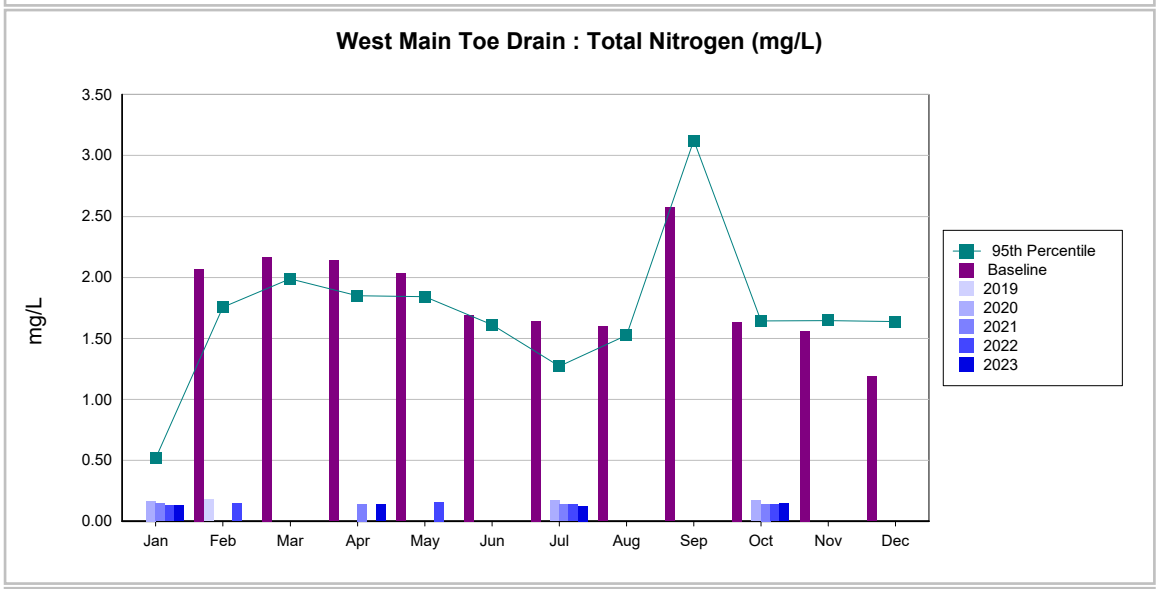
Annual Report Drainage Water

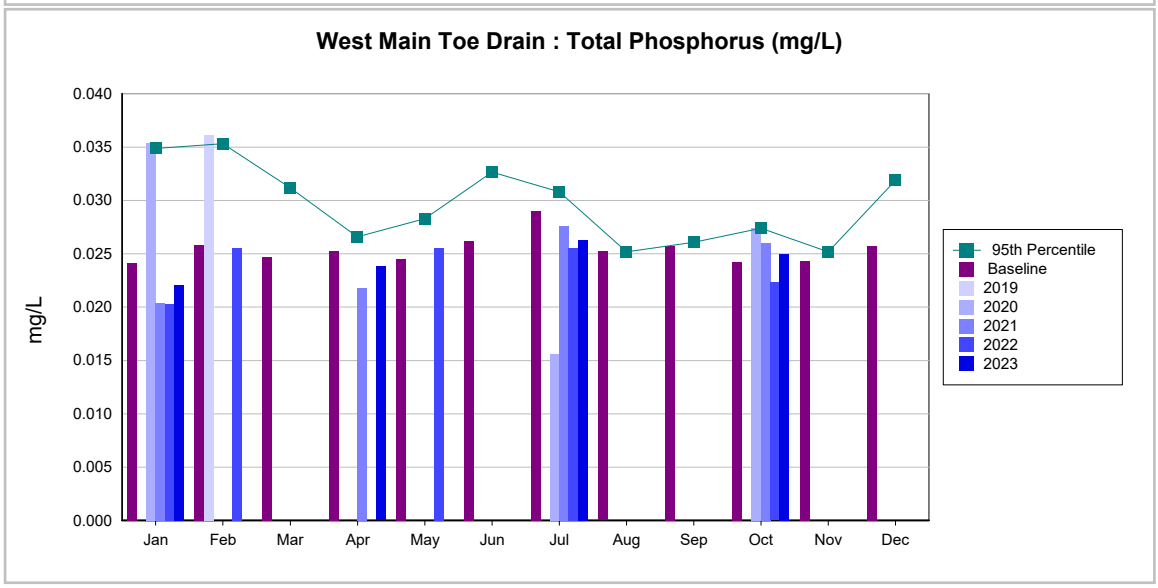
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







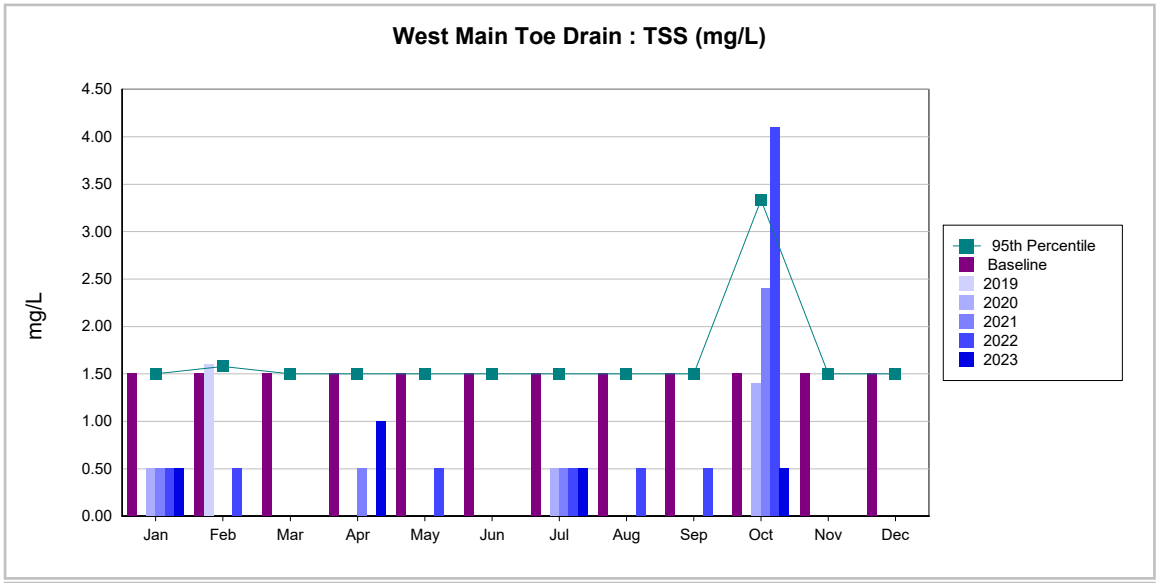
Water Quality Report

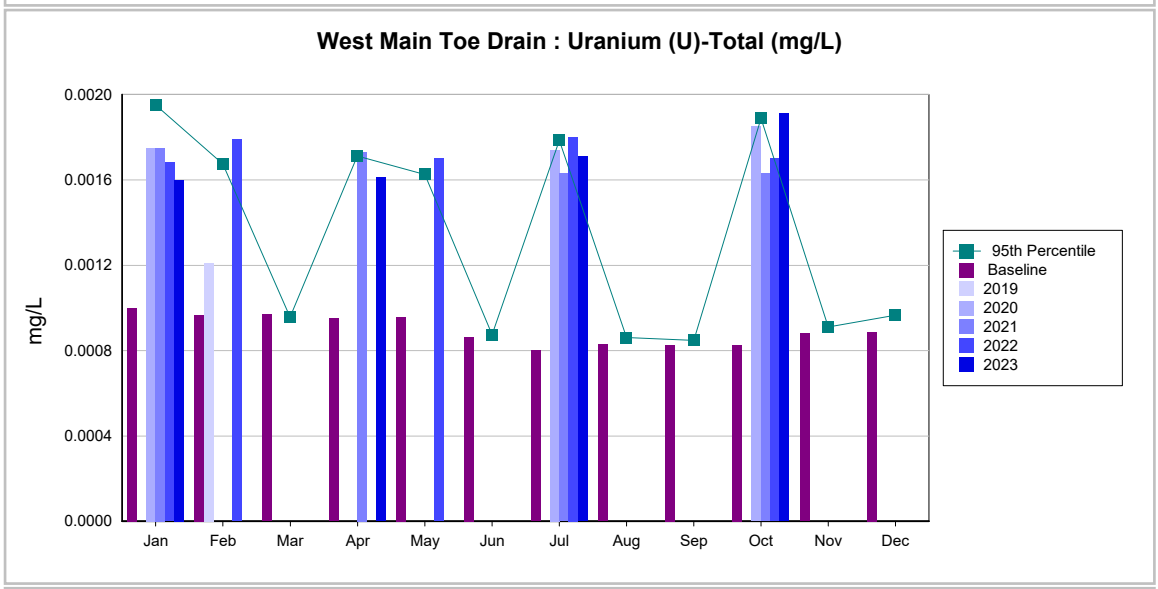
Annual Report Drainage Water

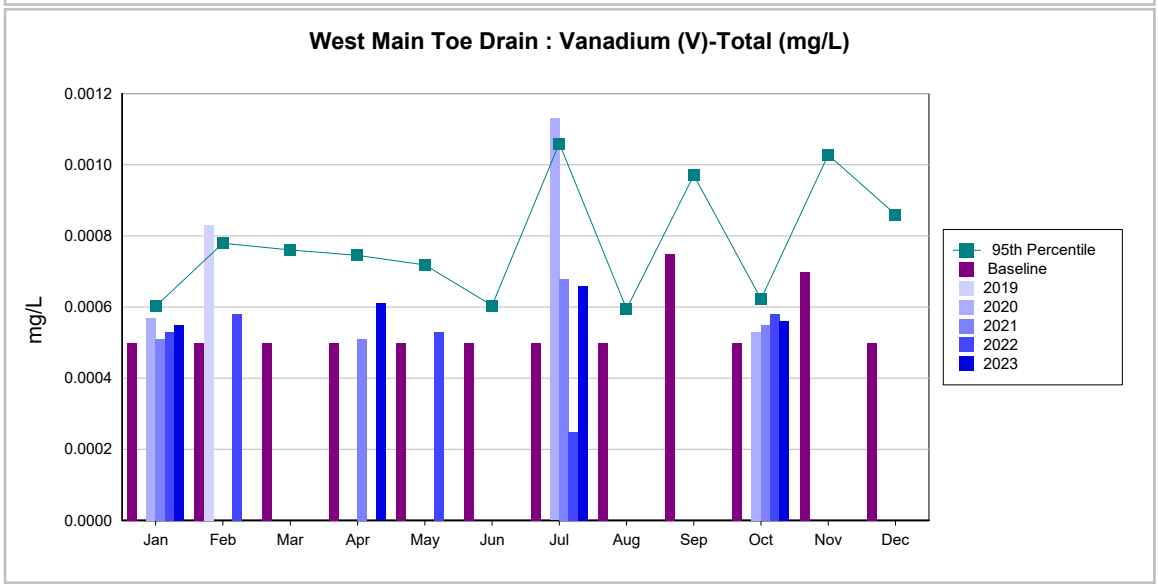
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







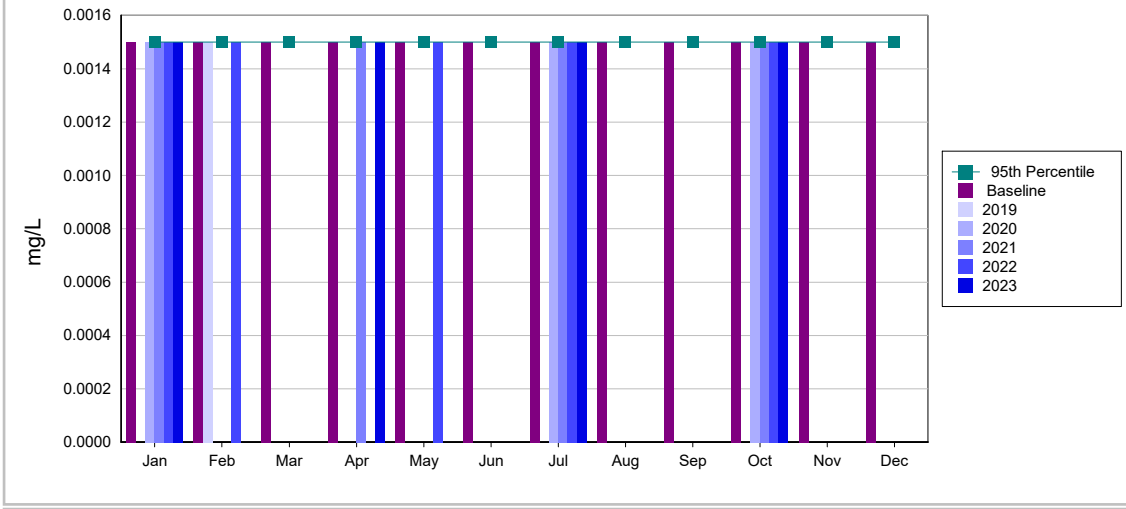
Water Quality Report

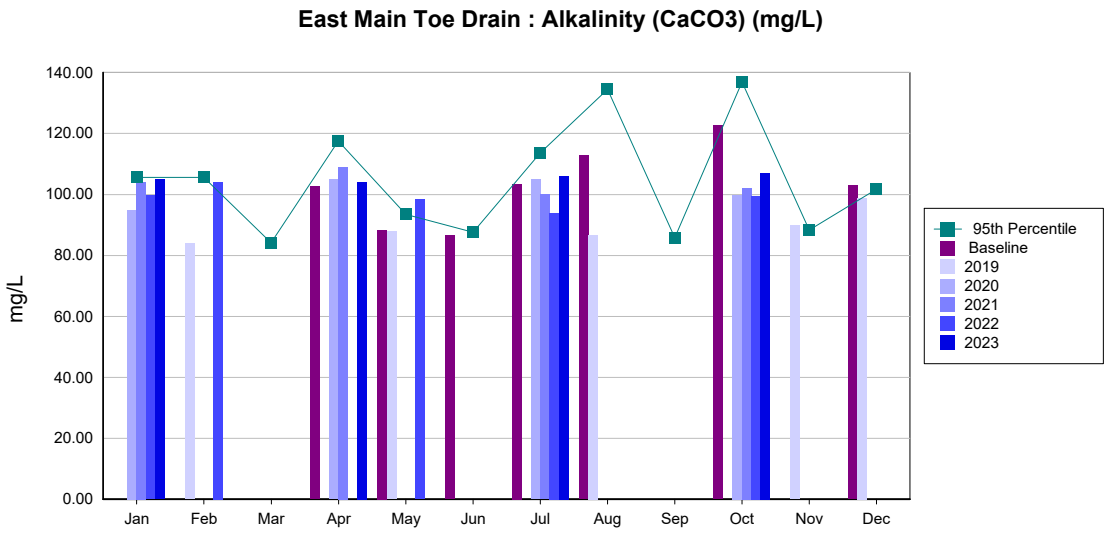
Annual Report Drainage Water

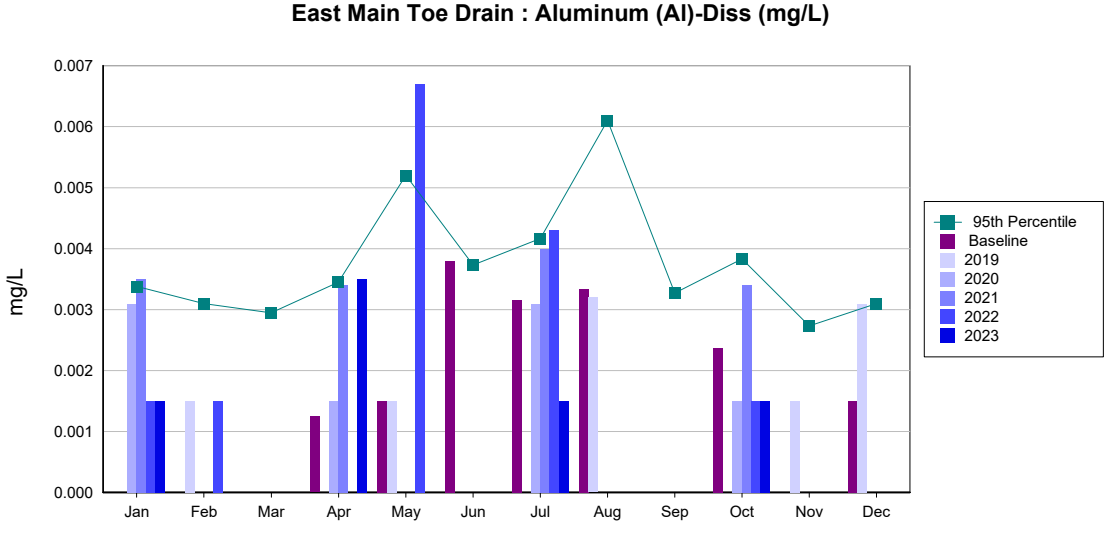
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







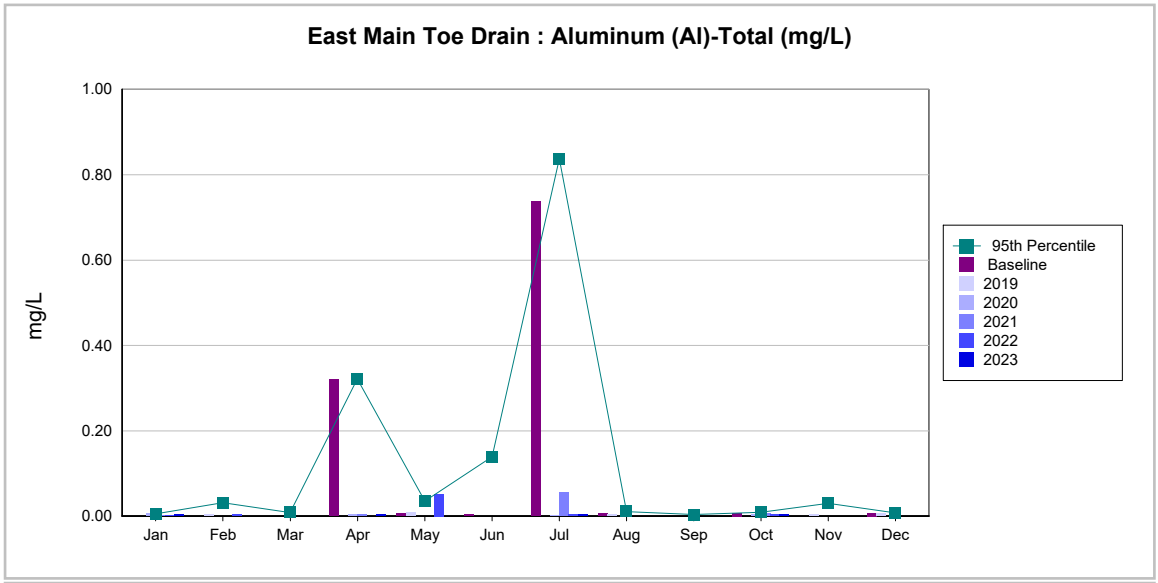
Water Quality Report

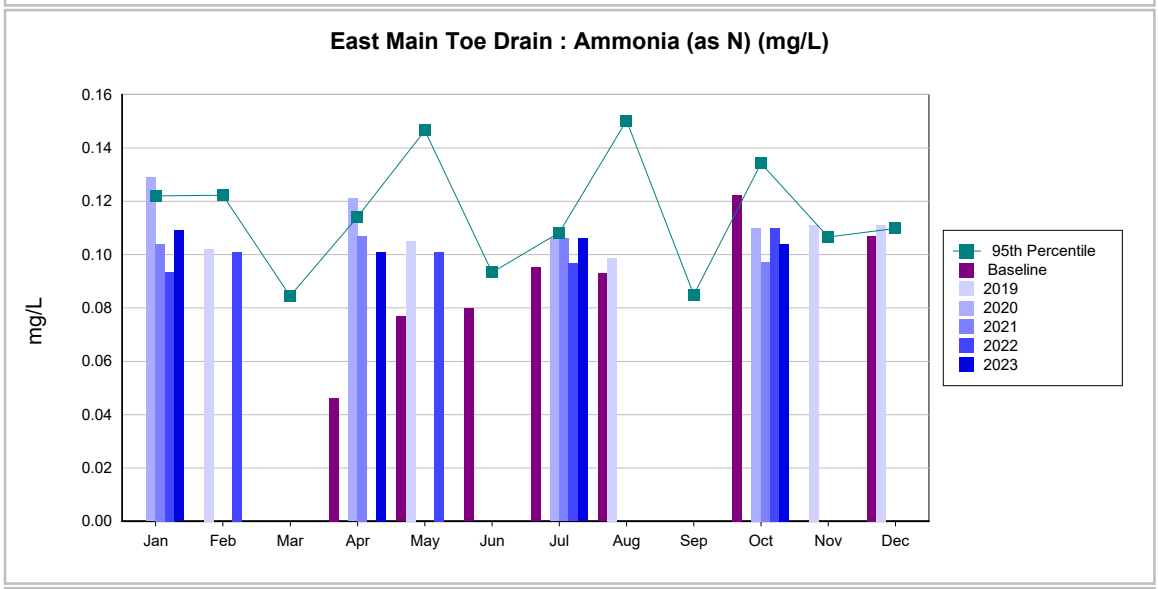
Annual Report Drainage Water

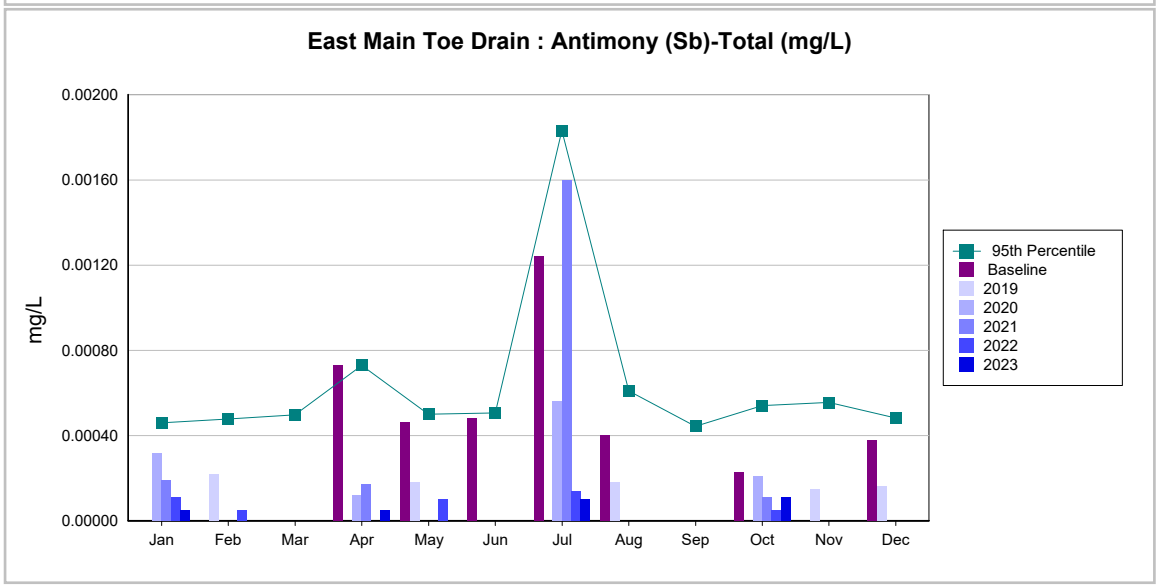
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







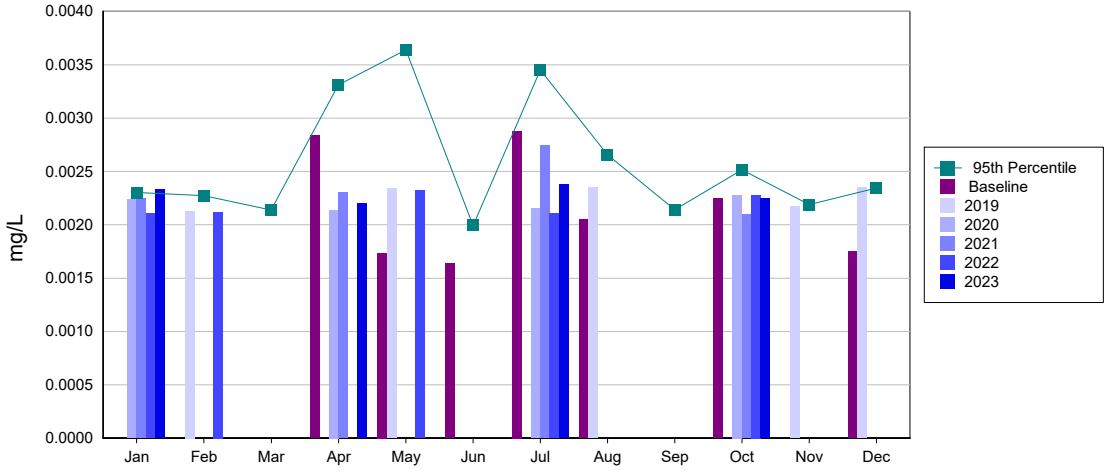
Water Quality Report

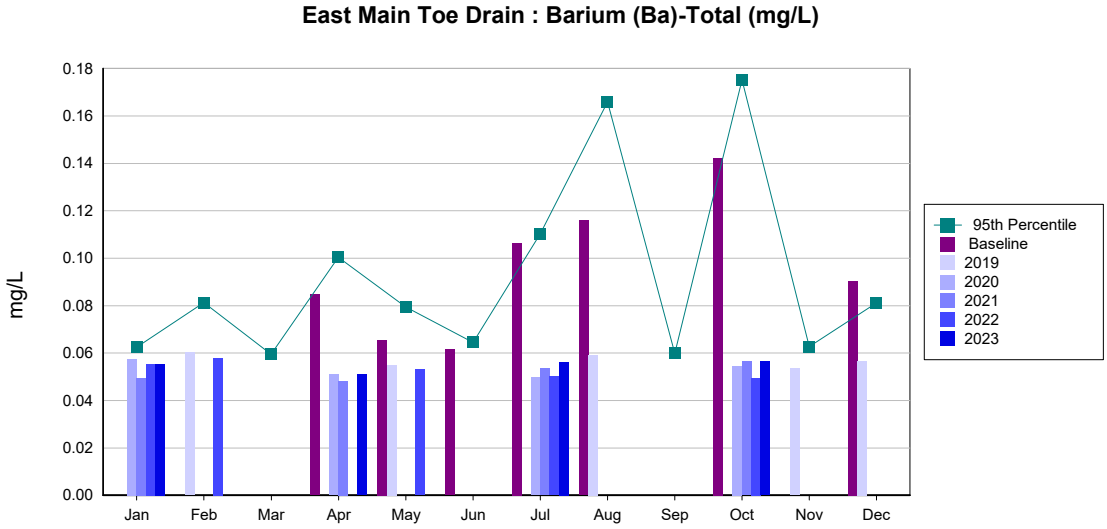
Annual Report Drainage Water

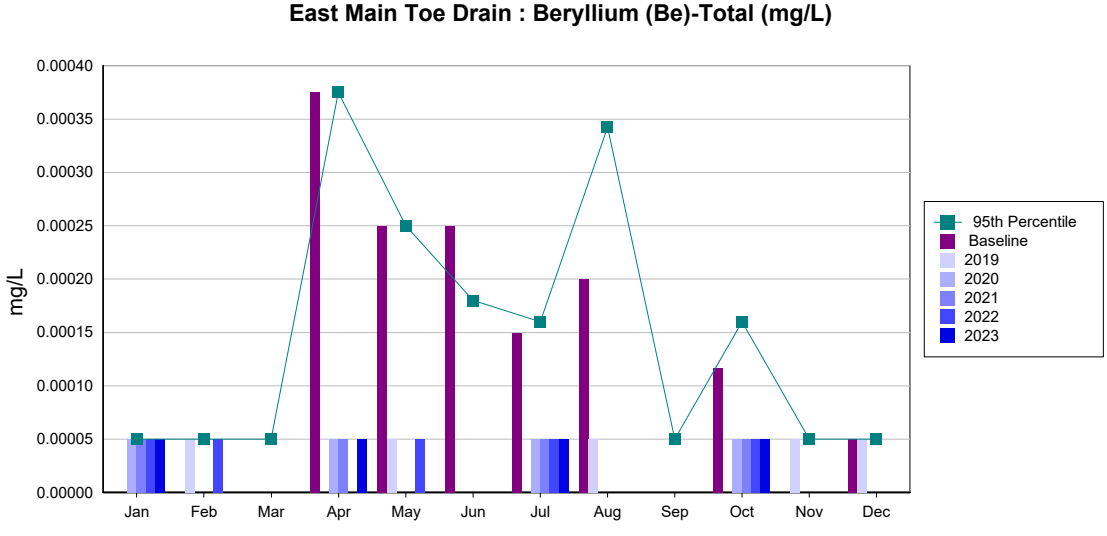
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







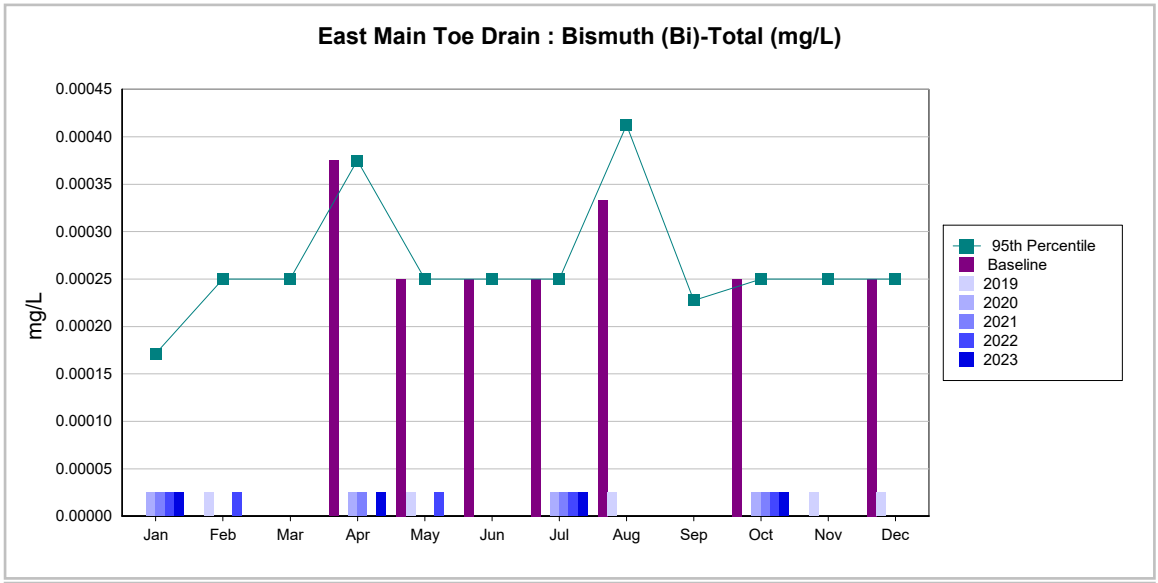
Water Quality Report

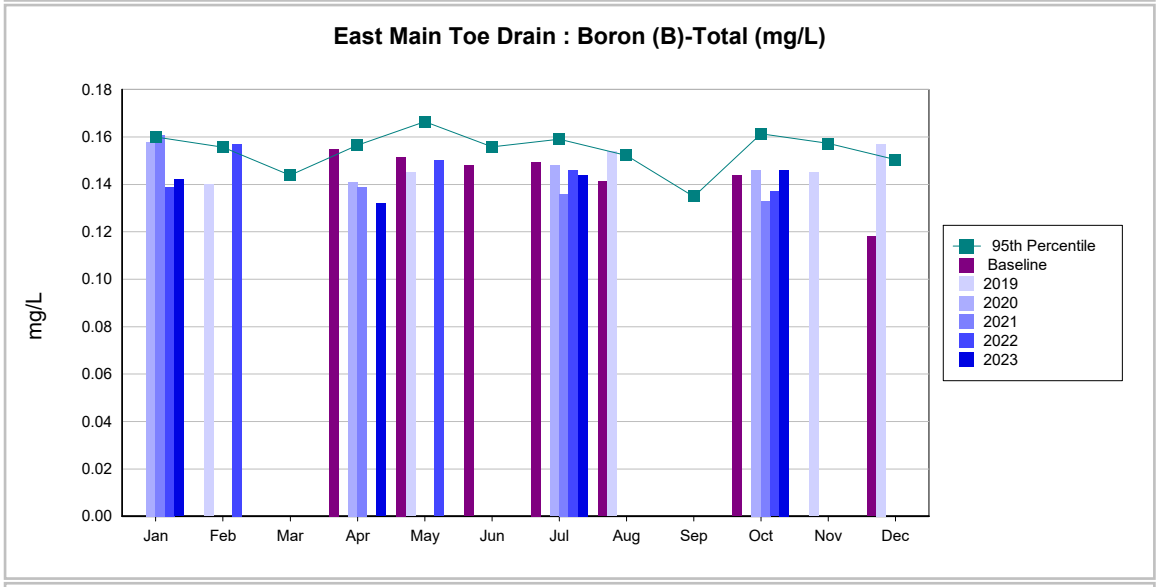
Annual Report Drainage Water

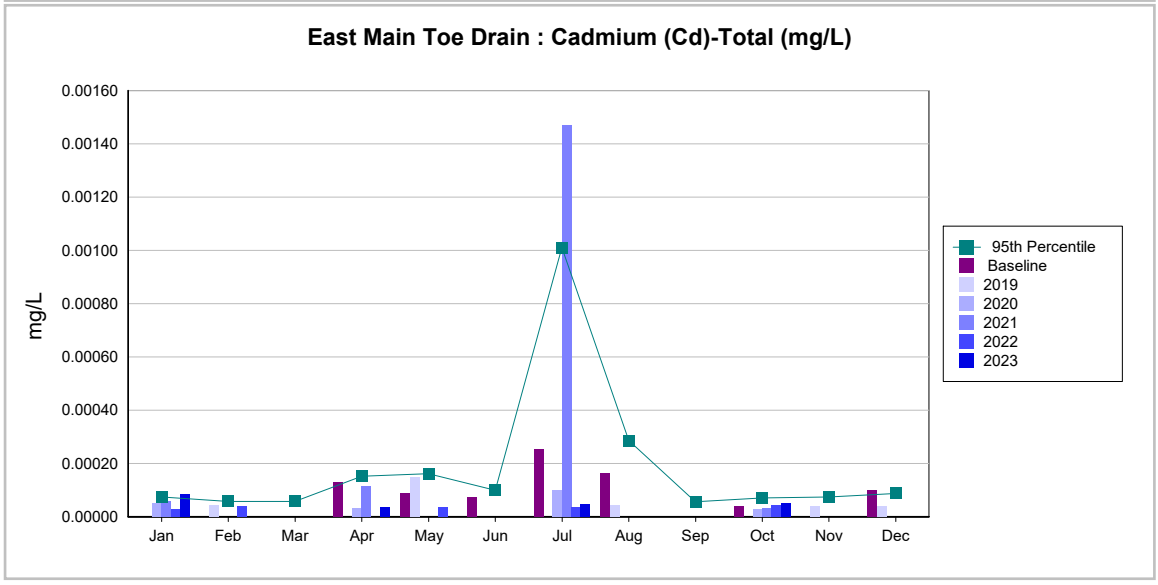
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







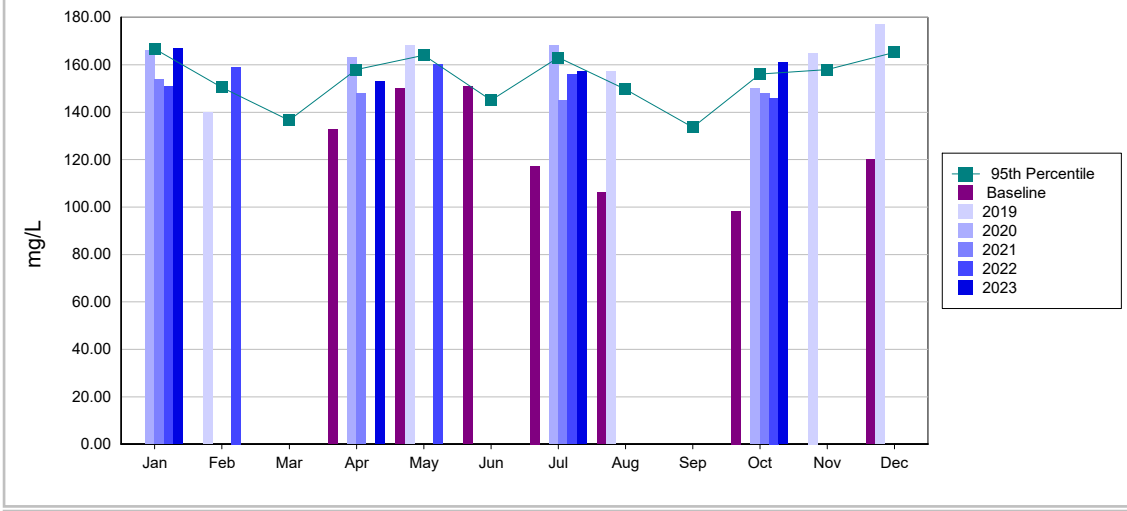
Water Quality Report

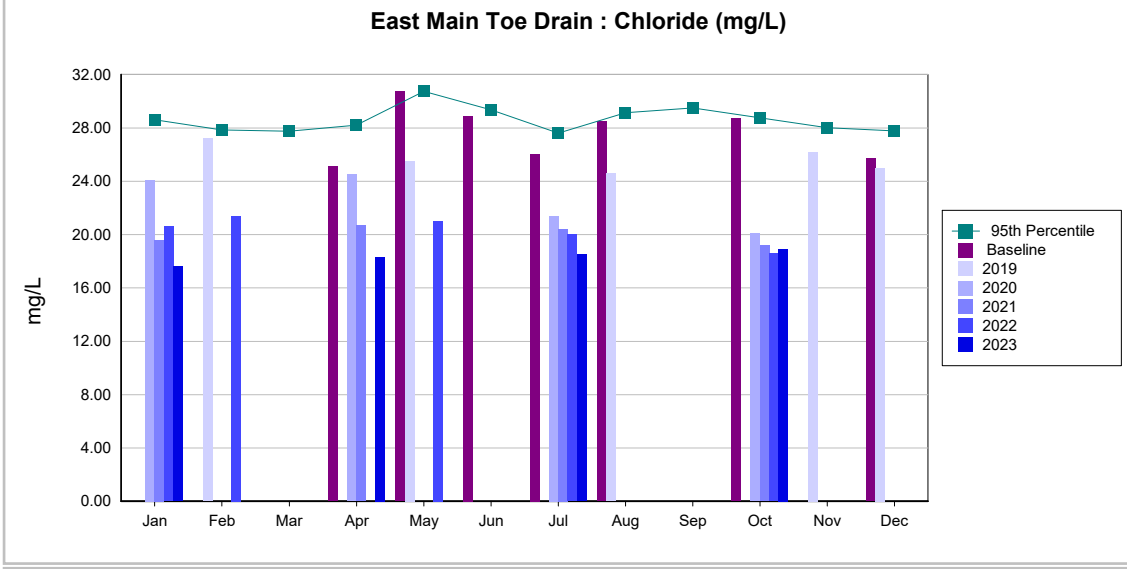
Annual Report Drainage Water

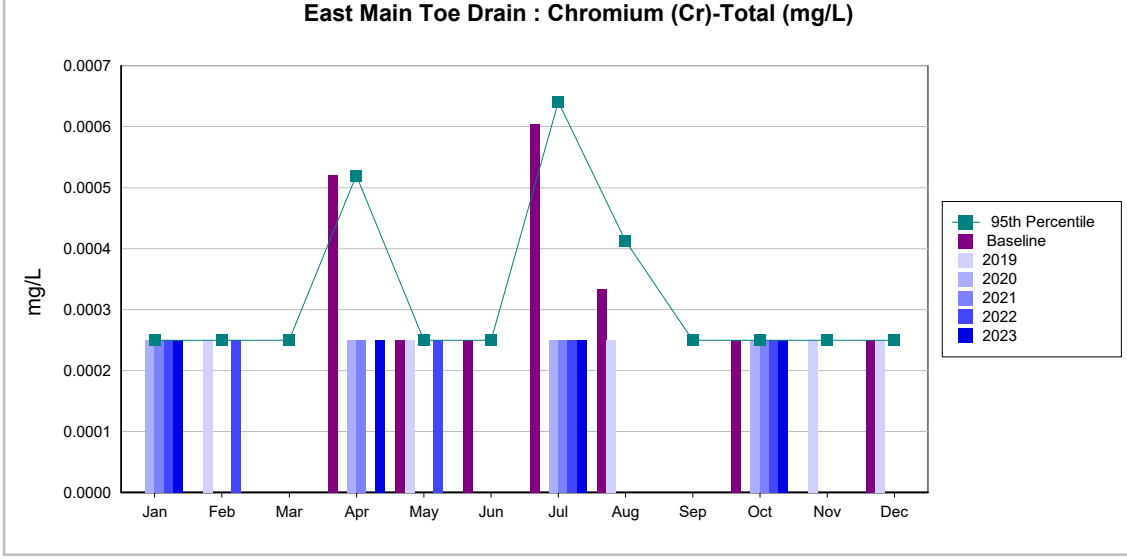
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







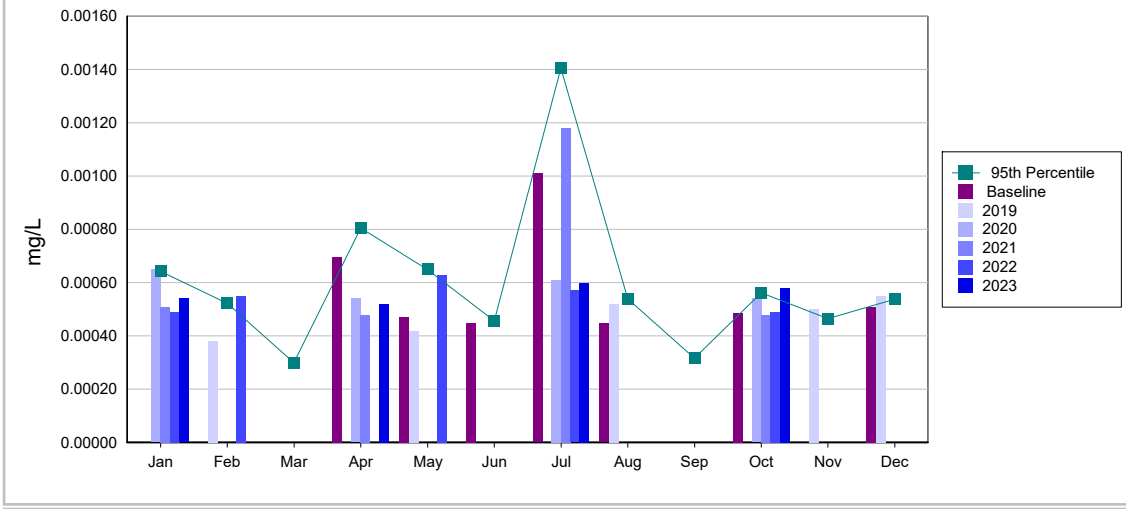
Water Quality Report

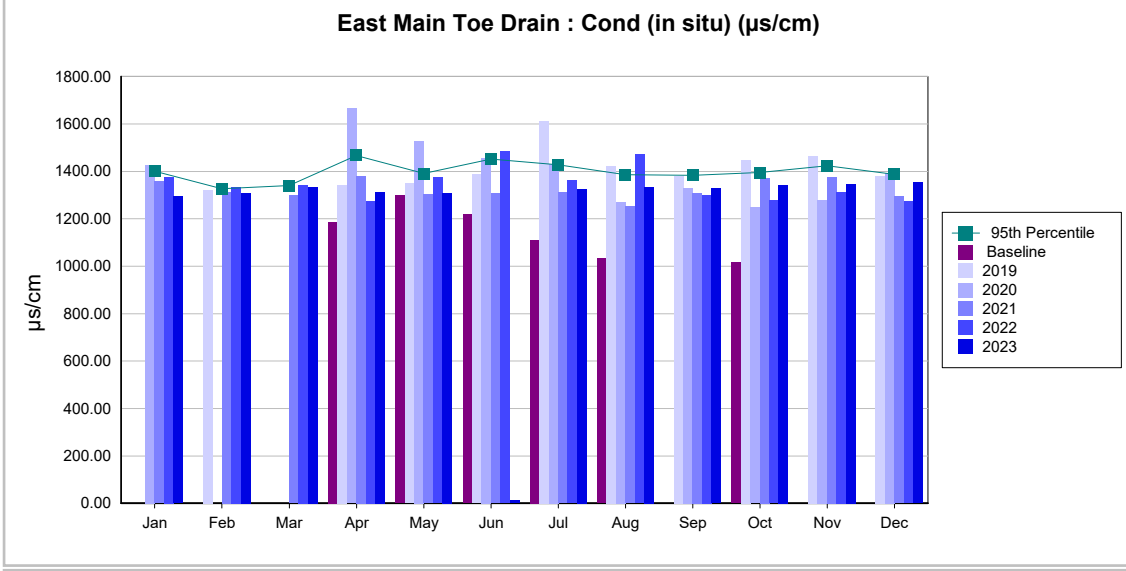
Annual Report Drainage Water

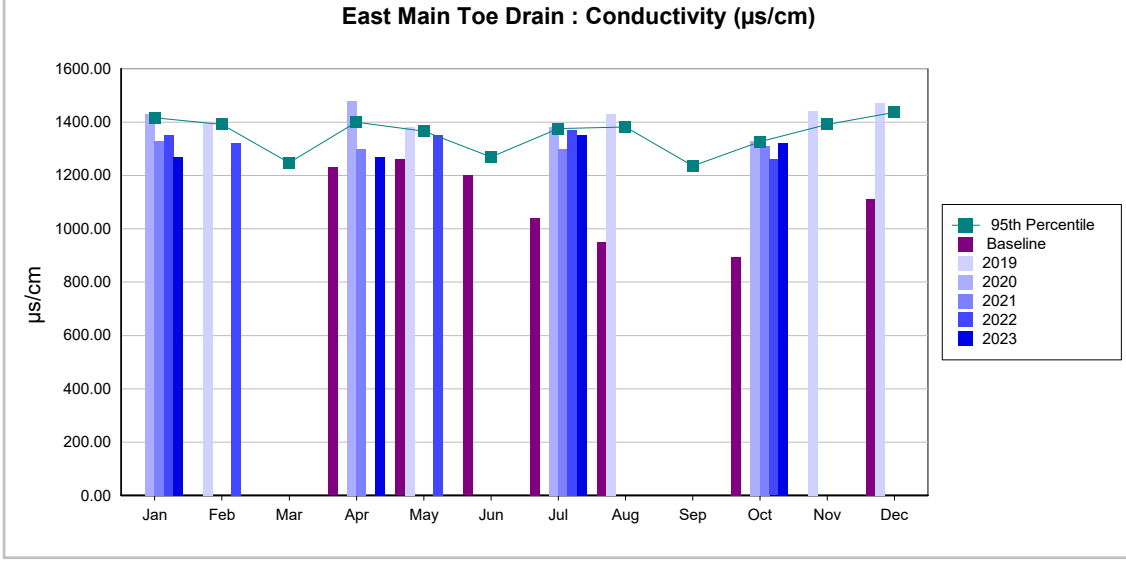
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







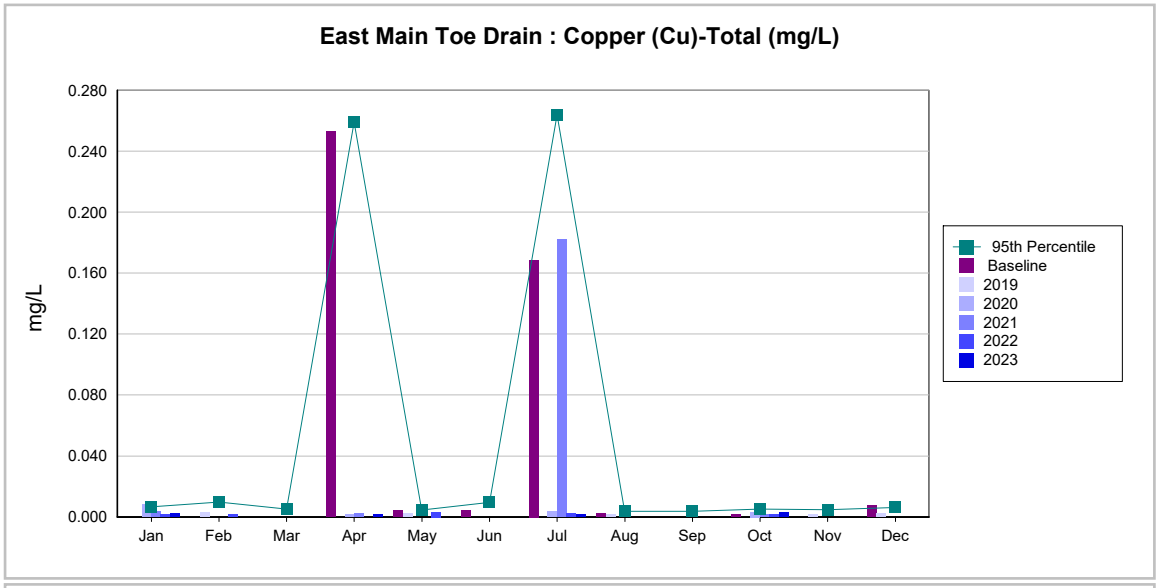
Water Quality Report

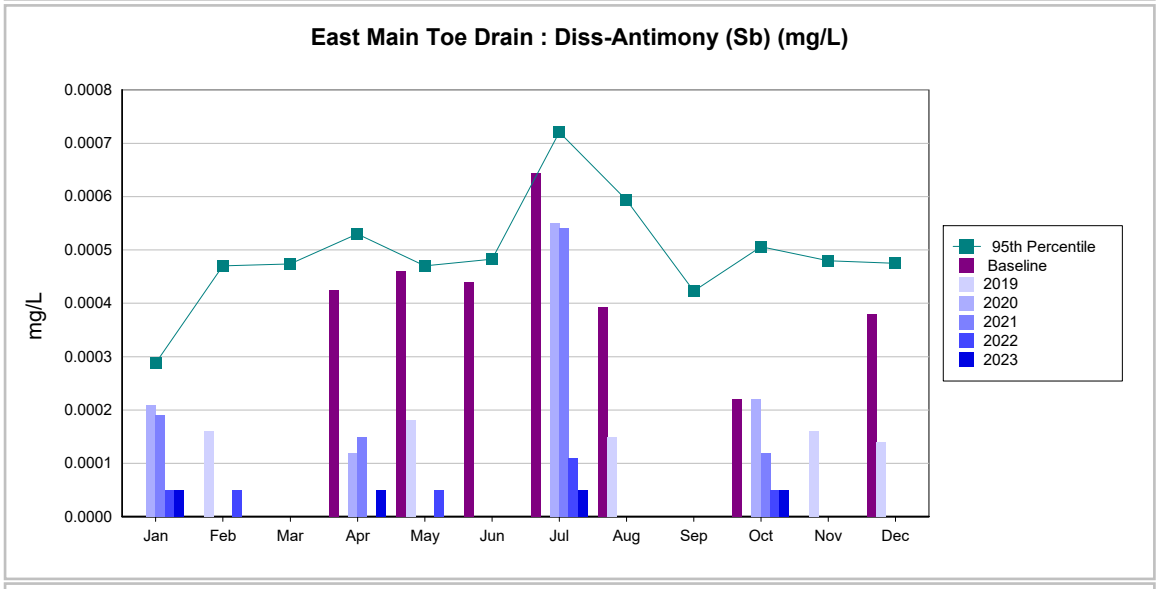
Annual Report Drainage Water

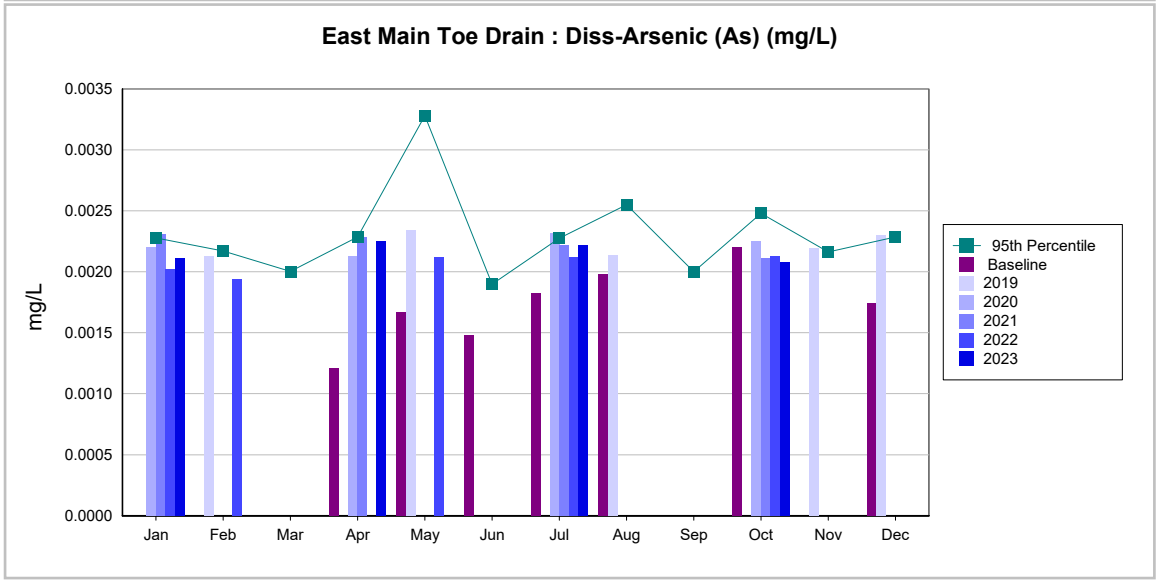
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







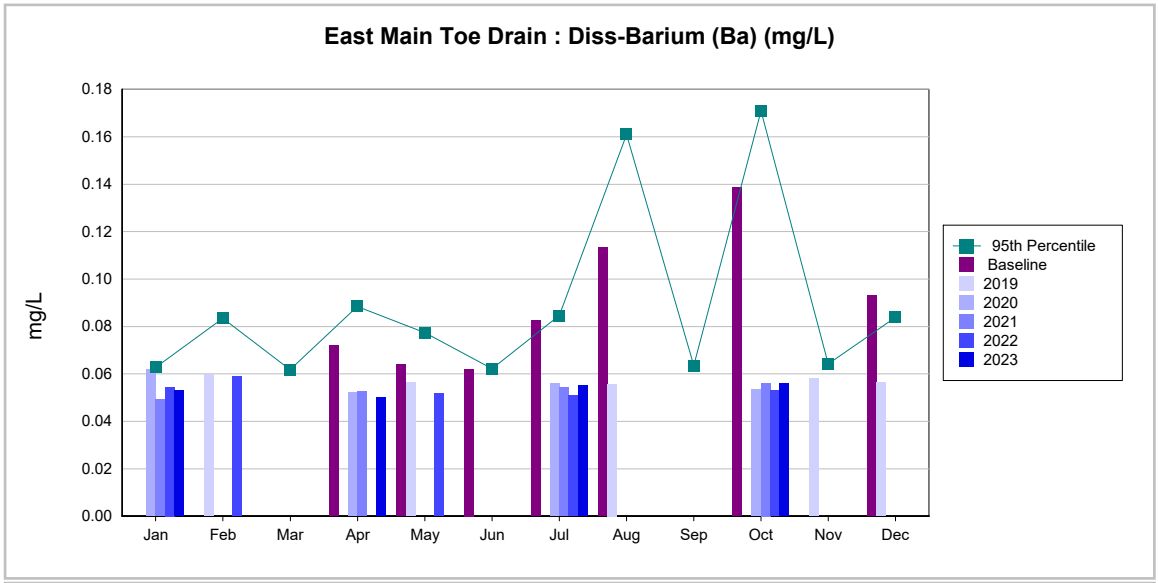
Water Quality Report

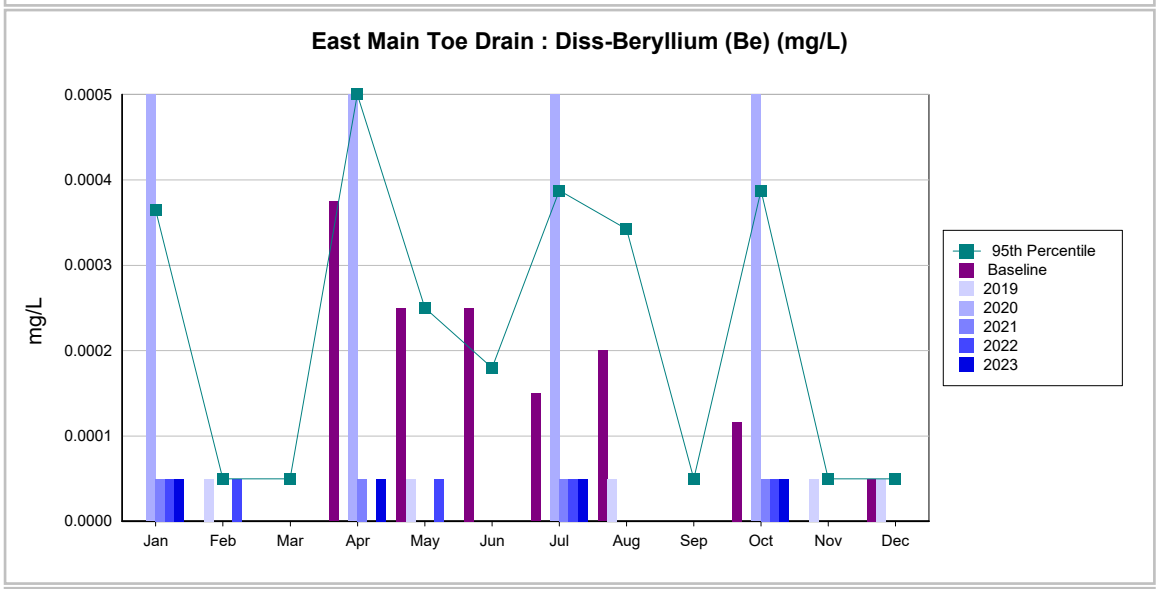
Annual Report Drainage Water

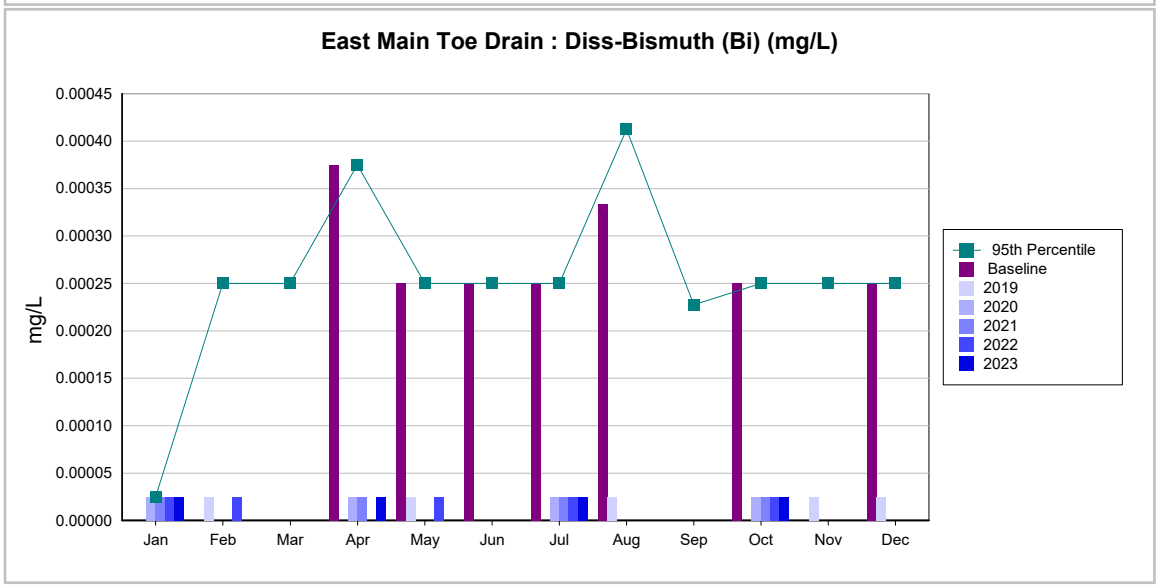
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







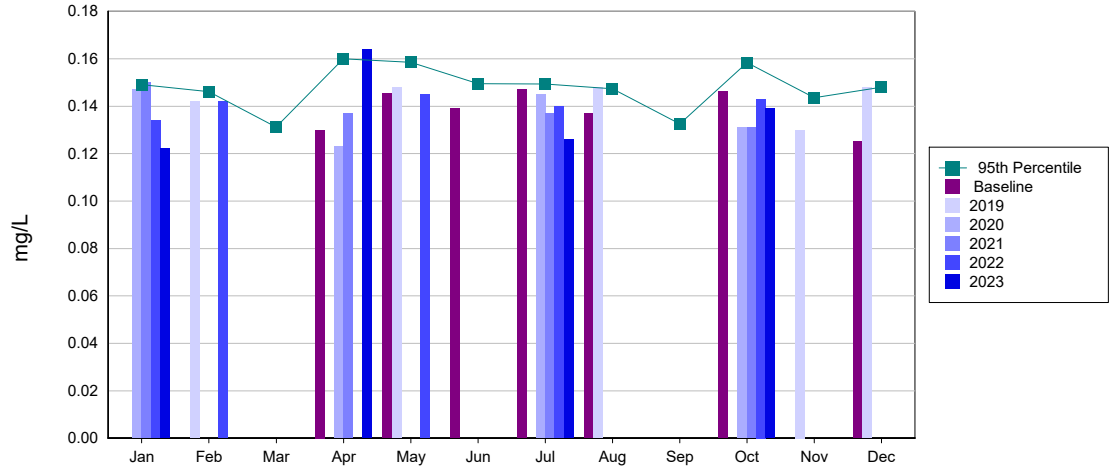
Water Quality Report

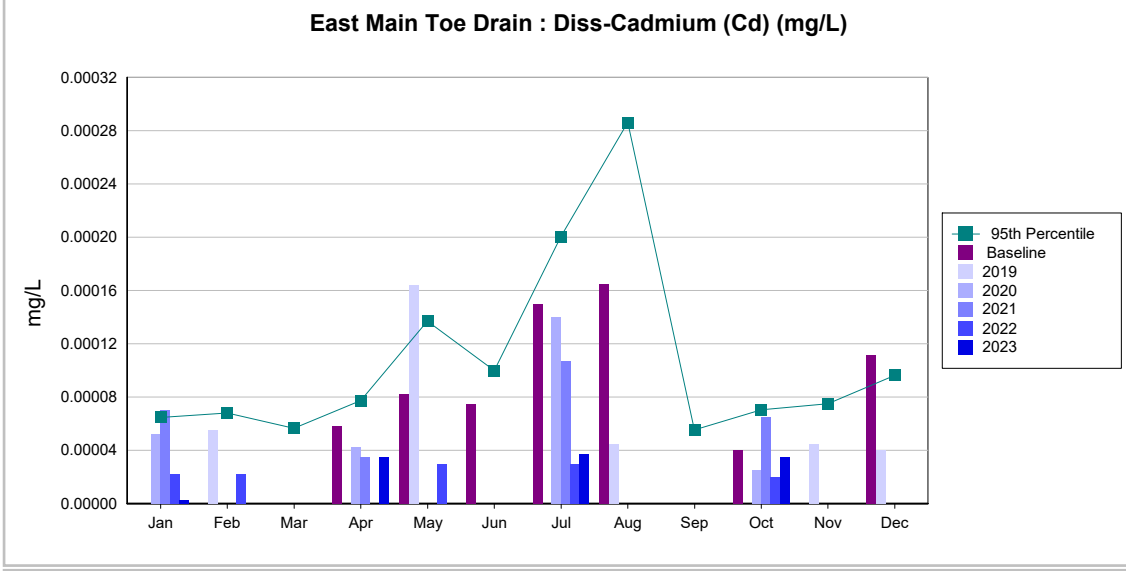
Annual Report Drainage Water

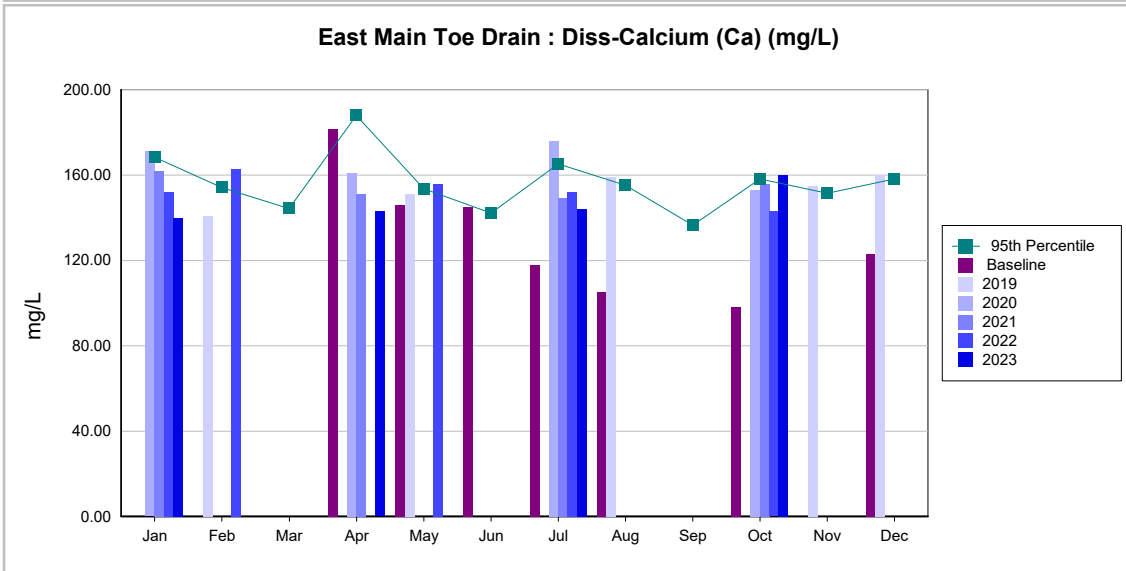
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







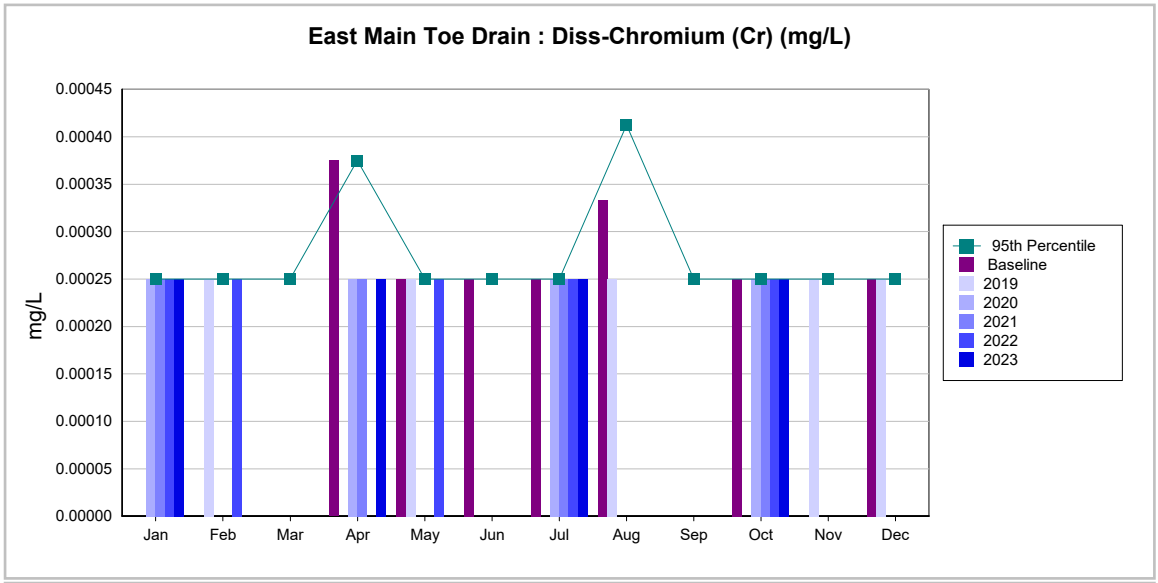
Water Quality Report

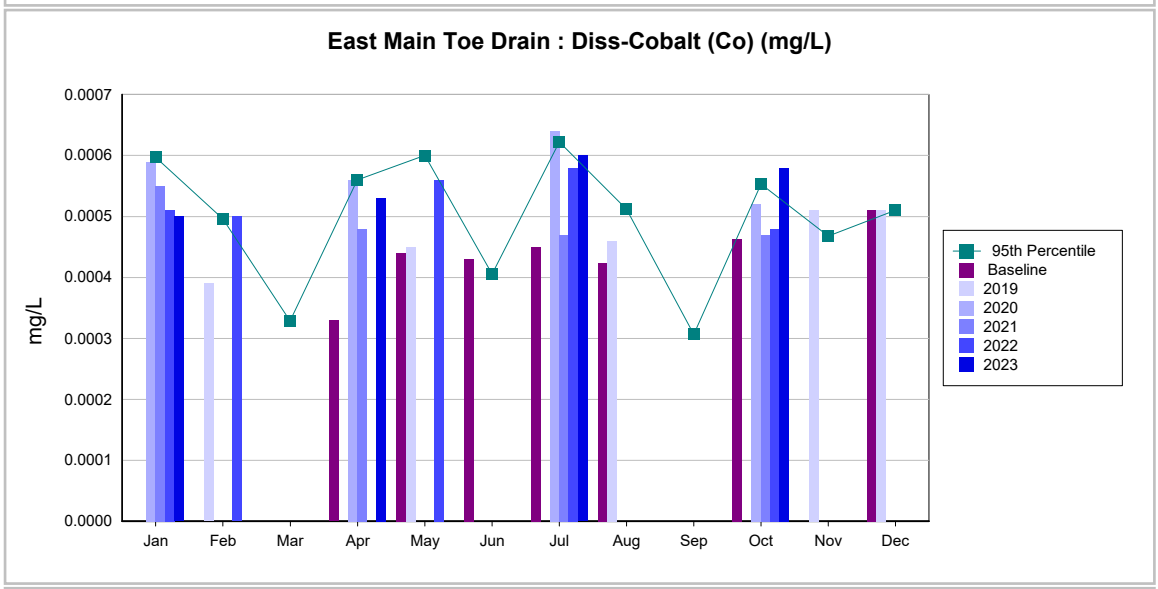
Annual Report Drainage Water

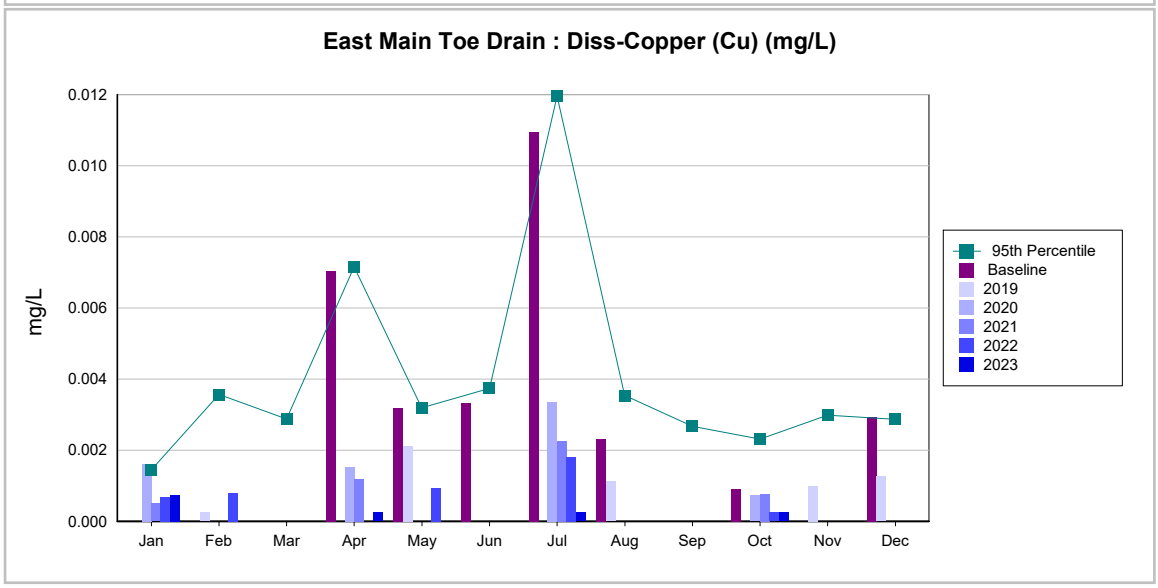
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







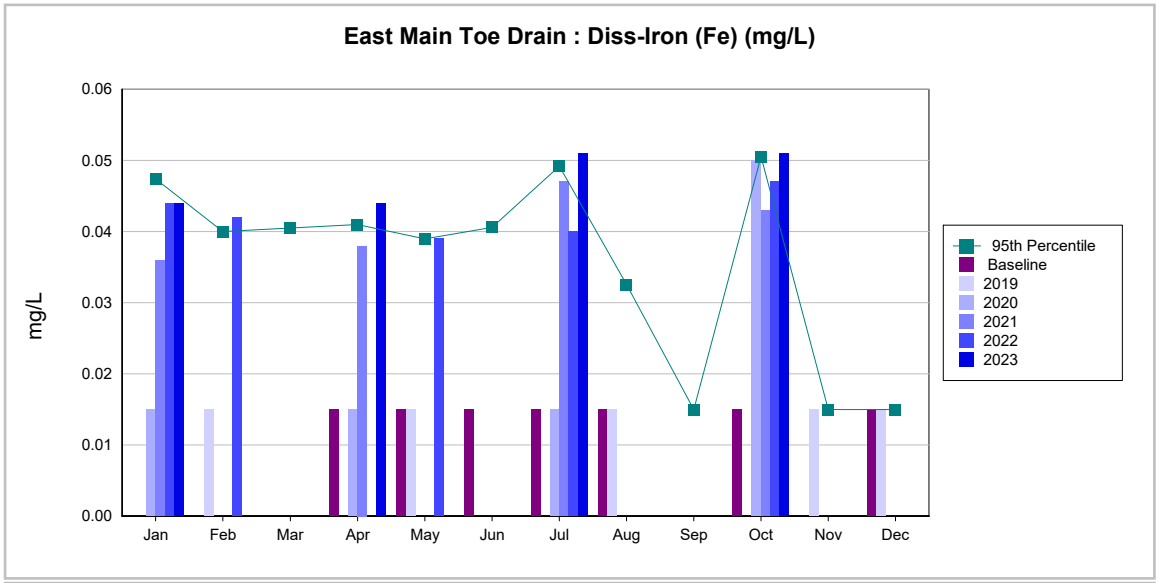
Water Quality Report

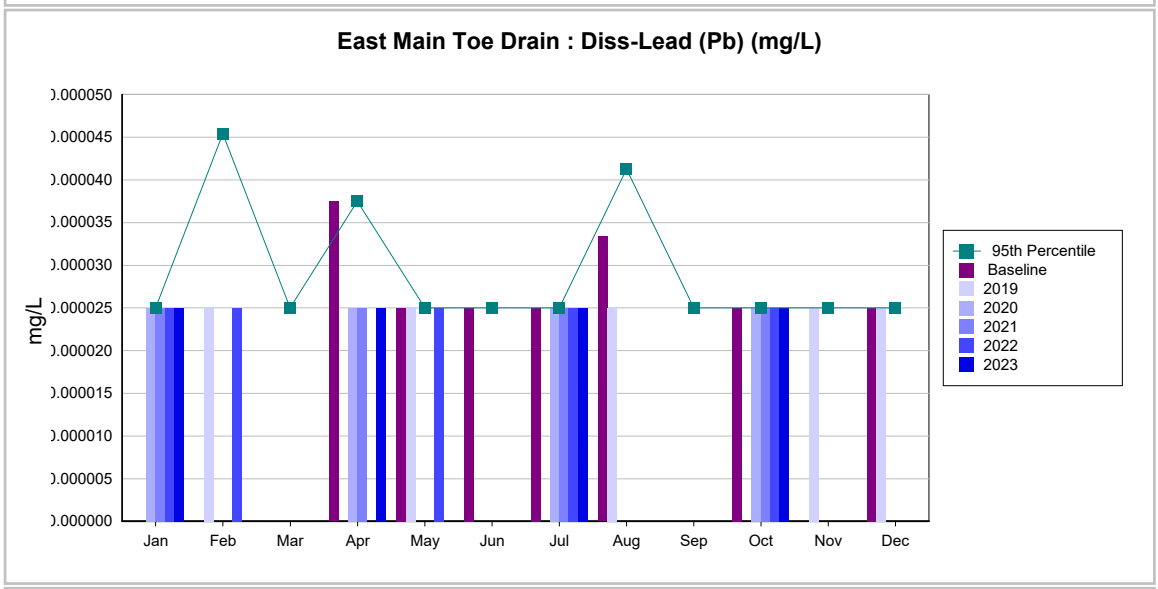
Annual Report Drainage Water

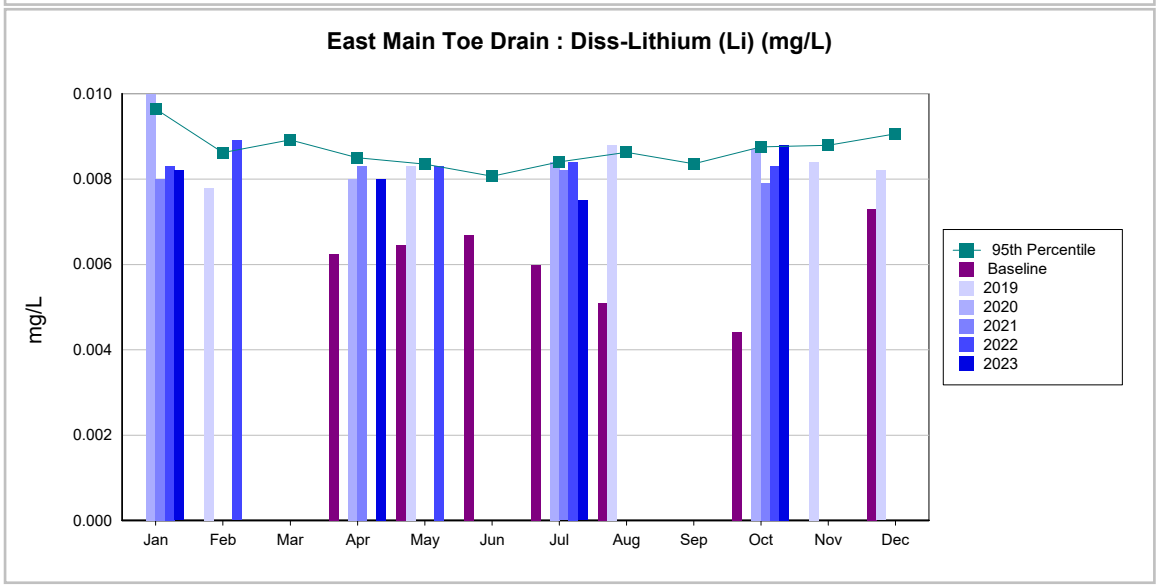
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







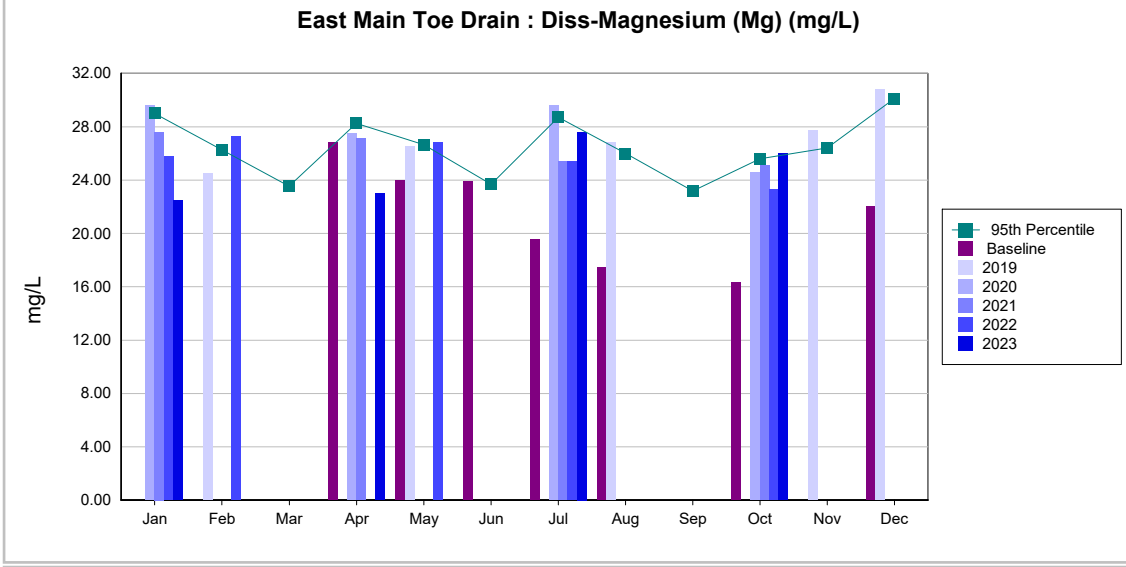
Water Quality Report

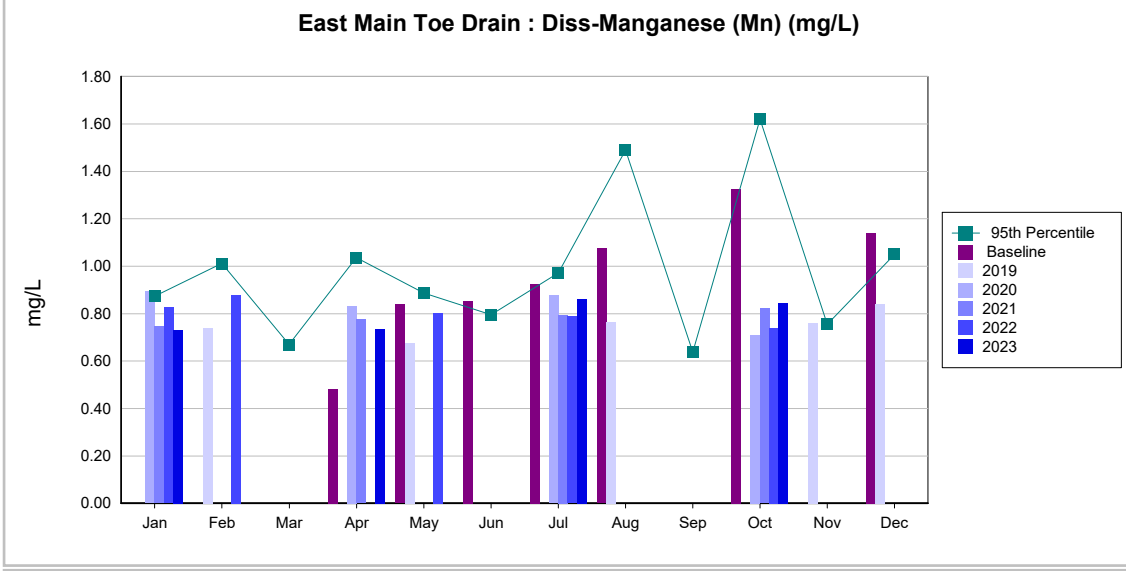
Annual Report Drainage Water

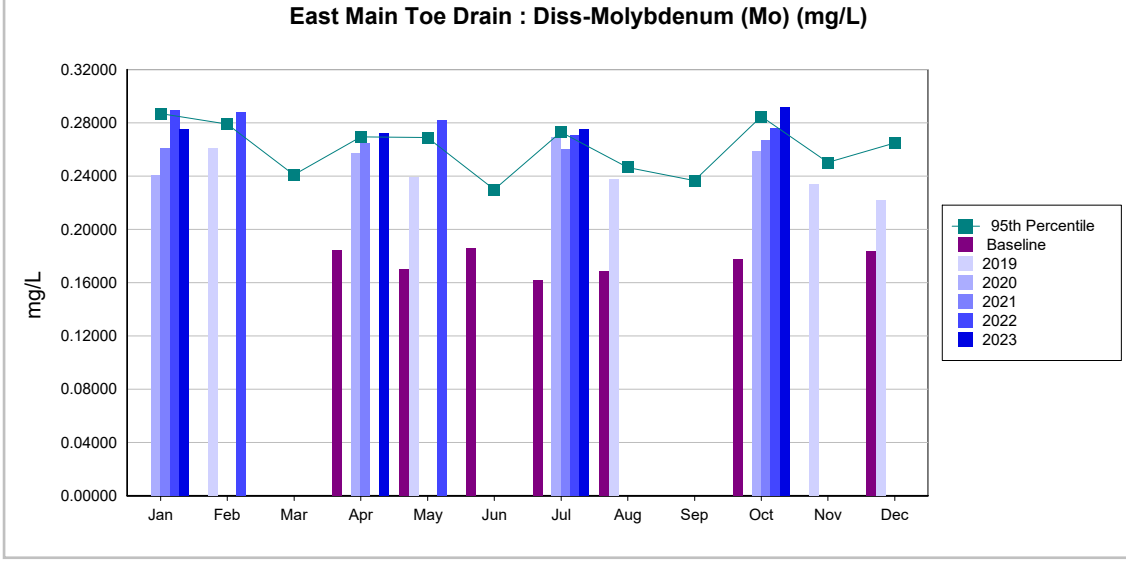
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







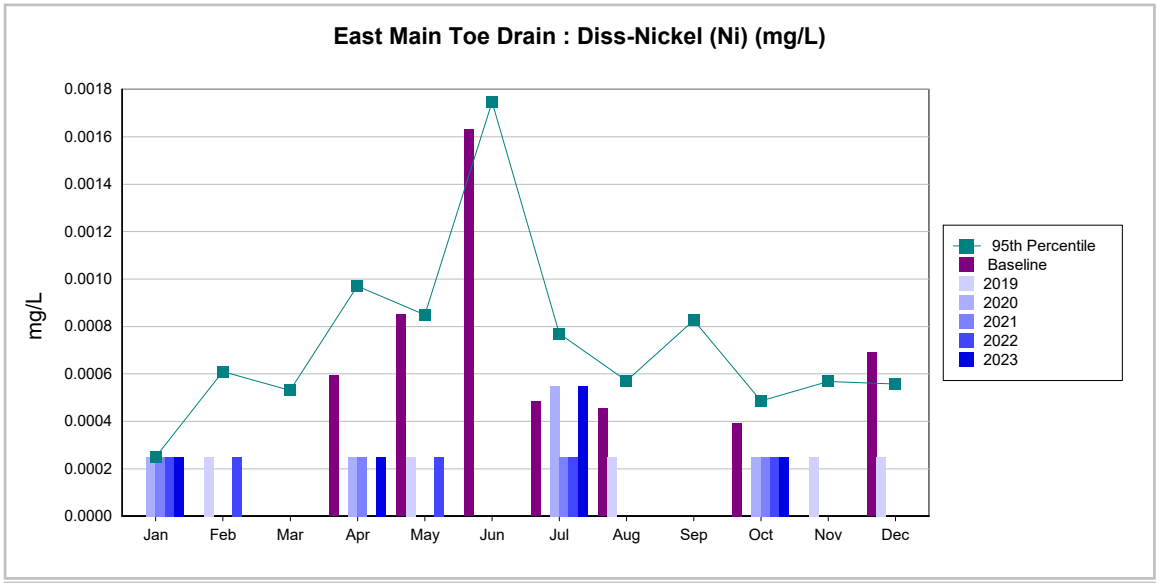
Water Quality Report

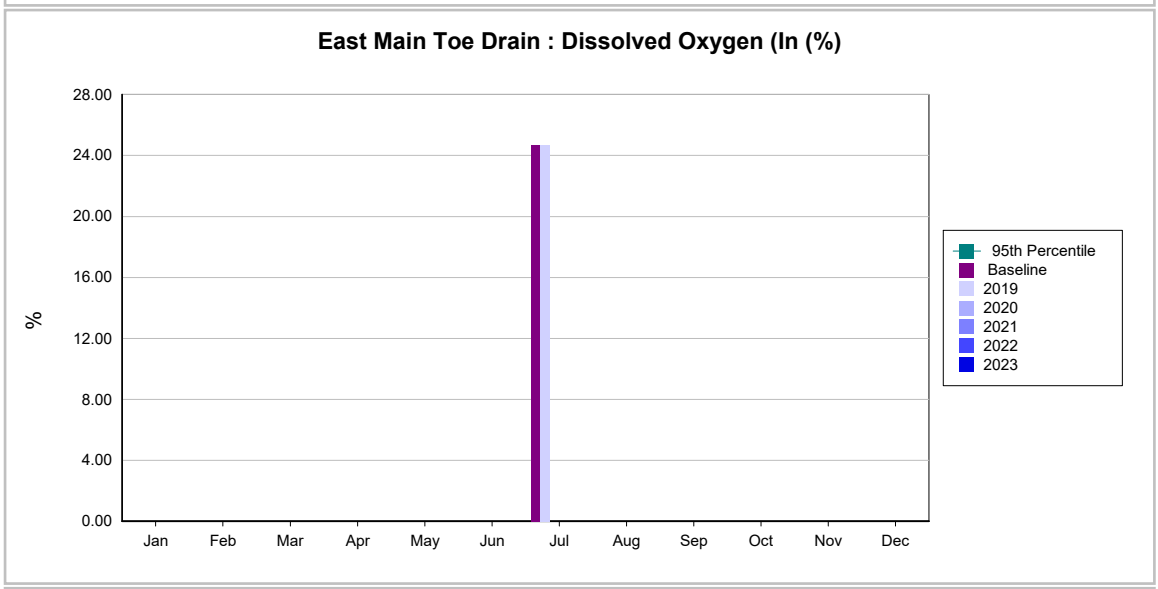
Annual Report Drainage Water

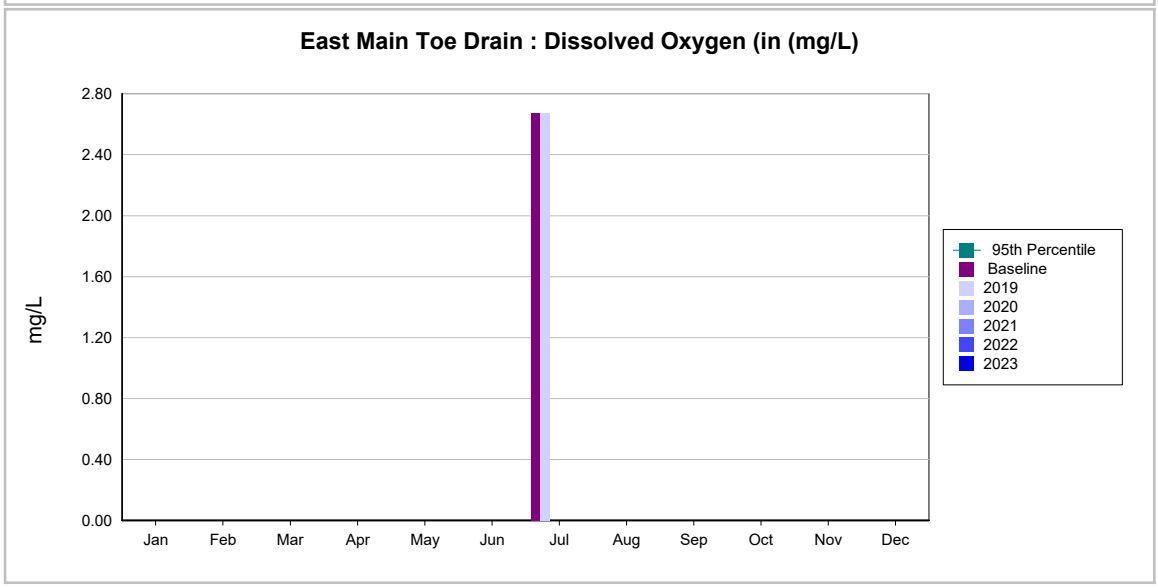
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







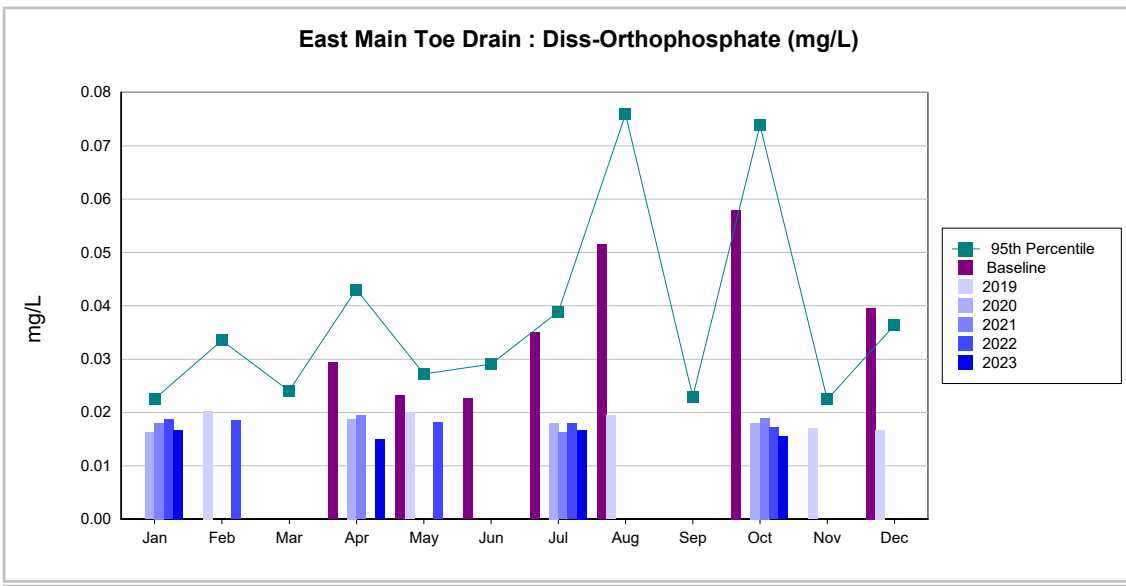
Water Quality Report

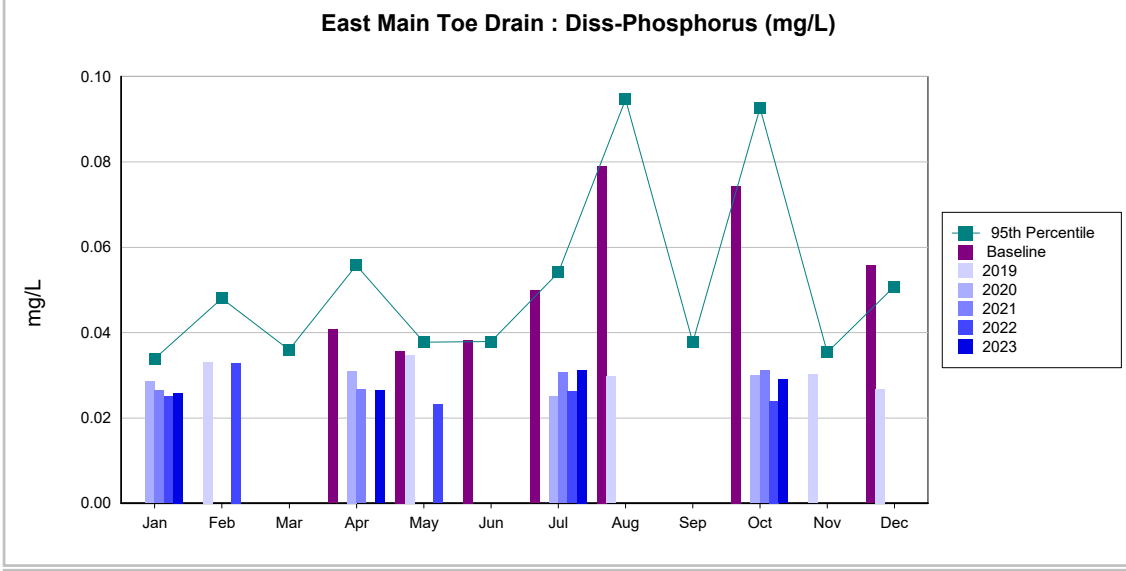
Annual Report Drainage Water

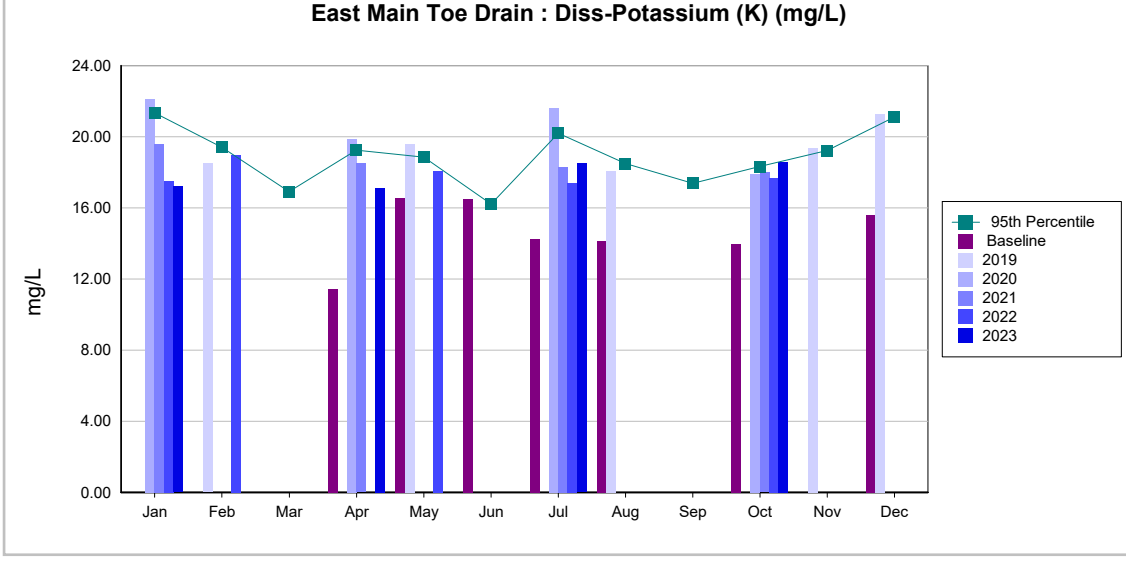
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







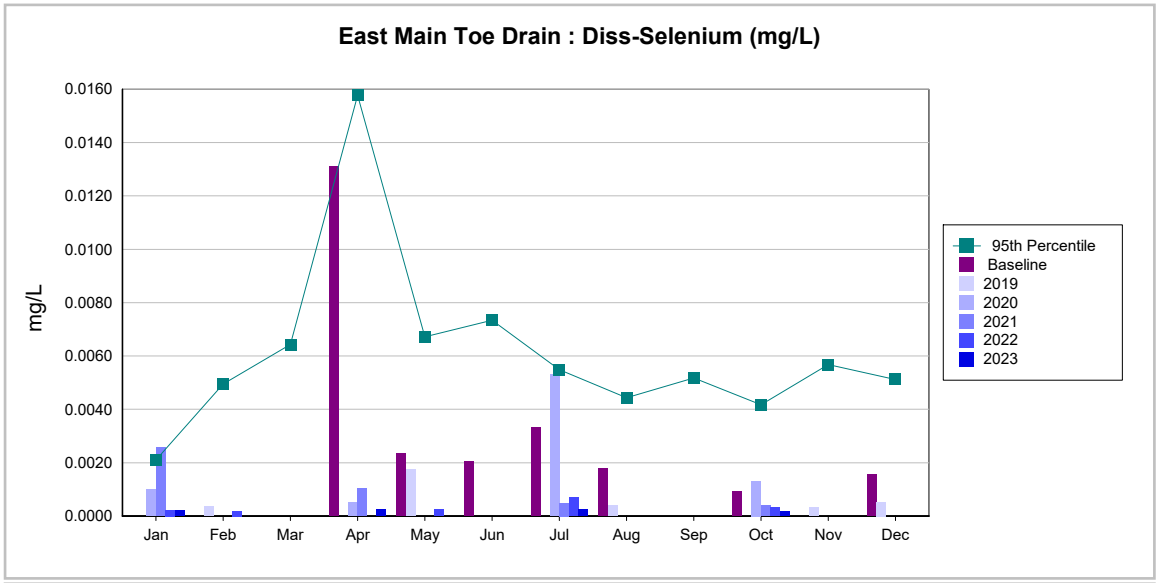
Water Quality Report

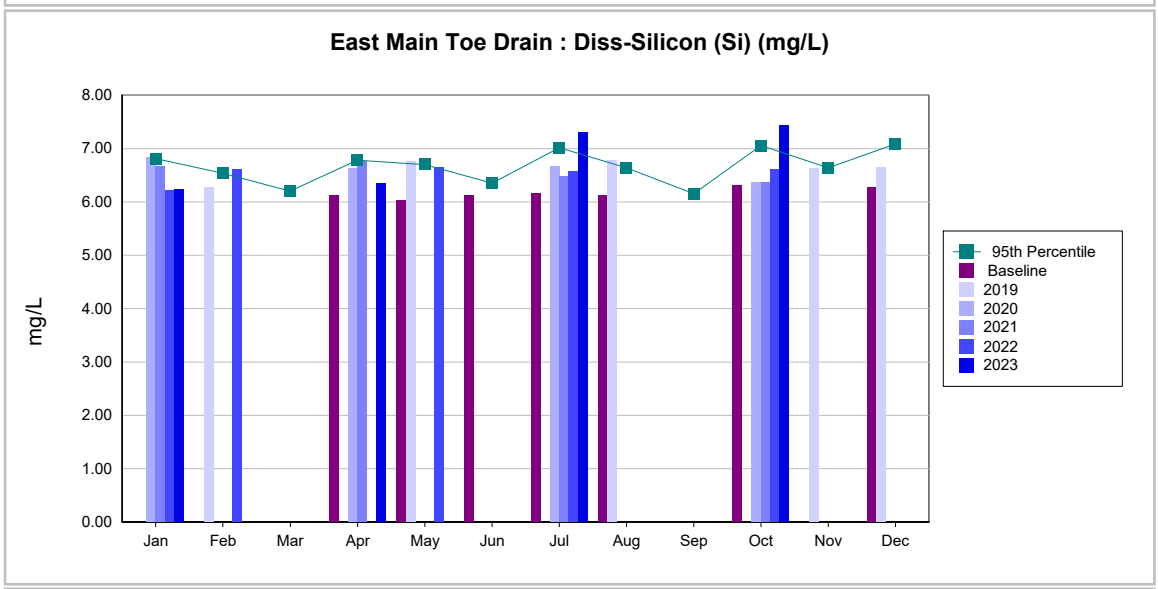
Annual Report Drainage Water

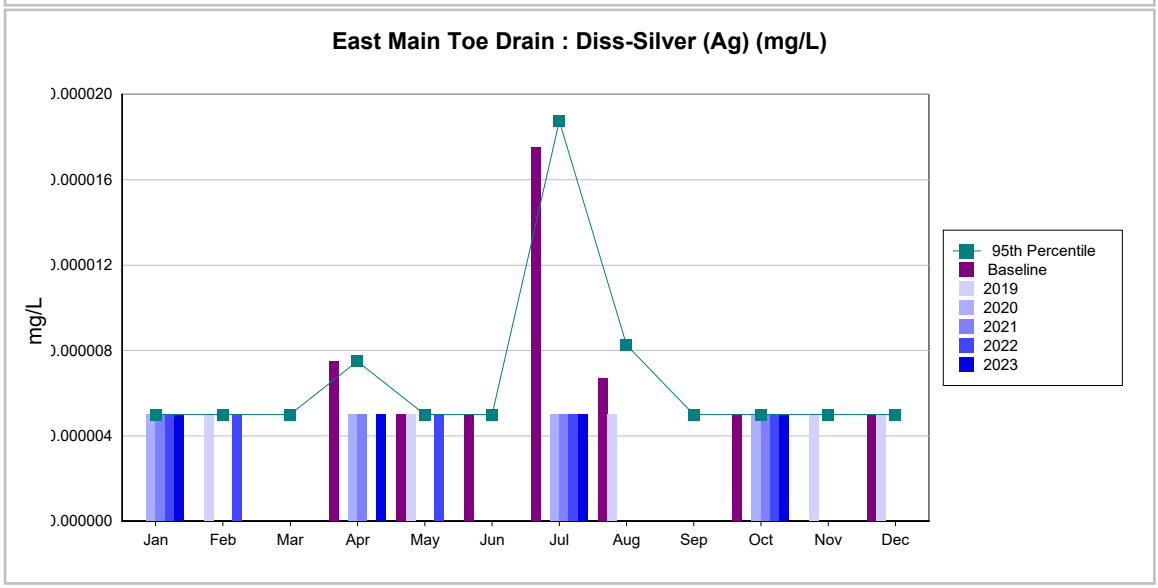
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







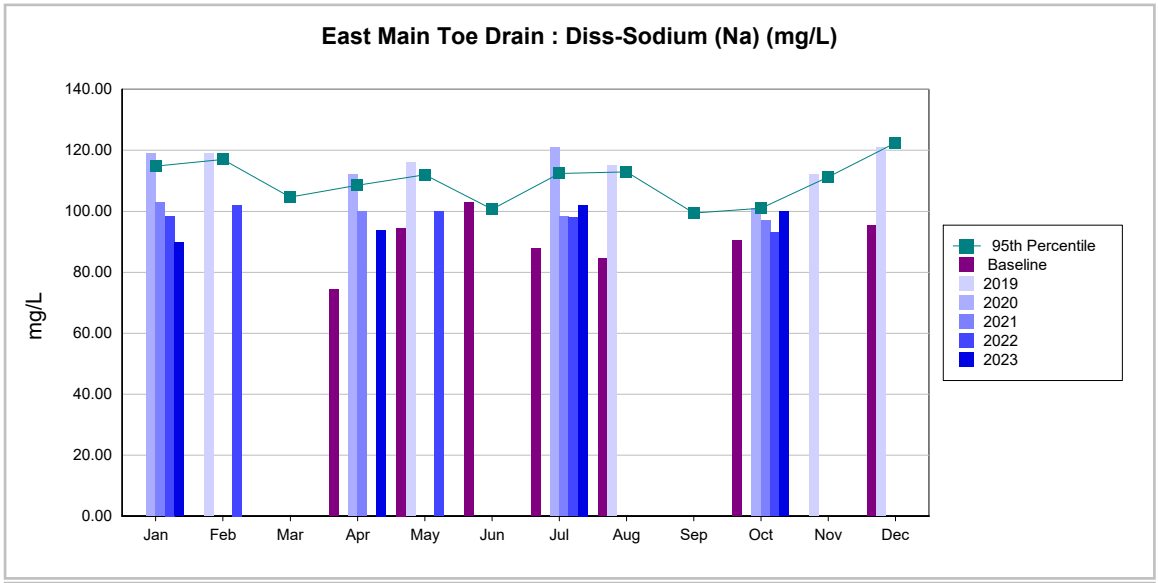
Water Quality Report

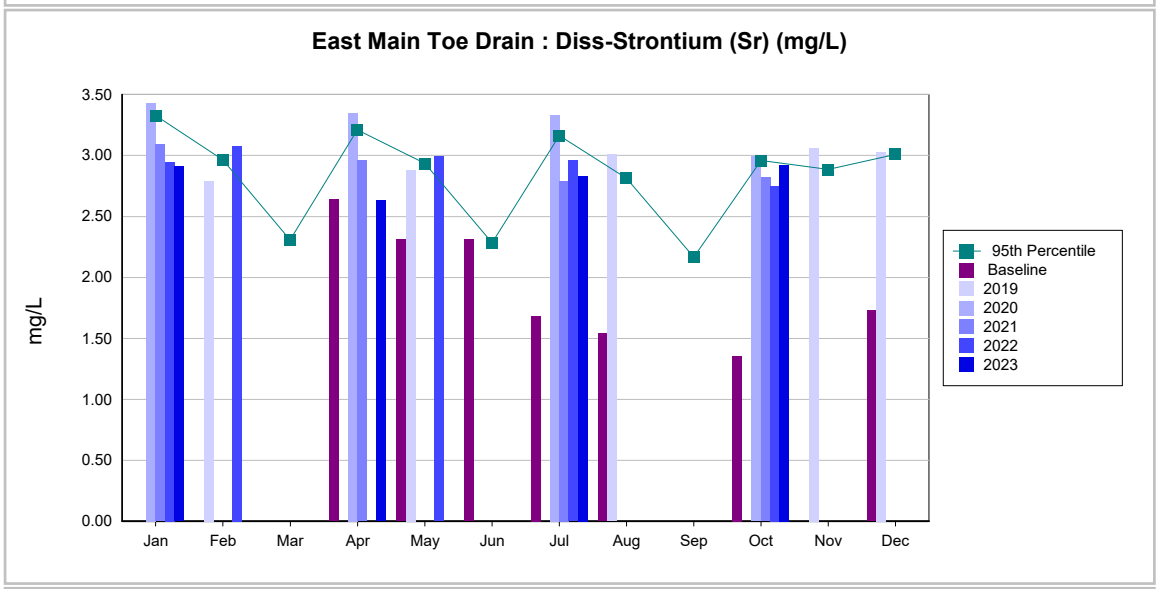
Annual Report Drainage Water

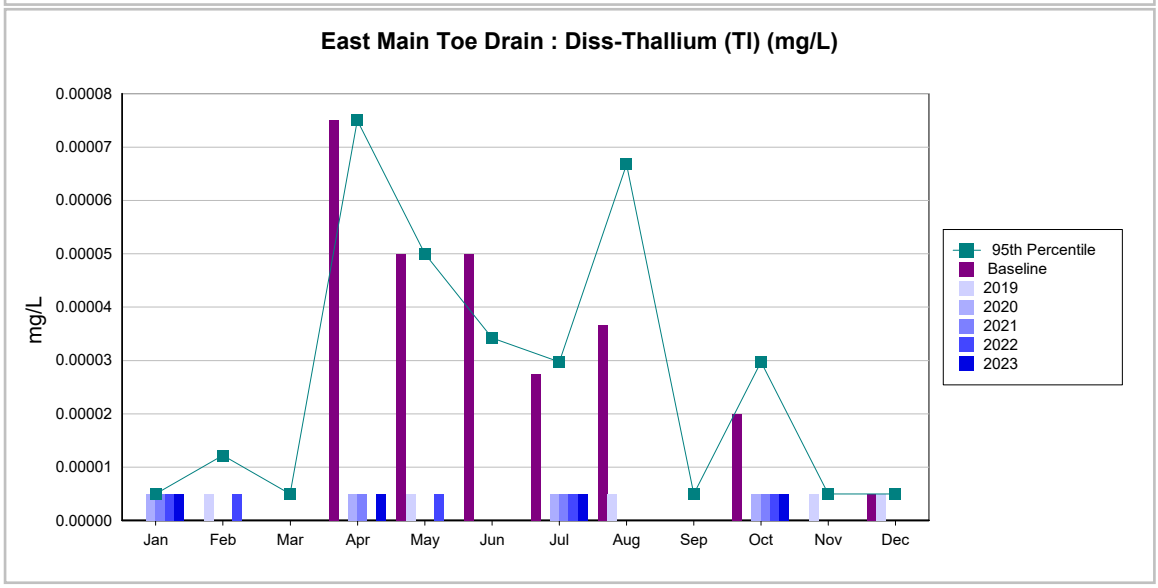
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







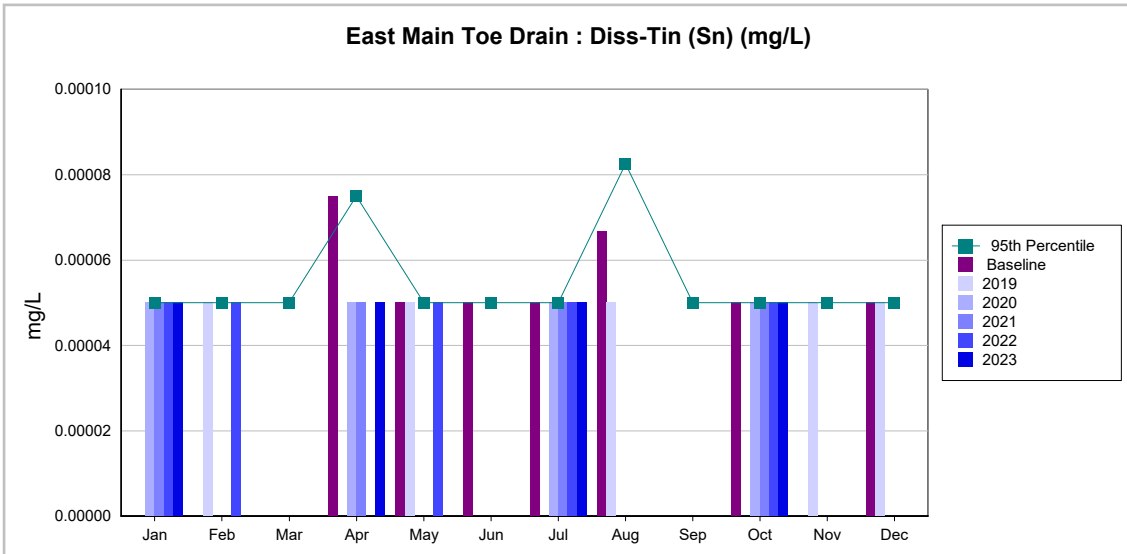
Water Quality Report

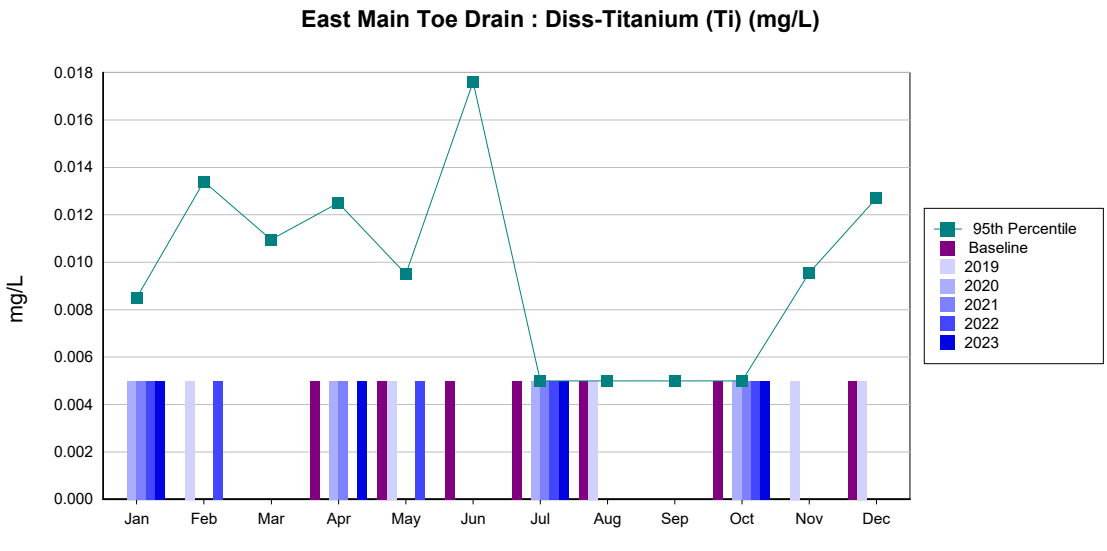
Annual Report Drainage Water

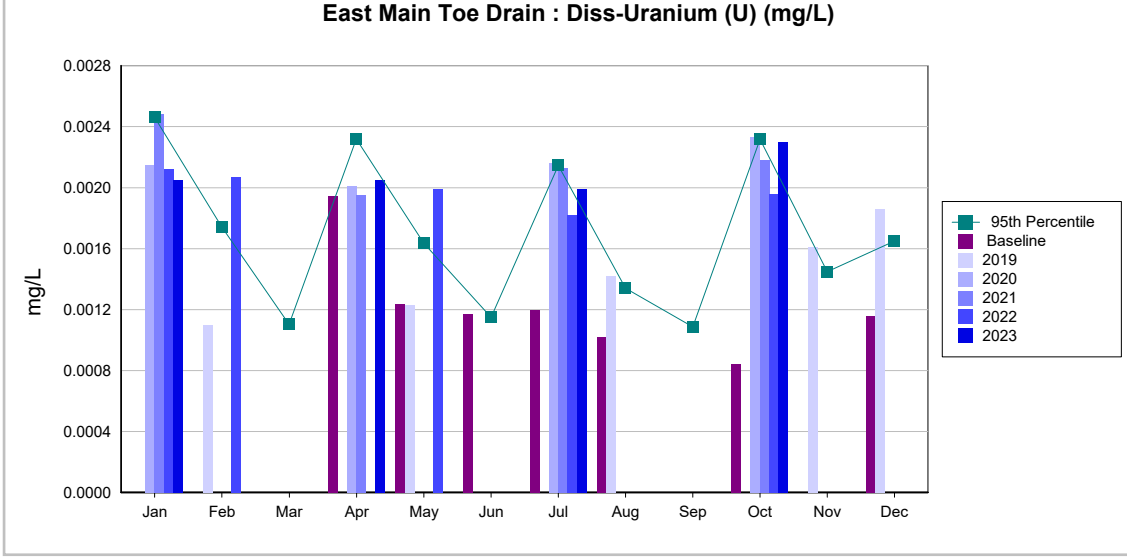
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







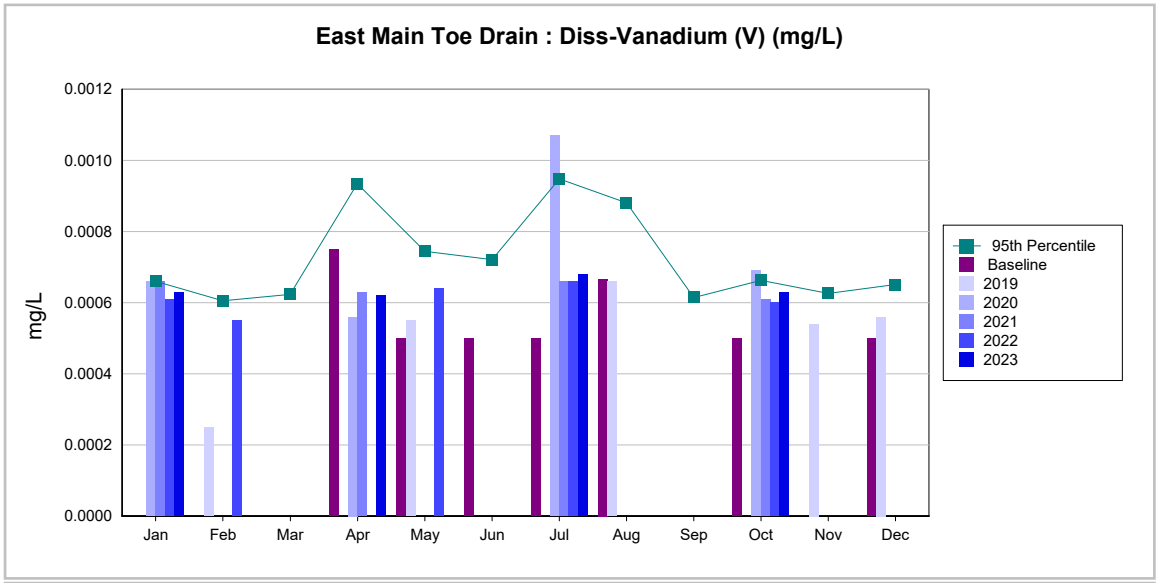
Water Quality Report

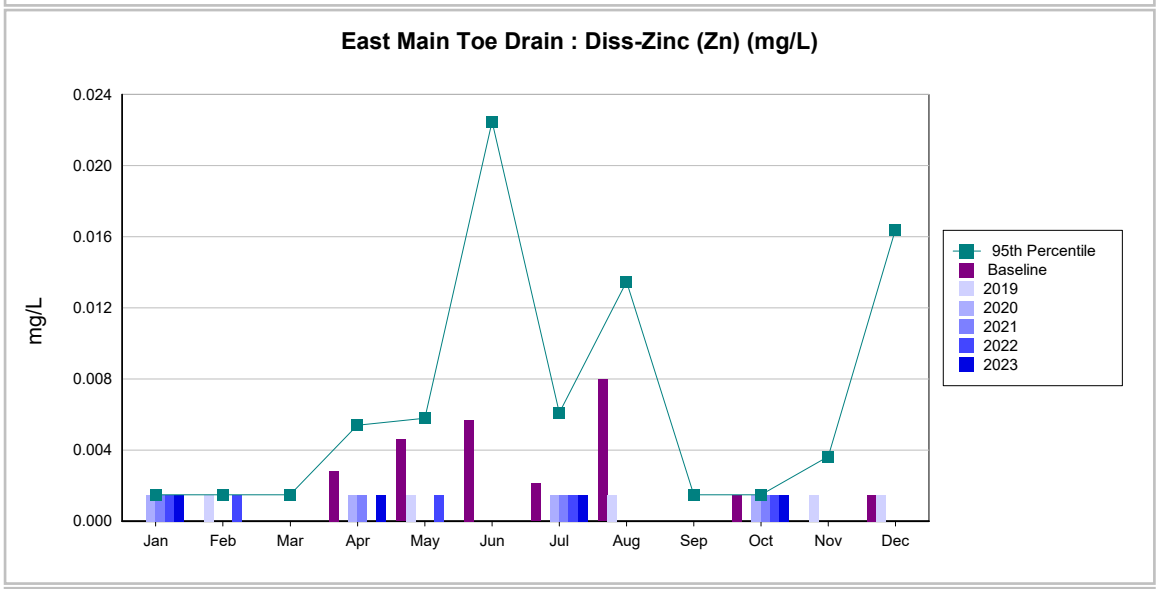
Annual Report Drainage Water

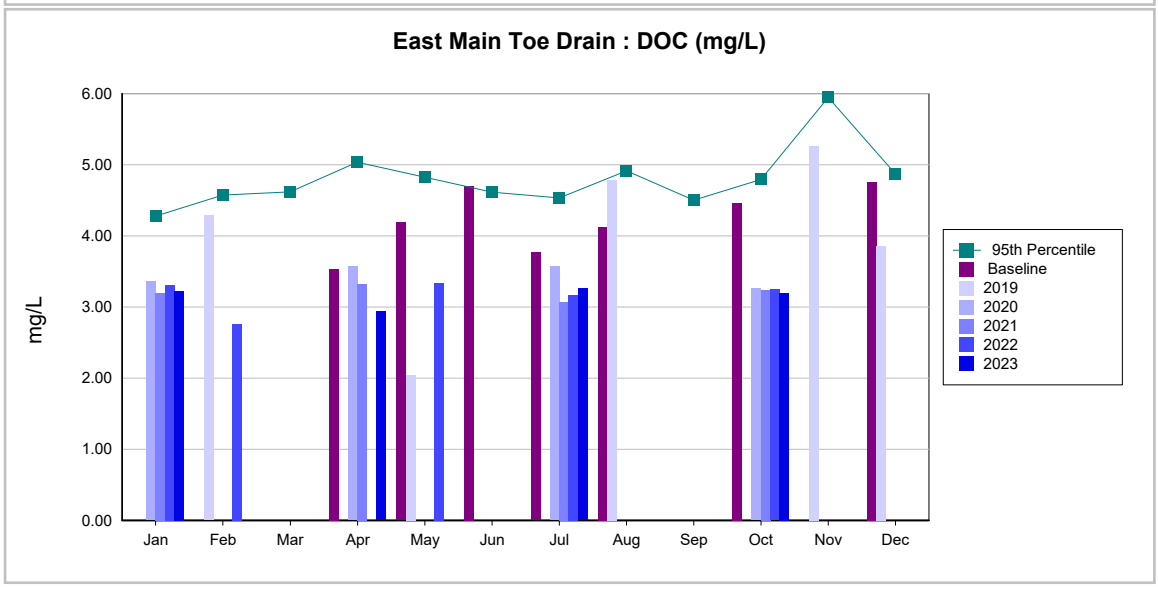
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







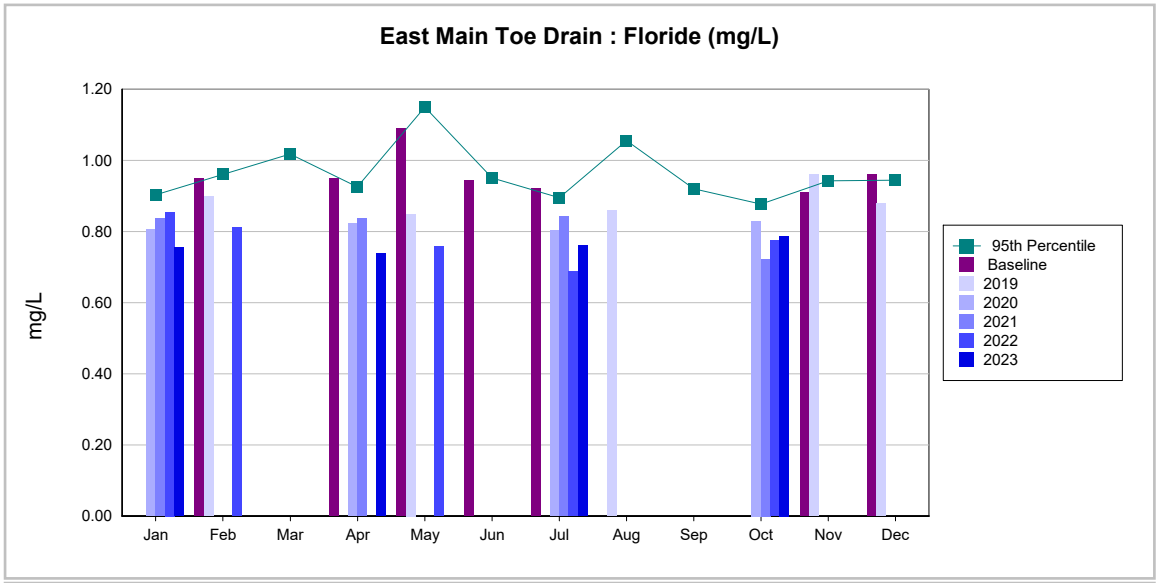
Water Quality Report

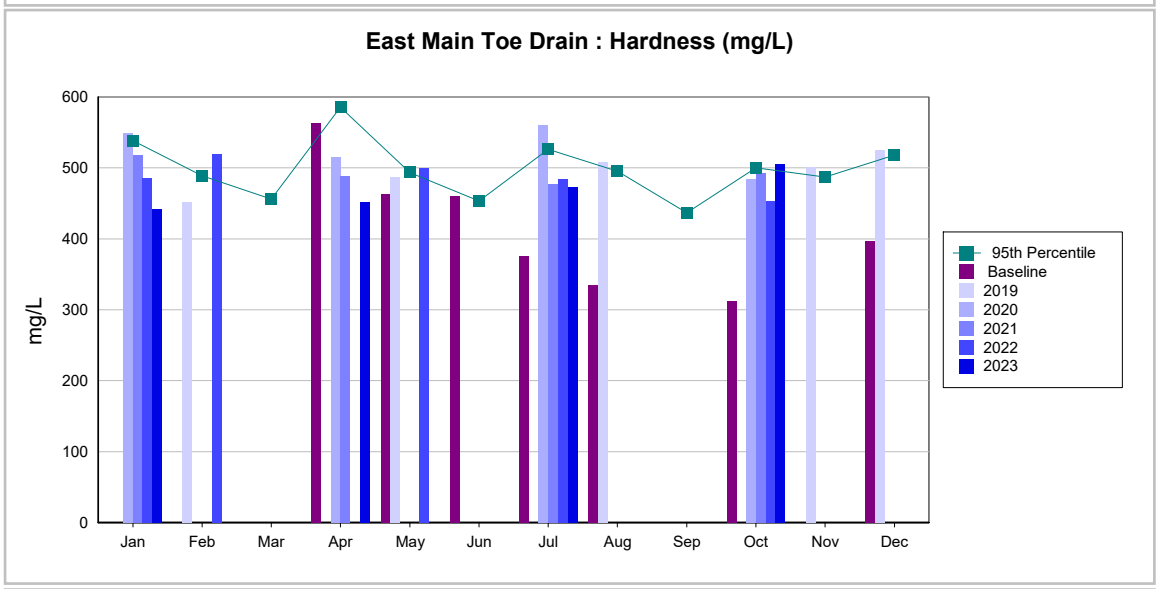
Annual Report Drainage Water

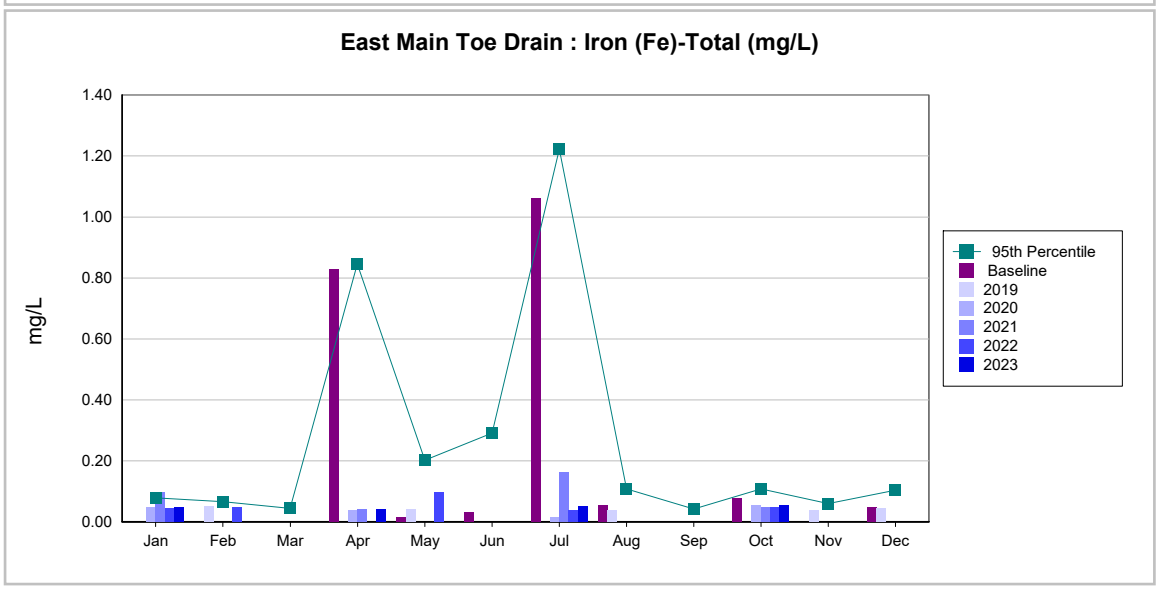
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







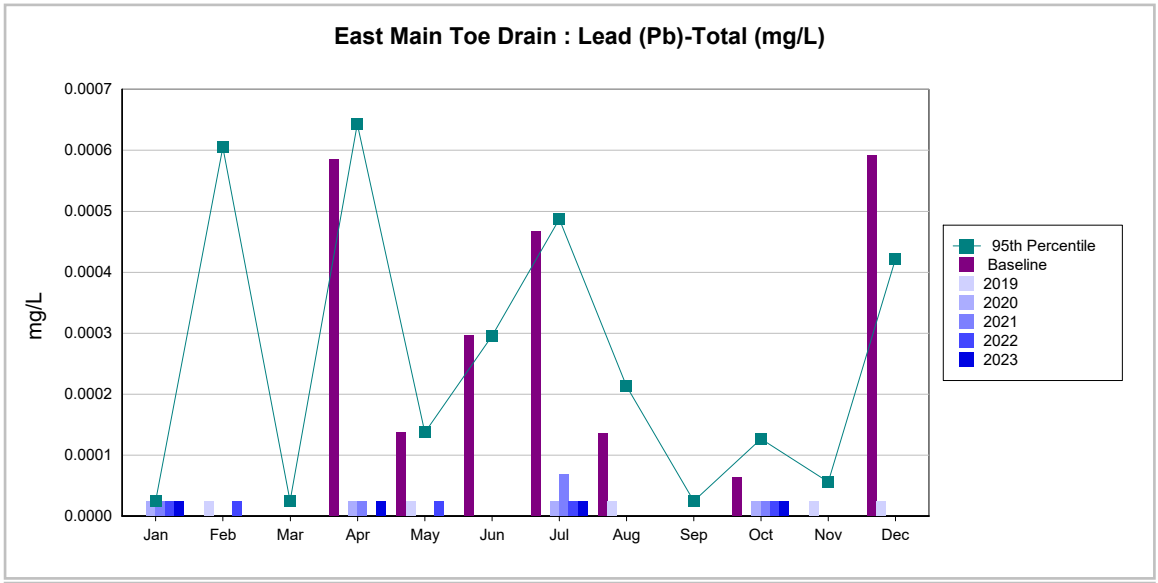
Water Quality Report

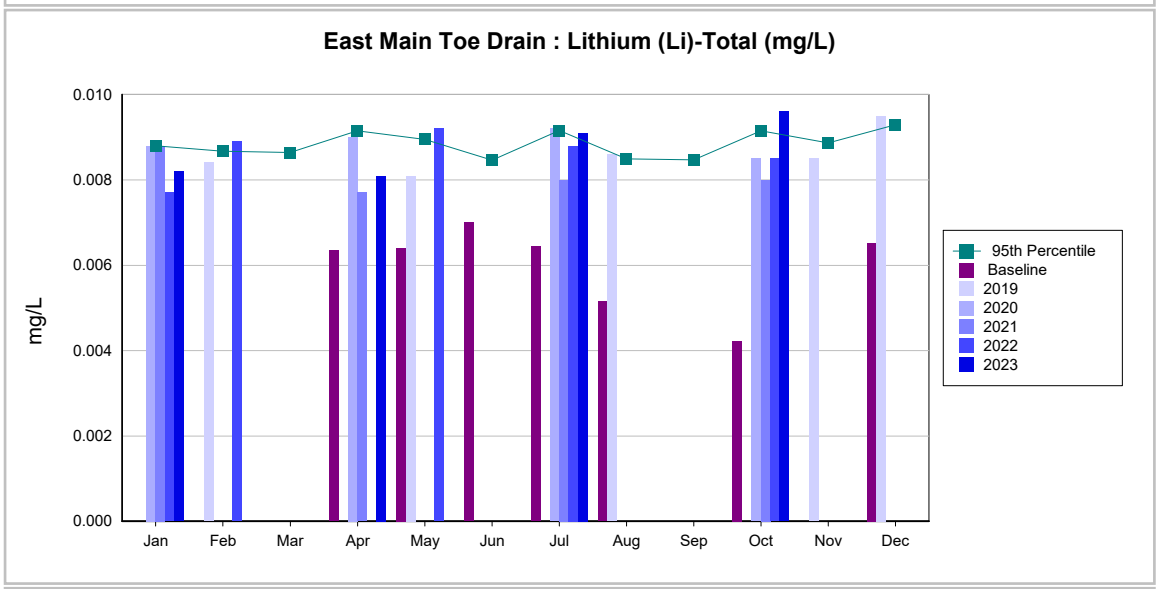
Annual Report Drainage Water

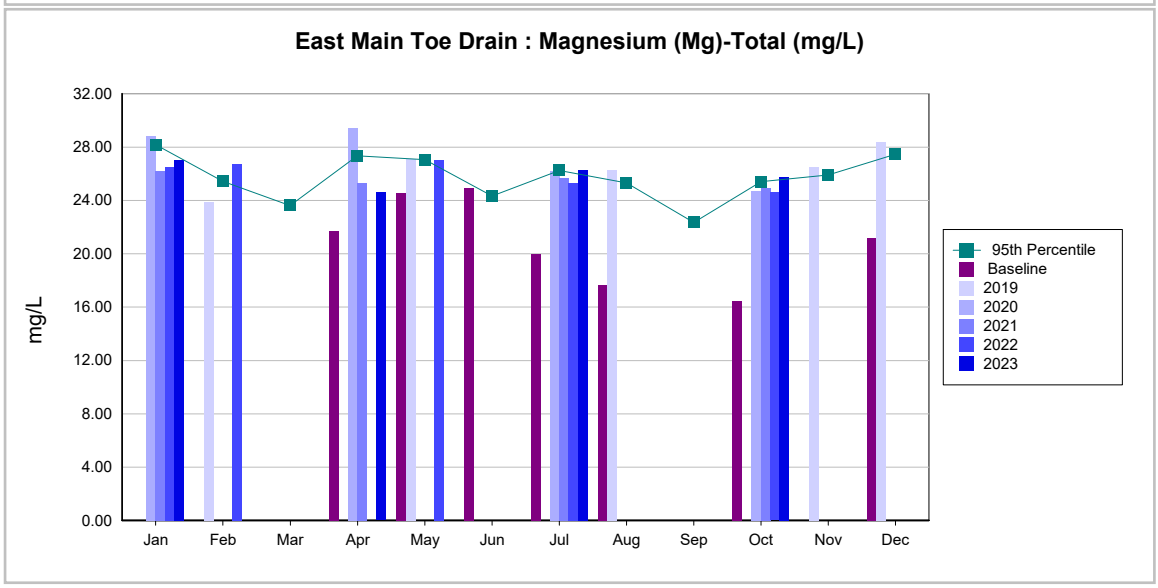
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







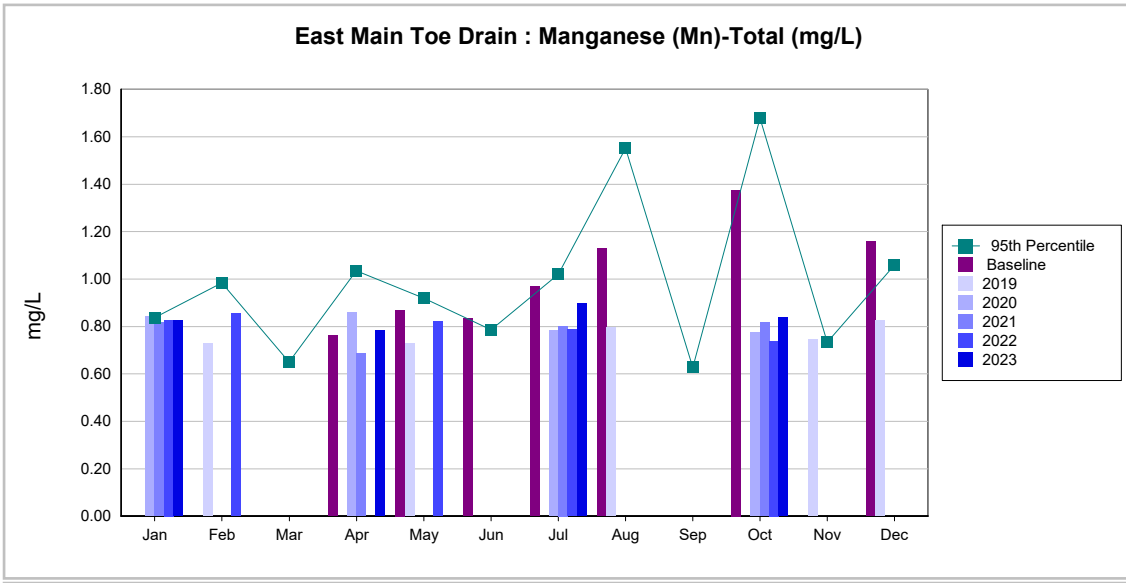
Water Quality Report

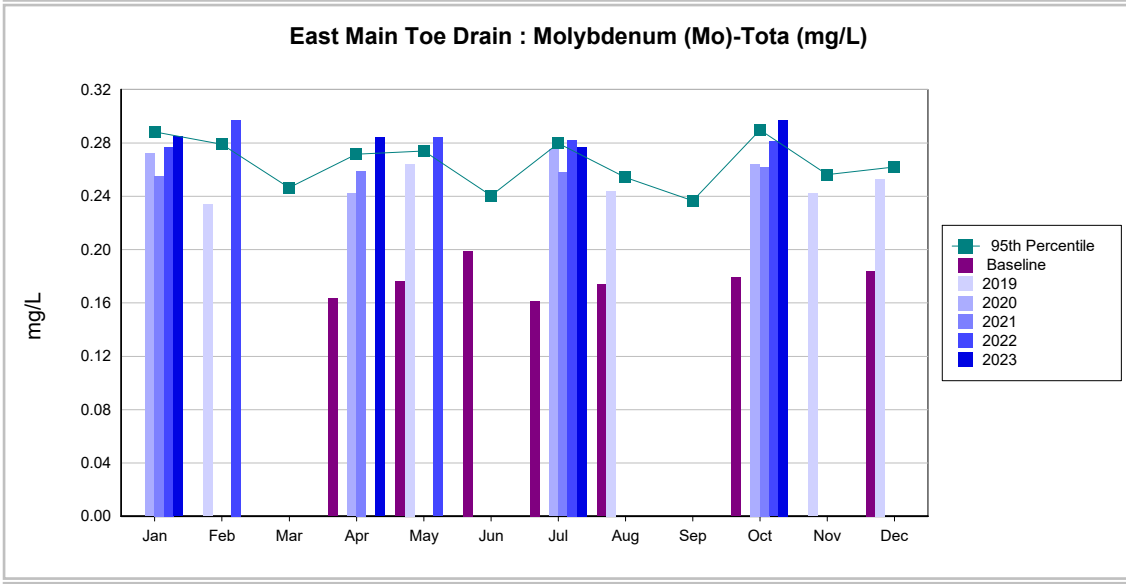
Annual Report Drainage Water

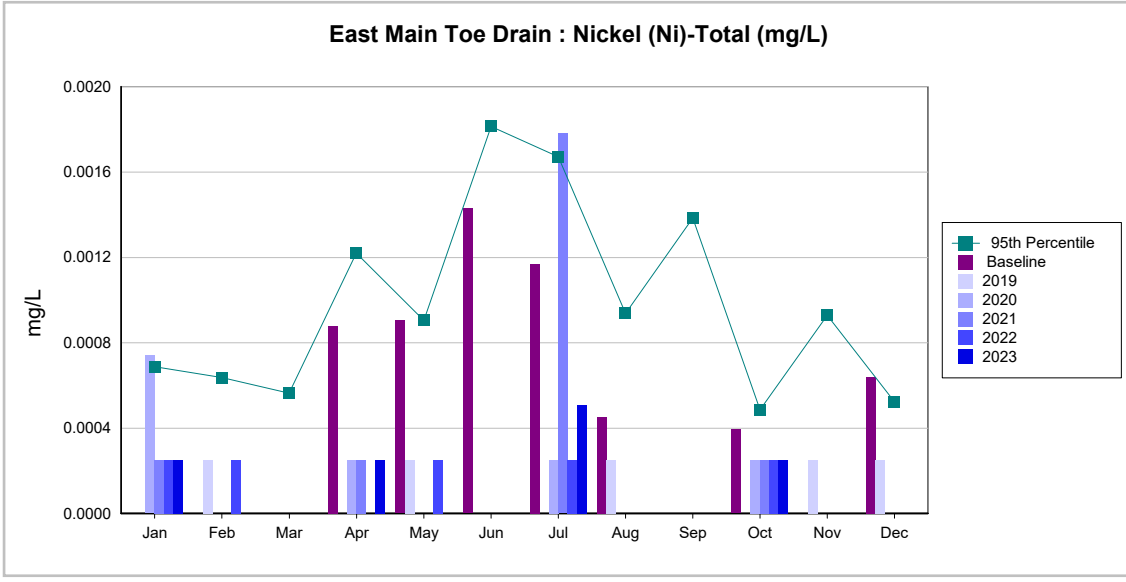
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







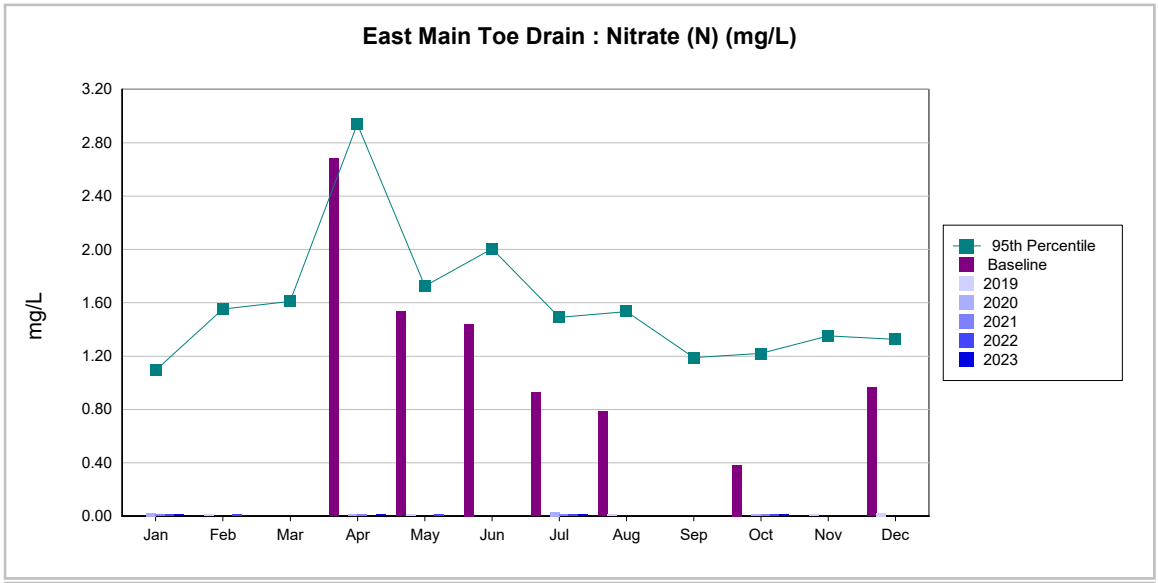
Water Quality Report

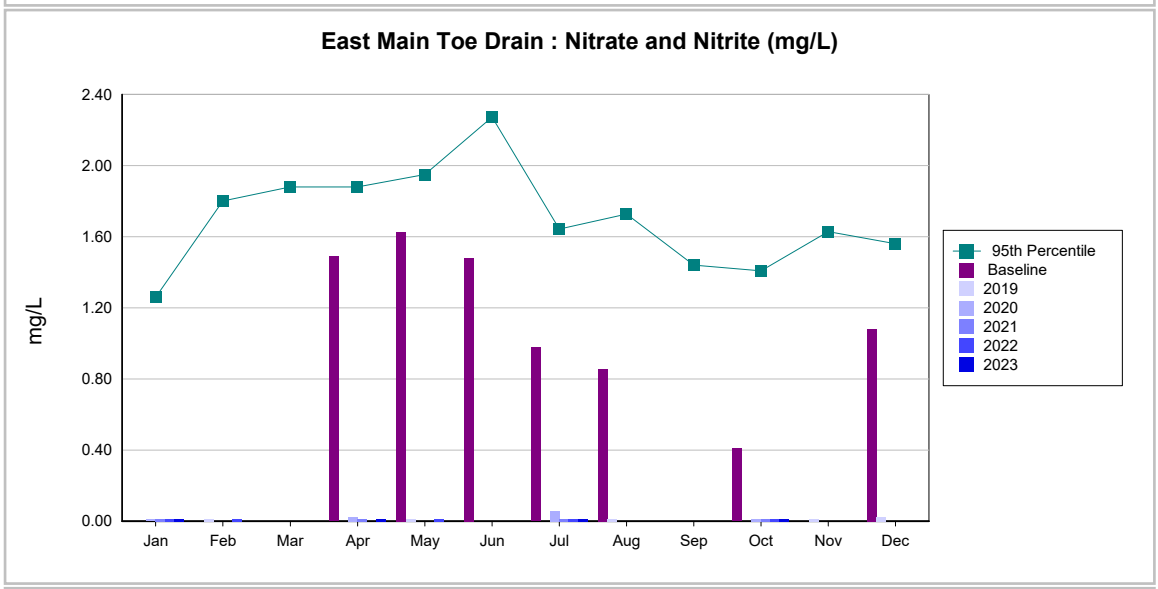
Annual Report Drainage Water

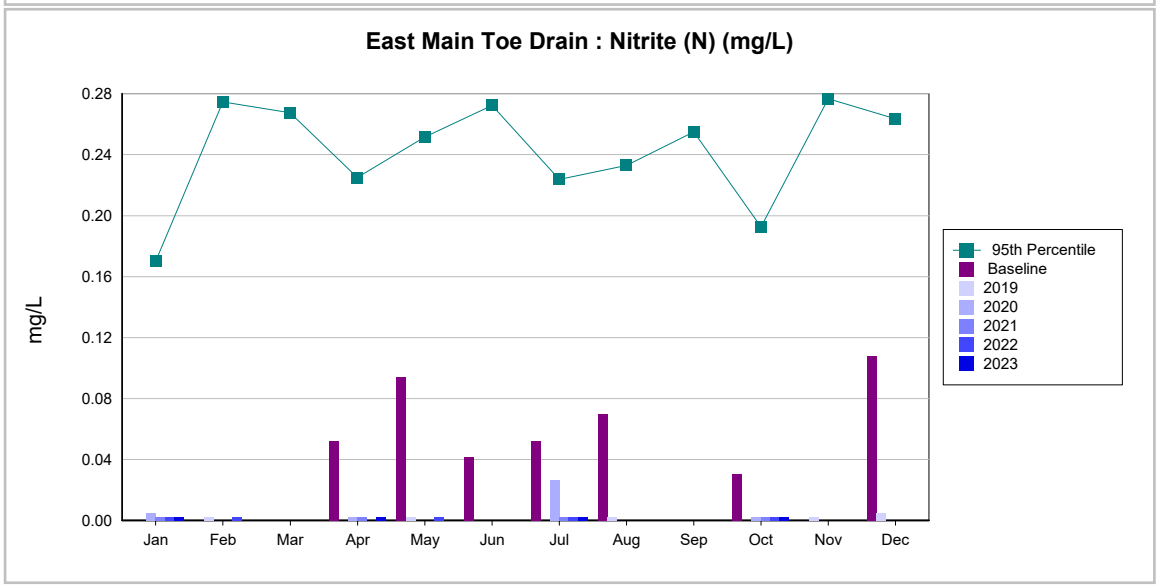
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







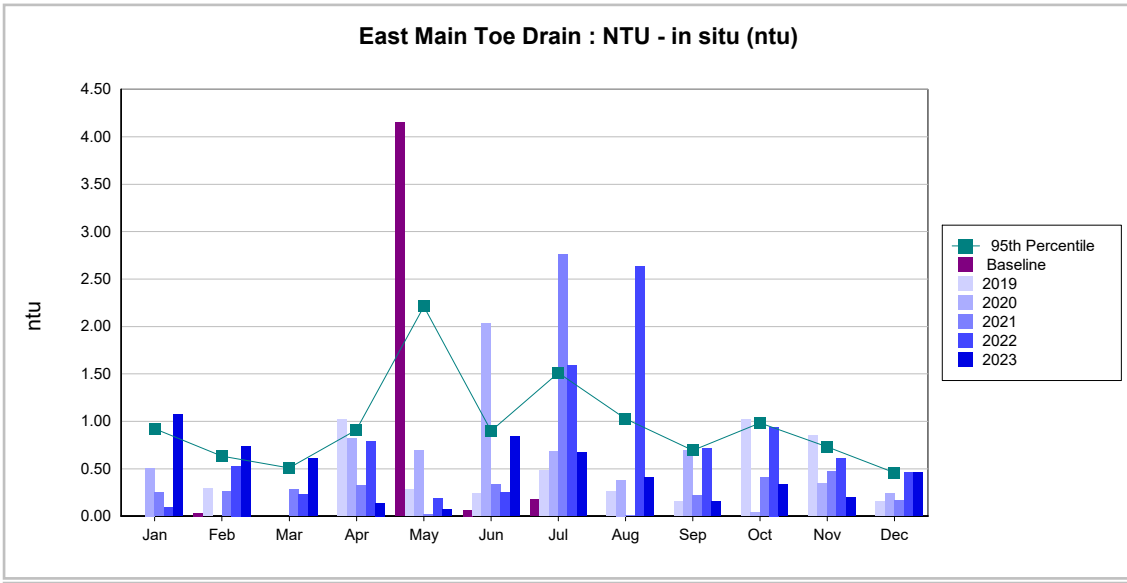
Water Quality Report

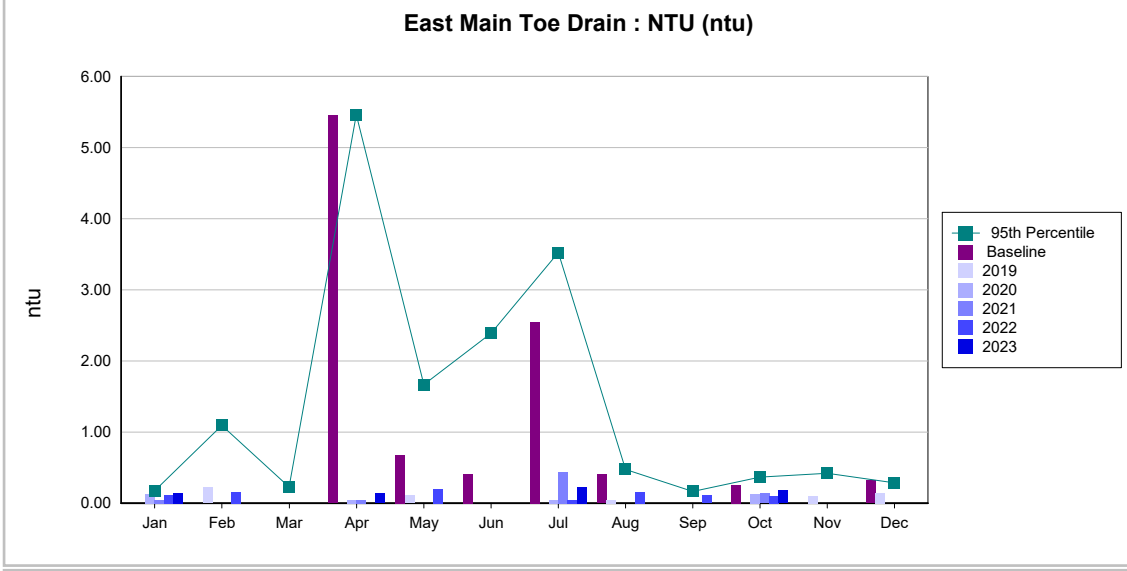
Annual Report Drainage Water

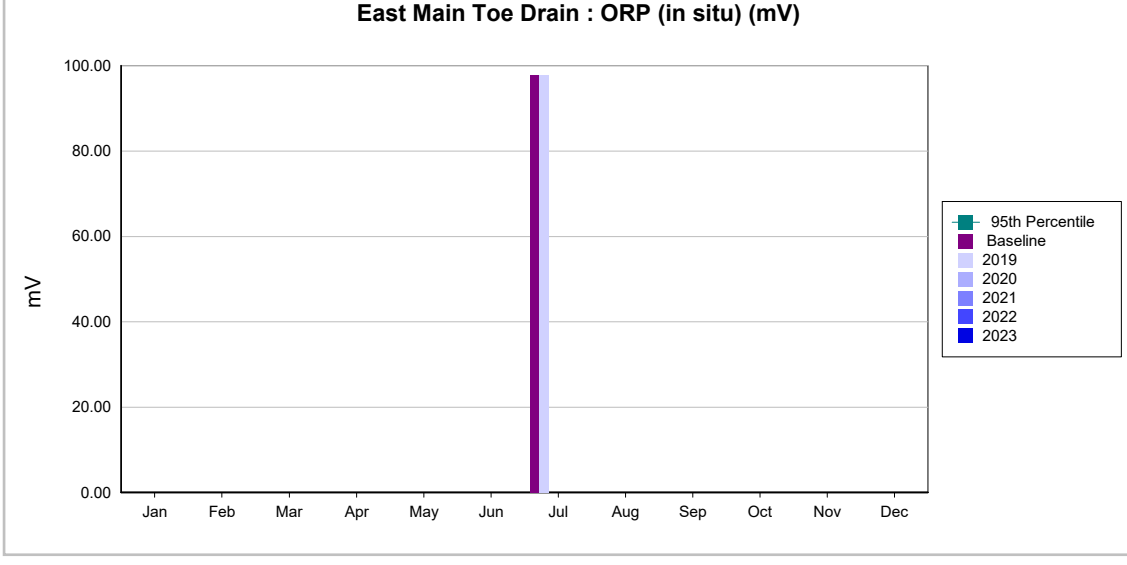
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







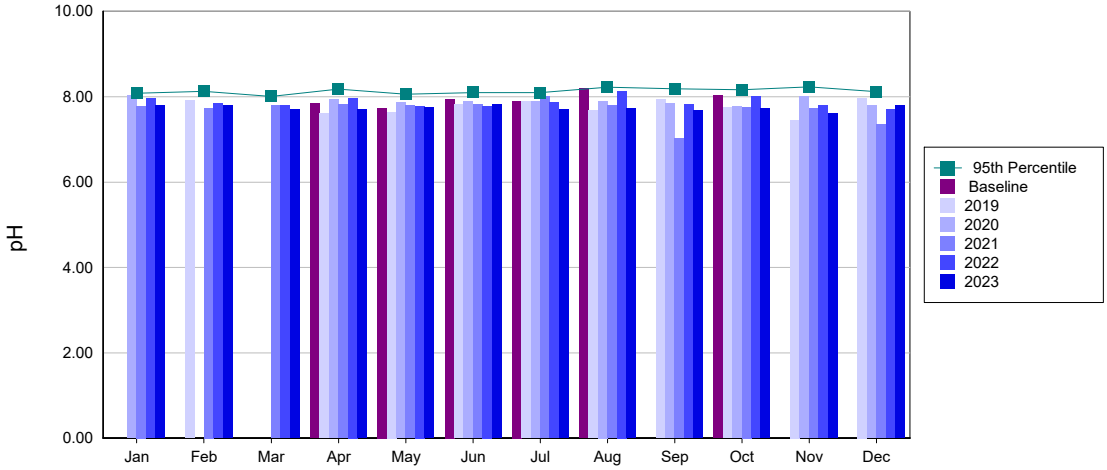
Water Quality Report

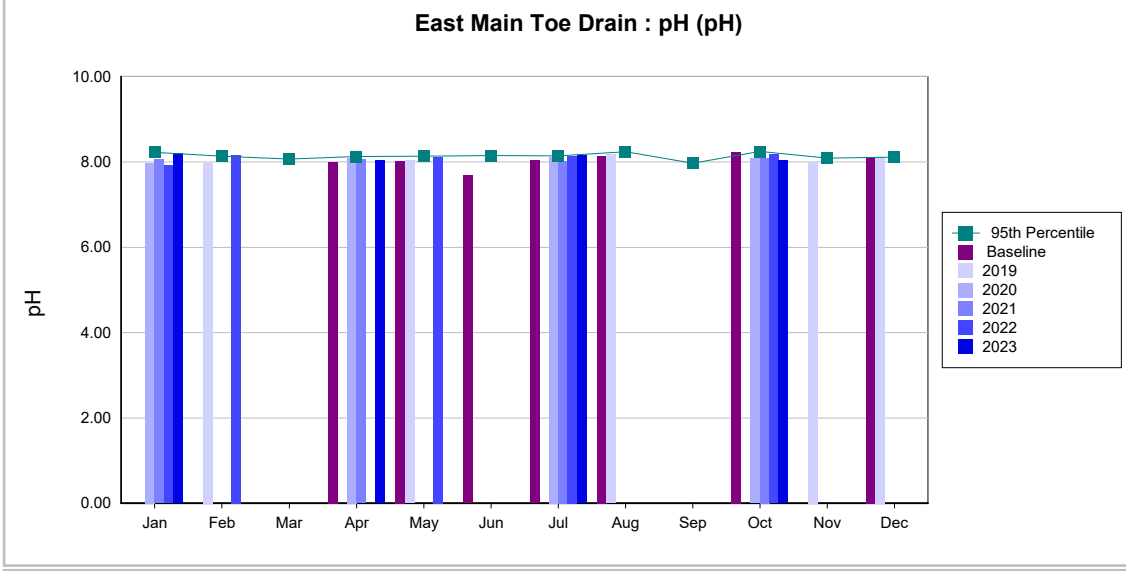
Annual Report Drainage Water

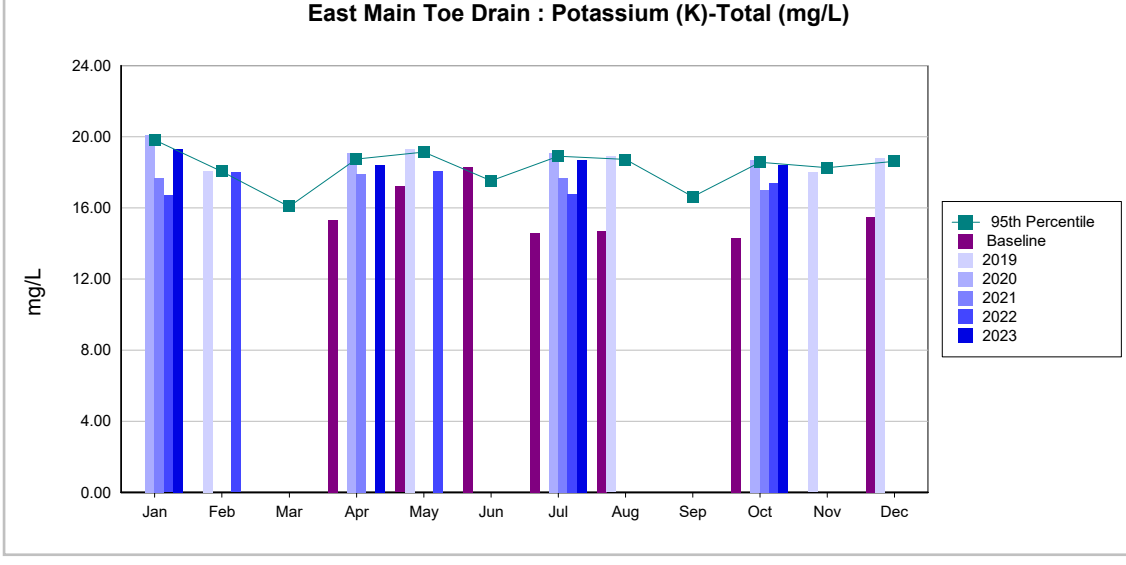
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







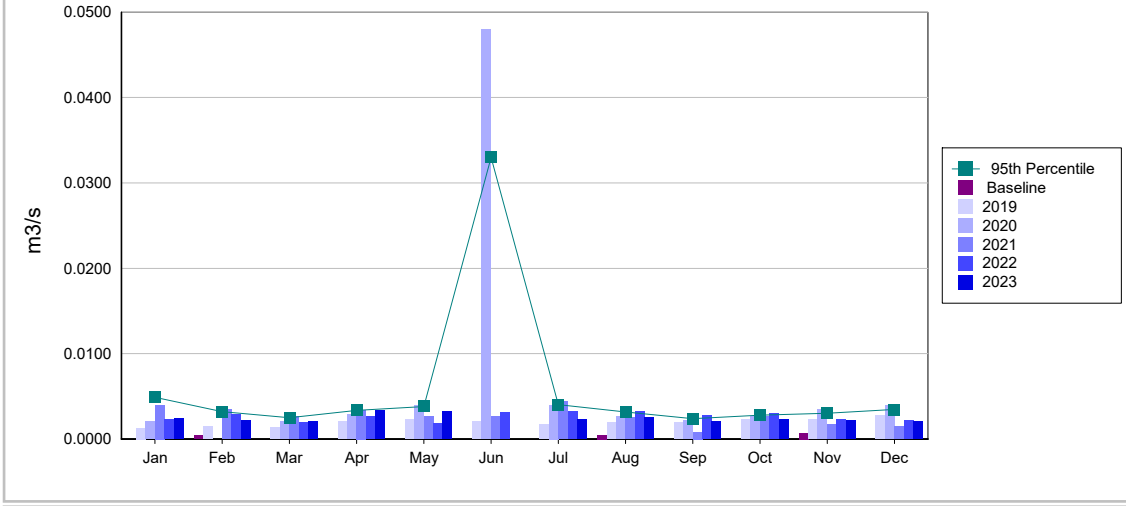
Water Quality Report

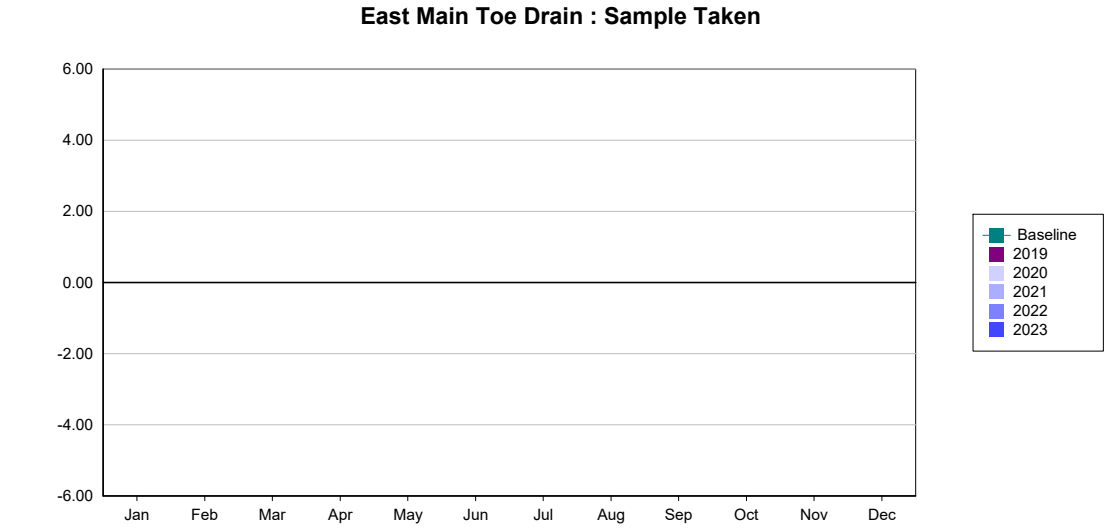
Annual Report Drainage Water

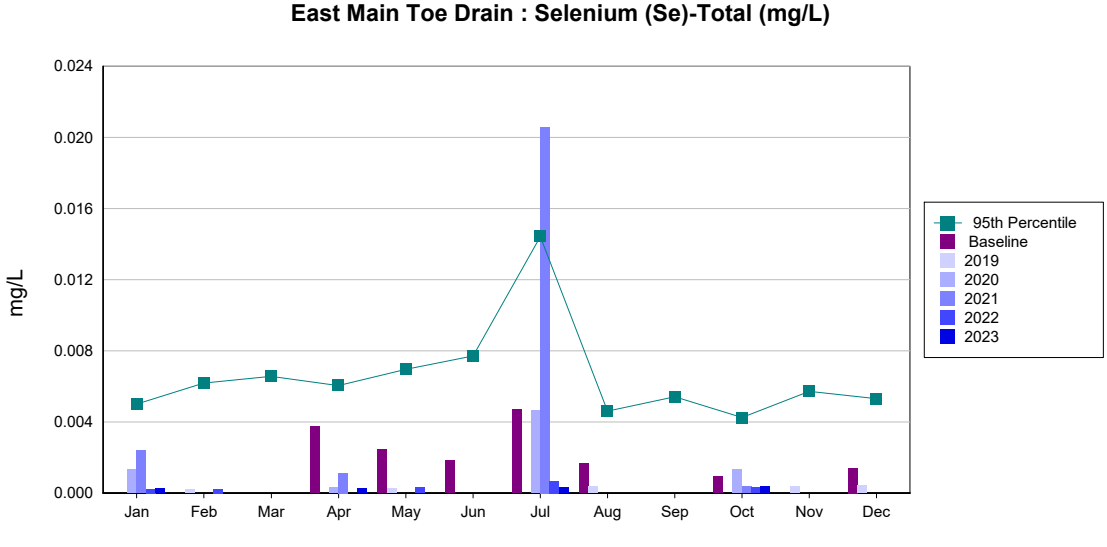
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







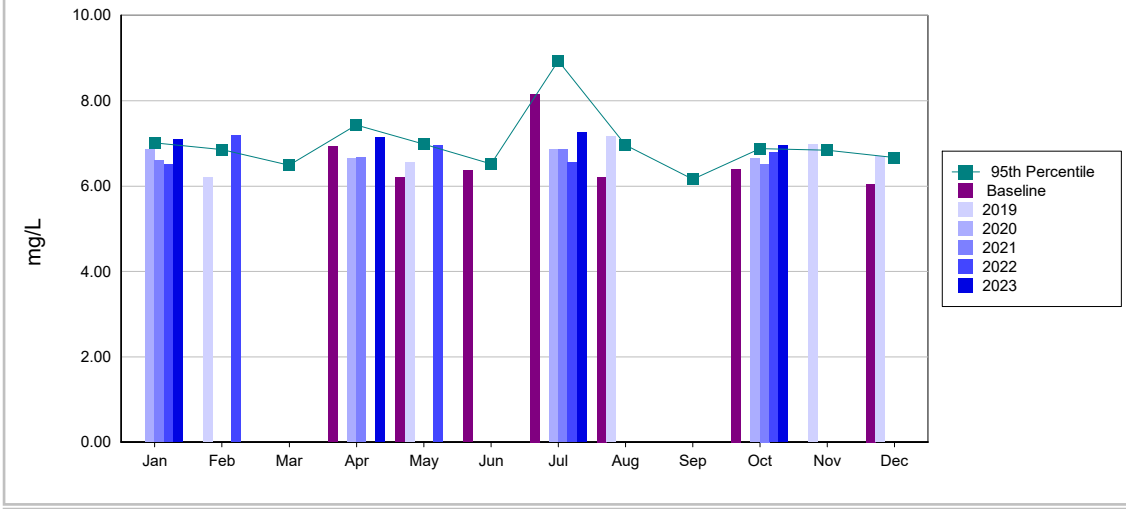
Water Quality Report

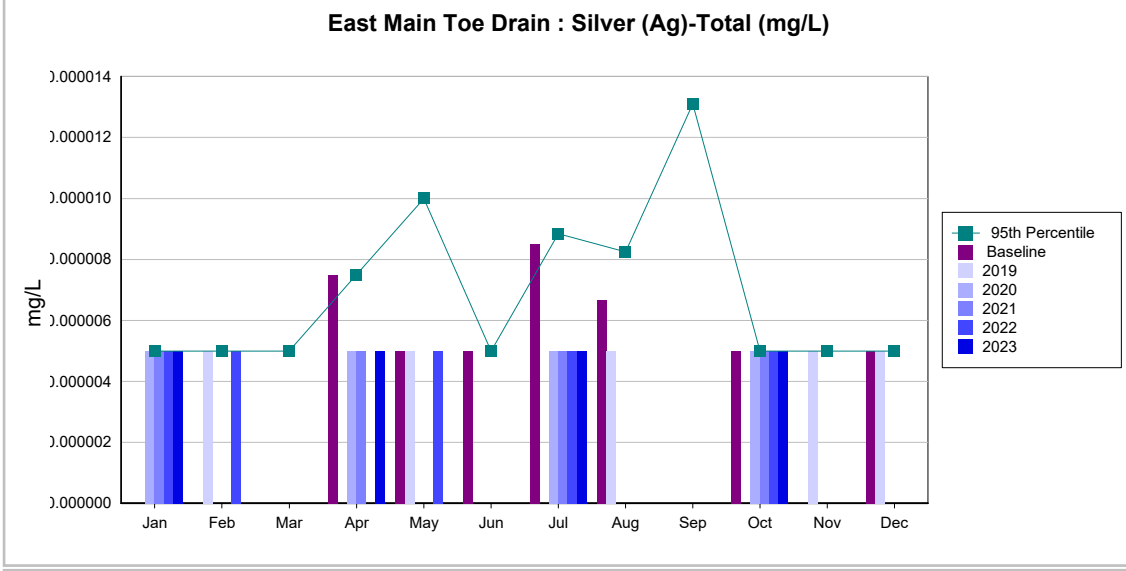
Annual Report Drainage Water

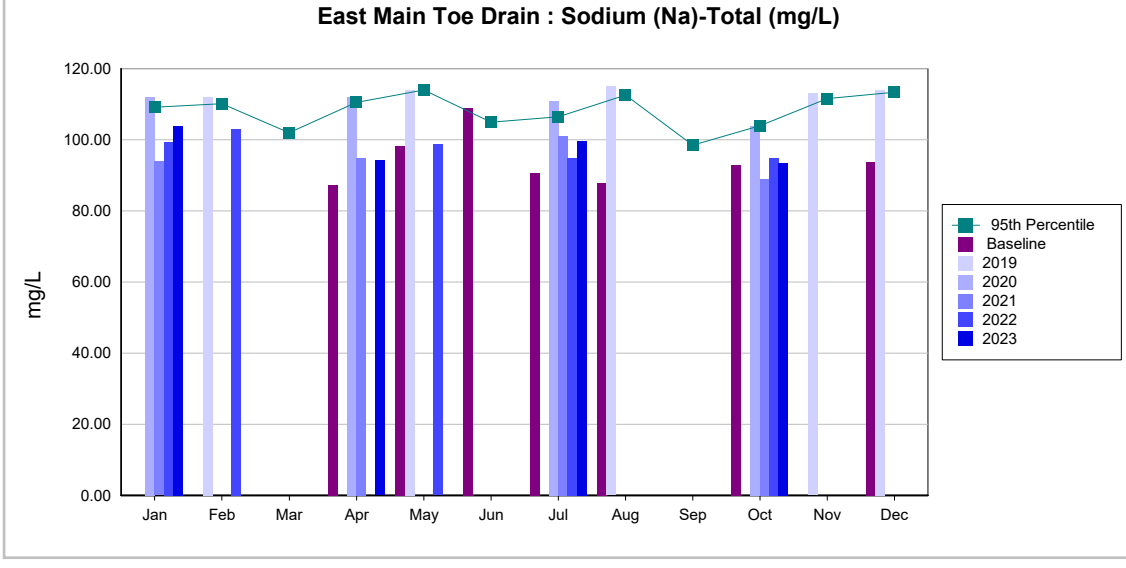
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







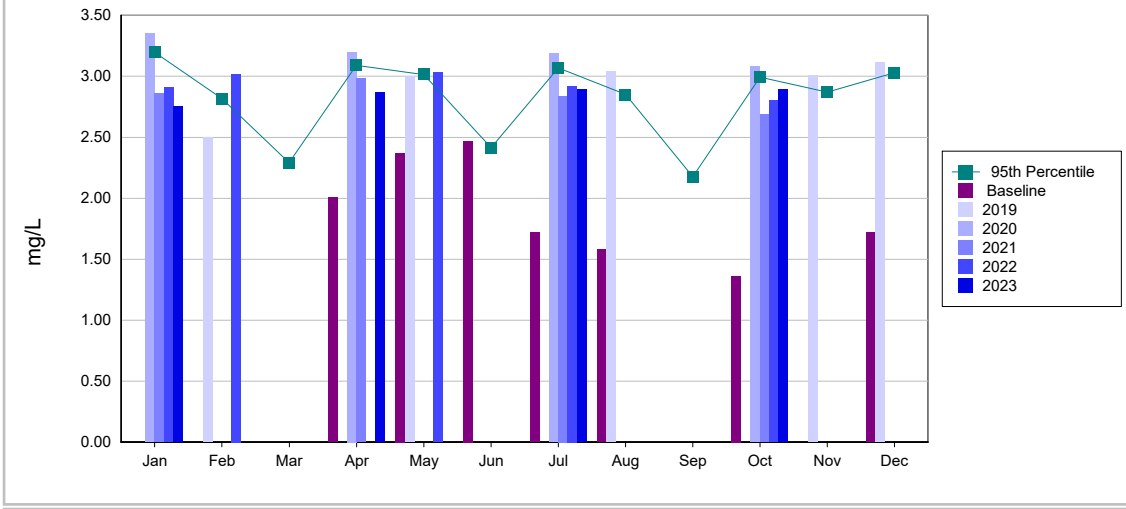
Water Quality Report

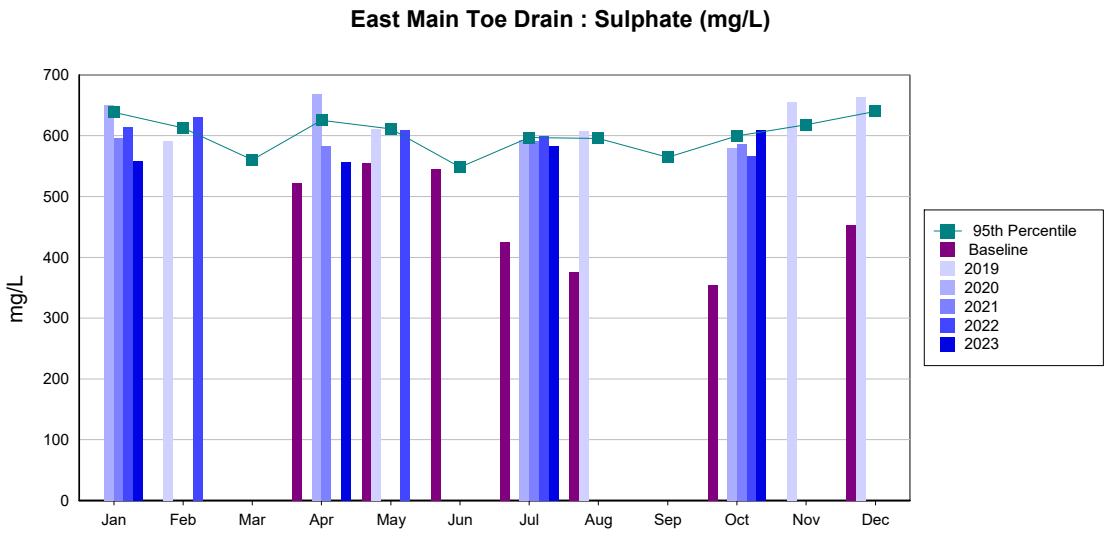
Annual Report Drainage Water

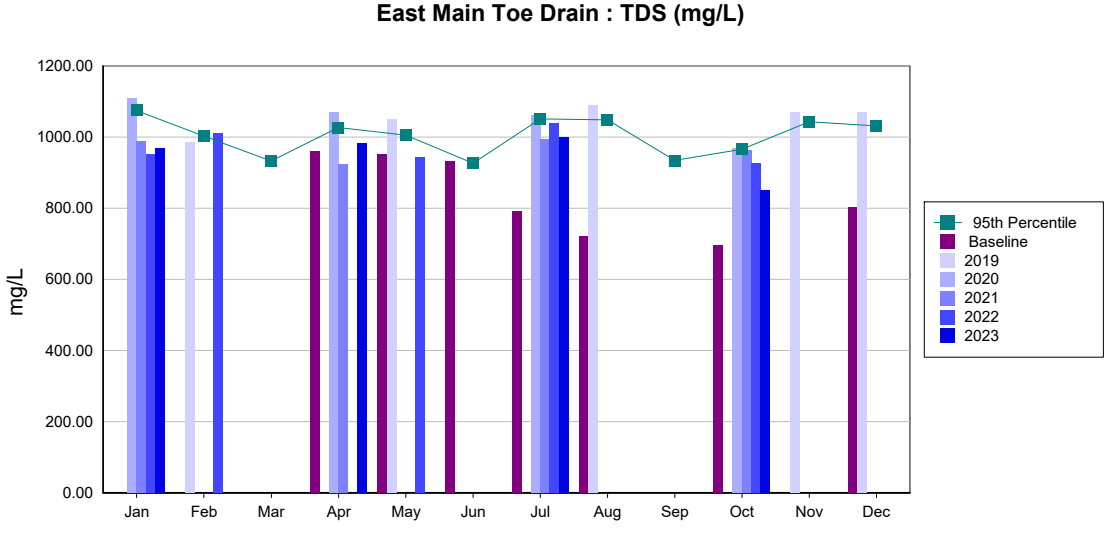
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







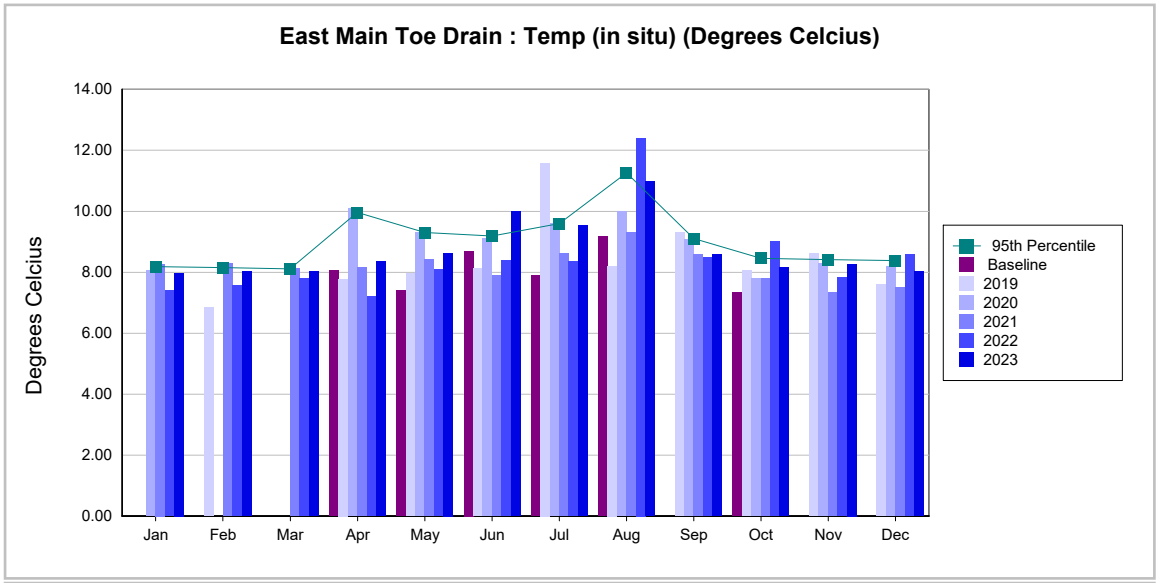
Water Quality Report

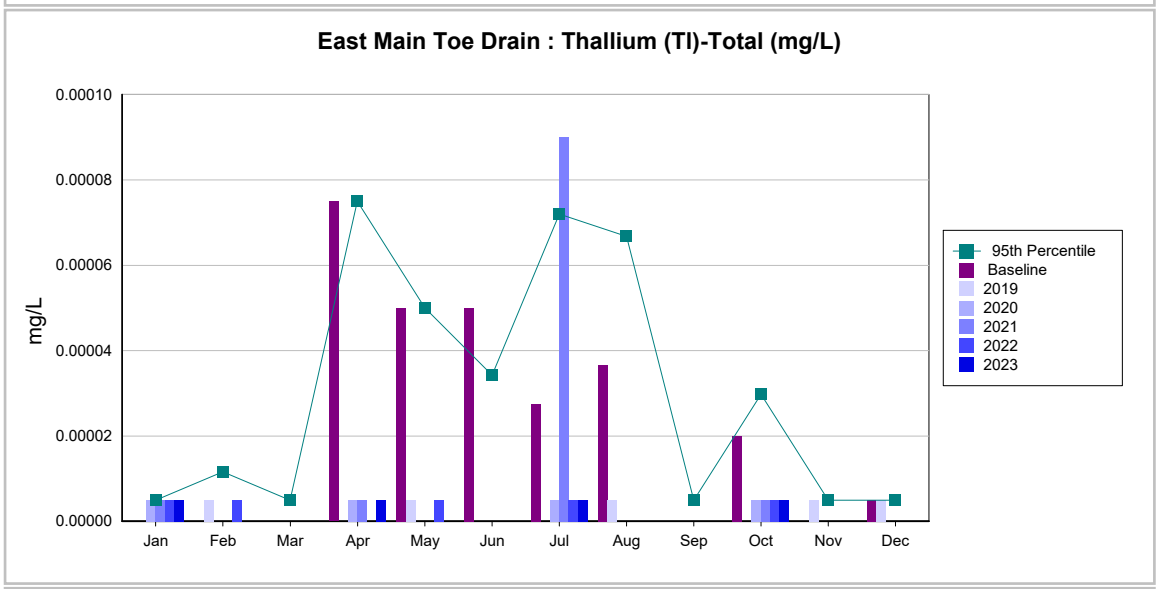
Annual Report Drainage Water

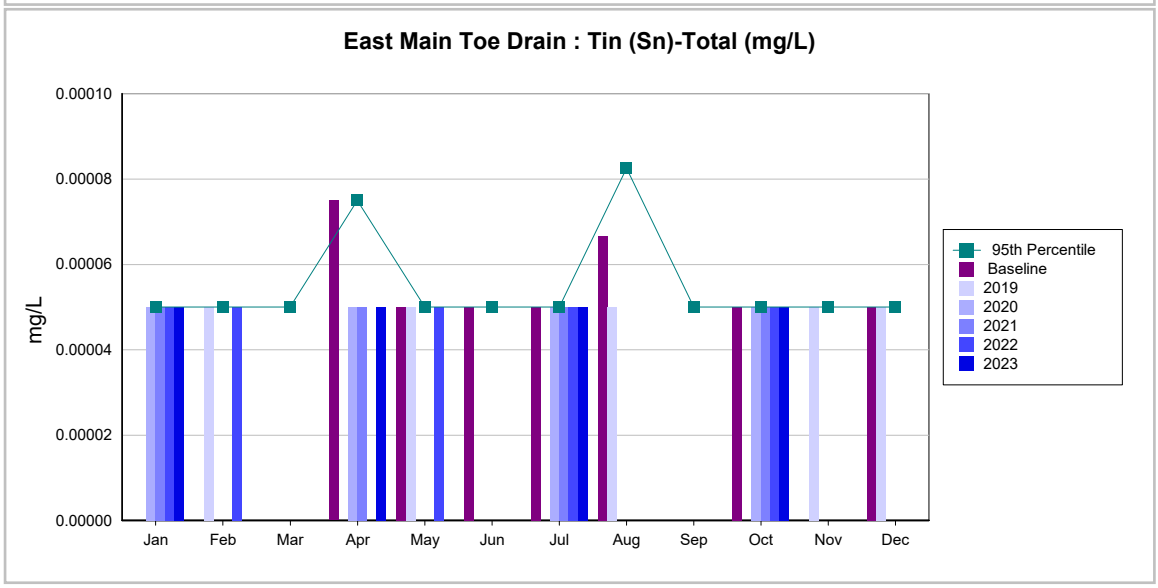
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







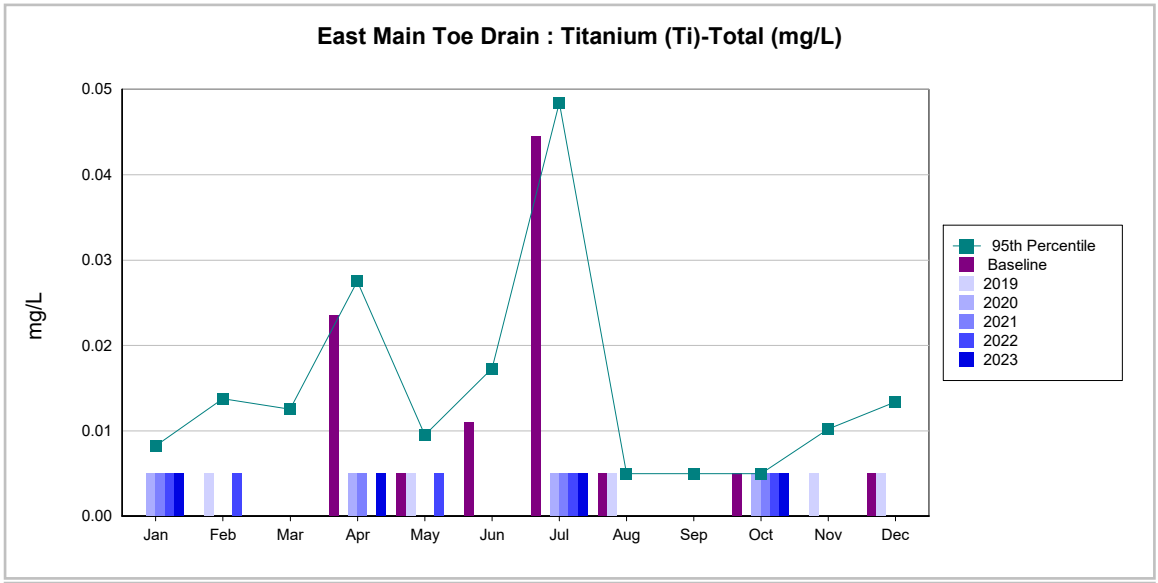
Water Quality Report

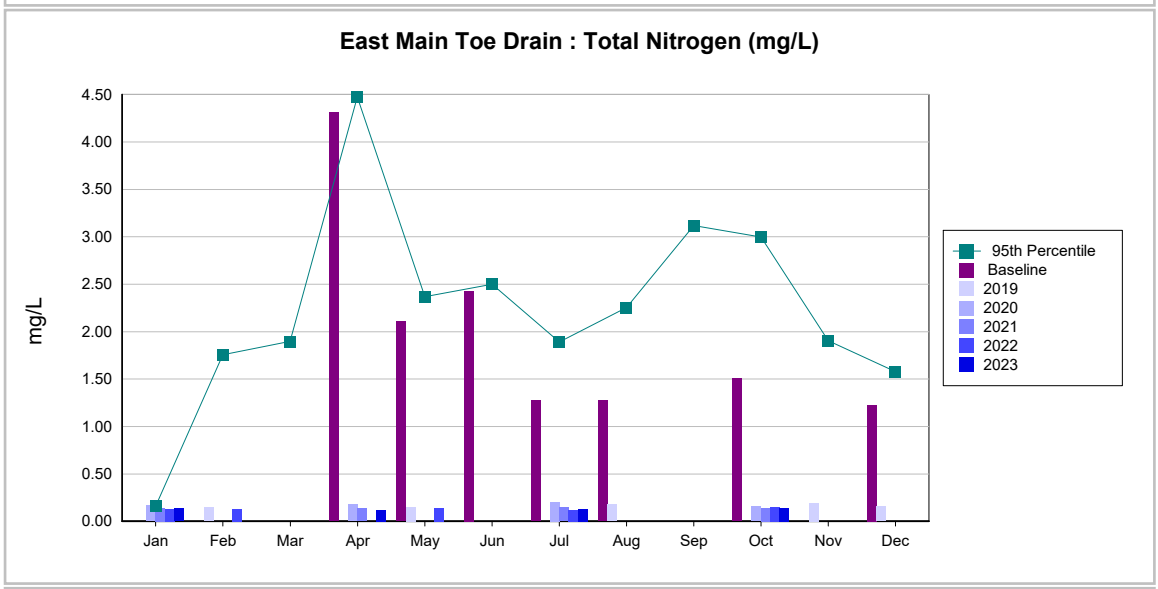
Annual Report Drainage Water

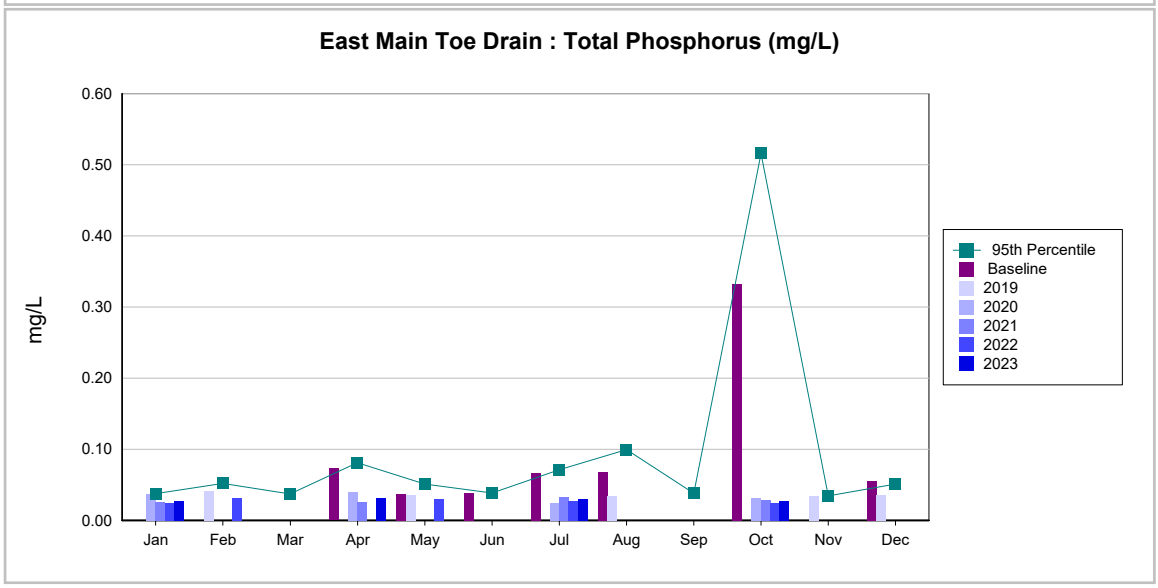
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







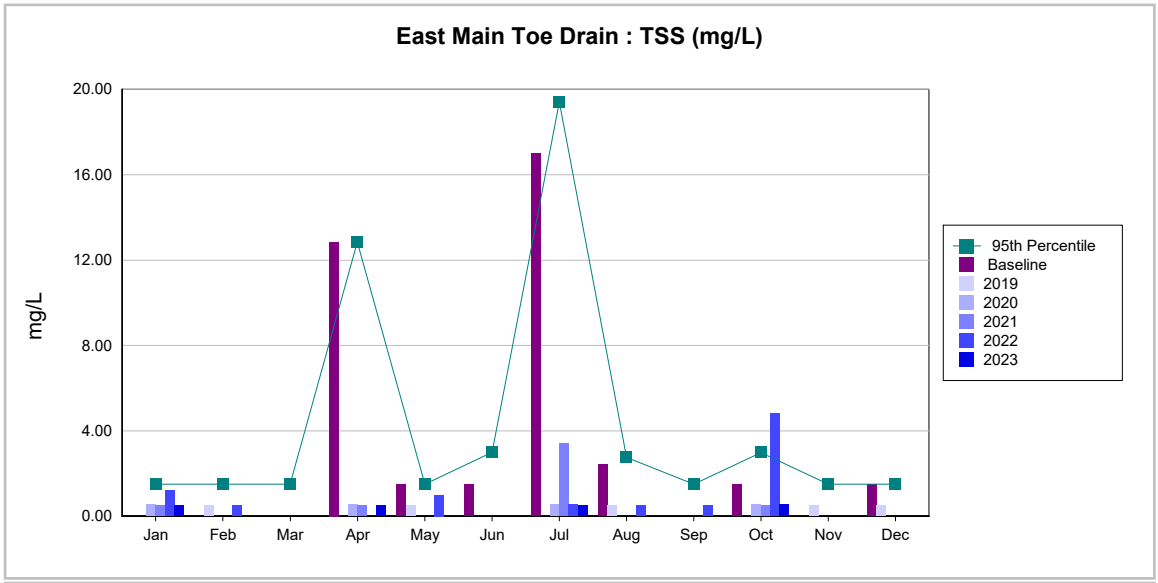
Water Quality Report

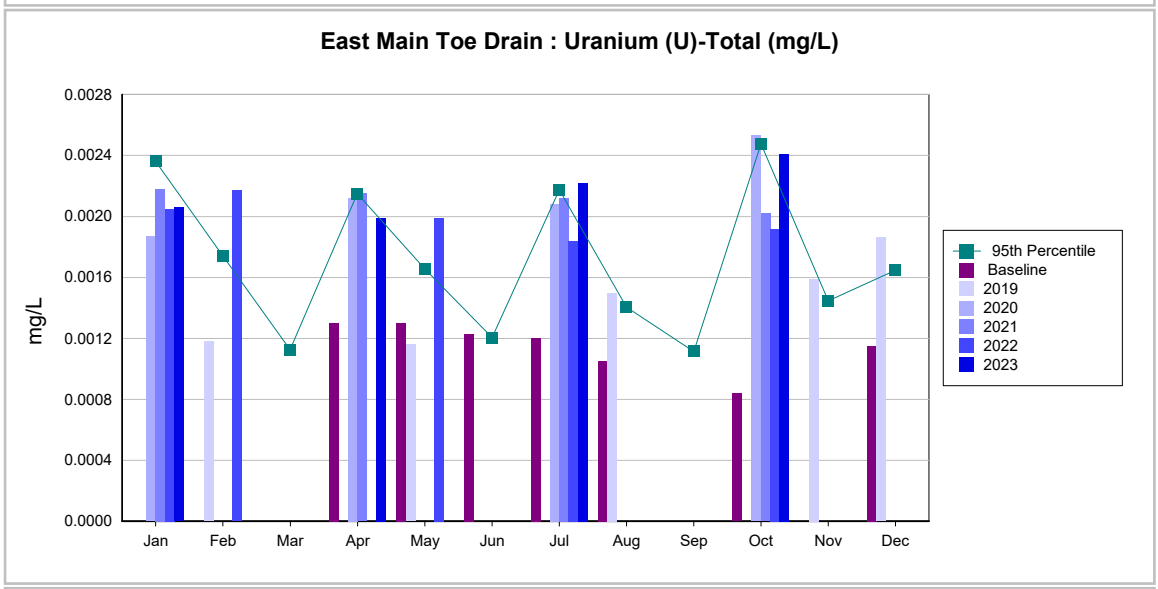
Annual Report Drainage Water

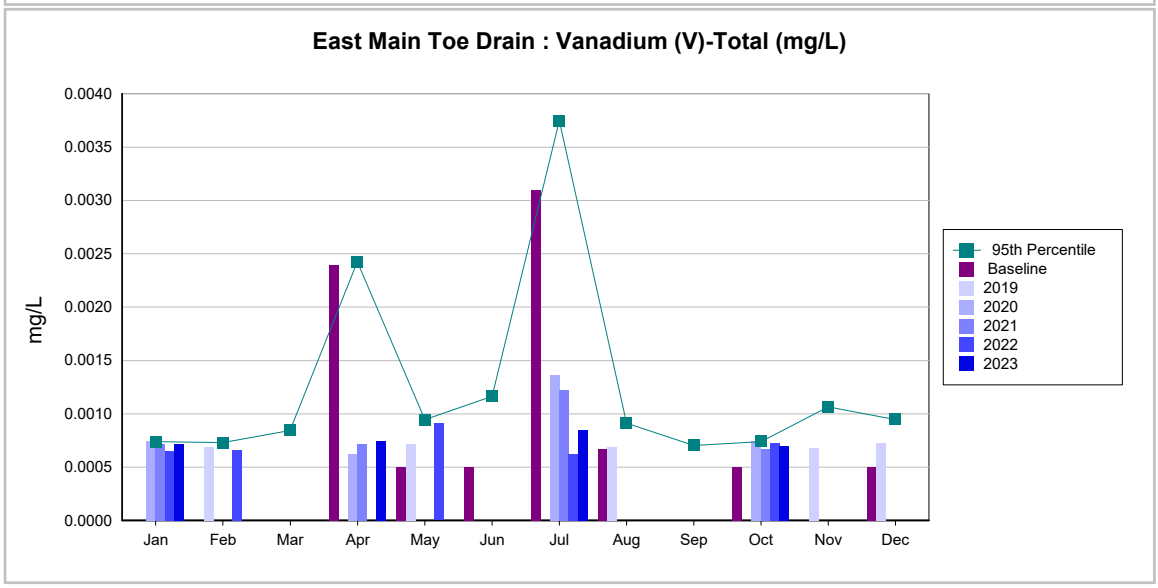
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

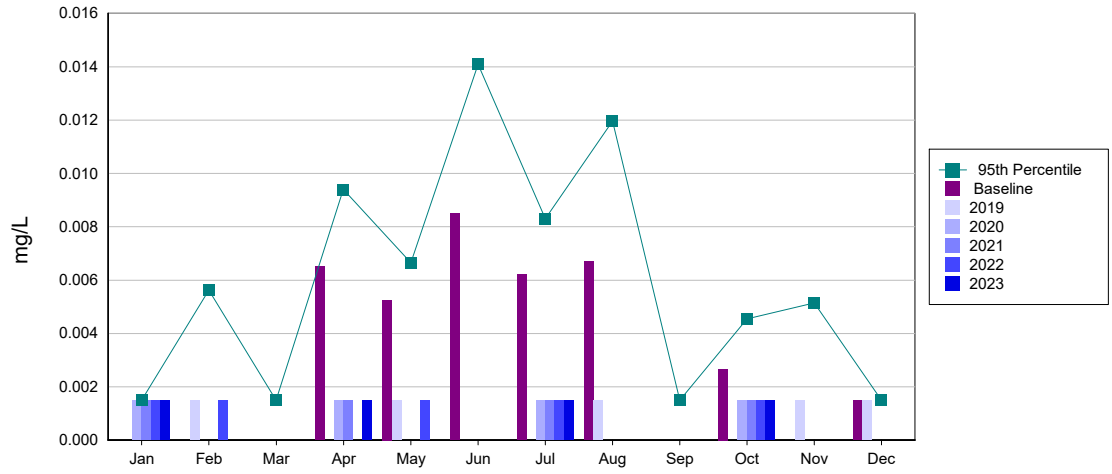
Annual Report Drainage Water

Mount Polley

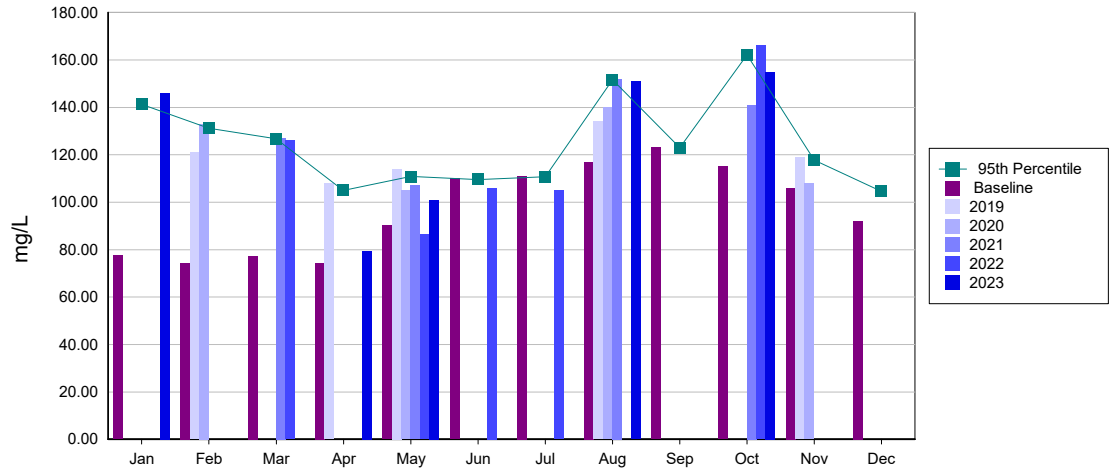
Mining Corporation

IMPERIAL METALS CORPORATION

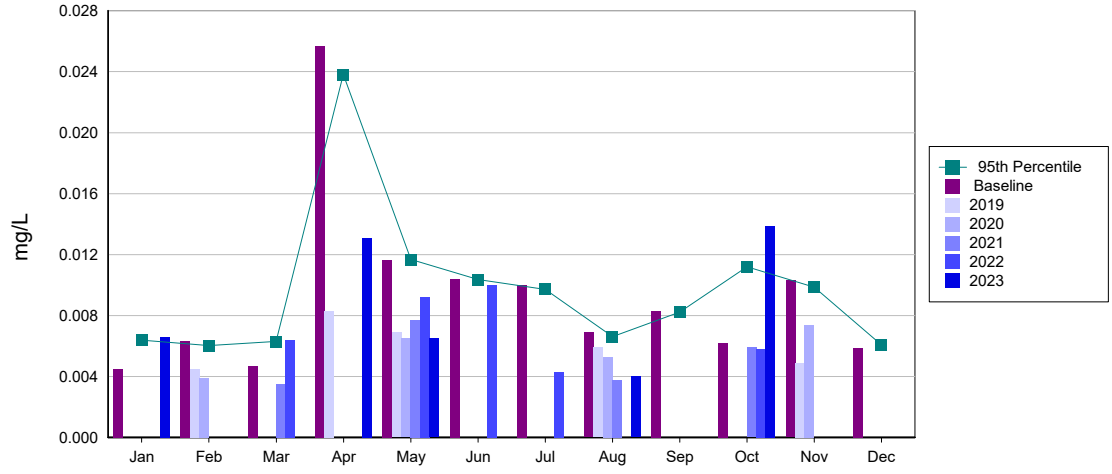
East Main Toe Drain : Zinc (Zn)-Total (mg/L)



Mine Drainage Creek : Alkalinity (CaCO3) (mg/L)



Mine Drainage Creek : Aluminum (Al)-Diss (mg/L)



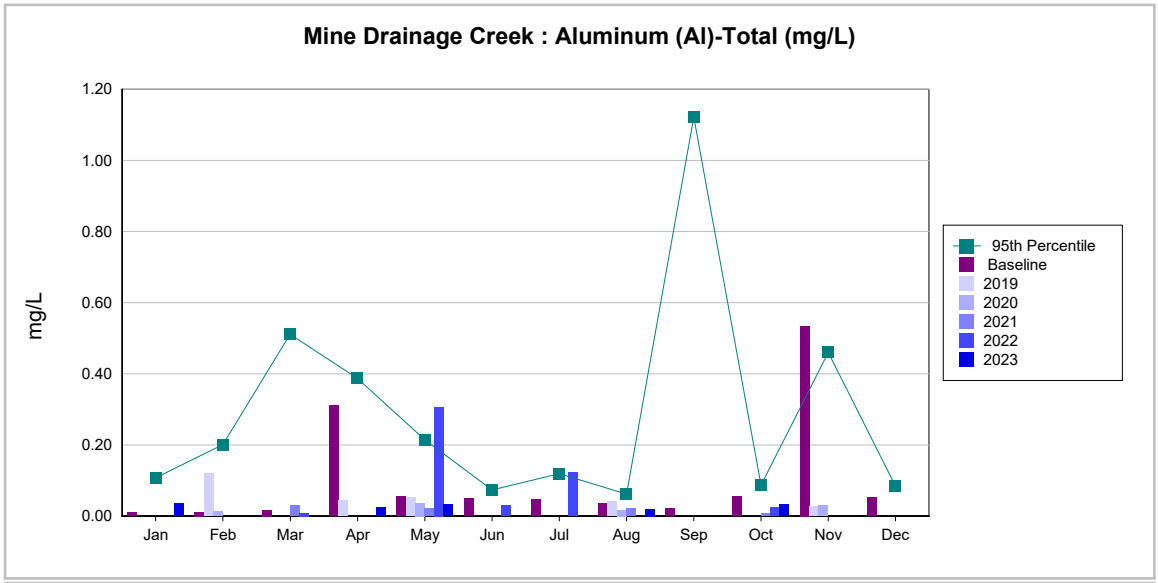
Water Quality Report

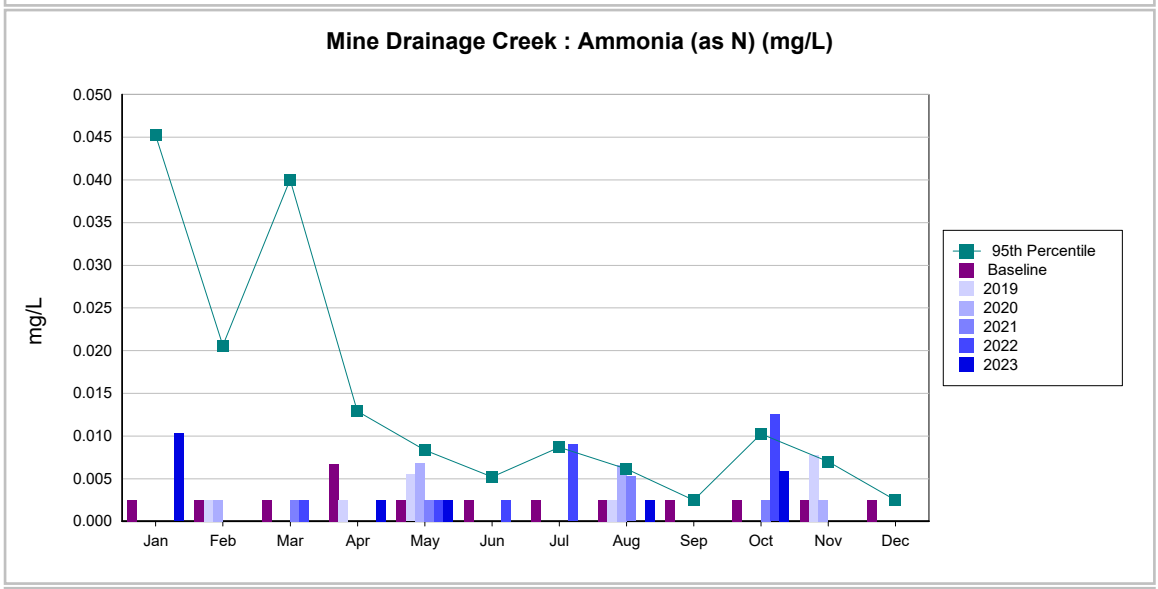
Annual Report Drainage Water

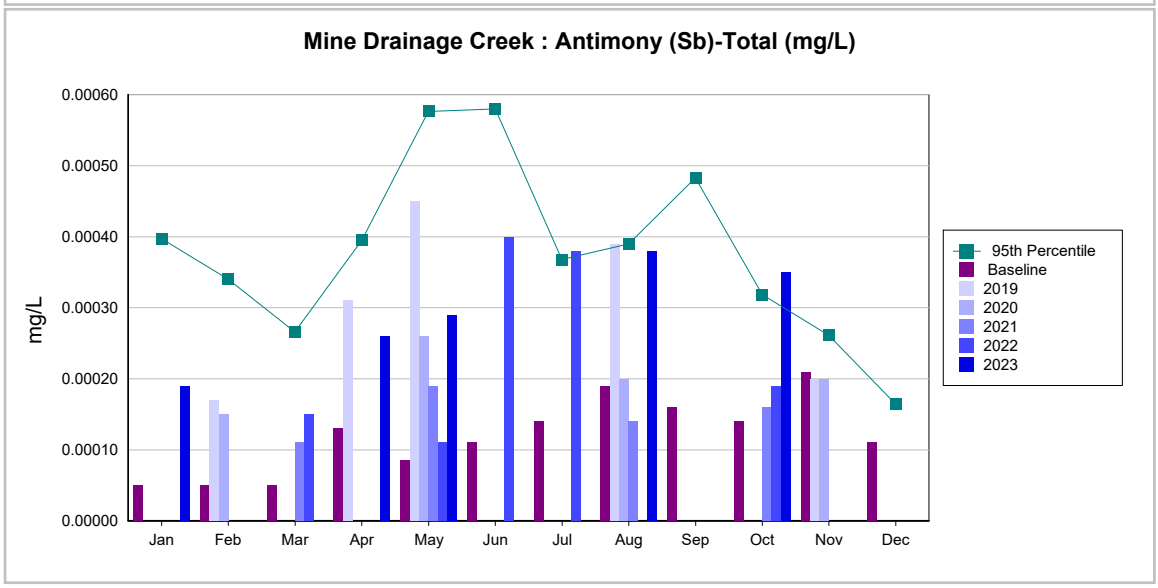
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







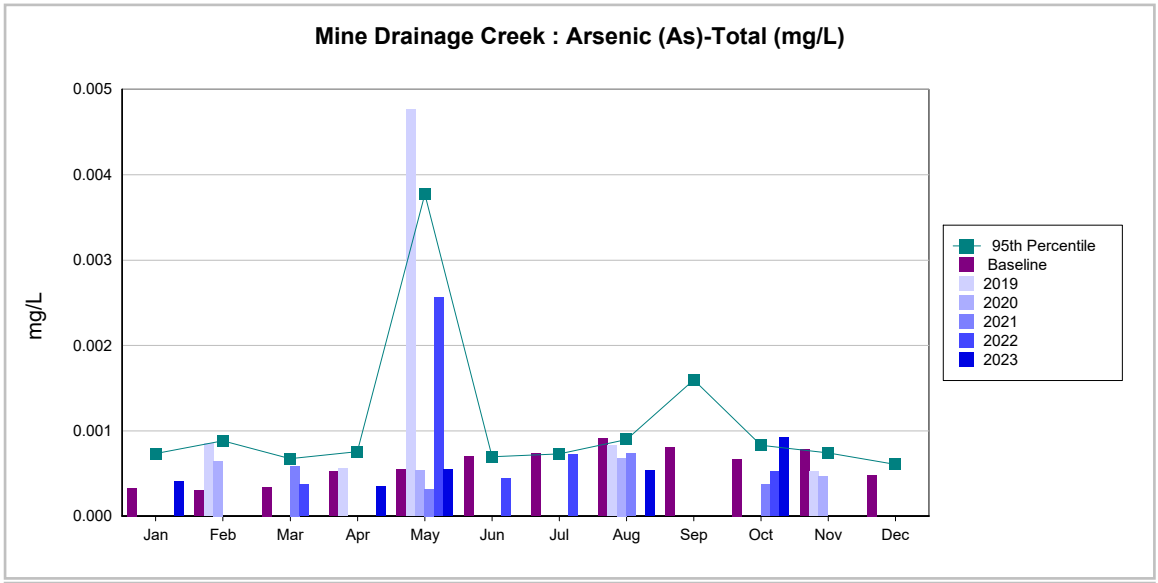
Water Quality Report

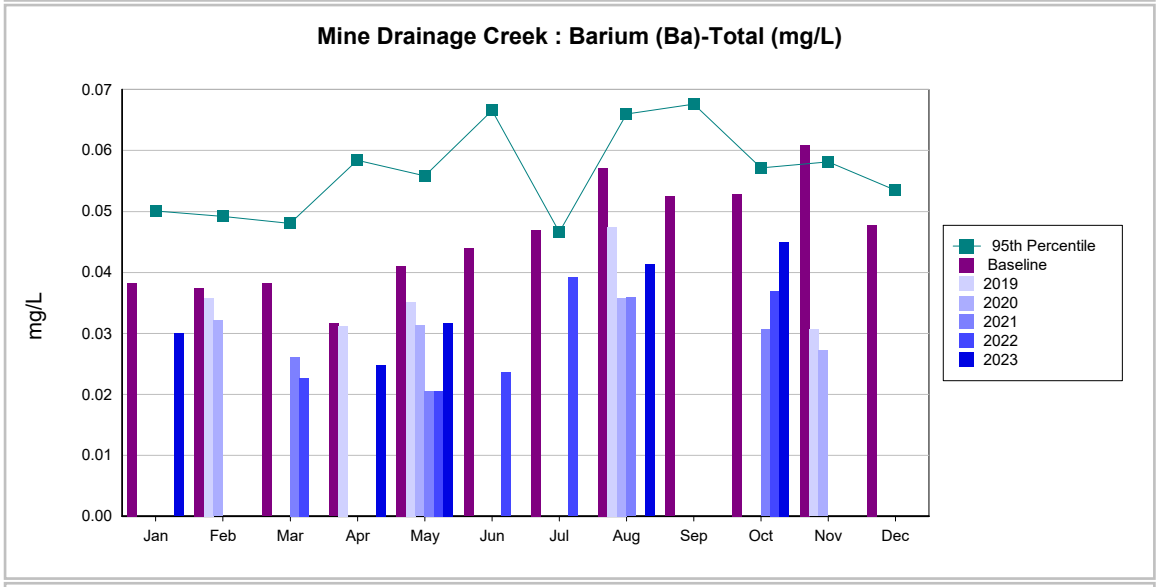
Annual Report Drainage Water

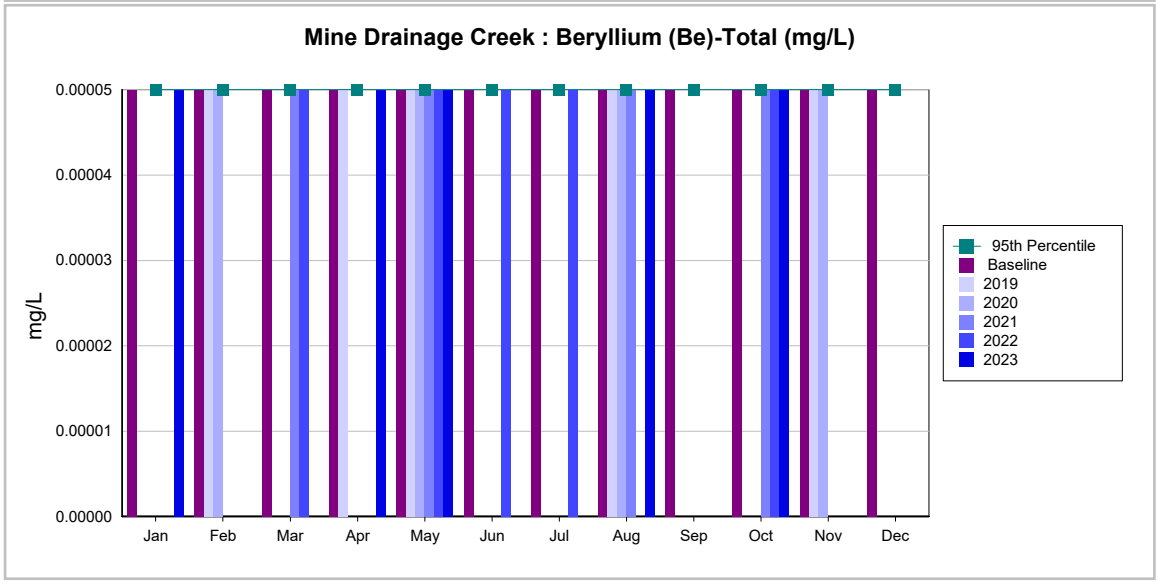
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







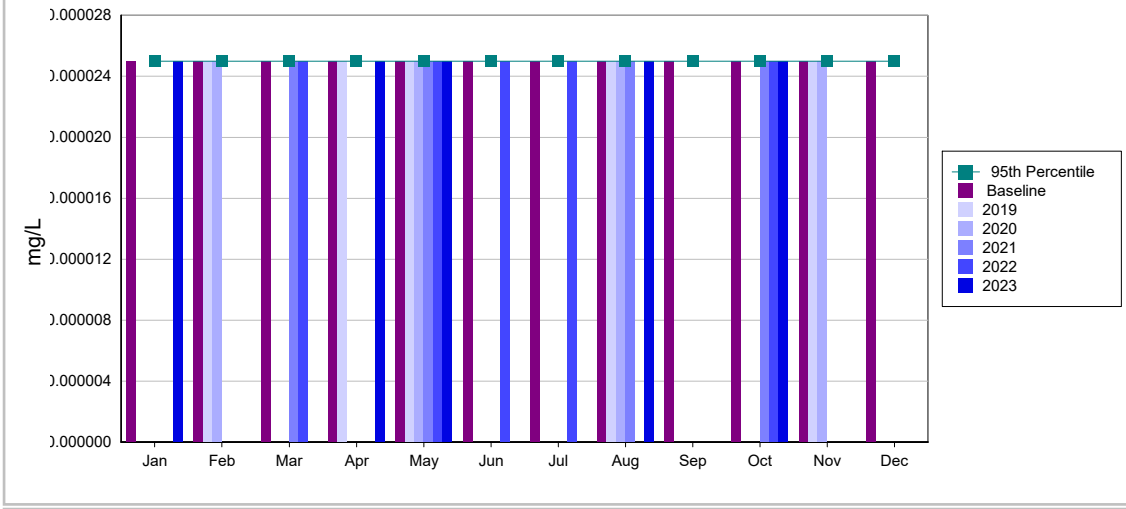
Water Quality Report

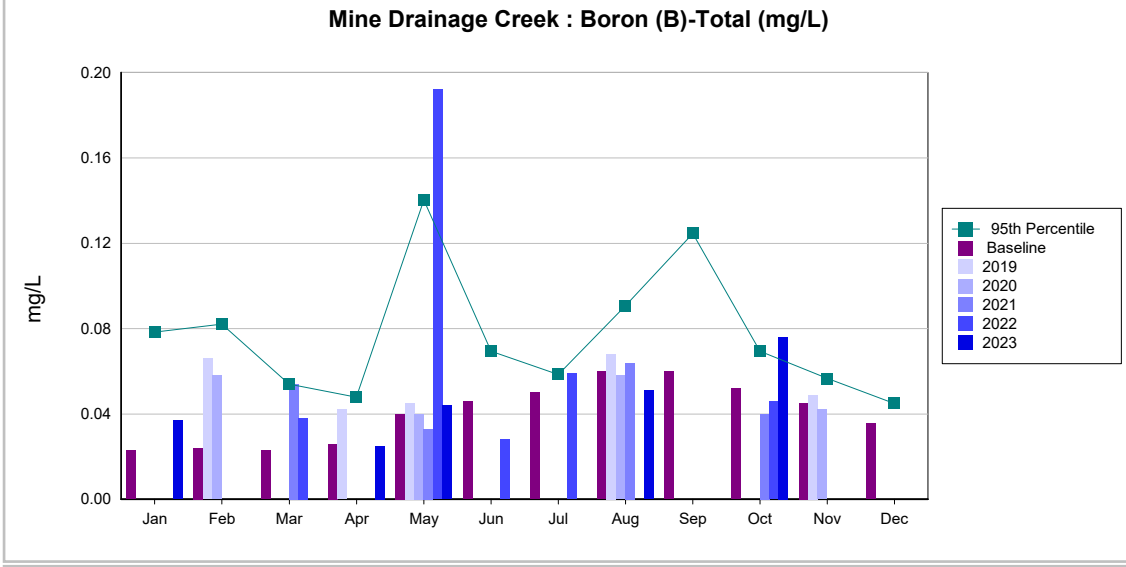
Annual Report Drainage Water

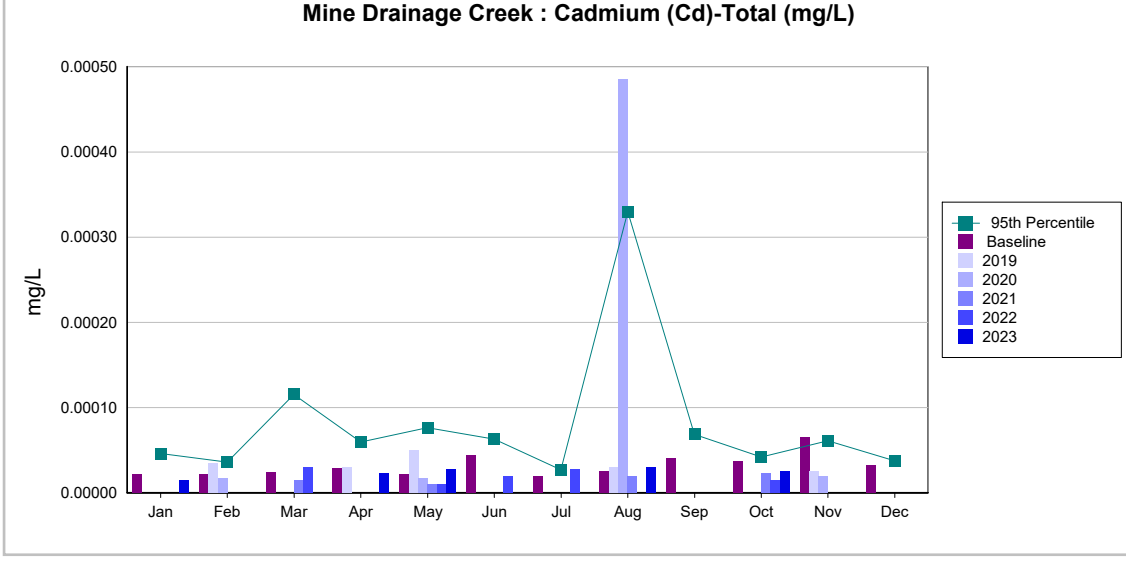
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







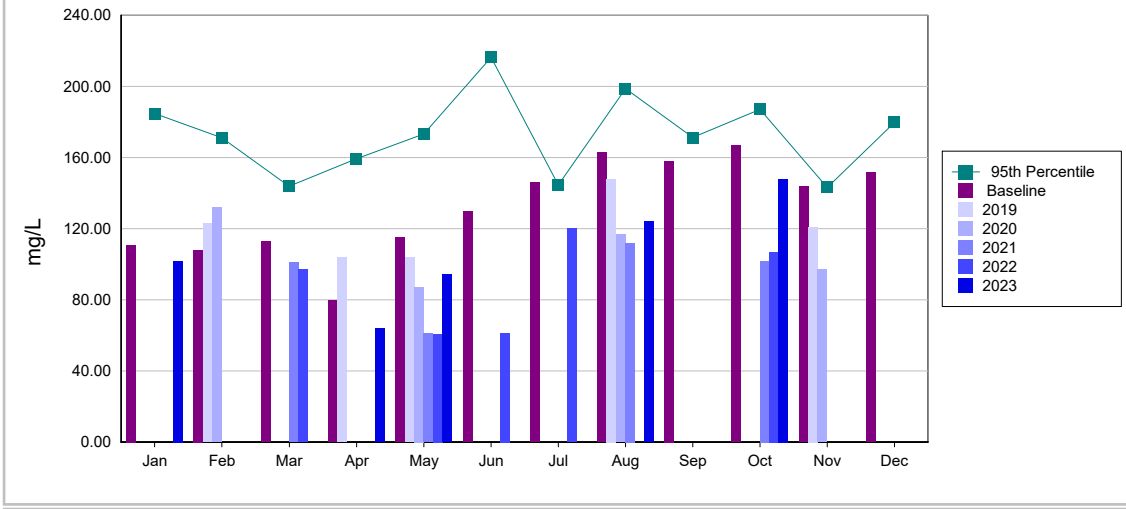
Water Quality Report

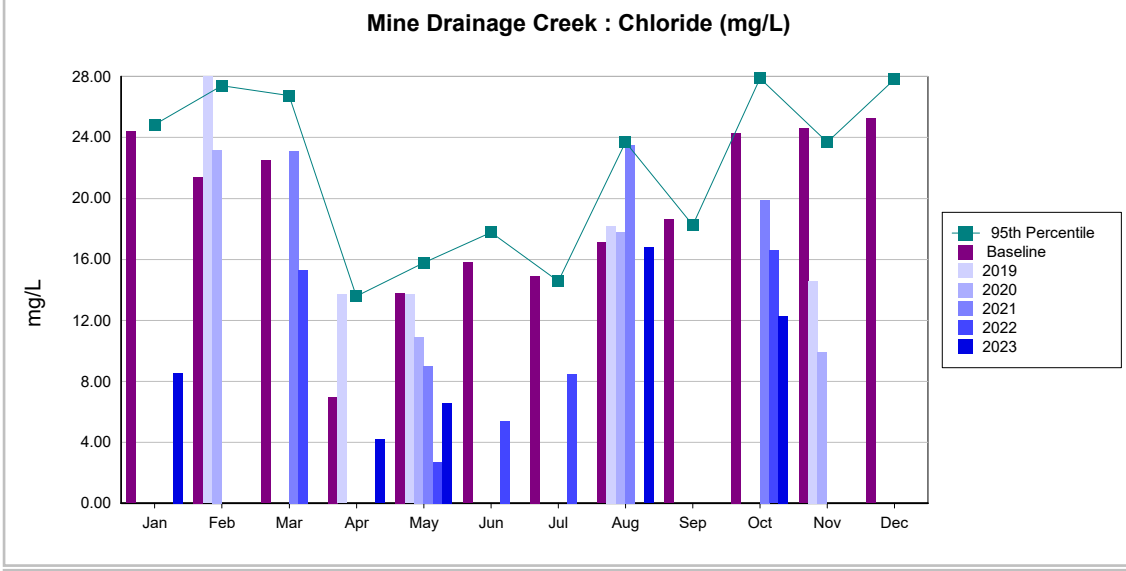
Annual Report Drainage Water

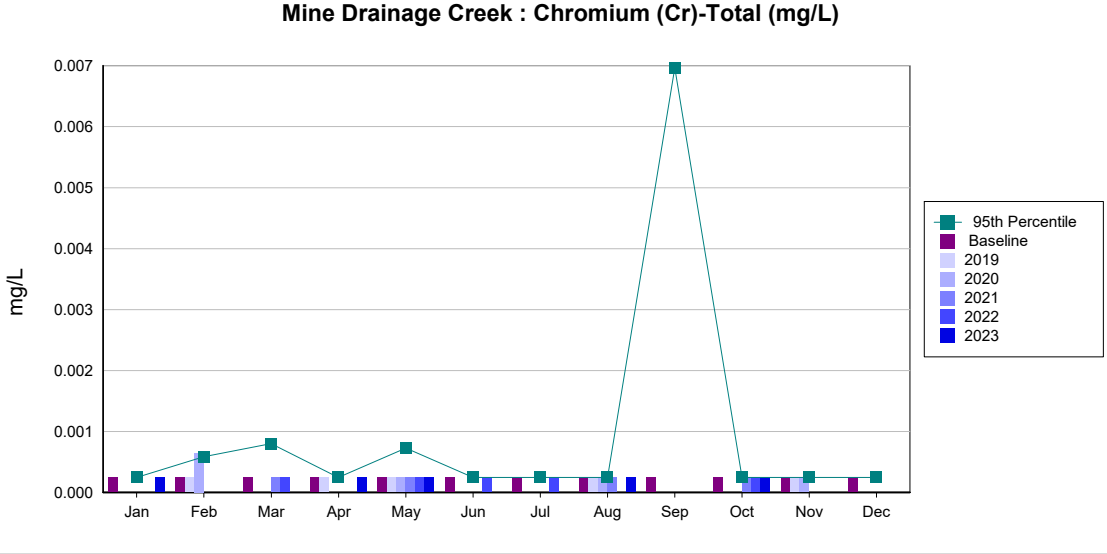
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







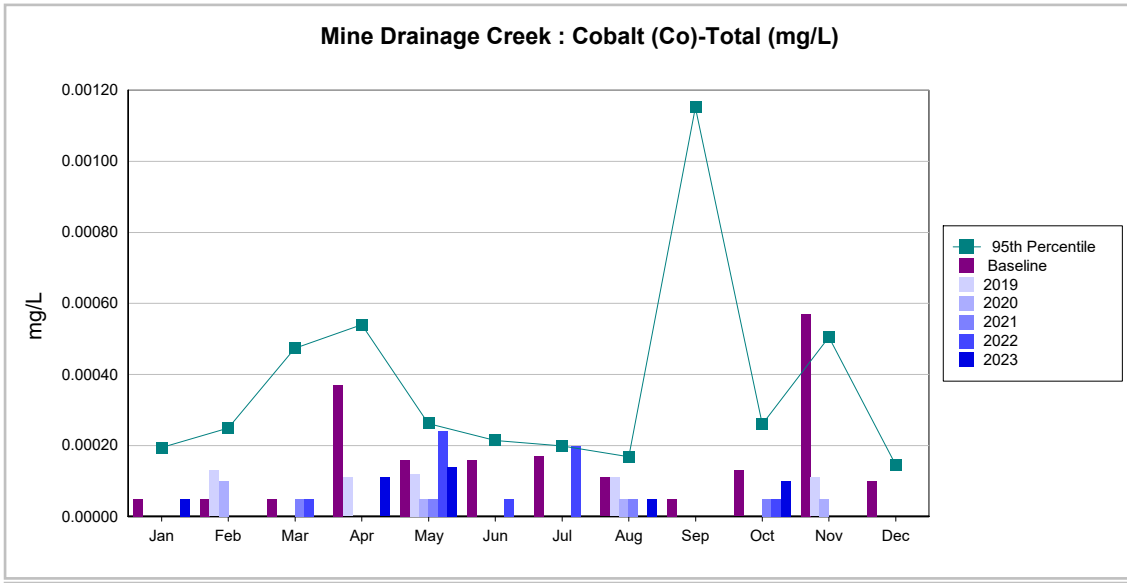
Water Quality Report

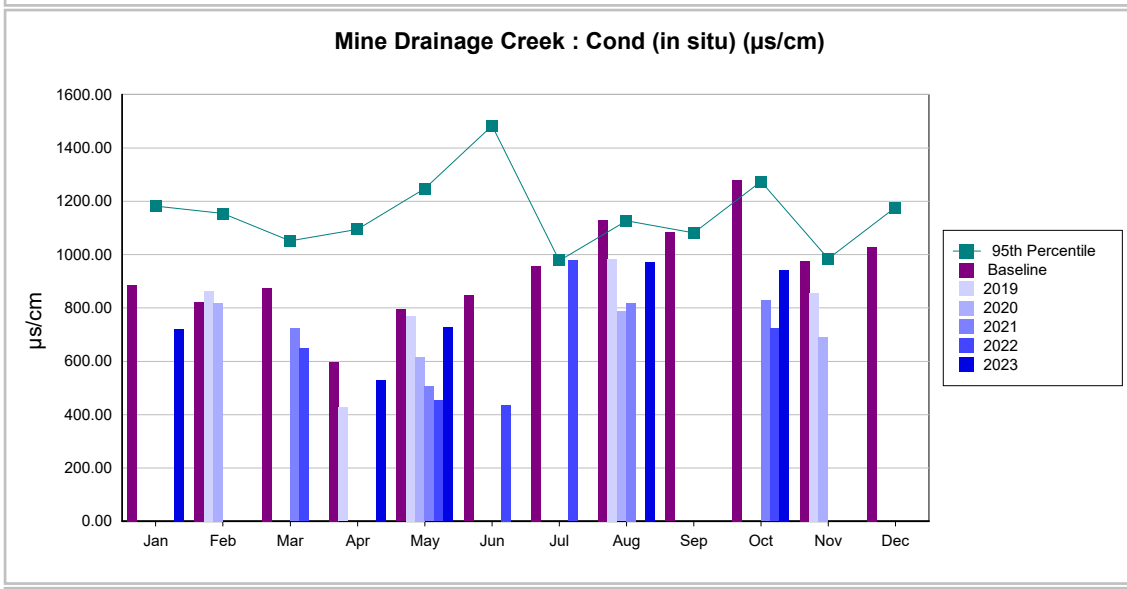
Annual Report Drainage Water

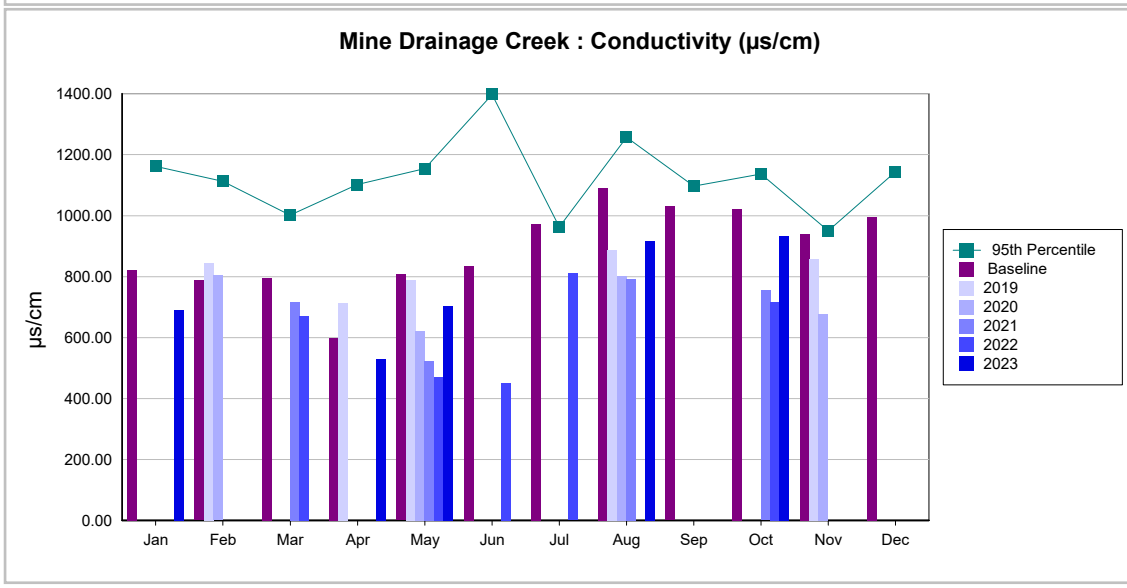
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







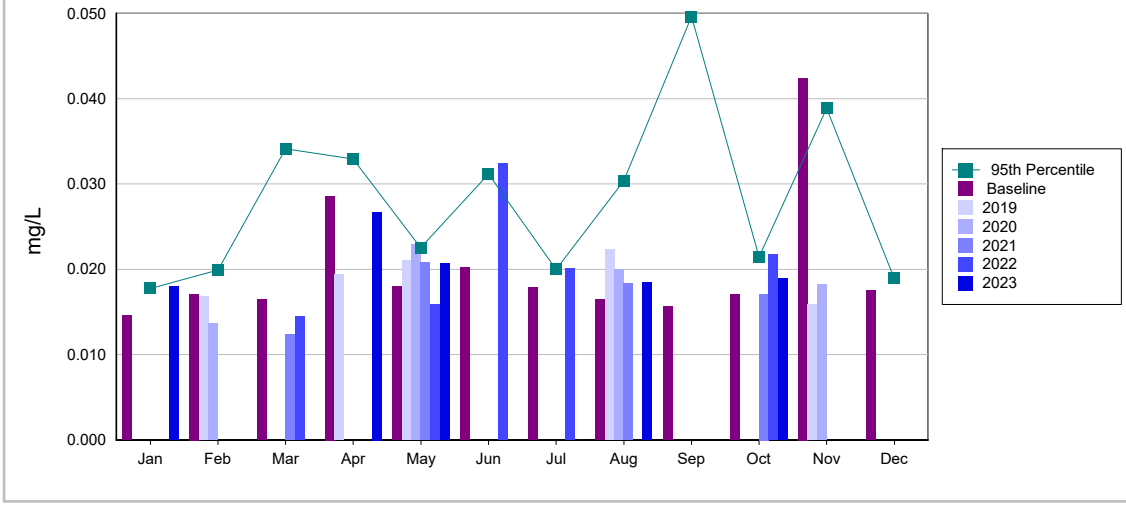
Water Quality Report

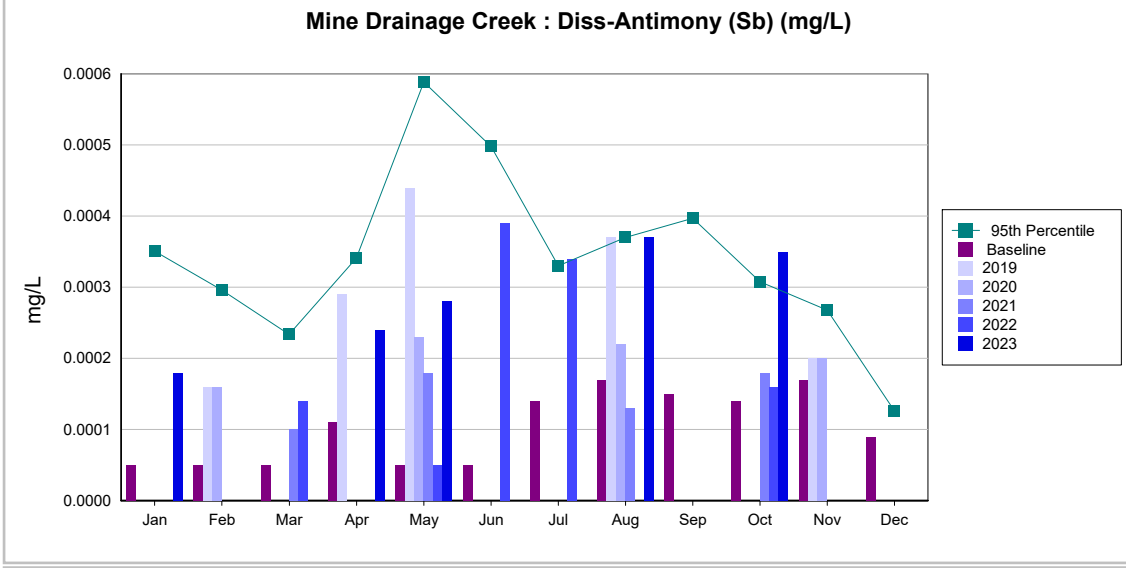
Annual Report Drainage Water

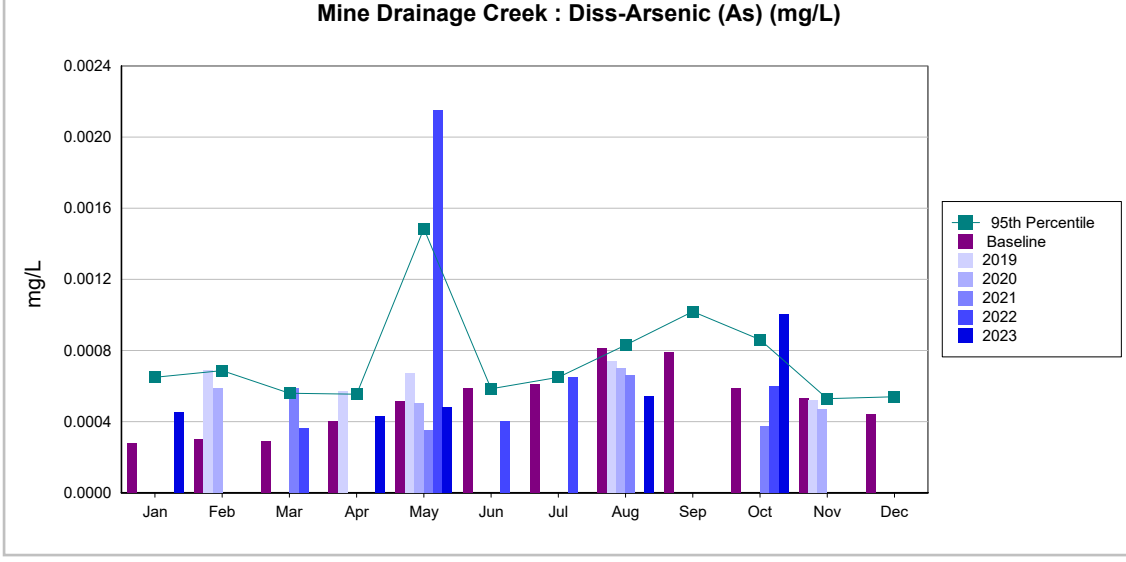
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







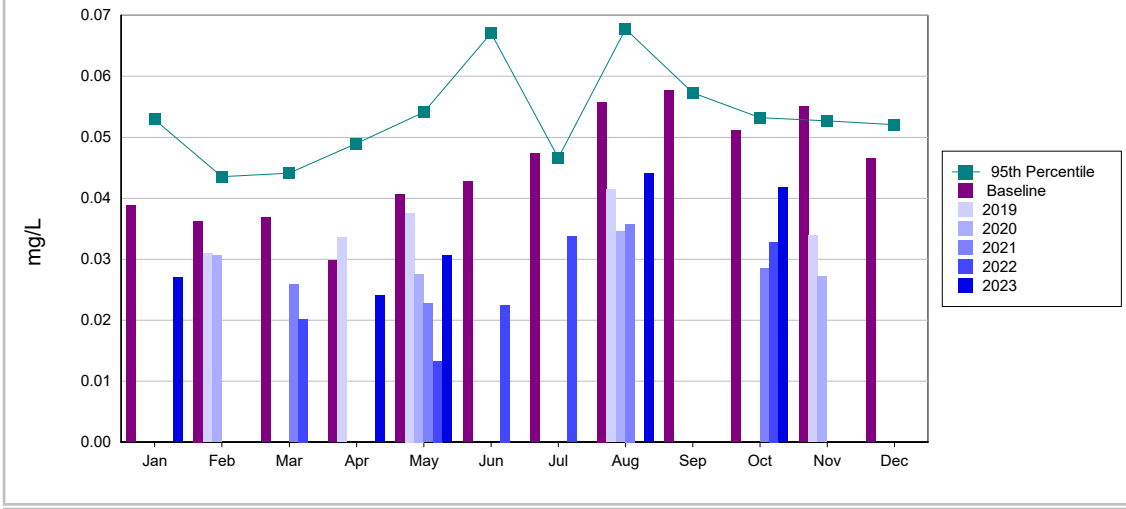
Water Quality Report

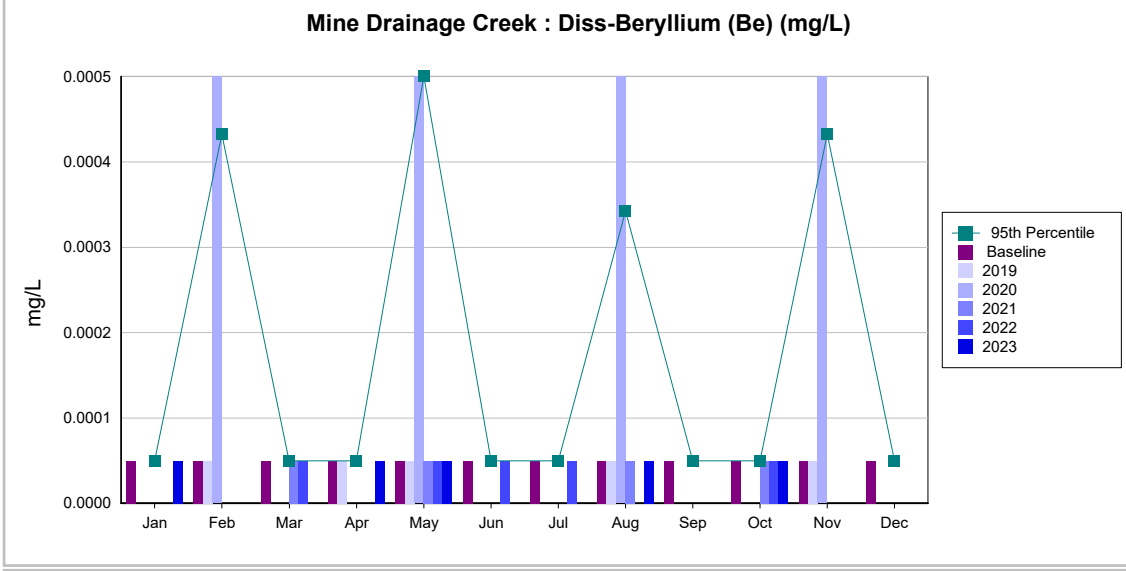
Annual Report Drainage Water

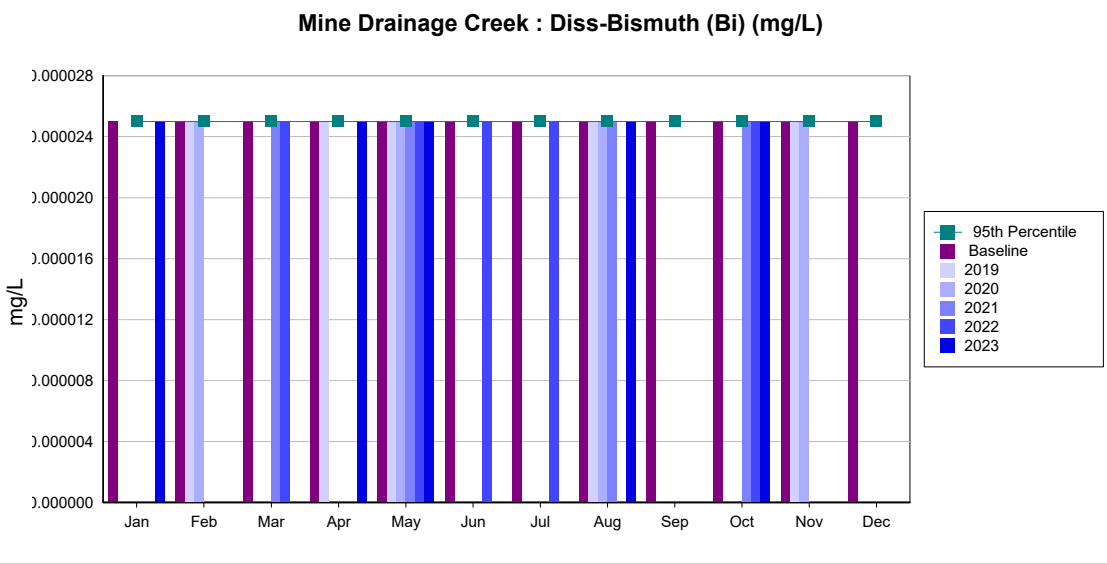
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







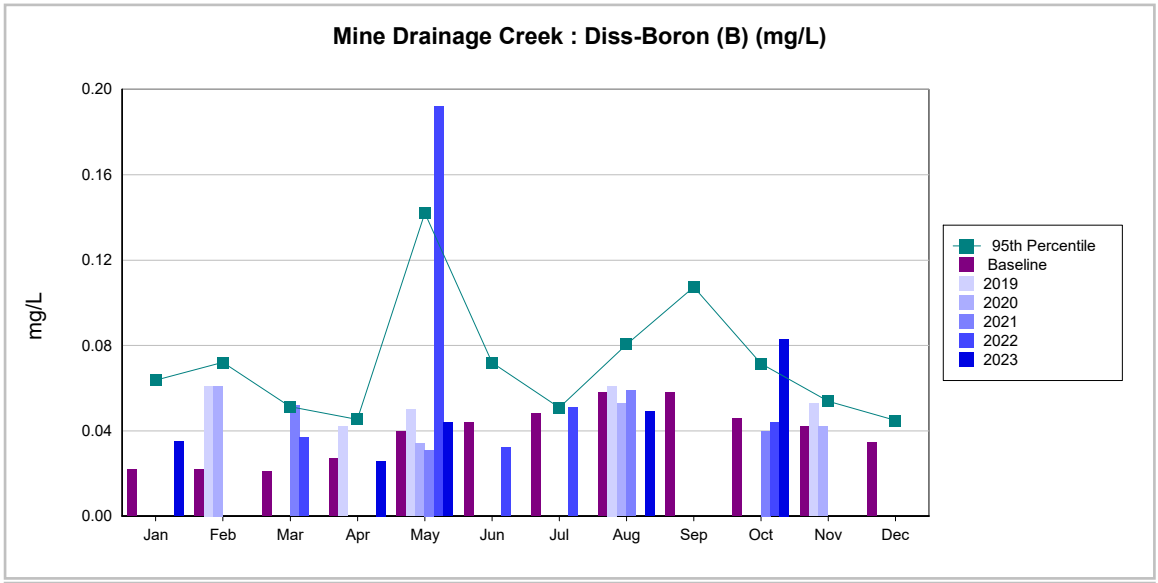
Water Quality Report

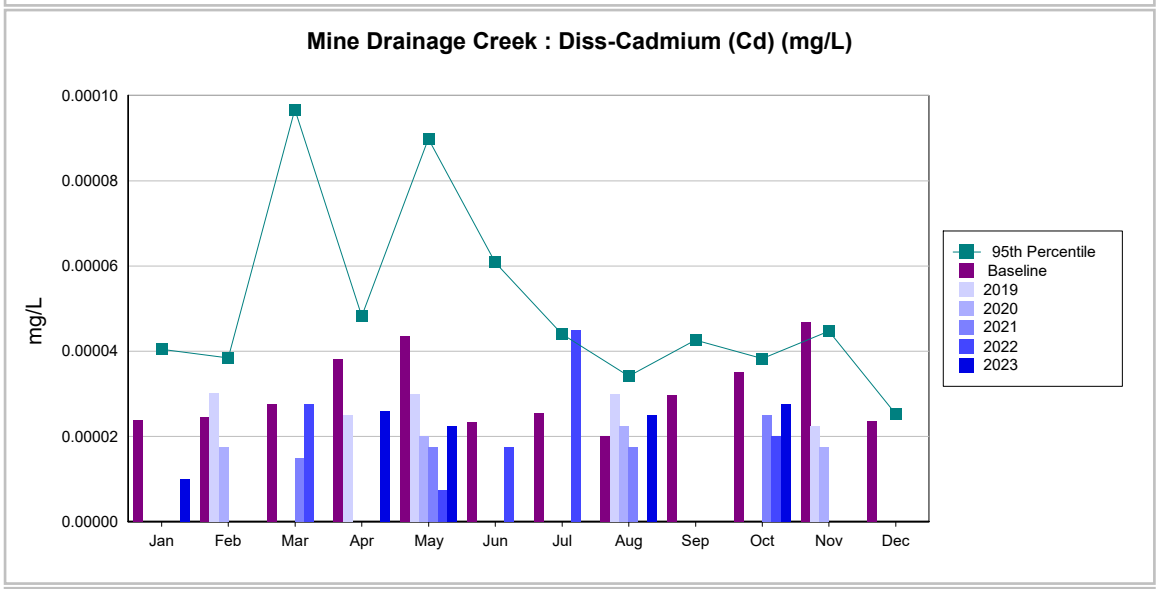
Annual Report Drainage Water

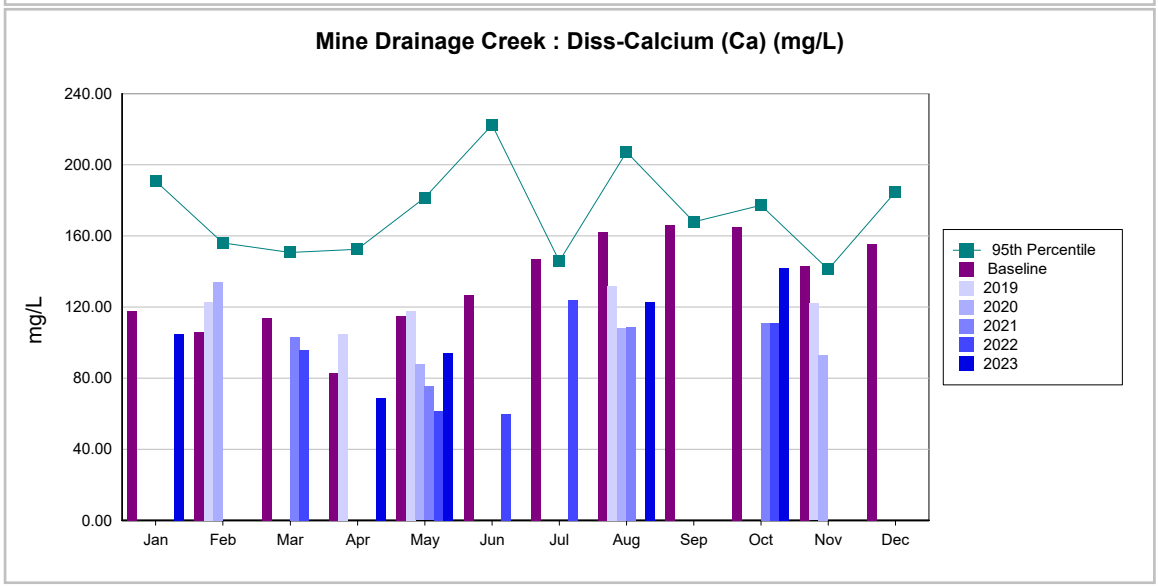
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







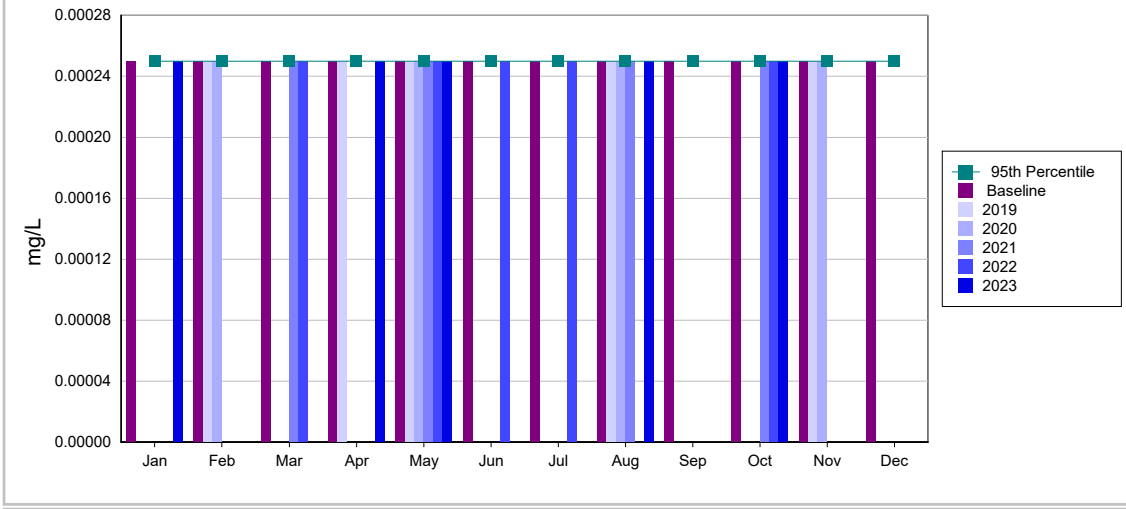
Water Quality Report

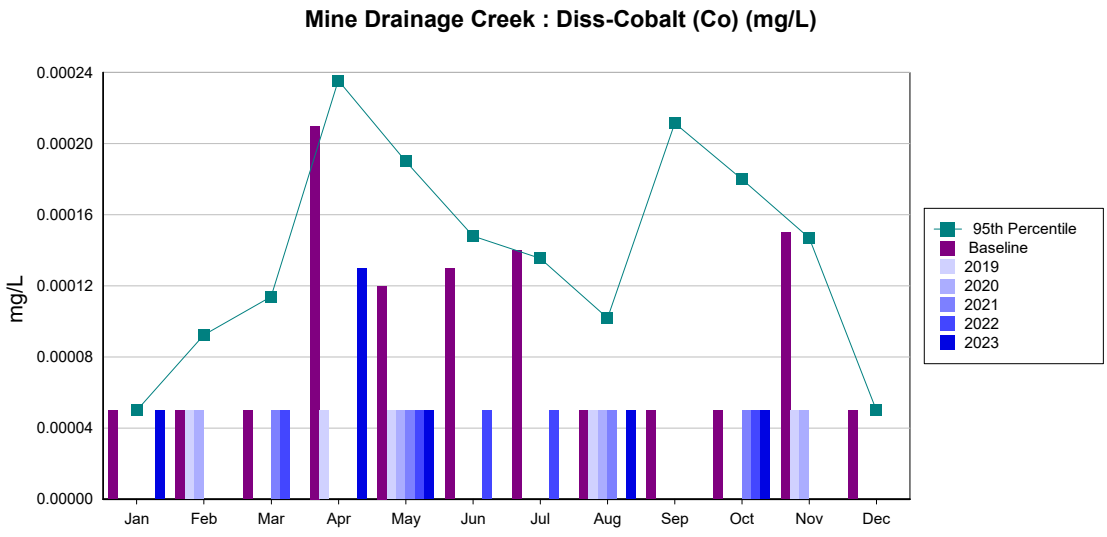
Annual Report Drainage Water

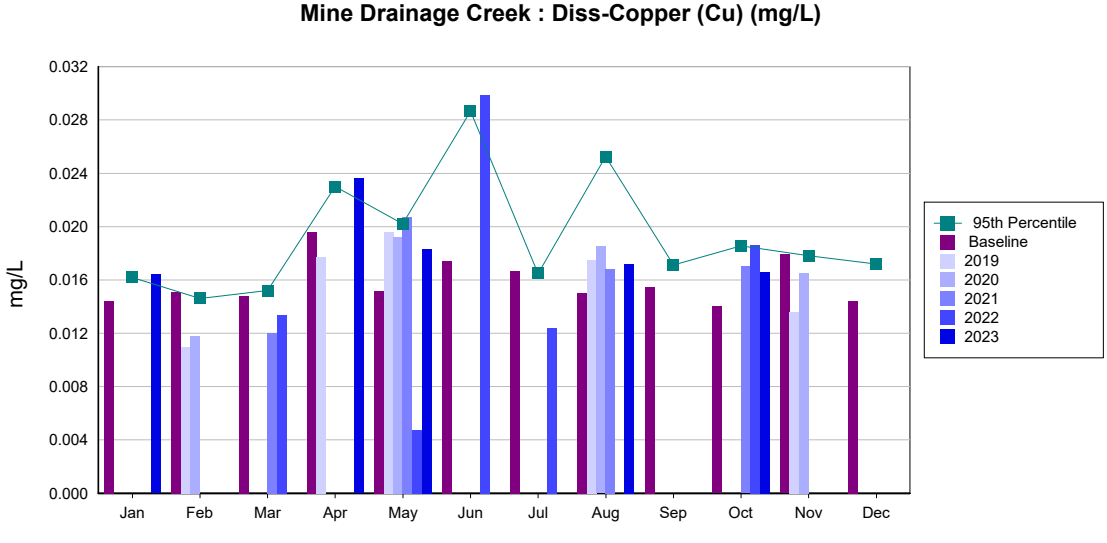
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







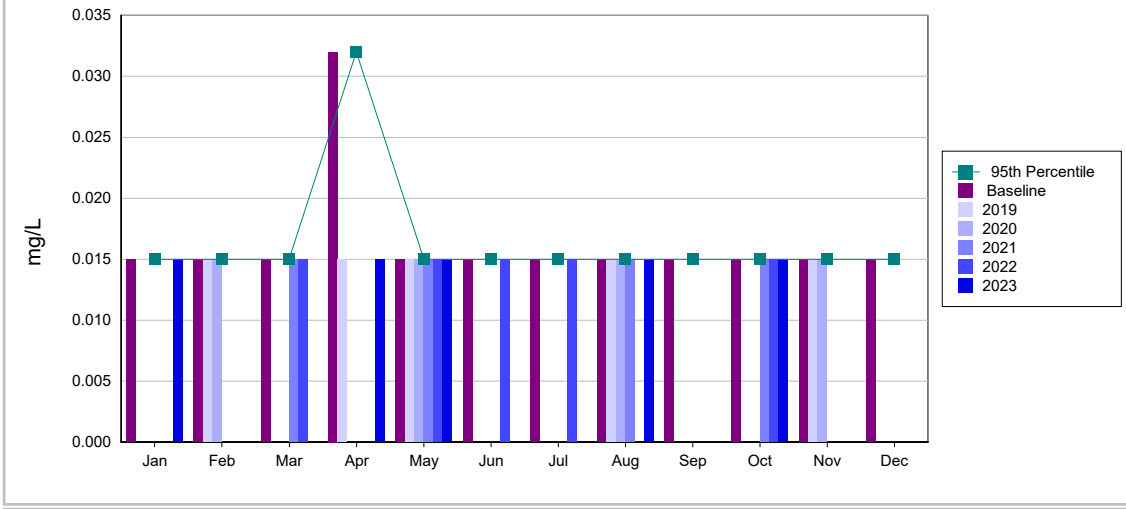
Water Quality Report

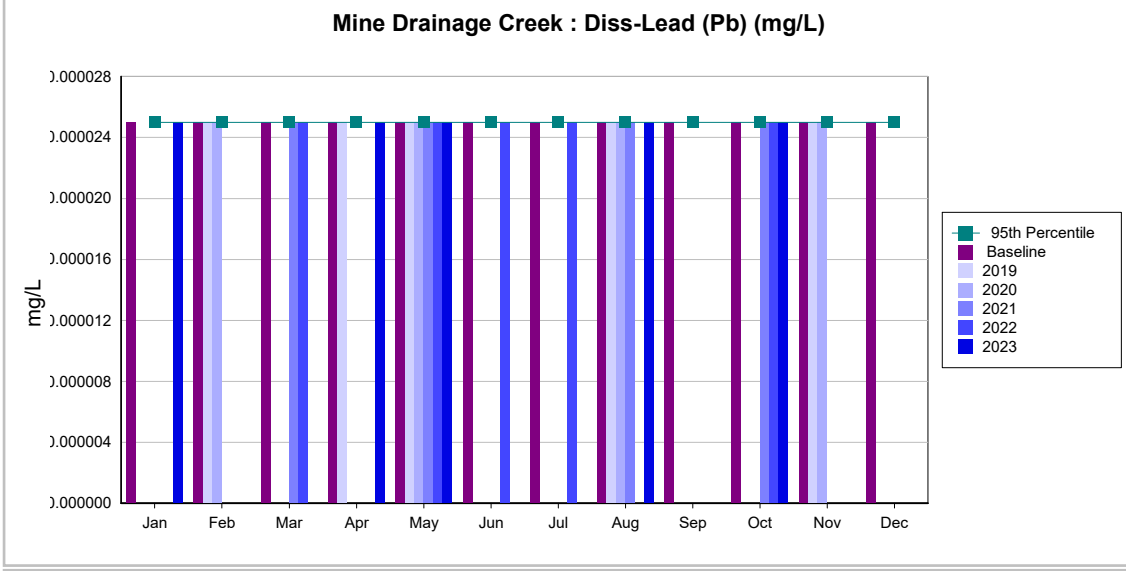
Annual Report Drainage Water

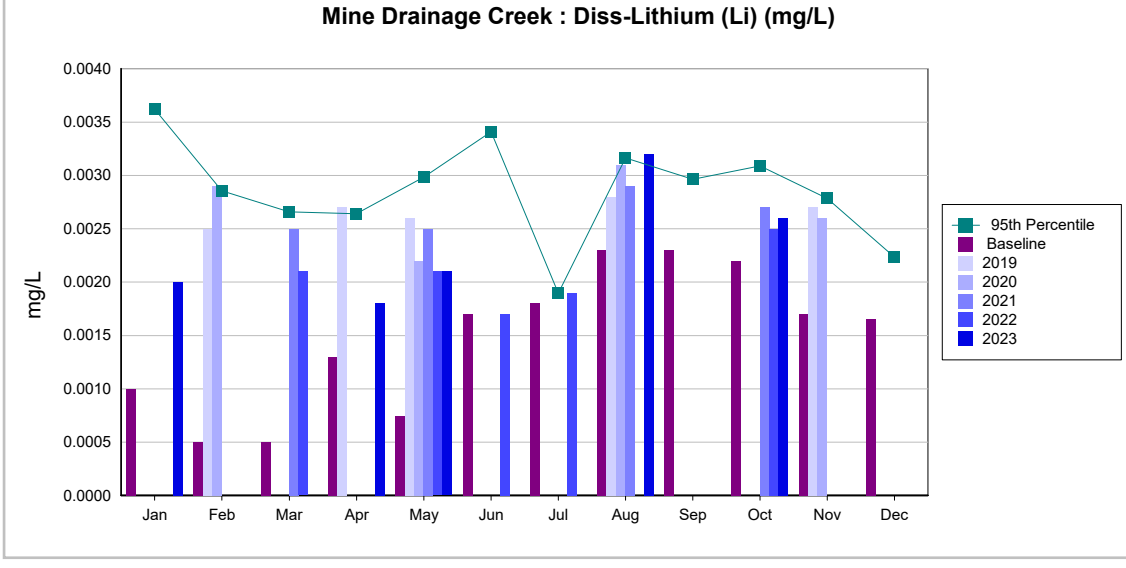
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







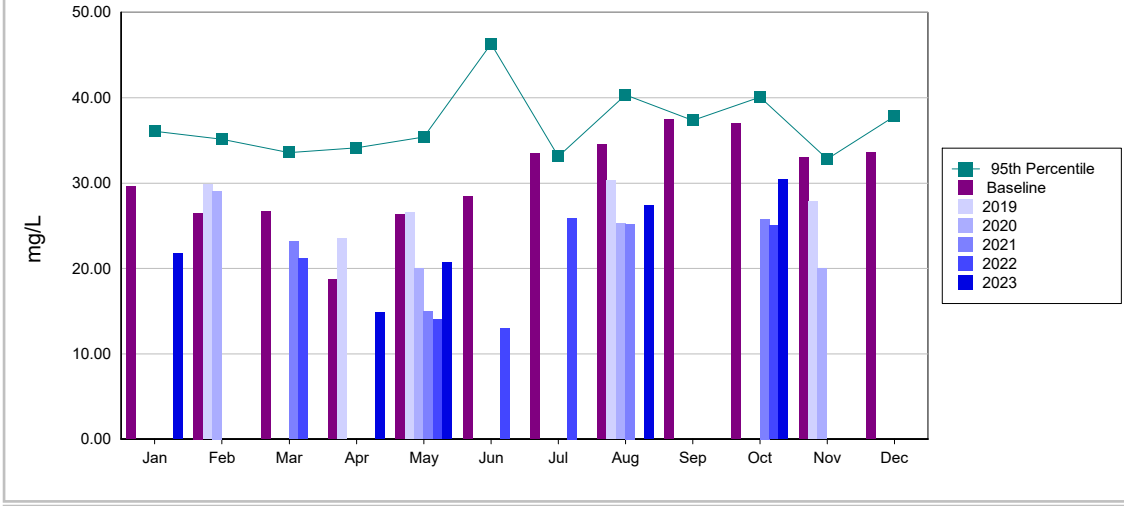
Water Quality Report

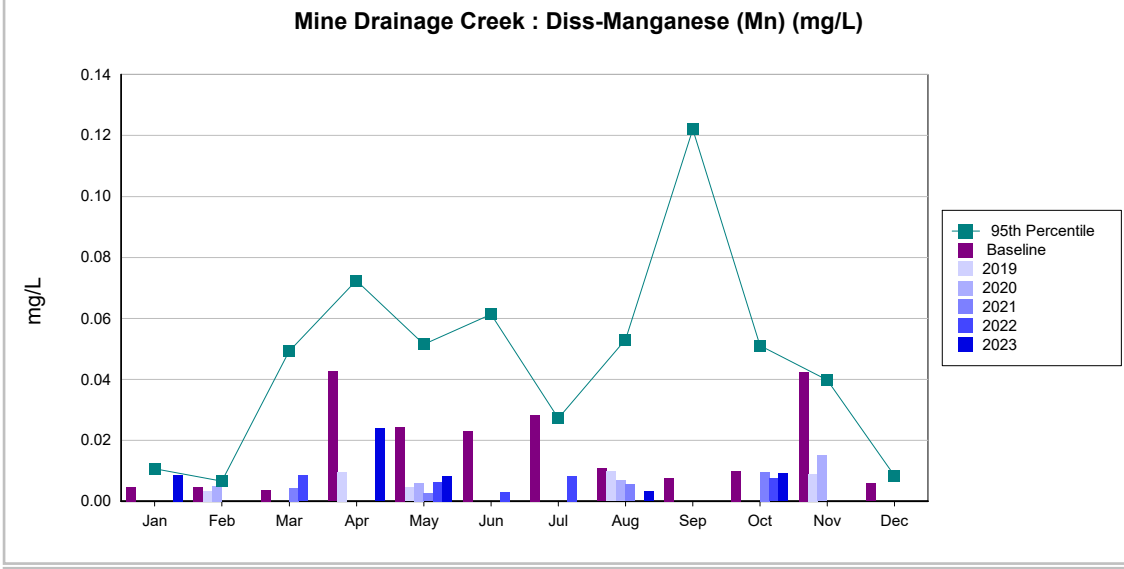
Annual Report Drainage Water

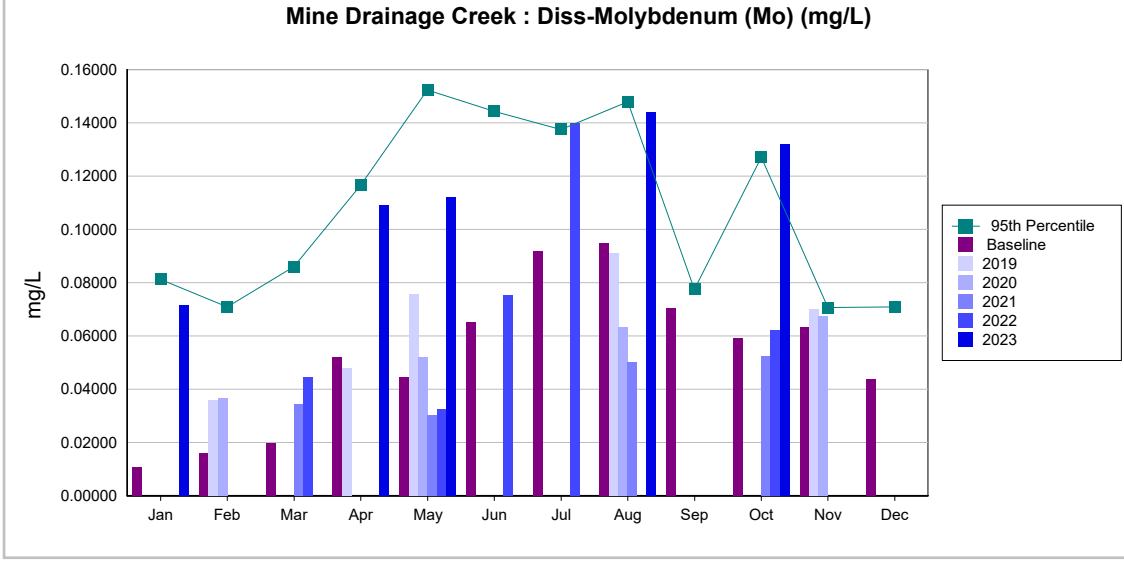
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







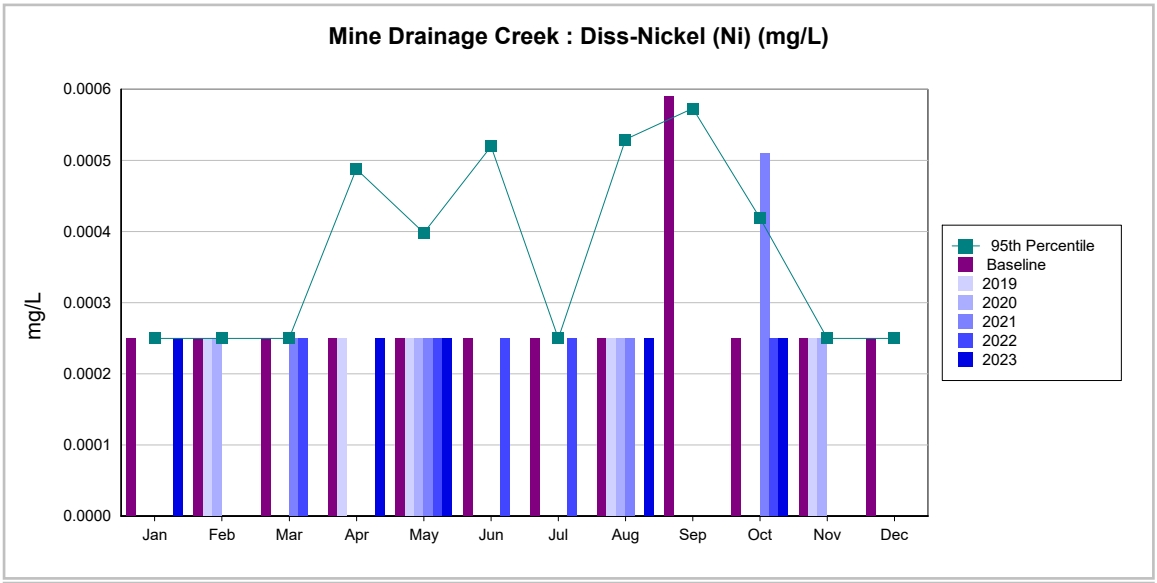
Water Quality Report

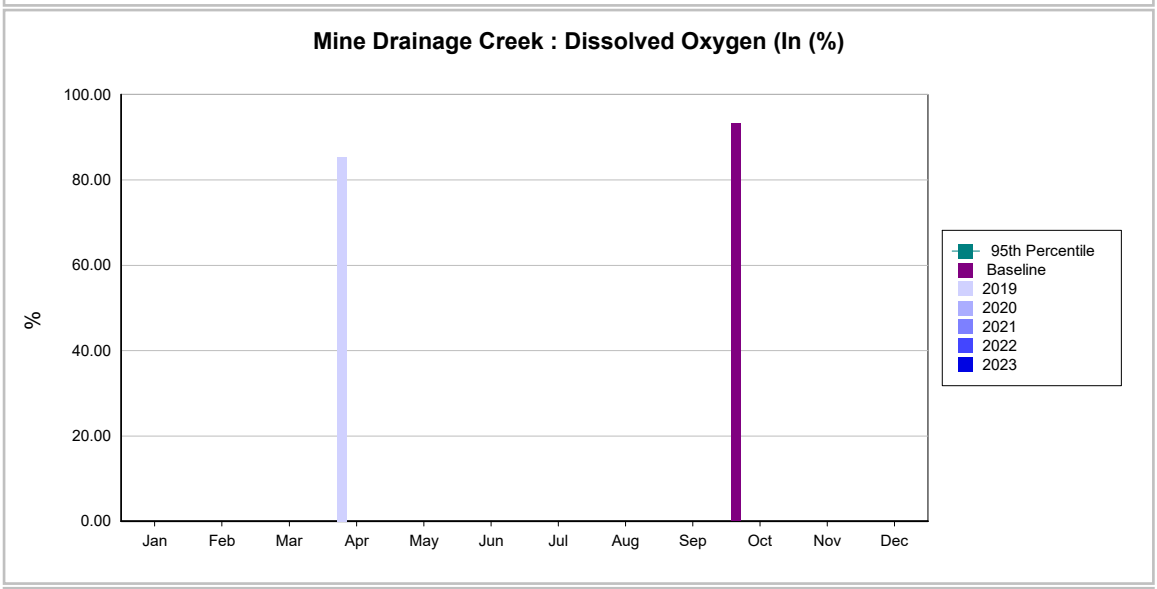
Annual Report Drainage Water

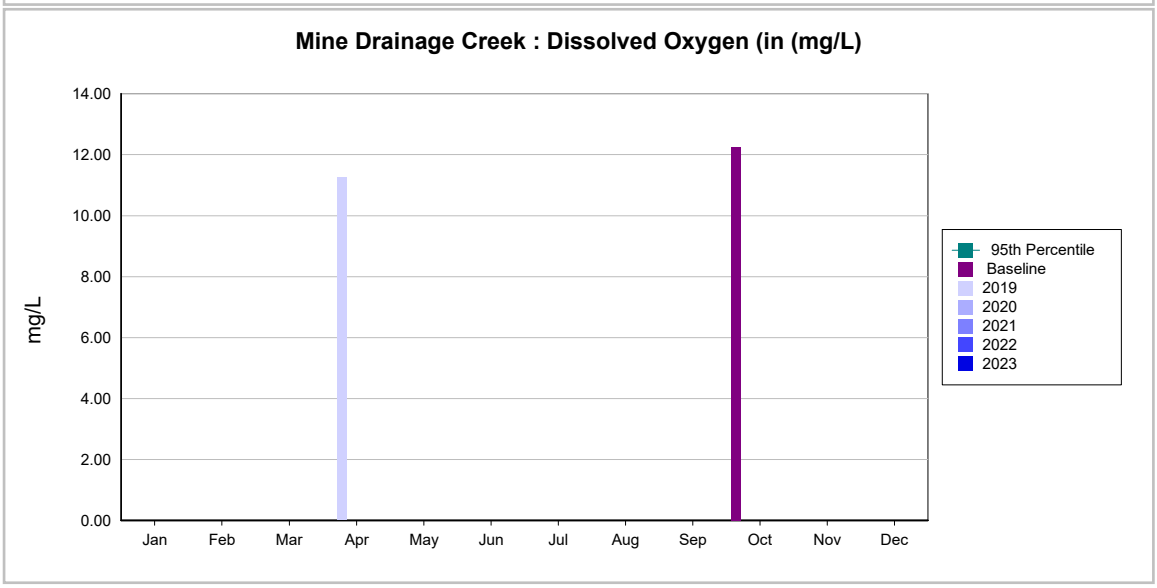
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







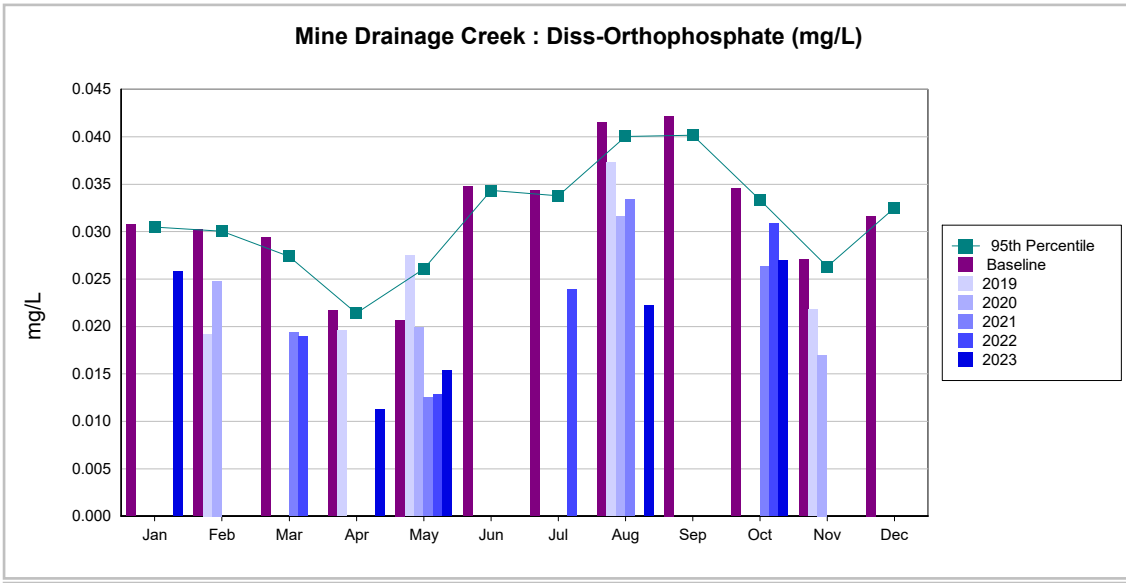
Water Quality Report

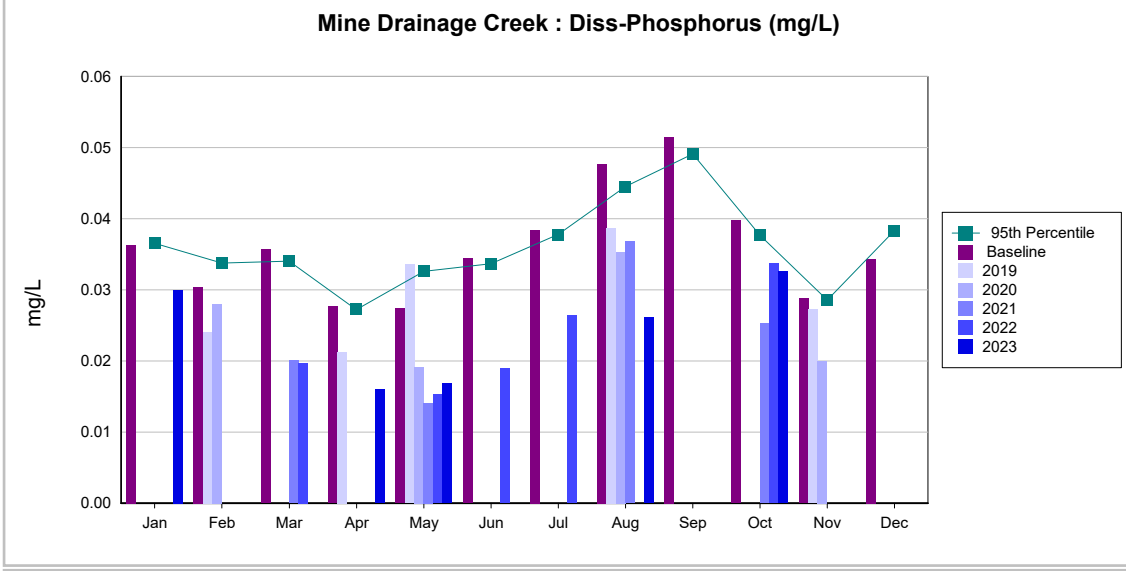
Annual Report Drainage Water

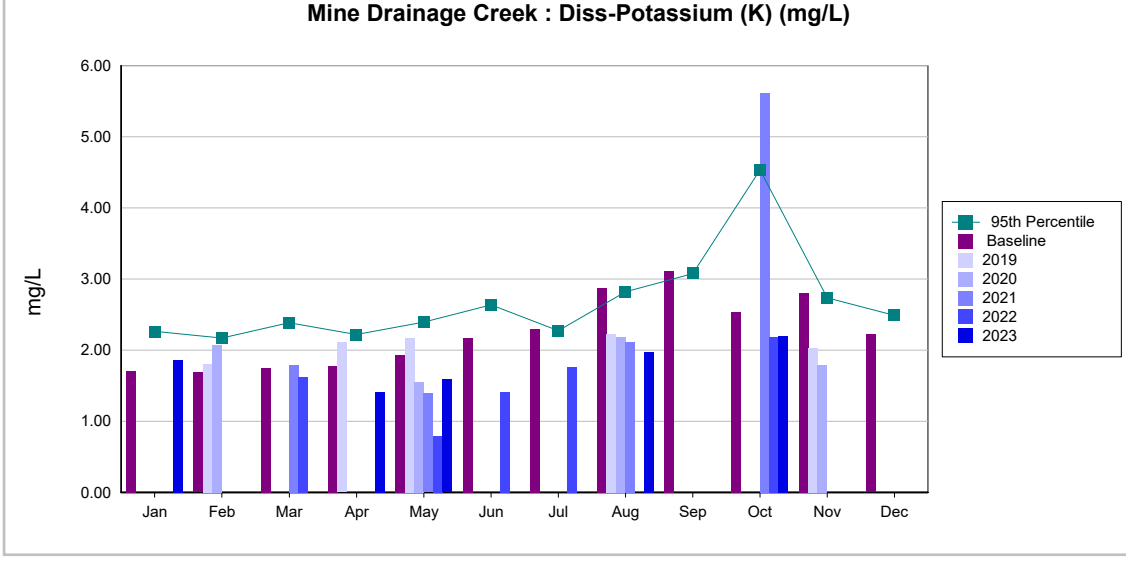
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







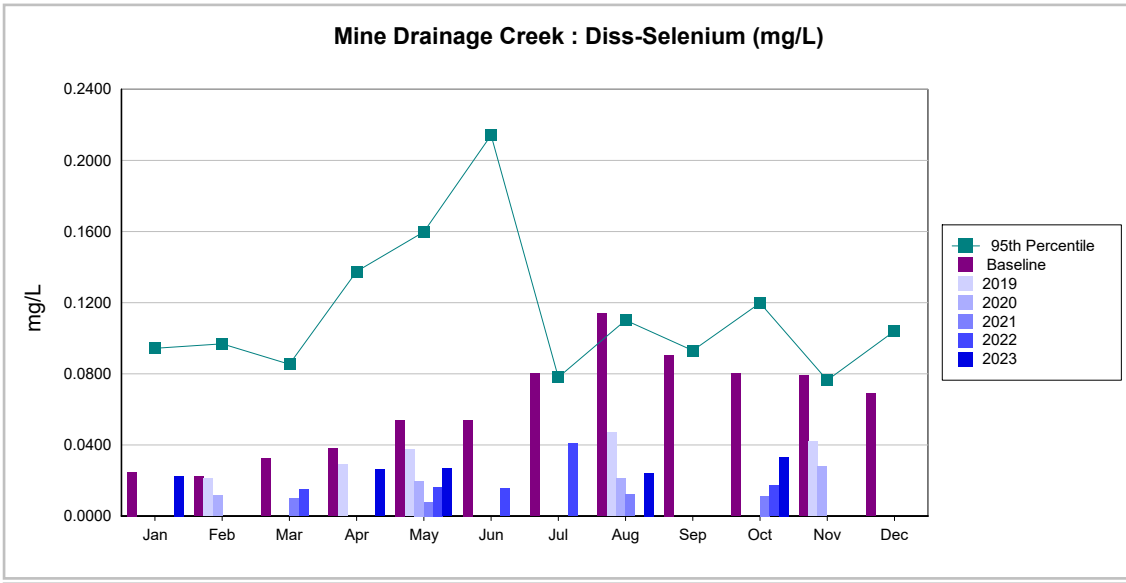
Water Quality Report

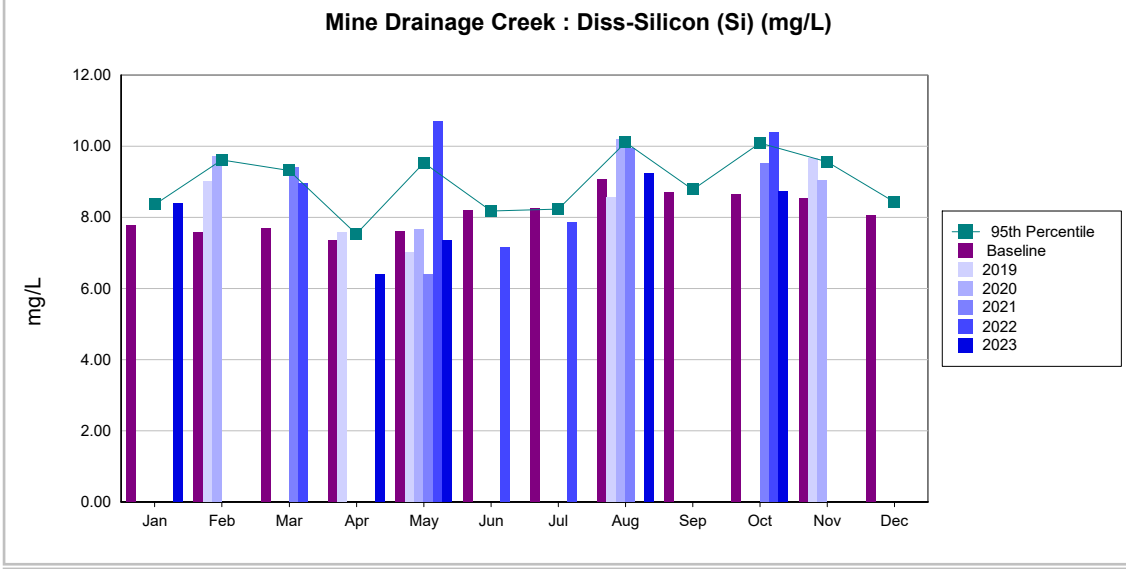
Annual Report Drainage Water

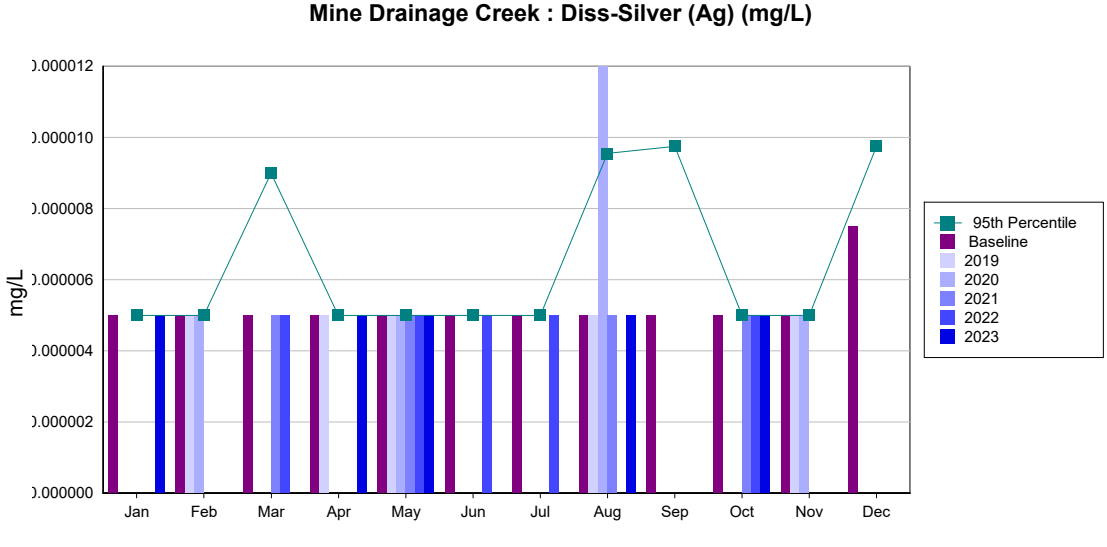
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







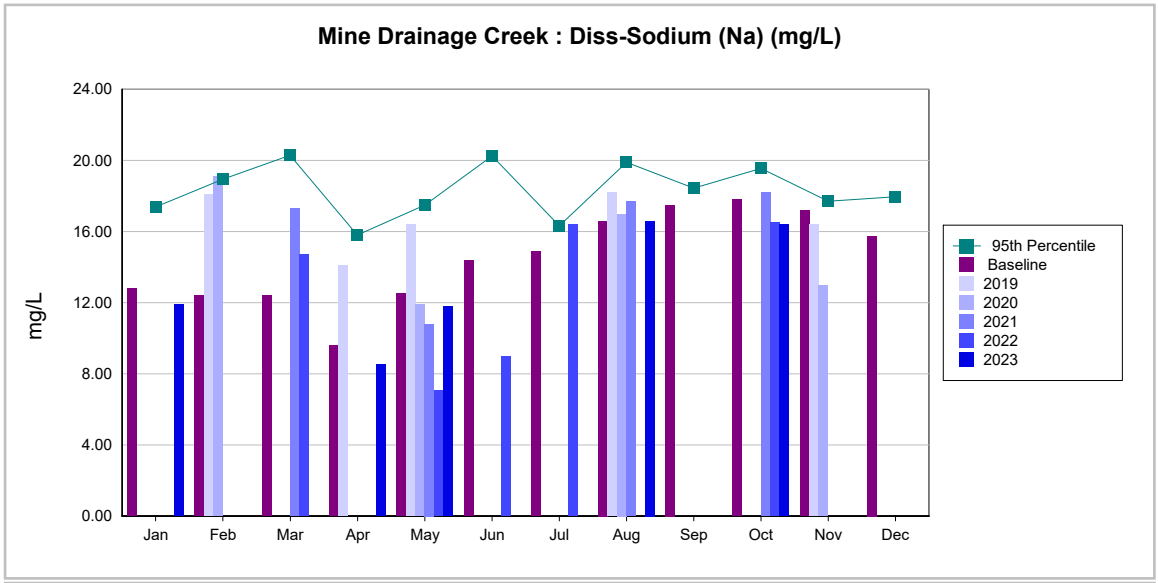
Water Quality Report

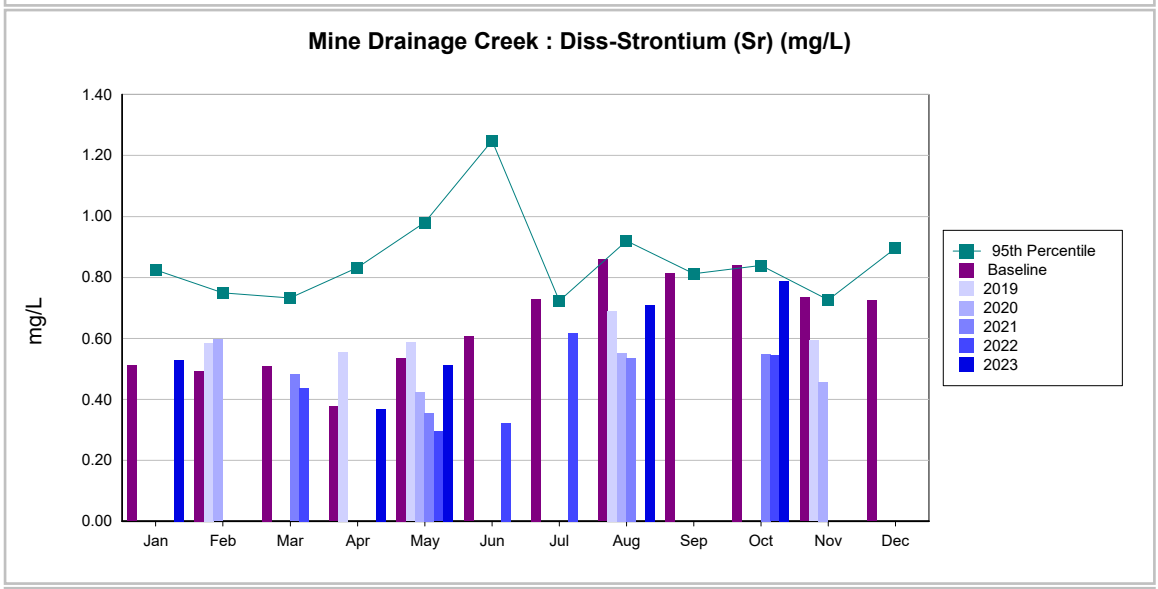
Annual Report Drainage Water

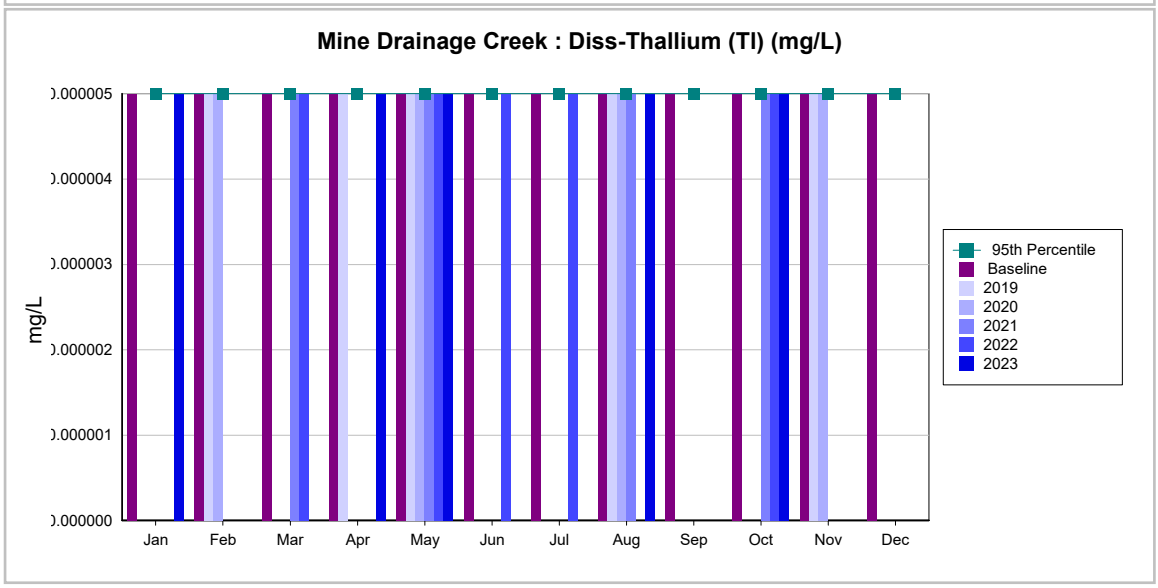
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







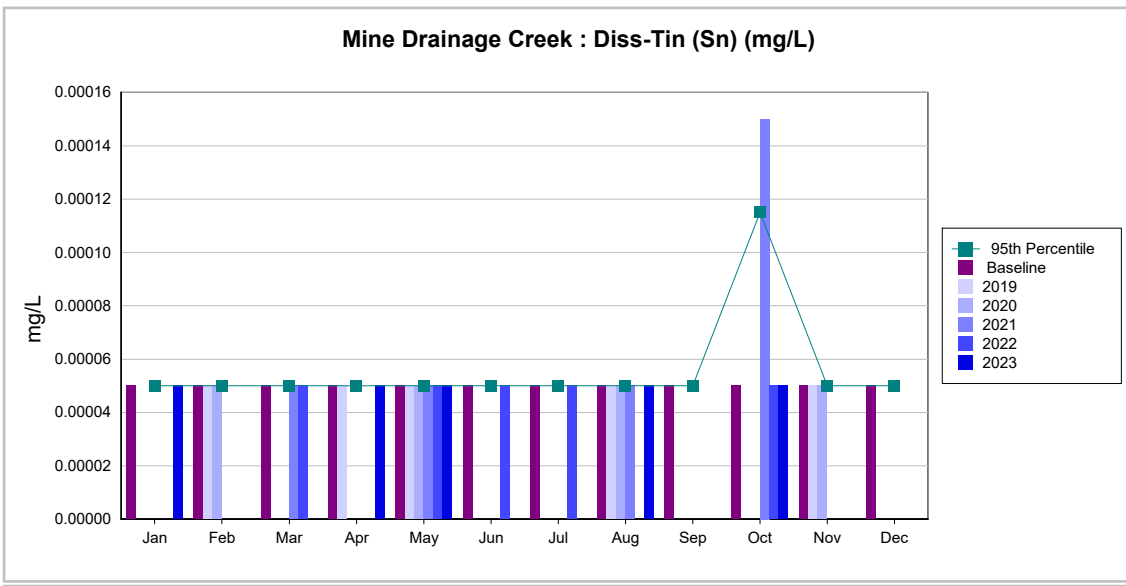
Water Quality Report

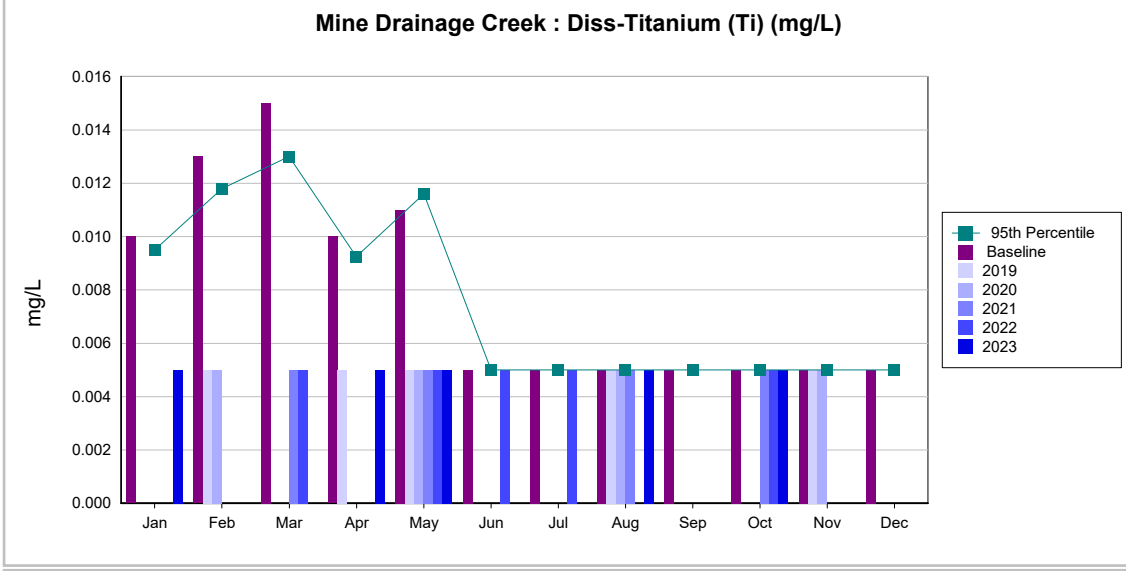
Annual Report Drainage Water

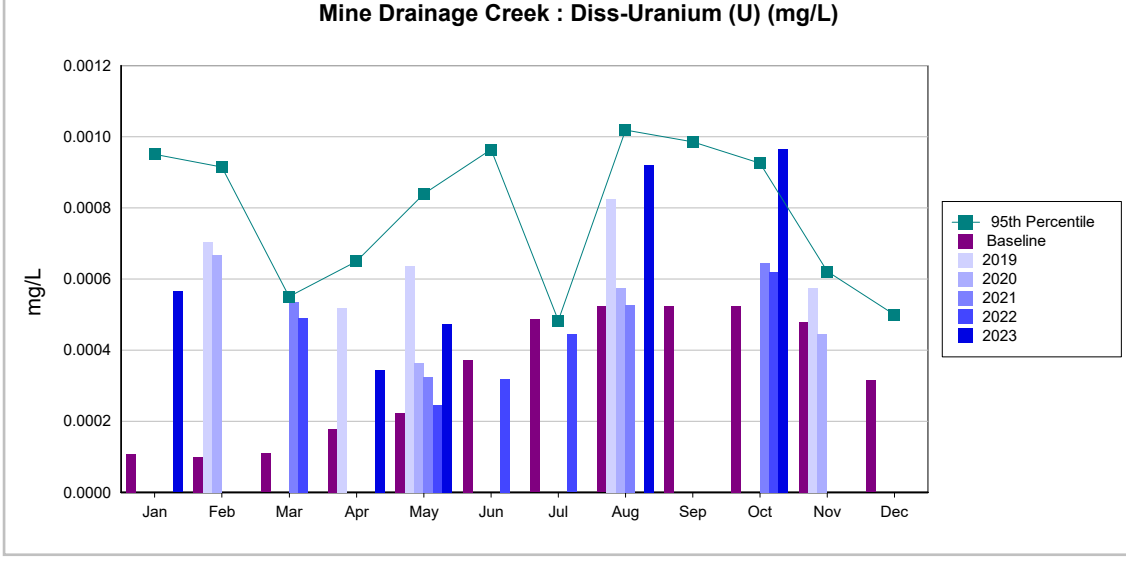
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







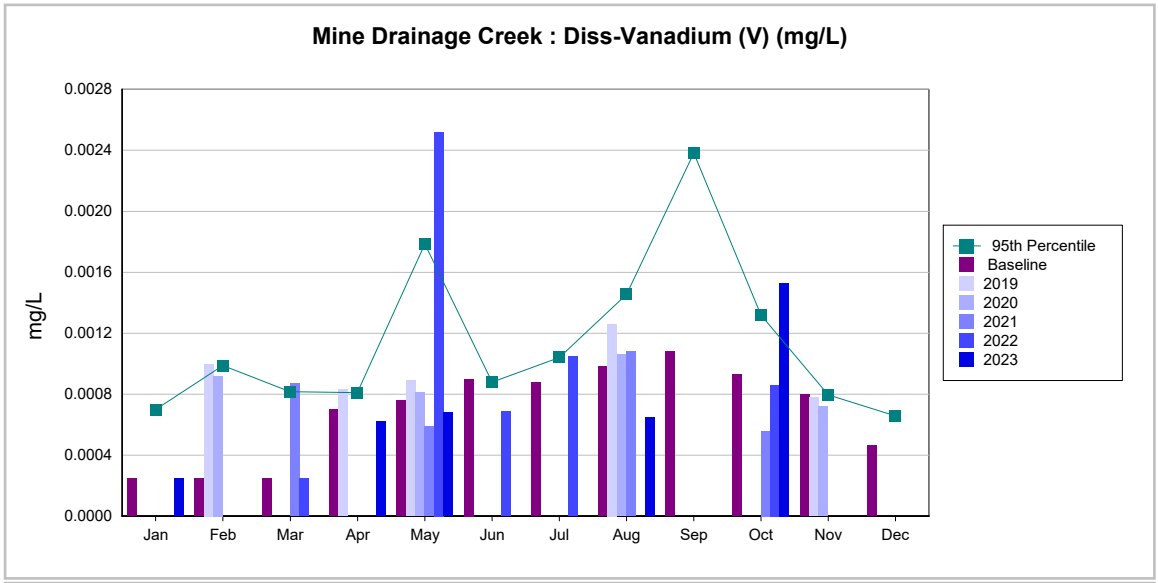
Water Quality Report

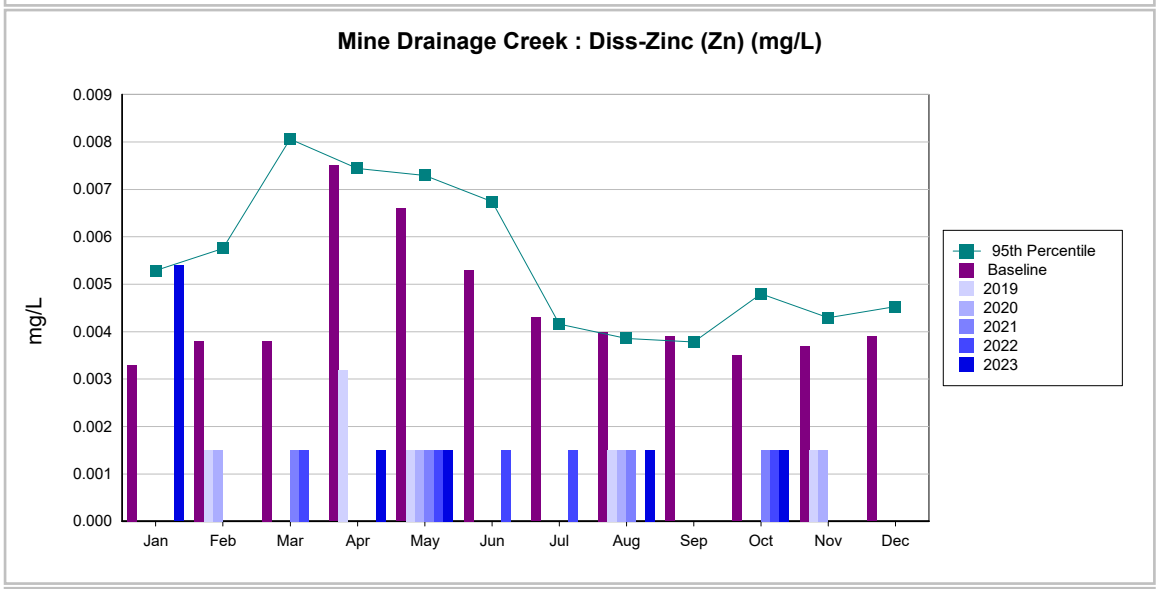
Annual Report Drainage Water

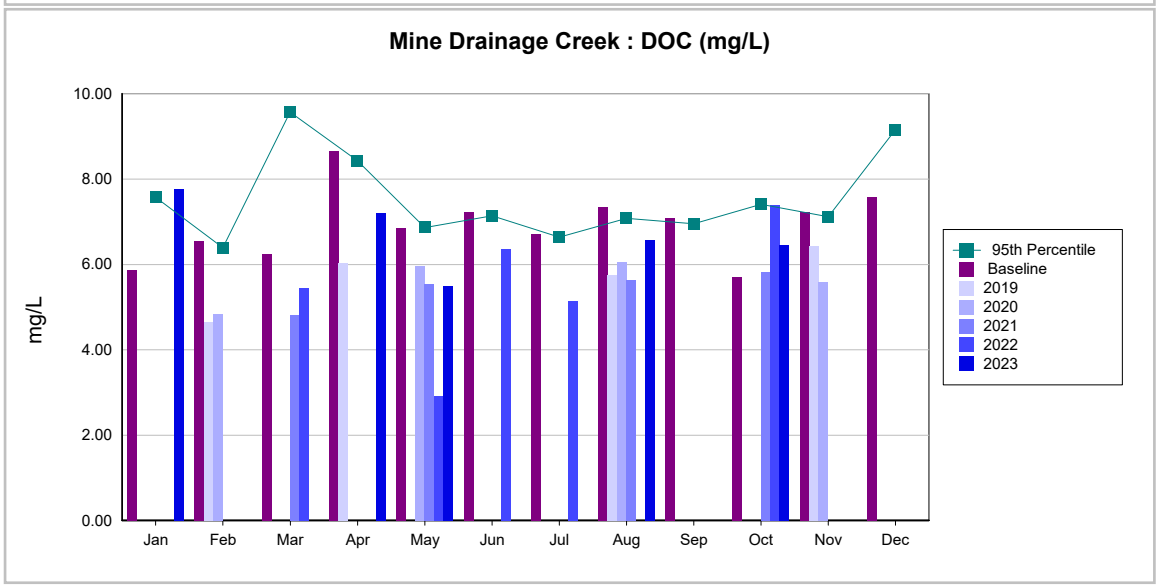
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







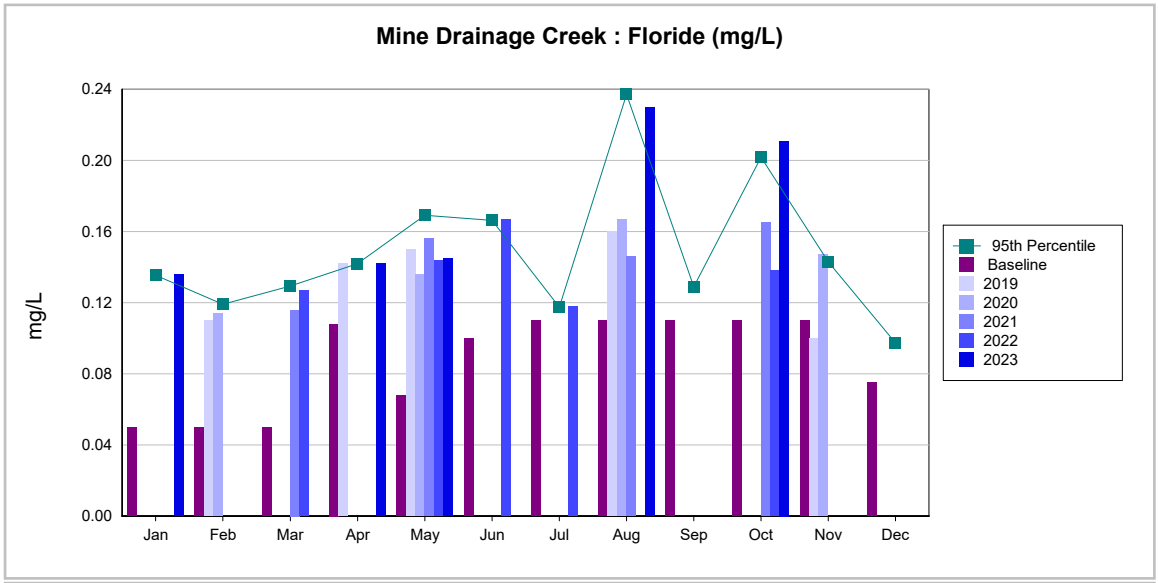
Water Quality Report

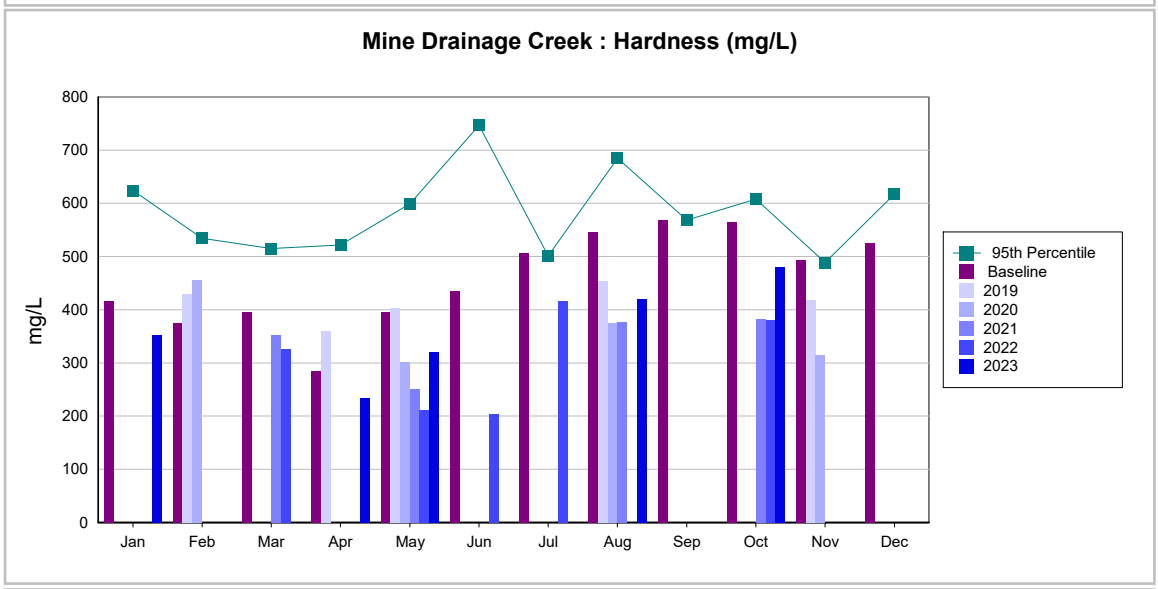
Annual Report Drainage Water

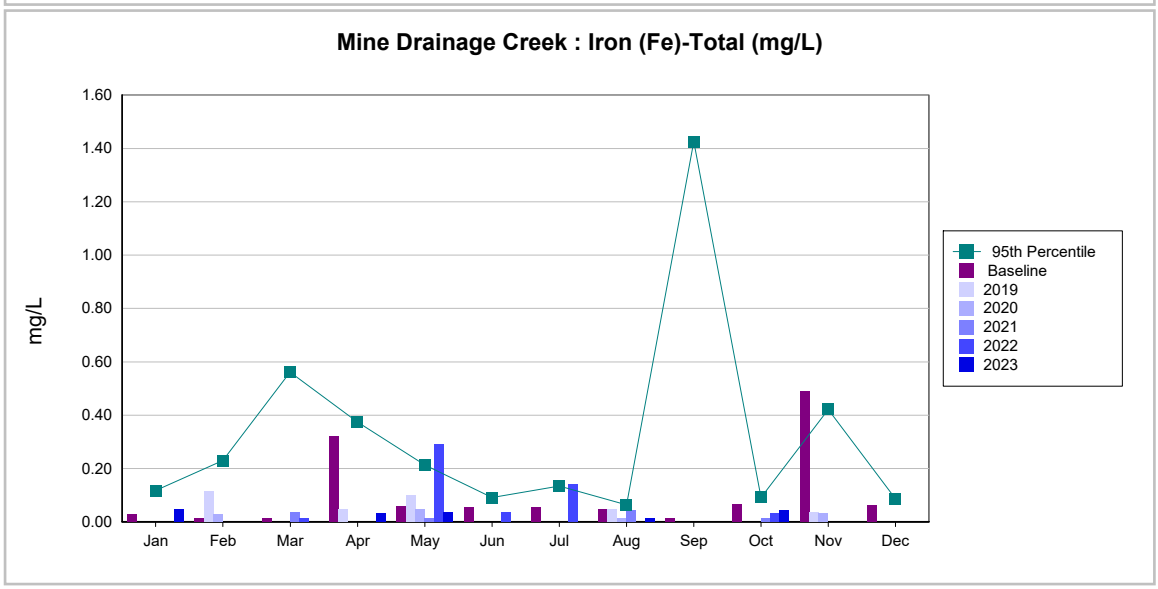
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







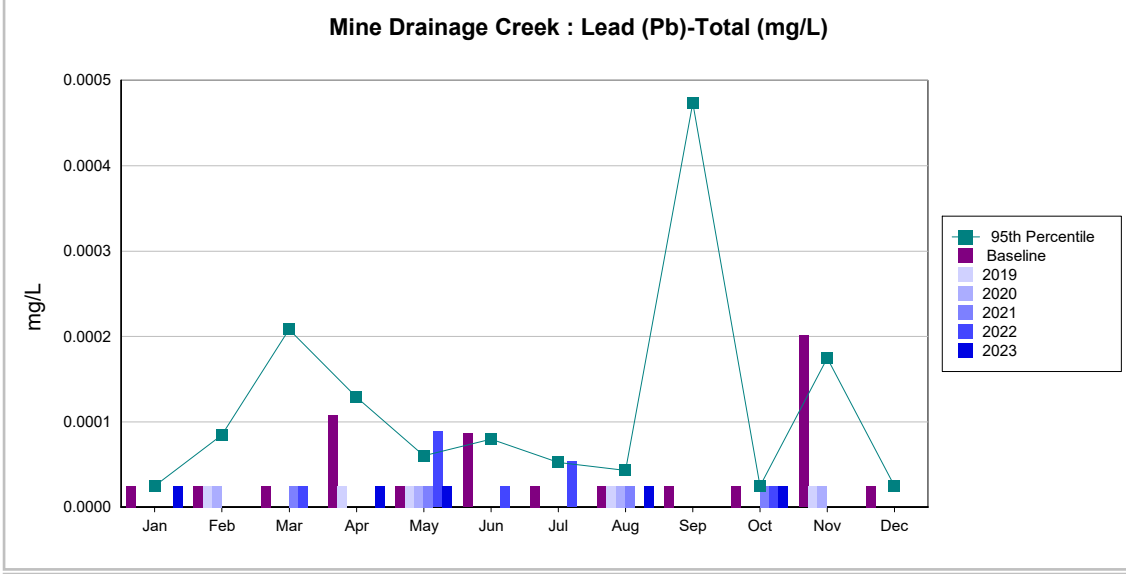
Water Quality Report

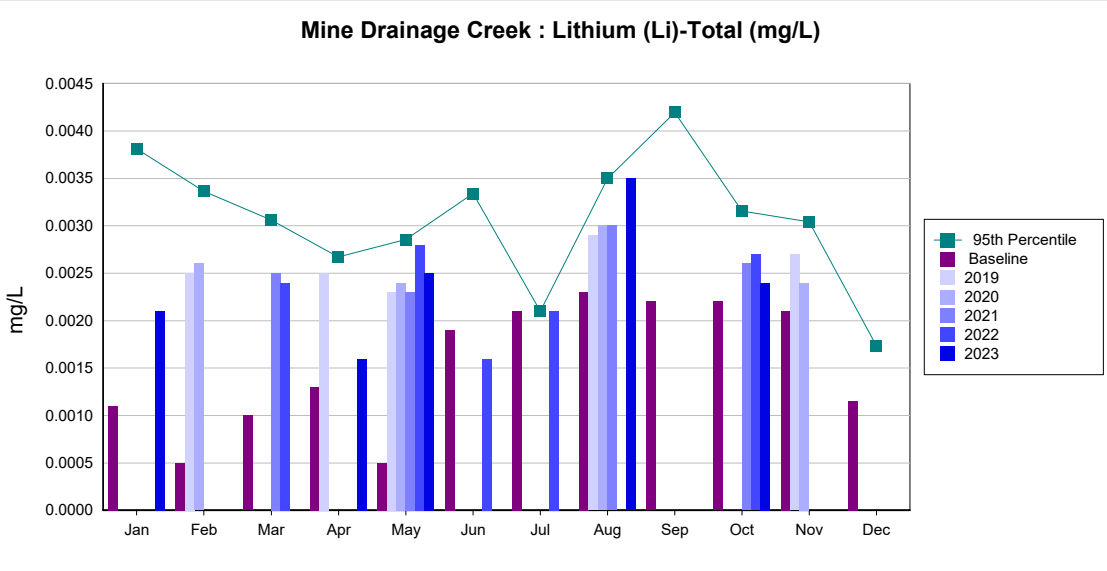
Annual Report Drainage Water

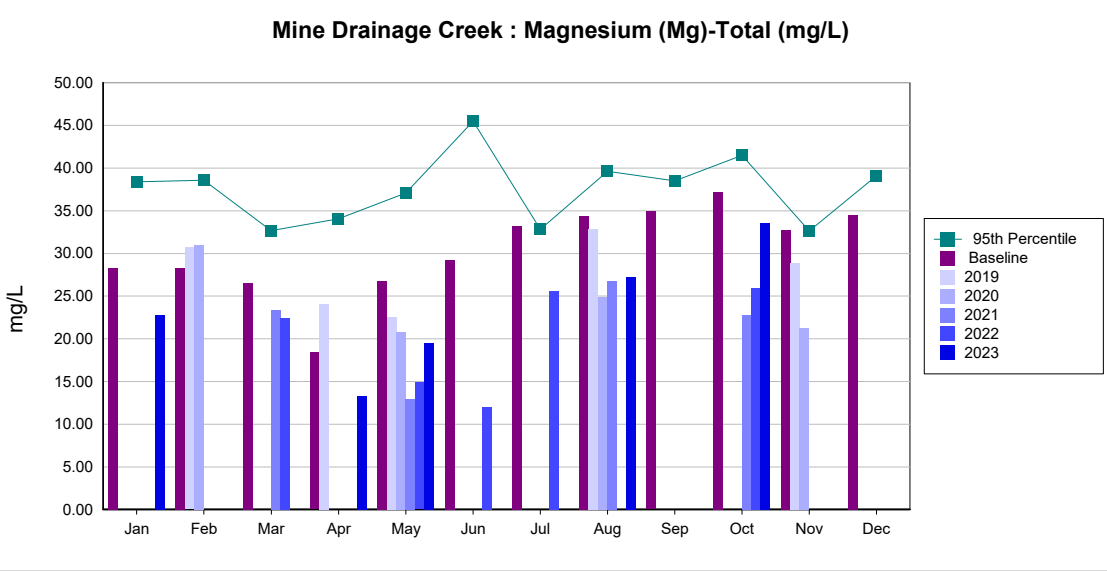
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







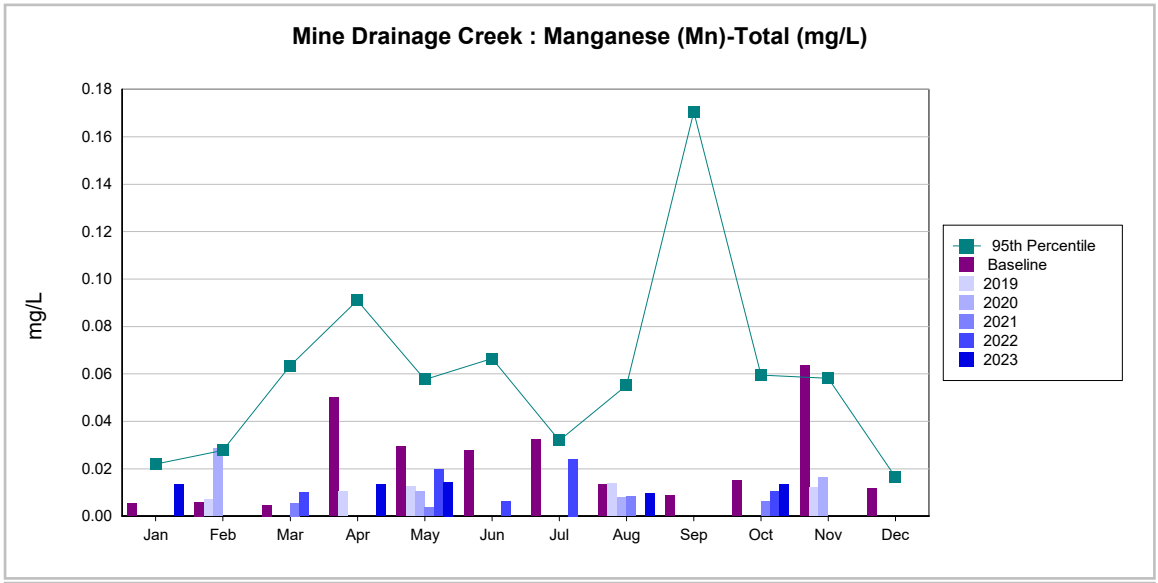
Water Quality Report

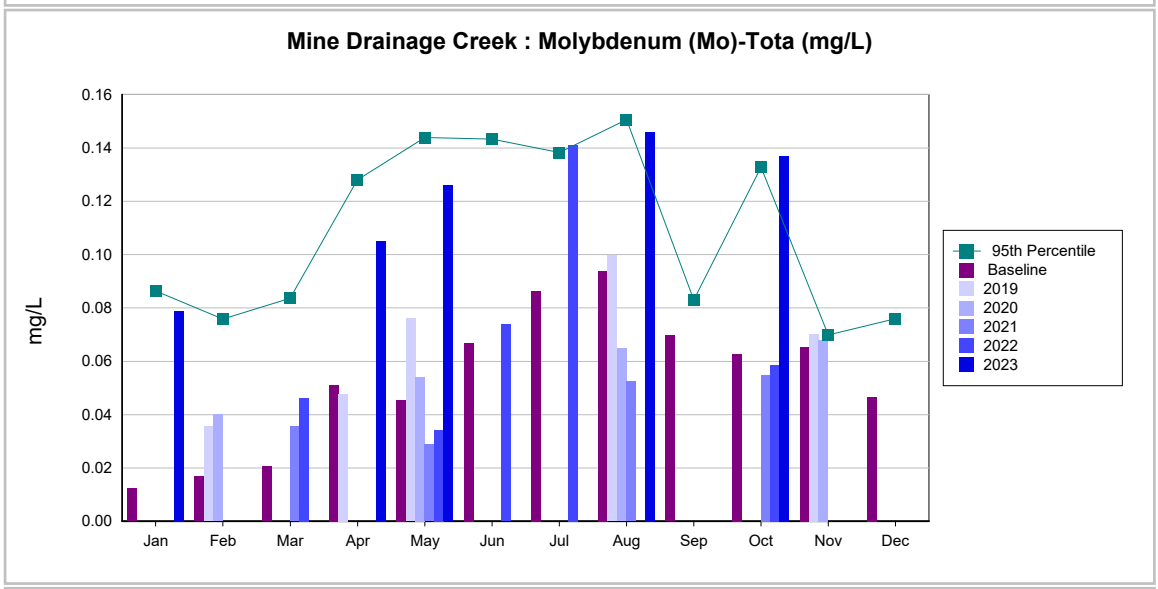
Annual Report Drainage Water

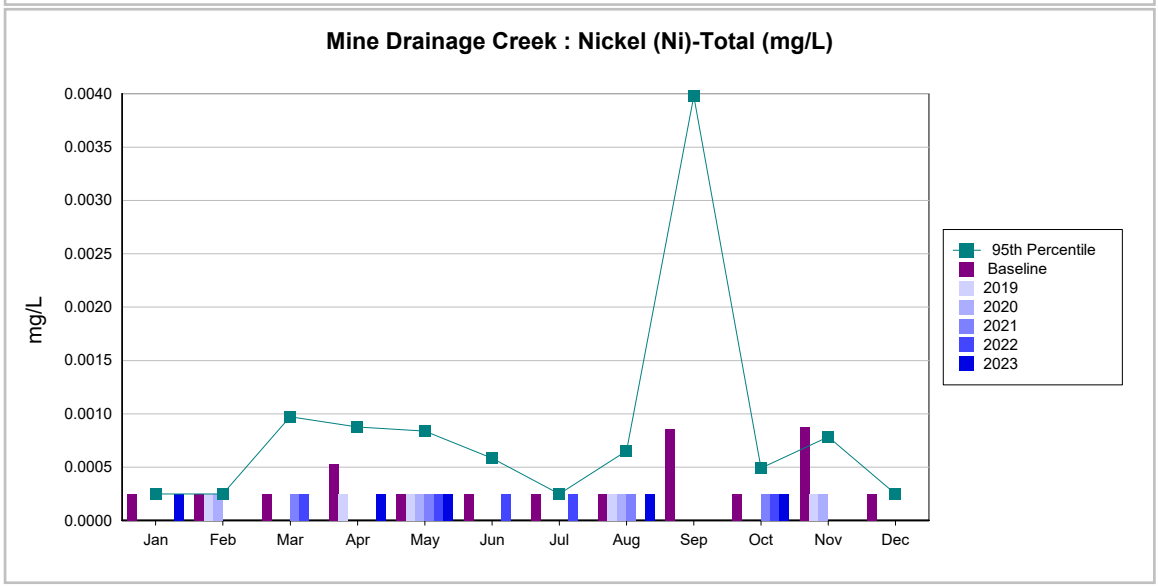
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







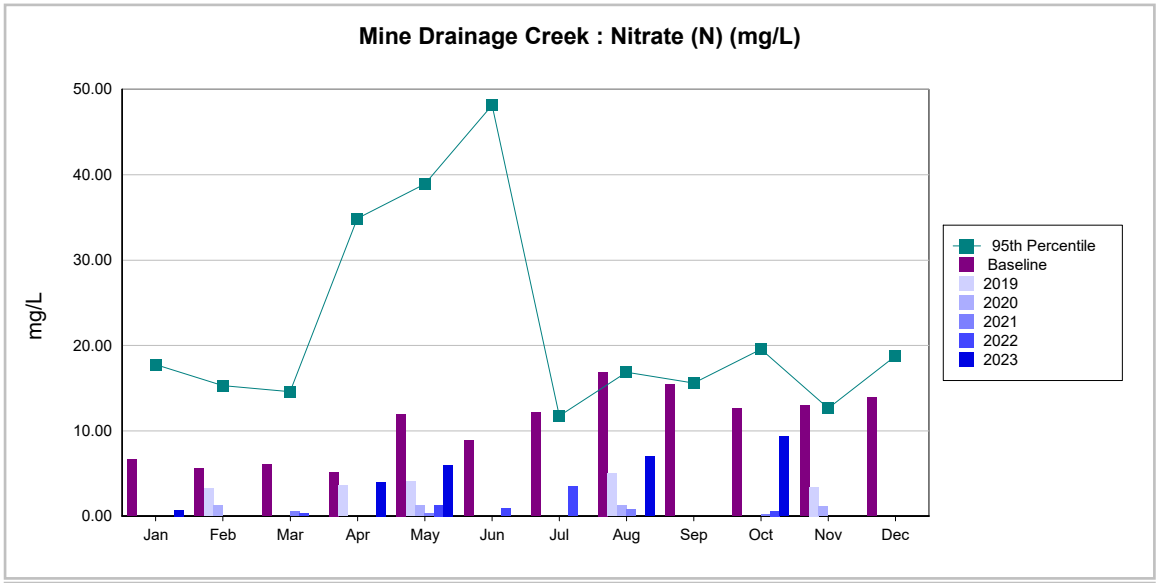
Water Quality Report

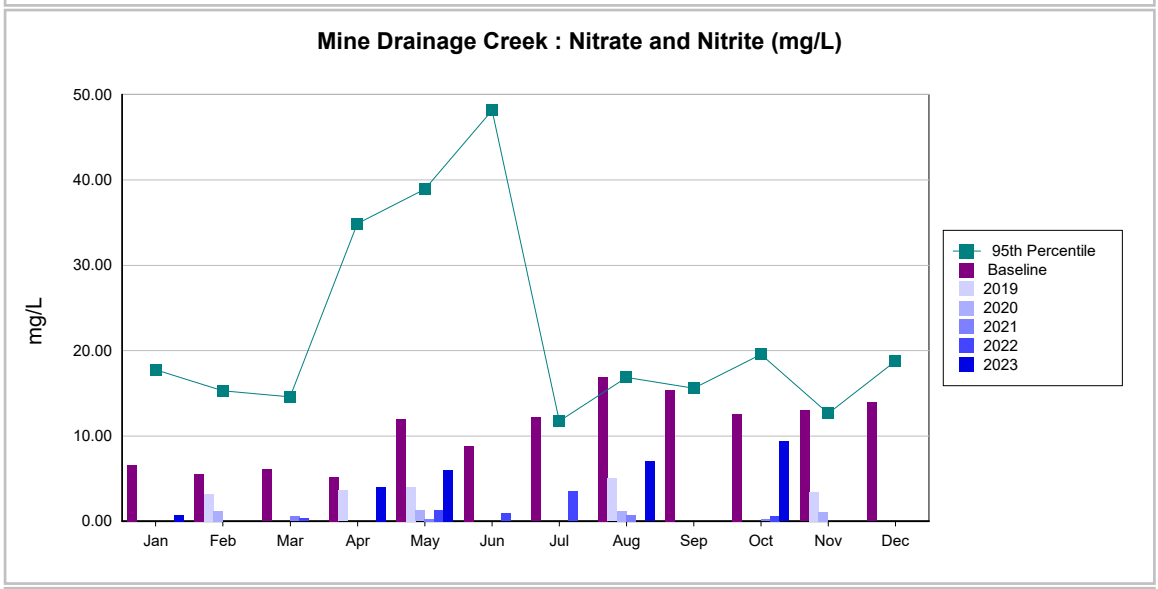
Annual Report Drainage Water

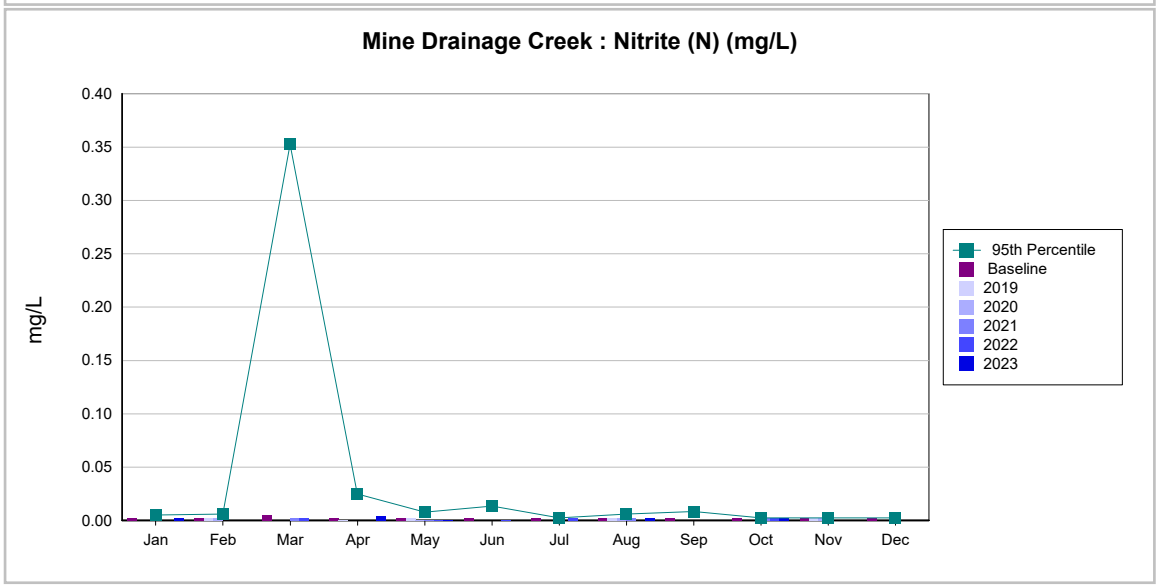
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







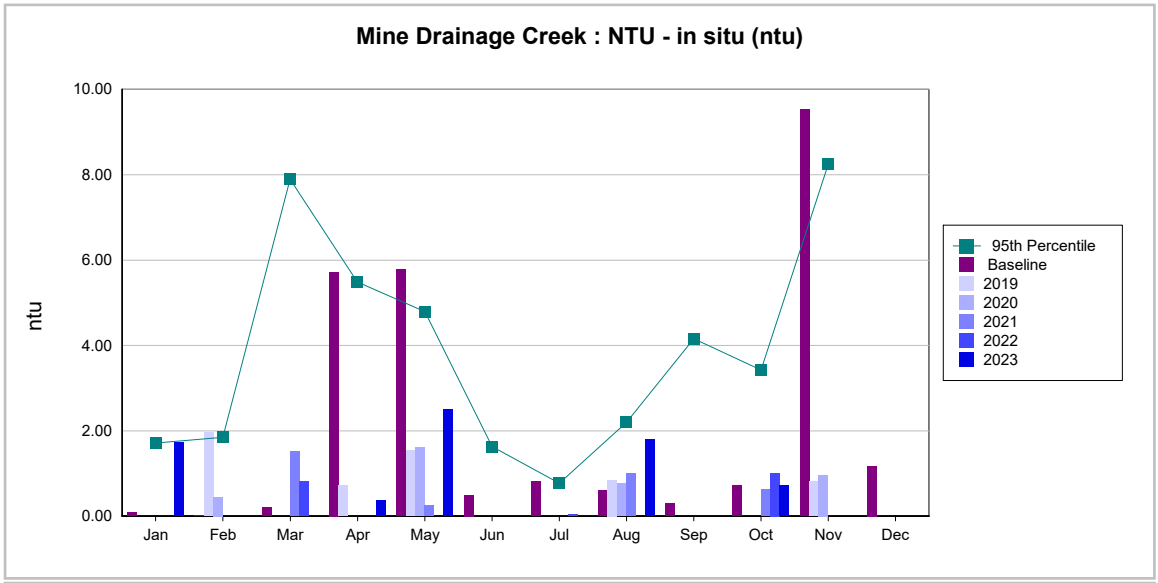
Water Quality Report

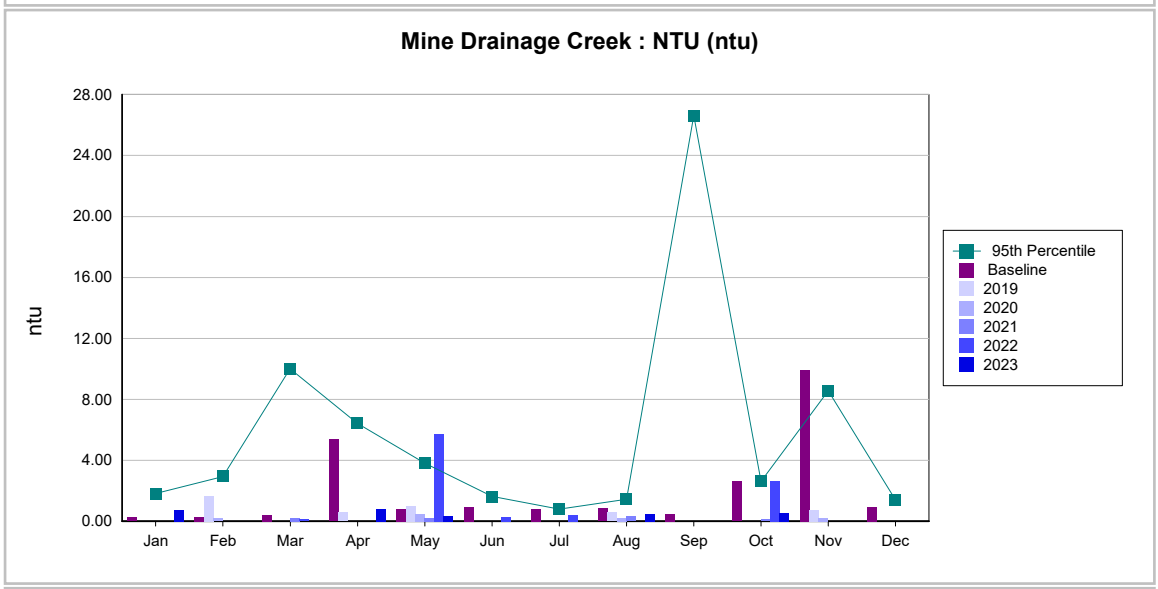
Annual Report Drainage Water

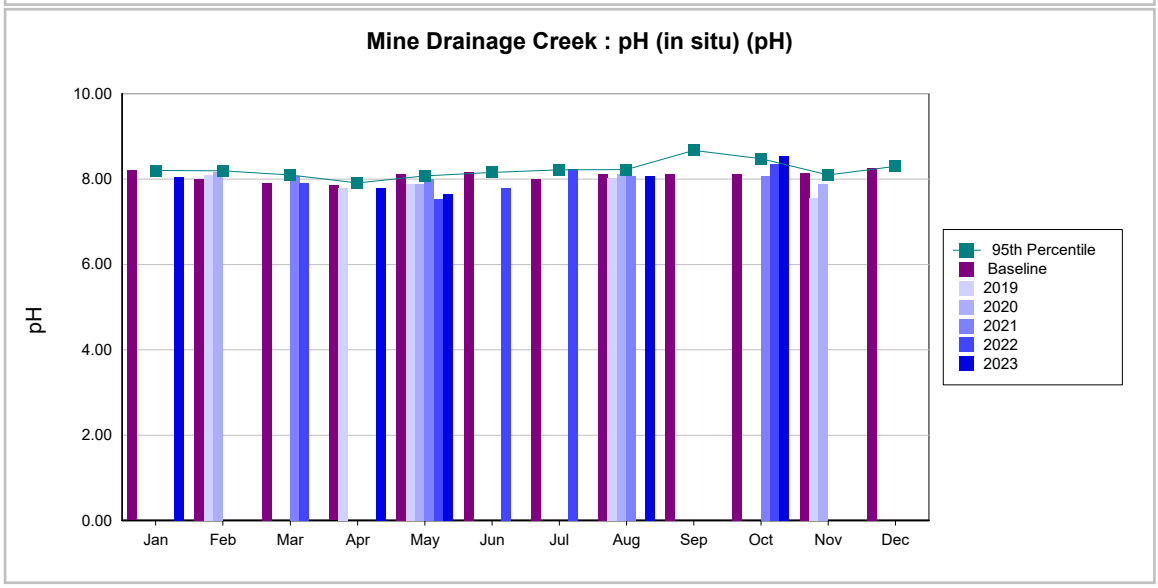
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







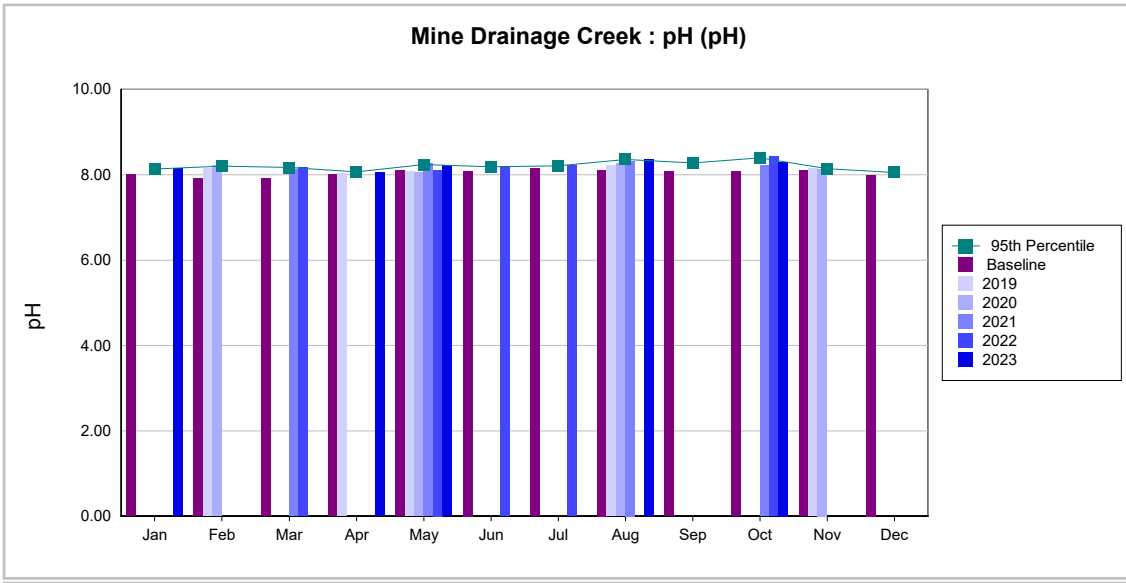
Water Quality Report

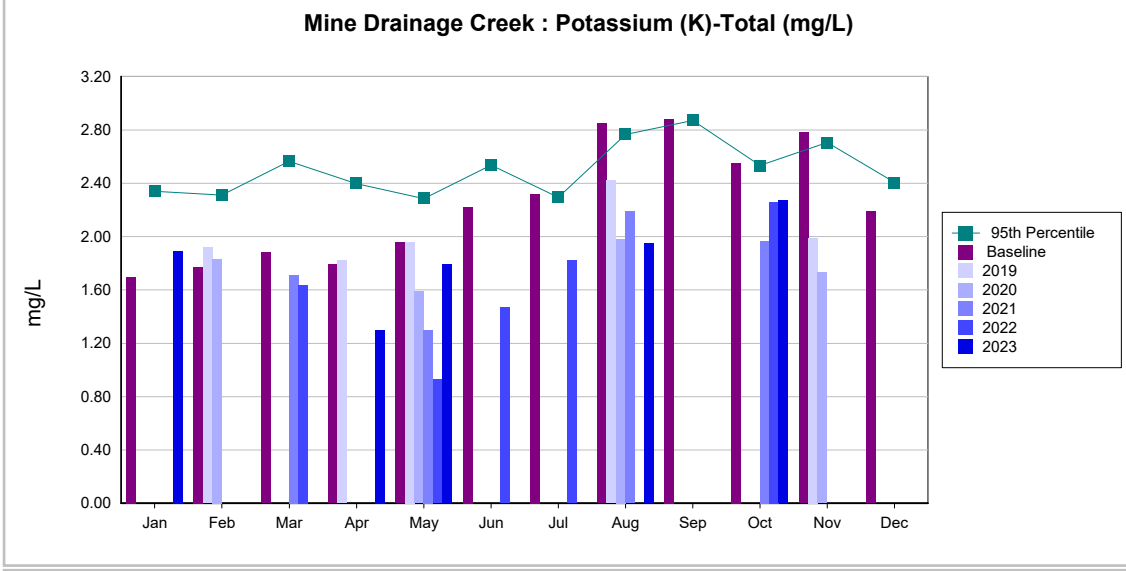
Annual Report Drainage Water

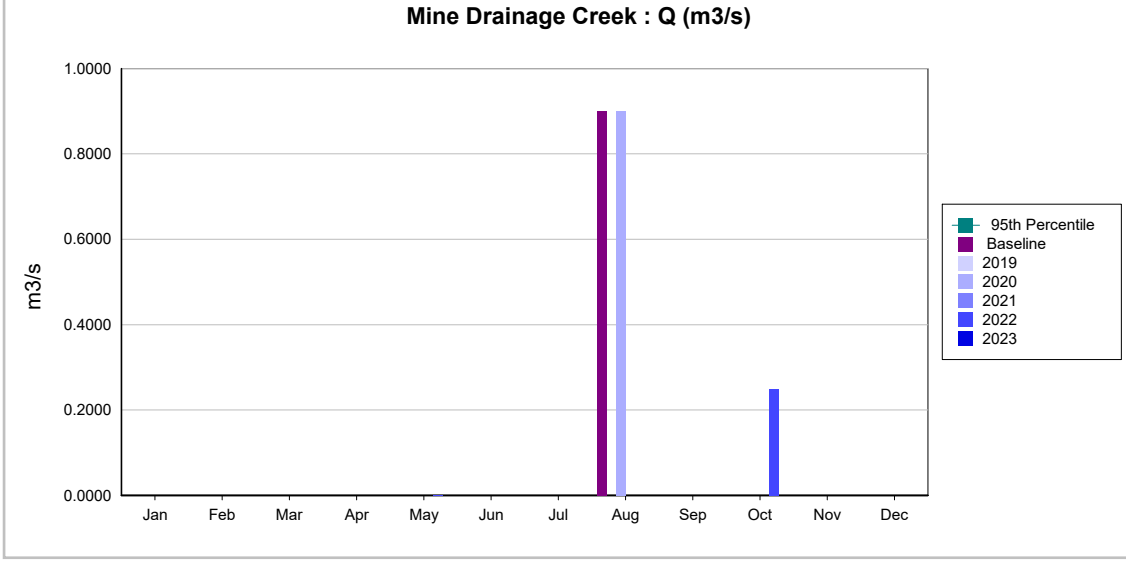
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

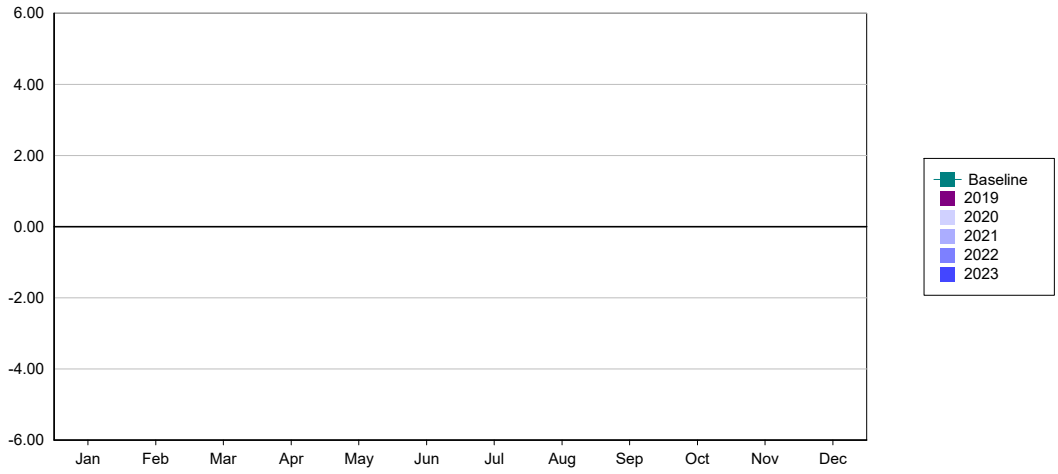
Annual Report Drainage Water

Mount Polley

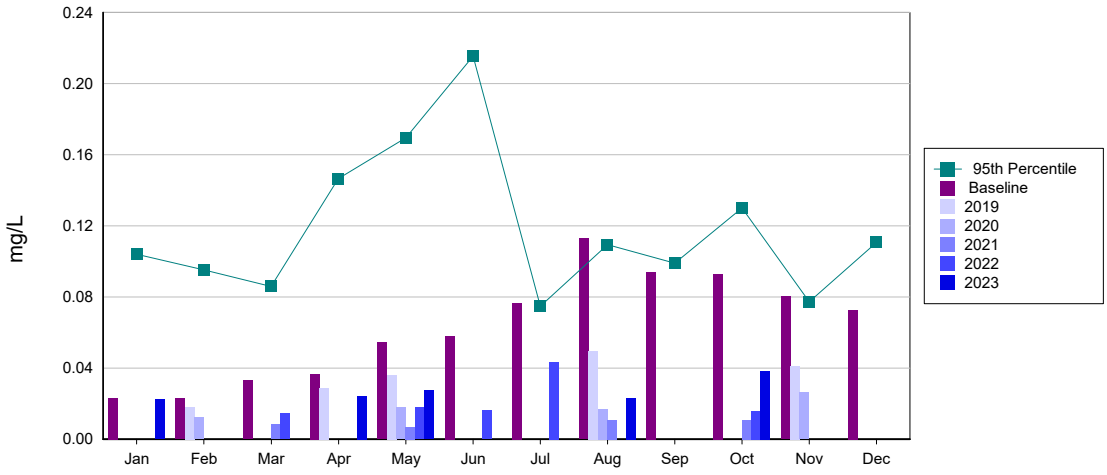
Mining Corporation

IMPERIAL METALS CORPORATION

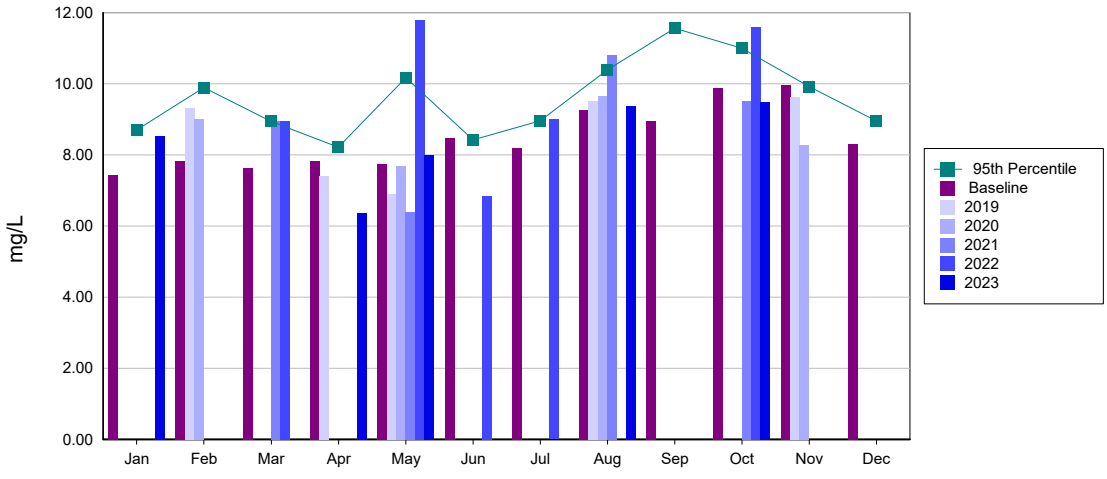
Mine Drainage Creek : Sample Taken



Mine Drainage Creek : Selenium (Se)-Total (mg/L)



Mine Drainage Creek : Silicon (Si)-Total (mg/L)



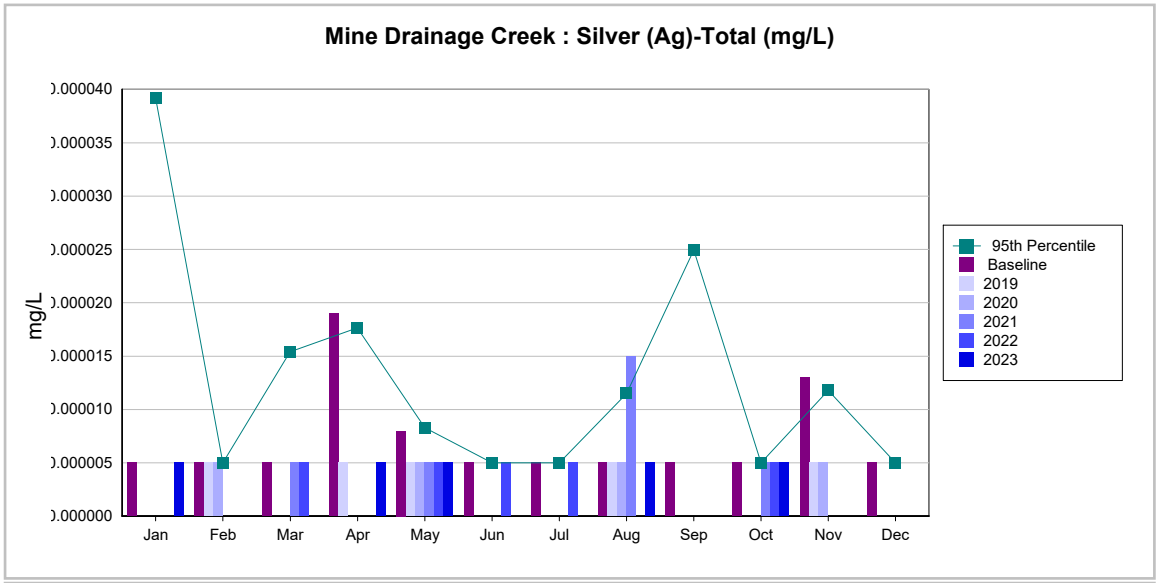
Water Quality Report

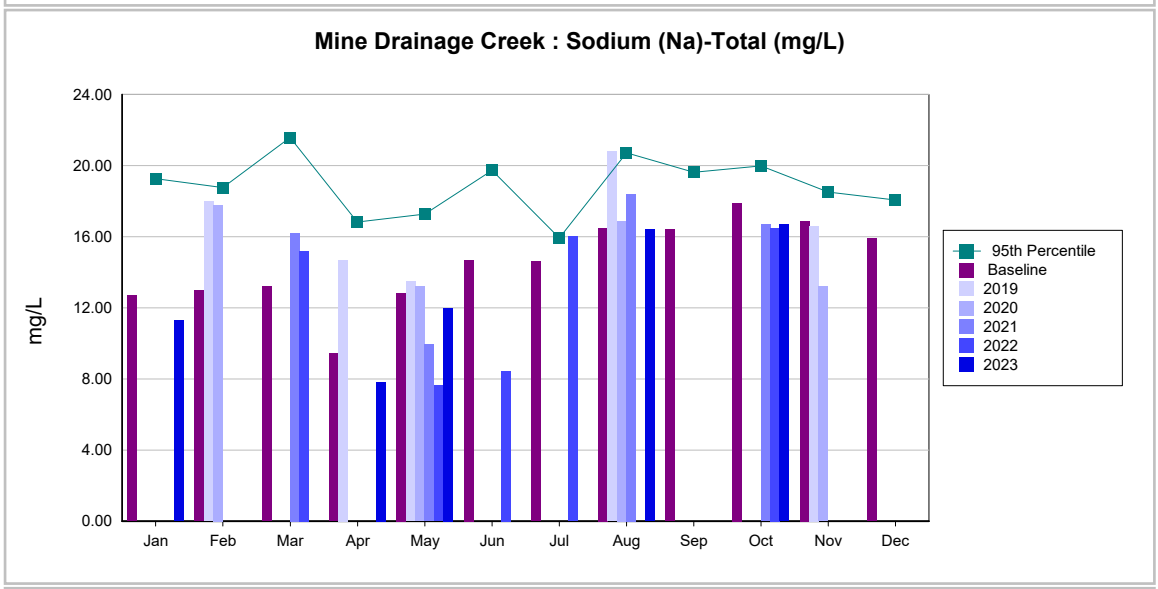
Annual Report Drainage Water

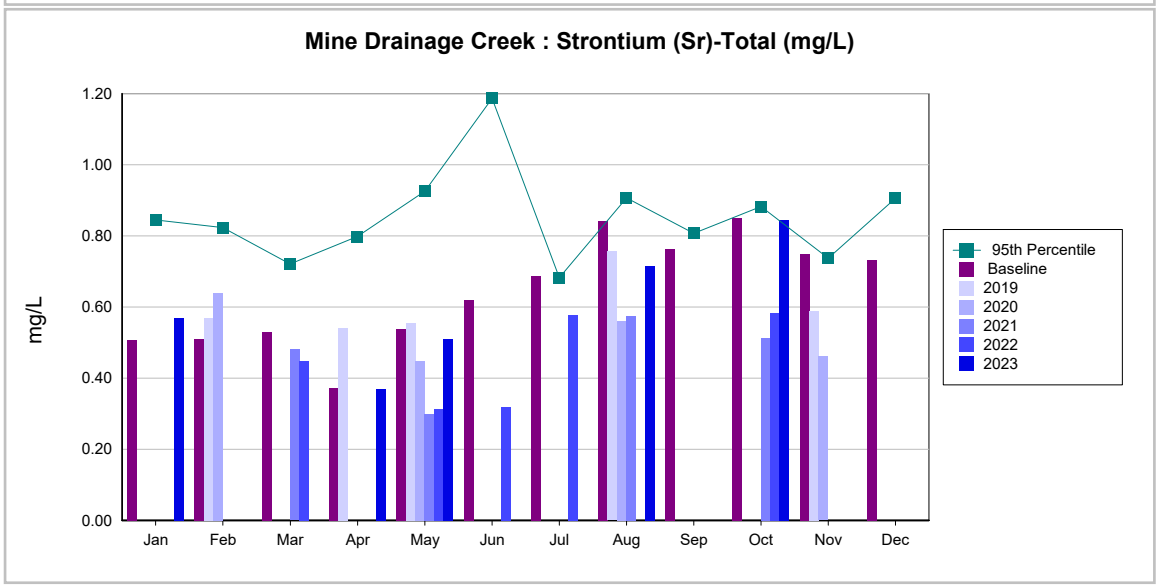
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







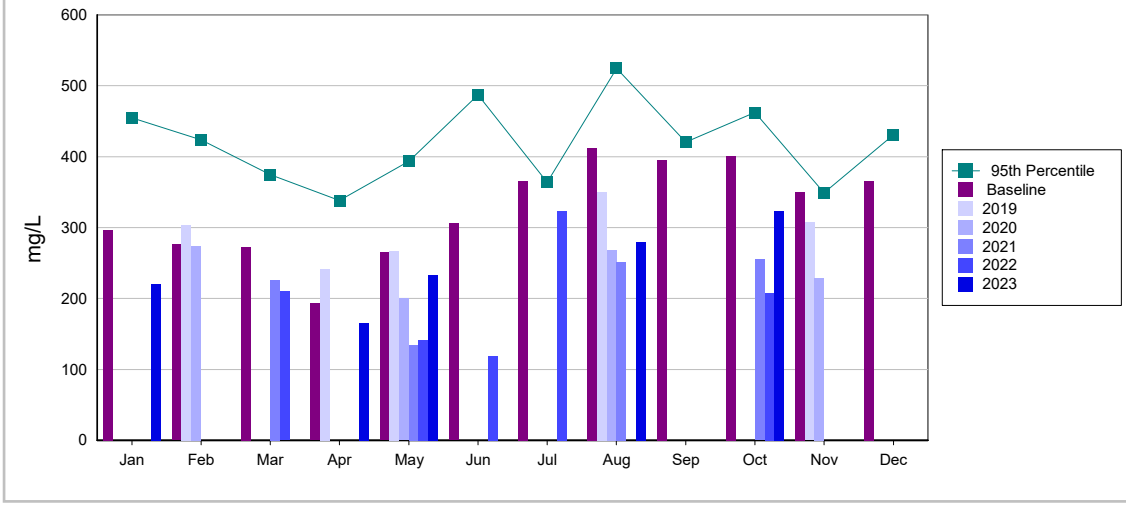
Water Quality Report

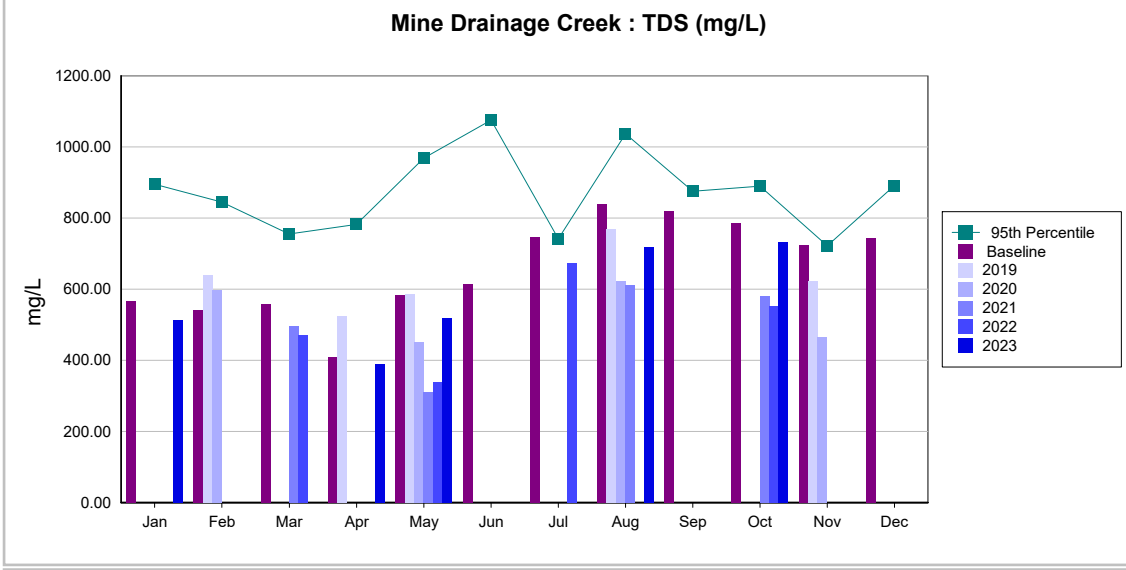
Annual Report Drainage Water

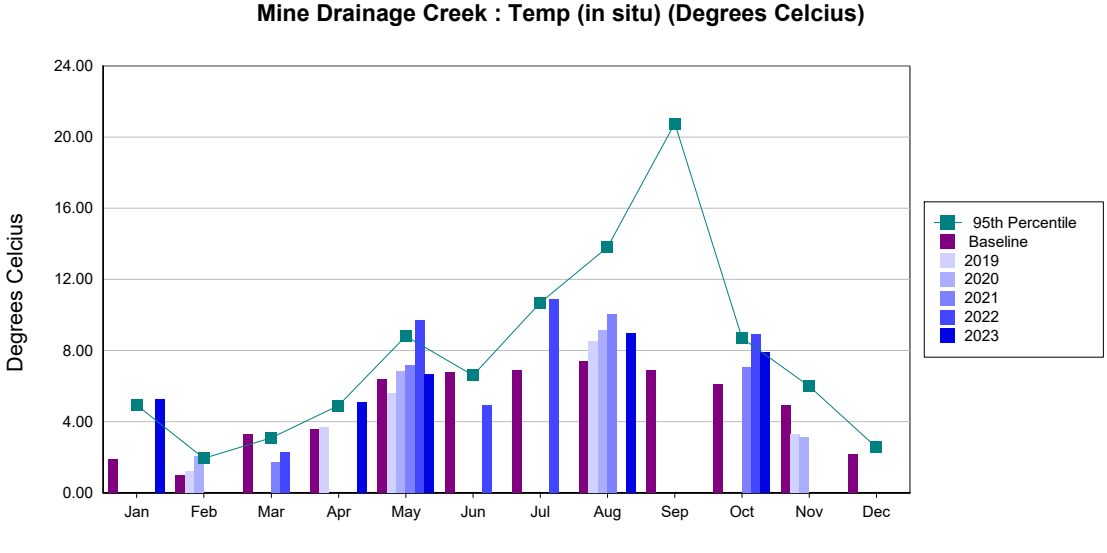
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







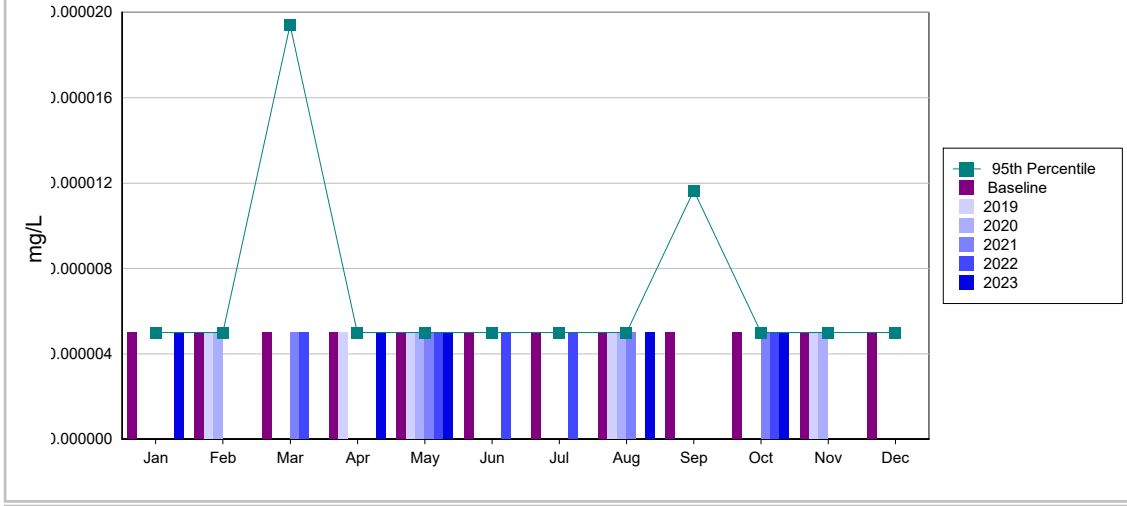
Water Quality Report

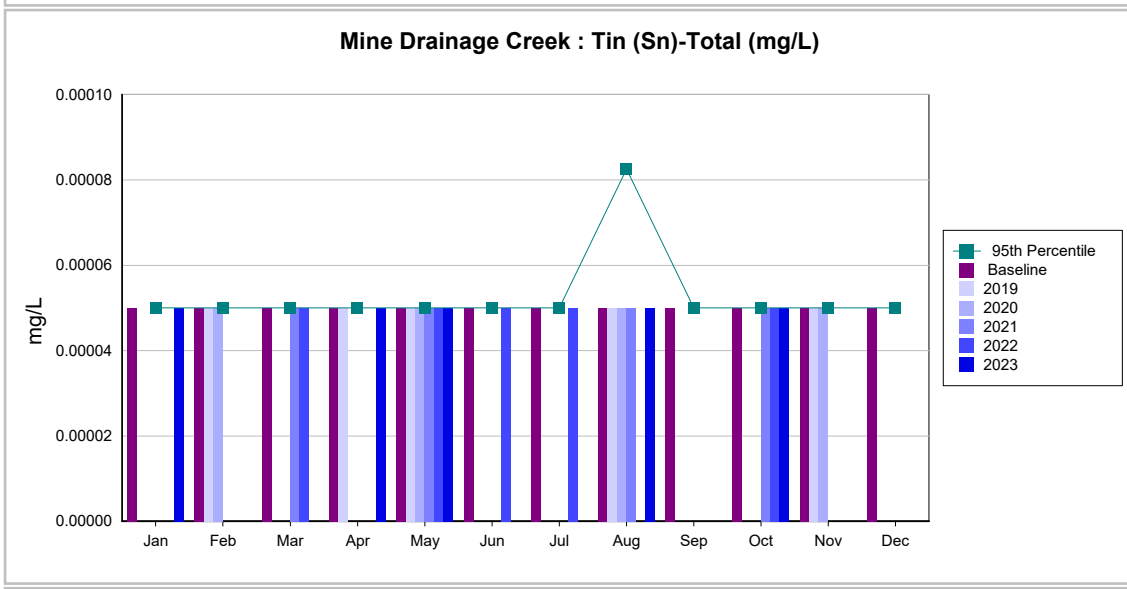
Annual Report Drainage Water

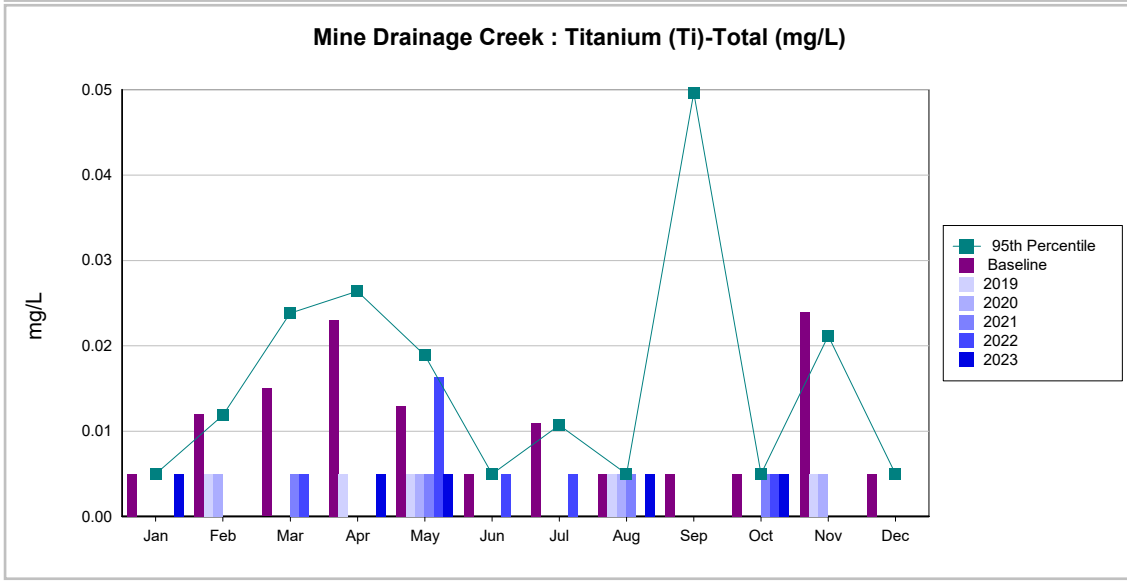
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







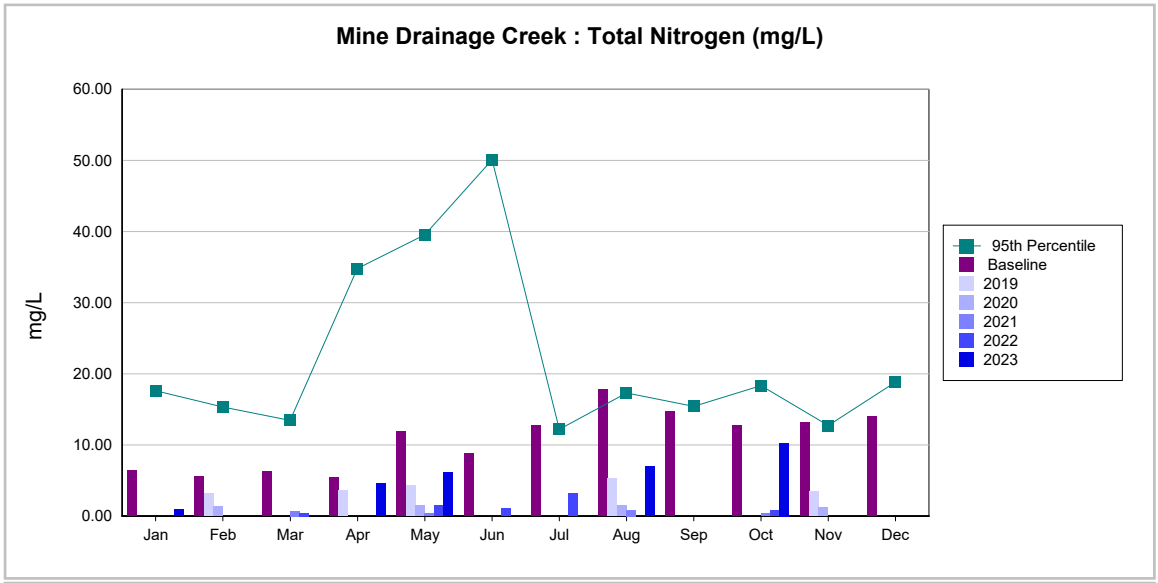
Water Quality Report

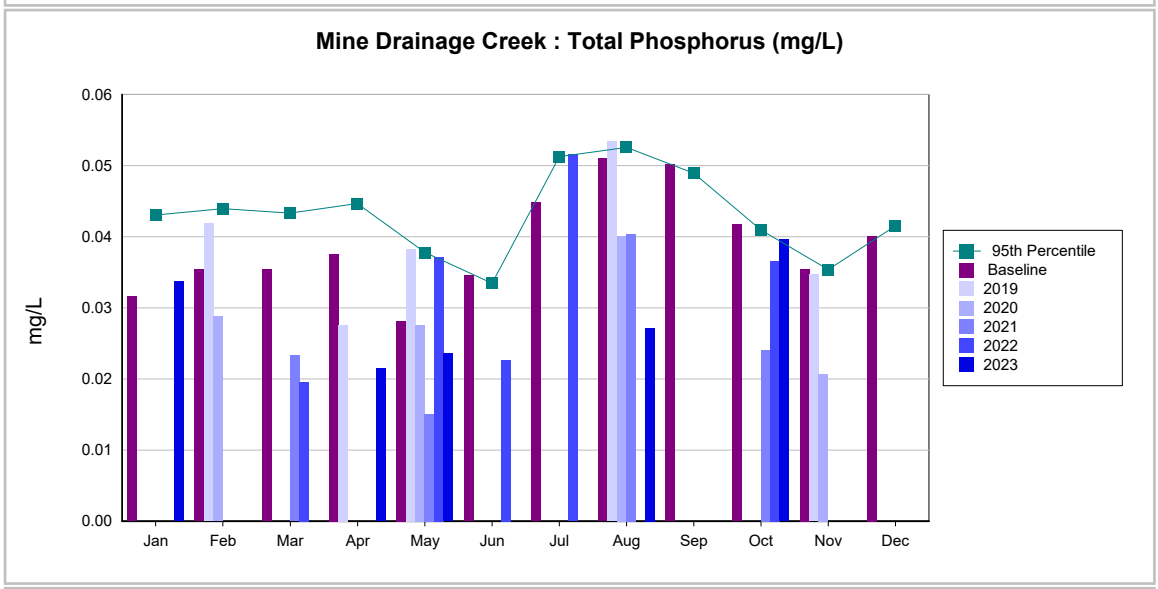
Annual Report Drainage Water

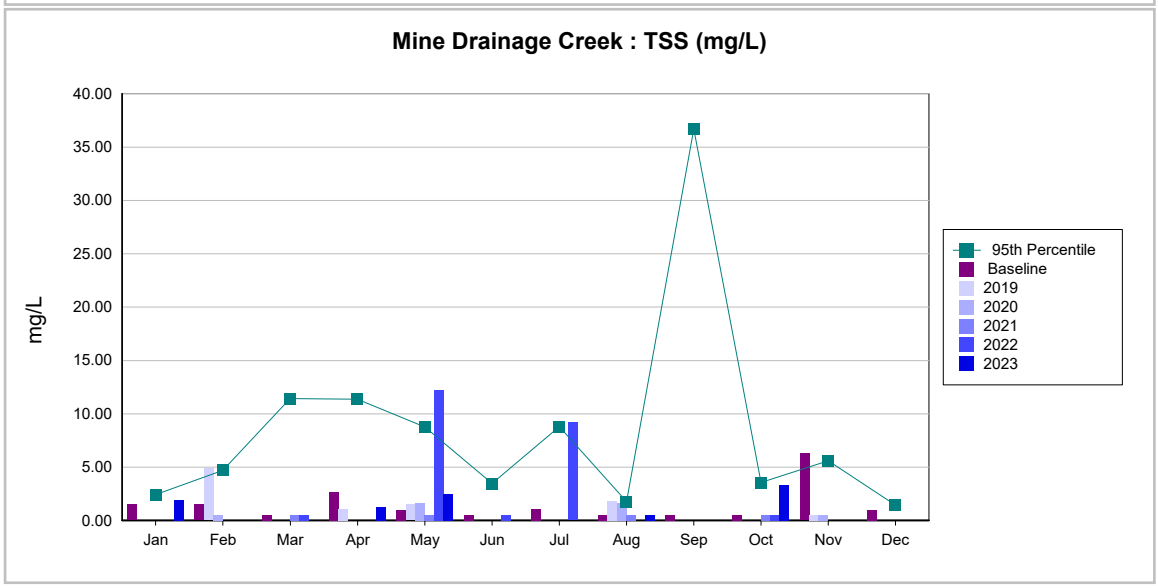
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







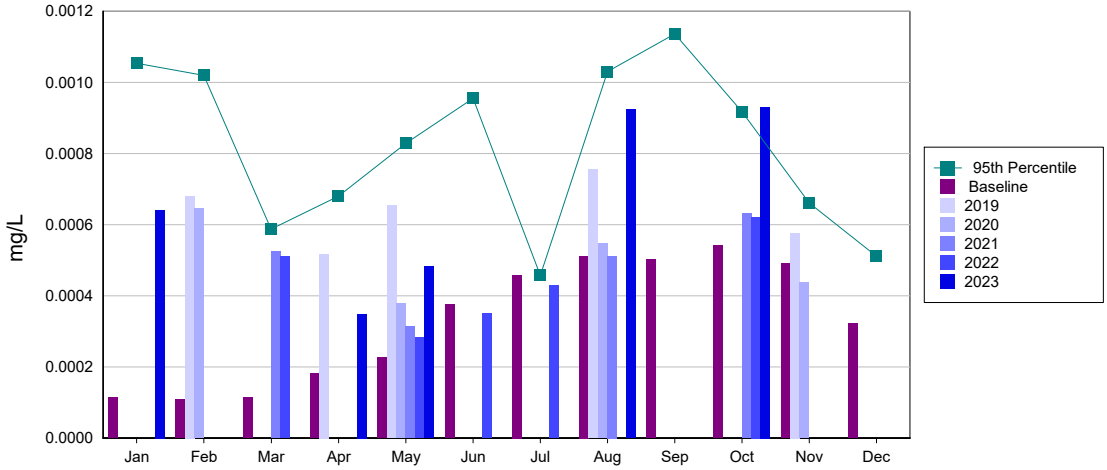
Water Quality Report

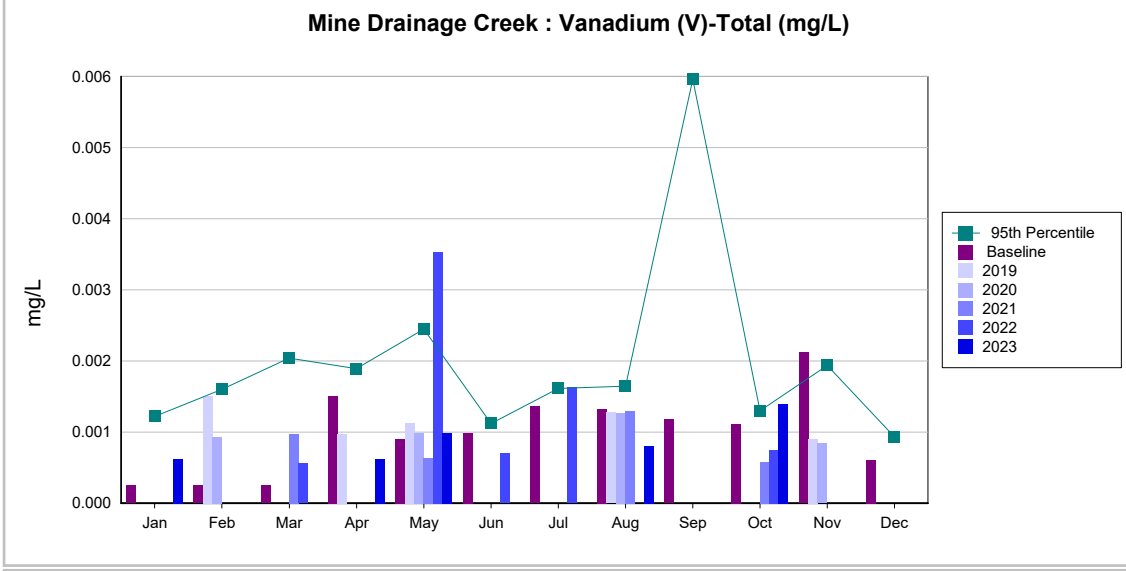
Annual Report Drainage Water

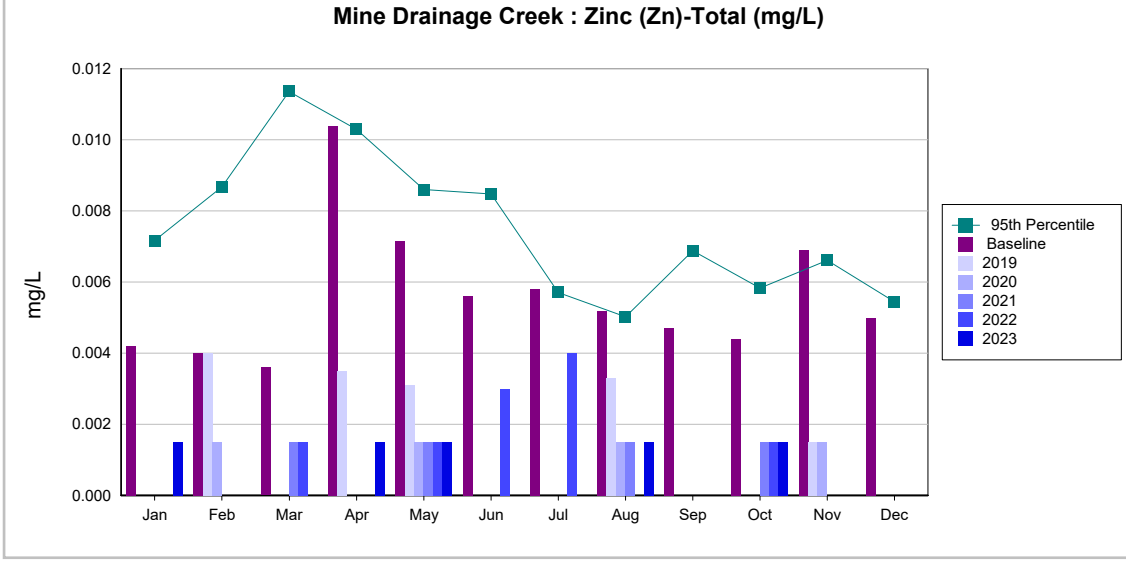
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







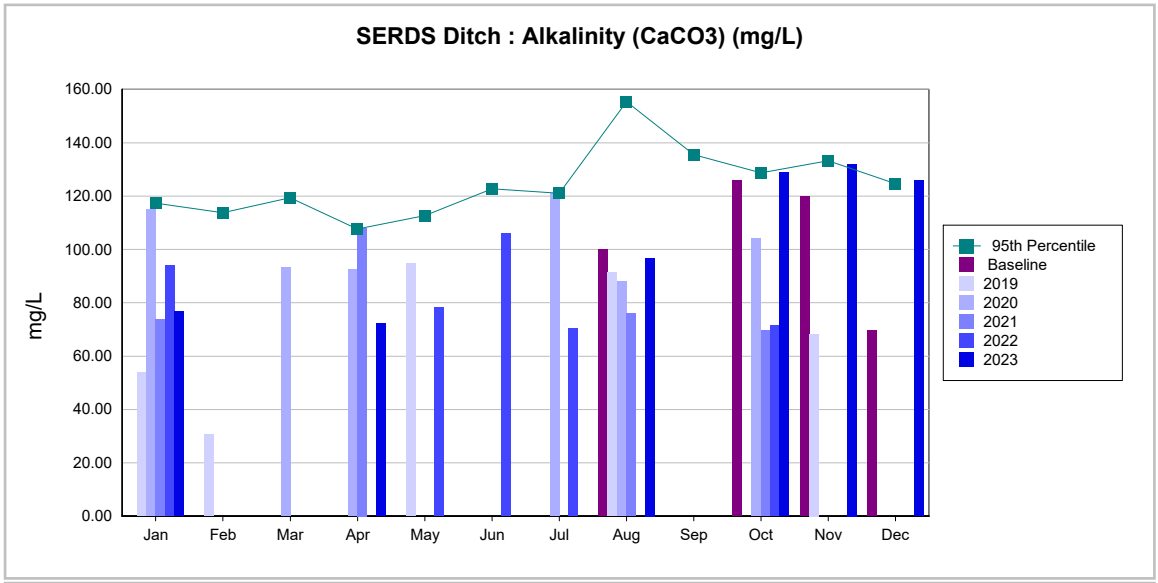
Water Quality Report

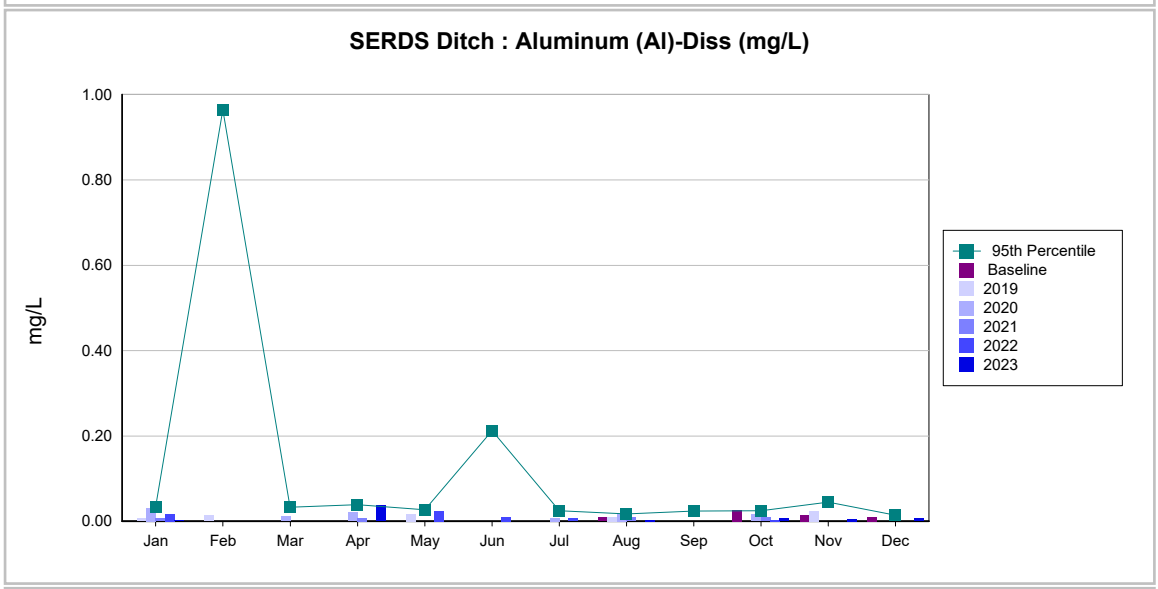
Annual Report Drainage Water

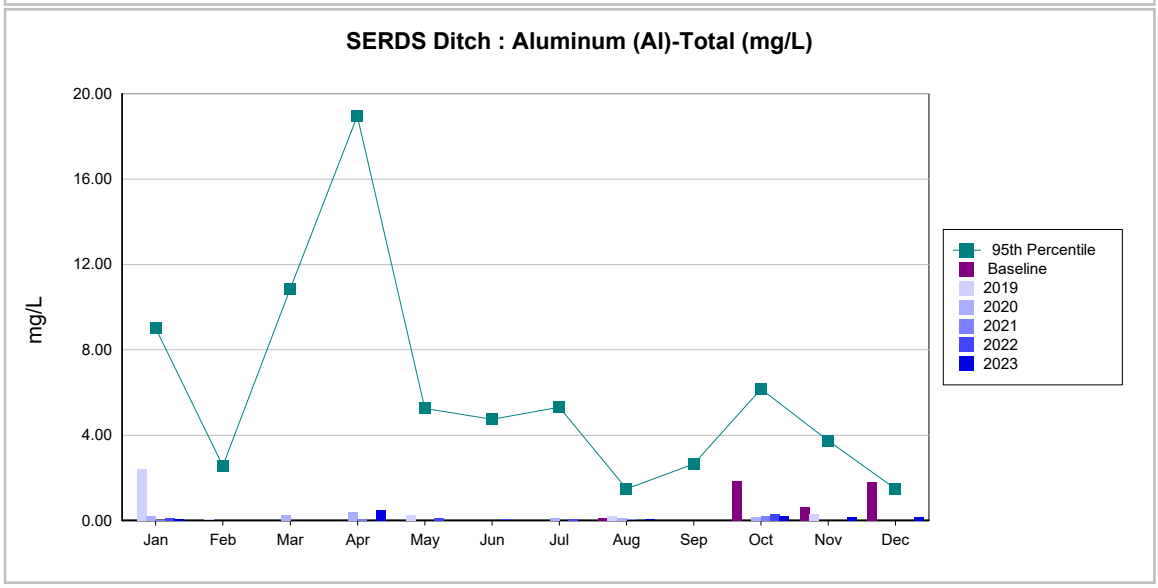
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







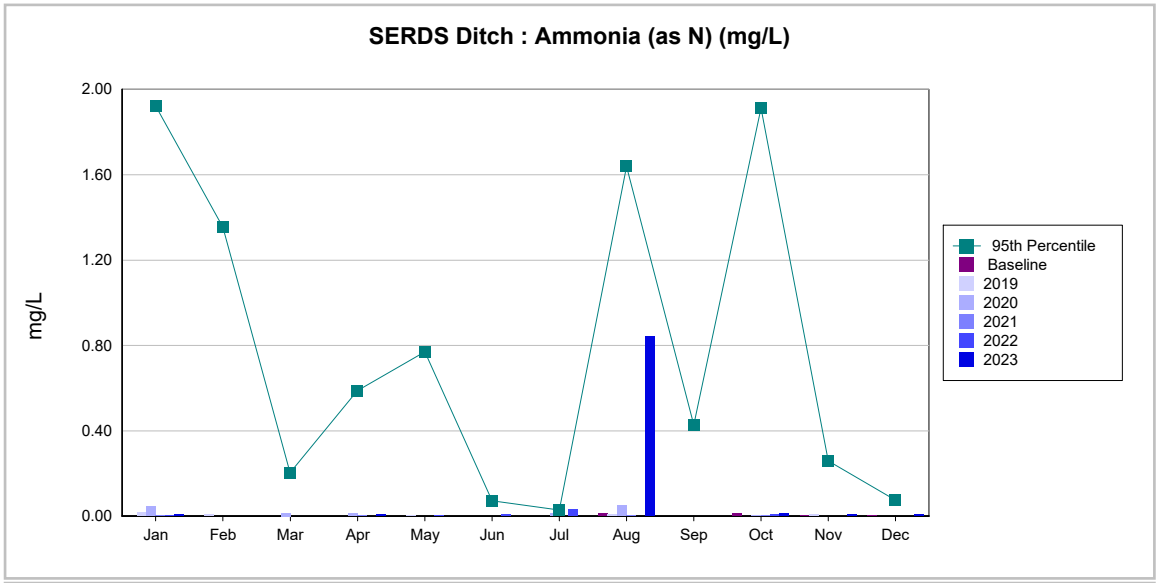
Water Quality Report

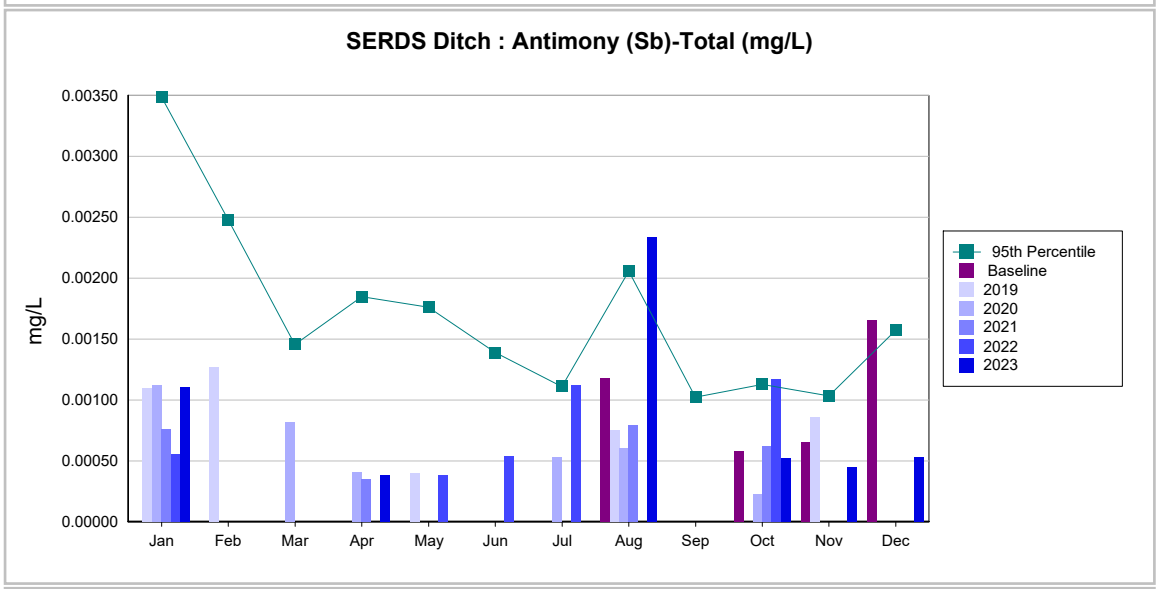
Annual Report Drainage Water

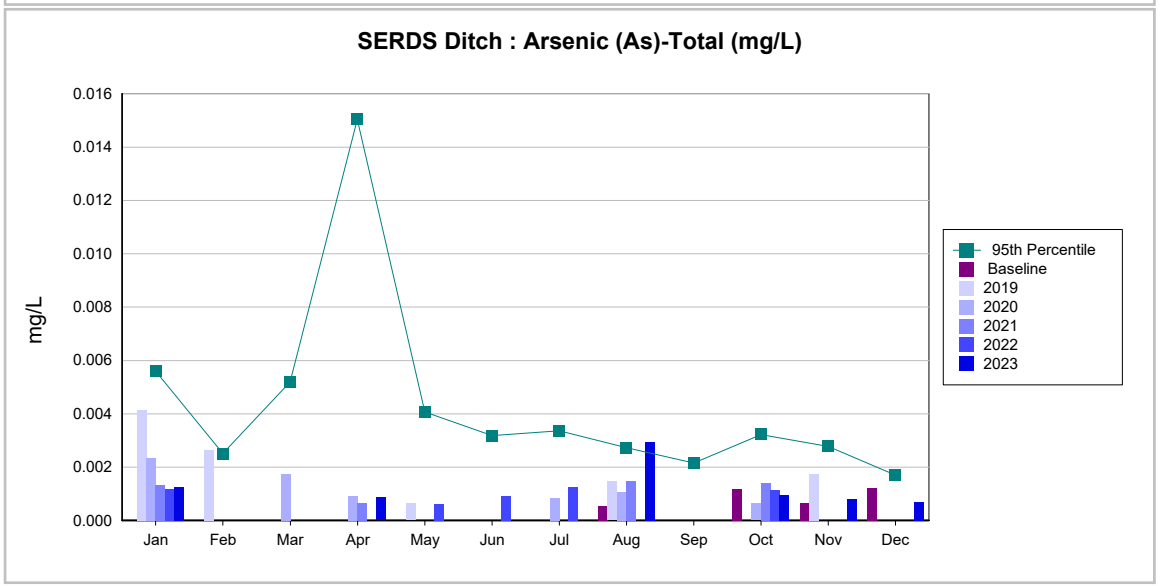
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







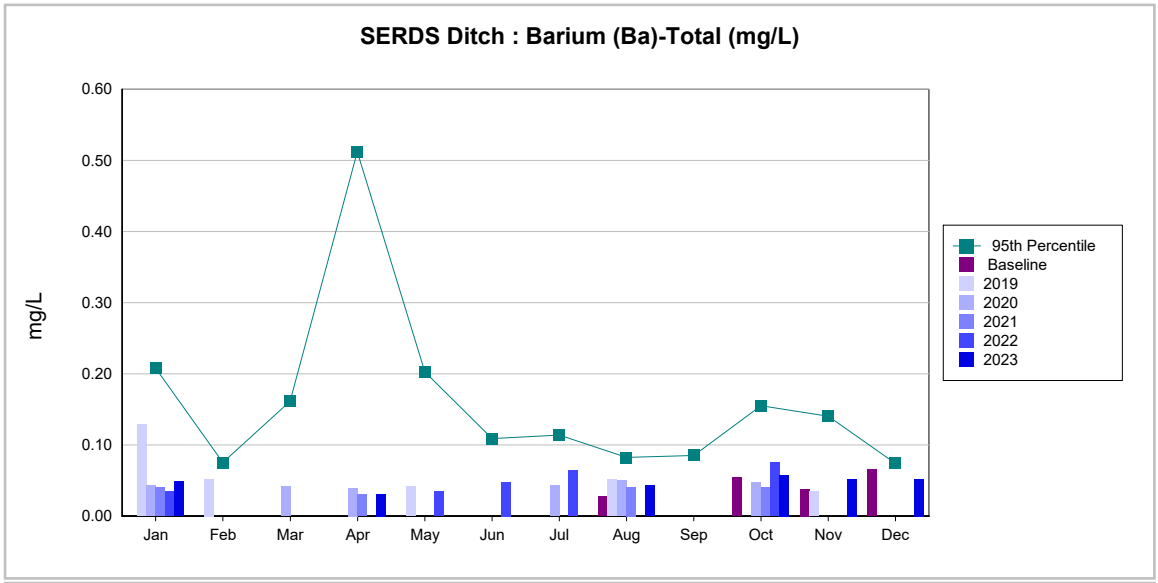
Water Quality Report

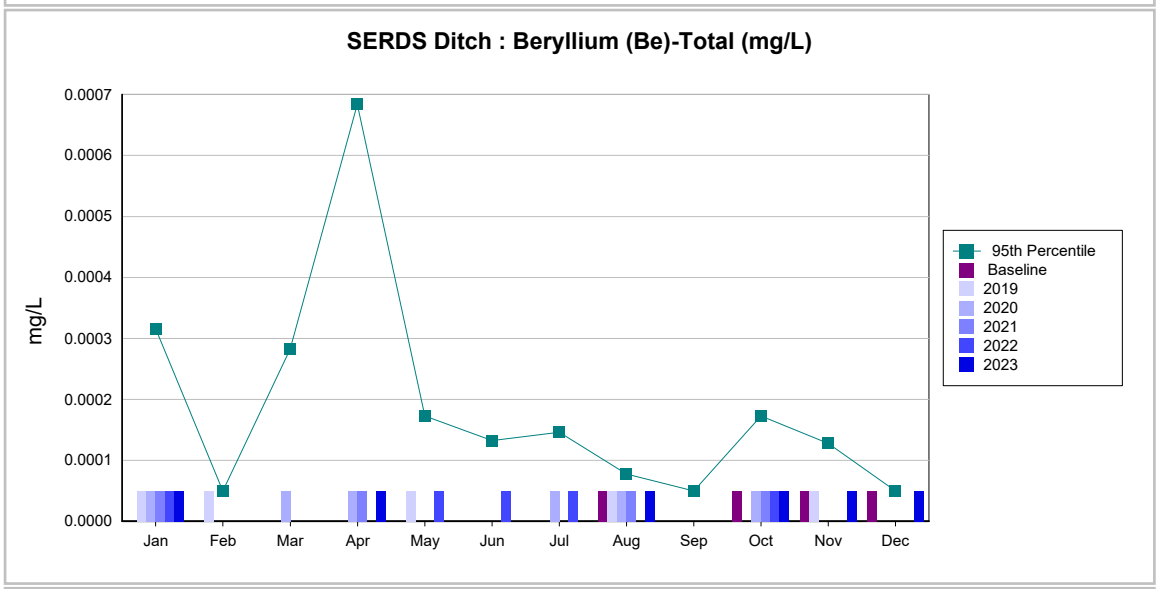
Annual Report Drainage Water

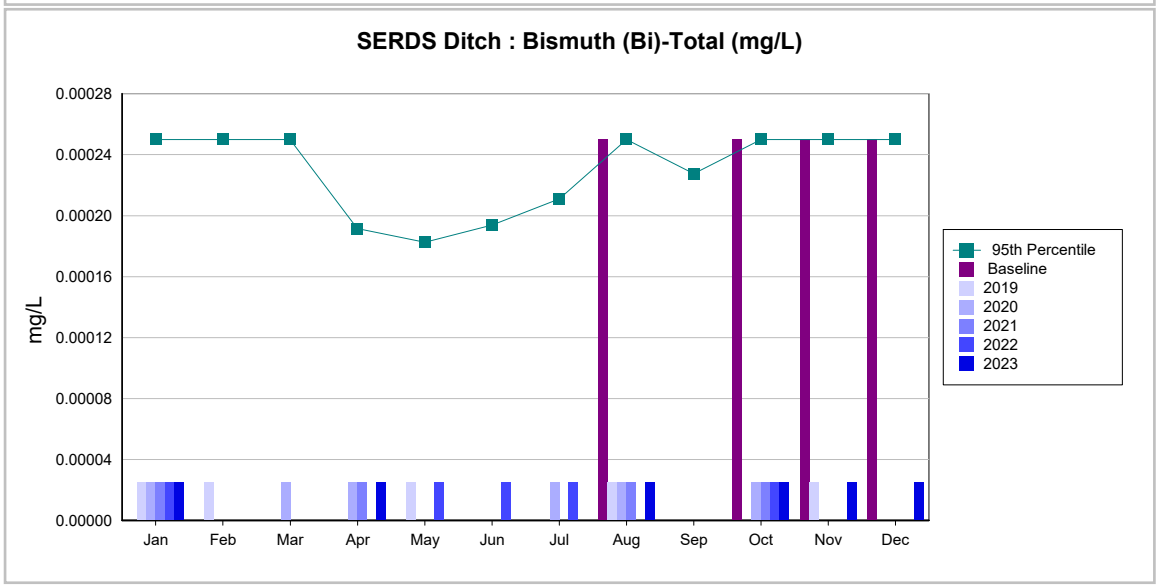
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







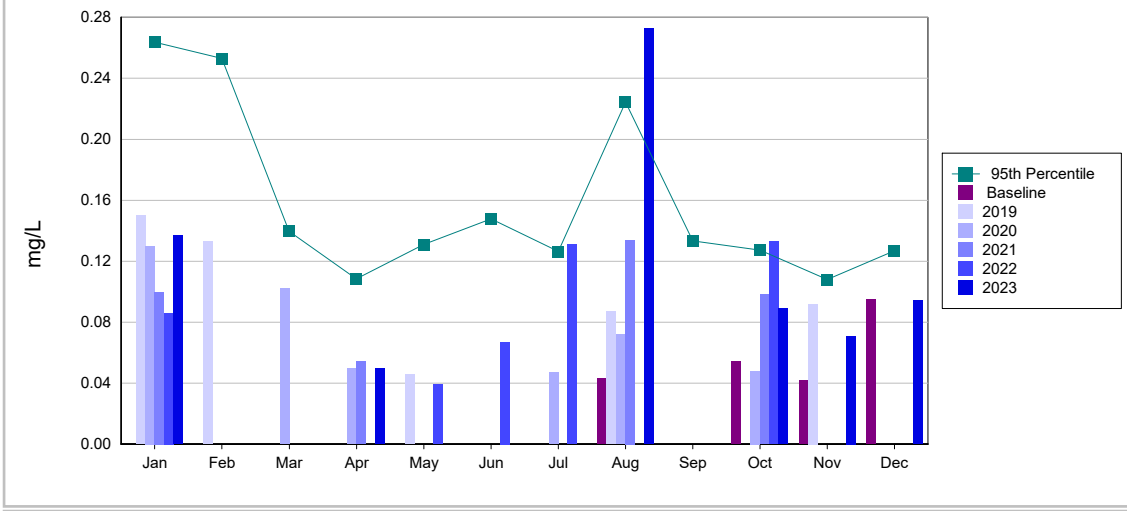
Water Quality Report

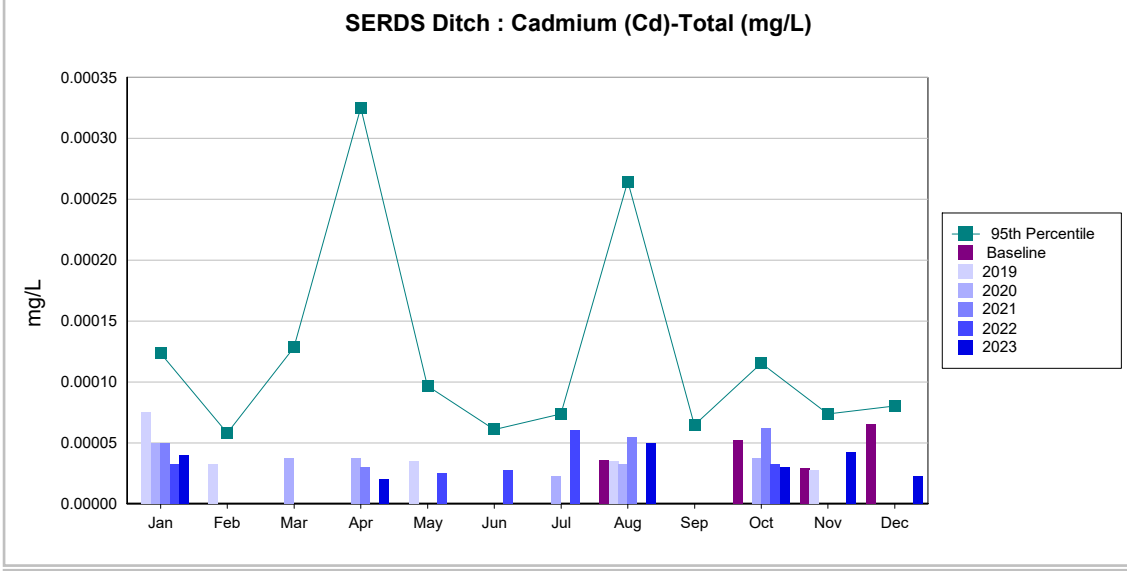
Annual Report Drainage Water

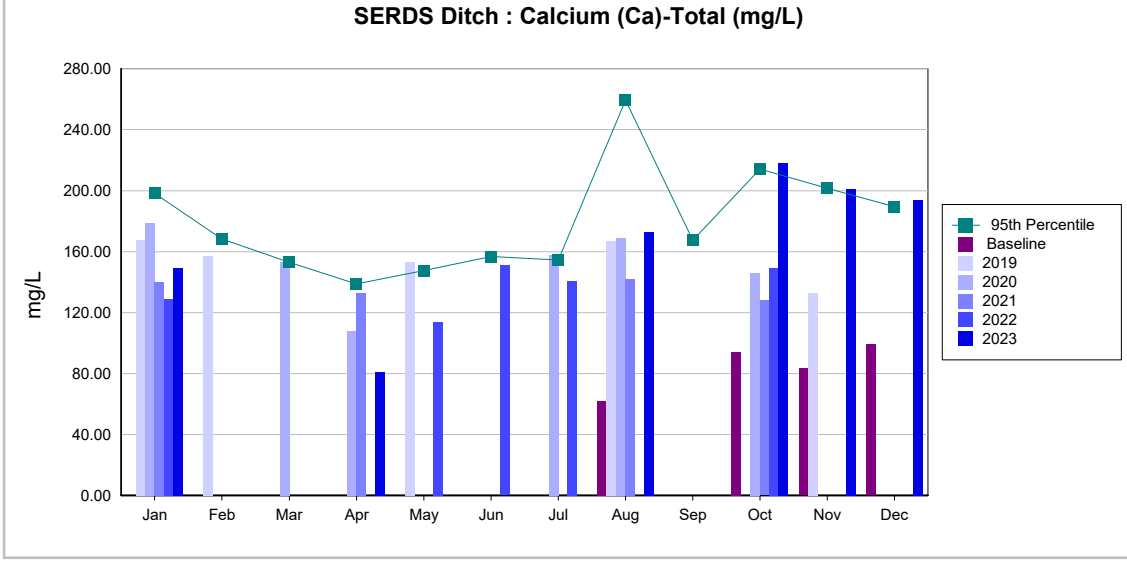
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







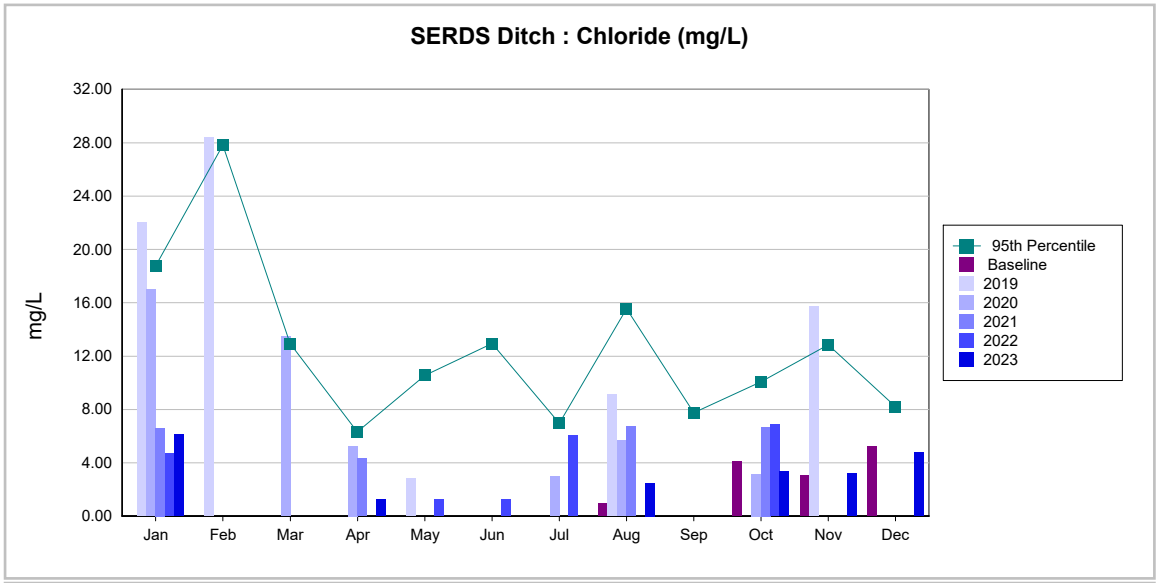
Water Quality Report

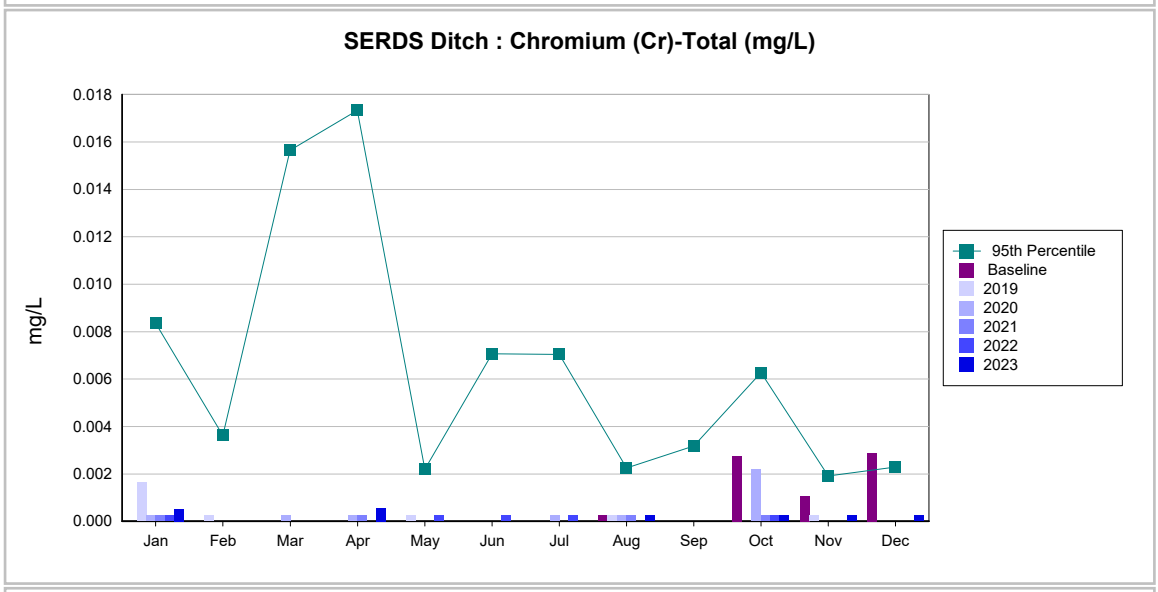
Annual Report Drainage Water

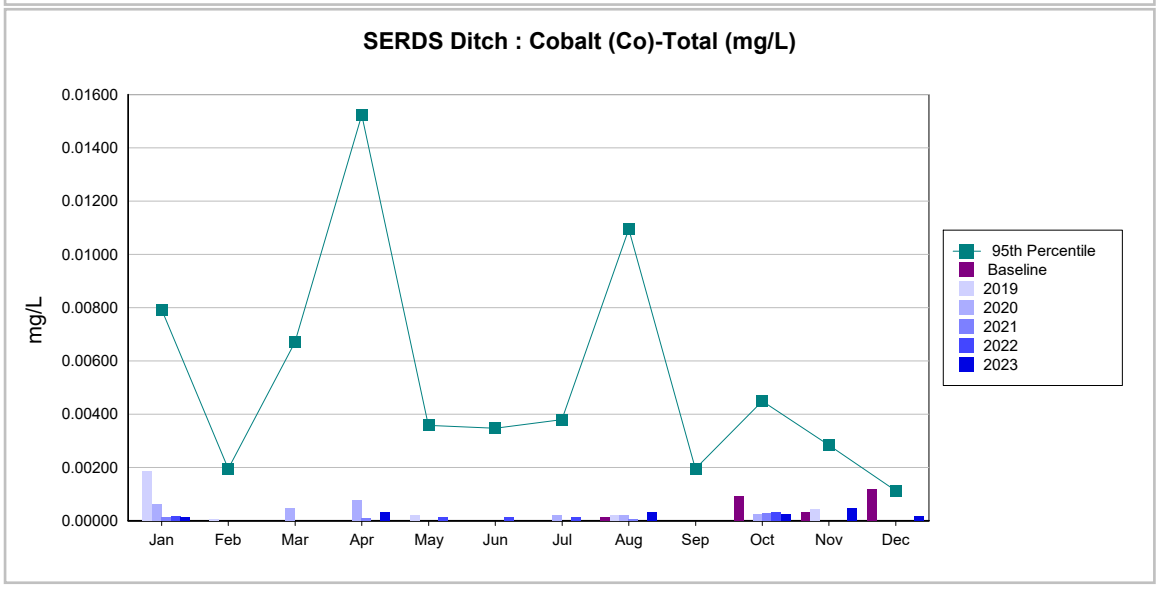
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







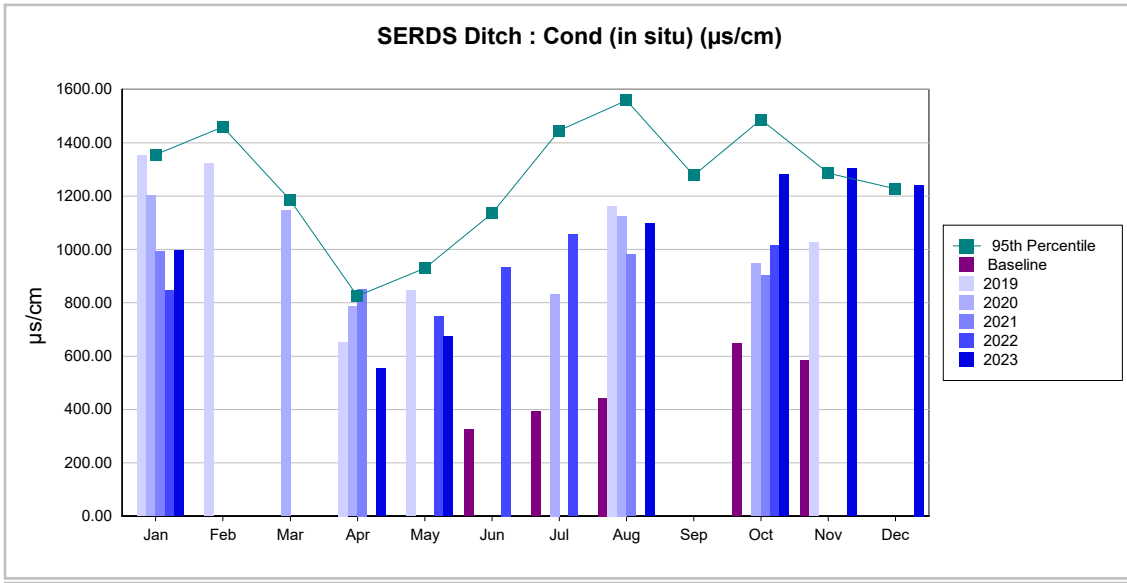
Water Quality Report

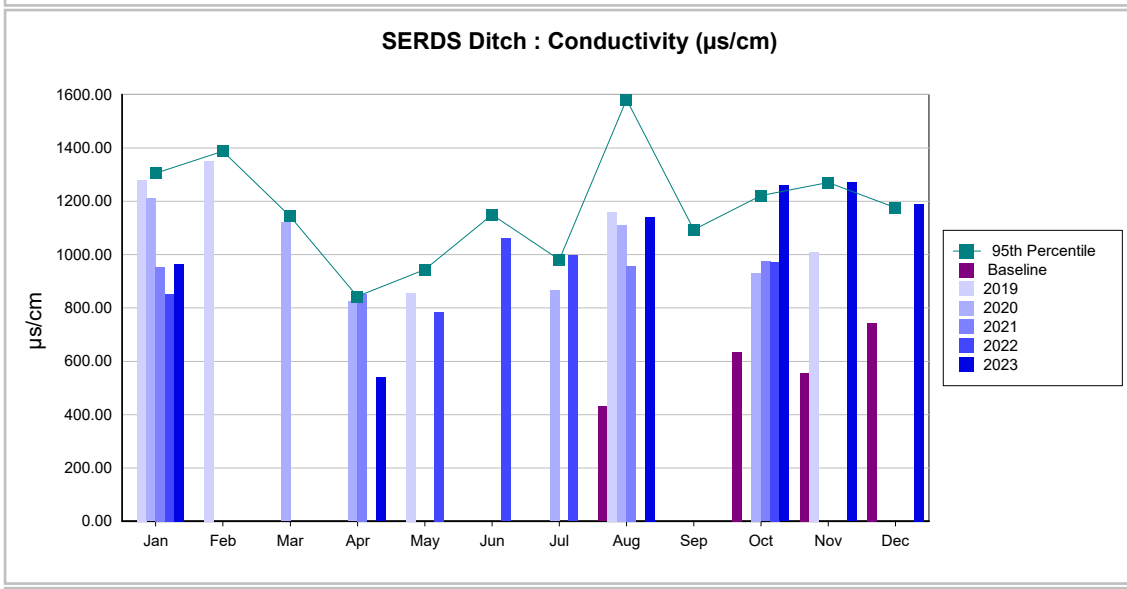
Annual Report Drainage Water

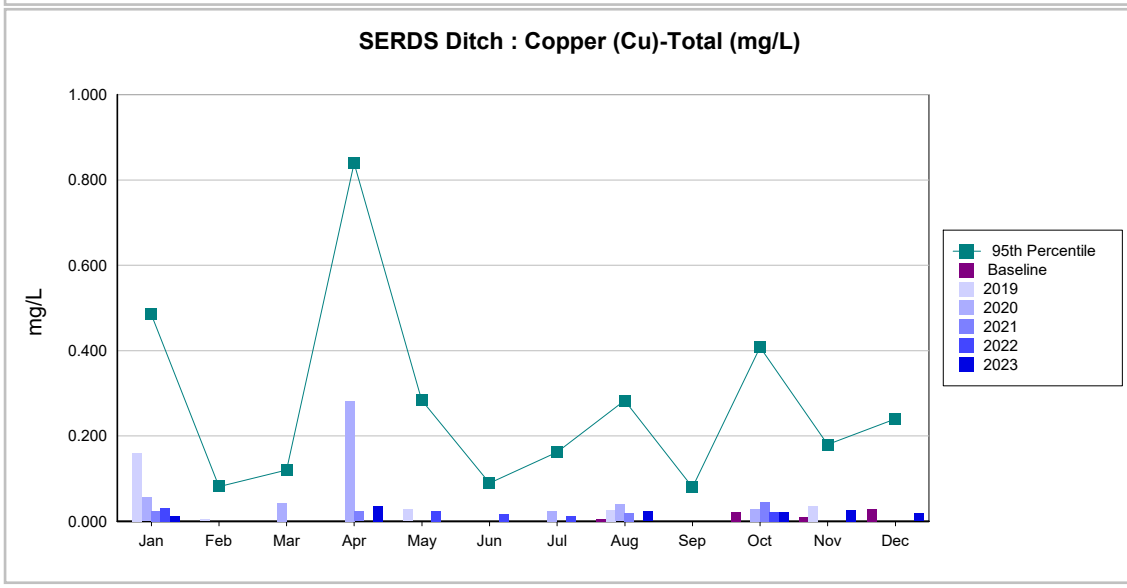
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







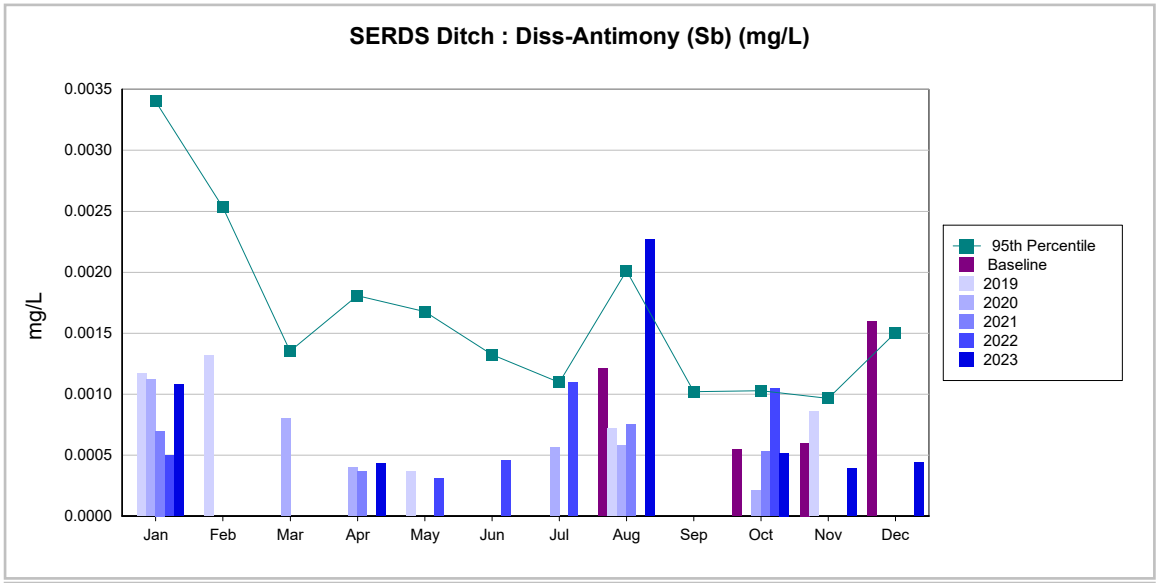
Water Quality Report

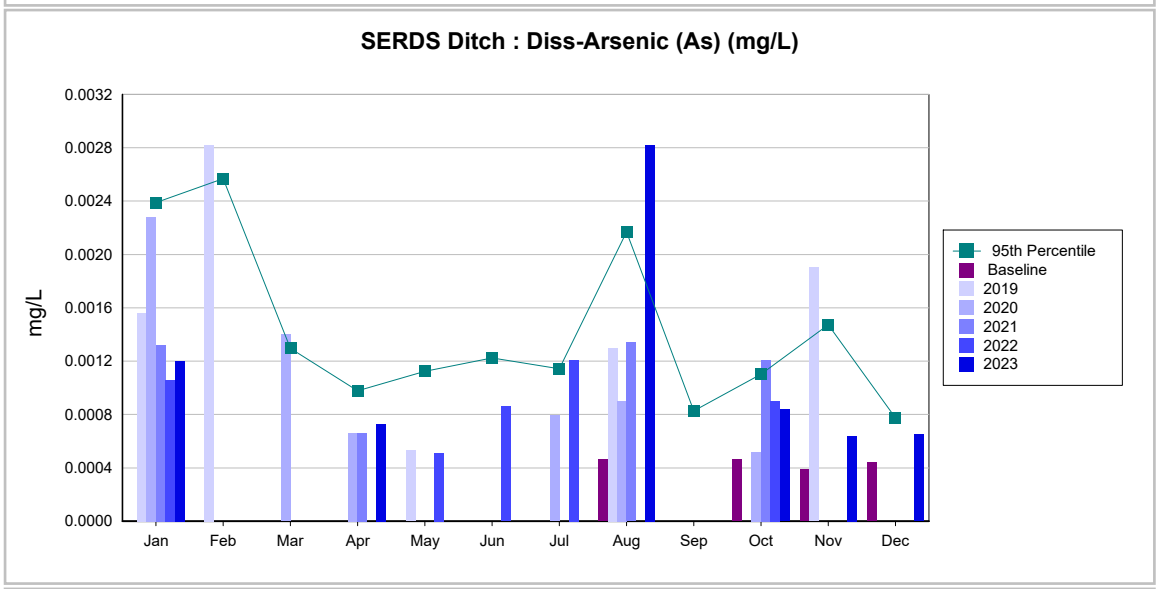
Annual Report Drainage Water

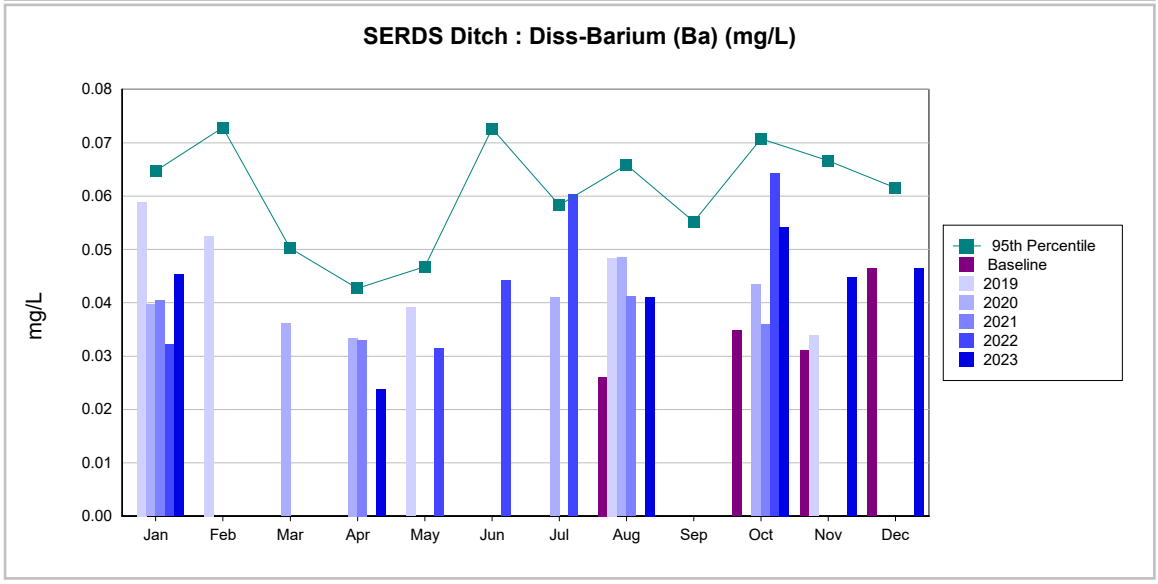
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







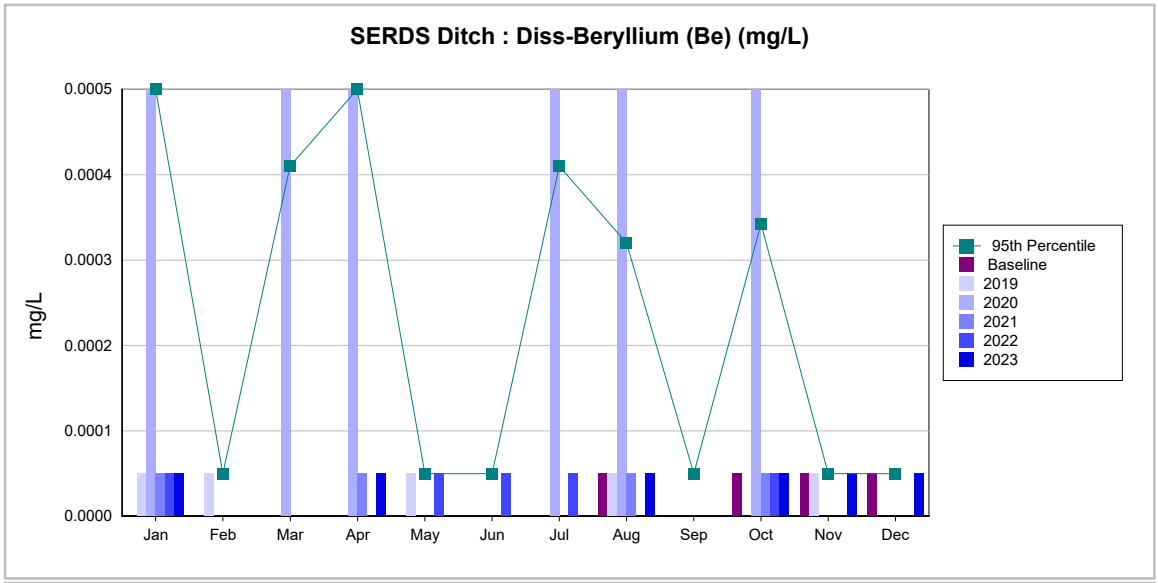
Water Quality Report

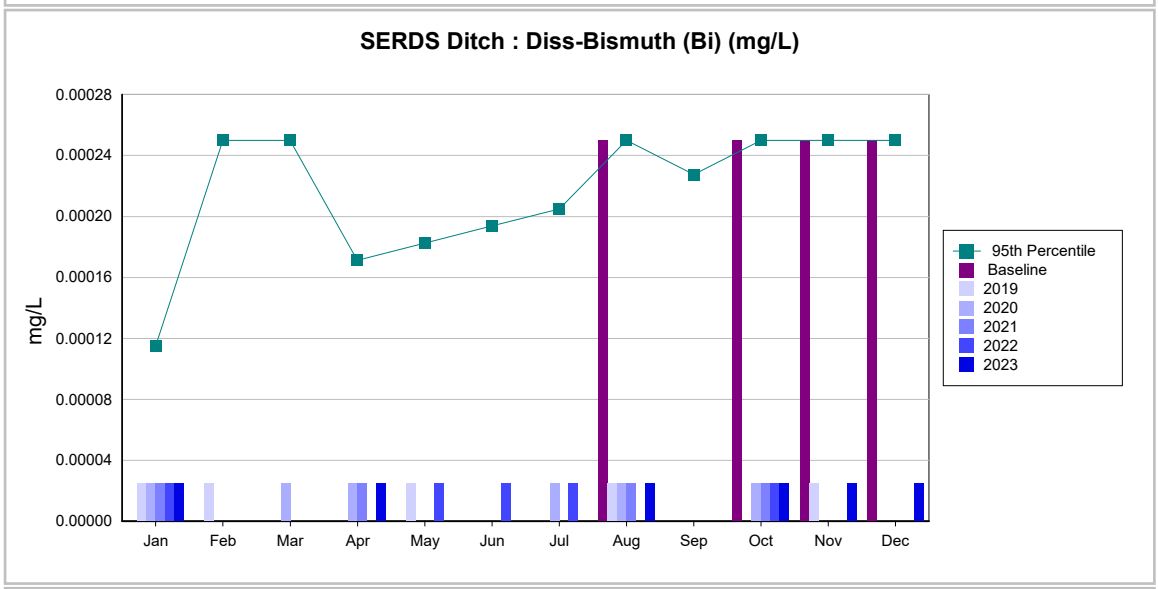
Annual Report Drainage Water

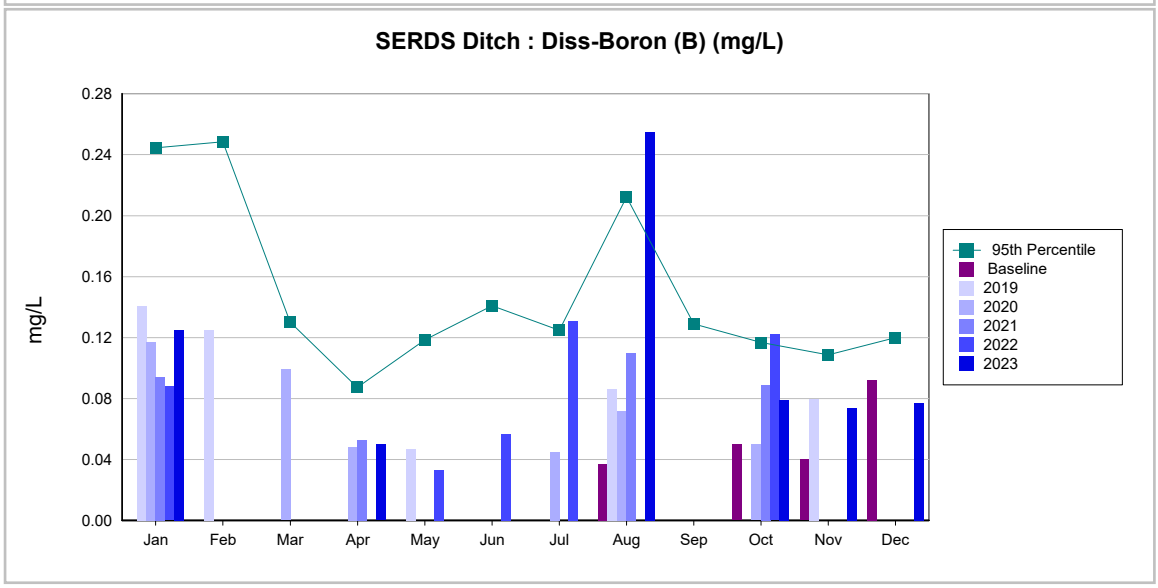
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







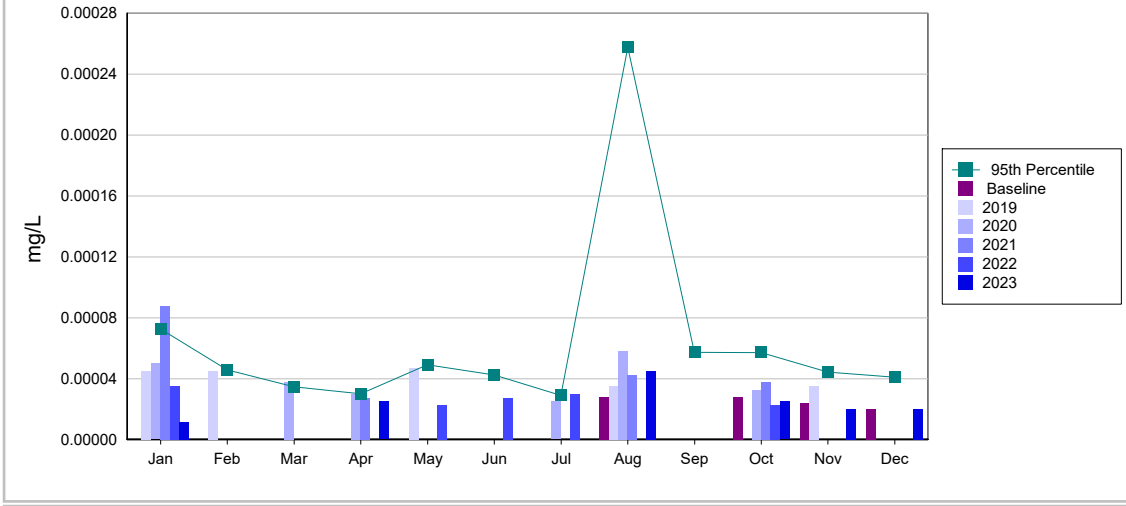
Water Quality Report

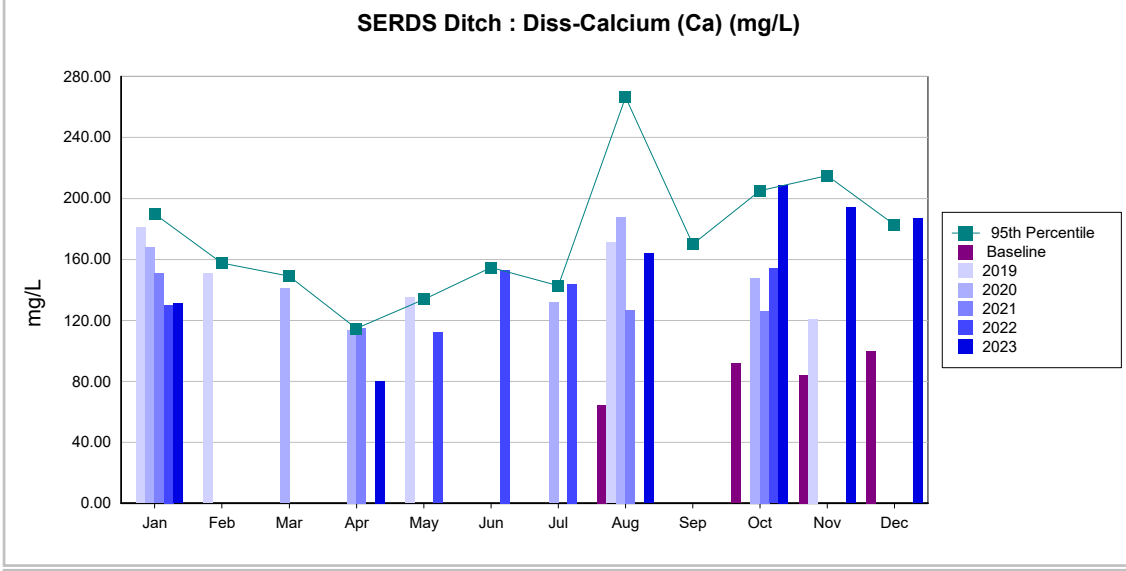
Annual Report Drainage Water

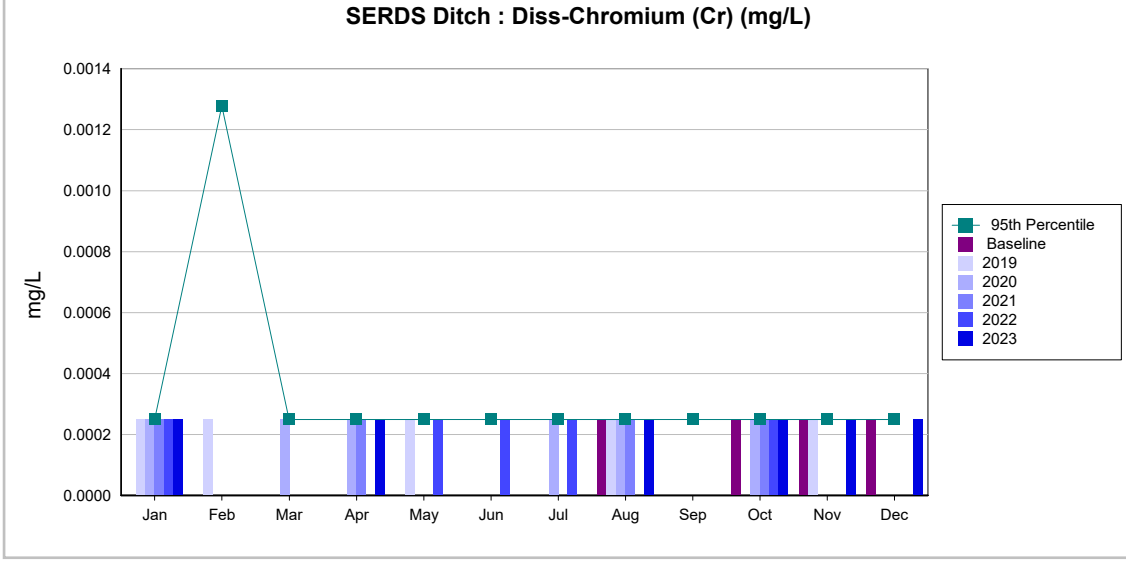
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







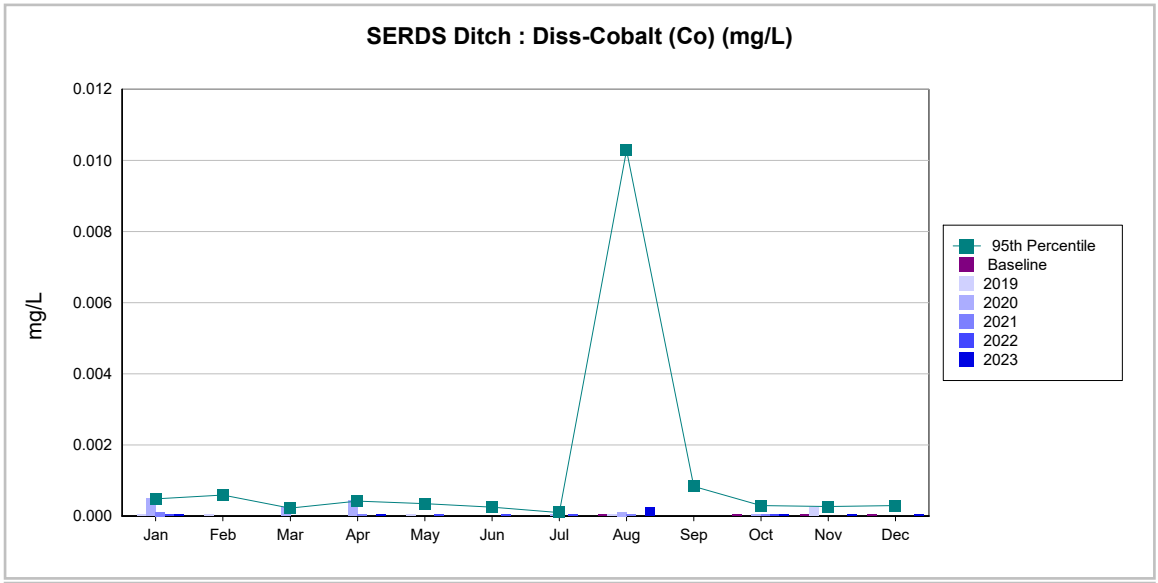
Water Quality Report

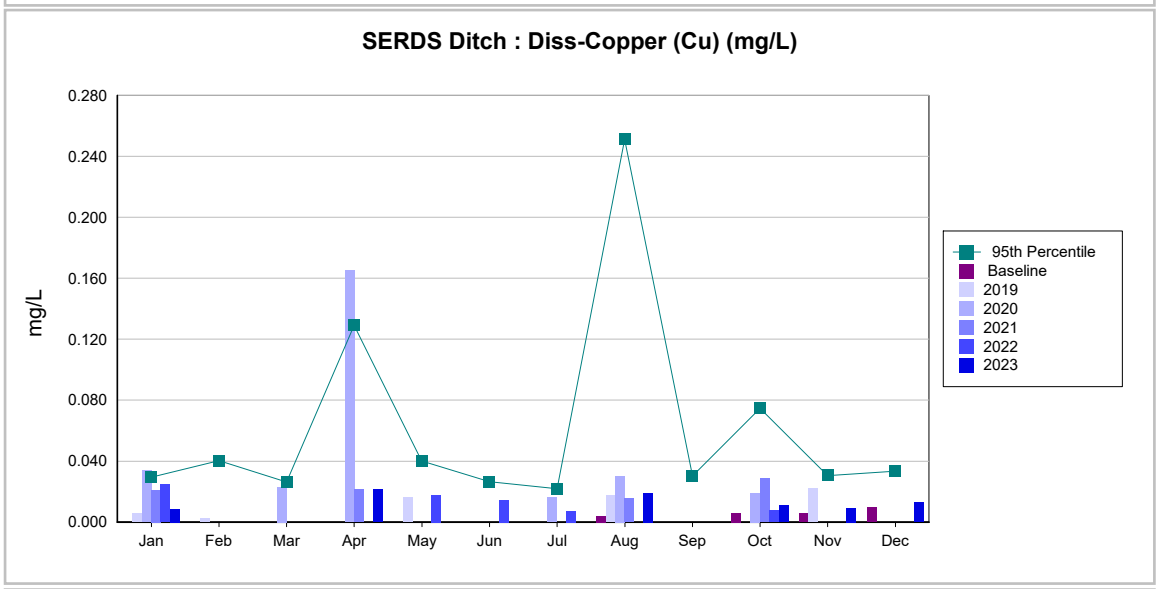
Annual Report Drainage Water

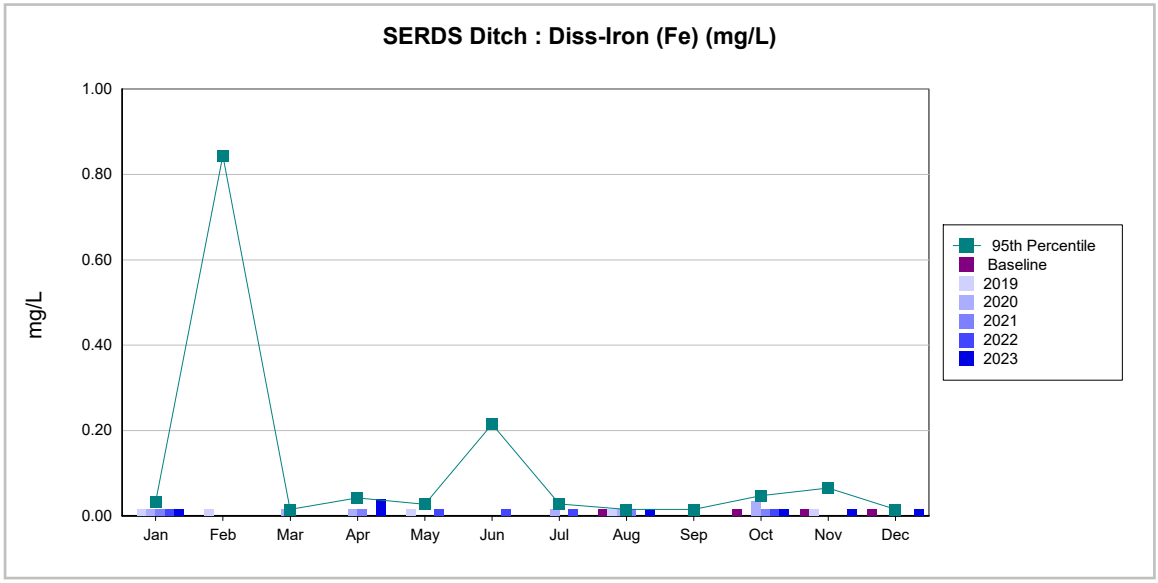
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







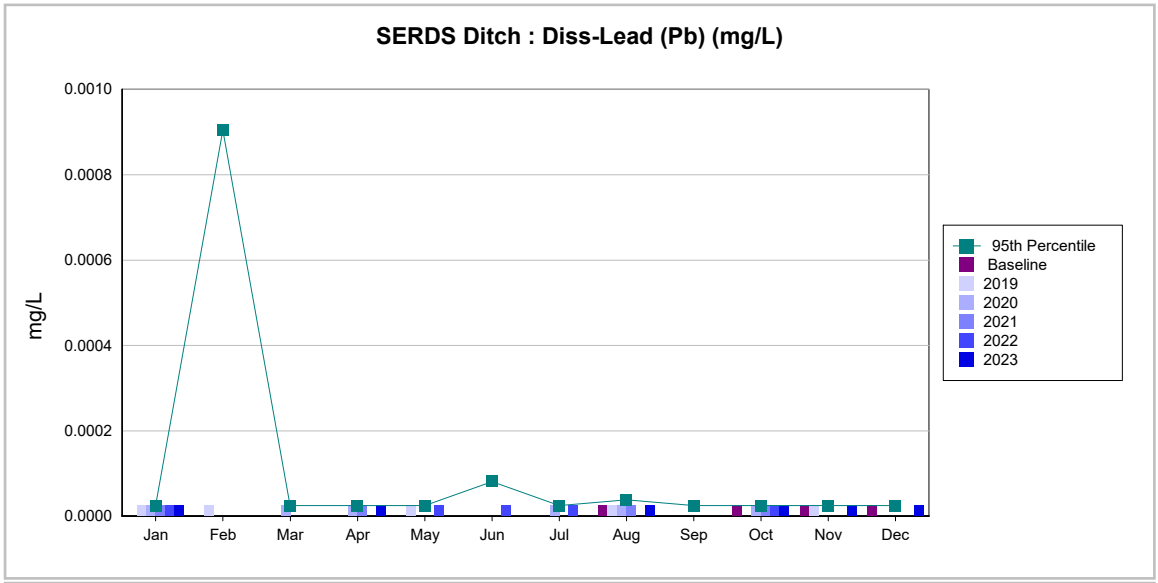
Water Quality Report

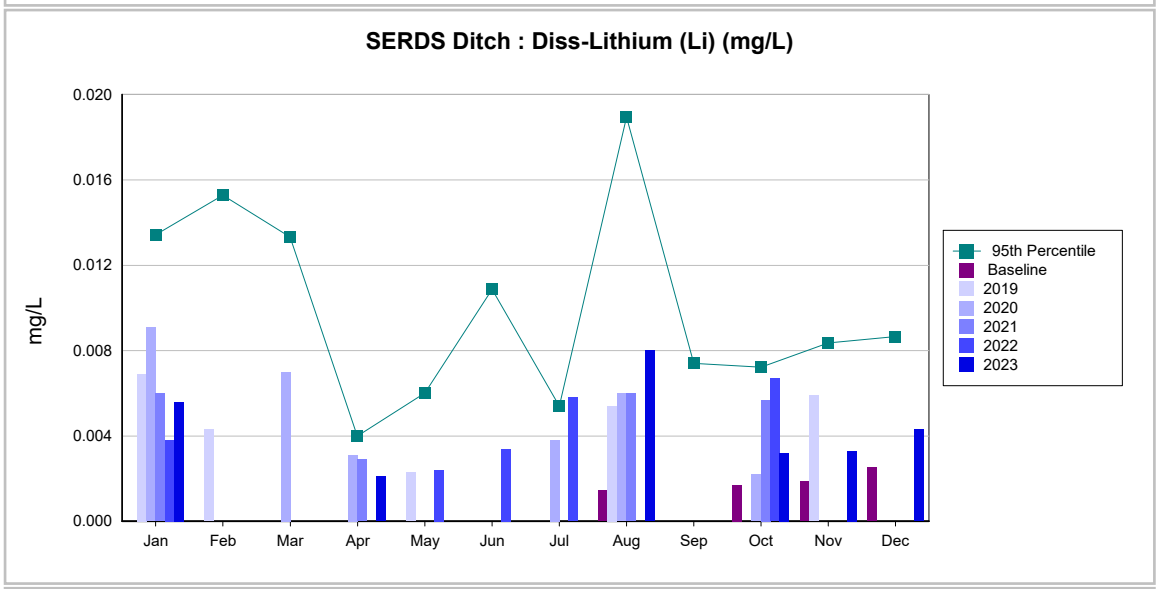
Annual Report Drainage Water

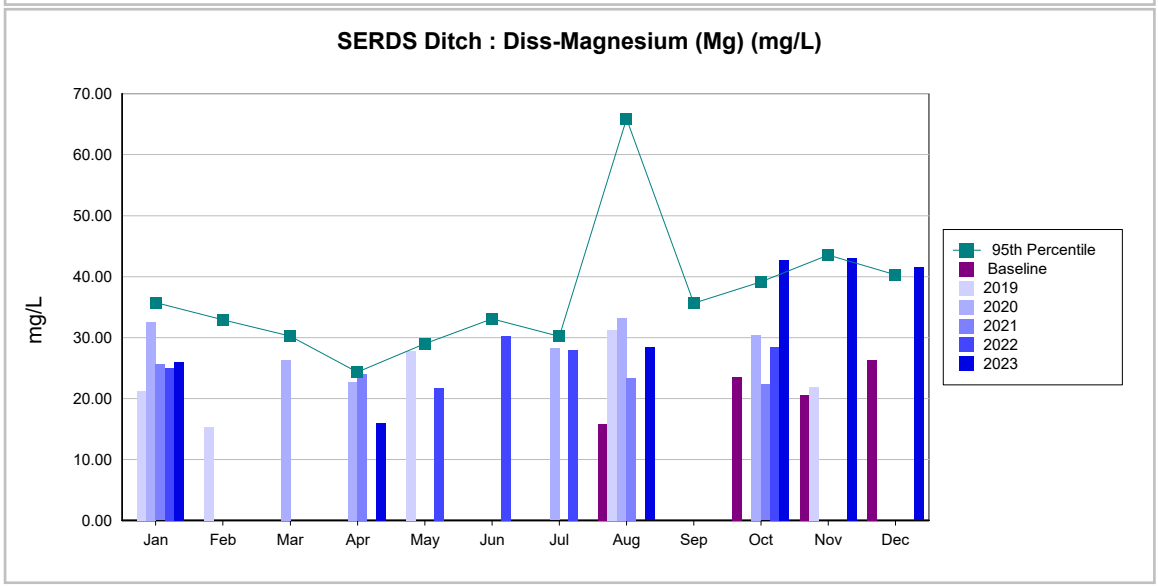
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







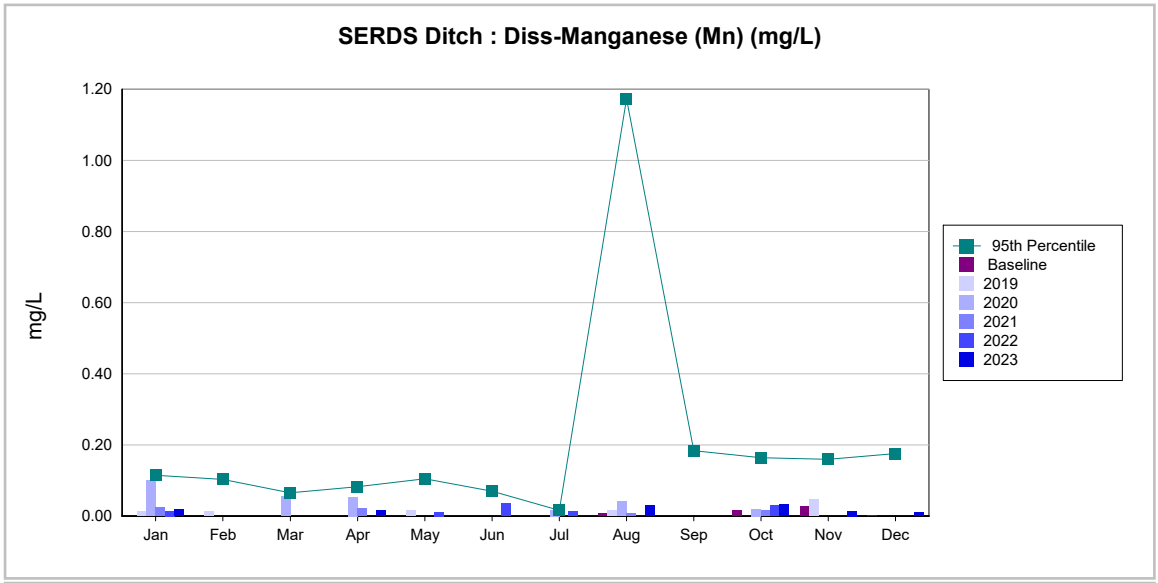
Water Quality Report

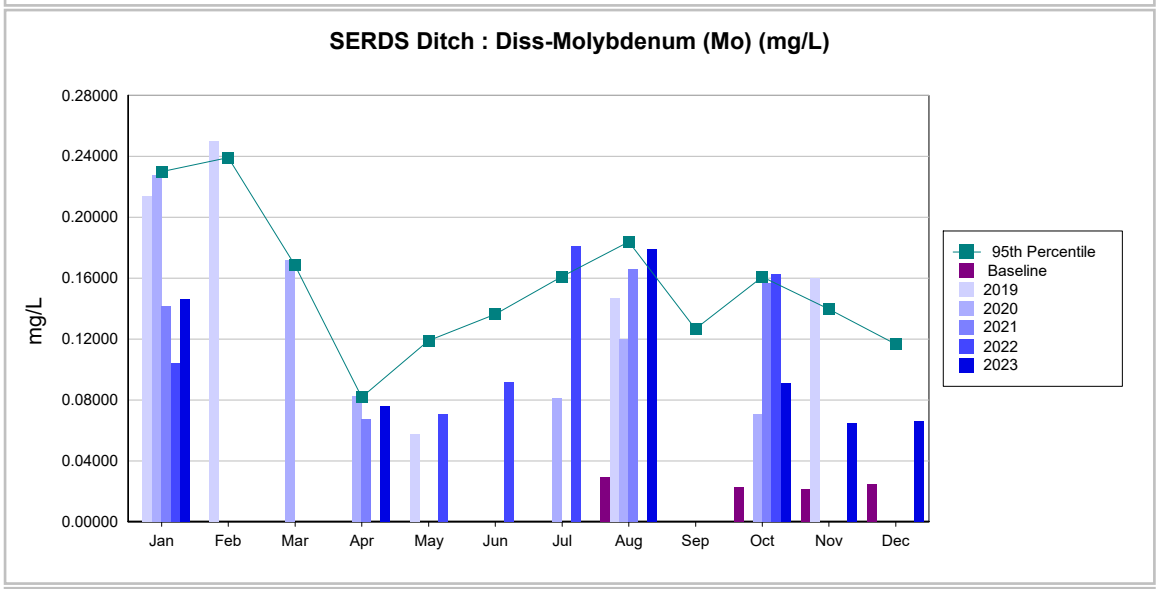
Annual Report Drainage Water

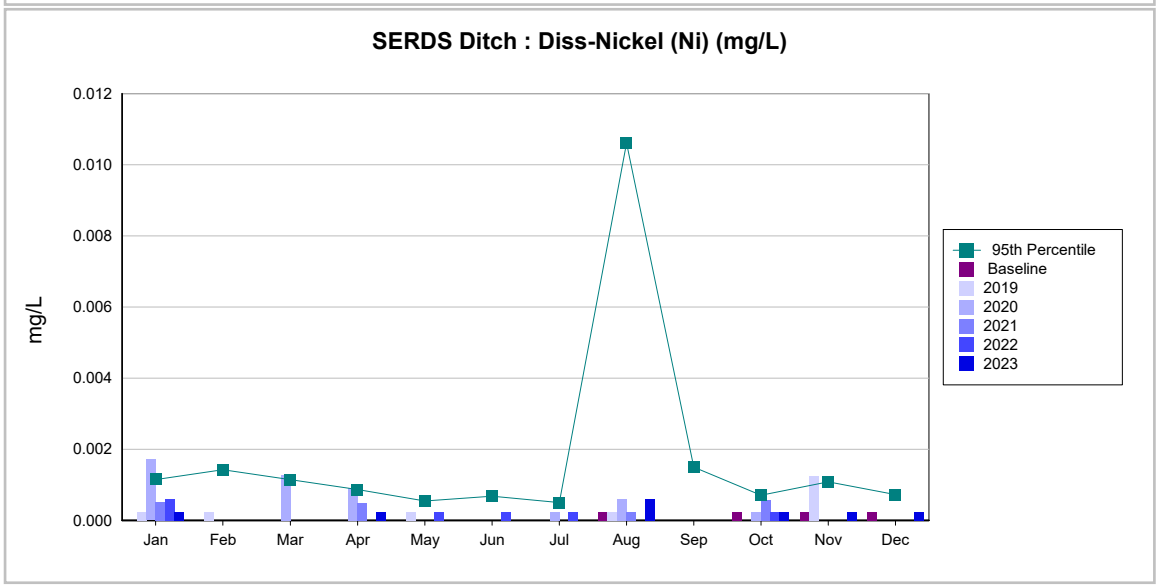
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







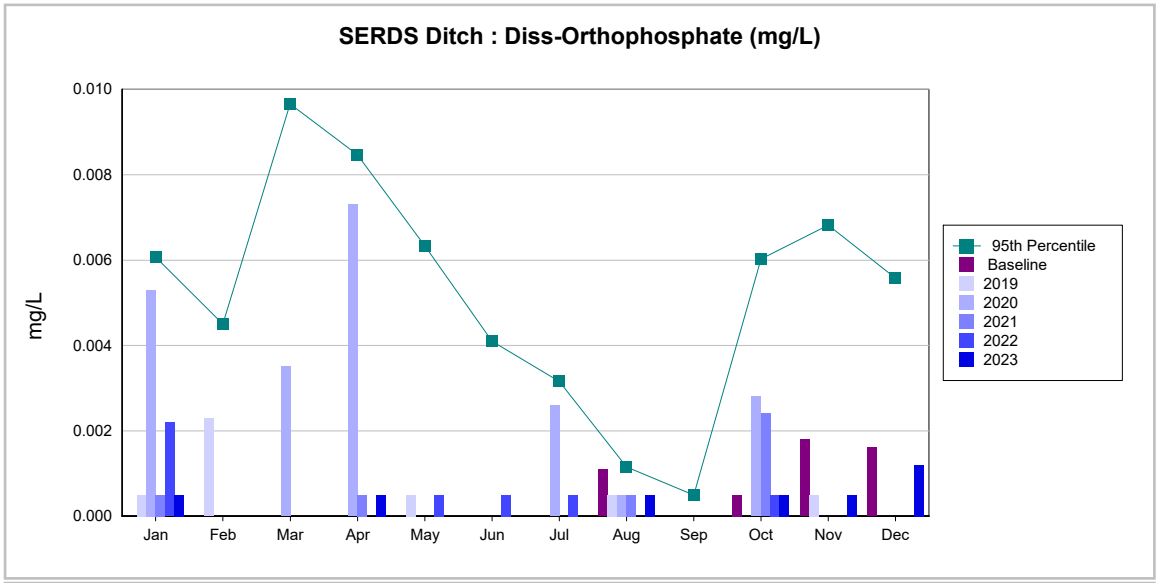
Water Quality Report

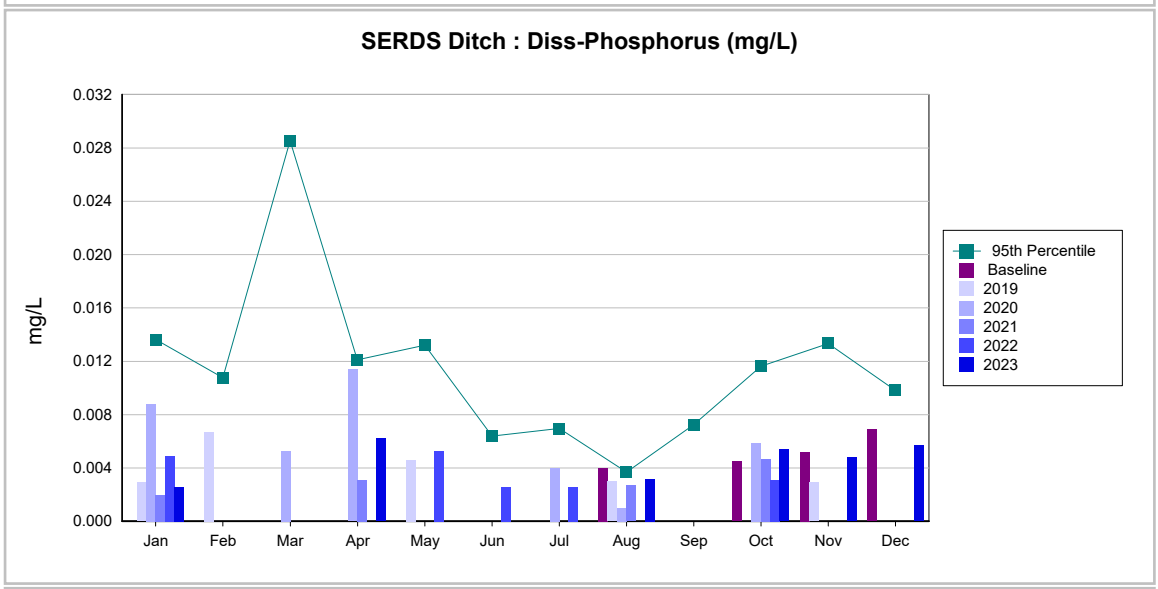
Annual Report Drainage Water

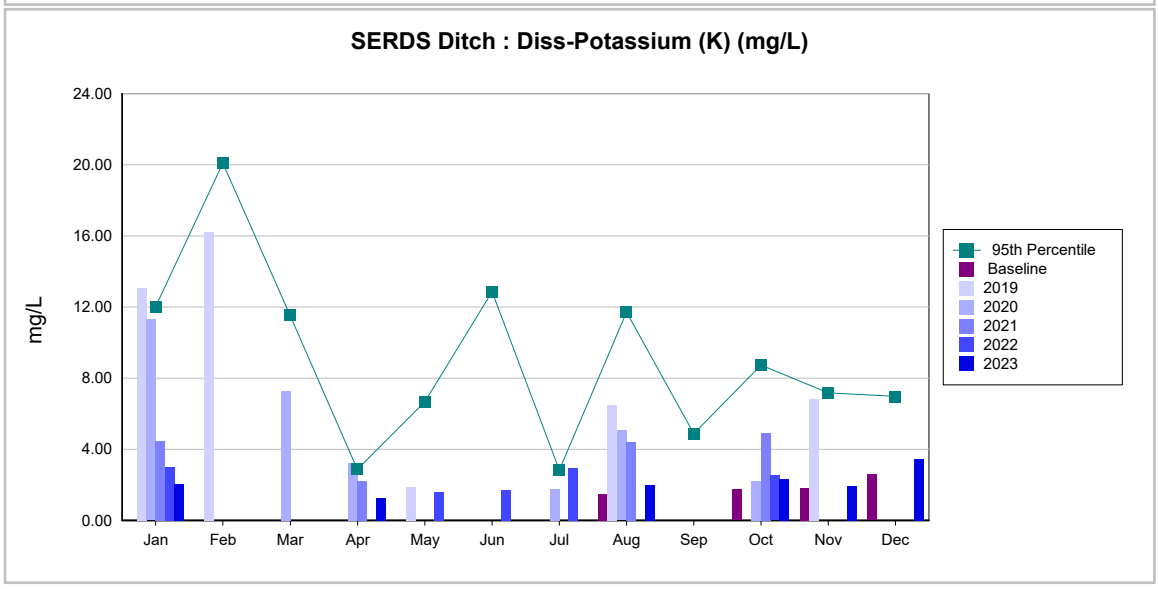
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







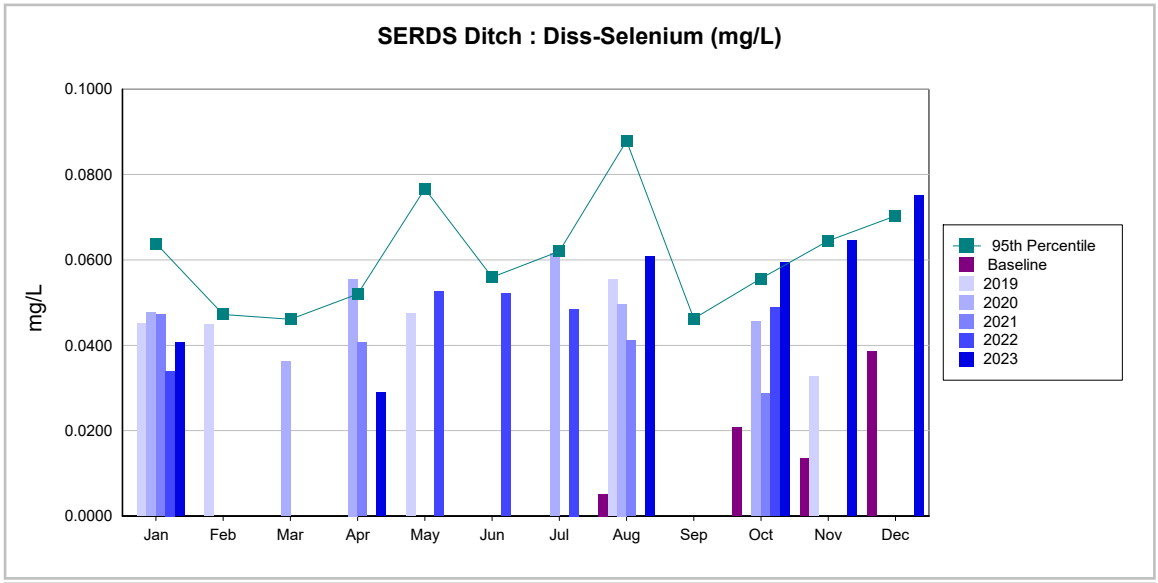
Water Quality Report

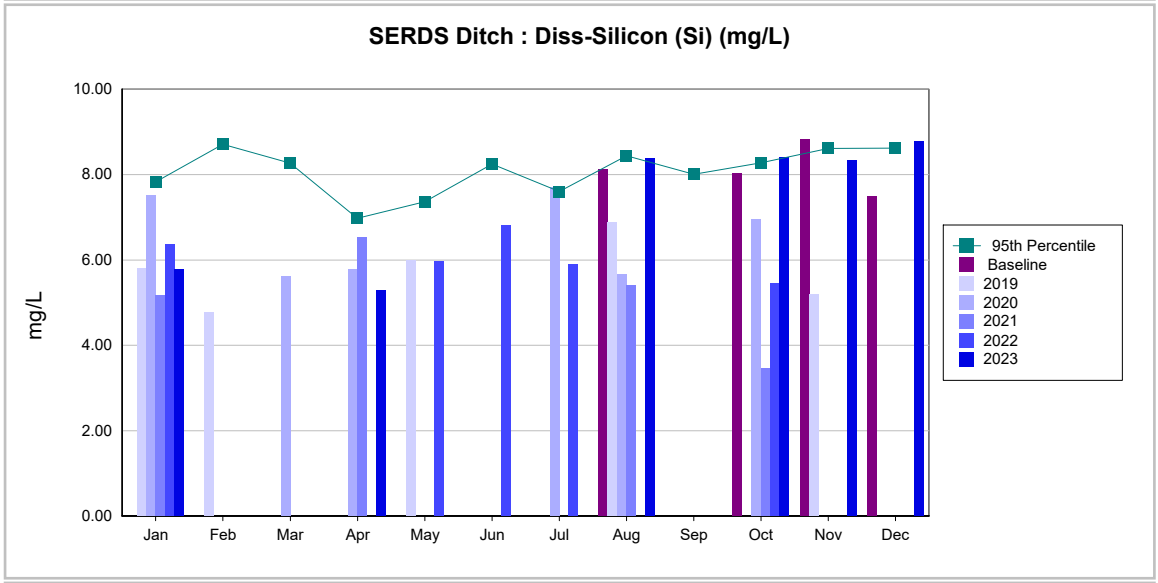
Annual Report Drainage Water

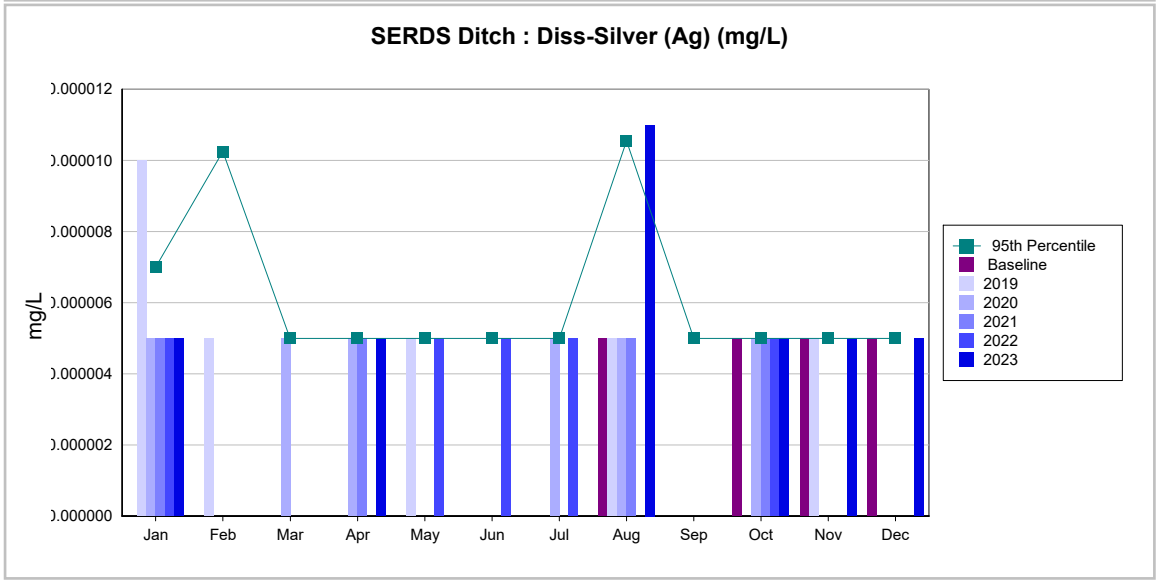
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







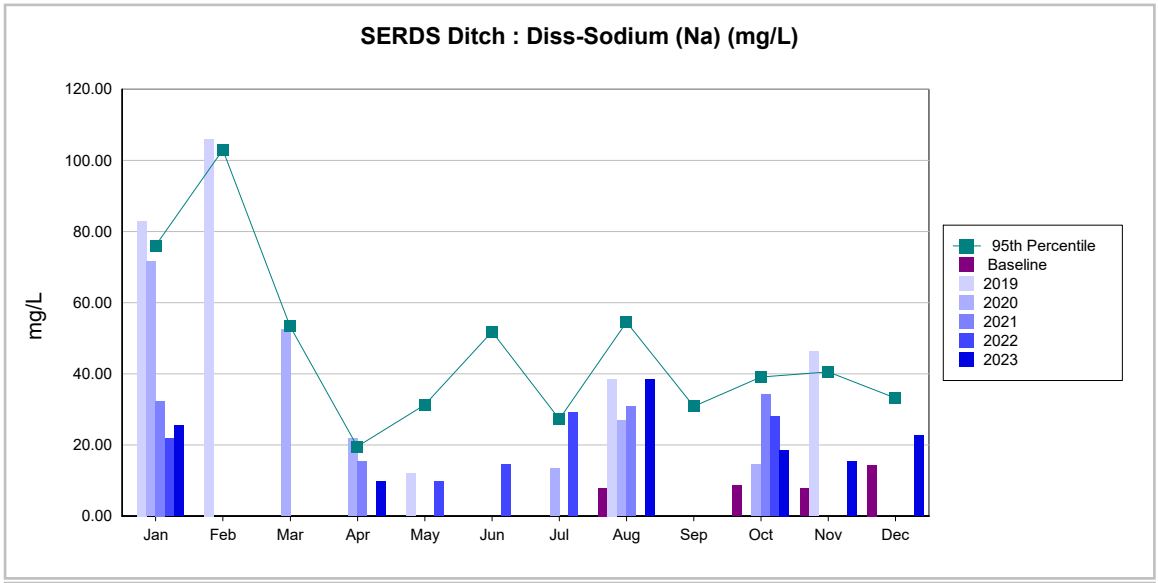
Water Quality Report

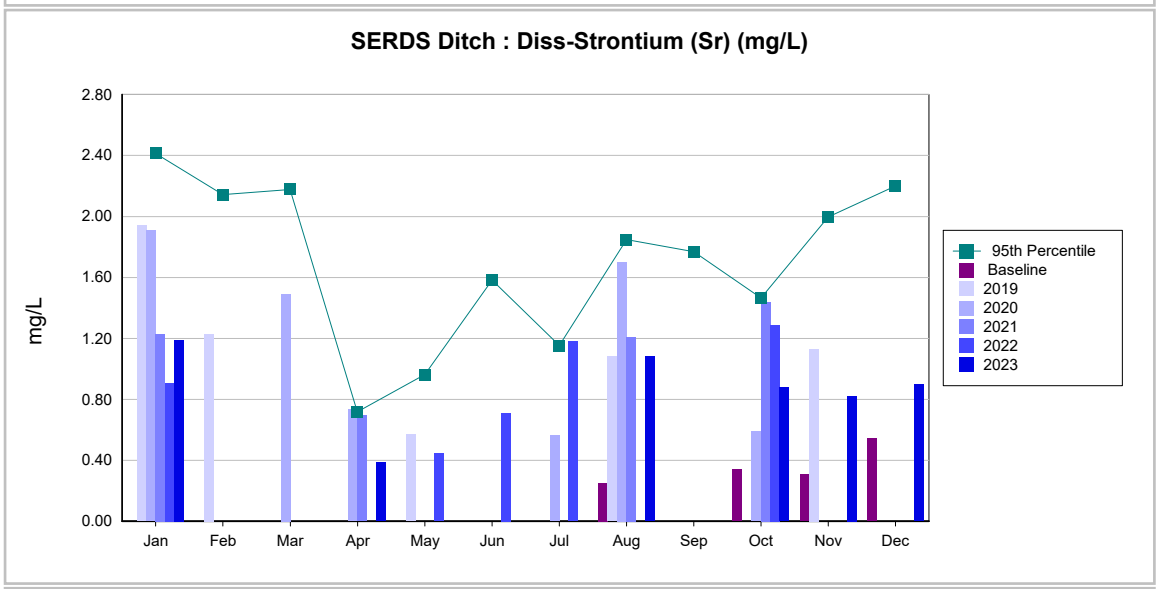
Annual Report Drainage Water

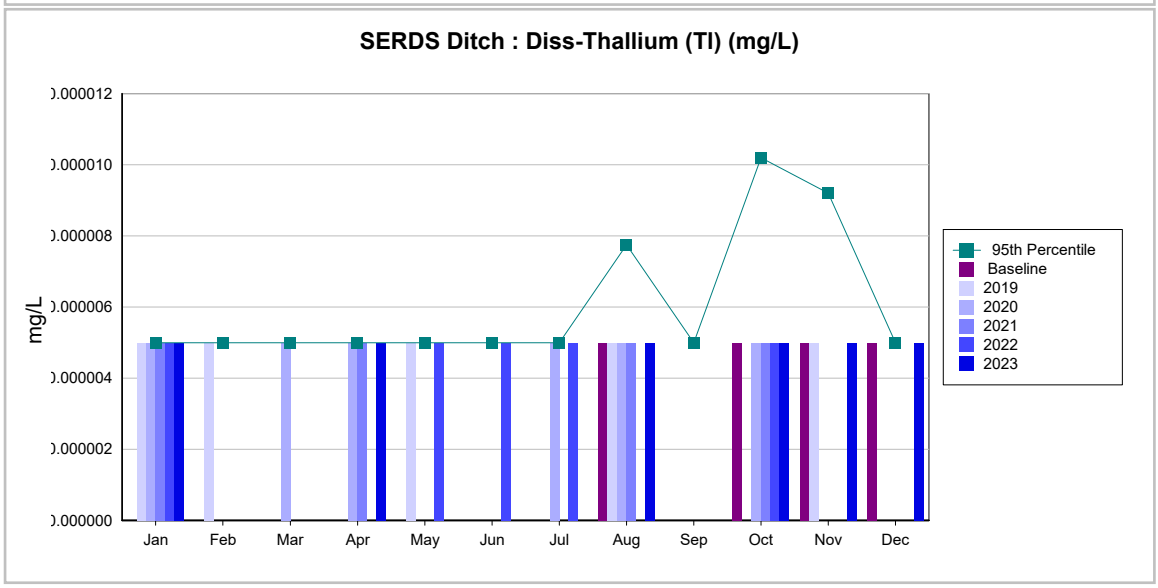
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







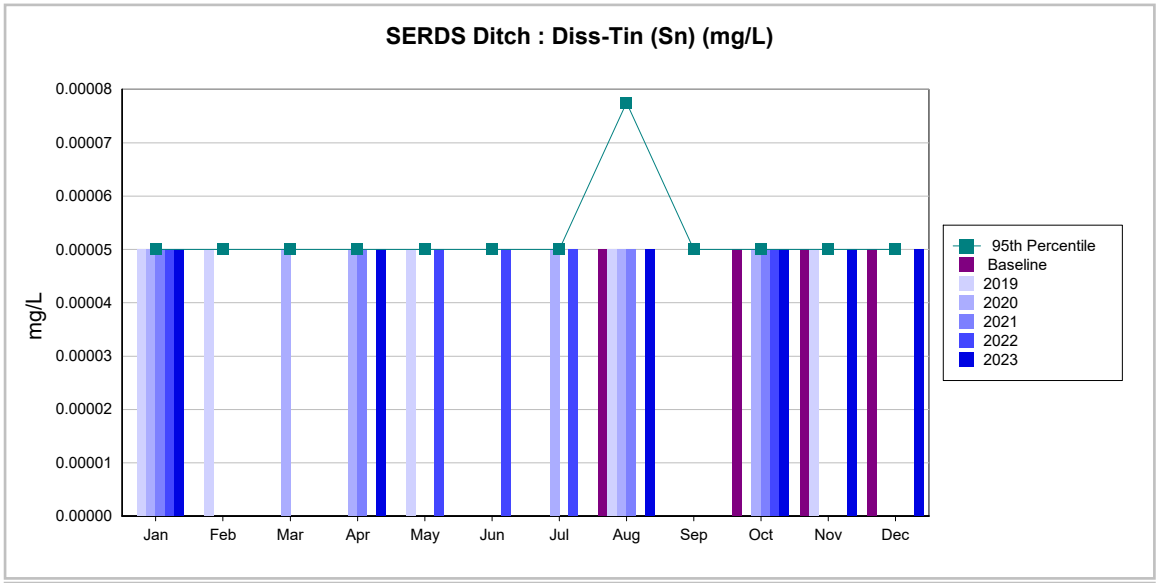
Water Quality Report

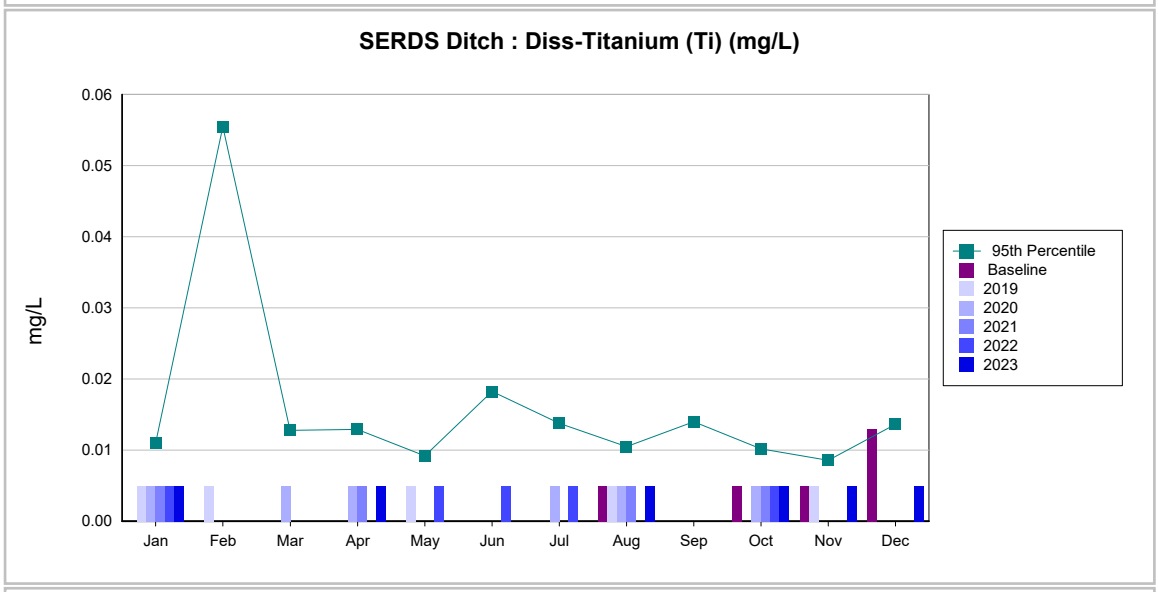
Annual Report Drainage Water

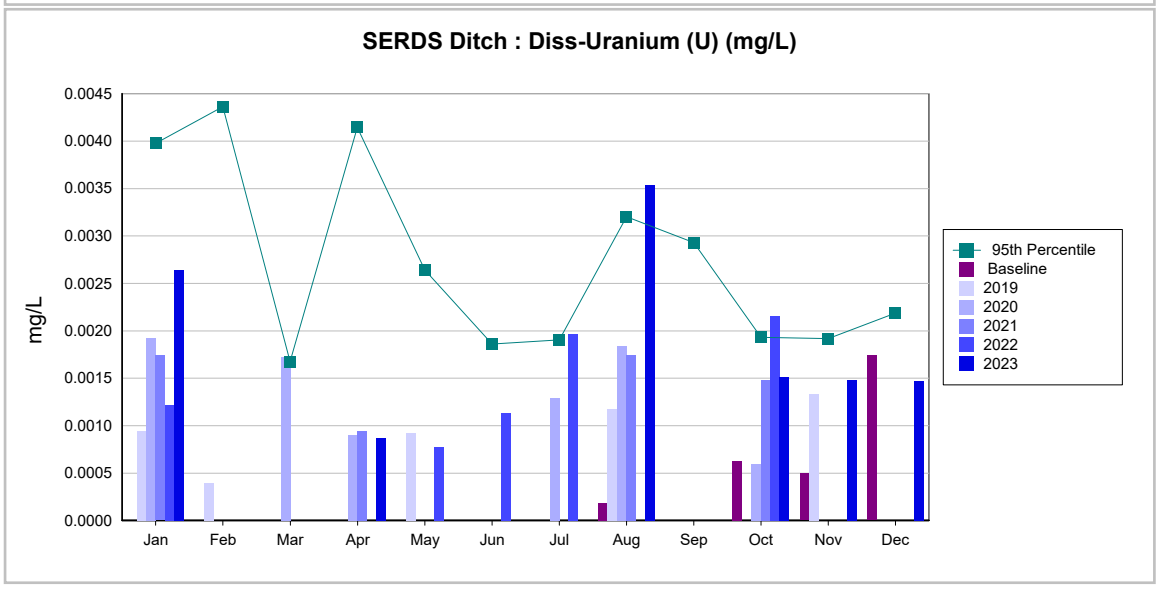
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







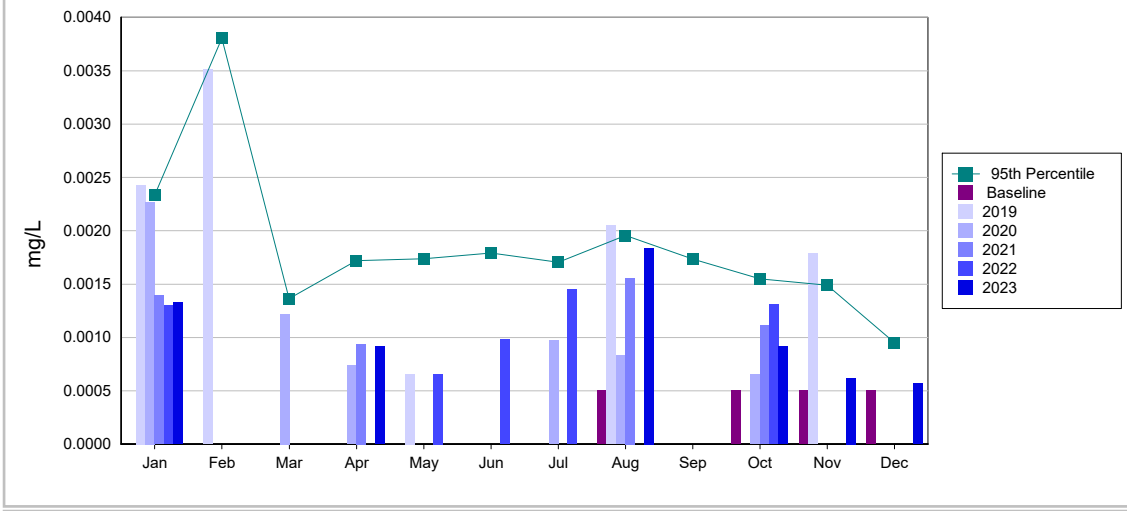
Water Quality Report

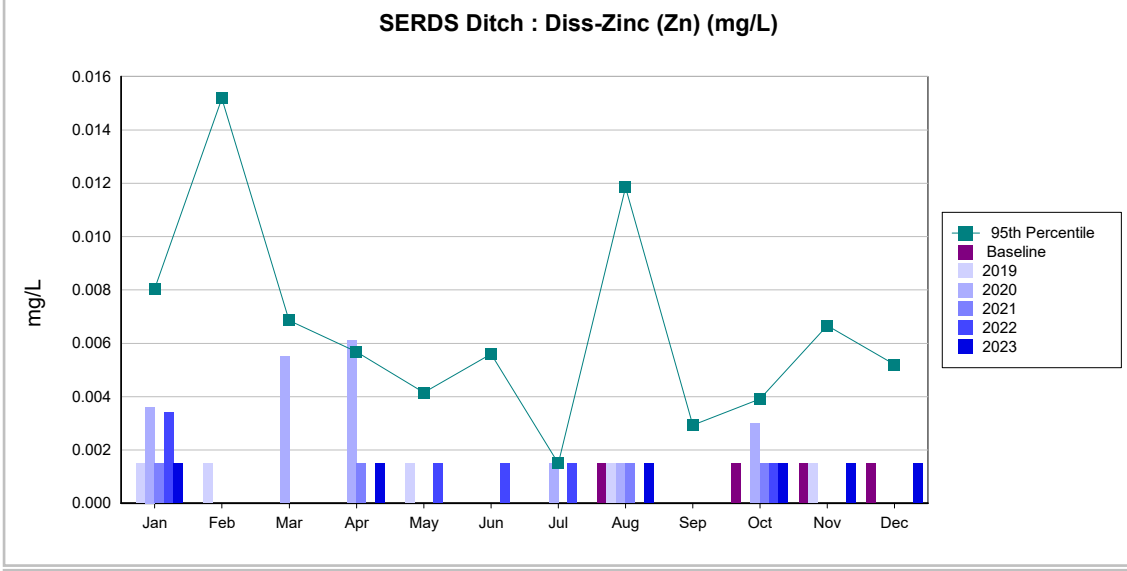
Annual Report Drainage Water

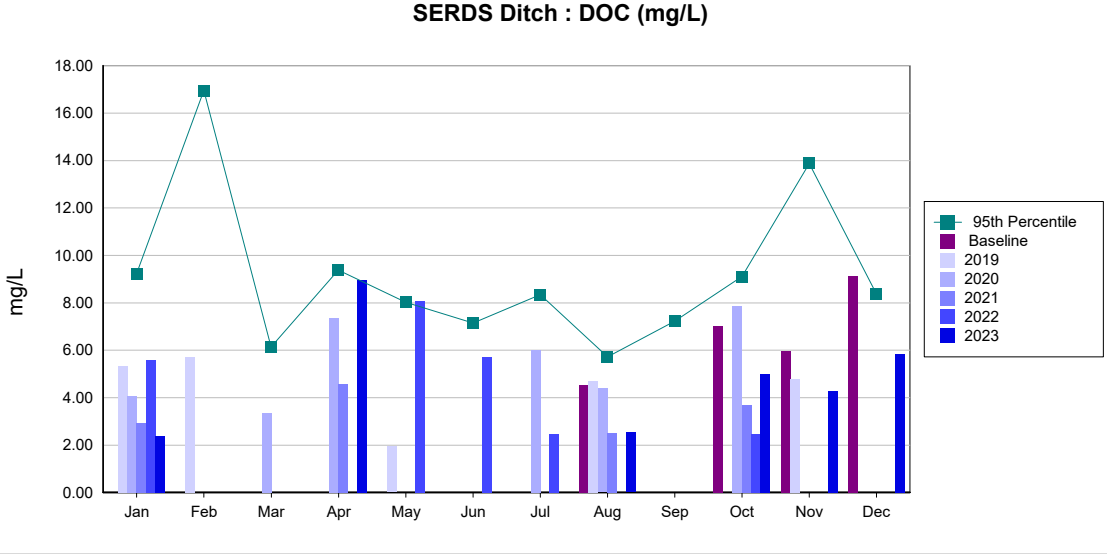
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







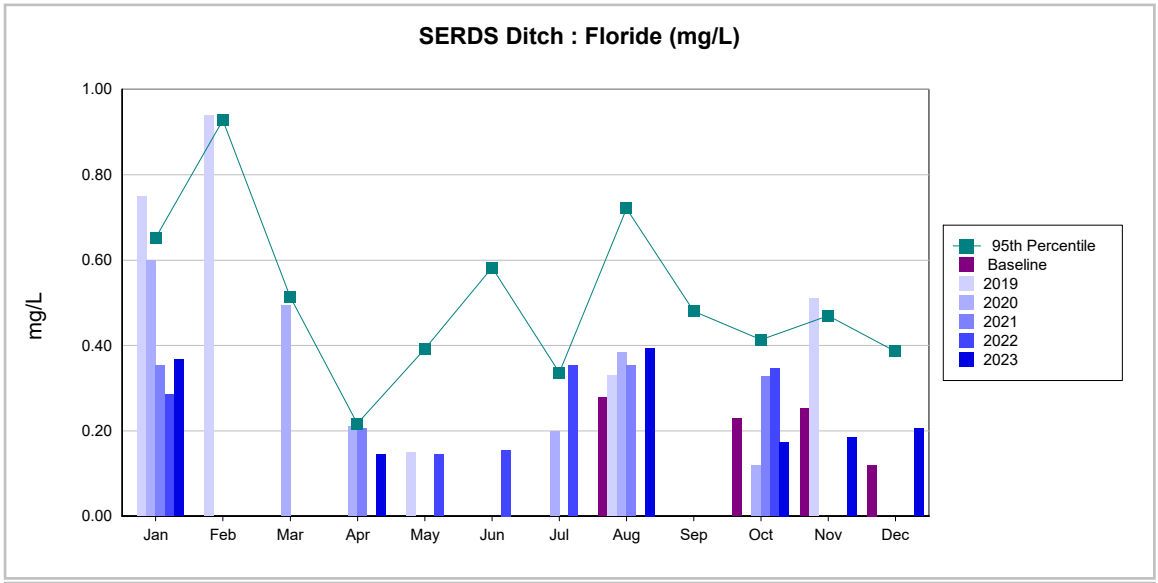
Water Quality Report

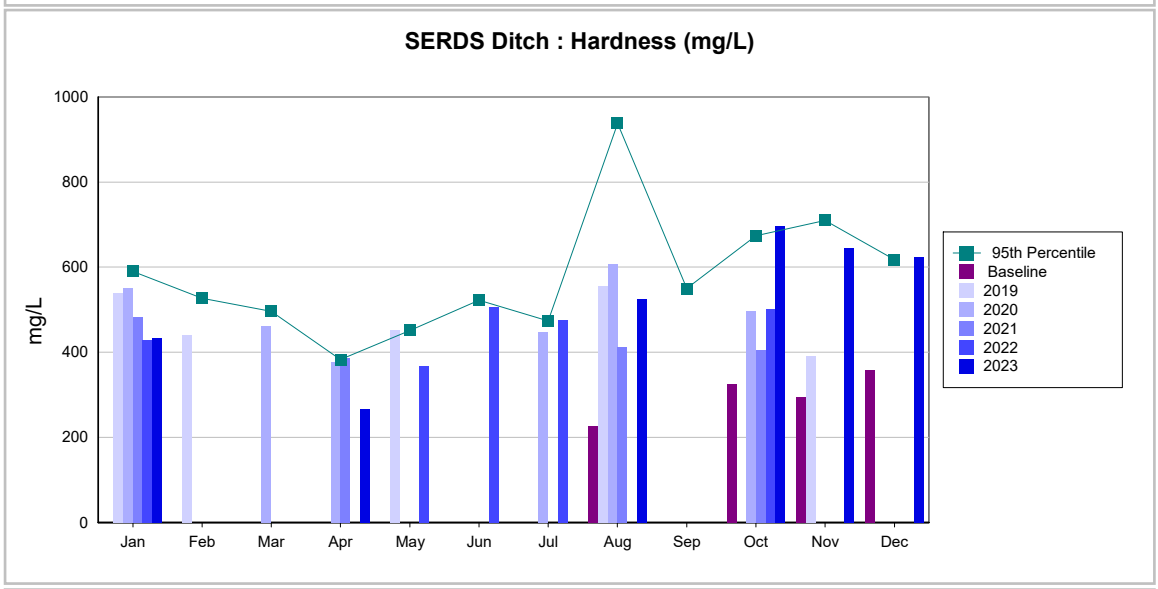
Annual Report Drainage Water

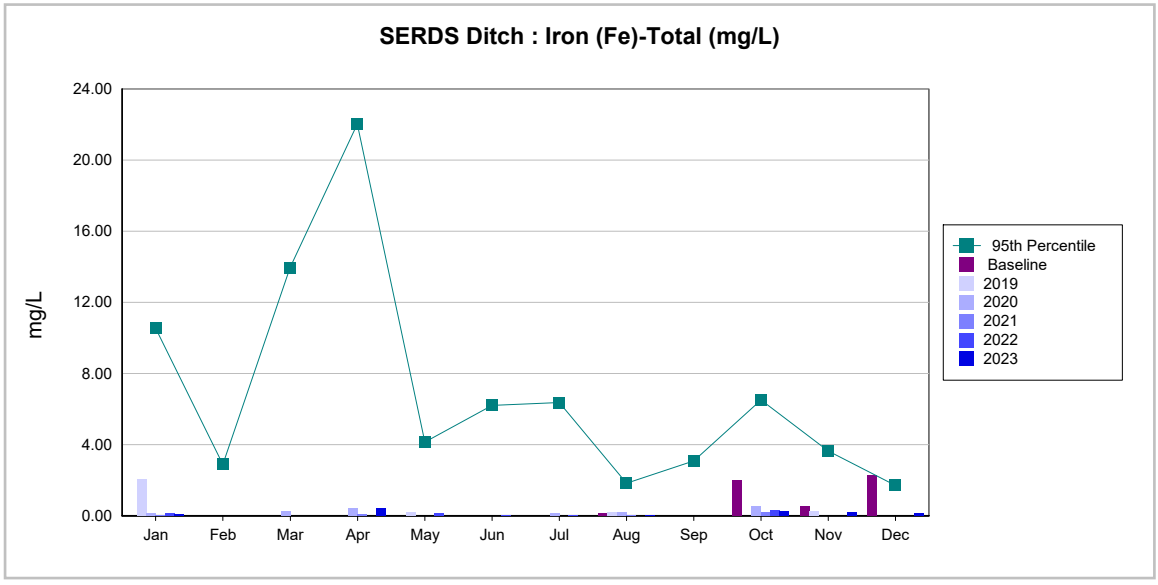
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







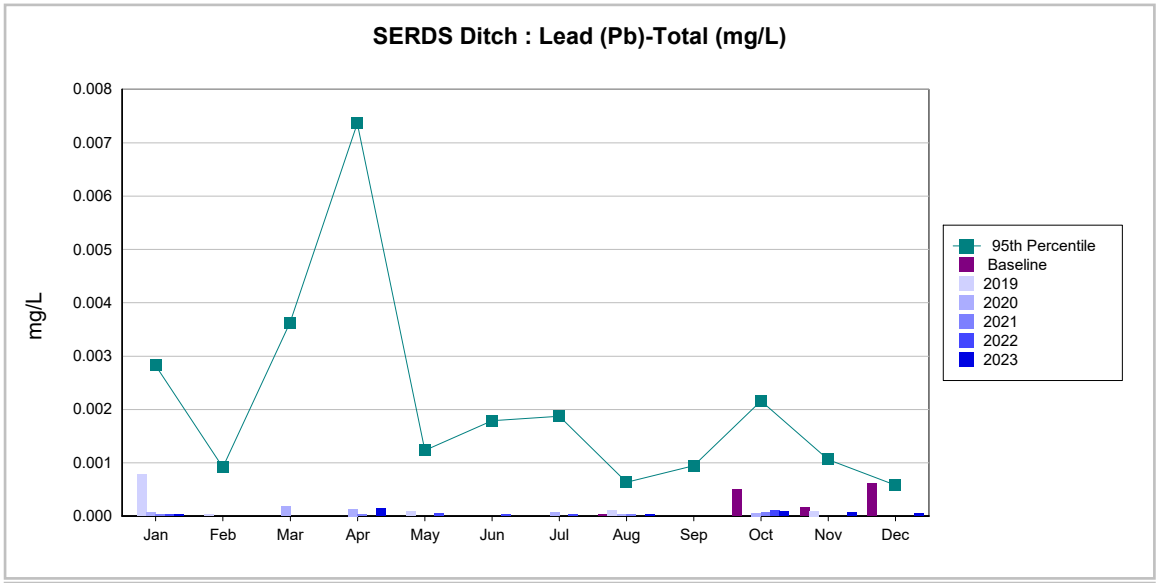
Water Quality Report

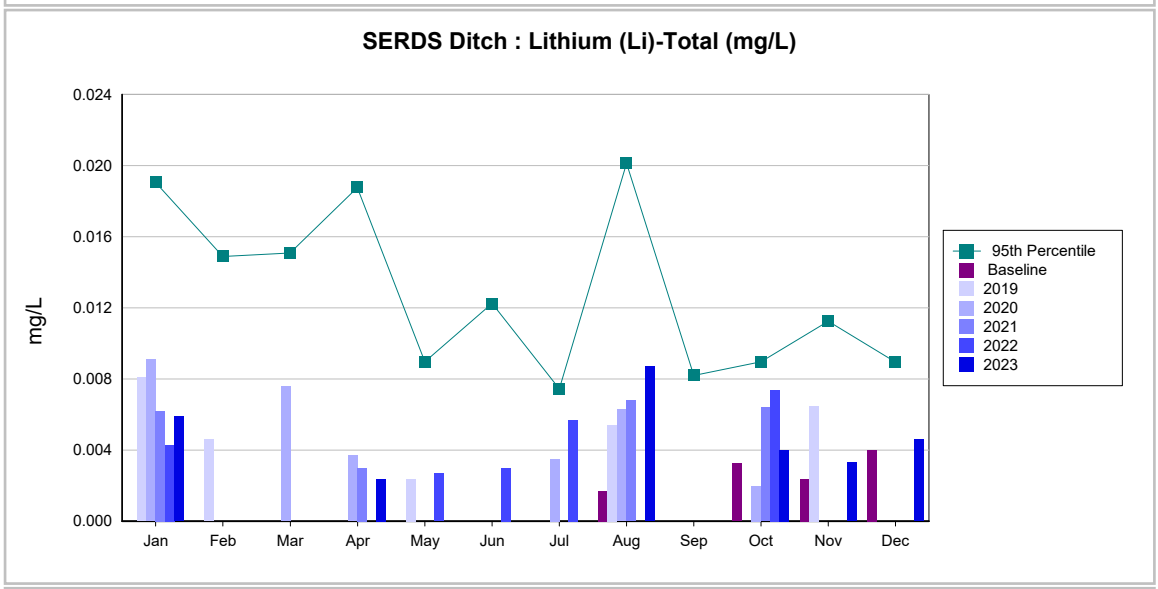
Annual Report Drainage Water

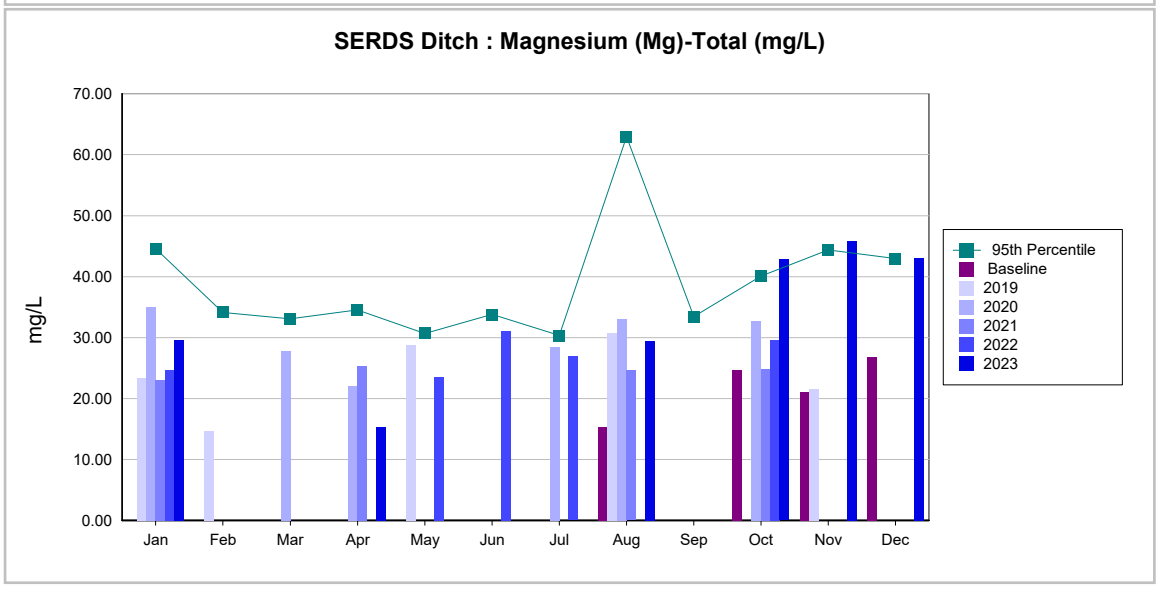
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







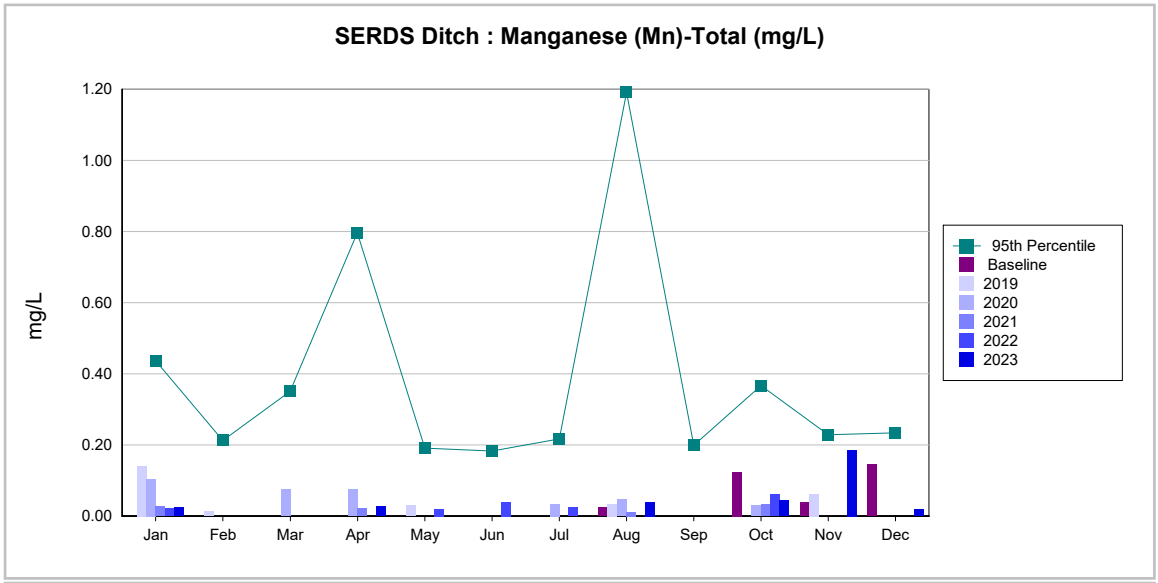
Water Quality Report

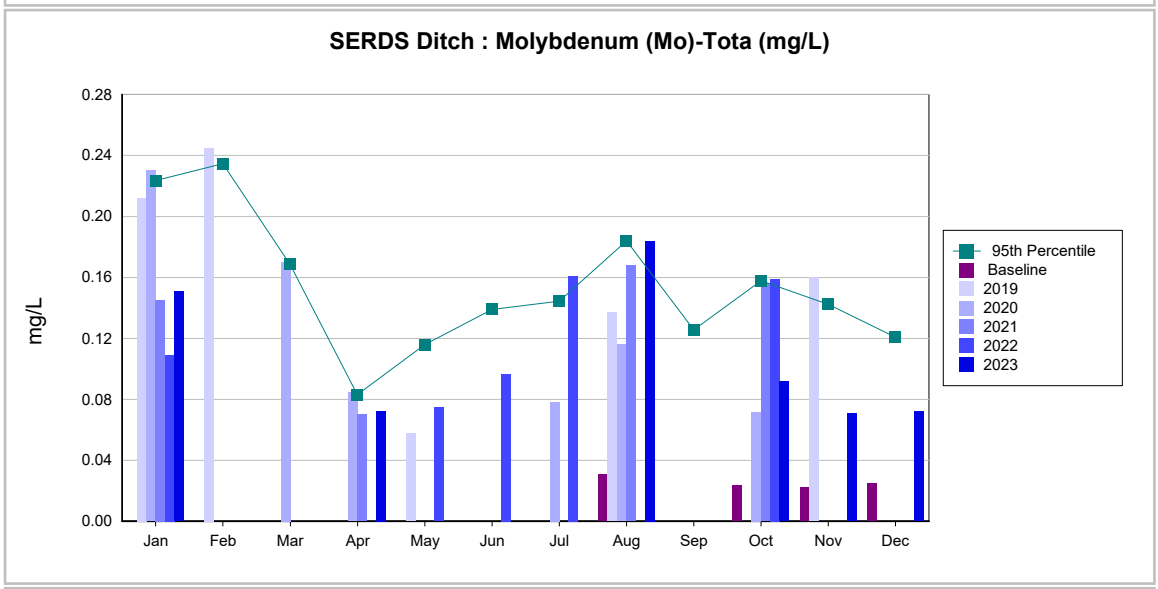
Annual Report Drainage Water

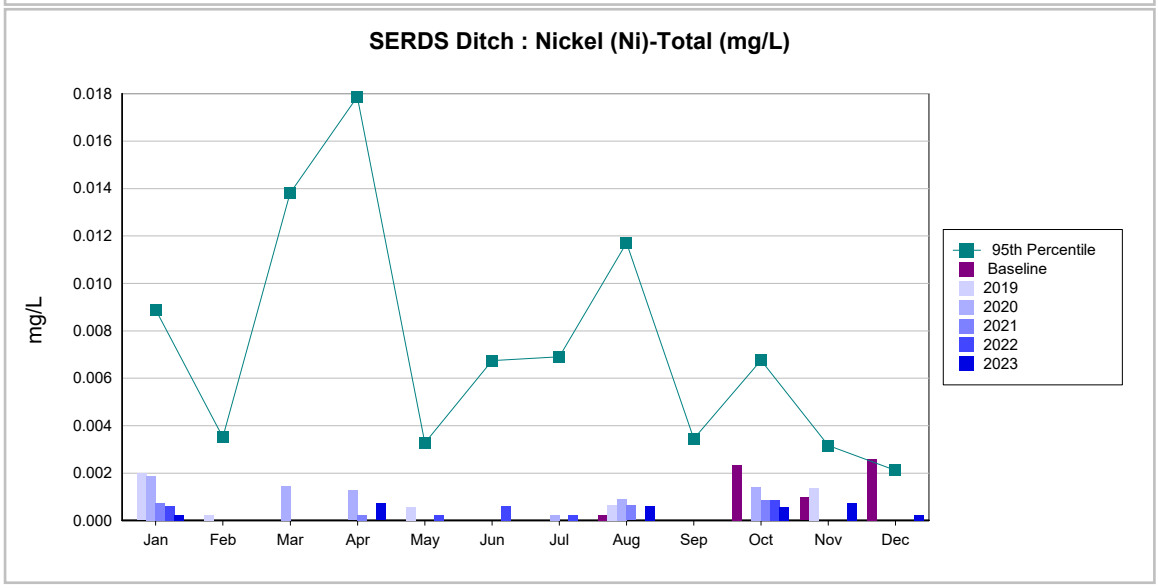
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







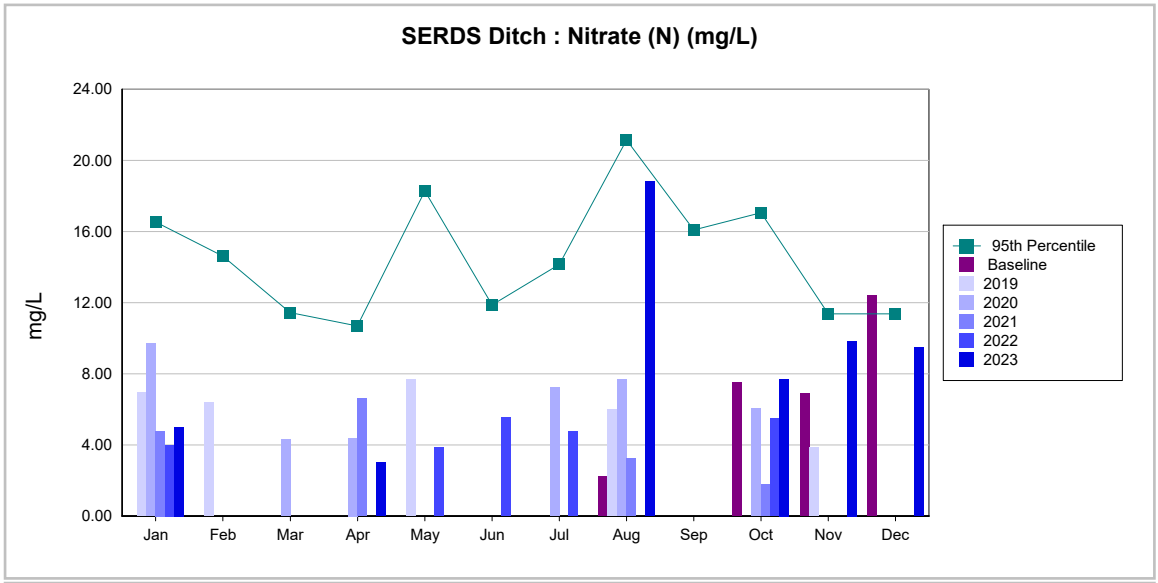
Water Quality Report

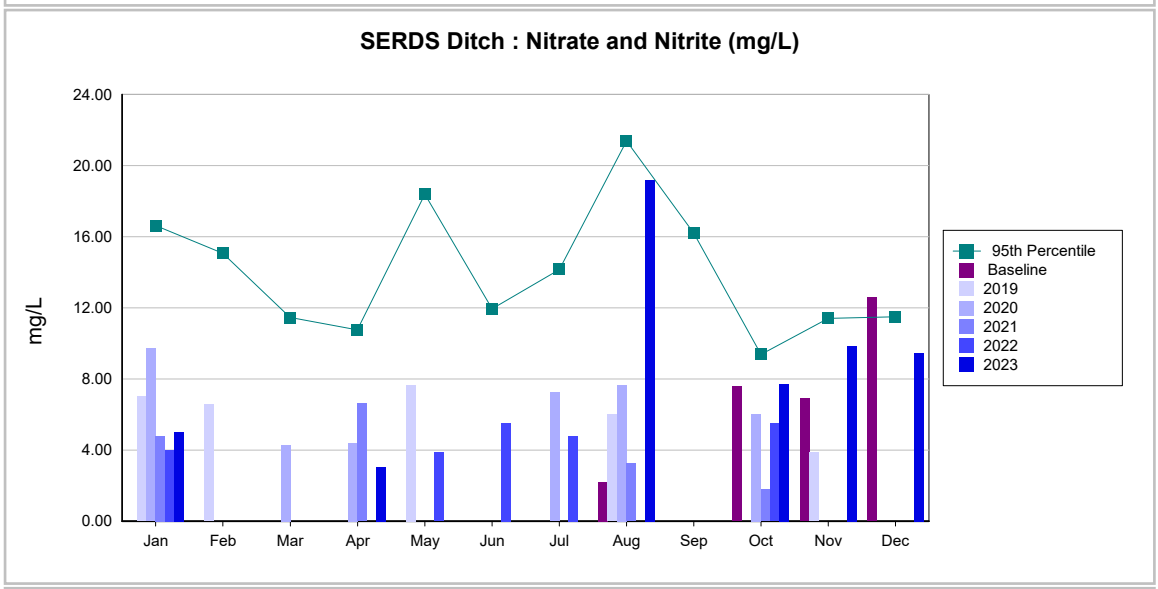
Annual Report Drainage Water

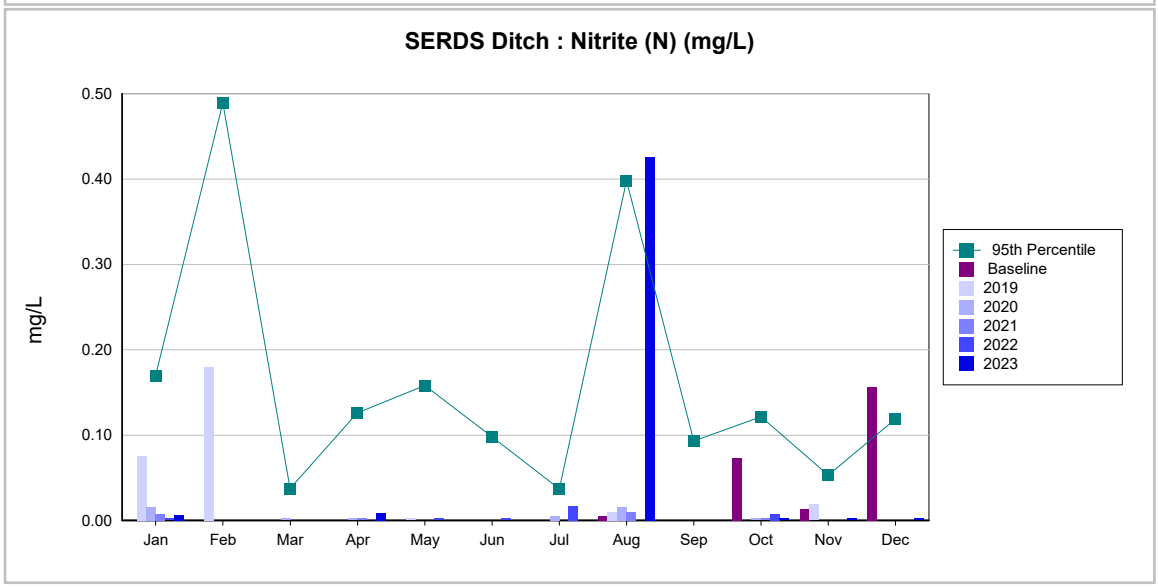
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







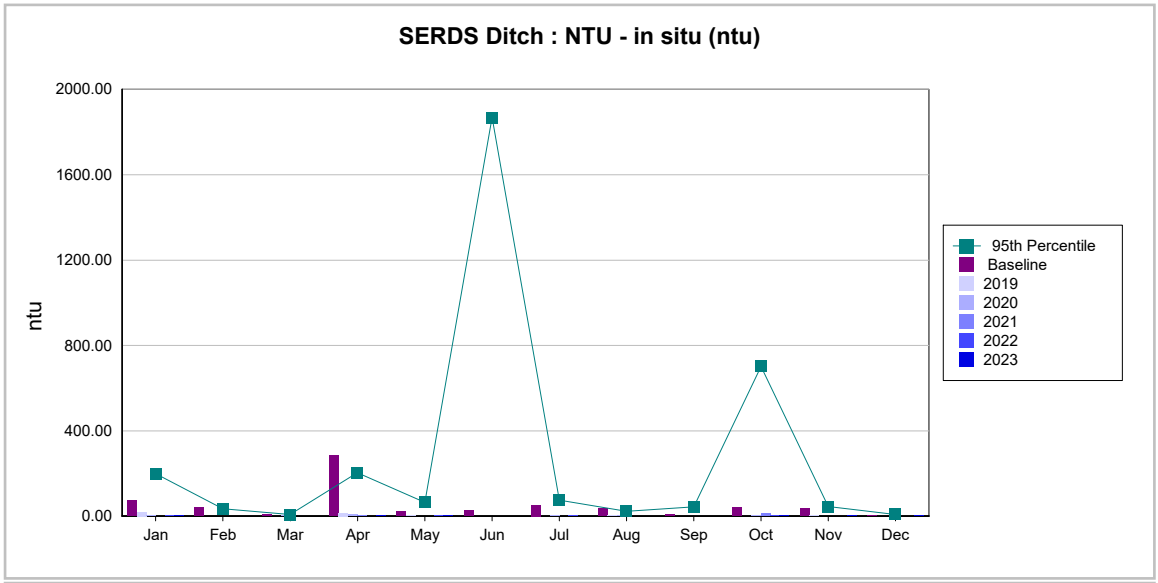
Water Quality Report

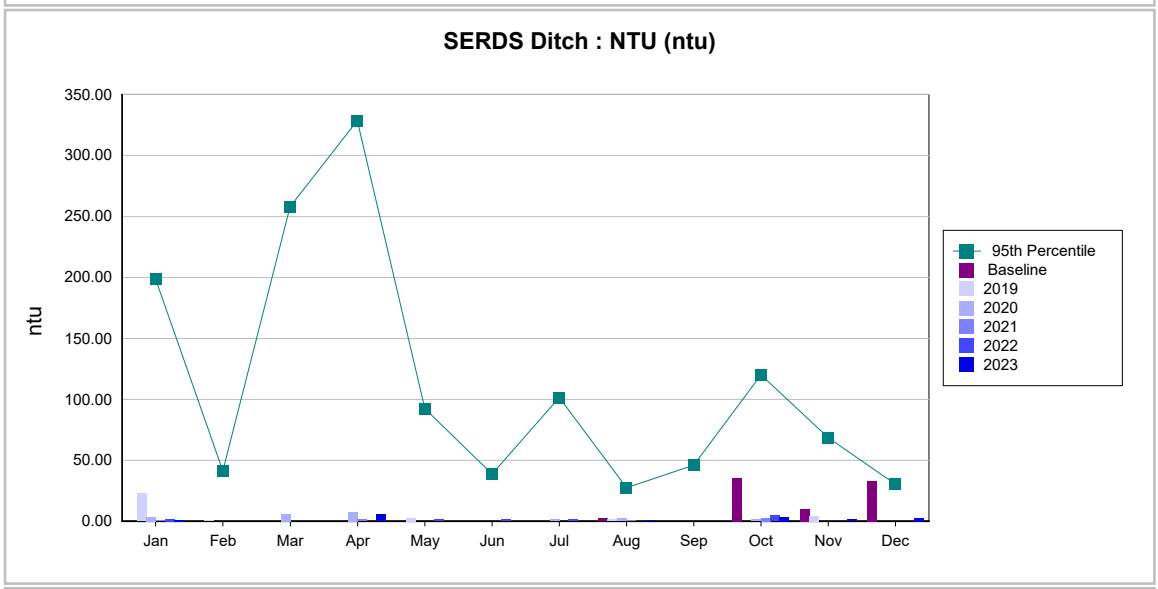
Annual Report Drainage Water

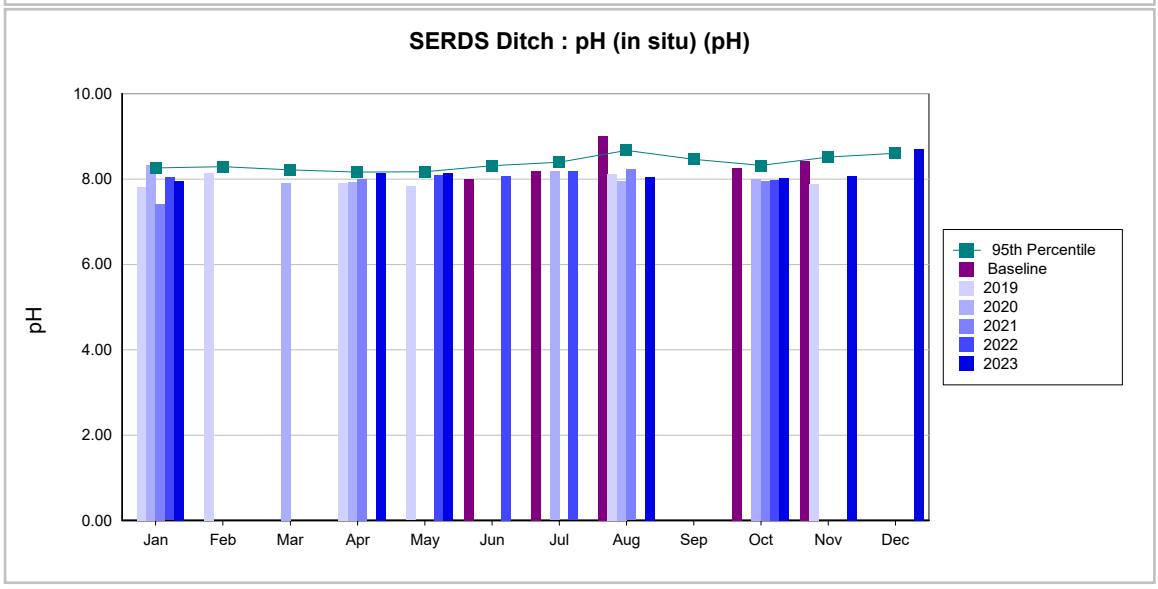
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







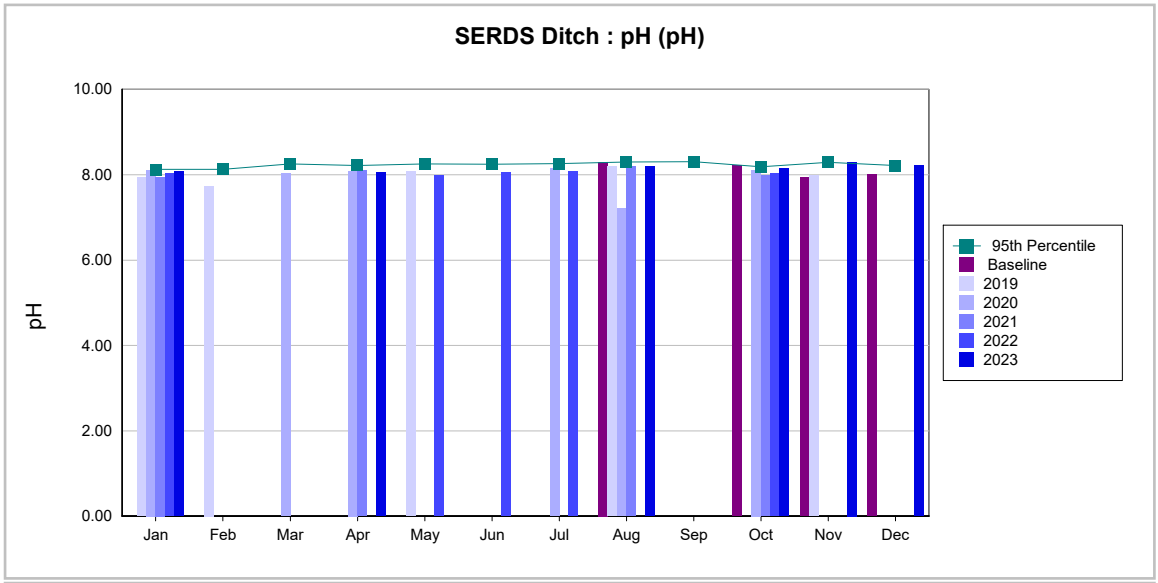
Water Quality Report

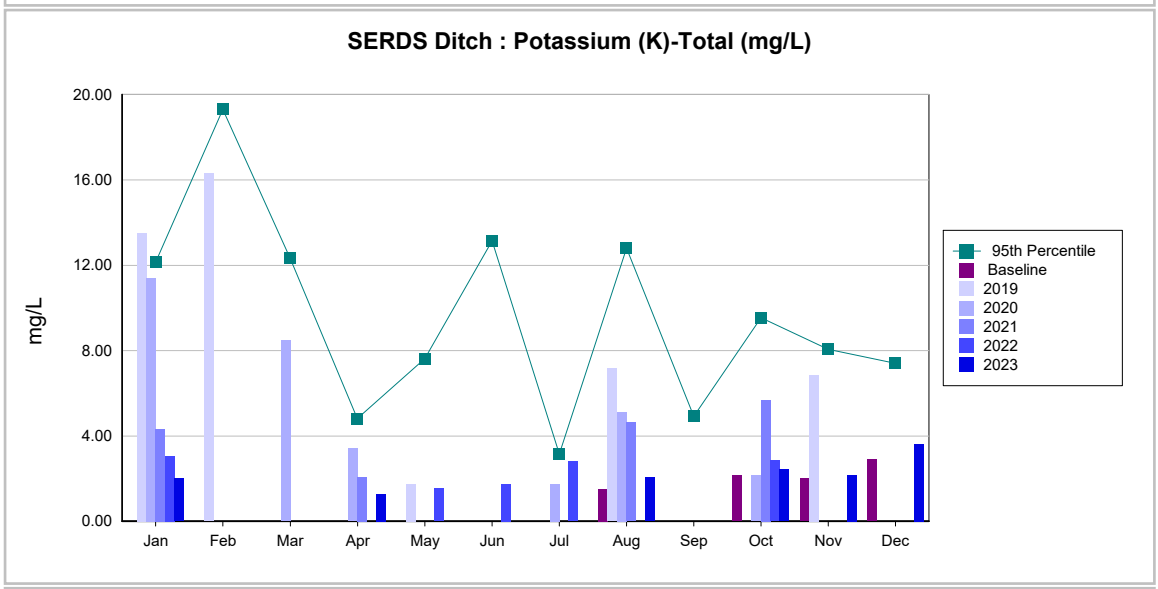
Annual Report Drainage Water

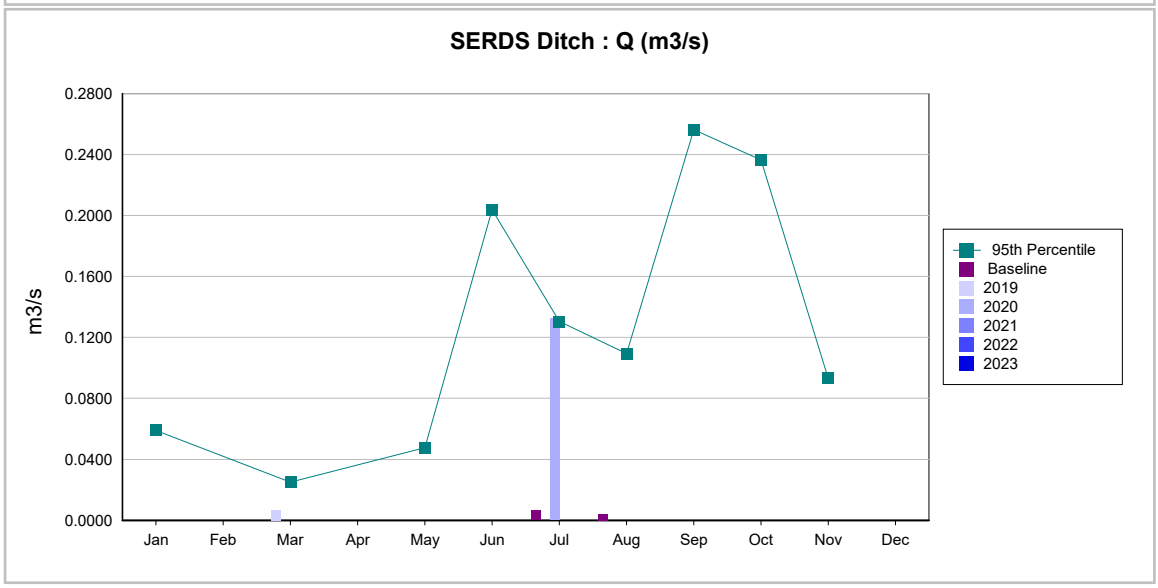
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

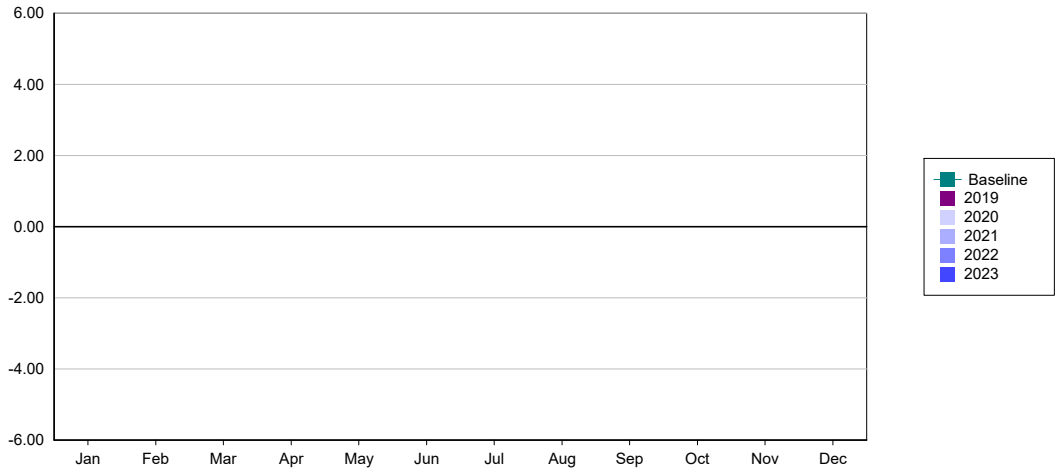
Annual Report Drainage Water

Mount Polley

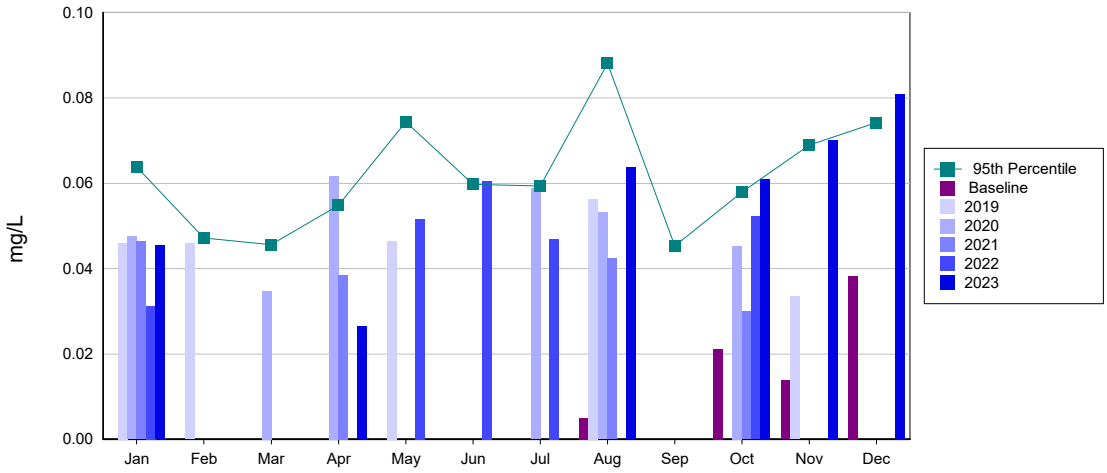
Mining Corporation

IMPERIAL METALS CORPORATION

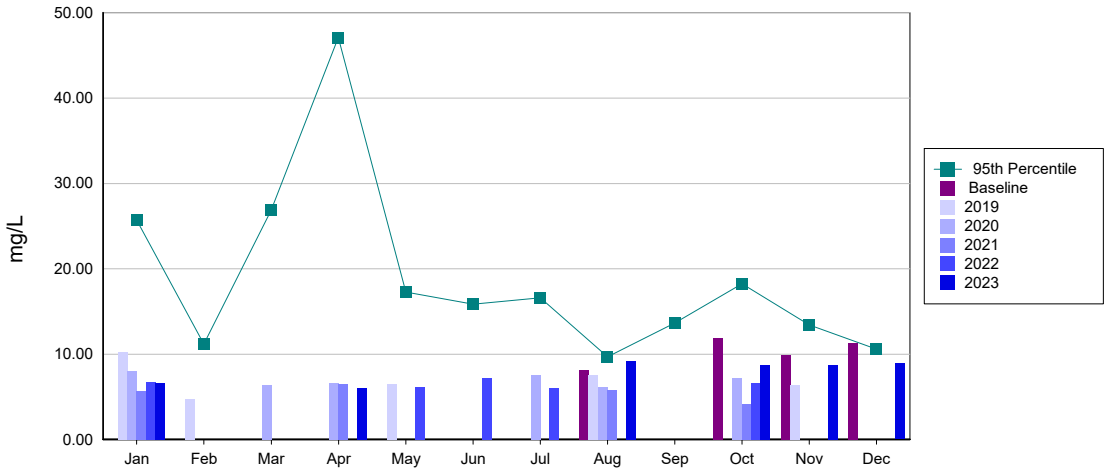
SERDS Ditch : Sample Taken



SERDS Ditch : Selenium (Se)-Total (mg/L)



SERDS Ditch : Silicon (Si)-Total (mg/L)



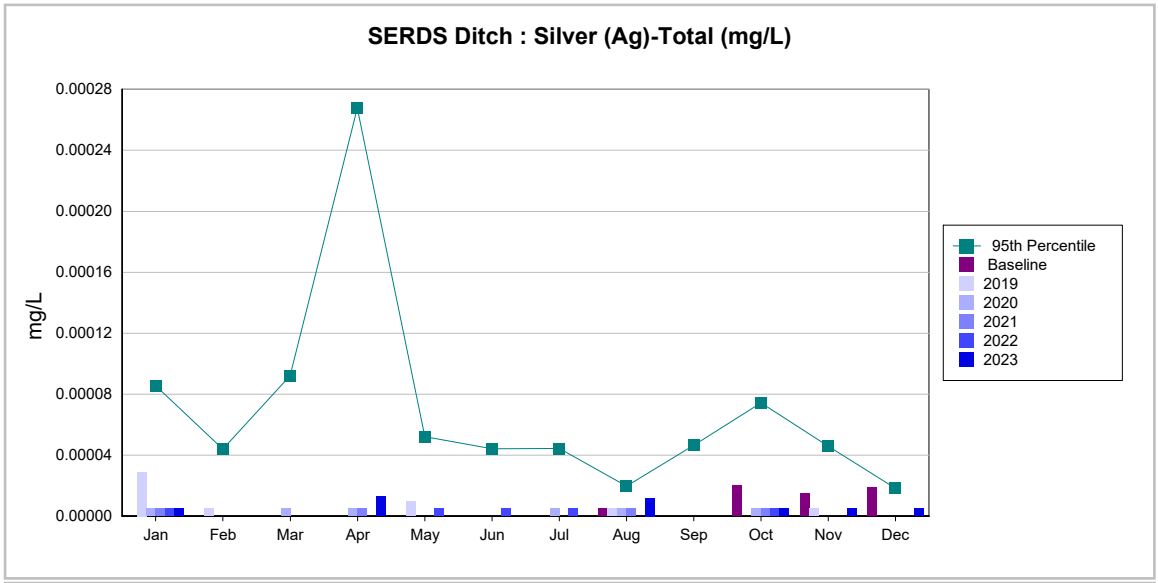
Water Quality Report

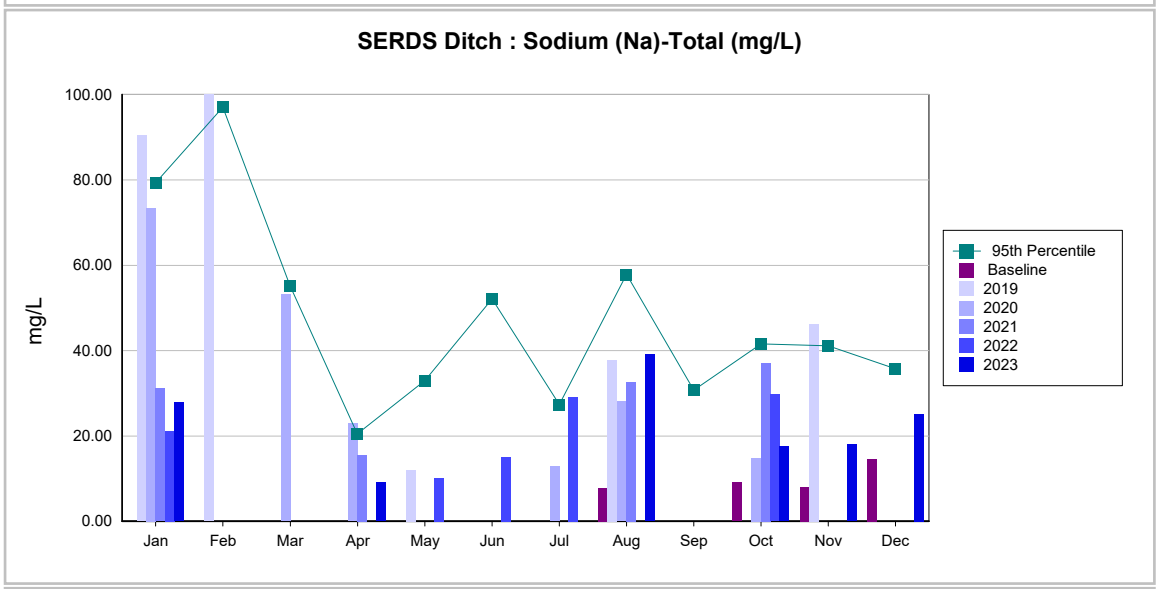
Annual Report Drainage Water

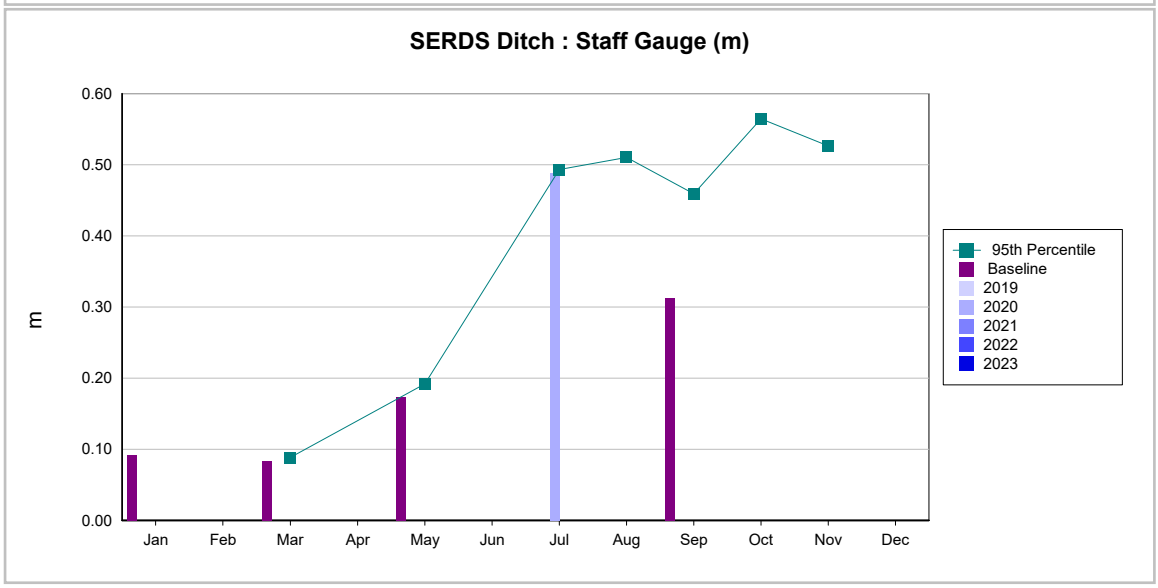
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







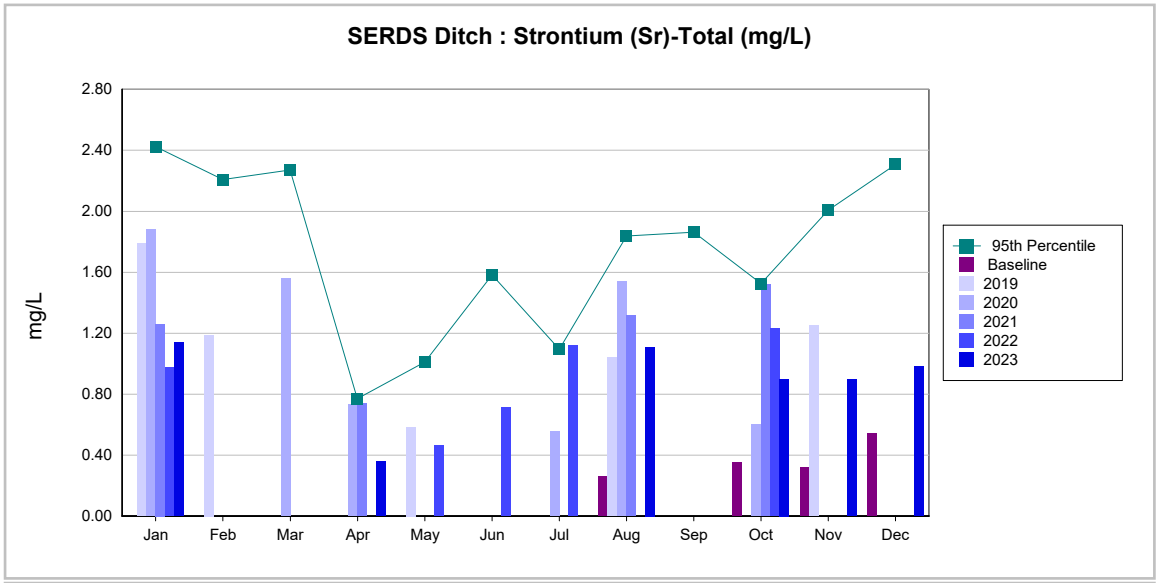
Water Quality Report

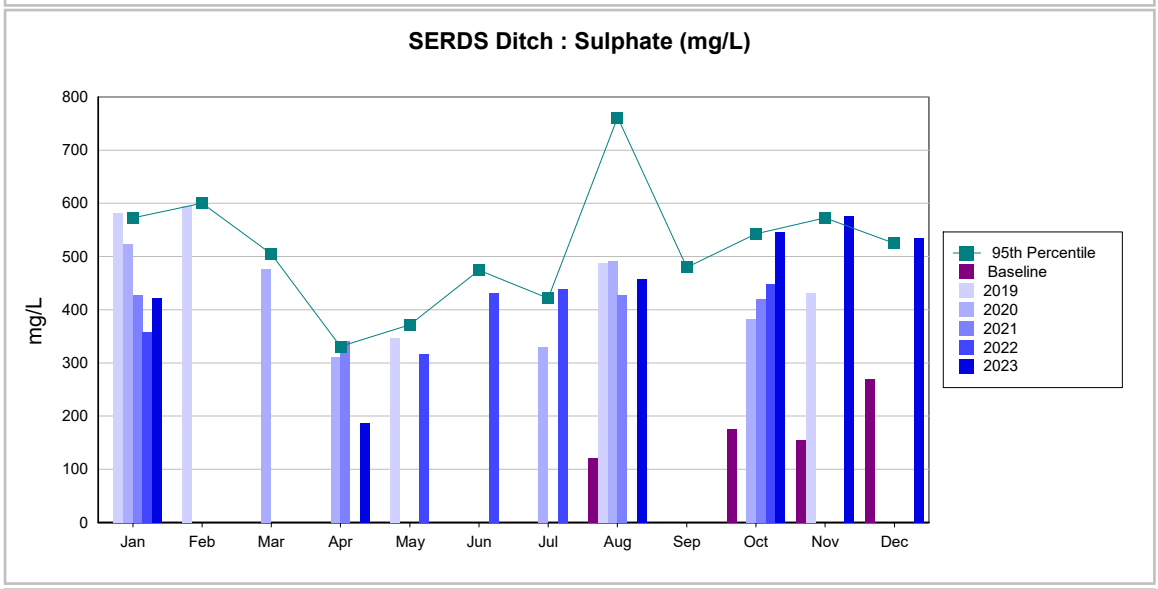
Annual Report Drainage Water

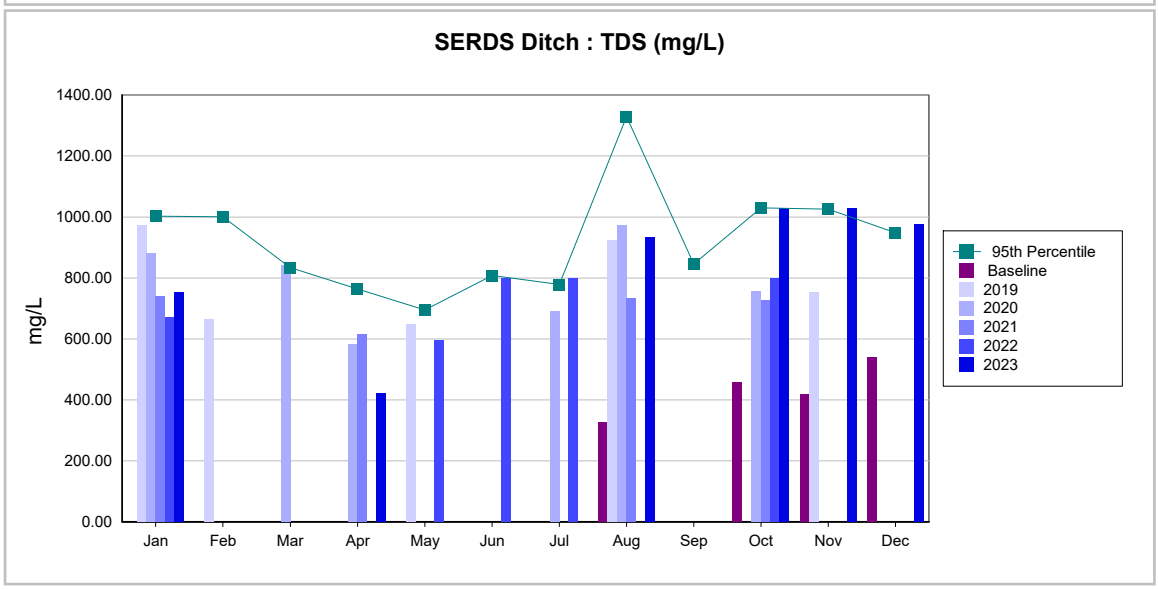
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







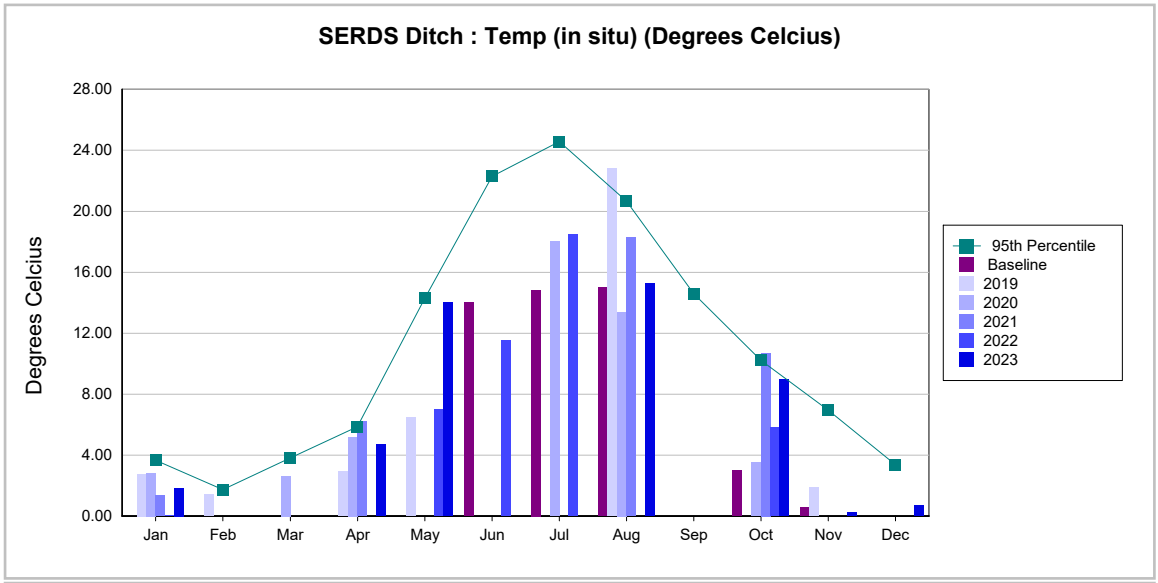
Water Quality Report

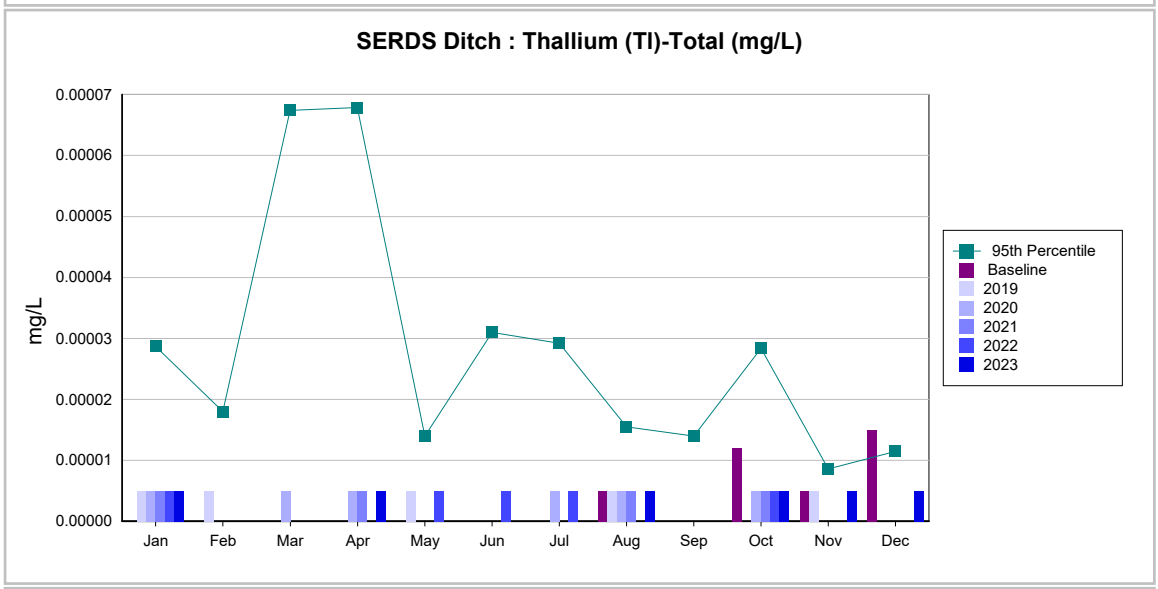
Annual Report Drainage Water

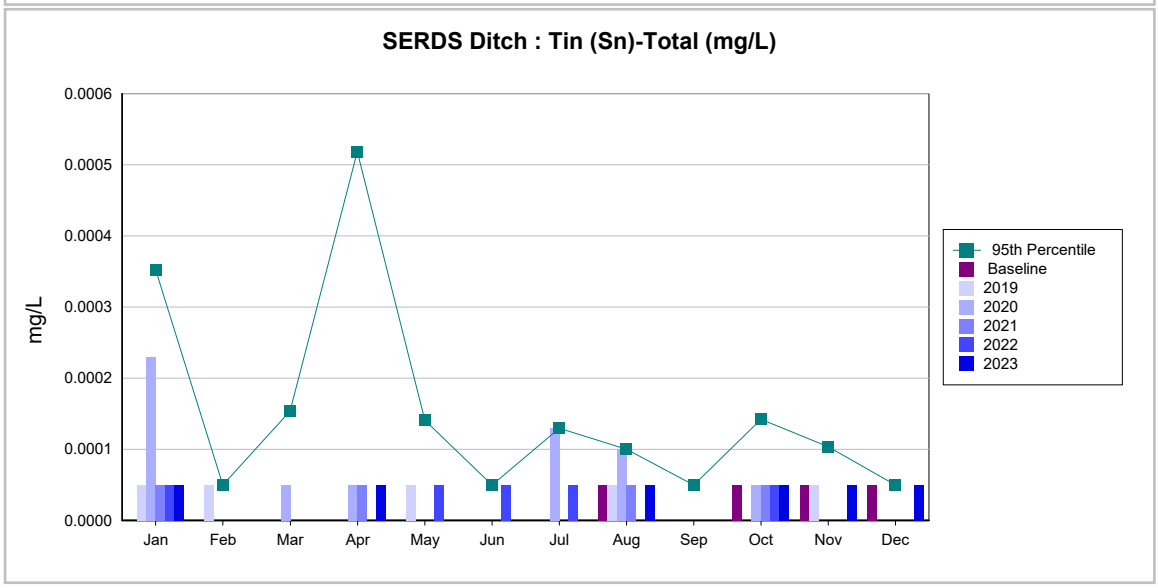
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







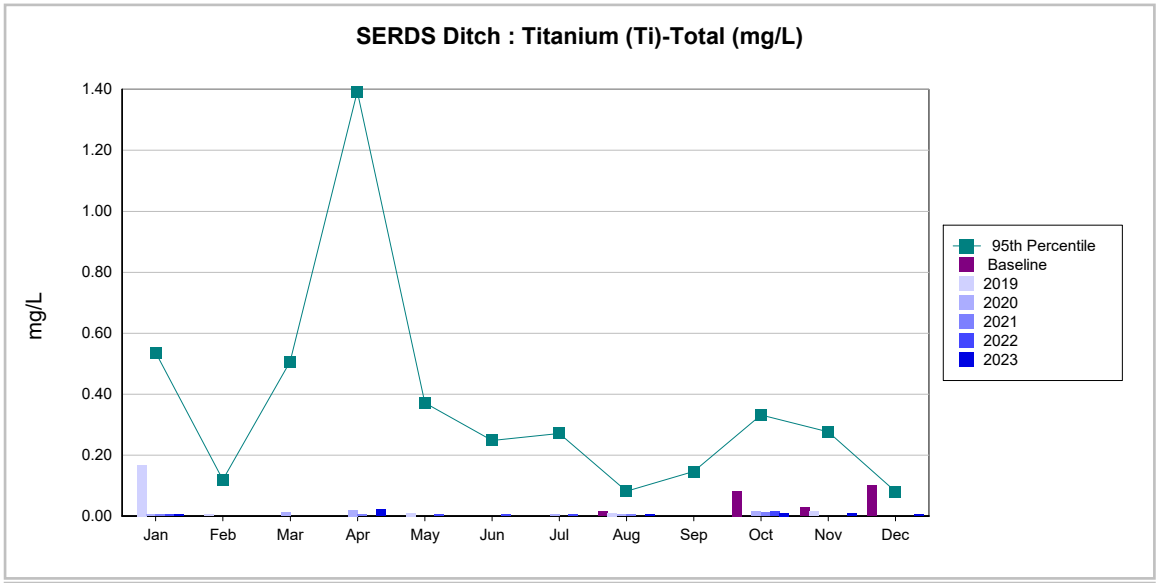
Water Quality Report

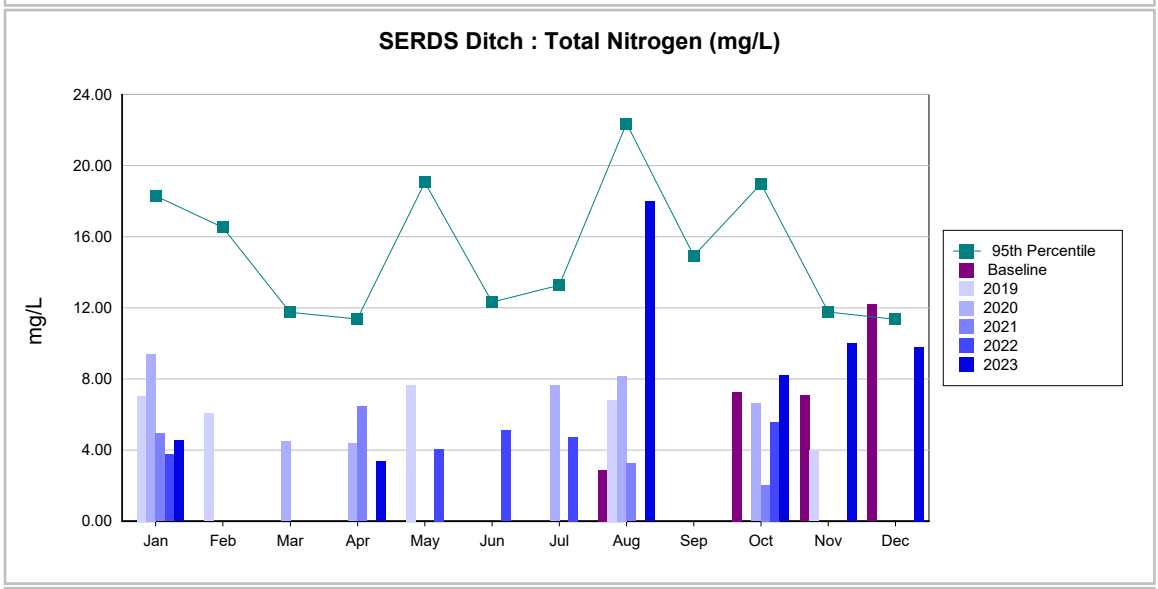
Annual Report Drainage Water

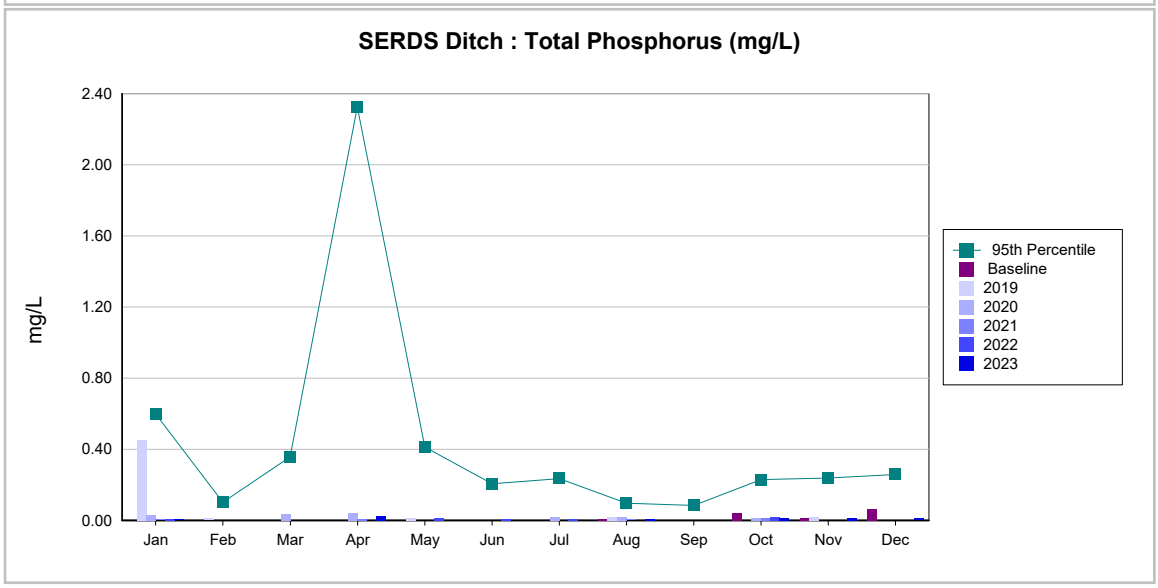
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







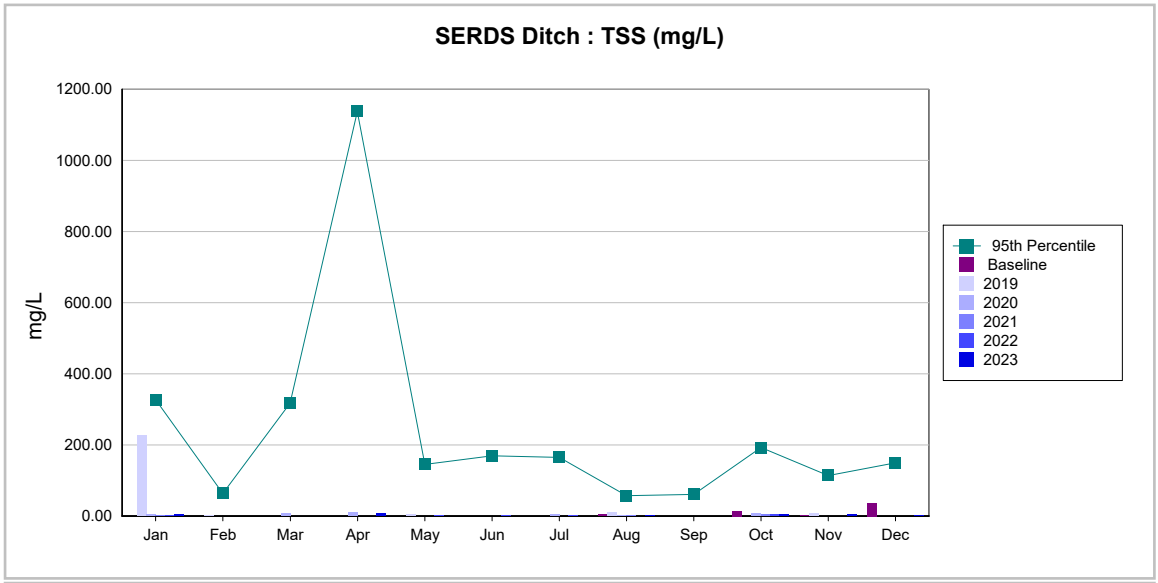
Water Quality Report

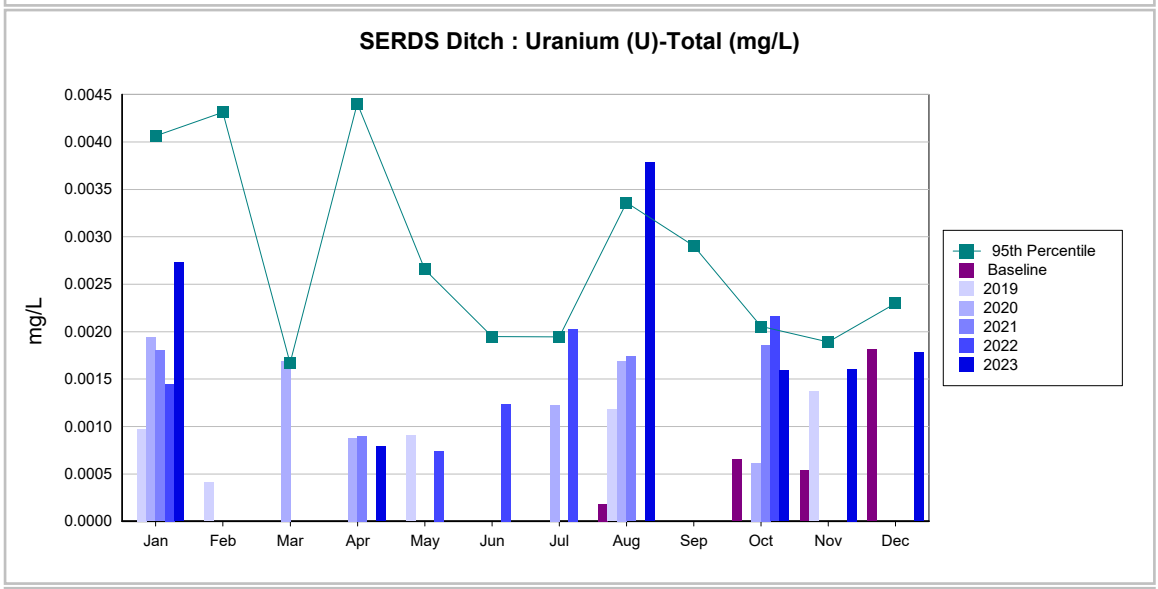
Annual Report Drainage Water

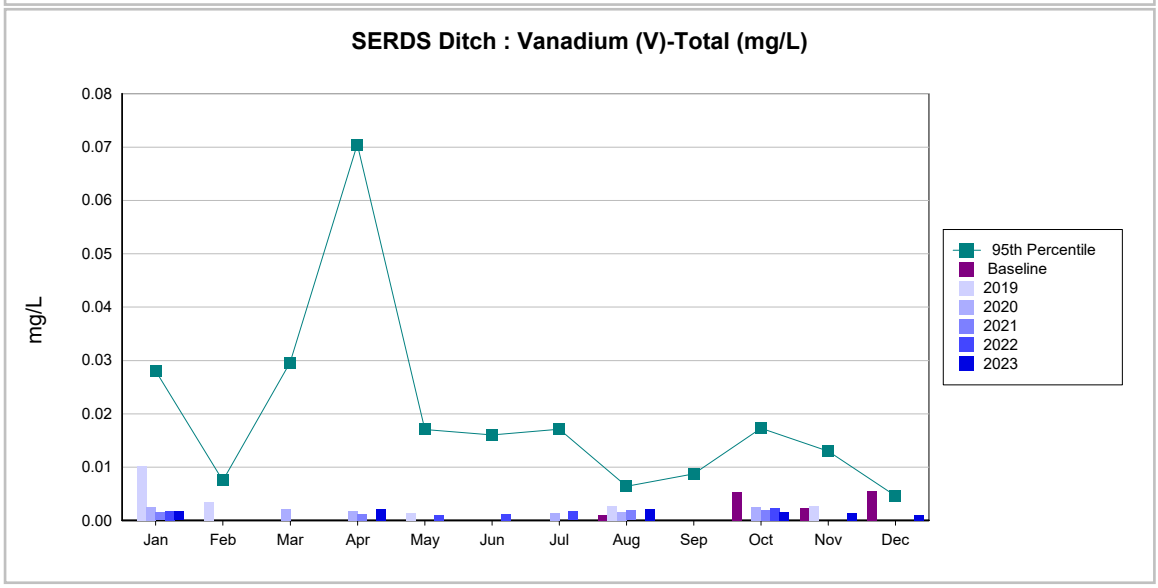
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







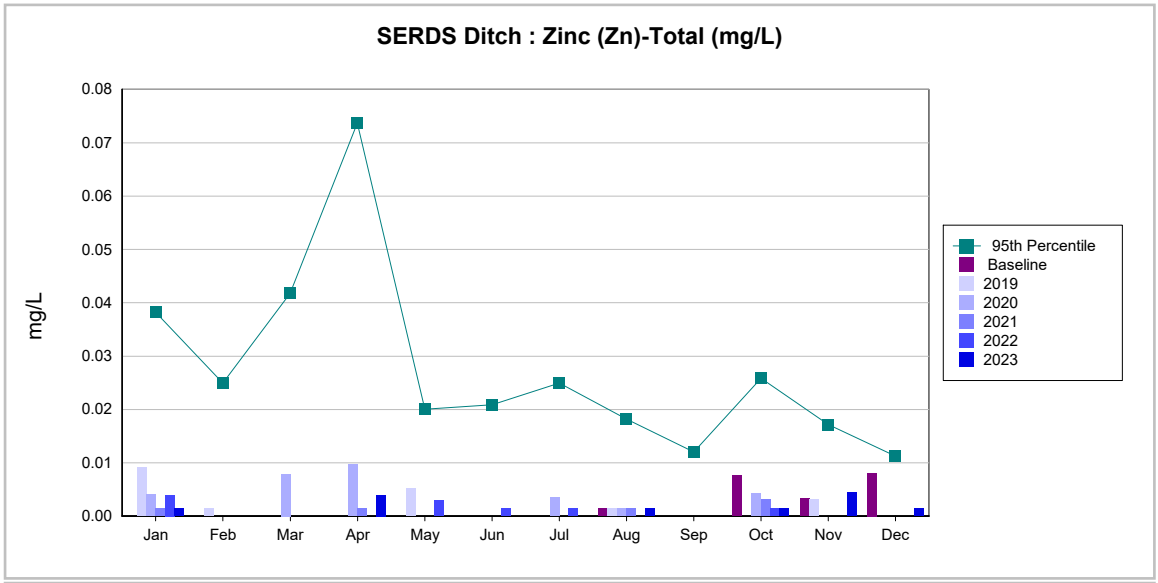
Water Quality Report

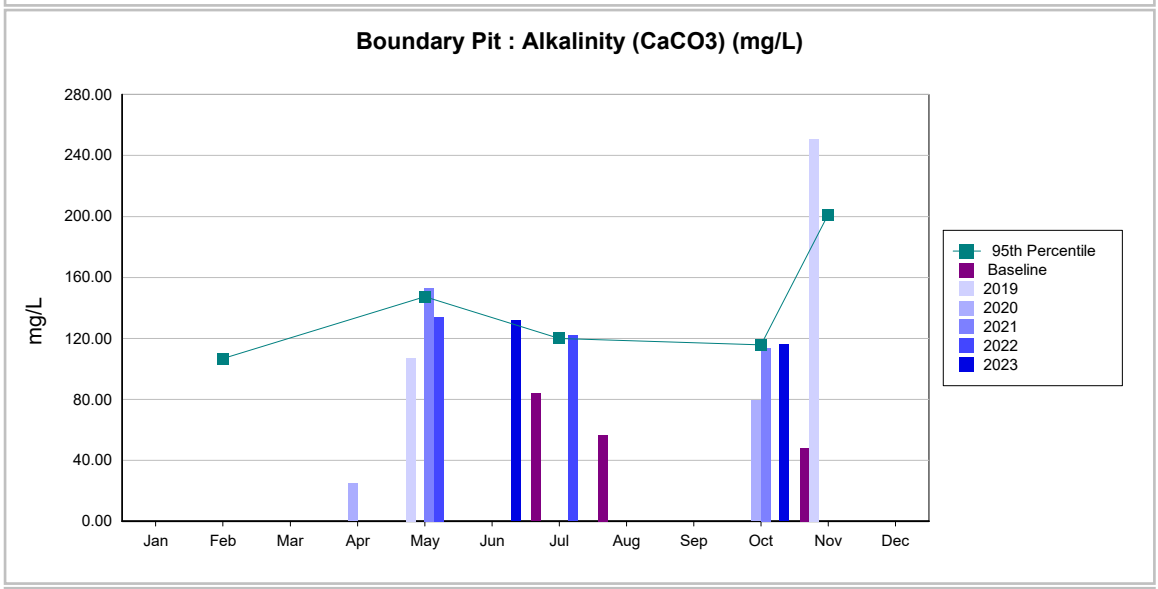
Annual Report Drainage Water

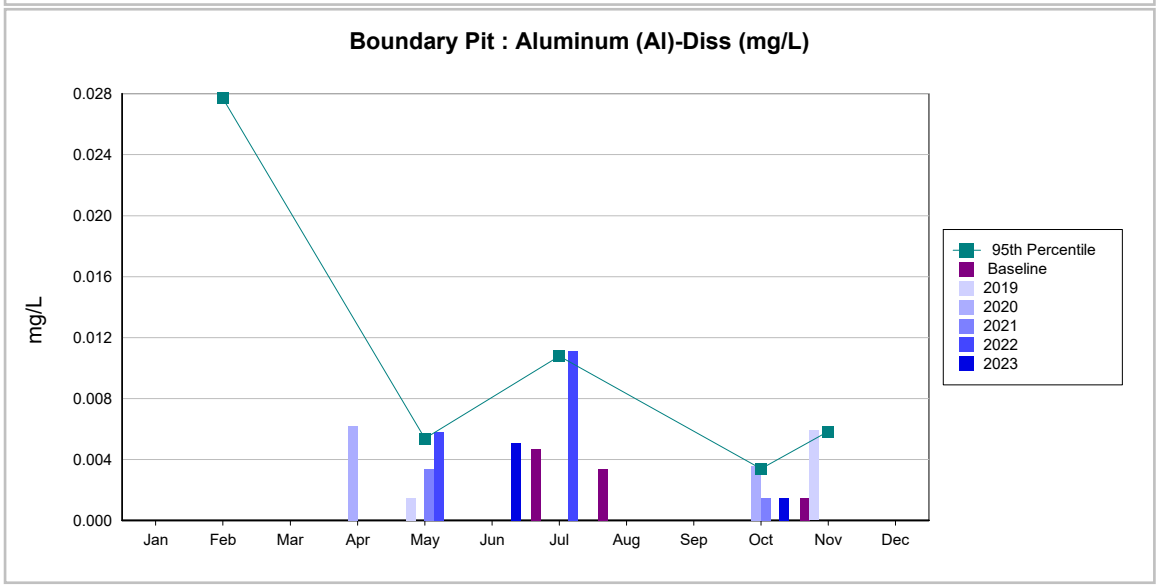
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







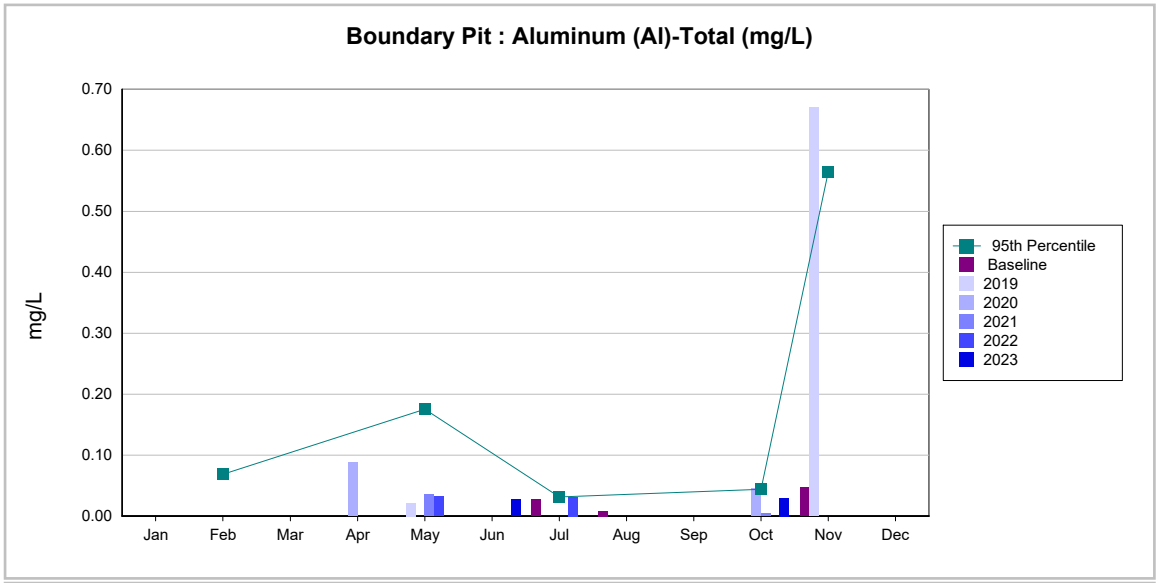
Water Quality Report

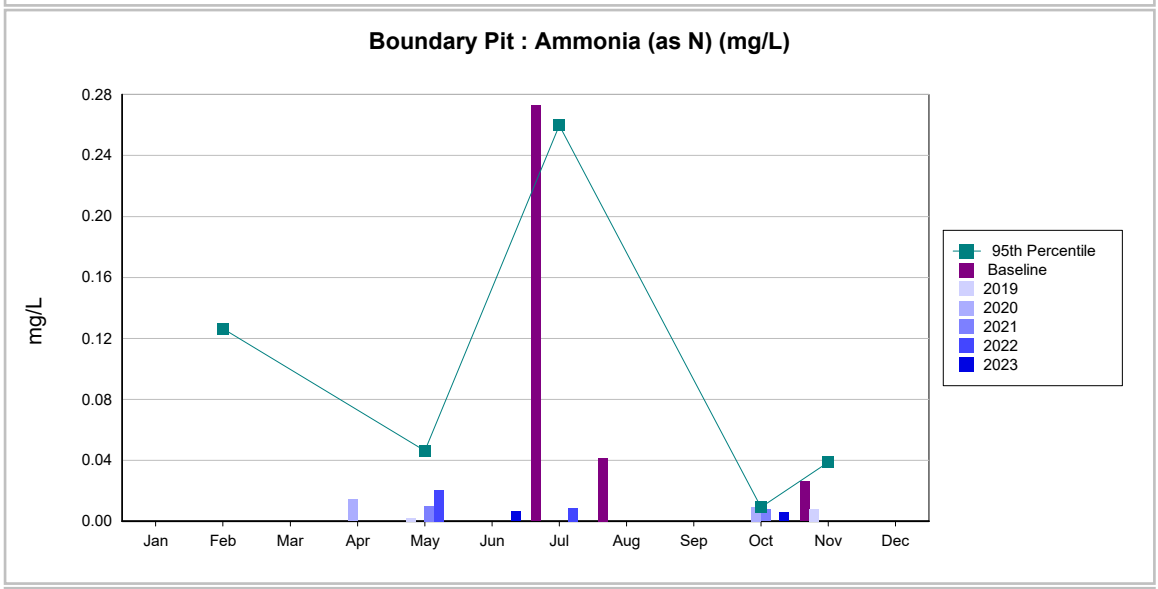
Annual Report Drainage Water

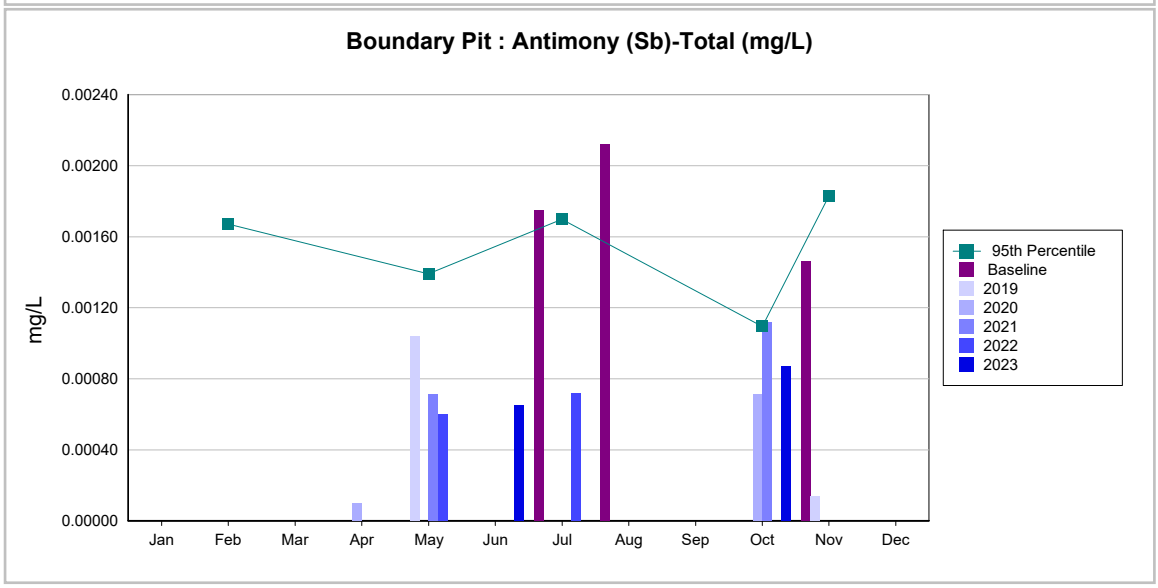
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







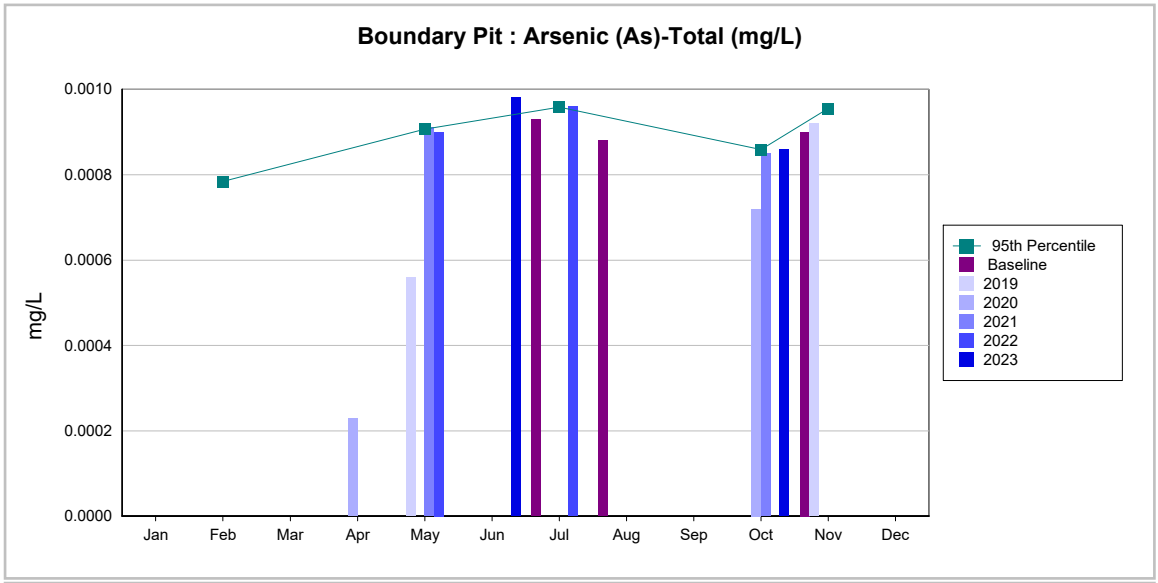
Water Quality Report

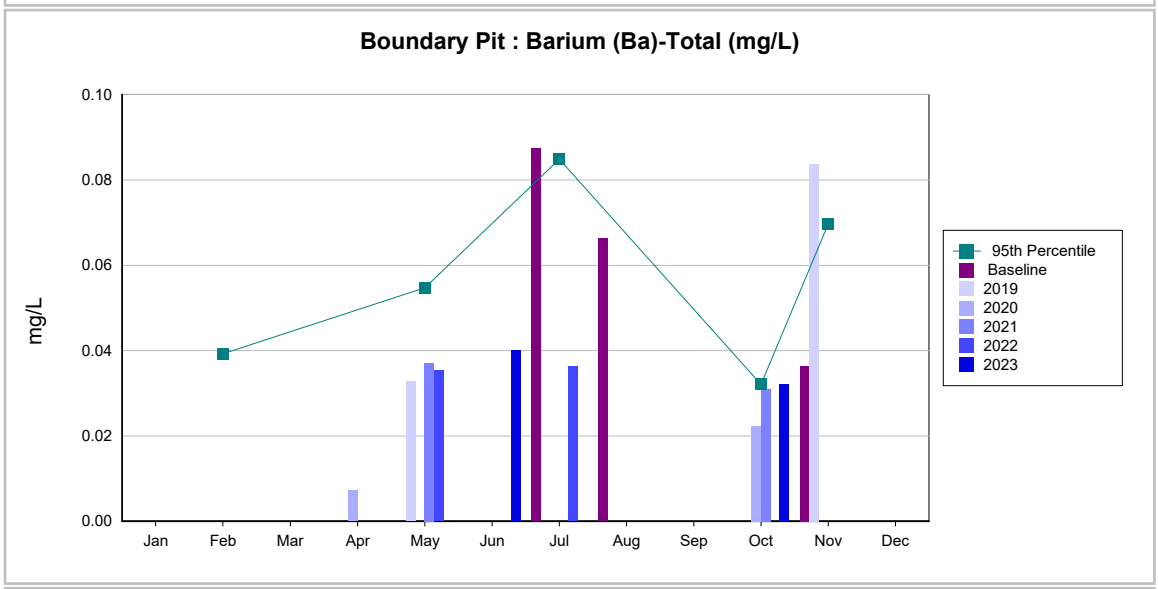
Annual Report Drainage Water

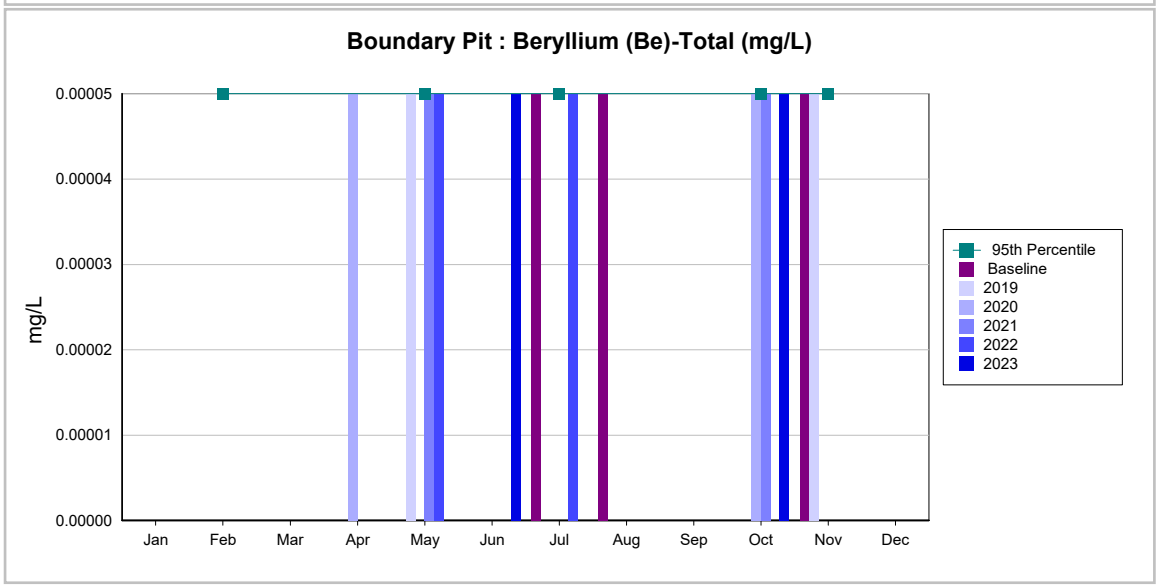
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







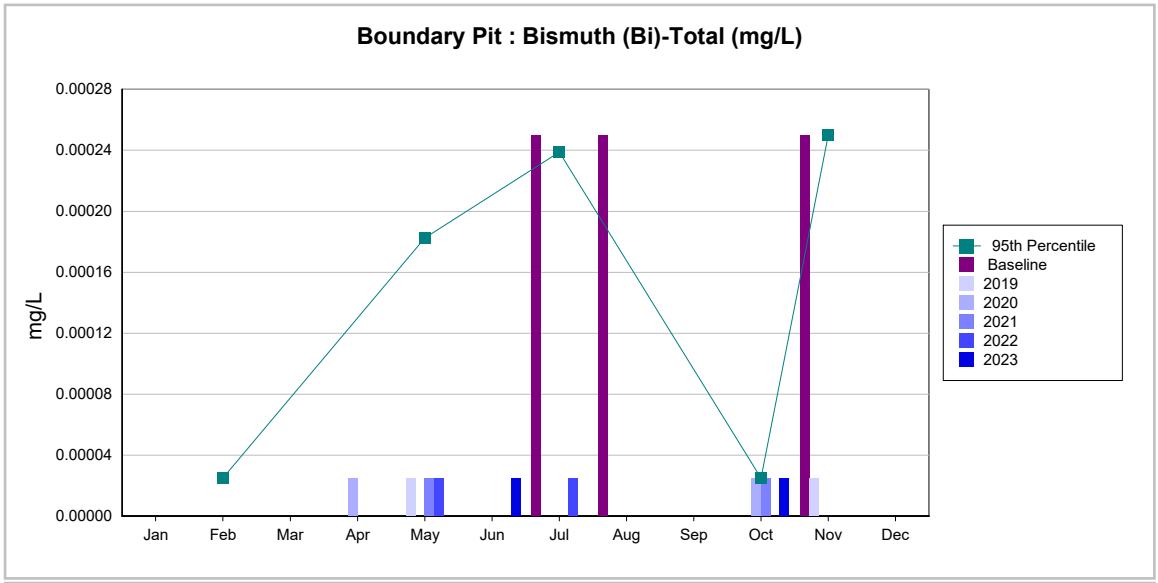
Water Quality Report

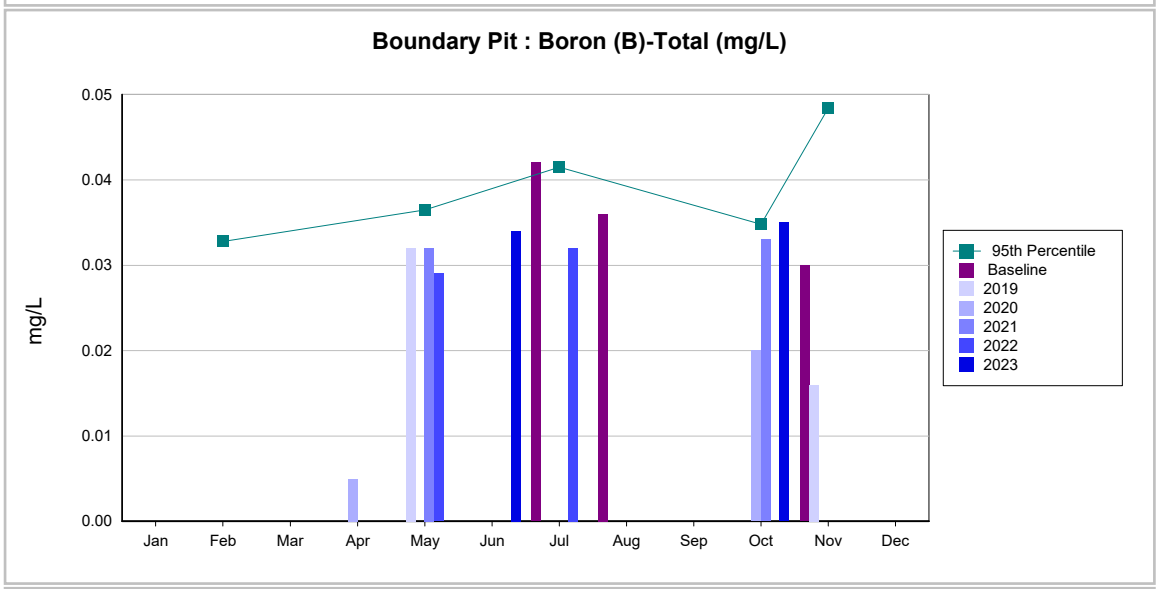
Annual Report Drainage Water

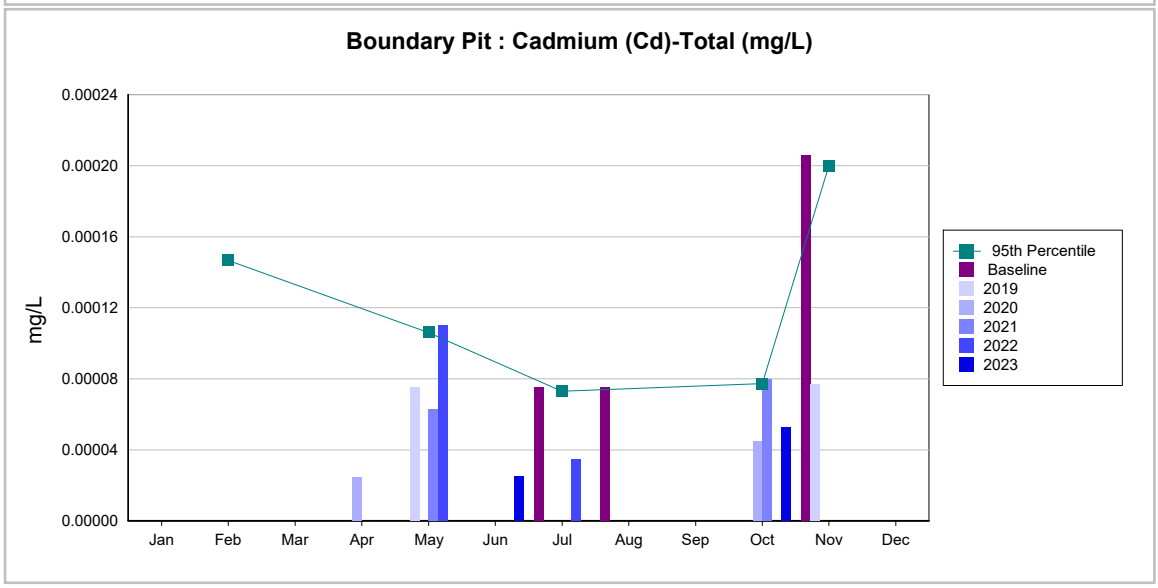
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







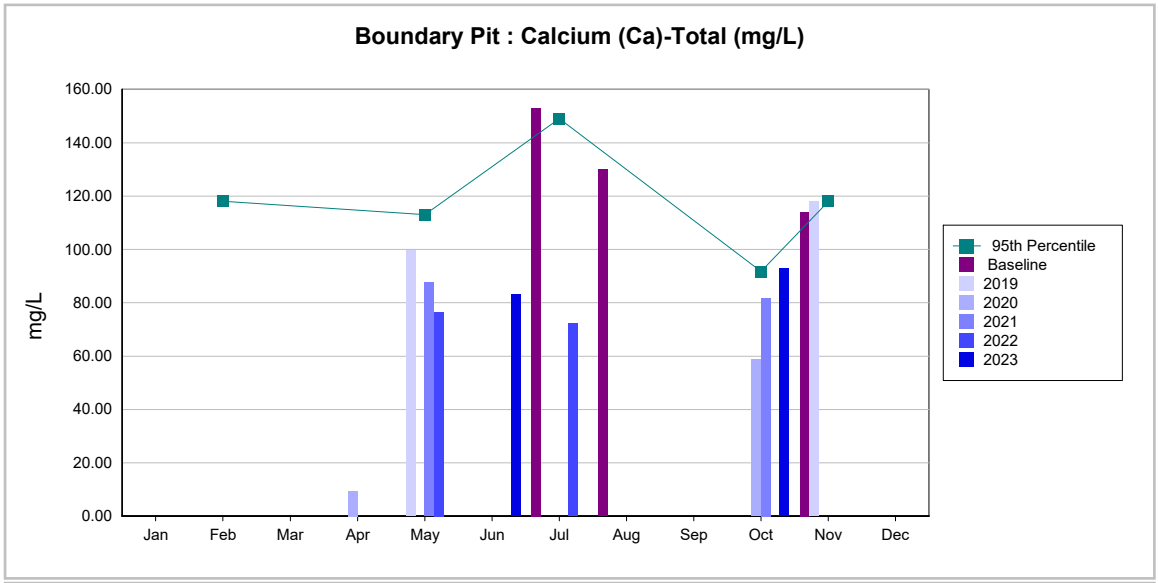
Water Quality Report

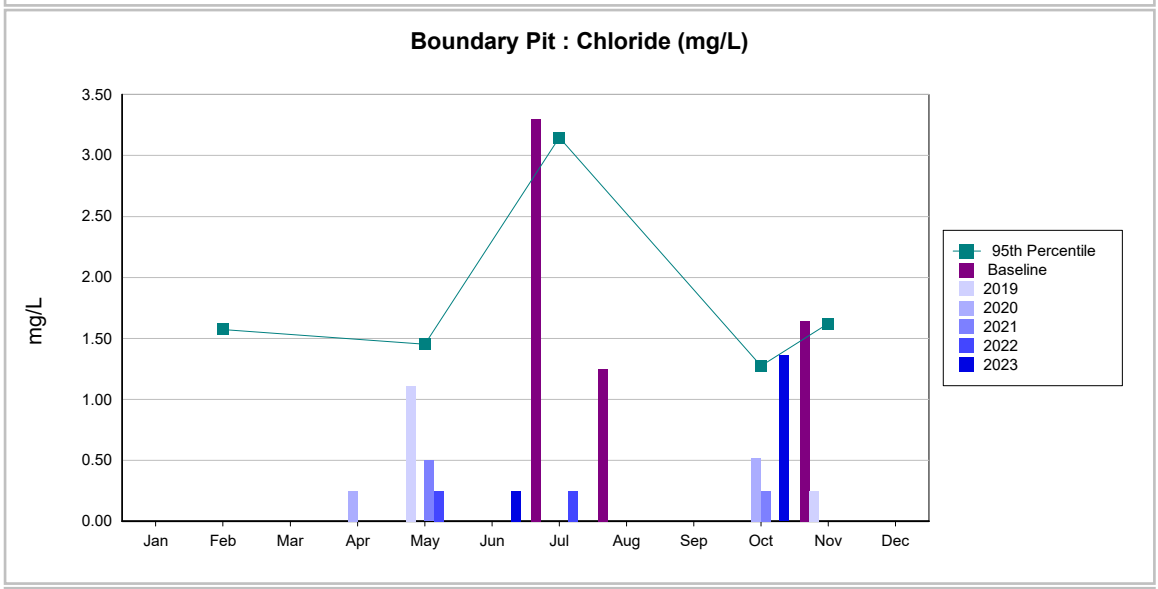
Annual Report Drainage Water

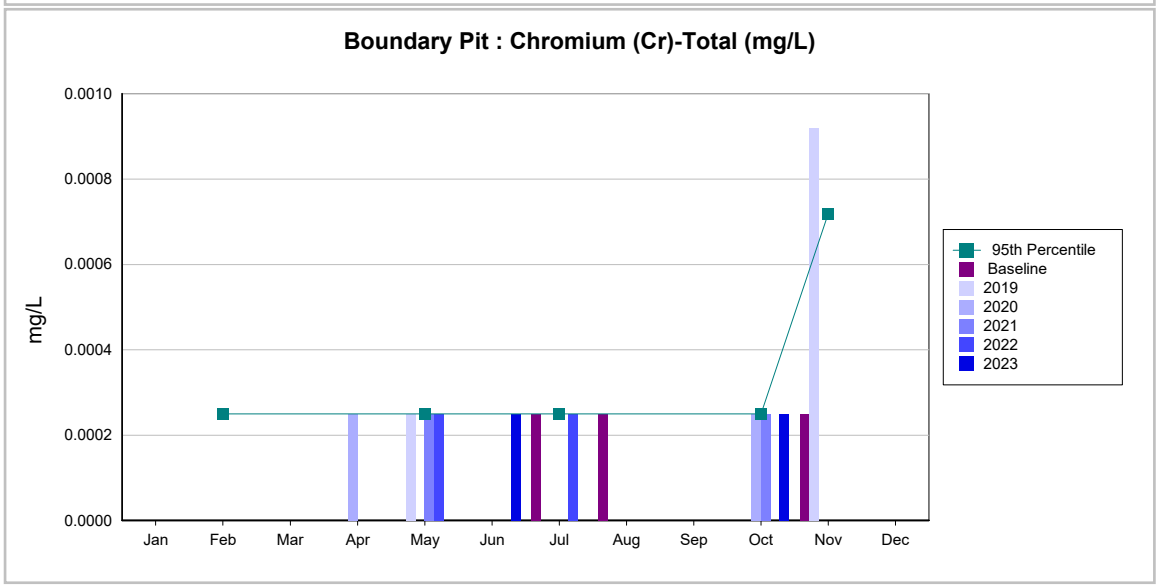
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







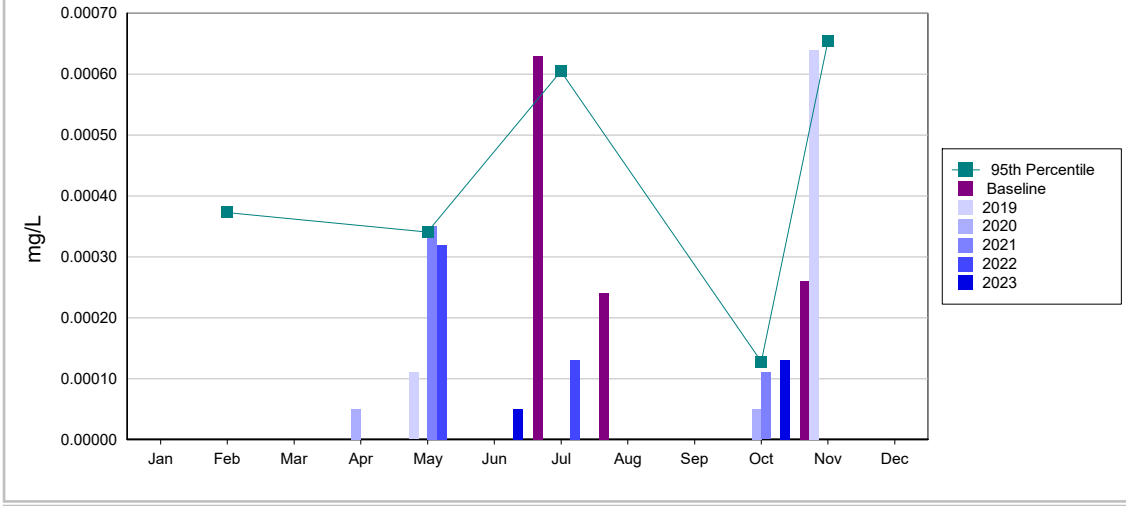
Water Quality Report

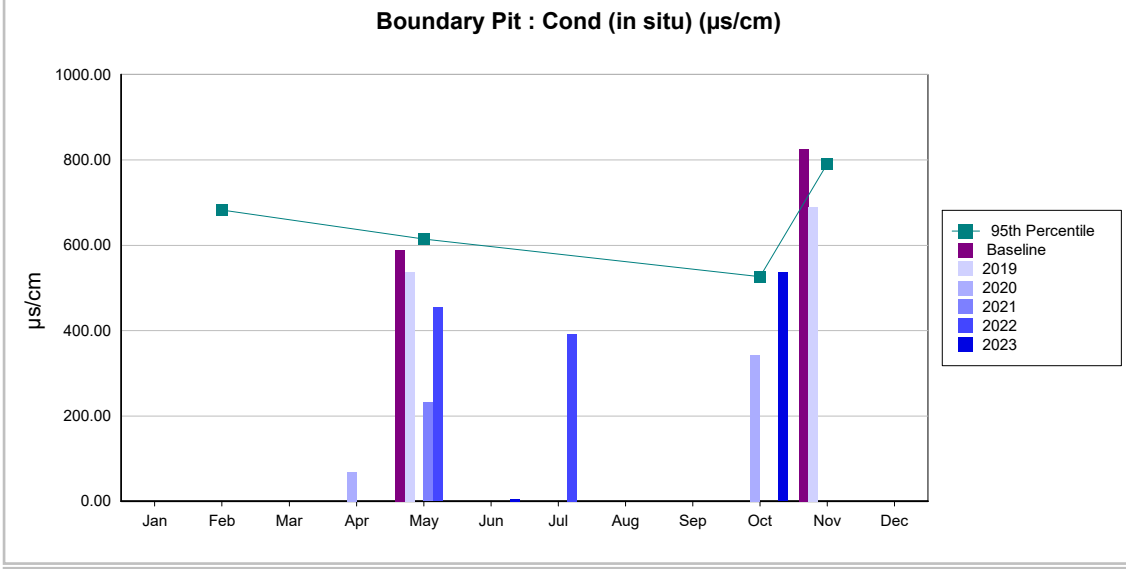
Annual Report Drainage Water

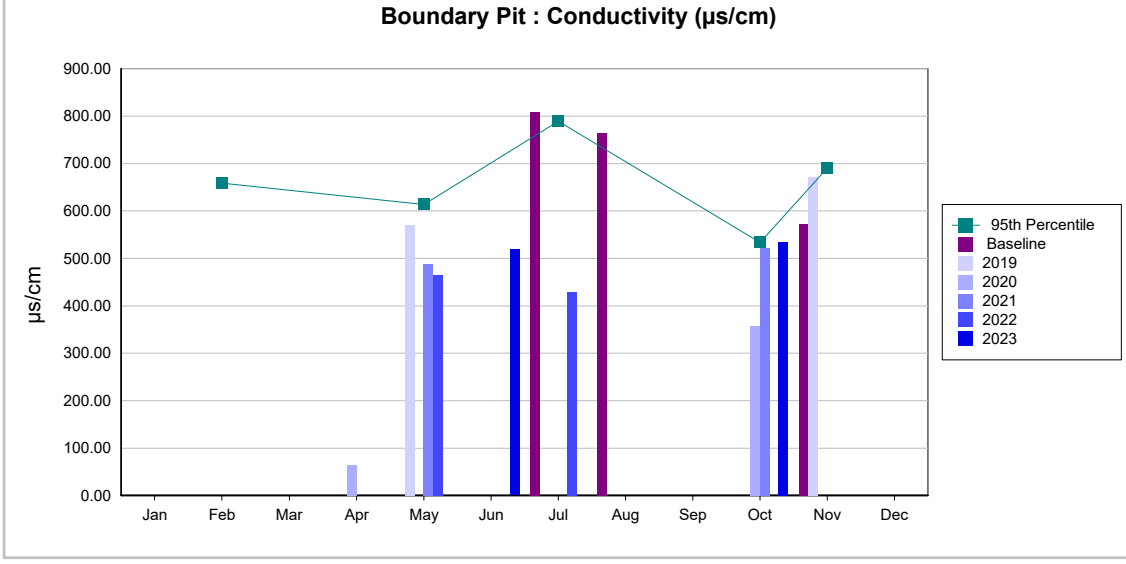
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

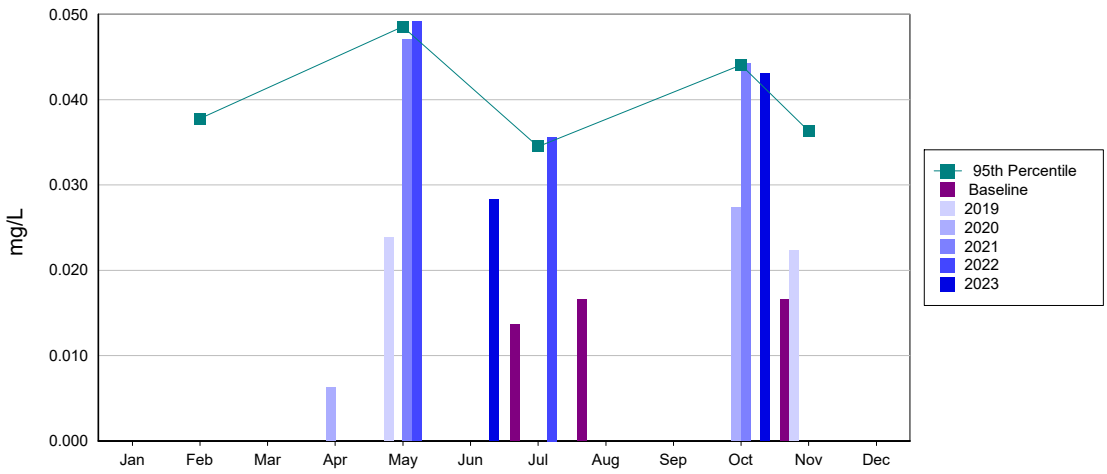
Annual Report Drainage Water

Mount Polley

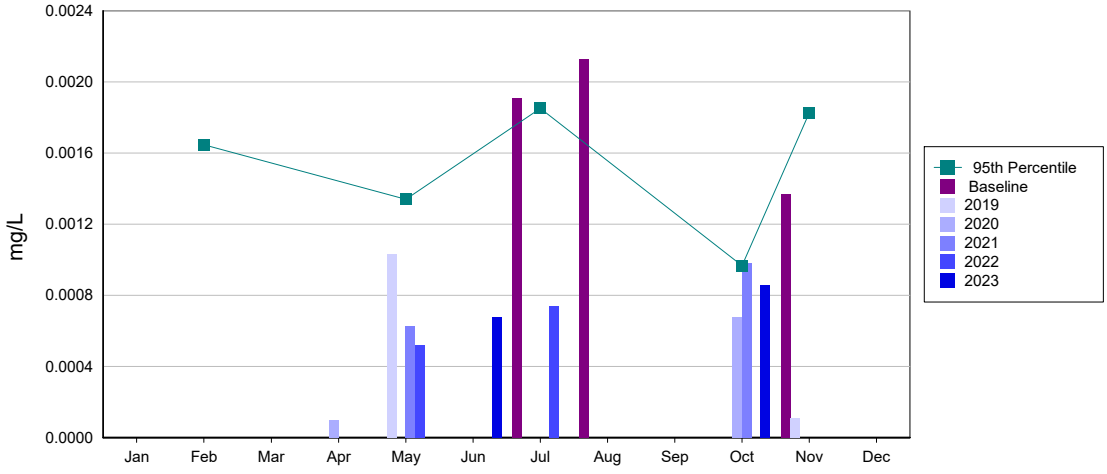
Mining Corporation

IMPERIAL METALS CORPORATION

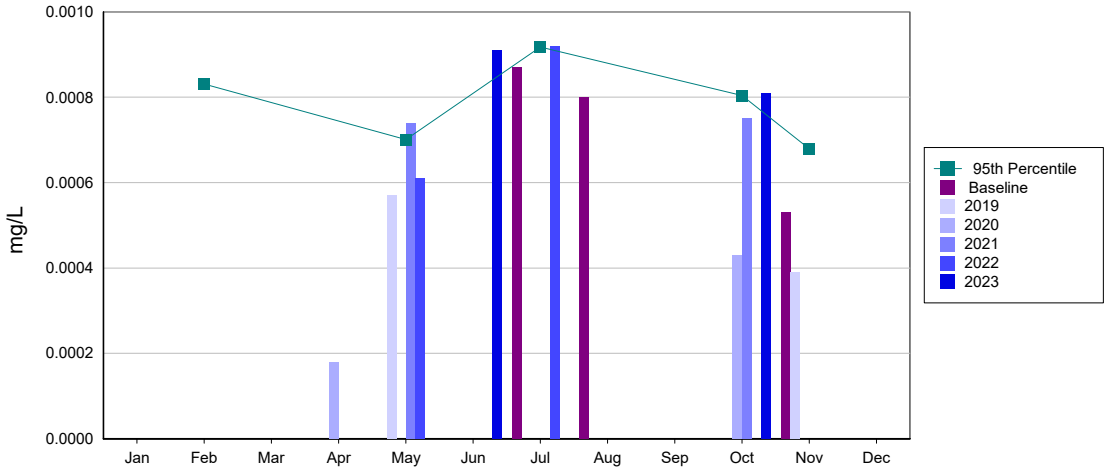
Boundary Pit : Copper (Cu)-Total (mg/L)



Boundary Pit : Diss-Antimony (Sb) (mg/L)



Boundary Pit : Diss-Arsenic (As) (mg/L)



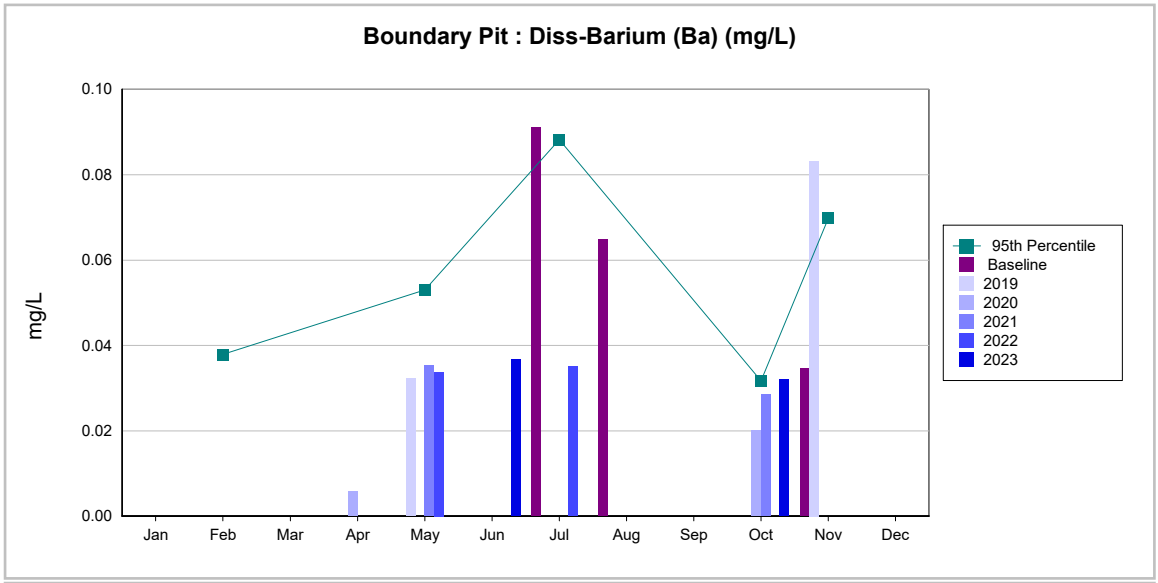
Water Quality Report

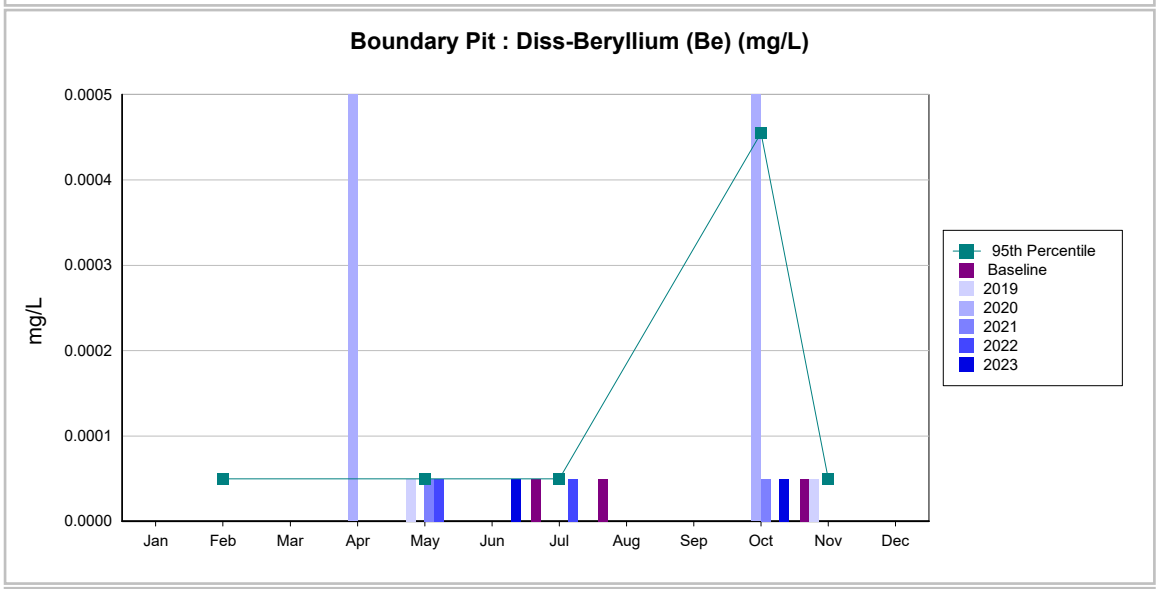
Annual Report Drainage Water

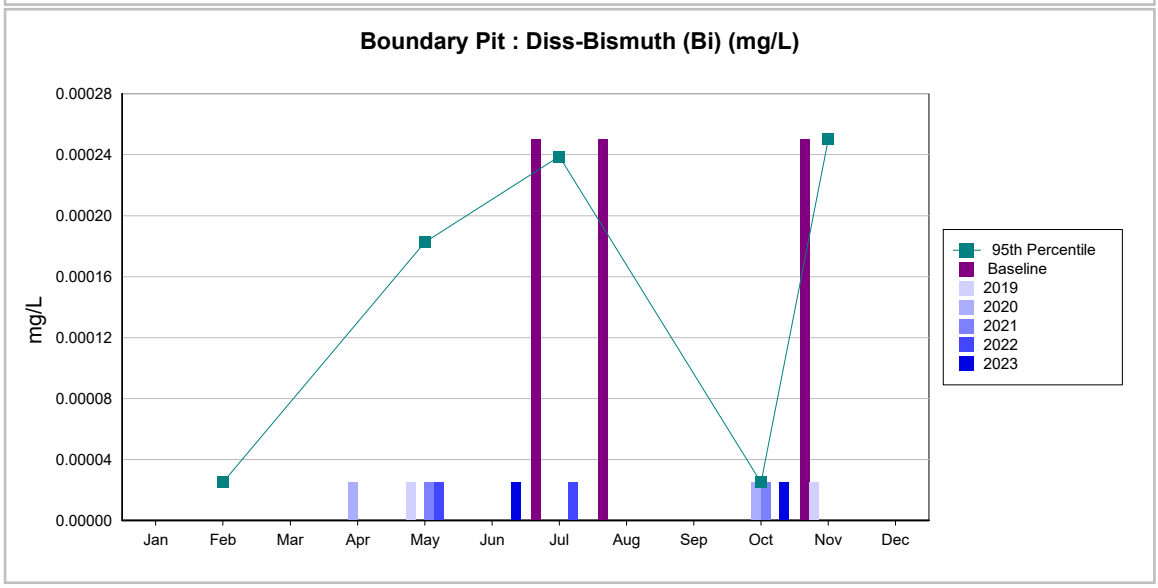
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







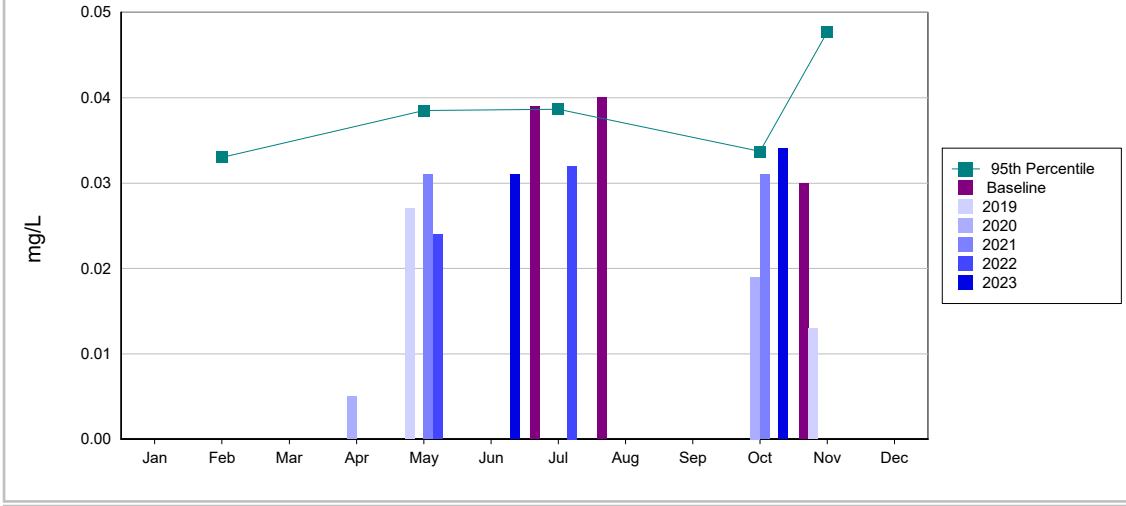
Water Quality Report

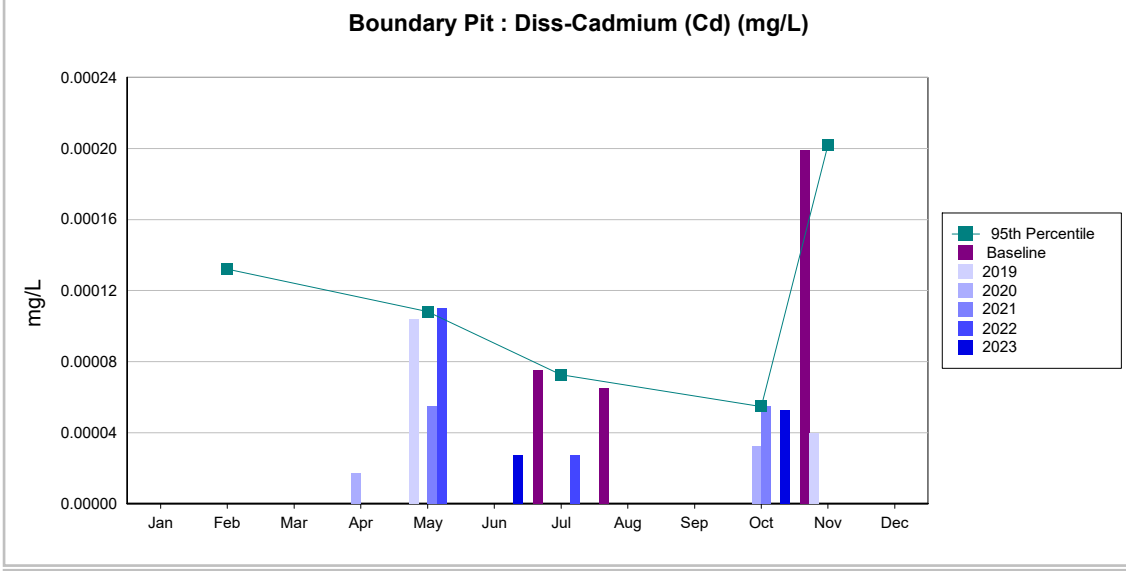
Annual Report Drainage Water

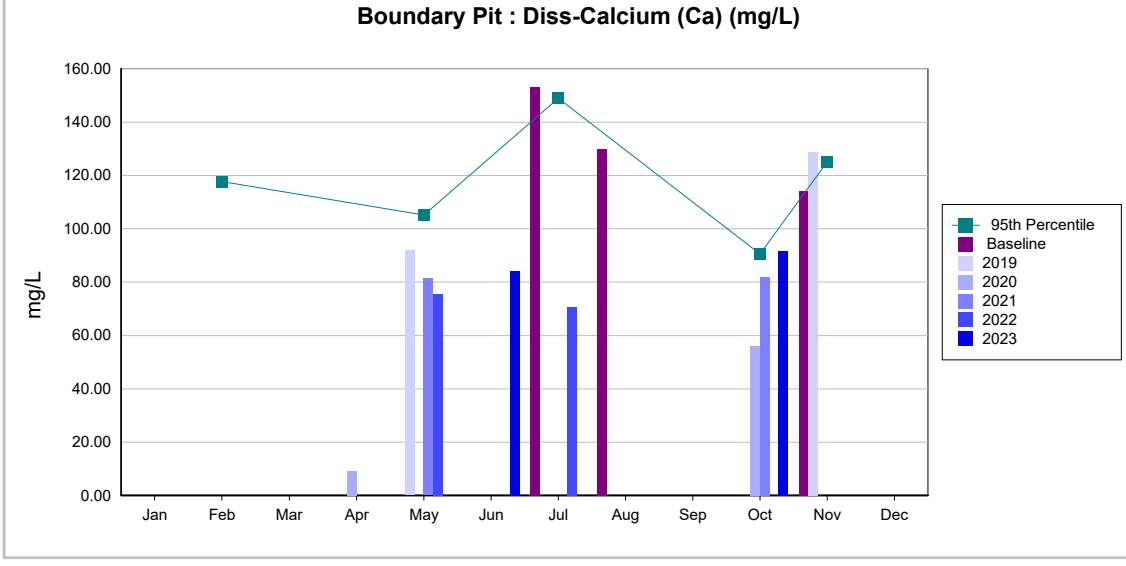
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







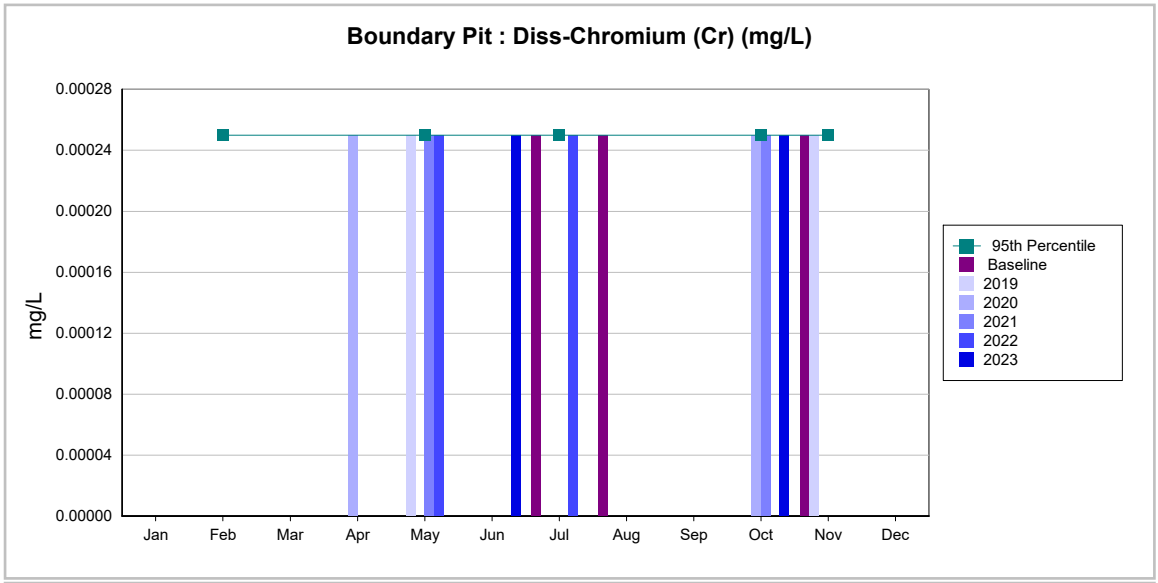
Water Quality Report

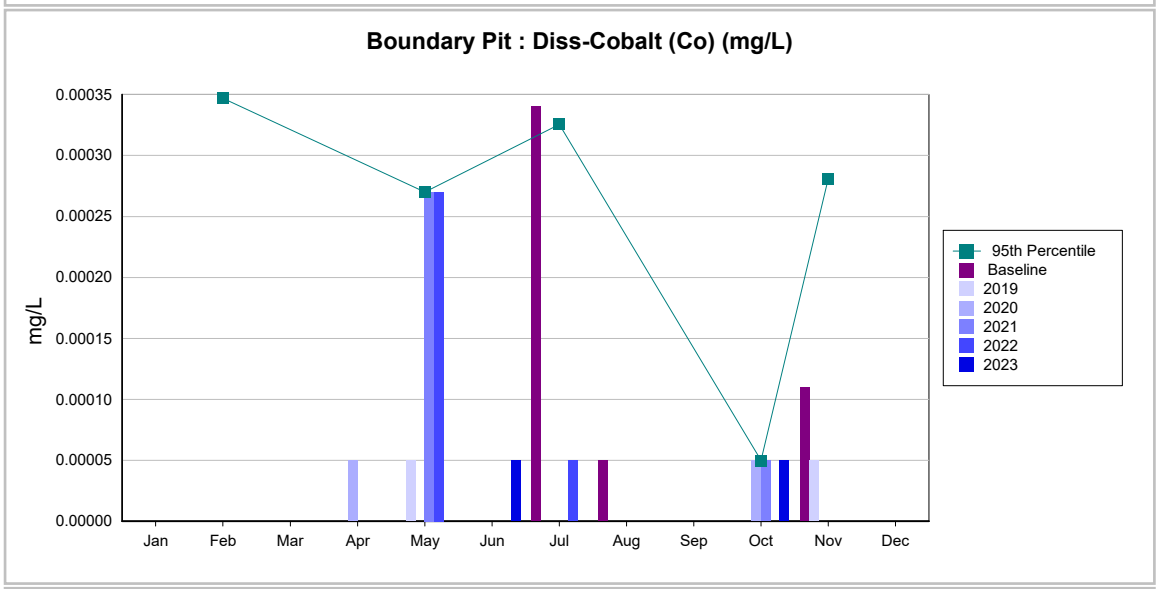
Annual Report Drainage Water

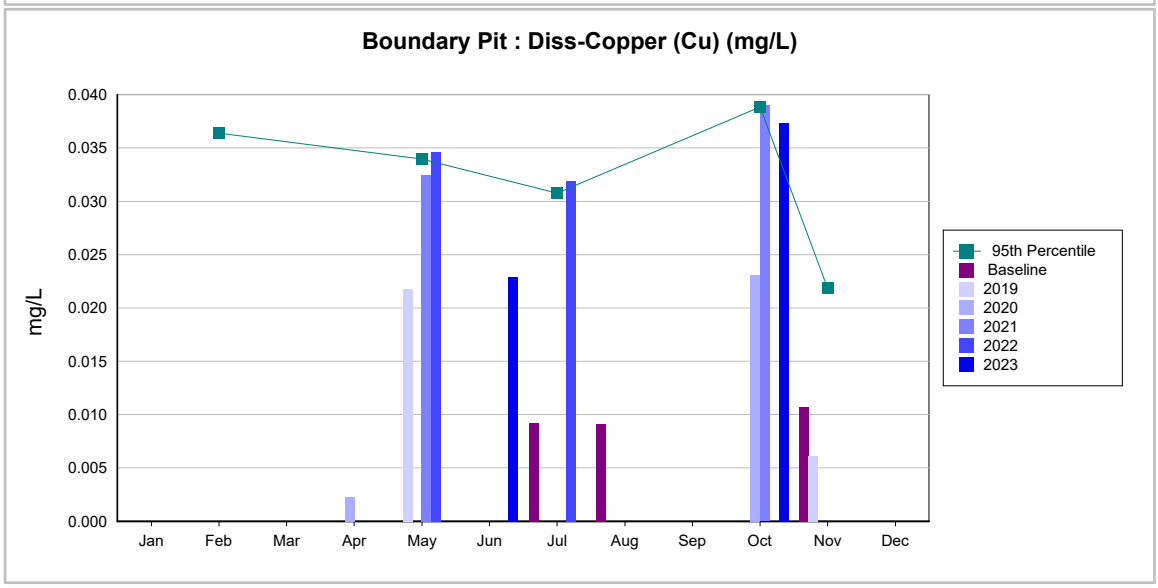
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







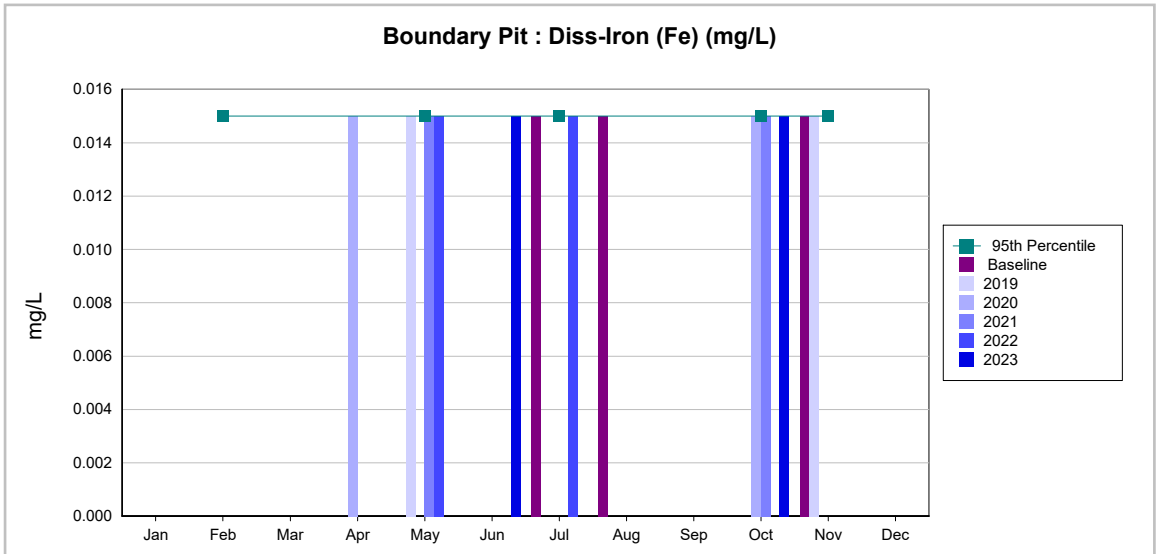
Water Quality Report

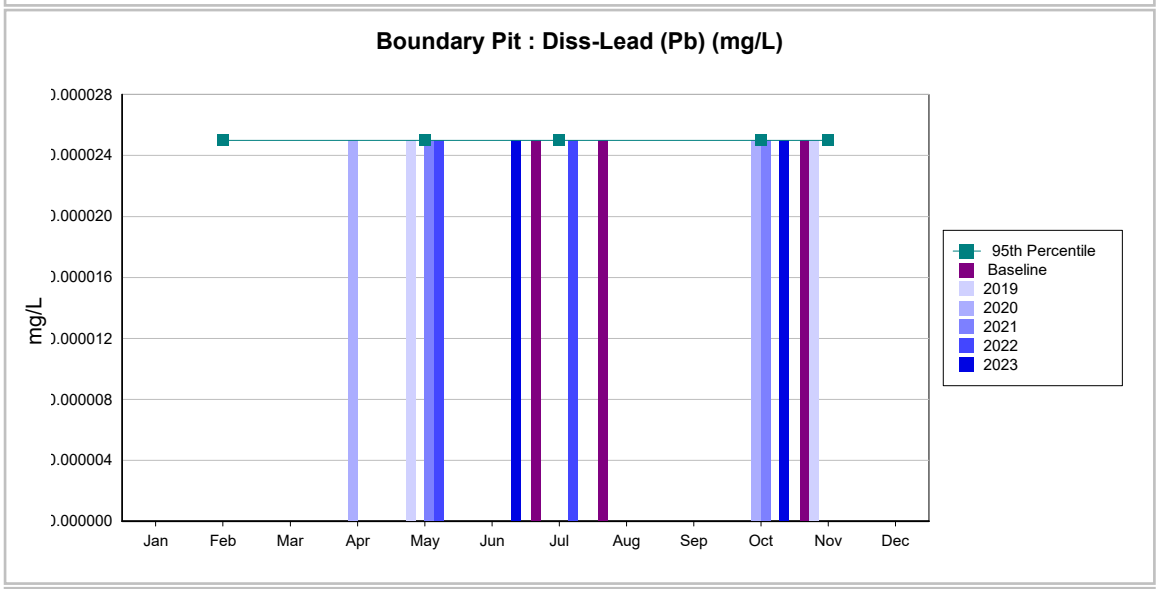
Annual Report Drainage Water

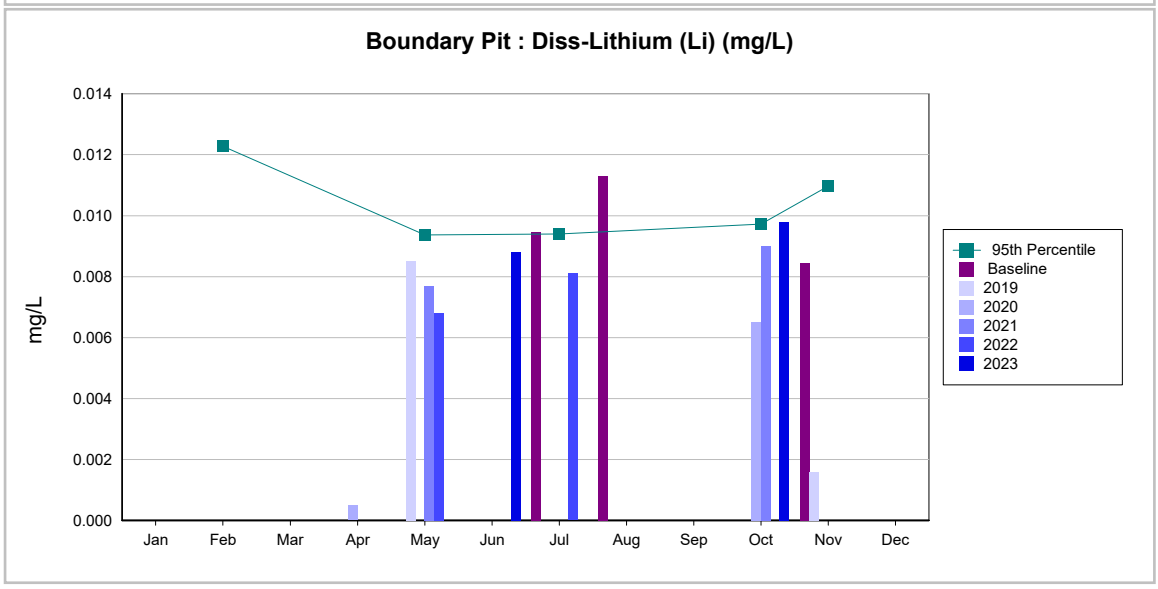
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







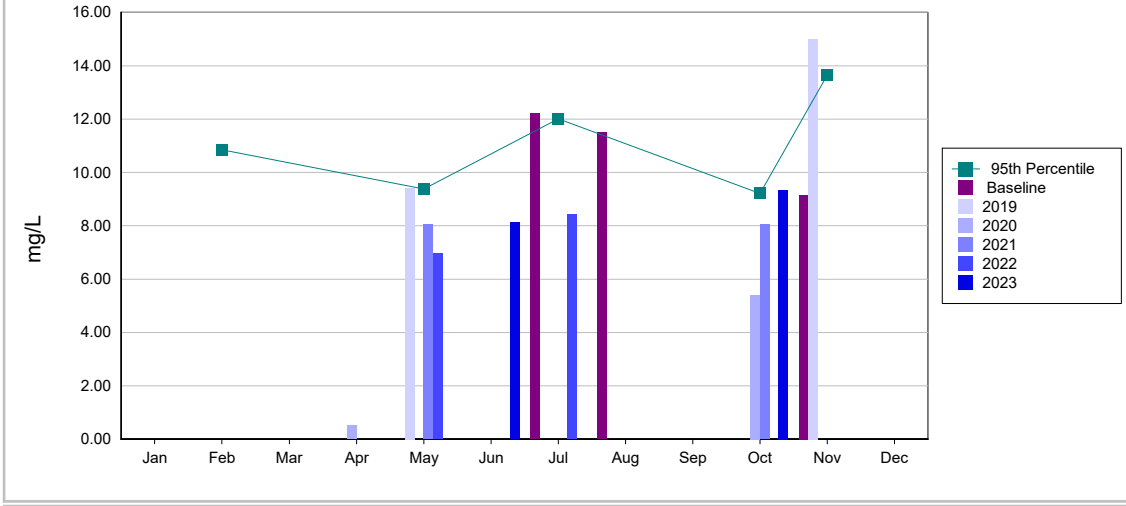
Water Quality Report

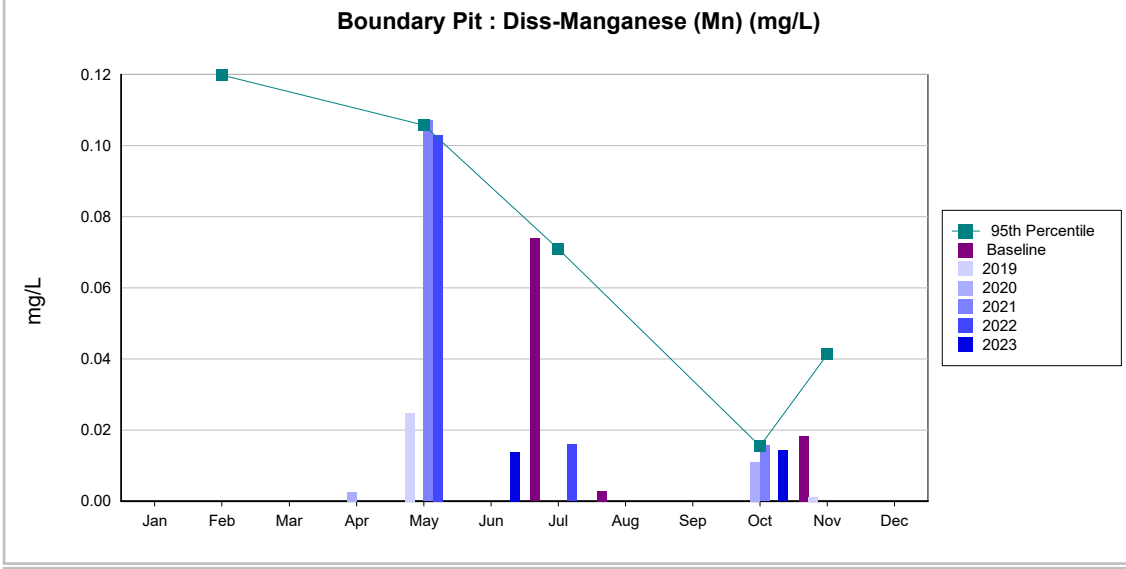
Annual Report Drainage Water

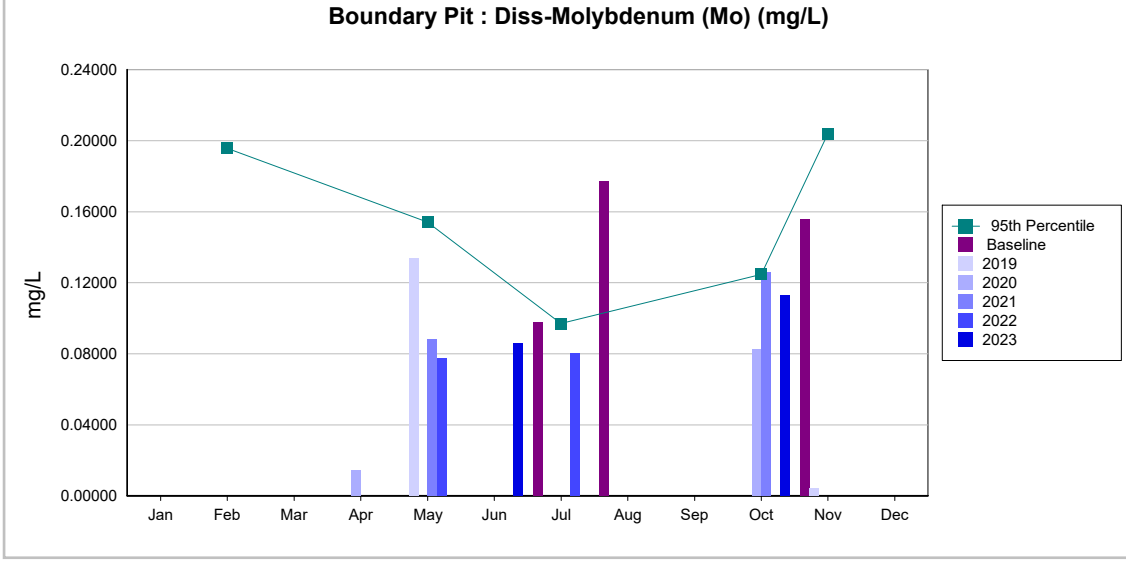
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







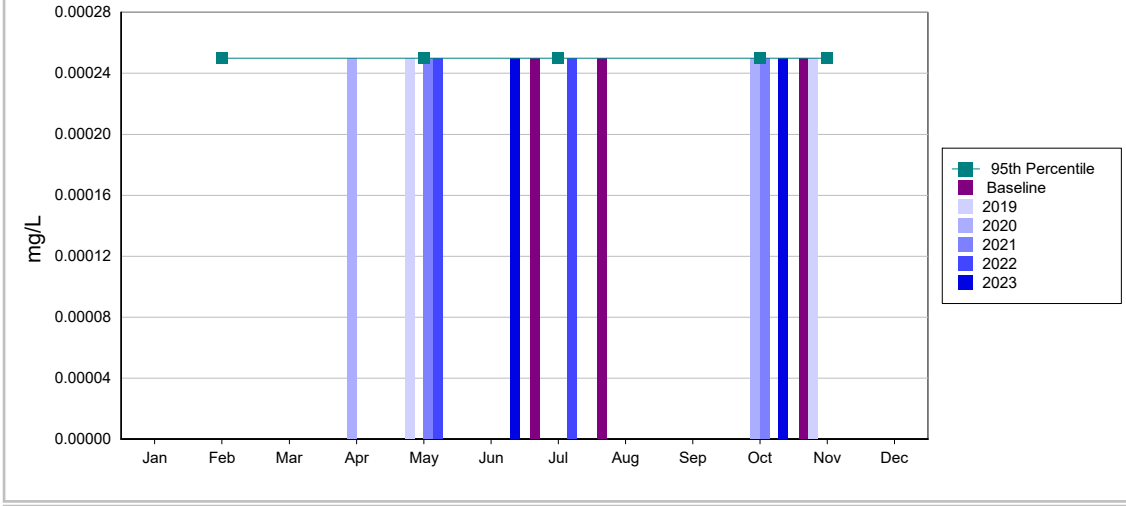
Water Quality Report

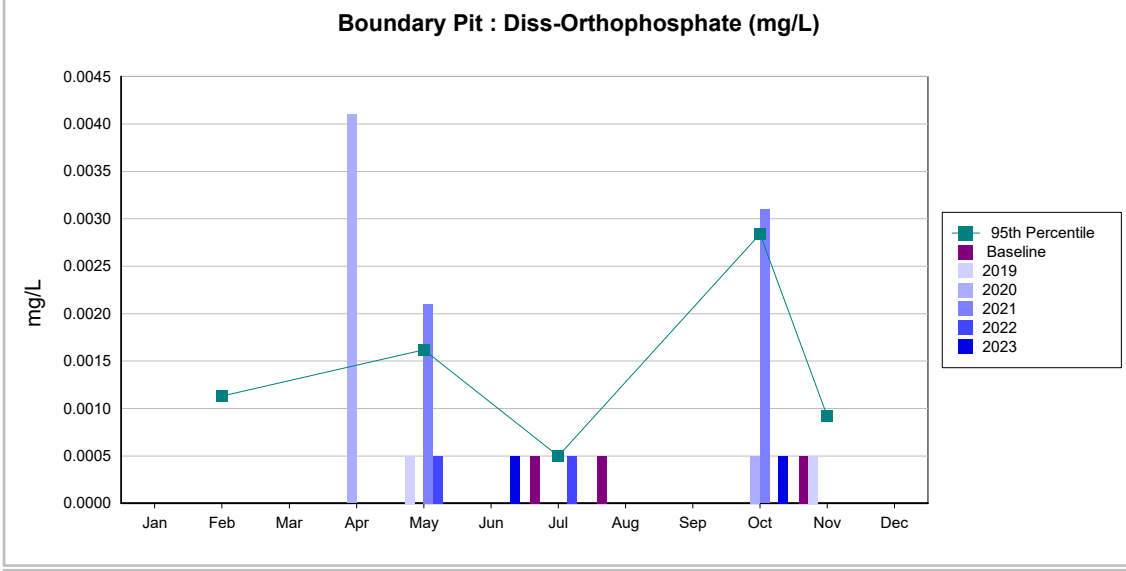
Annual Report Drainage Water

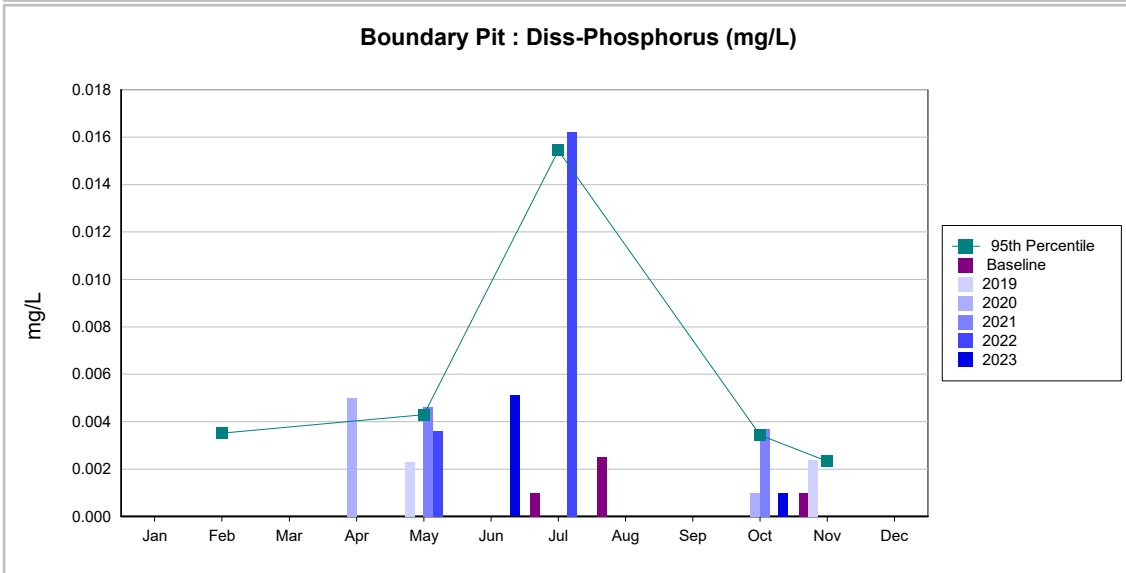
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







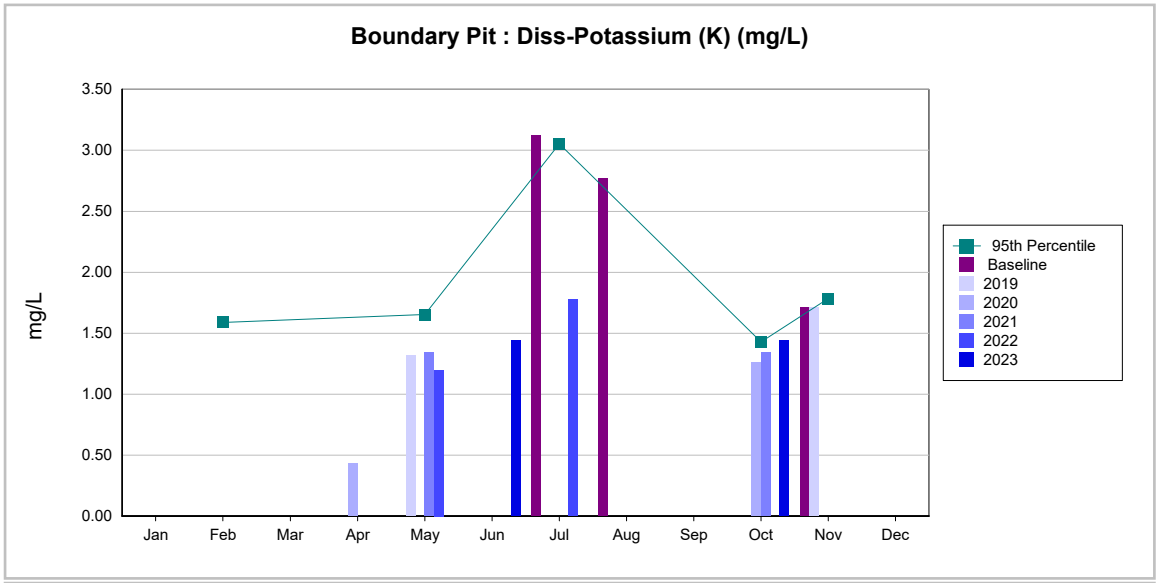
Water Quality Report

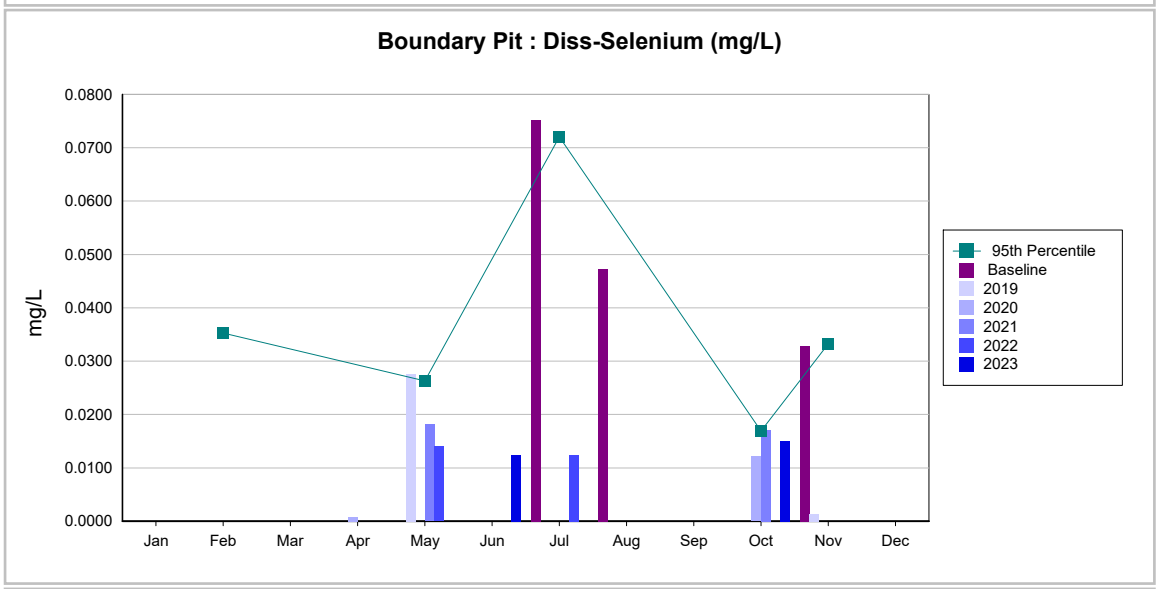
Annual Report Drainage Water

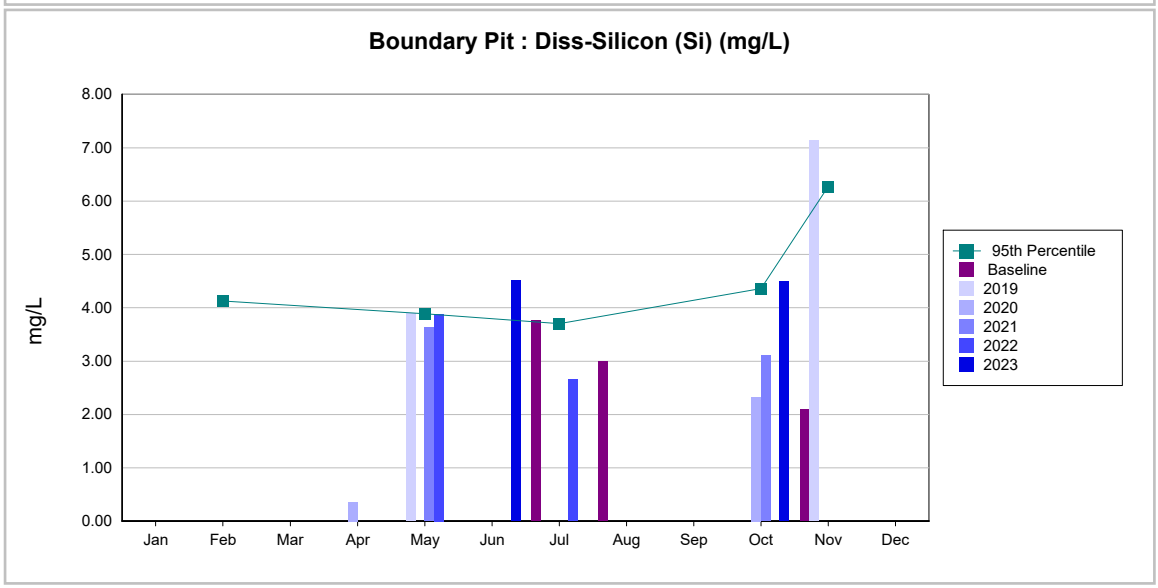
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







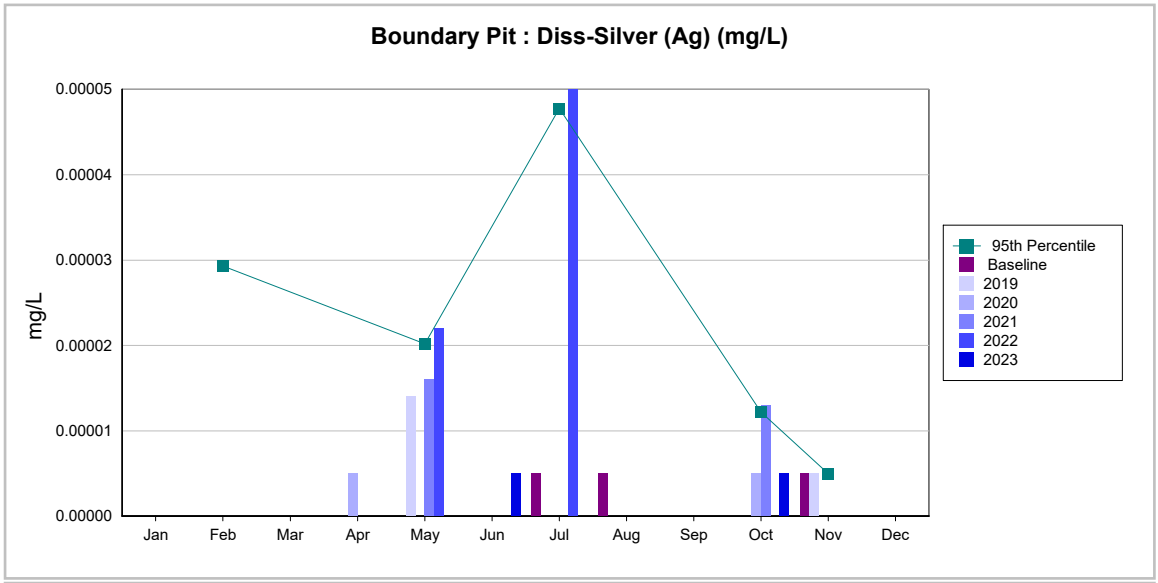
Water Quality Report

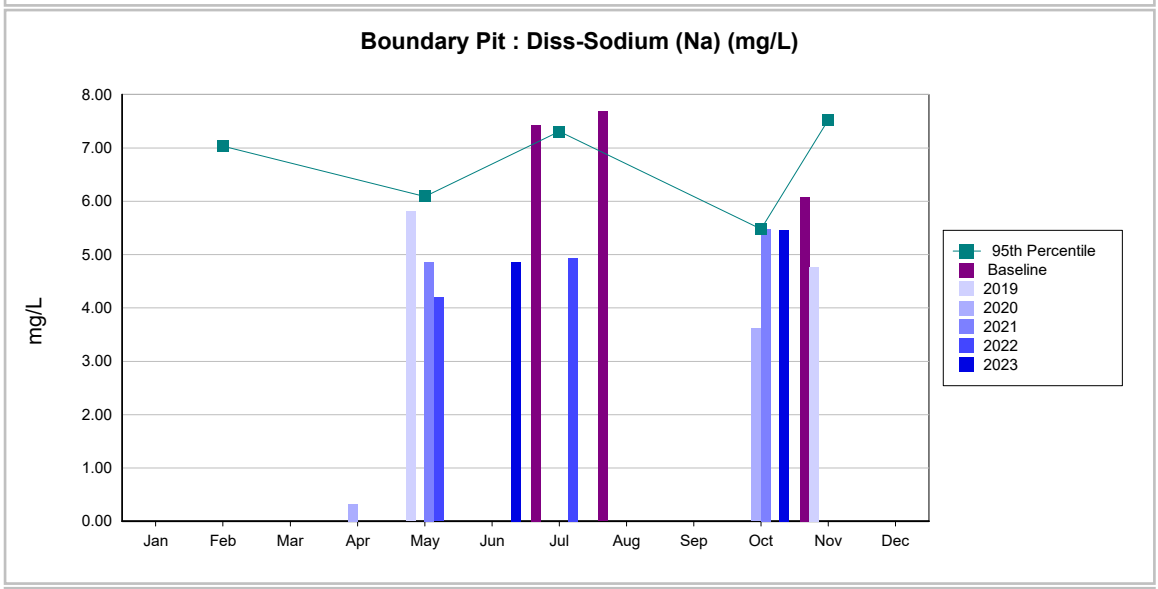
Annual Report Drainage Water

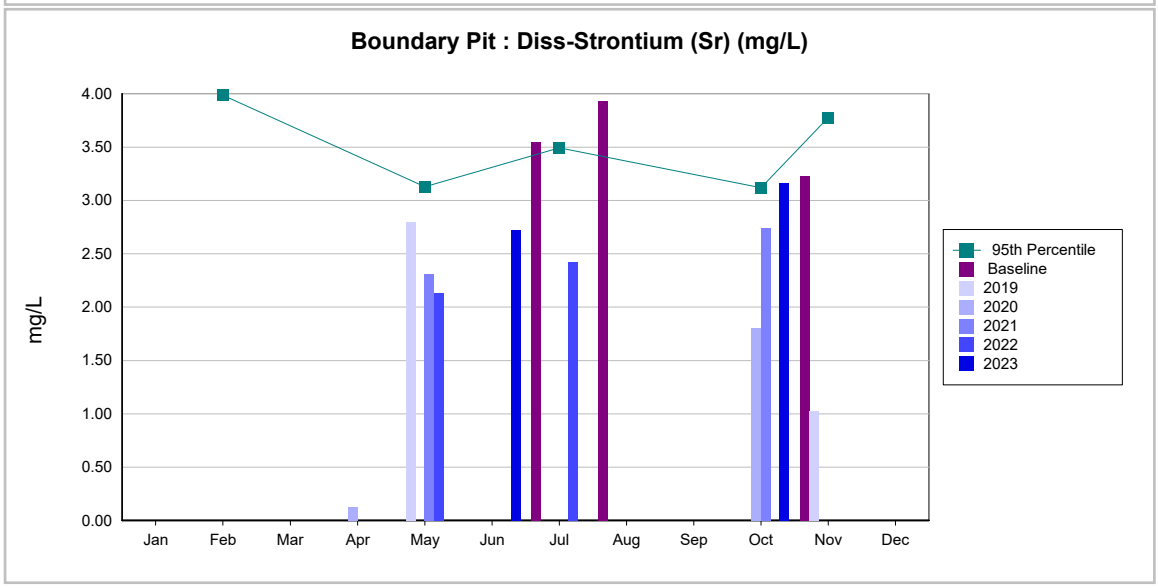
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







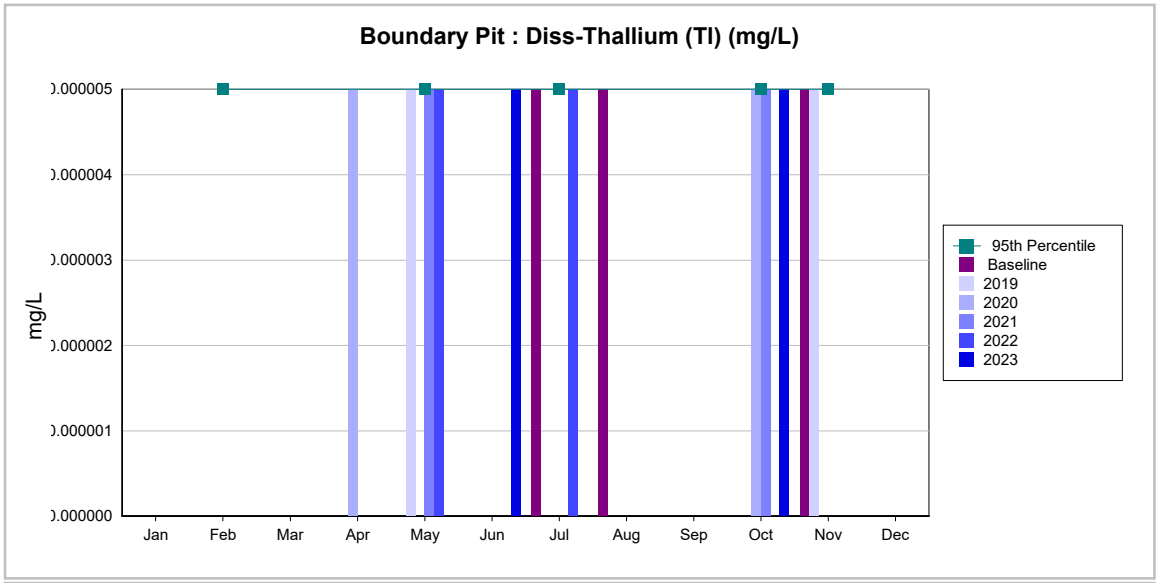
Water Quality Report

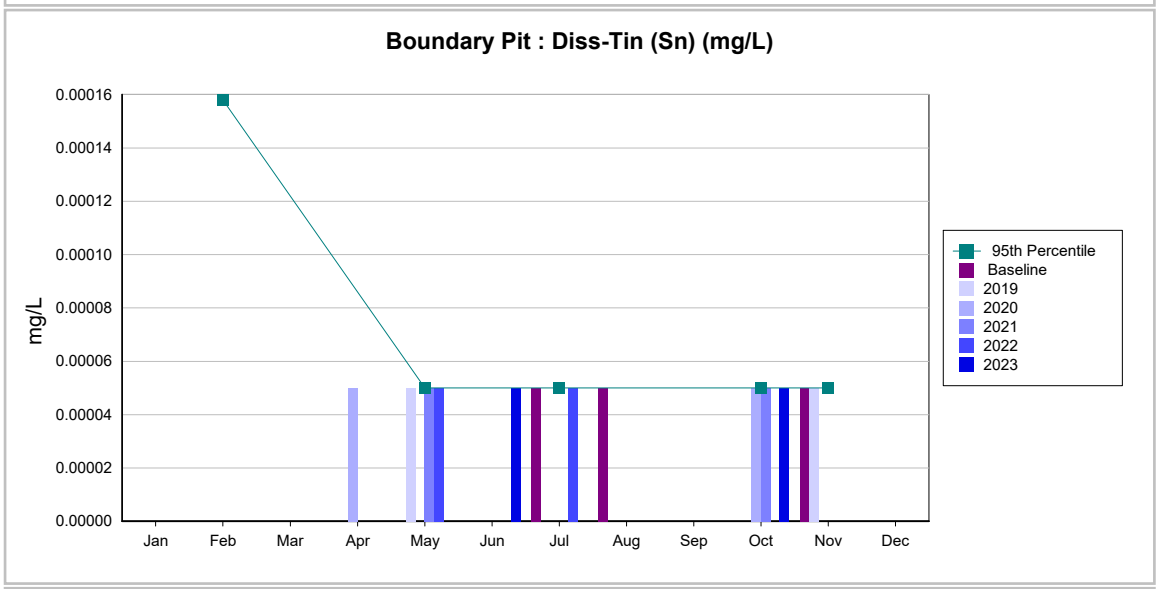
Annual Report Drainage Water

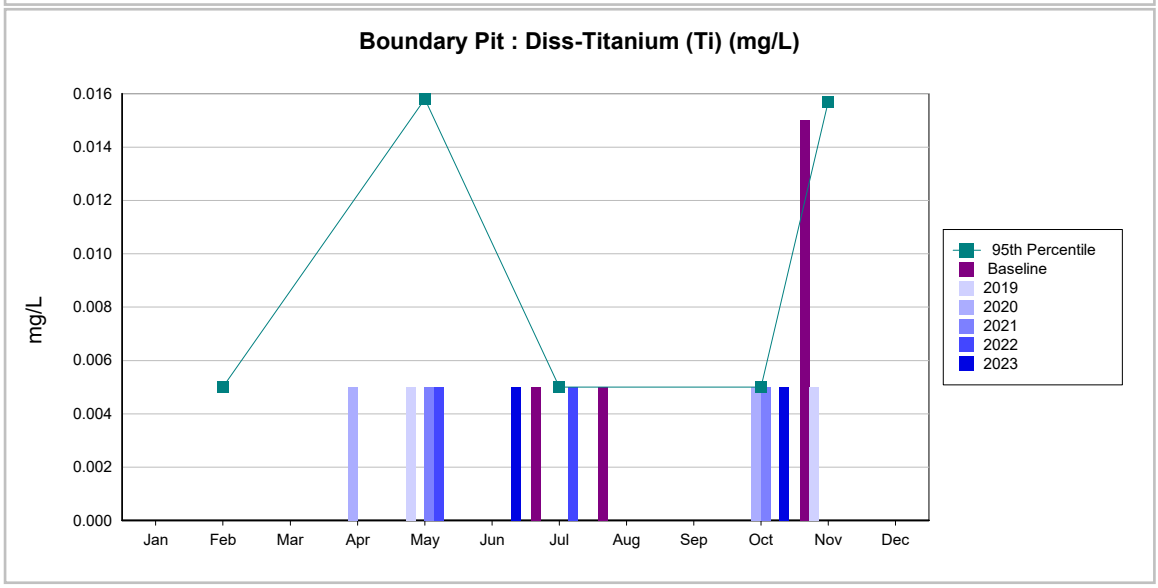
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







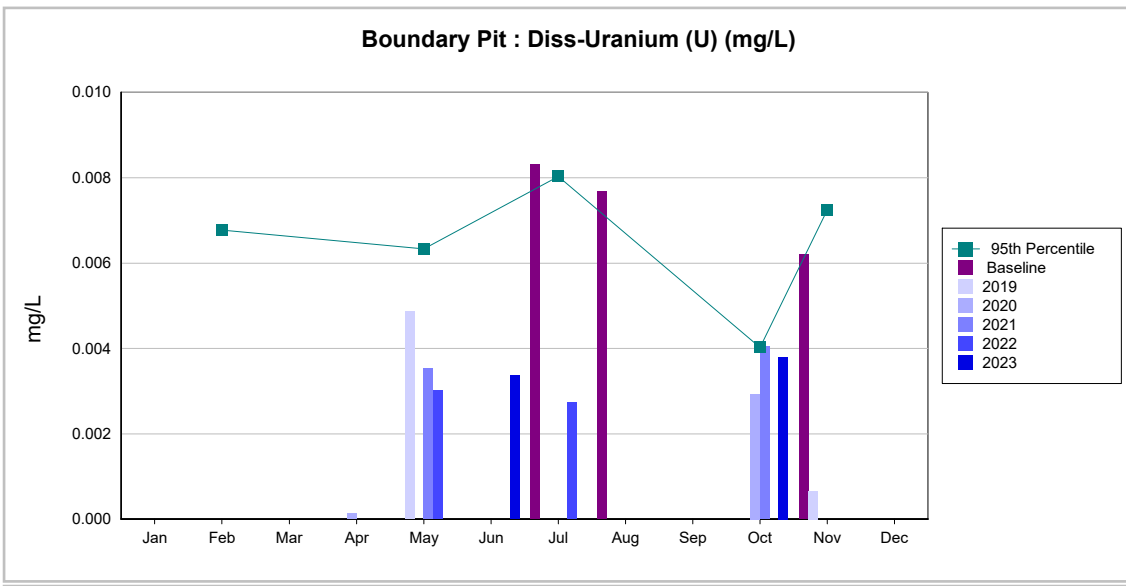
Water Quality Report

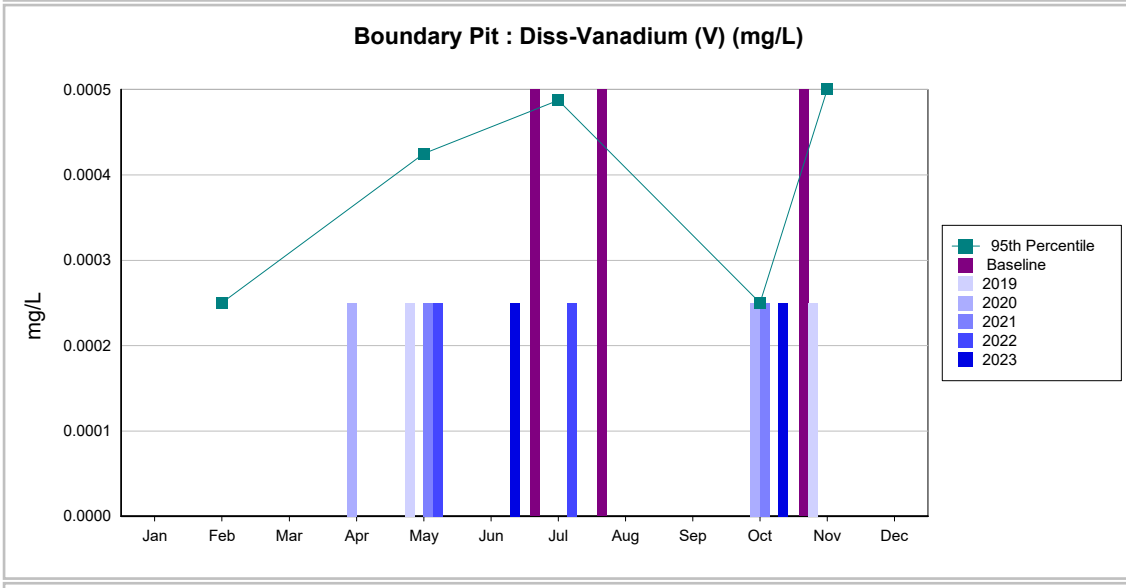
Annual Report Drainage Water

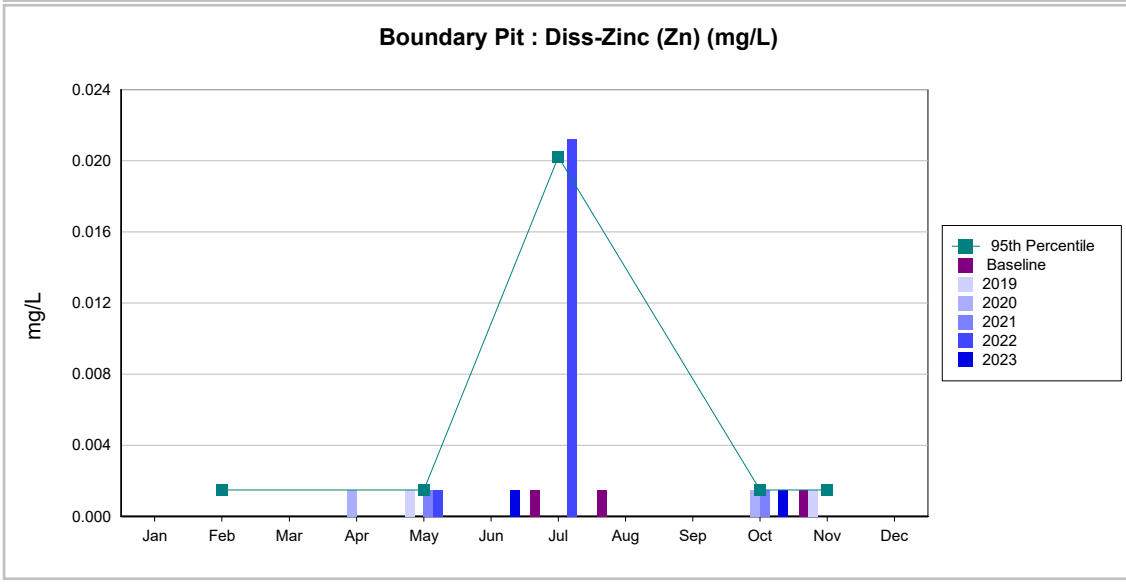
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







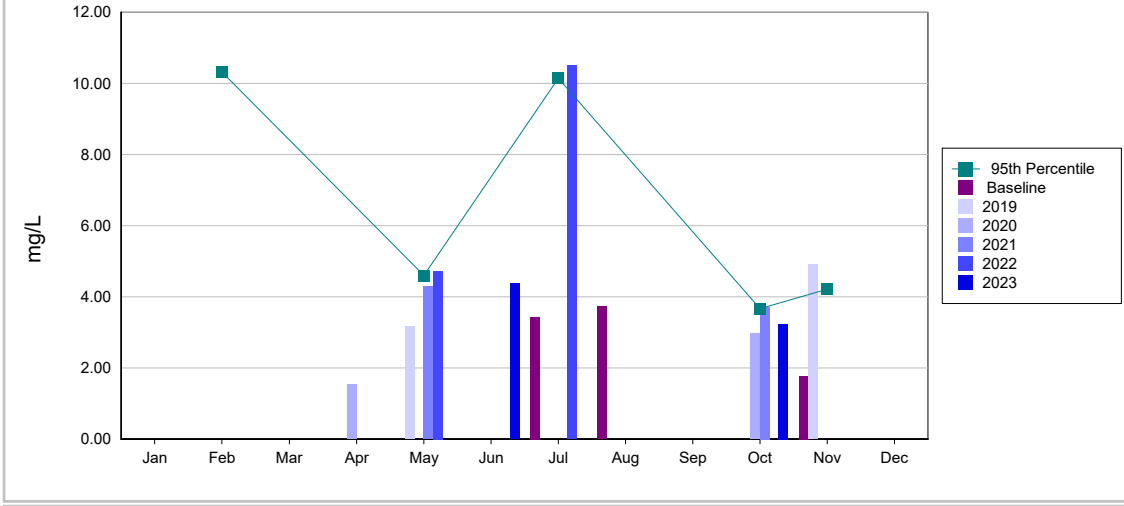
Water Quality Report

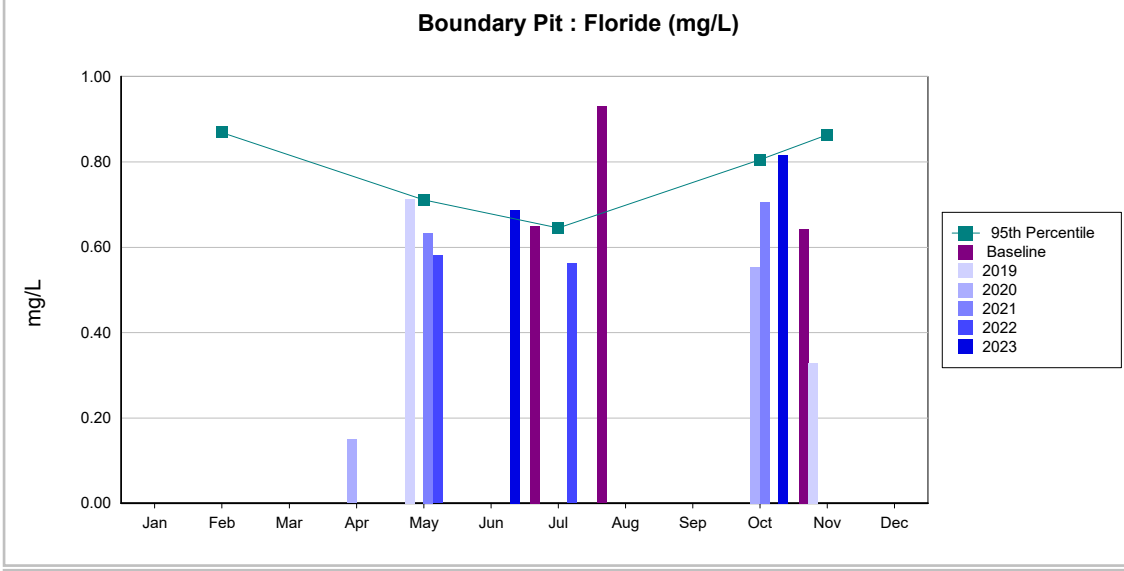
Annual Report Drainage Water

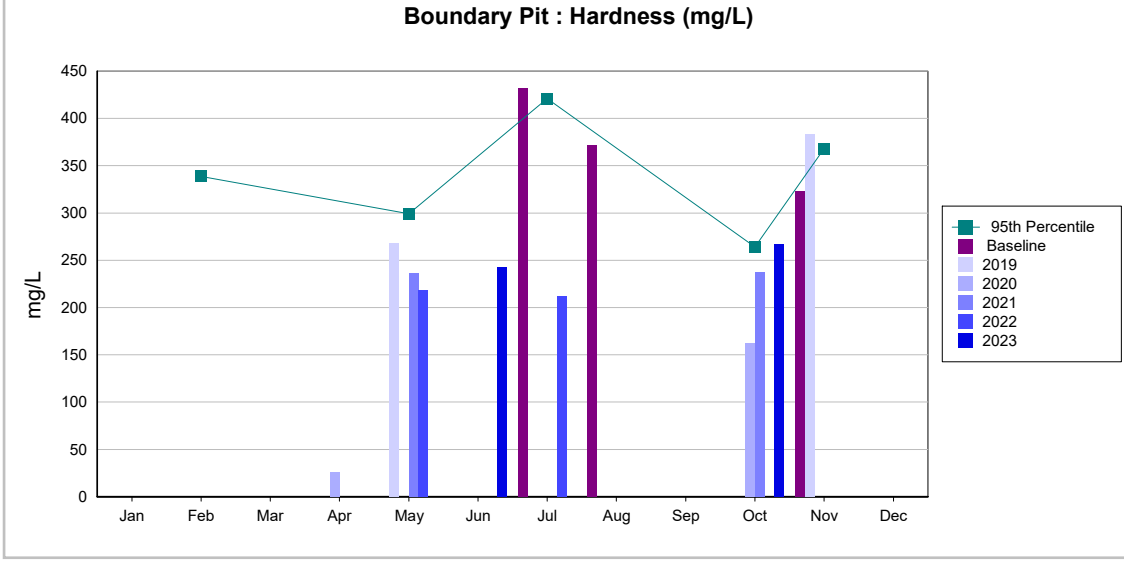
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







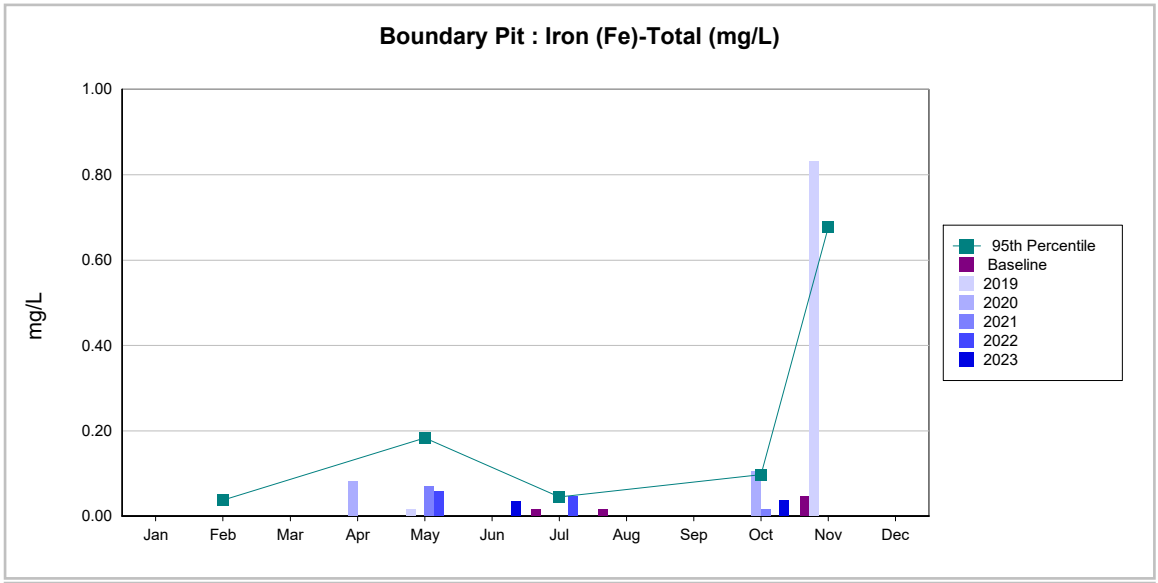
Water Quality Report

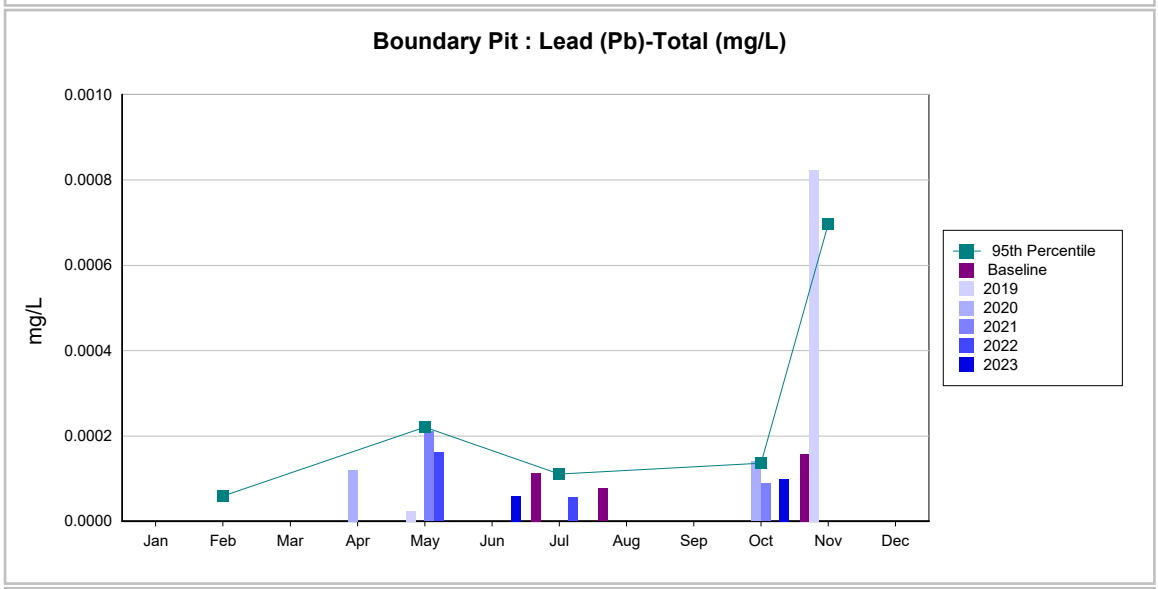
Annual Report Drainage Water

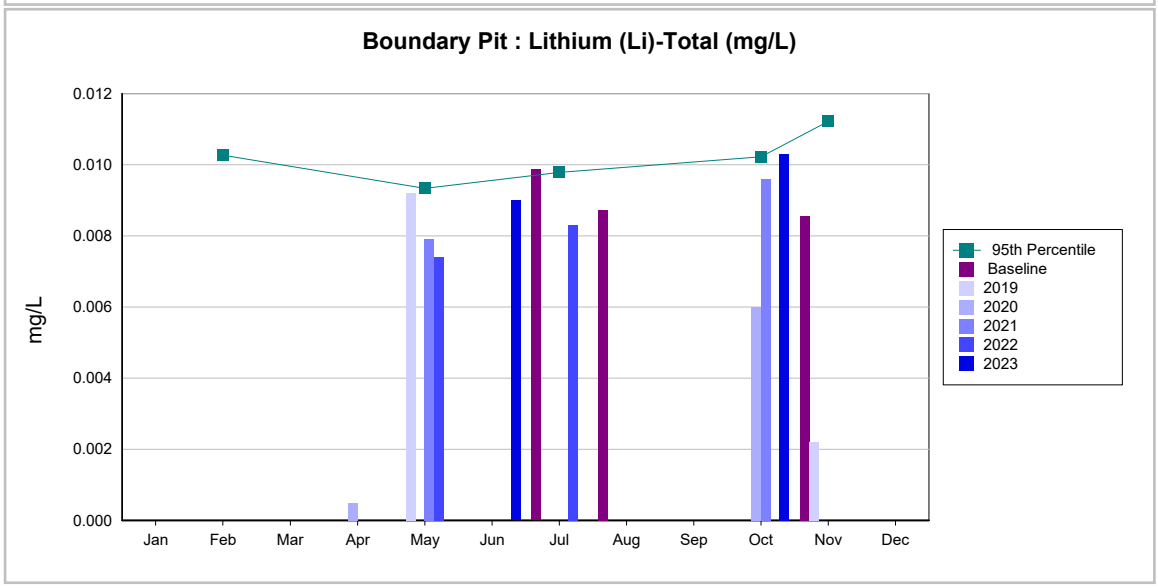
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







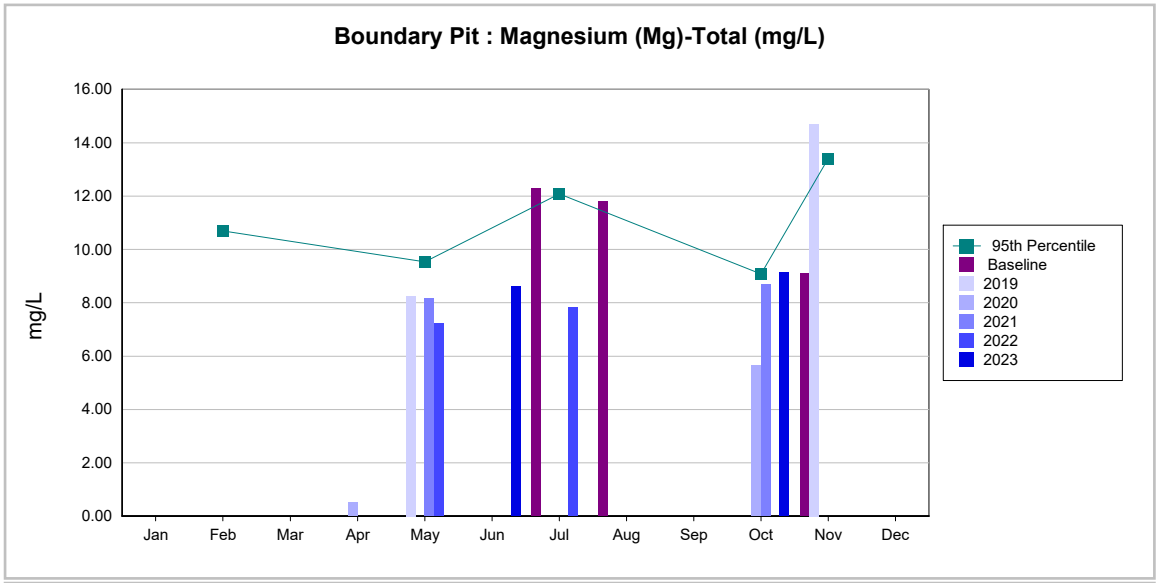
Water Quality Report

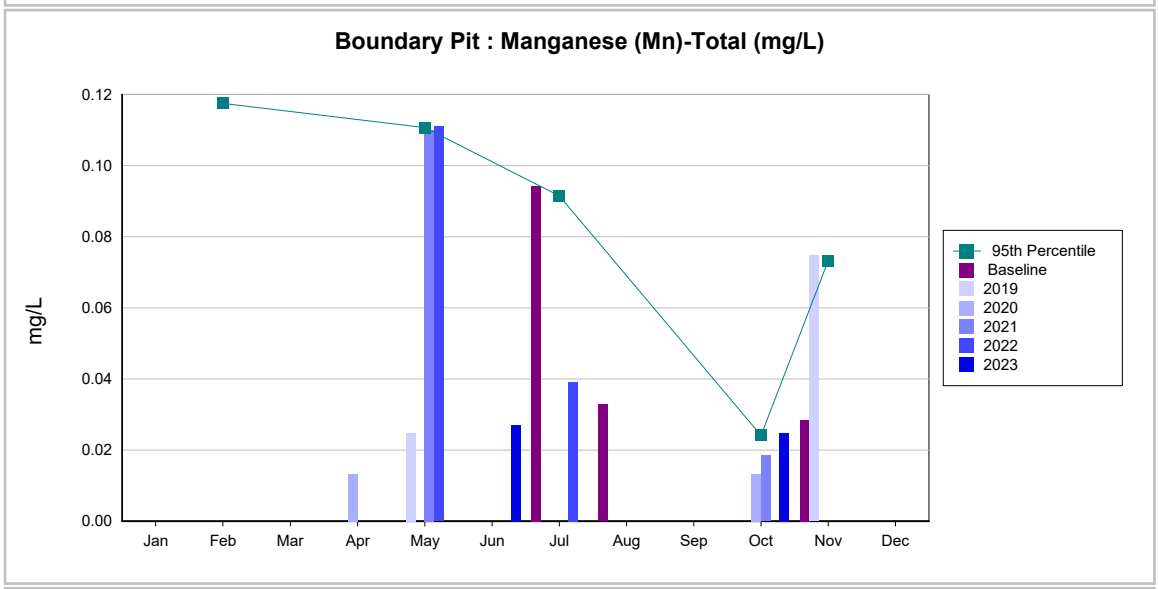
Annual Report Drainage Water

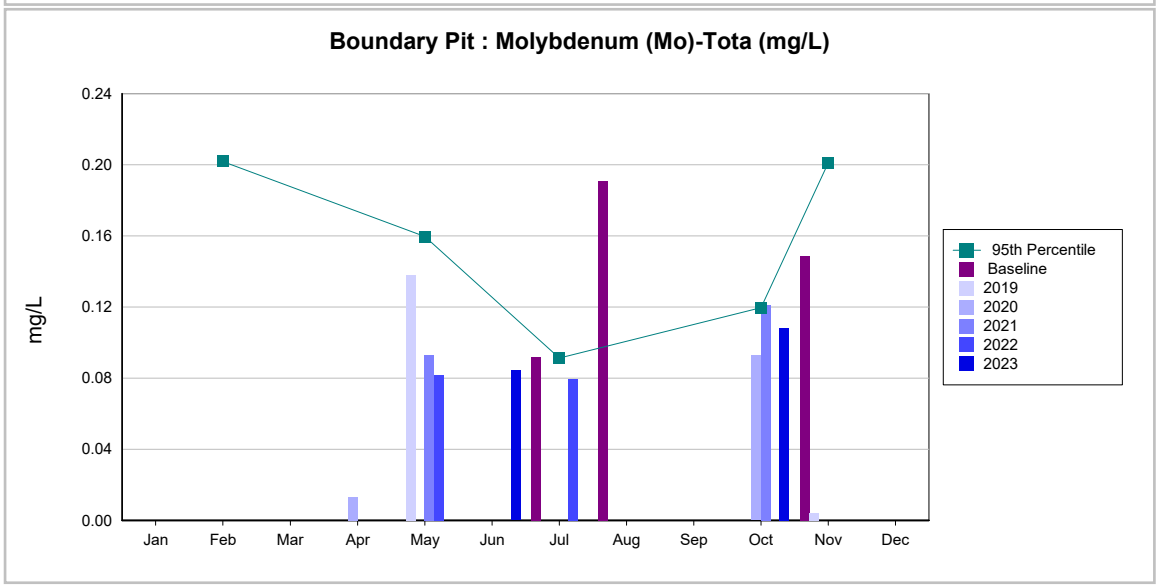
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







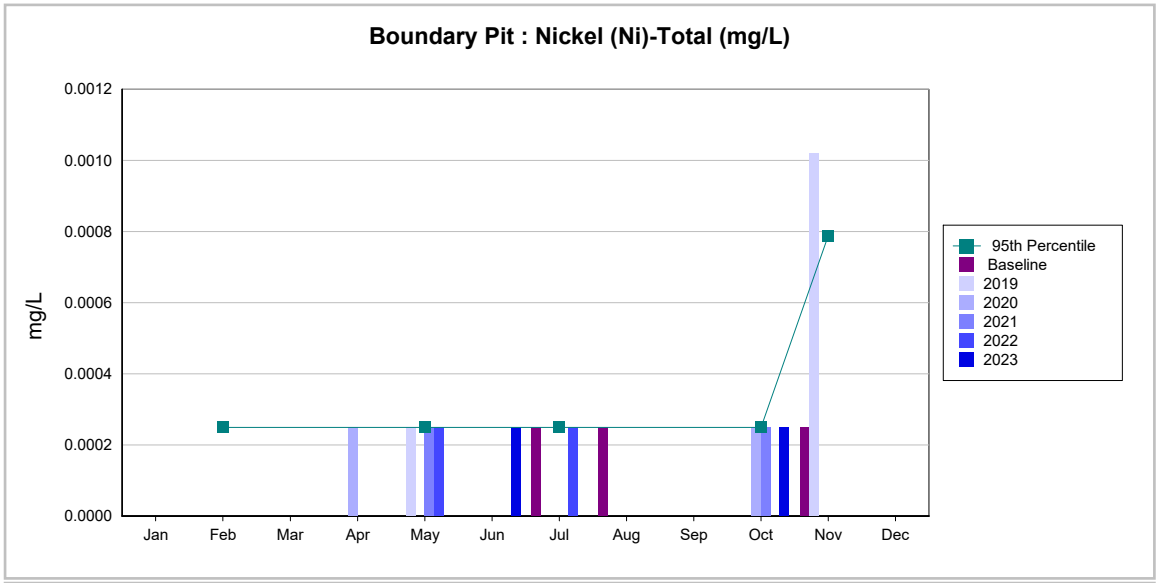
Water Quality Report

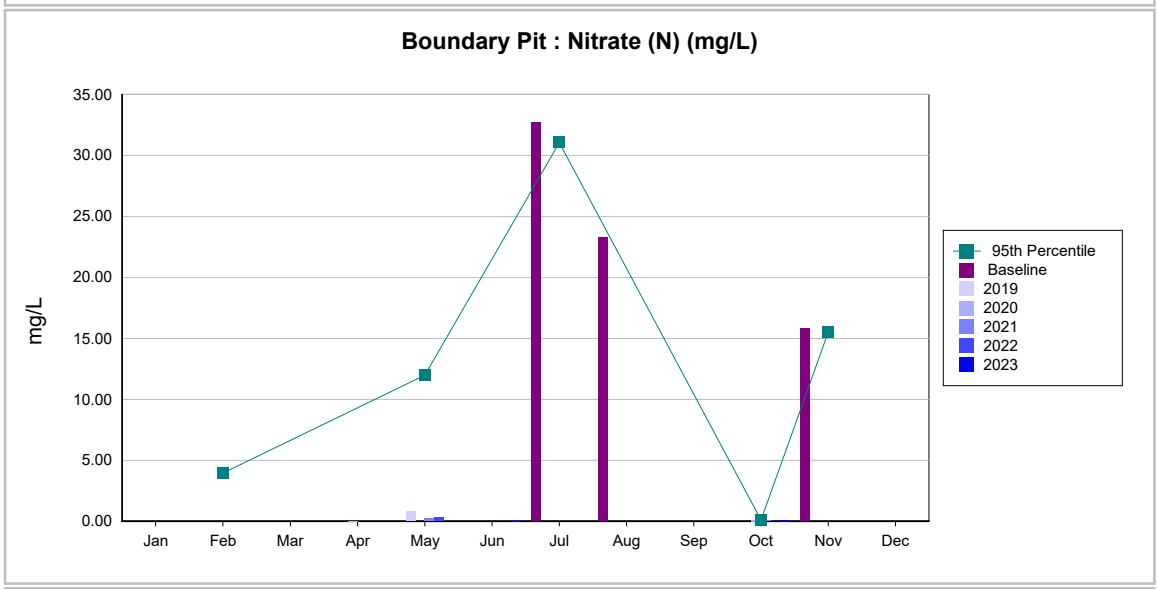
Annual Report Drainage Water

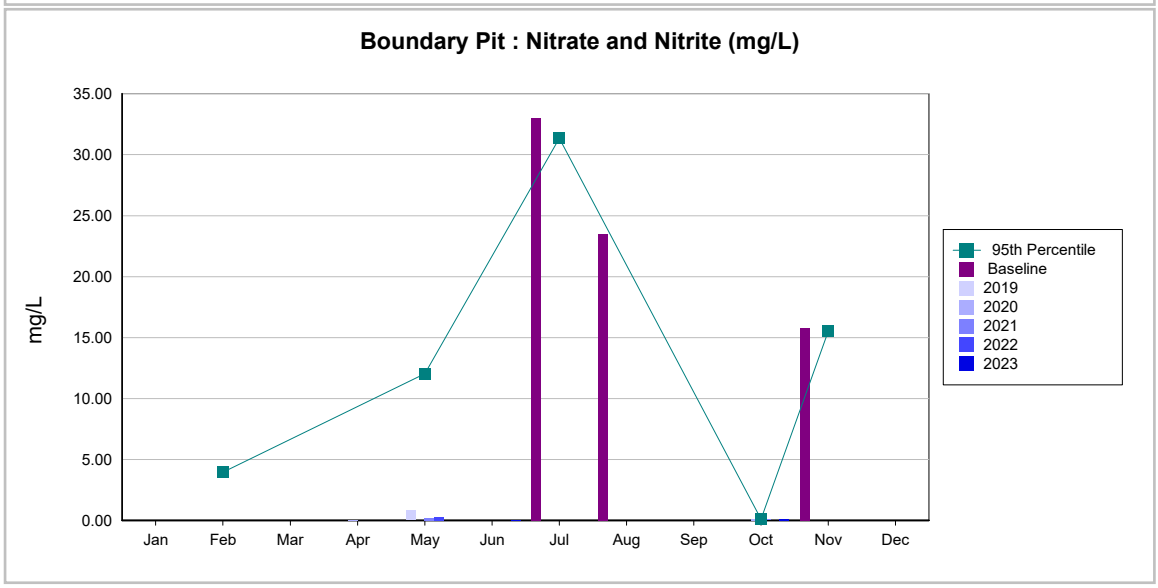
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







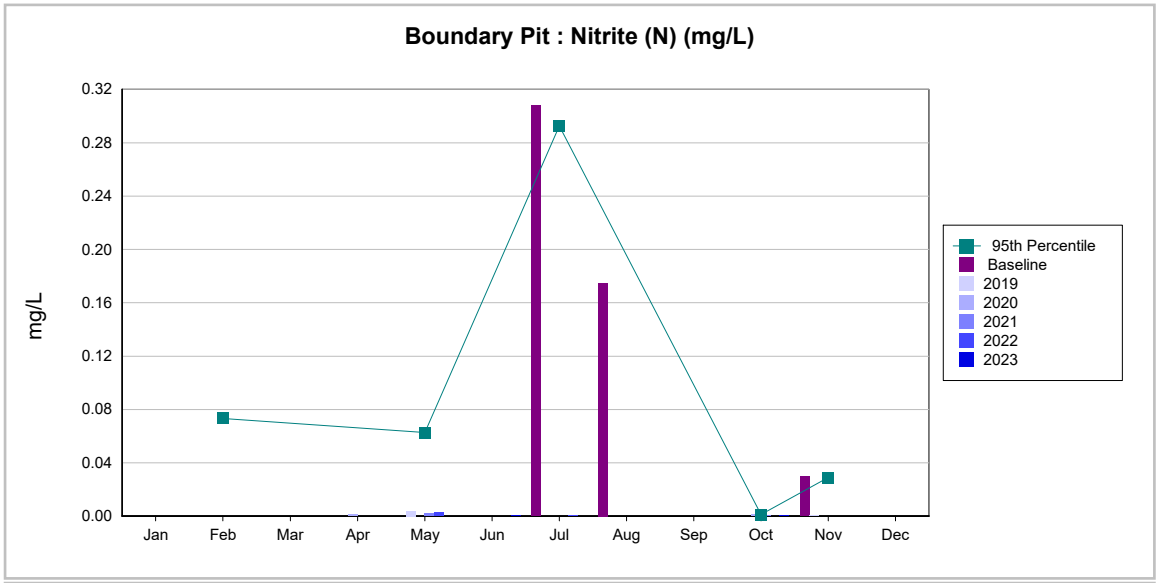
Water Quality Report

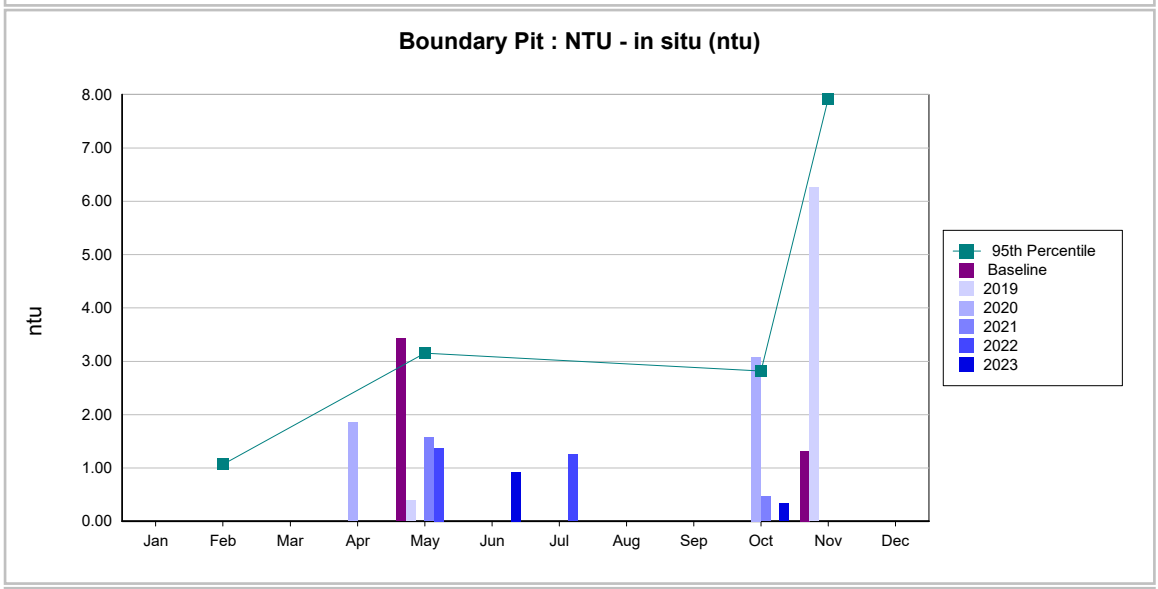
Annual Report Drainage Water

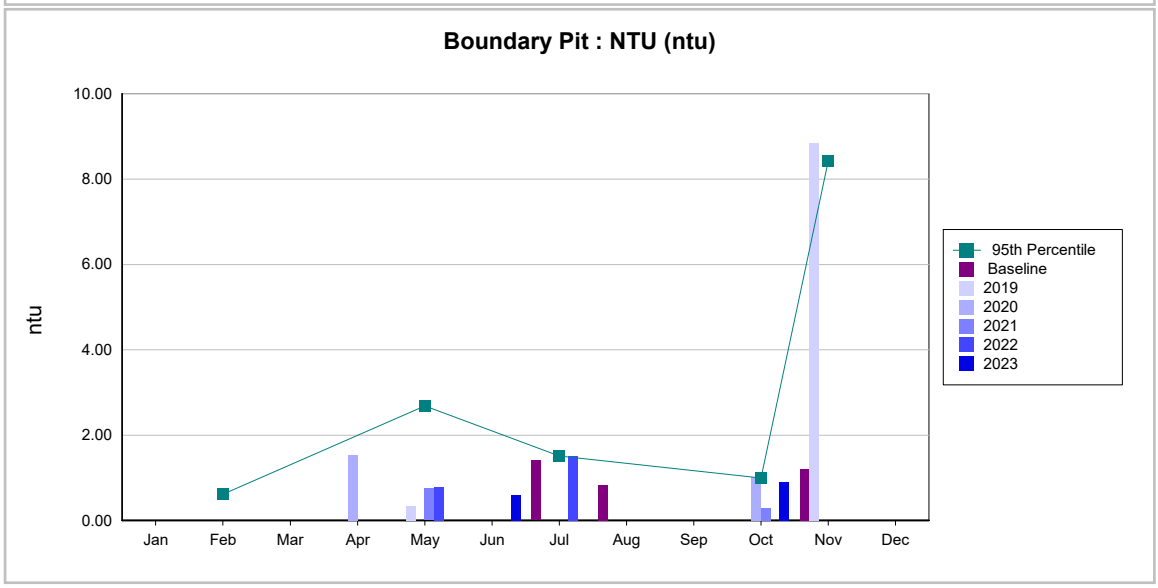
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







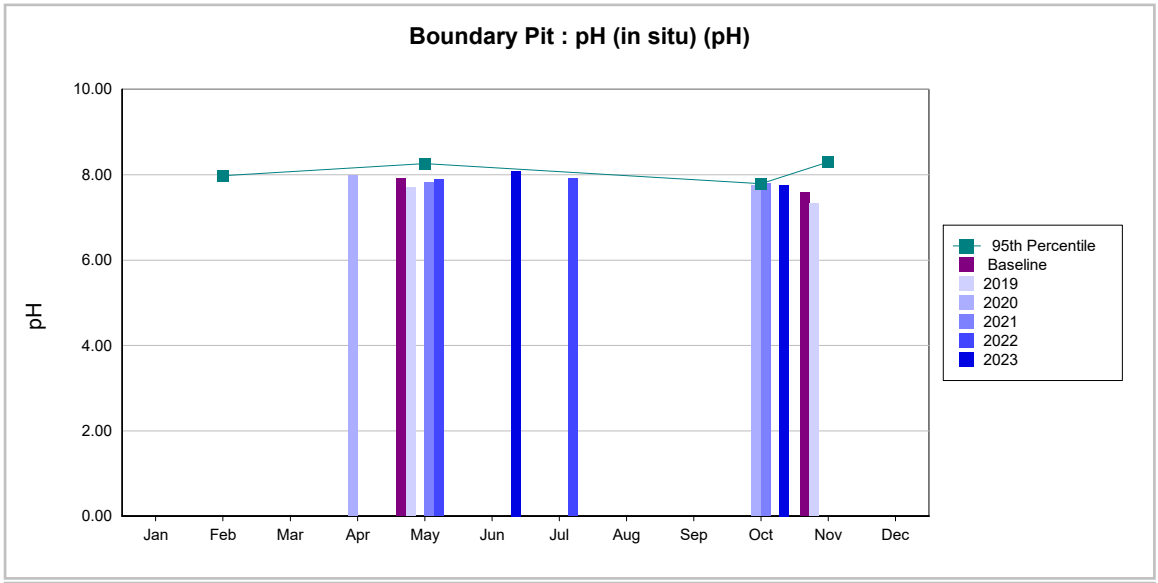
Water Quality Report

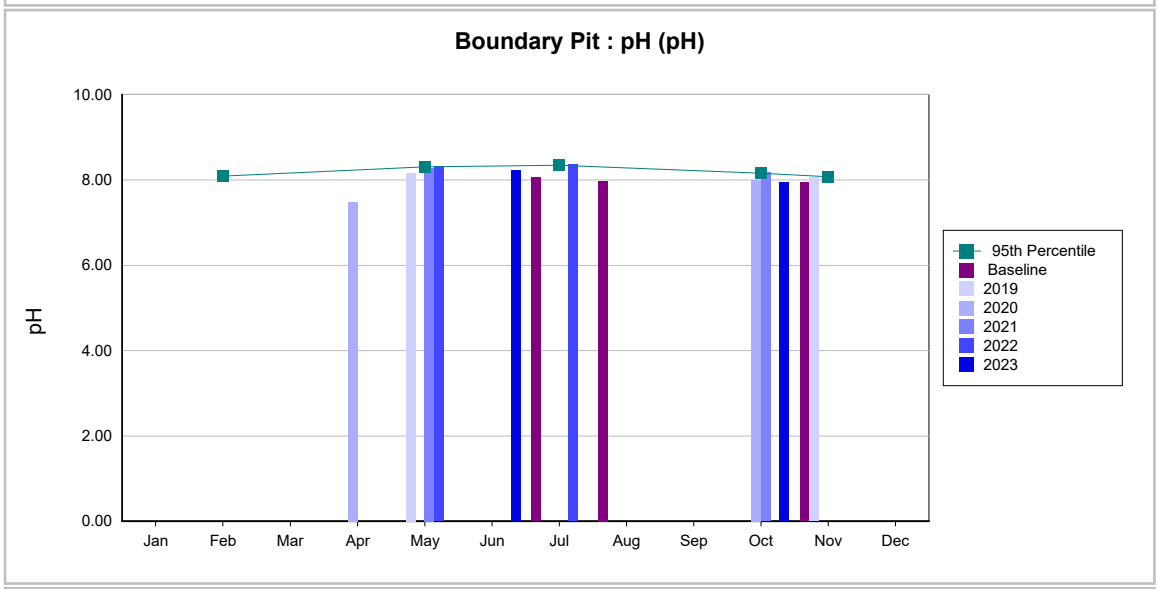
Annual Report Drainage Water

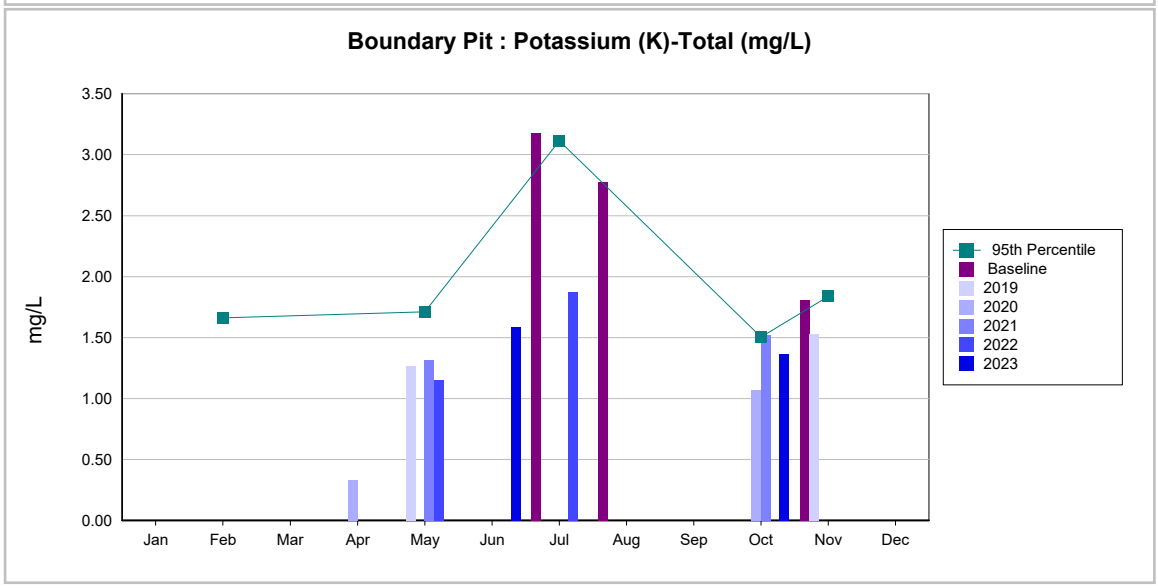
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

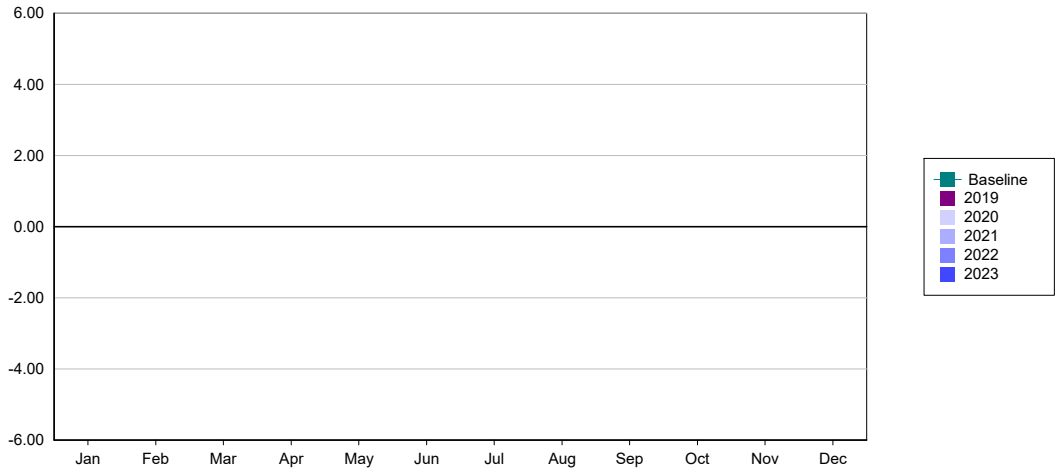
Annual Report Drainage Water

Mount Polley

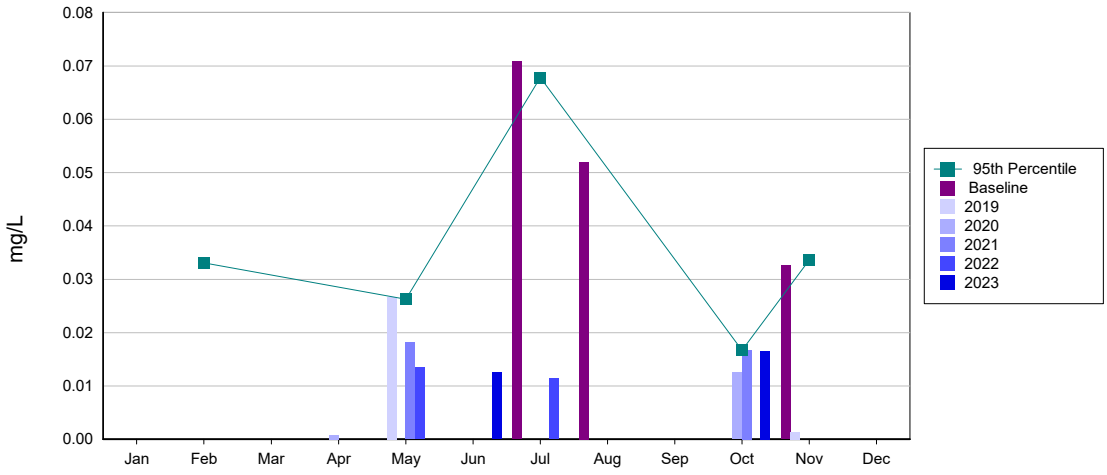
Mining Corporation

IMPERIAL METALS CORPORATION

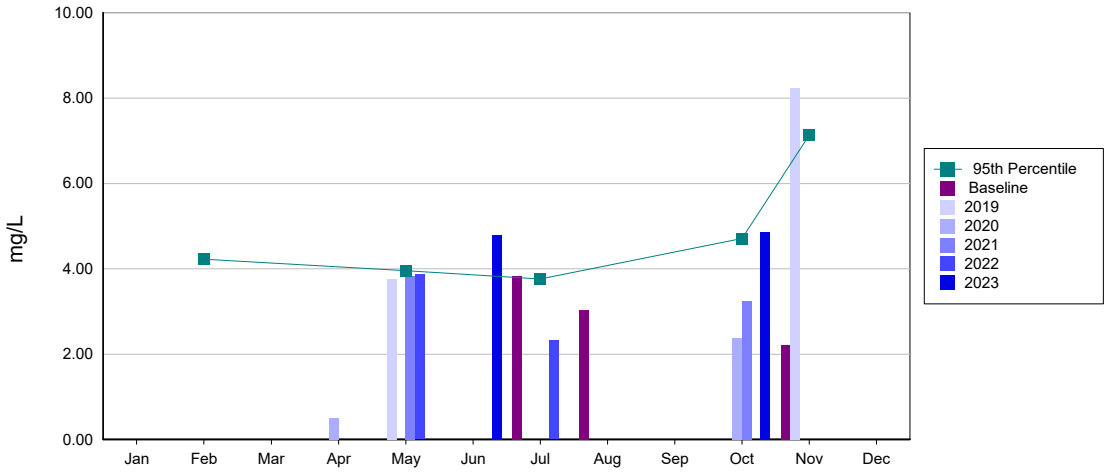
Boundary Pit : Sample Taken



Boundary Pit : Selenium (Se)-Total (mg/L)



Boundary Pit : Silicon (Si)-Total (mg/L)



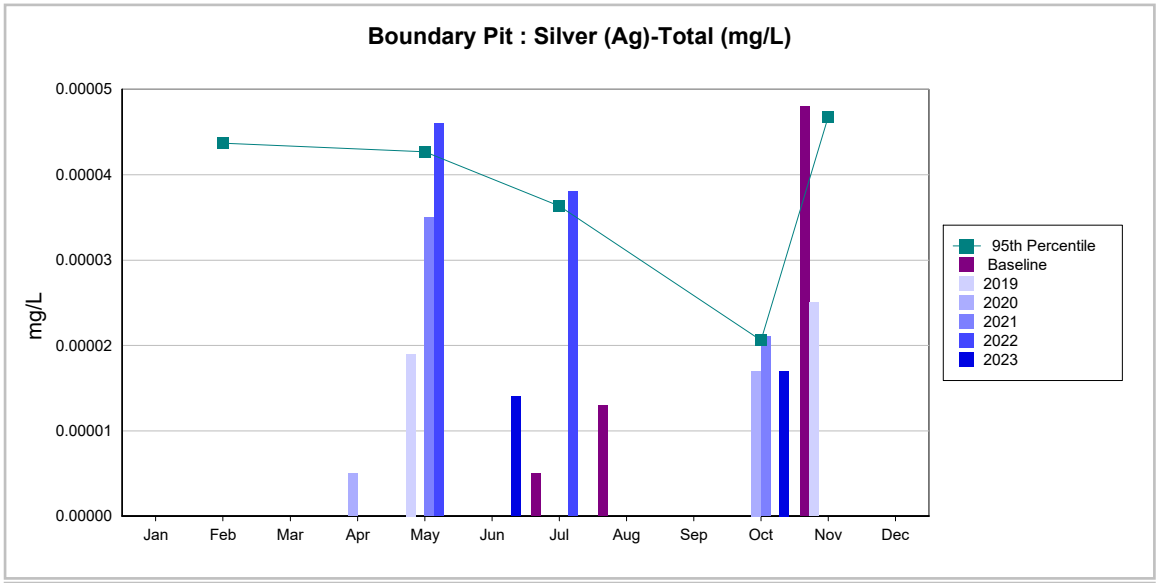
Water Quality Report

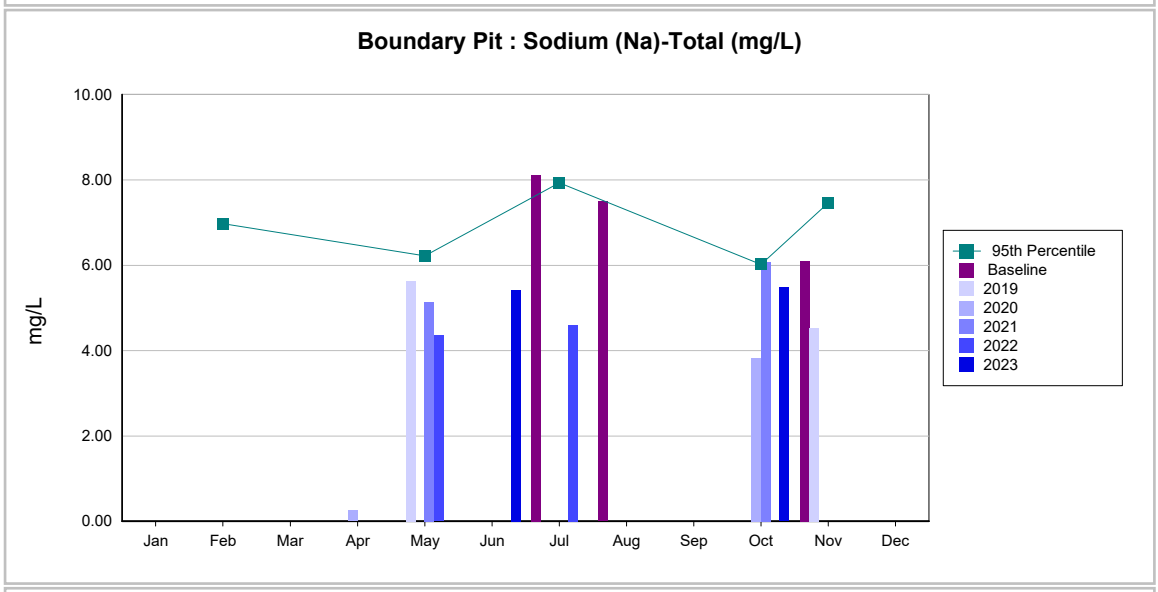
Annual Report Drainage Water

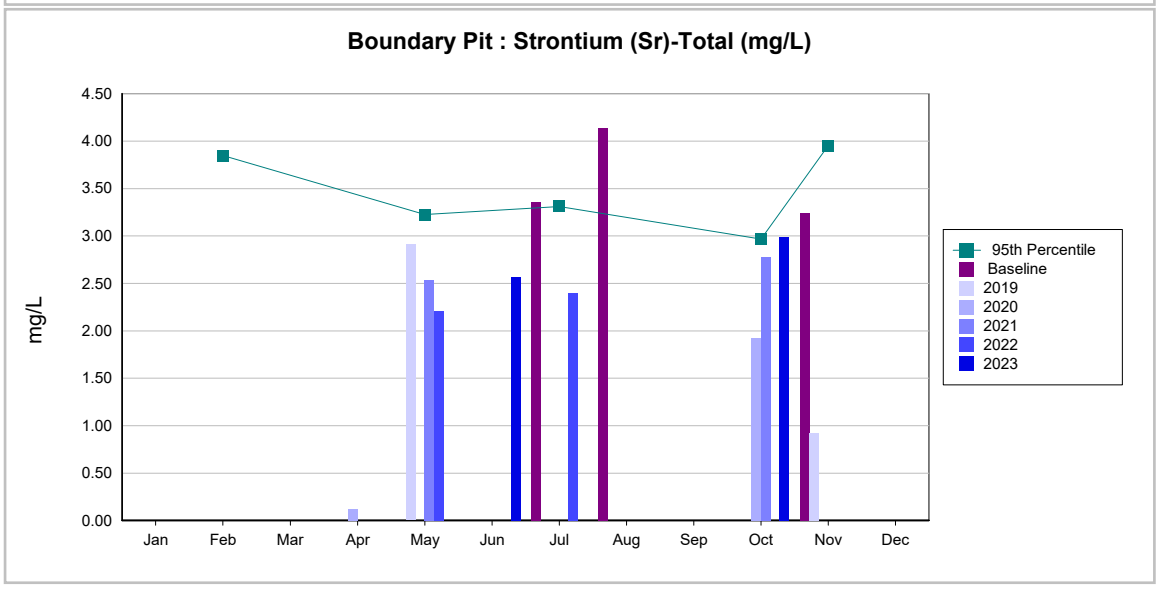
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







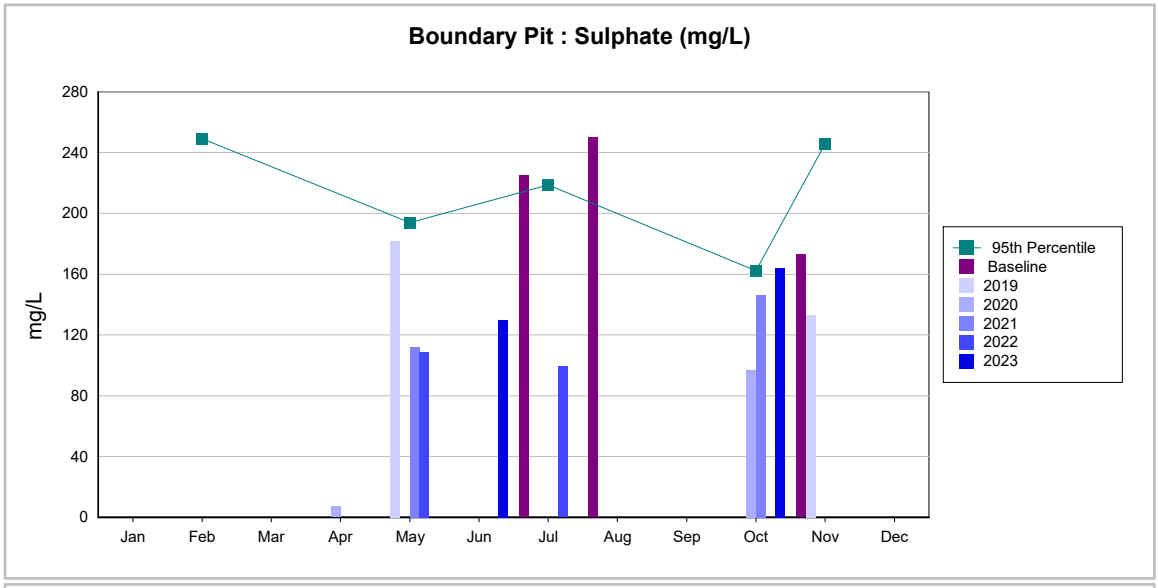
Water Quality Report

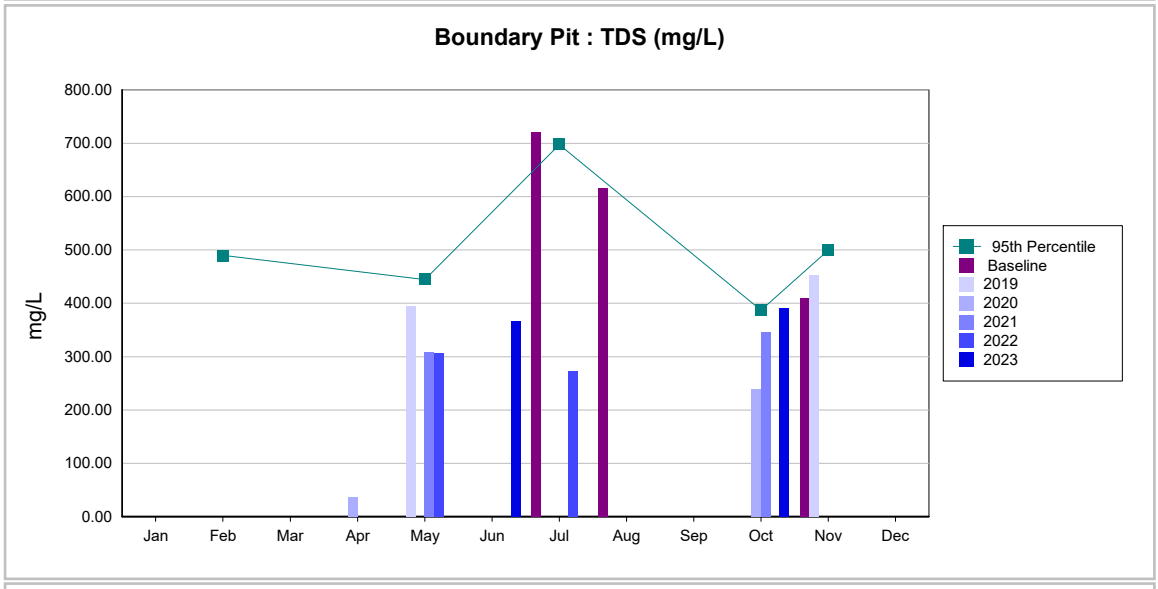
Annual Report Drainage Water

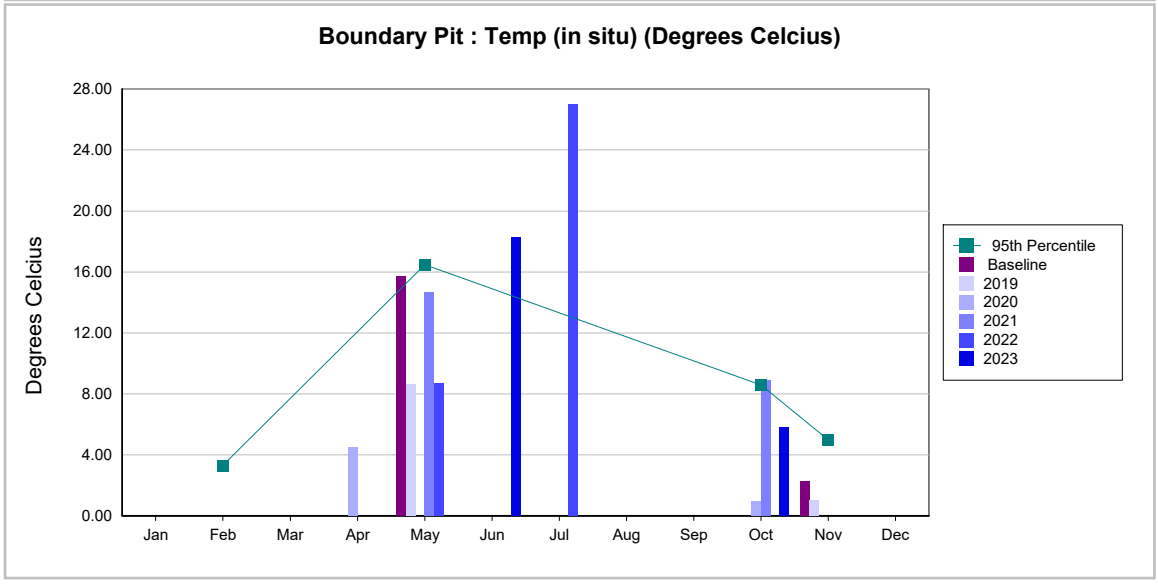
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







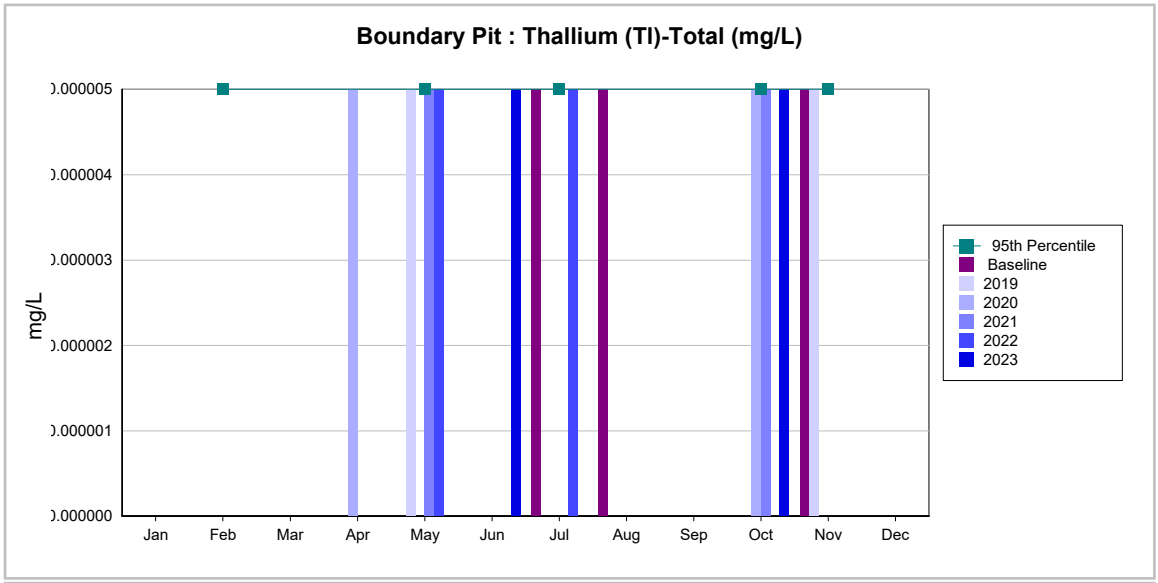
Water Quality Report

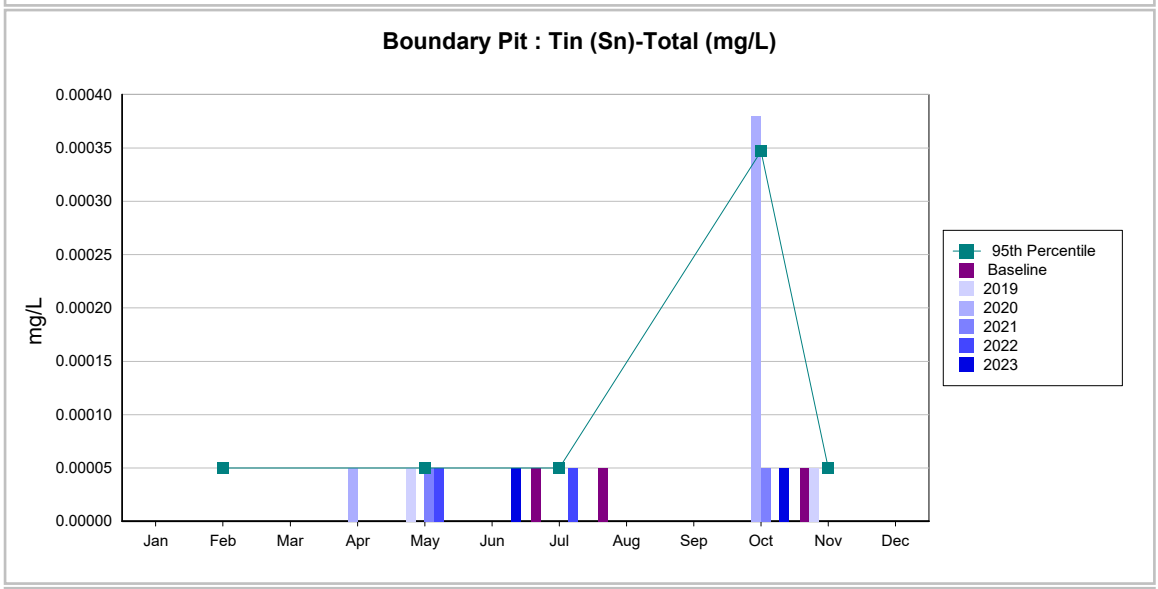
Annual Report Drainage Water

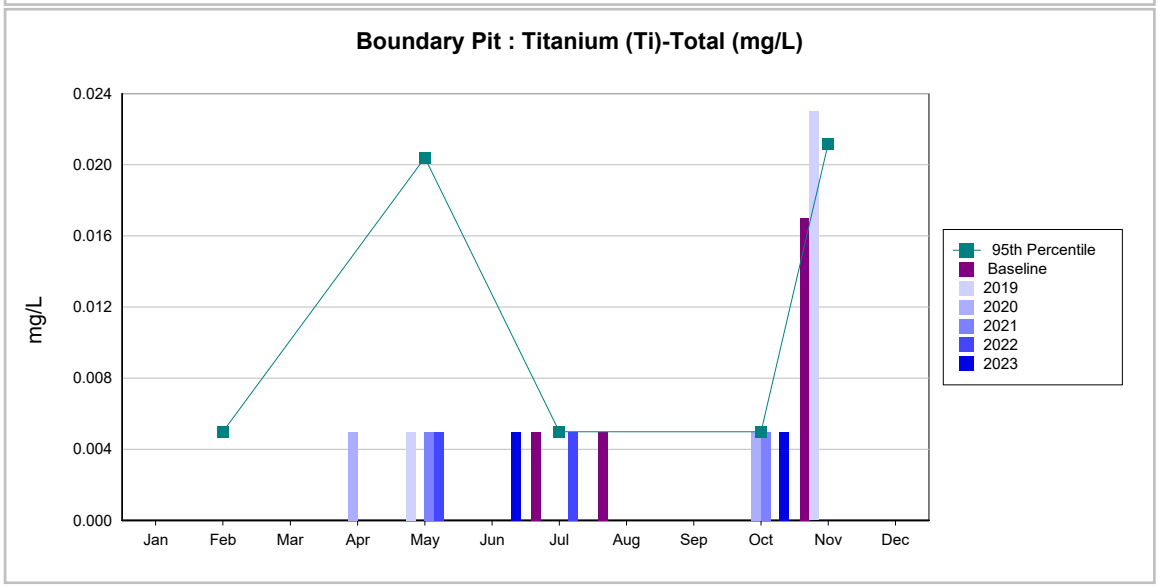
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







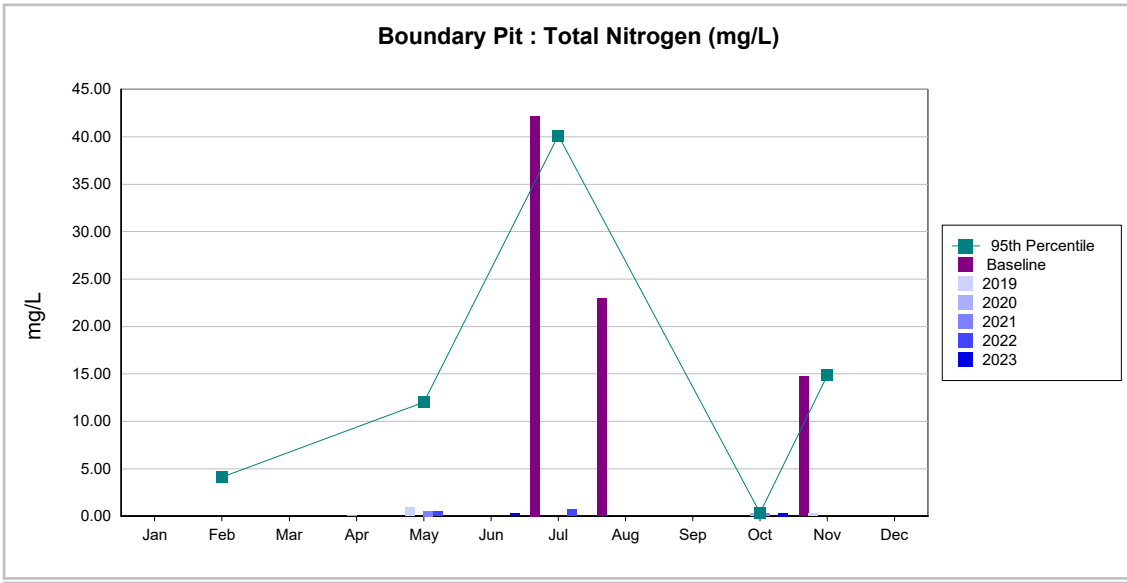
Water Quality Report

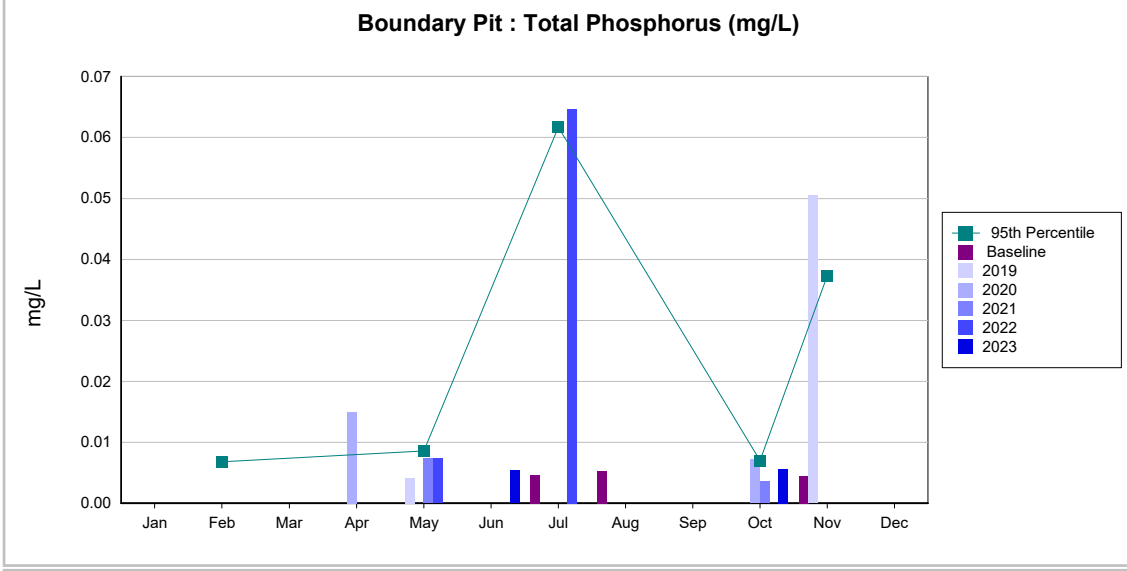
Annual Report Drainage Water

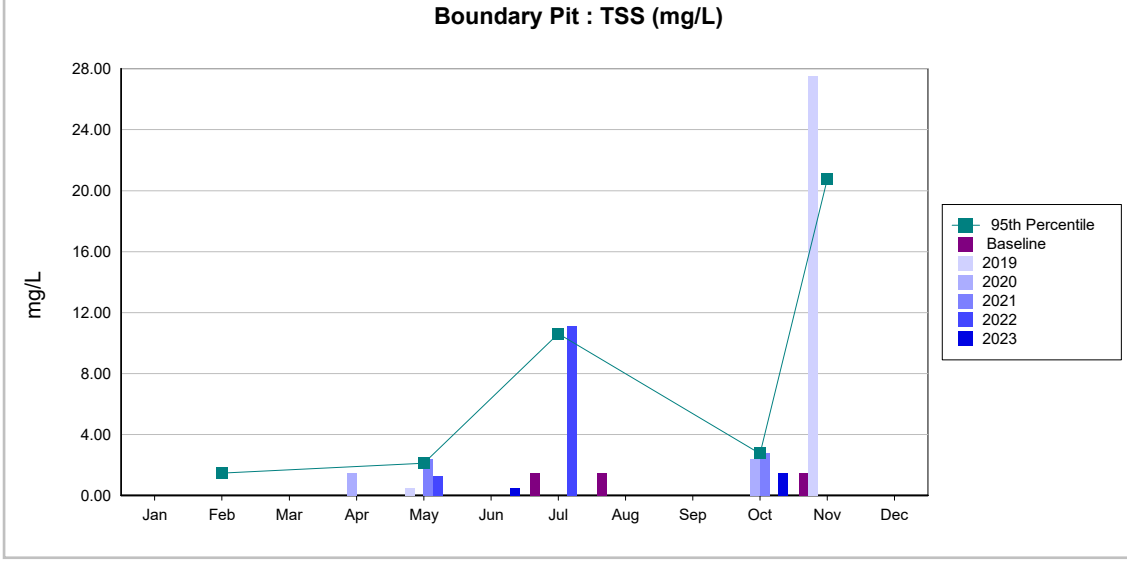
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







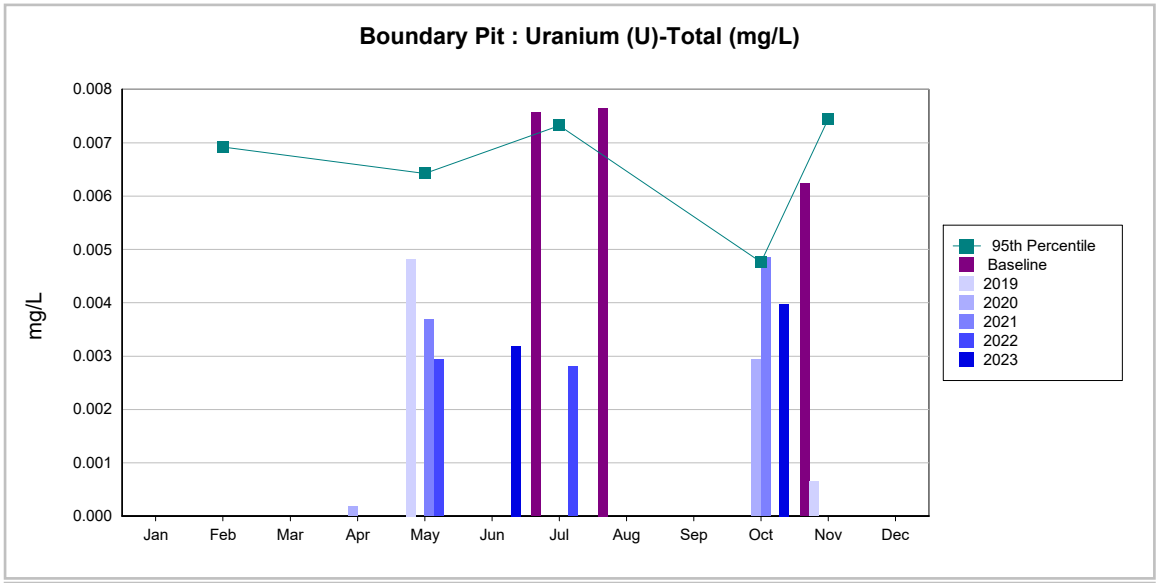
Water Quality Report

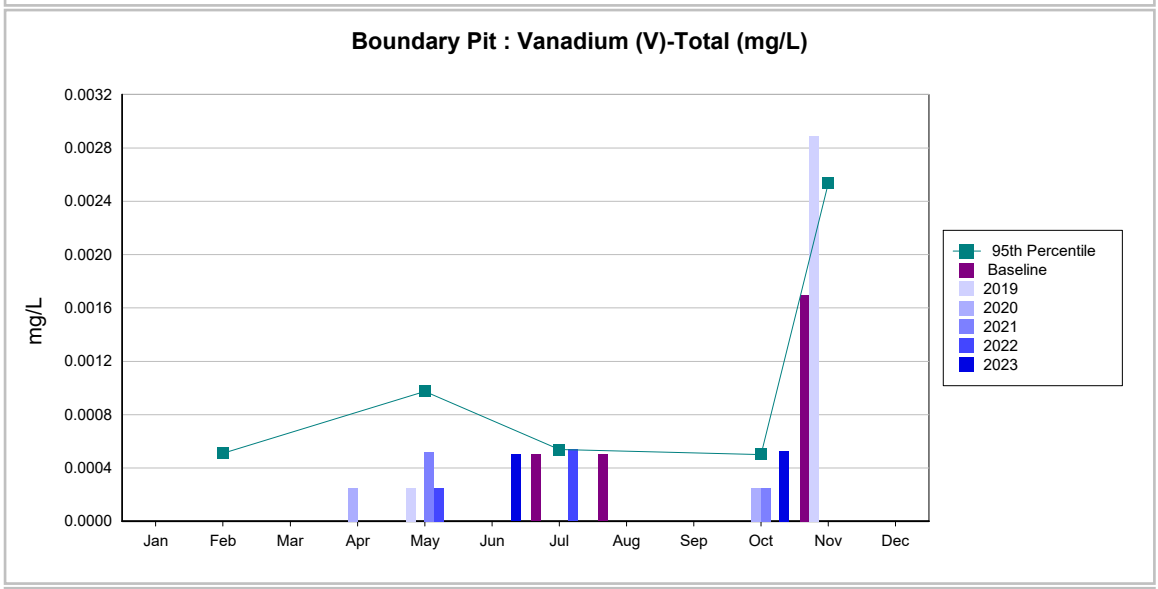
Annual Report Drainage Water

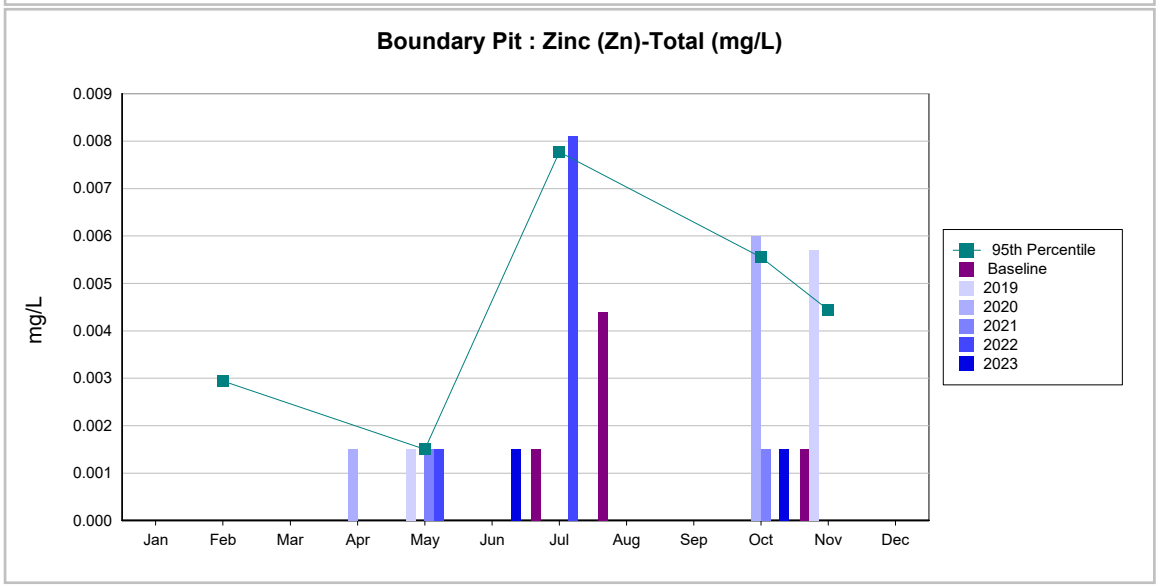
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







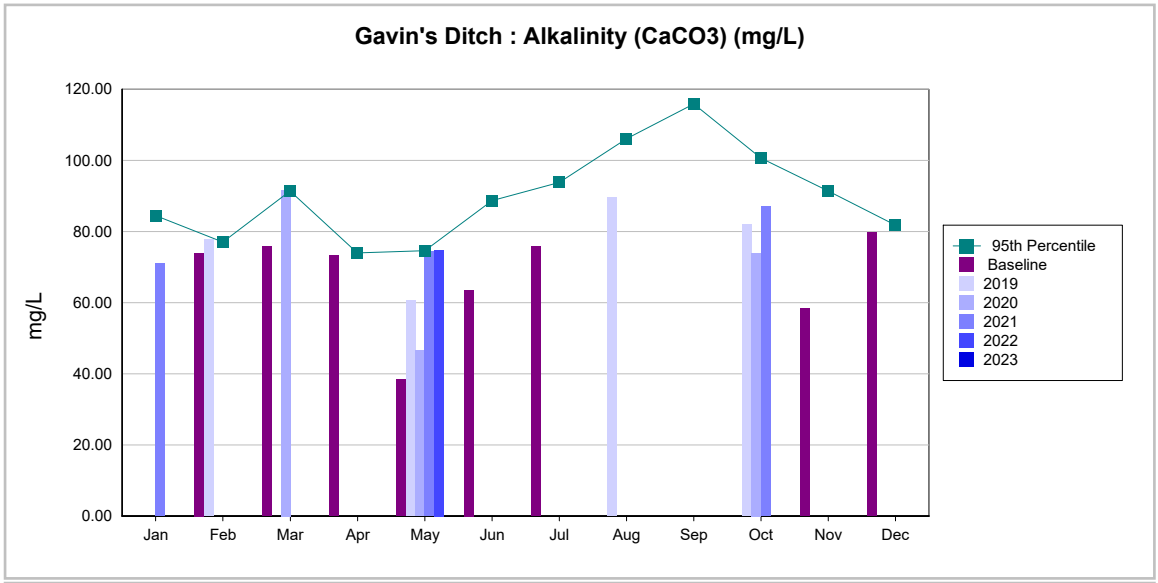
Water Quality Report

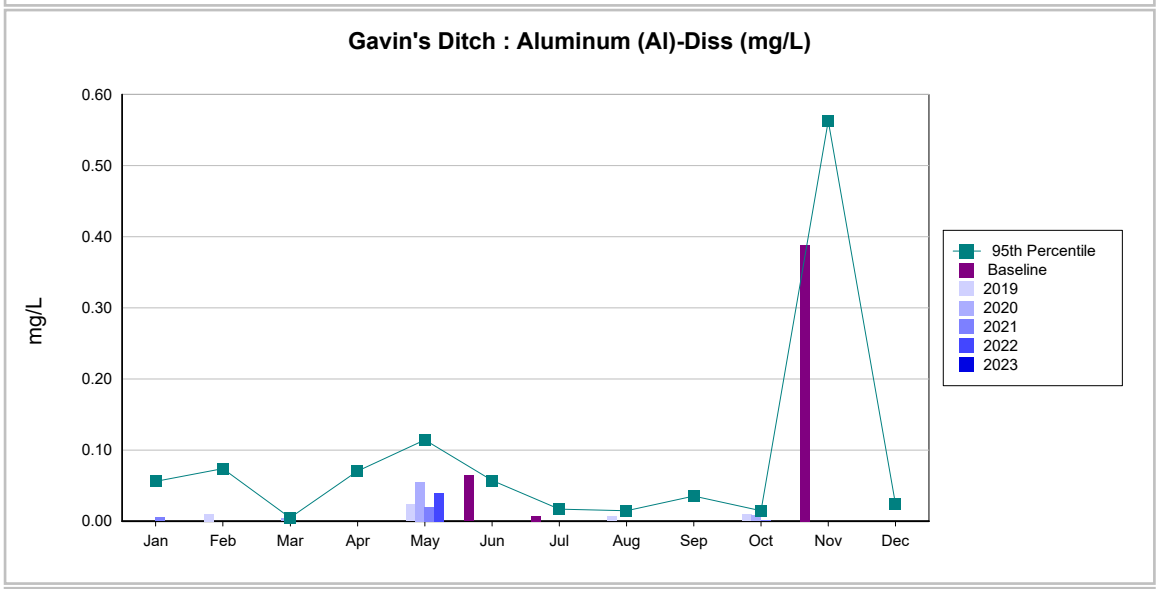
Annual Report Drainage Water

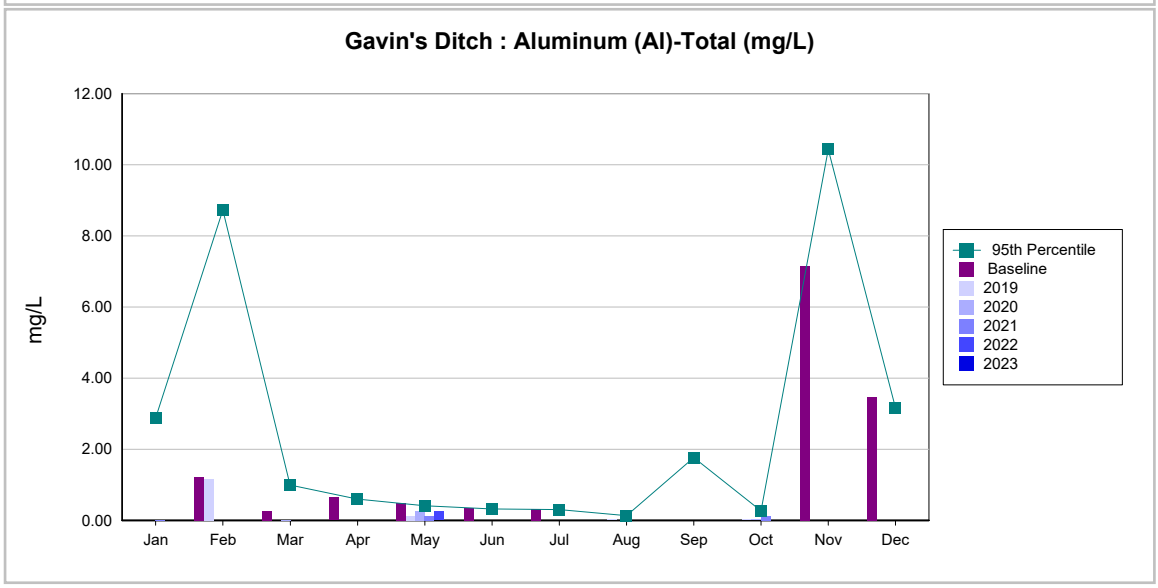
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







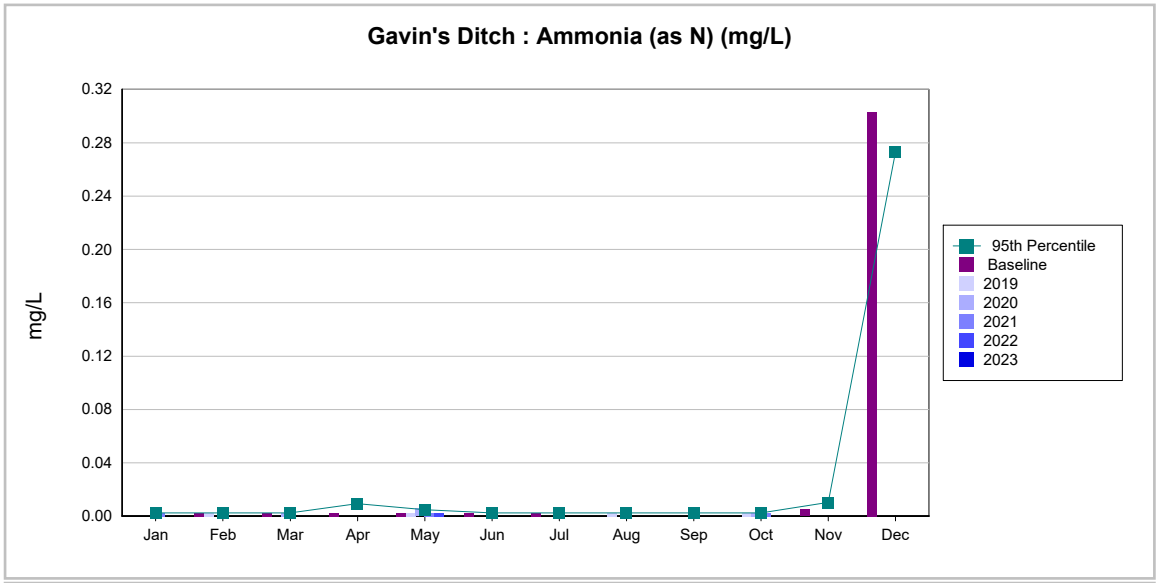
Water Quality Report

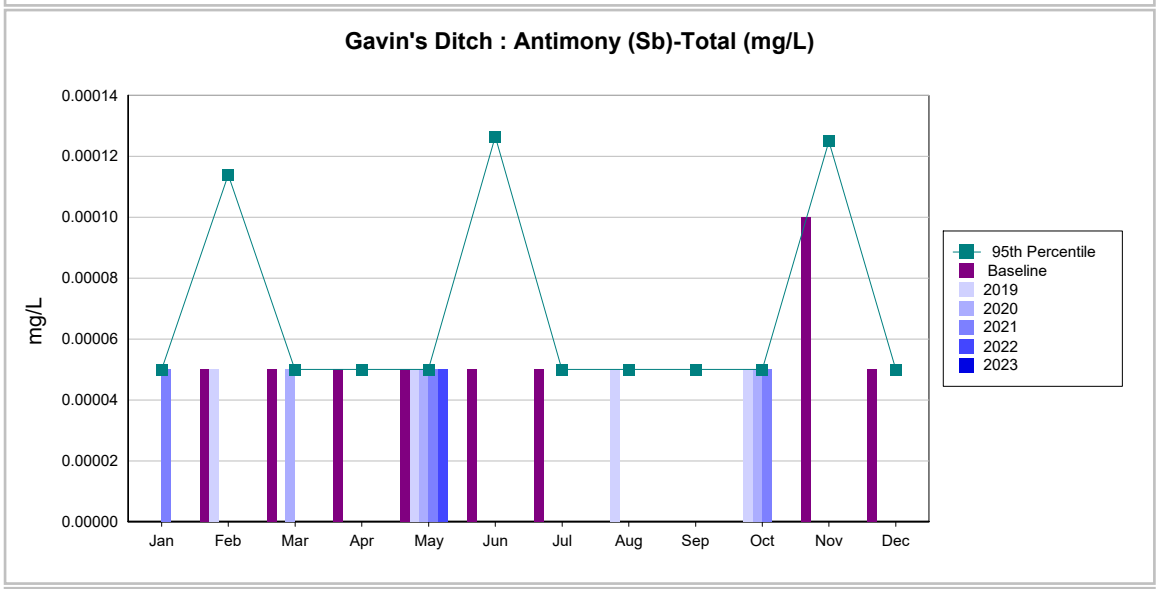
Annual Report Drainage Water

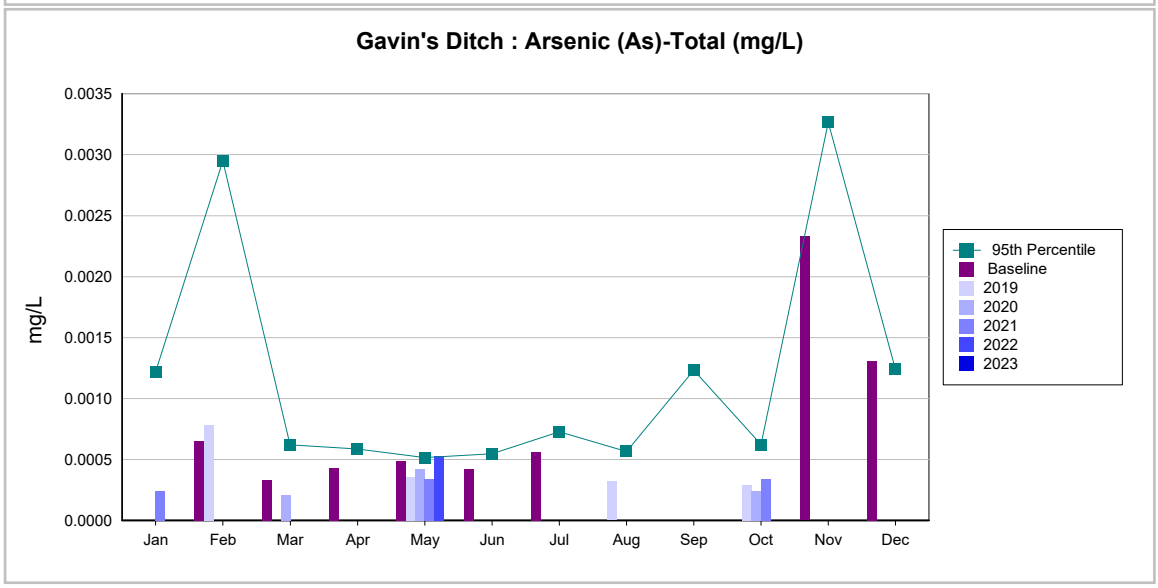
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







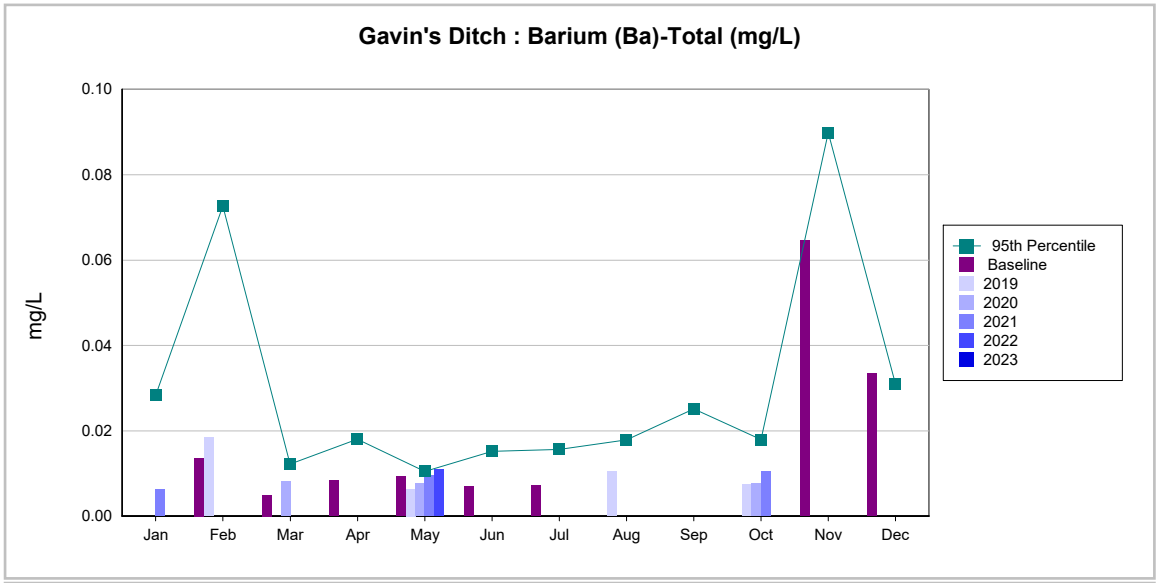
Water Quality Report

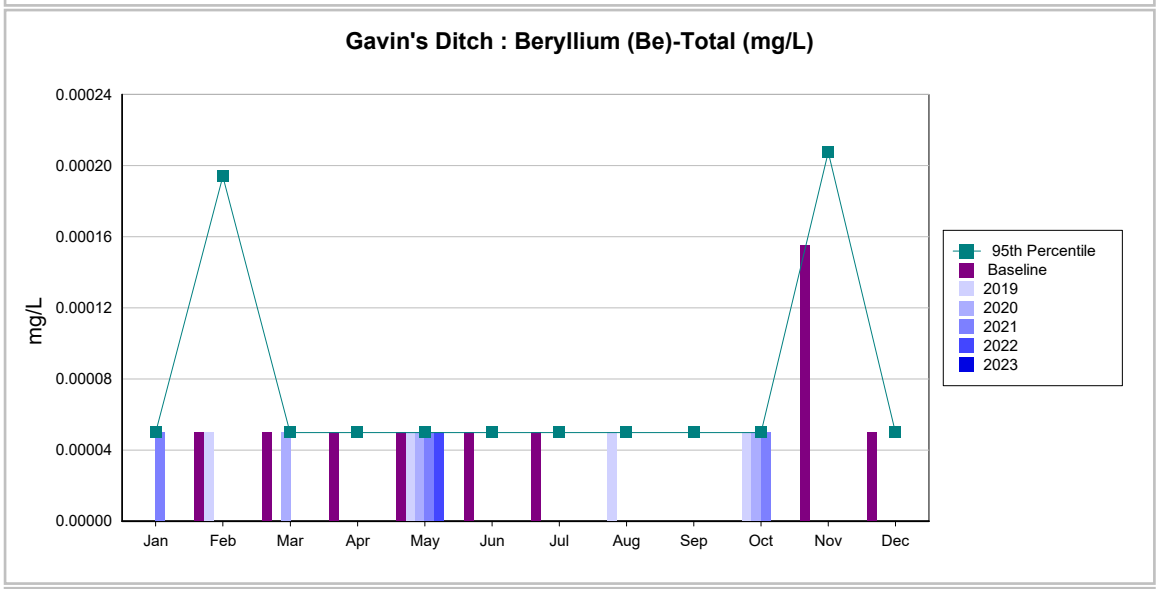
Annual Report Drainage Water

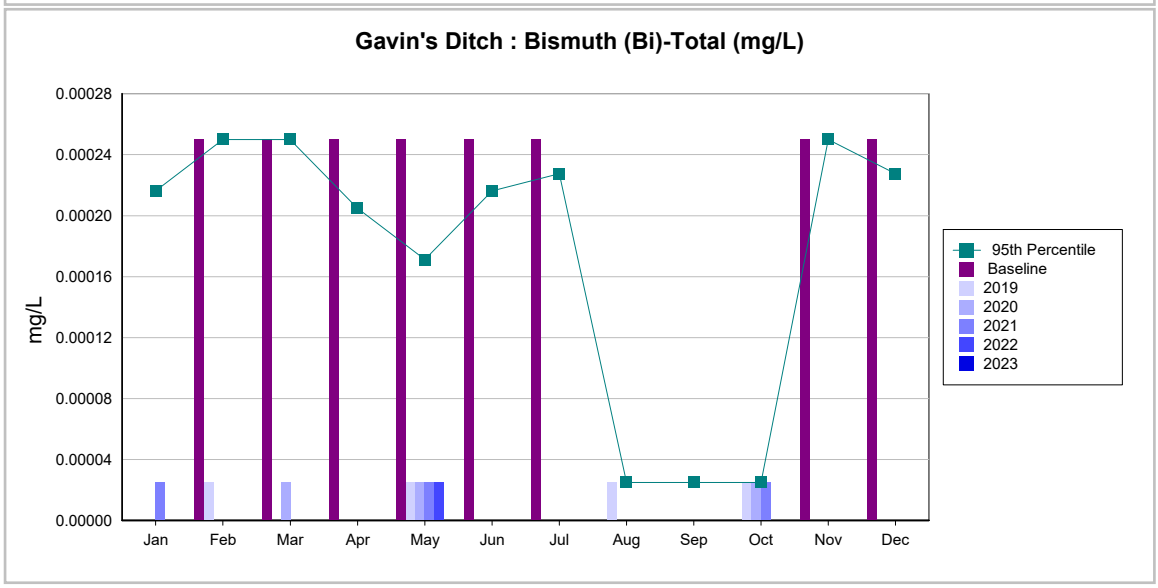
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







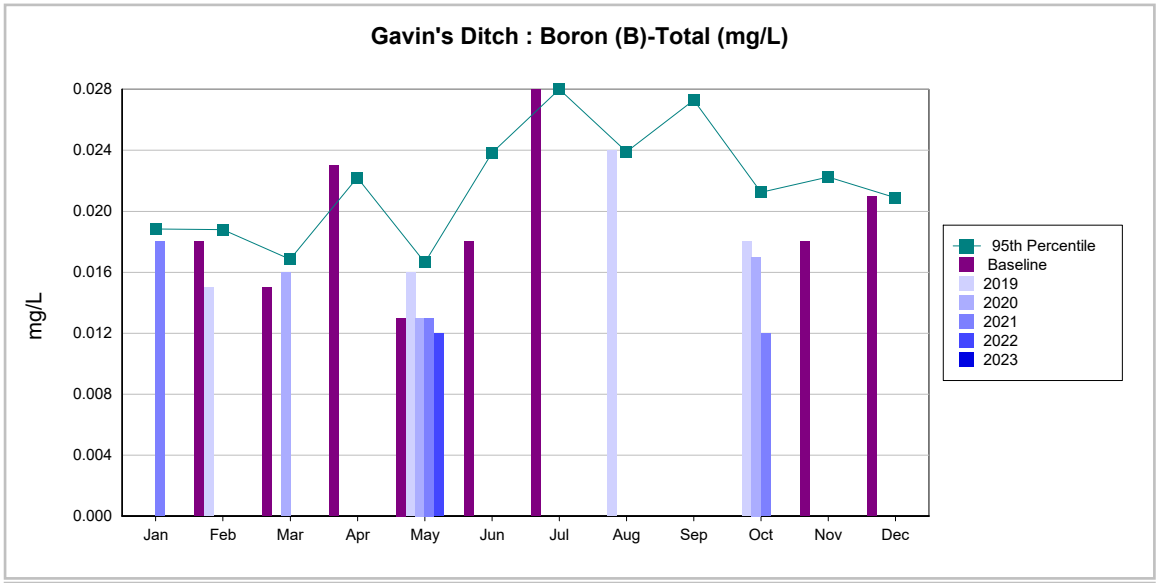
Water Quality Report

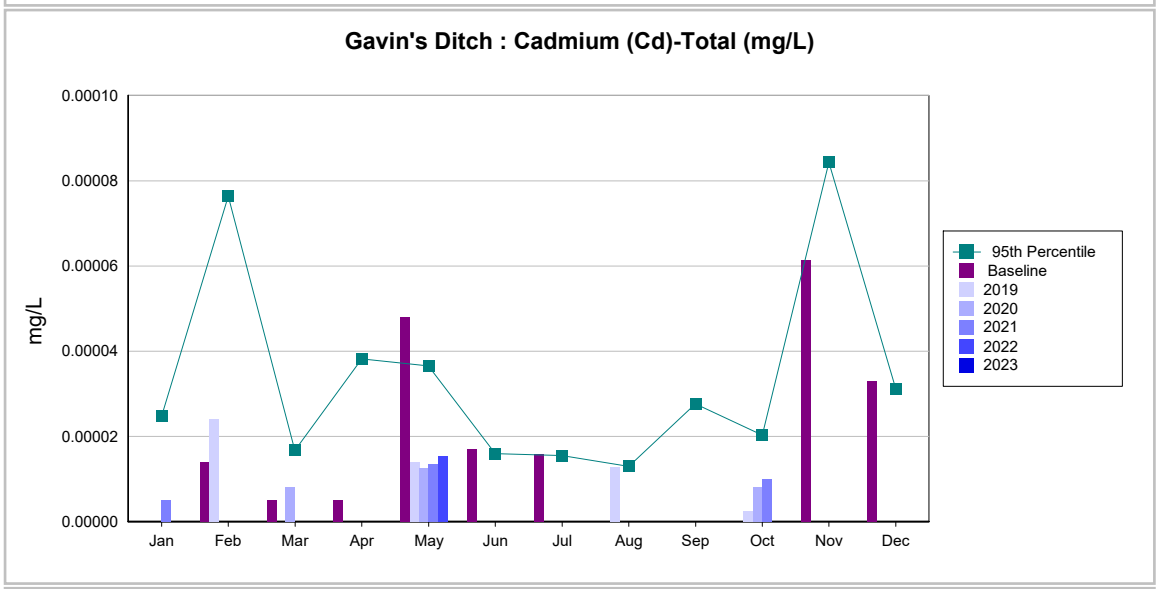
Annual Report Drainage Water

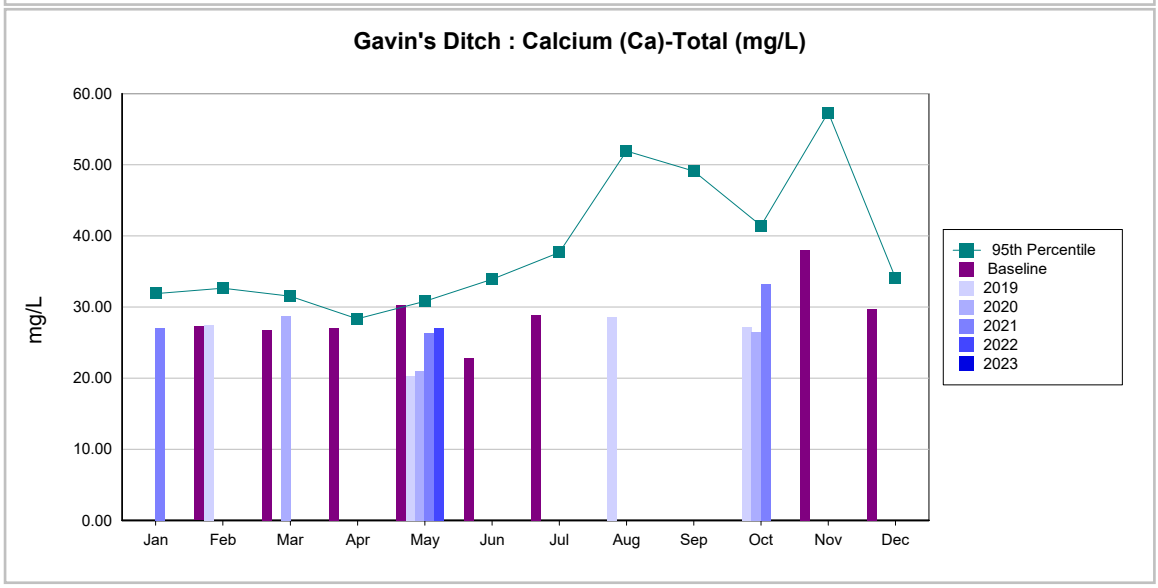
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







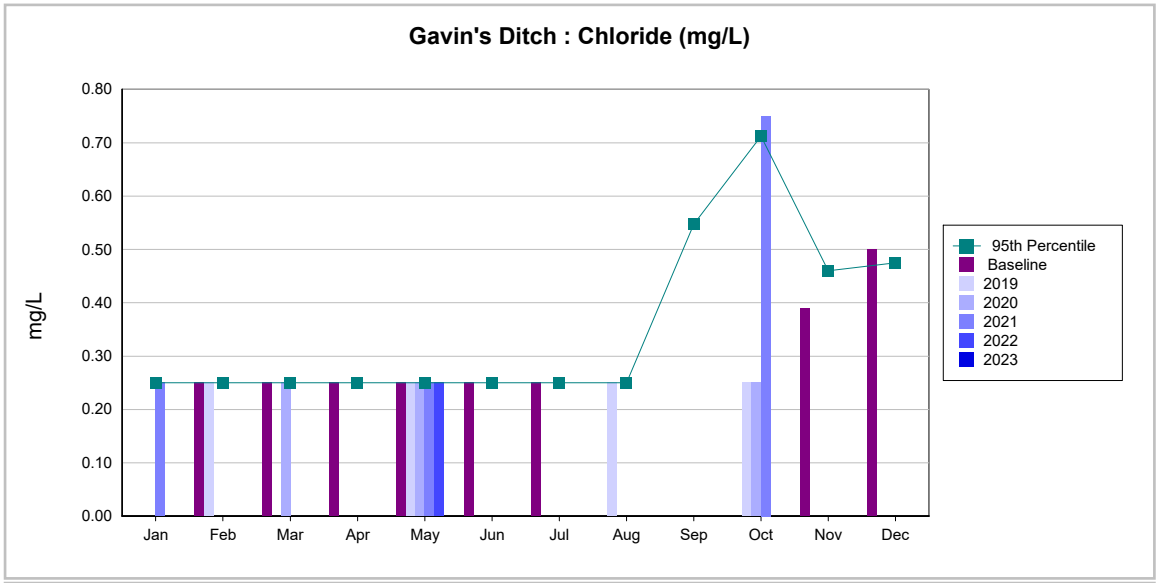
Water Quality Report

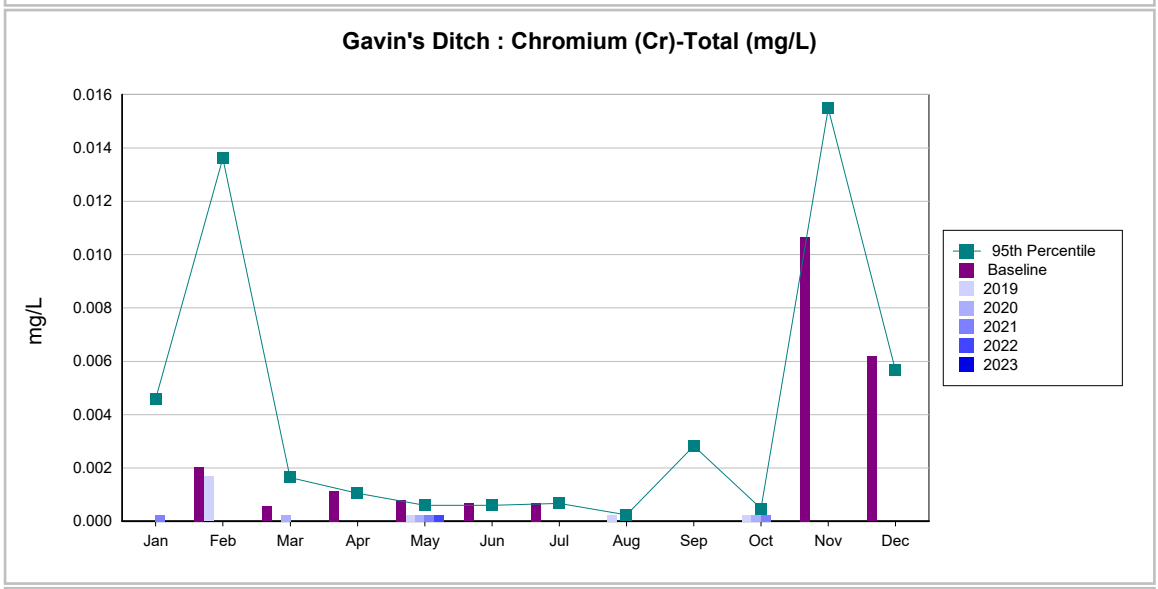
Annual Report Drainage Water

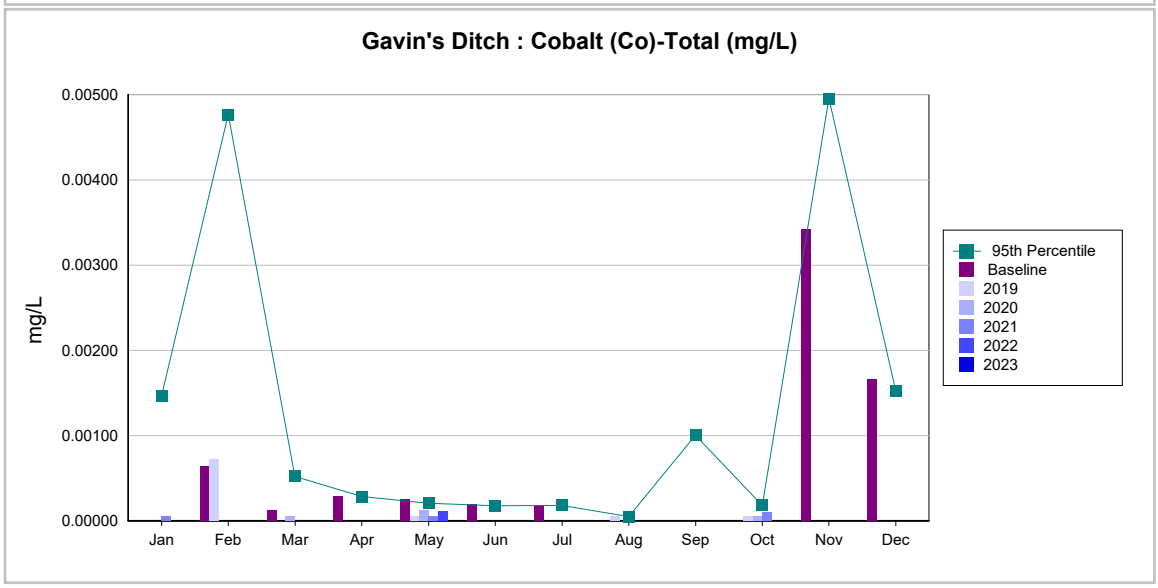
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







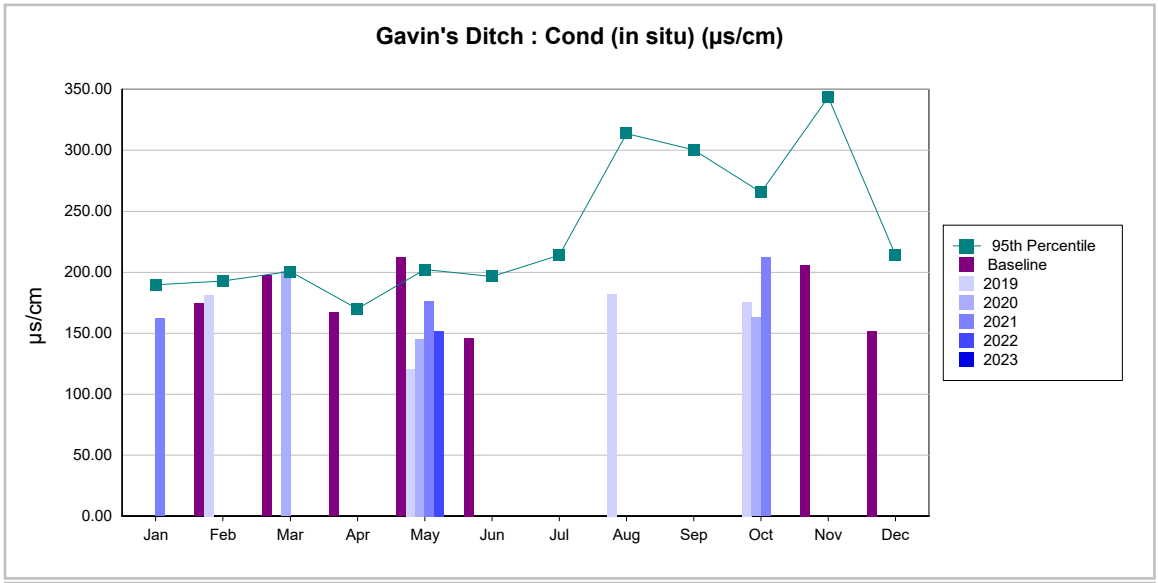
Water Quality Report

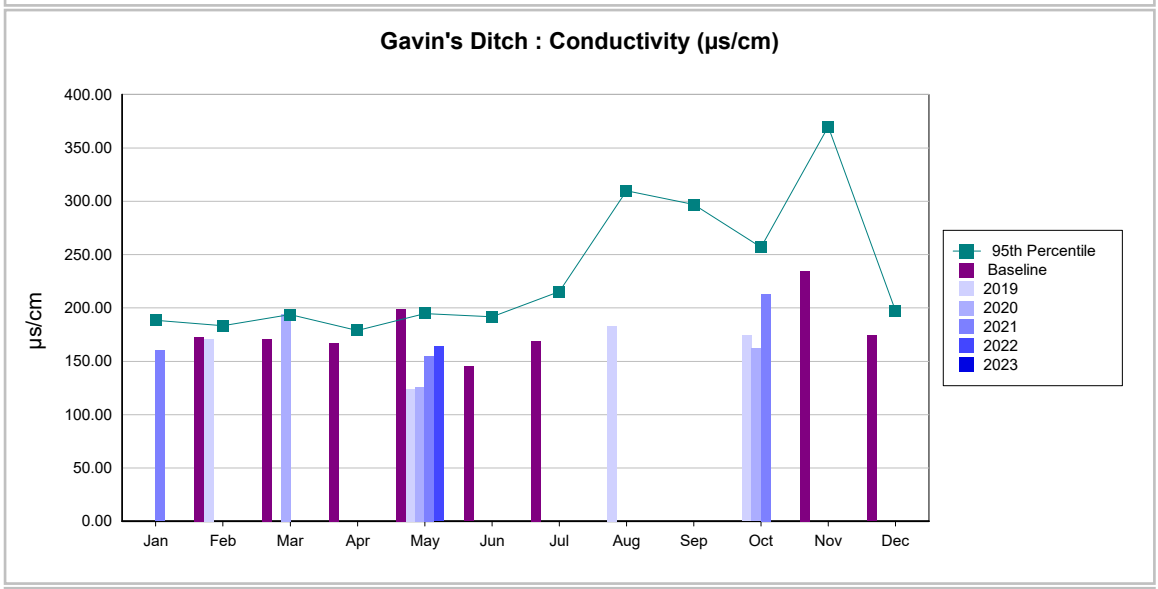
Annual Report Drainage Water

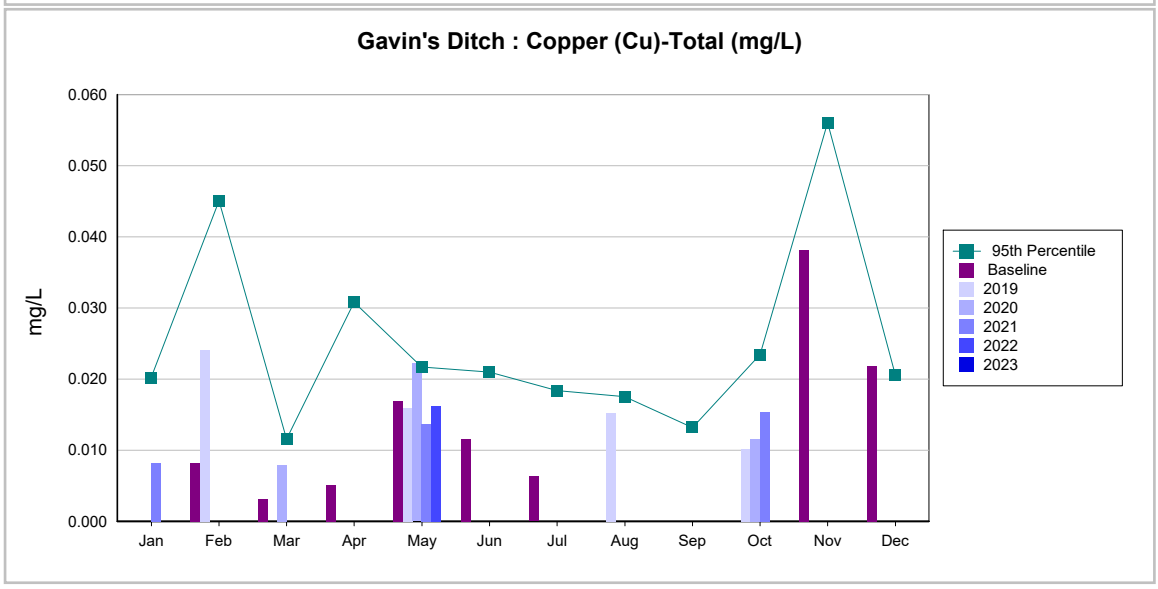
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







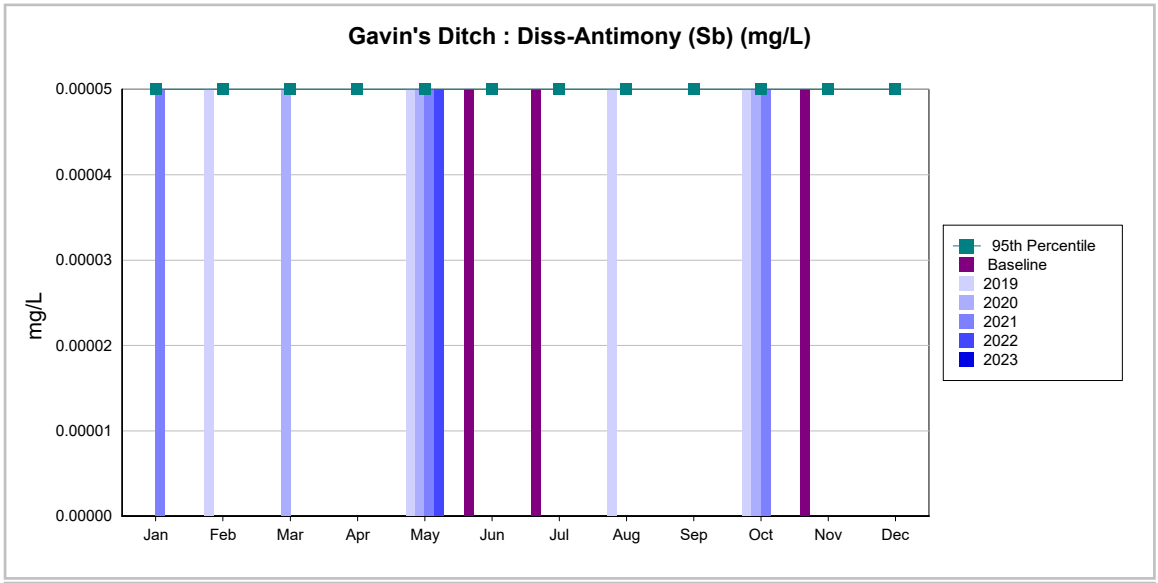
Water Quality Report

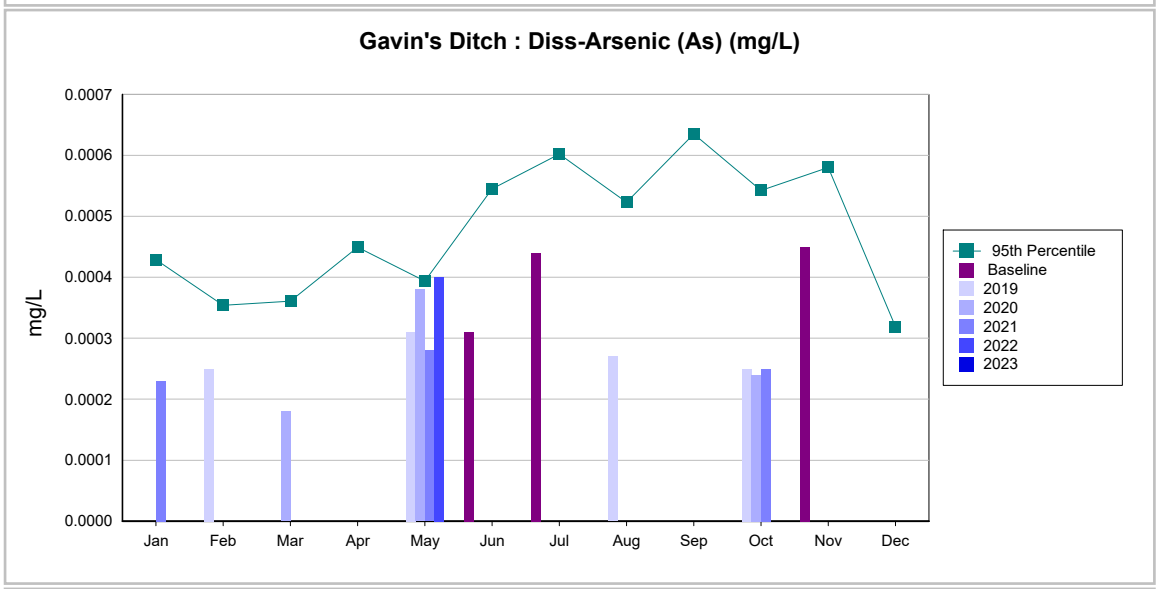
Annual Report Drainage Water

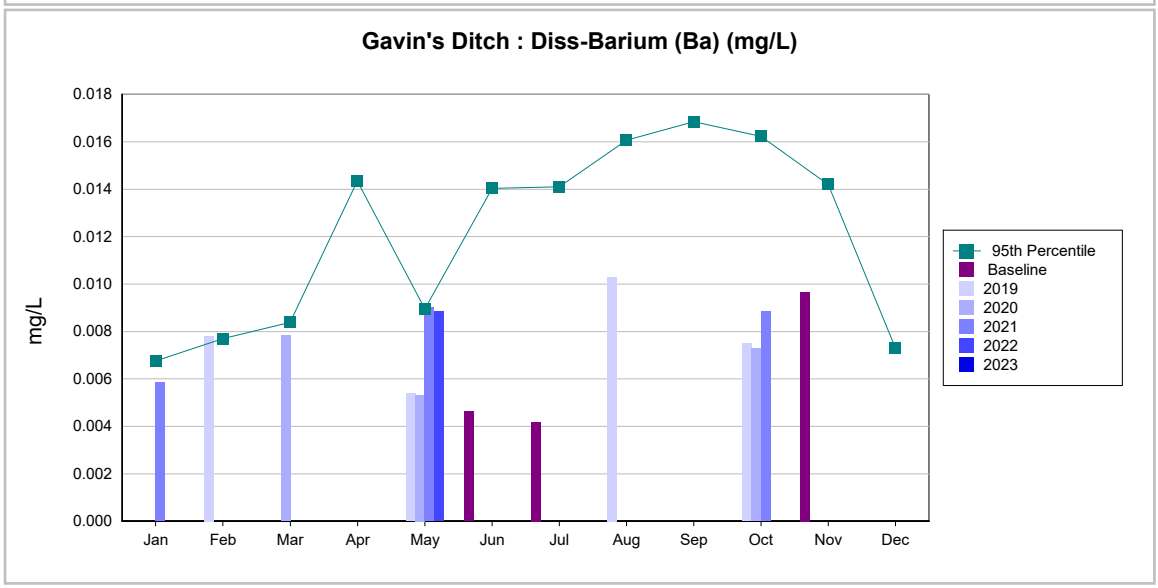
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







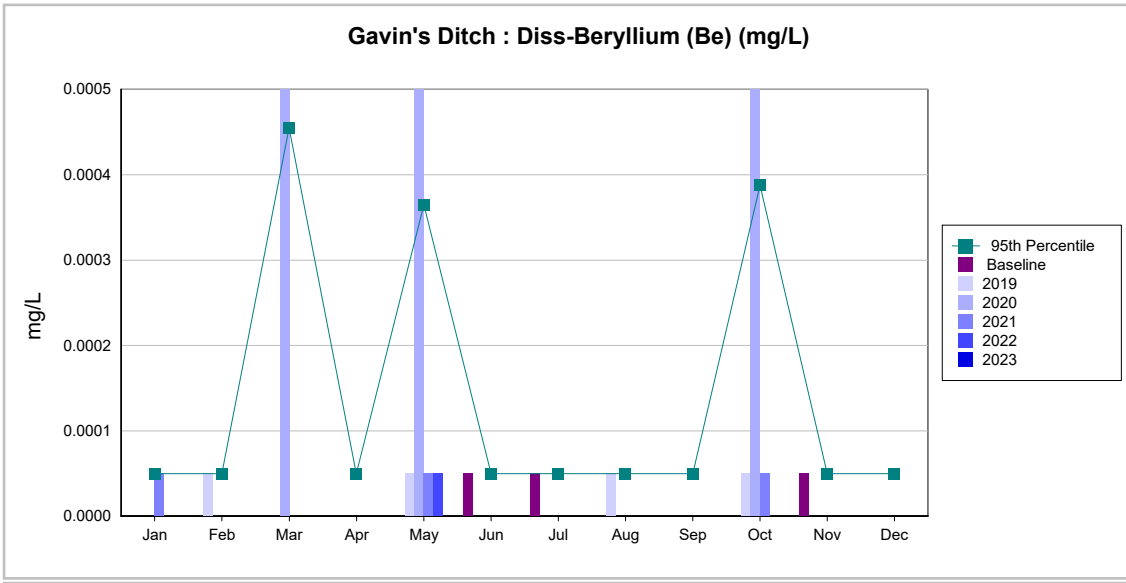
Water Quality Report

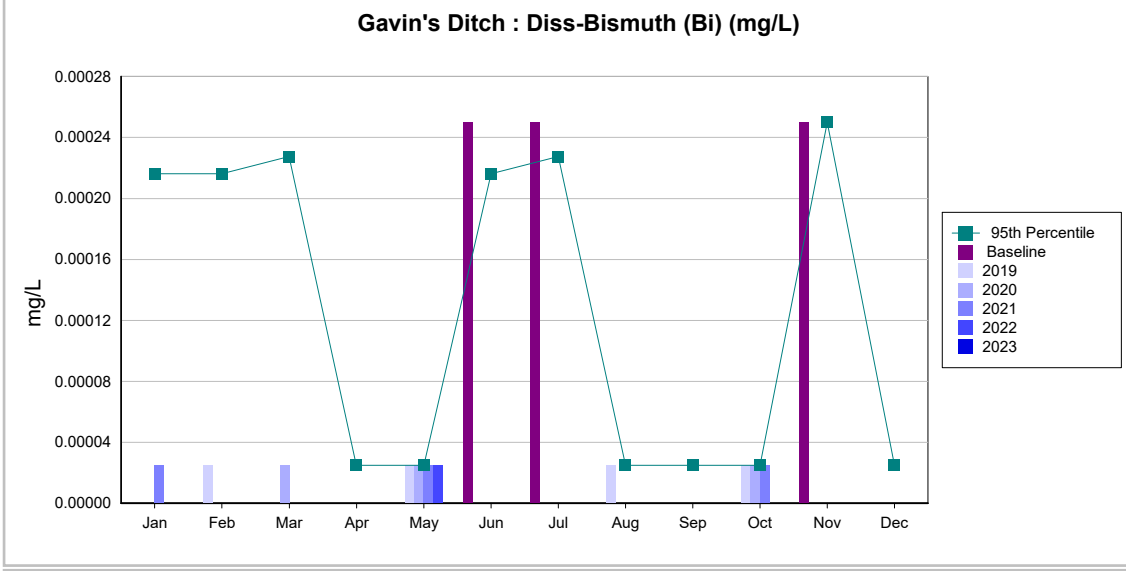
Annual Report Drainage Water

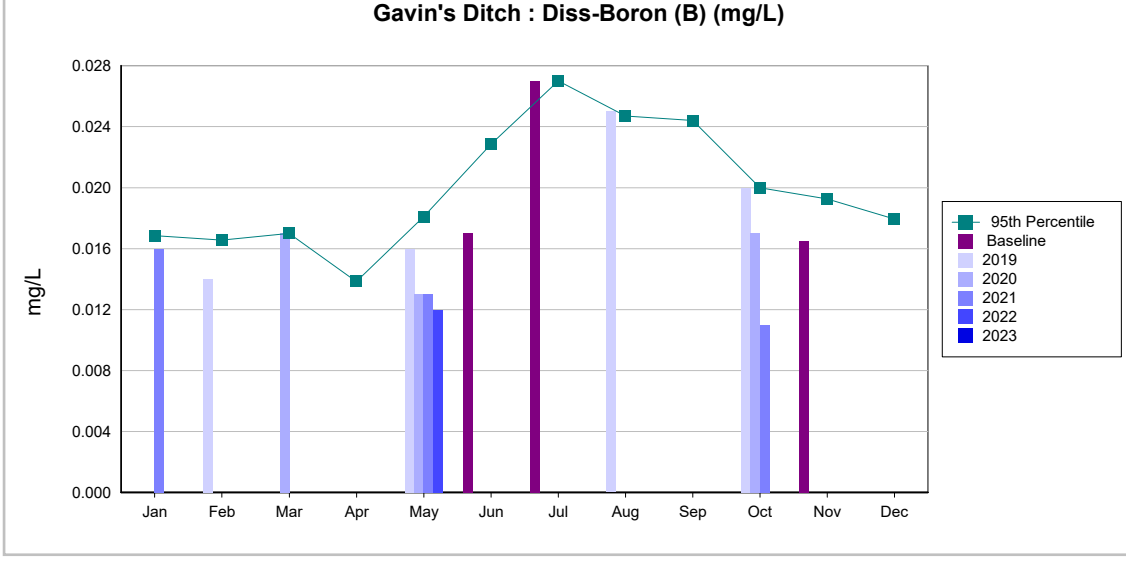
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

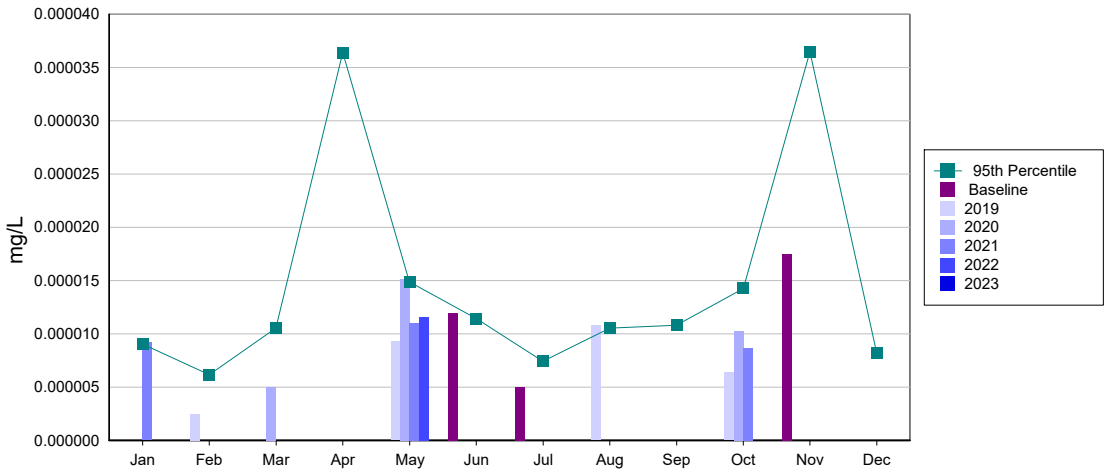
Annual Report Drainage Water

Mount Polley

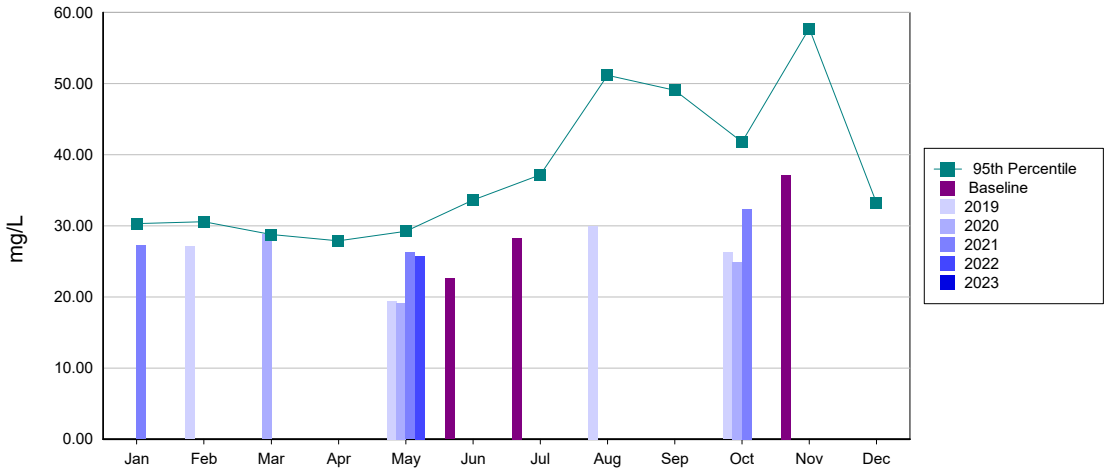
Mining Corporation

IMPERIAL METALS CORPORATION

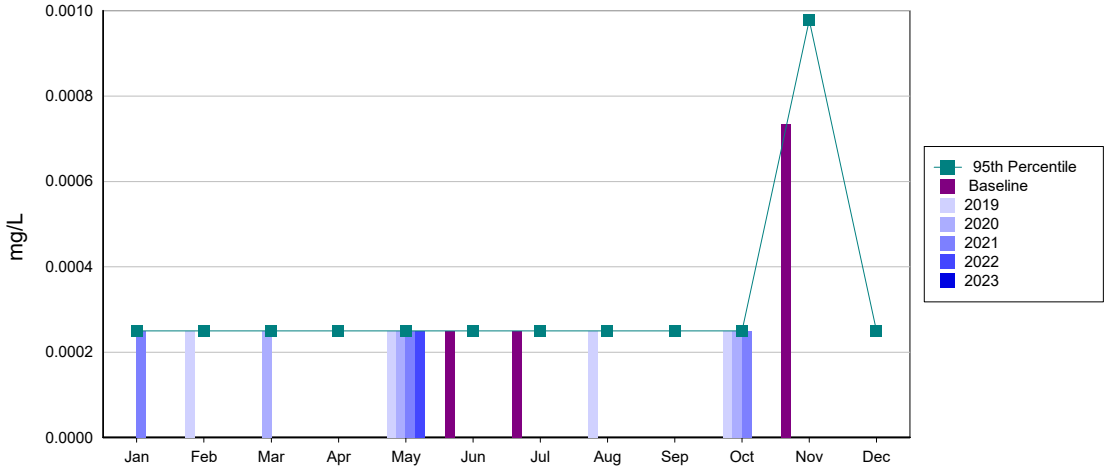
Gavin's Ditch : Diss-Cadmium (Cd) (mg/L)



Gavin's Ditch : Diss-Calcium (Ca) (mg/L)



Gavin's Ditch : Diss-Chromium (Cr) (mg/L)



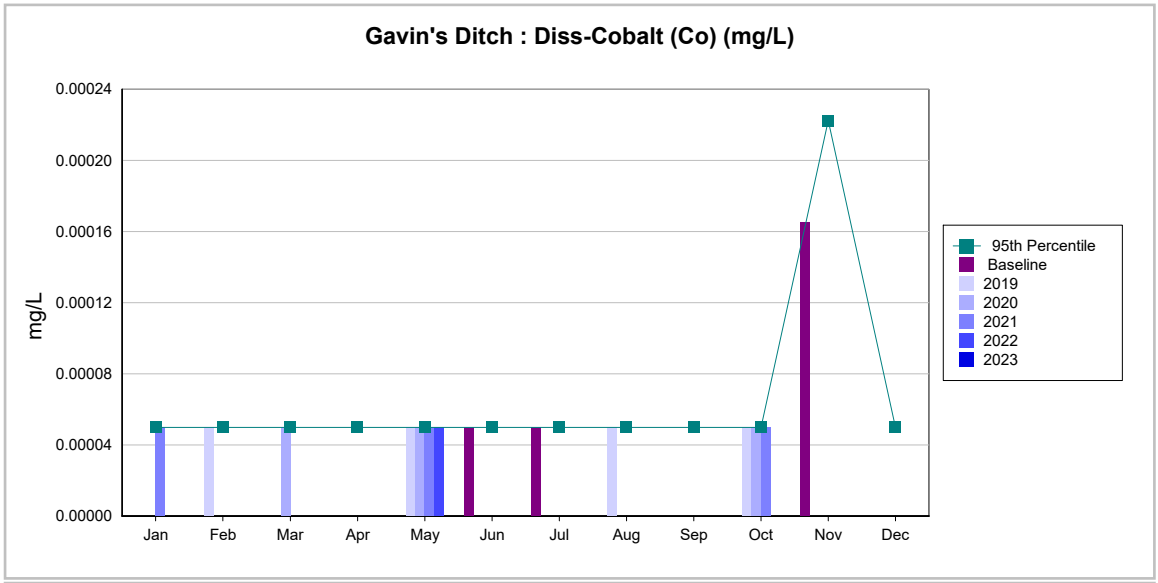
Water Quality Report

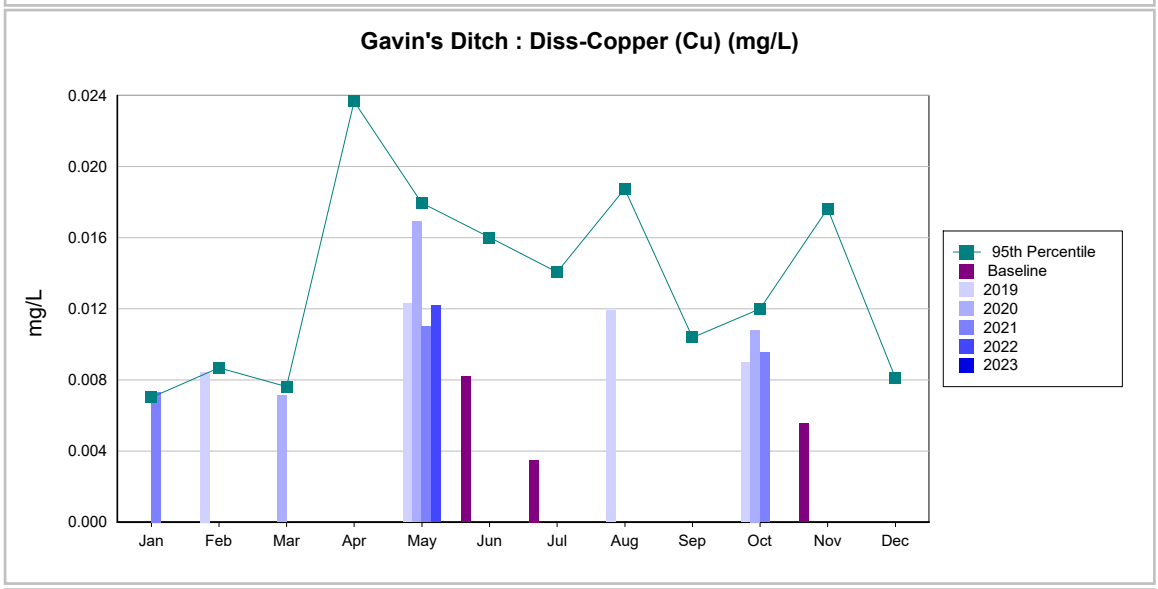
Annual Report Drainage Water

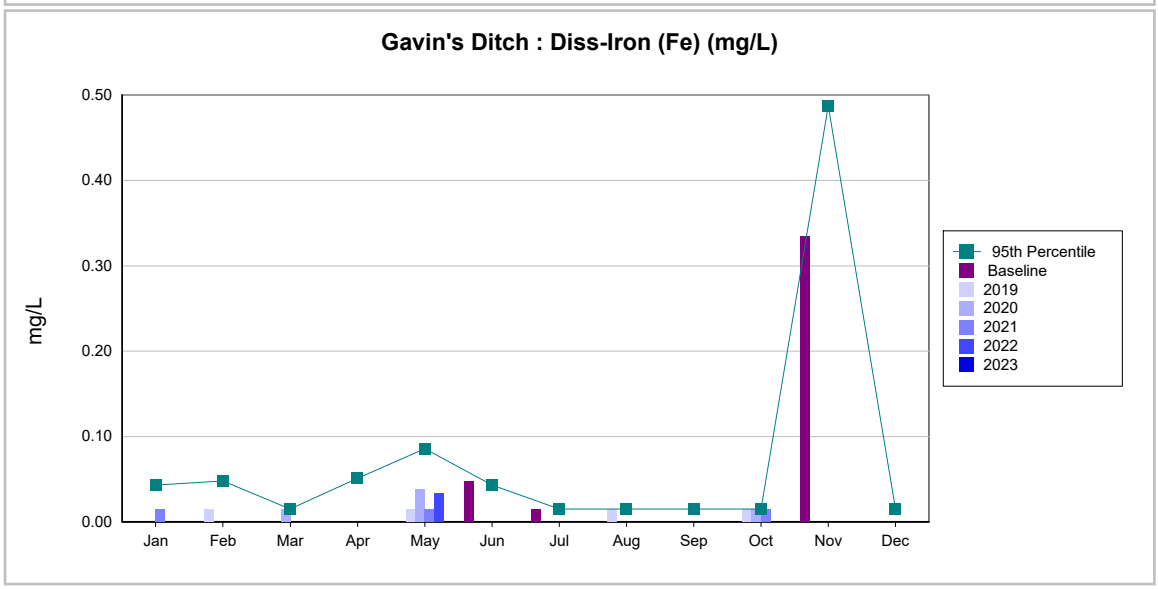
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







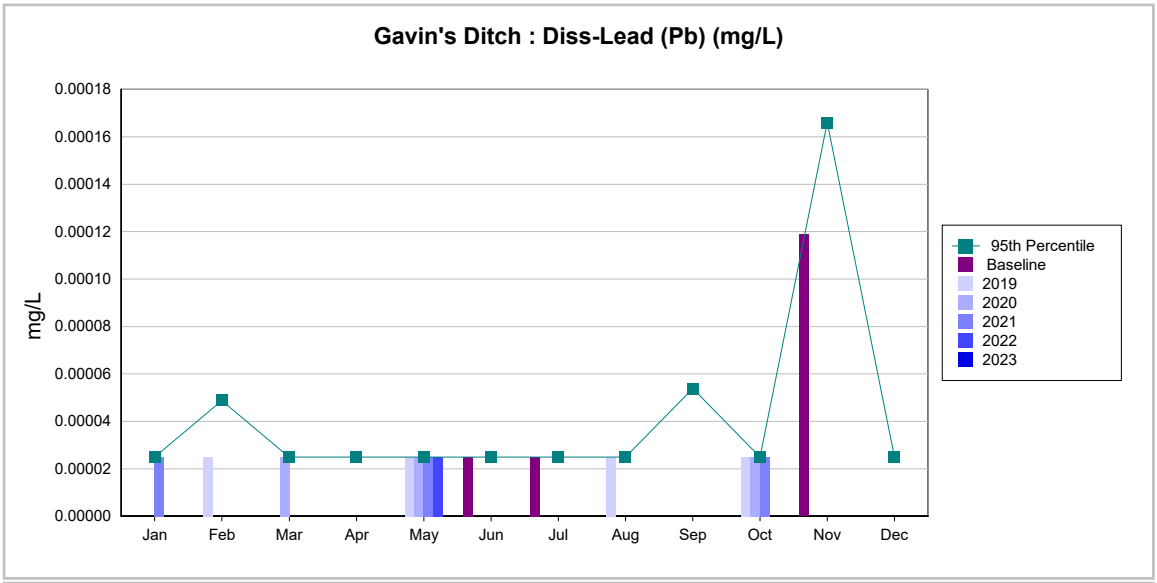
Water Quality Report

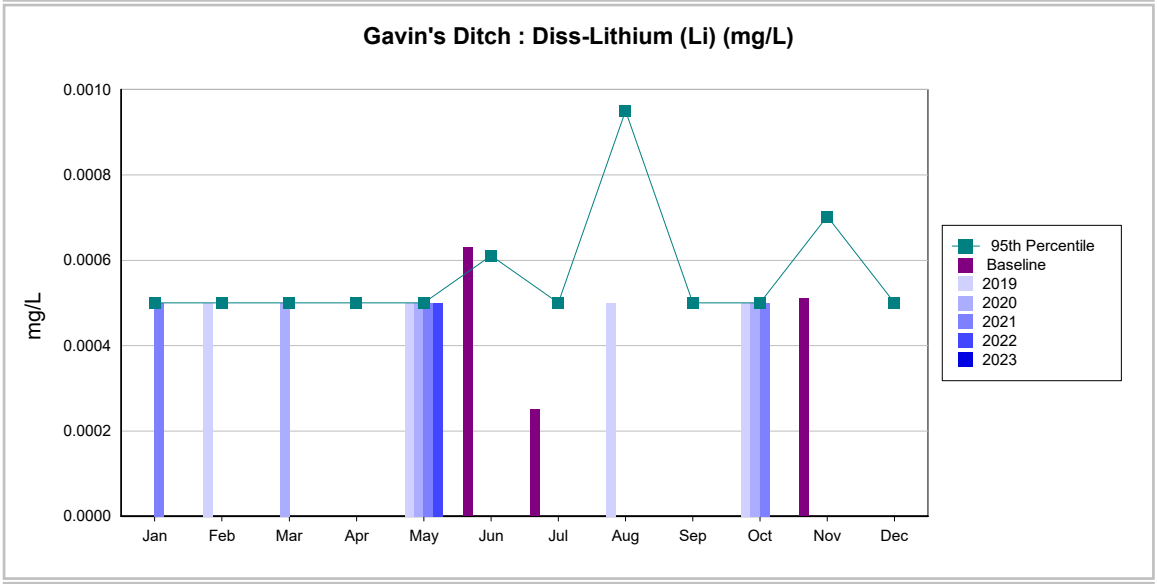
Annual Report Drainage Water

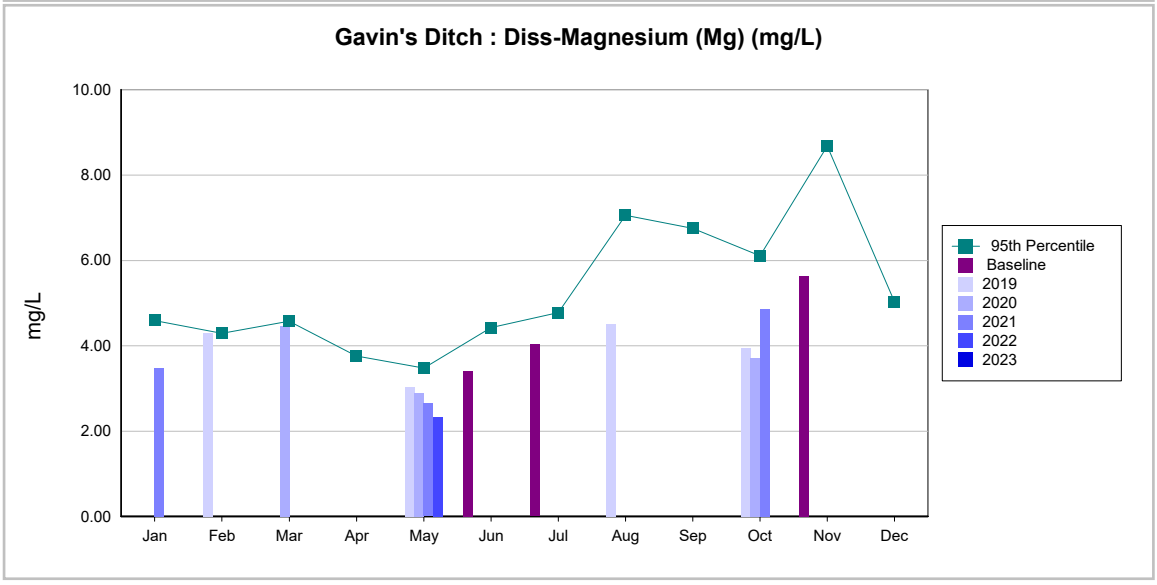
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







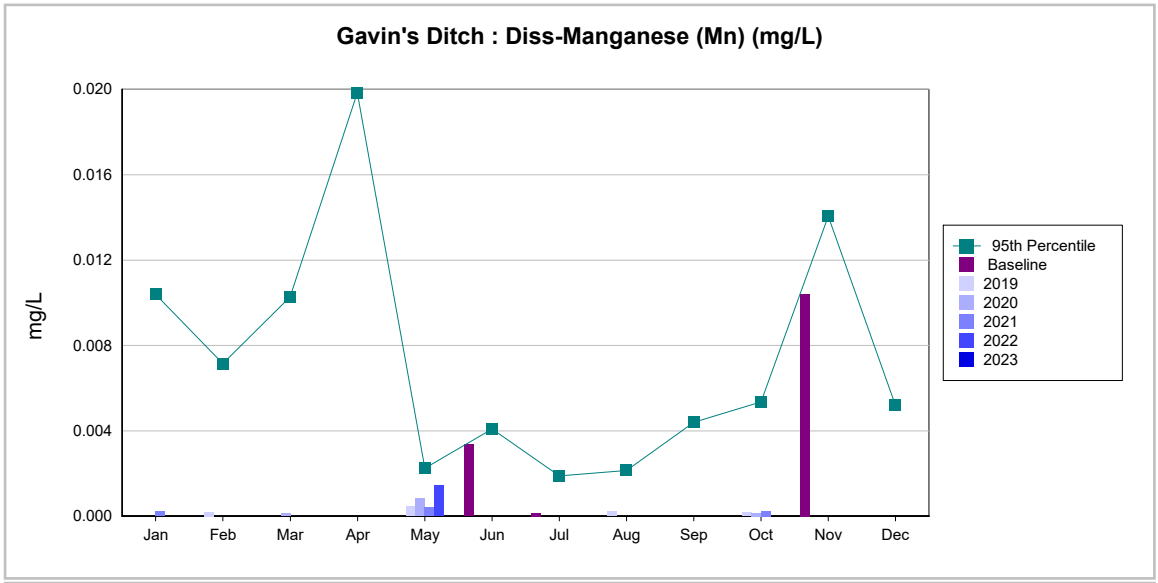
Water Quality Report

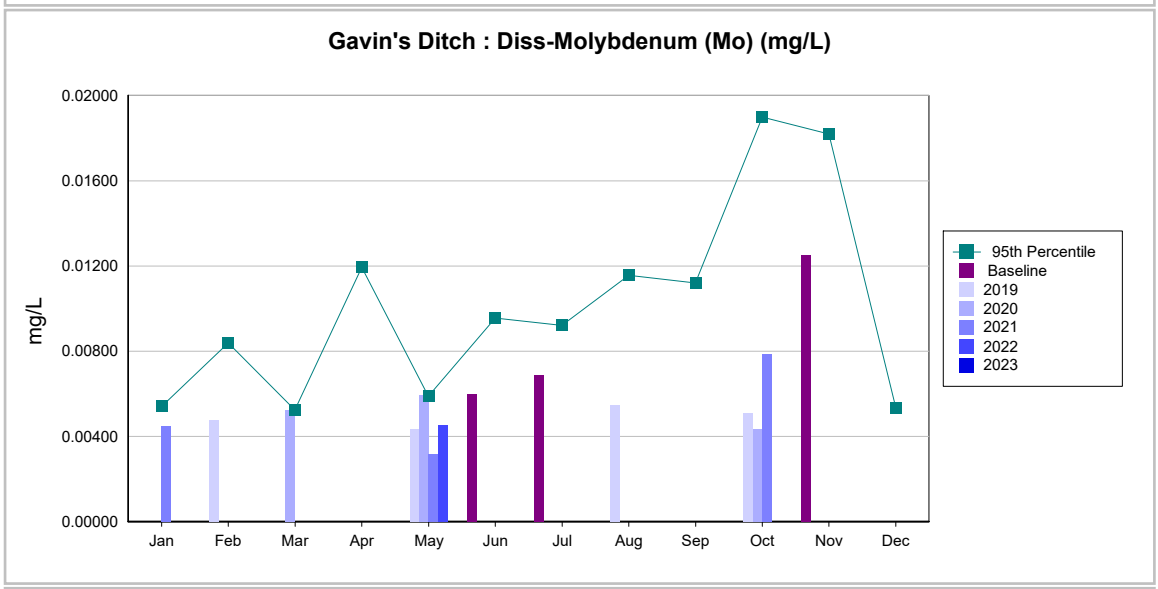
Annual Report Drainage Water

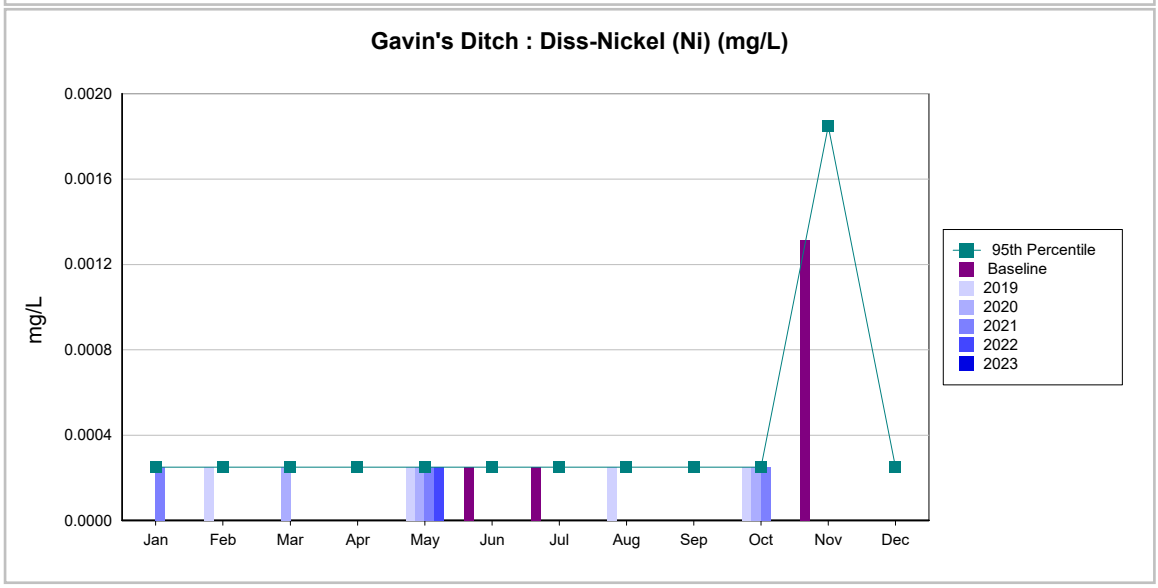
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







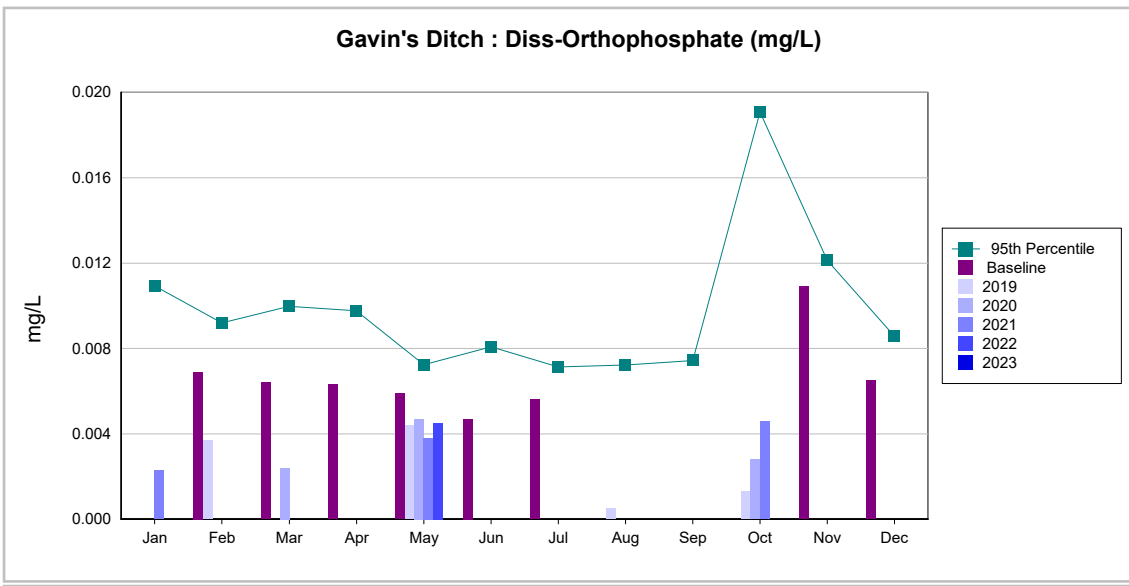
Water Quality Report

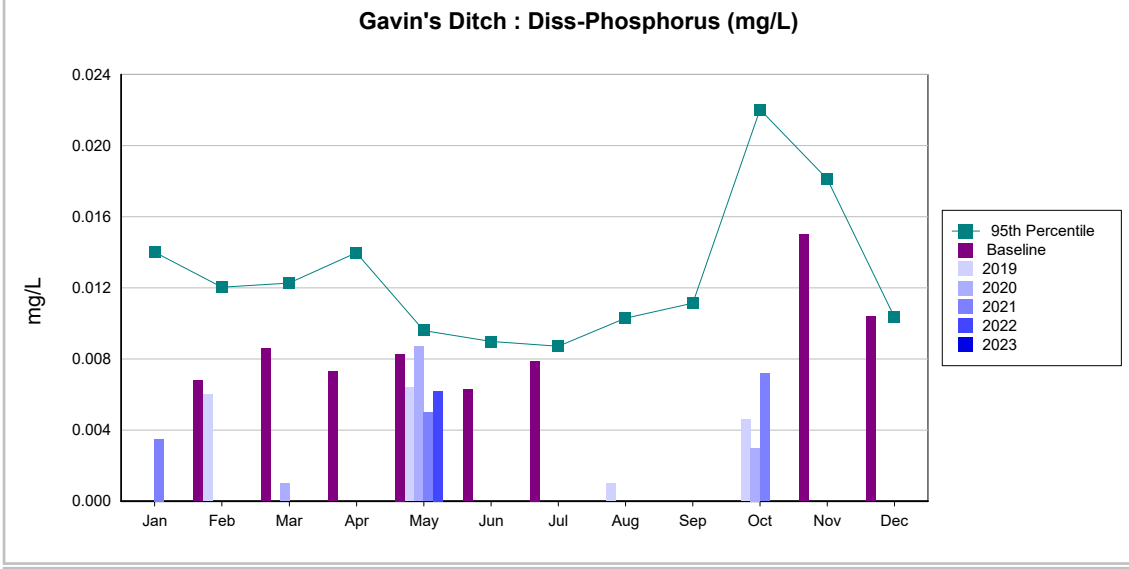
Annual Report Drainage Water

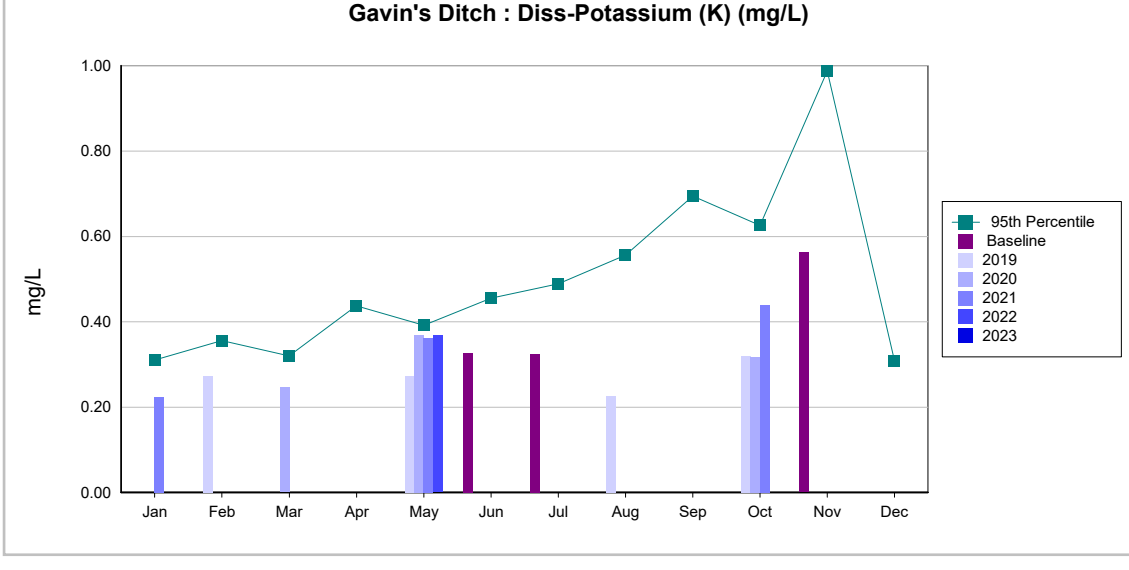
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







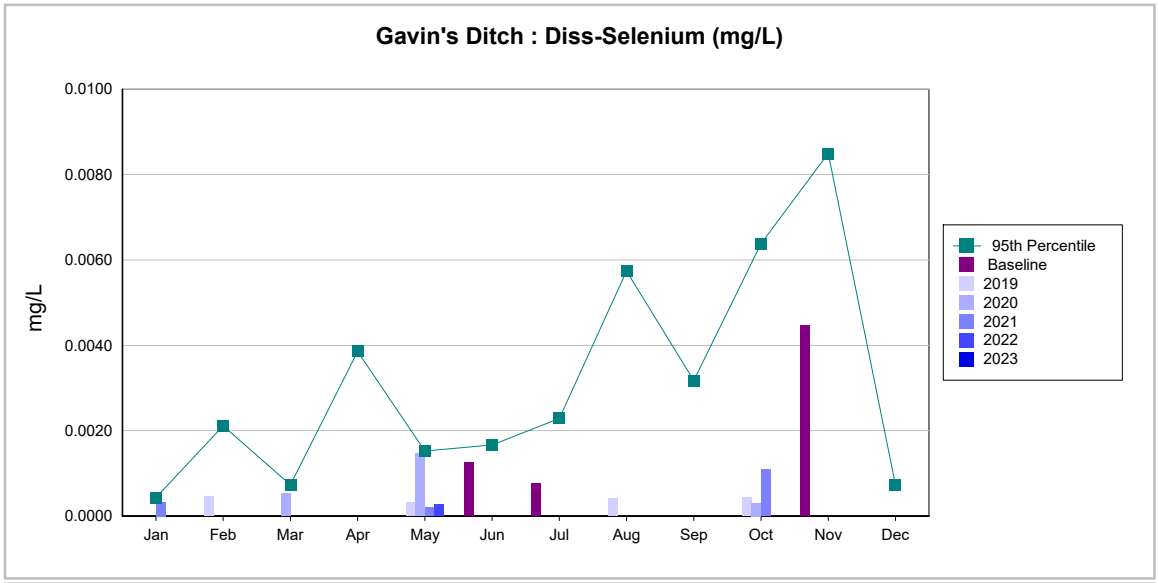
Water Quality Report

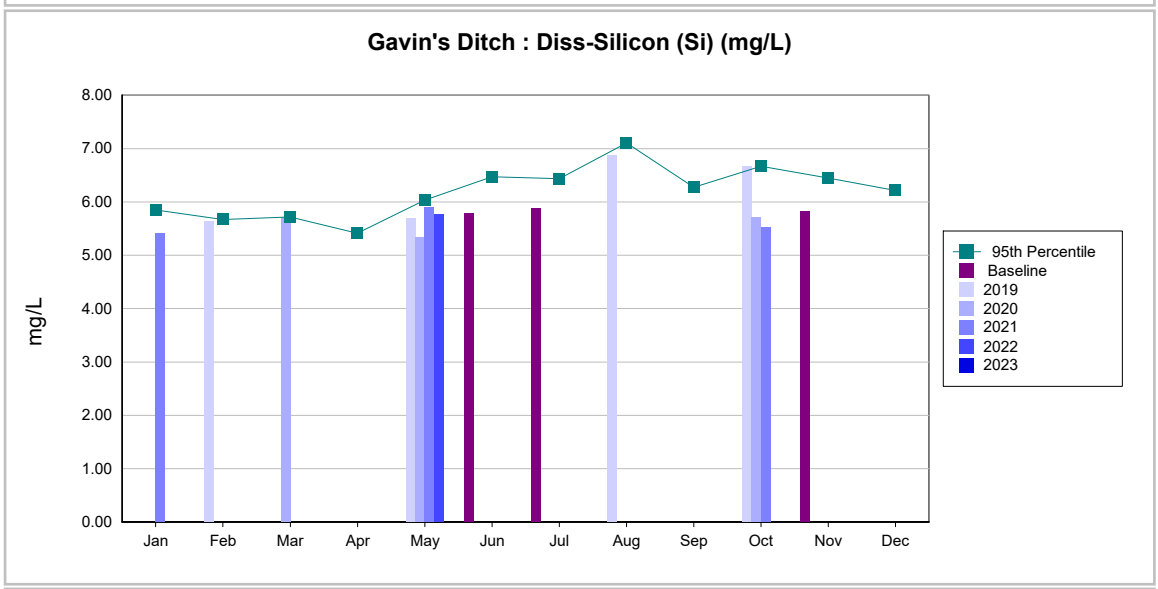
Annual Report Drainage Water

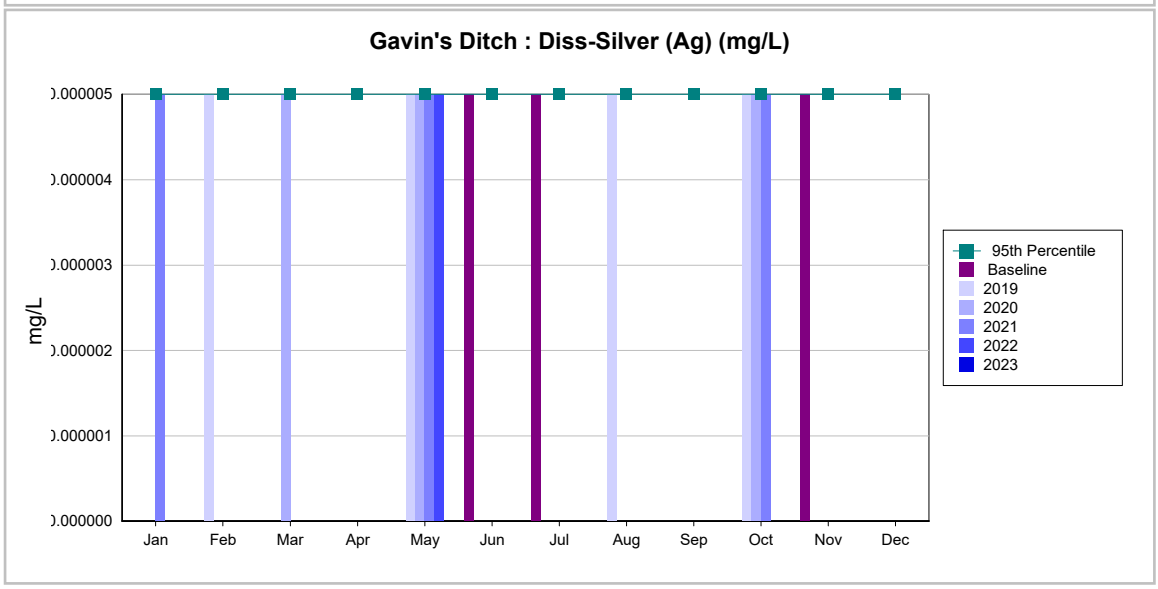
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







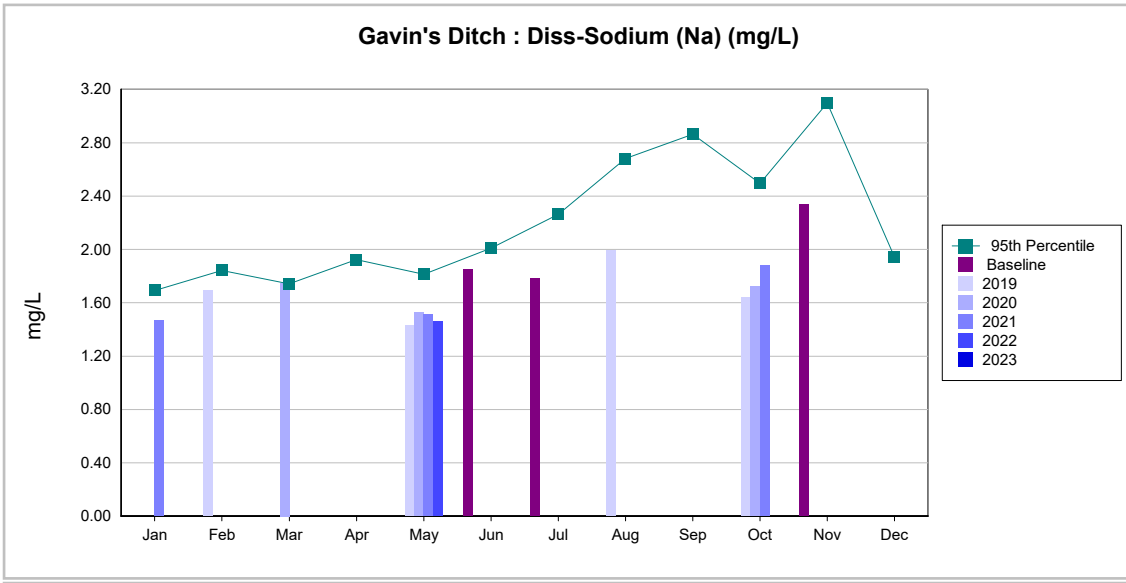
Water Quality Report

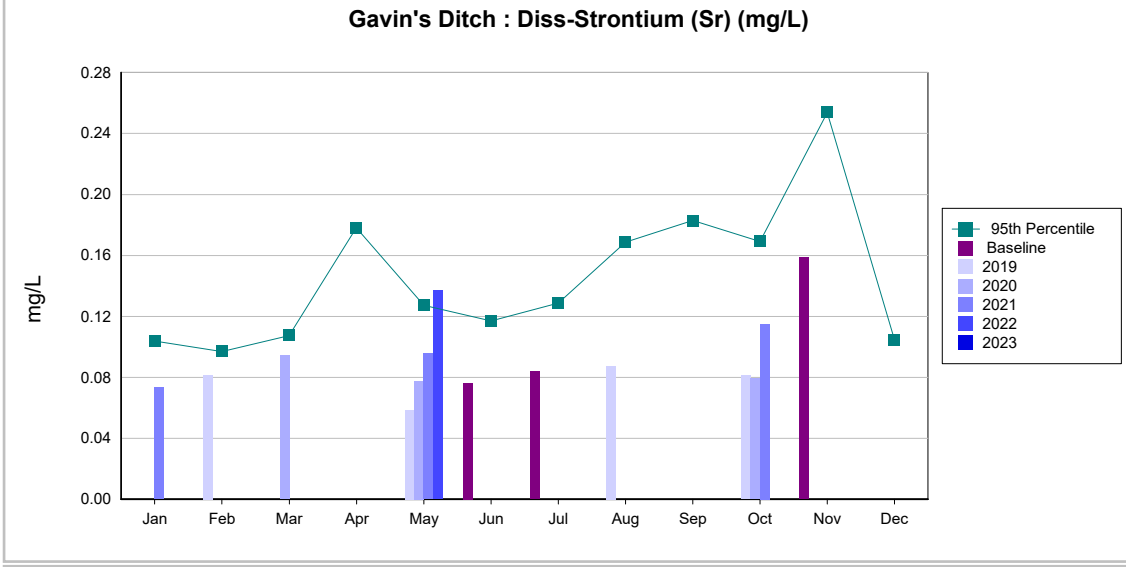
Annual Report Drainage Water

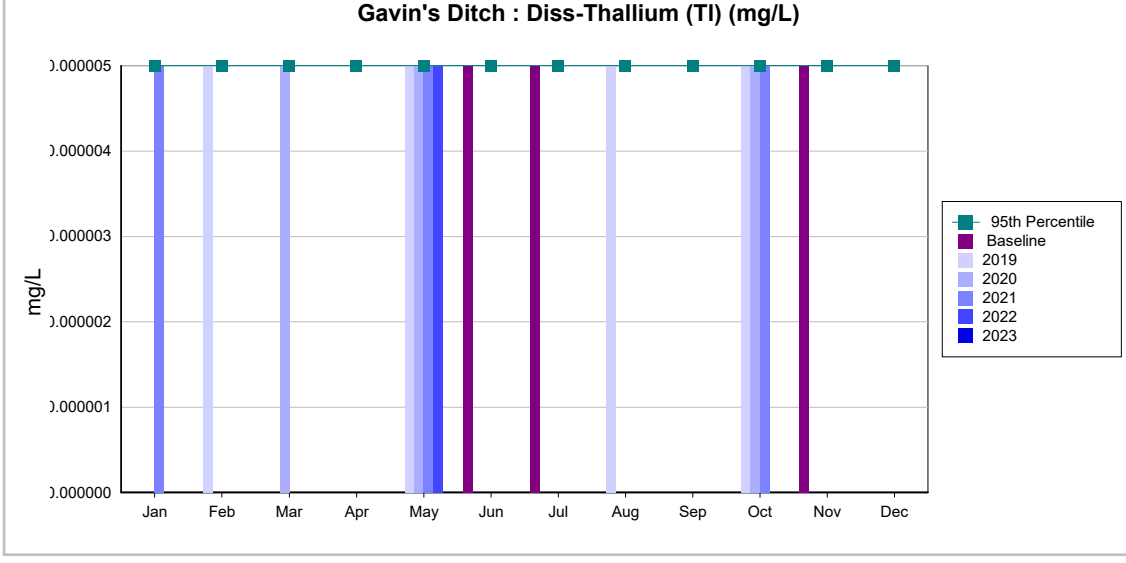
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







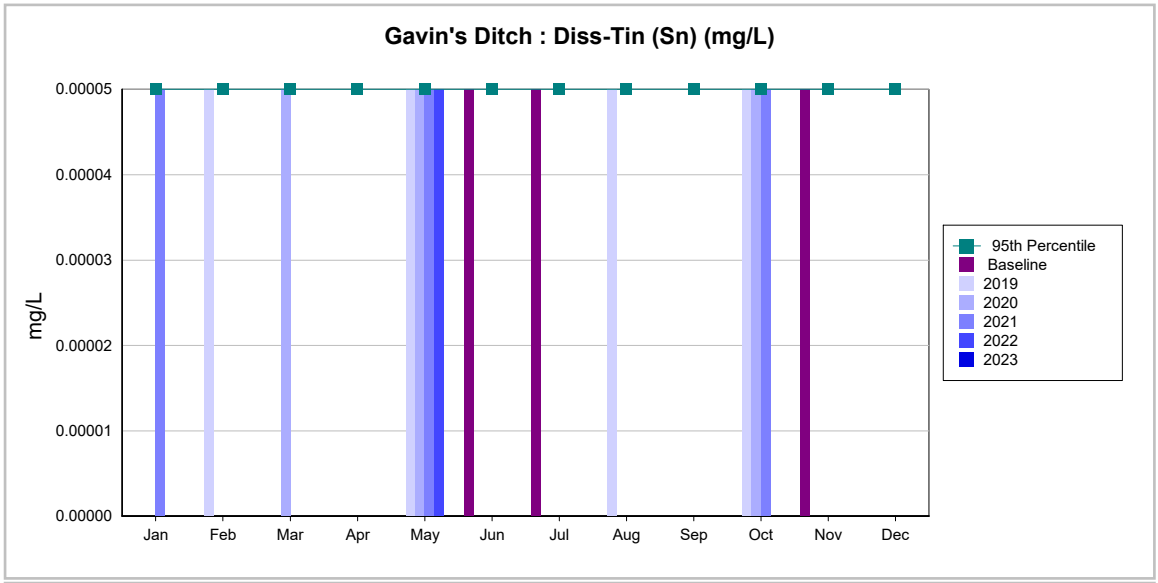
Water Quality Report

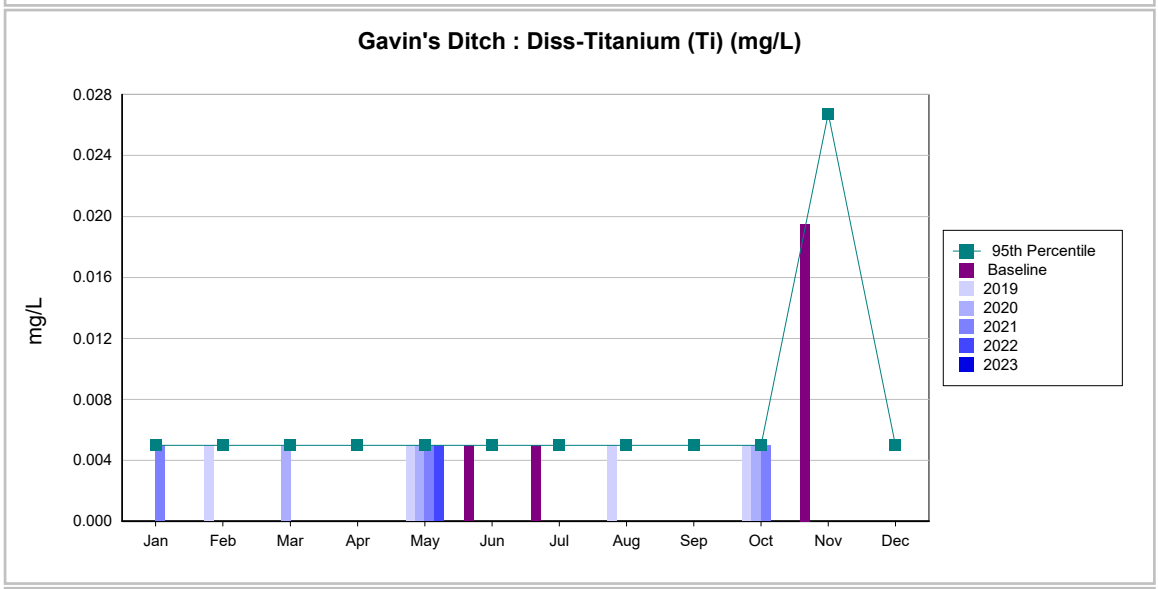
Annual Report Drainage Water

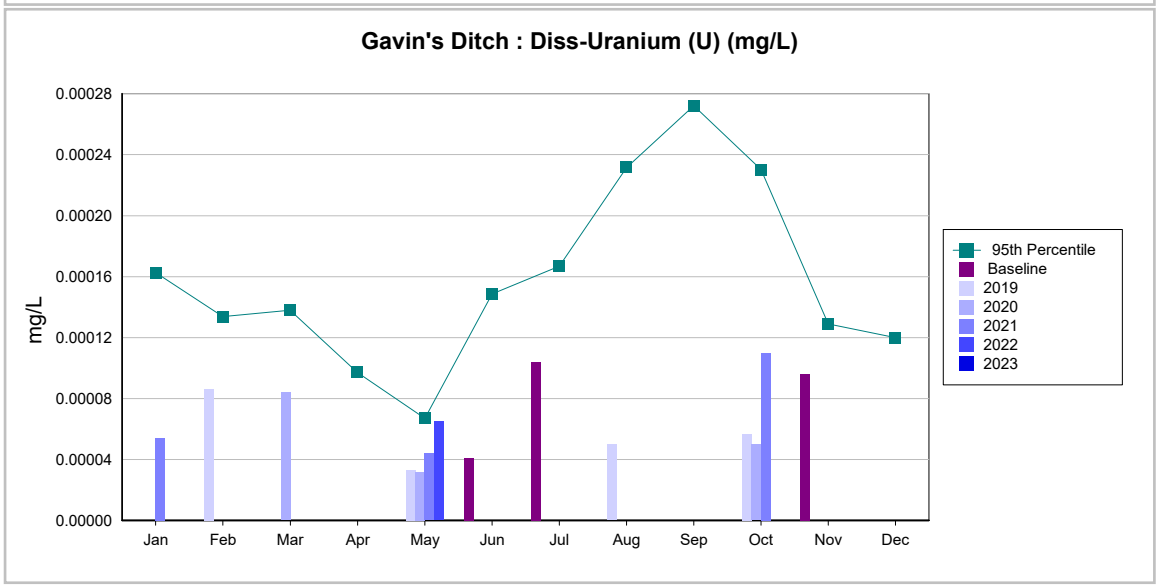
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







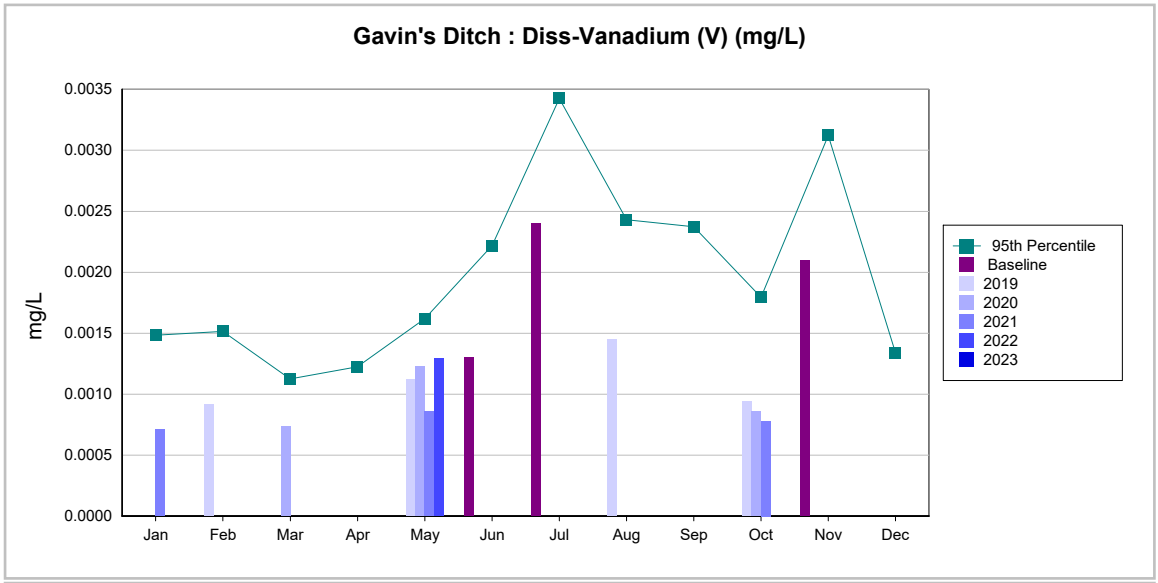
Water Quality Report

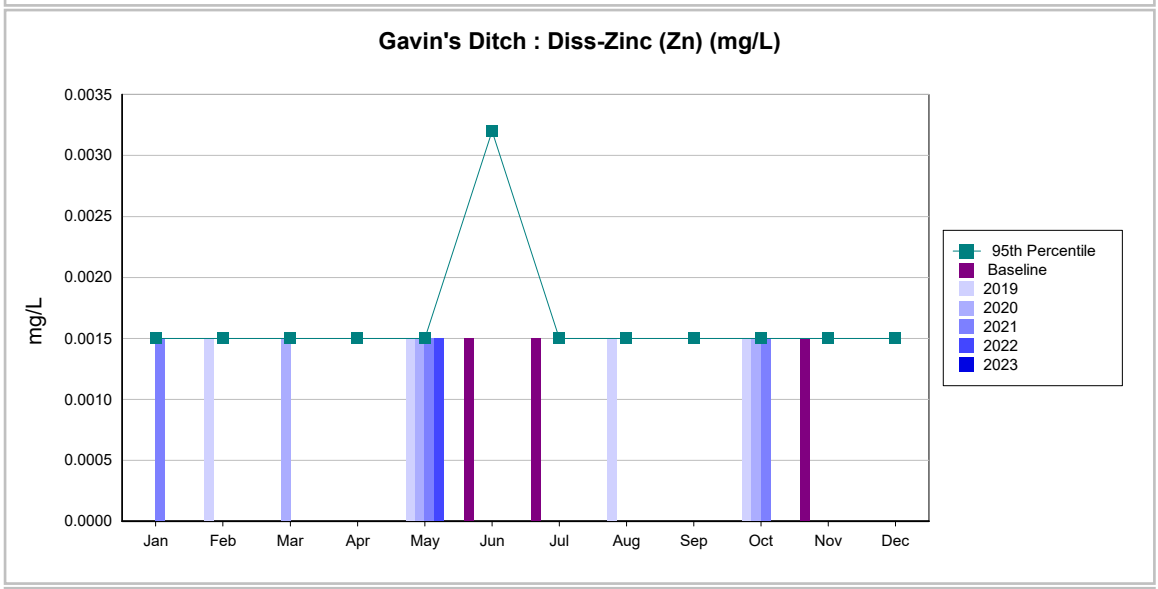
Annual Report Drainage Water

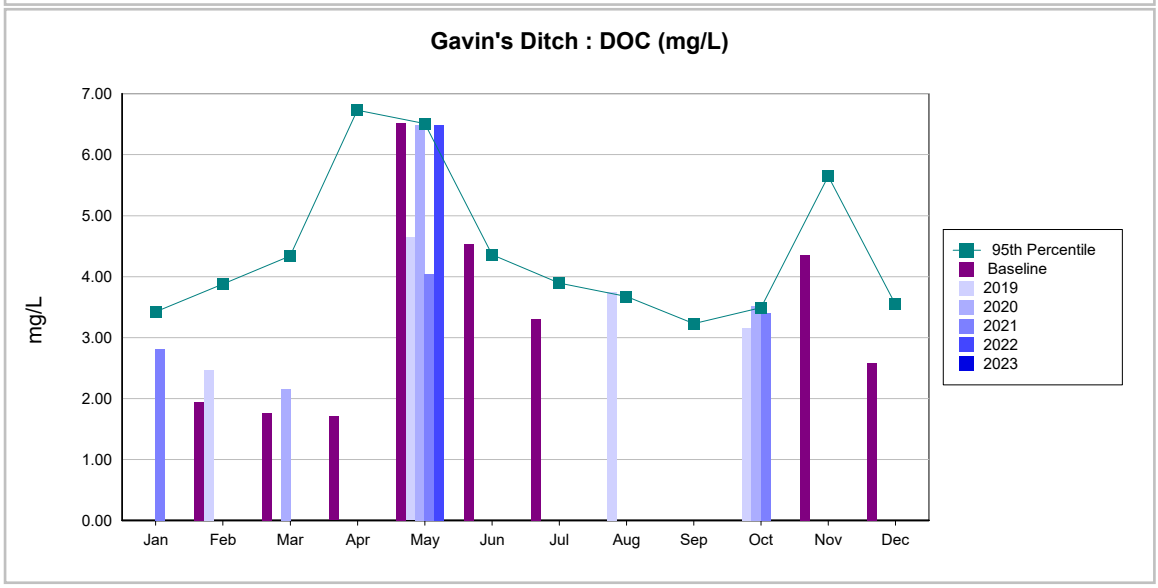
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

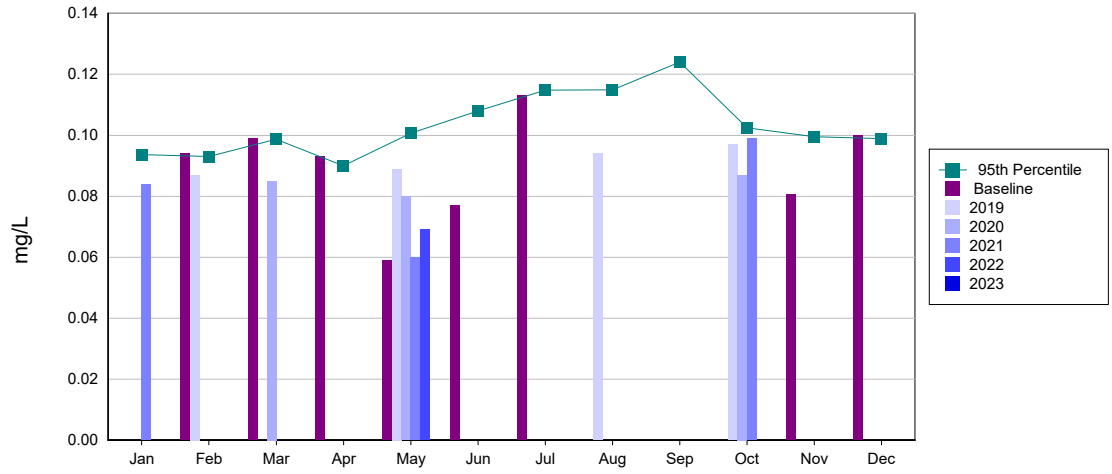
Annual Report Drainage Water

Mount Polley

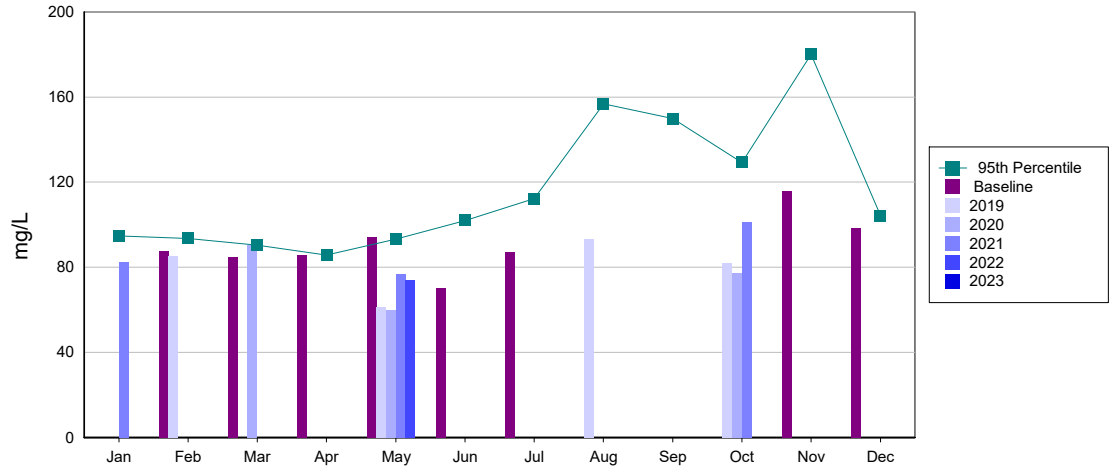
Mining Corporation

IMPERIAL METALS CORPORATION

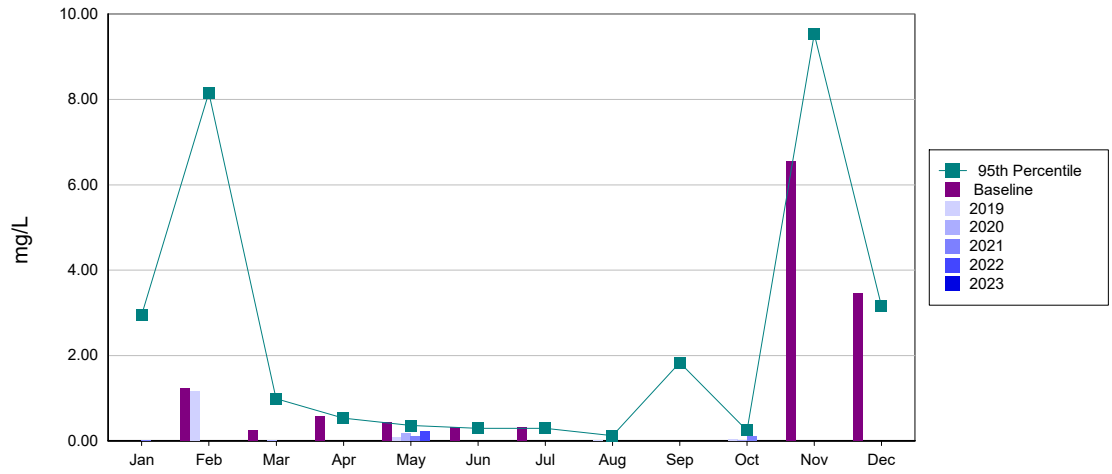
Gavin's Ditch : Floride (mg/L)



Gavin's Ditch : Hardness (mg/L)



Gavin's Ditch : Iron (Fe)-Total (mg/L)



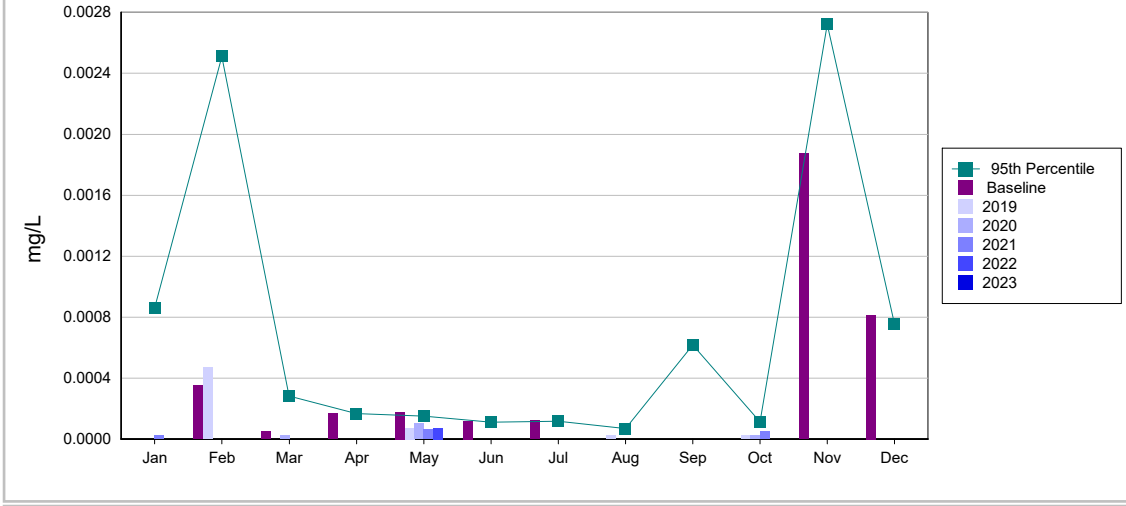
Water Quality Report

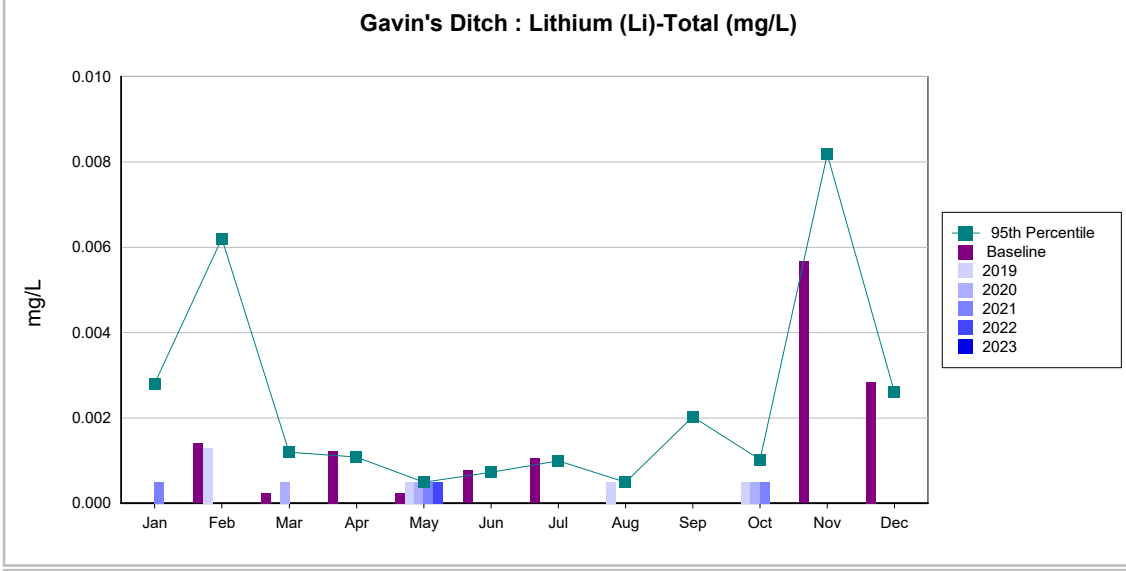
Annual Report Drainage Water

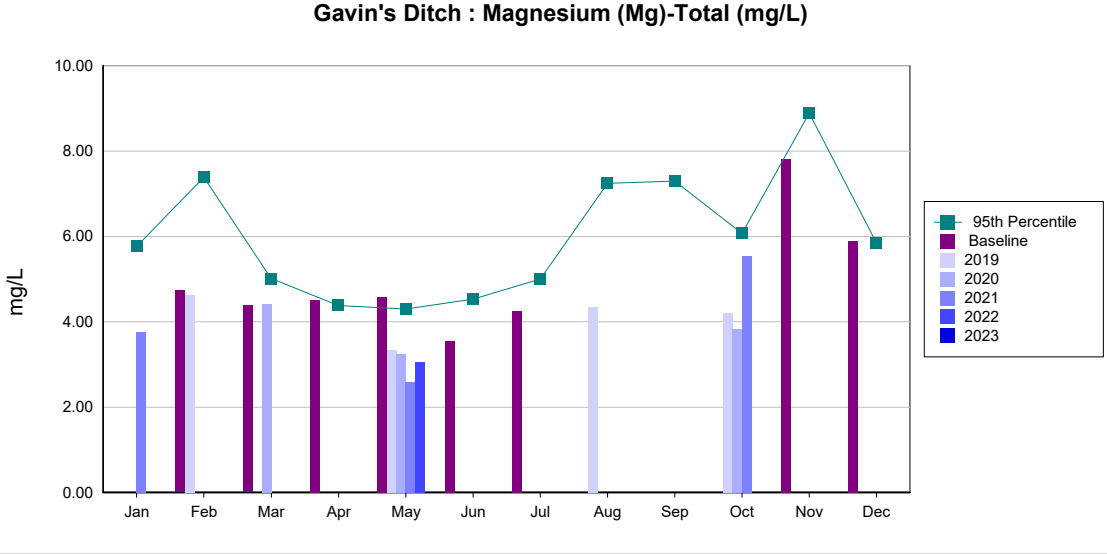
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







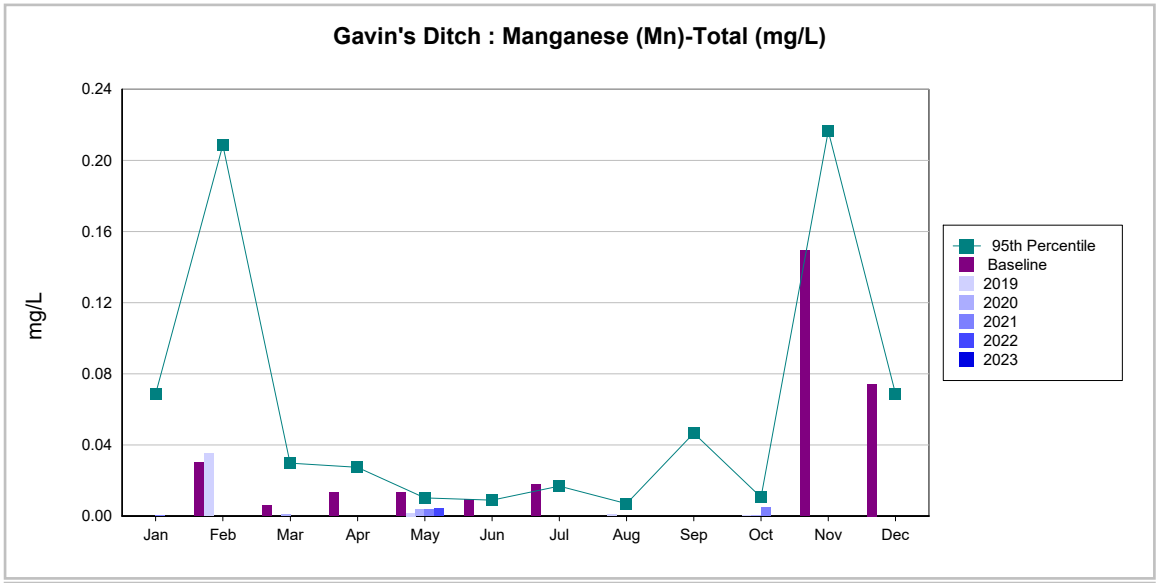
Water Quality Report

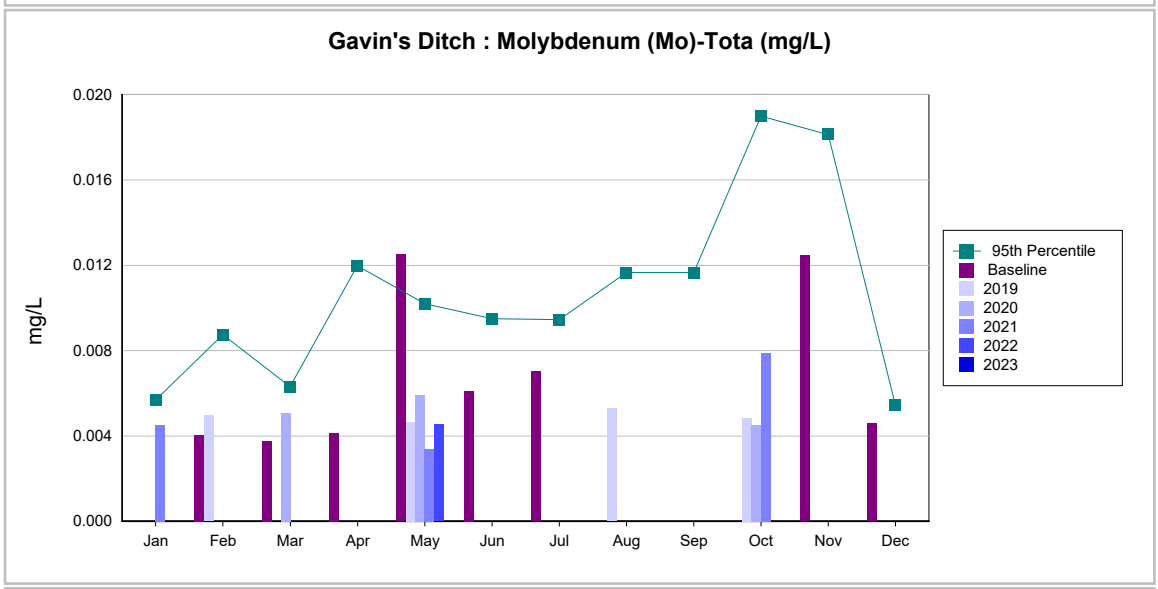
Annual Report Drainage Water

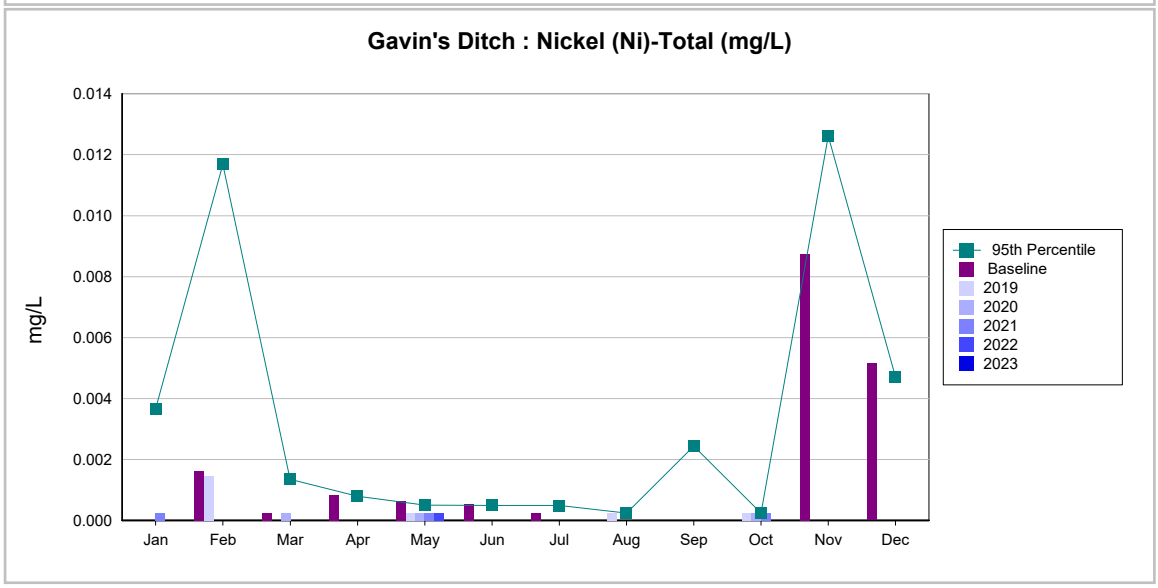
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







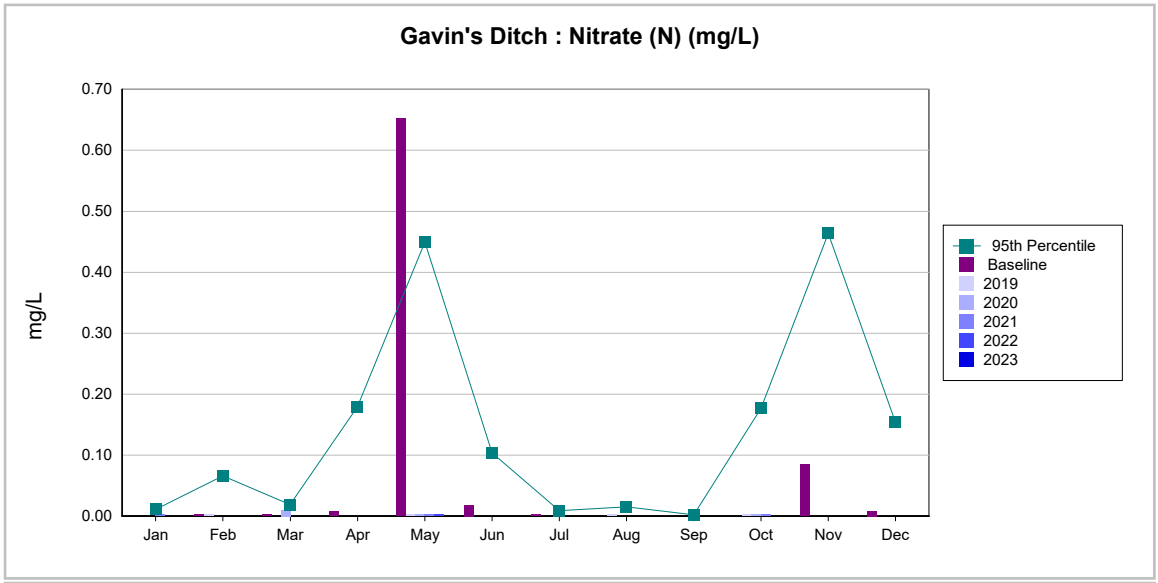
Water Quality Report

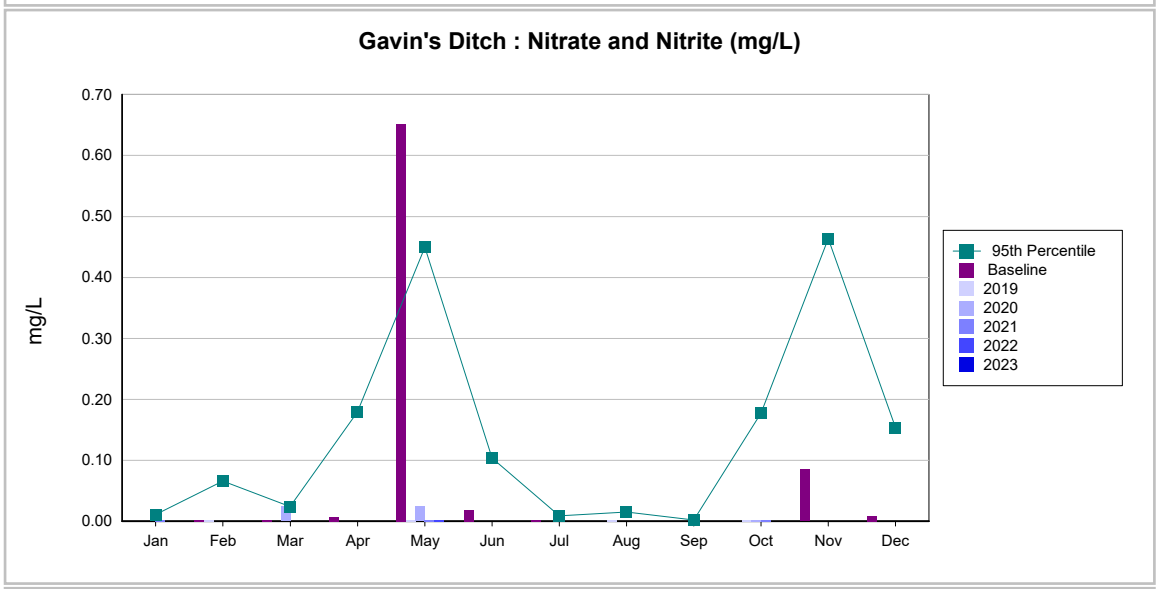
Annual Report Drainage Water

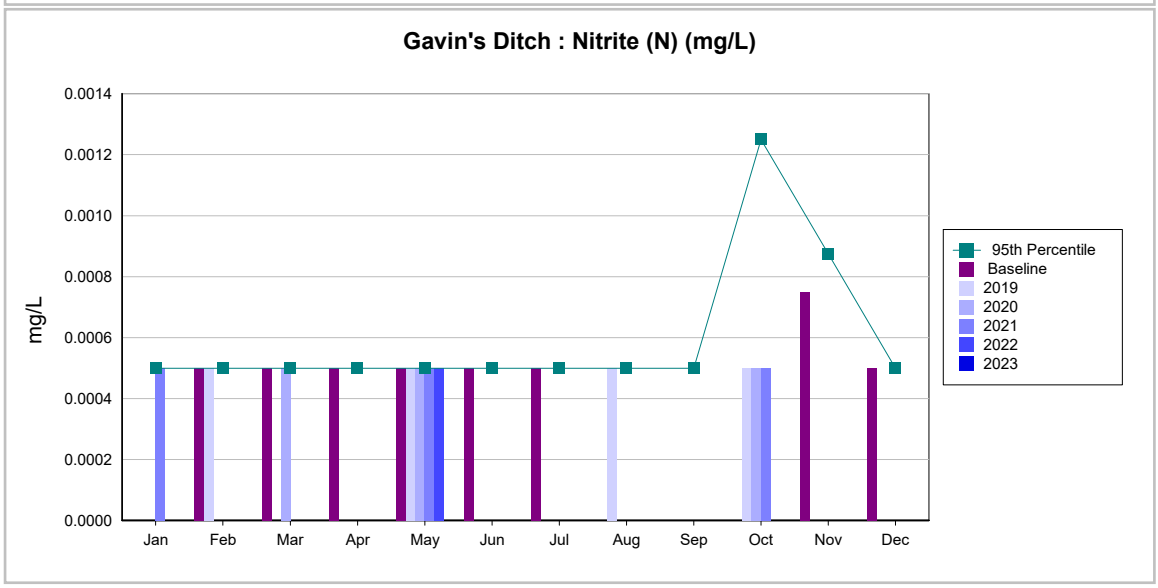
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







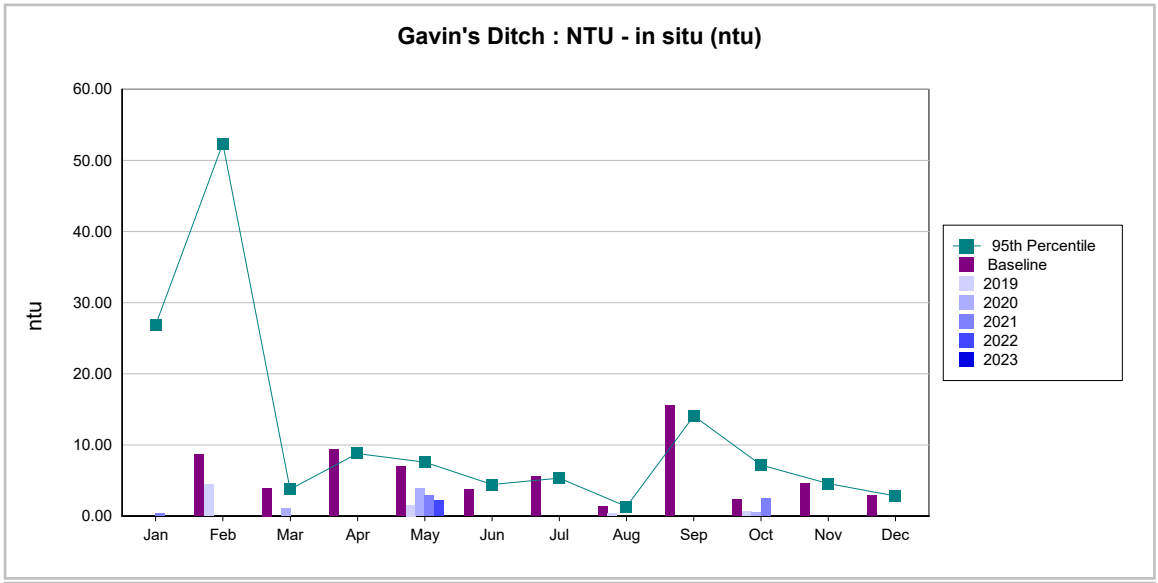
Water Quality Report

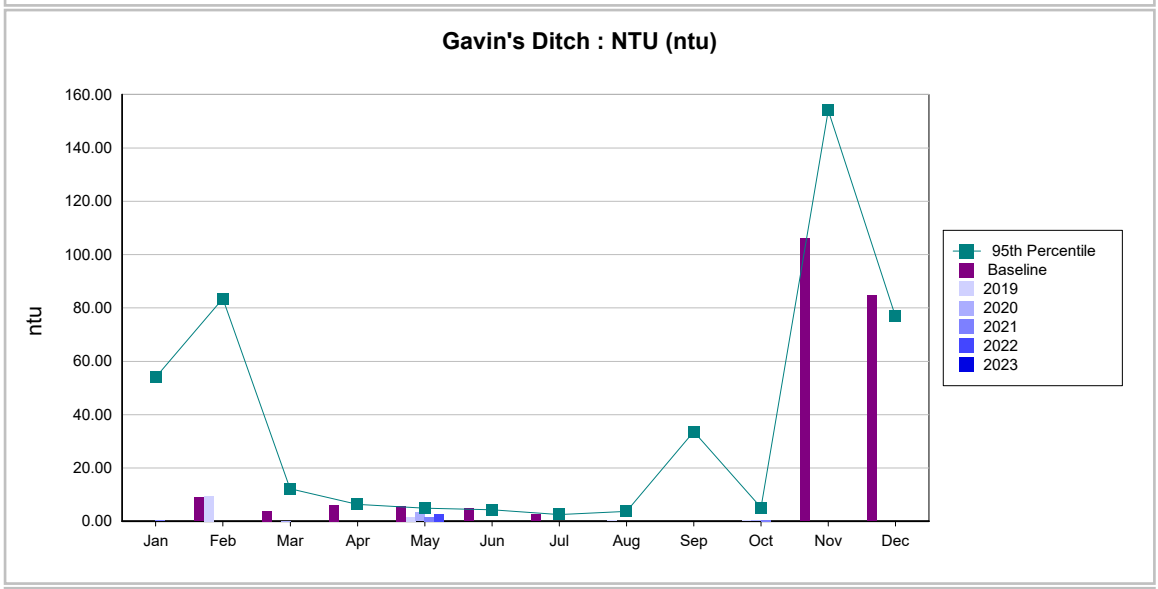
Annual Report Drainage Water

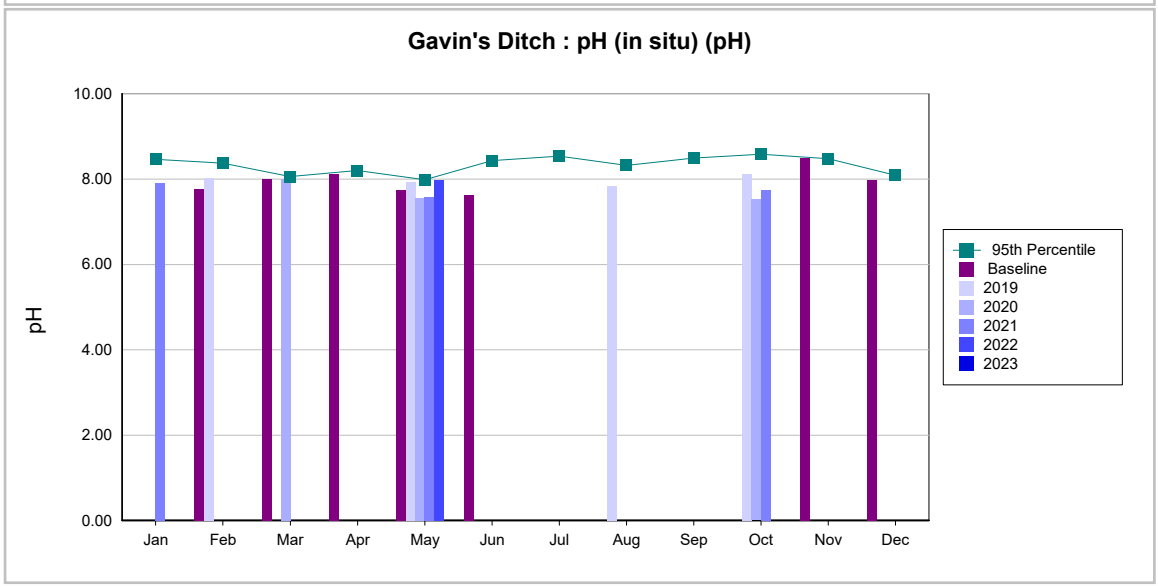
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







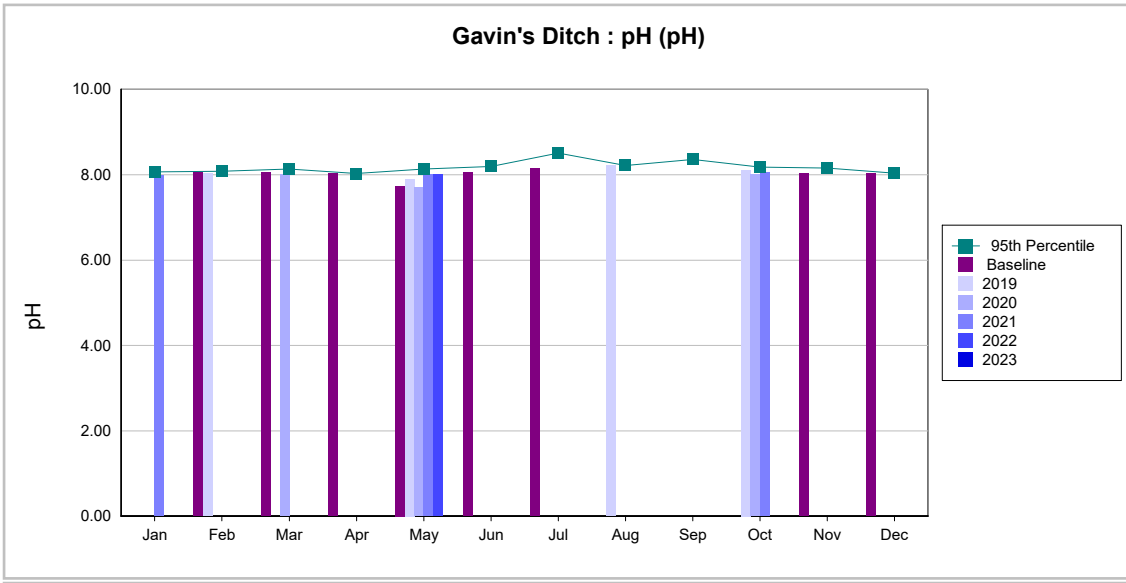
Water Quality Report

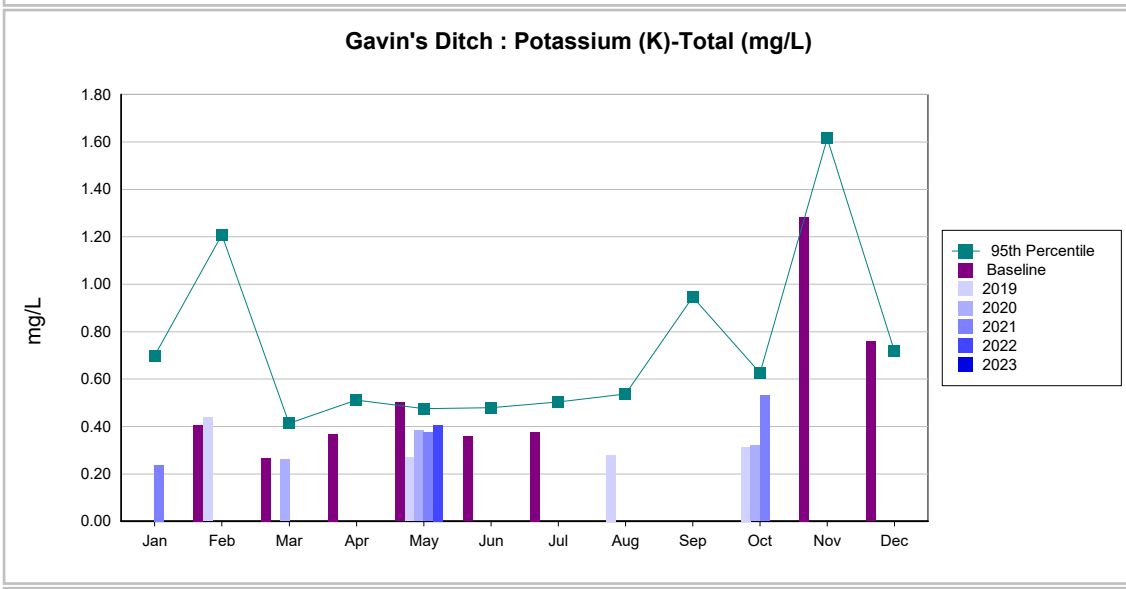
Annual Report Drainage Water

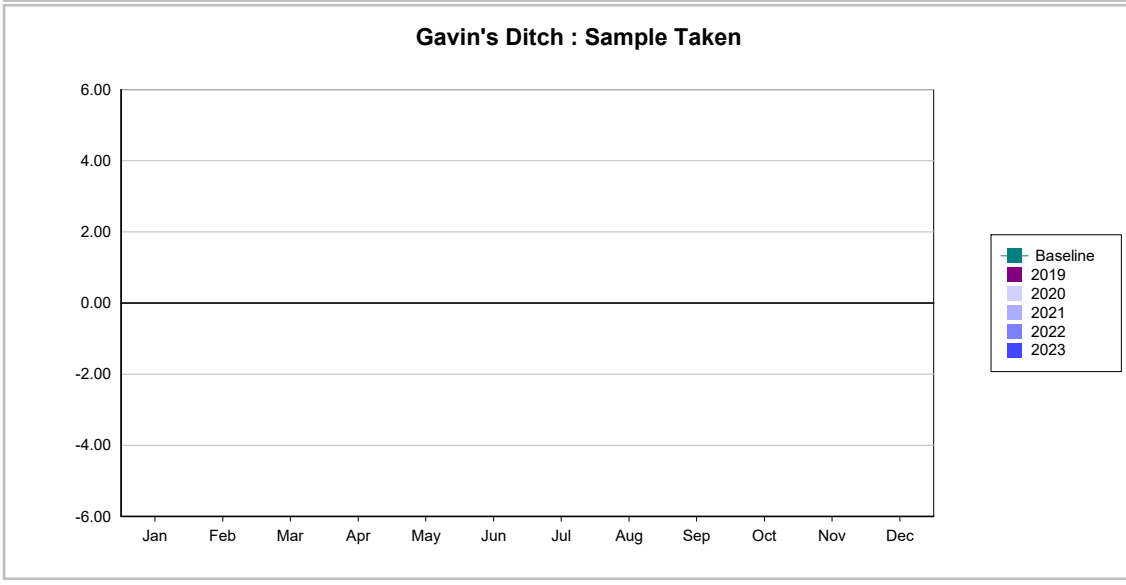
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







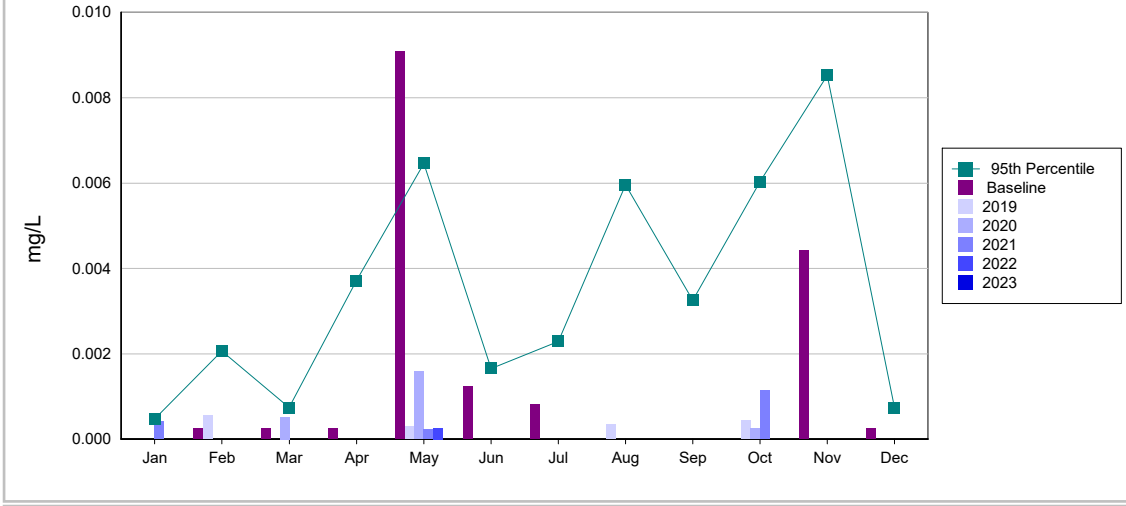
Water Quality Report

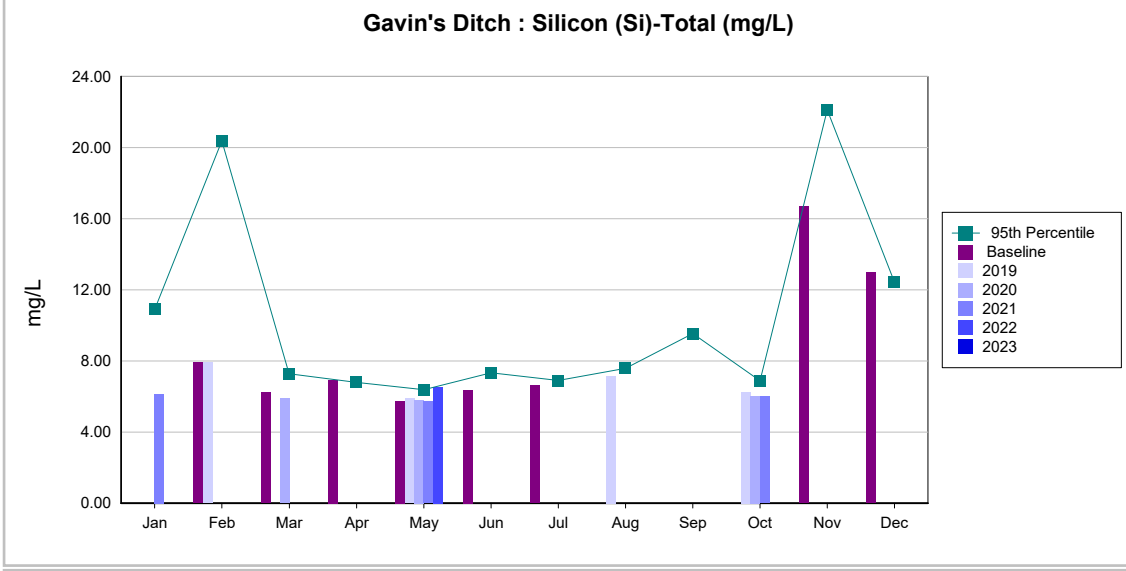
Annual Report Drainage Water

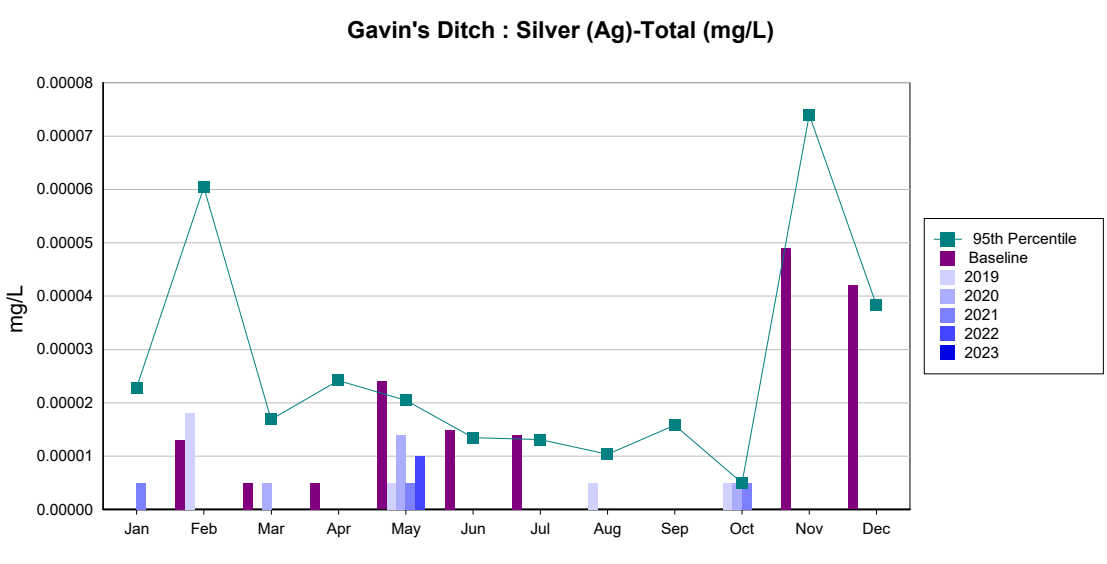
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

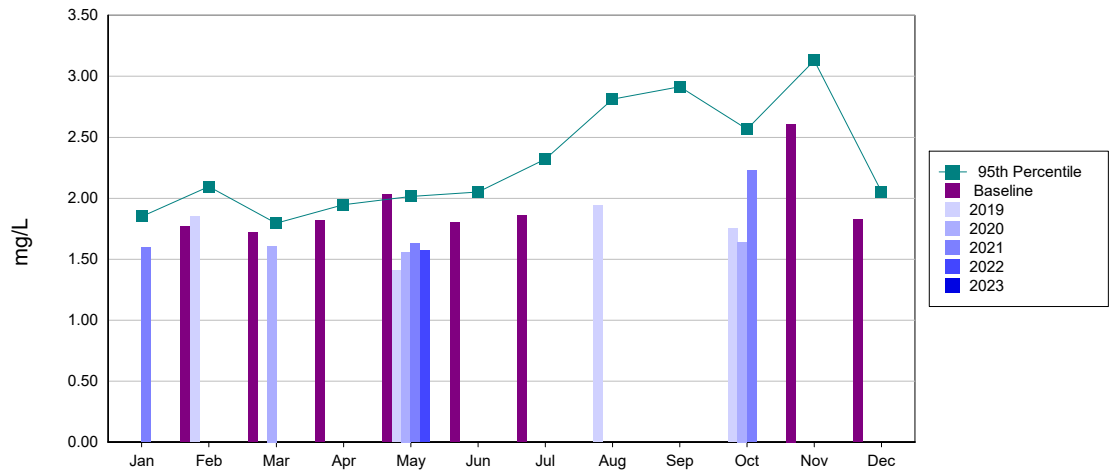
Annual Report Drainage Water

Mount Polley

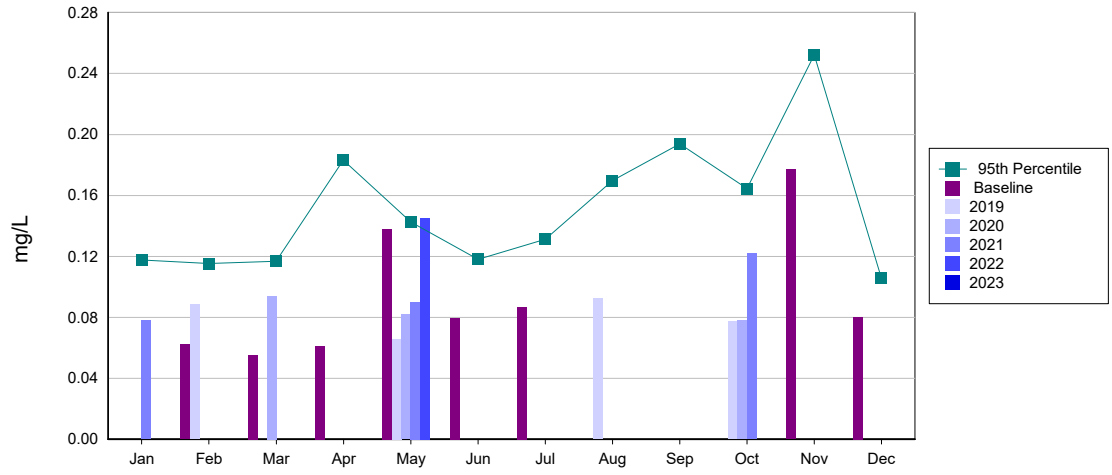
Mining Corporation

IMPERIAL METALS CORPORATION

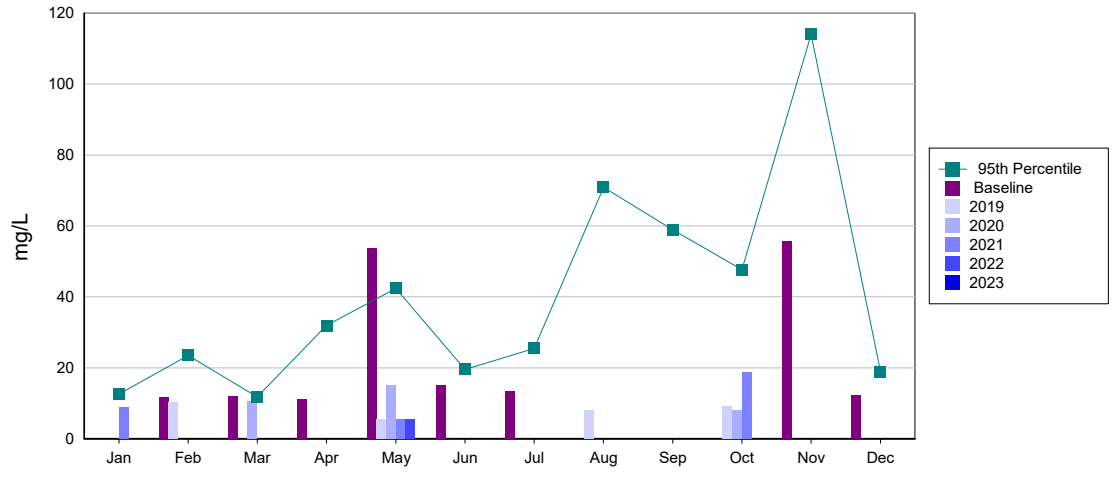
Gavin's Ditch : Sodium (Na)-Total (mg/L)



Gavin's Ditch : Strontium (Sr)-Total (mg/L)



Gavin's Ditch : Sulphate (mg/L)



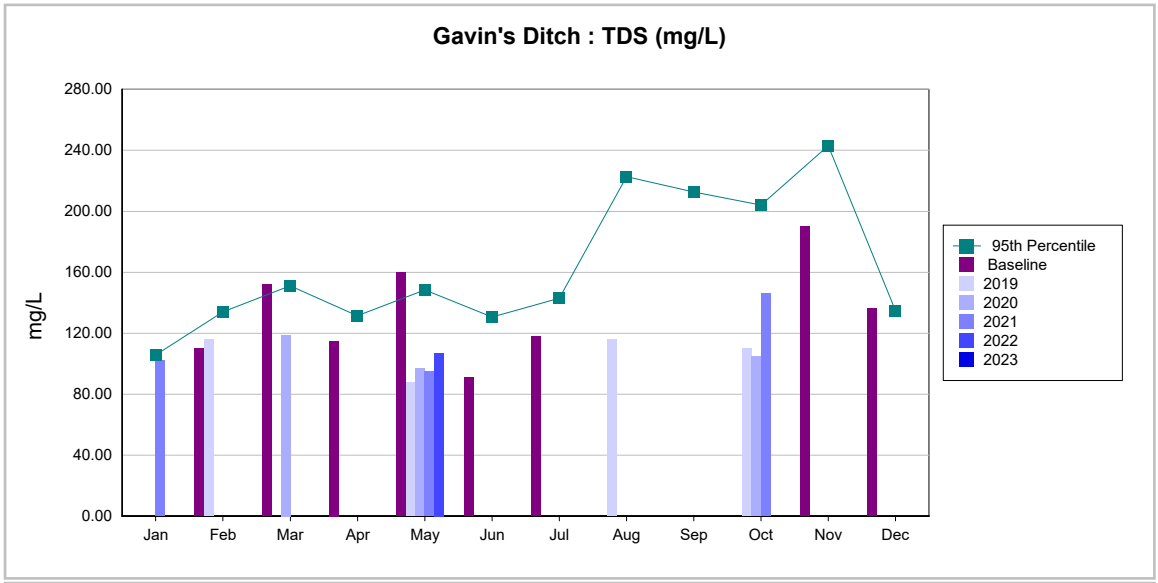
Water Quality Report

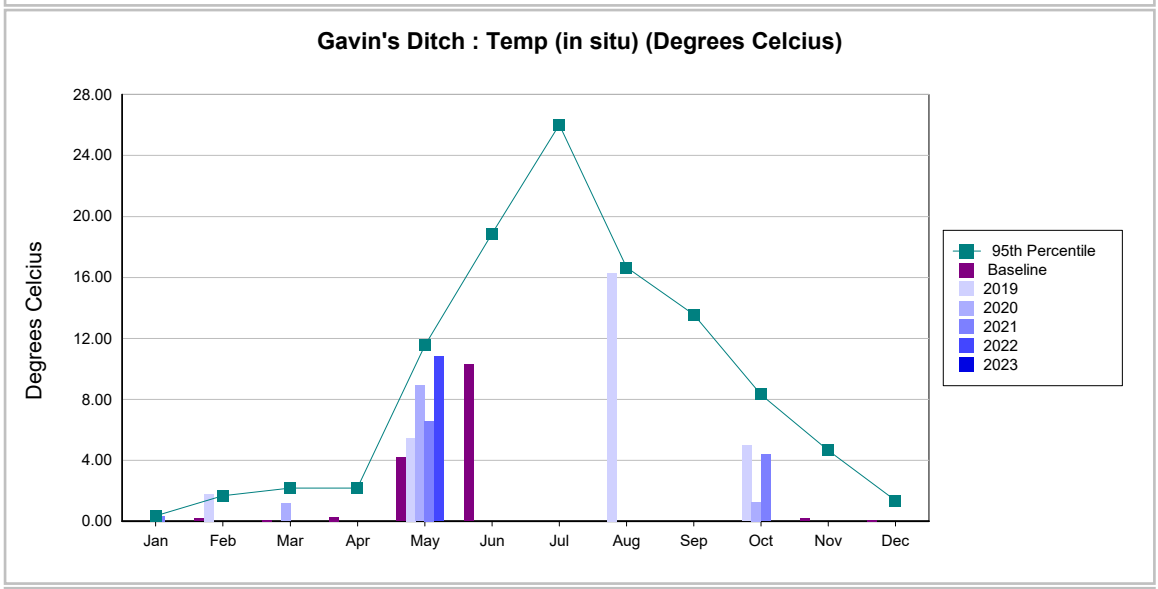
Annual Report Drainage Water

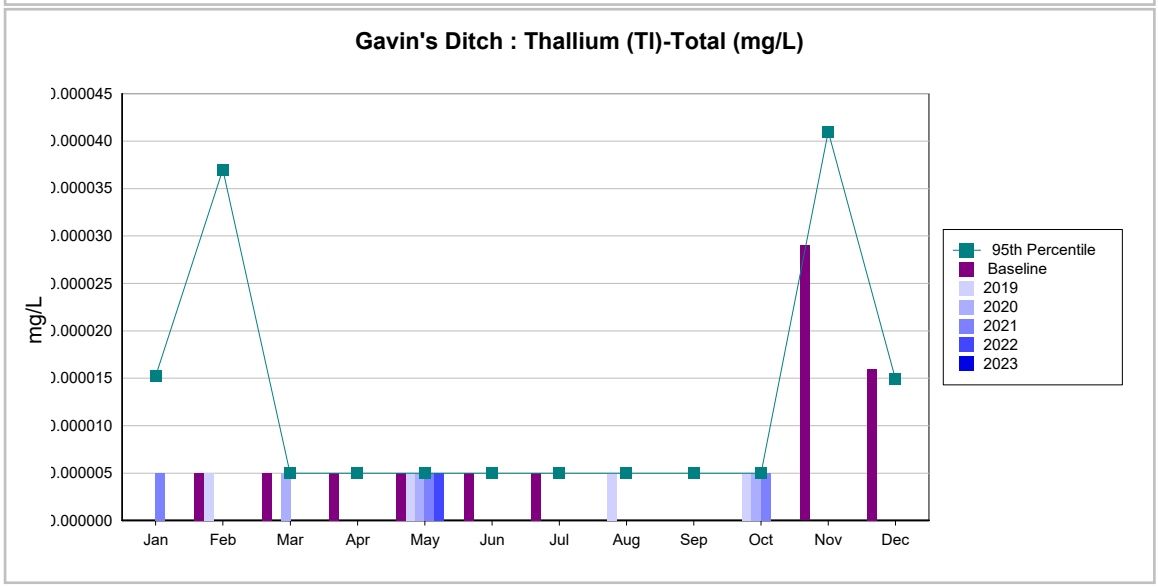
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







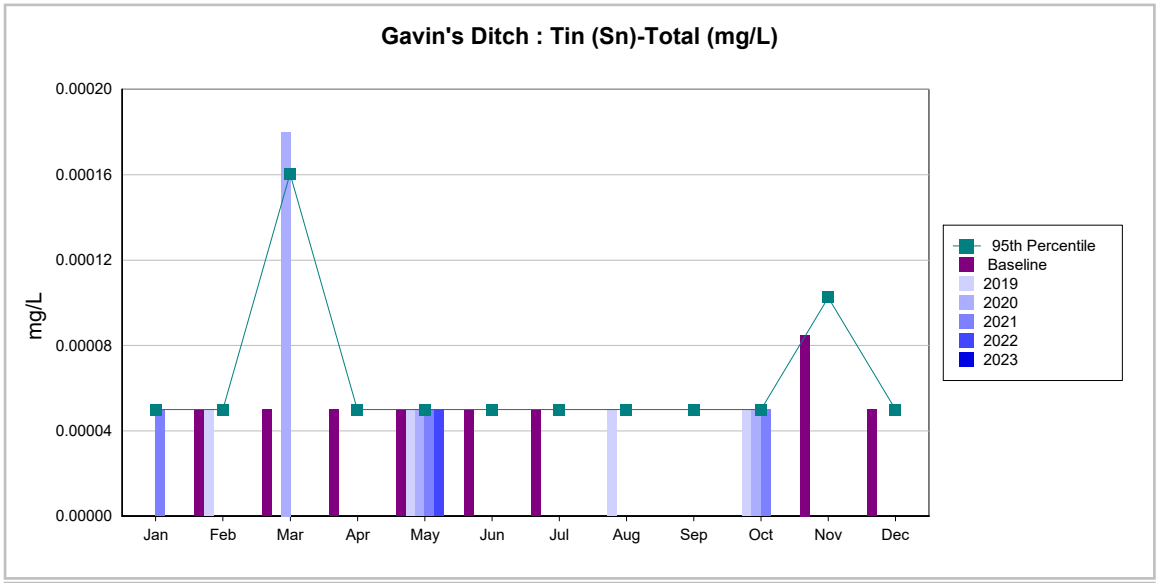
Water Quality Report

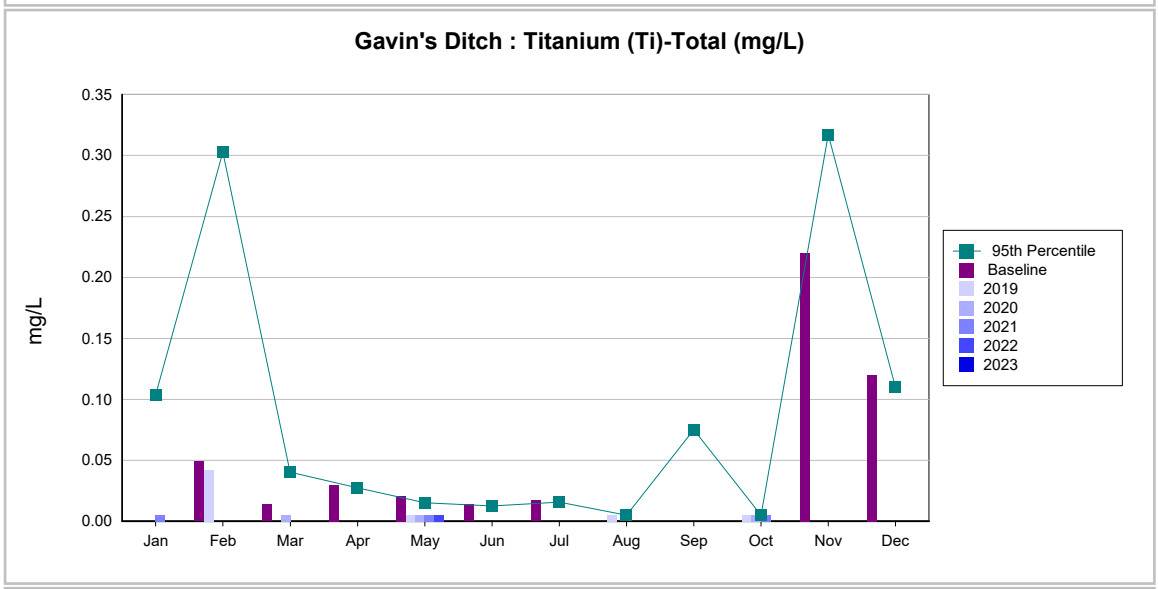
Annual Report Drainage Water

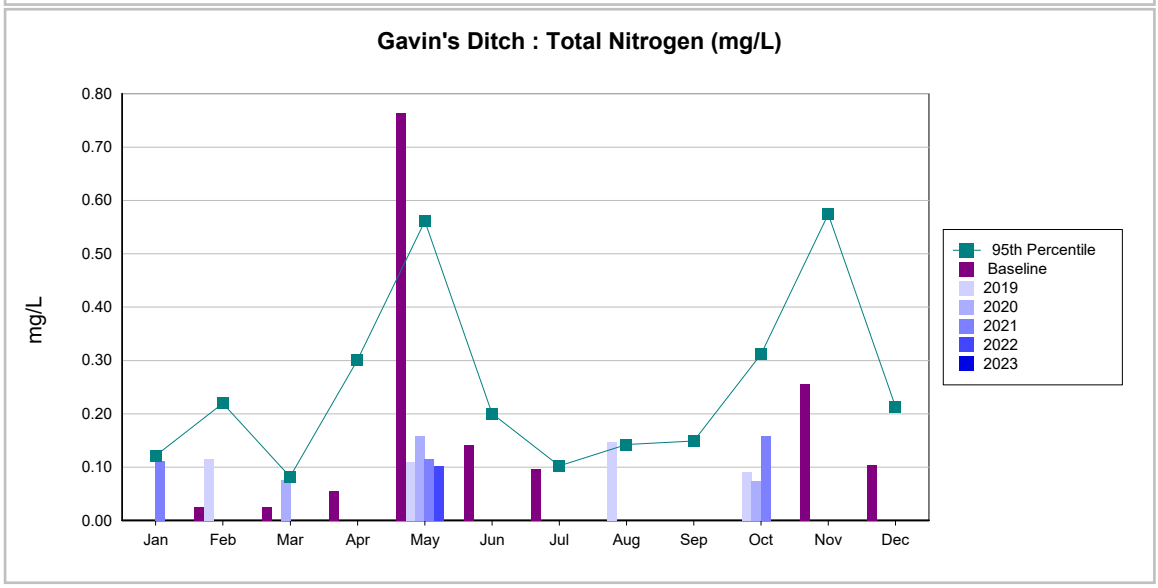
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







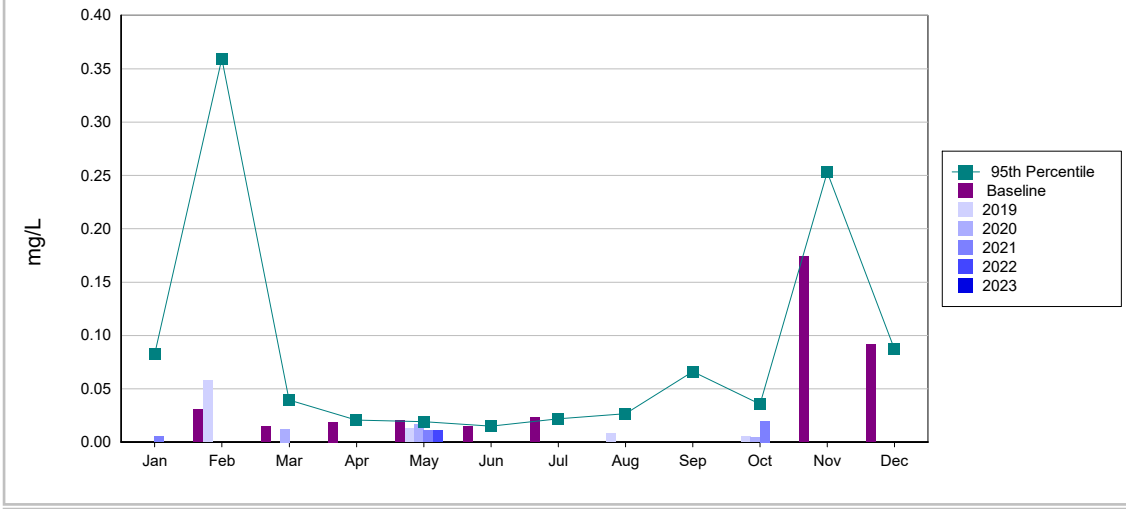
Water Quality Report

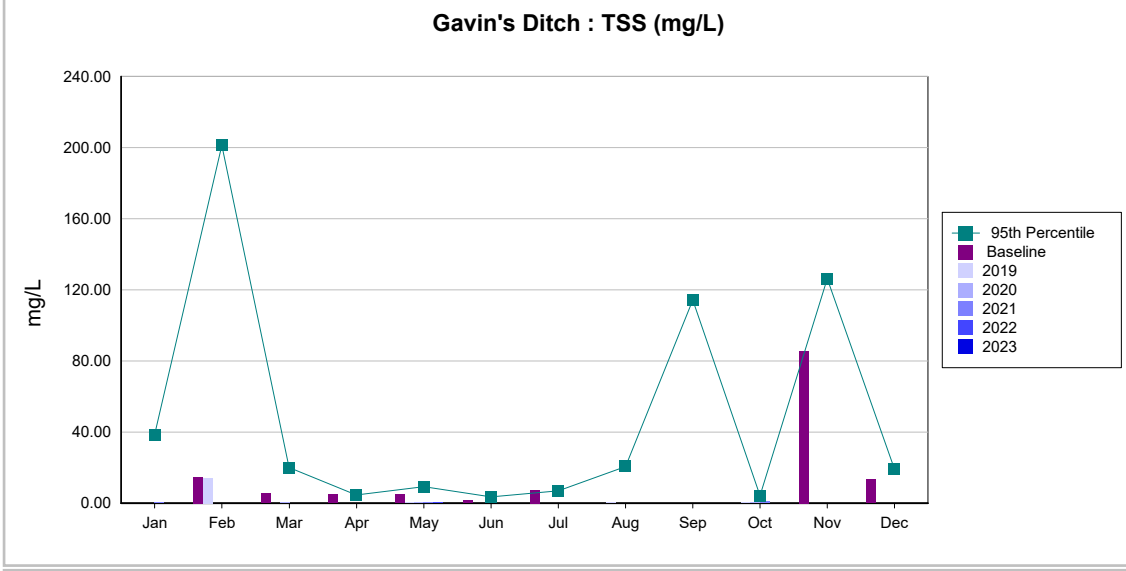
Annual Report Drainage Water

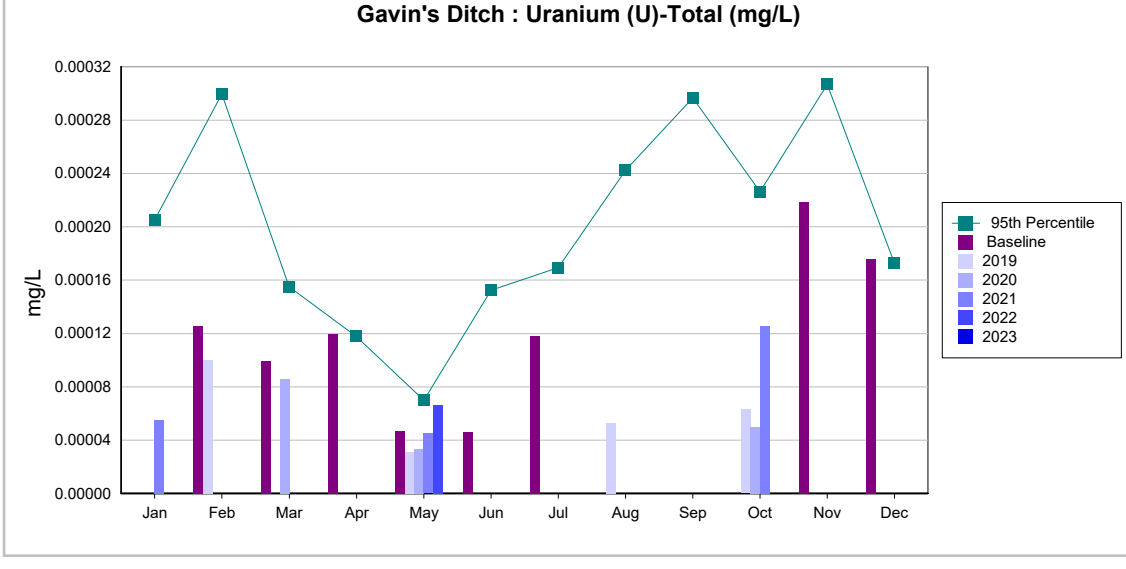
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







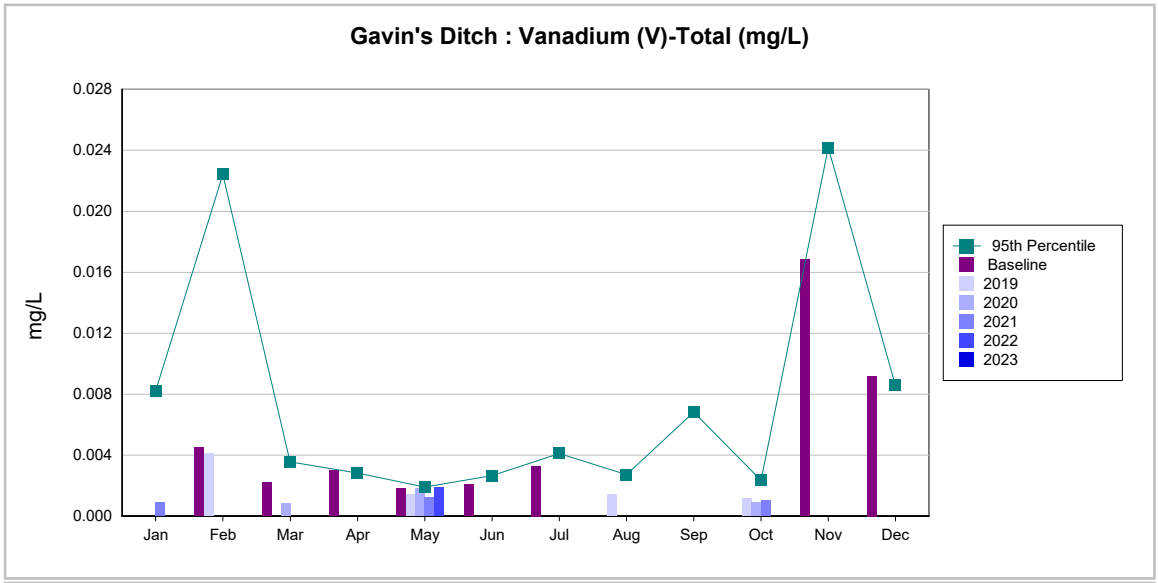
Water Quality Report

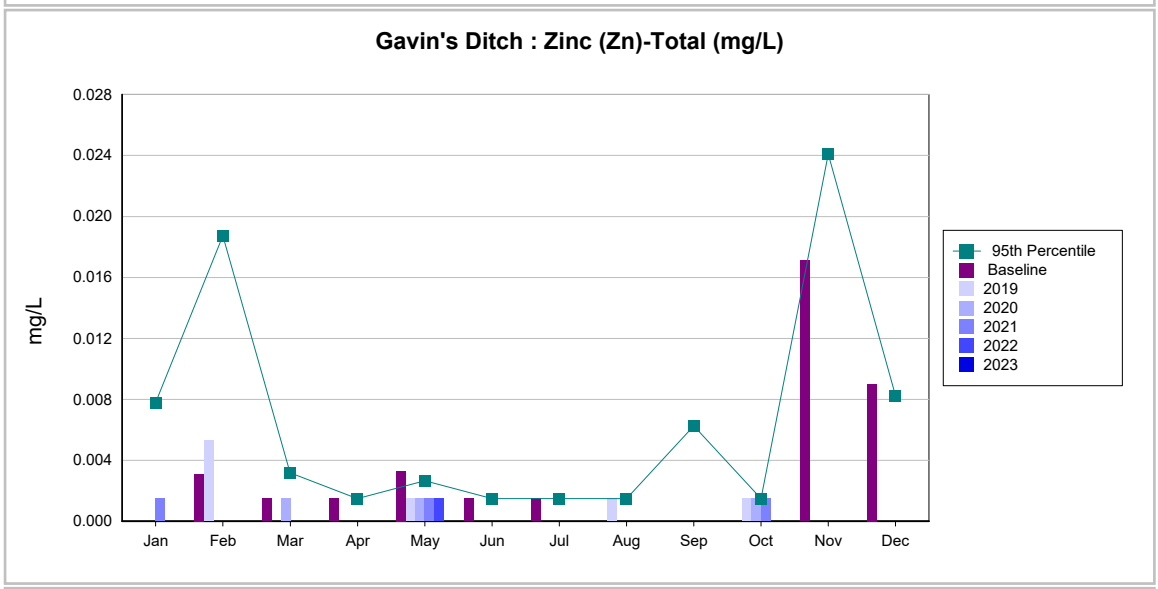
Annual Report Drainage Water

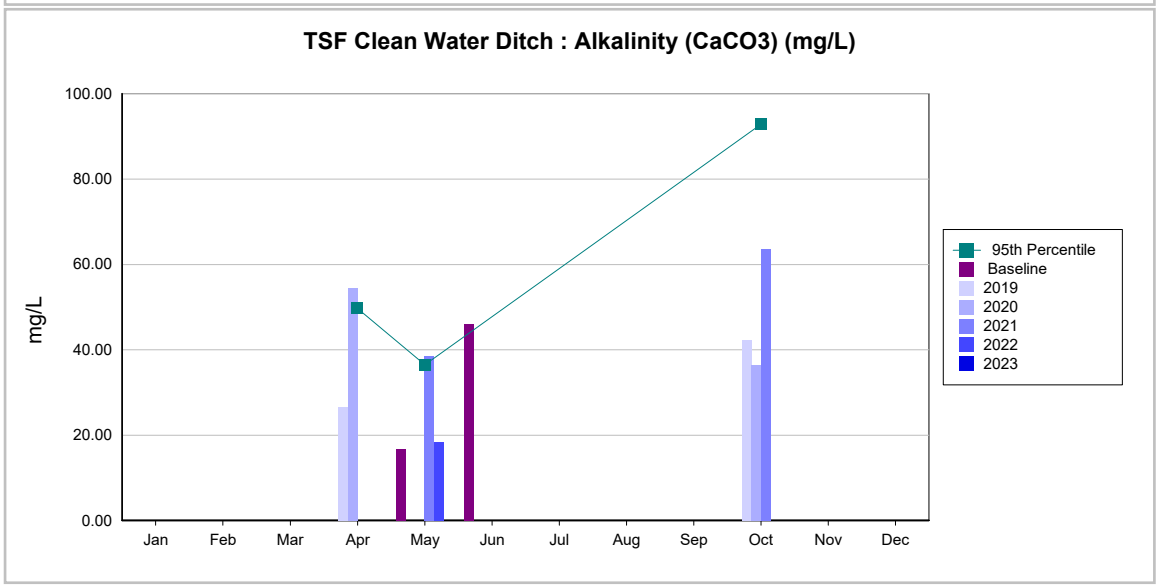
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







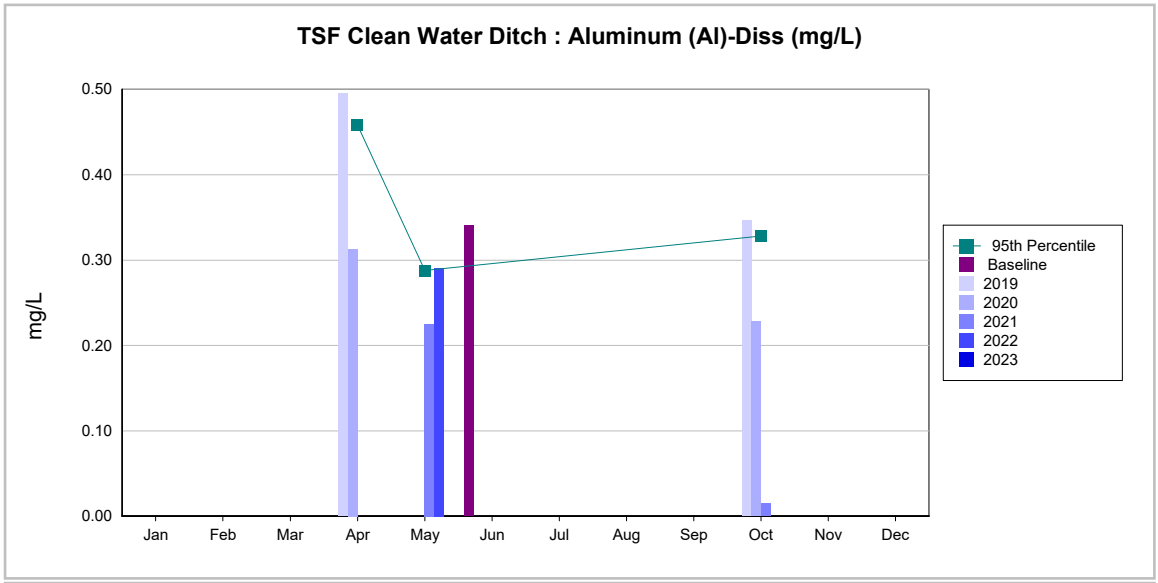
Water Quality Report

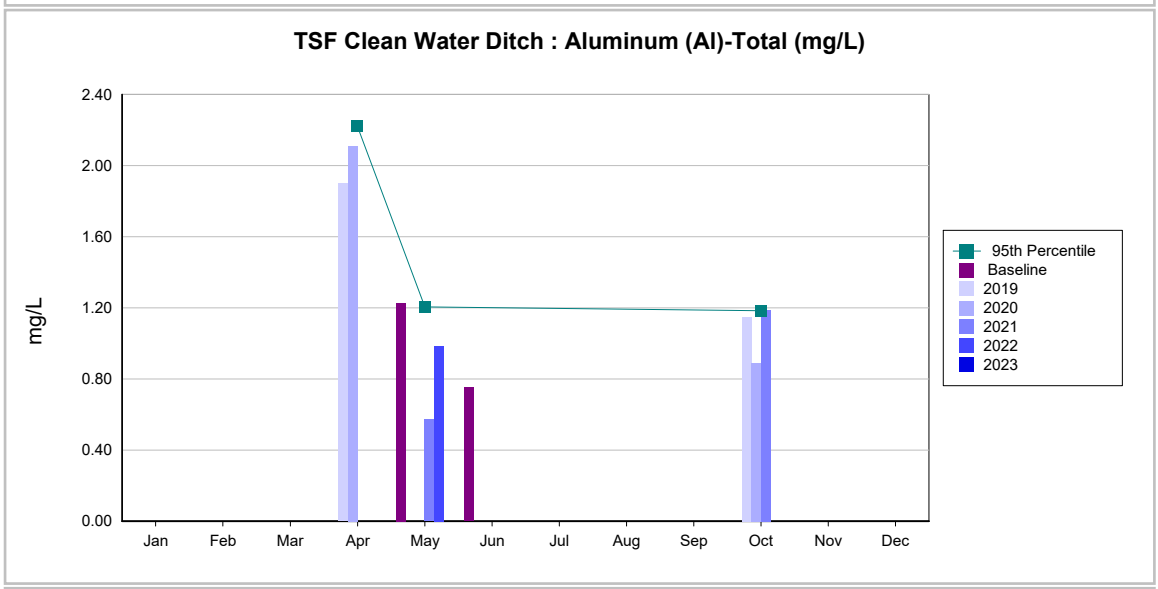
Annual Report Drainage Water

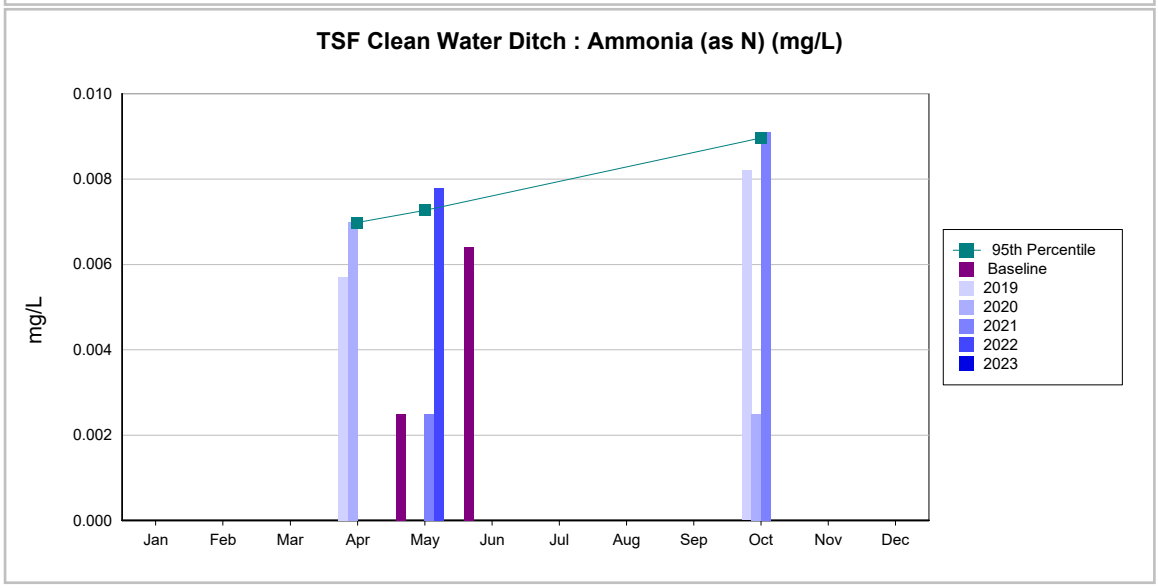
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







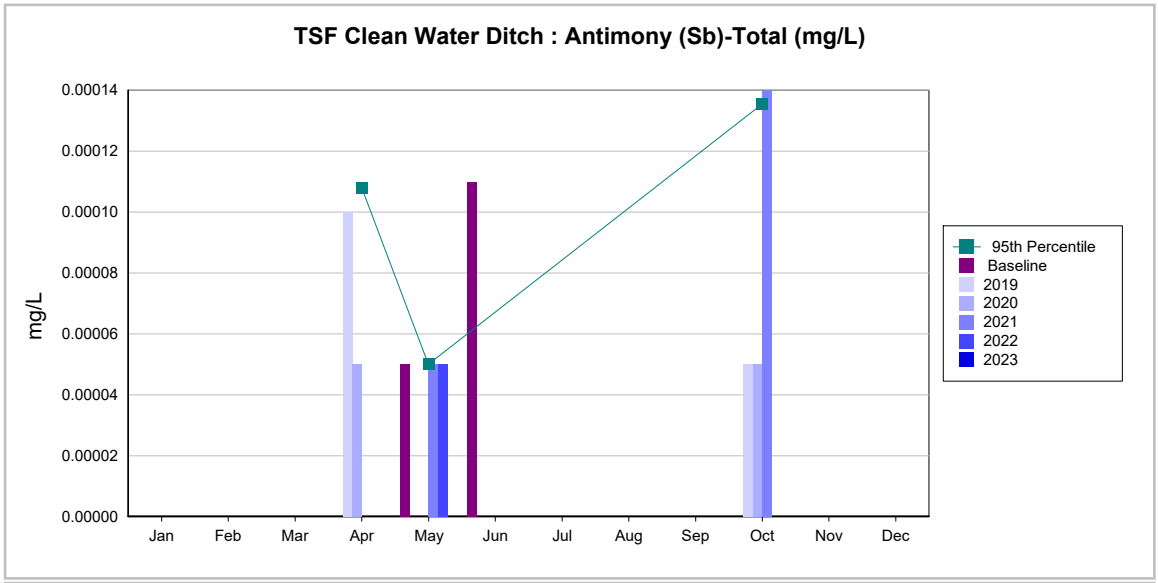
Water Quality Report

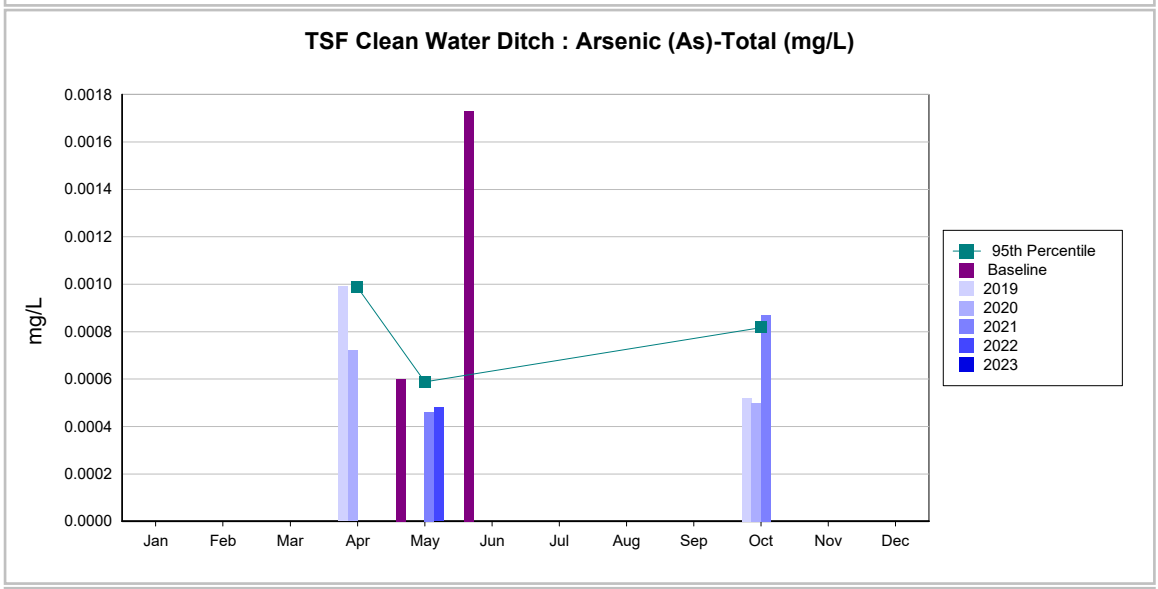
Annual Report Drainage Water

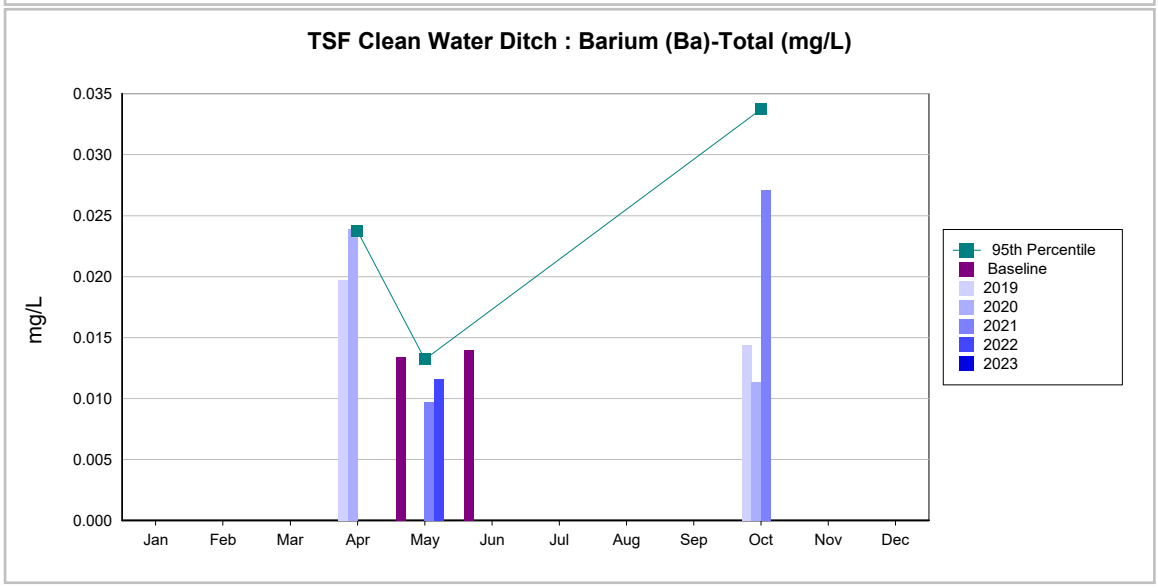
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







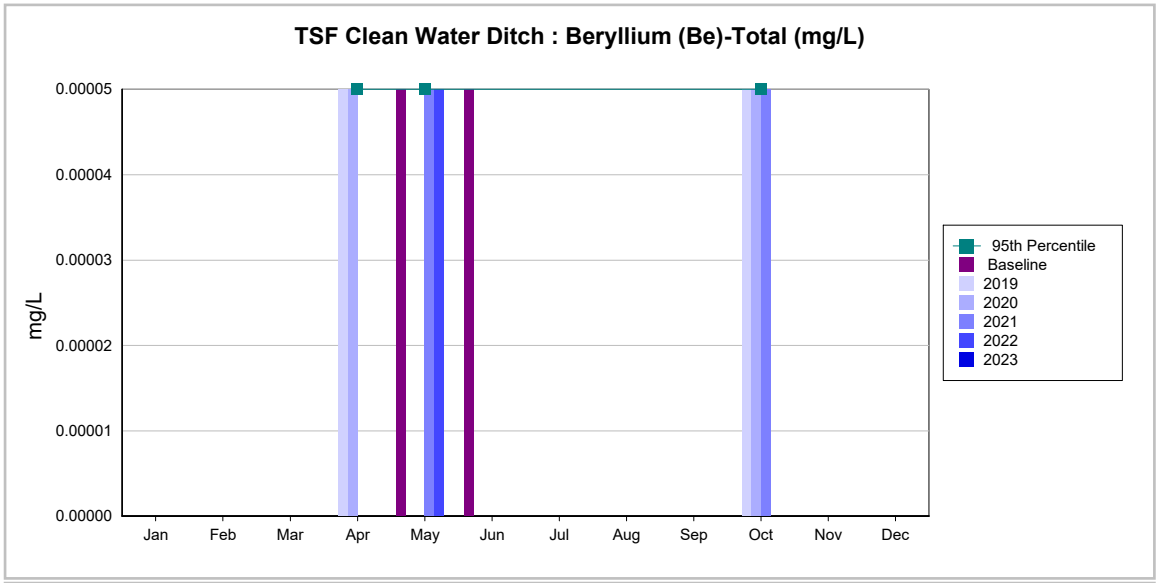
Water Quality Report

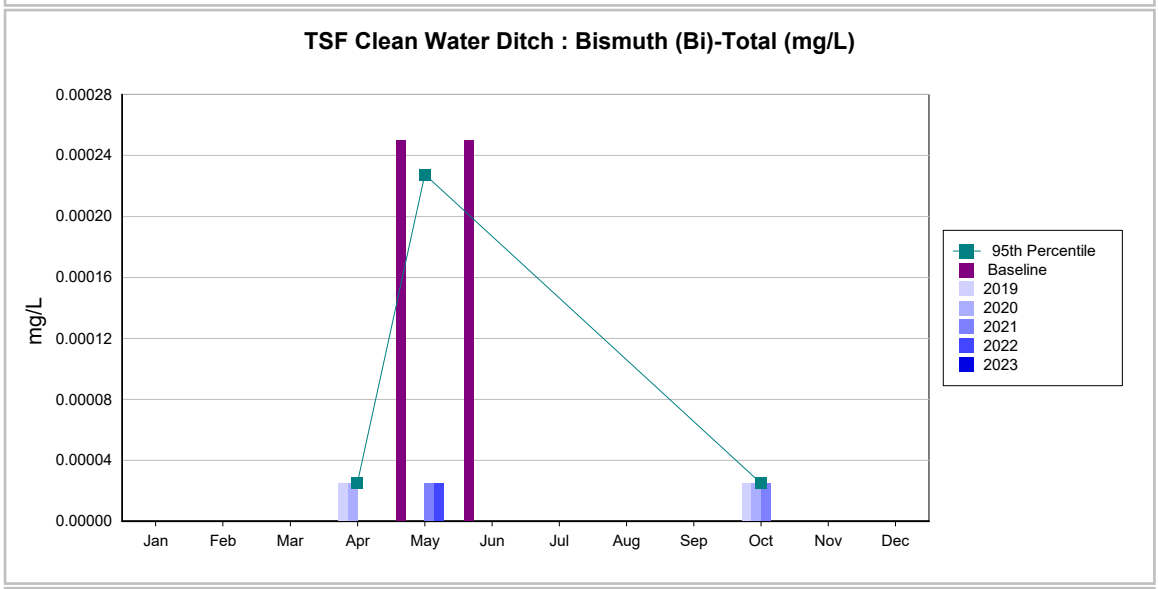
Annual Report Drainage Water

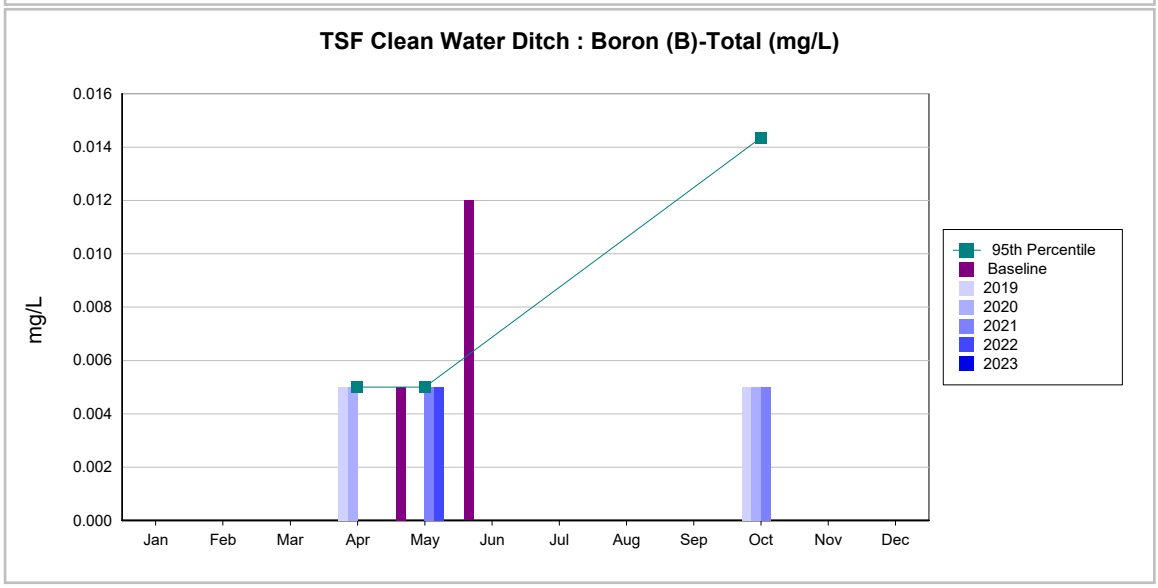
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







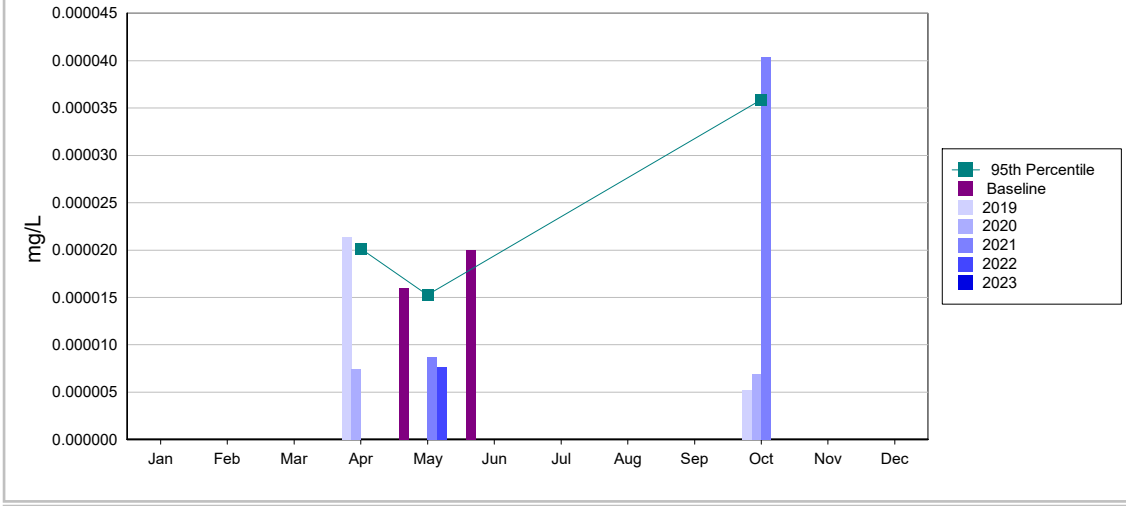
Water Quality Report

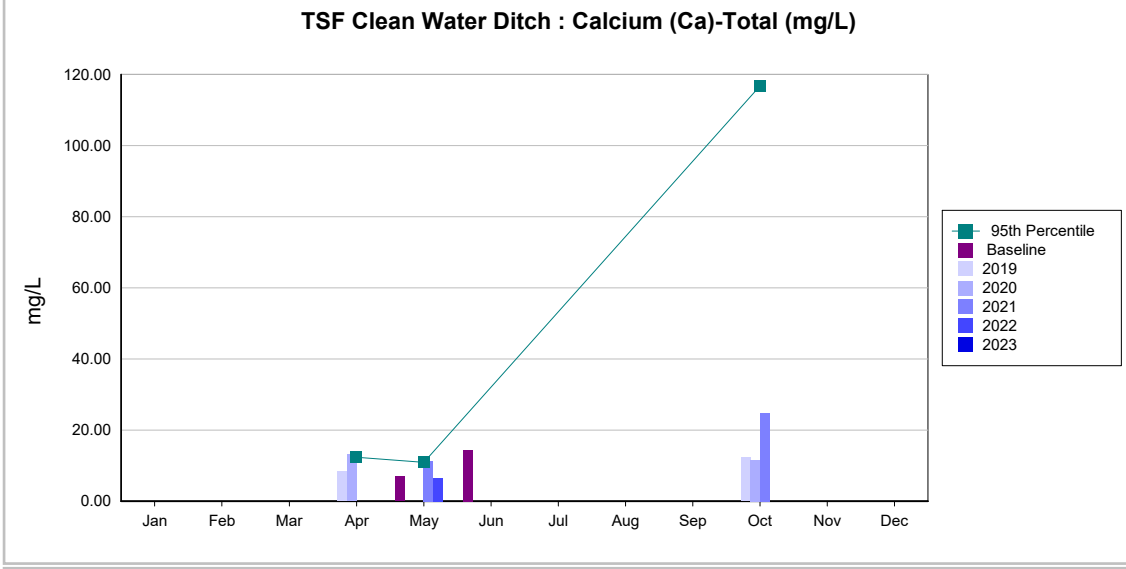
Annual Report Drainage Water

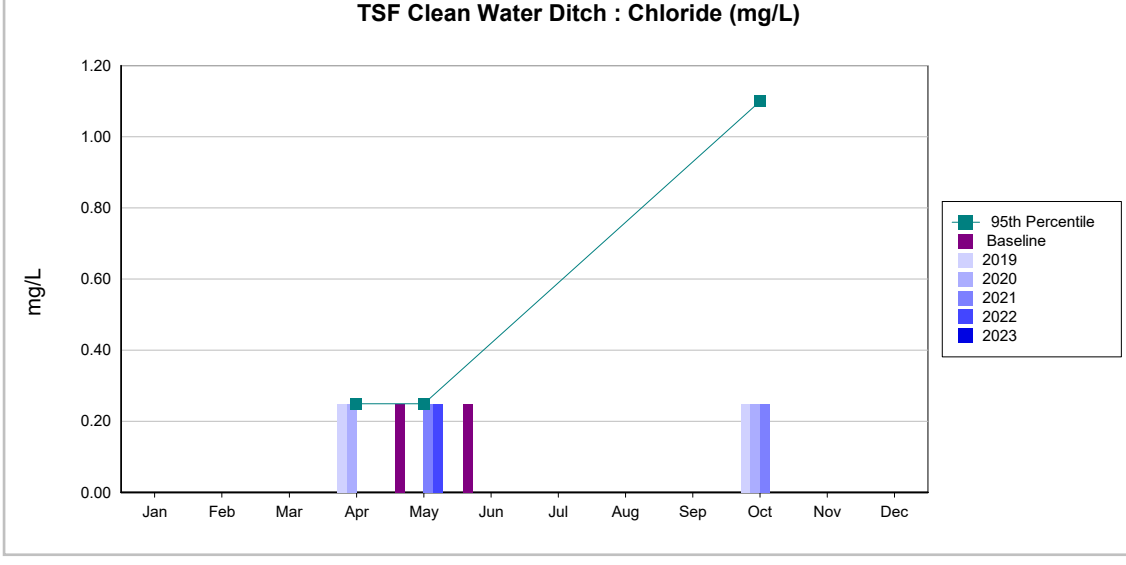
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







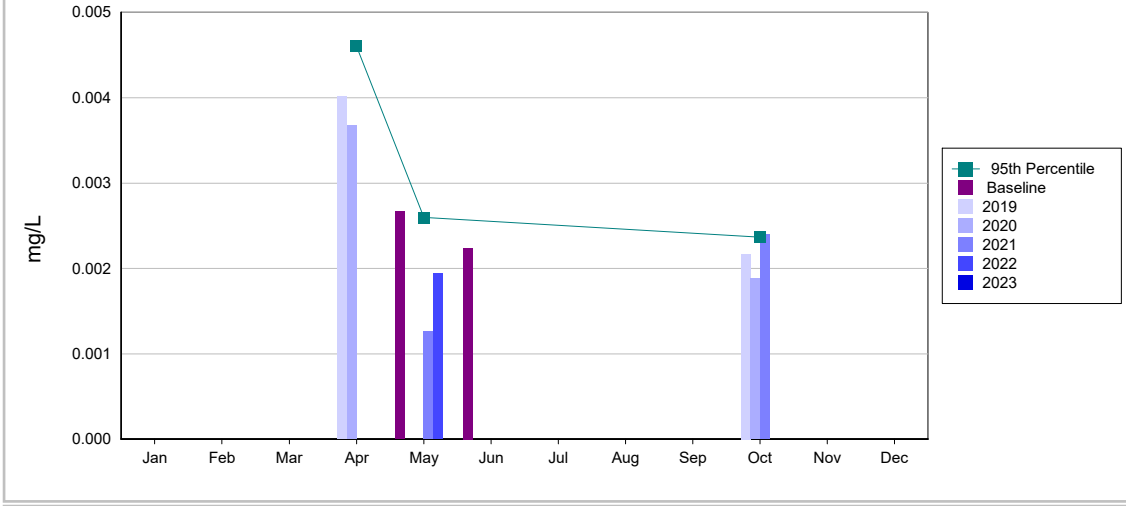
Water Quality Report

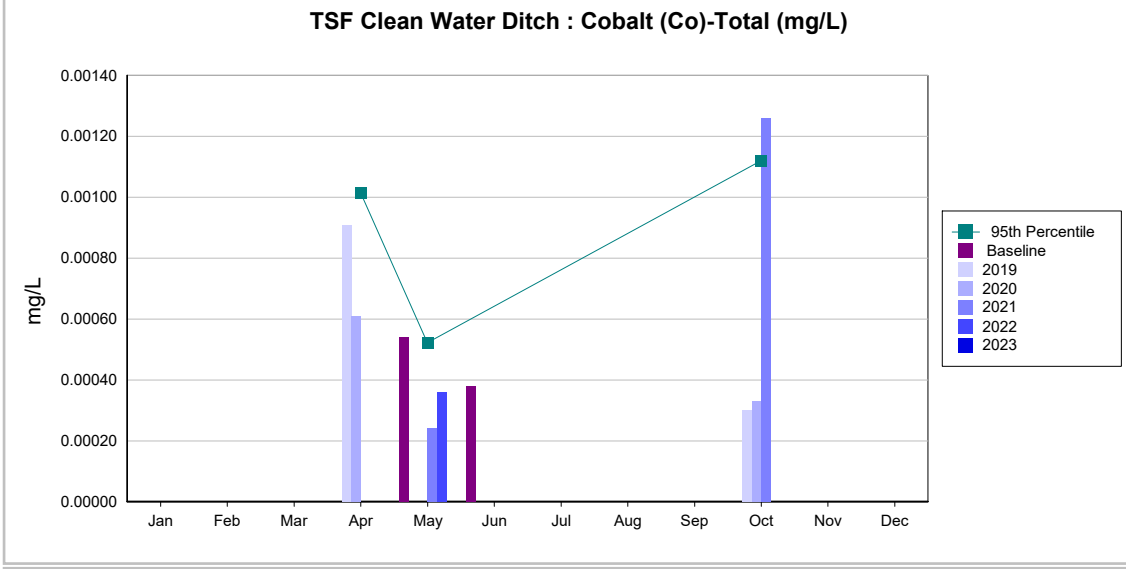
Annual Report Drainage Water

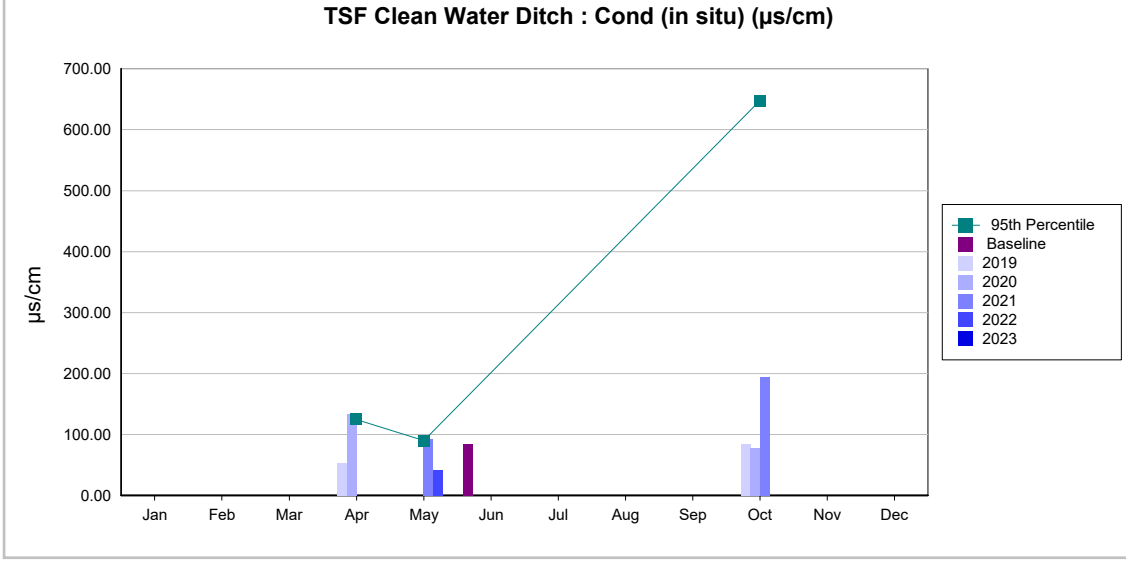
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







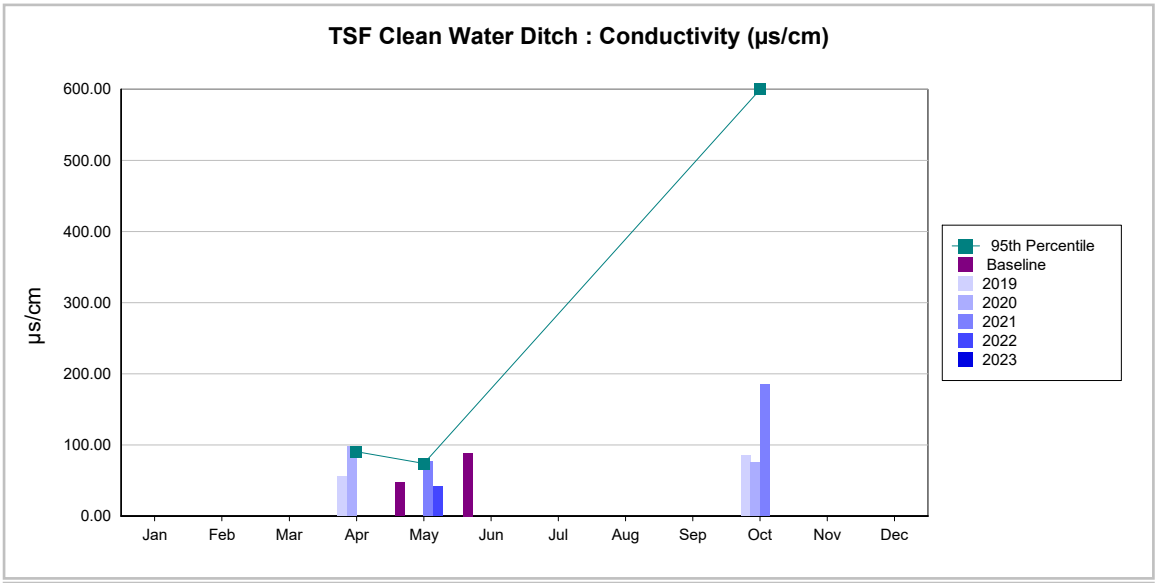
Water Quality Report

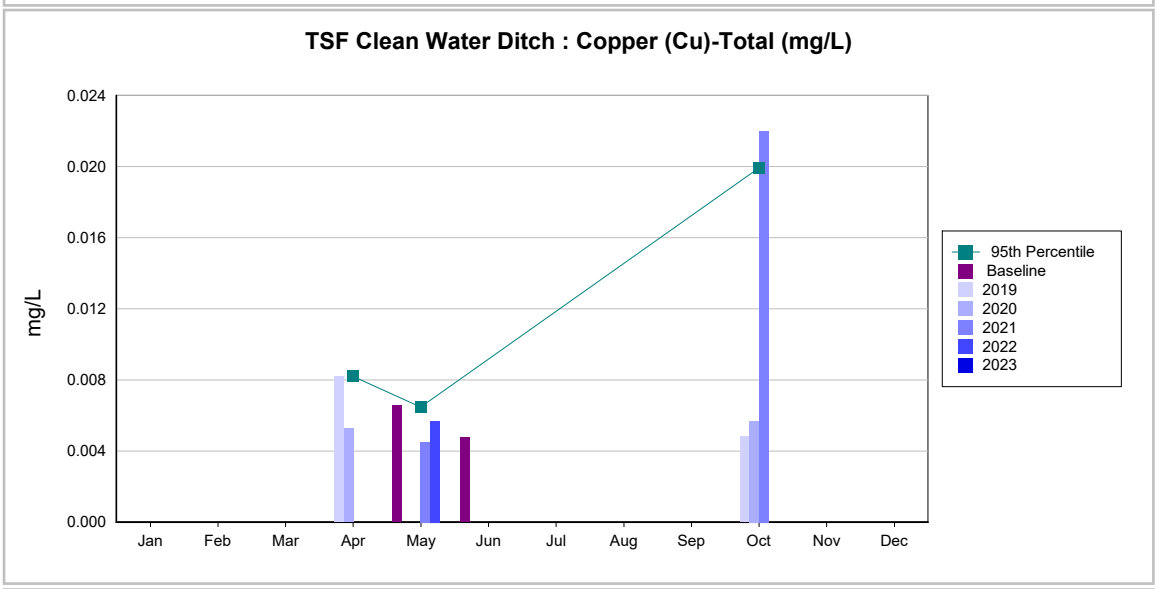
Annual Report Drainage Water

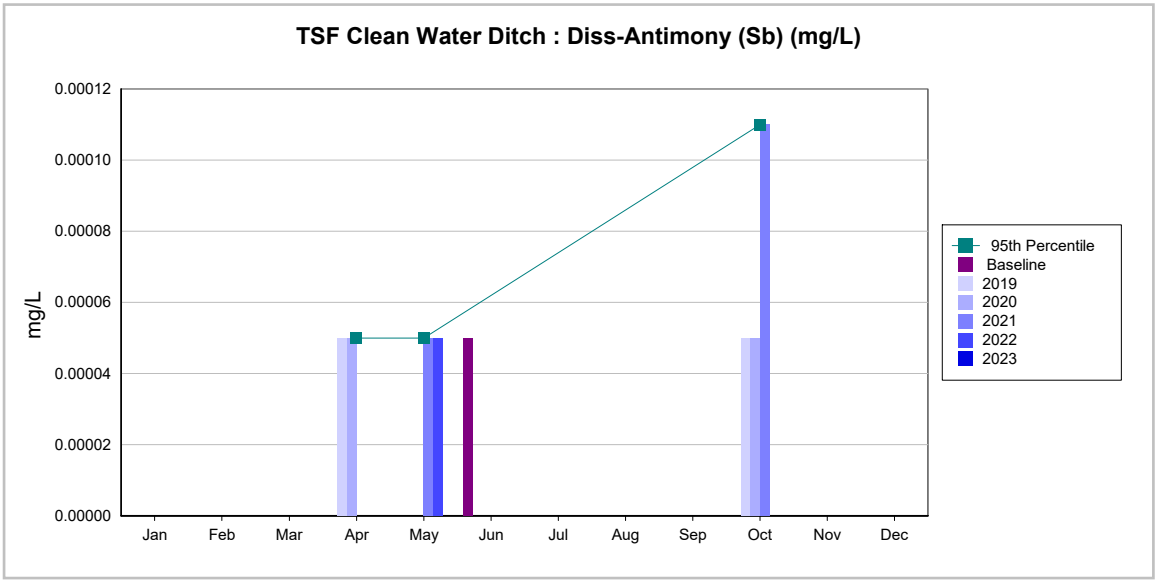
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







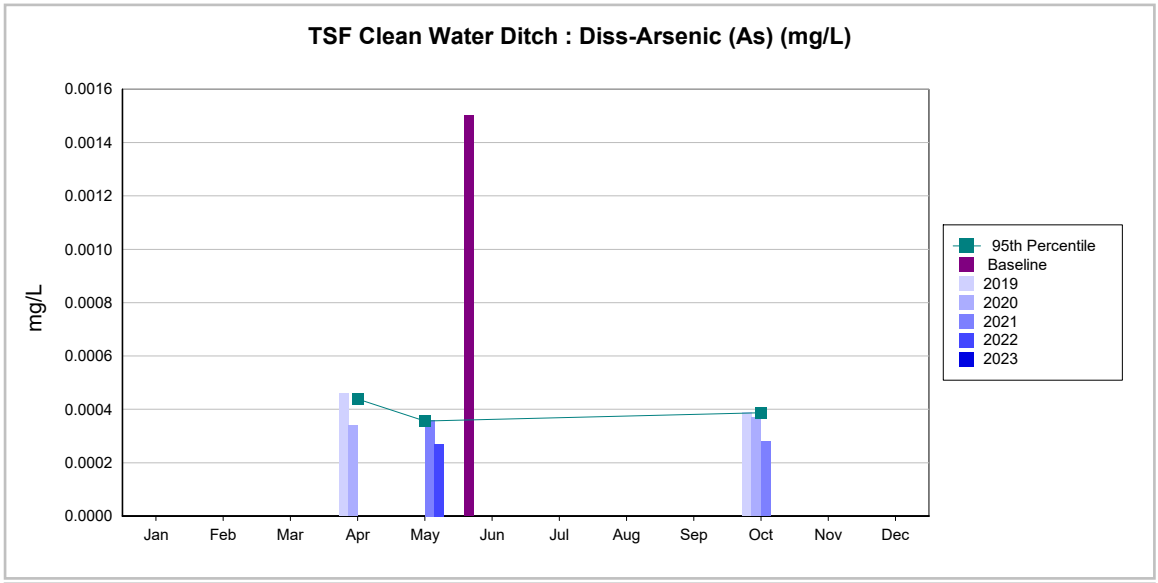
Water Quality Report

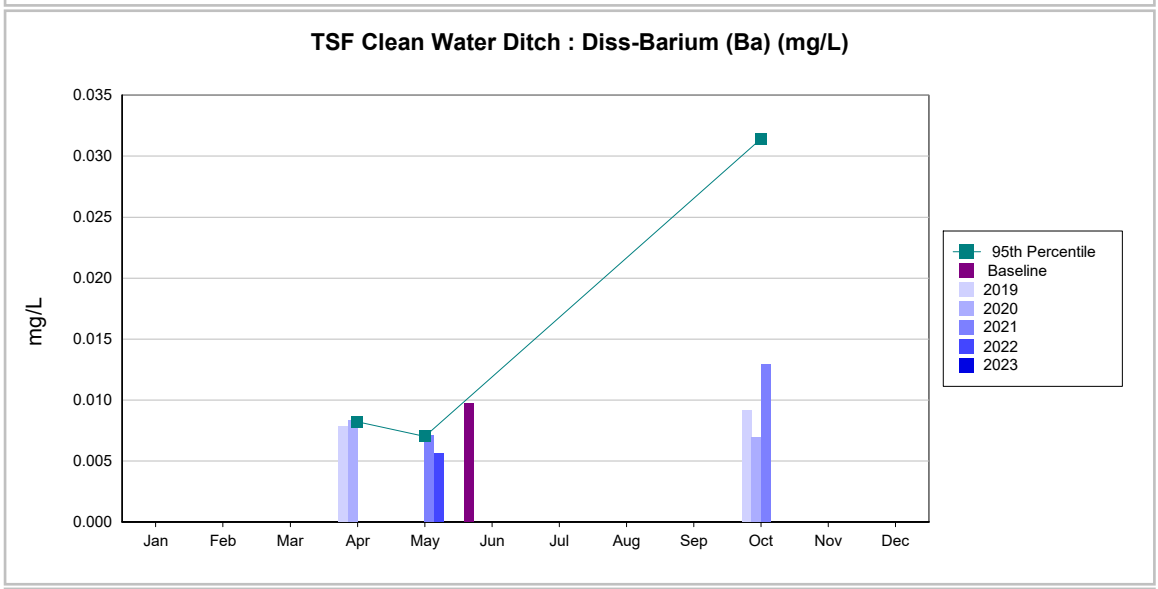
Annual Report Drainage Water

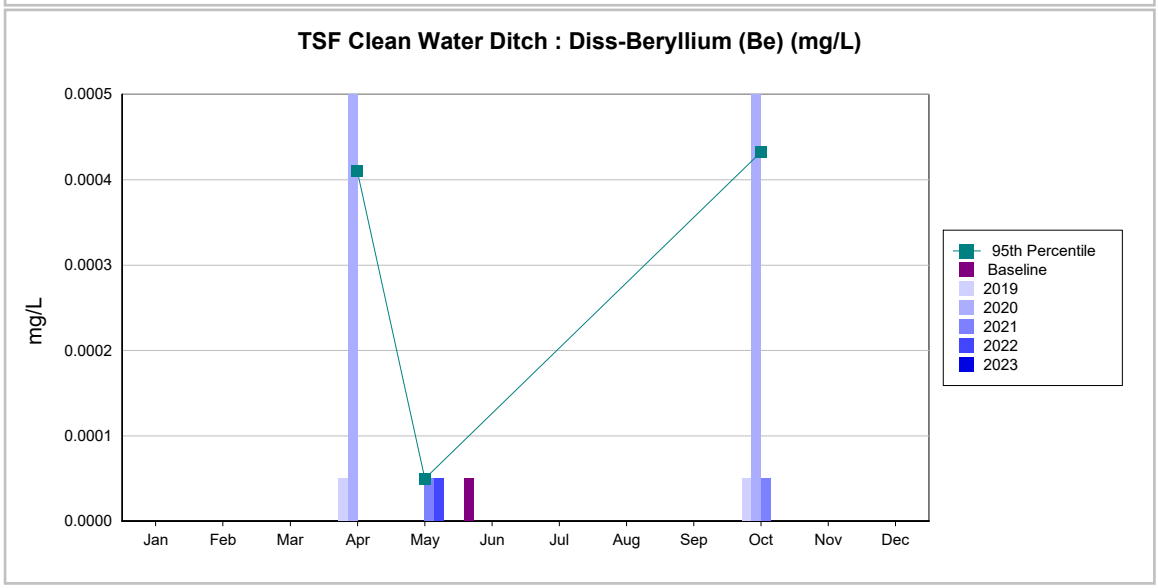
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







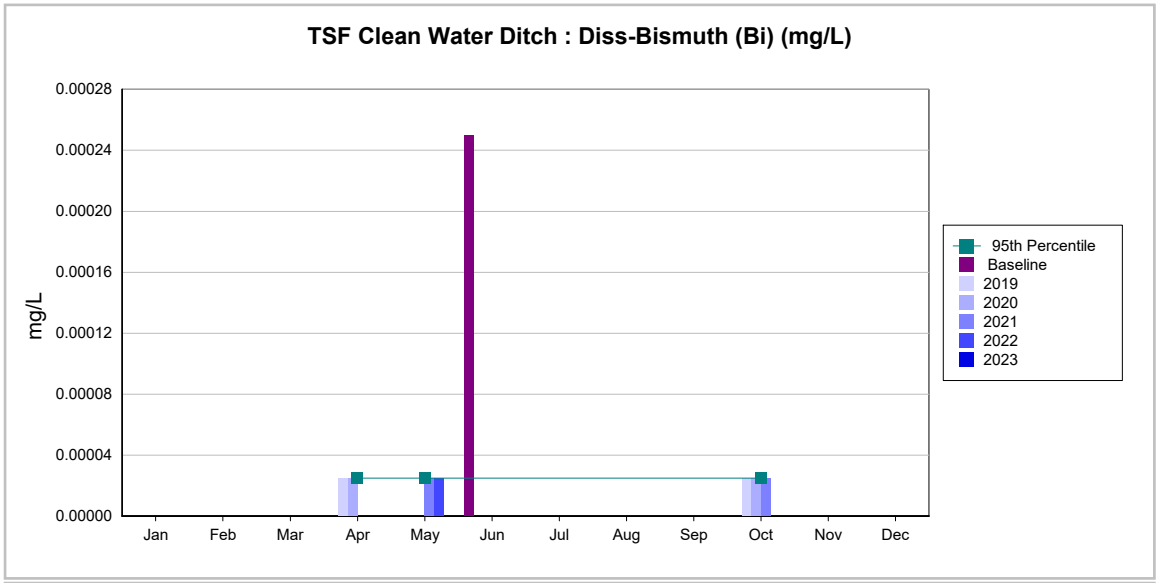
Water Quality Report

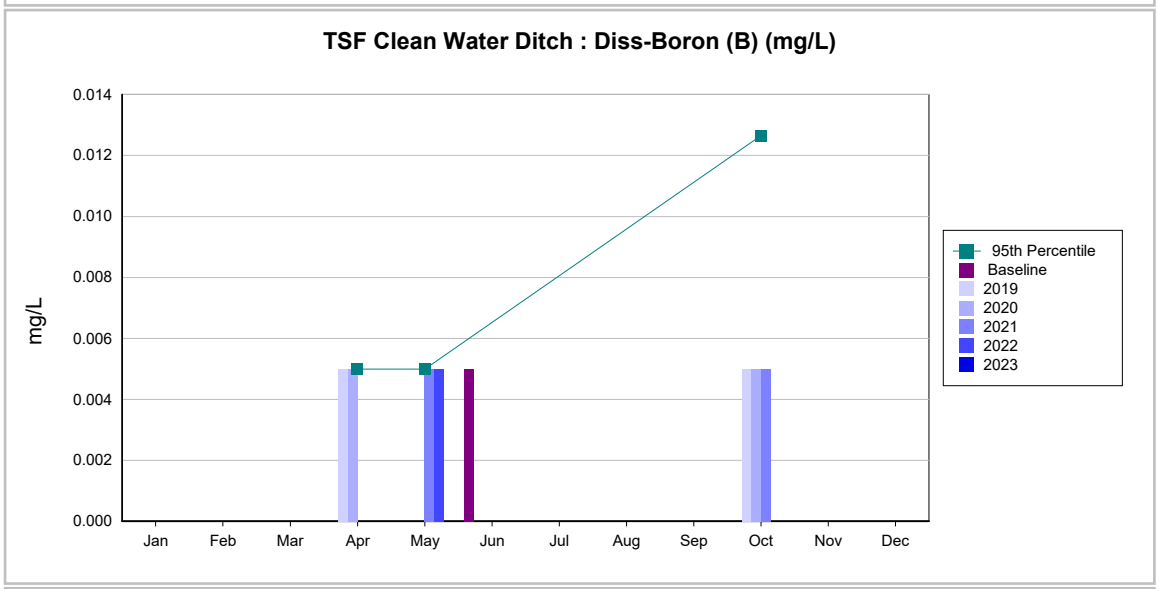
Annual Report Drainage Water

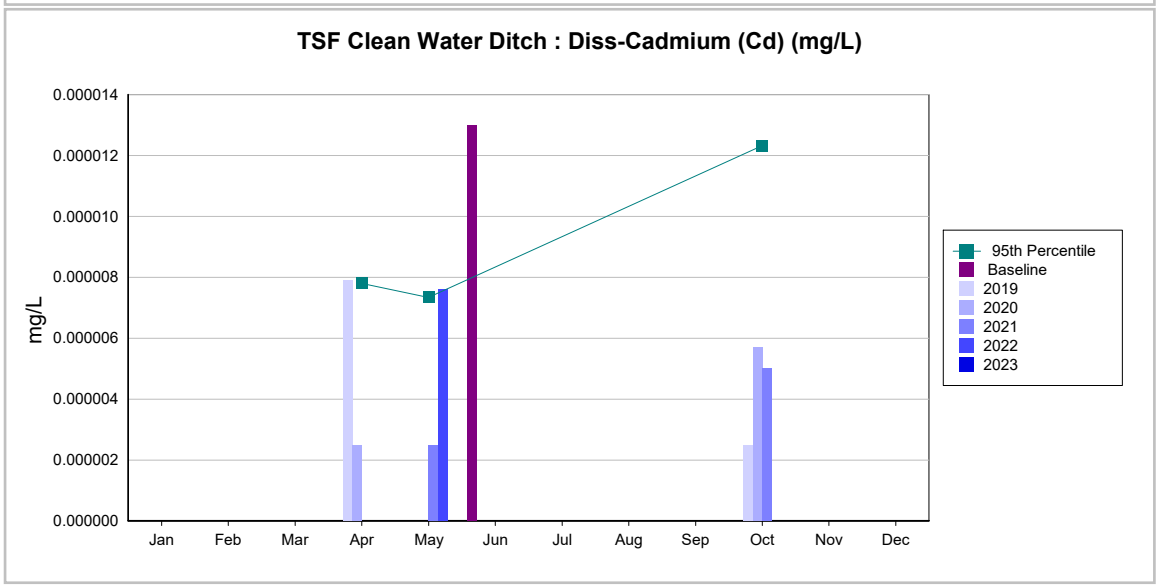
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







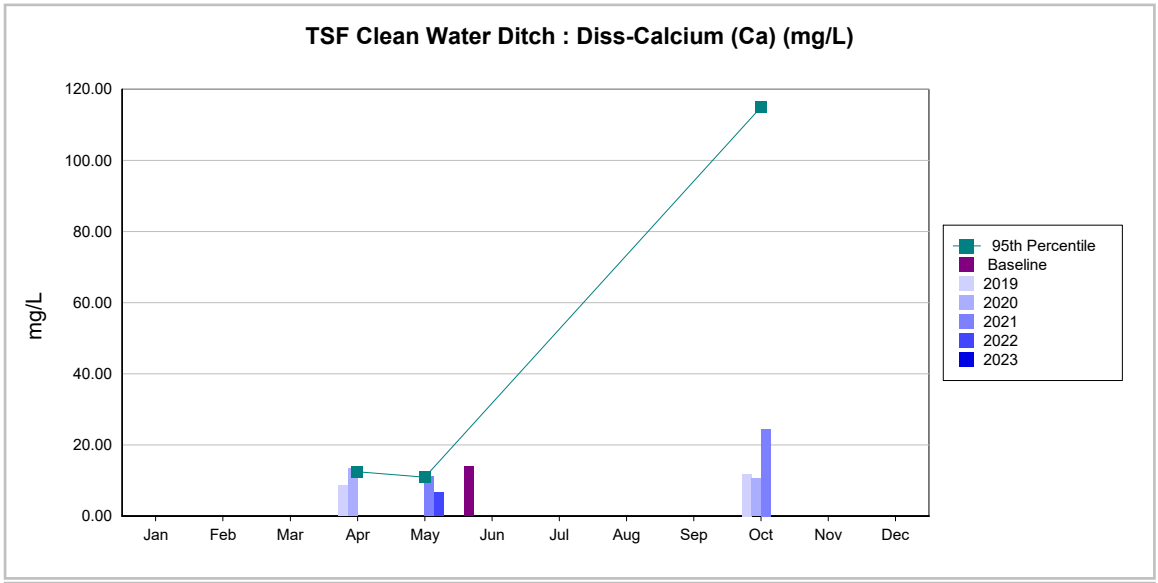
Water Quality Report

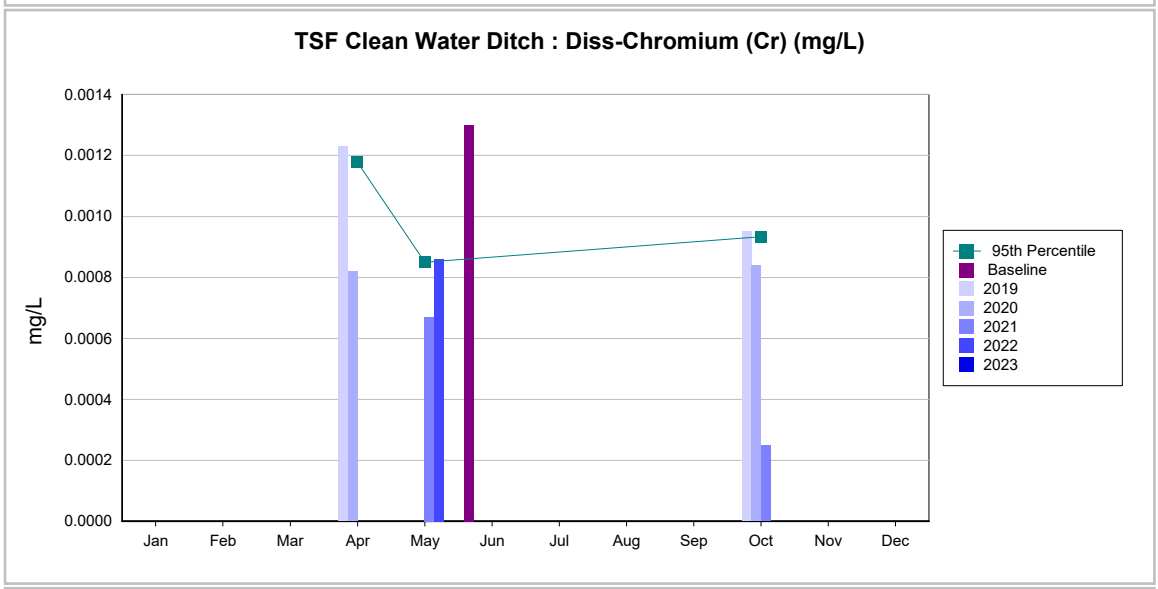
Annual Report Drainage Water

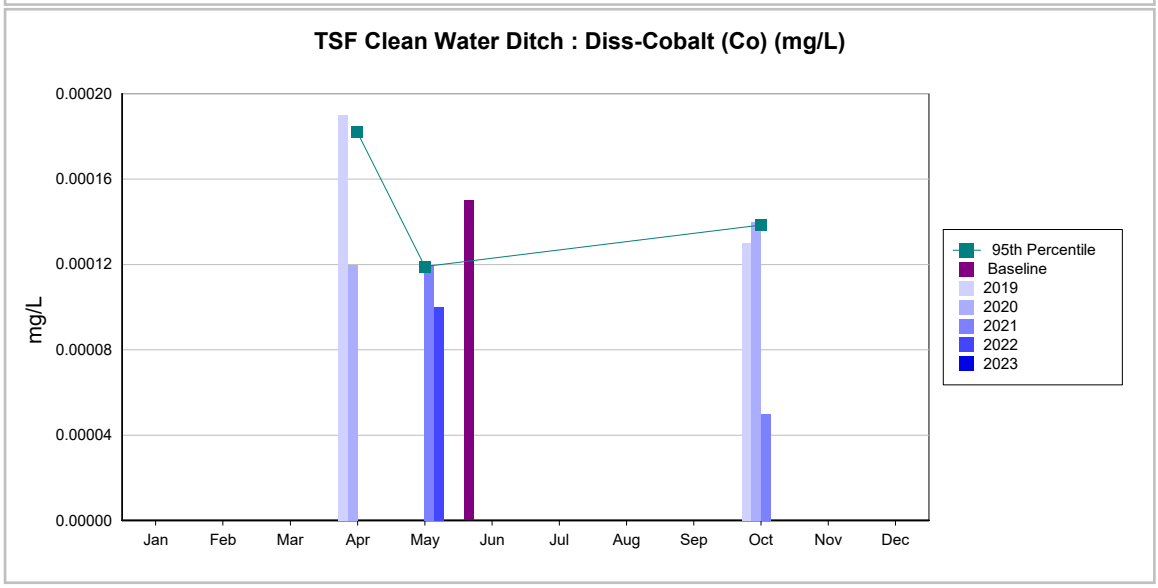
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







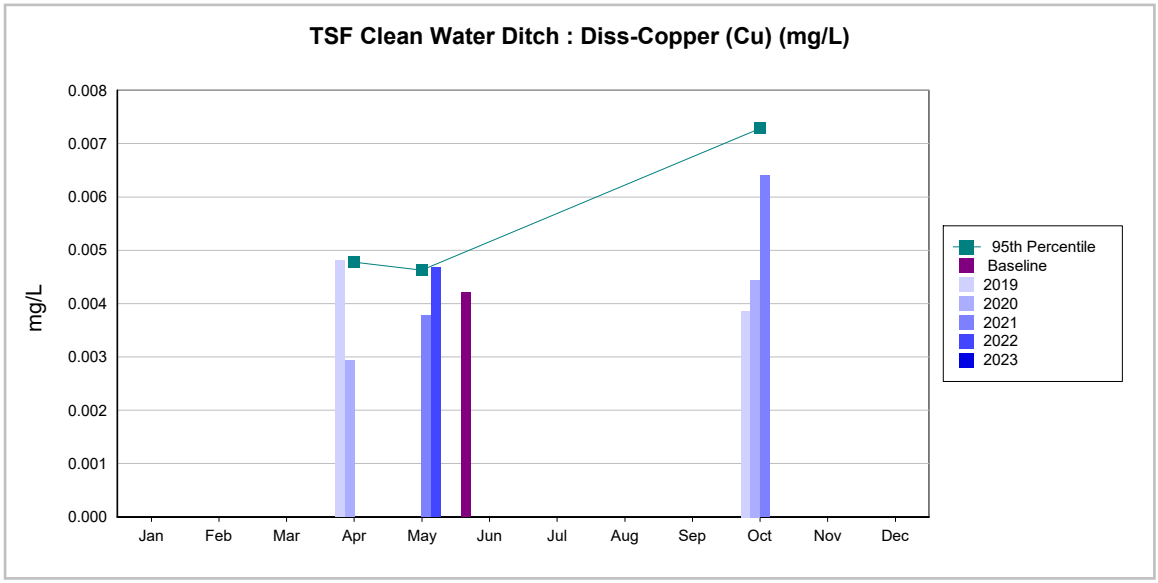
Water Quality Report

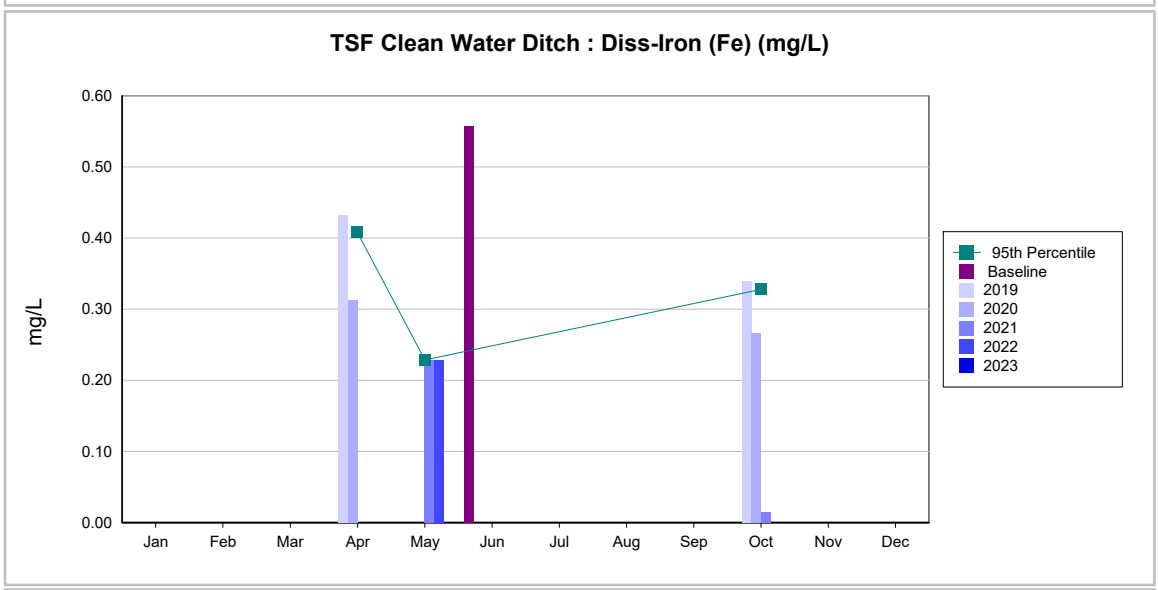
Annual Report Drainage Water

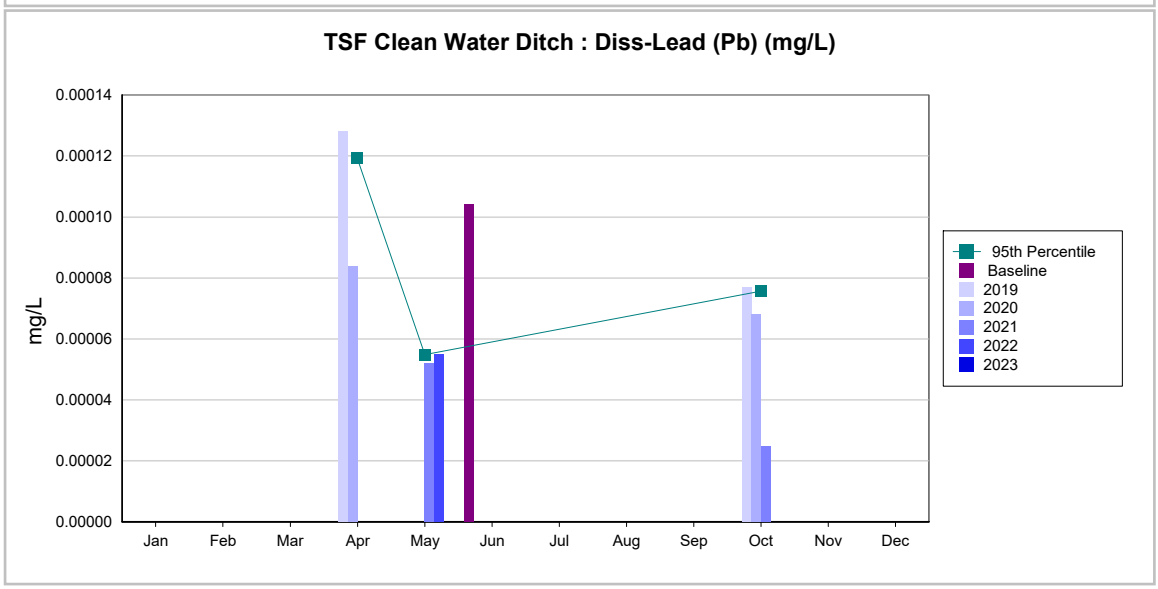
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







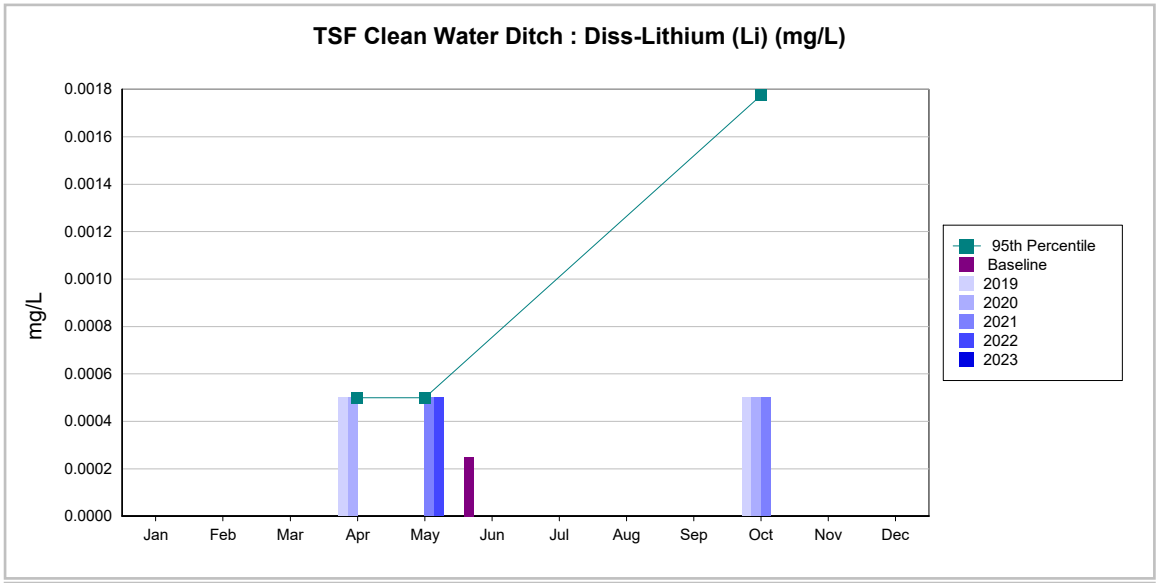
Water Quality Report

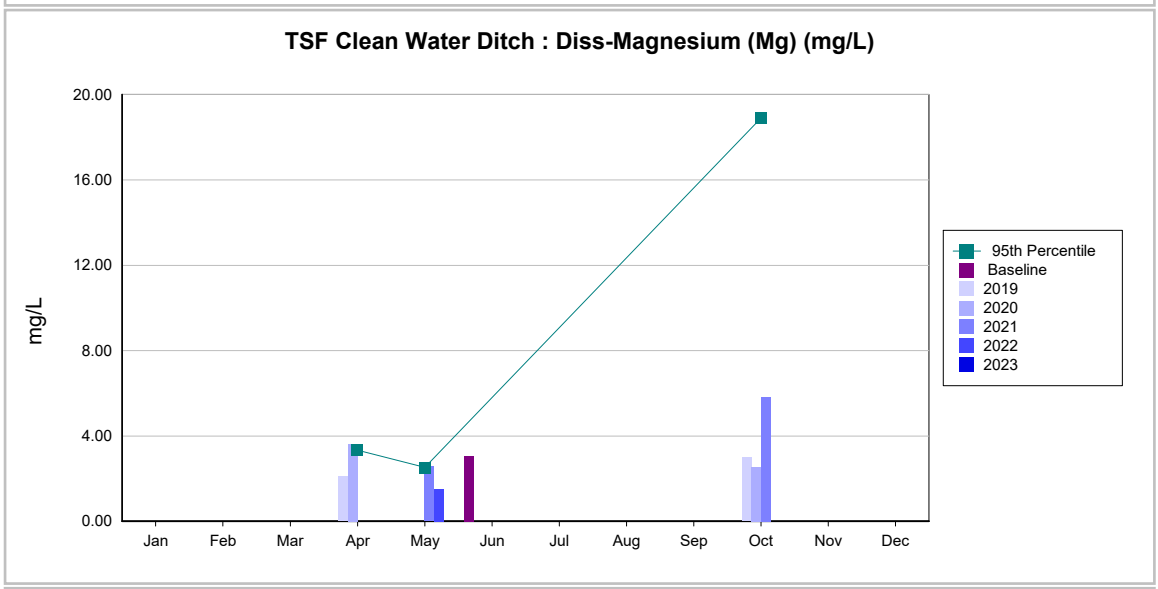
Annual Report Drainage Water

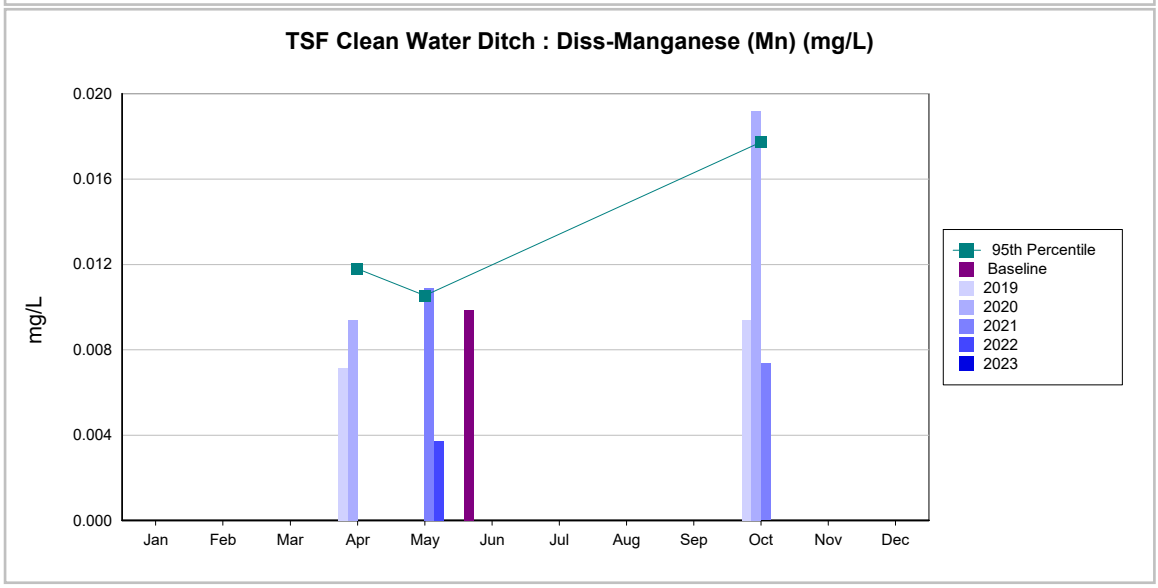
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







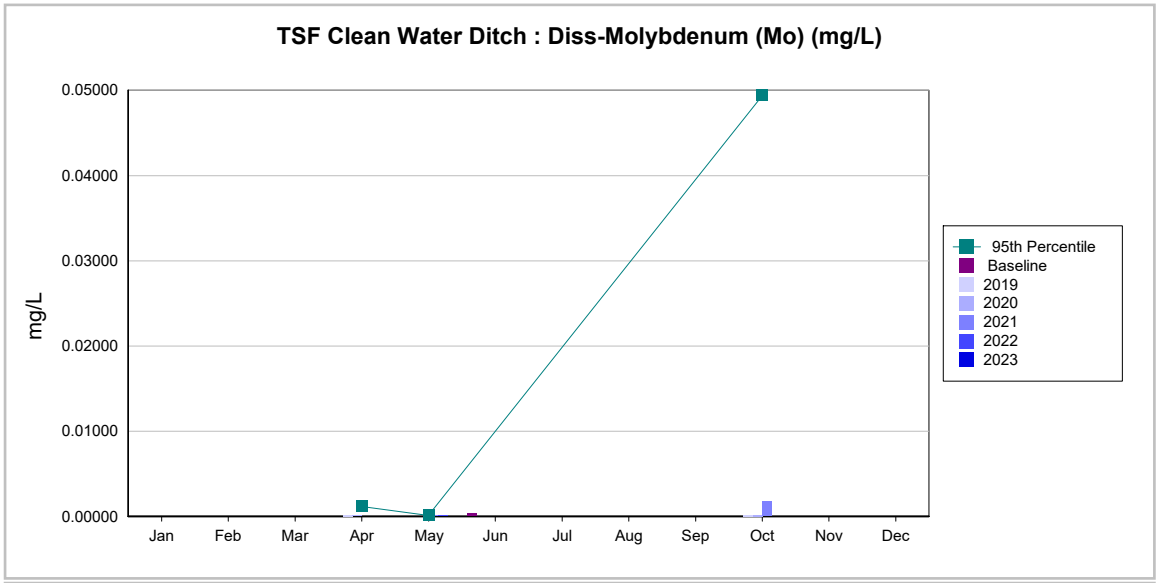
Water Quality Report

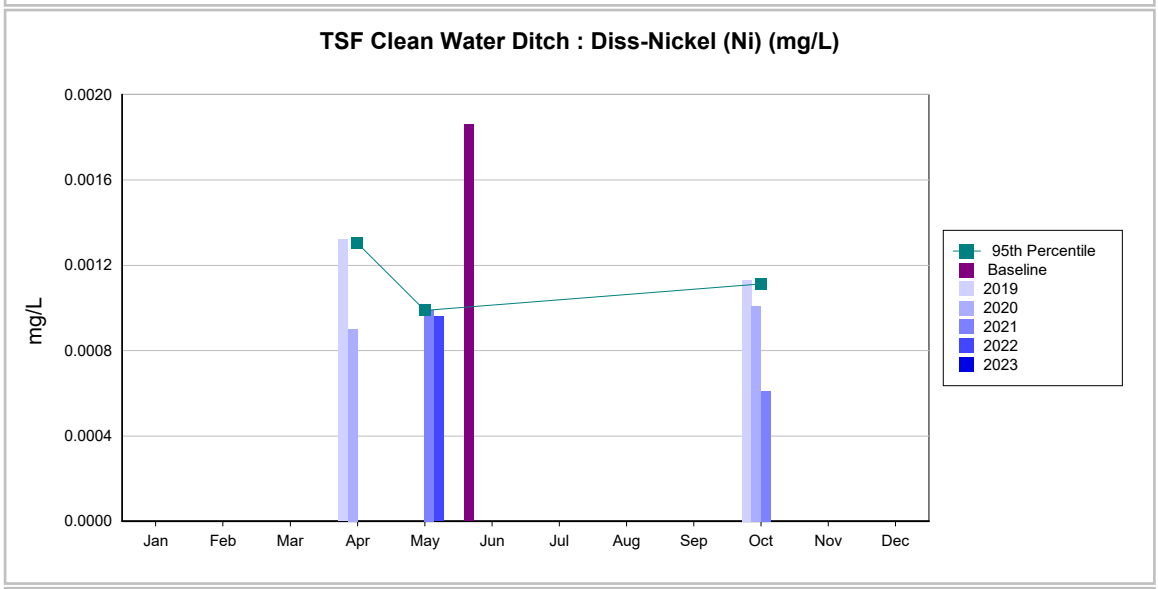
Annual Report Drainage Water

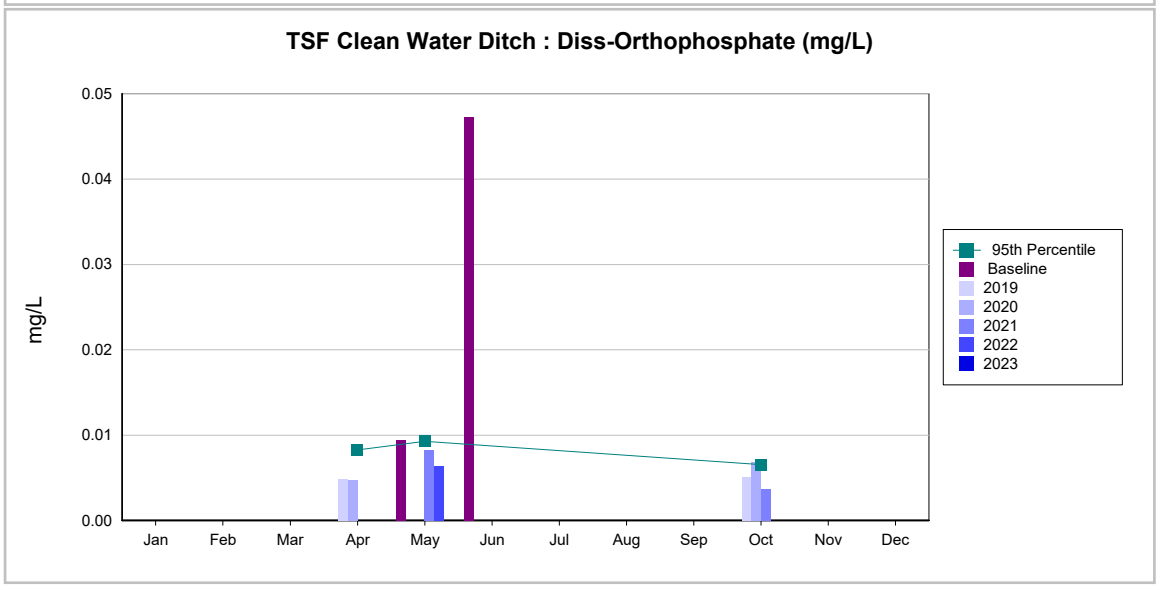
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







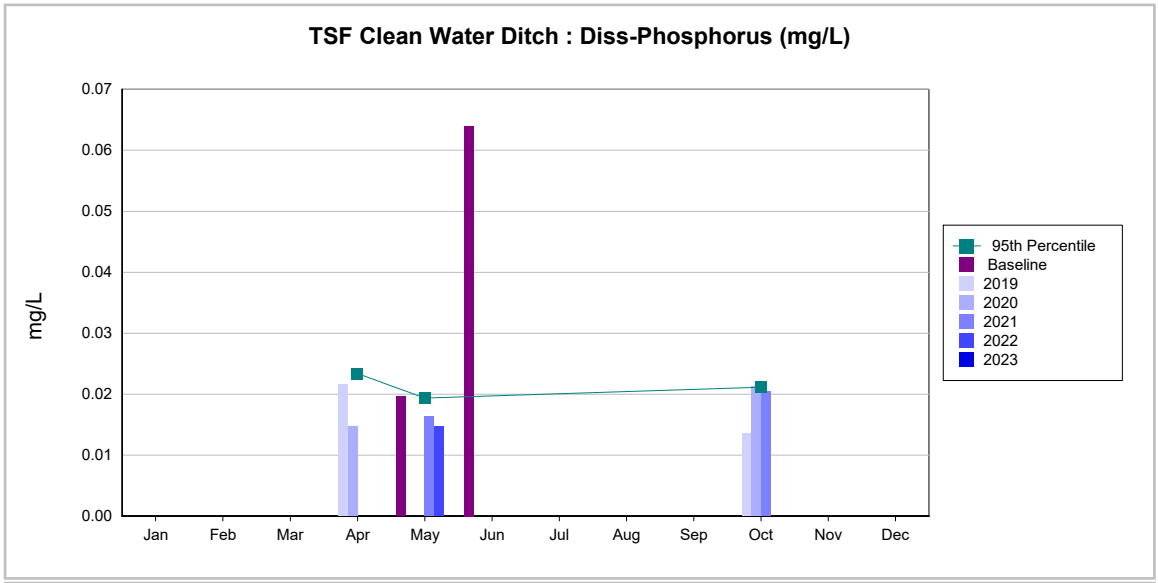
Water Quality Report

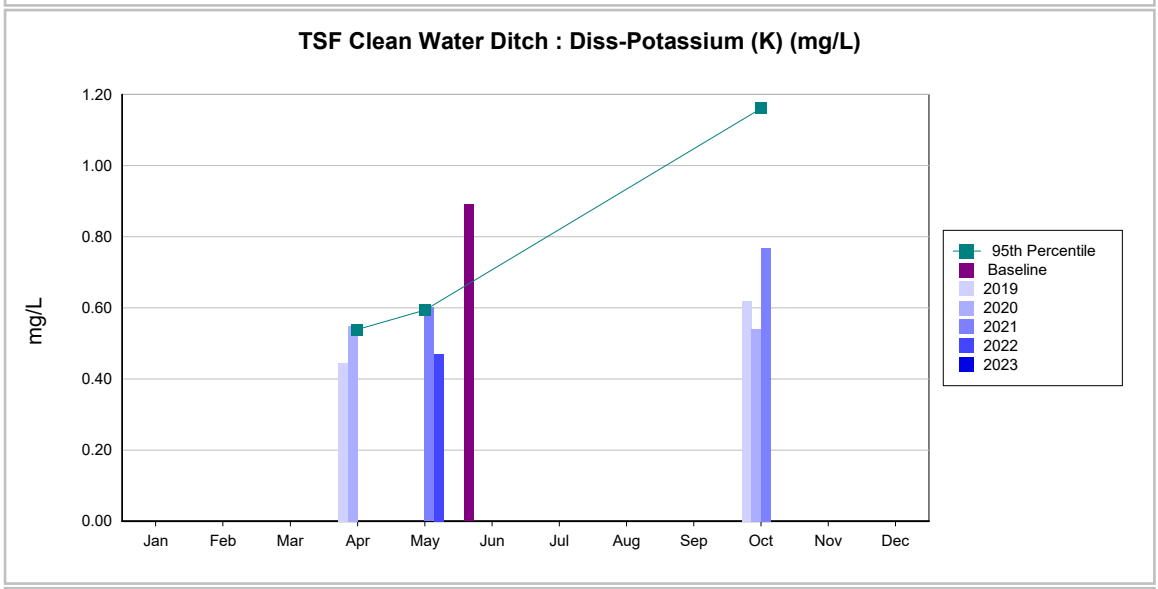
Annual Report Drainage Water

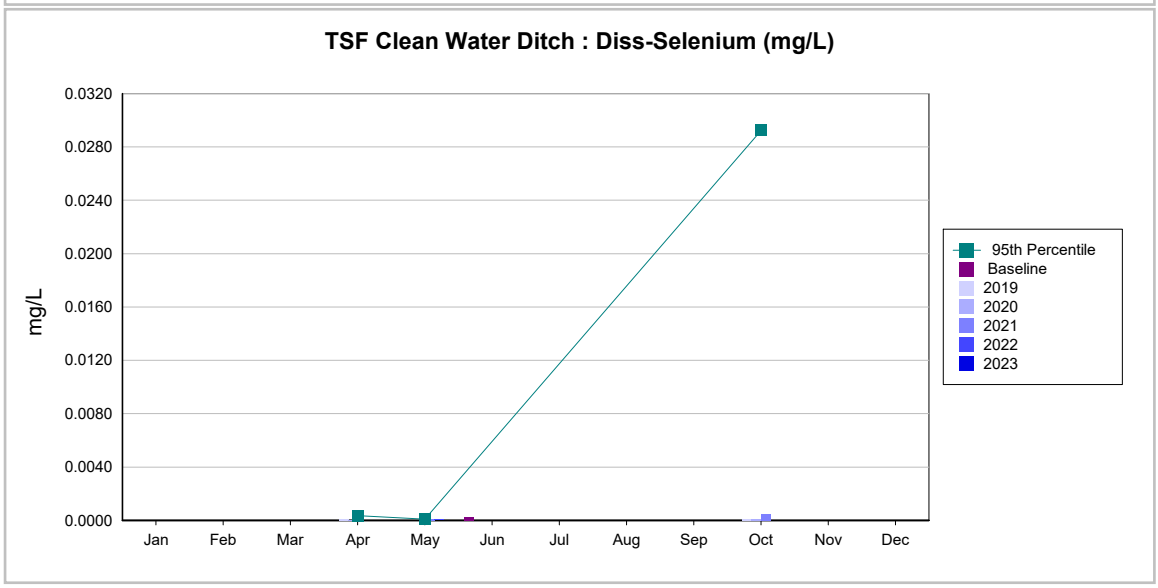
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







Water Quality Report

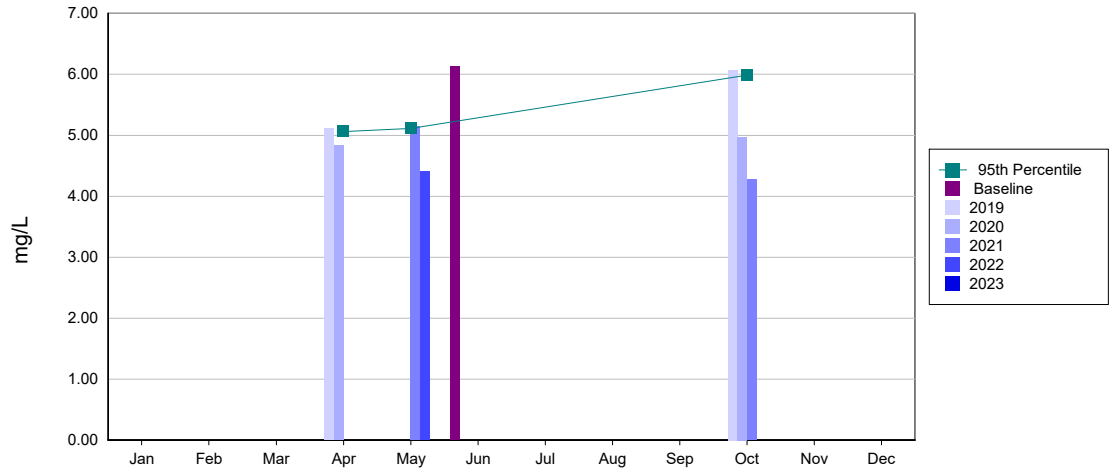
Annual Report Drainage Water

Mount Polley

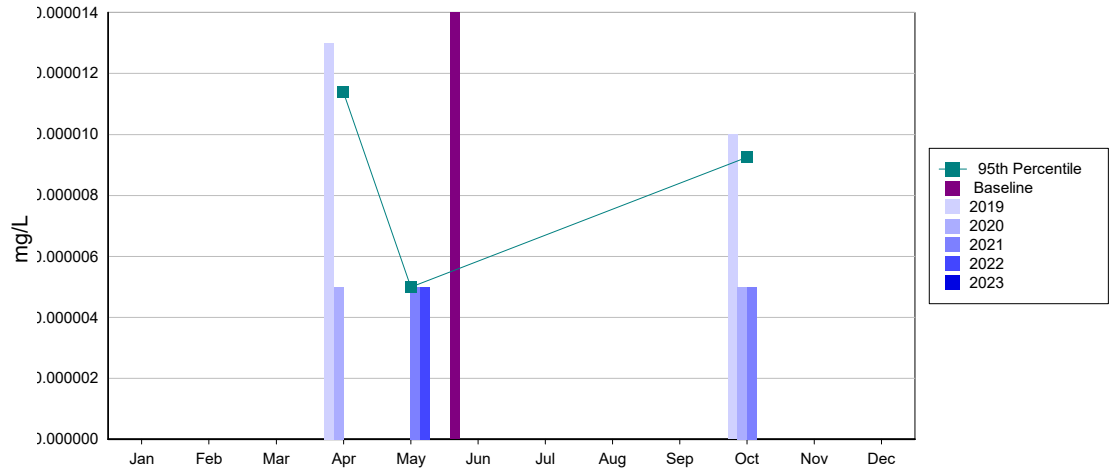
Mining Corporation

IMPERIAL METALS CORPORATION

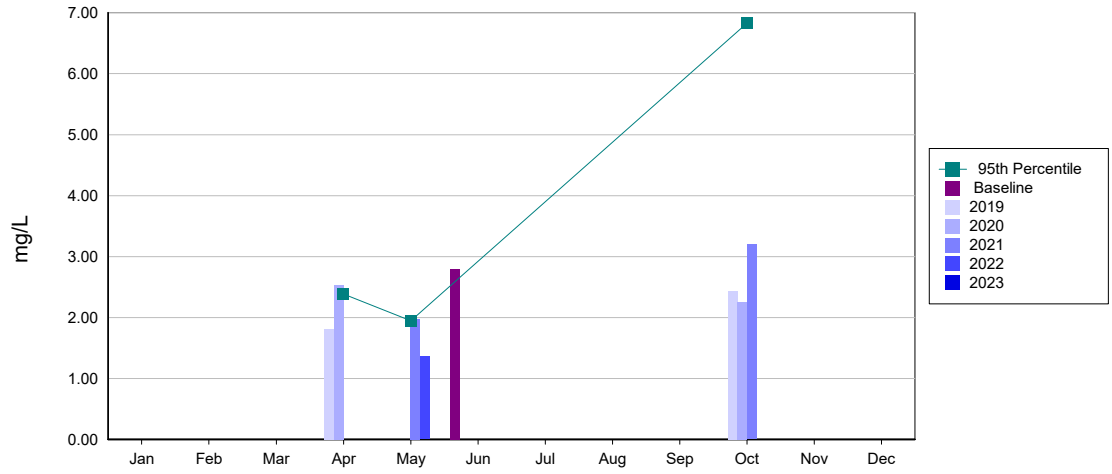
TSF Clean Water Ditch : Diss-Silicon (Si) (mg/L)



TSF Clean Water Ditch : Diss-Silver (Ag) (mg/L)



TSF Clean Water Ditch : Diss-Sodium (Na) (mg/L)



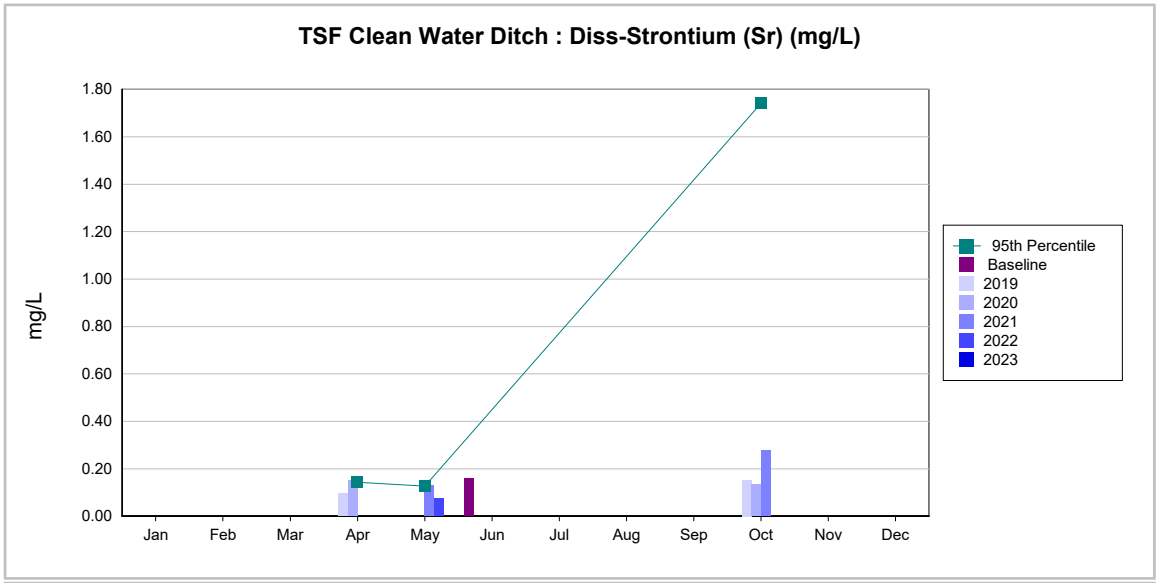
Water Quality Report

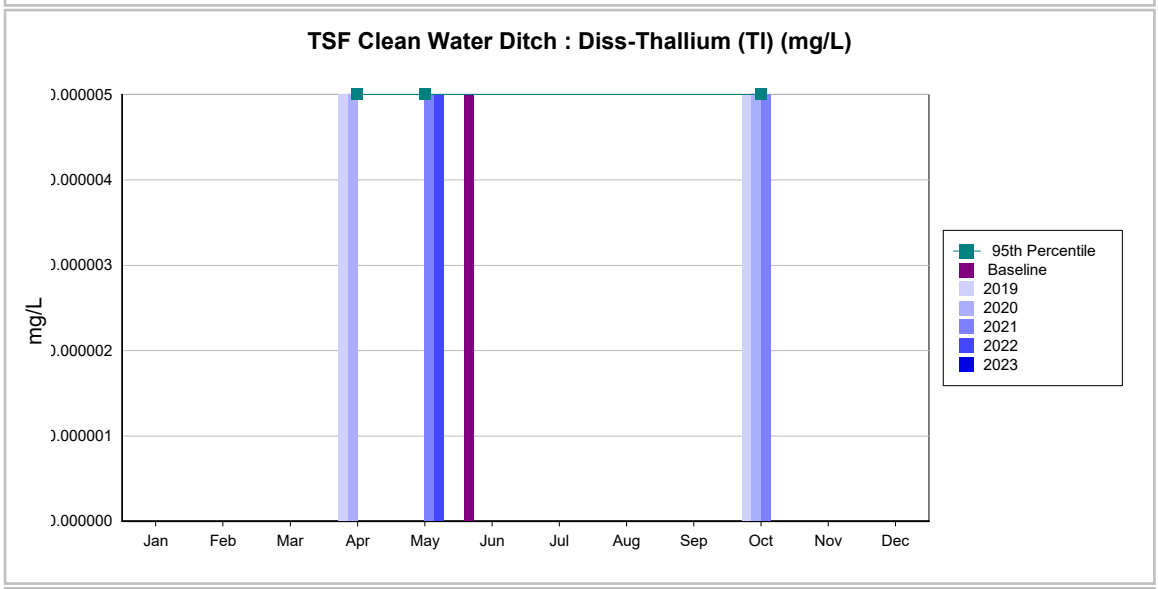
Annual Report Drainage Water

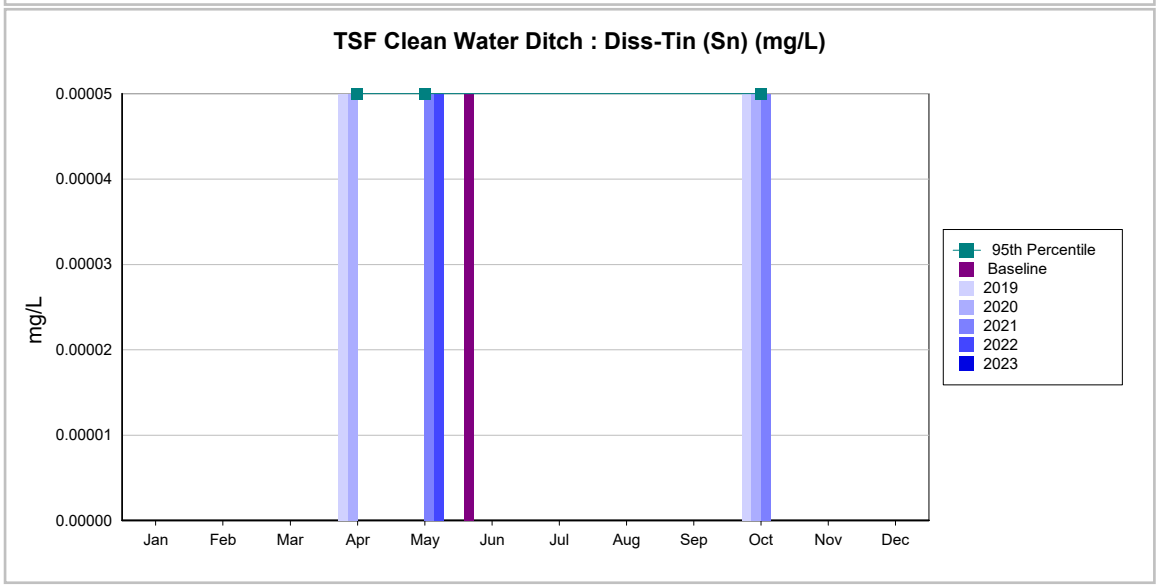
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







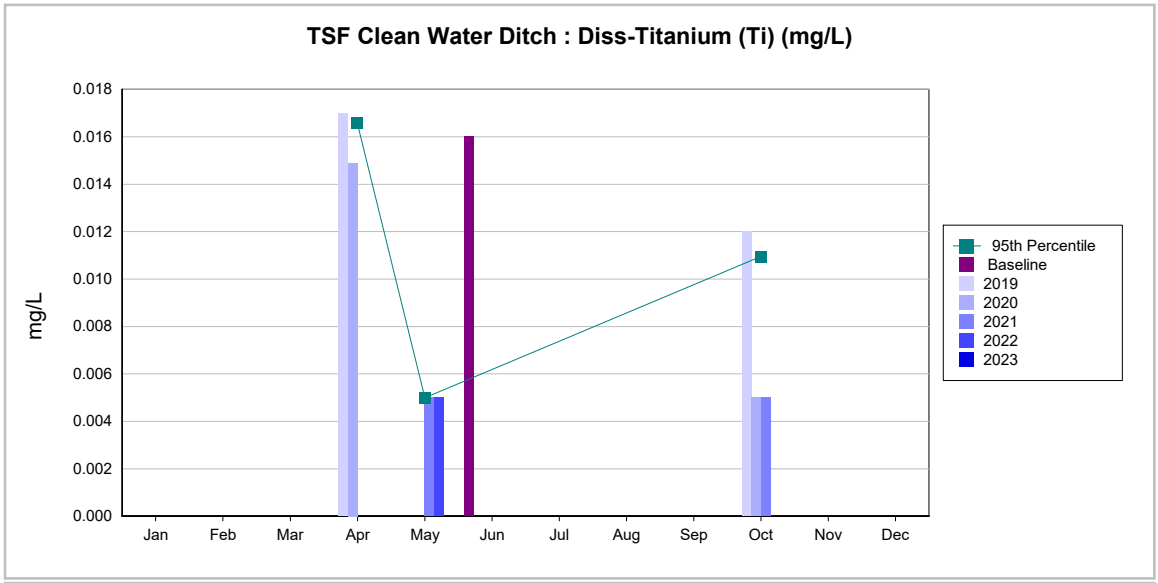
Water Quality Report

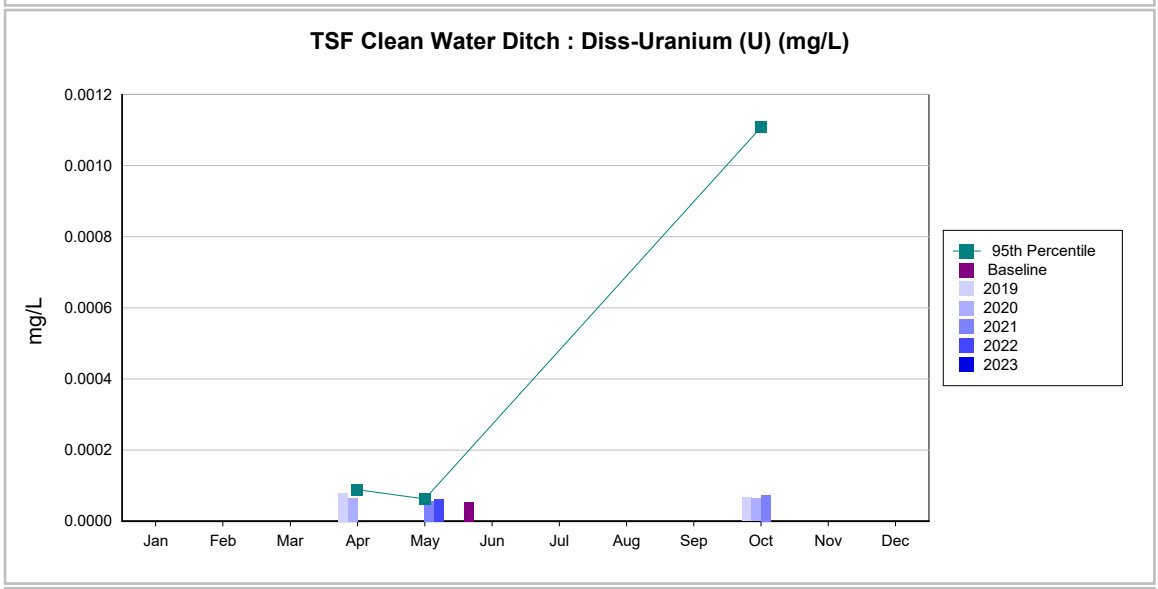
Annual Report Drainage Water

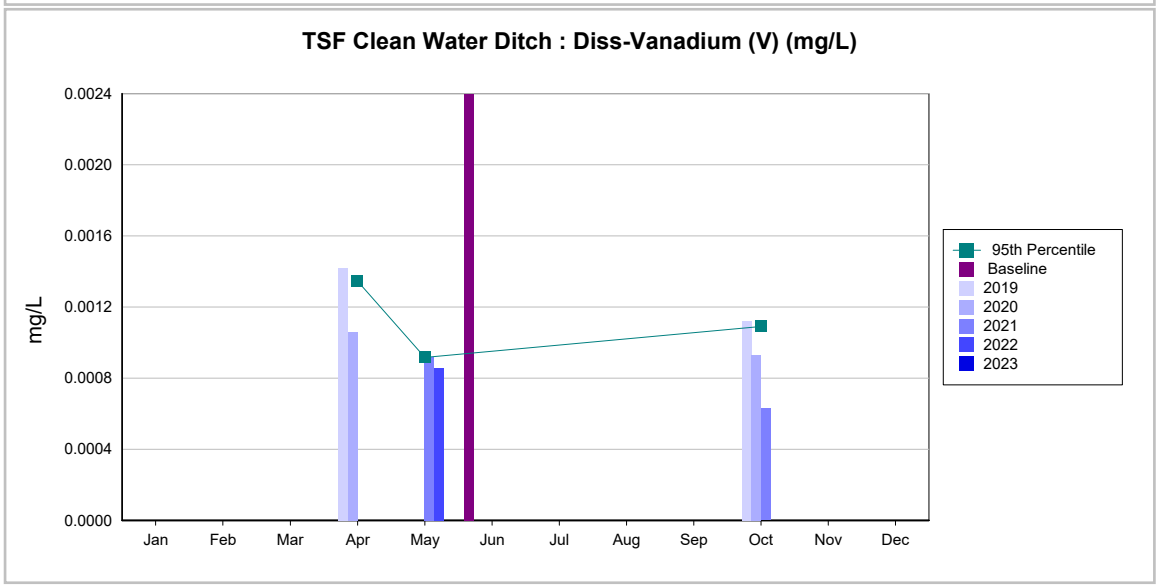
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







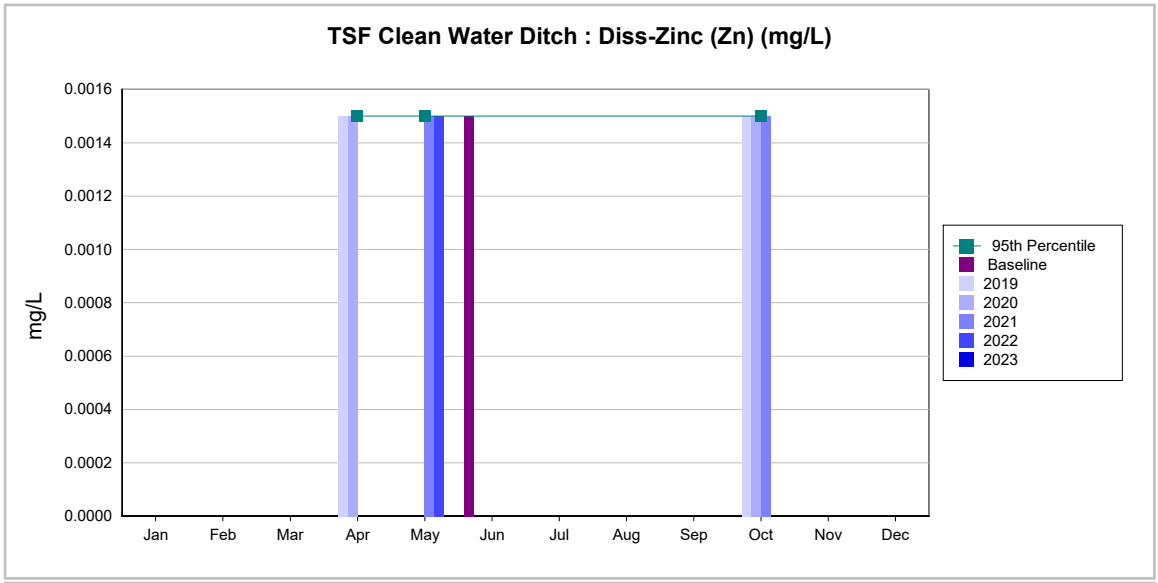
Water Quality Report

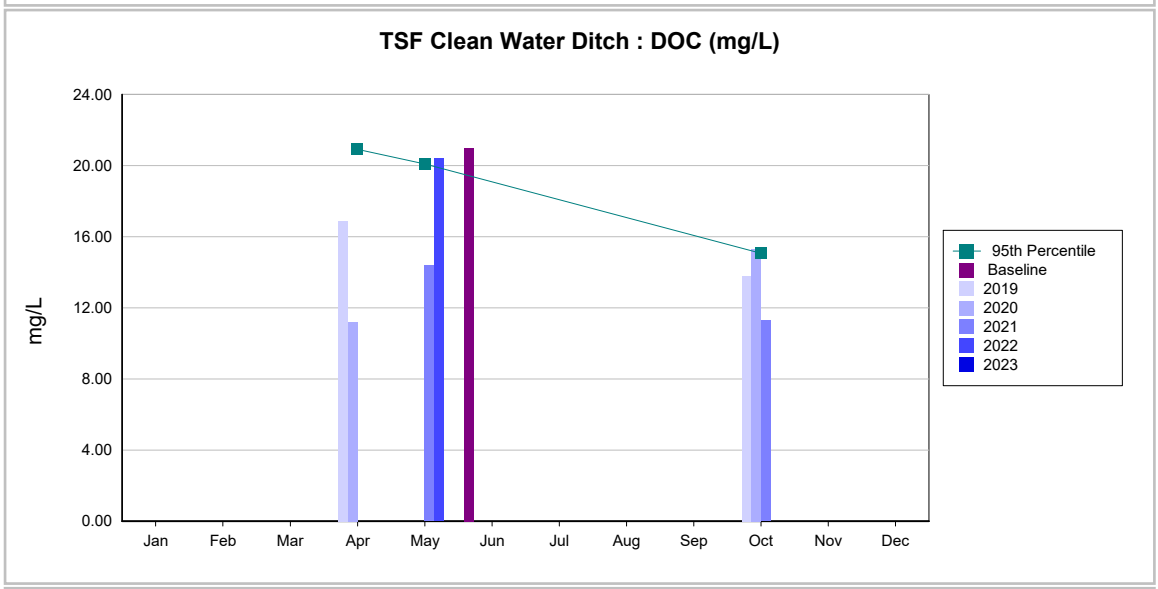
Annual Report Drainage Water

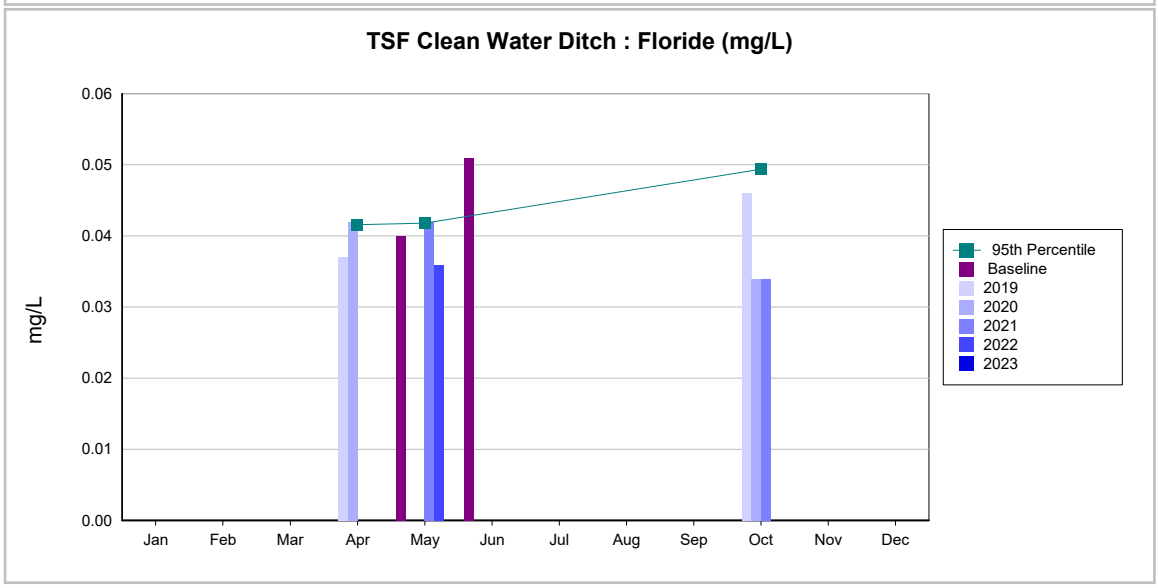
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







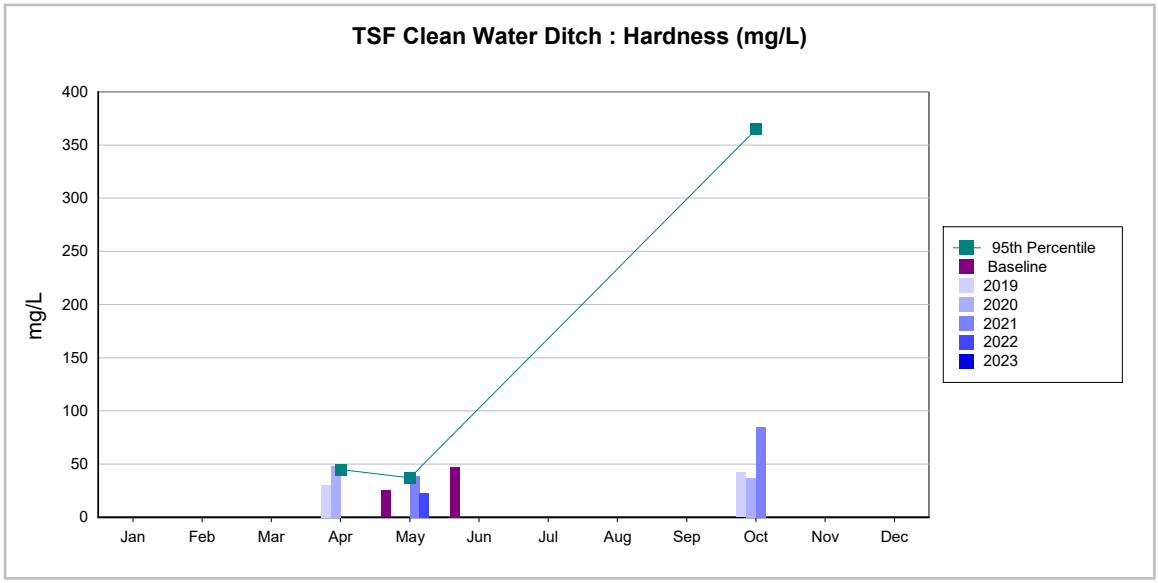
Water Quality Report

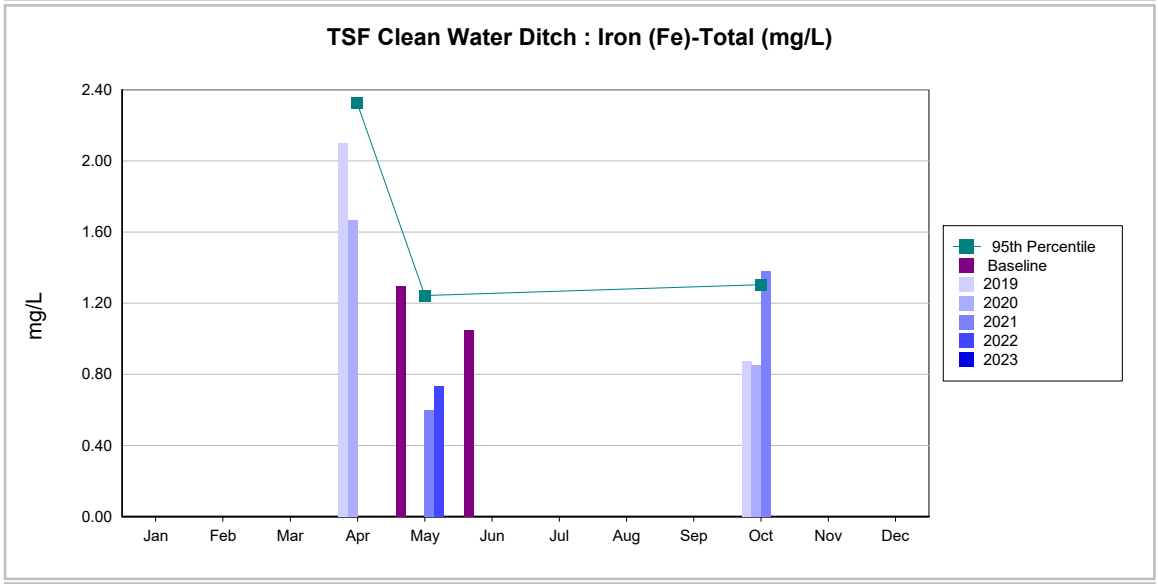
Annual Report Drainage Water

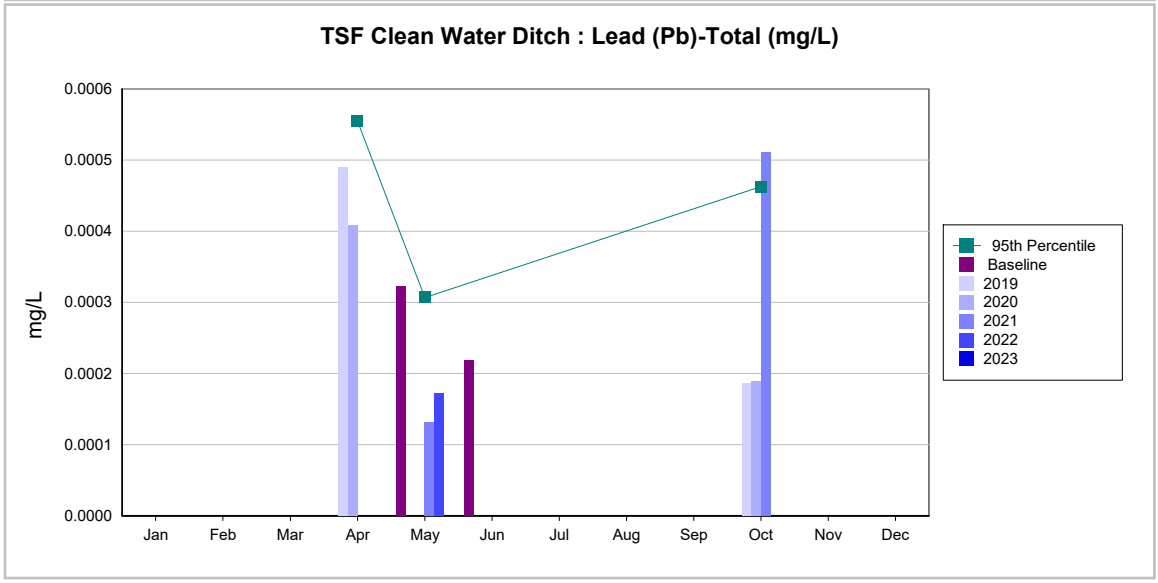
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







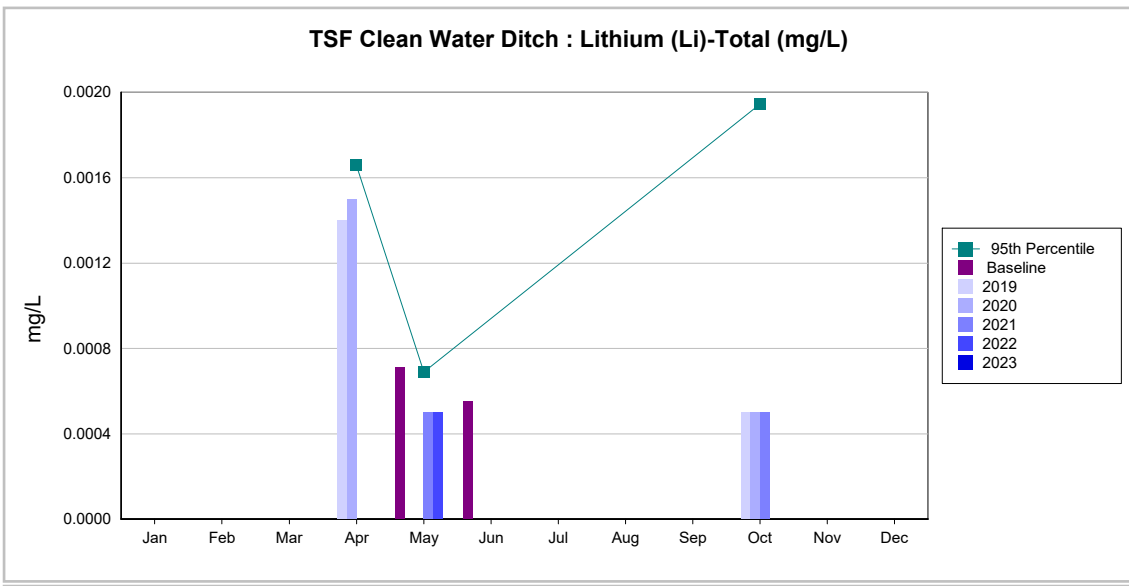
Water Quality Report

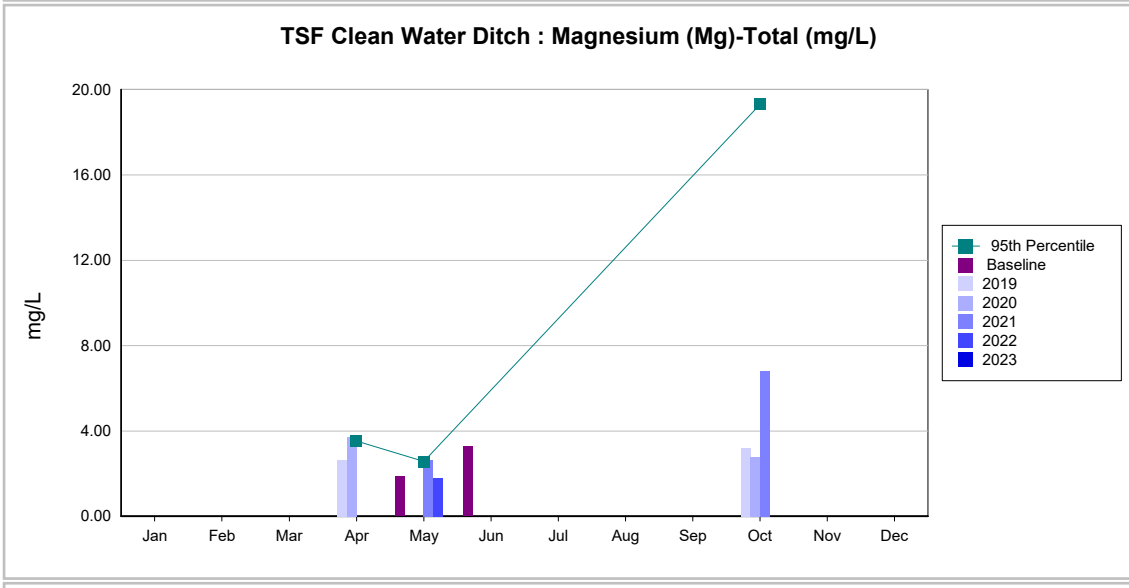
Annual Report Drainage Water

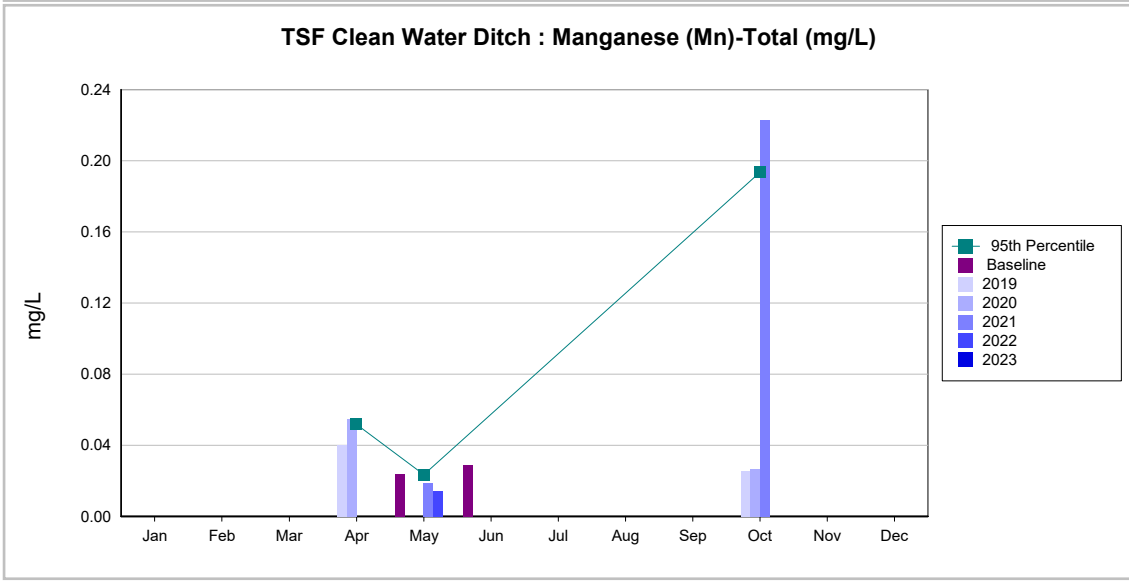
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







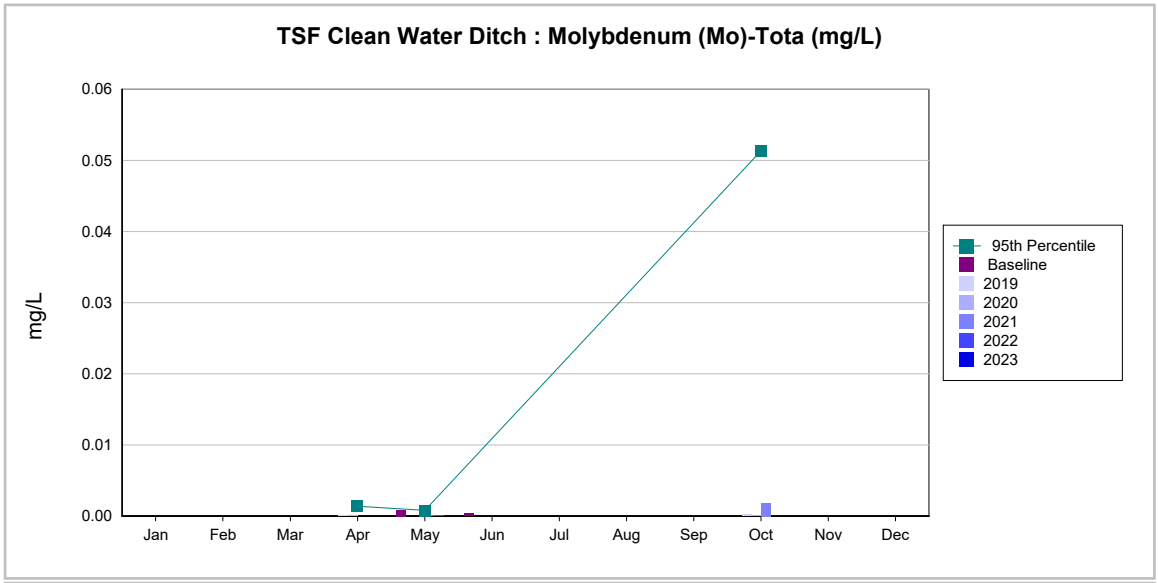
Water Quality Report

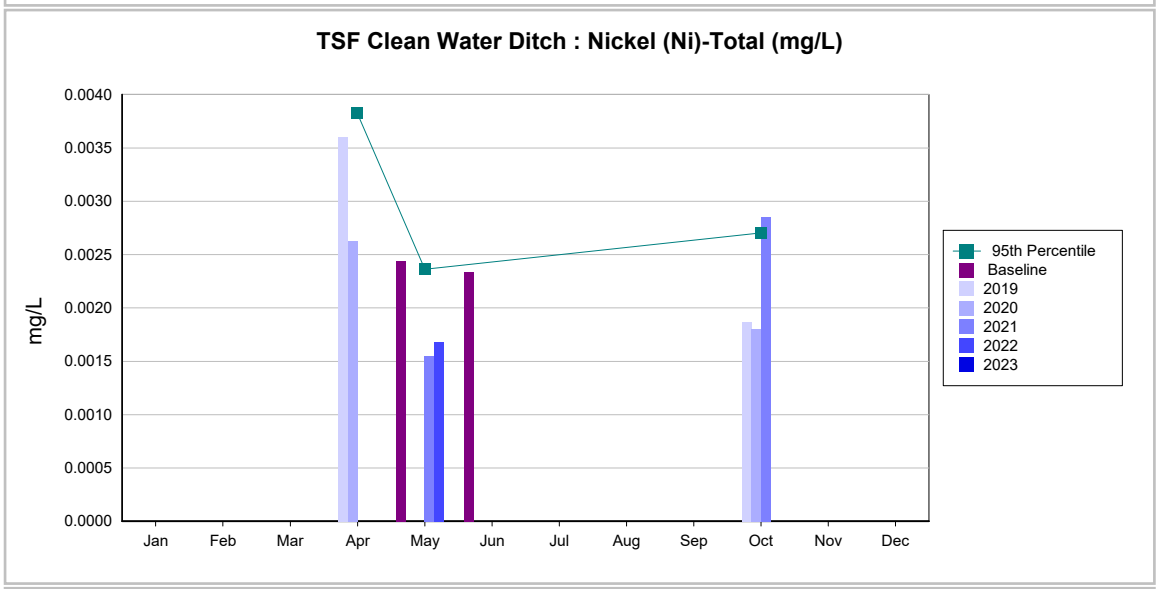
Annual Report Drainage Water

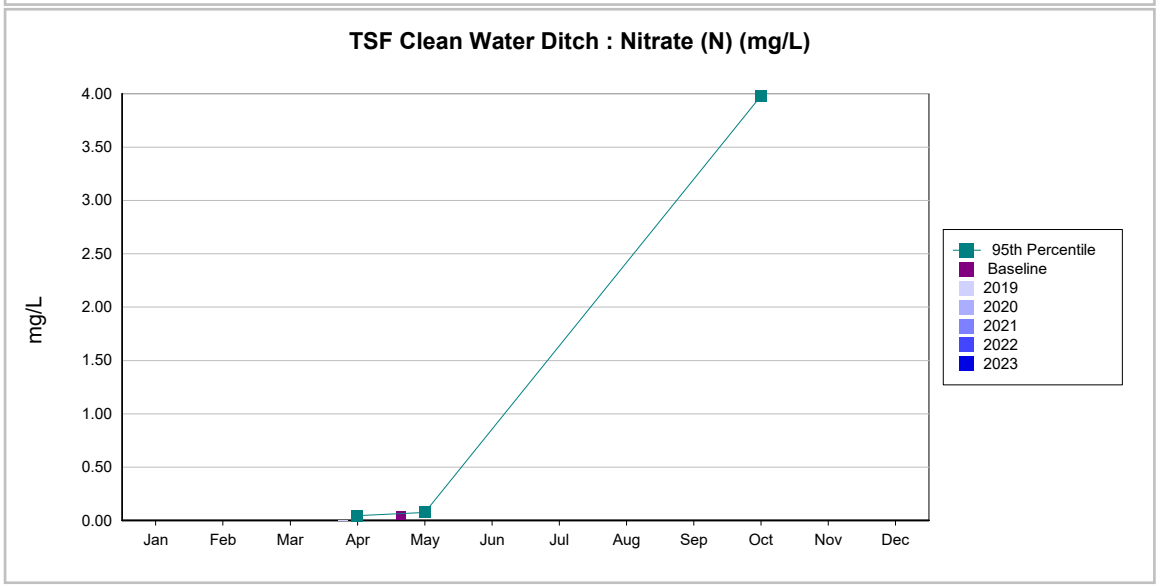
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







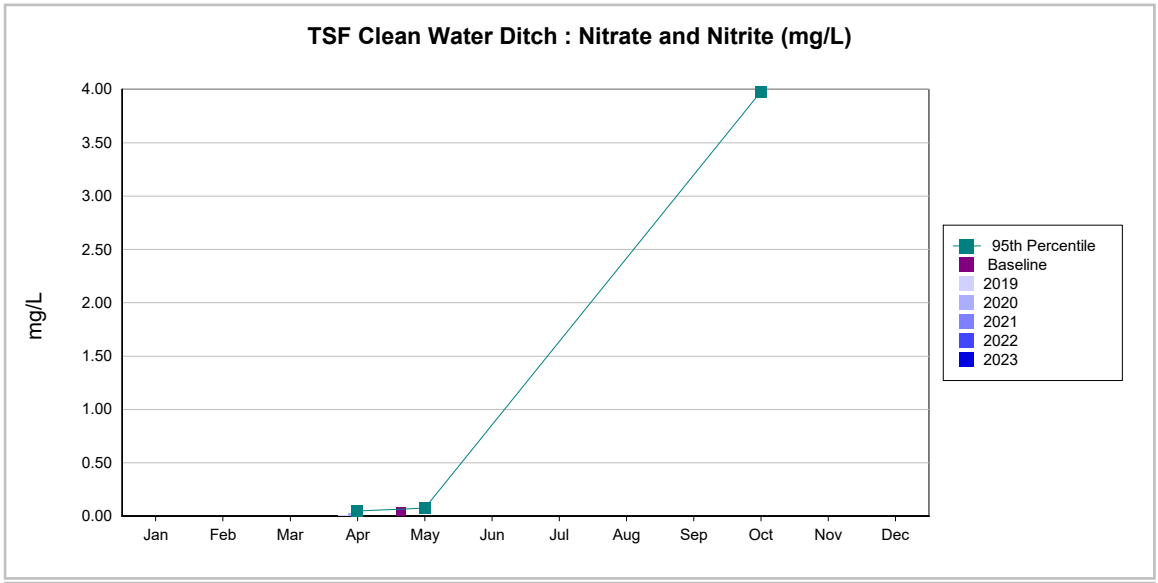
Water Quality Report

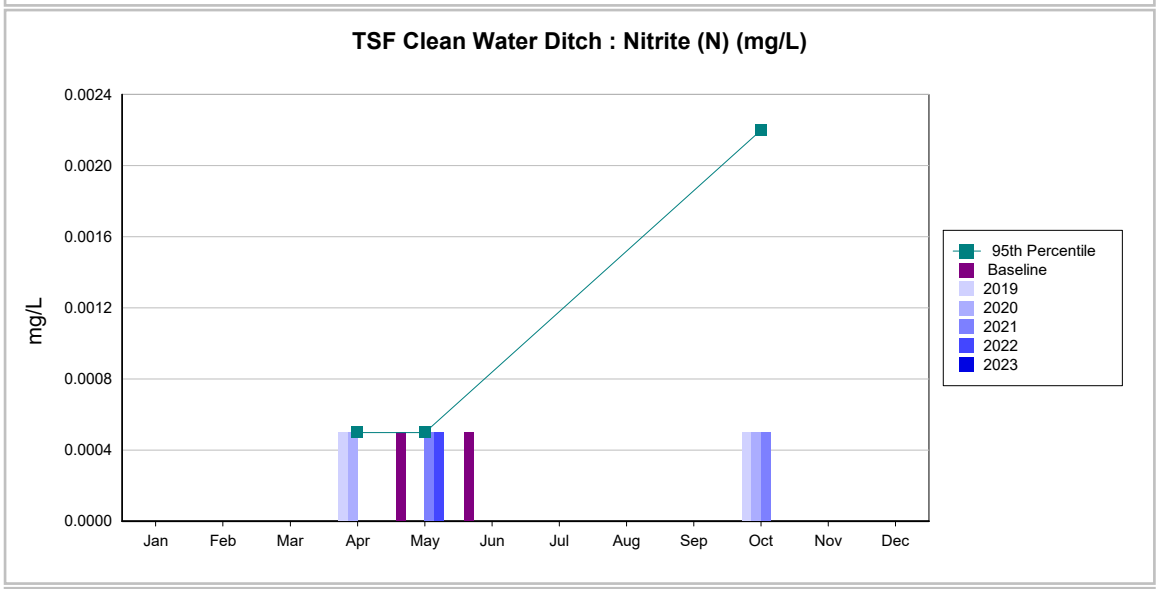
Annual Report Drainage Water

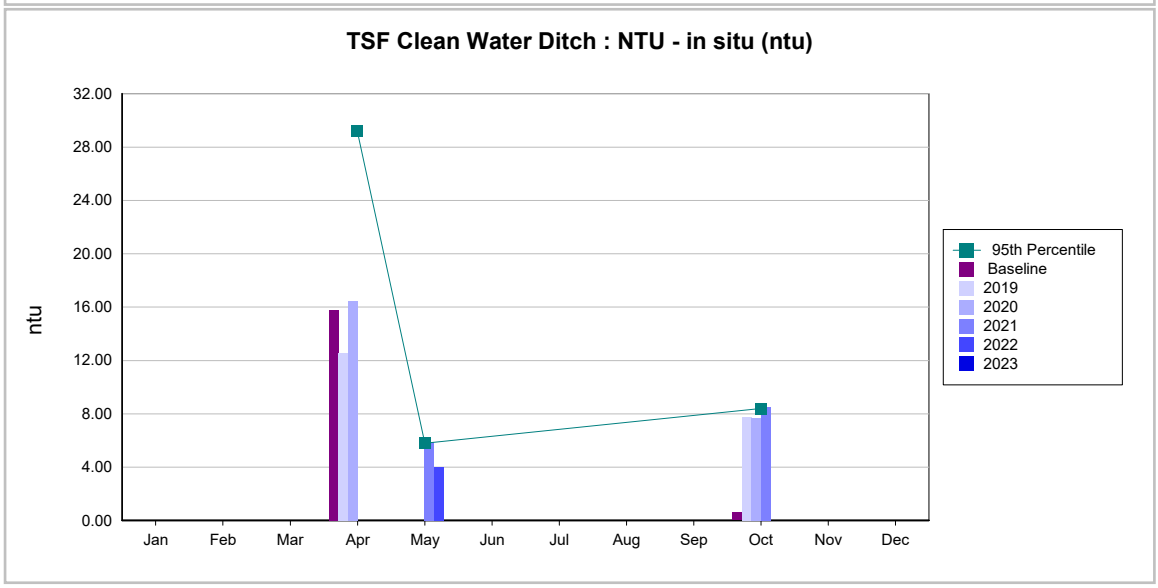
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







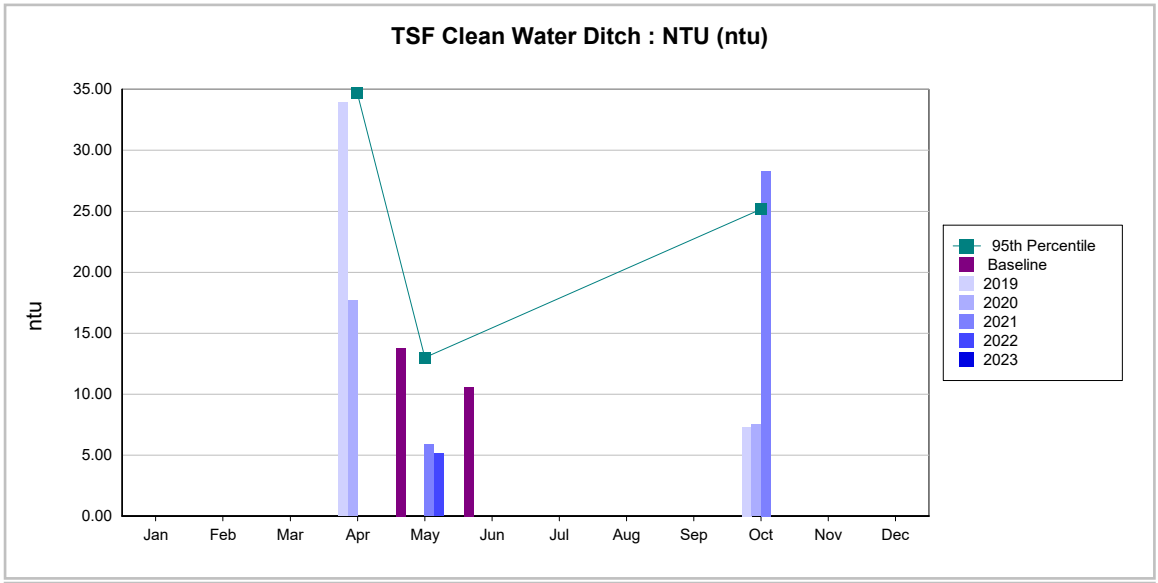
Water Quality Report

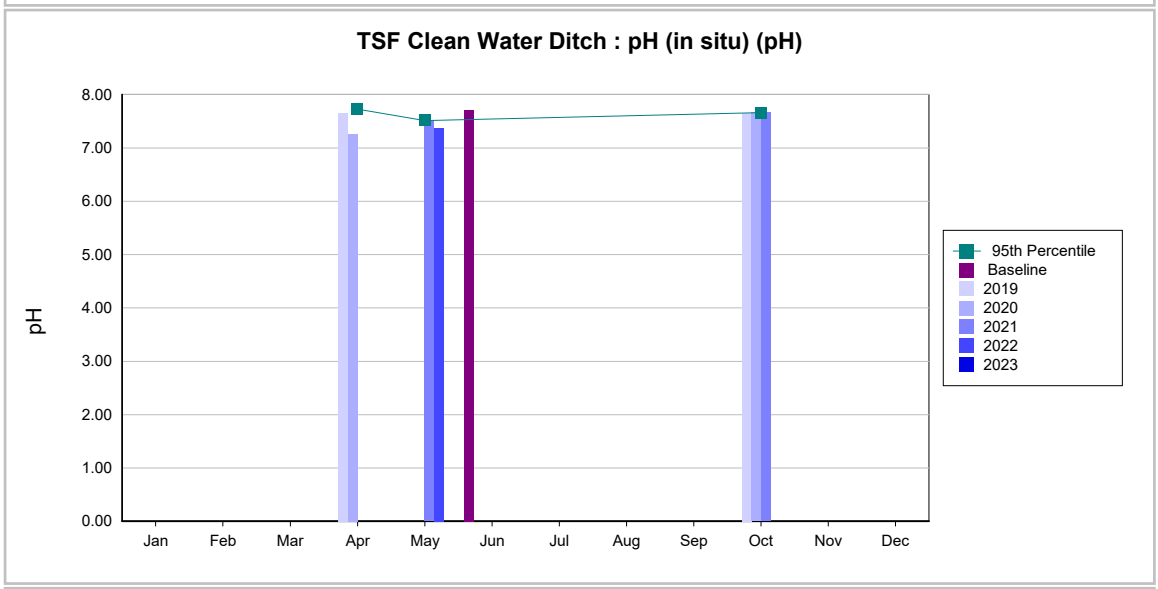
Annual Report Drainage Water

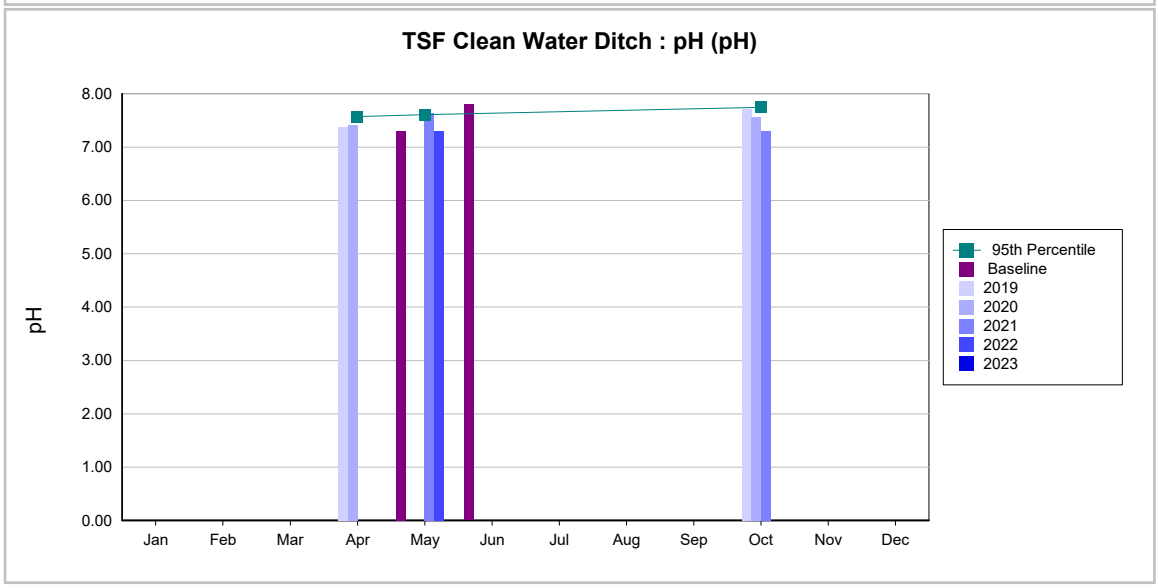
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







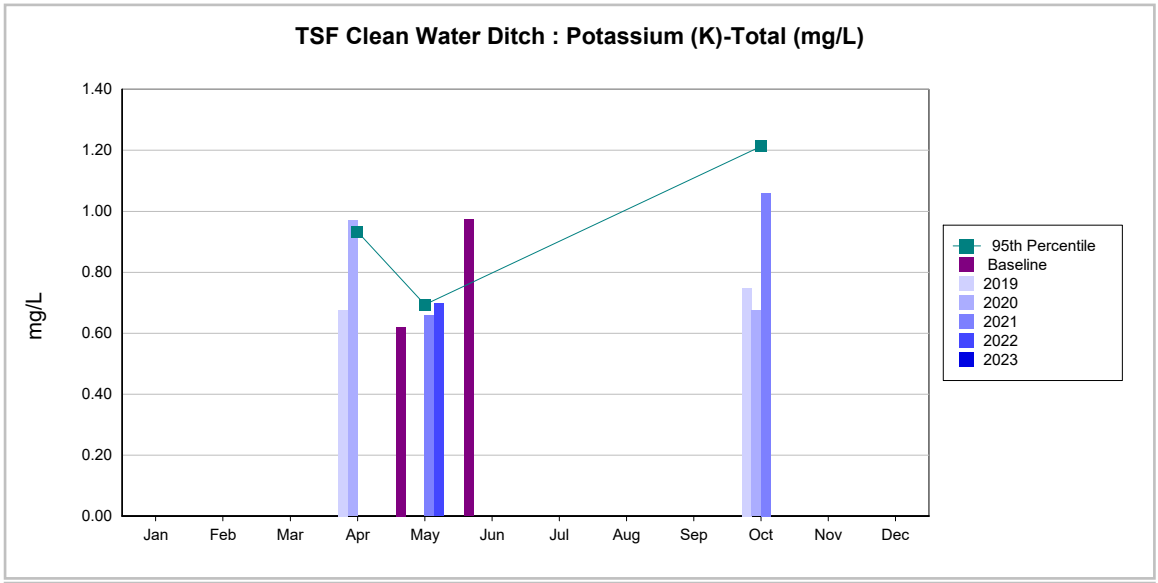
Water Quality Report

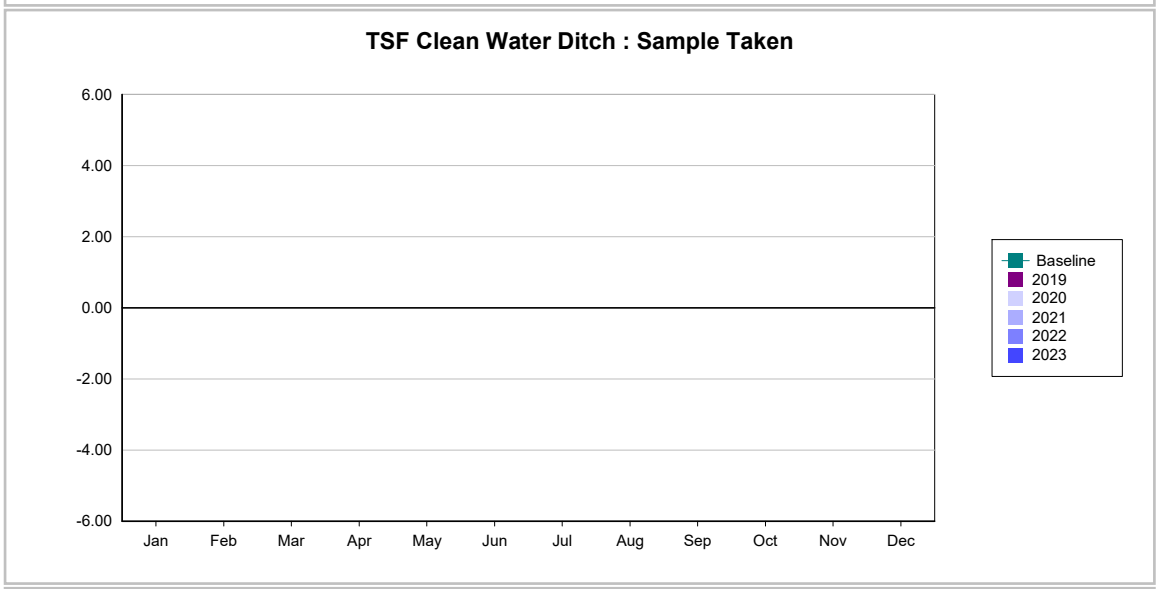
Annual Report Drainage Water

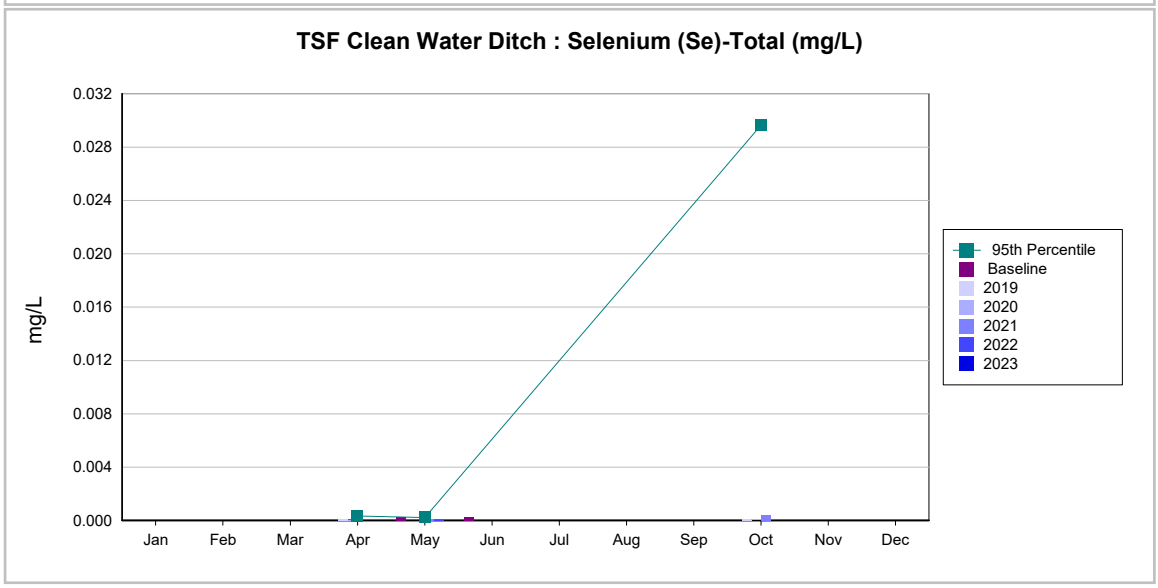
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







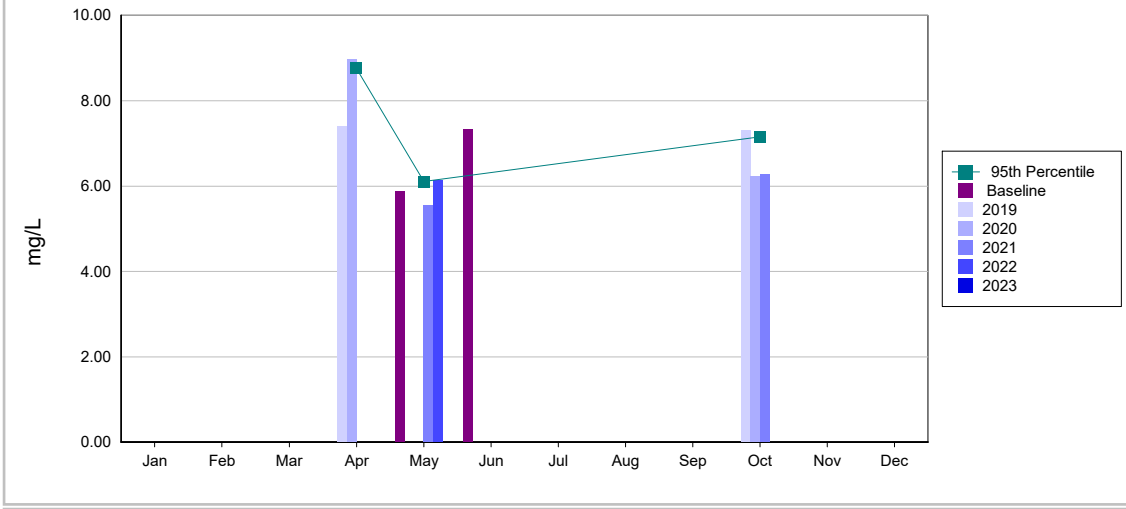
Water Quality Report

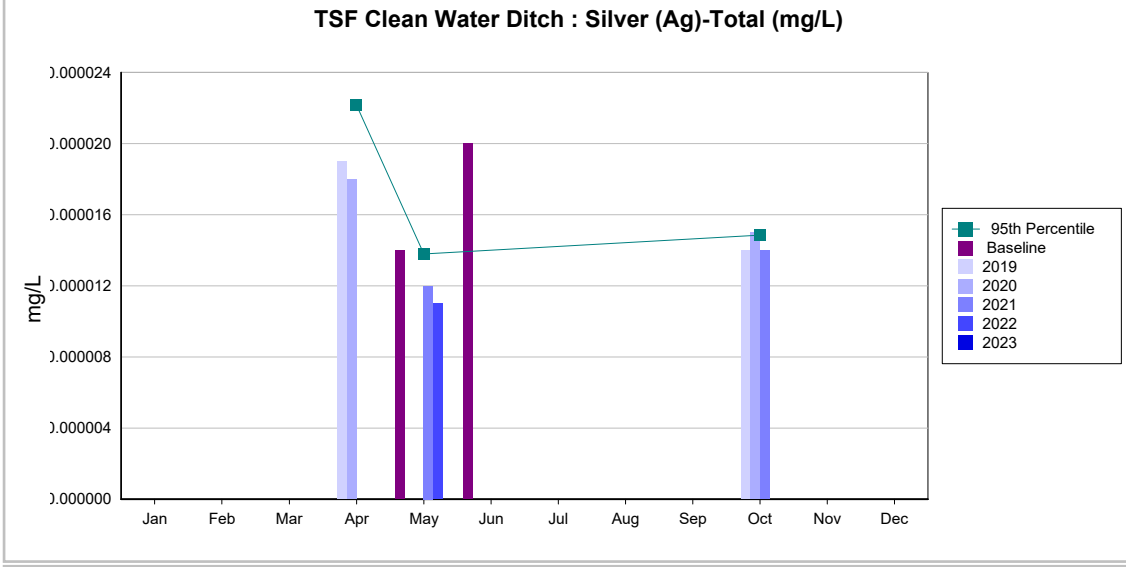
Annual Report Drainage Water

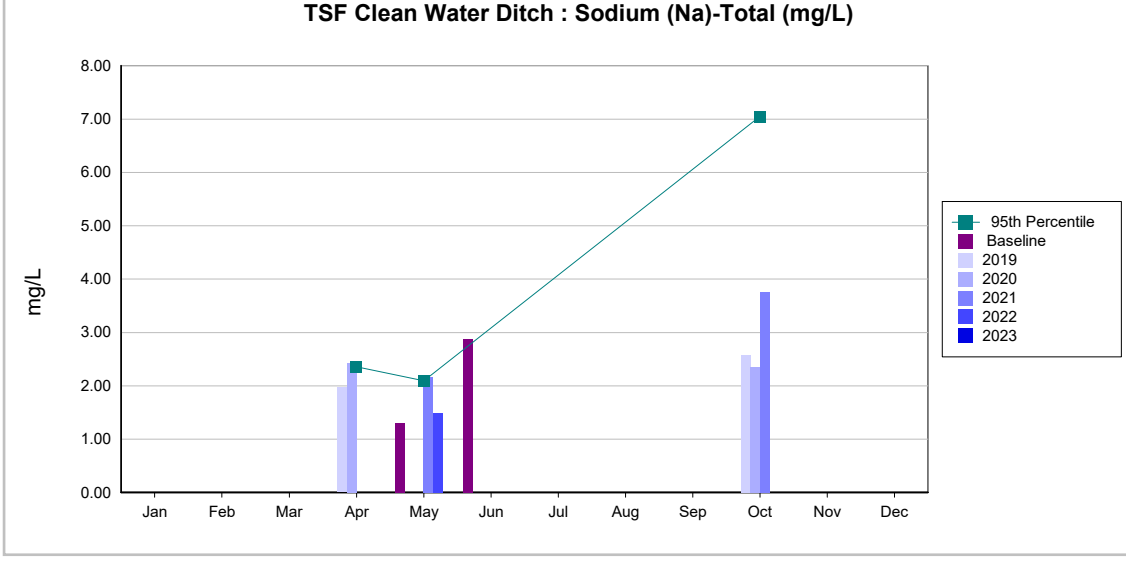
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







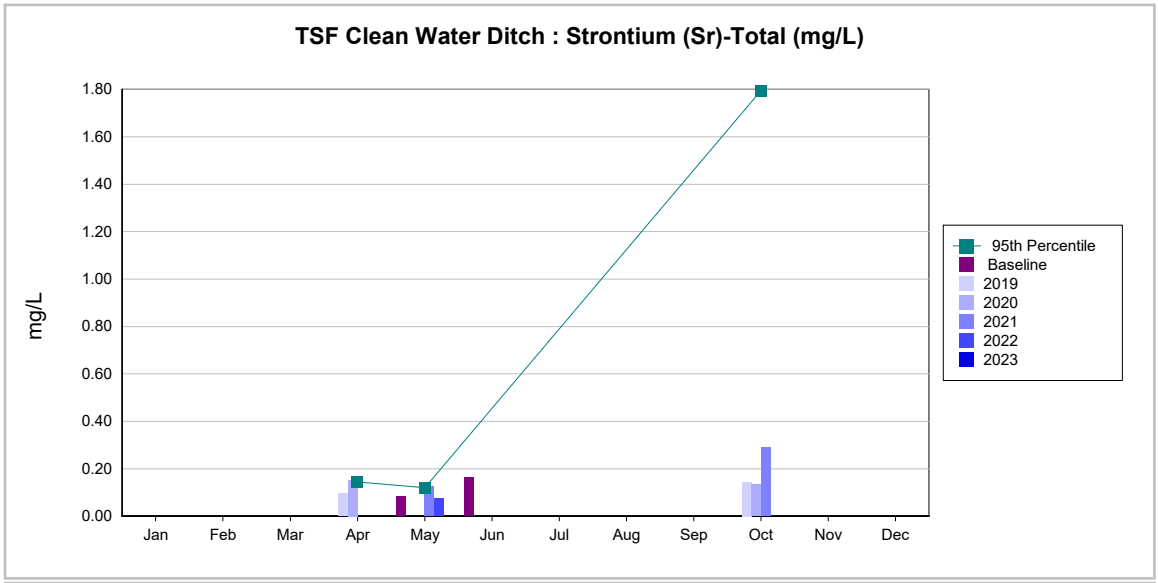
Water Quality Report

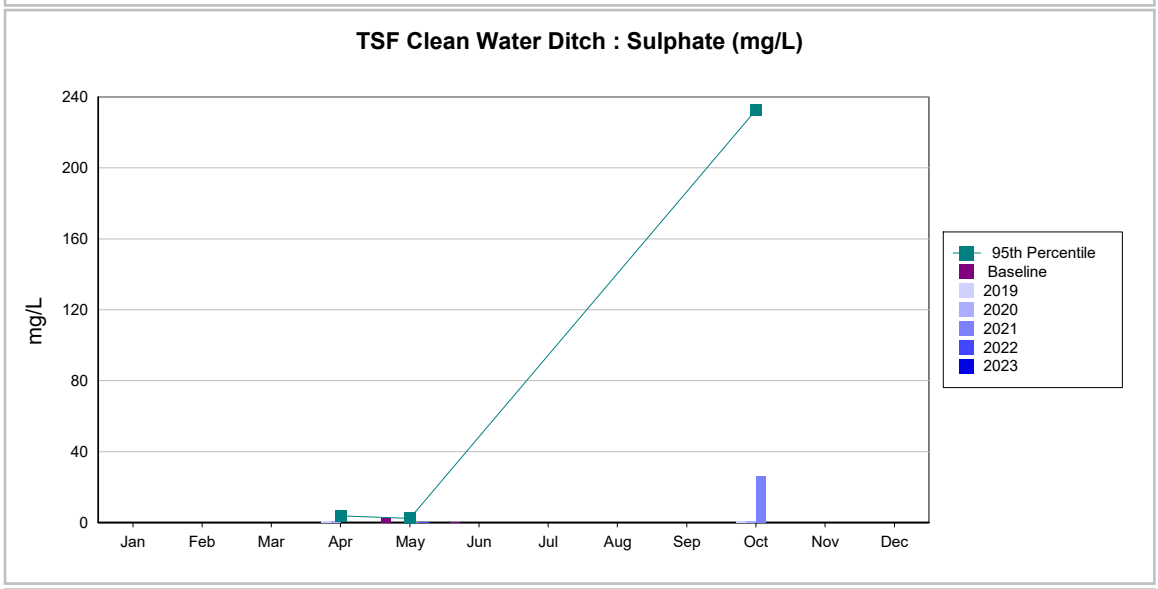
Annual Report Drainage Water

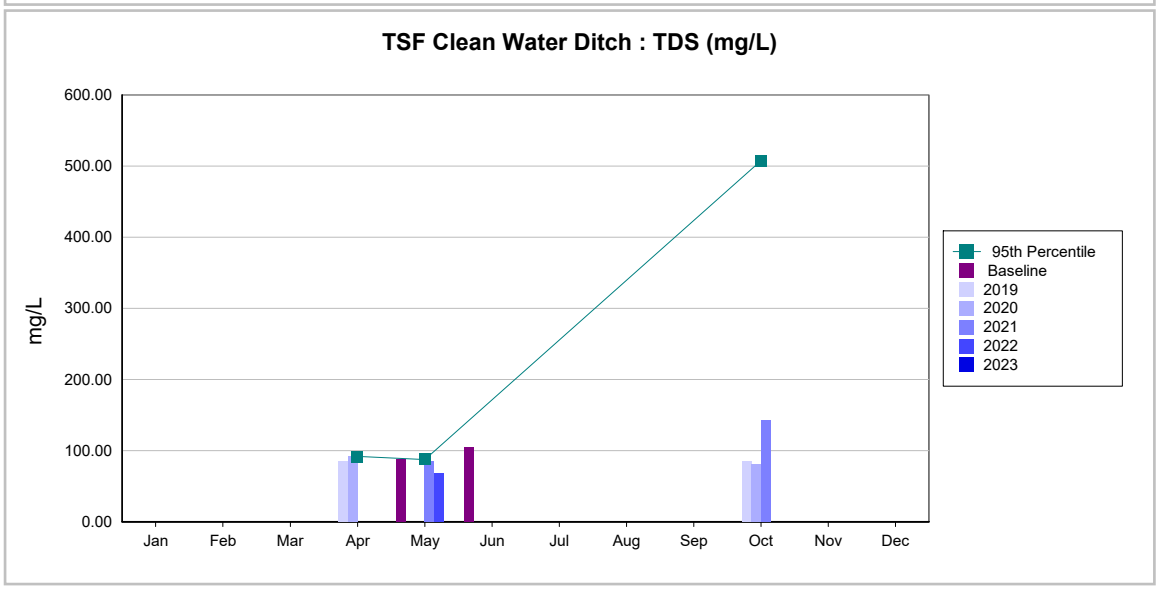
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







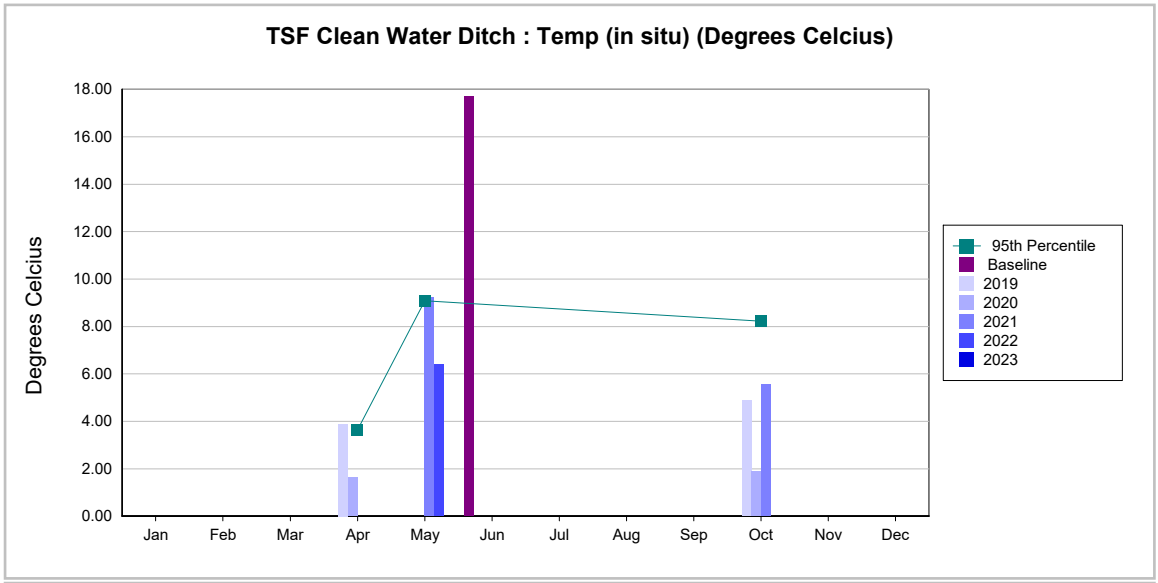
Water Quality Report

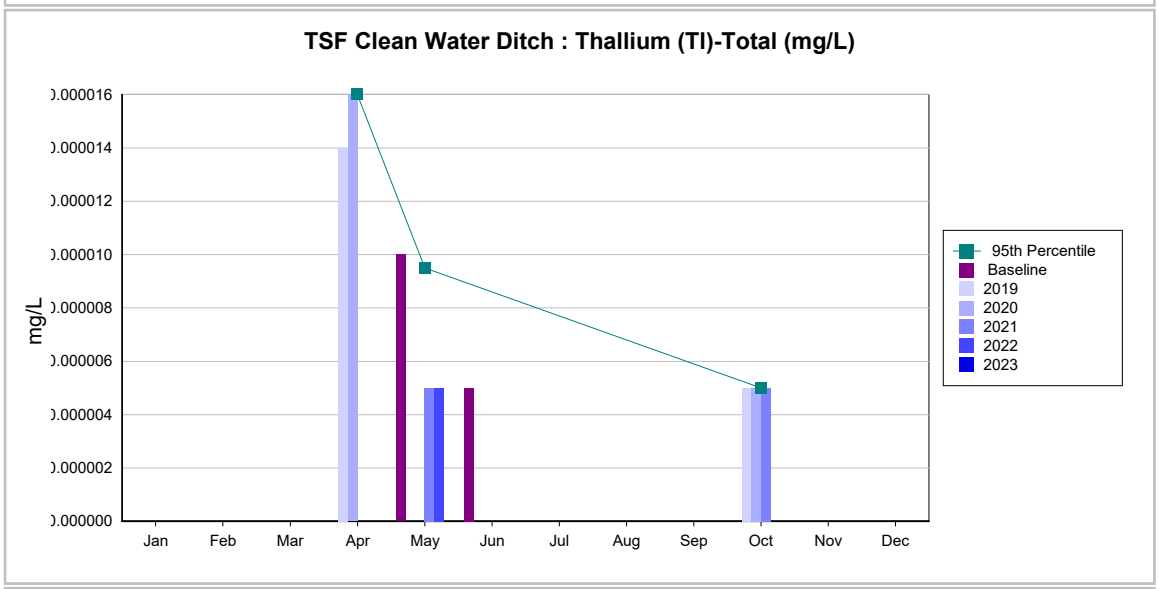
Annual Report Drainage Water

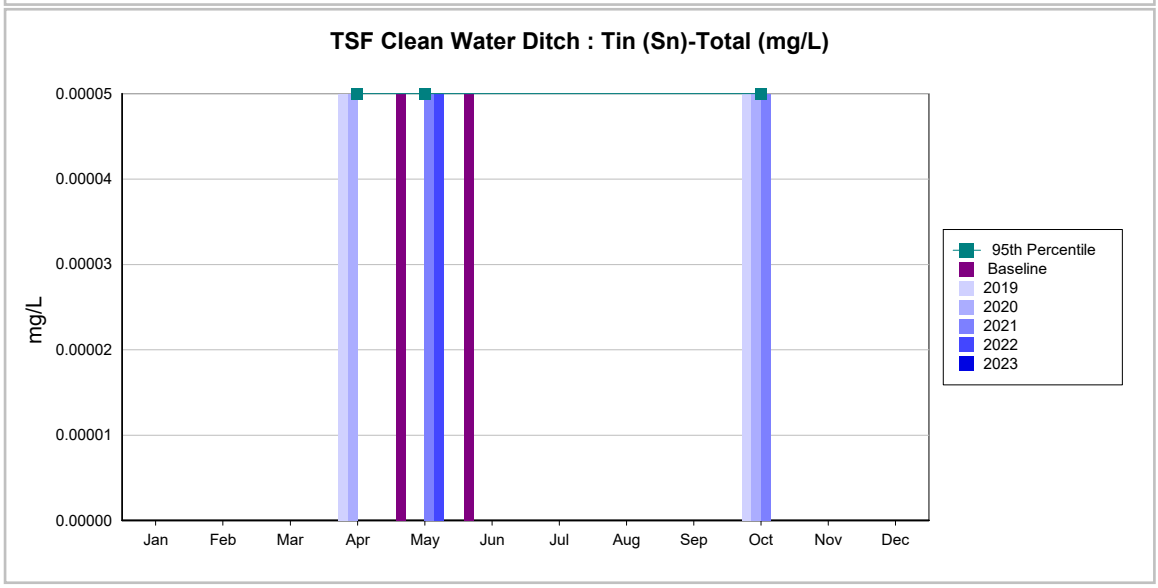
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







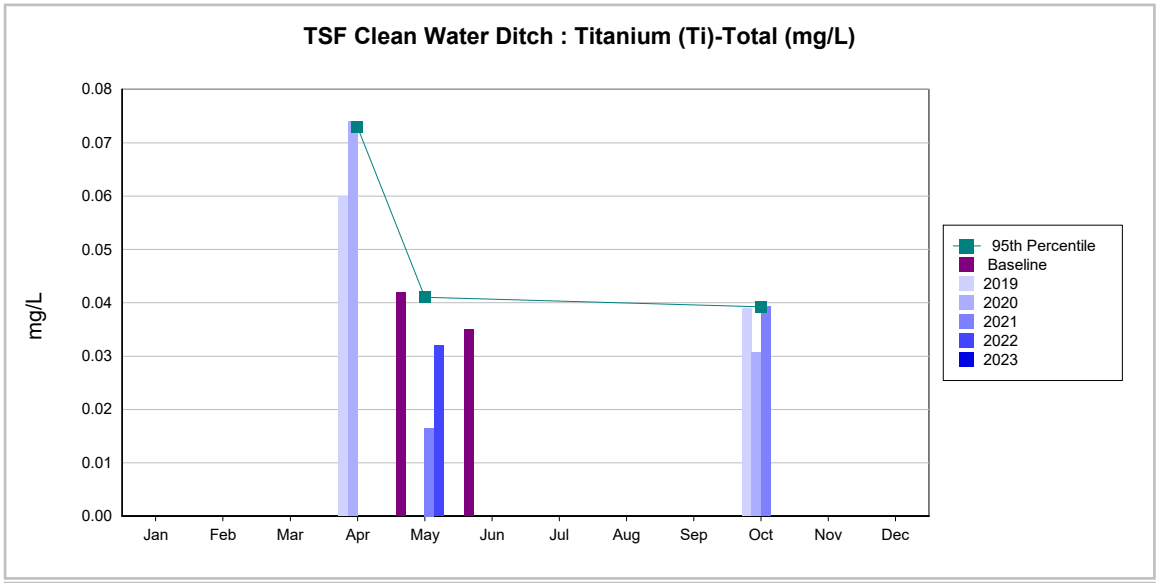
Water Quality Report

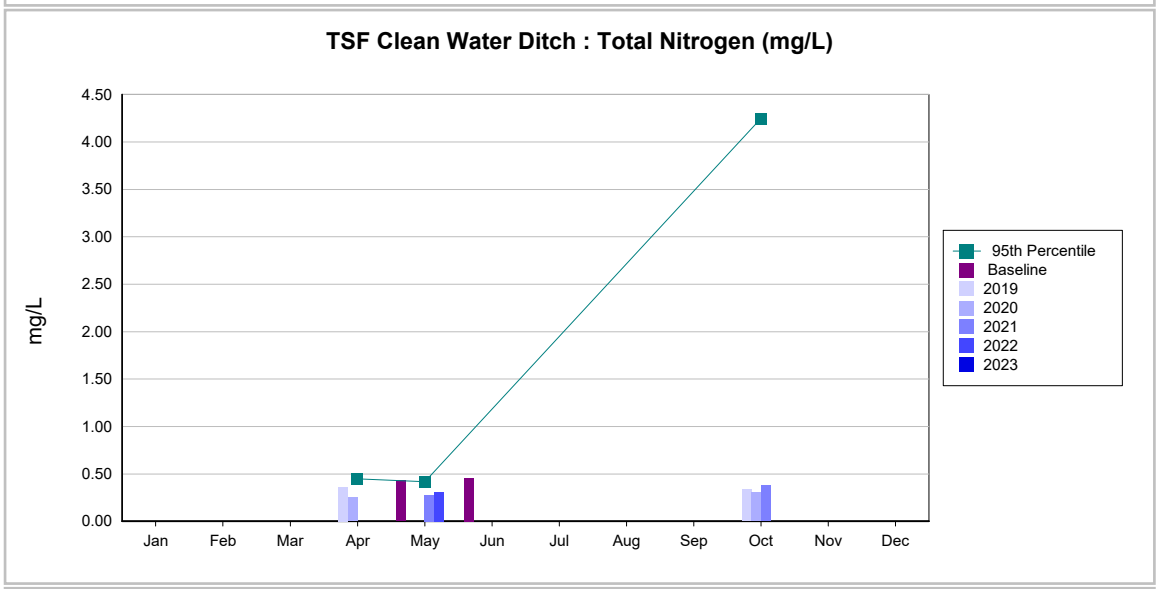
Annual Report Drainage Water

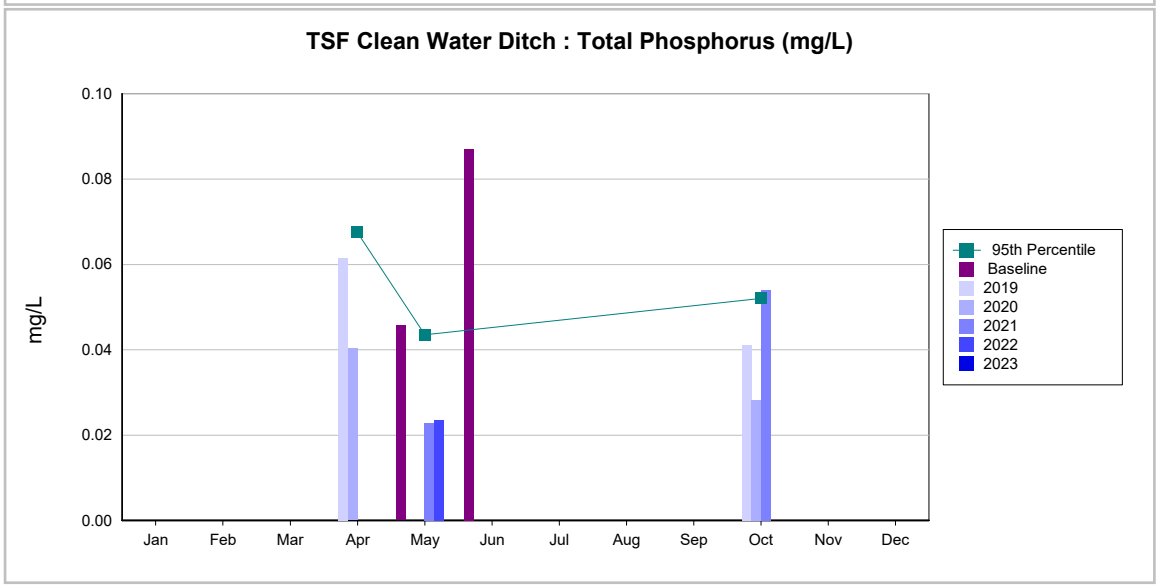
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







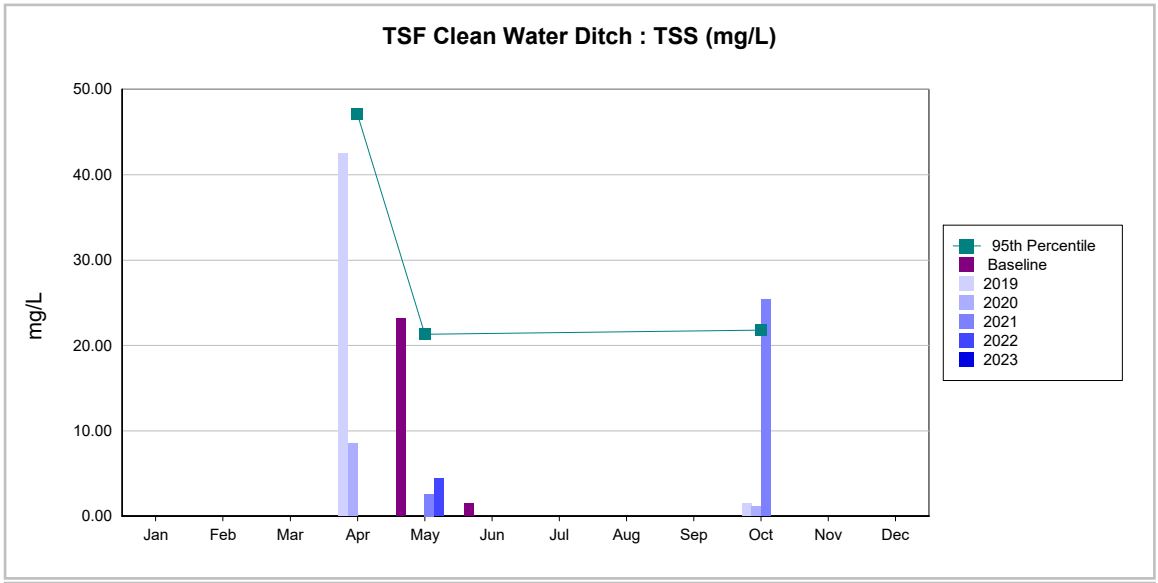
Water Quality Report

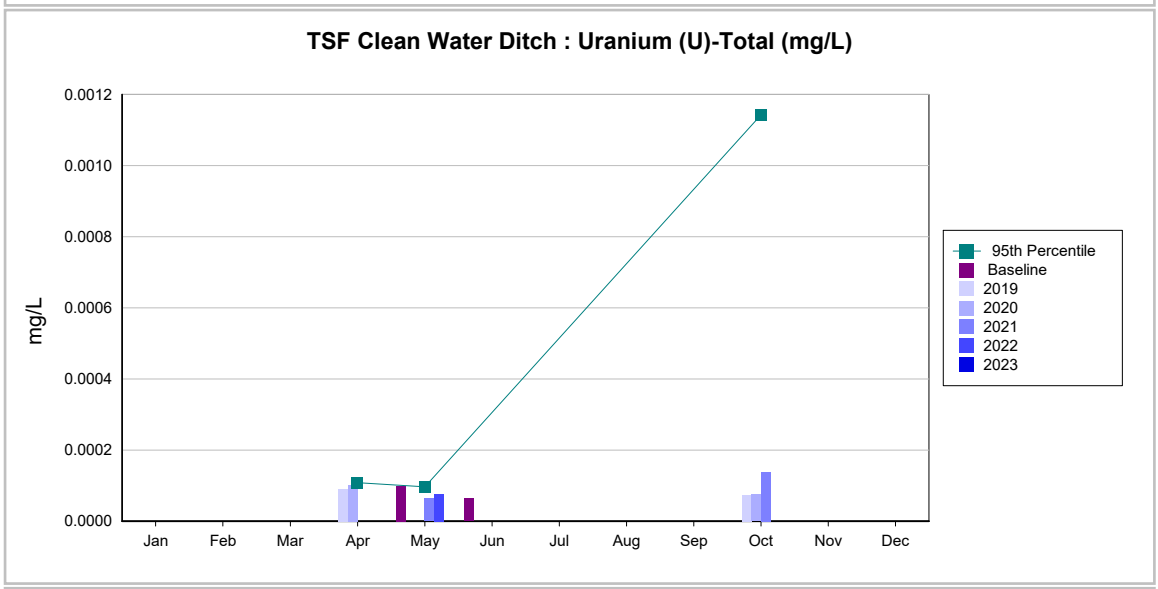
Annual Report Drainage Water

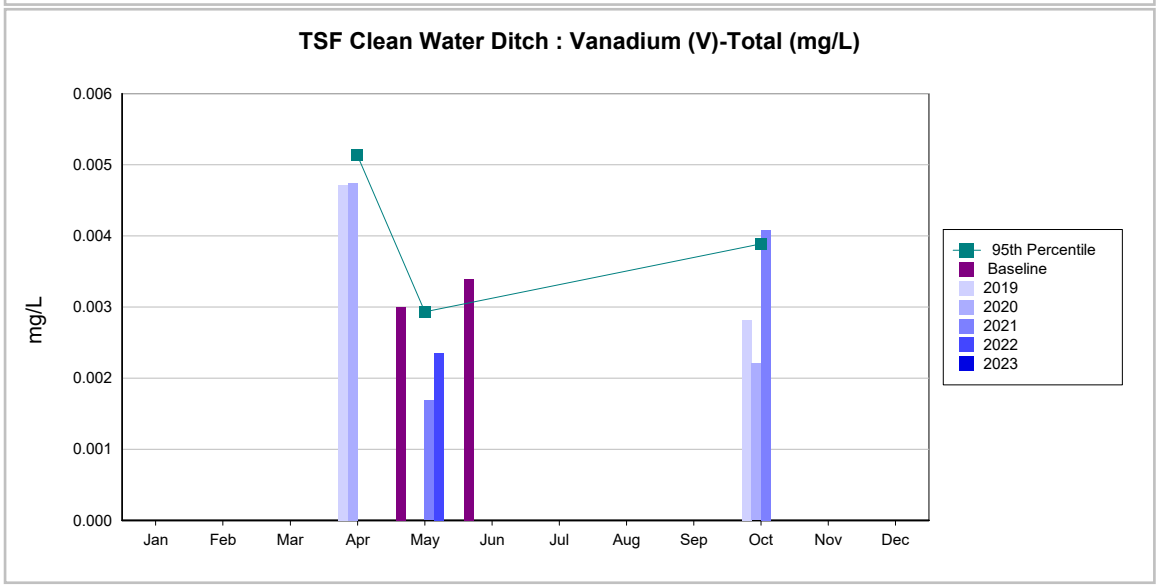
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







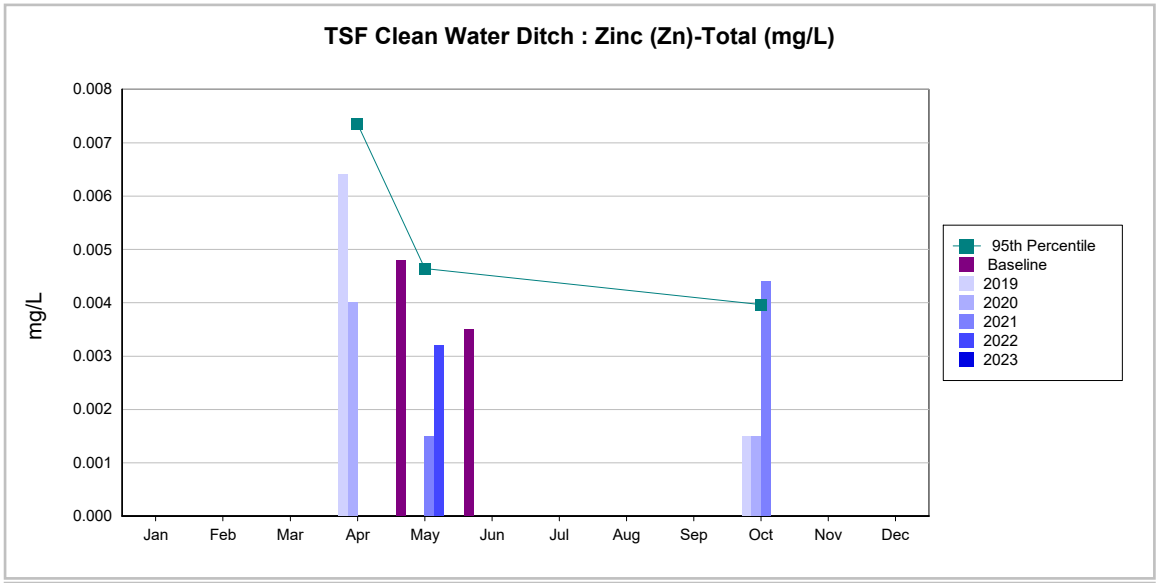
Water Quality Report

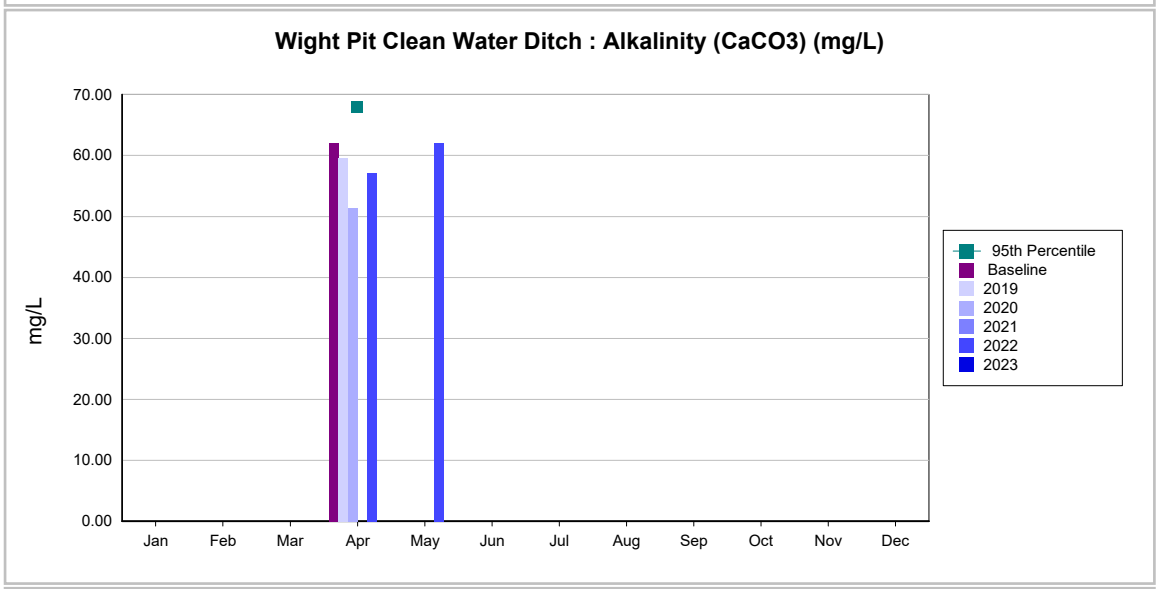
Annual Report Drainage Water

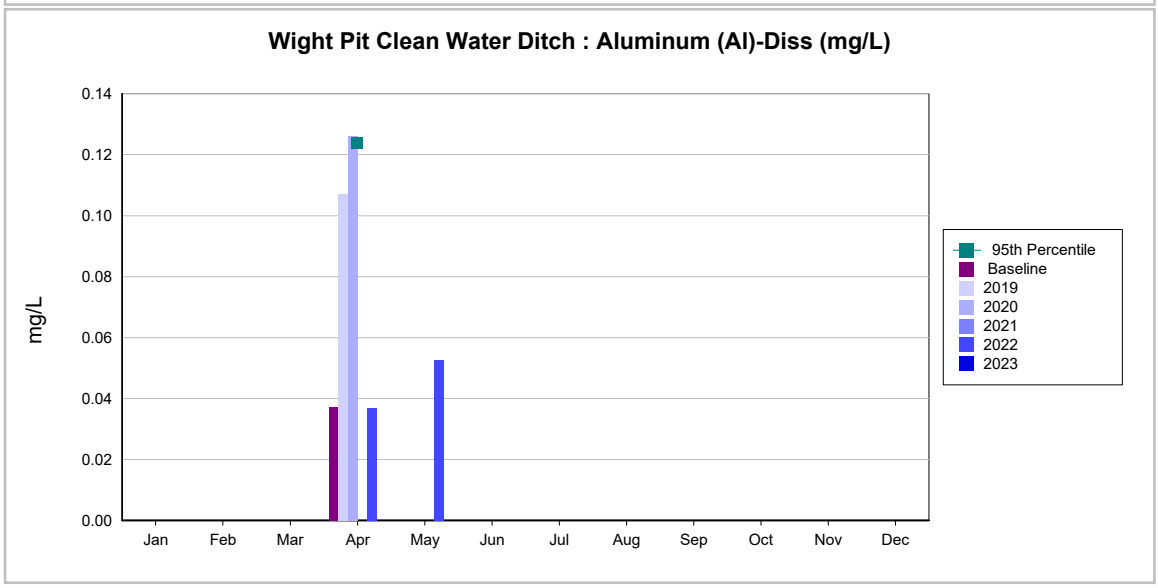
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







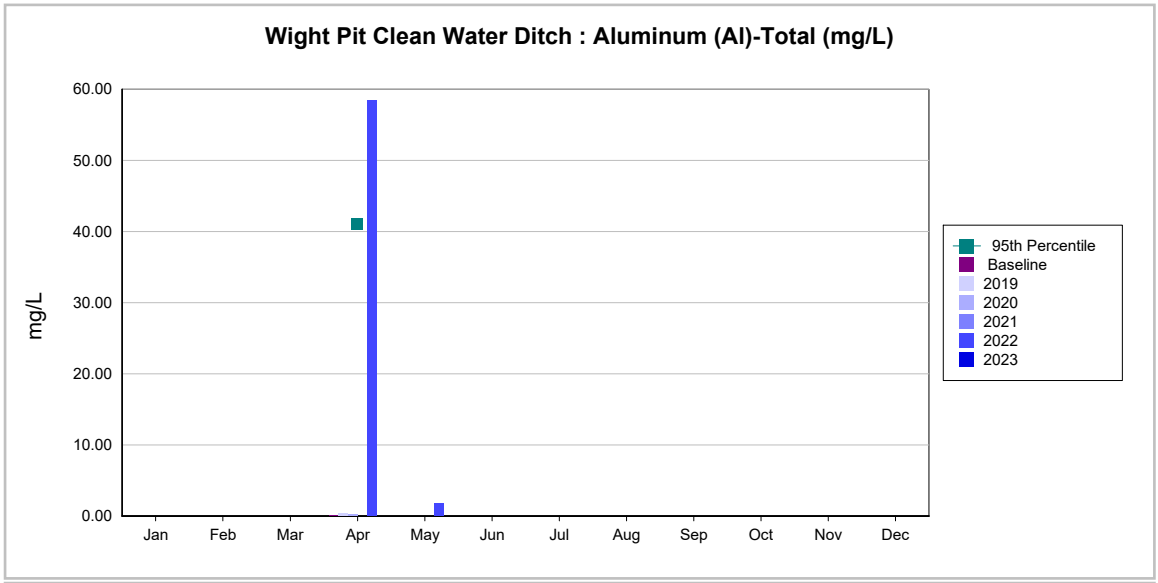
Water Quality Report

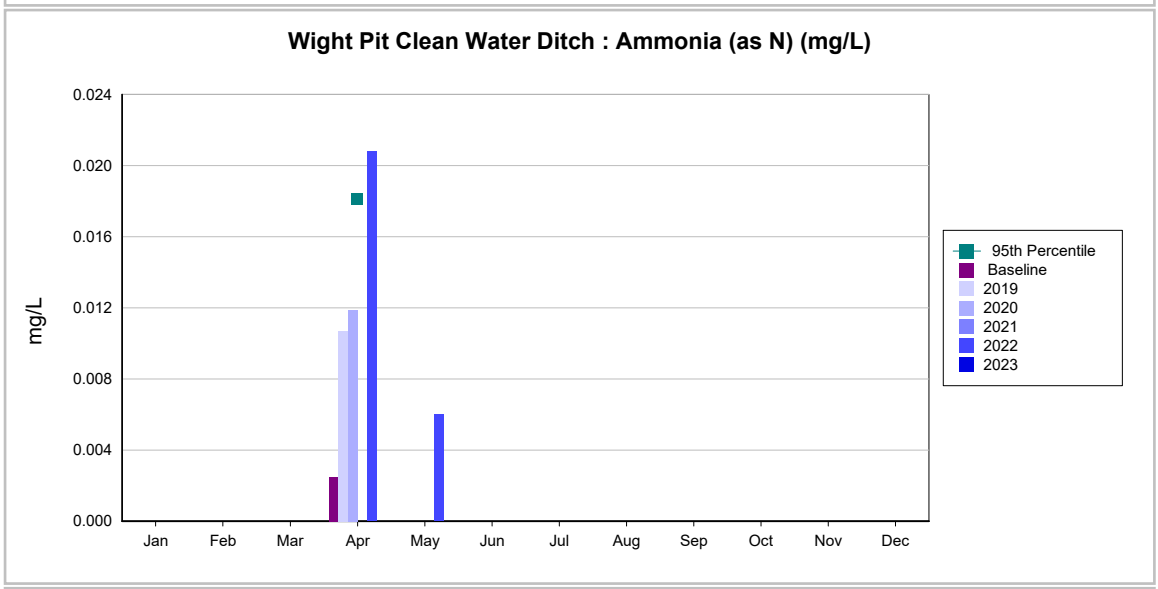
Annual Report Drainage Water

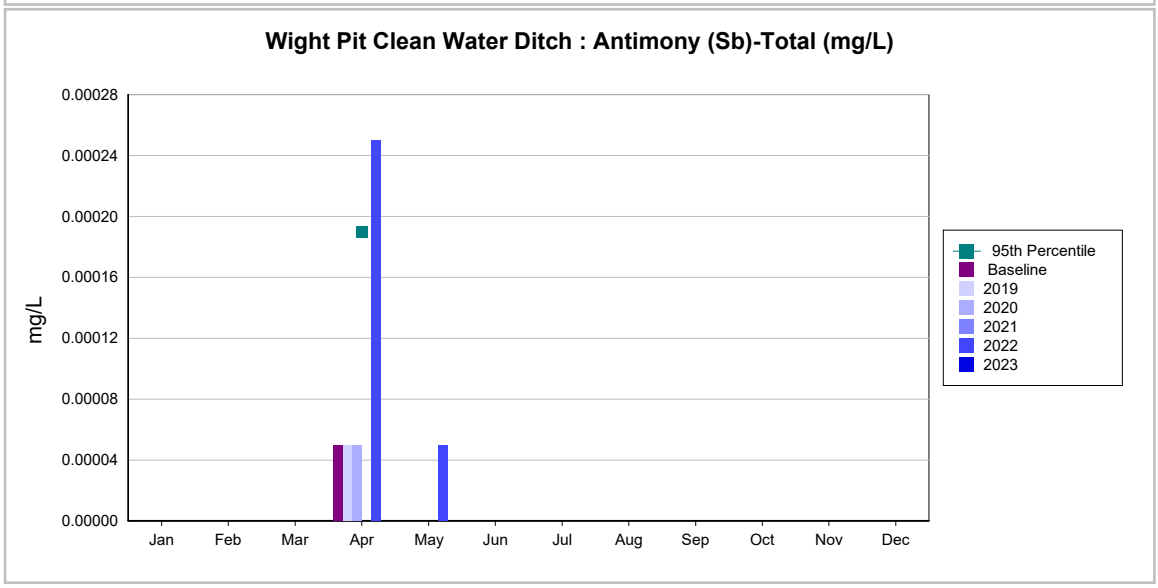
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







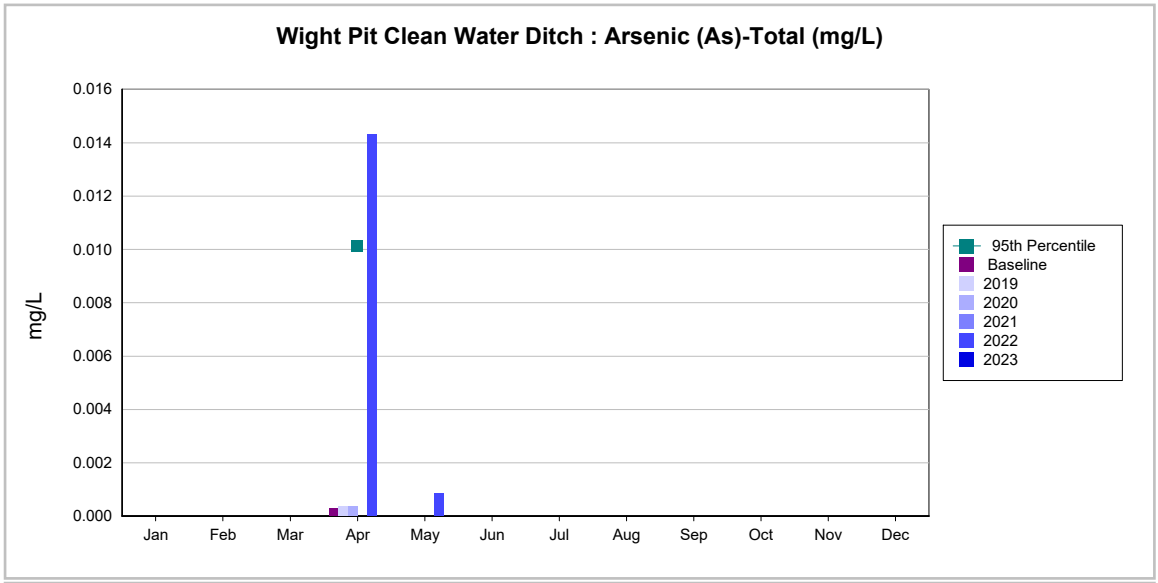
Water Quality Report

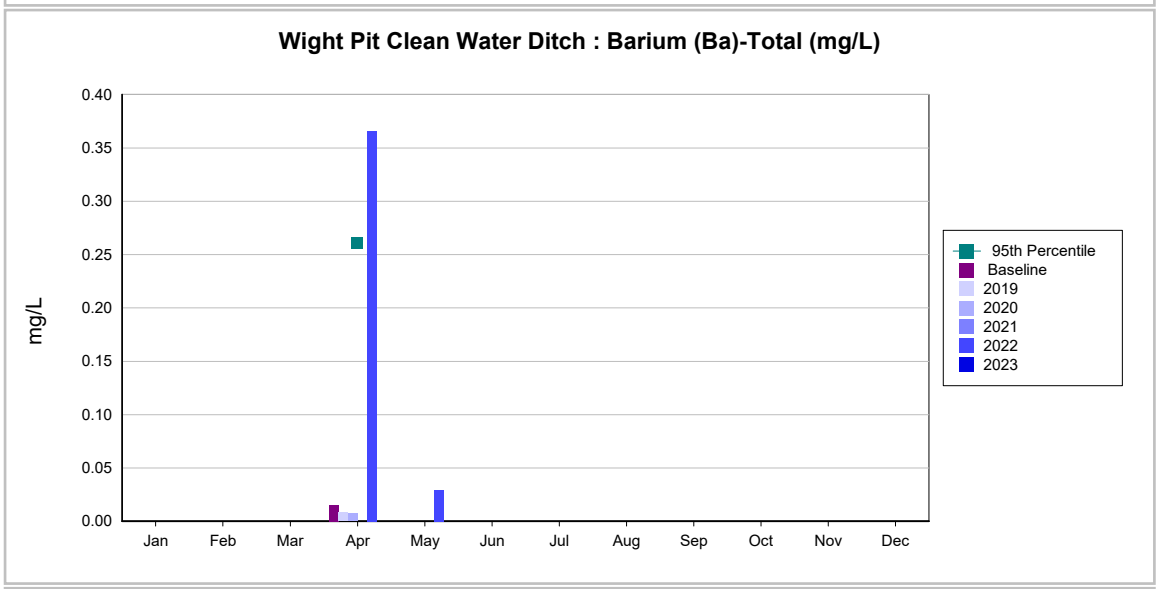
Annual Report Drainage Water

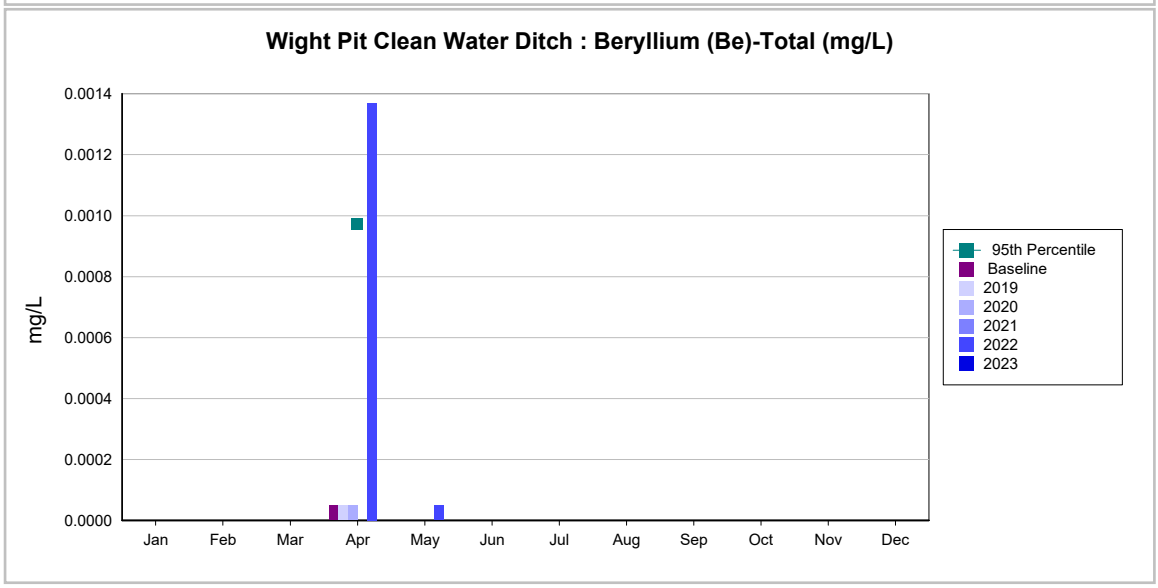
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







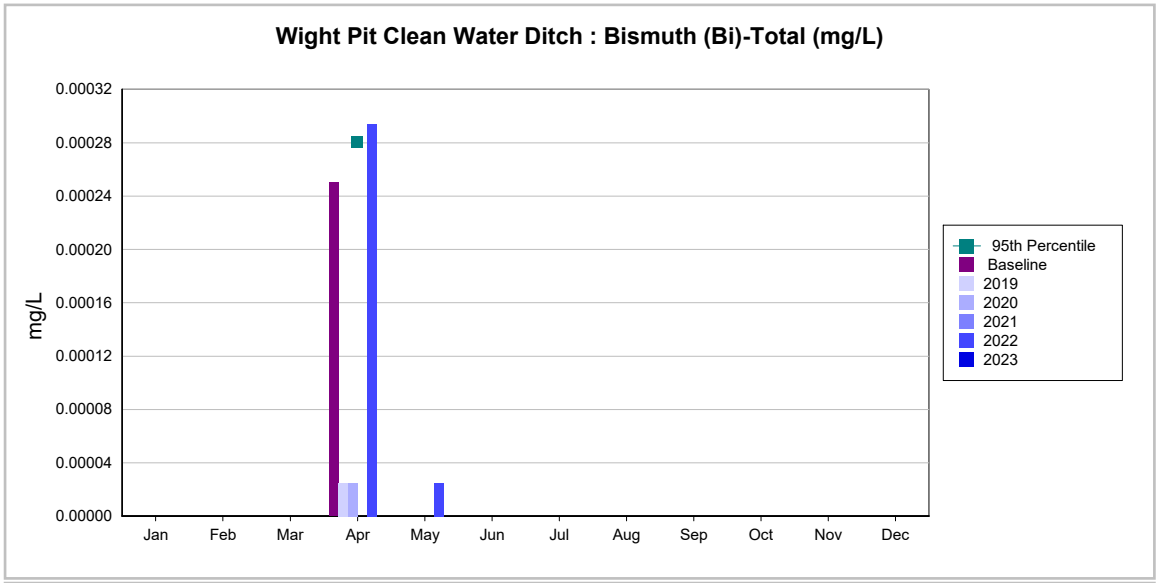
Water Quality Report

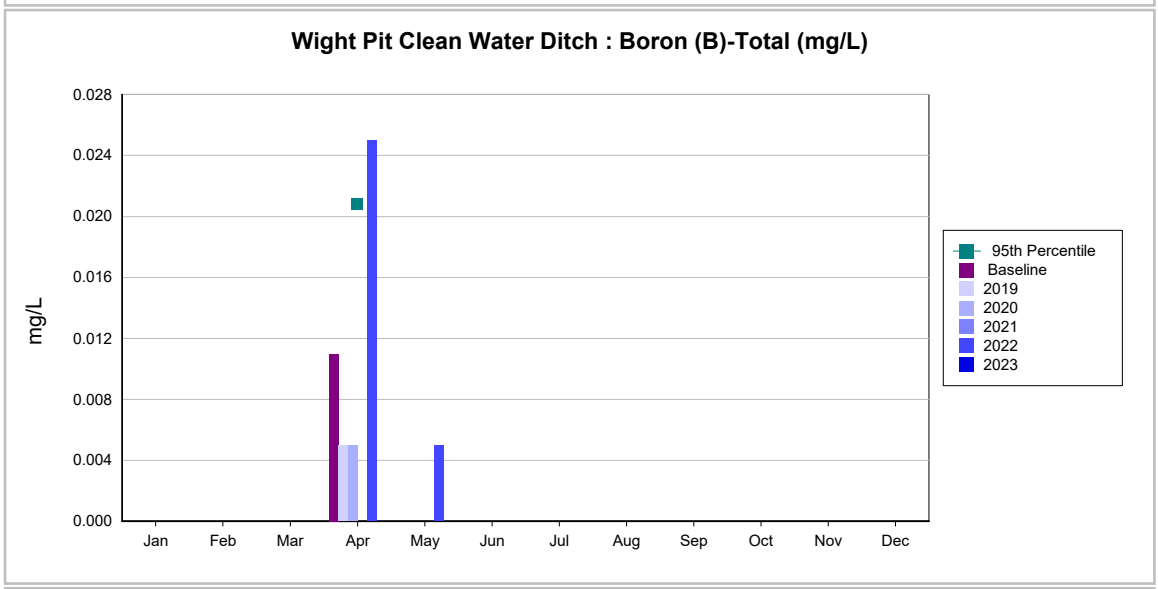
Annual Report Drainage Water

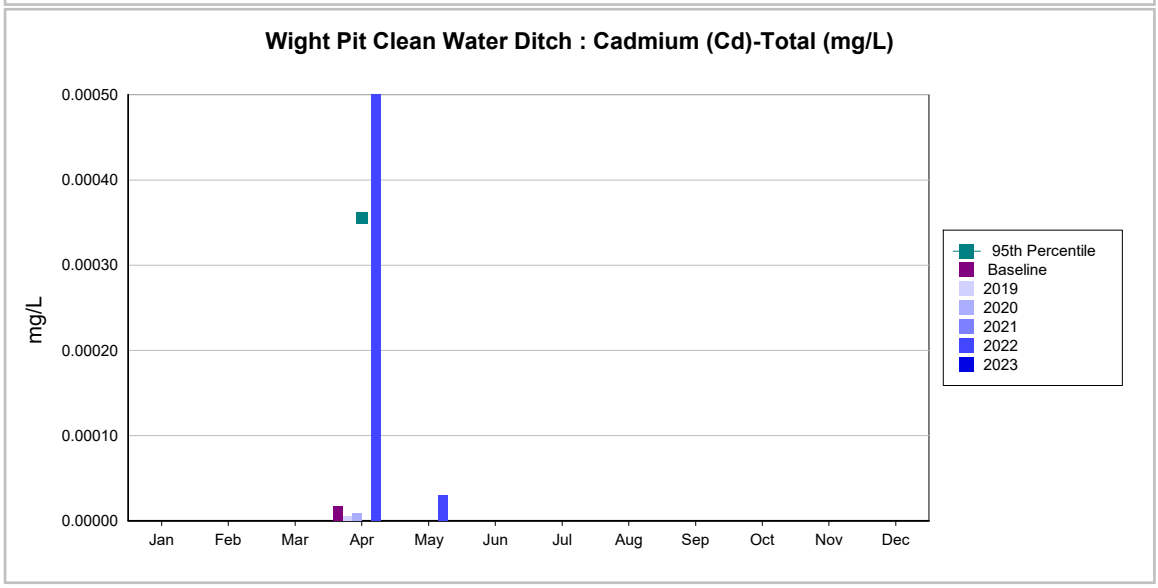
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







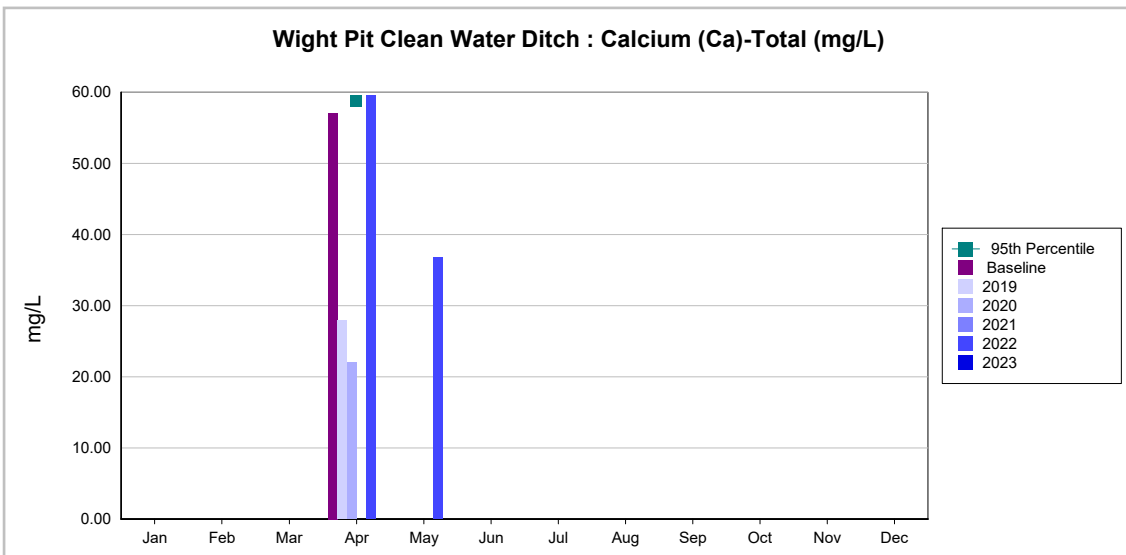
Water Quality Report

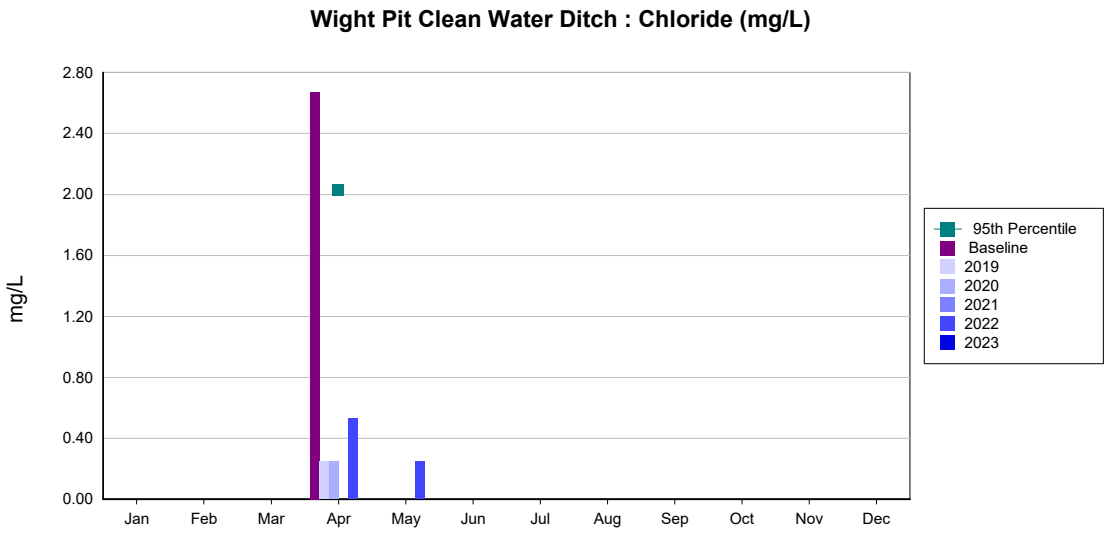
Annual Report Drainage Water

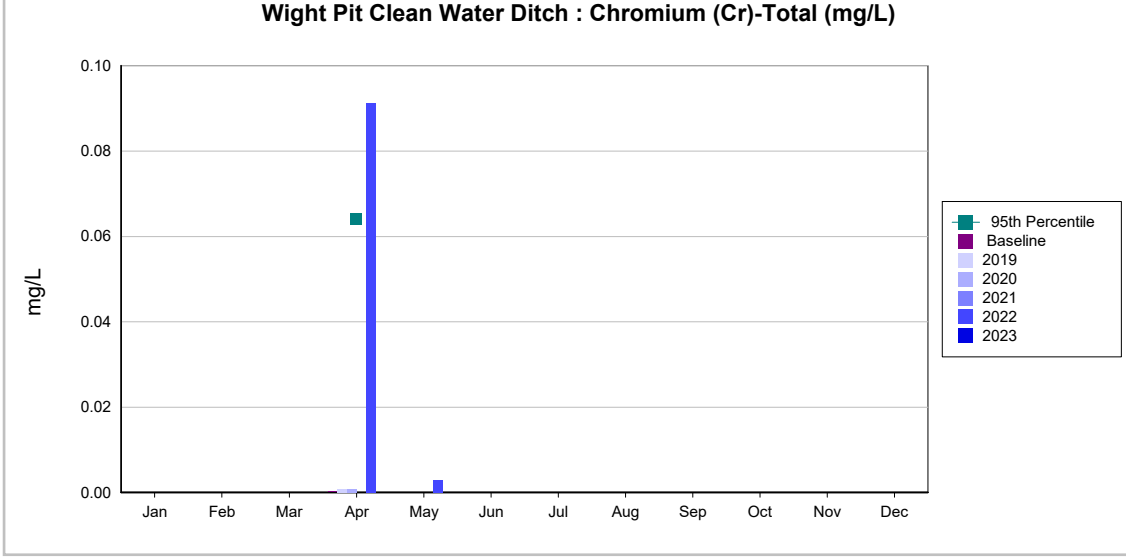
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







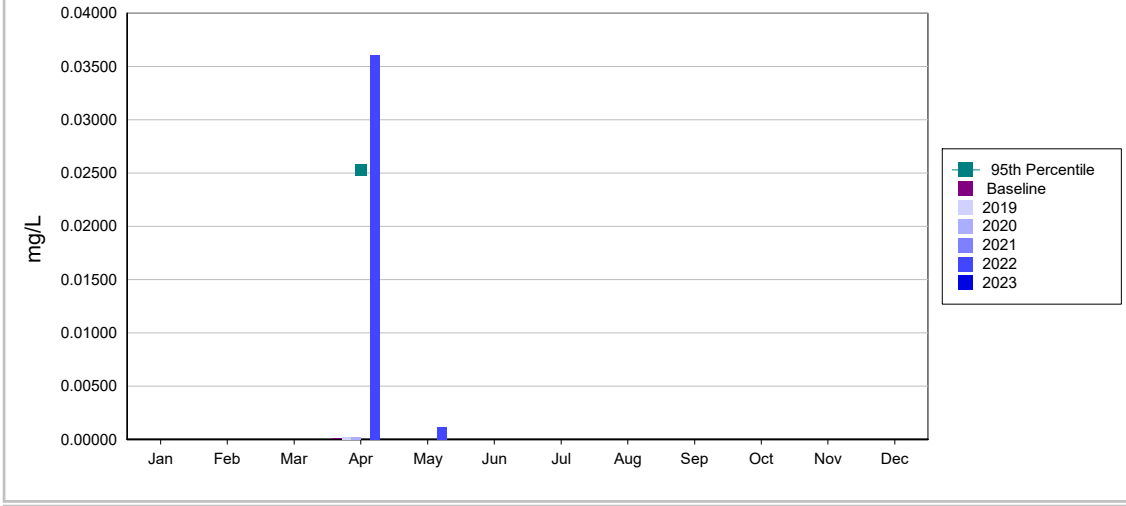
Water Quality Report

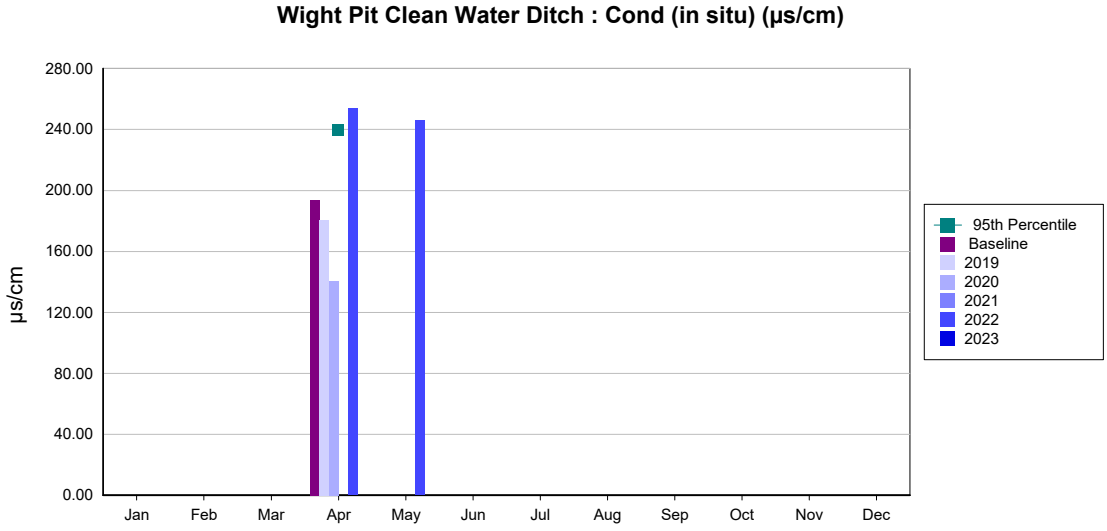
Annual Report Drainage Water

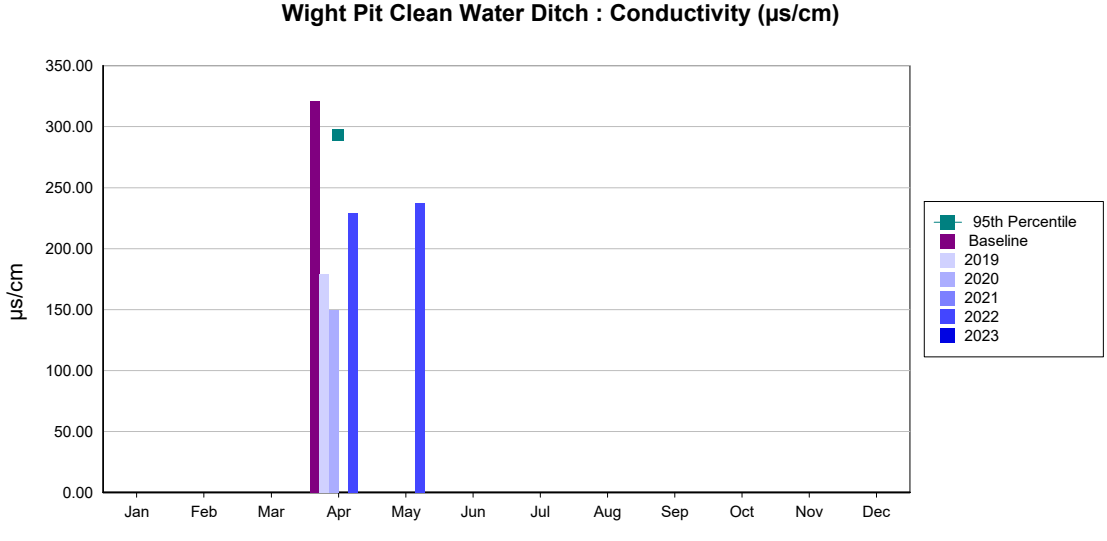
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







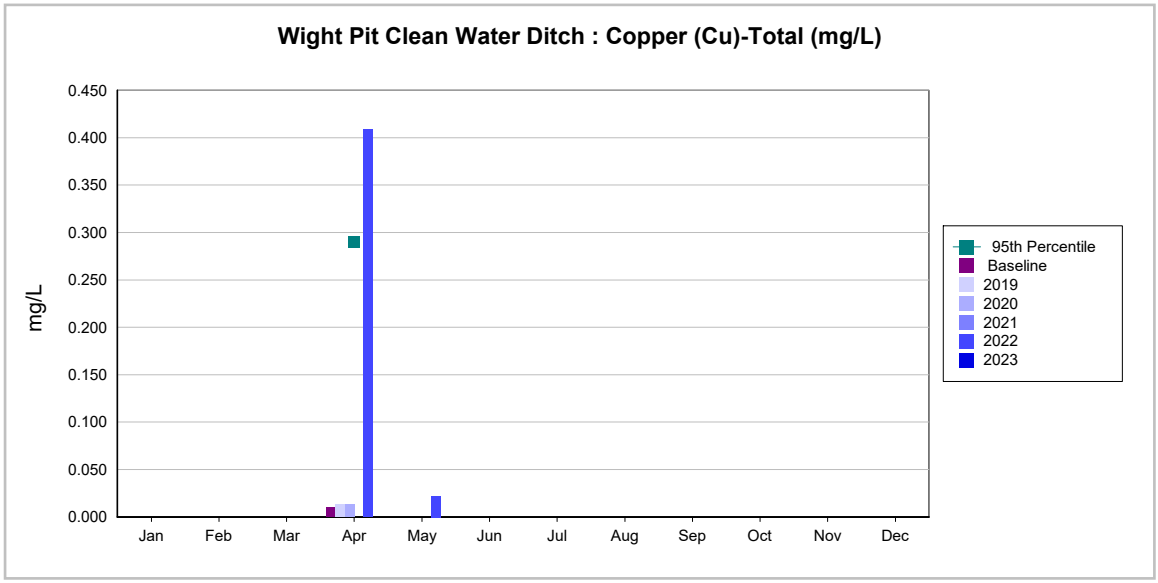
Water Quality Report

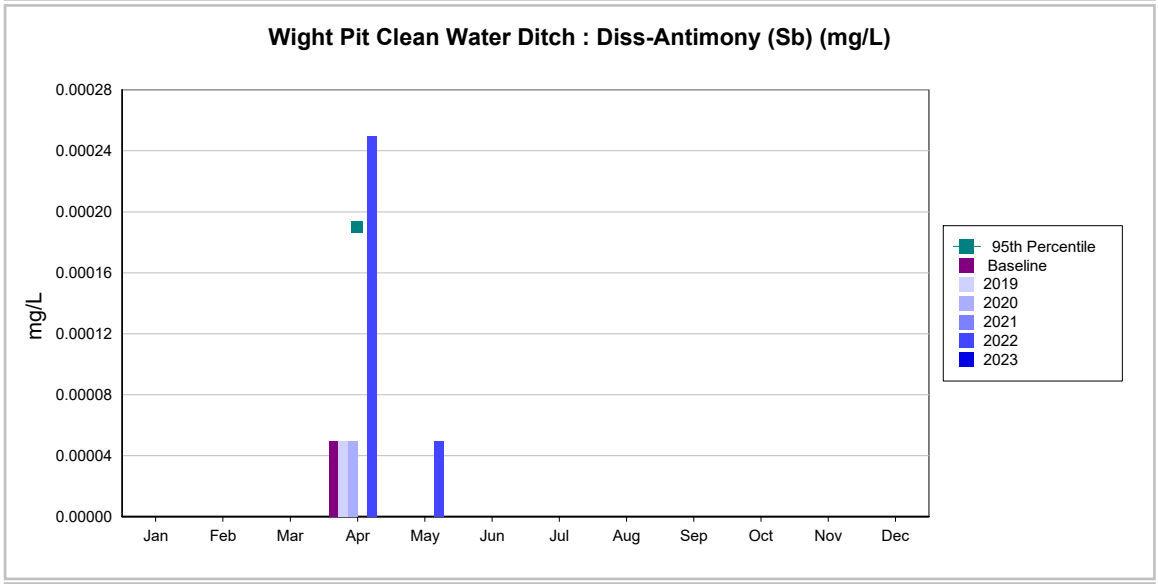
Annual Report Drainage Water

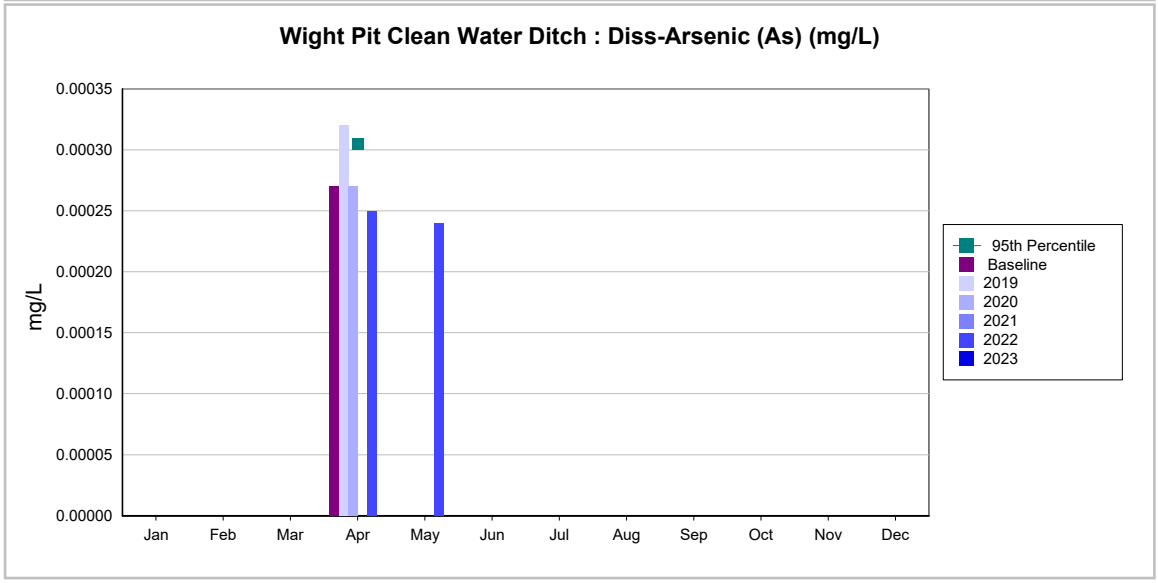
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







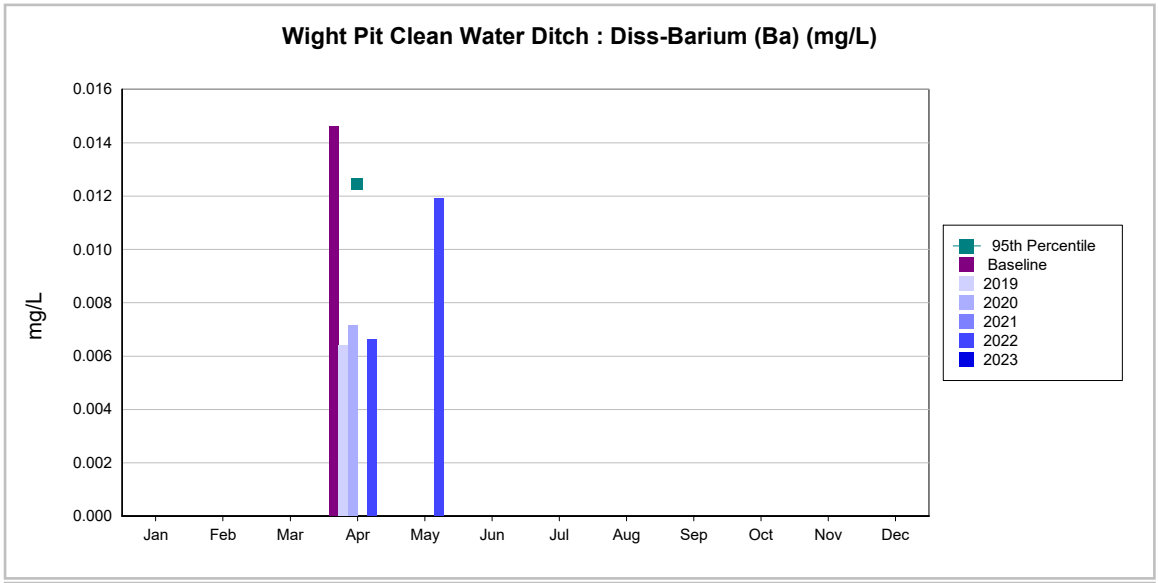
Water Quality Report

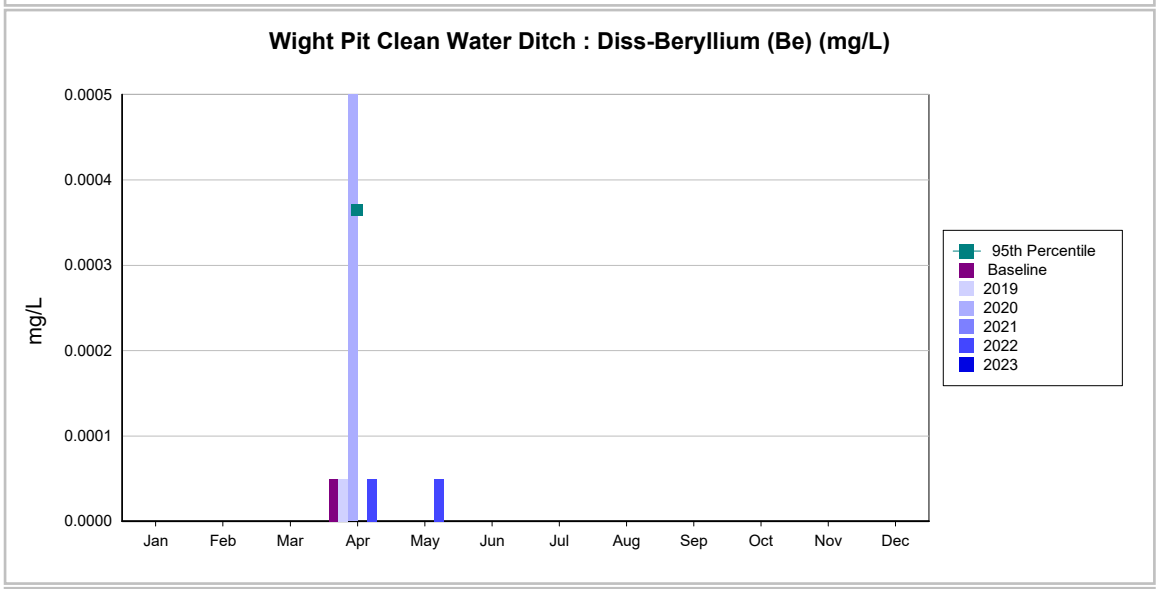
Annual Report Drainage Water

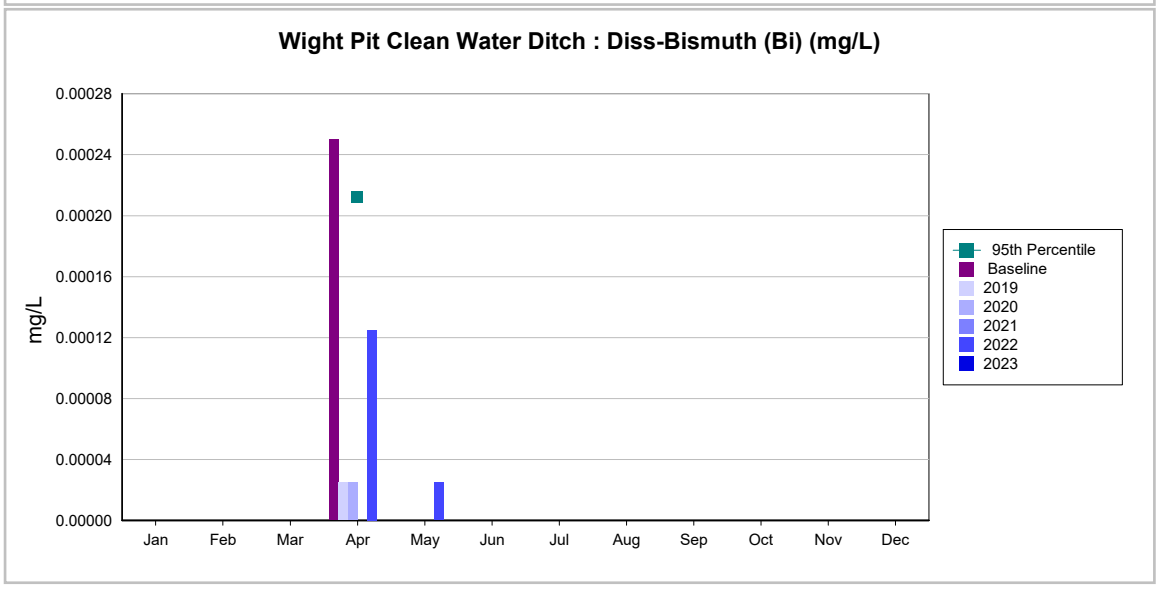
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







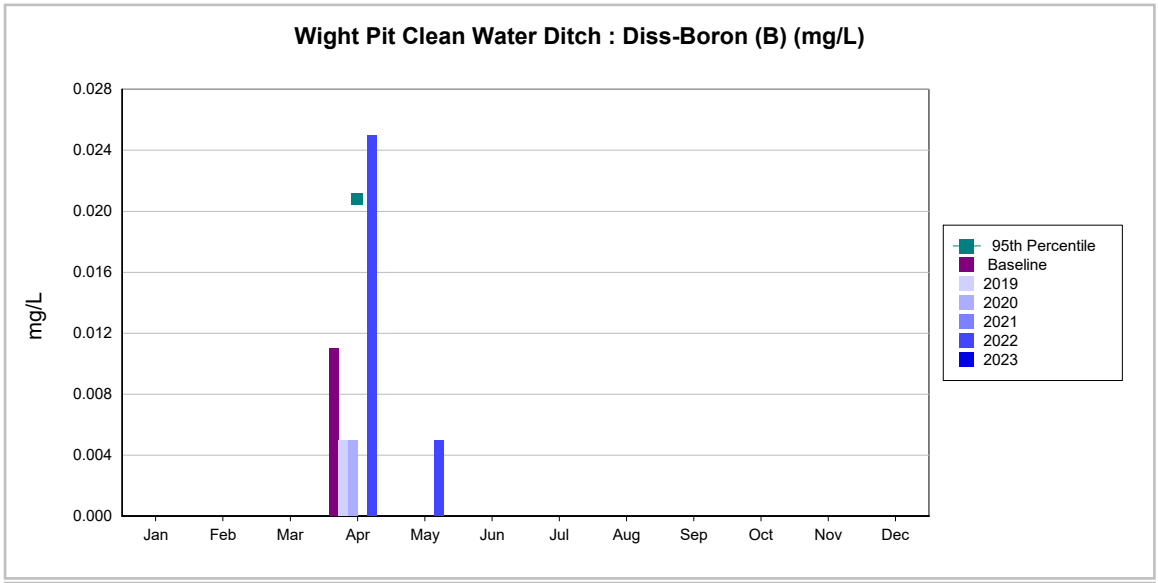
Water Quality Report

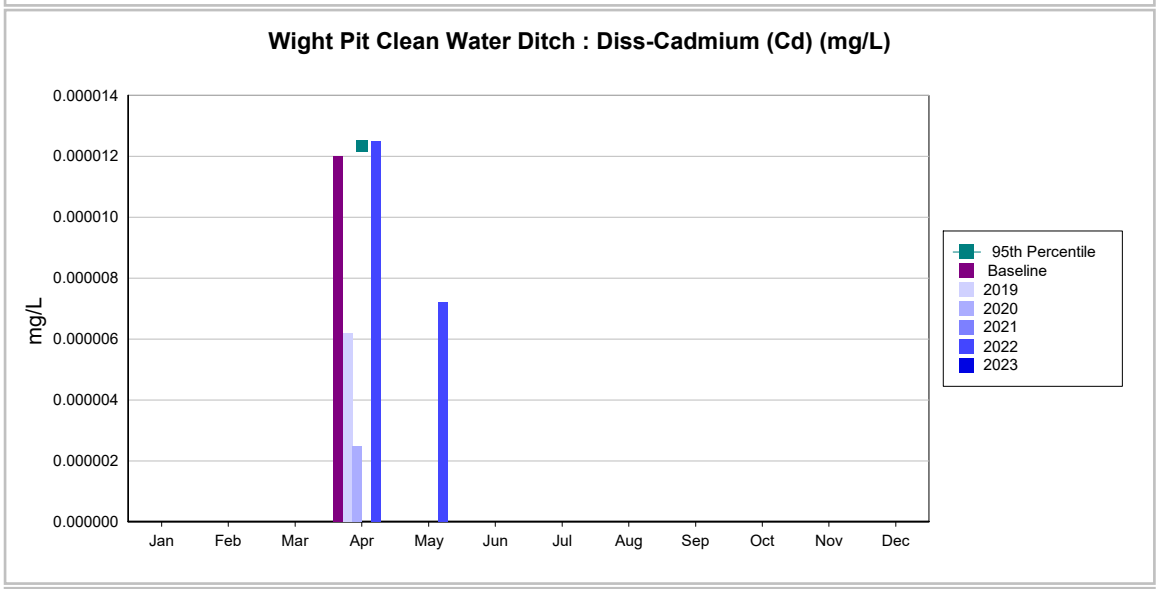
Annual Report Drainage Water

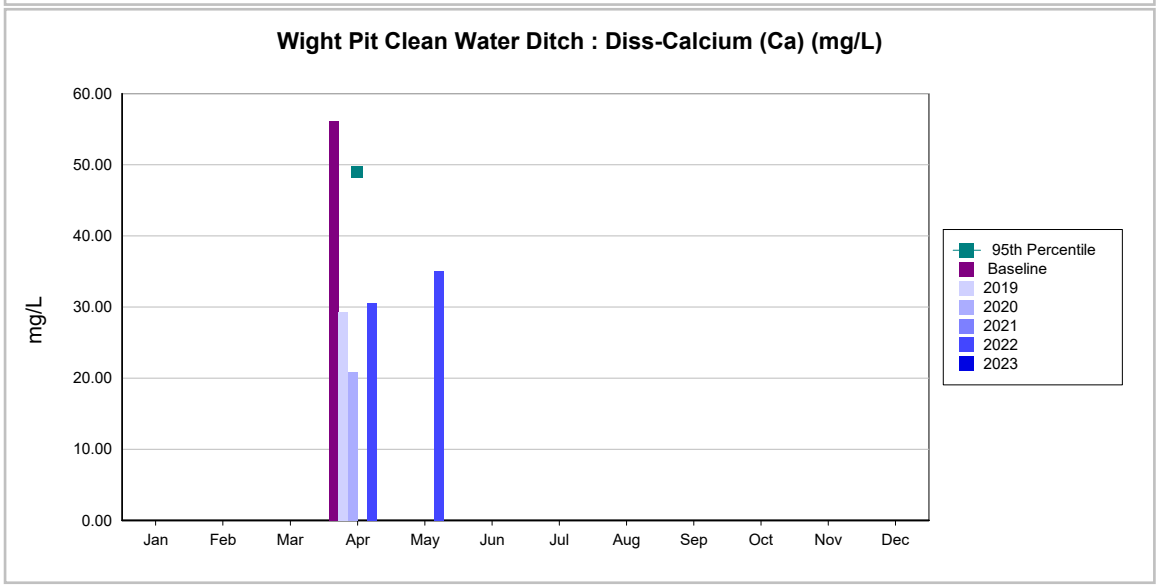
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







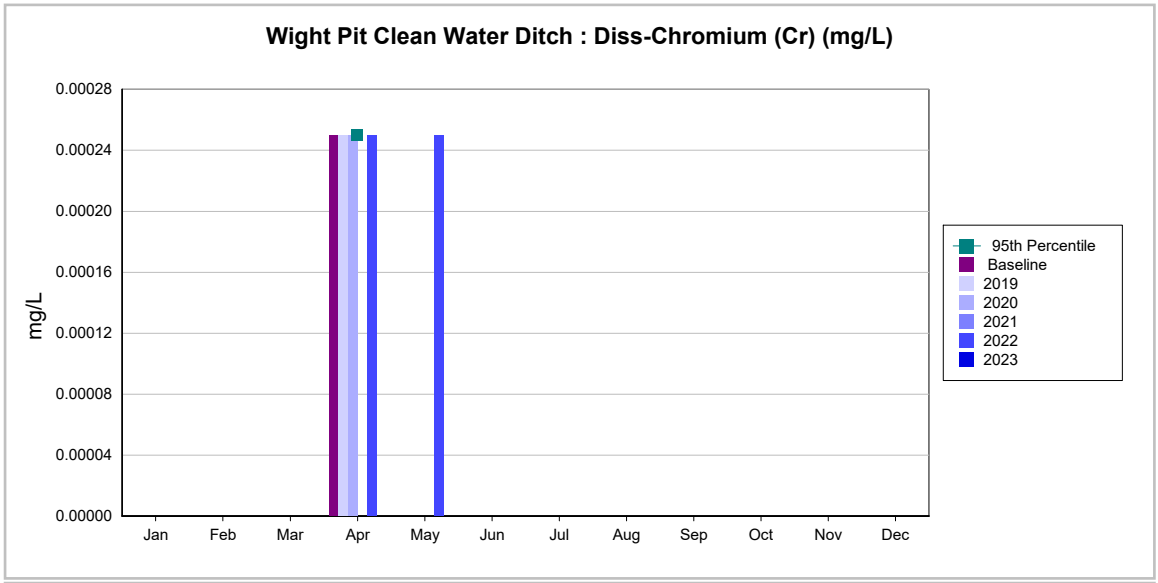
Water Quality Report

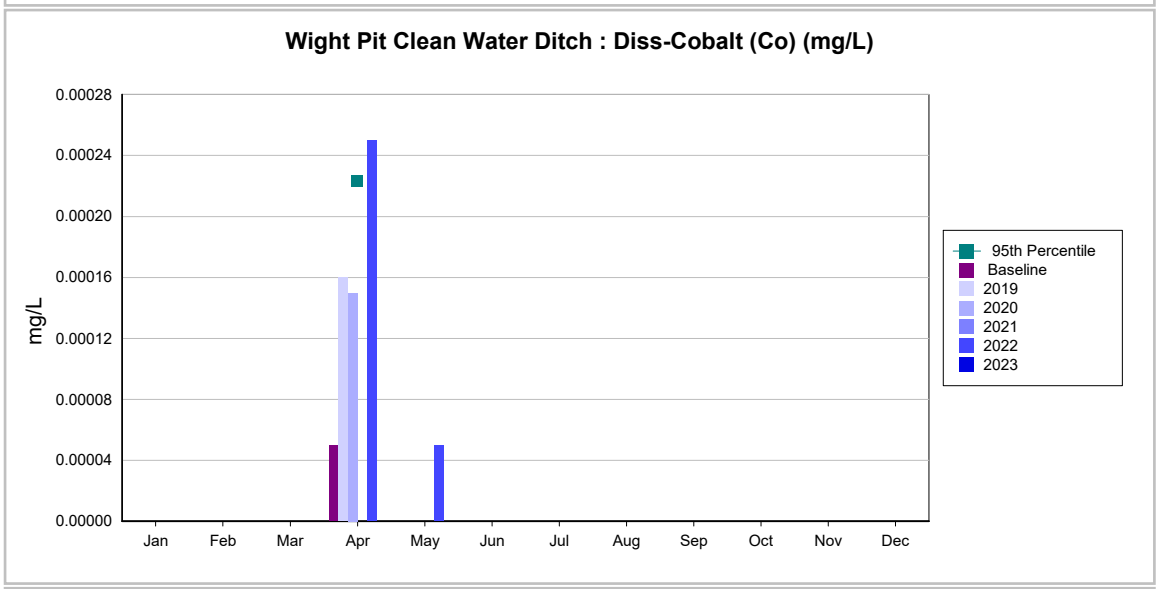
Annual Report Drainage Water

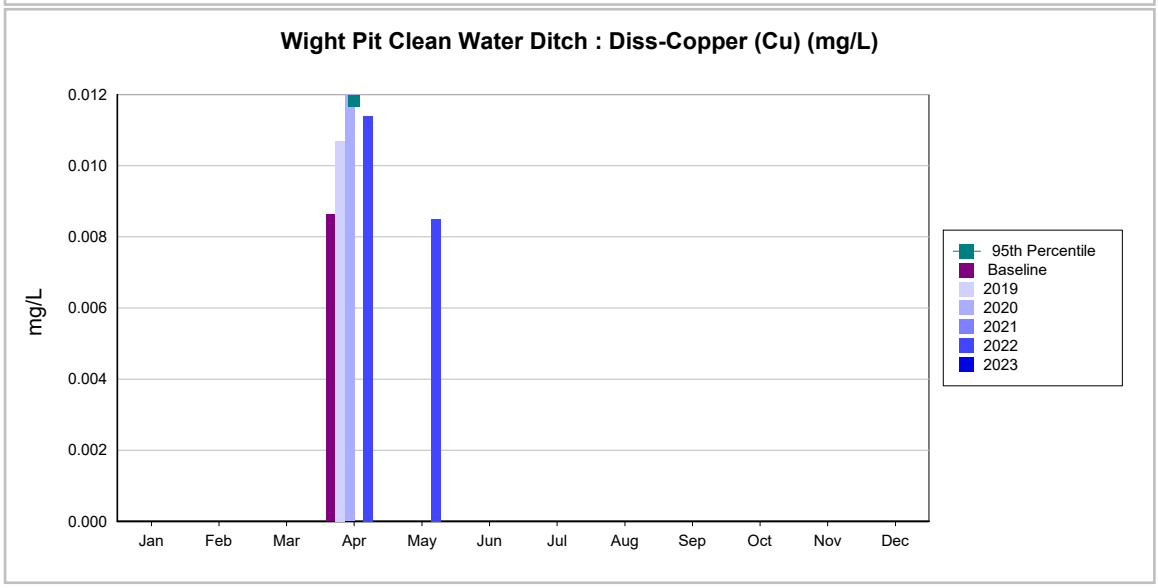
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







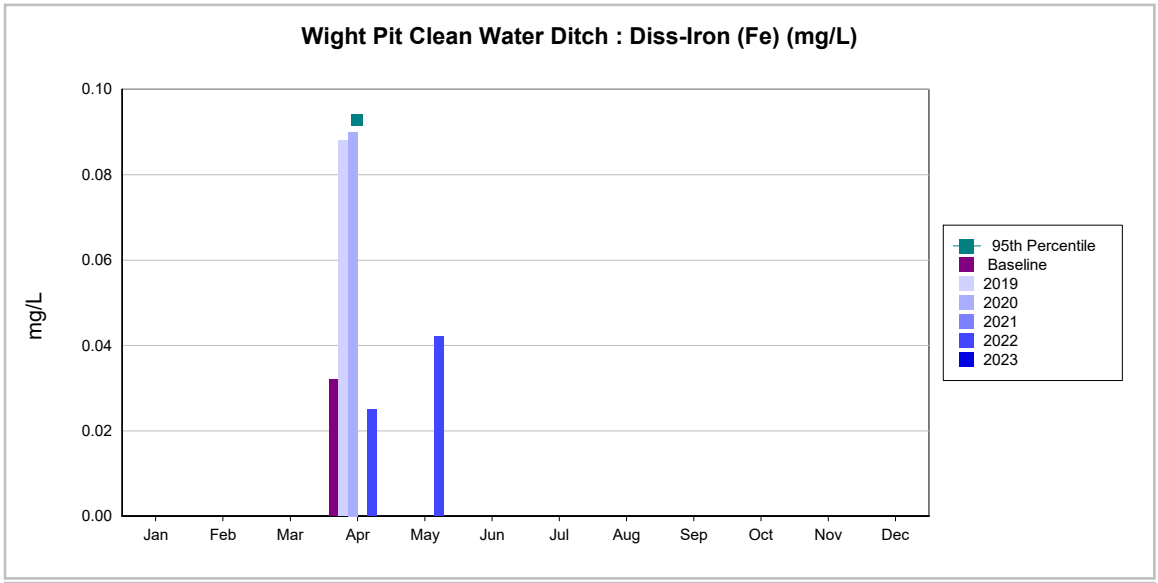
Water Quality Report

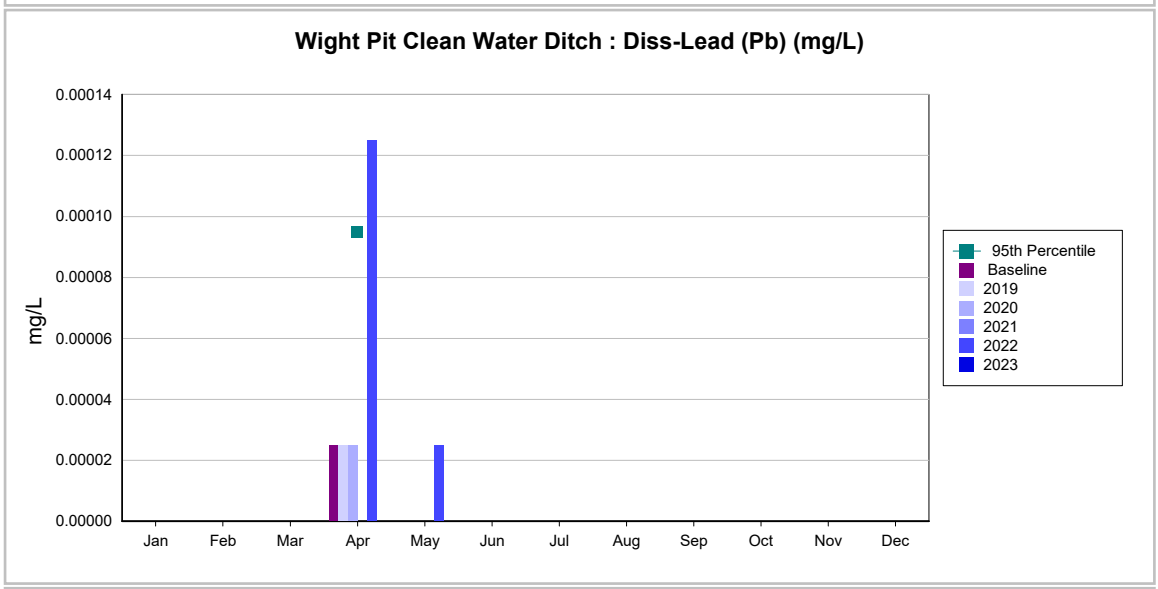
Annual Report Drainage Water

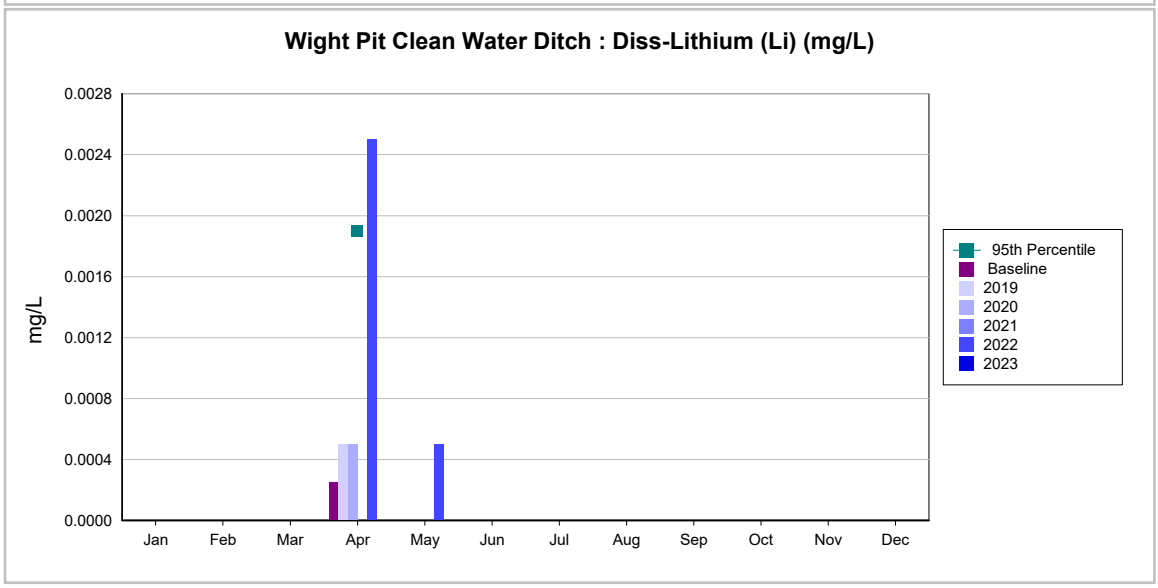
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







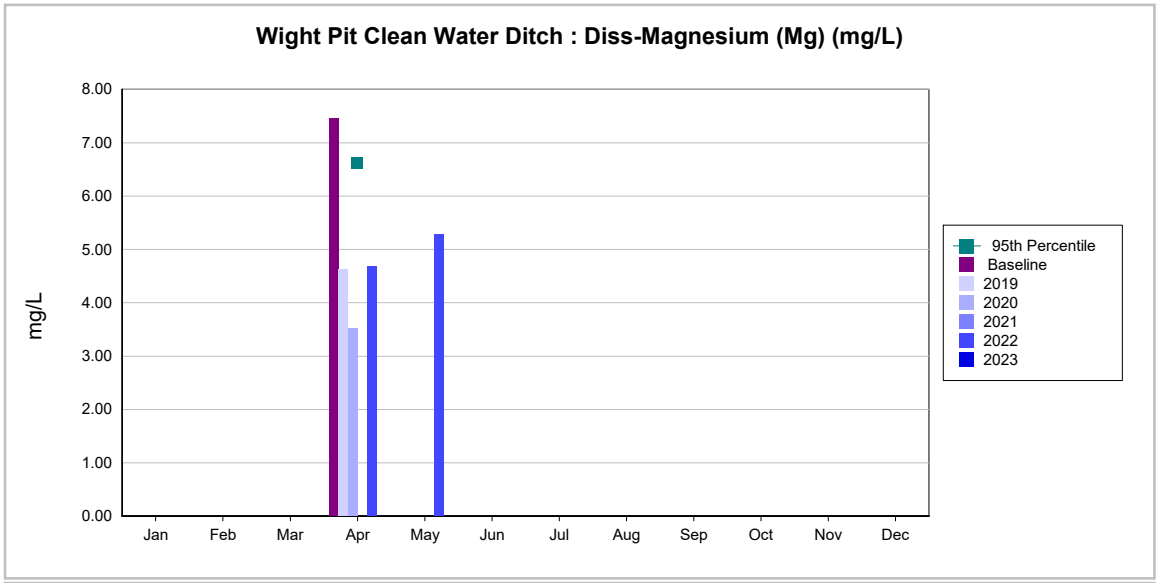
Water Quality Report

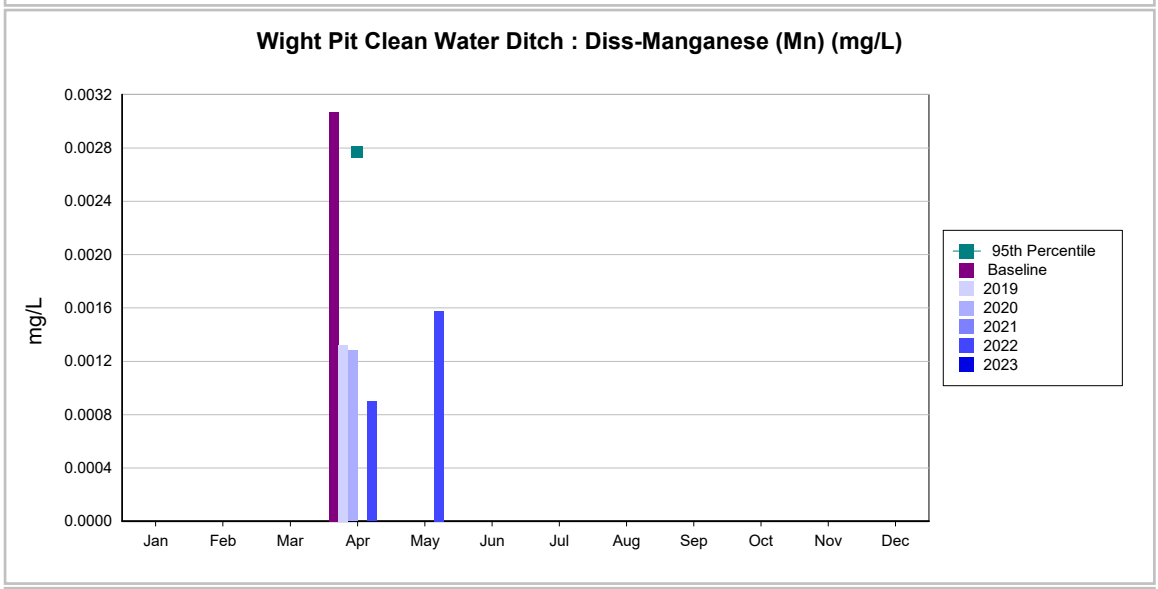
Annual Report Drainage Water

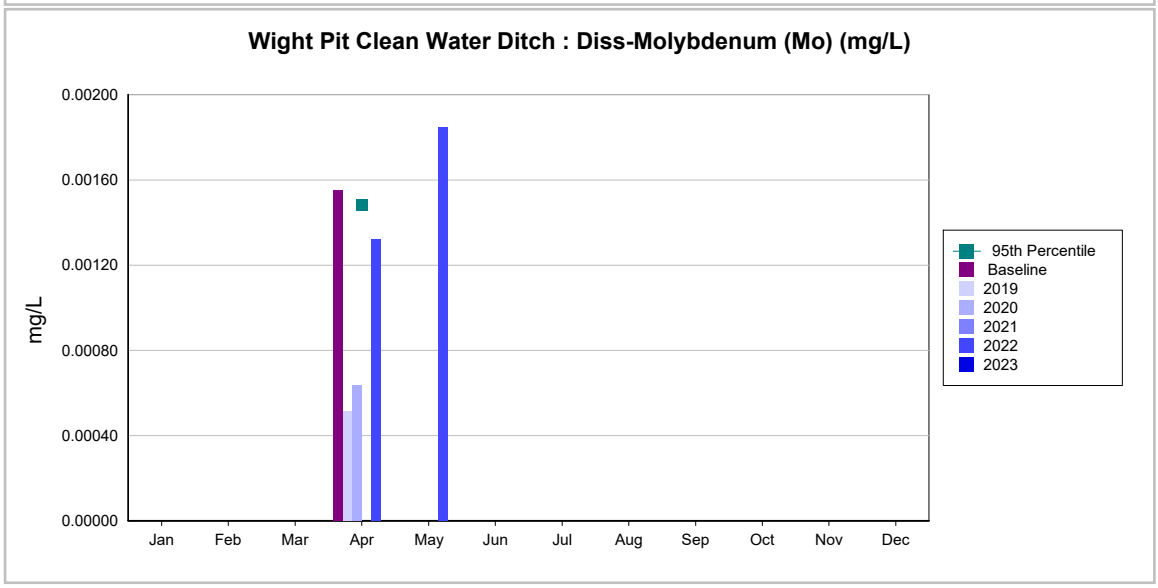
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







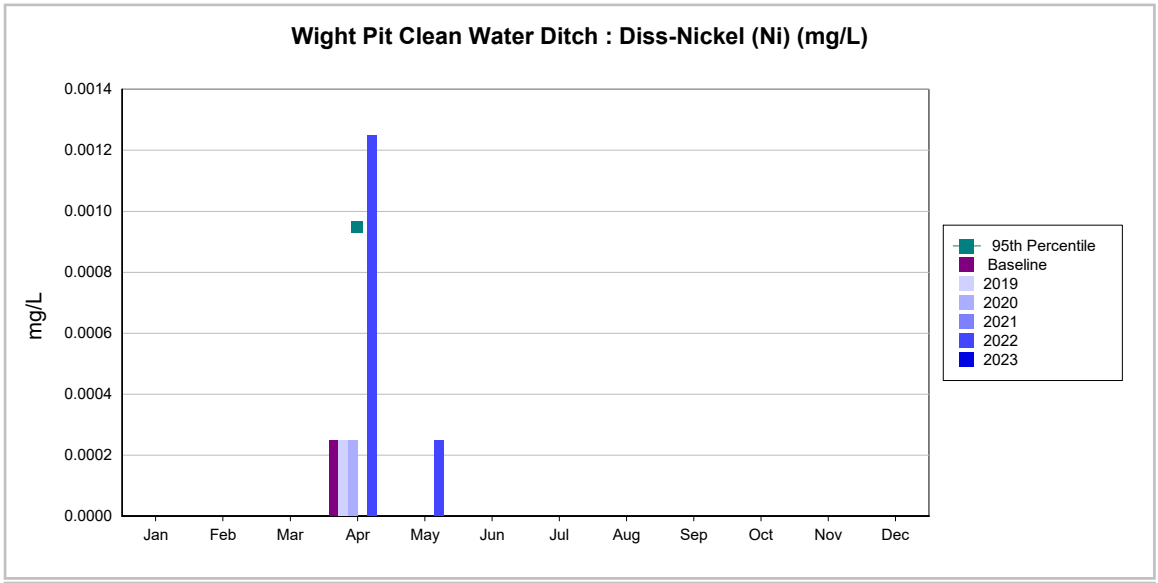
Water Quality Report

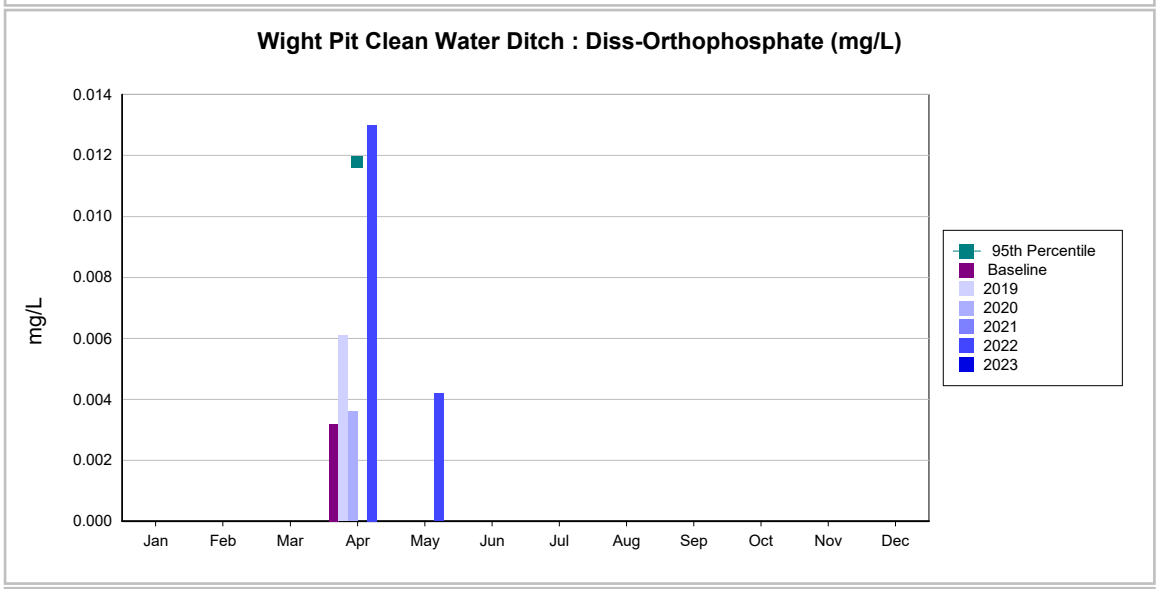
Annual Report Drainage Water

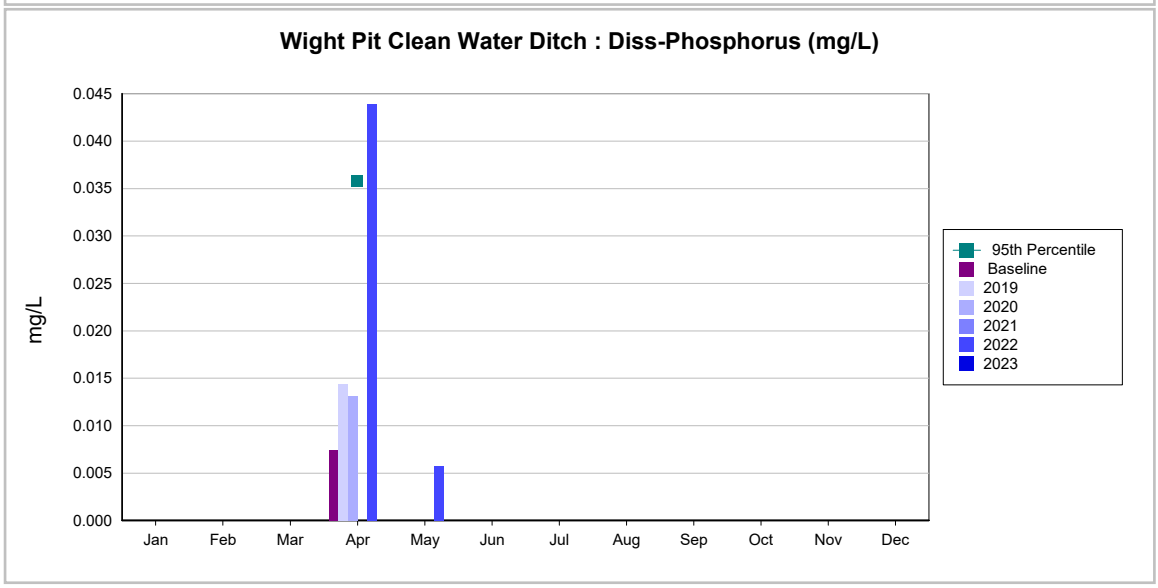
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







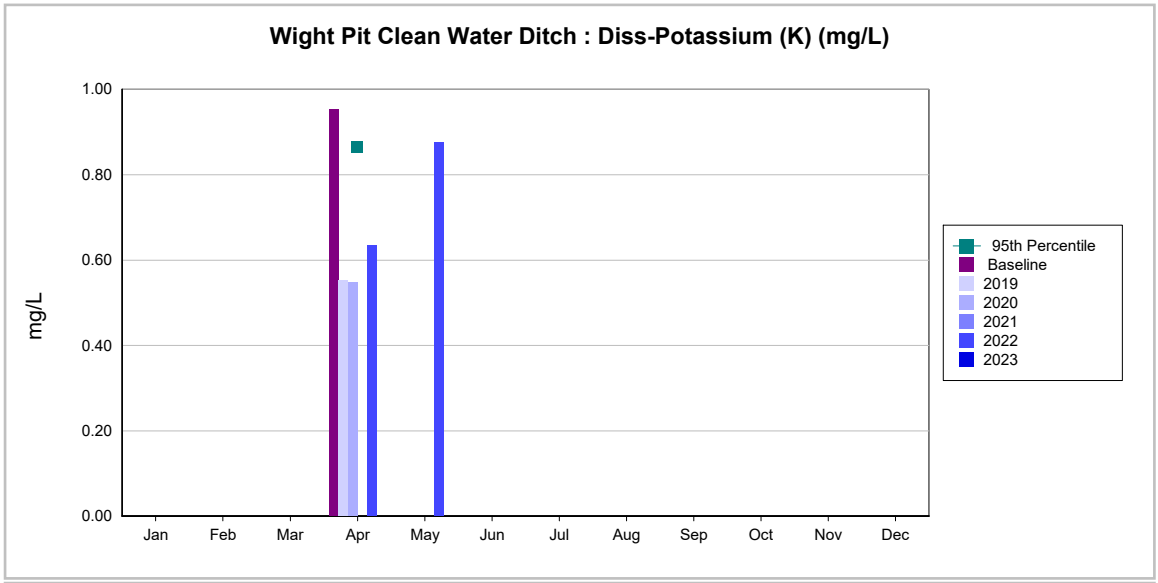
Water Quality Report

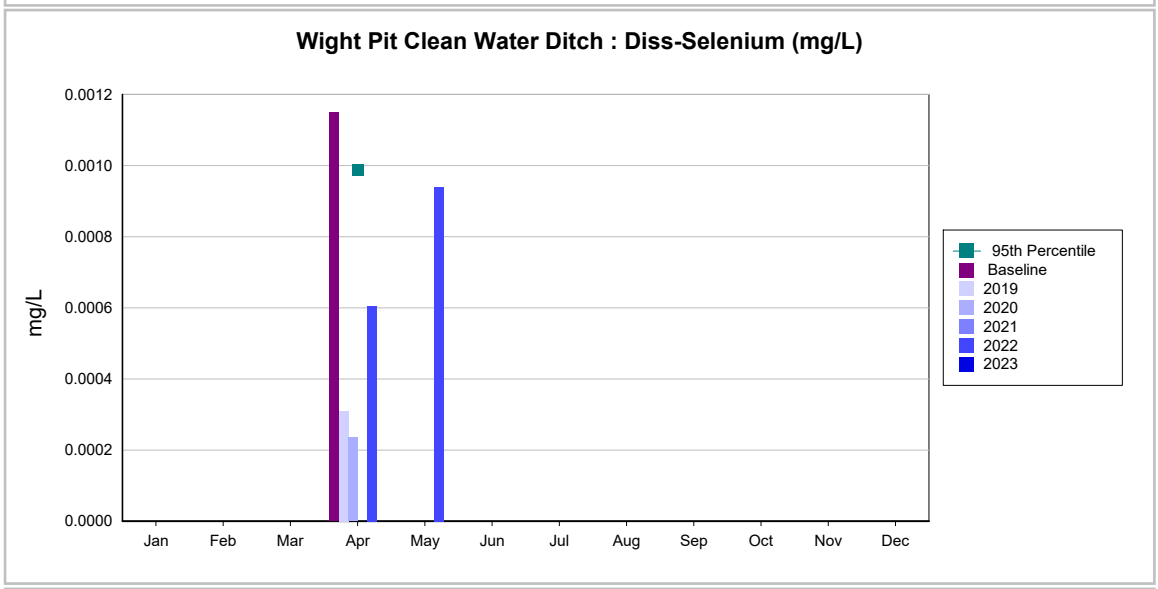
Annual Report Drainage Water

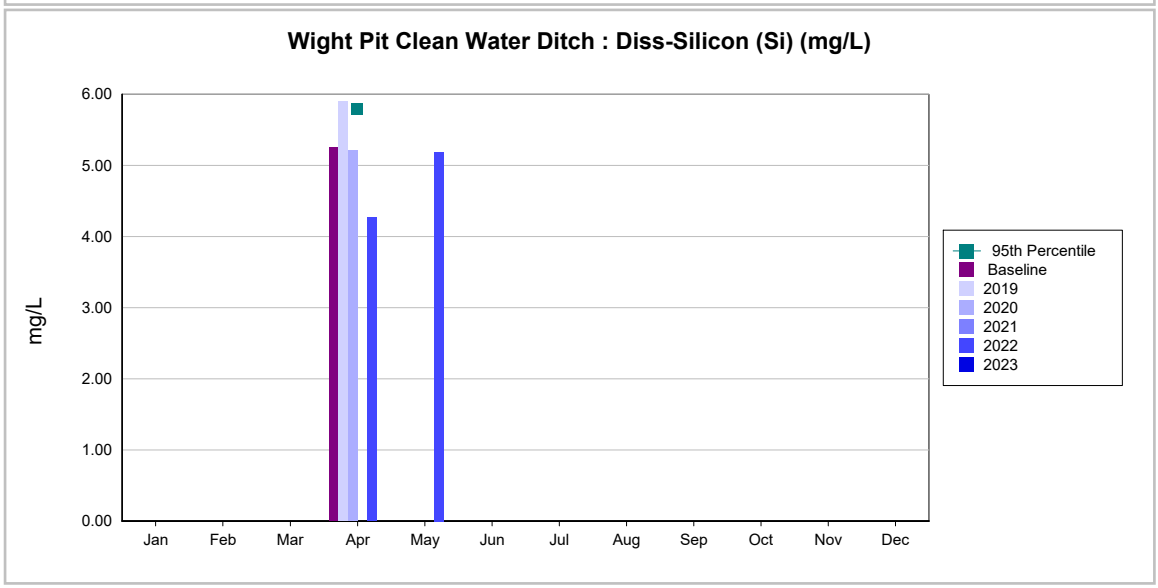
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







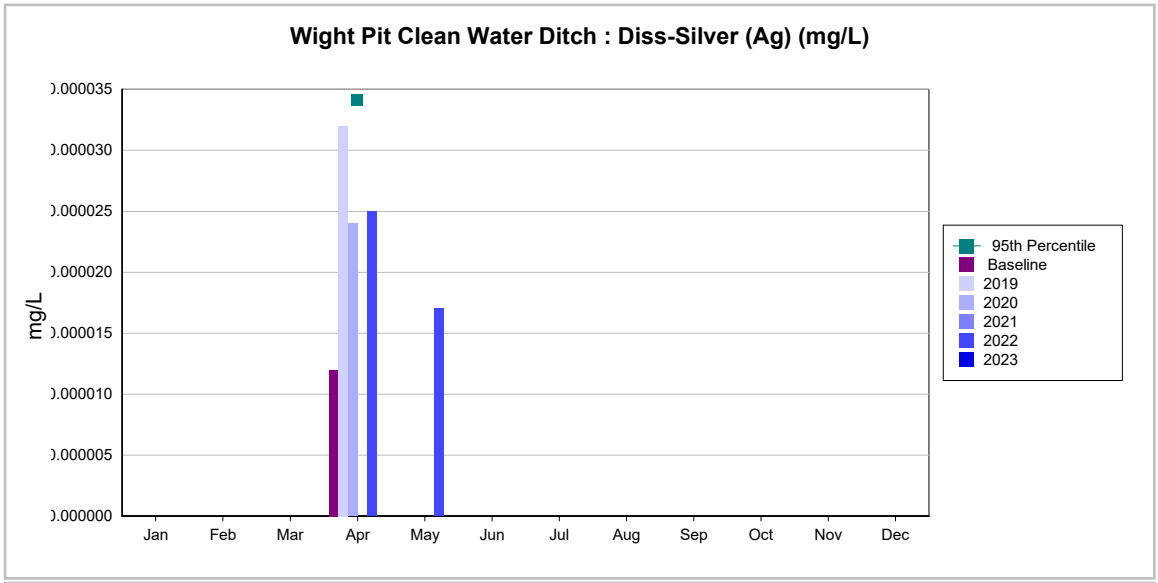
Water Quality Report

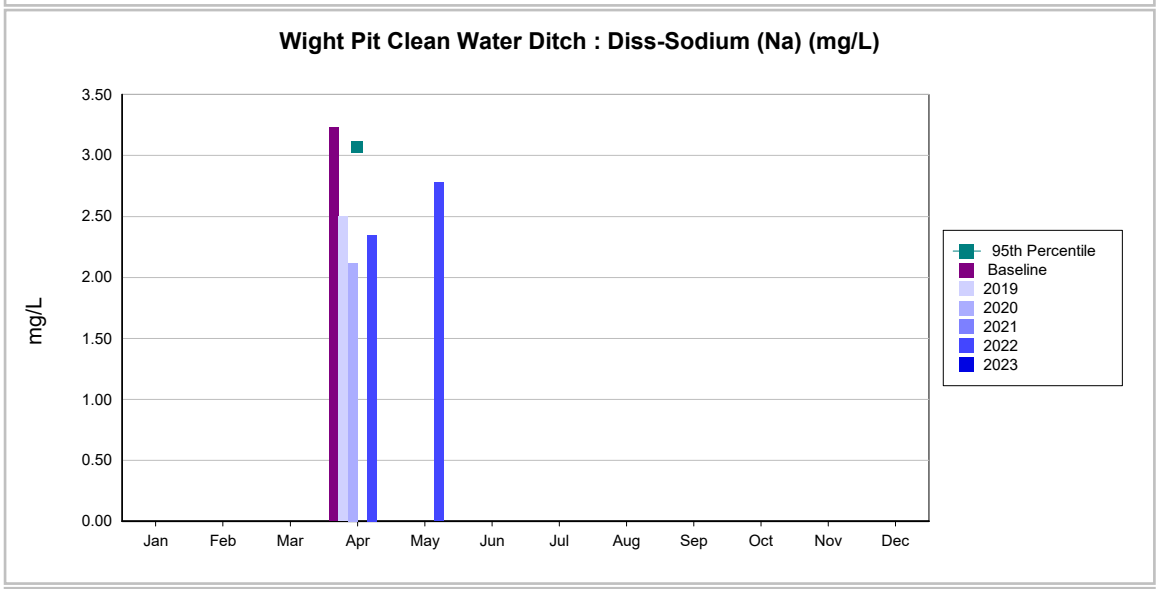
Annual Report Drainage Water

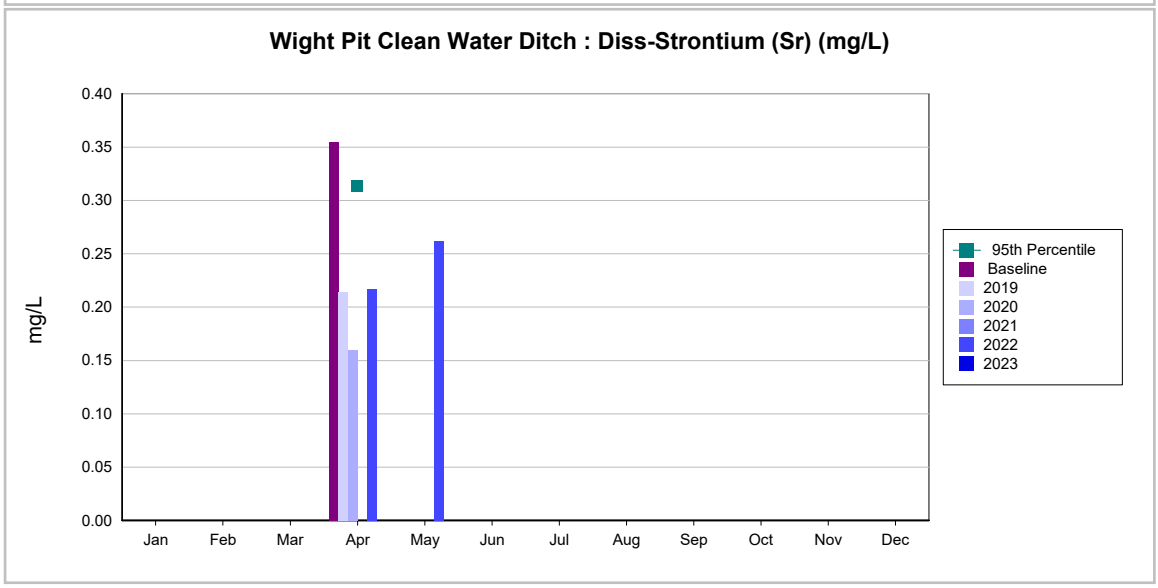
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







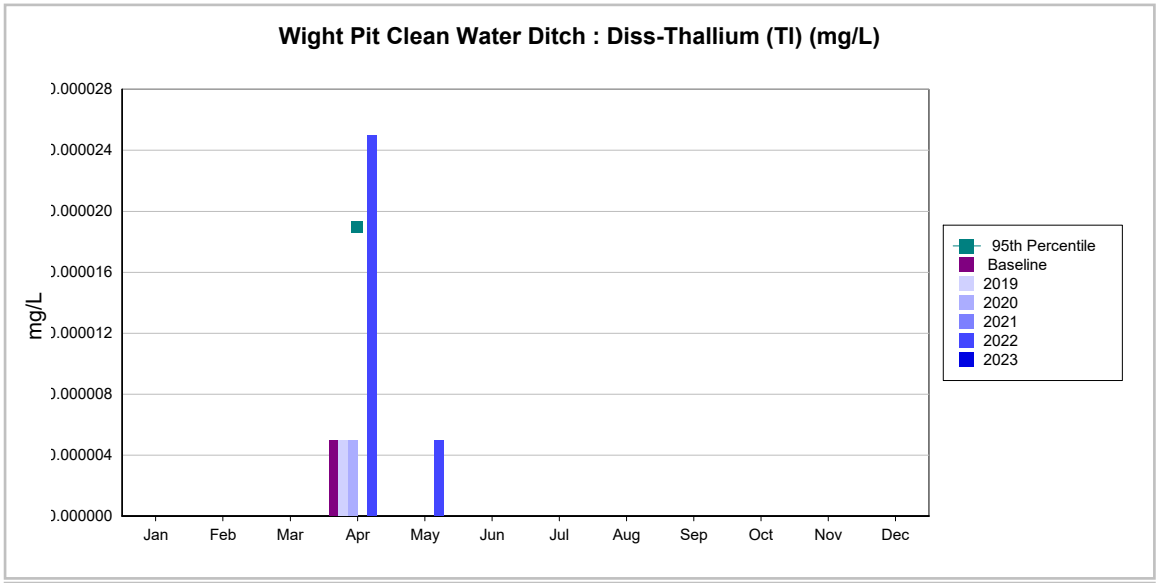
Water Quality Report

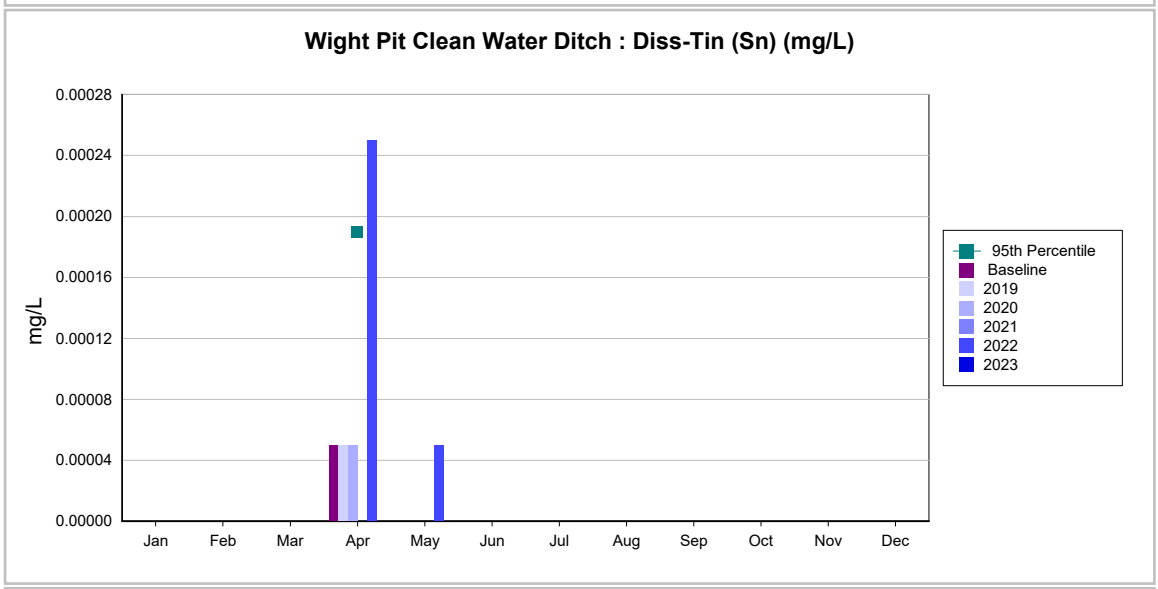
Annual Report Drainage Water

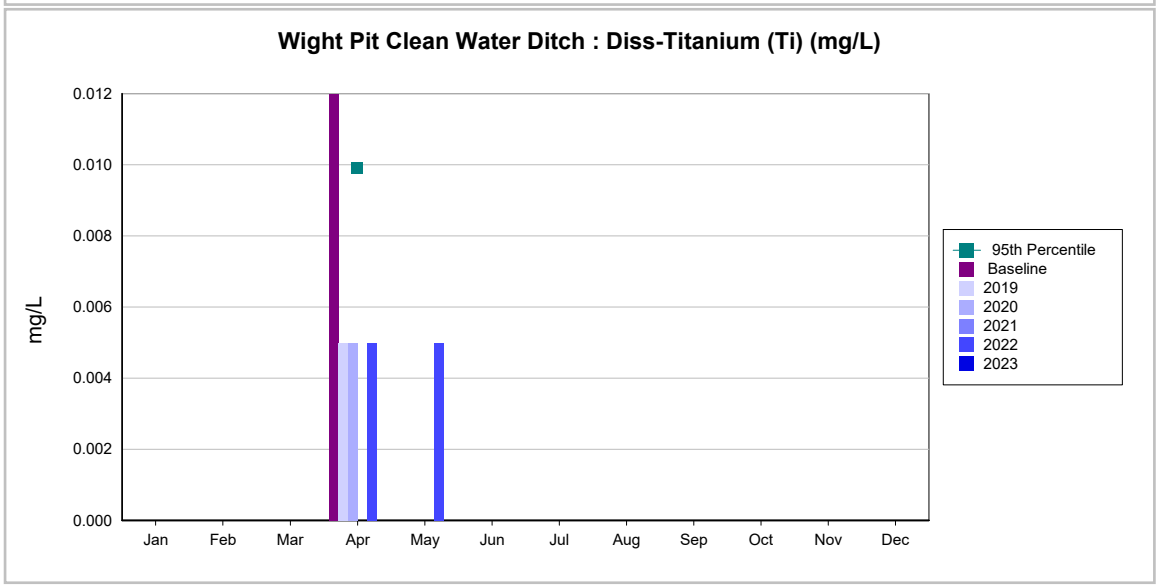
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







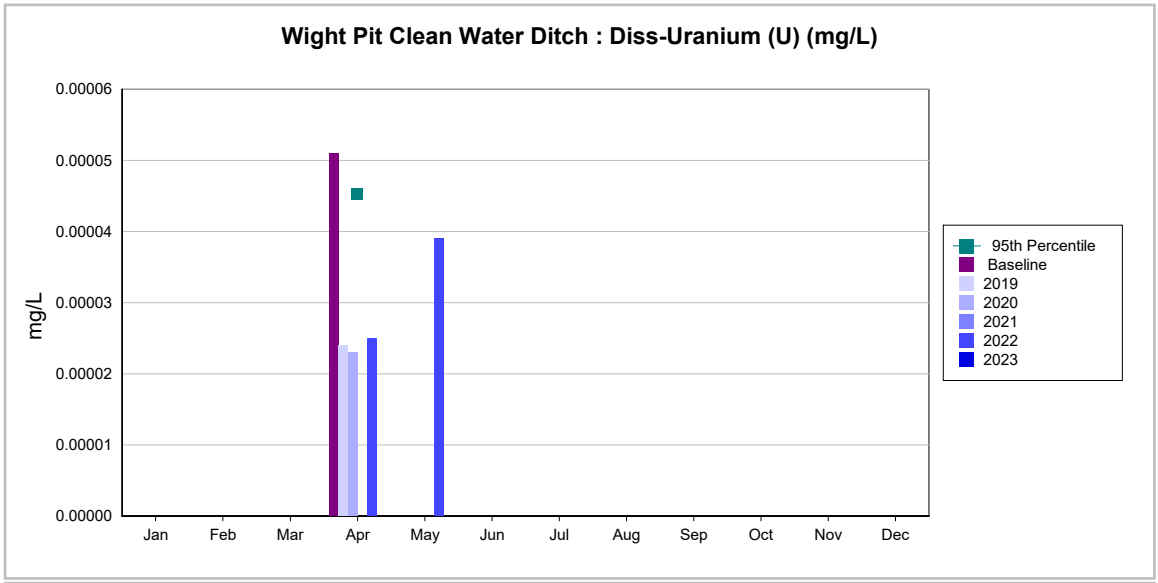
Water Quality Report

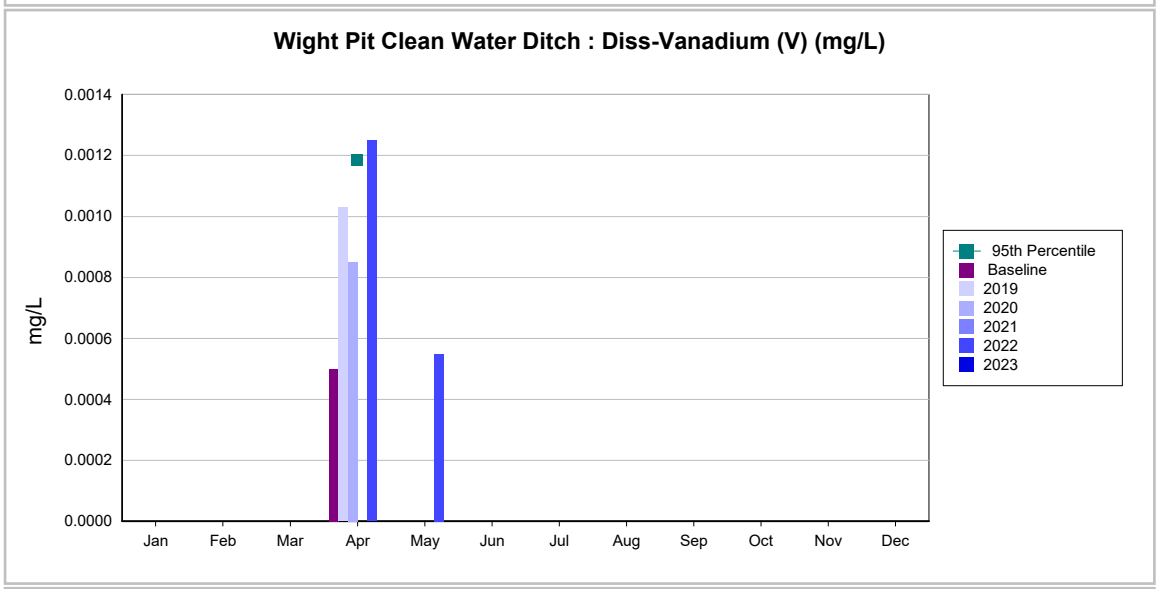
Annual Report Drainage Water

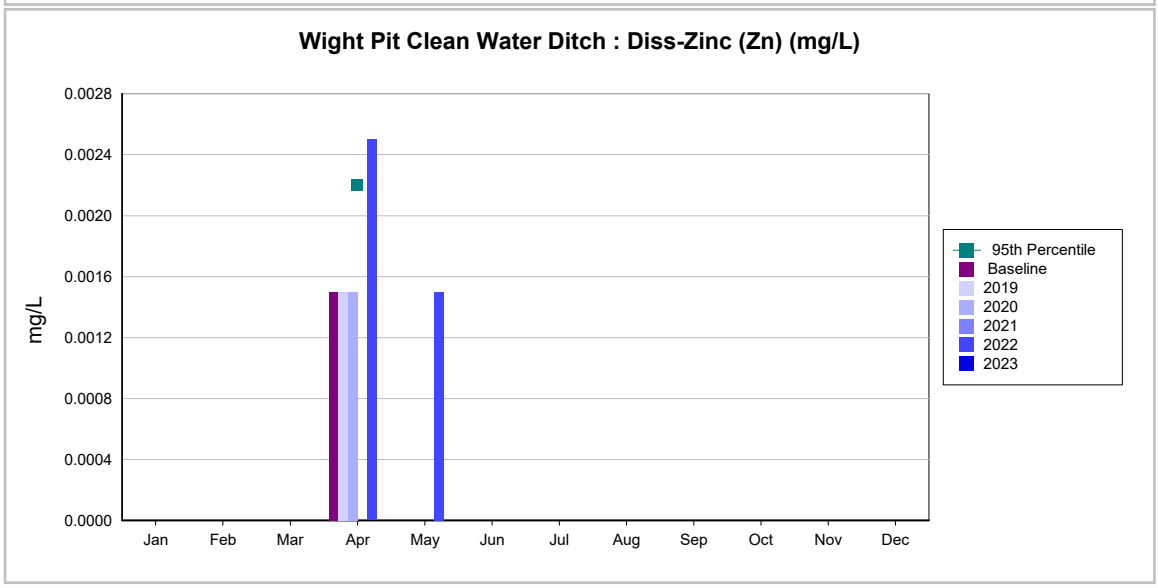
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







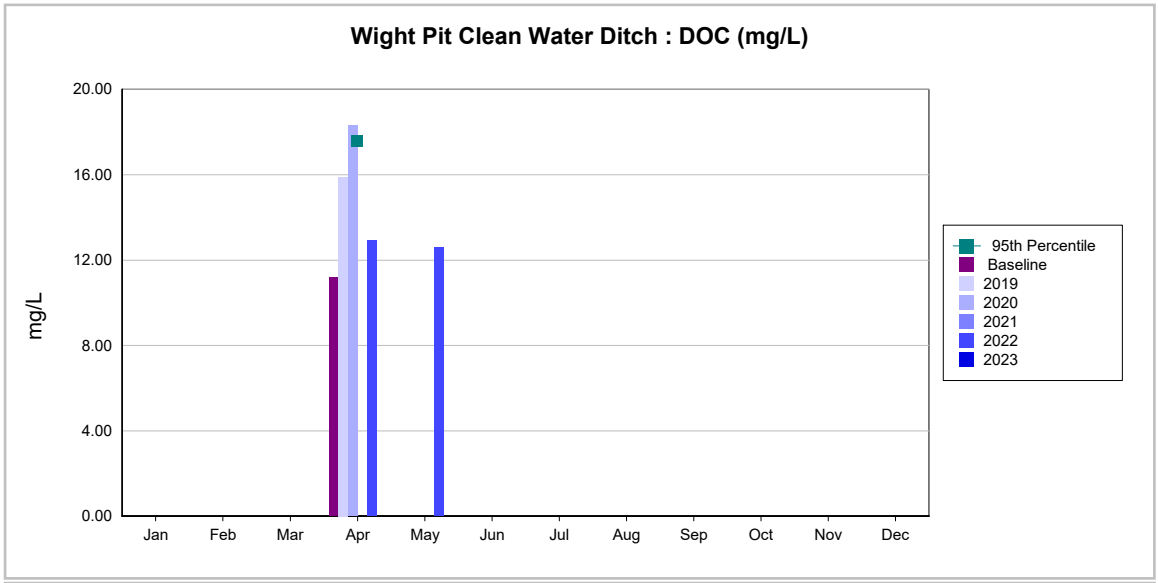
Water Quality Report

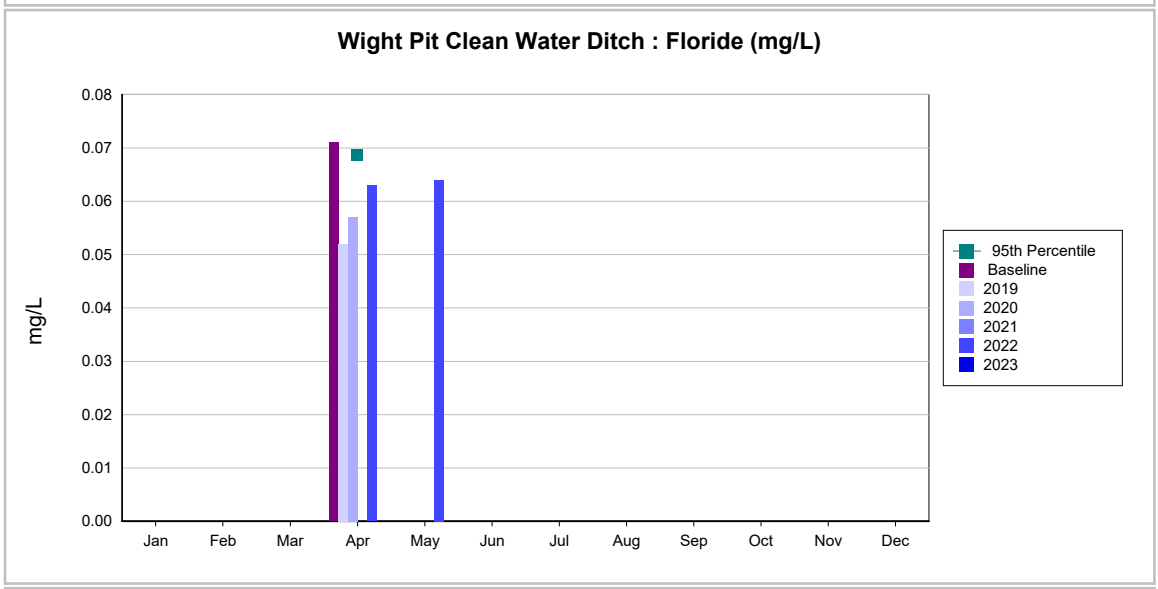
Annual Report Drainage Water

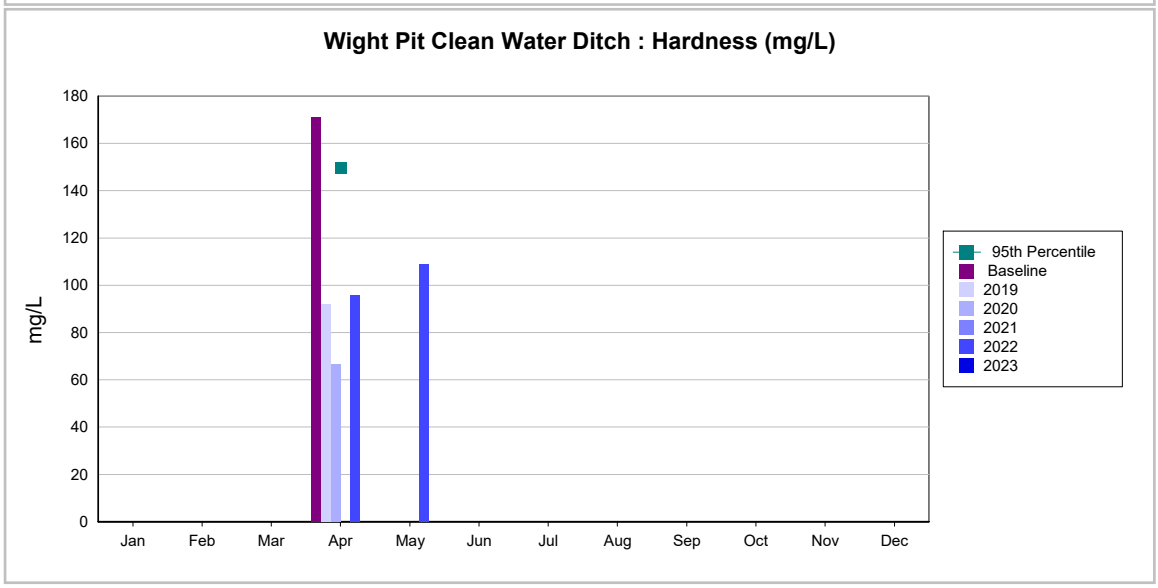
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







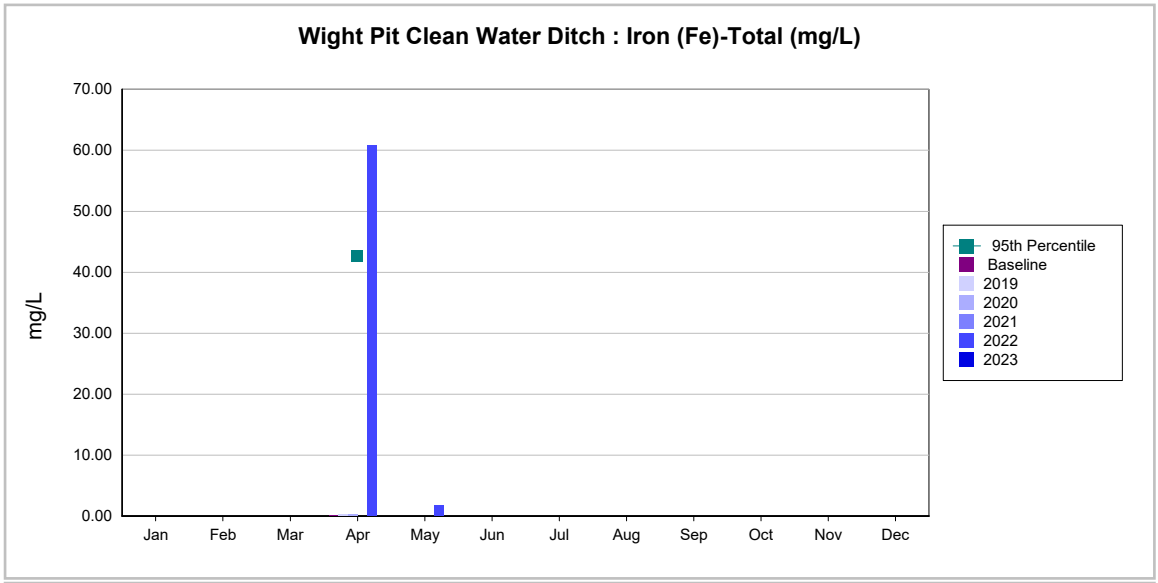
Water Quality Report

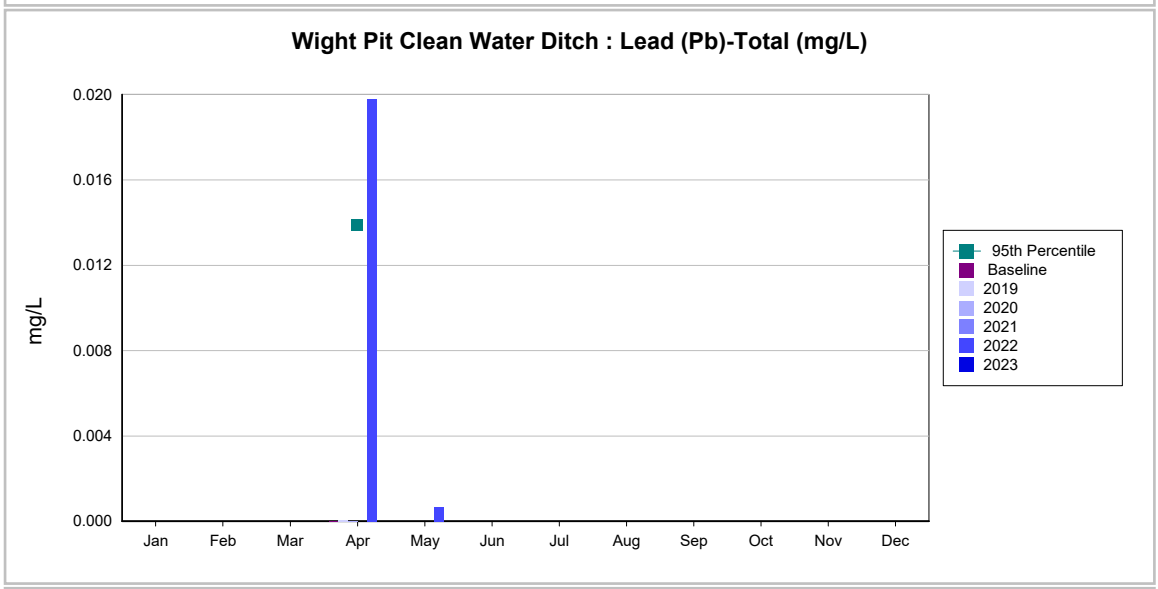
Annual Report Drainage Water

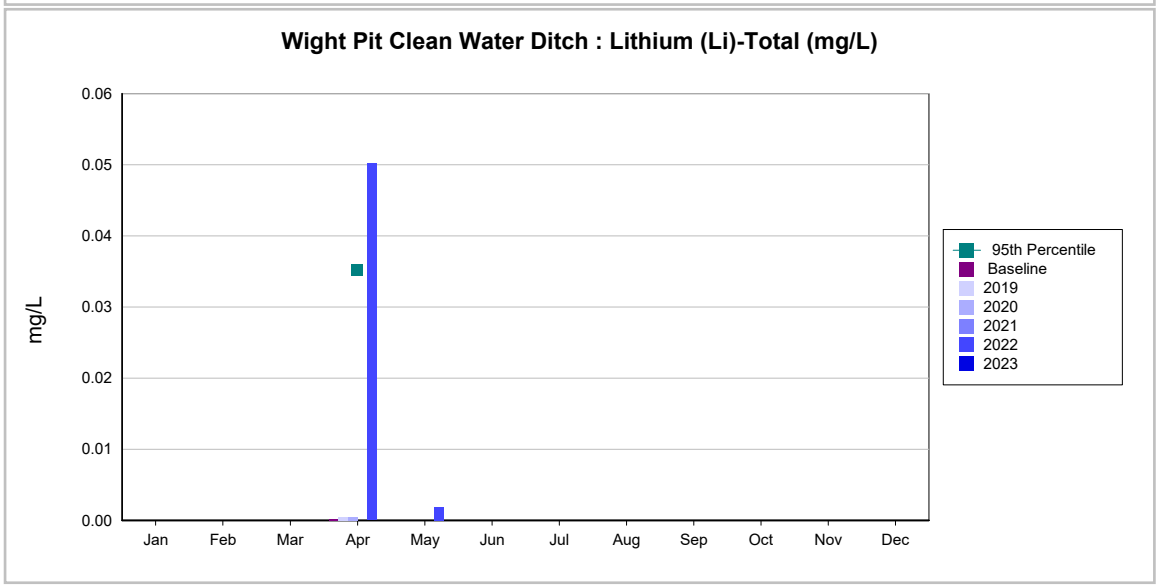
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







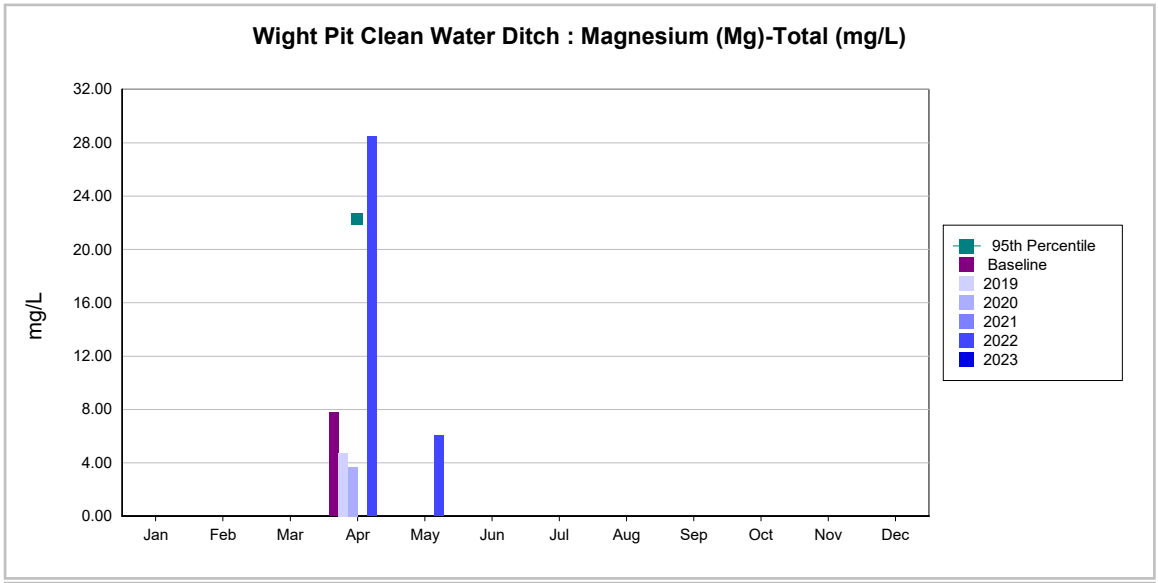
Water Quality Report

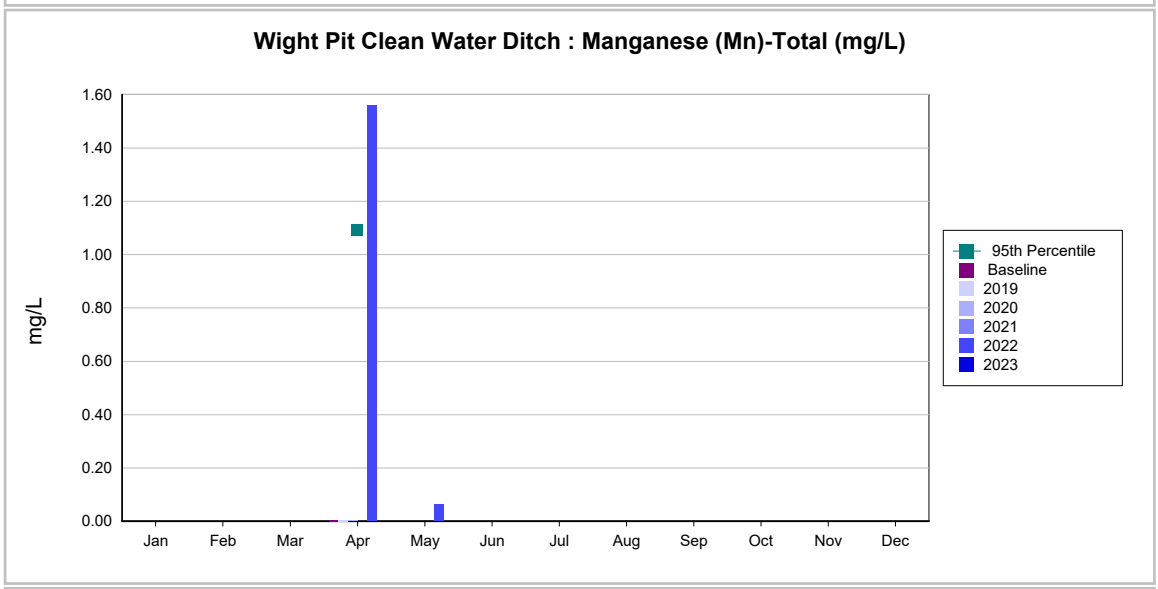
Annual Report Drainage Water

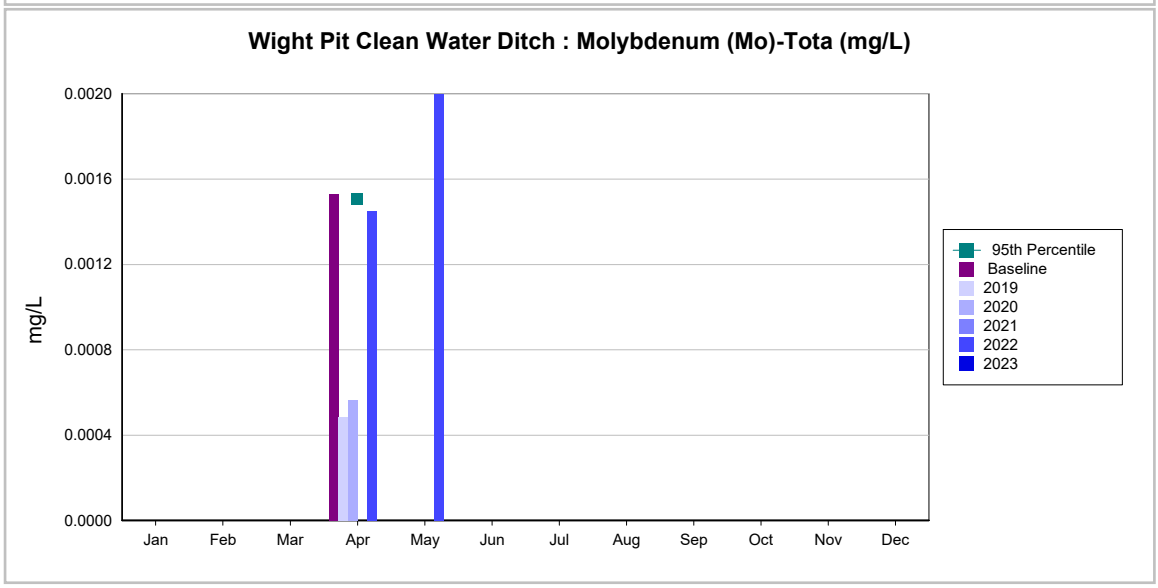
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







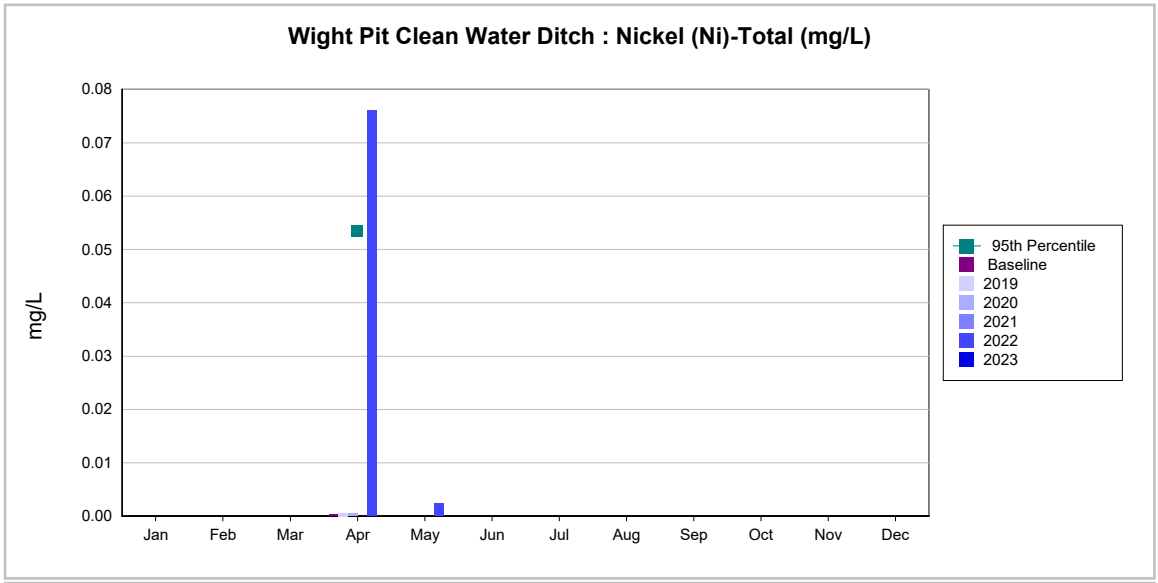
Water Quality Report

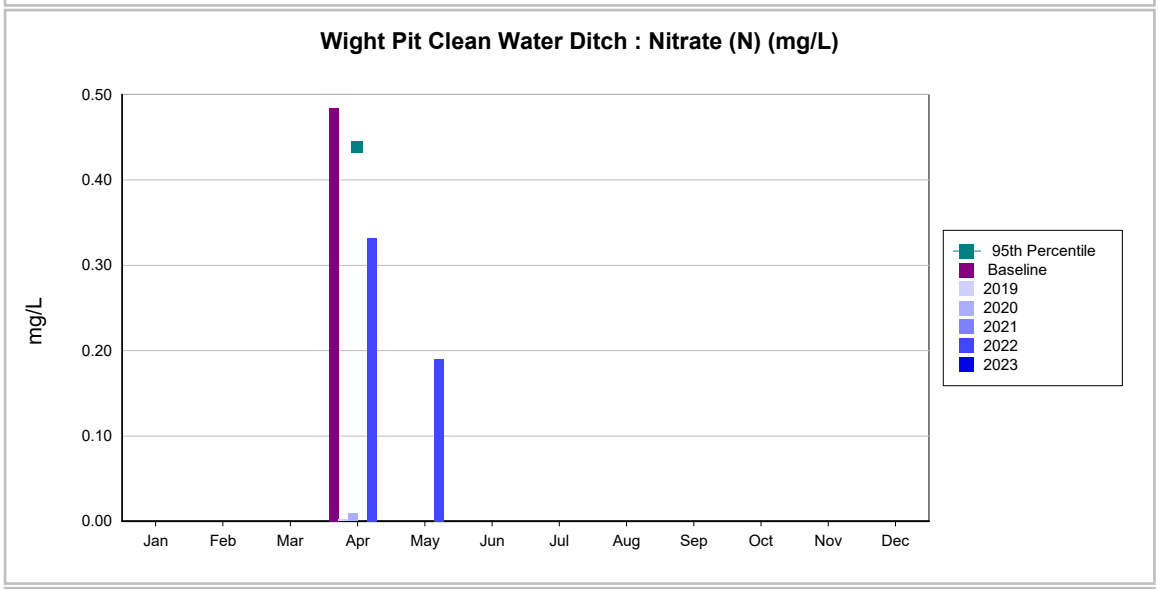
Annual Report Drainage Water

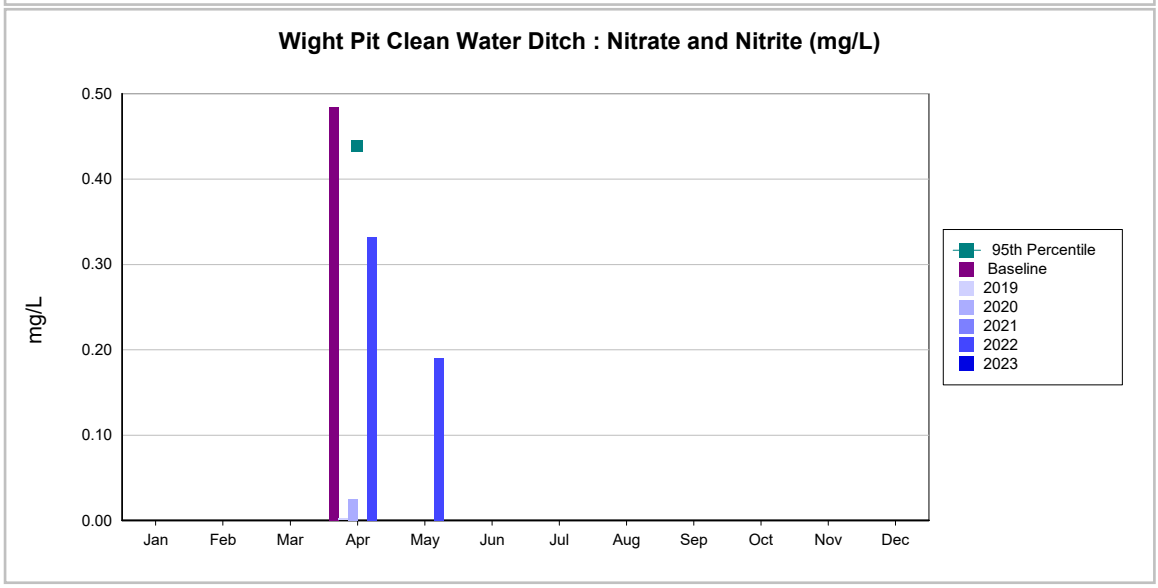
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







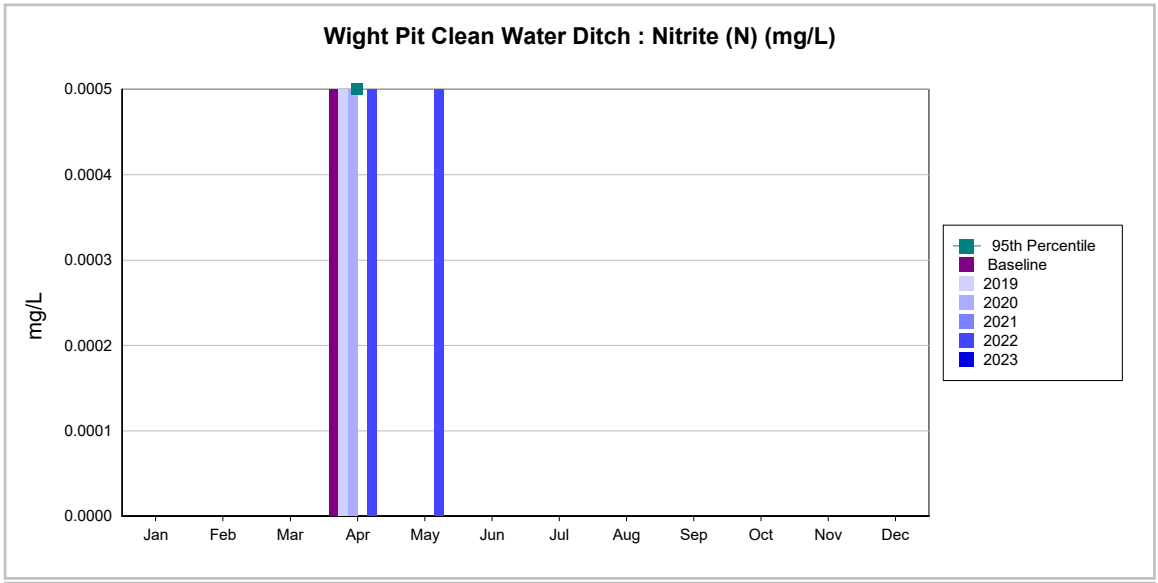
Water Quality Report

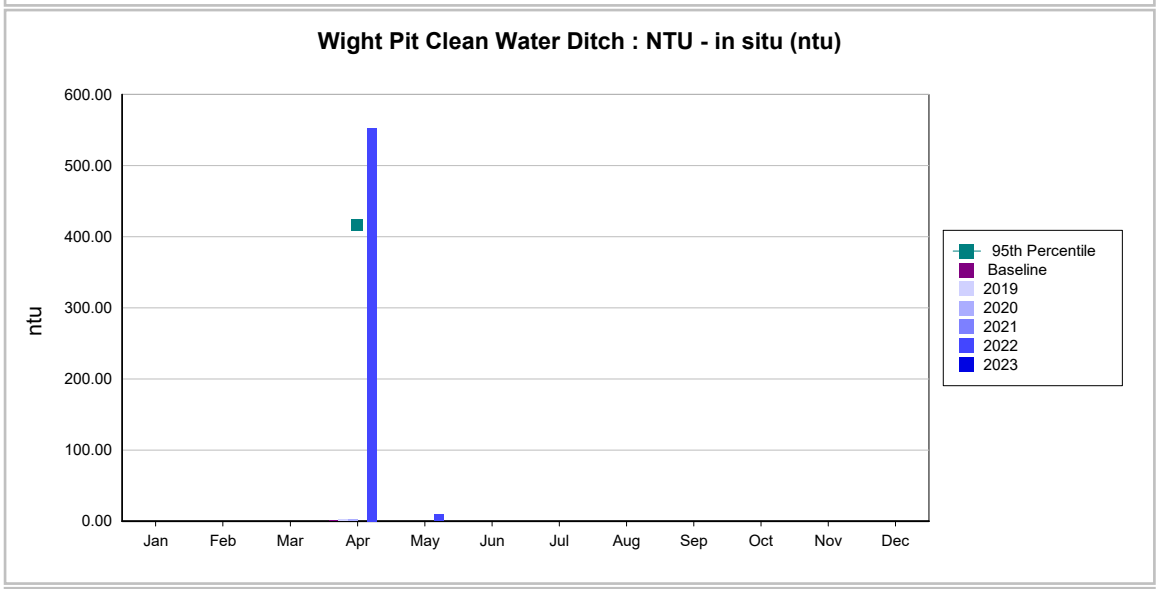
Annual Report Drainage Water

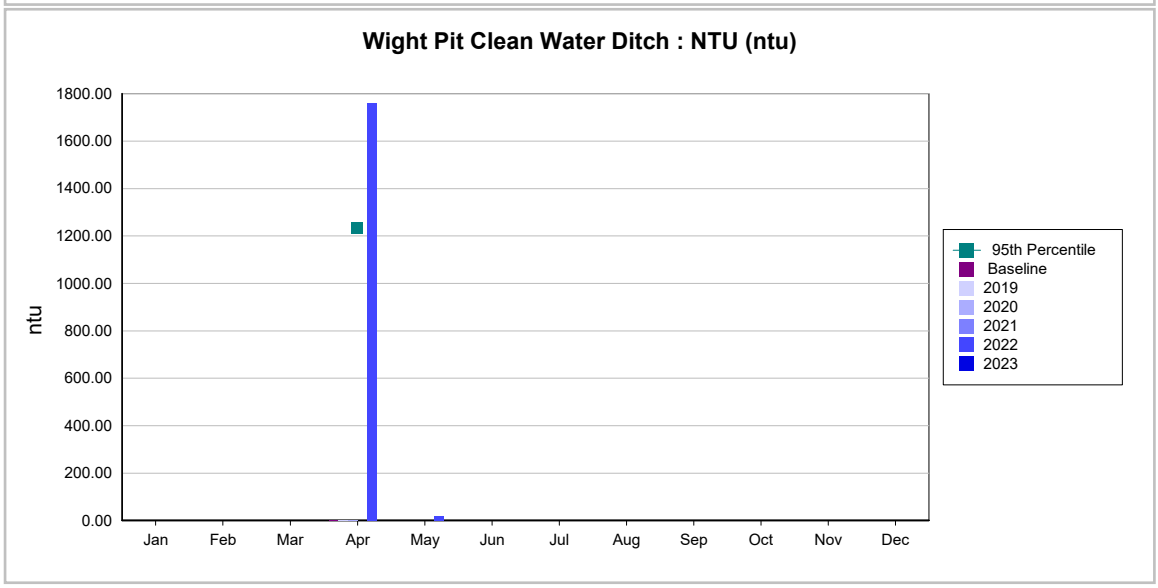
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







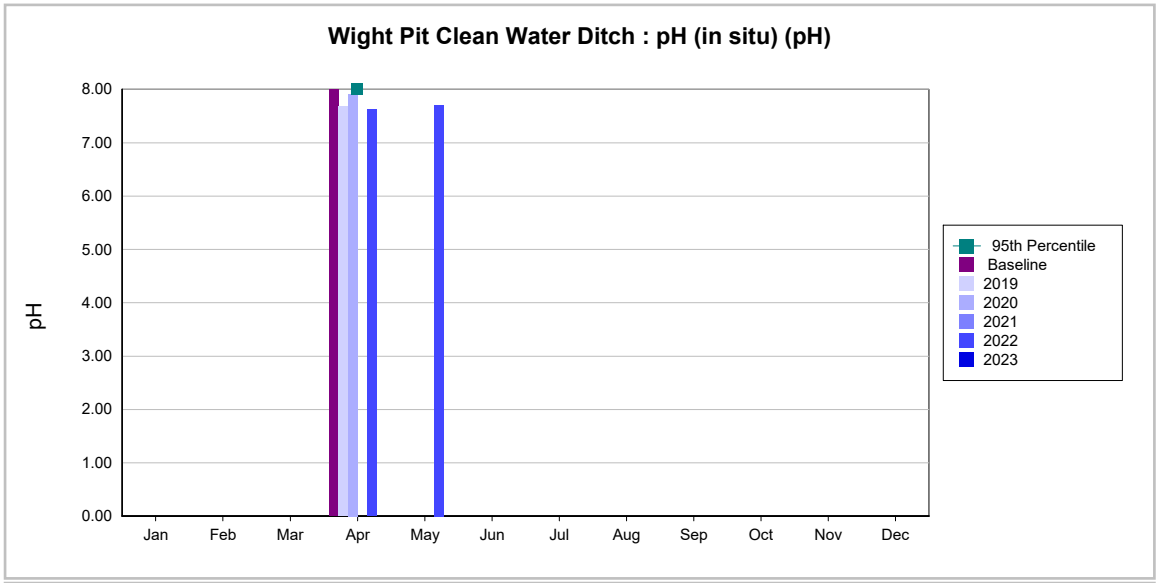
Water Quality Report

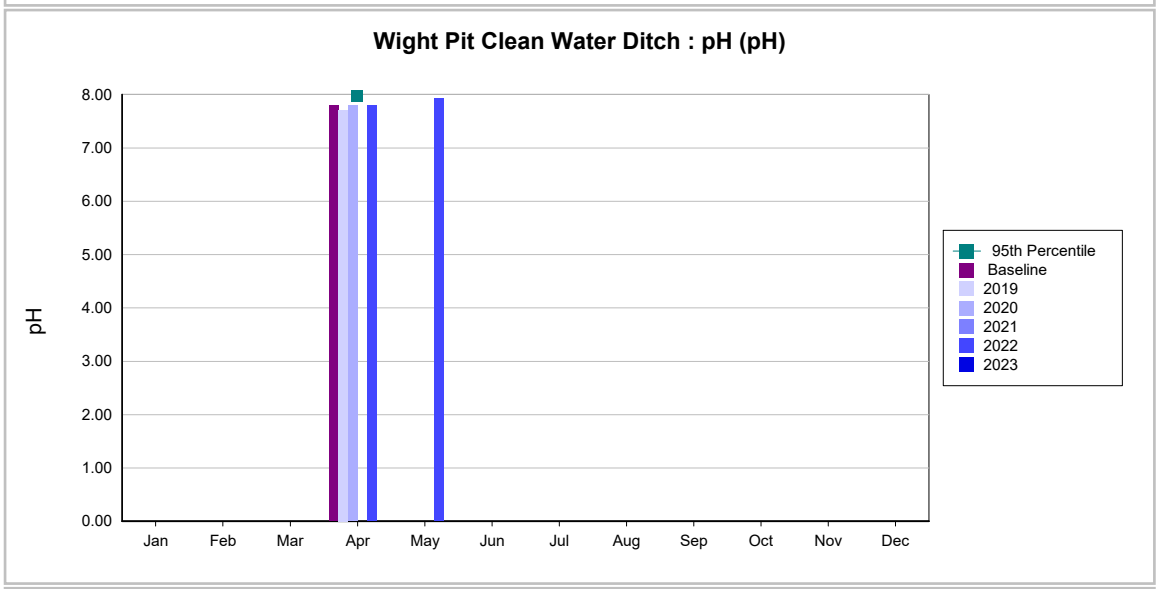
Annual Report Drainage Water

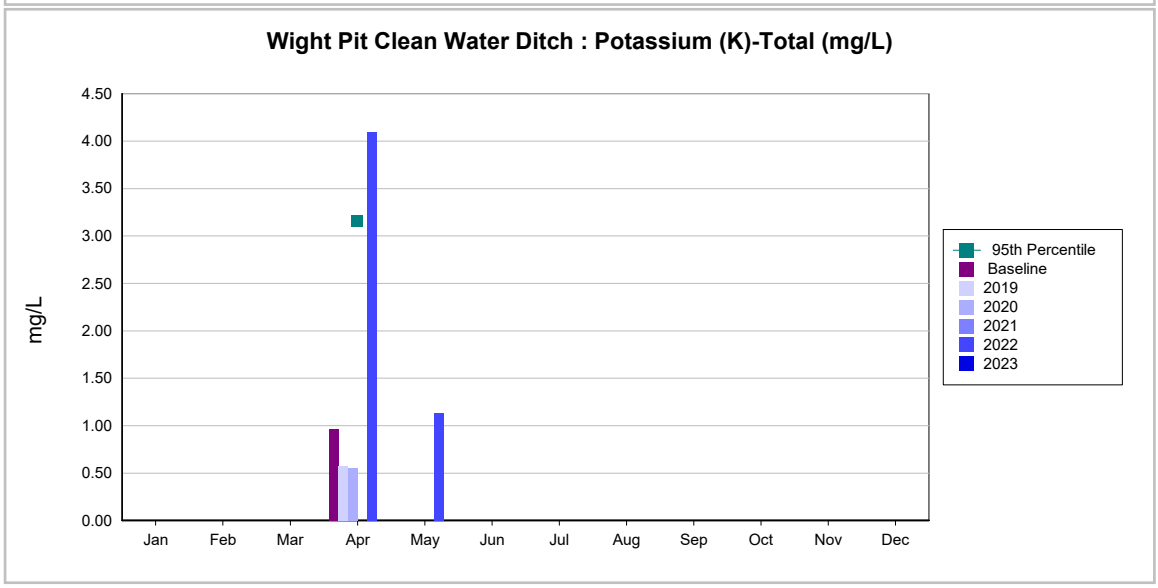
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







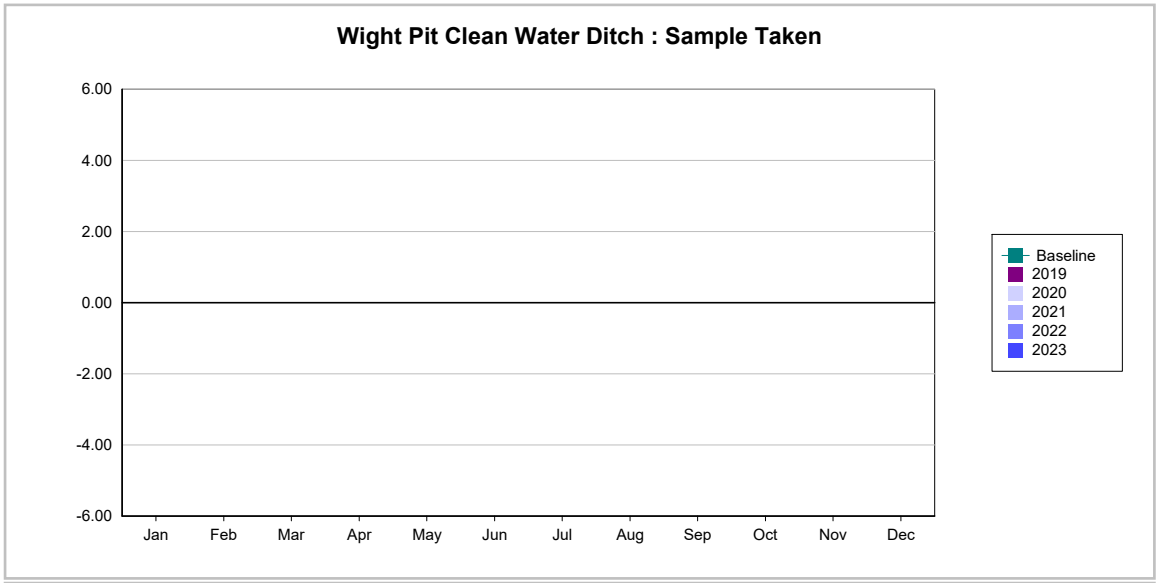
Water Quality Report

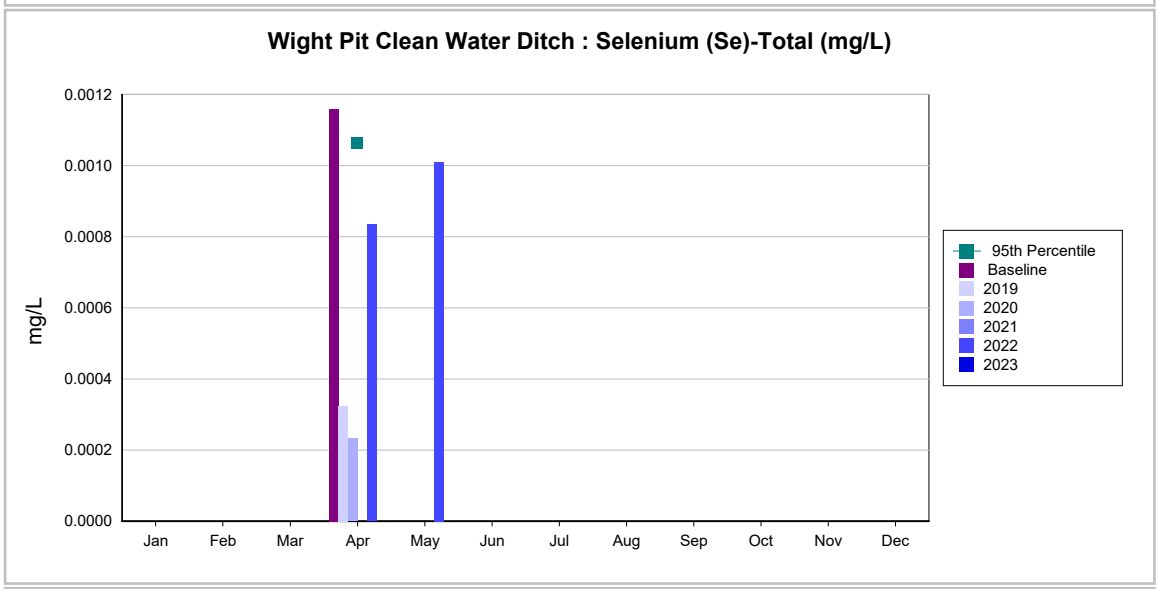
Annual Report Drainage Water

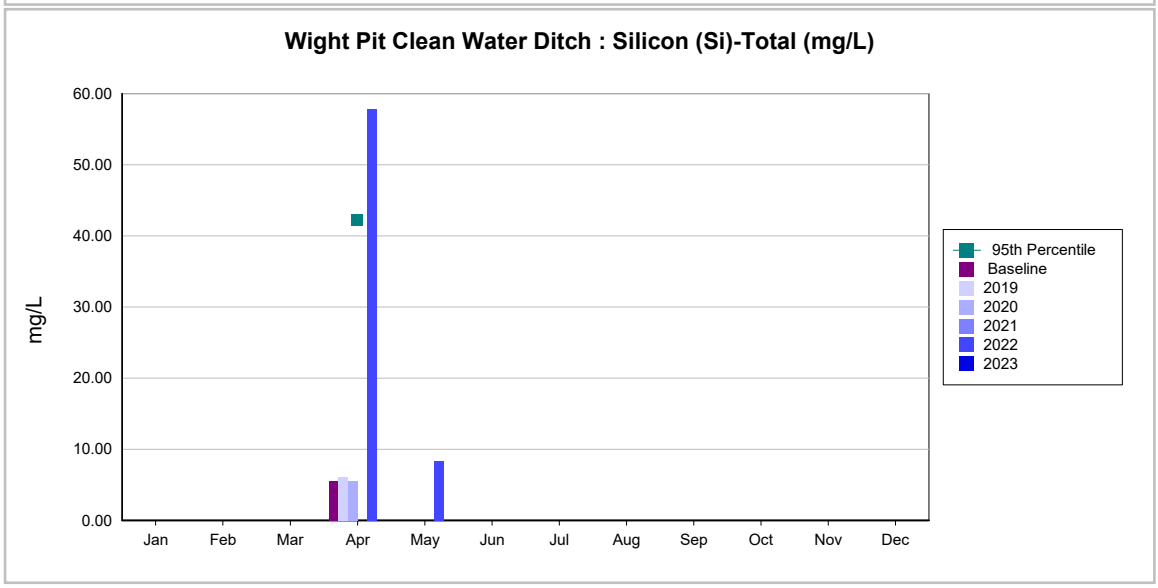
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







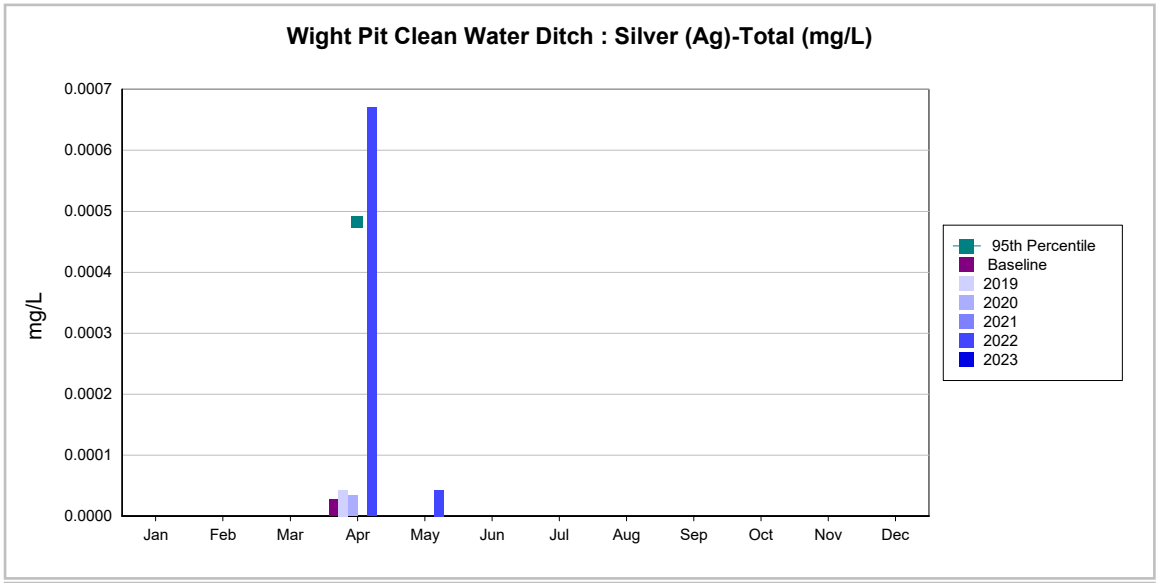
Water Quality Report

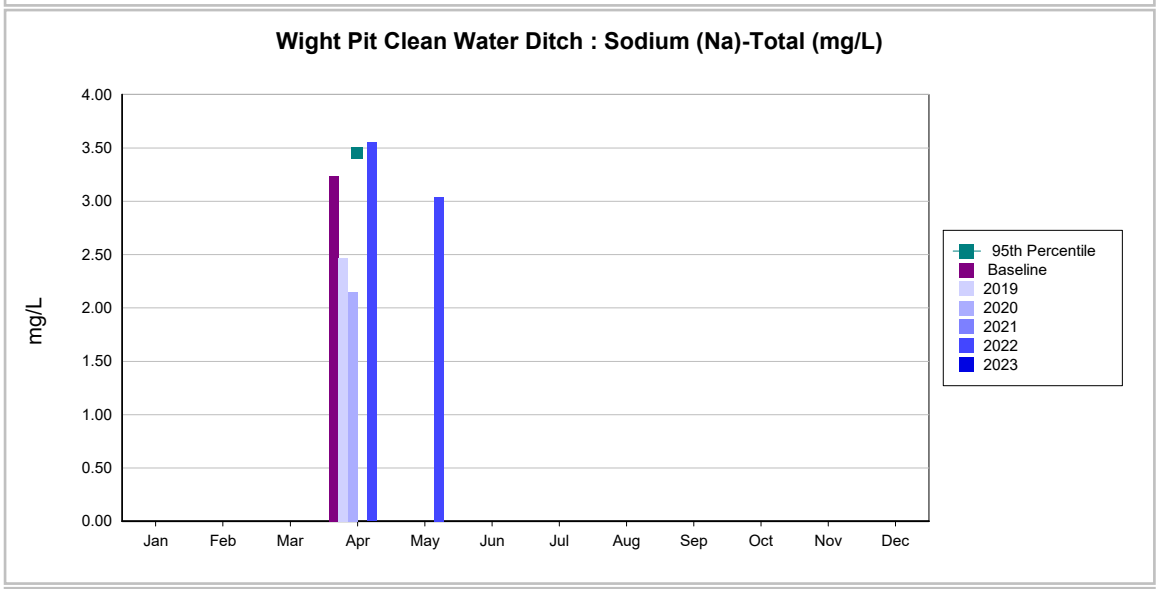
Annual Report Drainage Water

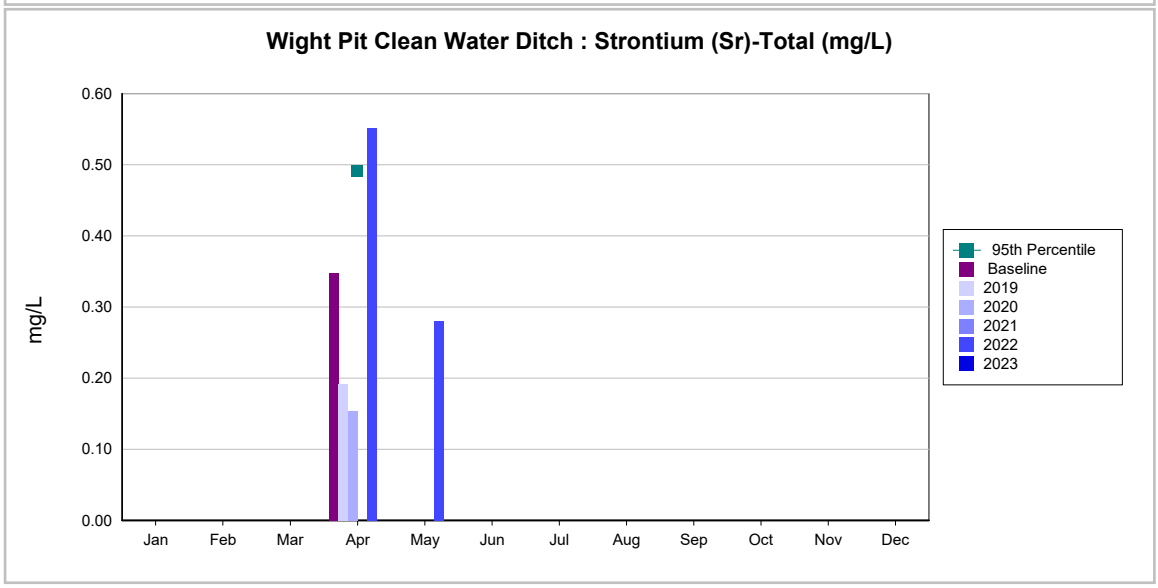
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







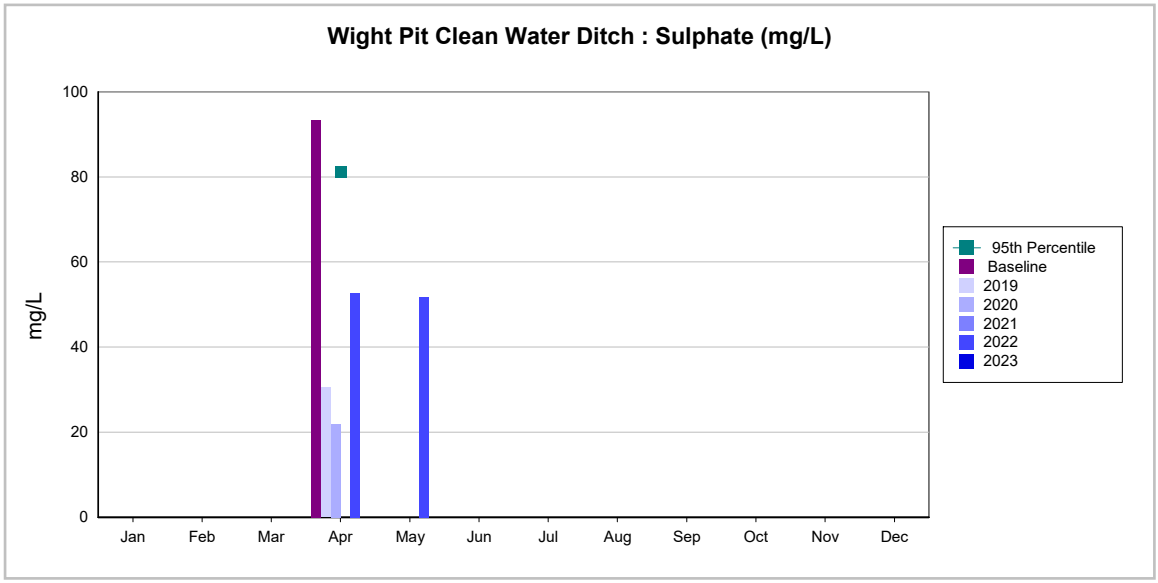
Water Quality Report

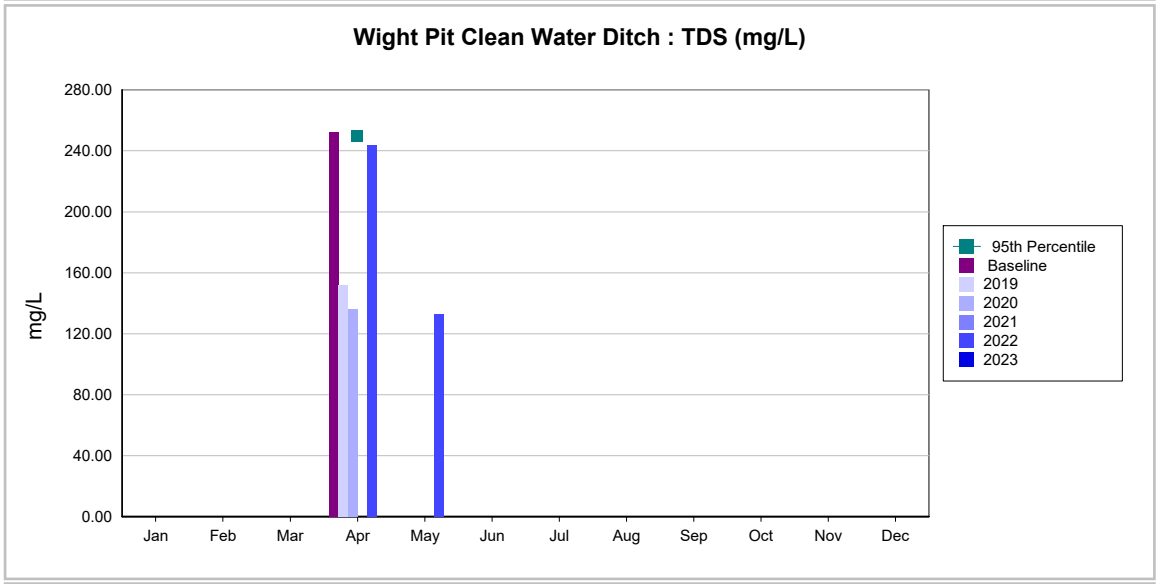
Annual Report Drainage Water

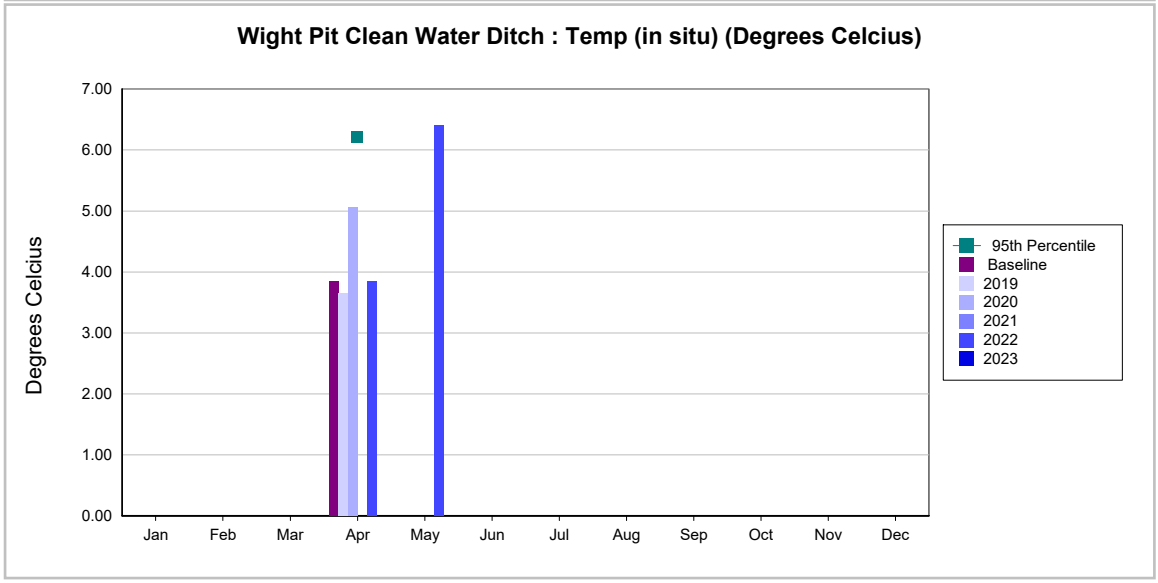
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







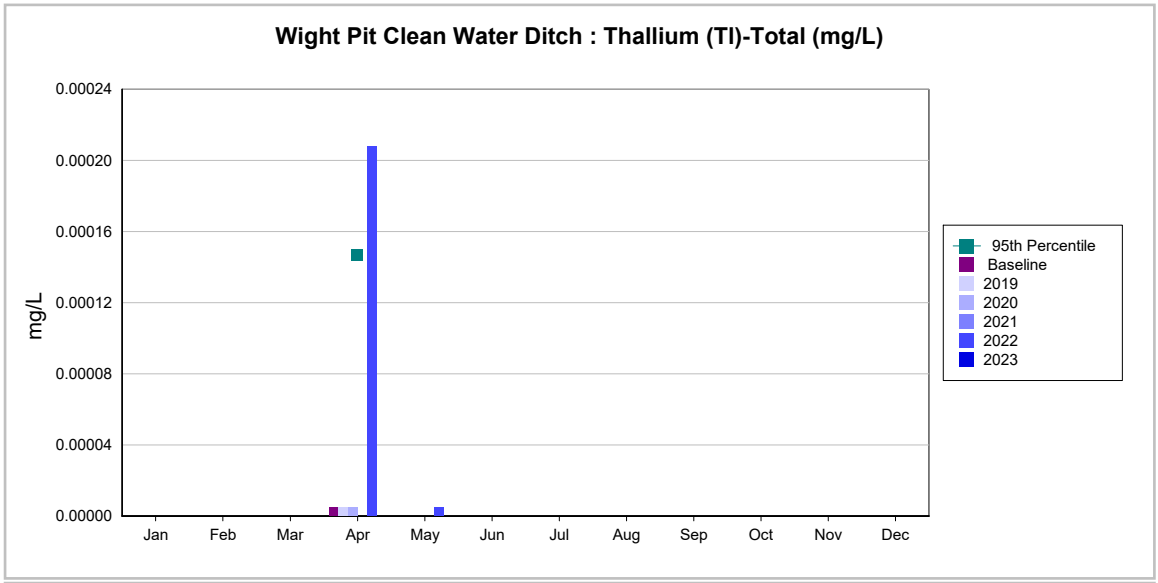
Water Quality Report

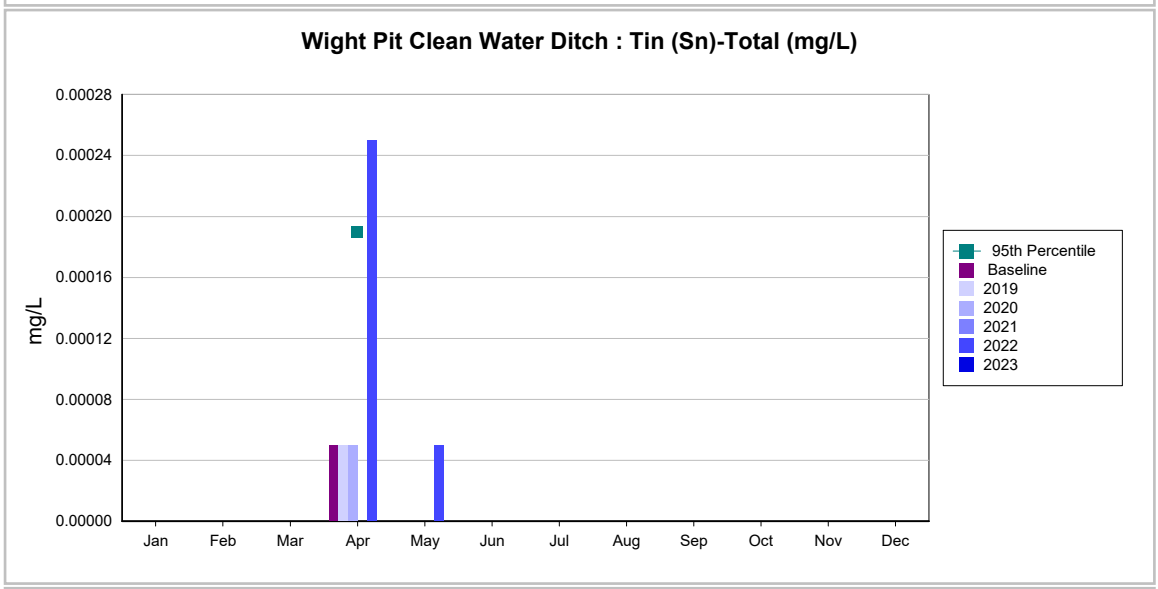
Annual Report Drainage Water

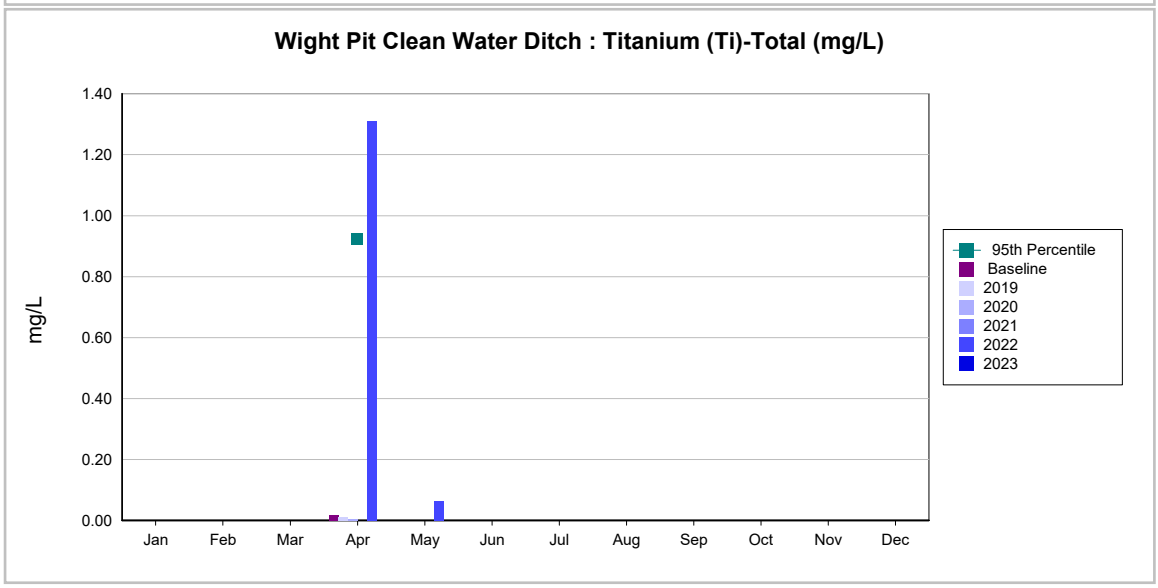
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







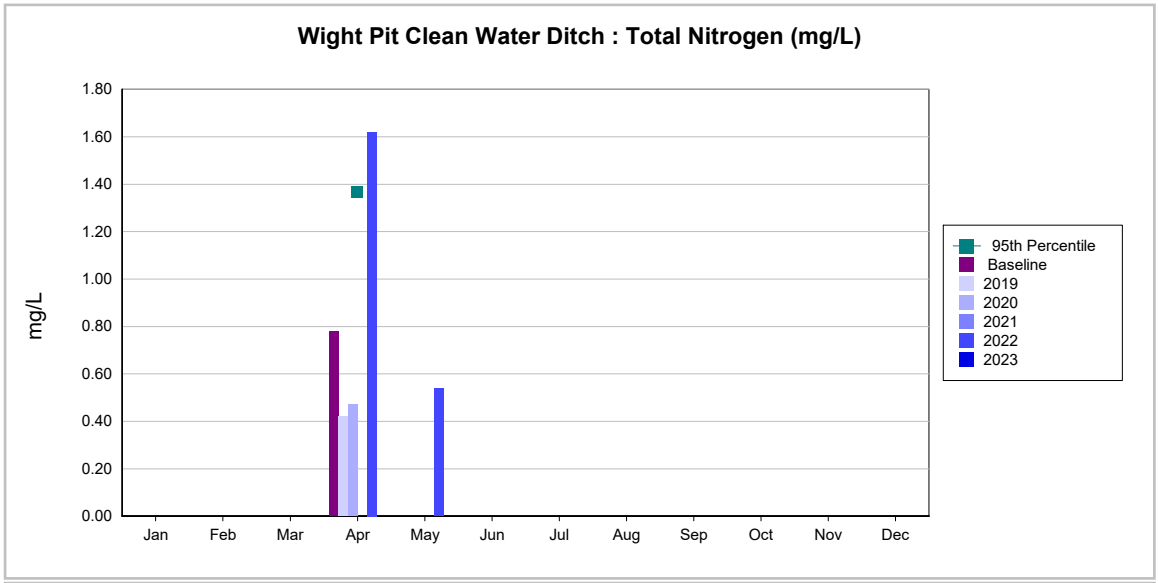
Water Quality Report

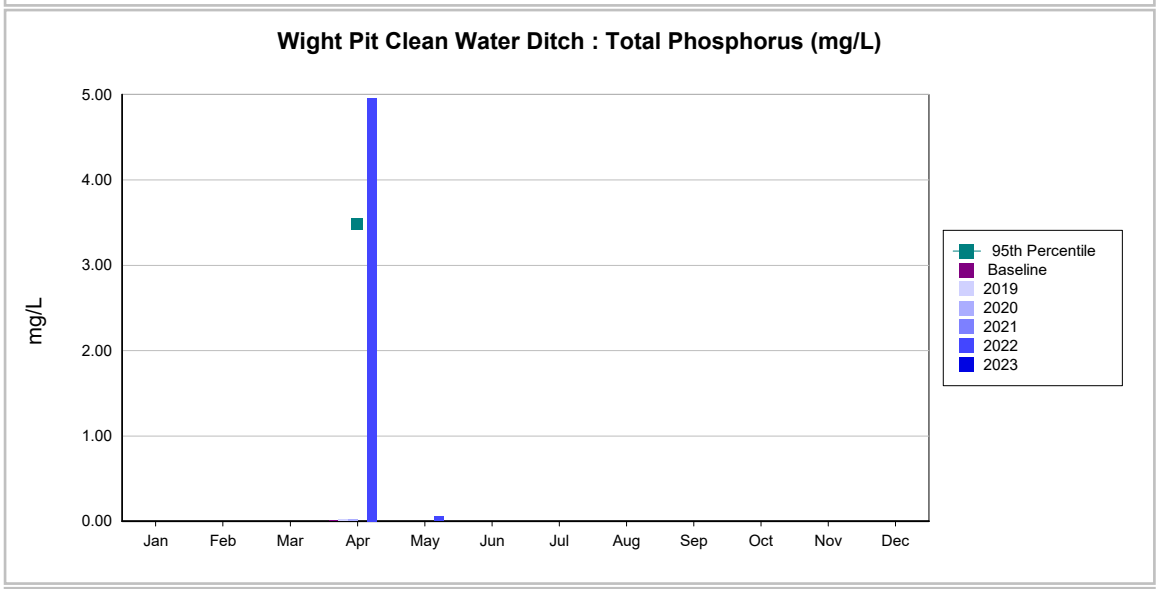
Annual Report Drainage Water

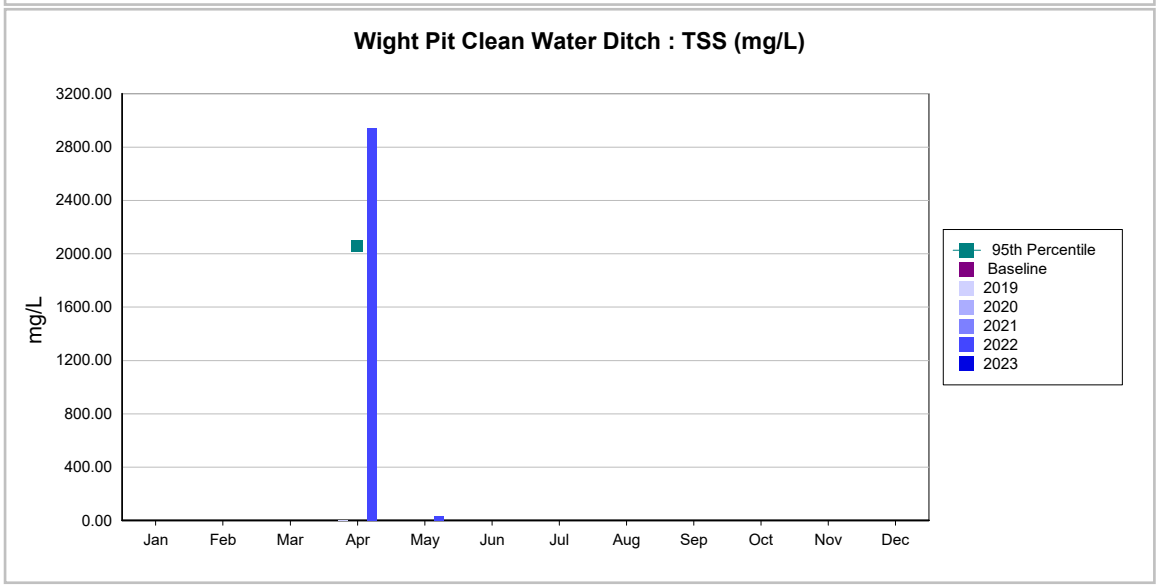
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







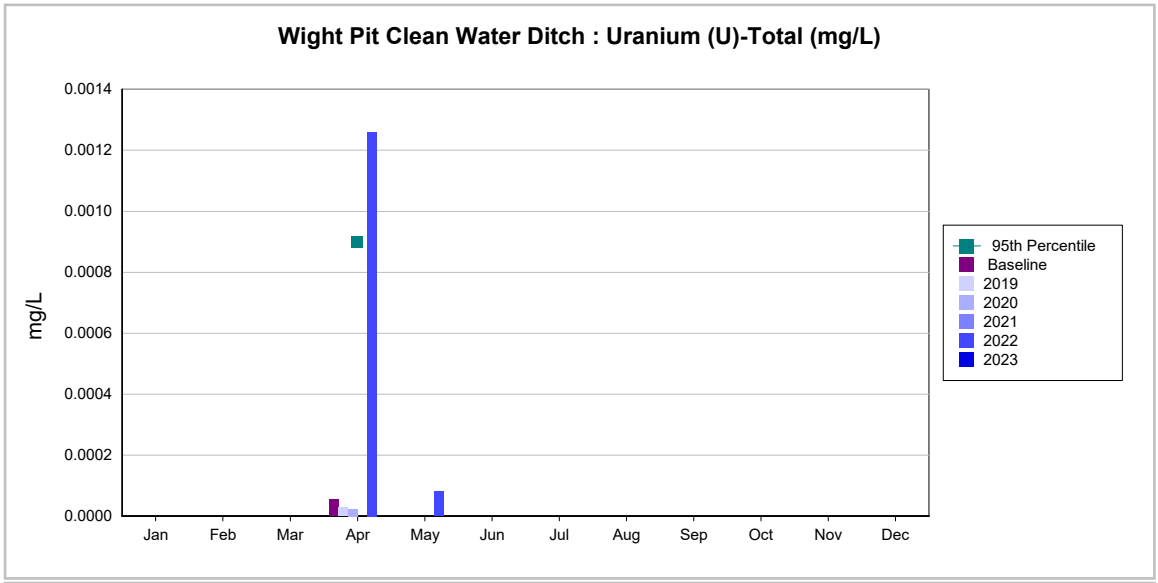
Water Quality Report

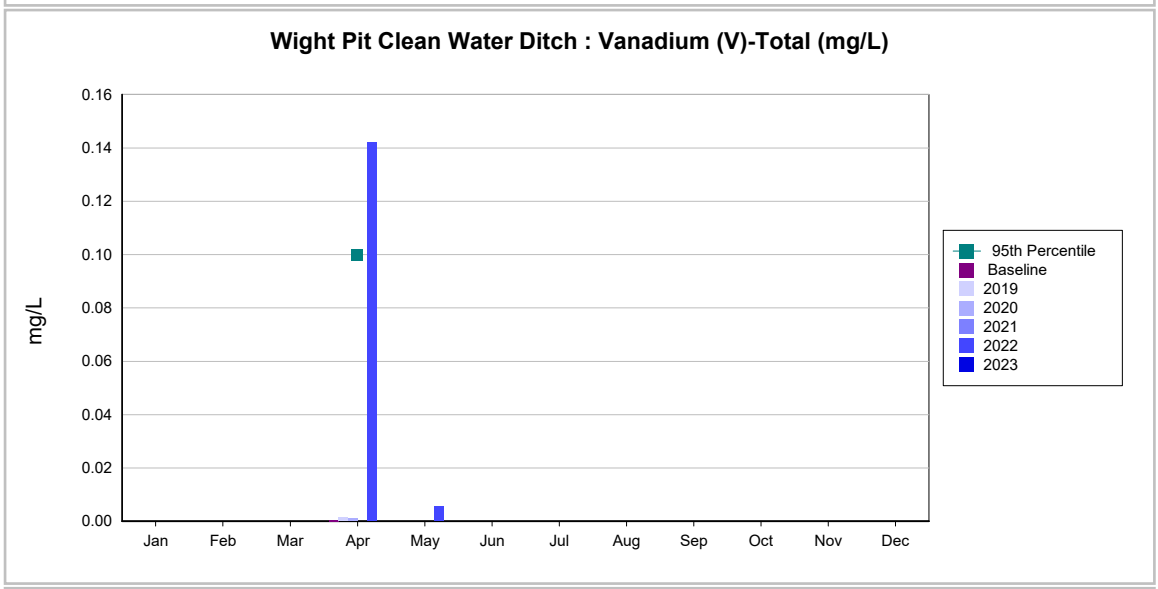
Annual Report Drainage Water

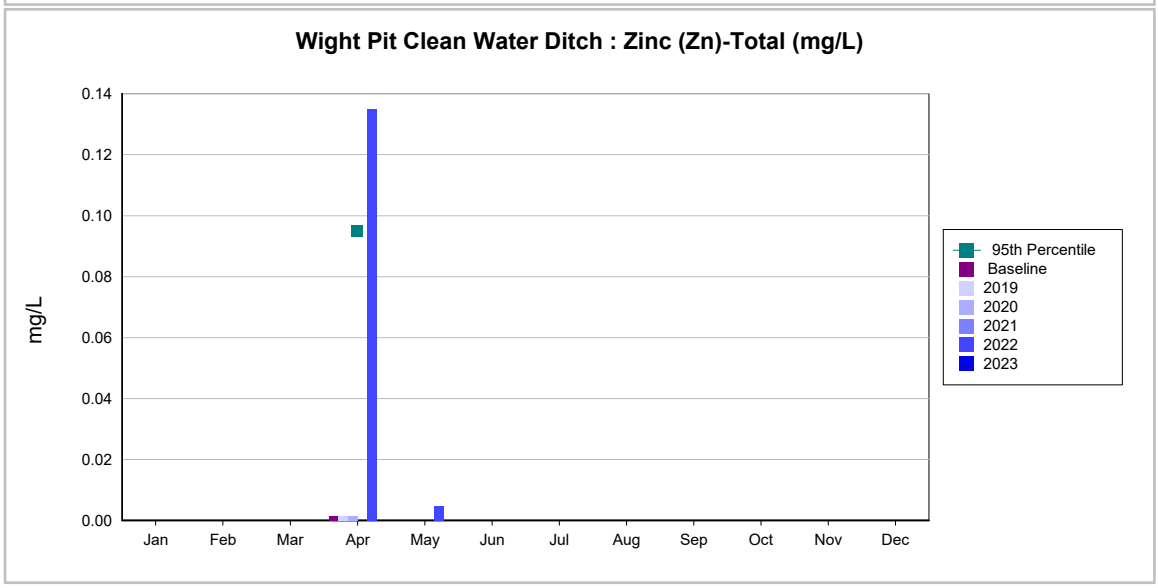
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







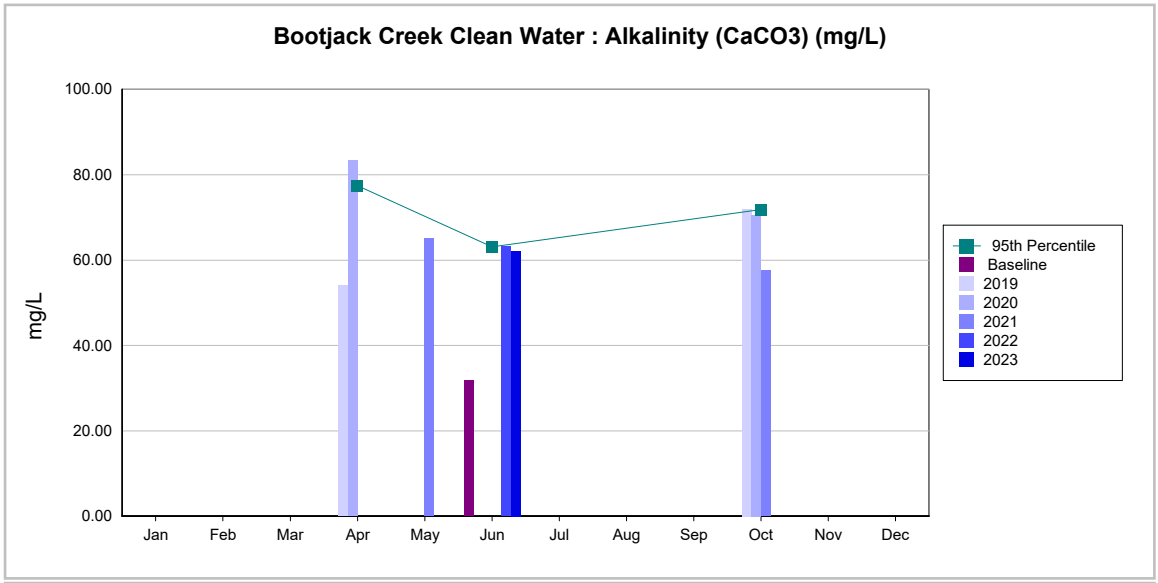
Water Quality Report

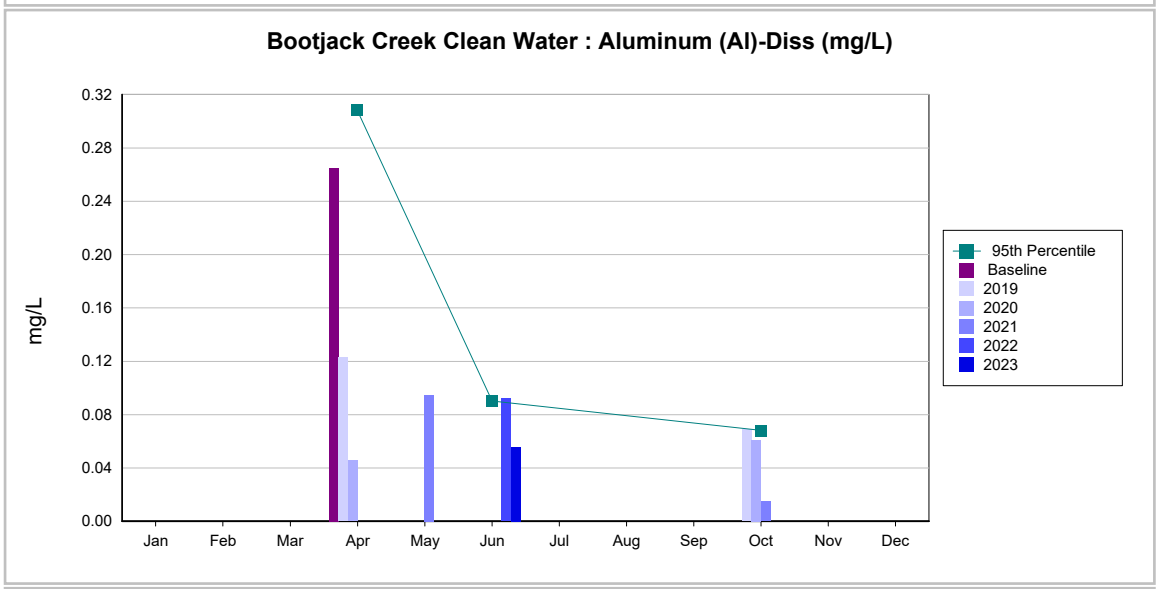
Annual Report Drainage Water

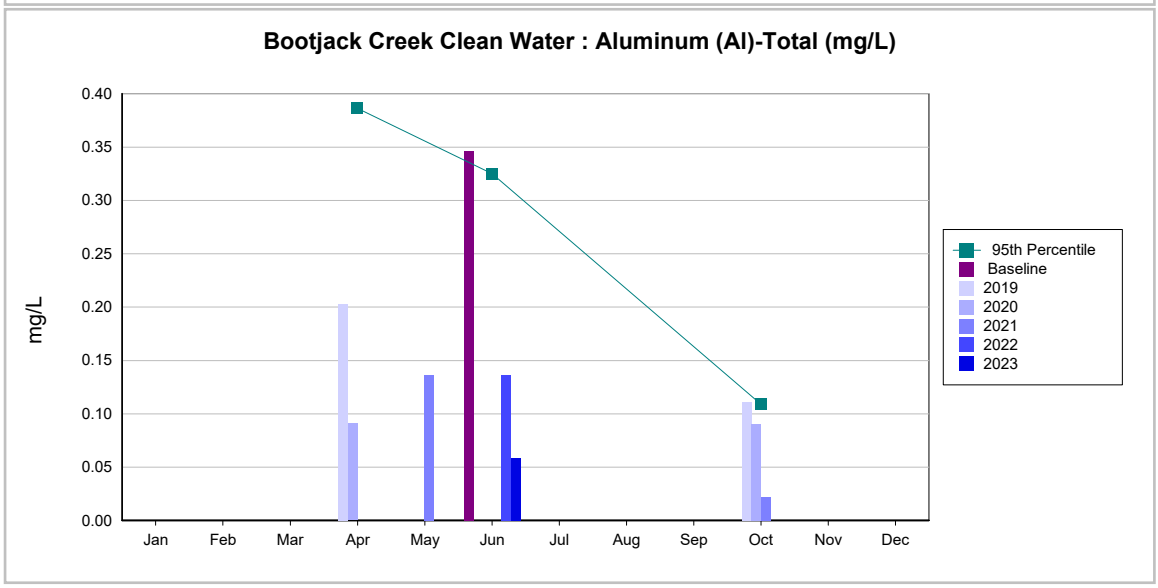
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







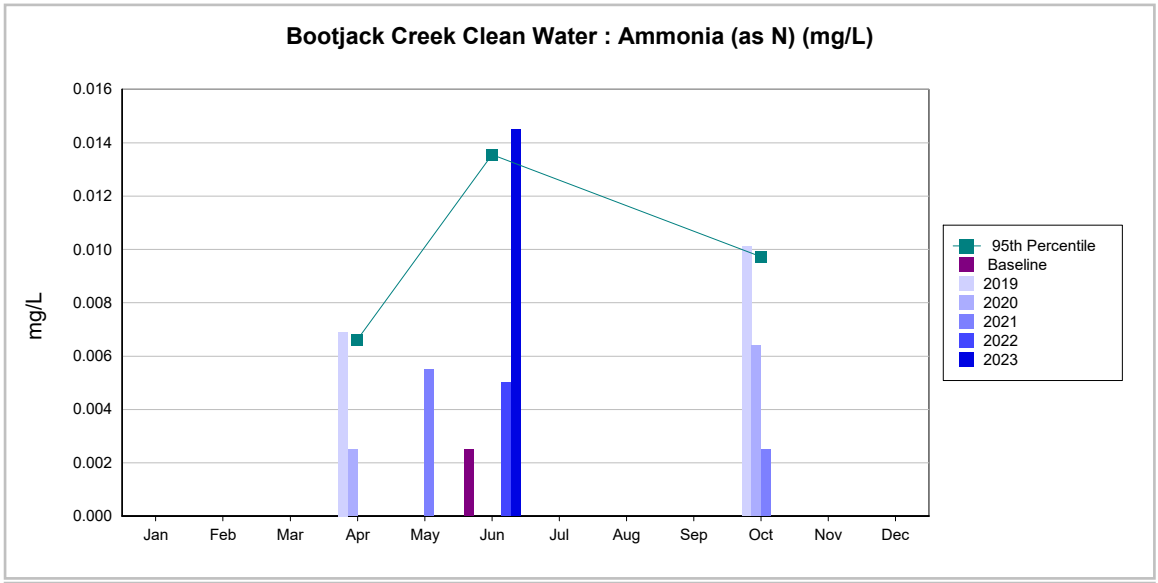
Water Quality Report

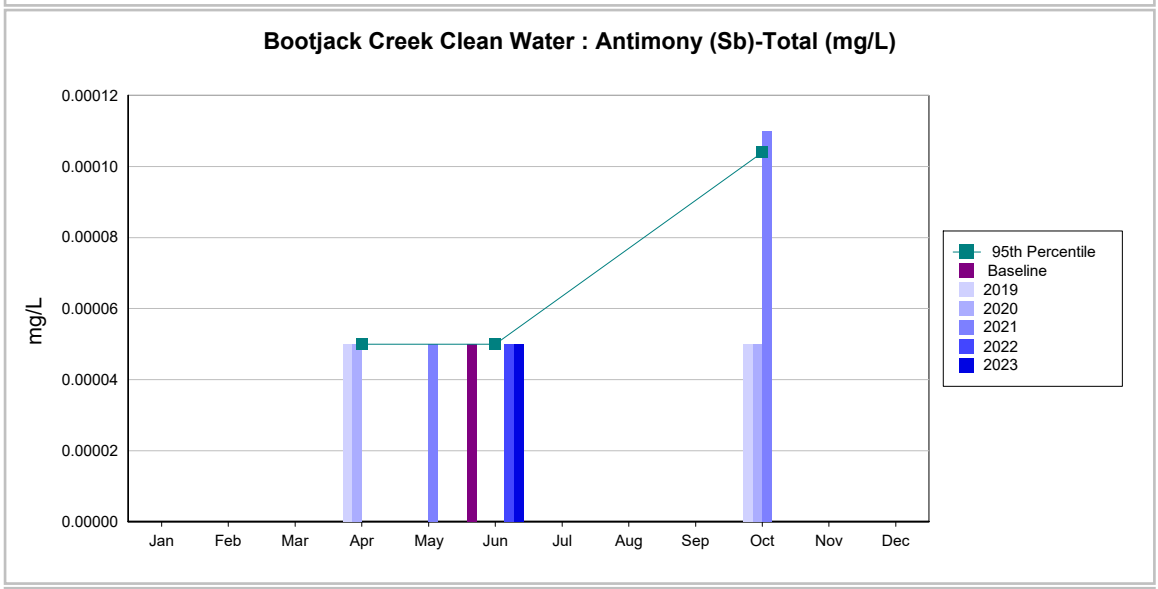
Annual Report Drainage Water

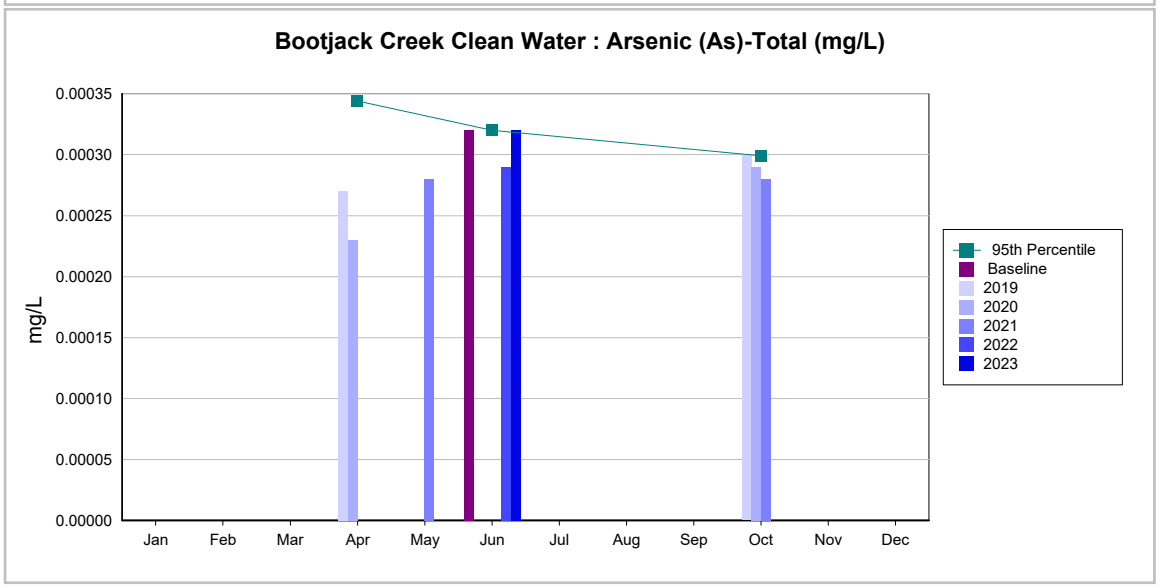
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







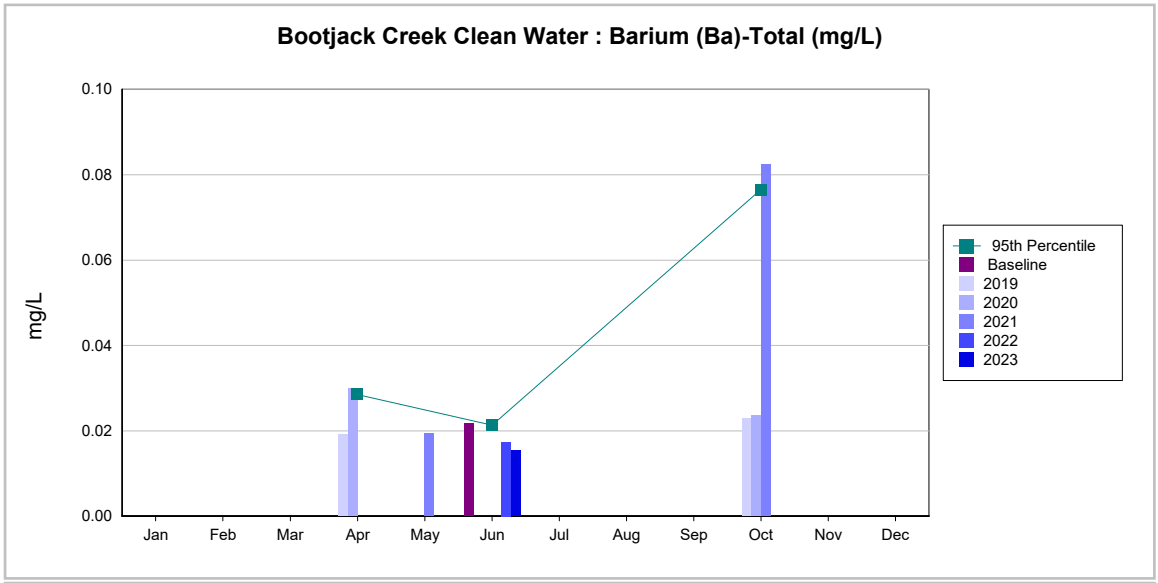
Water Quality Report

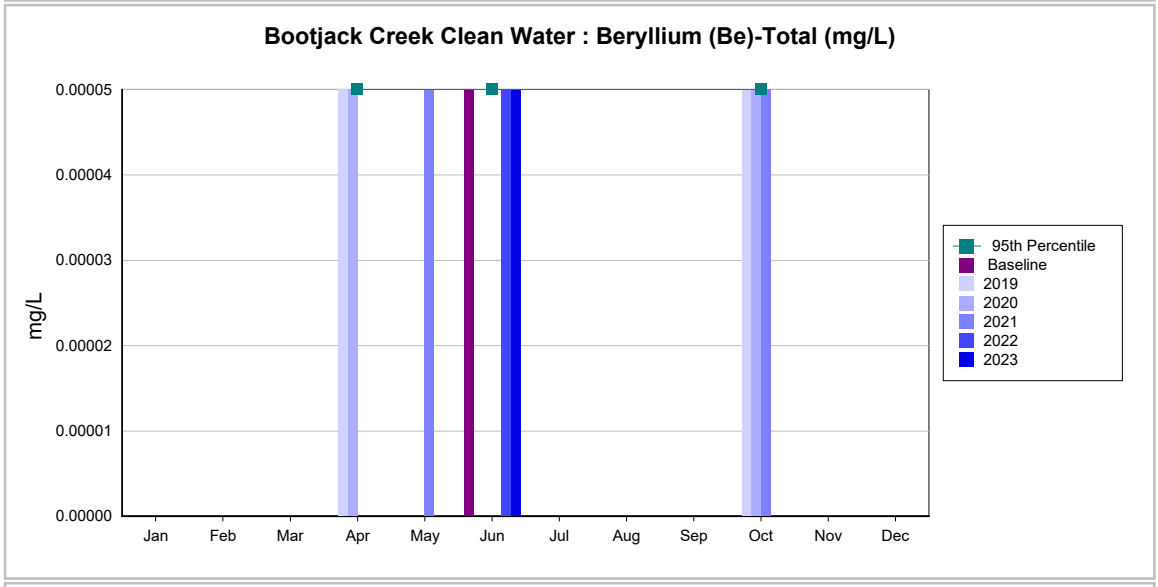
Annual Report Drainage Water

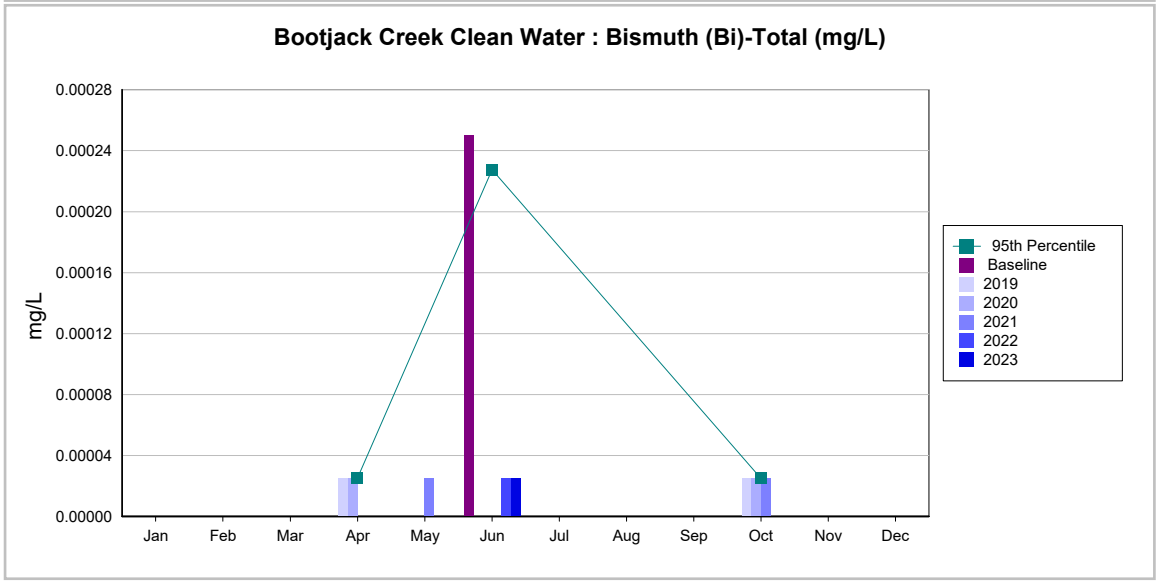
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







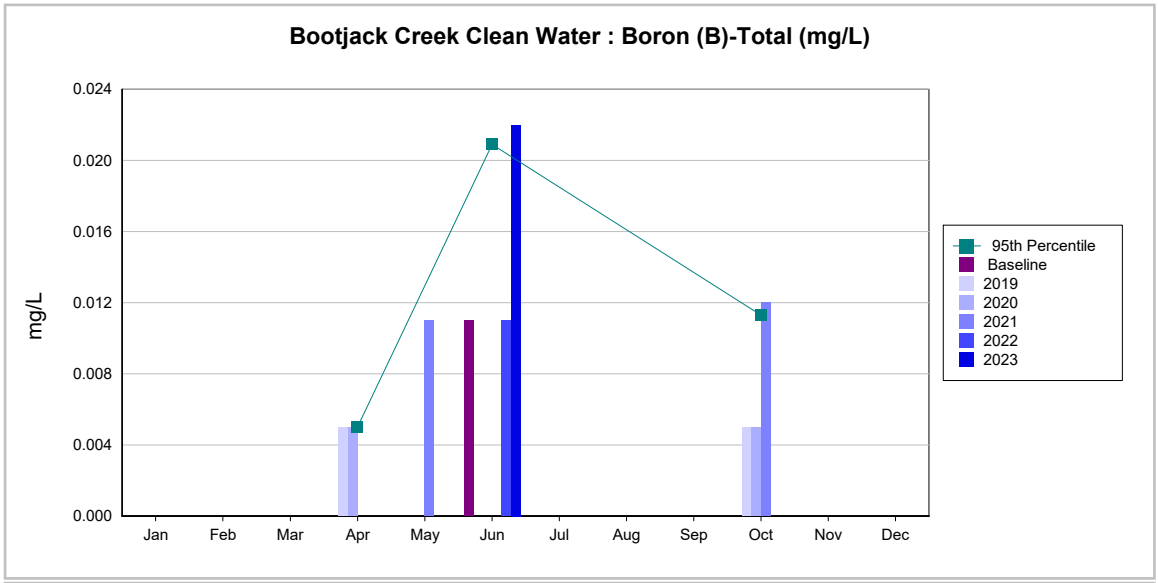
Water Quality Report

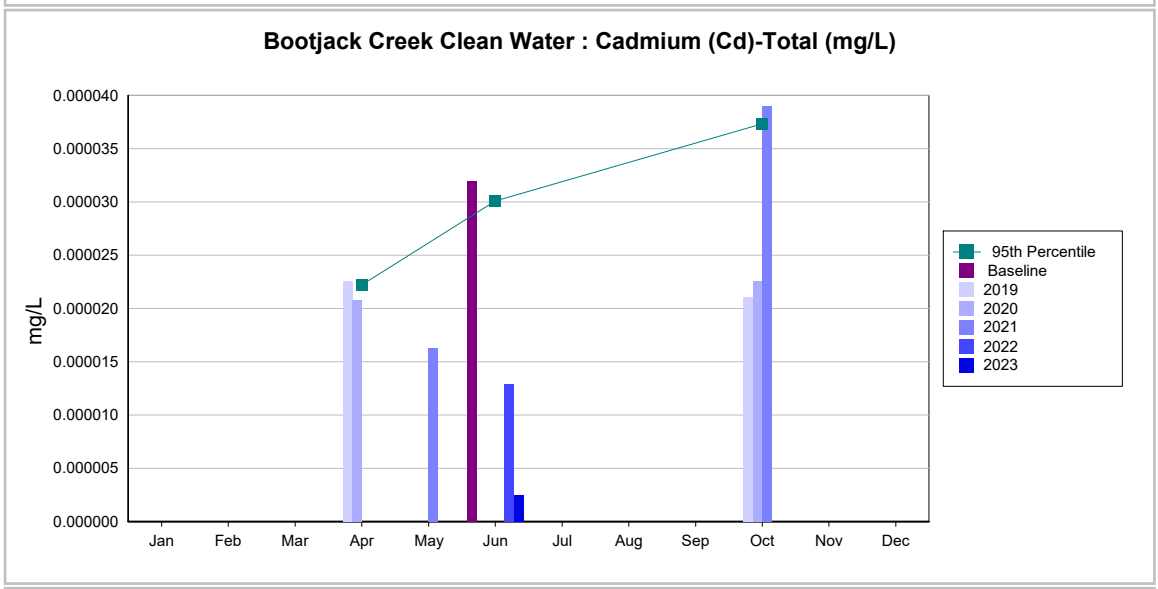
Annual Report Drainage Water

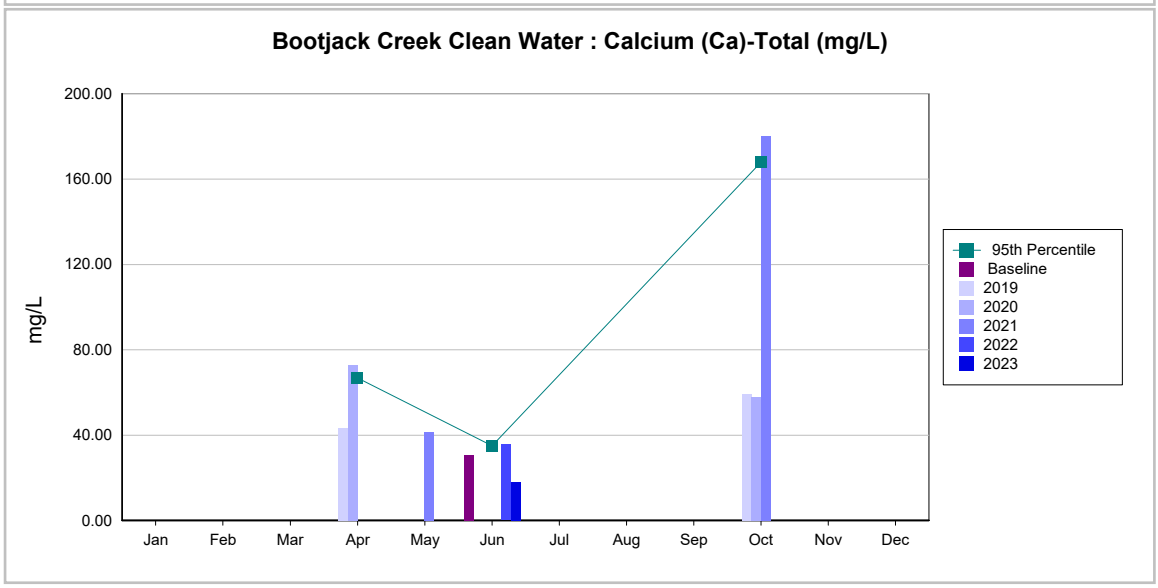
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







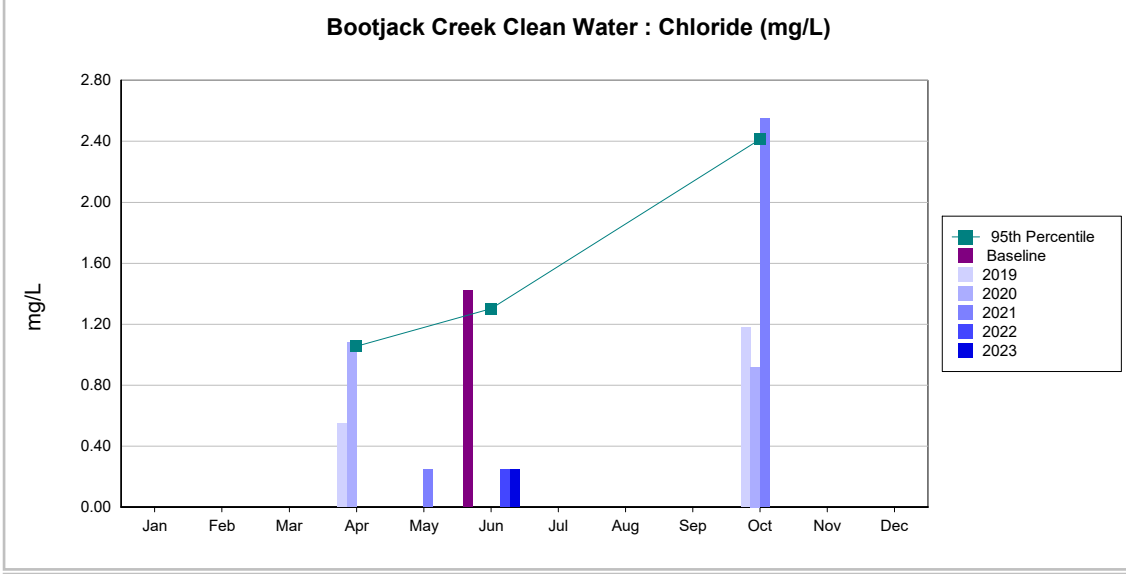
Water Quality Report

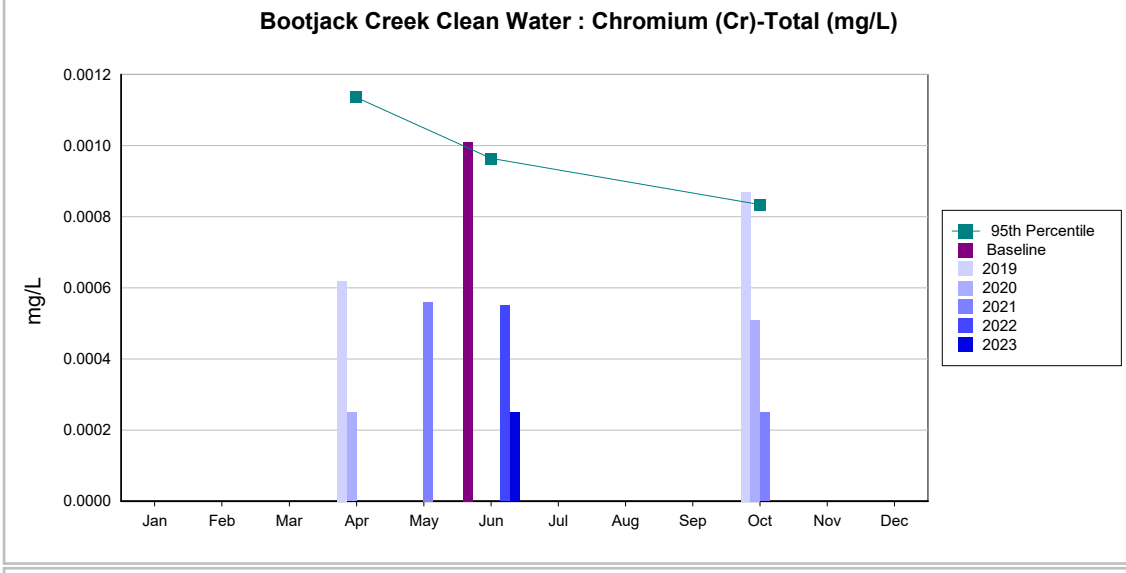
Annual Report Drainage Water

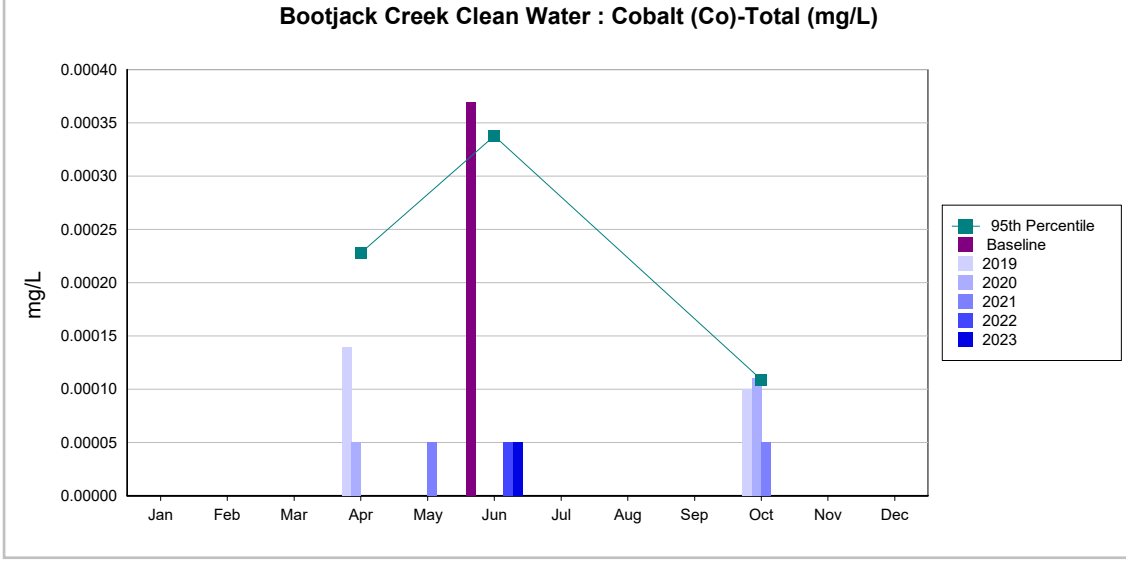
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







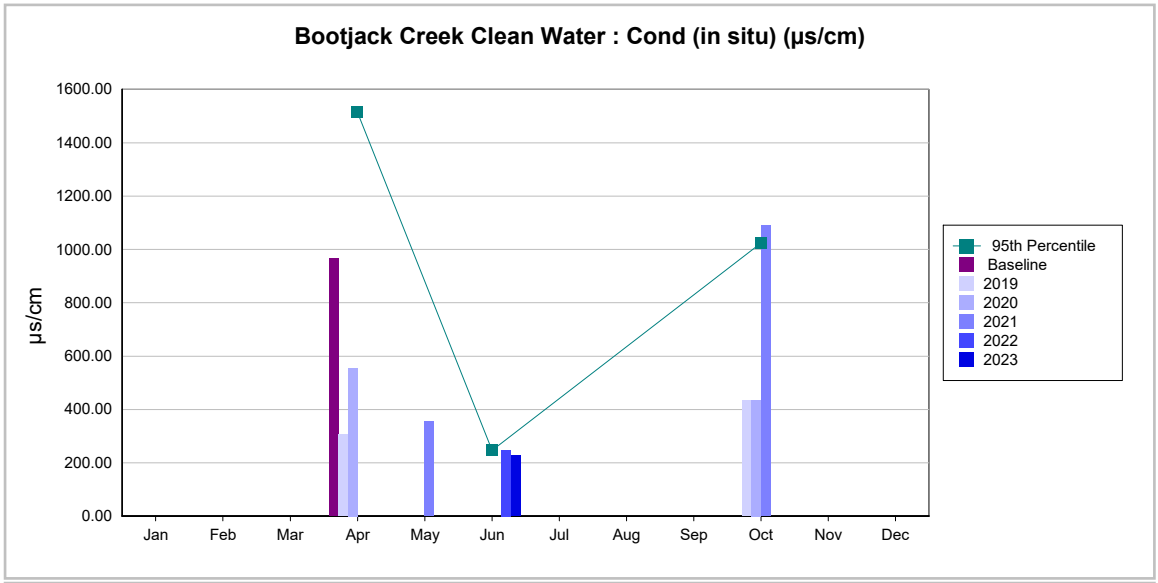
Water Quality Report

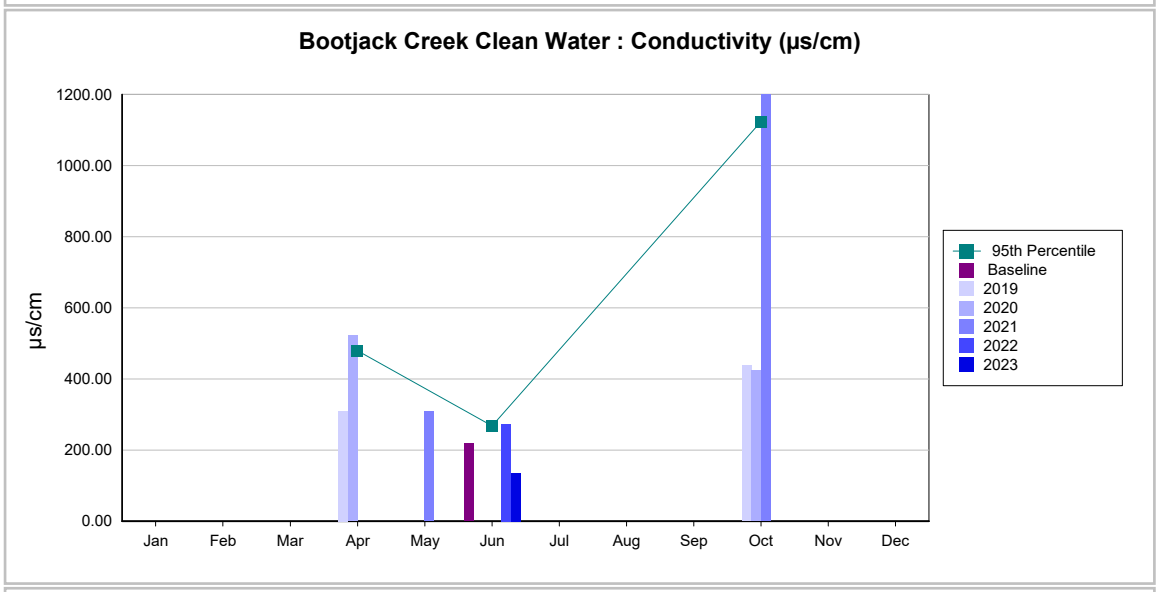
Annual Report Drainage Water

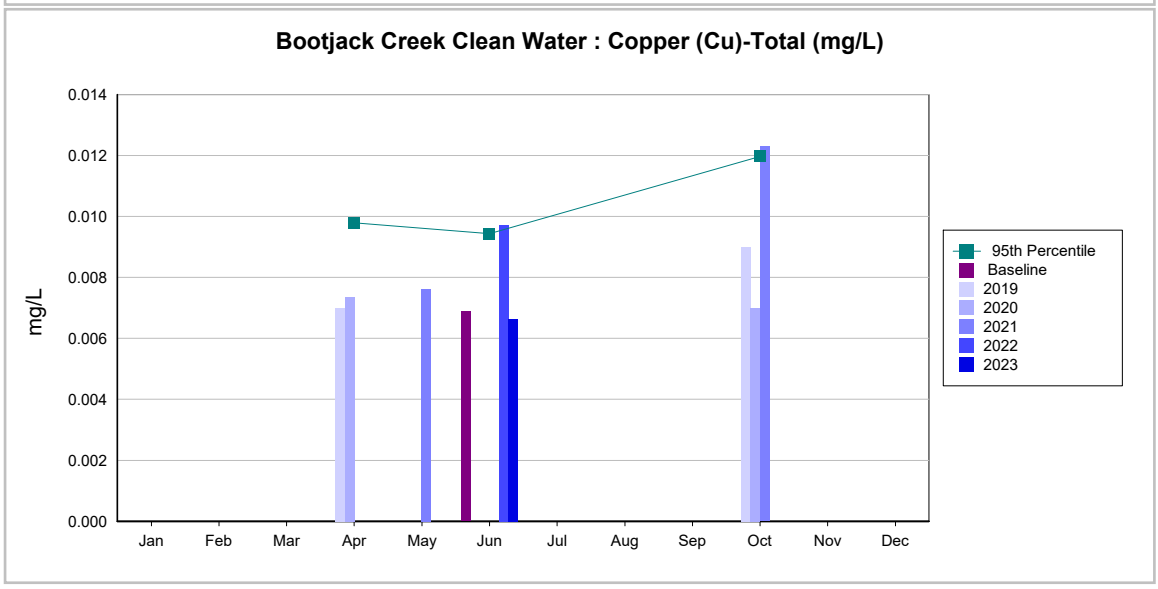
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







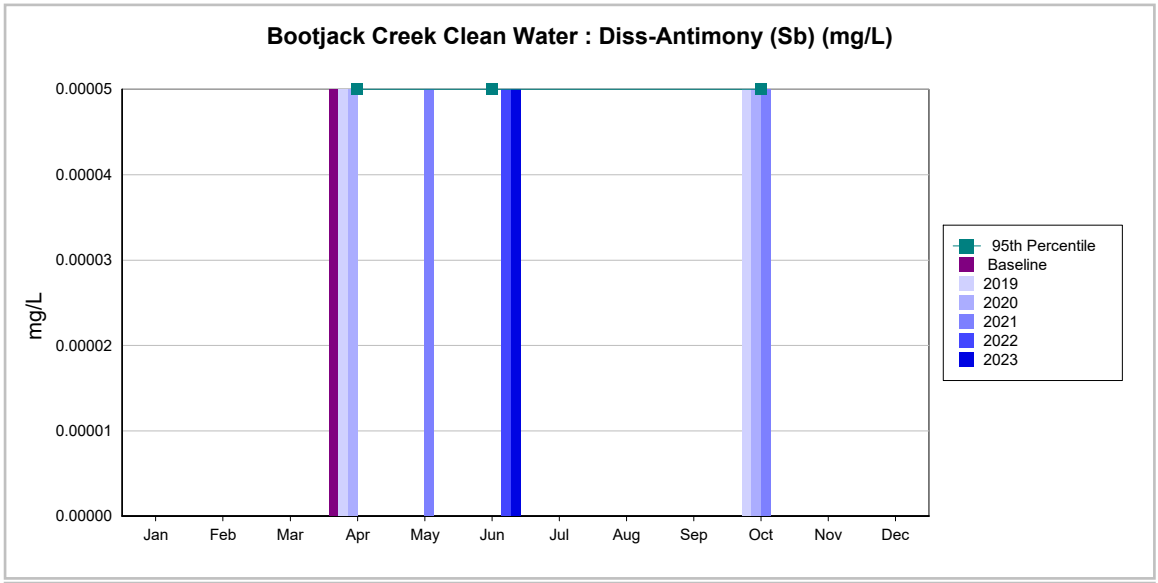
Water Quality Report

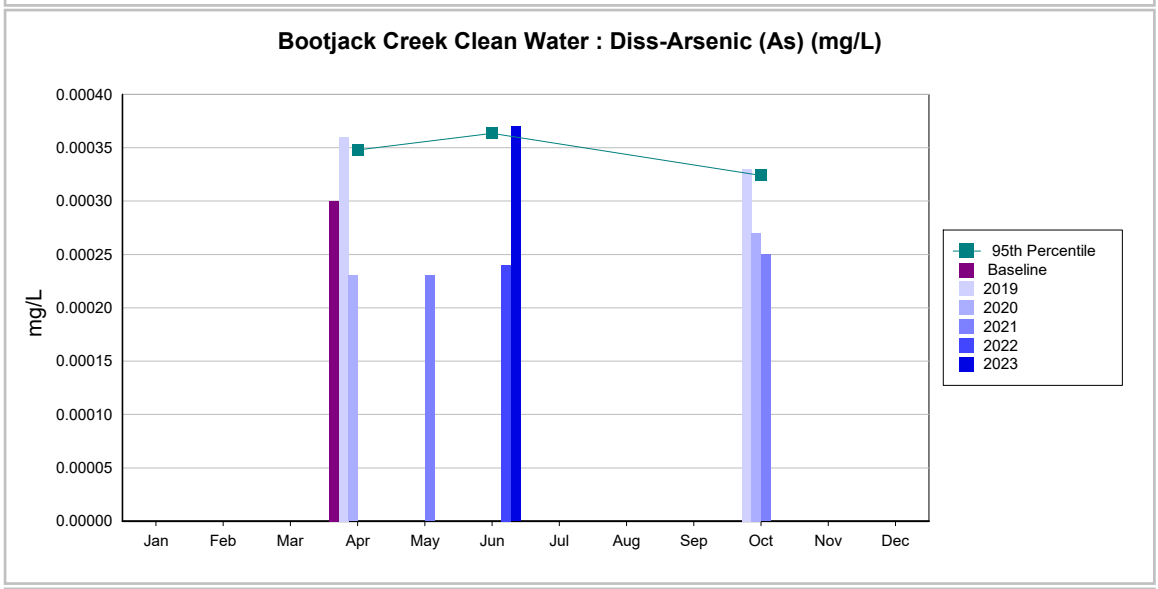
Annual Report Drainage Water

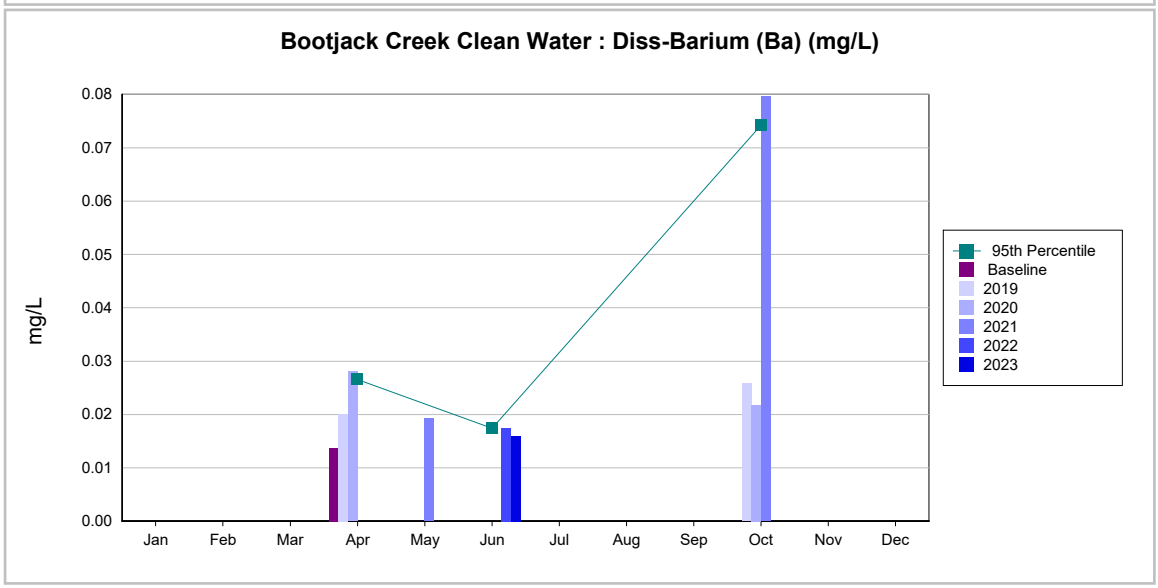
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







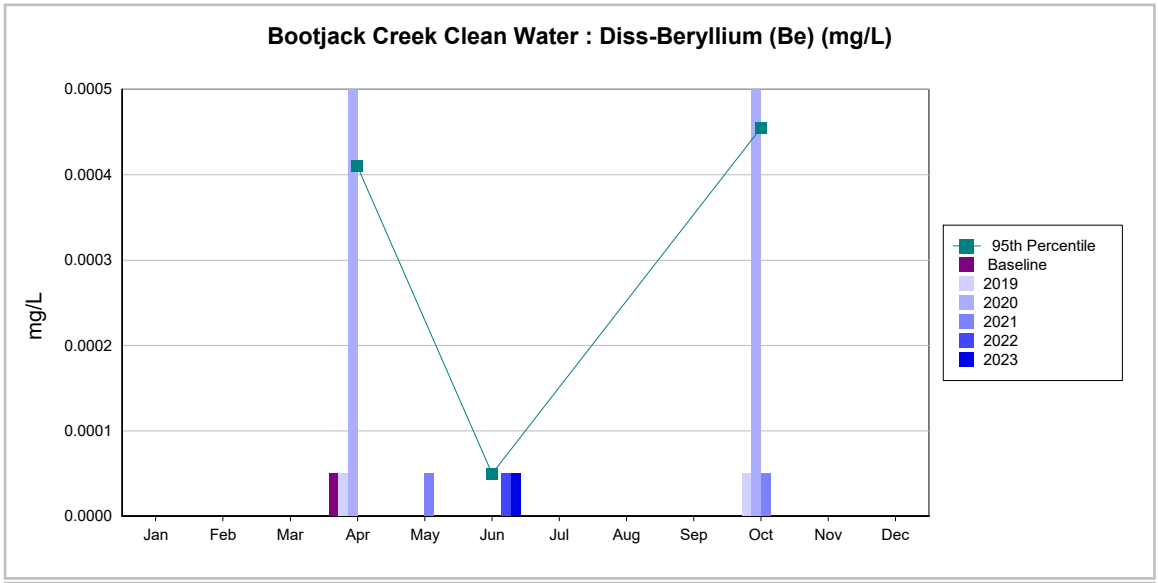
Water Quality Report

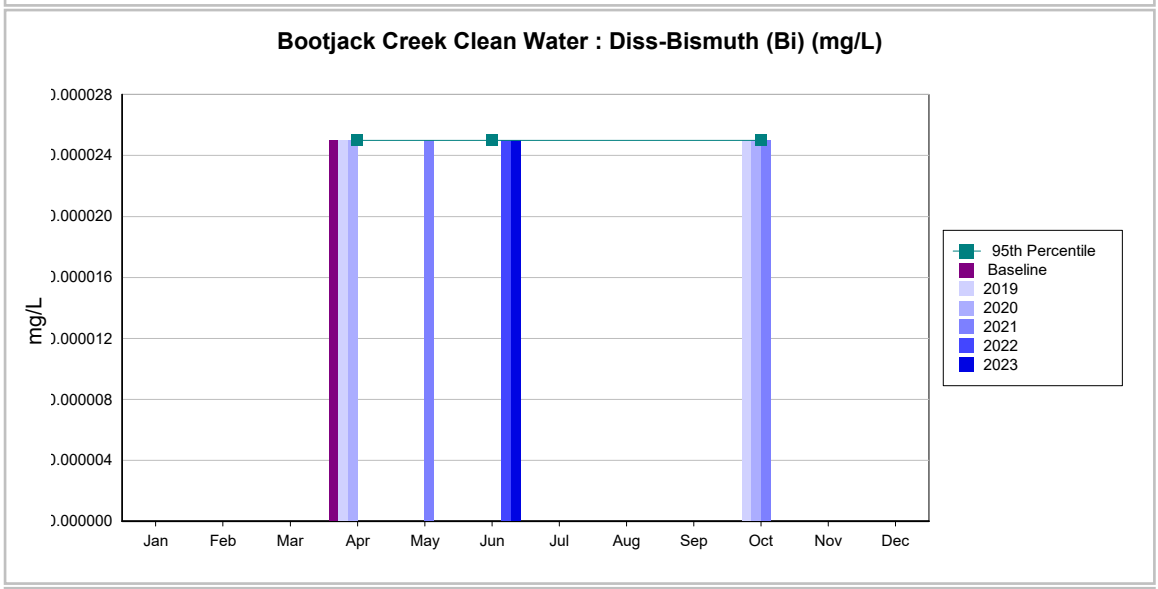
Annual Report Drainage Water

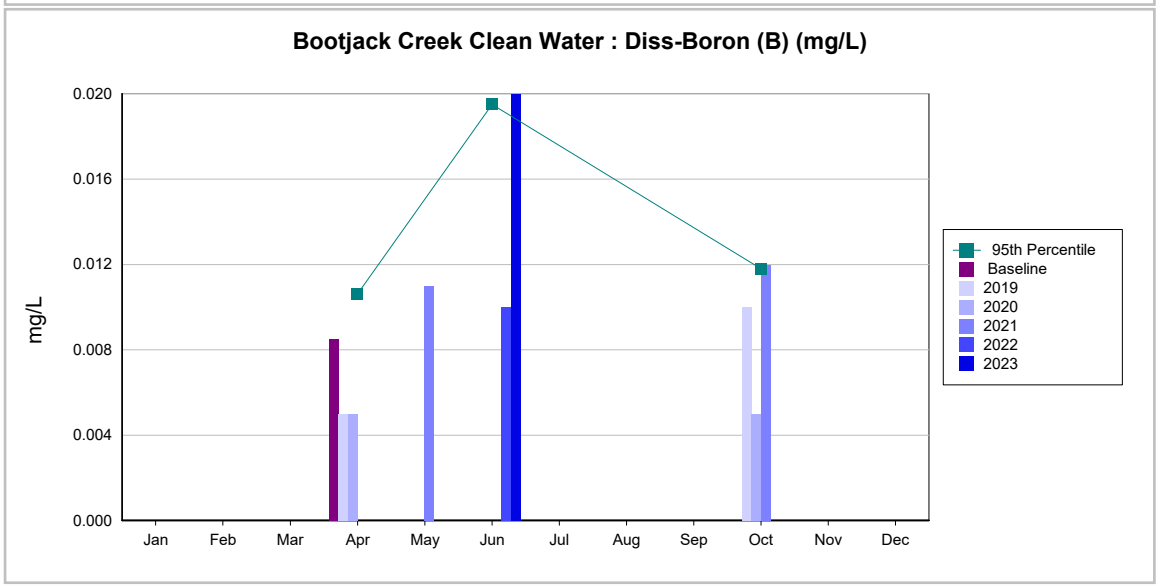
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







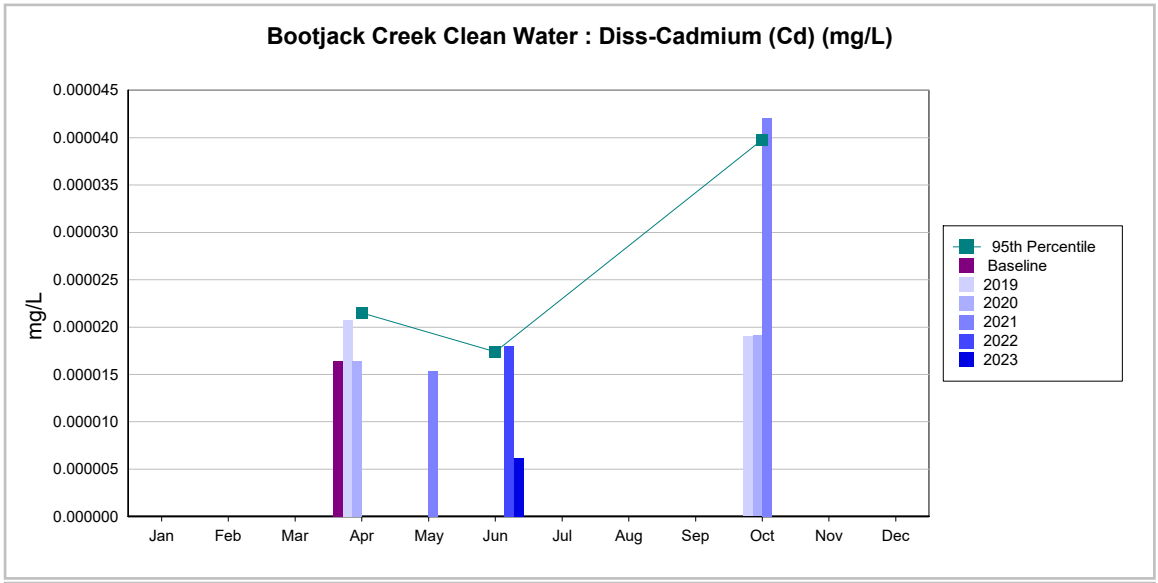
Water Quality Report

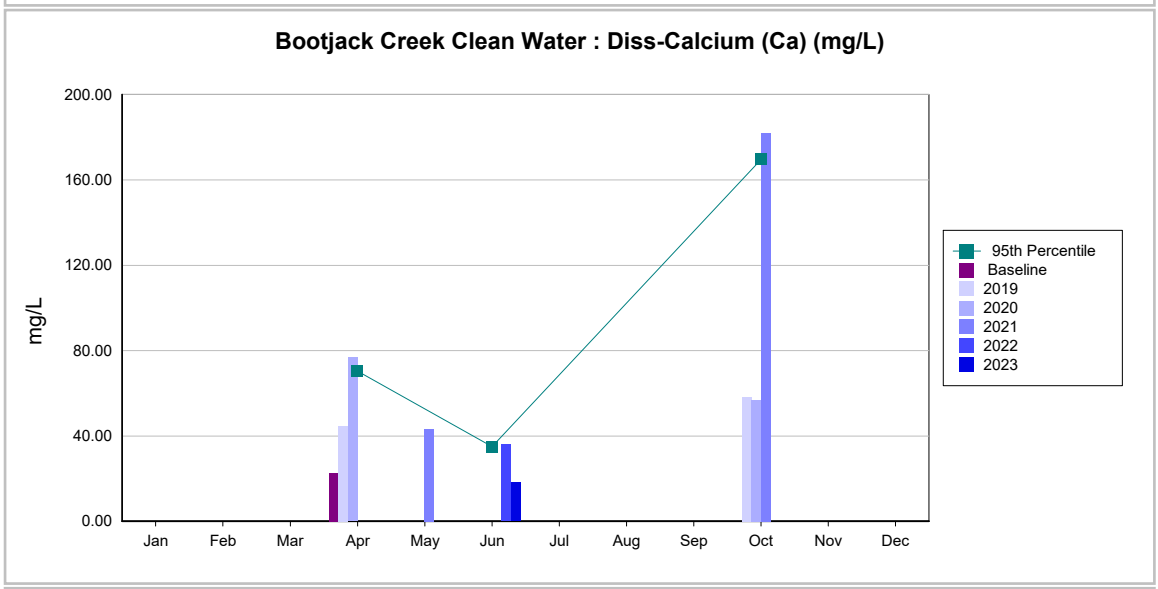
Annual Report Drainage Water

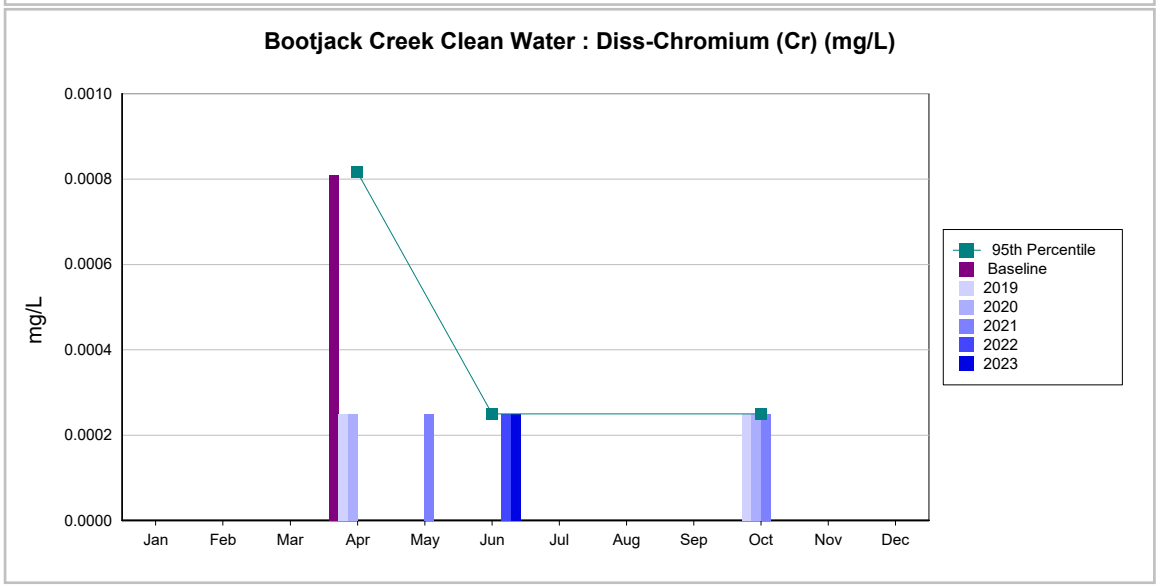
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







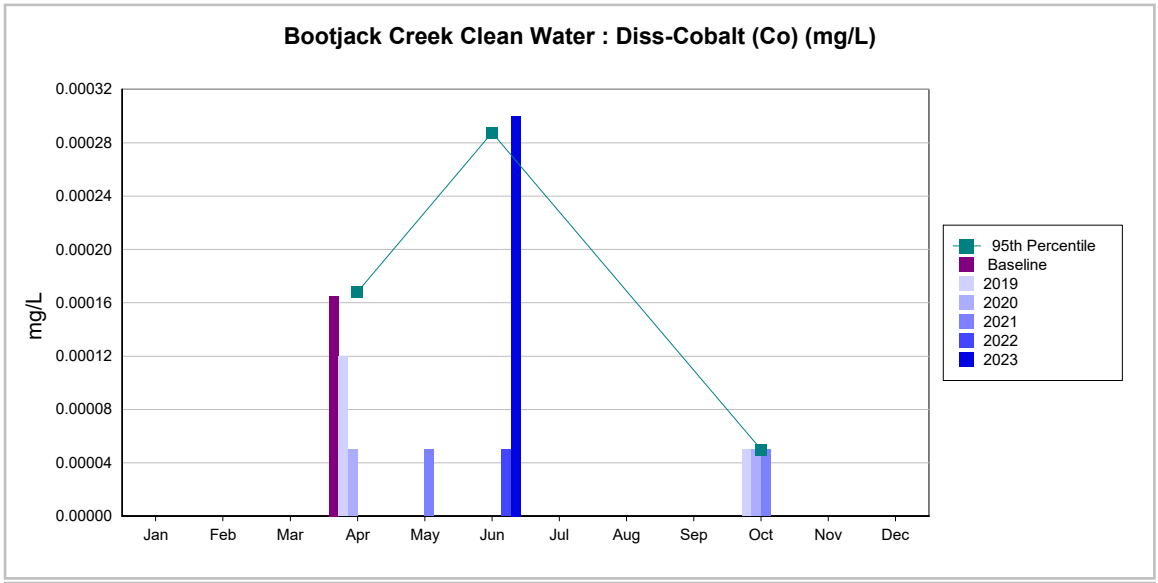
Water Quality Report

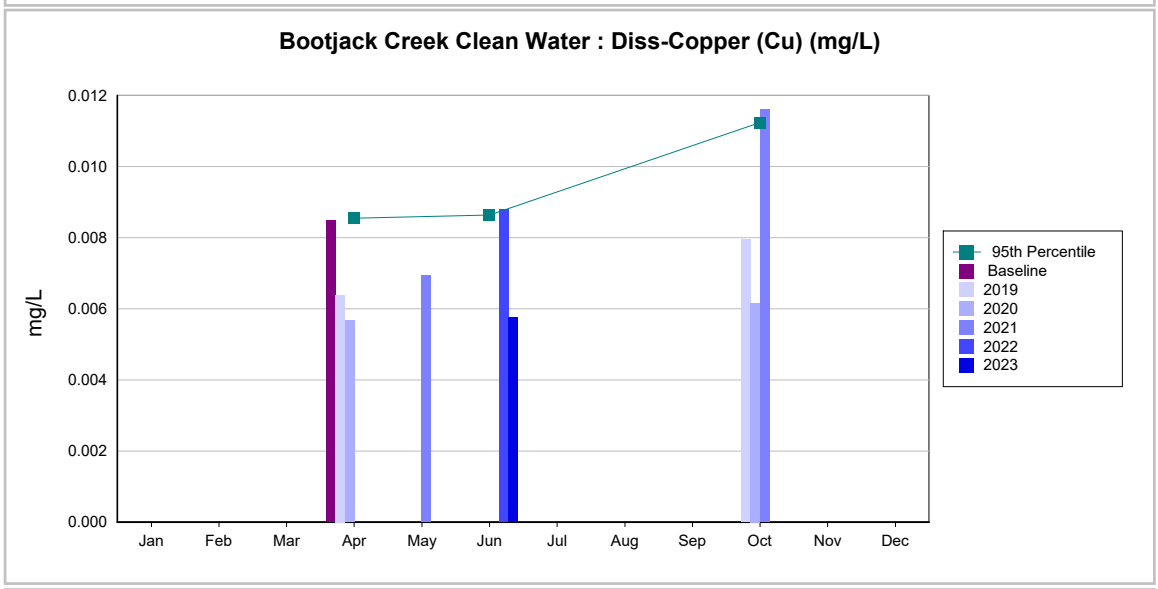
Annual Report Drainage Water

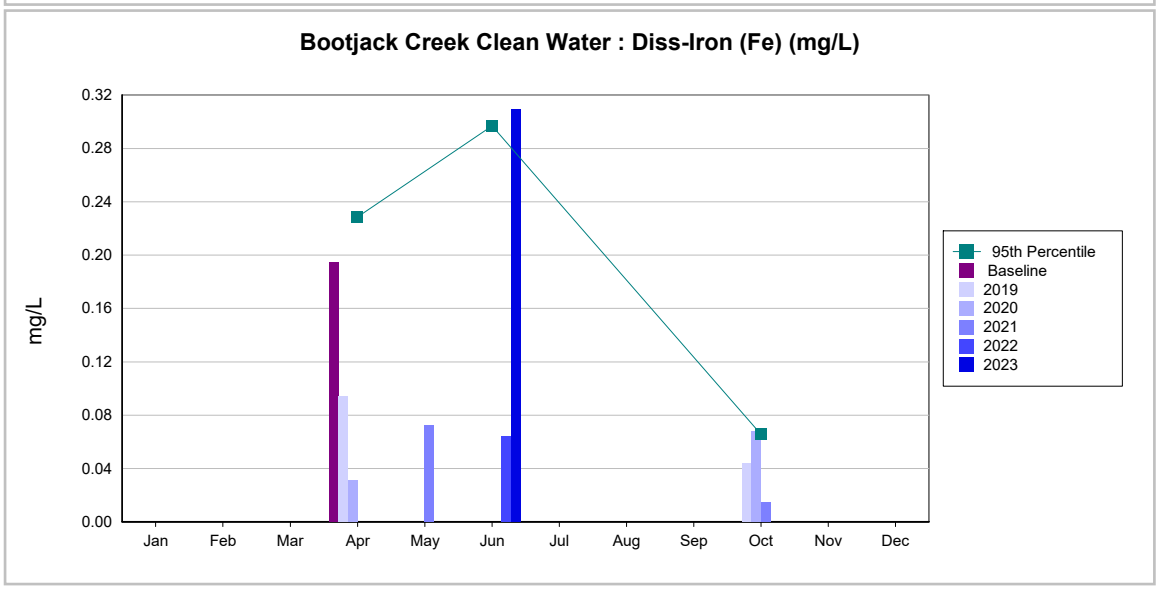
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







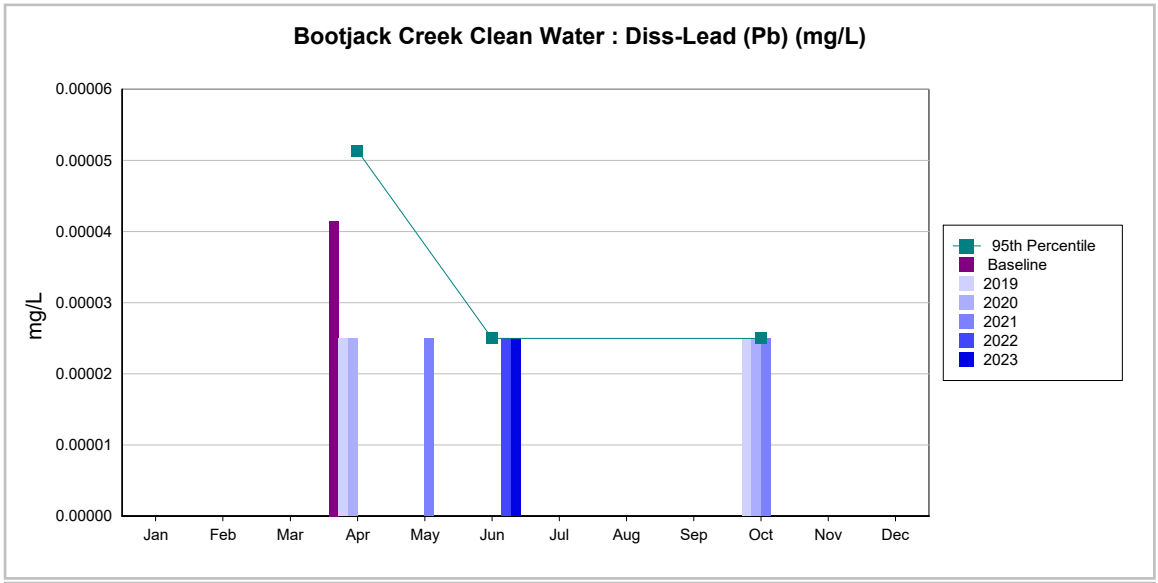
Water Quality Report

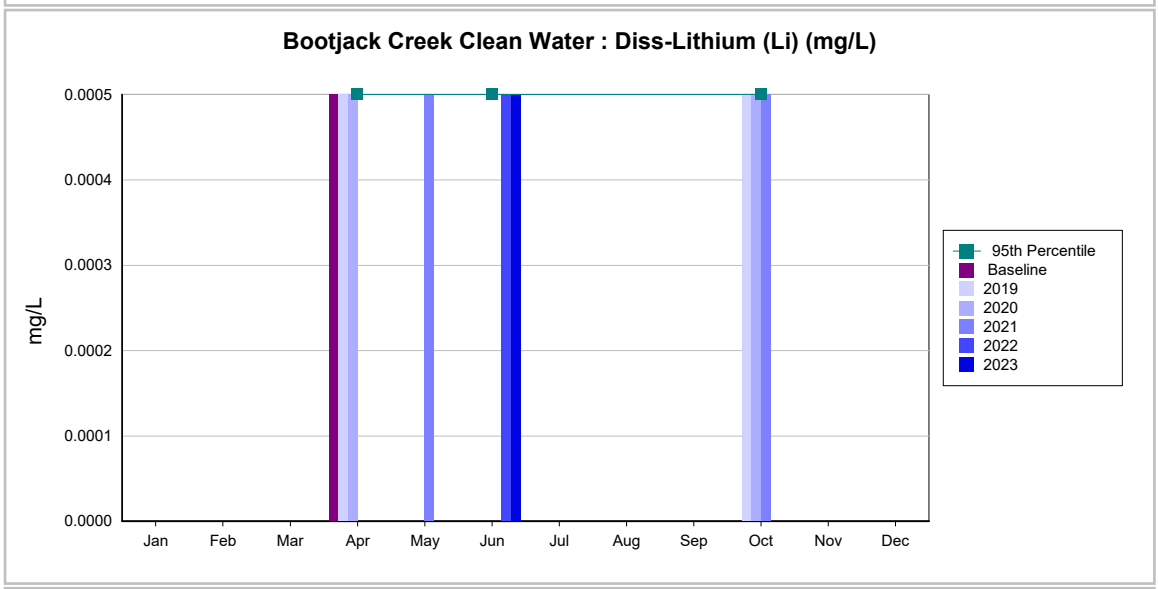
Annual Report Drainage Water

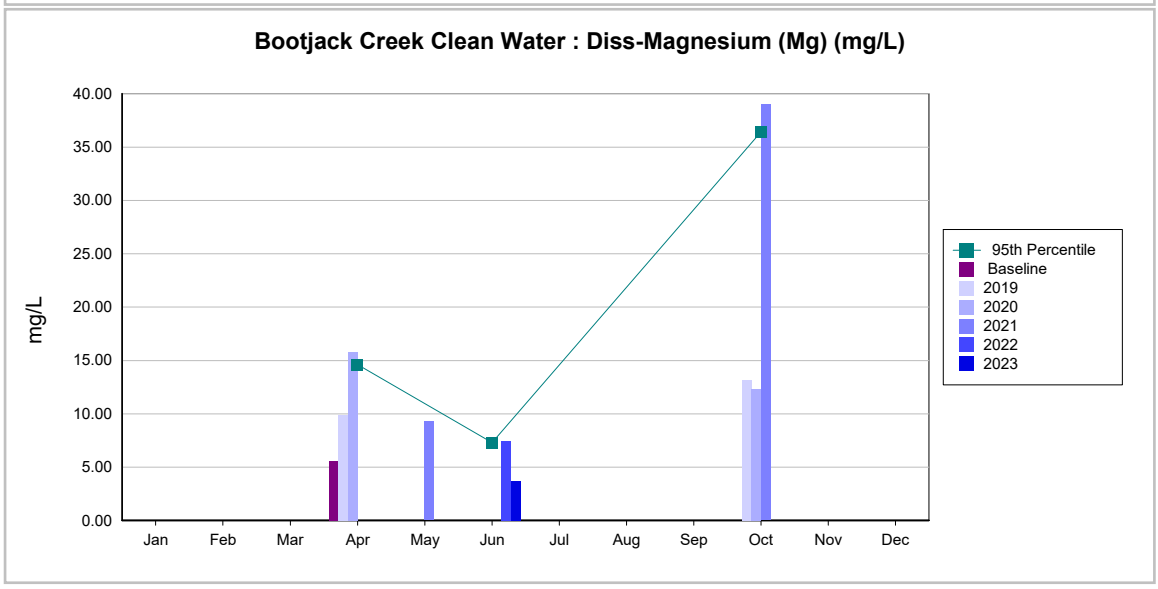
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







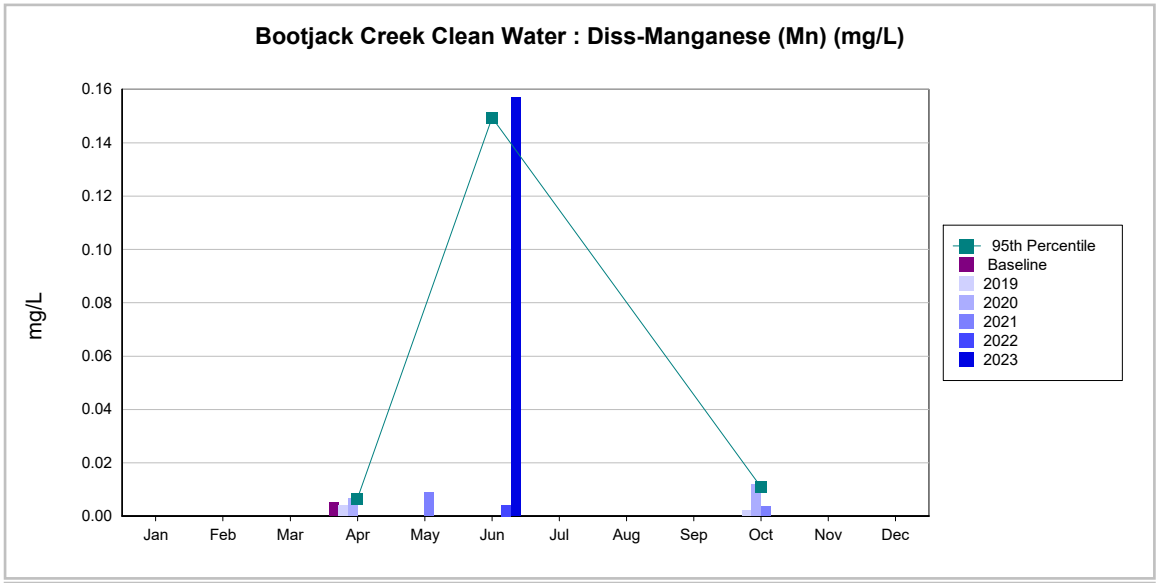
Water Quality Report

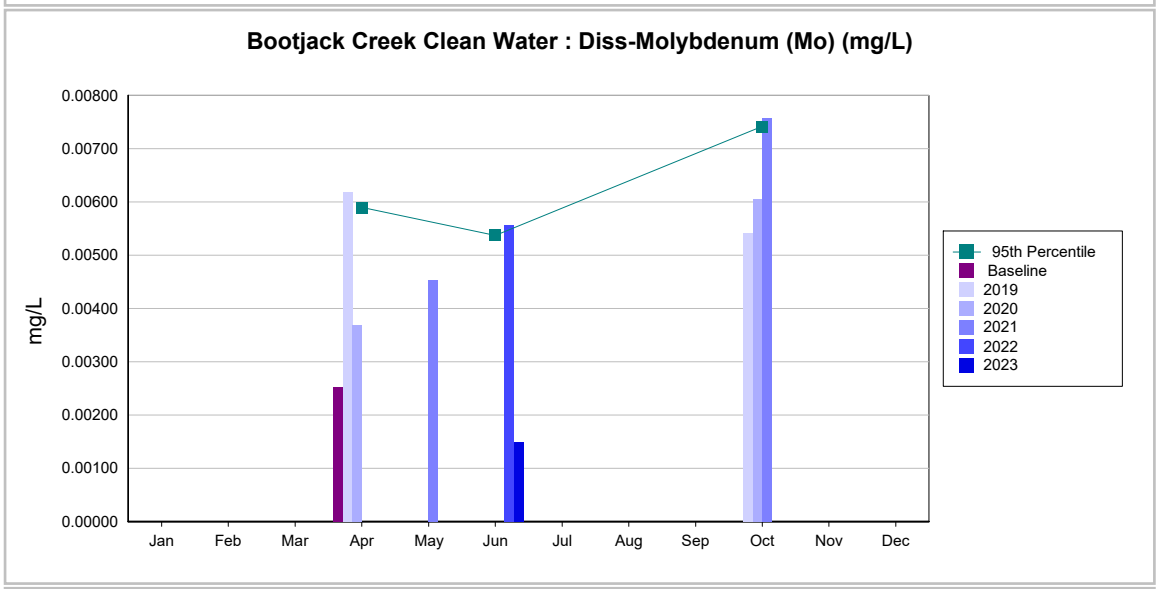
Annual Report Drainage Water

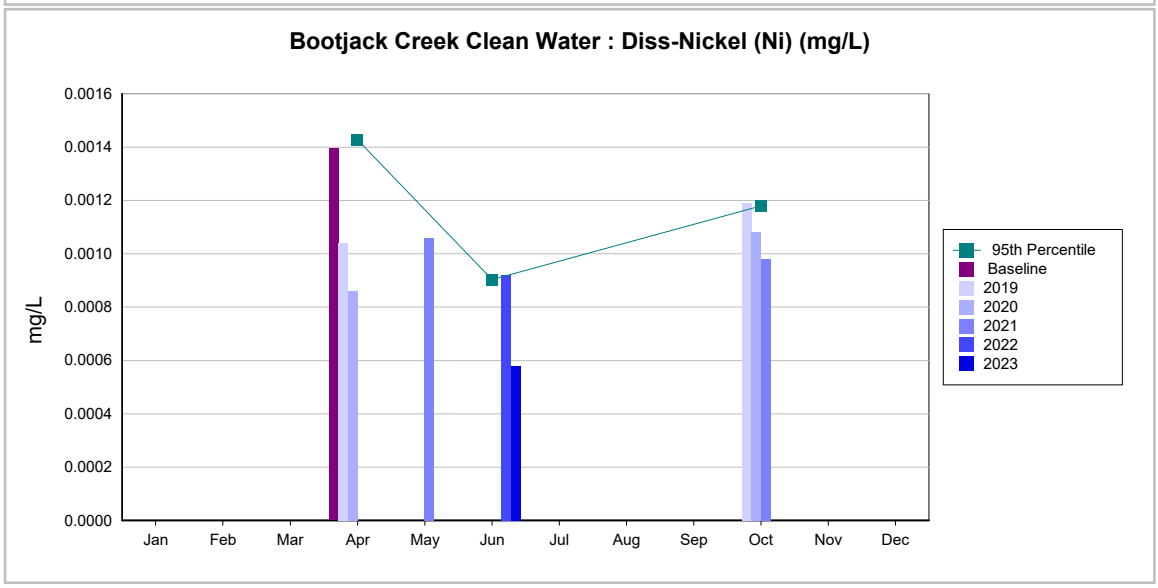
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







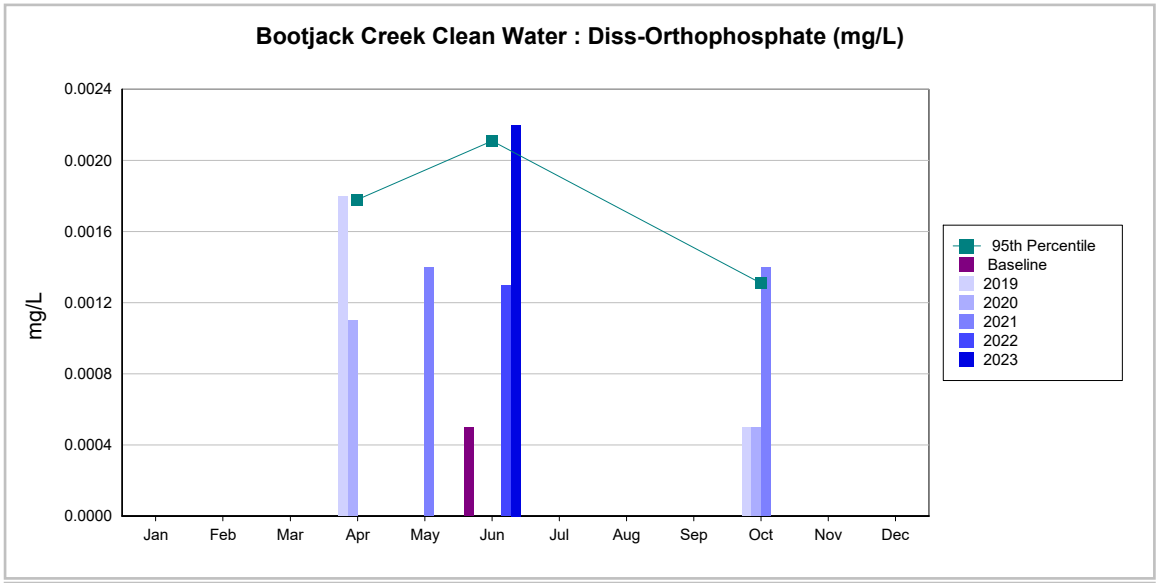
Water Quality Report

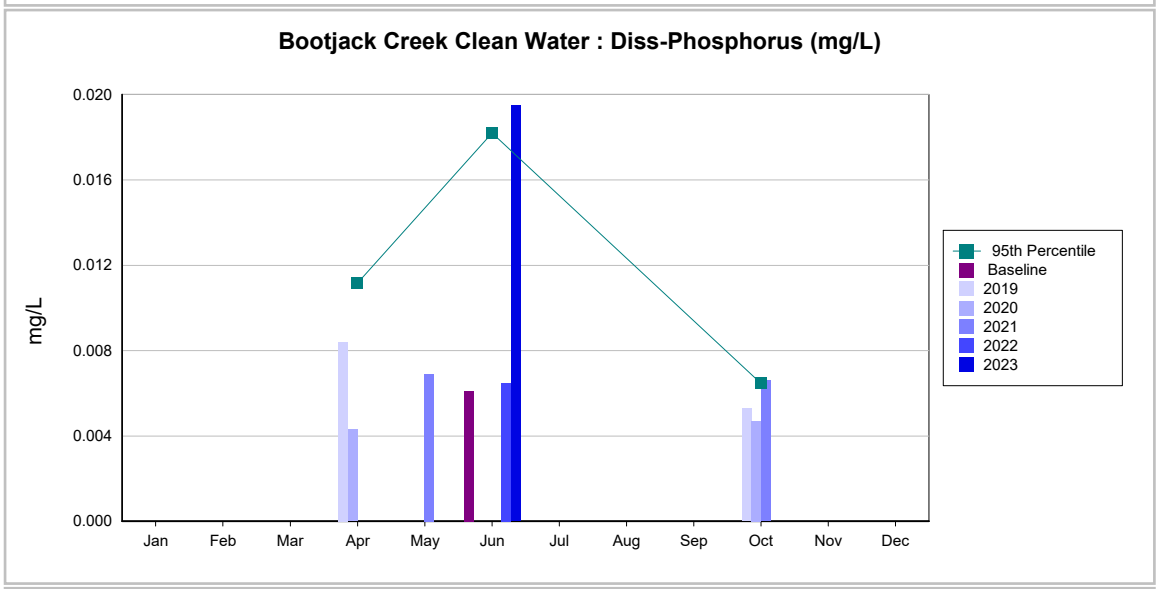
Annual Report Drainage Water

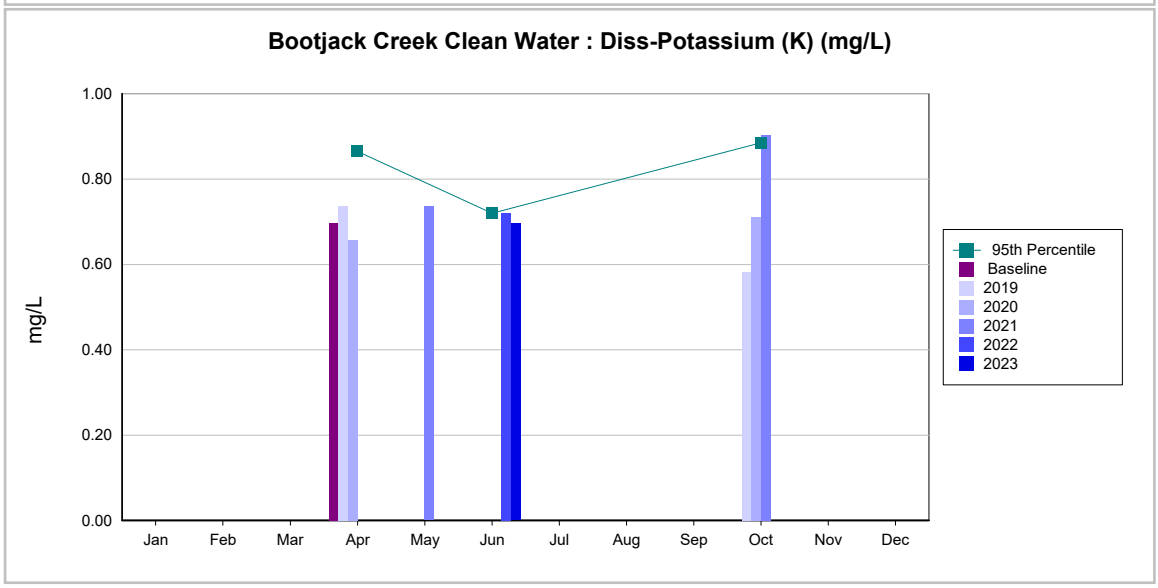
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







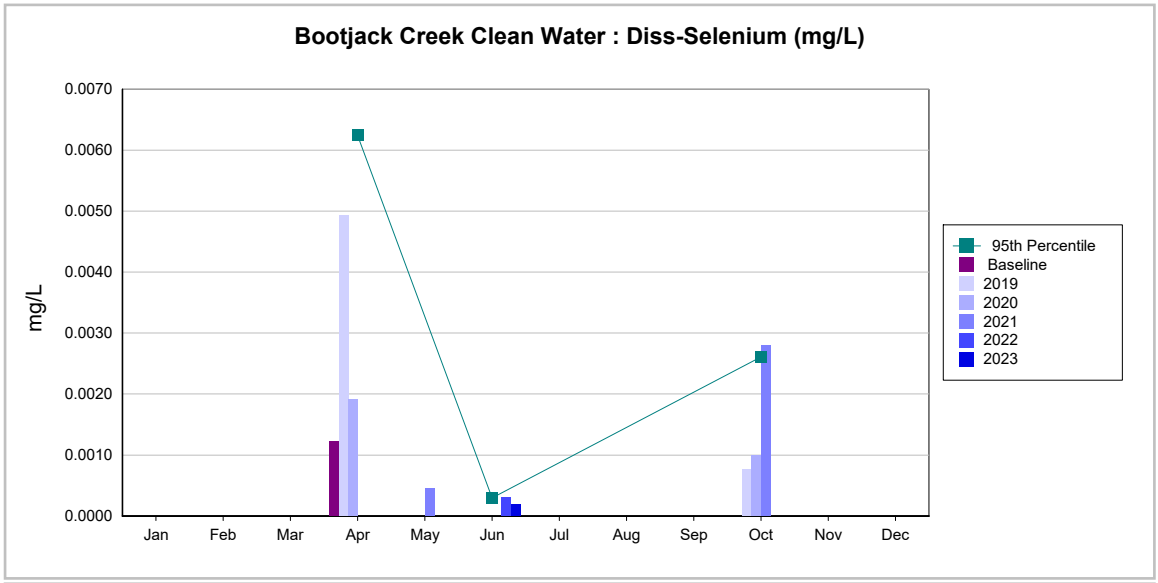
Water Quality Report

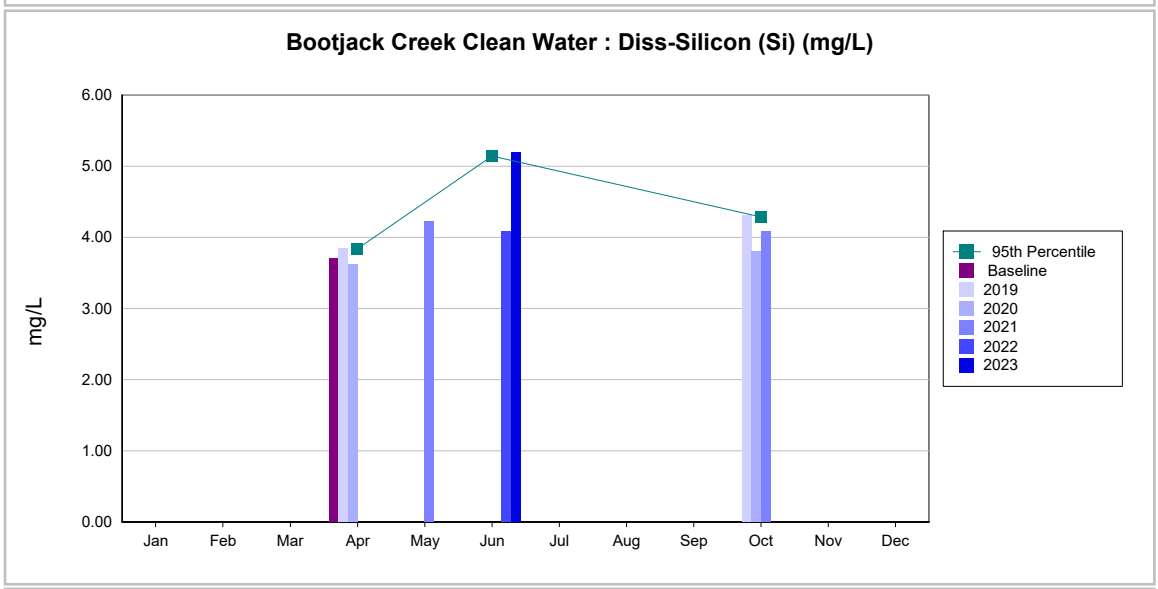
Annual Report Drainage Water

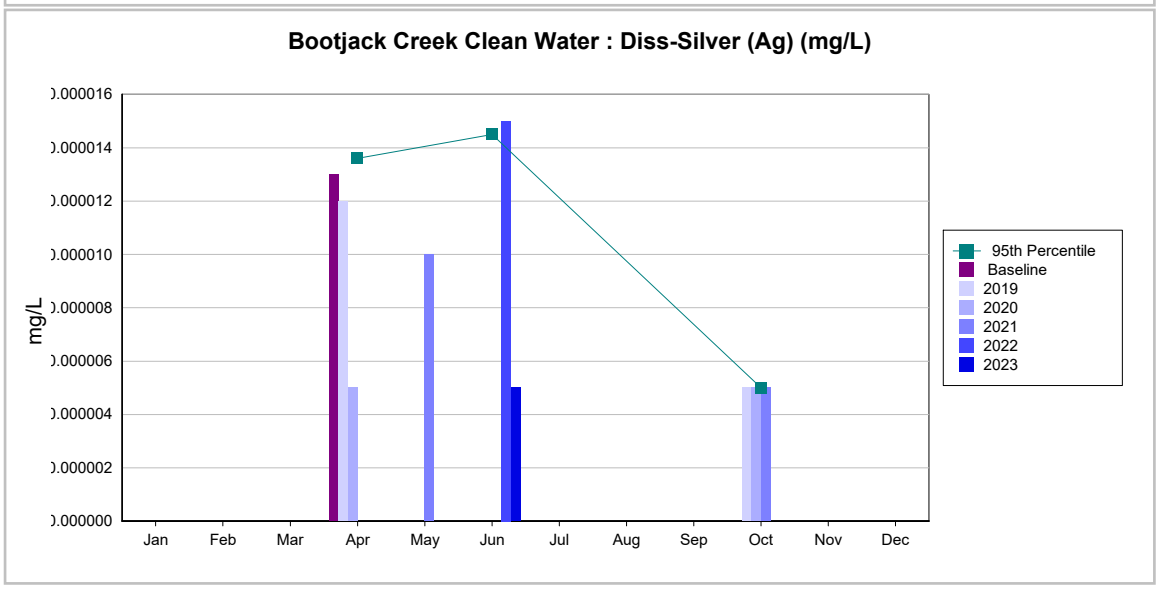
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







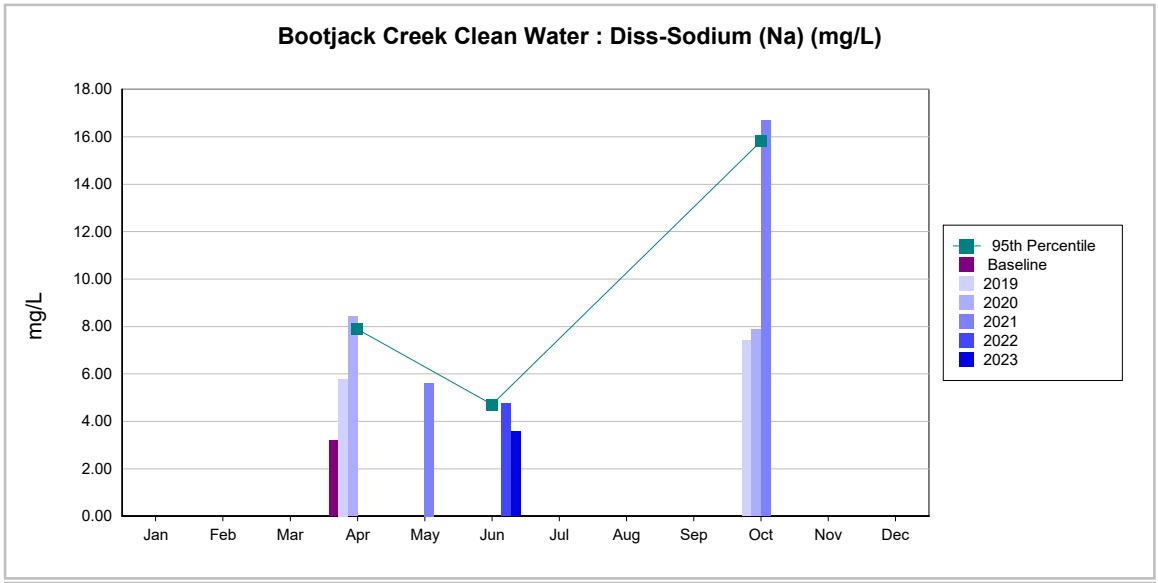
Water Quality Report

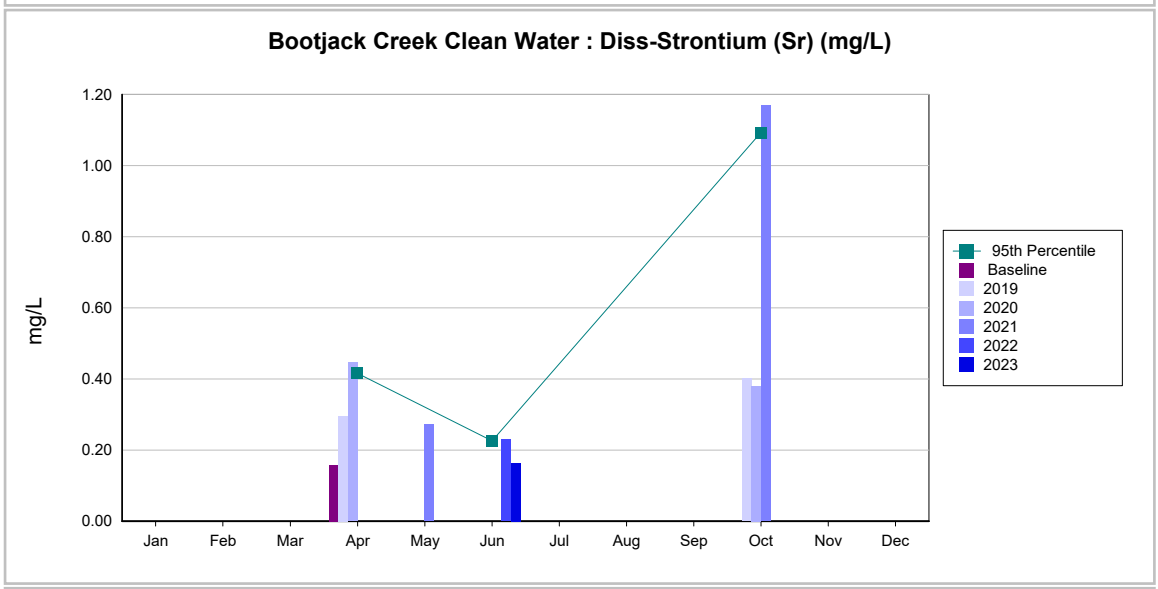
Annual Report Drainage Water

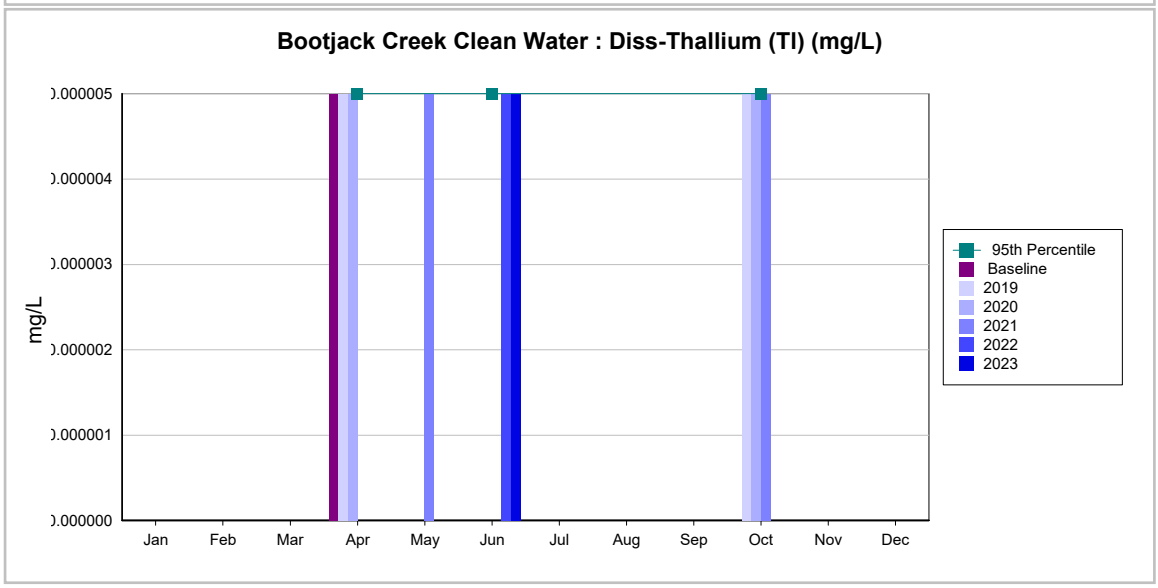
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







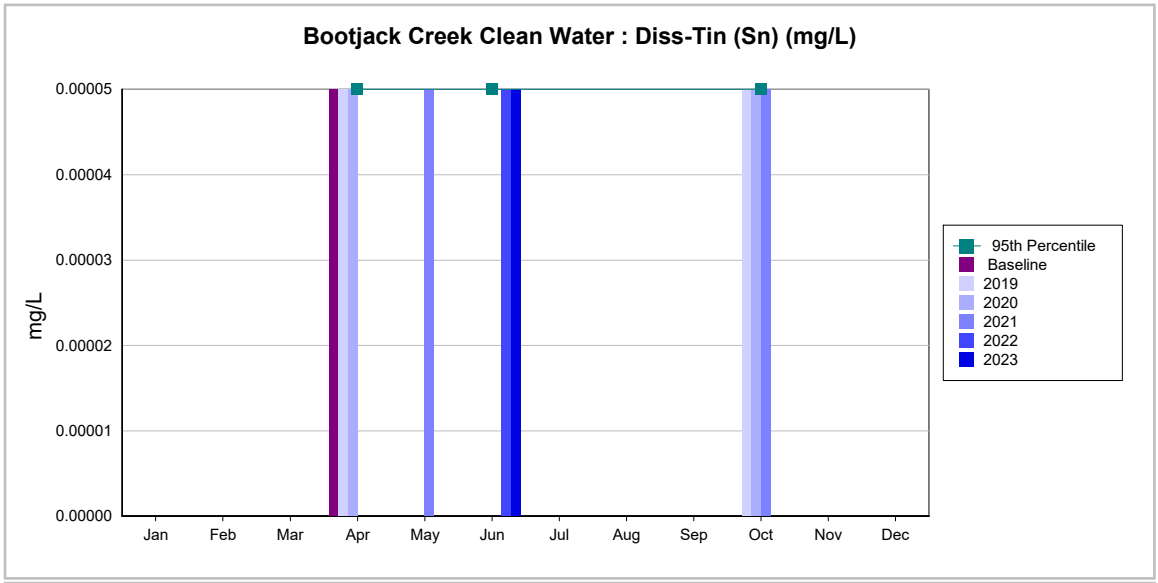
Water Quality Report

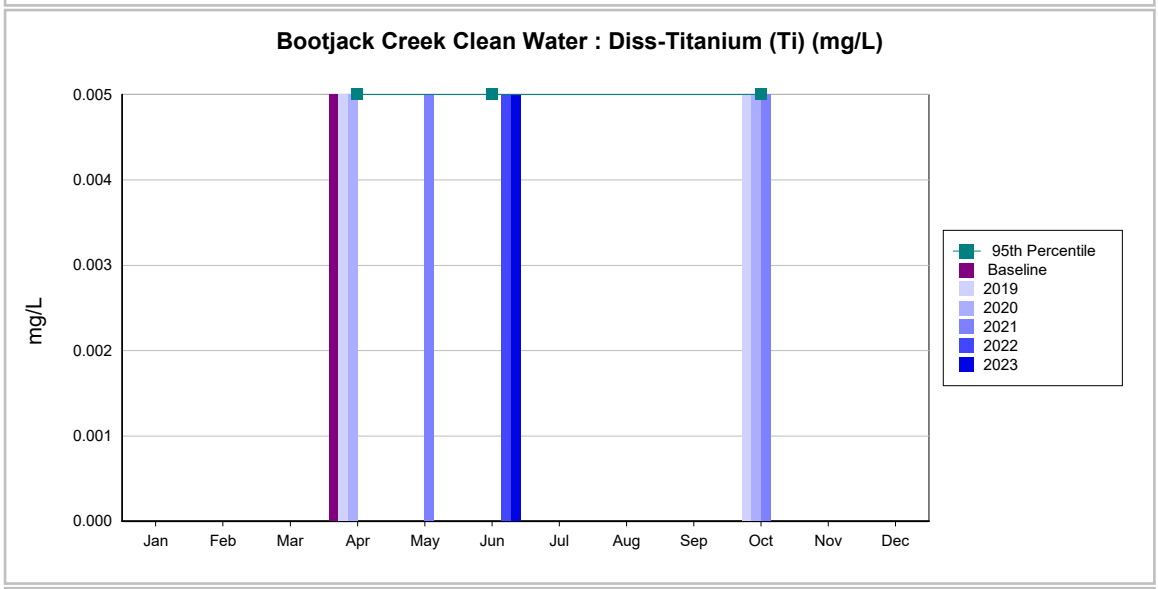
Annual Report Drainage Water

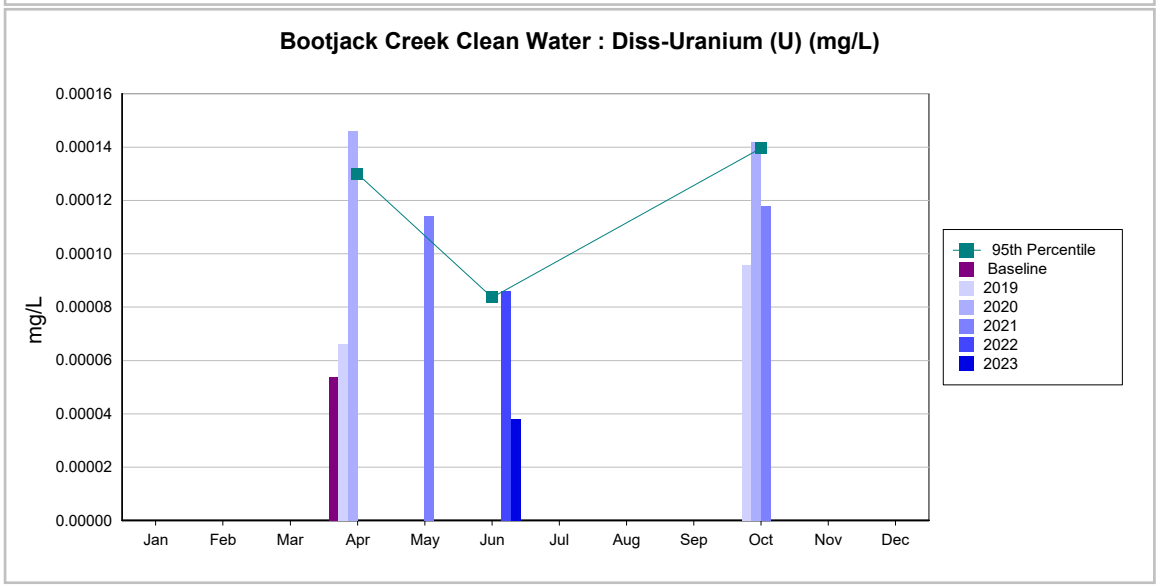
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







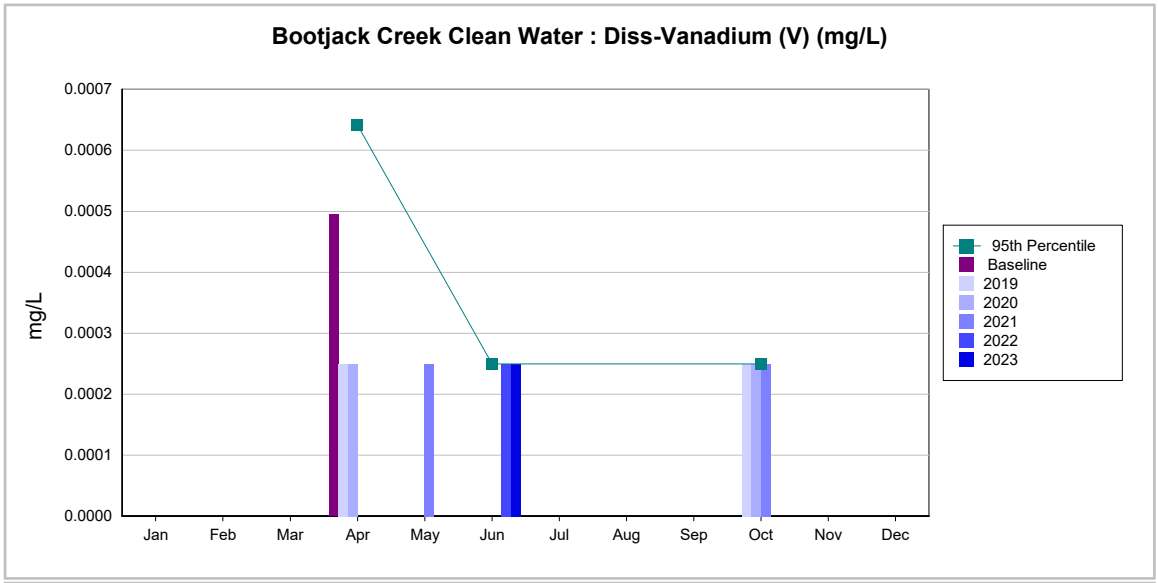
Water Quality Report

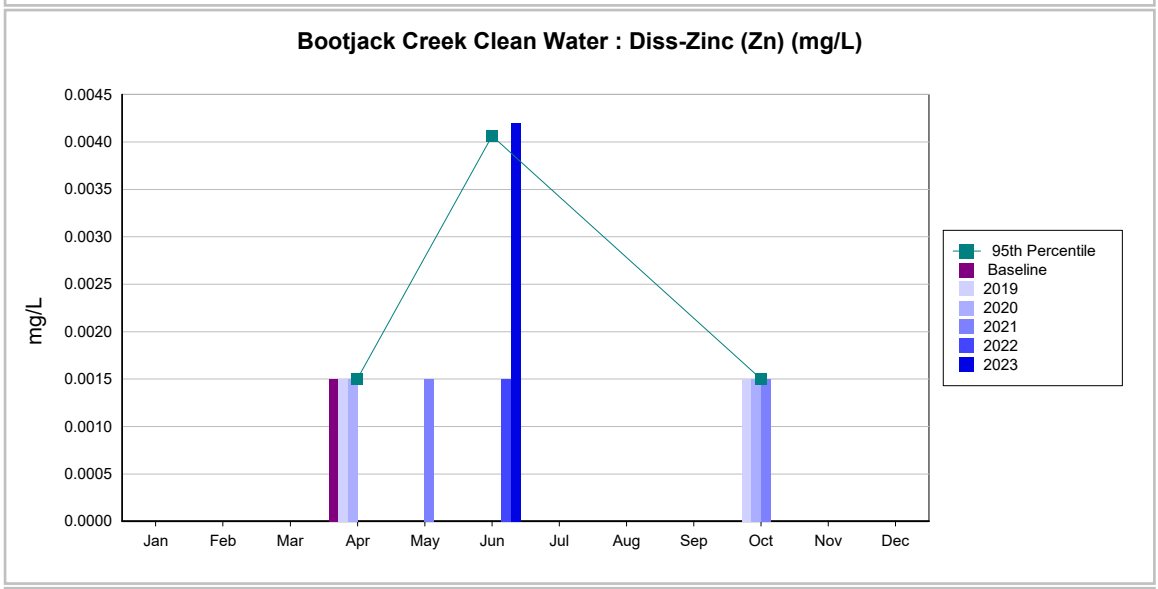
Annual Report Drainage Water

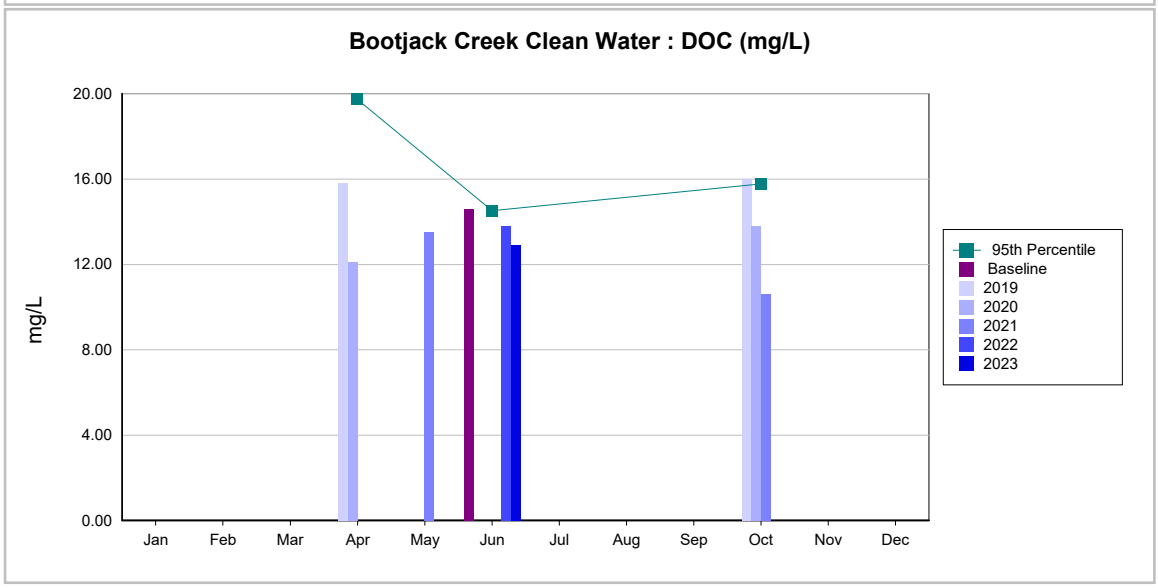
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







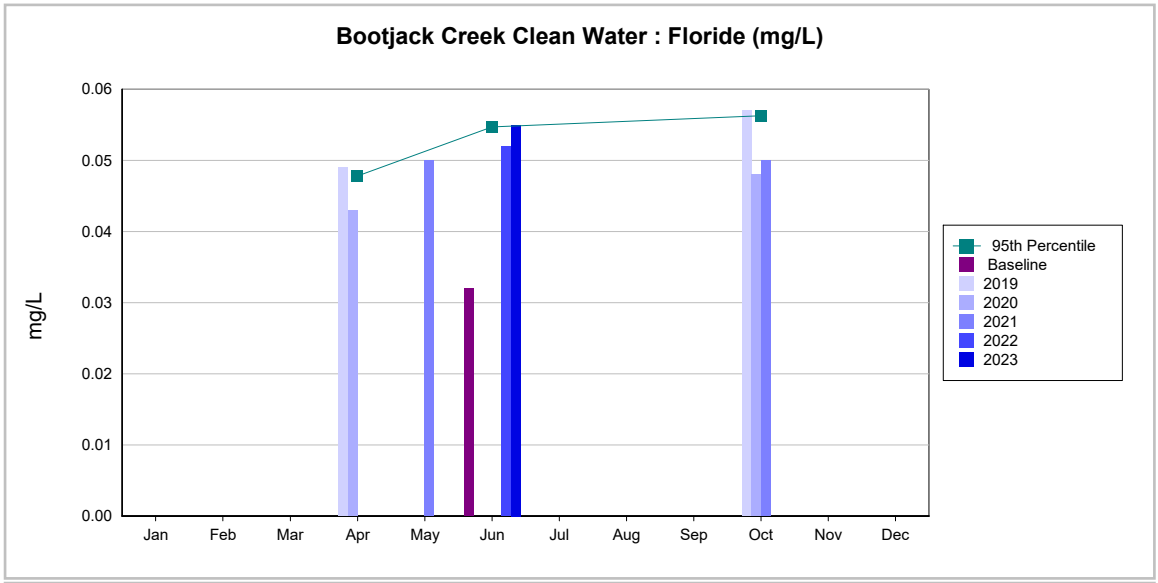
Water Quality Report

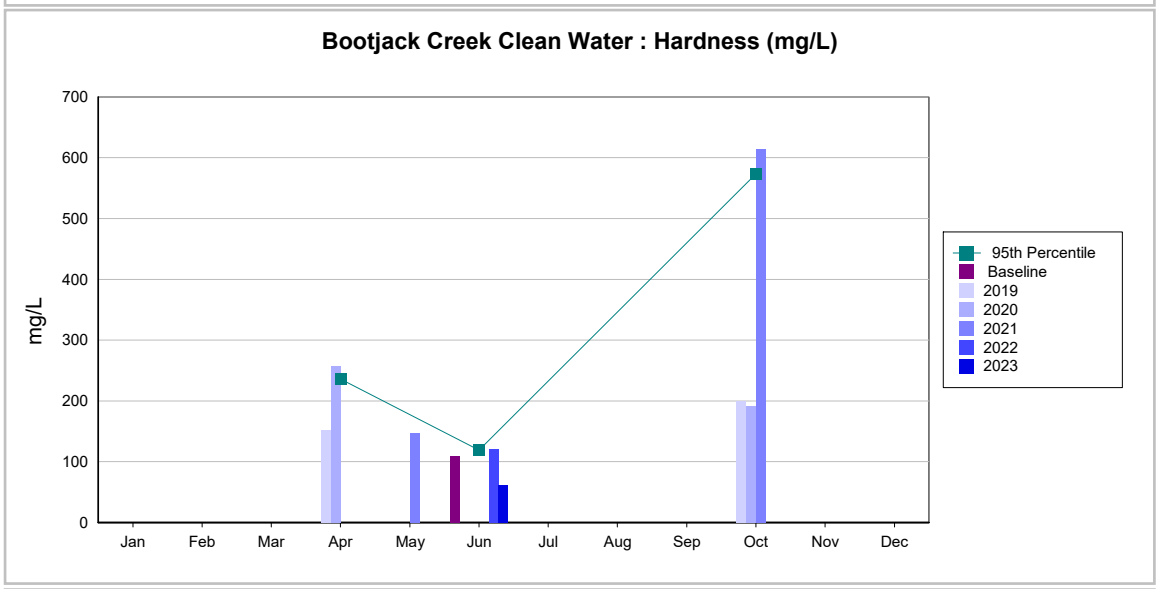
Annual Report Drainage Water

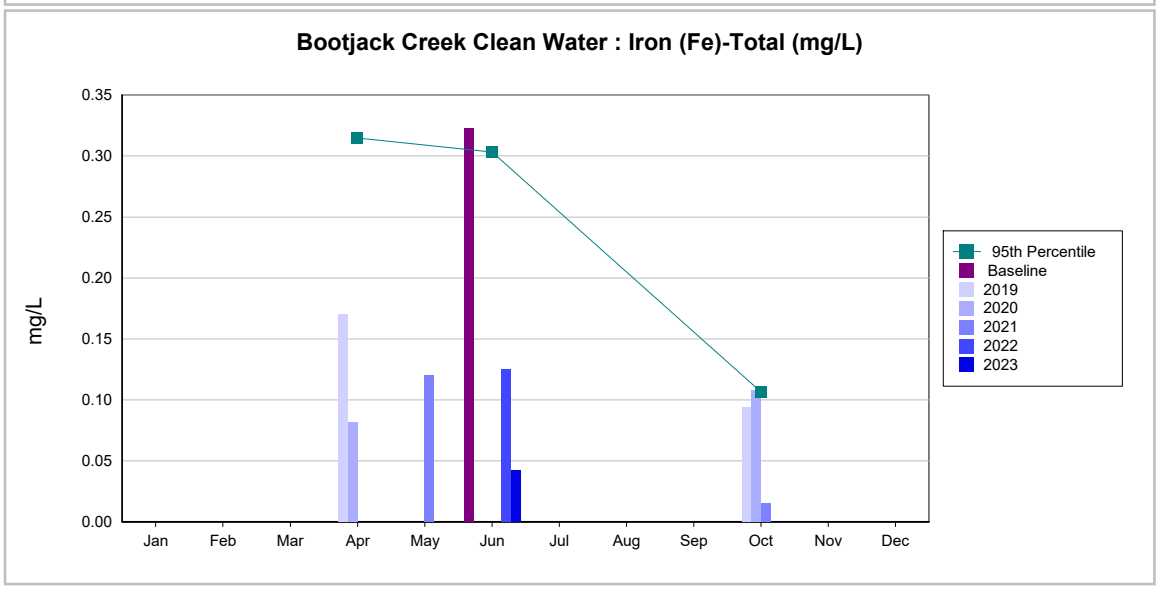
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







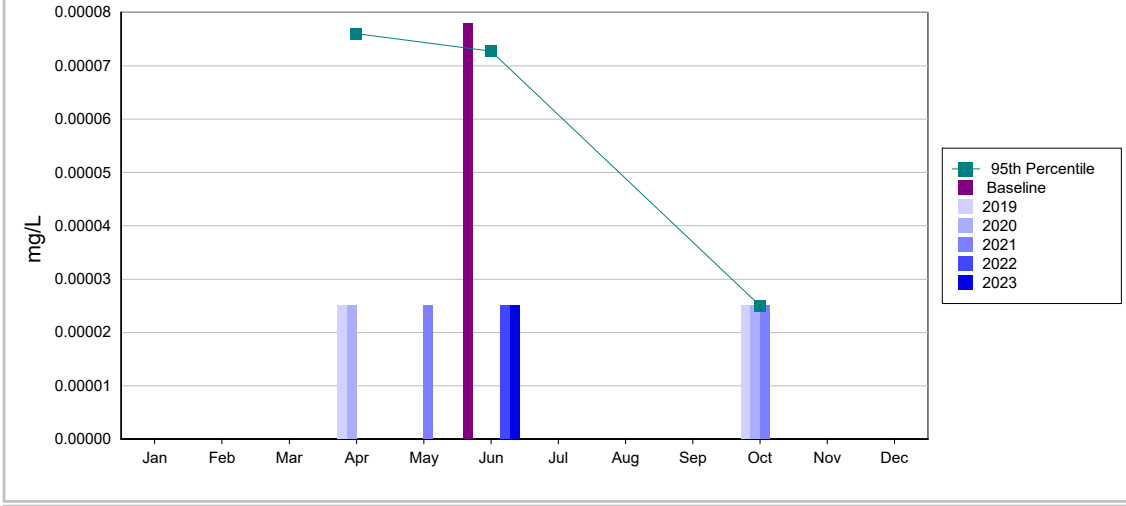
Water Quality Report

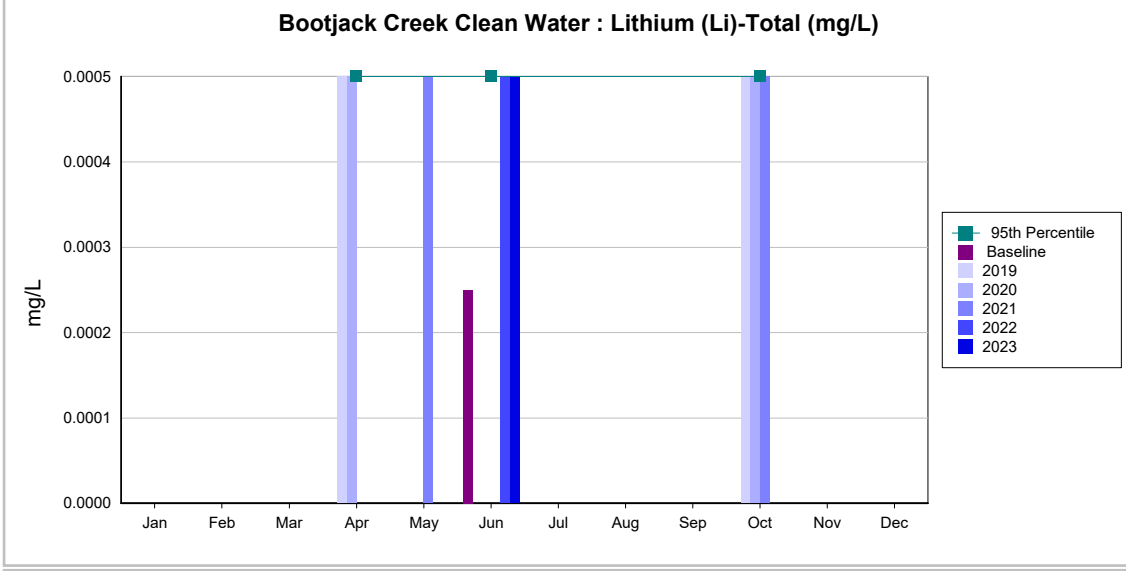
Annual Report Drainage Water

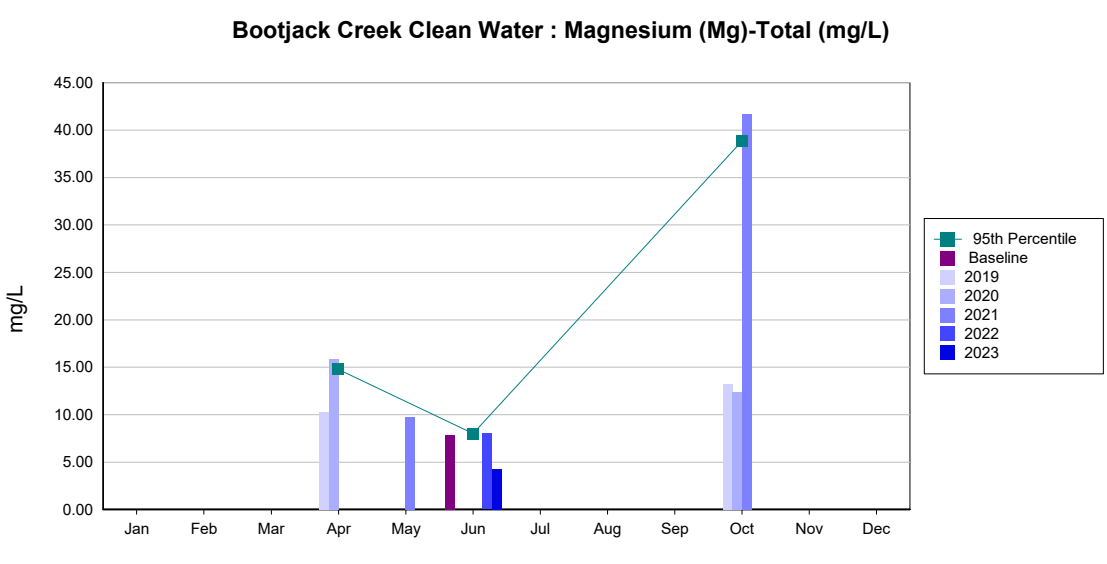
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







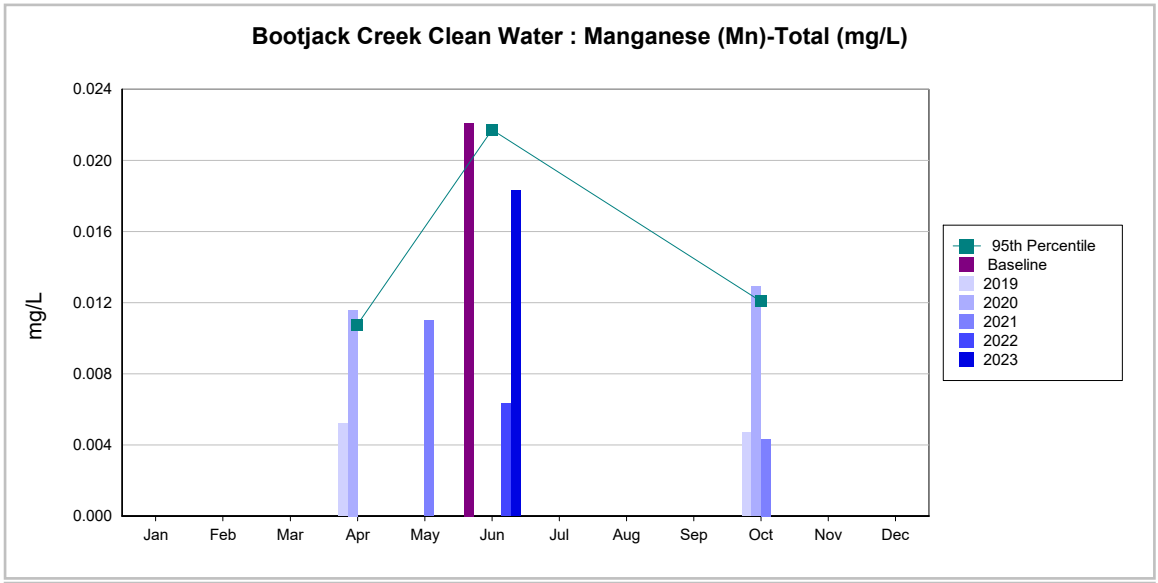
Water Quality Report

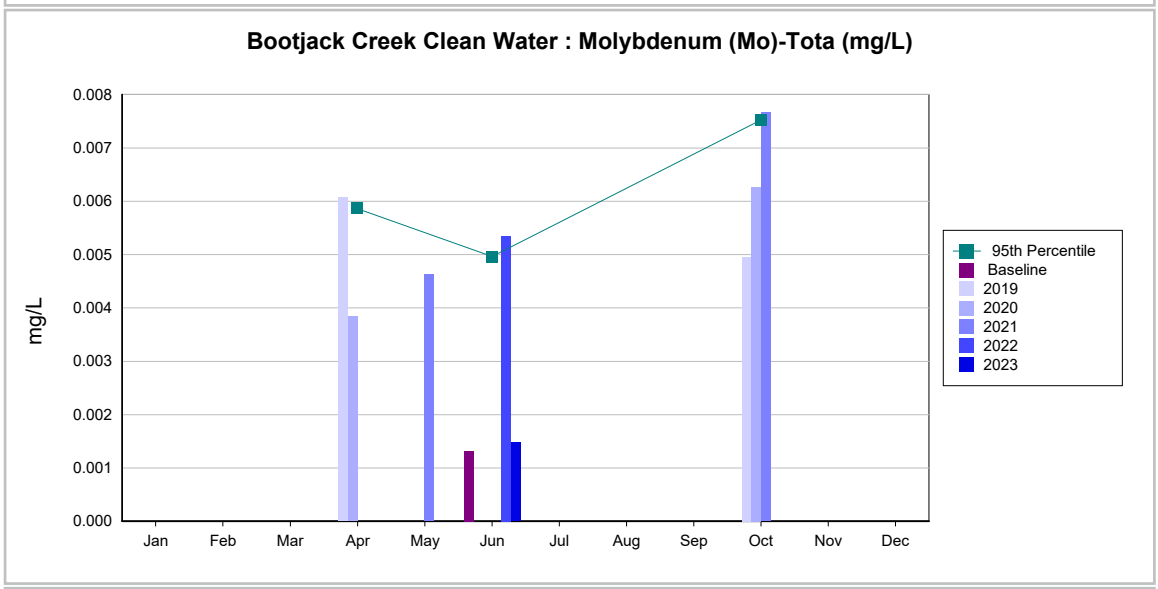
Annual Report Drainage Water

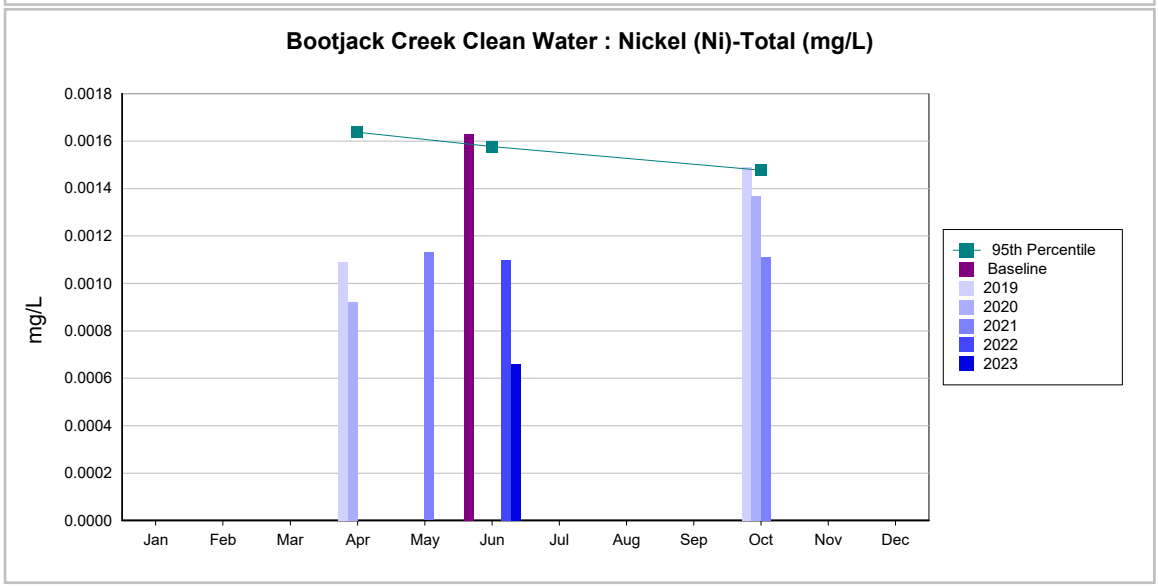
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







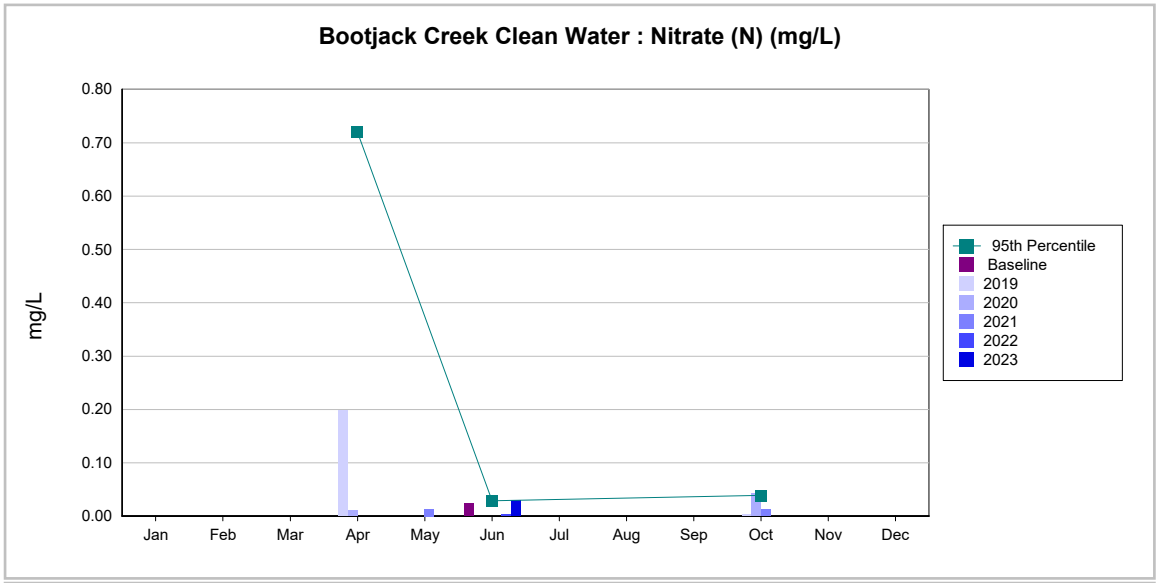
Water Quality Report

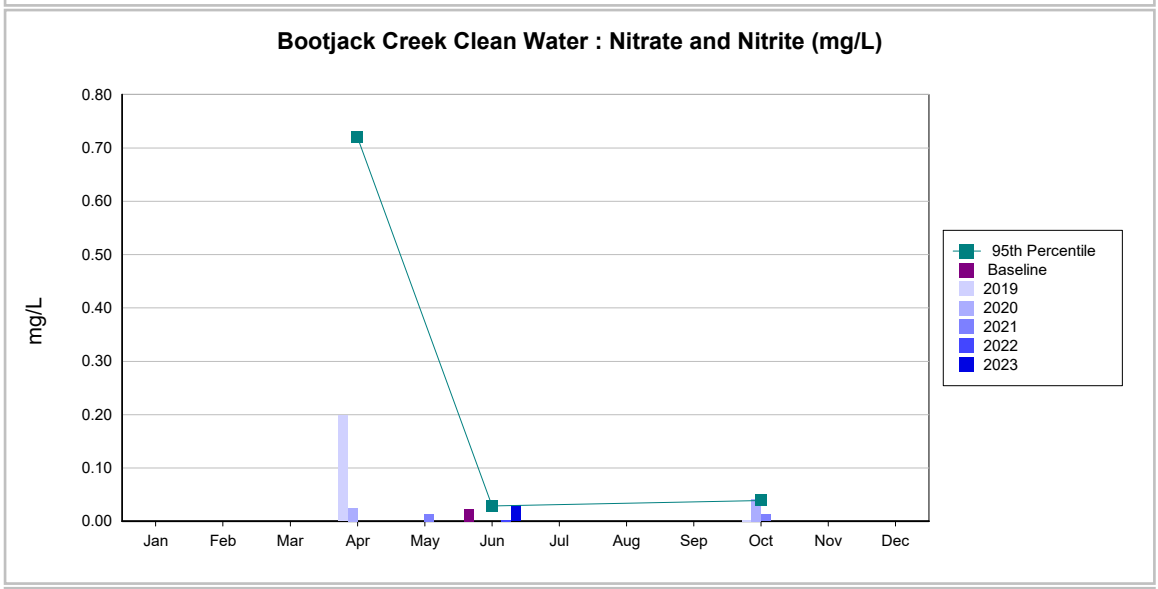
Annual Report Drainage Water

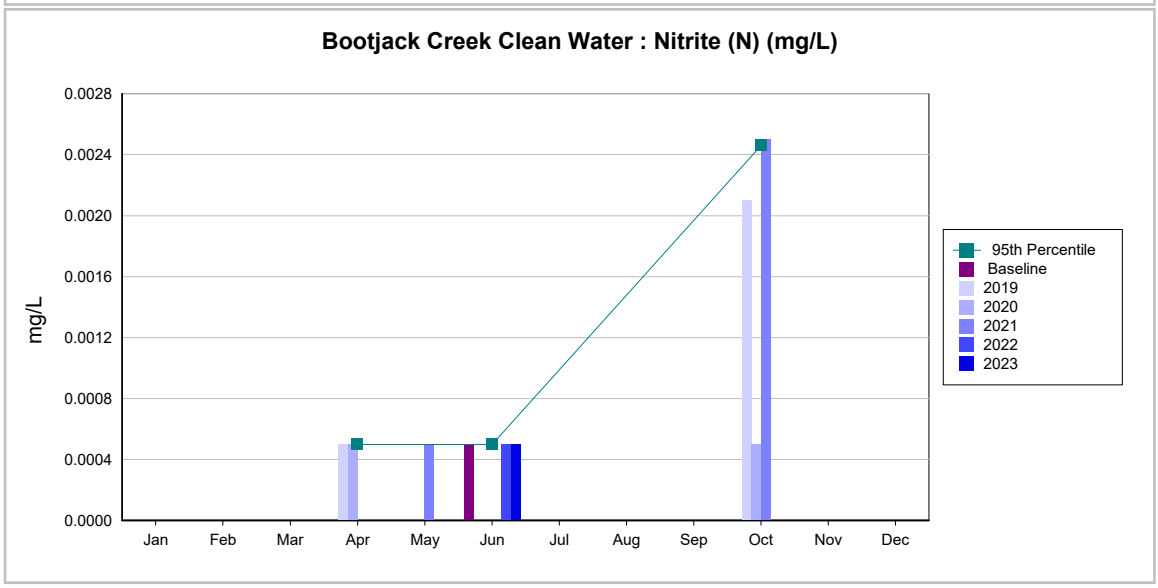
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







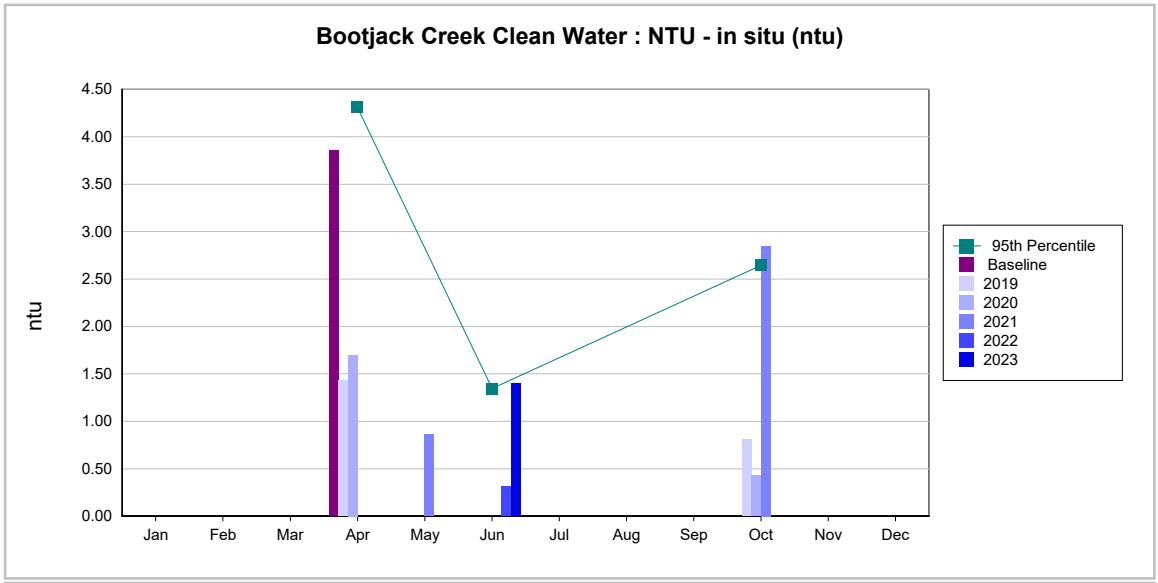
Water Quality Report

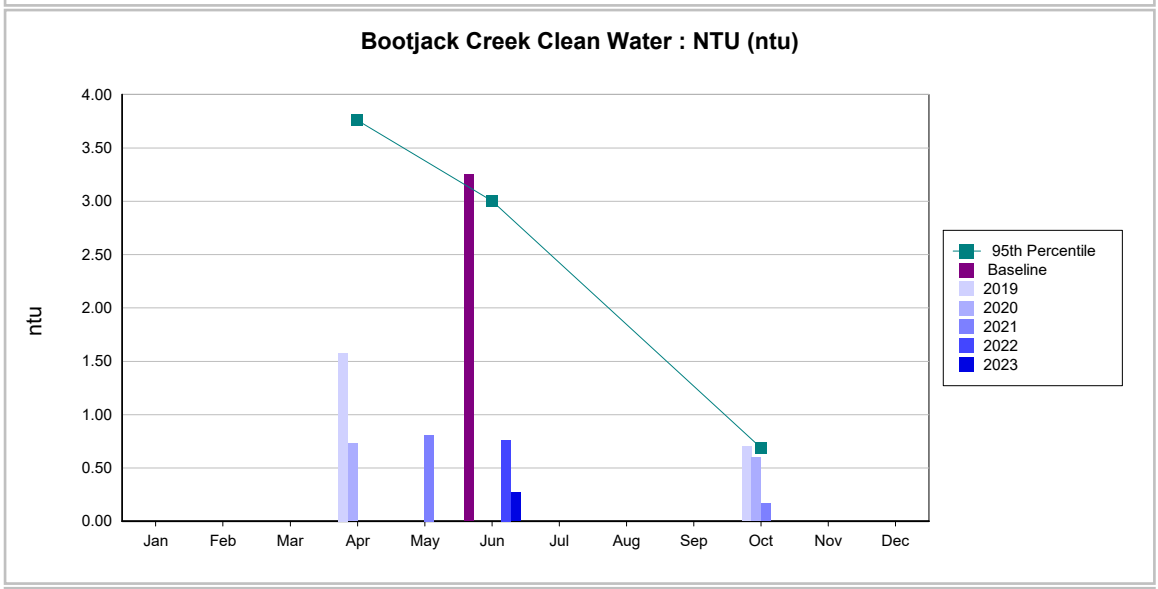
Annual Report Drainage Water

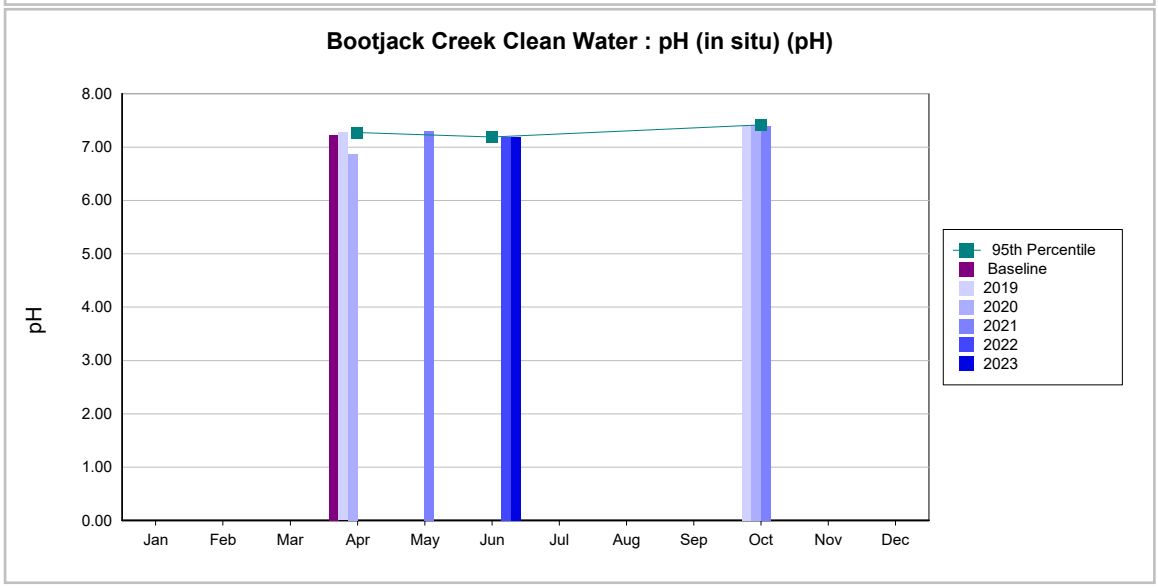
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







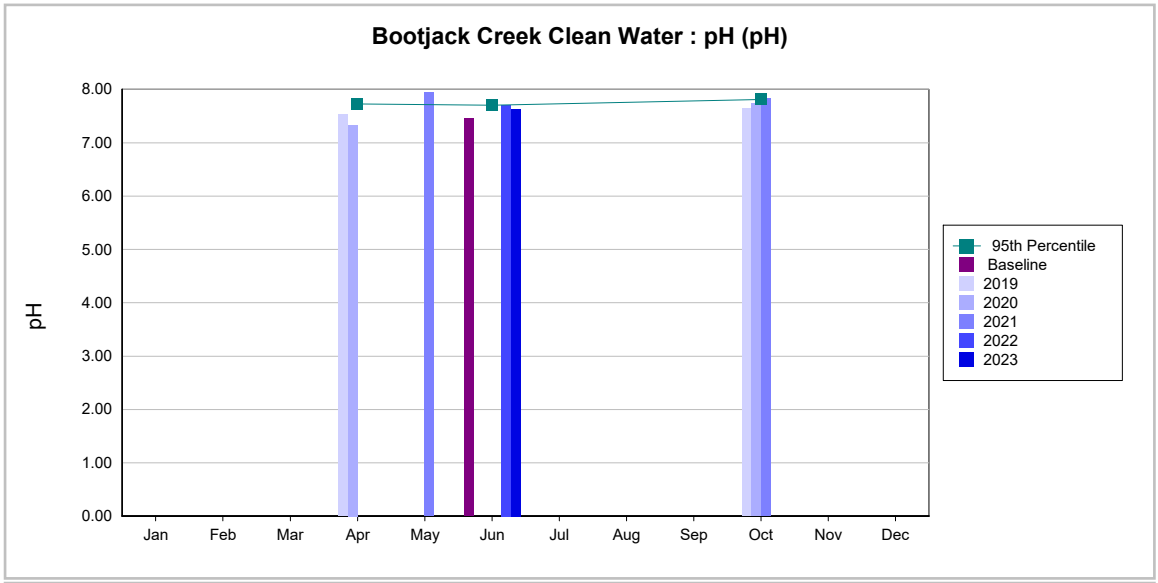
Water Quality Report

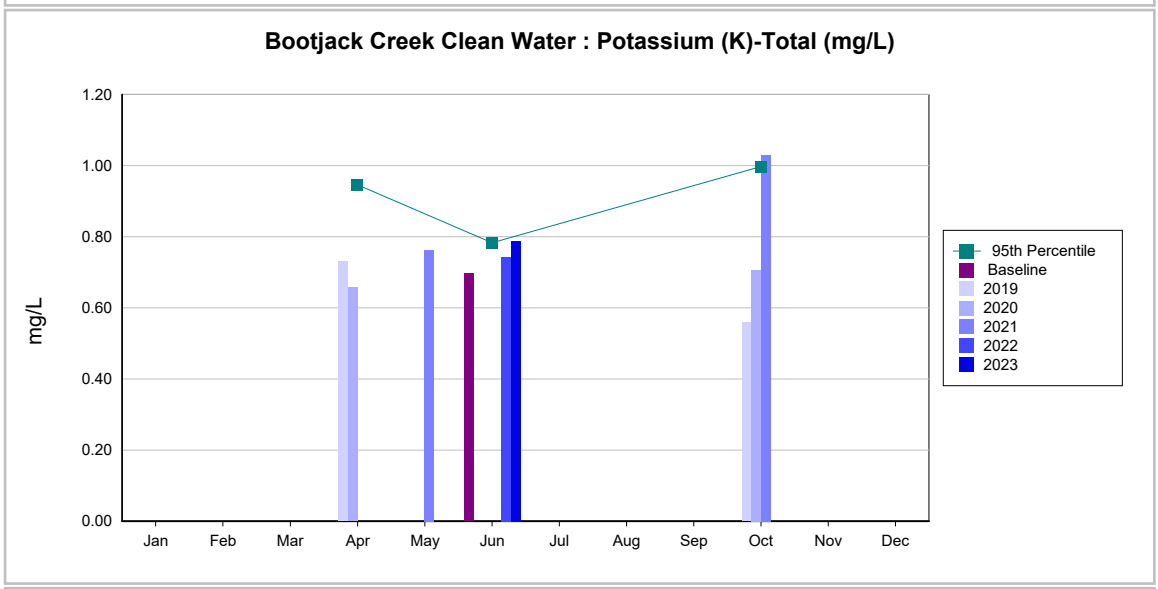
Annual Report Drainage Water

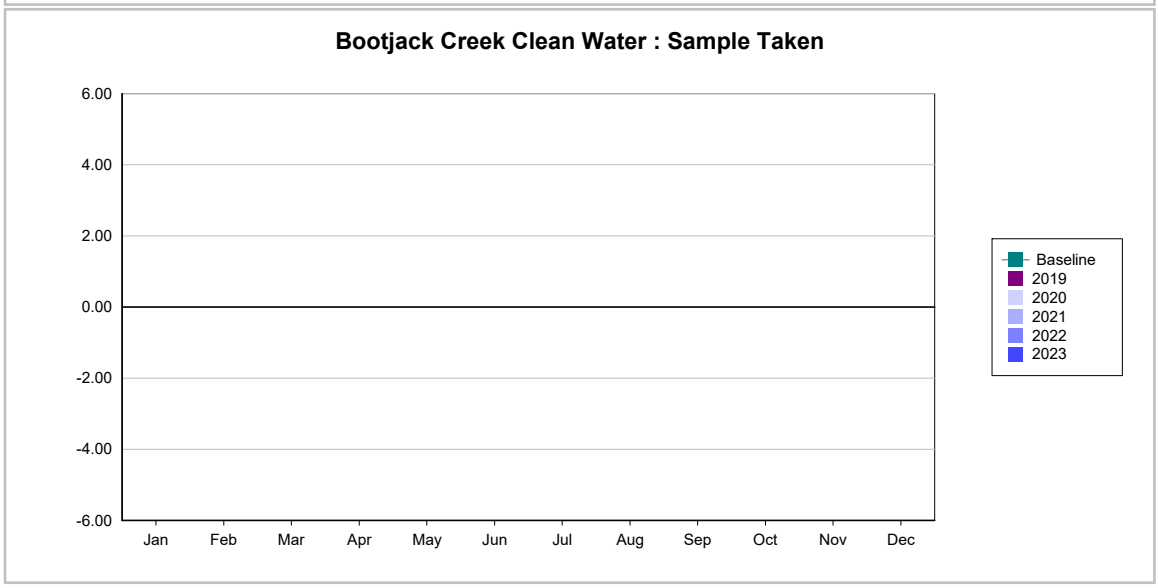
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







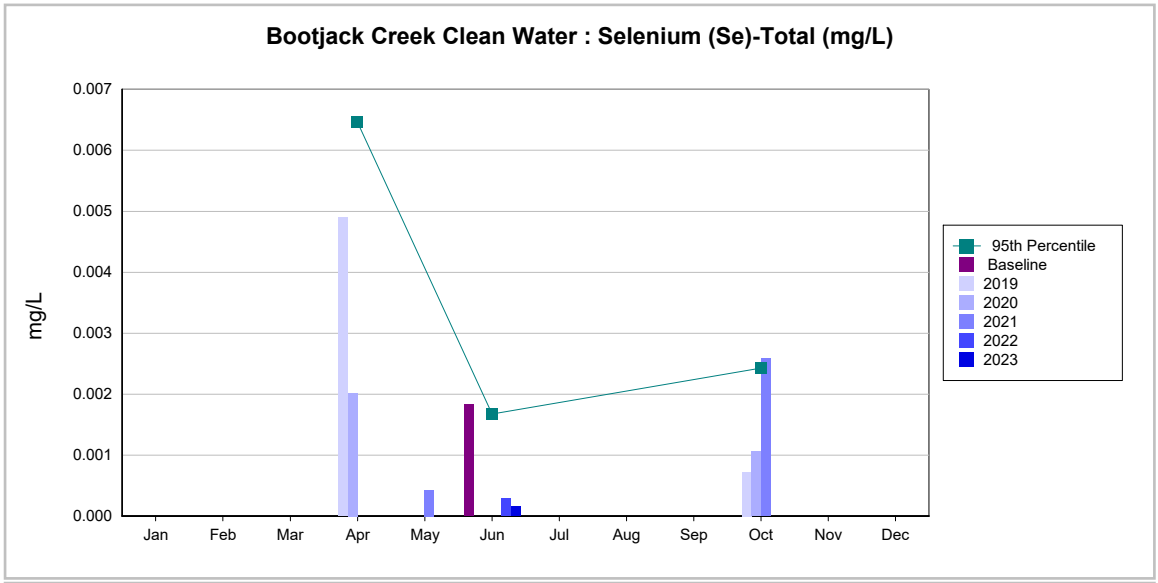
Water Quality Report

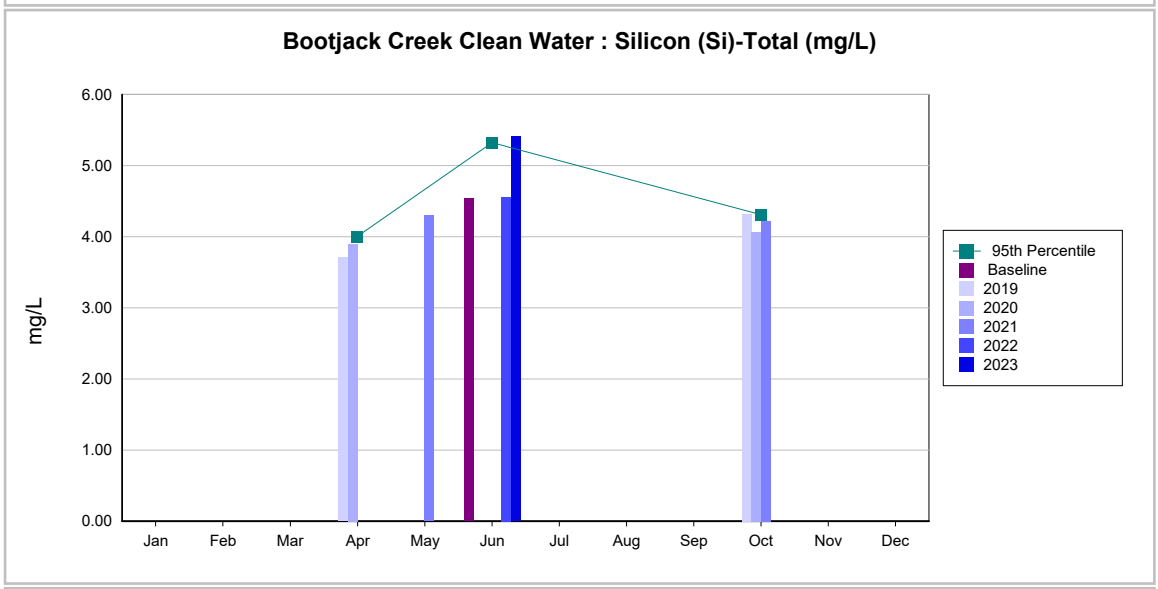
Annual Report Drainage Water

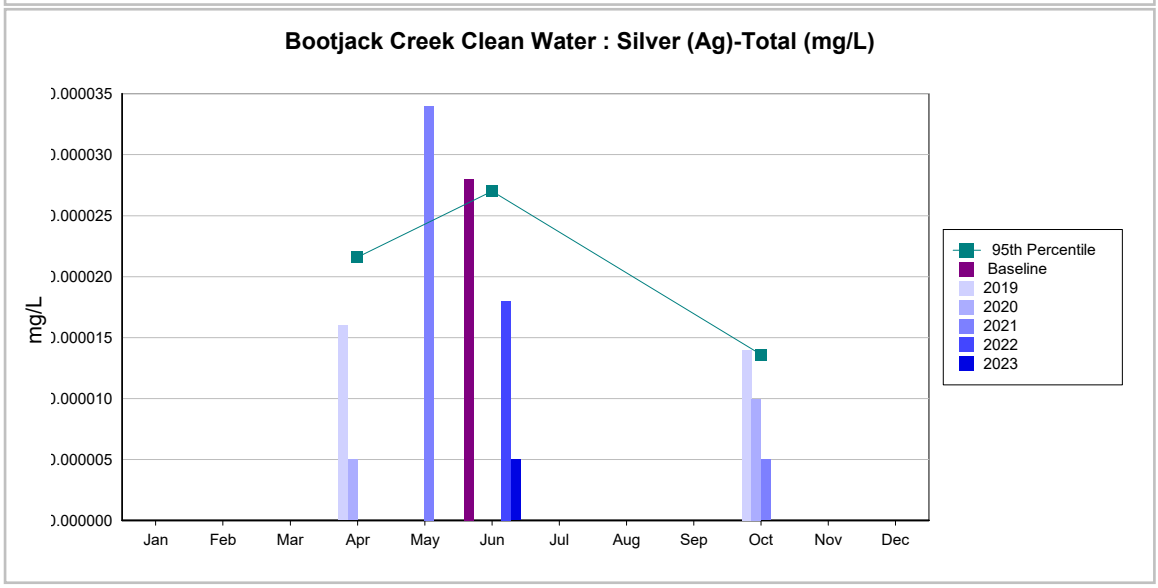
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







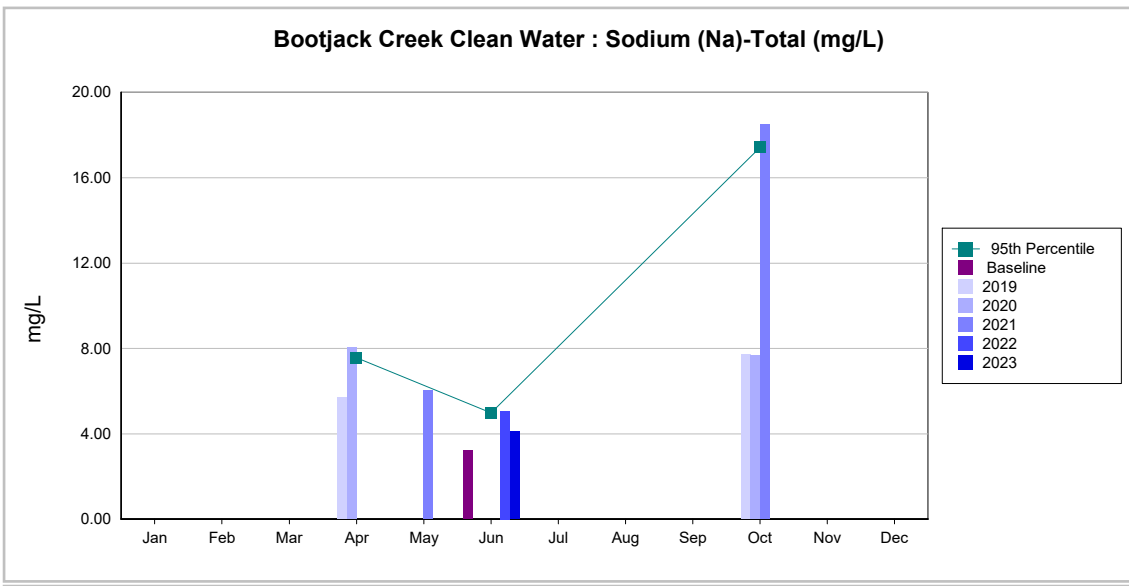
Water Quality Report

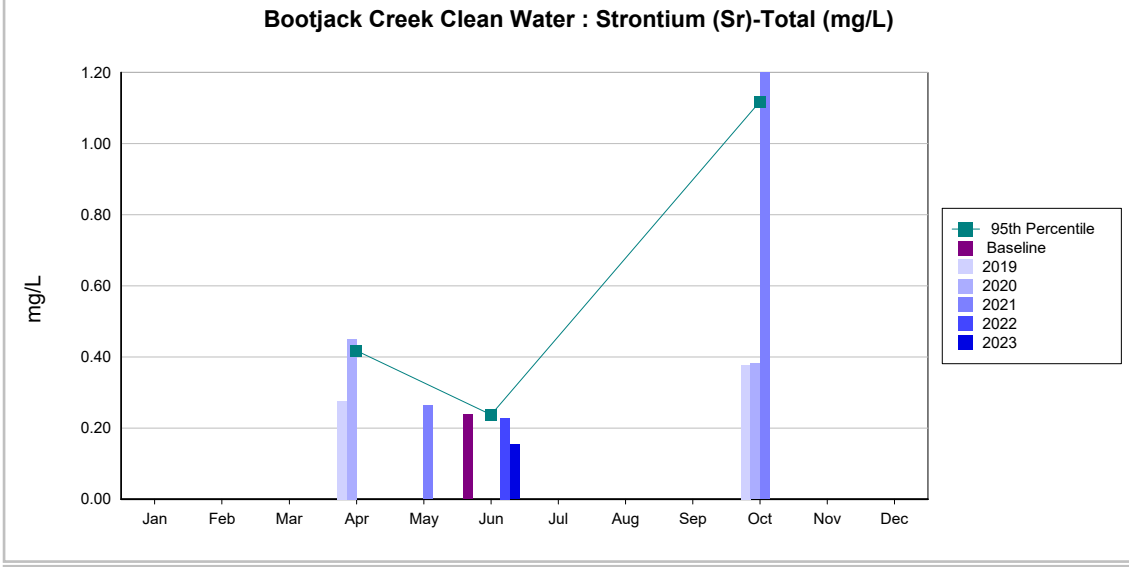
Annual Report Drainage Water

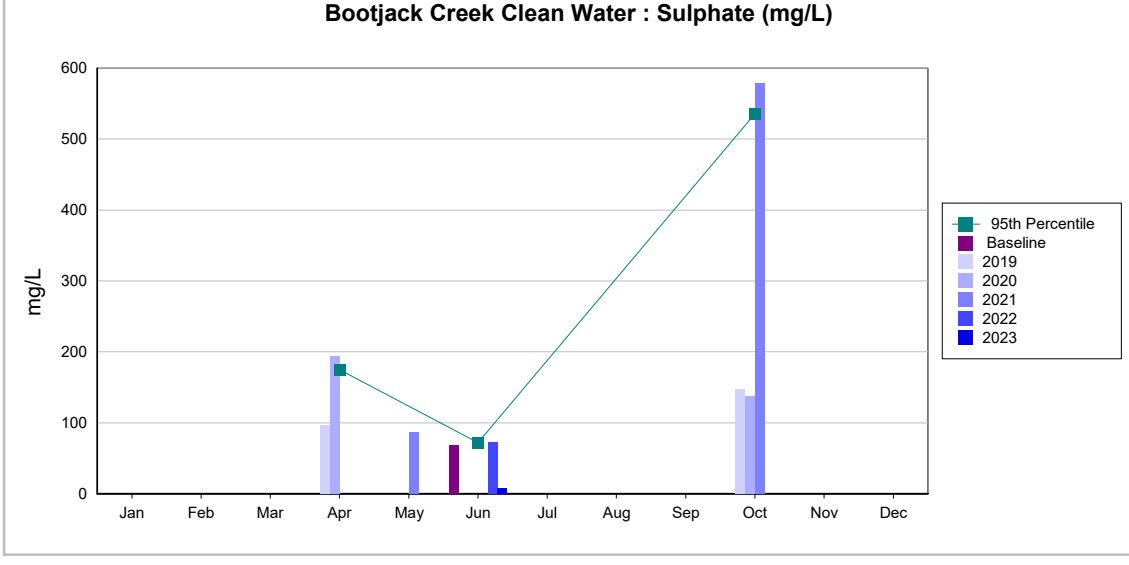
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







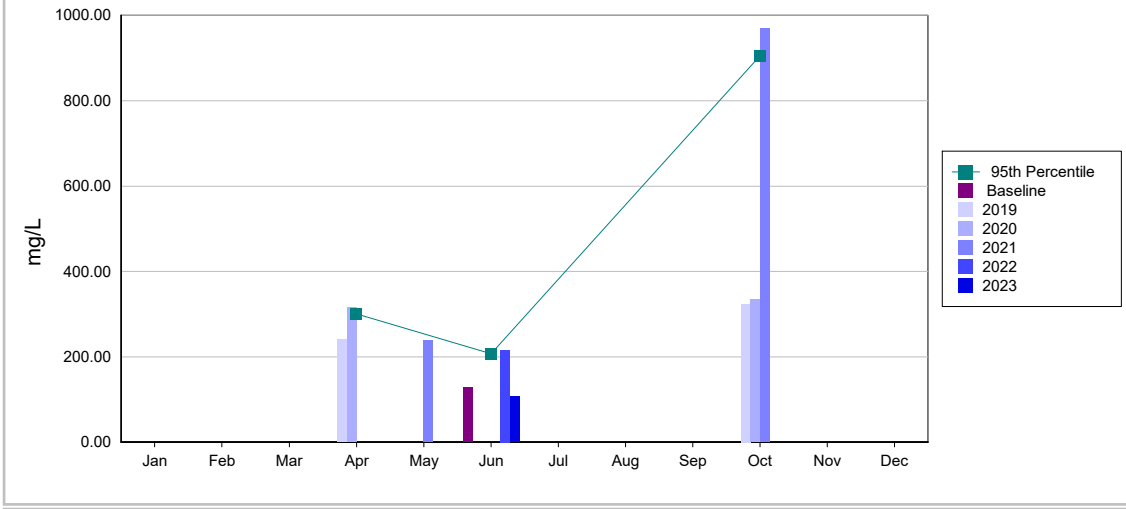
Water Quality Report

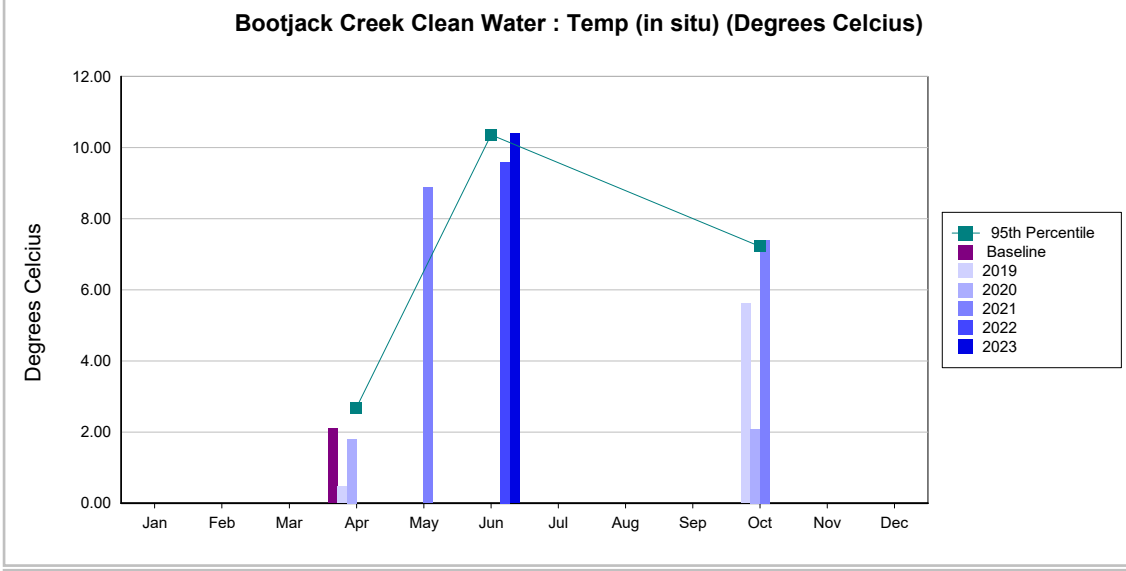
Annual Report Drainage Water

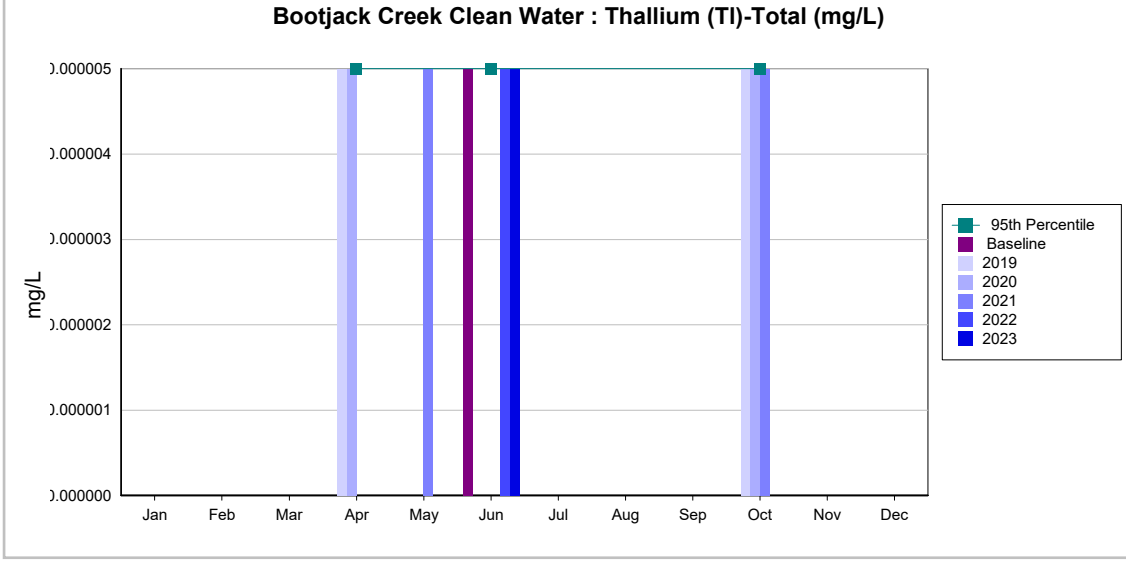
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







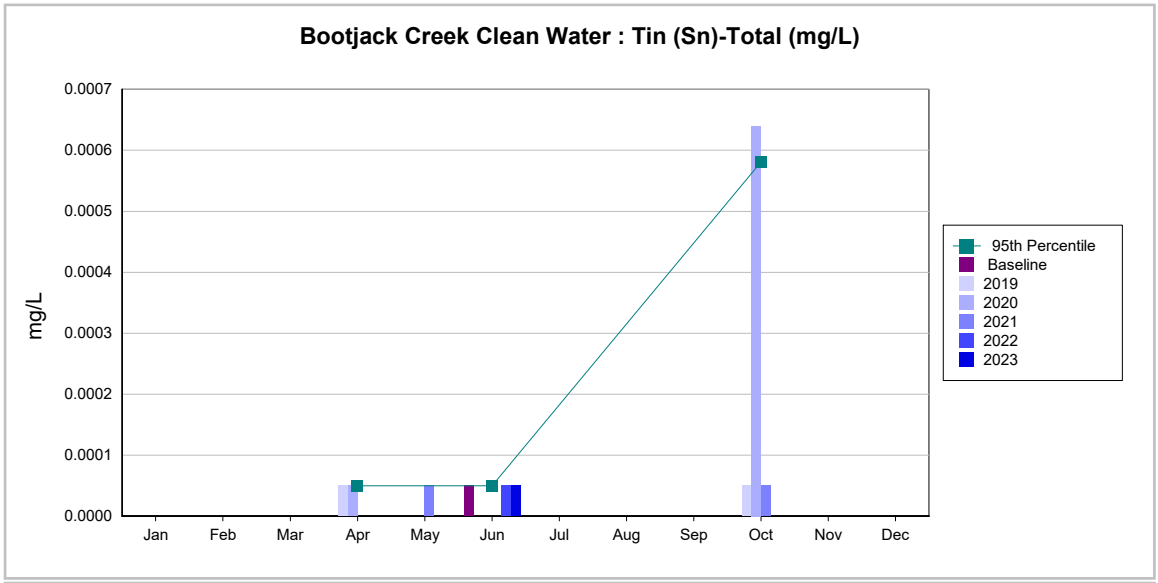
Water Quality Report

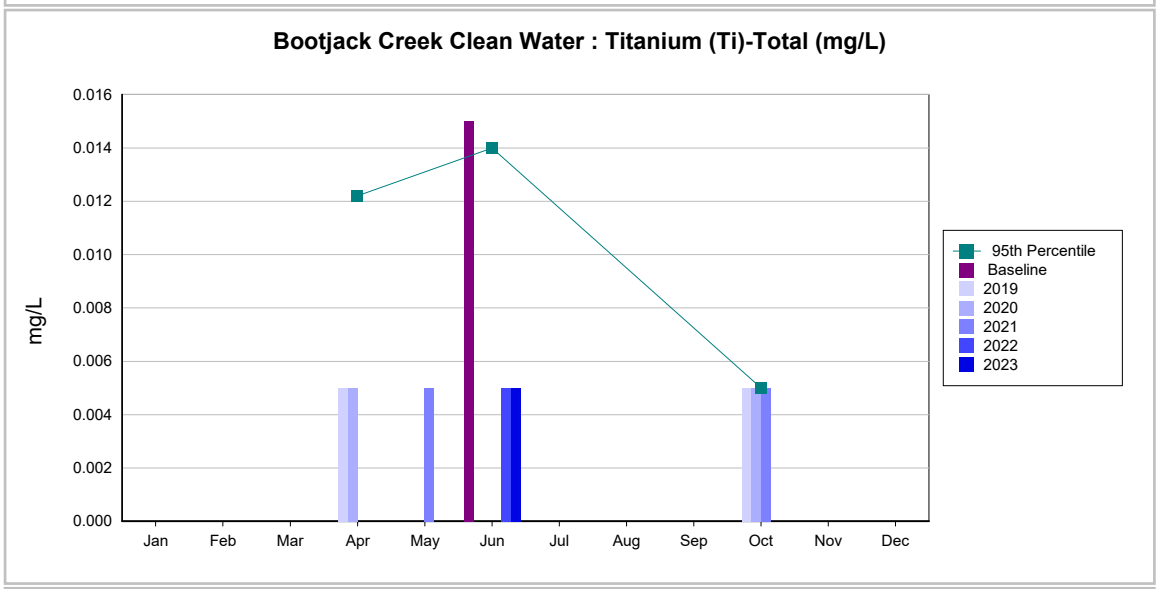
Annual Report Drainage Water

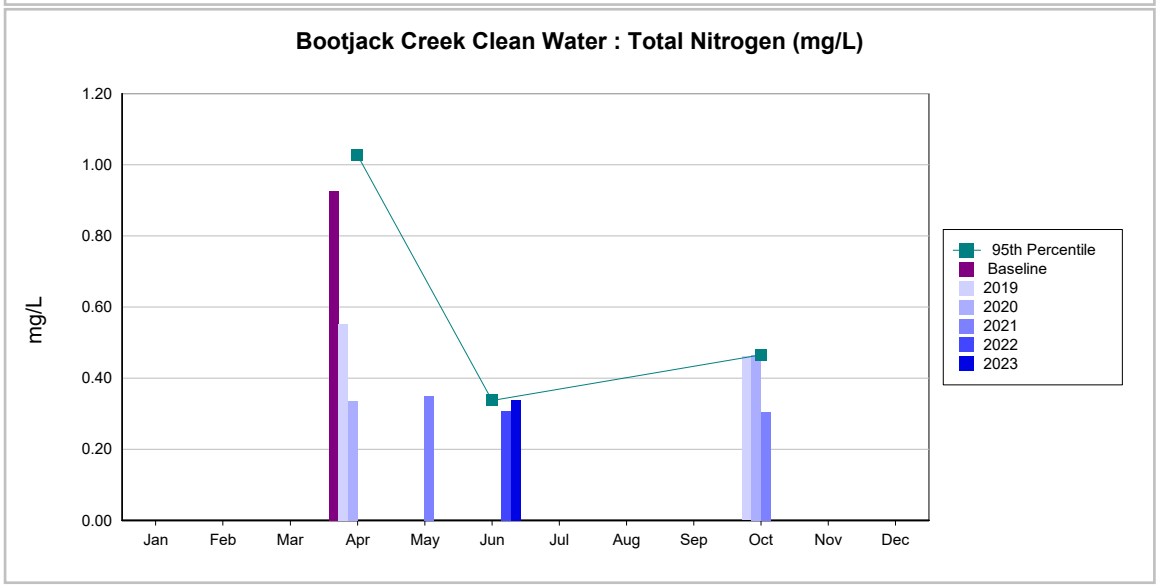
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







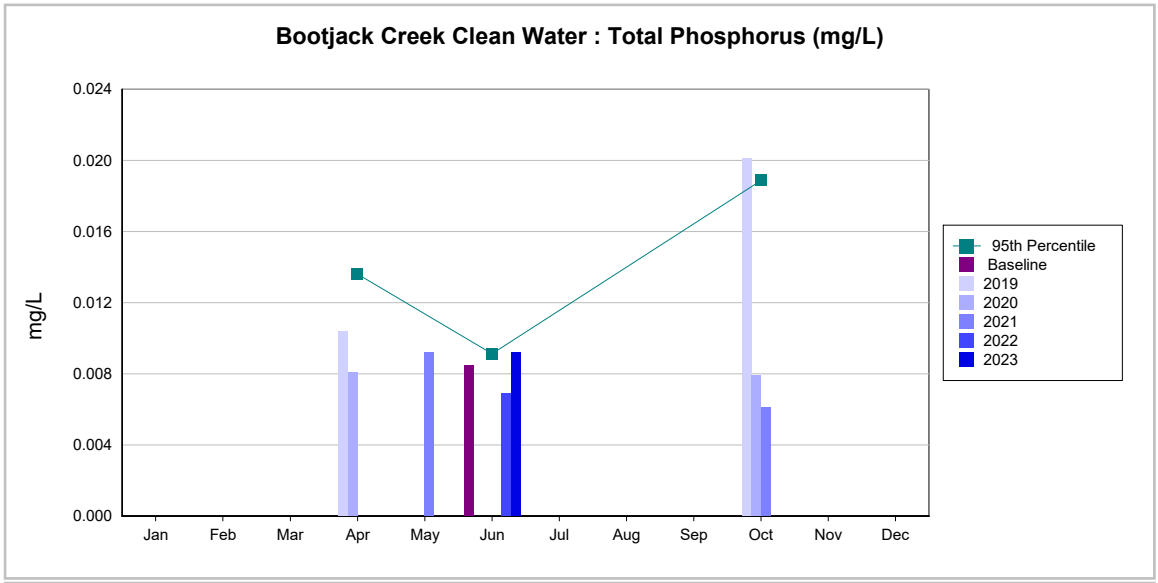
Water Quality Report

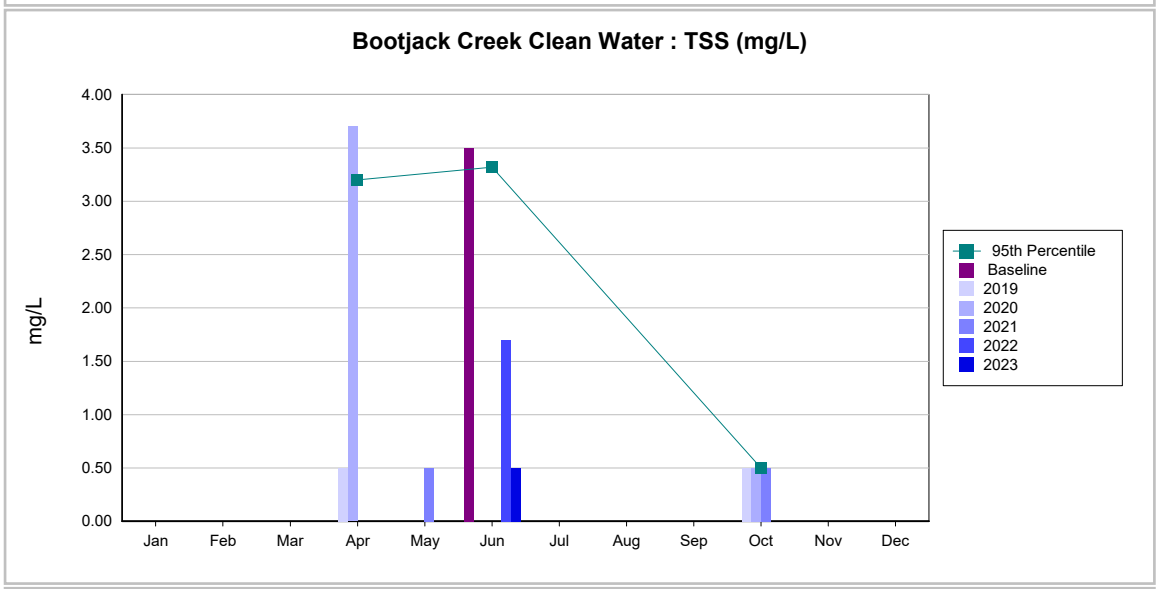
Annual Report Drainage Water

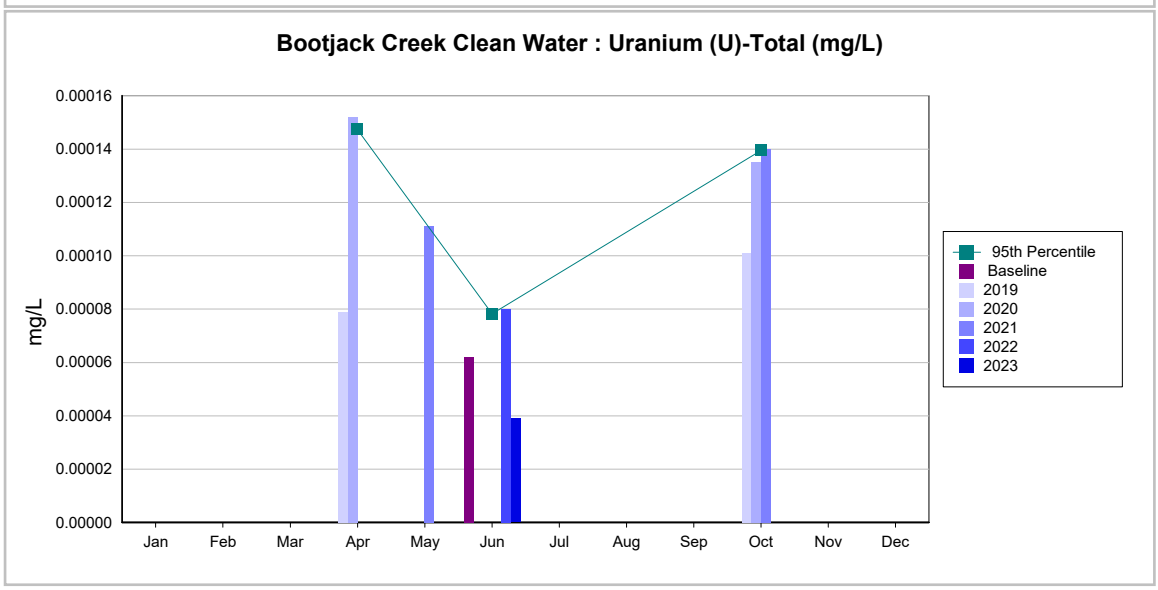
Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION







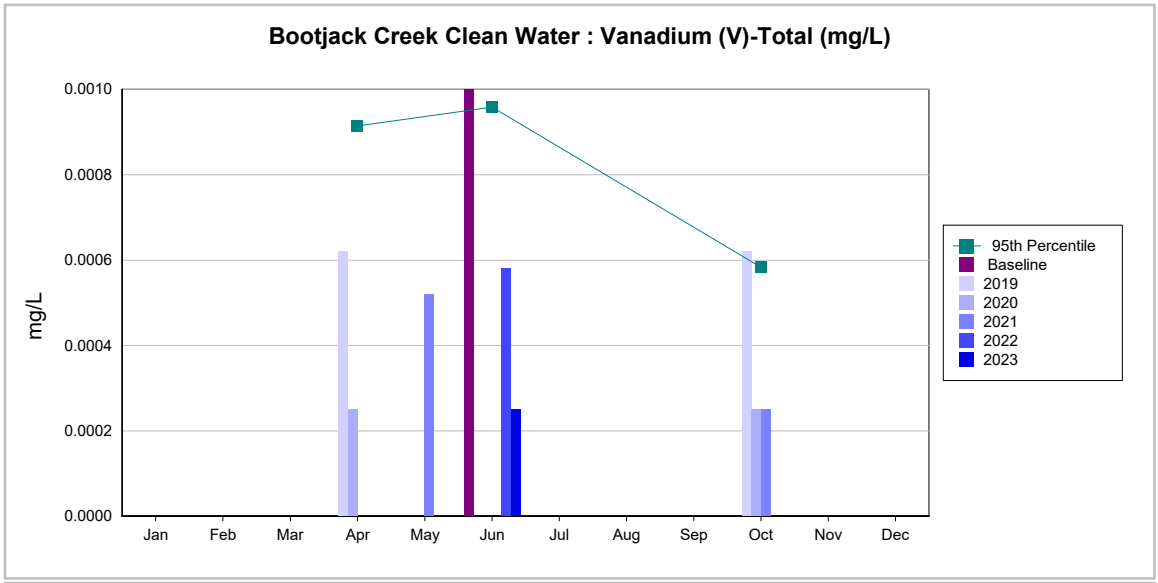
Water Quality Report

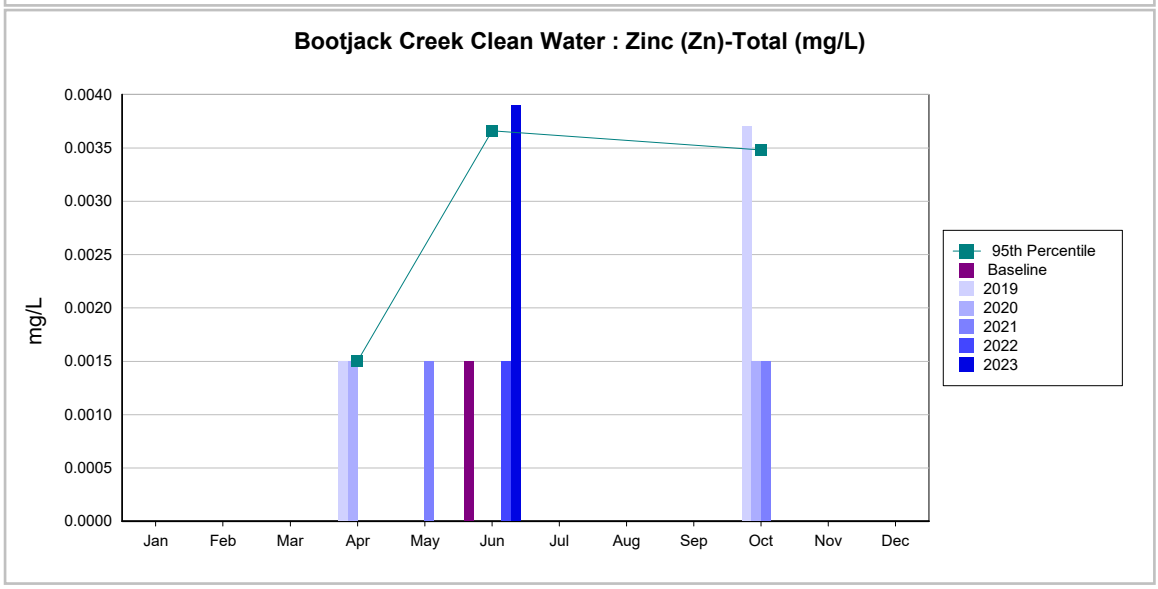
Annual Report Drainage Water

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION





Grid Format Report : Bootjack Creek Clean Water

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Bootjack Creek Clean										
	3-Apr-19	22-Oct-19	3-Dec-19	14-Apr-20	26-Oct-20	27-May-21	14-Oct-21	2-Jun-22	3-Apr-23	13-Jun-23	19-Oct-23
Anions and Nutrients											
Alkalinity (CaCO3) (mg/L)	54.0	72.0		83.3	70.6	65.1	57.6	63.2		62.1	
Ammonia (as N) (mg/L)	0.0069	0.0101		<0.0050	0.0064	0.0055	<0.0050	0.0050		0.0145	
Chloride (mg/L)	0.55	1.18		1.08	0.92	<0.50	2.55	<0.50		<0.50	
Diss-Orthophosphate (mg/L)	0.0018	<0.0010		0.0011	<0.0010	0.0014	0.0014	0.0013		0.0022	
Diss-Phosphorus (mg/L)	0.0084	0.0053		0.0043	0.0047	0.0069	0.0066	0.0065		0.0195	
Floride (mg/L)	0.049	0.057		0.043	0.048	0.050	<0.100	0.052		0.055	
Nitrate (N) (mg/L)	0.198	<0.0050		0.0102	0.0419	0.0133	<0.0250	<0.0050		0.0296	
Nitrate and Nitrite (mg/L)	0.198	<0.0051		<0.0500	0.0423	0.0133	<0.0255	<0.0051		0.0296	
Nitrite (N) (mg/L)	<0.0010	0.0021		<0.0010	<0.0010	<0.0010	<0.0050	<0.0010		<0.0010	
Sulphate (mg/L)	96.1	147		194	138	86.6	579	72.2		7.24	
Total Nitrogen (mg/L)	0.552	0.461		0.336	0.466	0.351	0.304	0.309		0.339	
Total Phosphorus (mg/L)	0.0104	0.0201		0.0081	0.0079	0.0092	0.0061	0.0069		0.0092	
Dissolved Metals											
Aluminum (Al)-Diss (mg/L)	0.123	0.0690		0.0458	0.0608	0.0946	0.0149	0.0921		0.0556	
Diss-Antimony (Sb) (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	
Diss-Arsenic (As) (mg/L)	0.00036	0.00033		0.00023	0.00027	0.00023	0.00025	0.00024		0.00037	
Diss-Barium (Ba) (mg/L)	0.0201	0.0258		0.0281	0.0218	0.0192	0.0796	0.0175		0.0160	
Diss-Beryllium (Be) (mg/L)	<0.00010	<0.00010		<0.00100	<0.00100	<0.000100	<0.000100	<0.000100		<0.000100	
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	
Diss-Boron (B) (mg/L)	<0.010	0.010		<0.010	<0.010	0.011	0.012	0.010		0.020	
Diss-Cadmium (Cd) (mg/L)	0.0000208	0.0000190		0.0000164	0.0000191	0.0000154	0.0000421	0.0000180		0.0000062	
Diss-Calcium (Ca) (mg/L)	44.6	58.2		76.9	56.8	43.4	182	35.9		18.2	
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	
Diss-Cobalt (Co) (mg/L)	0.00012	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		0.00030	
Diss-Copper (Cu) (mg/L)	0.00639	0.00795		0.00568	0.00616	0.00693	0.0116	0.00879		0.00575	
Diss-Iron (Fe) (mg/L)	0.094	0.044		0.031	0.068	0.072	<0.030	0.064		0.309	
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	
Diss-Lithium (Li) (mg/L)	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	
Diss-Magnesium (Mg) (mg/L)	9.90	13.2		15.8	12.3	9.29	39.0	7.50		3.71	
Diss-Manganese (Mn) (mg/L)	0.00389	0.00210		0.00676	0.0118	0.00897	0.00373	0.00424		0.157	
Diss-Molybdenum (Mo) (mg/L)	0.00618	0.00542		0.00369	0.00606	0.00453	0.00757	0.00558		0.00150	
Diss-Nickel (Ni) (mg/L)	0.00104	0.00119		0.00086	0.00108	0.00106	0.00098	0.00092		0.00058	
Diss-Potassium (K) (mg/L)	0.737	0.582		0.658	0.712	0.736	0.904	0.721		0.696	
Diss-Selenium (mg/L)	0.00493	0.000760		0.00191	0.00100	0.000452	0.00279	0.000303		0.000194	

Grid Format Report : Bootjack Creek Clean Water

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Bootjack Creek Clean										
	3-Apr-19	22-Oct-19	3-Dec-19	14-Apr-20	26-Oct-20	27-May-21	14-Oct-21	2-Jun-22	3-Apr-23	13-Jun-23	19-Oct-23
Diss-Silicon (Si) (mg/L)	3.84	4.31		3.62	3.81	4.23	4.09	4.08		5.20	
Diss-Silver (Ag) (mg/L)	0.000012	<0.000010		<0.000010	<0.000010	0.000010	<0.000010	0.000015		<0.000010	
Diss-Sodium (Na) (mg/L)	5.79	7.40		8.41	7.87	5.62	16.7	4.77		3.57	
Diss-Strontium (Sr) (mg/L)	0.296	0.401		0.447	0.381	0.273	1.17	0.230		0.164	
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	
Diss-Titanium (Ti) (mg/L)	<0.010	<0.010		<0.0100	<0.0100	<0.0100	<0.0100	<0.0100		<0.0100	
Diss-Uranium (U) (mg/L)	0.000066	0.000096		0.000146	0.000142	0.000114	0.000118	0.000086		0.000038	
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		0.0042	
TDS (mg/L)	241	324		316	334	239	969	216		108	
Field Tests											
Cond (in situ) (µs/cm)	308.1	435.1		554.74	435.3	356.2	1090	248.4		226	
NTU - in situ (ntu)	1.43	0.81		1.7	0.43	0.86	2.85	0.31		1.4	
pH (in situ) (pH)	7.27	7.4		6.88	7.42	7.31	7.4	7.19		7.19	
Sample Taken	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Temp (in situ) (Degrees Celcius)	0.477	5.618		1.805	2.09	8.883	7.4	9.602		10.4	
Organic / Inorganic											
DOC (mg/L)	15.8	16.0		12.1	13.8	13.5	10.6	13.8		12.9	
Physical Test											
Conductivity (µs/cm)	310	439		522	424	309	1200	274		137	
Hardness (mg/L)	152	200		257	192	147	615	120		60.7	
NTU (ntu)	1.58	0.70		0.73	0.60	0.81	0.17	0.76		0.27	
pH (pH)	7.53	7.64		7.33	7.74	7.94	7.82	7.71		7.63	
TDS (mg/L)	241	324		316	334	239	969	216		108	
TSS (mg/L)	<1.0	<1.0		3.7	<1.0	<1.0	<1.0	1.7		<1.0	
Total Metals											
Aluminum (Al)-Total (mg/L)	0.203	0.111		0.0910	0.0900	0.136	0.0224	0.136		0.0591	
Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010	0.00011	<0.00010		<0.00010	
Arsenic (As)-Total (mg/L)	0.00027	0.00030		0.00023	0.00029	0.00028	0.00028	0.00029		0.00032	
Barium (Ba)-Total (mg/L)	0.0192	0.0230		0.0299	0.0236	0.0193	0.0824	0.0174		0.0154	
Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100	
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	
Boron (B)-Total (mg/L)	<0.010	<0.010		<0.010	<0.010	0.011	0.012	0.011		0.022	
Cadmium (Cd)-Total (mg/L)	0.0000226	0.0000211		0.0000208	0.0000226	0.0000163	0.0000390	0.0000129		<0.0000050	

Grid Format Report : Bootjack Creek Clean Water

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Bootjack Creek Clean										
	3-Apr-19	22-Oct-19	3-Dec-19	14-Apr-20	26-Oct-20	27-May-21	14-Oct-21	2-Jun-22	3-Apr-23	13-Jun-23	19-Oct-23
Calcium (Ca)-Total (mg/L)	43.2	59.3		72.8	58.1	41.3	180	35.6		18.1	
Chromium (Cr)-Total (mg/L)	0.00062	0.00087		<0.00050	0.00051	0.00056	<0.00050	0.00055		<0.00050	
Cobalt (Co)-Total (mg/L)	0.00014	0.00010		<0.00010	0.00011	<0.00010	<0.00010	<0.00010		<0.00010	
Copper (Cu)-Total (mg/L)	0.00699	0.00901		0.00736	0.00701	0.00763	0.0123	0.00972		0.00663	
Iron (Fe)-Total (mg/L)	0.170	0.094		0.082	0.108	0.120	<0.030	0.125		0.042	
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	
Lithium (Li)-Total (mg/L)	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	
Magnesium (Mg)-Total (mg/L)	10.3	13.2		15.9	12.4	9.79	41.7	8.03		4.33	
Manganese (Mn)-Total (mg/L)	0.00523	0.00470		0.0116	0.0129	0.0110	0.00435	0.00636		0.0183	
Molybdenum (Mo)-Tota (mg/L)	0.00607	0.00495		0.00384	0.00627	0.00463	0.00766	0.00535		0.00148	
Nickel (Ni)-Total (mg/L)	0.00109	0.00149		0.00092	0.00137	0.00113	0.00111	0.00110		0.00066	
Potassium (K)-Total (mg/L)	0.730	0.559		0.658	0.706	0.763	1.03	0.744		0.788	
Selenium (Se)-Total (mg/L)	0.00490	0.000723		0.00202	0.00106	0.000429	0.00258	0.000293		0.000159	
Silicon (Si)-Total (mg/L)	3.71	4.32		3.90	4.07	4.30	4.22	4.56		5.41	
Silver (Ag)-Total (mg/L)	0.000016	0.000014		<0.000010	0.000010	0.000034	<0.000010	0.000018		<0.000010	
Sodium (Na)-Total (mg/L)	5.69	7.74		8.04	7.67	6.03	18.5	5.08		4.10	
Strontium (Sr)-Total (mg/L)	0.277	0.378		0.451	0.382	0.264	1.20	0.229		0.155	
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010		<0.00010	0.00064	<0.00010	<0.00010	<0.00010		<0.00010	
Titanium (Ti)-Total (mg/L)	<0.010	<0.010		<0.0100	<0.0100	<0.0100	<0.0100	<0.0100		<0.0100	
Uranium (U)-Total (mg/L)	0.000079	0.000101		0.000152	0.000135	0.000111	0.000140	0.000080		0.000039	
Vanadium (V)-Total (mg/L)	0.00062	0.00062		<0.00050	<0.00050	0.00052	<0.00050	0.00058		<0.00050	
Zinc (Zn)-Total (mg/L)	<0.0030	0.0037		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		0.0039	

Grid Format Report : Bootjack Creek Clean Water

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Bootjack Creek Clean						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	8	8	54.00000	83.30000	65.98750	48.48000	9.21853
Ammonia (as N) (mg/L)	8	6	0.00250	0.01450	0.00668	0.00505	0.00400
Chloride (mg/L)	8	5	0.25000	2.55000	0.87875	1.35100	0.77645
Diss-Orthophosphate (mg/L)	8	6	0.00050	0.00220	0.00128	0.00161	0.00058
Diss-Phosphorus (mg/L)	8	8	0.00430	0.01950	0.00778	0.01125	0.00492
Floride (mg/L)	8	7	0.04300	0.05700	0.05050	0.04000	0.00431
Nitrate (N) (mg/L)	8	5	0.00250	0.19800	0.03881	0.73235	0.06572
Nitrate and Nitrite (mg/L)	8	4	0.00255	0.19800	0.04076	0.73235	0.06498
Nitrite (N) (mg/L)	8	1	0.00050	0.00250	0.00095	0.00050	0.00084
Sulphate (mg/L)	8	8	7.24000	579.00000	165.01750	94.01000	176.34537
Total Nitrogen (mg/L)	8	8	0.30400	0.55200	0.38975	1.02900	0.09107
Total Phosphorus (mg/L)	8	8	0.00610	0.02010	0.00974	0.01372	0.00440
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	8	8	0.01490	0.12300	0.06948	0.32260	0.03341
Diss-Antimony (Sb) (mg/L)	8	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Arsenic (As) (mg/L)	8	8	0.00023	0.00037	0.00029	0.00030	0.00006
Diss-Barium (Ba) (mg/L)	8	8	0.01600	0.07960	0.02851	0.01994	0.02104
Diss-Beryllium (Be) (mg/L)	8	0	0.00005	0.00050	0.00016	0.00005	0.00021
Diss-Bismuth (Bi) (mg/L)	8	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Boron (B) (mg/L)	8	5	0.00500	0.02000	0.00975	0.01130	0.00506
Diss-Cadmium (Cd) (mg/L)	8	8	0.00001	0.00004	0.00002	0.00002	0.00001
Diss-Calcium (Ca) (mg/L)	8	8	18.20000	182.00000	64.50000	41.15000	50.51430
Diss-Chromium (Cr) (mg/L)	8	0	0.00025	0.00025	0.00025	0.00082	0.00000
Diss-Cobalt (Co) (mg/L)	8	2	0.00005	0.00030	0.00009	0.00017	0.00009
Diss-Copper (Cu) (mg/L)	8	8	0.00568	0.01160	0.00741	0.00857	0.00201
Diss-Iron (Fe) (mg/L)	8	7	0.01500	0.30900	0.08713	0.23970	0.09306
Diss-Lead (Pb) (mg/L)	8	0	0.00003	0.00003	0.00003	0.00005	0.00000
Diss-Lithium (Li) (mg/L)	8	0	0.00050	0.00050	0.00050	0.00050	0.00000
Diss-Magnesium (Mg) (mg/L)	8	8	3.71000	39.00000	13.83750	9.09600	10.81459
Diss-Manganese (Mn) (mg/L)	8	8	0.00210	0.15700	0.02481	0.00547	0.05351
Diss-Molybdenum (Mo) (mg/L)	8	8	0.00150	0.00757	0.00507	0.00460	0.00184
Diss-Nickel (Ni) (mg/L)	8	8	0.00058	0.00119	0.00096	0.00144	0.00019
Diss-Potassium (K) (mg/L)	8	8	0.58200	0.90400	0.71825	0.87990	0.09095

Grid Format Report : Bootjack Creek Clean Water

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Bootjack Creek Clean						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Selenium (mg/L)	8	8	0.00019	0.00493	0.00154	0.00604	0.00163
Diss-Silicon (Si) (mg/L)	8	8	3.62000	5.20000	4.14750	3.80500	0.48337
Diss-Silver (Ag) (mg/L)	8	3	0.00001	0.00002	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	8	8	3.57000	16.70000	7.51625	4.94100	4.05267
Diss-Strontium (Sr) (mg/L)	8	8	0.16400	1.17000	0.42025	0.25970	0.31707
Diss-Thallium (Tl) (mg/L)	8	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	8	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	8	0	0.00500	0.00500	0.00500	0.00500	0.00000
Diss-Uranium (U) (mg/L)	8	8	0.00004	0.00015	0.00010	0.00006	0.00004
Diss-Vanadium (V) (mg/L)	8	0	0.00025	0.00025	0.00025	0.00069	0.00000
Diss-Zinc (Zn) (mg/L)	8	1	0.00150	0.00420	0.00184	0.00150	0.00095
TDS (mg/L)	8	8	108.00000	969.00000	343.37500	222.05000	263.38995
Field Tests							
Cond (in situ) (µs/cm)	8	8	226.00000	1,090.00000	456.73000	1,611.85000	277.84858
NTU - in situ (ntu)	8	8	0.31000	2.85000	1.22375	4.46700	0.82059
pH (in situ) (pH)	8	8	6.88000	7.42000	7.25750	7.26170	0.17790
Sample Taken							
Temp (in situ) (Degrees Celcius)	8	8	0.47700	10.40000	5.78438	2.77190	3.88715
Organic / Inorganic							
DOC (mg/L)	8	8	10.60000	16.00000	13.56250	19.98000	1.78960
Physical Test							
Conductivity (µs/cm)	8	8	137.00000	1,200.00000	451.87500	297.20000	324.45094
Hardness (mg/L)	8	8	60.70000	615.00000	217.96250	141.30000	170.66018
NTU (ntu)	8	8	0.17000	1.58000	0.70250	3.78600	0.42540
pH (pH)	8	8	7.33000	7.94000	7.66750	7.73350	0.18499
TDS (mg/L)	8	8	108.00000	969.00000	343.37500	222.05000	263.38995
TSS (mg/L)	8	2	0.50000	3.70000	1.05000	3.15500	1.15016
Total Metals							
Aluminum (Al)-Total (mg/L)	8	8	0.02240	0.20300	0.10606	0.39020	0.05465
Antimony (Sb)-Total (mg/L)	8	1	0.00005	0.00011	0.00006	0.00005	0.00002
Arsenic (As)-Total (mg/L)	8	8	0.00023	0.00032	0.00028	0.00035	0.00003
Barium (Ba)-Total (mg/L)	8	8	0.01540	0.08240	0.02878	0.02291	0.02213
Beryllium (Be)-Total (mg/L)	8	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	8	0	0.00003	0.00003	0.00003	0.00022	0.00000
Boron (B)-Total (mg/L)	8	4	0.00500	0.02200	0.00950	0.01010	0.00595

Grid Format Report : Bootjack Creek Clean Water

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Bootjack Creek Clean						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Cadmium (Cd)-Total (mg/L)	8	7	0.00000	0.00004	0.00002	0.00003	0.00001
Calcium (Ca)-Total (mg/L)	8	8	18.10000	180.00000	63.55000	41.04000	49.92855
Chromium (Cr)-Total (mg/L)	8	5	0.00025	0.00087	0.00048	0.00117	0.00022
Cobalt (Co)-Total (mg/L)	8	3	0.00005	0.00014	0.00008	0.00035	0.00004
Copper (Cu)-Total (mg/L)	8	8	0.00663	0.01230	0.00833	0.00987	0.00193
Iron (Fe)-Total (mg/L)	8	7	0.01500	0.17000	0.09450	0.32640	0.04884
Lead (Pb)-Total (mg/L)	8	0	0.00003	0.00003	0.00003	0.00008	0.00000
Lithium (Li)-Total (mg/L)	8	0	0.00050	0.00050	0.00050	0.00050	0.00000
Magnesium (Mg)-Total (mg/L)	8	8	4.33000	41.70000	14.45625	9.47650	11.54493
Manganese (Mn)-Total (mg/L)	8	8	0.00435	0.01830	0.00931	0.01991	0.00497
Molybdenum (Mo)-Tota (mg/L)	8	8	0.00148	0.00766	0.00503	0.00479	0.00184
Nickel (Ni)-Total (mg/L)	8	8	0.00066	0.00149	0.00111	0.00167	0.00025
Potassium (K)-Total (mg/L)	8	8	0.55900	1.03000	0.74725	0.95620	0.13484
Selenium (Se)-Total (mg/L)	8	8	0.00016	0.00490	0.00152	0.00611	0.00161
Silicon (Si)-Total (mg/L)	8	8	3.71000	5.41000	4.31125	4.46350	0.51637
Silver (Ag)-Total (mg/L)	8	5	0.00001	0.00003	0.00001	0.00003	0.00001
Sodium (Na)-Total (mg/L)	8	8	4.10000	18.50000	7.85625	5.31150	4.52321
Strontium (Sr)-Total (mg/L)	8	8	0.15500	1.20000	0.41700	0.27980	0.33037
Thallium (Tl)-Total (mg/L)	8	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	8	1	0.00005	0.00064	0.00012	0.00005	0.00021
Titanium (Ti)-Total (mg/L)	8	0	0.00500	0.00500	0.00500	0.01485	0.00000
Uranium (U)-Total (mg/L)	8	8	0.00004	0.00015	0.00010	0.00012	0.00004
Vanadium (V)-Total (mg/L)	8	4	0.00025	0.00062	0.00042	0.00099	0.00018
Zinc (Zn)-Total (mg/L)	8	2	0.00150	0.00390	0.00208	0.00150	0.00107

Grid Format Report : Boundary Dump Seep 2

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Dump Seep 2														
	19-Feb-19	6-May-19	8-Aug-19	6-Nov-19	26-Feb-20	28-May-20	18-Aug-20	22-Oct-20	2-Mar-21	13-May-21	26-May-21	17-Aug-21	30-Sep-21	27-Oct-21	28-Mar-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	223	132	189	183	216	142	182	187	194	129	157			192	
Ammonia (as N) (mg/L)	0.246	0.0050	0.0066	0.0055	0.0225	0.0178	0.0238	<0.0050	0.0218	<0.0050	<0.0050			0.0070	
Chloride (mg/L)	<2.5	<2.5	<2.5	<2.5	<2.50	<2.50	<2.50	<2.50	<2.50	<0.50	<0.50			<2.50	
Diss-Orthophosphate (mg/L)	0.0908	0.0036	0.0144	0.0209	0.0365	0.0176	0.0122	0.0216	0.0293	0.0176	0.0118			0.0215	
Diss-Phosphorus (mg/L)	0.121	0.0091	0.0172	0.0226	0.0368	0.0223	0.0074	0.0262	0.0316	0.0201	0.0156			0.0251	
Floride (mg/L)	0.16	0.17	0.14	0.12	0.115	0.176	0.113	0.121	0.138	0.188	0.124			0.159	
Nitrate (N) (mg/L)	0.166	0.682	0.381	0.627	0.178	0.393	0.309	0.392	0.174	0.609	0.418			0.386	
Nitrate and Nitrite (mg/L)	0.173	0.682	0.381	0.627	0.182	0.394	0.311	0.393	0.174	0.609	0.418			0.386	
Nitrite (N) (mg/L)	0.0075	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0010	<0.0010			<0.0050	
Sulphate (mg/L)	534	371	275	333	420	248	312	179	308	242	136			205	
Total Nitrogen (mg/L)	0.635	0.846	0.573		0.391	0.573	0.844	0.531	0.376	0.836	0.560			0.510	
Total Phosphorus (mg/L)	0.151	0.0238	0.0292	0.0283	0.0584	0.0216	0.261	0.0295	0.0484	0.0215	0.0201			0.0593	
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0059	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0043	<0.0030			<0.0030	
Diss-Antimony (Sb) (mg/L)	<0.00010	0.00016	0.00011	<0.00010	<0.00010	0.00012	<0.00010	<0.00010	0.00011	0.00013	0.00010			<0.00010	
Diss-Arsenic (As) (mg/L)	0.00122	0.00049	0.00042	0.00044	0.00074	0.00043	0.00035	0.00056	0.00076	0.00041	0.00042			0.00055	
Diss-Barium (Ba) (mg/L)	0.0442	0.0278	0.0291	0.0299	0.0330	0.0197	0.0260	0.0211	0.0232	0.0212	0.0206			0.0229	
Diss-Beryllium (Be) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00100	<0.00100	<0.00100	<0.00100	<0.000100	<0.000100	<0.000100			<0.000100	
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050			<0.000050	
Diss-Boron (B) (mg/L)	0.054	0.057	0.064	0.076	0.054	0.054	0.065	0.065	0.064	0.056	0.059			0.058	
Diss-Cadmium (Cd) (mg/L)	0.0000242	<0.000050	0.0000392	0.0000281	0.0000441	<0.0000250	0.0000376	<0.0000300	<0.0000350	<0.0000300	<0.0000300			<0.0000250	
Diss-Calcium (Ca) (mg/L)	241	163	138	161	192	109	130	123	166	112	94.8			116	
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050			<0.00050	
Diss-Cobalt (Co) (mg/L)	0.00032	<0.00010	<0.00010	<0.00010	0.00012	<0.00010	<0.00010	<0.00010	0.00016	<0.00010	<0.00010			<0.00010	
Diss-Copper (Cu) (mg/L)	0.00322	0.00699	0.00714	0.00568	0.00864	0.00697	0.00745	0.00702	0.00551	0.00816	0.00786			0.00534	
Diss-Iron (Fe) (mg/L)	0.301	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.043	<0.030	<0.030			<0.030	
Diss-Lead (Pb) (mg/L)	0.000174	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000084	<0.000050	<0.000050			<0.000050	
Diss-Lithium (Li) (mg/L)	0.0023	0.0021	0.0019	0.0016	0.0017	0.0017	0.0015	0.0015	0.0019	0.0017	0.0013			0.0014	
Diss-Magnesium (Mg) (mg/L)	36.5	25.7	17.6	16.3	26.5	15.5	12.1	11.6	20.9	16.9	11.7			13.3	
Diss-Manganese (Mn) (mg/L)	0.404	0.00984	0.00404	0.00062	0.0302	0.00727	0.00132	0.00104	0.0433	0.00583	0.0175			0.0489	
Diss-Molybdenum (Mo) (mg/L)	0.0210	0.0437	0.0204	0.0171	0.0194	0.0278	0.00979	0.0207	0.0250	0.0333	0.0180			0.0186	
Diss-Nickel (Ni) (mg/L)	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050			<0.00050	
Diss-Potassium (K) (mg/L)	1.62	1.08	0.945	0.990	1.18	0.774	0.876	0.822	1.08	0.974	0.840			0.926	
Diss-Selenium (mg/L)	0.00299	0.00820	0.00310	0.00356	0.00228	0.00432	0.00216	0.00287	0.00231	0.00498	0.00272			0.00331	

	: Boundary Dump Seep 2									
	11-May-22	26-Jul-22	21-Sep-22	19-Oct-22	30-Jan-23	27-Apr-23	23-May-23	3-Aug-23	13-Sep-23	1-Nov-23
Anions and Nutrients										
Alkalinity (CaCO3) (mg/L)	115			177	233	125	140			
Ammonia (as N) (mg/L)	0.0058			0.0160	0.101	0.0364	<0.0050			
Chloride (mg/L)	<2.50			<2.50	<2.50	<2.50	<2.50			
Diss-Orthophosphate (mg/L)	0.0167			0.0278	0.0028	0.0077	0.0119			
Diss-Phosphorus (mg/L)	0.0206			0.0249	0.0492	0.0216	0.0023			
Floride (mg/L)	0.242			0.159	0.149	0.319	0.140			
Nitrate (N) (mg/L)	1.00			0.139	0.105	1.99	0.555			
Nitrate and Nitrite (mg/L)	1.00			0.139	0.105	2.00	0.555			
Nitrite (N) (mg/L)	<0.0050			<0.0050	<0.0050	0.0083	<0.0050			
Sulphate (mg/L)	363			341	253	524	253			
Total Nitrogen (mg/L)	1.12			0.389	0.389	2.17	1.39			
Total Phosphorus (mg/L)	0.0216			0.0252	0.0503	0.0240	0.0028			
Dissolved Metals										
Aluminum (Al)-Diss (mg/L)	0.0059			0.0039	0.0037	0.0105	0.0035			
Diss-Antimony (Sb) (mg/L)	0.00016			0.00011	<0.00010	0.00023	0.00012			
Diss-Arsenic (As) (mg/L)	0.00042			0.00048	0.00058	0.00046	0.00042			
Diss-Barium (Ba) (mg/L)	0.0249			0.0270	0.0284	0.0341	0.0186			
Diss-Beryllium (Be) (mg/L)	<0.000100			<0.000100	<0.000100	<0.000100	<0.000100			
Diss-Bismuth (Bi) (mg/L)	<0.000050			<0.000050	<0.000050	<0.000050	<0.000050			
Diss-Boron (B) (mg/L)	0.048			0.059	0.051	0.056	0.057			
Diss-Cadmium (Cd) (mg/L)	<0.0000400			0.0000329	0.0000272	<0.0000650	0.0000329			
Diss-Calcium (Ca) (mg/L)	138			136	147	188	104			
Diss-Chromium (Cr) (mg/L)	<0.00050			<0.00050	<0.00050	<0.00050	<0.00050			
Diss-Cobalt (Co) (mg/L)	<0.00010			<0.00010	0.00020	0.00021	<0.00010			
Diss-Copper (Cu) (mg/L)	0.00735			0.00762	0.00475	0.00693	0.00818			
Diss-Iron (Fe) (mg/L)	<0.030			<0.030	0.461	0.040	<0.030			
Diss-Lead (Pb) (mg/L)	<0.000050			<0.000050	<0.000050	<0.000050	<0.000050			
Diss-Lithium (Li) (mg/L)	0.0023			0.0020	0.0016	0.0032	0.0016			
Diss-Magnesium (Mg) (mg/L)	23.6			17.3	19.1	32.4	13.8			
Diss-Manganese (Mn) (mg/L)	0.0185			0.00713	0.503	0.0666	0.00307			
Diss-Molybdenum (Mo) (mg/L)	0.0523			0.0210	0.0179	0.0809	0.0245			
Diss-Nickel (Ni) (mg/L)	<0.00050			<0.00050	<0.00050	<0.00050	<0.00050			
Diss-Potassium (K) (mg/L)	1.17			0.961	1.06	1.37	0.813			
Diss-Selenium (mg/L)	0.0104			0.00187	0.00144	0.0207	0.00455			

Grid Format Report : Boundary Dump Seep 2

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Dump Seep 2														
	19-Feb-19	6-May-19	8-Aug-19	6-Nov-19	26-Feb-20	28-May-20	18-Aug-20	22-Oct-20	2-Mar-21	13-May-21	26-May-21	17-Aug-21	30-Sep-21	27-Oct-21	28-Mar-22
Diss-Silicon (Si) (mg/L)	7.28	5.46	5.99	6.18	6.49	4.86	6.33	5.83	6.69	5.08	5.37			6.10	
Diss-Silver (Ag) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010			<0.000010	
Diss-Sodium (Na) (mg/L)	7.95	6.18	5.10	4.93	6.64	4.22	4.11	4.49	5.74	4.68	3.83			4.44	
Diss-Strontium (Sr) (mg/L)	2.82	2.10	1.17	0.951	1.84	1.15	0.649	0.891	1.61	1.30	0.774			0.750	
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010			<0.000010	
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010			<0.00010	
Diss-Titanium (Ti) (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100			<0.0100	
Diss-Uranium (U) (mg/L)	0.000702	0.000888	0.000896	0.000682	0.000620	0.000624	0.000678	0.000670	0.000715	0.000656	0.000551			0.000712	
Diss-Vanadium (V) (mg/L)	0.00138	0.00051	<0.00050	<0.00050	0.00056	<0.00050	<0.00050	<0.00050	0.00061	<0.00050	<0.00050			<0.00050	
Diss-Zinc (Zn) (mg/L)	0.0058	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030			<0.0030	
TDS (mg/L)	1050	696	629	643	792	521	704	478	619	490	372			549	
Field Tests															
Cond (in situ) (µs/cm)	1302.04	947.2	847.8	1085	1002	736.9	765.7	739	878.2	770	578			795	
NTU - in situ (ntu)	0.56	0.68	0.75		1.45	0.38	1.77		2.16	0.05					
pH (in situ) (pH)	7.04	7.41	7.21	8.26	7.18	7.07	7.1	7.7	7.26	7.35	7.22			8.13	
Q (m3/s)											0.0005				
Sample Taken	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	yes	Yes	Yes	No	No	Yes	No
Temp (in situ) (Degrees Celcius)	0.857	3.178	5.371	2.9	0.216	4.353	8.858	3.3	0.544	3.525	4.4			4.2	
Organic / Inorganic															
DOC (mg/L)	7.35	5.38	4.71	4.21	5.41	4.93	4.28	4.24	5.44	5.27	4.53			4.98	
Physical Test															
Conductivity (µs/cm)	1270	939	787	869	1080	697	880	675	869	688	542			729	
Hardness (mg/L)	752	513	416	469	589	337	374	354	500	349	285			344	
NTU (ntu)	1.45	0.87	0.15	<0.10	1.23	0.11	1.49	0.15	0.78	0.18	<0.10			0.29	
pH (pH)	7.90	8.12	8.27	8.07	7.87	7.96	7.94	8.05	7.65	8.09	8.15			8.08	
TDS (mg/L)	1050	696	629	643	792	521	704	478	619	490	372			549	
TSS (mg/L)	1.2	1.3	<1.0	<1.0	2.7	<1.0	17.2	1.5	4.8	1.5	1.2			3.4	
Total Metals															
Aluminum (Al)-Total (mg/L)	0.0058	0.0046	0.0074	0.0059	0.0054	0.0070	0.0171	0.0097	0.0063	0.0071	0.0047			0.0266	
Antimony (Sb)-Total (mg/L)	0.00011	0.00016	0.00013	<0.00010	<0.00010	0.00013	<0.00010	<0.00010	0.00012	0.00015	0.00012			0.00010	
Arsenic (As)-Total (mg/L)	0.00121	0.00049	0.00048	0.00049	0.00072	0.00042	0.00046	0.00072	0.00083	0.00046	0.00040			0.00057	
Barium (Ba)-Total (mg/L)	0.0414	0.0273	0.0303	0.0300	0.0310	0.0212	0.0289	0.0222	0.0241	0.0216	0.0197			0.0238	
Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100			<0.000100	
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050			<0.000050	
Boron (B)-Total (mg/L)	0.052	0.062	0.071	0.075	0.053	0.058	0.069	0.070	0.065	0.056	0.056			0.059	

	: Boundary Dump Seep 2									
	11-May-22	**26-Jul-22**	**21-Sep-22**	**19-Oct-22**	**30-Jan-23**	**27-Apr-23**	**23-May-23**	**3-Aug-23**	**13-Sep-23**	**1-Nov-23**
Diss-Silicon (Si) (mg/L)	4.98			6.38	6.73	4.87	5.49			
Diss-Silver (Ag) (mg/L)	<0.000010			<0.000010	<0.000010	<0.000010	<0.000010			
Diss-Sodium (Na) (mg/L)	5.86			5.12	5.27	7.55	4.01			
Diss-Strontium (Sr) (mg/L)	1.96			1.35	1.18	2.74	0.862			
Diss-Thallium (Tl) (mg/L)	<0.000010			<0.000010	<0.000010	<0.000010	<0.000010			
Diss-Tin (Sn) (mg/L)	<0.00010			<0.00010	<0.00010	<0.00010	<0.00010			
Diss-Titanium (Ti) (mg/L)	<0.0100			<0.0100	<0.0100	<0.0100	<0.0100			
Diss-Uranium (U) (mg/L)	0.000875			0.000749	0.000713	0.00133	0.000835			
Diss-Vanadium (V) (mg/L)	0.00055			<0.00050	0.00057	0.00092	<0.00050			
Diss-Zinc (Zn) (mg/L)	<0.0030			<0.0030	<0.0030	<0.0030	<0.0030			
TDS (mg/L)	717			692	597	920	541			
Field Tests										
Cond (in situ) (µs/cm)	843			831	947	1098	747			
NTU - in situ (ntu)	0.21				4.7	0.2	3.07			
pH (in situ) (pH)	7.48			8.97	7.08	7.28	7.35			
Q (m3/s)				0.01						
Sample Taken	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No
Temp (in situ) (Degrees Celcius)	3.886			4.8	0.699	4.045	3.02			
Organic / Inorganic										
DOC (mg/L)	6.65			5.10	5.83	8.11	4.78			
Physical Test										
Conductivity (µs/cm)	881			907	847	1120	724			
Hardness (mg/L)	442			411	446	603	316			
NTU (ntu)	0.13			0.38	1.33	0.24	0.31			
pH (pH)	8.06			8.30	8.33	8.16	8.15			
TDS (mg/L)	717			692	597	920	541			
TSS (mg/L)	<1.0			<1.0	3.2	<1.0	1.7			
Total Metals										
Aluminum (Al)-Total (mg/L)	0.0084			0.0756	0.0226	0.0130	0.0328			
Antimony (Sb)-Total (mg/L)	0.00019			0.00016	<0.00010	0.00024	0.00014			
Arsenic (As)-Total (mg/L)	0.00048			0.00054	0.00068	0.00050	0.00046			
Barium (Ba)-Total (mg/L)	0.0261			0.0290	0.0298	0.0324	0.0201			
Beryllium (Be)-Total (mg/L)	<0.000100			<0.000100	<0.000100	<0.000100	<0.000100			
Bismuth (Bi)-Total (mg/L)	<0.000050			<0.000050	<0.000050	<0.000050	<0.000050			
Boron (B)-Total (mg/L)	0.058			0.063	0.051	0.056	0.059			

Grid Format Report : Boundary Dump Seep 2

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Dump Seep 2														
	19-Feb-19	6-May-19	8-Aug-19	6-Nov-19	26-Feb-20	28-May-20	18-Aug-20	22-Oct-20	2-Mar-21	13-May-21	26-May-21	17-Aug-21	30-Sep-21	27-Oct-21	28-Mar-22
Cadmium (Cd)-Total (mg/L)	0.0000290	<0.000050	0.0000397	0.0000274	0.0000478	<0.0000300	0.0000344	<0.0000400	<0.0000400	<0.0000350	<0.0000250			0.0000633	
Calcium (Ca)-Total (mg/L)	240	163	135	151	191	105	142	118	165	119	88.6			122	
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050			<0.00050	
Cobalt (Co)-Total (mg/L)	0.00029	<0.00010	<0.00010	<0.00010	0.00016	<0.00010	<0.00010	<0.00010	0.00020	<0.00010	<0.00010			<0.00010	
Copper (Cu)-Total (mg/L)	0.00535	0.00826	0.00939	0.00726	0.0127	0.00839	0.0126	0.00917	0.0102	0.00894	0.00720			0.00904	
Iron (Fe)-Total (mg/L)	0.316	<0.030	<0.030	<0.030	0.069	<0.030	0.041	<0.030	0.106	<0.030	<0.030			0.065	
Lead (Pb)-Total (mg/L)	0.000278	<0.000050	<0.000050	<0.000050	0.000126	<0.000050	0.000095	<0.000050	0.000242	<0.000050	<0.000050			0.000054	
Lithium (Li)-Total (mg/L)	0.0020	0.0022	0.0018	0.0017	0.0017	0.0015	0.0016	0.0015	0.0018	0.0017	0.0012			0.0014	
Magnesium (Mg)-Total (mg/L)	35.8	27.3	17.0	15.5	26.4	12.4	15.0	13.8	21.8	17.2	9.64			13.3	
Manganese (Mn)-Total (mg/L)	0.370	0.00994	0.00583	0.00096	0.0402	0.00380	0.00640	0.00521	0.0493	0.00639	0.00230			0.0374	
Molybdenum (Mo)-Tota (mg/L)	0.0217	0.0437	0.0195	0.0174	0.0179	0.0219	0.0107	0.0193	0.0259	0.0344	0.0148			0.0204	
Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050			<0.00050	
Potassium (K)-Total (mg/L)	1.50	1.12	0.995	0.965	1.13	0.805	0.989	0.934	1.06	0.939	0.712			0.959	
Selenium (Se)-Total (mg/L)	0.00151	0.00677	0.00322	0.00408	0.00200	0.00278	0.00209	0.00275	0.00219	0.00512	0.00219			0.00265	
Silicon (Si)-Total (mg/L)	8.01	5.14	6.69	6.65	6.62	5.30	6.64	6.29	6.60	5.14	5.44			6.26	
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010			<0.000010	
Sodium (Na)-Total (mg/L)	7.68	6.12	5.04	4.86	6.86	3.93	4.70	4.56	6.04	5.16	3.54			4.59	
Strontium (Sr)-Total (mg/L)	2.79	2.03	1.11	0.970	1.68	0.886	0.794	0.790	1.68	1.34	0.555			0.822	
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010			<0.000010	
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00017	0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010			<0.00010	
Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100			<0.0100	
Uranium (U)-Total (mg/L)	0.000716	0.000914	0.000869	0.000736	0.000574	0.000595	0.000625	0.000722	0.000716	0.000660	0.000502			0.000596	
Vanadium (V)-Total (mg/L)	0.00145	0.00060	<0.00050	<0.00050	0.00063	0.00059	<0.00050	0.00073	0.00087	0.00055	<0.00050			0.00053	
Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030			<0.0030	

	: Boundary Dump Seep 2									
	11-May-22	26-Jul-22	21-Sep-22	19-Oct-22	30-Jan-23	27-Apr-23	23-May-23	3-Aug-23	13-Sep-23	1-Nov-23
Cadmium (Cd)-Total (mg/L)	<0.0000500			<0.0000600	0.0000291	<0.0000650	0.0000266			
Calcium (Ca)-Total (mg/L)	141			169	160	185	104			
Chromium (Cr)-Total (mg/L)	<0.00050			<0.00050	<0.00050	<0.00050	<0.00050			
Cobalt (Co)-Total (mg/L)	<0.00010			<0.00010	0.00022	0.00020	<0.00010			
Copper (Cu)-Total (mg/L)	0.00798			0.0126	0.00833	0.00798	0.0101			
Iron (Fe)-Total (mg/L)	<0.030			<0.030	0.576	0.045	0.042			
Lead (Pb)-Total (mg/L)	<0.000050			<0.000050	0.000091	0.000058	<0.000050			
Lithium (Li)-Total (mg/L)	0.0025			0.0025	0.0014	0.0032	0.0017			
Magnesium (Mg)-Total (mg/L)	25.9			23.6	19.5	32.2	12.9			
Manganese (Mn)-Total (mg/L)	0.0199			0.0156	0.556	0.0668	0.00383			
Molybdenum (Mo)-Tota (mg/L)	0.0593			0.0314	0.0182	0.0816	0.0254			
Nickel (Ni)-Total (mg/L)	<0.00050			<0.00050	<0.00050	<0.00050	<0.00050			
Potassium (K)-Total (mg/L)	1.16			0.993	1.05	1.29	0.803			
Selenium (Se)-Total (mg/L)	0.0110			0.00238	0.00133	0.0206	0.00453			
Silicon (Si)-Total (mg/L)	4.98			6.89	6.88	4.85	6.02			
Silver (Ag)-Total (mg/L)	<0.000010			<0.000010	<0.000010	<0.000010	<0.000010			
Sodium (Na)-Total (mg/L)	6.18			6.51	5.50	7.31	4.08			
Strontium (Sr)-Total (mg/L)	2.17			2.04	1.24	2.70	0.876			
Thallium (Tl)-Total (mg/L)	<0.000010			<0.000010	<0.000010	<0.000010	<0.000010			
Tin (Sn)-Total (mg/L)	<0.00010			<0.00010	0.00036	<0.00010	<0.00010			
Titanium (Ti)-Total (mg/L)	<0.0100			<0.0100	<0.0100	<0.0100	<0.0100			
Uranium (U)-Total (mg/L)	0.000850			0.000928	0.000686	0.00131	0.000729			
Vanadium (V)-Total (mg/L)	0.00066			0.00051	0.00081	0.00097	0.00060			
Zinc (Zn)-Total (mg/L)	<0.0030			<0.0030	<0.0030	<0.0030	<0.0030			

Grid Format Report : Boundary Dump Seep 2

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Dump Seep 2						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	17	17	115.00000	233.00000	171.52941	222.30000	36.18894
Ammonia (as N) (mg/L)	17	13	0.00250	0.24600	0.03089	0.33680	0.06028
Chloride (mg/L)	17	0	0.25000	1.25000	1.13235	2.50000	0.33211
Diss-Orthophosphate (mg/L)	17	17	0.00280	0.09080	0.02145	0.16165	0.01995
Diss-Phosphorus (mg/L)	17	17	0.00230	0.12100	0.02786	0.18030	0.02639
Floride (mg/L)	17	17	0.11300	0.31900	0.16076	0.29650	0.05196
Nitrate (N) (mg/L)	17	17	0.10500	1.99000	0.50024	1.51615	0.44969
Nitrate and Nitrite (mg/L)	17	17	0.10500	2.00000	0.50171	1.51720	0.45118
Nitrite (N) (mg/L)	17	2	0.00050	0.00830	0.00290	0.01359	0.00200
Sulphate (mg/L)	17	17	136.00000	534.00000	311.58824	653.05000	109.17592
Total Nitrogen (mg/L)	16	16	0.37600	2.17000	0.75831	2.13850	0.47146
Total Phosphorus (mg/L)	17	17	0.00280	0.26100	0.05153	0.30930	0.06309
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	17	7	0.00150	0.01050	0.00310	0.00779	0.00248
Diss-Antimony (Sb) (mg/L)	17	10	0.00005	0.00023	0.00010	0.00021	0.00005
Diss-Arsenic (As) (mg/L)	17	17	0.00035	0.00122	0.00054	0.00184	0.00021
Diss-Barium (Ba) (mg/L)	17	17	0.01860	0.04420	0.02657	0.05176	0.00644
Diss-Beryllium (Be) (mg/L)	17	0	0.00005	0.00050	0.00016	0.00005	0.00020
Diss-Bismuth (Bi) (mg/L)	17	0	0.00003	0.00003	0.00003	0.00025	0.00000
Diss-Boron (B) (mg/L)	17	17	0.04800	0.07600	0.05865	0.06600	0.00659
Diss-Cadmium (Cd) (mg/L)	17	8	0.00001	0.00004	0.00003	0.00007	0.00001
Diss-Calcium (Ca) (mg/L)	17	17	94.80000	241.00000	144.63529	263.00000	37.59303
Diss-Chromium (Cr) (mg/L)	17	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	17	5	0.00005	0.00032	0.00009	0.00105	0.00008
Diss-Copper (Cu) (mg/L)	17	17	0.00322	0.00864	0.00675	0.00892	0.00141
Diss-Iron (Fe) (mg/L)	17	4	0.01500	0.46100	0.06118	0.29905	0.12396
Diss-Lead (Pb) (mg/L)	17	2	0.00003	0.00017	0.00004	0.00016	0.00004
Diss-Lithium (Li) (mg/L)	17	17	0.00130	0.00320	0.00184	0.00273	0.00046
Diss-Magnesium (Mg) (mg/L)	17	17	11.60000	36.50000	19.45882	40.29000	7.29786
Diss-Manganese (Mn) (mg/L)	17	17	0.00062	0.50300	0.06895	0.43525	0.14704
Diss-Molybdenum (Mo) (mg/L)	17	17	0.00979	0.08090	0.02773	0.05416	0.01715
Diss-Nickel (Ni) (mg/L)	17	1	0.00025	0.00050	0.00026	0.00025	0.00006
Diss-Potassium (K) (mg/L)	17	17	0.77400	1.62000	1.02829	1.84600	0.21721

Grid Format Report : Boundary Dump Seep 2

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Dump Seep 2						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Selenium (mg/L)	17	17	0.00144	0.02070	0.00481	0.00955	0.00470
Diss-Silicon (Si) (mg/L)	17	17	4.86000	7.28000	5.88882	7.12000	0.72517
Diss-Silver (Ag) (mg/L)	17	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	17	17	3.83000	7.95000	5.30118	8.73050	1.21347
Diss-Strontium (Sr) (mg/L)	17	17	0.64900	2.82000	1.41747	3.33350	0.66862
Diss-Thallium (Tl) (mg/L)	17	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	17	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	17	0	0.00500	0.00500	0.00500	0.01900	0.00000
Diss-Uranium (U) (mg/L)	17	17	0.00055	0.00133	0.00076	0.00130	0.00018
Diss-Vanadium (V) (mg/L)	17	7	0.00025	0.00138	0.00045	0.00094	0.00031
Diss-Zinc (Zn) (mg/L)	17	1	0.00150	0.00580	0.00175	0.00350	0.00104
TDS (mg/L)	17	17	372.00000	1,050.00000	647.64706	1,116.50000	165.77581
Field Tests							
Cond (in situ) (µs/cm)	17	17	578.00000	1,302.04000	877.22588	1,433.70000	172.82143
NTU - in situ (ntu)	12	12	0.05000	4.70000	1.33167	4.21000	1.40471
pH (in situ) (pH)	17	17	7.04000	8.97000	7.47588	8.11030	0.51978
Q (m3/s)	2	2	0.00050	0.01000	0.00525		0.00672
Sample Taken							
Temp (in situ) (Degrees Celcius)	17	17	0.21600	8.85800	3.42071	6.18000	2.11178
Organic / Inorganic							
DOC (mg/L)	17	17	4.21000	8.11000	5.36471	8.17650	1.09009
Physical Test							
Conductivity (µs/cm)	17	17	542.00000	1,270.00000	853.17647	1,353.00000	181.21439
Hardness (mg/L)	17	17	285.00000	752.00000	441.17647	806.55000	121.59782
NTU (ntu)	17	15	0.05000	1.49000	0.54059	30.47500	0.53005
pH (pH)	17	17	7.65000	8.33000	8.06765	8.21000	0.16939
TDS (mg/L)	17	17	372.00000	1,050.00000	647.64706	1,116.50000	165.77581
TSS (mg/L)	17	11	0.50000	17.20000	2.51176	26.79500	3.98574
Total Metals							
Aluminum (Al)-Total (mg/L)	17	17	0.00460	0.07560	0.01529	0.04780	0.01767
Antimony (Sb)-Total (mg/L)	17	12	0.00005	0.00024	0.00012	0.00027	0.00006
Arsenic (As)-Total (mg/L)	17	17	0.00040	0.00121	0.00058	0.00263	0.00020
Barium (Ba)-Total (mg/L)	17	17	0.01970	0.04140	0.02699	0.05426	0.00556
Beryllium (Be)-Total (mg/L)	17	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	17	0	0.00003	0.00003	0.00003	0.00025	0.00000

Grid Format Report : Boundary Dump Seep 2

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Dump Seep 2						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Boron (B)-Total (mg/L)	17	17	0.05100	0.07500	0.06076	0.06725	0.00710
Cadmium (Cd)-Total (mg/L)	17	8	0.00001	0.00006	0.00003	0.00011	0.00001
Calcium (Ca)-Total (mg/L)	17	17	88.60000	240.00000	146.97647	264.25000	37.71319
Chromium (Cr)-Total (mg/L)	17	0	0.00025	0.00025	0.00025	0.00025	0.00000
Cobalt (Co)-Total (mg/L)	17	5	0.00005	0.00029	0.00010	0.00141	0.00008
Copper (Cu)-Total (mg/L)	17	17	0.00535	0.01270	0.00915	0.03653	0.00202
Iron (Fe)-Total (mg/L)	17	8	0.01500	0.57600	0.08206	1.16935	0.14682
Lead (Pb)-Total (mg/L)	17	7	0.00003	0.00028	0.00007	0.00077	0.00008
Lithium (Li)-Total (mg/L)	17	17	0.00120	0.00320	0.00185	0.00281	0.00050
Magnesium (Mg)-Total (mg/L)	17	17	9.64000	35.80000	19.95529	39.98500	7.52029
Manganese (Mn)-Total (mg/L)	17	17	0.00096	0.55600	0.07058	0.53000	0.15252
Molybdenum (Mo)-Tota (mg/L)	17	17	0.01070	0.08160	0.02844	0.05334	0.01807
Nickel (Ni)-Total (mg/L)	17	0	0.00025	0.00025	0.00025	0.00055	0.00000
Potassium (K)-Total (mg/L)	17	17	0.71200	1.50000	1.02376	1.93300	0.18682
Selenium (Se)-Total (mg/L)	17	17	0.00133	0.02060	0.00454	0.00972	0.00477
Silicon (Si)-Total (mg/L)	17	17	4.85000	8.01000	6.14118	7.60300	0.87028
Silver (Ag)-Total (mg/L)	17	0	0.00001	0.00001	0.00001	0.00002	0.00000
Sodium (Na)-Total (mg/L)	17	17	3.54000	7.68000	5.45059	8.49850	1.20951
Strontium (Sr)-Total (mg/L)	17	17	0.55500	2.79000	1.43959	3.20450	0.69714
Thallium (Tl)-Total (mg/L)	17	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	17	3	0.00005	0.00036	0.00008	0.00005	0.00008
Titanium (Ti)-Total (mg/L)	17	0	0.00500	0.00500	0.00500	0.02000	0.00000
Uranium (U)-Total (mg/L)	17	17	0.00050	0.00131	0.00075	0.00133	0.00019
Vanadium (V)-Total (mg/L)	17	13	0.00025	0.00145	0.00062	0.00176	0.00031
Zinc (Zn)-Total (mg/L)	17	0	0.00150	0.00150	0.00150	0.00477	0.00000

Grid Format Report : Boundary Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Pit									
	1-May-19	21-Nov-19	30-Apr-20	29-Oct-20	13-May-21	14-Oct-21	11-May-22	13-Jul-22	13-Jun-23	24-Oct-23
Anions and Nutrients										
Alkalinity (CaCO3) (mg/L)	107	251	24.9	79.2	153	114	134	122	132	116
Ammonia (as N) (mg/L)	<0.0050	0.0082	0.0144	0.0094	0.0101	0.0078	0.0207	0.0087	0.0064	0.0059
Chloride (mg/L)	1.11	<0.50	<0.50	0.52	0.50	<0.50	<0.50	<0.50	<0.50	1.36
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	0.0041	<0.0010	0.0021	0.0031	<0.0010	<0.0010	<0.0010	<0.0010
Diss-Phosphorus (mg/L)	0.0023	0.0024	0.0050	<0.0020	0.0046	0.0037	0.0036	0.0162	0.0051	<0.0020
Floride (mg/L)	0.713	0.329	0.150	0.554	0.633	0.706	0.580	0.562	0.688	0.816
Nitrate (N) (mg/L)	0.815	0.0138	0.0310	0.105	0.248	0.0781	0.324	<0.0050	0.0478	0.112
Nitrate and Nitrite (mg/L)	0.819	0.0138	<0.0500	0.106	0.250	0.0781	0.327	<0.0051	0.0478	0.112
Nitrite (N) (mg/L)	0.0040	<0.0010	0.0010	0.0013	0.0017	<0.0010	0.0030	<0.0010	<0.0010	<0.0010
Sulphate (mg/L)	182	133	7.14	96.9	112	146	109	99.3	130	164
Total Nitrogen (mg/L)	0.949	0.240	0.110	0.320	0.548	0.273	0.511	0.688	0.298	0.350
Total Phosphorus (mg/L)	0.0042	0.0505	0.0150	0.0072	0.0074	0.0036	0.0074	0.0647	0.0054	0.0056
Dissolved Metals										
Aluminum (Al)-Diss (mg/L)	<0.0030	0.0059	0.0062	0.0036	0.0034	<0.0030	0.0058	0.0111	0.0051	<0.0030
Diss-Antimony (Sb) (mg/L)	0.00103	0.00011	0.00010	0.00068	0.00063	0.00098	0.00052	0.00074	0.00068	0.00086
Diss-Arsenic (As) (mg/L)	0.00057	0.00039	0.00018	0.00043	0.00074	0.00075	0.00061	0.00092	0.00091	0.00081
Diss-Barium (Ba) (mg/L)	0.0323	0.0832	0.00572	0.0201	0.0353	0.0285	0.0338	0.0350	0.0368	0.0321
Diss-Beryllium (Be) (mg/L)	<0.00010	<0.00010	<0.00100	<0.00100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Boron (B) (mg/L)	0.027	0.013	<0.010	0.019	0.031	0.031	0.024	0.032	0.031	0.034
Diss-Cadmium (Cd) (mg/L)	0.000104	0.0000398	0.0000171	<0.0000650	<0.000110	<0.000110	0.000110	<0.0000550	<0.0000550	<0.000105
Diss-Calcium (Ca) (mg/L)	91.9	129	9.41	56.0	81.4	81.8	75.6	70.8	84.1	91.5
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00027	<0.00010	0.00027	<0.00010	<0.00010	<0.00010
Diss-Copper (Cu) (mg/L)	0.0218	0.00615	0.00228	0.0231	0.0325	0.0390	0.0346	0.0319	0.0229	0.0373
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	0.0085	0.0016	<0.0010	0.0065	0.0077	0.0090	0.0068	0.0081	0.0088	0.0098
Diss-Magnesium (Mg) (mg/L)	9.42	15.0	0.511	5.41	8.04	8.04	6.98	8.43	8.11	9.34
Diss-Manganese (Mn) (mg/L)	0.0249	0.00118	0.00262	0.0111	0.107	0.0157	0.103	0.0160	0.0139	0.0143
Diss-Molybdenum (Mo) (mg/L)	0.134	0.00415	0.0144	0.0824	0.0885	0.126	0.0773	0.0802	0.0862	0.113
Diss-Nickel (Ni) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Potassium (K) (mg/L)	1.32	1.71	0.436	1.26	1.34	1.34	1.20	1.78	1.44	1.44
Diss-Selenium (mg/L)	0.0276	0.00129	0.000814	0.0121	0.0181	0.0171	0.0140	0.0124	0.0124	0.0150

Grid Format Report : Boundary Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Pit									
	1-May-19	21-Nov-19	30-Apr-20	29-Oct-20	13-May-21	14-Oct-21	11-May-22	13-Jul-22	13-Jun-23	24-Oct-23
Diss-Silicon (Si) (mg/L)	3.89	7.13	0.362	2.33	3.64	3.10	3.88	2.65	4.51	4.50
Diss-Silver (Ag) (mg/L)	0.000014	<0.000010	<0.000010	<0.000010	0.000016	0.000013	0.000022	0.000050	<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	5.81	4.77	0.324	3.62	4.86	5.48	4.20	4.94	4.86	5.46
Diss-Strontium (Sr) (mg/L)	2.80	1.03	0.129	1.80	2.31	2.74	2.13	2.42	2.72	3.16
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	0.00487	0.000659	0.000138	0.00293	0.00352	0.00405	0.00301	0.00273	0.00337	0.00380
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0212	<0.0030	<0.0030
TDS (mg/L)	394	452	37	240	308	345	307	272	366	392
Field Tests										
Cond (in situ) (µs/cm)	537.9	689.6	68.1	343	231		454.3	392	5.22	536
NTU - in situ (ntu)	0.39	6.26	1.85	3.08	1.57	0.47	1.37	1.26	0.93	0.33
pH (in situ) (pH)	7.69	7.33	7.98	7.75	7.83	7.79	7.88	7.92	8.09	7.76
Sample Taken	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Temp (in situ) (Degrees Celcius)	8.603	1.044	4.508	0.951	14.688	8.9	8.701	27	18.3	5.785
Organic / Inorganic										
DOC (mg/L)	3.17	4.92	1.54	2.98	4.30	3.72	4.73	10.5	4.39	3.24
Physical Test										
Conductivity (µs/cm)	571	671	64.9	358	488	522	465	430	519	535
Hardness (mg/L)	268	383	25.6	162	236	237	218	212	243	267
NTU (ntu)	0.34	8.84	1.53	1.01	0.75	0.29	0.78	1.52	0.59	0.91
pH (pH)	8.16	8.05	7.48	8.00	8.28	8.17	8.31	8.36	8.22	7.94
TDS (mg/L)	394	452	37	240	308	345	307	272	366	392
TSS (mg/L)	<1.0	27.5	1.5	2.4	2.4	2.8	1.3	11.1	<1.0	1.5
Total Metals										
Aluminum (Al)-Total (mg/L)	0.0219	0.671	0.0885	0.0456	0.0351	0.0037	0.0320	0.0316	0.0279	0.0300
Antimony (Sb)-Total (mg/L)	0.00104	0.00014	0.00010	0.00071	0.00071	0.00112	0.00060	0.00072	0.00065	0.00087
Arsenic (As)-Total (mg/L)	0.00056	0.00092	0.00023	0.00072	0.00091	0.00085	0.00090	0.00096	0.00098	0.00086
Barium (Ba)-Total (mg/L)	0.0328	0.0837	0.00723	0.0223	0.0372	0.0310	0.0354	0.0363	0.0400	0.0322
Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total (mg/L)	0.032	0.016	<0.010	0.020	0.032	0.033	0.029	0.032	0.034	0.035
Cadmium (Cd)-Total (mg/L)	<0.00015	0.0000769	0.0000243	<0.0000900	<0.000125	<0.000160	0.000110	<0.0000700	<0.0000500	<0.000105

Grid Format Report : Boundary Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Pit									
	1-May-19	21-Nov-19	30-Apr-20	29-Oct-20	13-May-21	14-Oct-21	11-May-22	13-Jul-22	13-Jun-23	24-Oct-23
Calcium (Ca)-Total (mg/L)	99.5	118	9.44	58.6	87.7	81.8	76.6	72.4	83.2	92.8
Chromium (Cr)-Total (mg/L)	<0.00050	0.00092	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)	0.00011	0.00064	<0.00010	<0.00010	0.00035	0.00011	0.00032	0.00013	<0.00010	0.00013
Copper (Cu)-Total (mg/L)	0.0238	0.0223	0.00631	0.0273	0.0470	0.0442	0.0492	0.0356	0.0283	0.0430
Iron (Fe)-Total (mg/L)	<0.030	0.831	0.082	0.104	0.070	<0.030	0.057	0.047	0.034	0.036
Lead (Pb)-Total (mg/L)	<0.000050	0.000823	0.000120	0.000140	0.000211	0.000089	0.000161	0.000056	0.000060	0.000100
Lithium (Li)-Total (mg/L)	0.0092	0.0022	<0.0010	0.0060	0.0079	0.0096	0.0074	0.0083	0.0090	0.0103
Magnesium (Mg)-Total (mg/L)	8.26	14.7	0.525	5.65	8.16	8.68	7.21	7.84	8.61	9.13
Manganese (Mn)-Total (mg/L)	0.0248	0.0747	0.0133	0.0134	0.110	0.0185	0.111	0.0391	0.0270	0.0248
Molybdenum (Mo)-Tota (mg/L)	0.138	0.00406	0.0131	0.0928	0.0931	0.121	0.0816	0.0796	0.0843	0.108
Nickel (Ni)-Total (mg/L)	<0.00050	0.00102	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Potassium (K)-Total (mg/L)	1.27	1.53	0.337	1.07	1.32	1.52	1.15	1.87	1.59	1.37
Selenium (Se)-Total (mg/L)	0.0267	0.00132	0.000873	0.0125	0.0182	0.0167	0.0135	0.0114	0.0125	0.0165
Silicon (Si)-Total (mg/L)	3.77	8.23	0.50	2.39	3.84	3.25	3.87	2.32	4.80	4.87
Silver (Ag)-Total (mg/L)	0.000019	0.000025	<0.000010	0.000017	0.000035	0.000021	0.000046	0.000038	0.000014	0.000017
Sodium (Na)-Total (mg/L)	5.64	4.53	0.259	3.82	5.14	6.08	4.35	4.60	5.42	5.48
Strontium (Sr)-Total (mg/L)	2.91	0.924	0.121	1.93	2.54	2.78	2.21	2.40	2.57	2.99
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00038	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total (mg/L)	<0.010	0.023	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Uranium (U)-Total (mg/L)	0.00482	0.000655	0.000183	0.00294	0.00369	0.00485	0.00293	0.00281	0.00319	0.00398
Vanadium (V)-Total (mg/L)	<0.00050	0.00289	<0.00050	<0.00050	0.00052	<0.00050	<0.00050	0.00054	0.00050	0.00053
Zinc (Zn)-Total (mg/L)	<0.0030	0.0057	<0.0030	0.0060	<0.0030	<0.0030	<0.0030	0.0081	<0.0030	<0.0030

Grid Format Report : Boundary Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Pit						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	10	10	24.90000	251.00000	123.31000	107.60000	57.16845
Ammonia (as N) (mg/L)	10	9	0.00250	0.02070	0.00941	0.17920	0.00502
Chloride (mg/L)	10	4	0.25000	1.36000	0.49900	2.13800	0.40649
Diss-Orthophosphate (mg/L)	10	3	0.00050	0.00410	0.00128	0.00113	0.00134
Diss-Phosphorus (mg/L)	10	8	0.00100	0.01620	0.00449	0.00289	0.00438
Floride (mg/L)	10	10	0.15000	0.81600	0.57310	0.89500	0.19781
Nitrate (N) (mg/L)	10	9	0.00250	0.81500	0.17772	26.12000	0.24675
Nitrate and Nitrite (mg/L)	10	8	0.00255	0.81900	0.17813	26.35000	0.24853
Nitrite (N) (mg/L)	10	5	0.00050	0.00400	0.00135	0.21490	0.00123
Sulphate (mg/L)	10	10	7.14000	182.00000	117.93400	250.00000	47.80376
Total Nitrogen (mg/L)	10	10	0.11000	0.94900	0.42870	28.69000	0.24843
Total Phosphorus (mg/L)	10	10	0.00360	0.06470	0.01710	0.00849	0.02183
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	10	7	0.00150	0.01110	0.00456	0.01317	0.00297
Diss-Antimony (Sb) (mg/L)	10	10	0.00010	0.00103	0.00063	0.00198	0.00032
Diss-Arsenic (As) (mg/L)	10	10	0.00018	0.00092	0.00063	0.00086	0.00024
Diss-Barium (Ba) (mg/L)	10	10	0.00572	0.08320	0.03428	0.07266	0.01961
Diss-Beryllium (Be) (mg/L)	10	0	0.00005	0.00050	0.00014	0.00005	0.00019
Diss-Bismuth (Bi) (mg/L)	10	0	0.00003	0.00003	0.00003	0.00025	0.00000
Diss-Boron (B) (mg/L)	10	9	0.00500	0.03400	0.02470	0.04330	0.00956
Diss-Cadmium (Cd) (mg/L)	10	4	0.00002	0.00011	0.00005	0.00020	0.00003
Diss-Calcium (Ca) (mg/L)	10	10	9.41000	129.00000	77.15100	136.90000	30.32903
Diss-Chromium (Cr) (mg/L)	10	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	10	2	0.00005	0.00027	0.00009	0.00036	0.00009
Diss-Copper (Cu) (mg/L)	10	10	0.00228	0.03900	0.02515	0.02690	0.01262
Diss-Iron (Fe) (mg/L)	10	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	10	0	0.00003	0.00003	0.00003	0.00003	0.00000
Diss-Lithium (Li) (mg/L)	10	9	0.00050	0.00980	0.00673	0.01163	0.00316
Diss-Magnesium (Mg) (mg/L)	10	10	0.51100	15.00000	7.92810	11.71000	3.60238
Diss-Manganese (Mn) (mg/L)	10	10	0.00118	0.10700	0.03097	0.09133	0.03961
Diss-Molybdenum (Mo) (mg/L)	10	10	0.00415	0.13400	0.08062	0.20270	0.04255
Diss-Nickel (Ni) (mg/L)	10	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Potassium (K) (mg/L)	10	10	0.43600	1.78000	1.32660	2.87500	0.36398

Grid Format Report : Boundary Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Pit						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Selenium (mg/L)	10	10	0.00081	0.02760	0.01308	0.05567	0.00780
Diss-Silicon (Si) (mg/L)	10	10	0.36200	7.13000	3.59920	4.18600	1.74843
Diss-Silver (Ag) (mg/L)	10	5	0.00001	0.00005	0.00001	0.00001	0.00001
Diss-Sodium (Na) (mg/L)	10	10	0.32400	5.81000	4.43240	7.68900	1.57697
Diss-Strontium (Sr) (mg/L)	10	10	0.12900	3.16000	2.12390	3.96300	0.92310
Diss-Thallium (Tl) (mg/L)	10	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	10	0	0.00005	0.00005	0.00005	0.00009	0.00000
Diss-Titanium (Ti) (mg/L)	10	0	0.00500	0.00500	0.00500	0.01630	0.00000
Diss-Uranium (U) (mg/L)	10	10	0.00014	0.00487	0.00291	0.00786	0.00146
Diss-Vanadium (V) (mg/L)	10	0	0.00025	0.00025	0.00025	0.00050	0.00000
Diss-Zinc (Zn) (mg/L)	10	1	0.00150	0.02120	0.00347	0.00150	0.00623
TDS (mg/L)	10	10	37.00000	452.00000	311.30000	647.20000	115.07201
Field Tests							
Cond (in situ) (µs/cm)	9	9	5.22000	689.60000	361.90222	748.80000	226.14955
NTU - in situ (ntu)	10	10	0.33000	6.26000	1.75100	5.45000	1.78614
pH (in situ) (pH)	10	10	7.33000	8.09000	7.80200	8.30360	0.20422
Sample Taken							
Temp (in situ) (Degrees Celcius)	10	10	0.95100	27.00000	9.84800	18.12000	8.12751
Organic / Inorganic							
DOC (mg/L)	10	10	1.54000	10.50000	4.34900	5.97100	2.38258
Physical Test							
Conductivity (µs/cm)	10	10	64.90000	671.00000	462.39000	777.90000	162.60104
Hardness (mg/L)	10	10	25.60000	383.00000	225.16000	390.00000	90.13145
NTU (ntu)	10	10	0.29000	8.84000	1.65600	4.59400	2.55909
pH (pH)	10	10	7.48000	8.36000	8.09700	8.18800	0.25591
TDS (mg/L)	10	10	37.00000	452.00000	311.30000	647.20000	115.07201
TSS (mg/L)	10	8	0.50000	27.50000	5.15000	2.97000	8.43462
Total Metals							
Aluminum (Al)-Total (mg/L)	10	10	0.00370	0.67100	0.09873	0.25650	0.20224
Antimony (Sb)-Total (mg/L)	10	10	0.00010	0.00112	0.00067	0.00193	0.00033
Arsenic (As)-Total (mg/L)	10	10	0.00023	0.00098	0.00079	0.00094	0.00023
Barium (Ba)-Total (mg/L)	10	10	0.00723	0.08370	0.03581	0.07263	0.01932
Beryllium (Be)-Total (mg/L)	10	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	10	0	0.00003	0.00003	0.00003	0.00025	0.00000
Boron (B)-Total (mg/L)	10	9	0.00500	0.03500	0.02680	0.04760	0.00990

Grid Format Report : Boundary Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: Boundary Pit						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Cadmium (Cd)-Total (mg/L)	10	3	0.00002	0.00011	0.00006	0.00019	0.00003
Calcium (Ca)-Total (mg/L)	10	10	9.44000	118.00000	78.00400	136.90000	28.91945
Chromium (Cr)-Total (mg/L)	10	1	0.00025	0.00092	0.00032	0.00025	0.00021
Cobalt (Co)-Total (mg/L)	10	7	0.00005	0.00064	0.00019	0.00064	0.00019
Copper (Cu)-Total (mg/L)	10	10	0.00631	0.04920	0.03270	0.03916	0.01356
Iron (Fe)-Total (mg/L)	10	8	0.01500	0.83100	0.12910	0.25750	0.24826
Lead (Pb)-Total (mg/L)	10	9	0.00003	0.00082	0.00018	0.00028	0.00023
Lithium (Li)-Total (mg/L)	10	9	0.00050	0.01030	0.00704	0.01098	0.00326
Magnesium (Mg)-Total (mg/L)	10	10	0.52500	14.70000	7.87650	11.95000	3.47994
Manganese (Mn)-Total (mg/L)	10	10	0.01330	0.11100	0.04566	0.10471	0.03850
Molybdenum (Mo)-Tota (mg/L)	10	10	0.00406	0.13800	0.08156	0.20290	0.04269
Nickel (Ni)-Total (mg/L)	10	1	0.00025	0.00102	0.00033	0.00025	0.00024
Potassium (K)-Total (mg/L)	10	10	0.33700	1.87000	1.30270	2.90000	0.41085
Selenium (Se)-Total (mg/L)	10	10	0.00087	0.02670	0.01302	0.05764	0.00766
Silicon (Si)-Total (mg/L)	10	10	0.50000	8.23000	3.78400	4.34200	2.03157
Silver (Ag)-Total (mg/L)	10	9	0.00001	0.00005	0.00002	0.00005	0.00001
Sodium (Na)-Total (mg/L)	10	10	0.25900	6.08000	4.53190	7.68300	1.64938
Strontium (Sr)-Total (mg/L)	10	10	0.12100	2.99000	2.13750	4.04900	0.92745
Thallium (Tl)-Total (mg/L)	10	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	10	1	0.00005	0.00038	0.00008	0.00005	0.00010
Titanium (Ti)-Total (mg/L)	10	1	0.00500	0.02300	0.00680	0.01960	0.00569
Uranium (U)-Total (mg/L)	10	10	0.00018	0.00485	0.00300	0.00759	0.00155
Vanadium (V)-Total (mg/L)	10	5	0.00025	0.00289	0.00062	0.00155	0.00081
Zinc (Zn)-Total (mg/L)	10	3	0.00150	0.00810	0.00303	0.00349	0.00254

Grid Format Report : E10 - Effluent from Wight Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E10														
	2-Jan-19	14-Feb-19	6-Mar-19	7-Mar-19	4-Apr-19	9-May-19	1-Aug-19	9-Sep-19	3-Oct-19	19-Nov-19	25-Nov-19	19-Feb-20	16-Apr-20	20-Apr-20	27-May-20
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	144	139		134	134	134	150	154	162		156	157		151	153
Ammonia (as N) (mg/L)	<0.0050	<0.0050		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050		<0.0050	<0.0050
Chloride (mg/L)	<2.5	1.61		<2.5	<5.0	<2.5	<2.5	<2.5	<2.5		<2.5	<2.50		<2.50	<5.00
Diss-Orthophosphate (mg/L)	0.0035	0.0036		<0.0010	0.0045	0.0015	0.0032	0.0033	0.0032		0.0031	0.0047		0.0045	0.0042
Diss-Phosphorus (mg/L)	0.0036	0.0040		0.0042	0.0052	0.0060	0.0068	0.0044	0.0032		0.0055	0.0047		0.0044	0.0042
Floride (mg/L)	0.91	0.949		0.89	0.91	0.91	0.82	0.89	0.87		0.83	0.822		0.891	0.734
Nitrate (N) (mg/L)	0.538	0.372		0.180	0.096	0.363	0.496	0.481	0.210		0.173	0.330		0.0950	0.775
Nitrate and Nitrite (mg/L)	0.538	0.372		0.180	0.096	0.363	0.503	0.481	0.210		0.173	0.33		0.0950	0.782
Nitrite (N) (mg/L)	<0.0050	<0.0010		<0.0050	<0.010	<0.0050	0.0072	<0.0050	<0.0050		<0.0050	<0.0050		<0.0050	<0.0100
Sulphate (mg/L)	728	712		698	707	723	618	556	592		562	563		560	981
TKN (mg/L)															
Total Nitrogen (mg/L)	0.550	0.377		0.209	0.12	0.385	0.602	0.520	0.254		0.196	0.356		0.125	0.832
Total Phosphorus (mg/L)	0.0076	0.0096		0.0082	0.0065	0.0059	0.0069	0.0051	0.0051		0.0132	0.0107		0.0058	0.0055
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	<0.0030	<0.0030		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		<0.0030	<0.0030		<0.0030	<0.0030
Diss-Antimony (Sb) (mg/L)	0.00064	0.00060		0.00065	0.00069	0.00064	0.00065	0.00059	0.00070		0.00065	0.00061		0.00058	0.00059
Diss-Arsenic (As) (mg/L)	0.00059	0.00069		0.00054	0.00054	0.00057	0.00067	0.00060	0.00060		0.00063	0.00055		0.00056	0.00049
Diss-Barium (Ba) (mg/L)	0.0213	0.0218		0.0243	0.0286	0.0240	0.0256	0.0227	0.0269		0.0244	0.0234		0.0237	0.0345
Diss-Beryllium (Be) (mg/L)	<0.00010	<0.00010		<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00100		<0.00100	<0.00100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050		<0.000050	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050		<0.000050	<0.000050
Diss-Boron (B) (mg/L)	0.360	0.388		0.371	0.349	0.340	0.350	0.304	0.362		0.344	0.320		0.313	0.318
Diss-Cadmium (Cd) (mg/L)	0.000283	0.000282		0.000426	0.000455	0.000453	0.000531	0.000547	0.000510		0.000416	0.000342		0.000266	0.000733
Diss-Calcium (Ca) (mg/L)	299	272		278	291	255	258	219	271		227	214		222	410
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050		<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	0.00013	0.00011		0.00026	0.00042	0.00033	0.00076	0.00025	0.00074		0.00063	0.00075		0.00032	0.00141
Diss-Copper (Cu) (mg/L)	0.0126	0.0107		0.0148	0.0181	0.0163	0.0192	0.0187	0.0210		0.0182	0.0168		0.0127	0.0255
Diss-Iron (Fe) (mg/L)	<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030		<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050		<0.000050	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050		<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	0.0098	0.0091		0.0085	0.0086	0.0076	0.0086	0.0080	0.0091		0.0086	0.0074		0.0073	0.0117
Diss-Magnesium (Mg) (mg/L)	30.9	29.2		29.5	30.8	27.8	28.9	28.1	28.1		25.0	24.0		23.5	47.5
Diss-Manganese (Mn) (mg/L)	0.0377	0.0333		0.108	0.167	0.152	0.257	0.201	0.282		0.230	0.211		0.102	0.404
Diss-Molybdenum (Mo) (mg/L)	0.150	0.144		0.128	0.132	0.129	0.141	0.129	0.150		0.137	0.131		0.132	0.110
Diss-Nickel (Ni) (mg/L)	0.00059	0.00056		0.00072	<0.0010	0.00075	0.00094	0.00098	0.00090		0.00081	0.00064		0.00051	0.00177
Diss-Potassium (K) (mg/L)	1.39	1.46		1.59	1.61	1.44	1.51	1.37	1.59		1.46	1.40		1.33	1.88

	: E10														
	31-Aug-20	11-Nov-20	24-Nov-20	8-Dec-20	21-Dec-20	4-Jan-21	5-Jan-21	12-Jan-21	27-Jan-21	23-Feb-21	9-Mar-21	22-Mar-21	7-Apr-21	8-Apr-21	13-Apr-21
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	134	136	146	138	146				150	147		147			151
Ammonia (as N) (mg/L)	<0.0050	0.0230	<0.0050	<0.0050	<0.0050				<0.0050	<0.0050		<0.0050			<0.0050
Chloride (mg/L)	<2.50	<2.50	<2.50	<5.00	<2.50				<2.50	<2.50		<2.50			<2.50
Diss-Orthophosphate (mg/L)	0.0045	0.0030	0.0039	0.0044	0.0026				0.0052	0.0049		0.0043			0.0049
Diss-Phosphorus (mg/L)	0.0045	0.0034	0.0043	0.0021	0.0035				0.0064	0.0045		0.0053			0.0050
Floride (mg/L)	0.838	0.767	0.807	0.841	0.837				0.869	0.840		0.875			0.865
Nitrate (N) (mg/L)	0.311	0.359	0.434	0.394	0.269				0.0874	0.0301		<0.0250			<0.0250
Nitrate and Nitrite (mg/L)	0.319	0.373	0.435	0.396	0.274				0.0936	0.0301		<0.0255			<0.0255
Nitrite (N) (mg/L)	0.0077	0.0138	<0.0050	<0.0100	0.0051				0.0062	<0.0050		<0.0050			<0.0050
Sulphate (mg/L)	663	610	726	760	719				668	624		611			574
TKN (mg/L)															
Total Nitrogen (mg/L)	0.346	0.421	0.436	0.409	0.331				0.118	0.059		0.044			0.060
Total Phosphorus (mg/L)	0.0059	0.0052	0.0148	0.0051	0.0051				0.0061	0.0054		0.0064			0.0056
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030				<0.0030	<0.0030		<0.0060			<0.0060
Diss-Antimony (Sb) (mg/L)	0.00054	0.00055	0.00053	0.00053	0.00057				0.00053	0.00054		0.00052			0.00056
Diss-Arsenic (As) (mg/L)	0.00055	0.00066	0.00052	0.00049	0.00056				0.00052	0.00057		0.00045			0.00055
Diss-Barium (Ba) (mg/L)	0.0238	0.0272	0.0268	0.0256	0.0257				0.0224	0.0232		0.0234			0.0233
Diss-Beryllium (Be) (mg/L)	<0.00100	<0.00100	<0.00100	<0.000100	<0.000100				<0.000100	<0.000100		<0.000200			<0.000200
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050				<0.000050	<0.000050		<0.000100			<0.000100
Diss-Boron (B) (mg/L)	0.261	0.239	0.281	0.291	0.296				0.310	0.326		0.346			0.315
Diss-Cadmium (Cd) (mg/L)	0.000347	0.000345	<0.000455	<0.000385	0.000521				0.000377	0.000356		0.000296			0.000277
Diss-Calcium (Ca) (mg/L)	274	235	271	275	307				278	248		257			220
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050				<0.00050	<0.00050		<0.00100			<0.00100
Diss-Cobalt (Co) (mg/L)	0.00075	0.00049	0.00064	0.00088	0.00111				0.00091	0.00073		0.00069			0.00068
Diss-Copper (Cu) (mg/L)	0.0158	0.0137	0.0203	0.0158	0.0181				0.0160	0.0156		0.0160			0.0152
Diss-Iron (Fe) (mg/L)	0.032	<0.030	<0.030	<0.030	<0.030				<0.030	<0.030		<0.060			<0.060
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050				<0.000050	<0.000050		<0.000100			<0.000100
Diss-Lithium (Li) (mg/L)	0.0091	0.0100	0.0093	0.0100	0.0096				0.0088	0.0086		0.0092			0.0085
Diss-Magnesium (Mg) (mg/L)	31.3	29.1	32.5	34.6	35.8				27.6	28.6		28.6			26.0
Diss-Manganese (Mn) (mg/L)	0.187	0.0773	0.153	0.207	0.256				0.202	0.190		0.184			0.166
Diss-Molybdenum (Mo) (mg/L)	0.134	0.134	0.129	0.132	0.131				0.130	0.133		0.135			0.133
Diss-Nickel (Ni) (mg/L)	0.00080	0.00089	0.00100	0.00102	0.00157				0.00086	0.00085		<0.00100			<0.00100
Diss-Potassium (K) (mg/L)	1.44	1.58	1.59	1.65	1.52				1.32	1.47		1.50			1.44

	: E10														
	20-Apr-21	3-May-21	17-May-21	2-Jun-21	16-Jun-21	29-Jun-21	13-Jul-21	27-Jul-21	3-Aug-21	23-Aug-21	8-Sep-21	14-Sep-21	27-Sep-21	6-Oct-21	19-Oct-21
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	146	139	119	126	134	137	137		157		143		145	178	124
Ammonia (as N) (mg/L)	<0.0050	0.0063	0.0384	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050		0.0051		<0.0050	<0.0050	0.0100
Chloride (mg/L)	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50		<2.50		<2.50		<2.50	<2.50	<2.50
Diss-Orthophosphate (mg/L)	0.0051	0.0022	0.0015	0.0019	0.0038	0.0049	0.0041		0.0053		0.0047		0.0048	0.0012	0.0020
Diss-Phosphorus (mg/L)	0.0047	<0.0020	<0.0020	<0.0020	0.0049	0.0044	0.0072		0.0060		0.0044		0.0067	<0.0020	0.0024
Floride (mg/L)	0.901	0.779	0.765	0.787	0.762	0.882	0.854		0.871		0.765		0.852	0.824	0.819
Nitrate (N) (mg/L)	<0.0250	0.263	0.540	0.426	0.316	0.216	0.131		0.0603		0.0341		0.271	0.274	0.220
Nitrate and Nitrite (mg/L)	<0.0255	0.263	0.547	0.426	0.316	0.216	0.131		0.0603		0.0341		0.271	0.274	0.220
Nitrite (N) (mg/L)	<0.0050	<0.0050	0.0073	<0.0050	<0.0050	<0.0050	<0.0050		<0.0050		<0.0050		<0.0050	<0.0050	<0.0050
Sulphate (mg/L)	586	572	630	663	704	719	681		669		584		520	540	516
TKN (mg/L)															
Total Nitrogen (mg/L)	0.034	0.313	0.595	0.450	0.340	0.232	0.162		0.083		0.062		0.305	0.315	0.255
Total Phosphorus (mg/L)	0.0055	0.0044	0.0031	0.0034	0.0040	0.0045	0.0051		0.0067		0.0032		0.0059	0.0063	0.0095
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	<0.0060	<0.0060	<0.0060	<0.0030	<0.0030	<0.0060	<0.0030		<0.0060		0.0057		<0.0030	<0.0030	<0.0030
Diss-Antimony (Sb) (mg/L)	0.00053	0.00053	0.00049	0.00054	0.00054	0.00053	0.00048		0.00056		0.00050		0.00048	0.00050	0.00042
Diss-Arsenic (As) (mg/L)	0.00050	0.00052	0.00044	0.00054	0.00049	0.00046	0.00048		0.00049		0.00048		0.00051	0.00014	0.00010
Diss-Barium (Ba) (mg/L)	0.0216	0.0271	0.0230	0.0255	0.0248	0.0234	0.0221		0.0234		0.0221		0.0203	0.0193	0.0153
Diss-Beryllium (Be) (mg/L)	<0.000200	<0.000200	<0.000200	<0.000100	<0.000100	<0.000200	<0.000100		<0.000200		<0.000100		<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000050	<0.000050	<0.000100	<0.000050		<0.000100		<0.000050		<0.000050	<0.000050	<0.000050
Diss-Boron (B) (mg/L)	0.317	0.228	0.203	0.210	0.264	0.275	0.273		0.309		0.311		0.256	0.259	0.231
Diss-Cadmium (Cd) (mg/L)	0.000216	<0.000300	0.000265	0.000428	0.000346	0.000373	0.000335		0.000418		0.000337		0.000326	<0.000285	0.0000809
Diss-Calcium (Ca) (mg/L)	237	232	216	246	263	254	234		261		214		209	213	199
Diss-Chromium (Cr) (mg/L)	<0.00100	<0.00100	<0.00100	<0.00050	<0.00050	<0.00100	<0.00050		<0.00100		<0.00050		<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	0.00056	0.00020	0.00022	0.00040	0.00068	0.00069	0.00079		0.00068		0.00051		0.00057	0.00055	0.00064
Diss-Copper (Cu) (mg/L)	0.0131	0.0114	0.0124	0.0145	0.0153	0.0164	0.0156		0.0160		0.0140		0.0140	0.0212	0.00229
Diss-Iron (Fe) (mg/L)	<0.060	<0.060	<0.060	<0.030	<0.030	<0.060	<0.030		<0.060		<0.030		<0.030	<0.030	0.194
Diss-Lead (Pb) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000050	<0.000050	<0.000100	<0.000050		<0.000100		<0.000050		<0.000050	<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	0.0083	0.0074	0.0081	0.0078	0.0093	0.0095	0.0084		0.0086		0.0076		0.0073	0.0070	0.0078
Diss-Magnesium (Mg) (mg/L)	25.7	26.2	27.3	33.5	32.4	30.4	28.9		30.0		25.9		23.9	22.1	23.3
Diss-Manganese (Mn) (mg/L)	0.140	0.0322	0.0320	0.0769	0.156	0.166	0.176		0.179		0.134		0.155	0.156	0.161
Diss-Molybdenum (Mo) (mg/L)	0.120	0.110	0.118	0.131	0.138	0.133	0.137		0.130		0.129		0.125	0.129	0.131
Diss-Nickel (Ni) (mg/L)	<0.00100	<0.00100	<0.00100	0.00085	0.00094	<0.00100	0.00093		<0.00100		0.00080		0.00070	0.00101	0.00301
Diss-Potassium (K) (mg/L)	1.28	1.17	1.41	1.53	1.60	1.45	1.45		1.42		1.40		1.29	1.27	1.29

	: E10														
	3-Nov-21	9-Nov-21	17-Nov-21	24-Nov-21	2-Dec-21	8-Dec-21	13-Dec-21	20-Dec-21	17-Jan-22	25-Jan-22	2-Feb-22	10-Feb-22	15-Feb-22	22-Feb-22	15-Mar-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		136	141	137	145		140	140	139		145	140	142	135	127
Ammonia (as N) (mg/L)		<0.0050	<0.0050	0.141	0.132		0.108	0.0775	0.0815		0.0621	0.0572	0.0507	0.0510	0.0264
Chloride (mg/L)		<2.50	1.83	2.24	2.34		2.68	<2.50	<2.50		<2.50	<2.50	<2.50	2.65	3.86
Diss-Orthophosphate (mg/L)		0.0048	0.0047	0.0047	<0.0010		0.0013	<0.0010	<0.0010		0.0020	<0.0010	<0.0010	0.0013	0.0013
Diss-Phosphorus (mg/L)		0.0065	0.0041	<0.0020	<0.0020		0.0023	0.0028	0.0021		<0.0020	0.0037	0.0034	0.0025	0.0025
Floride (mg/L)		0.876	0.690	0.814	0.898		0.955	0.929	0.931		1.00	0.925	0.943	0.899	
Nitrate (N) (mg/L)		0.307	0.144	0.0634	0.0427		0.0523	0.0348	0.0475		0.0433	0.0466	0.118	0.345	0.498
Nitrate and Nitrite (mg/L)		0.307	0.146	0.0650	0.0448		0.0523	0.0348	0.0475		0.0433	0.0466	0.118	0.345	0.498
Nitrite (N) (mg/L)		<0.0050	0.0019	0.0016	0.0021		<0.0050	<0.0050	<0.0050		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Sulphate (mg/L)		464	494	545	523		556	540	569		577	576	587	592	605
TKN (mg/L)			<0.050	0.217	0.135										
Total Nitrogen (mg/L)		0.329	0.146	0.282	0.180		0.193	0.155	0.187		0.142	0.133	0.168	0.395	0.521
Total Phosphorus (mg/L)		0.0073	0.0040	0.0036	0.0027		0.0020	0.0034	0.0025		<0.0020	0.0037	0.0027	0.0034	0.0034
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		<0.0060	<0.0030	<0.0030	<0.0030		<0.0060	0.0074	<0.0060		<0.0030	<0.0030	<0.0030	<0.0060	<0.0100
Diss-Antimony (Sb) (mg/L)		0.00054	0.00053	0.00033	0.00038		0.00046	0.00043	0.00035		0.00037	0.00037	0.00038	0.00036	<0.00100
Diss-Arsenic (As) (mg/L)		0.00052	0.00056	0.00082	0.00090		0.00111	0.00116	0.00159		0.00172	0.00166	0.00176	0.00188	0.00108
Diss-Barium (Ba) (mg/L)		0.0193	0.0223	0.0166	0.0183		0.0176	0.0177	0.0172		0.0174	0.0161	0.0164	0.0166	0.0214
Diss-Beryllium (Be) (mg/L)		<0.000200	<0.000100	<0.000100	<0.000100		<0.000200	<0.000200	<0.000200		<0.000100	<0.000100	<0.000100	<0.000200	<0.000200
Diss-Bismuth (Bi) (mg/L)		<0.000100	<0.000050	<0.000050	<0.000050		<0.000100	<0.000100	<0.000100		<0.000100	<0.000100	<0.000050	<0.000100	<0.000500
Diss-Boron (B) (mg/L)		0.204	0.274	0.277	0.259		0.268	0.323	0.269		0.302	0.305	0.326	0.295	0.349
Diss-Cadmium (Cd) (mg/L)		0.000185	0.000267	0.000168	0.000178		<0.0000950	<0.000145	<0.000135		<0.000125	<0.000110	0.000132	<0.000130	0.000197
Diss-Calcium (Ca) (mg/L)		172	204	205	208		210	194	206		215	230	213	209	214
Diss-Chromium (Cr) (mg/L)		<0.00100	<0.00050	<0.00050	<0.00050		<0.00100	<0.00100	<0.00100		<0.00050	<0.00050	<0.00050	<0.00100	<0.00100
Diss-Cobalt (Co) (mg/L)		0.00041	0.00063	0.00081	0.00075		0.00037	0.00042	0.00043		0.00030	0.00030	0.00028	0.00028	0.00200
Diss-Copper (Cu) (mg/L)		0.0119	0.0134	0.00440	0.00345		0.00230	0.00314	0.00278		0.00186	0.00277	0.00354	0.00293	0.0127
Diss-Iron (Fe) (mg/L)		<0.060	<0.030	0.422	0.170		0.213	0.202	0.198		0.232	0.223	0.246	0.260	0.187
Diss-Lead (Pb) (mg/L)		<0.000100	<0.000050	<0.000050	<0.000050		<0.000100	<0.000100	<0.000100		<0.000100	<0.000100	<0.000050	<0.000100	<0.000500
Diss-Lithium (Li) (mg/L)		0.0070	0.0072	0.0099	0.0096		0.0104	0.0095	0.0086		0.0097	0.0088	0.0089	0.0085	<0.0100
Diss-Magnesium (Mg) (mg/L)		19.8	25.0	22.4	21.7		22.0	21.8	22.6		24.8	24.0	22.4	24.1	22.0
Diss-Manganese (Mn) (mg/L)		0.0848	0.149	0.160	0.155		0.0933	0.107	0.120		0.0922	0.102	0.104	0.107	0.351
Diss-Molybdenum (Mo) (mg/L)		0.124	0.122	0.220	0.224		0.255	0.229	0.179		0.182	0.181	0.174	0.168	0.132
Diss-Nickel (Ni) (mg/L)		<0.00100	0.00068	<0.00050	<0.00050		<0.00100	<0.00100	<0.00100		<0.00100	<0.00100	<0.00050	<0.00100	<0.00500
Diss-Potassium (K) (mg/L)		1.26	1.31	1.60	1.46		1.51	1.40	1.42		1.33	1.24	1.22	1.19	1.01

	: E10														
	5-Apr-22	12-Apr-22	25-Apr-22	2-May-22	5-May-22	8-Jun-22	14-Jun-22	21-Jun-22	4-Oct-22	18-Oct-22	16-Nov-22	24-Nov-22	29-Nov-22	6-Dec-22	13-Dec-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	122	125	119		109	117	118	120	77.7	75.9	81.6	78.9	80.6	83.5	
Ammonia (as N) (mg/L)	0.0232	0.0221	0.0184		<0.0050	<0.0050	0.0067	<0.0050	0.0053	0.0075	0.0135	<0.0050	0.0062	<0.0050	
Chloride (mg/L)	3.14	3.45	3.29		3.69	3.28	3.18	<5.00	6.33	6.32	6.24	6.01	5.67	5.74	
Diss-Orthophosphate (mg/L)	0.0017	0.0018	0.0017		0.0024	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Diss-Phosphorus (mg/L)	<0.0020	0.0035	0.0030		0.0030	<0.0020	0.0029	0.0035	<0.0020	<0.0020	<0.0020	<0.0020	0.0032	0.0021	
Floride (mg/L)	0.896	0.926	0.816		0.647	0.722	0.688	0.730	0.478	0.498	0.519	0.526	0.470	0.483	
Nitrate (N) (mg/L)	0.582	0.659	0.690		1.40	1.09	1.08	1.09	3.78	3.72	3.55	3.45	3.37	3.39	
Nitrate and Nitrite (mg/L)	0.590	0.659	0.690		1.40	1.10	1.09	1.10	3.81	3.74	3.56	3.46	3.38	3.40	
Nitrite (N) (mg/L)	0.0081	<0.0050	<0.0050		<0.0050	0.0125	0.0106	0.0122	0.0270	0.0236	0.0149	0.0137	0.0098	0.0095	
Sulphate (mg/L)	607	610	619		594	616	664	698	565	569	645	629	609	609	
TKN (mg/L)															
Total Nitrogen (mg/L)	0.638	0.684	0.781		1.53	1.12	1.18	1.14	3.58	3.56	3.33	3.31	3.41	3.36	
Total Phosphorus (mg/L)	0.0022	0.0037	0.0035		0.0122	0.0105	0.0282	0.0060	0.0025	0.0029	0.0031	<0.0020	0.0177	0.0033	
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	<0.0060	<0.0060	<0.0100		<0.0030	0.0080	0.0080	0.0067	0.0036	0.0033	0.0054	<0.0060	0.0039	0.0035	
Diss-Antimony (Sb) (mg/L)	0.00043	0.00041	<0.00100		0.00054	0.00083	0.00079	0.00067	0.00112	0.00107	0.00107	0.00105	0.00097	0.00090	
Diss-Arsenic (As) (mg/L)	0.00123	0.00110	0.00103		0.00053	0.00071	0.00081	0.00077	0.00113	0.00103	0.00098	0.00106	0.00100	0.00097	
Diss-Barium (Ba) (mg/L)	0.0218	0.0206	0.0232		0.0298	0.0467	0.0499	0.0474	0.0627	0.0598	0.0561	0.0553	0.0570	0.0559	
Diss-Beryllium (Be) (mg/L)	<0.000200	<0.000200	<0.000200		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000200	<0.000100	<0.000100	
Diss-Bismuth (Bi) (mg/L)	<0.000100	<0.000100	<0.000500		<0.000050	<0.000250	<0.000250	<0.000250	<0.000050	<0.000050	<0.000100	<0.000100	<0.000100	<0.000100	
Diss-Boron (B) (mg/L)	0.310	0.274	0.292		0.155	0.281	0.184	0.184	0.118	0.110	0.132	0.131	0.118	0.118	
Diss-Cadmium (Cd) (mg/L)	0.000188	0.000164	0.000182		0.000270	0.000334	0.000382	0.000350	<0.000215	<0.000135	<0.000175	0.000168	0.000176	0.000166	
Diss-Calcium (Ca) (mg/L)	240	197	230		218	226	246	246	201	185	202	214	205	193	
Diss-Chromium (Cr) (mg/L)	<0.00100	<0.00100	<0.00100		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00100	<0.00050	<0.00050	
Diss-Cobalt (Co) (mg/L)	0.00162	0.00155	0.00148		0.00017	<0.00050	<0.00050	<0.00050	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020	
Diss-Copper (Cu) (mg/L)	0.0136	0.0125	0.0114		0.0139	0.0114	0.0115	0.0107	0.00776	0.00735	0.00840	0.00829	0.00798	0.00810	
Diss-Iron (Fe) (mg/L)	0.143	0.159	<0.100		<0.030	<0.050	<0.050	<0.050	<0.030	<0.030	<0.030	<0.060	<0.030	<0.030	
Diss-Lead (Pb) (mg/L)	<0.000100	<0.000100	<0.000500		<0.000050	<0.000250	<0.000250	<0.000250	<0.000050	<0.000050	<0.000100	<0.000100	<0.000100	<0.000100	
Diss-Lithium (Li) (mg/L)	0.0072	0.0067	<0.0100		0.0064	0.0100	0.0094	0.0107	0.0073	0.0079	0.0083	0.0083	0.0073	0.0077	
Diss-Magnesium (Mg) (mg/L)	26.7	22.2	24.9		28.3	30.0	30.4	33.7	30.8	28.5	29.0	31.2	30.0	27.6	
Diss-Manganese (Mn) (mg/L)	0.246	0.220	0.209		0.0251	0.0573	0.0688	0.0637	0.00372	0.00274	0.00828	0.00780	0.00899	0.00804	
Diss-Molybdenum (Mo) (mg/L)	0.143	0.138	0.145		0.127	0.174	0.163	0.166	0.185	0.174	0.181	0.184	0.174	0.148	
Diss-Nickel (Ni) (mg/L)	<0.00100	<0.00100	<0.00500		0.00066	<0.00250	<0.00250	<0.00250	<0.00050	<0.00050	<0.00100	<0.00100	<0.00100	<0.00100	
Diss-Potassium (K) (mg/L)	1.17	1.15	1.19		1.47	2.04	2.19	2.17	2.73	2.59	2.58	2.61	2.31	2.30	

	: E10														
	27-Dec-22	5-Jan-23	10-Jan-23	16-Jan-23	23-Jan-23	1-Feb-23	6-Feb-23	9-Feb-23	13-Feb-23	22-Feb-23	6-Mar-23	14-Mar-23	21-Mar-23	29-Mar-23	30-Mar-23
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	88.9	91.2	92.3	94.9	94.2	98.3		91.2	93.6	96.8	77.0	108	101		
Ammonia (as N) (mg/L)	<0.0050	0.0056	0.0057	<0.0050	<0.0050	<0.0050		<0.0050	0.0278	0.0099	0.0089	<0.0050	0.0097		
Chloride (mg/L)	6.08	5.58	5.46	5.25	5.13	5.20		5.46	5.57	5.49	4.96	4.97	5.21		
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010	0.0011	0.0024	0.0025		
Diss-Phosphorus (mg/L)	0.0023	0.0024	0.0022	0.0025	0.0027	0.0034		<0.0020	<0.0020	0.0058	<0.0020	0.0032	0.0048		
Floride (mg/L)	0.467	0.500	0.429	0.520	0.403	0.493		0.485	0.503	0.554	0.413	0.454	0.566		
Nitrate (N) (mg/L)	3.55	3.14	3.09	2.98	3.02	3.00		3.18	3.15	3.08	2.72	2.66	2.77		
Nitrate and Nitrite (mg/L)	3.56	3.15	3.10	2.99	3.03	3.01		3.19	3.17	3.09	2.73	2.66	2.78		
Nitrite (N) (mg/L)	0.0121	0.0076	0.0089	0.0075	0.0066	0.0078		0.0100	0.0162	0.0075	0.0063	<0.0050	0.0097		
Sulphate (mg/L)	654	589	568	541	529	536		582	579	577	528	522	568		
TKN (mg/L)															
Total Nitrogen (mg/L)	3.36	3.26	3.25	3.02	3.30	3.18		3.21	3.17	3.09	2.92	3.00	3.11		
Total Phosphorus (mg/L)	0.0036	0.0040	0.0040	0.0034	0.0041	0.0046		0.0032	0.0053	0.0050	0.0046	0.0560	0.0117		
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	<0.0030	<0.0060	0.0032	0.0030	<0.0030	<0.0030		<0.0030	0.0047	0.0034	0.0060	0.0052	0.0036		
Diss-Antimony (Sb) (mg/L)	0.00098	0.00098	0.00091	0.00091	0.00089	0.00094		0.00092	0.00097	0.00087	0.00077	0.00077	0.00086		
Diss-Arsenic (As) (mg/L)	0.00099	0.00095	0.00095	0.00098	0.00098	0.00099		0.00099	0.00095	0.00089	0.00088	0.00080	0.00081		
Diss-Barium (Ba) (mg/L)	0.0558	0.0508	0.0527	0.0534	0.0514	0.0506		0.0539	0.0537	0.0507	0.0494	0.0469	0.0454		
Diss-Beryllium (Be) (mg/L)	<0.000100	<0.000200	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		
Diss-Bismuth (Bi) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000050	<0.000050	<0.000050		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		
Diss-Boron (B) (mg/L)	0.122	0.119	0.122	0.106	0.102	0.119		0.114	0.128	0.121	0.109	0.102	0.109		
Diss-Cadmium (Cd) (mg/L)	0.000160	<0.000175	0.000156	0.000161	0.000140	0.000145		0.000165	0.000150	<0.000165	0.000139	0.000150	0.000178		
Diss-Calcium (Ca) (mg/L)	199	203	196	185	191	196		192	201	193	197	171	193		
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00100	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Diss-Cobalt (Co) (mg/L)	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Diss-Copper (Cu) (mg/L)	0.00781	0.00826	0.00791	0.00814	0.00780	0.00816		0.00856	0.00858	0.00844	0.00918	0.0102	0.0118		
Diss-Iron (Fe) (mg/L)	<0.030	<0.060	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		
Diss-Lead (Pb) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000050	<0.000050	<0.000050		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		
Diss-Lithium (Li) (mg/L)	0.0082	0.0076	0.0078	0.0073	0.0072	0.0076		0.0081	0.0083	0.0078	0.0066	0.0065	0.0078		
Diss-Magnesium (Mg) (mg/L)	28.8	28.5	28.8	26.7	28.2	27.2		28.4	28.6	28.3	28.3	24.6	26.9		
Diss-Manganese (Mn) (mg/L)	0.00896	0.00898	0.00917	0.00964	0.00892	0.00959		0.00961	0.00896	0.0125	0.0140	0.0254	0.0139		
Diss-Molybdenum (Mo) (mg/L)	0.164	0.160	0.152	0.156	0.155	0.160		0.159	0.167	0.149	0.144	0.137	0.151		
Diss-Nickel (Ni) (mg/L)	<0.00100	<0.00100	<0.00100	<0.00050	<0.00050	<0.00050		<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100		
Diss-Potassium (K) (mg/L)	2.37	2.26	2.35	2.31	2.20	2.20		2.34	2.32	2.19	2.00	1.97	2.01		

	: E10														
	6-Apr-23	20-Apr-23	26-Apr-23	3-May-23	8-May-23	15-May-23	29-May-23	8-Jun-23	12-Jun-23	13-Jun-23	29-Jun-23	6-Jul-23	13-Jul-23	25-Jul-23	3-Aug-23
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)					85.9	90.9	97.1			105	108		126	124	126
Ammonia (as N) (mg/L)					<0.0050	<0.0050	<0.0050			<0.0050	<0.0050		<0.0050	0.0070	<0.0050
Chloride (mg/L)					1.61	2.64	3.44			3.90	4.16		3.48	<10.0	5.03
Diss-Orthophosphate (mg/L)					<0.0010	<0.0010	<0.0010			<0.0010	<0.0010		<0.0010	<0.0010	<0.0010
Diss-Phosphorus (mg/L)					<0.0020	<0.0020	<0.0020			<0.0020	<0.0020		0.0027	<0.0020	<0.0020
Floride (mg/L)					0.370	0.384	0.433			0.533	0.694		0.506	0.651	0.619
Nitrate (N) (mg/L)					1.18	1.49	1.80			1.89	1.82		1.38	1.54	1.51
Nitrate and Nitrite (mg/L)					1.19	1.50	1.81			1.91	1.84		1.39	1.54	1.52
Nitrite (N) (mg/L)					0.0070	0.0118	0.0132			0.0241	0.0216		0.0126	<0.0200	0.0155
Sulphate (mg/L)					249	344	439			532	731		850	1140	1140
TKN (mg/L)															
Total Nitrogen (mg/L)					1.28	1.51	1.95			1.95	1.79		1.46	1.58	1.67
Total Phosphorus (mg/L)					0.0067	<0.0020	0.0033			0.0026	0.0028		0.0025	0.0027	0.0023
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)					0.0036	<0.0030	<0.0060			0.0042	0.0048		<0.0050	<0.0030	<0.0050
Diss-Antimony (Sb) (mg/L)					0.00047	0.00057	0.00080			0.00089	0.00080		0.00066	0.00073	0.00074
Diss-Arsenic (As) (mg/L)					0.00061	0.00075	0.00094			0.00106	0.00091		0.00064	0.00059	0.00061
Diss-Barium (Ba) (mg/L)					0.0311	0.0374	0.0418			0.0439	0.0400		0.0431	0.0366	0.0367
Diss-Beryllium (Be) (mg/L)					<0.000100	<0.000100	<0.000200			<0.000100	<0.000100		<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)					<0.000050	<0.000050	<0.000100			<0.000100	<0.000100		<0.000250	<0.000100	<0.000250
Diss-Boron (B) (mg/L)					0.070	0.085	0.112			0.115	0.130		0.151	0.176	0.185
Diss-Cadmium (Cd) (mg/L)					0.0000942	0.000127	<0.00135			<0.000170	<0.000460		<0.000590	0.000716	0.000694
Diss-Calcium (Ca) (mg/L)					97.5	131	161			195	262		331	407	401
Diss-Chromium (Cr) (mg/L)					<0.00050	<0.00050	<0.00100			<0.00050	<0.00050		<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)					<0.00010	<0.00010	<0.00020			<0.00020	<0.00020		<0.00050	0.00033	<0.00050
Diss-Copper (Cu) (mg/L)					0.0101	0.0104	0.0109			0.00925	0.0138		0.0122	0.0118	0.0107
Diss-Iron (Fe) (mg/L)					<0.030	<0.030	<0.060			<0.030	<0.030		<0.050	<0.030	<0.050
Diss-Lead (Pb) (mg/L)					<0.000050	<0.000050	<0.000100			<0.000100	<0.000100		<0.000250	<0.000100	<0.000250
Diss-Lithium (Li) (mg/L)					0.0049	0.0059	0.0074			0.0085	0.0095		0.0093	0.0127	0.0142
Diss-Magnesium (Mg) (mg/L)					12.9	17.6	24.0			26.1	32.6		38.6	49.9	49.2
Diss-Manganese (Mn) (mg/L)					0.00888	0.00761	0.00637			0.00796	0.0195		0.0578	0.129	0.102
Diss-Molybdenum (Mo) (mg/L)					0.0916	0.112	0.141			0.154	0.158		0.128	0.148	0.147
Diss-Nickel (Ni) (mg/L)					<0.00050	<0.00050	<0.00100			<0.00100	<0.00100		<0.00250	0.00146	<0.00250
Diss-Potassium (K) (mg/L)					0.950	1.32	1.73			2.00	2.16		2.38	2.45	2.42

	: E10														
	9-Aug-23	14-Aug-23	21-Aug-23	31-Aug-23	11-Sep-23	13-Sep-23	21-Sep-23	26-Sep-23	5-Oct-23	11-Oct-23	16-Oct-23	17-Oct-23	23-Oct-23	1-Nov-23	8-Nov-23
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		131	132	134					156	157		142			
Ammonia (as N) (mg/L)		<0.0050	<0.0050	<0.0050					<0.0050	<0.0050		<0.0050			
Chloride (mg/L)		<10.0	<10.0	<10.0					<10.0	<10.0		<5.00			
Diss-Orthophosphate (mg/L)		<0.0010	<0.0010	<0.0010					<0.0010	<0.0010		<0.0010			
Diss-Phosphorus (mg/L)		<0.0020	0.0037	<0.0020					<0.0020	0.0045		<0.0020			
Floride (mg/L)		0.672	0.584	0.675					0.779	0.655		0.706			
Nitrate (N) (mg/L)		1.36	1.17	1.04					0.406	0.328		0.466			
Nitrate and Nitrite (mg/L)		1.36	1.17	1.04					0.406	0.328		0.466			
Nitrite (N) (mg/L)		<0.0200	<0.0200	<0.0200					<0.0200	<0.0200		<0.0100			
Sulphate (mg/L)		1190	1200	1120					1370	1290		1190			
TKN (mg/L)															
Total Nitrogen (mg/L)		1.41	1.36	1.15					0.472	0.638		0.501			
Total Phosphorus (mg/L)		0.0035	0.0028	0.0025					<0.0020	0.0027		0.0020			
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		<0.0050	0.0301	0.0083					<0.0060	<0.0030		0.0060			
Diss-Antimony (Sb) (mg/L)		0.00080	0.00079	0.00087					0.00073	0.00059		0.00078			
Diss-Arsenic (As) (mg/L)		0.00060	0.00054	0.00068					0.00051	0.00066		0.00059			
Diss-Barium (Ba) (mg/L)		0.0342	0.0290	0.0280					0.0312	0.0352		0.0249			
Diss-Beryllium (Be) (mg/L)		<0.000100	<0.000500	<0.000100					<0.000200	<0.000100		<0.000100			
Diss-Bismuth (Bi) (mg/L)		<0.000250	<0.000250	<0.000250					<0.000100	<0.000100		<0.000100			
Diss-Boron (B) (mg/L)		0.170	0.158	0.146					0.168	0.156		0.169			
Diss-Cadmium (Cd) (mg/L)		0.000706	<0.000760	0.000788					0.000937	0.000658		0.000798			
Diss-Calcium (Ca) (mg/L)		395	404	386					486	420		421			
Diss-Chromium (Cr) (mg/L)		<0.00050	<0.00250	<0.00050					<0.00100	<0.00050		<0.00050			
Diss-Cobalt (Co) (mg/L)		<0.00050	<0.00050	<0.00050					0.0117	0.0103		0.00081			
Diss-Copper (Cu) (mg/L)		0.0105	0.0106	0.0124					0.0457	0.0429		0.0126			
Diss-Iron (Fe) (mg/L)		<0.050	<0.050	<0.050					<0.060	<0.030		<0.030			
Diss-Lead (Pb) (mg/L)		<0.000250	<0.000250	<0.000250					<0.000100	<0.000100		<0.000100			
Diss-Lithium (Li) (mg/L)		0.0145	0.0138	0.0137					0.0137	0.0108		0.0143			
Diss-Magnesium (Mg) (mg/L)		52.6	53.4	49.9					59.2	58.3		57.5			
Diss-Manganese (Mn) (mg/L)		0.112	0.159	0.146					1.04	0.888		0.243			
Diss-Molybdenum (Mo) (mg/L)		0.151	0.142	0.148					0.126	0.103		0.128			
Diss-Nickel (Ni) (mg/L)		<0.00250	<0.00250	<0.00250					0.00337	0.00283		0.00187			
Diss-Potassium (K) (mg/L)		2.68	2.65	2.49					2.46	2.33		2.82			

	: E10					
	23-Nov-23	28-Nov-23	7-Dec-23	12-Dec-23	19-Dec-23	27-Dec-23
Anions and Nutrients						
Alkalinity (CaCO3) (mg/L)	155	147	147		146	143
Ammonia (as N) (mg/L)	<0.0050	<0.0050	<0.0050		<0.0050	<0.0050
Chloride (mg/L)	<5.00	<5.00	<5.00		<5.00	<5.00
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Diss-Phosphorus (mg/L)	<0.0020	<0.0020	<0.0020		<0.0020	0.0027
Floride (mg/L)	0.601	0.600	0.562		0.649	0.634
Nitrate (N) (mg/L)	0.254	0.245	0.241		0.218	0.232
Nitrate and Nitrite (mg/L)	0.254	0.245	0.241		0.218	0.232
Nitrite (N) (mg/L)	<0.0100	<0.0100	<0.0100		<0.0100	<0.0100
Sulphate (mg/L)	1230	1190	1150		1070	1120
TKN (mg/L)						
Total Nitrogen (mg/L)	0.307	0.302	0.277		0.287	0.266
Total Phosphorus (mg/L)	<0.0020	0.0022	0.0028		0.0023	0.0023
Dissolved Metals						
Aluminum (Al)-Diss (mg/L)	<0.0050	0.0053	<0.0030		<0.0060	0.0166
Diss-Antimony (Sb) (mg/L)	0.00068	0.00069	0.00068		0.00069	0.00065
Diss-Arsenic (As) (mg/L)	<0.00050	0.00054	0.00054		0.00056	0.00059
Diss-Barium (Ba) (mg/L)	0.0228	0.0235	0.0225		0.0222	0.0211
Diss-Beryllium (Be) (mg/L)	<0.000100	<0.000100	<0.000100		<0.000200	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000250	<0.000100	<0.000100		<0.000100	<0.000100
Diss-Boron (B) (mg/L)	0.166	0.165	0.162		0.174	0.171
Diss-Cadmium (Cd) (mg/L)	0.000860	<0.000825	0.000720		0.000723	0.000730
Diss-Calcium (Ca) (mg/L)	433	423	409		374	360
Diss-Chromium (Cr) (mg/L)	<0.00250	<0.00100	<0.00100		<0.00100	<0.00100
Diss-Cobalt (Co) (mg/L)	0.00095	0.00080	0.00066		0.00054	0.00049
Diss-Copper (Cu) (mg/L)	0.0125	0.0140	0.0124		0.0131	0.0145
Diss-Iron (Fe) (mg/L)	<0.050	<0.030	<0.030		<0.060	<0.030
Diss-Lead (Pb) (mg/L)	<0.000250	<0.000100	<0.000100		<0.000100	<0.000100
Diss-Lithium (Li) (mg/L)	0.0132	0.0118	0.0120		0.0119	0.0104
Diss-Magnesium (Mg) (mg/L)	55.8	55.4	49.7		45.9	45.0
Diss-Manganese (Mn) (mg/L)	0.331	0.269	0.218		0.175	0.150
Diss-Molybdenum (Mo) (mg/L)	0.116	0.116	0.111		0.107	0.105
Diss-Nickel (Ni) (mg/L)	<0.00250	0.00214	0.00194		0.00184	0.00171
Diss-Potassium (K) (mg/L)	2.84	2.67	2.48		2.40	2.31

Grid Format Report : E10 - Effluent from Wight Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E10														
	2-Jan-19	14-Feb-19	6-Mar-19	7-Mar-19	4-Apr-19	9-May-19	1-Aug-19	9-Sep-19	3-Oct-19	19-Nov-19	25-Nov-19	19-Feb-20	16-Apr-20	20-Apr-20	27-May-20
Diss-Selenium (mg/L)	0.00914	0.00725		0.00985	0.00816	0.0164	0.0119	0.0135	0.00790		0.00959	0.00827		0.0100	0.0199
Diss-Silicon (Si) (mg/L)	9.09	8.68		8.01	8.19	7.92	7.83	8.06	7.76		7.79	7.36		6.86	7.82
Diss-Silver (Ag) (mg/L)	0.000011	<0.000010		<0.000010	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	<0.000010		<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	32.7	32.2		30.7	30.7	26.5	27.6	25.3	26.1		24.4	25.1		24.3	30.3
Diss-Strontium (Sr) (mg/L)	11.9	11.3		7.76	8.36	7.13	6.53	5.12	6.70		5.94	5.48		5.34	8.16
Diss-Thallium (Tl) (mg/L)	0.000013	0.000013		0.000016	<0.000020	0.000014	0.000010	0.000012	0.000015		0.000013	0.000013		0.000010	0.000015
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010		<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010		<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		<0.010	<0.0100		<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	0.00289	0.00281		0.00329	0.00331	0.00328	0.00333	0.00291	0.00342		0.00321	0.00319		0.00300	0.00489
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050		<0.00050	<0.0010	<0.00050	<0.00050	0.00050	<0.00050		<0.00050	<0.00050		<0.00050	<0.00050
Diss-Zinc (Zn) (mg/L)	0.0189	0.0162		0.0181	0.0198	0.0196	0.0208	0.0185	0.0187		0.0153	0.0124		0.0129	0.0360
TDS (mg/L)	1200	1230		1200	1130	1130	1160	1000	992		992	966		988	1700
Field Tests															
Cond (in situ) (µs/cm)	1471.6	1434.4		1435.1	1429.8	1462.7	1379.1	1276.4	1319.3		1275.5	1167		1213.7	1811
NTU - in situ (ntu)	0.54	0.77		0.24	0.55	0	0.71	0.23	0.29		0.92	0.06		0.84	0.14
pH (in situ) (pH)	7.38	7.24		7.58	7.42	7.22	7.02	7.44	7.4		7.21	7.74		7.1	7.33
Sample Taken	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Temp (in situ) (Degrees Celcius)	9.225	8.649		8.524	10.48	9.646	10.782	10.205	8.685		8.703	5.9		9.89	10.4
Organic / Inorganic															
DOC (mg/L)	1.19	1.05		1.07	1.22	1.30	1.17	1.03	0.97		1.27	1.83		2.74	1.10
Physical Test															
Conductivity (µs/cm)	1440	1390		1390	1400	1420	1360	1230	1200		1250	1210		1200	1860
Hardness (mg/L)	873	800		817	852	752	762	663	791		669	634		652	1220
NTU (ntu)	0.46	0.40		<0.10	0.31	<0.10	<0.10	<0.10	0.12		<0.10	<0.10		<0.10	<0.10
pH (pH)	8.06	7.78		8.01	7.72	8.23	8.32	8.22	8.13		7.93	8.24		7.61	7.53
TDS (mg/L)	1200	1230		1200	1130	1130	1160	1000	992		992	966		988	1700
TSS (mg/L)	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.1		<1.0	<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030	<0.0030		<0.0060	0.0166	0.0150	<0.0030	<0.0030	<0.0030		0.0115	<0.0030		0.0111	0.0043
Antimony (Sb)-Total (mg/L)	0.00060	0.00060		0.00066	0.00065	0.00062	0.00066	0.00064	0.00063		0.00065	0.00063		0.00067	0.00072
Arsenic (As)-Total (mg/L)	0.00084	0.00086		0.00058	0.00068	0.00063	0.00060	0.00062	0.00062		0.00060	0.00058		0.00059	0.00058
Barium (Ba)-Total (mg/L)	0.0209	0.0214		0.0237	0.0257	0.0246	0.0245	0.0223	0.0242		0.0233	0.0230		0.0222	0.0363
Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010		<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.000100		<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050		<0.00010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050		<0.000050	<0.000050
Boron (B)-Total (mg/L)	0.373	0.395		0.356	0.355	0.371	0.360	0.339	0.321		0.326	0.332		0.313	0.346

	: E10														
	31-Aug-20	11-Nov-20	24-Nov-20	8-Dec-20	21-Dec-20	4-Jan-21	5-Jan-21	12-Jan-21	27-Jan-21	23-Feb-21	9-Mar-21	22-Mar-21	7-Apr-21	8-Apr-21	13-Apr-21
Diss-Selenium (mg/L)	0.0317	0.0297	0.0220	0.0224	0.0214				0.0127	0.00970		0.00485			0.00529
Diss-Silicon (Si) (mg/L)	6.68	7.28	6.94	7.13	7.20				6.64	7.31		7.44			7.69
Diss-Silver (Ag) (mg/L)	0.000011	<0.000010	<0.000010	<0.000010	0.000010				<0.000010	<0.000010		<0.000020			<0.000020
Diss-Sodium (Na) (mg/L)	23.6	23.7	24.5	25.8	28.3				24.4	25.3		25.5			25.7
Diss-Strontium (Sr) (mg/L)	5.70	5.86	5.57	6.22	6.21				5.65	5.38		5.03			5.25
Diss-Thallium (Tl) (mg/L)	0.000013	0.000011	<0.000020	<0.000020	0.000017				0.000011	0.000010		<0.000020			<0.000020
Diss-Tin (Sn) (mg/L)	0.00028	<0.00010	<0.00010	<0.00010	<0.00010				<0.00010	<0.00010		<0.00020			<0.00020
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100				<0.0100	<0.0100		<0.0200			<0.0200
Diss-Uranium (U) (mg/L)	0.00283	0.00251	0.00293	0.00321	0.00322				0.00298	0.00286		0.00270			0.00276
Diss-Vanadium (V) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050				<0.00050	<0.00050		<0.00100			<0.00100
Diss-Zinc (Zn) (mg/L)	0.0129	0.0272	0.0213	0.0151	0.0137				0.0121	0.0115		0.0114			0.0100
TDS (mg/L)	1200	1050	1230	1090	1190				1110	1050		1010			920
Field Tests															
Cond (in situ) (µs/cm)	1378.5	1299.7	1381	1472.1	1483.7				1380.2	1316.6		1294			1296.7
NTU - in situ (ntu)	0.64	2.14	1.46	0.07	0.13				0.23	0.56		0.22			0.4
pH (in situ) (pH)	7.37	7.57	7.11	7.31	7.4				7.33	7.13		7.26			7.21
Sample Taken	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	yes	no	yes	No	No	Yes
Temp (in situ) (Degrees Celcius)	10.376	6.27	7.927	7.349	7.521				8.213	8.821		8.465			9.997
Organic / Inorganic															
DOC (mg/L)	1.14	1.47	1.47	1.14	1.38				1.51	1.60		1.45			1.34
Physical Test															
Conductivity (µs/cm)	1360	1280	1420	1400	1410				1360	1290		1270			1240
Hardness (mg/L)	814	706	810	829	914				808	737		760			656
NTU (ntu)	<0.10	0.30	1.84	0.11	0.50				<0.10	0.10		<0.10			<0.10
pH (pH)	7.66	8.05	7.84	8.16	7.86				7.77	7.93		7.59			7.95
TDS (mg/L)	1200	1050	1230	1090	1190				1110	1050		1010			920
TSS (mg/L)	<1.0	<1.1	4.8	<1.1	<1.1				1.8	<1.0		<1.0			<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030	0.0184	0.0987	0.0044	0.0170				<0.0030	<0.0030		<0.0030			<0.0030
Antimony (Sb)-Total (mg/L)	0.00061	0.00051	0.00053	0.00059	0.00049				0.00057	0.00055		0.00052			0.00052
Arsenic (As)-Total (mg/L)	0.00067	0.00071	0.00063	0.00058	0.00056				0.00055	0.00053		0.00056			0.00052
Barium (Ba)-Total (mg/L)	0.0252	0.0272	0.0282	0.0255	0.0248				0.0257	0.0236		0.0218			0.0206
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100				<0.000100	<0.000100		<0.000100			<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050				<0.000050	<0.000050		<0.000050			<0.000050
Boron (B)-Total (mg/L)	0.263	0.263	0.320	0.282	0.293				0.332	0.388		0.381			0.295

	: E10														
	20-Apr-21	3-May-21	17-May-21	2-Jun-21	16-Jun-21	29-Jun-21	13-Jul-21	27-Jul-21	3-Aug-21	23-Aug-21	8-Sep-21	14-Sep-21	27-Sep-21	6-Oct-21	19-Oct-21
Diss-Selenium (mg/L)	0.00656	0.0191	0.0284	0.0270	0.0272	0.0214	0.0192		0.0141		0.00823		0.0126	0.0141	0.0141
Diss-Silicon (Si) (mg/L)	7.20	6.15	6.05	6.48	7.15	7.09	7.14		6.94		6.99		6.38	6.51	5.62
Diss-Silver (Ag) (mg/L)	<0.000020	<0.000020	<0.000020	<0.000010	<0.000010	<0.000020	<0.000010		<0.000020		<0.000010		<0.000010	<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	23.4	21.4	21.0	25.4	25.0	24.0	23.3		22.5		23.8		23.2	22.7	22.9
Diss-Strontium (Sr) (mg/L)	5.09	5.07	5.52	5.85	6.02	5.52	5.26		5.60		5.24		4.30	4.42	4.17
Diss-Thallium (Tl) (mg/L)	<0.000020	<0.000020	<0.000020	0.000010	0.000013	<0.000020	0.000011		<0.000020		<0.000010		<0.000010	<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00020	<0.00010		<0.00020		<0.00010		<0.00010	<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.0200	<0.0200	<0.0200	<0.0100	<0.0100	<0.0200	<0.0100		<0.0200		<0.0100		<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	0.00281	0.00251	0.00225	0.00279	0.00297	0.00301	0.00284		0.00288		0.00271		0.00247	0.00241	0.00240
Diss-Vanadium (V) (mg/L)	<0.00100	<0.00100	<0.00100	<0.00050	<0.00050	<0.00100	<0.00050		<0.00100		<0.00050		<0.00050	<0.00050	<0.00050
Diss-Zinc (Zn) (mg/L)	0.0100	0.0197	0.0299	0.0271	0.0158	0.0153	0.0121		0.0121		0.0104		0.0084	0.0082	<0.0030
TDS (mg/L)	967	980	1050	1050	1260	1160	1070		1210		1040		985	900	843
Field Tests															
Cond (in situ) (µs/cm)	1290	1187	944.9	1418	1610	1480.4	1148		1543		1263.3		1126	1225	1158
NTU - in situ (ntu)	0.05	0.16	0.34	0.55	0.28	0.39	0.11		0.43		0.37		0.27	3.96	20.2
pH (in situ) (pH)	7.36	7.43	7.32	7.35	7.87	7.27	6.93		7.48		7.33		7.54	7.18	7.71
Sample Taken	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Temp (in situ) (Degrees Celcius)	9.208	10.1	10.237	12.111	8.803	12.463	9.826		10.911		10.228		11.3	8.127	9.904
Organic / Inorganic															
DOC (mg/L)	1.23	1.27	1.42	1.25	1.34	1.60	1.33		1.21		1.16		1.25	1.31	1.37
Physical Test															
Conductivity (µs/cm)	1220	1150	1290	1340	1420	1330	1370		1380		1270		1150	1160	1130
Hardness (mg/L)	698	687	652	752	790	759	703		775		641		620	623	593
NTU (ntu)	<0.10	0.26	0.31	0.13	<0.10	1.02	<0.10		<0.10		<0.10		0.12	2.83	20.9
pH (pH)	7.73	8.11	7.94	8.12	8.03	8.10	7.84		8.11		8.02		8.25	8.03	8.04
TDS (mg/L)	967	980	1050	1050	1260	1160	1070		1210		1040		985	900	843
TSS (mg/L)	1.3	<1.0	<1.0	1.1	<1.0	1.0	3.6		<1.0		3.1		<1.1	2.4	5.9
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0030	0.0076	0.0033	<0.0060	<0.0060	<0.0060	<0.0030		<0.0030		<0.0060		<0.0060	0.0084	<0.0030
Antimony (Sb)-Total (mg/L)	0.00053	0.00055	0.00057	0.00049	0.00053	0.00051	0.00053		0.00054		0.00054		0.00054	0.00046	0.00041
Arsenic (As)-Total (mg/L)	0.00056	0.00058	0.00055	0.00046	0.00045	0.00048	0.00048		0.00058		0.00049		0.00052	0.00061	0.00084
Barium (Ba)-Total (mg/L)	0.0222	0.0252	0.0252	0.0231	0.0236	0.0225	0.0252		0.0227		0.0244		0.0215	0.0207	0.0146
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000200	<0.000200	<0.000200	<0.000100		<0.000100		<0.000200		<0.000200	<0.000200	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000100	<0.000100	<0.000100	<0.000050		<0.000050		<0.000100		<0.000100	<0.000100	<0.000050
Boron (B)-Total (mg/L)	0.359	0.245	0.227	0.230	0.257	0.281	0.288		0.299		0.332		0.281	0.255	0.242

	: E10														
	3-Nov-21	9-Nov-21	17-Nov-21	24-Nov-21	2-Dec-21	8-Dec-21	13-Dec-21	20-Dec-21	17-Jan-22	25-Jan-22	2-Feb-22	10-Feb-22	15-Feb-22	22-Feb-22	15-Mar-22
Diss-Selenium (mg/L)		0.0185	0.0148	0.00708	0.00609		0.00526	0.00473	0.00784		0.00686	0.00881	0.00946	0.0128	0.0131
Diss-Silicon (Si) (mg/L)		6.83	6.90	6.81	7.12		7.68	7.71	7.74		8.14	8.27	7.96	8.47	7.36
Diss-Silver (Ag) (mg/L)		<0.000020	<0.000010	<0.000010	<0.000010		<0.000020	<0.000020	<0.000020		<0.000020	<0.000020	<0.000010	<0.000020	<0.000100
Diss-Sodium (Na) (mg/L)		20.9	24.0	40.0	38.5		40.4	36.1	33.4		34.9	32.5	30.7	32.2	26.5
Diss-Strontium (Sr) (mg/L)		3.65	4.65	9.16	9.14		9.68	9.04	8.82		9.69	9.50	8.84	9.11	6.97
Diss-Thallium (Tl) (mg/L)		<0.000020	<0.000010	<0.000010	<0.000010		<0.000020	<0.000020	<0.000020		<0.000020	<0.000020	<0.000010	<0.000020	<0.000100
Diss-Tin (Sn) (mg/L)		<0.00020	<0.00010	<0.00010	<0.00010		<0.00020	<0.00020	<0.00020		<0.00020	<0.00020	<0.00010	<0.00020	<0.00100
Diss-Titanium (Ti) (mg/L)		<0.0200	<0.0100	<0.0100	<0.0100		<0.0200	<0.0200	<0.0200		<0.0100	<0.0100	<0.0100	<0.0200	<0.0100
Diss-Uranium (U) (mg/L)		0.00228	0.00240	0.00255	0.00306		0.00326	0.00295	0.00230		0.00247	0.00213	0.00220	0.00211	0.00222
Diss-Vanadium (V) (mg/L)		<0.00100	<0.00050	0.00052	<0.00050		<0.00100	<0.00100	<0.00100		<0.00100	<0.00100	<0.00050	<0.00100	<0.00500
Diss-Zinc (Zn) (mg/L)		0.0064	0.0076	0.0170	0.0100		0.0092	0.0093	0.0072		0.0058	0.0060	0.0062	0.0065	<0.0100
TDS (mg/L)		790	828	906	904		892	907	900		916	971	978	986	950
Field Tests															
Cond (in situ) (µs/cm)		1083.9	1179.1	1233.4	1190		1205	1188.4	1190		1220.4	1181	1225.1	1211.9	1247.5
NTU - in situ (ntu)		0.76	0.08	0.79	1.64		0.33	0.83	0.4		0.29	0.46	0.07	0.98	0.48
pH (in situ) (pH)		7.44	7.5	7.61	7.53		7.36	7.63	7.58		7.58	7.67	7.32	7.46	7.44
Sample Taken	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Temp (in situ) (Degrees Celcius)		8.417	8.568	9.59	9.326		9.041	7.991	9.7		9.165	9.1	9.306	8.779	8.518
Organic / Inorganic															
DOC (mg/L)		1.43	1.66	1.32	1.43		1.44	1.14	1.52		1.44	1.55	1.38	2.52	1.40
Physical Test															
Conductivity (µs/cm)		1020	1090	1140	1100		1210	1130	1200		1190	1240	1200	1240	1280
Hardness (mg/L)		511	612	604	609		615	574	607		639	673	624	621	625
NTU (ntu)		0.10	<0.10	2.53	3.83		1.79	1.60	1.62		1.75	1.45	1.48	1.42	0.63
pH (pH)		8.09	7.74	7.90	7.89		8.17	8.03	7.85		7.93	7.87	7.90	8.24	7.98
TDS (mg/L)		790	828	906	904		892	907	900		916	971	978	986	950
TSS (mg/L)		<1.0	<1.5	<1.4	<1.0		<1.0	<1.0	1.0		2.1	<1.0	<1.1	<1.1	<1.1
Total Metals															
Aluminum (Al)-Total (mg/L)		0.0052	<0.0030	0.0037	0.0076		<0.0060	<0.0060	<0.0060		<0.0150	<0.0060	<0.0060	<0.0060	<0.0030
Antimony (Sb)-Total (mg/L)		0.00055	0.00051	0.00036	0.00044		0.00048	0.00043	0.00037		<0.00050	0.00039	0.00040	0.00041	0.00039
Arsenic (As)-Total (mg/L)		0.00060	0.00059	0.00073	0.00100		0.00140	0.00142	0.00174		0.00183	0.00191	0.00204	0.00211	0.00135
Barium (Ba)-Total (mg/L)		0.0190	0.0220	0.0168	0.0177		0.0188	0.0172	0.0172		0.0178	0.0167	0.0172	0.0179	0.0216
Beryllium (Be)-Total (mg/L)		<0.000100	<0.000100	<0.000100	<0.000100		<0.000200	<0.000200	<0.000100		<0.000100	<0.000100	<0.000200	<0.000200	<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050	<0.000050	<0.000050	<0.000050		<0.000100	<0.000100	<0.000100		<0.000250	<0.000100	<0.000100	<0.000100	<0.000050
Boron (B)-Total (mg/L)		0.211	0.239	0.321	0.279		0.314	0.284	0.300		0.331	0.336	0.326	0.336	0.376

	: E10														
	5-Apr-22	12-Apr-22	25-Apr-22	2-May-22	5-May-22	8-Jun-22	14-Jun-22	21-Jun-22	4-Oct-22	18-Oct-22	16-Nov-22	24-Nov-22	29-Nov-22	6-Dec-22	13-Dec-22
Diss-Selenium (mg/L)	0.0179	0.0206	0.0209		0.0370	0.0269	0.0287	0.0238	0.0495	0.0501	0.0490	0.0448	0.0458	0.0431	
Diss-Silicon (Si) (mg/L)	7.65	7.33	7.95		5.74	5.76	5.70	5.69	4.48	4.29	4.36	4.53	4.81	4.68	
Diss-Silver (Ag) (mg/L)	<0.000020	<0.000020	<0.000100		<0.000010	<0.000050	<0.000050	<0.000050	<0.000010	<0.000010	<0.000020	<0.000020	<0.000020	<0.000020	
Diss-Sodium (Na) (mg/L)	31.4	27.8	29.6		23.6	29.7	33.0	32.6	29.7	28.4	26.8	27.7	27.8	26.0	
Diss-Strontium (Sr) (mg/L)	8.07	7.36	7.78		4.64	12.2	12.6	13.5	5.32	5.65	6.79	6.71	6.20	6.06	
Diss-Thallium (Tl) (mg/L)	<0.000020	<0.000020	<0.000100		<0.000010	<0.000050	<0.000050	<0.000050	<0.000010	<0.000010	<0.000020	<0.000020	<0.000020	<0.000020	
Diss-Tin (Sn) (mg/L)	<0.00020	<0.00020	<0.00100		<0.00010	<0.00050	<0.00050	<0.00050	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020	
Diss-Titanium (Ti) (mg/L)	<0.0200	<0.0200	<0.0100		<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0200	<0.0100	<0.0100	
Diss-Uranium (U) (mg/L)	0.00208	0.00210	0.00198		0.00225	0.00349	0.00389	0.00357	0.00240	0.00246	0.00298	0.00291	0.00273	0.00296	
Diss-Vanadium (V) (mg/L)	<0.00100	<0.00100	<0.00500		<0.00050	<0.00250	<0.00250	<0.00250	0.00131	0.00118	0.00116	0.00108	0.00106	0.00108	
Diss-Zinc (Zn) (mg/L)	<0.0060	<0.0060	<0.0100		0.0230	0.0477	0.0530	0.0510	0.0046	0.0051	0.0098	0.0111	0.0087	0.0090	
TDS (mg/L)	951	1040	1050		968	1060	1130	1140	918	928	1040	982	990	919	
Field Tests															
Cond (in situ) (µs/cm)	1250.4	1216.9	1261		1223	1257	1307.2	1322.7	1149.9	1150	1229	1281	1263	1221	
NTU - in situ (ntu)	0.06	0.49	0.21		1.83	25.41	6.23	1.56	0.67	0.13		0.47	1.21	0.24	
pH (in situ) (pH)	7.33	7.46	7.38		7.5	7.67	7.77	7.83	8.02	7.94	8.61	7.62	7.86	7.9	
Sample Taken	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Temp (in situ) (Degrees Celcius)	7.936	7.847	8.136		9.1	15.32	16.792	15.974	15.107	13.026	4.1	5.432	2.853	3.125	
Organic / Inorganic															
DOC (mg/L)	1.71	1.28	1.44		1.58	1.45	1.71	2.10	2.11	1.08	1.70	1.92	1.72	1.52	
Physical Test															
Conductivity (µs/cm)	1260	1280	1280		1240	1280	1360	1480	1130	1130	1250	1220	1180	1240	
Hardness (mg/L)	709	583	677		661	688	739	753	629	579	624	663	635	596	
NTU (ntu)	0.56	0.57	0.55		2.21	2.42	2.32	0.77	0.22	0.18	0.14	0.17	2.25	0.18	
pH (pH)	7.94	8.14	8.26		8.13	8.25	8.08	8.09	8.05	8.12	8.07	7.98	7.85	8.03	
TDS (mg/L)	951	1040	1050		968	1060	1130	1140	918	928	1040	982	990	919	
TSS (mg/L)	1.4	<1.1	<1.0		<1.0	1.1	3.4	1.4	<1.0	1.1	1.4	<1.0	3.4	<1.1	
Total Metals															
Aluminum (Al)-Total (mg/L)	<0.0060	<0.0060	<0.0150		0.126	0.100	0.216	0.0484	0.0070	0.0066	<0.0060	0.0243	0.115	0.0080	
Antimony (Sb)-Total (mg/L)	0.00044	0.00046	<0.00050		0.00058	0.00088	0.00090	0.00086	0.00101	0.00105	0.00103	0.00104	0.00103	0.00097	
Arsenic (As)-Total (mg/L)	0.00143	0.00122	0.00085		0.00086	0.00100	0.00097	0.00094	0.00109	0.00098	0.00100	0.00111	0.00106	0.00105	
Barium (Ba)-Total (mg/L)	0.0225	0.0216	0.0204		0.0304	0.0464	0.0494	0.0549	0.0684	0.0602	0.0555	0.0548	0.0606	0.0531	
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100		<0.000100	<0.000200	<0.000500	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	
Bismuth (Bi)-Total (mg/L)	<0.000100	<0.000100	<0.000250		<0.000050	<0.000100	<0.000250	<0.000250	<0.000050	<0.000050	<0.000100	<0.000100	<0.000100	<0.000100	
Boron (B)-Total (mg/L)	0.329	0.331	0.300		0.162	0.196	0.175	0.214	0.109	0.128	0.130	0.123	0.133	0.127	

	: E10														
	27-Dec-22	5-Jan-23	10-Jan-23	16-Jan-23	23-Jan-23	1-Feb-23	6-Feb-23	9-Feb-23	13-Feb-23	22-Feb-23	6-Mar-23	14-Mar-23	21-Mar-23	29-Mar-23	30-Mar-23
Diss-Selenium (mg/L)	0.0433	0.0437	0.0415	0.0423	0.0423	0.0395		0.0420	0.0425	0.0378	0.0348	0.0328	0.0364		
Diss-Silicon (Si) (mg/L)	4.70	4.66	4.74	4.83	4.89	5.07		4.81	4.75	4.48	4.91	4.81	4.86		
Diss-Silver (Ag) (mg/L)	<0.000020	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010		<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		
Diss-Sodium (Na) (mg/L)	25.6	24.6	25.9	24.2	25.4	24.0		26.2	25.3	24.2	25.5	22.3	23.3		
Diss-Strontium (Sr) (mg/L)	6.48	6.45	5.98	6.24	6.28	6.33		6.11	6.42	6.26	6.22	5.23	6.08		
Diss-Thallium (Tl) (mg/L)	<0.000020	<0.000020	<0.000020	0.000010	0.000011	<0.000010		<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		
Diss-Tin (Sn) (mg/L)	<0.00020	<0.00020	<0.00020	<0.00010	0.00014	<0.00010		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0200	<0.0100	<0.0100	<0.0100	<0.0100		<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100		
Diss-Uranium (U) (mg/L)	0.00295	0.00271	0.00276	0.00264	0.00268	0.00273		0.00275	0.00297	0.00301	0.00263	0.00253	0.00270		
Diss-Vanadium (V) (mg/L)	0.00105	0.00108	0.00105	0.00109	0.00110	0.00112		0.00114	0.00112	0.00108	<0.00100	<0.00100	<0.00100		
Diss-Zinc (Zn) (mg/L)	0.0094	0.0108	0.0087	0.0081	0.0103	0.0087		0.0091	0.0098	0.0100	0.0095	0.0133	0.0090		
TDS (mg/L)	1000	973	919	961	966	892		954	922	937	885	924	1000		
Field Tests															
Cond (in situ) (µs/cm)	1253	1229.5	1421	1205.6	1205	1203		1232	1238	1226	1160	1132	1213		
NTU - in situ (ntu)	1.52	0.89	3.31	1.03	0.33	1.17		1.28	1.14	1.38	1.2	16.01	0.77		
pH (in situ) (pH)	7.79	7.84	7.71	7.73	7.76	7.73		7.87	7.85	7.85	7.82	7.61	7.74		
Sample Taken	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Temp (in situ) (Degrees Celcius)	4.141	3.413	2.903	4.72	4.102	3.637		4.453	3.795	2.736	2.593	3.691	6.12		
Organic / Inorganic															
DOC (mg/L)	1.54	1.85	1.67	1.74	1.87	1.80		1.64	1.86	1.67	1.50	1.75	1.91		
Physical Test															
Conductivity (µs/cm)	1260	1240	1210	1180	1170	1200		1290	1250	1210	1130	1110	1200		
Hardness (mg/L)	616	624	608	572	593	601		596	620	598	608	528	593		
NTU (ntu)	0.45	0.38	0.13	0.21	0.34	0.36		0.38	0.99	0.66	0.65	17.2	0.97		
pH (pH)	7.97	8.12	8.10	8.07	7.97	8.00		8.07	8.11	8.20	8.00	8.07	7.99		
TDS (mg/L)	1000	973	919	961	966	892		954	922	937	885	924	1000		
TSS (mg/L)	1.5	1.8	1.4	1.1	<1.0	<1.0		<1.0	1.1	1.5	<1.0	25.8	1.0		
Total Metals															
Aluminum (Al)-Total (mg/L)	0.0142	0.0245	0.0099	0.0076	0.0272	0.0225		0.0324	0.0769	0.0641	0.0528	0.934	0.0400		
Antimony (Sb)-Total (mg/L)	0.00111	0.00099	0.00098	0.00090	0.00094	0.00091		0.00094	0.00094	0.00093	0.00089	0.00080	0.00100		
Arsenic (As)-Total (mg/L)	0.00109	0.00104	0.00100	0.00099	0.00107	0.00107		0.00099	0.00104	0.00101	0.00097	0.00165	0.00098		
Barium (Ba)-Total (mg/L)	0.0579	0.0545	0.0570	0.0527	0.0558	0.0560		0.0556	0.0556	0.0509	0.0515	0.0688	0.0468		
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000200	<0.000100		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		
Bismuth (Bi)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000050		
Boron (B)-Total (mg/L)	0.129	0.119	0.123	0.115	0.112	0.120		0.120	0.123	0.133	0.121	0.104	0.123		

	: E10														
	6-Apr-23	20-Apr-23	26-Apr-23	3-May-23	8-May-23	15-May-23	29-May-23	8-Jun-23	12-Jun-23	13-Jun-23	29-Jun-23	6-Jul-23	13-Jul-23	25-Jul-23	3-Aug-23
Diss-Selenium (mg/L)					0.0206	0.0267	0.0293			0.0295	0.0314		0.0269	0.0299	0.0302
Diss-Silicon (Si) (mg/L)					4.01	4.46	4.76			4.89	5.13		5.62	5.59	5.61
Diss-Silver (Ag) (mg/L)					<0.000010	<0.000010	<0.000020			<0.000020	<0.000020		<0.000050	<0.000020	<0.000050
Diss-Sodium (Na) (mg/L)					10.8	14.9	19.0			21.3	25.4		26.6	29.8	28.6
Diss-Strontium (Sr) (mg/L)					2.98	3.88	5.61			7.18	7.78		10.1	14.7	13.8
Diss-Thallium (Tl) (mg/L)					<0.000010	<0.000010	<0.000020			<0.000020	<0.000020		<0.000050	0.000021	<0.000050
Diss-Tin (Sn) (mg/L)					<0.00010	<0.00010	<0.00020			<0.00020	<0.00020		<0.00050	<0.00020	<0.00050
Diss-Titanium (Ti) (mg/L)					<0.0100	<0.0100	<0.0200			<0.0100	<0.0100		<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)					0.00184	0.00235	0.00269			0.00295	0.00350		0.00360	0.00539	0.00538
Diss-Vanadium (V) (mg/L)					0.00085	0.00099	0.00107			0.00110	<0.00100		<0.00250	<0.00100	<0.00250
Diss-Zinc (Zn) (mg/L)					0.0052	0.0067	0.0070			0.0098	0.0510		0.0706	0.0847	0.0750
TDS (mg/L)					496	642	777			972	1240		1380	1950	1920
Field Tests															
Cond (in situ) (µs/cm)					663	842	1022			1087	1417		1583	2018	1698
NTU - in situ (ntu)					0.23	0.27	0.45			1.11	1.28		1.3	0.53	0.33
pH (in situ) (pH)					7.77	7.63	7.79			7.91	7.62		7.42	7.6	7.72
Sample Taken	No	No	No	No	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes
Temp (in situ) (Degrees Celcius)					11.581	16.508	18.668			17.7	18.772		17.236	17.468	16.536
Organic / Inorganic															
DOC (mg/L)					1.24	1.67	1.84			1.31	1.64		1.70	1.38	1.74
Physical Test															
Conductivity (µs/cm)					629	817	1010			1180	1410		1670	2050	2010
Hardness (mg/L)					296	400	501			594	788		985	1220	1200
NTU (ntu)					0.42	0.18	0.32			0.35	0.30		0.51	0.38	0.54
pH (pH)					8.05	8.16	8.17			8.12	8.01		8.10	8.08	8.12
TDS (mg/L)					496	642	777			972	1240		1380	1950	1920
TSS (mg/L)					2.1	3.1	1.0			<1.0	1.4		<1.0	<1.0	<1.1
Total Metals															
Aluminum (Al)-Total (mg/L)					0.0522	0.0117	0.0241			0.0148	0.0178		0.0094	<0.0150	<0.0150
Antimony (Sb)-Total (mg/L)					0.00048	0.00064	0.00084			0.00089	0.00086		0.00068	0.00070	0.00079
Arsenic (As)-Total (mg/L)					0.00072	0.00090	0.00112			0.00114	0.00109		0.00064	0.00065	0.00058
Barium (Ba)-Total (mg/L)					0.0333	0.0406	0.0432			0.0470	0.0412		0.0393	0.0373	0.0380
Beryllium (Be)-Total (mg/L)					<0.000100	<0.000100	<0.000100			<0.000200	<0.000100		<0.000200	<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)					<0.000050	<0.000050	<0.000100			<0.000100	<0.000100		<0.000100	<0.000250	<0.000250
Boron (B)-Total (mg/L)					0.072	0.092	0.106			0.120	0.141		0.162	0.161	0.196

	: E10														
	9-Aug-23	14-Aug-23	21-Aug-23	31-Aug-23	11-Sep-23	13-Sep-23	21-Sep-23	26-Sep-23	5-Oct-23	11-Oct-23	16-Oct-23	17-Oct-23	23-Oct-23	1-Nov-23	8-Nov-23
Diss-Selenium (mg/L)		0.0253	0.0229	0.0234					0.0105	0.0247		0.0110			
Diss-Silicon (Si) (mg/L)		5.79	5.93	5.91					7.35	6.75		6.25			
Diss-Silver (Ag) (mg/L)		<0.000050	<0.000050	<0.000050					0.000025	<0.000020		<0.000020			
Diss-Sodium (Na) (mg/L)		31.4	30.9	29.8					30.8	26.5		32.3			
Diss-Strontium (Sr) (mg/L)		13.4	14.0	12.1					11.4	8.43		11.9			
Diss-Thallium (Tl) (mg/L)		<0.000050	<0.000050	<0.000050					0.000023	<0.000020		0.000025			
Diss-Tin (Sn) (mg/L)		<0.00050	<0.00050	<0.00050					<0.00020	<0.00020		<0.00020			
Diss-Titanium (Ti) (mg/L)		<0.0100	<0.0500	<0.0100					<0.0200	<0.0100		<0.0100			
Diss-Uranium (U) (mg/L)		0.00583	0.00638	0.00642					0.00667	0.00503		0.00722			
Diss-Vanadium (V) (mg/L)		<0.00250	<0.00250	<0.00250					<0.00100	<0.00100		<0.00100			
Diss-Zinc (Zn) (mg/L)		0.0761	0.0878	0.0836					0.0771	0.0587		0.0957			
TDS (mg/L)		1920	2000	1920					2060	2350		1890			
Field Tests															
Cond (in situ) (µs/cm)		1996	2101	1970					2272	2193		2034			
NTU - in situ (ntu)		0.58	0.93	0.65					0.34	0.46		0.45			
pH (in situ) (pH)		7.75	7.63	7.47					7.16	7.2		7.45			
Sample Taken	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes	No	Yes	No	No	No
Temp (in situ) (Degrees Celcius)		19.676	17.337	15.466					10.746	11.676		10.779			
Organic / Inorganic															
DOC (mg/L)		1.78	2.02	1.50					1.70	2.81		1.36			
Physical Test															
Conductivity (µs/cm)		2090	2100	2100					2230	2250		2100			
Hardness (mg/L)		1200	1230	1170					1460	1290		1290			
NTU (ntu)		0.78	0.55	0.51					0.21	0.30		0.24			
pH (pH)		8.17	7.89	8.12					7.91	8.04		8.18			
TDS (mg/L)		1920	2000	1920					2060	2350		1890			
TSS (mg/L)		<1.0	<1.1	<1.0					3.1	<1.0		3.3			
Total Metals															
Aluminum (Al)-Total (mg/L)		<0.0150	0.0153	<0.0150					0.0070	0.0213		0.0122			
Antimony (Sb)-Total (mg/L)		0.00077	0.00086	0.00090					0.00072	0.00075		0.00093			
Arsenic (As)-Total (mg/L)		0.00063	0.00064	0.00065					0.00068	0.00059		0.00062			
Barium (Ba)-Total (mg/L)		0.0333	0.0282	0.0280					0.0333	0.0323		0.0248			
Beryllium (Be)-Total (mg/L)		<0.000100	<0.000500	<0.000100					<0.000100	<0.000100		<0.000200			
Bismuth (Bi)-Total (mg/L)		<0.000250	<0.000250	<0.000250					<0.000050	<0.000100		<0.000100			
Boron (B)-Total (mg/L)		0.166	0.159	0.162					0.182	0.174		0.173			

	: E10					
	23-Nov-23	28-Nov-23	7-Dec-23	12-Dec-23	19-Dec-23	27-Dec-23
Diss-Selenium (mg/L)	0.00652	0.00696	0.00705		0.00687	0.00770
Diss-Silicon (Si) (mg/L)	6.80	6.69	6.47		6.50	6.21
Diss-Silver (Ag) (mg/L)	<0.000050	<0.000020	<0.000020		<0.000020	<0.000020
Diss-Sodium (Na) (mg/L)	31.6	31.0	28.5		28.2	26.3
Diss-Strontium (Sr) (mg/L)	10.8	10.4	10.0		9.30	8.58
Diss-Thallium (Tl) (mg/L)	<0.000050	0.000025	0.000021		0.000026	0.000021
Diss-Tin (Sn) (mg/L)	<0.00050	<0.00020	<0.00020		<0.00020	<0.00020
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0100	<0.0100		<0.0200	<0.0100
Diss-Uranium (U) (mg/L)	0.00726	0.00682	0.00644		0.00635	0.00621
Diss-Vanadium (V) (mg/L)	<0.00250	<0.00100	<0.00100		<0.00100	<0.00100
Diss-Zinc (Zn) (mg/L)	0.124	0.122	0.108		0.116	0.119
TDS (mg/L)	2090	1880	1900		1730	1710
Field Tests						
Cond (in situ) (µs/cm)	2143	2062	2051		1938	1906
NTU - in situ (ntu)	1.44	0.37	0.23		0.24	0.15
pH (in situ) (pH)	7.65	7.69	7.6		7.62	7.55
Sample Taken	Yes	Yes	Yes	No	Yes	Yes
Temp (in situ) (Degrees Celcius)	5.487	3.749	3.289		3.741	5.098
Organic / Inorganic						
DOC (mg/L)	1.32	1.09	1.22		1.20	1.16
Physical Test						
Conductivity (µs/cm)	2120	2090	2020		1910	1910
Hardness (mg/L)	1310	1280	1220		1120	1080
NTU (ntu)	0.27	0.20	0.36		0.23	0.20
pH (pH)	8.25	8.25	8.14		8.15	7.93
TDS (mg/L)	2090	1880	1900		1730	1710
TSS (mg/L)	<1.0	<1.0	<1.0		<1.0	<1.0
Total Metals						
Aluminum (Al)-Total (mg/L)	<0.0060	0.0084	<0.0060		<0.0060	0.0073
Antimony (Sb)-Total (mg/L)	0.00065	0.00069	0.00076		0.00068	0.00070
Arsenic (As)-Total (mg/L)	0.00050	0.00056	0.00061		0.00058	0.00057
Barium (Ba)-Total (mg/L)	0.0221	0.0226	0.0238		0.0228	0.0212
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000200	<0.000100		<0.000200	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100
Boron (B)-Total (mg/L)	0.168	0.158	0.176		0.175	0.171

Grid Format Report : E10 - Effluent from Wight Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E10														
	2-Jan-19	14-Feb-19	6-Mar-19	7-Mar-19	4-Apr-19	9-May-19	1-Aug-19	9-Sep-19	3-Oct-19	19-Nov-19	25-Nov-19	19-Feb-20	16-Apr-20	20-Apr-20	27-May-20
Cadmium (Cd)-Total (mg/L)	0.000293	0.000273		0.000382	0.000447	0.000433	0.000507	<0.00060	<0.00044		0.000422	0.000401		0.000257	0.000812
Calcium (Ca)-Total (mg/L)	271	268		272	277	264	261	237	240		221	227		222	394
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050		<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)	0.00015	0.00013		0.00026	0.00044	0.00035	0.00075	0.00024	0.00070		0.00065	0.00076		0.00032	0.00153
Copper (Cu)-Total (mg/L)	0.0137	0.0128		0.0156	0.0199	0.0186	0.0201	0.0187	0.0208		0.0198	0.0178		0.0135	0.0290
Iron (Fe)-Total (mg/L)	0.043	0.049		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030		<0.030	<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050		<0.00010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050		<0.000050	<0.000050
Lithium (Li)-Total (mg/L)	0.0097	0.0090		0.0083	0.0087	0.0081	0.0079	0.0079	0.0081		0.0077	0.0073		0.0076	0.0110
Magnesium (Mg)-Total (mg/L)	30.7	28.6		28.4	28.7	29.4	28.7	24.3	25.7		25.6	24.2		22.8	45.9
Manganese (Mn)-Total (mg/L)	0.0392	0.0343		0.105	0.154	0.155	0.256	0.197	0.269		0.226	0.217		0.104	0.434
Molybdenum (Mo)-Tota (mg/L)	0.142	0.142		0.125	0.121	0.134	0.142	0.127	0.134		0.137	0.137		0.137	0.128
Nickel (Ni)-Total (mg/L)	0.00077	0.00055		<0.0010	0.00079	0.00082	0.00092	0.00091	0.00086		0.00077	0.00067		0.00053	0.00186
Potassium (K)-Total (mg/L)	1.45	1.32		1.51	1.43	1.47	1.53	1.36	1.46		1.43	1.40		1.30	1.92
Selenium (Se)-Total (mg/L)	0.00903	0.00706		0.00865	0.00887	0.0160	0.0106	0.0118	0.00757		0.00921	0.00870		0.00952	0.0184
Silicon (Si)-Total (mg/L)	9.12	8.88		7.71	7.74	7.80	7.73	7.55	7.62		8.27	7.65		7.59	8.03
Silver (Ag)-Total (mg/L)	0.000016	0.000014		<0.000020	0.000019	0.000013	0.000013	0.000010	0.000015		0.000012	<0.000010		0.000012	0.000015
Sodium (Na)-Total (mg/L)	34.4	31.3		28.7	28.3	29.8	26.3	24.1	24.2		24.9	26.0		24.0	30.9
Strontium (Sr)-Total (mg/L)	10.6	10.3		8.37	7.52	7.07	6.61	5.30	5.61		5.61	5.67		5.07	9.01
Thallium (Tl)-Total (mg/L)	0.000012	0.000012		<0.000020	0.000014	0.000018	0.000014	0.000012	0.000012		0.000012	0.000012		0.000012	0.000022
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010		<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010		<0.00010	<0.00010
Titanium (Ti)-Total (mg/L)	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		<0.010	<0.0100		<0.0100	<0.0100
Uranium (U)-Total (mg/L)	0.00251	0.00273		0.00332	0.00347	0.00320	0.00340	0.00328	0.00323		0.00310	0.00322		0.00313	0.00501
Vanadium (V)-Total (mg/L)	0.00051	0.00063		<0.0010	0.00054	0.00052	0.00054	0.00053	0.00057		0.00062	<0.00050		<0.00050	0.00052
Zinc (Zn)-Total (mg/L)	0.0189	0.0157		0.0188	0.0189	0.0184	0.0201	0.0182	0.0176		0.0163	0.0131		0.0117	0.0394

	: E10														
	31-Aug-20	11-Nov-20	24-Nov-20	8-Dec-20	21-Dec-20	4-Jan-21	5-Jan-21	12-Jan-21	27-Jan-21	23-Feb-21	9-Mar-21	22-Mar-21	7-Apr-21	8-Apr-21	13-Apr-21
Cadmium (Cd)-Total (mg/L)	0.000383	0.000323	<0.000435	0.000388	0.000431				<0.000425	0.000367		0.000311			0.000290
Calcium (Ca)-Total (mg/L)	254	241	272	277	274				311	265		254			232
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050				<0.00050	<0.00050		<0.00050			<0.00050
Cobalt (Co)-Total (mg/L)	0.00081	0.00051	0.00074	0.00088	0.00112				0.00100	0.00073		0.00071			0.00061
Copper (Cu)-Total (mg/L)	0.0160	0.0168	0.0276	0.0170	0.0188				0.0179	0.0175		0.0164			0.0139
Iron (Fe)-Total (mg/L)	<0.030	0.052	0.159	0.043	<0.030				<0.030	<0.030		<0.030			<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000105	<0.000050	<0.000050				<0.000050	<0.000050		<0.000050			<0.000050
Lithium (Li)-Total (mg/L)	0.0095	0.0088	0.0089	0.0088	0.0095				0.0084	0.0088		0.0088			0.0082
Magnesium (Mg)-Total (mg/L)	32.5	30.8	32.0	33.8	34.6				32.9	28.9		29.1			26.1
Manganese (Mn)-Total (mg/L)	0.193	0.0753	0.154	0.197	0.259				0.211	0.195		0.194			0.149
Molybdenum (Mo)-Tota (mg/L)	0.137	0.144	0.136	0.134	0.121				0.134	0.132		0.139			0.133
Nickel (Ni)-Total (mg/L)	0.00088	0.00082	0.00113	0.00125	0.00124				0.00094	0.00100		0.00086			<0.00050
Potassium (K)-Total (mg/L)	1.46	1.43	1.47	1.54	1.59				1.42	1.36		1.47			1.32
Selenium (Se)-Total (mg/L)	0.0332	0.0262	0.0232	0.0238	0.0201				0.0142	0.00937		0.00492			0.00527
Silicon (Si)-Total (mg/L)	6.98	6.52	7.54	7.18	7.19				7.51	7.43		7.61			7.32
Silver (Ag)-Total (mg/L)	0.000012	<0.000010	0.000012	0.000011	<0.000010				0.000015	<0.000010		0.000014			0.000012
Sodium (Na)-Total (mg/L)	24.1	23.0	24.4	27.0	26.3				28.1	24.8		26.7			24.6
Strontium (Sr)-Total (mg/L)	5.36	5.85	5.63	6.28	5.55				5.92	5.39		5.72			5.28
Thallium (Tl)-Total (mg/L)	<0.000010	0.000010	0.000010	0.000010	0.000012				0.000017	0.000010		<0.000010			<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010				<0.00010	<0.00010		<0.00010			<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100				<0.0100	<0.0100		<0.0100			<0.0100
Uranium (U)-Total (mg/L)	0.00280	0.00245	0.00292	0.00299	0.00300				0.00298	0.00312		0.00292			0.00254
Vanadium (V)-Total (mg/L)	0.00059	0.00064	0.00089	0.00051	0.00059				0.00055	0.00056		0.00052			0.00057
Zinc (Zn)-Total (mg/L)	0.0121	0.0282	0.0221	0.0356	0.0146				0.0128	0.0116		0.0124			0.0094

	: E10														
	20-Apr-21	**3-May-21**	**17-May-21**	**2-Jun-21**	**16-Jun-21**	**29-Jun-21**	**13-Jul-21**	**27-Jul-21**	**3-Aug-21**	**23-Aug-21**	**8-Sep-21**	**14-Sep-21**	**27-Sep-21**	**6-Oct-21**	**19-Oct-21**
Cadmium (Cd)-Total (mg/L)	0.000258	0.000262	0.000302	0.000342	0.000379	0.000400	0.000370		0.000354		0.000303		0.000363	0.000269	0.000167
Calcium (Ca)-Total (mg/L)	229	227	226	244	291	253	252		233		226		216	192	190
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00100	<0.00100	<0.00100	<0.00050		<0.00050		<0.00100		<0.00100	<0.00100	<0.00050
Cobalt (Co)-Total (mg/L)	0.00059	0.00023	0.00020	0.00035	0.00063	0.00066	0.00077		0.00068		0.00053		0.00059	0.00064	0.00067
Copper (Cu)-Total (mg/L)	0.0142	0.0137	0.0148	0.0144	0.0156	0.0158	0.0163		0.0171		0.0154		0.0159	0.0423	0.0162
Iron (Fe)-Total (mg/L)	<0.030	<0.030	0.045	<0.060	<0.060	<0.060	<0.030		<0.030		<0.060		<0.060	0.412	2.18
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000100	<0.000100	<0.000100	<0.000050		<0.000050		<0.000100		<0.000100	<0.000100	<0.000050
Lithium (Li)-Total (mg/L)	0.0084	0.0081	0.0085	0.0083	0.0093	0.0086	0.0088		0.0082		0.0079		0.0074	0.0071	0.0070
Magnesium (Mg)-Total (mg/L)	25.3	26.4	29.6	29.8	32.7	29.4	28.3		28.2		25.3		24.2	23.6	22.8
Manganese (Mn)-Total (mg/L)	0.145	0.0322	0.0353	0.0690	0.151	0.156	0.182		0.172		0.138		0.158	0.168	0.155
Molybdenum (Mo)-Tota (mg/L)	0.134	0.131	0.132	0.124	0.132	0.128	0.143		0.136		0.128		0.120	0.123	0.128
Nickel (Ni)-Total (mg/L)	0.00054	0.00094	0.00086	<0.00100	0.00104	<0.00100	0.00098		0.00092		<0.00100		<0.00100	<0.00100	0.00318
Potassium (K)-Total (mg/L)	1.36	1.32	1.49	1.34	1.36	1.39	1.41		1.42		1.41		1.36	1.30	1.16
Selenium (Se)-Total (mg/L)	0.00647	0.0224	0.0326	0.0255	0.0242	0.0215	0.0185		0.0134		0.00799		0.0127	0.0144	0.0144
Silicon (Si)-Total (mg/L)	7.57	6.89	6.33	6.68	6.40	6.54	6.72		6.95		6.74		6.79	6.88	5.71
Silver (Ag)-Total (mg/L)	0.000013	<0.000010	<0.000010	<0.000020	<0.000020	<0.000020	<0.000010		0.000015		<0.000020		<0.000020	<0.000020	<0.000010
Sodium (Na)-Total (mg/L)	24.6	21.8	23.4	21.4	23.8	22.9	23.9		23.0		23.6		22.8	22.0	21.6
Strontium (Sr)-Total (mg/L)	5.28	5.53	5.73	5.46	5.47	5.40	5.57		5.18		5.04		4.34	4.37	4.11
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000020	<0.000020	<0.000020	<0.000010		0.000012		<0.000020		<0.000020	<0.000020	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00010		<0.00010		<0.00020		<0.00020	<0.00020	<0.00010
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0200	<0.0200	<0.0200	<0.0100		<0.0100		<0.0200		<0.0200	<0.0200	<0.0100
Uranium (U)-Total (mg/L)	0.00286	0.00231	0.00235	0.00266	0.00286	0.00283	0.00278		0.00292		0.00266		0.00258	0.00238	0.00224
Vanadium (V)-Total (mg/L)	0.00063	0.00069	<0.00050	<0.00100	<0.00100	<0.00100	<0.00050		0.00054		<0.00100		<0.00100	<0.00100	0.00066
Zinc (Zn)-Total (mg/L)	0.0095	0.0196	0.0338	0.0252	0.0140	0.0142	0.0124		0.0116		0.0102		0.0100	0.0092	0.0056

	: E10														
	3-Nov-21	9-Nov-21	17-Nov-21	24-Nov-21	2-Dec-21	8-Dec-21	13-Dec-21	20-Dec-21	17-Jan-22	25-Jan-22	2-Feb-22	10-Feb-22	15-Feb-22	22-Feb-22	15-Mar-22
Cadmium (Cd)-Total (mg/L)		0.000213	0.000259	0.000180	0.000184		<0.000130	<0.000135	<0.000160		<0.000145	<0.000135	<0.000160	<0.000140	0.000193
Calcium (Ca)-Total (mg/L)		175	203	216	193		212	191	215		219	225	218	225	230
Chromium (Cr)-Total (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050		<0.00100	<0.00100	<0.00050		<0.00050	<0.00050	<0.00100	<0.00100	<0.00050
Cobalt (Co)-Total (mg/L)		0.00040	0.00064	0.00083	0.00075		0.00045	0.00042	0.00043		<0.00050	0.00029	0.00030	0.00030	0.00196
Copper (Cu)-Total (mg/L)		0.0124	0.0145	0.00520	0.00683		0.00596	0.00704	0.00691		0.00560	0.00630	0.00651	0.00692	0.0145
Iron (Fe)-Total (mg/L)		<0.030	<0.030	0.287	0.270		0.272	0.270	0.273		0.293	0.321	0.311	0.323	0.204
Lead (Pb)-Total (mg/L)		<0.000050	<0.000050	0.000149	<0.000050		<0.000100	<0.000100	<0.000100		<0.000250	<0.000100	<0.000100	<0.000100	<0.000050
Lithium (Li)-Total (mg/L)		0.0069	0.0072	0.0098	0.0091		0.0100	0.0084	0.0091		0.0104	0.0097	0.0092	0.0093	0.0079
Magnesium (Mg)-Total (mg/L)		20.4	25.6	22.2	23.2		20.2	21.6	23.3		26.1	25.7	24.6	25.5	23.8
Manganese (Mn)-Total (mg/L)		0.0866	0.145	0.153	0.160		0.102	0.105	0.120		0.0958	0.109	0.110	0.115	0.348
Molybdenum (Mo)-Tota (mg/L)		0.129	0.123	0.226	0.226		0.268	0.224	0.183		0.195	0.192	0.188	0.181	0.149
Nickel (Ni)-Total (mg/L)		0.00056	0.00056	<0.00050	<0.00050		<0.00100	<0.00100	<0.00100		<0.00250	<0.00100	<0.00100	<0.00100	<0.00050
Potassium (K)-Total (mg/L)		1.24	1.32	1.62	1.50		1.60	1.48	1.38		1.36	1.28	1.26	1.24	1.15
Selenium (Se)-Total (mg/L)		0.0185	0.0137	0.00683	0.00526		0.00512	0.00496	0.00781		0.00706	0.00883	0.00964	0.0140	0.0164
Silicon (Si)-Total (mg/L)		6.68	6.83	6.92	7.07		7.62	7.62	7.93		8.61	8.83	8.27	8.93	8.01
Silver (Ag)-Total (mg/L)		0.000012	0.000010	<0.000010	0.000012		<0.000020	<0.000020	<0.000020		<0.000050	<0.000020	<0.000020	<0.000020	0.000013
Sodium (Na)-Total (mg/L)		20.9	22.9	36.8	37.9		43.6	35.1	34.3		37.7	34.6	32.6	34.7	30.2
Strontium (Sr)-Total (mg/L)		4.04	4.50	8.72	8.58		9.88	8.78	9.31		10.0	10.3	9.26	9.47	7.61
Thallium (Tl)-Total (mg/L)		<0.000010	0.000010	<0.000010	0.000010		<0.000020	<0.000020	<0.000020		<0.000050	<0.000020	<0.000020	<0.000020	<0.000010
Tin (Sn)-Total (mg/L)		<0.00010	<0.00010	<0.00010	<0.00010		<0.00020	<0.00020	<0.00020		<0.00050	<0.00020	<0.00020	<0.00020	<0.00010
Titanium (Ti)-Total (mg/L)		<0.0100	<0.0100	<0.0100	<0.0100		<0.0200	<0.0200	<0.0100		<0.0100	<0.0100	<0.0200	<0.0200	<0.0100
Uranium (U)-Total (mg/L)		0.00233	0.00234	0.00245	0.00332		0.00338	0.00277	0.00230		0.00245	0.00239	0.00230	0.00230	0.00215
Vanadium (V)-Total (mg/L)		0.00059	0.00054	<0.00050	0.00057		<0.00100	<0.00100	<0.00100		<0.00250	<0.00100	<0.00100	<0.00100	0.00079
Zinc (Zn)-Total (mg/L)		0.0065	0.0085	0.0281	0.0164		0.0133	0.0128	0.0093		<0.0150	0.0085	0.0083	0.0073	0.0047

	: E10														
	5-Apr-22	12-Apr-22	25-Apr-22	2-May-22	5-May-22	8-Jun-22	14-Jun-22	21-Jun-22	4-Oct-22	18-Oct-22	16-Nov-22	24-Nov-22	29-Nov-22	6-Dec-22	13-Dec-22
Cadmium (Cd)-Total (mg/L)	0.000202	0.000177	0.000198		0.000291	0.000376	0.000311	0.000403	<0.000125	<0.000140	<0.000190	0.000179	<0.000210	0.000172	
Calcium (Ca)-Total (mg/L)	238	238	237		219	223	229	263	182	182	209	222	206	210	
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	0.00063		<0.00050	<0.00100	<0.00250	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Cobalt (Co)-Total (mg/L)	0.00181	0.00161	0.00142		0.00034	0.00049	0.00064	0.00057	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020	
Copper (Cu)-Total (mg/L)	0.0176	0.0157	0.0132		0.0223	0.0182	0.0273	0.0151	0.00817	0.00820	0.00814	0.00946	0.0147	0.00884	
Iron (Fe)-Total (mg/L)	0.208	0.197	0.120		0.204	0.145	0.340	0.073	<0.030	<0.030	<0.030	0.113	0.122	<0.030	
Lead (Pb)-Total (mg/L)	<0.000100	<0.000100	<0.000250		0.000184	0.000240	0.000426	<0.000250	<0.000050	<0.000050	<0.000100	<0.000100	<0.000100	<0.000100	
Lithium (Li)-Total (mg/L)	0.0089	0.0077	0.0082		0.0071	0.0108	0.0102	0.0105	0.0076	0.0078	0.0083	0.0083	0.0080	0.0081	
Magnesium (Mg)-Total (mg/L)	26.6	23.4	22.8		28.4	30.5	28.5	35.4	28.4	27.9	29.9	31.1	29.0	29.3	
Manganese (Mn)-Total (mg/L)	0.272	0.225	0.186		0.0325	0.0660	0.0749	0.0753	0.00569	0.00490	0.00712	0.0101	0.0150	0.00898	
Molybdenum (Mo)-Tota (mg/L)	0.152	0.154	0.148		0.129	0.176	0.161	0.173	0.172	0.170	0.179	0.166	0.176	0.174	
Nickel (Ni)-Total (mg/L)	<0.00100	<0.00100	<0.00250		0.00066	<0.00100	<0.00250	<0.00250	<0.00050	<0.00050	<0.00100	<0.00100	<0.00100	<0.00100	
Potassium (K)-Total (mg/L)	1.36	1.14	1.09		1.46	2.40	2.14	2.35	2.61	2.59	2.58	2.48	2.36	2.46	
Selenium (Se)-Total (mg/L)	0.0204	0.0202	0.0215		0.0388	0.0268	0.0268	0.0281	0.0490	0.0534	0.0483	0.0467	0.0449	0.0444	
Silicon (Si)-Total (mg/L)	8.84	8.07	7.29		6.20	6.35	6.26	5.96	4.46	4.53	4.71	4.69	4.97	5.00	
Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000050		0.000019	0.000031	<0.000050	<0.000050	<0.000010	<0.000010	<0.000020	<0.000020	<0.000020	<0.000020	
Sodium (Na)-Total (mg/L)	34.3	28.2	26.4		23.0	32.9	31.0	34.4	28.2	28.0	26.3	28.1	26.5	27.0	
Strontium (Sr)-Total (mg/L)	8.05	8.06	7.68		4.73	12.7	12.9	14.4	4.82	5.56	6.74	6.52	6.41	6.66	
Thallium (Tl)-Total (mg/L)	<0.000020	<0.000020	<0.000050		<0.000010	<0.000020	<0.000050	<0.000050	<0.000010	0.000010	<0.000020	<0.000020	<0.000020	<0.000020	
Tin (Sn)-Total (mg/L)	<0.00020	<0.00020	<0.00050		<0.00010	<0.00020	<0.00050	<0.00050	<0.00010	<0.00010	<0.00020	<0.00020	<0.00020	<0.00020	
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100		<0.0100	<0.0200	<0.0500	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	
Uranium (U)-Total (mg/L)	0.00236	0.00230	0.00210		0.00223	0.00357	0.00371	0.00402	0.00235	0.00264	0.00288	0.00301	0.00286	0.00295	
Vanadium (V)-Total (mg/L)	<0.00100	<0.00100	<0.00250		0.00097	0.00154	<0.00250	<0.00250	0.00129	0.00122	0.00114	0.00119	0.00147	0.00108	
Zinc (Zn)-Total (mg/L)	<0.0060	<0.0060	<0.0150		0.0242	0.0537	0.0565	0.0592	0.0048	0.0052	0.0104	0.0100	0.0094	0.0082	

	: E10														
	27-Dec-22	5-Jan-23	10-Jan-23	16-Jan-23	23-Jan-23	1-Feb-23	6-Feb-23	9-Feb-23	13-Feb-23	22-Feb-23	6-Mar-23	14-Mar-23	21-Mar-23	29-Mar-23	30-Mar-23
Cadmium (Cd)-Total (mg/L)	0.000162	0.000176	0.000175	0.000145	0.000165	0.000160		0.000172	<0.000175	<0.000160	0.000140	0.000183	0.000193		
Calcium (Ca)-Total (mg/L)	226	199	206	187	182	193		199	196	203	186	176	189		
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00100	<0.00050		<0.00050	<0.00050	<0.00050	<0.00050	0.00086	<0.00050		
Cobalt (Co)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020	<0.00020	<0.00020	0.00082	<0.00010		
Copper (Cu)-Total (mg/L)	0.00885	0.0101	0.00908	0.00832	0.00938	0.0101		0.0106	0.0126	0.0124	0.0127	0.0711	0.0155		
Iron (Fe)-Total (mg/L)	<0.030	0.035	<0.030	<0.030	<0.060	<0.030		0.035	0.100	0.061	0.050	1.09	0.045		
Lead (Pb)-Total (mg/L)	<0.000100	0.000815	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100	<0.000100	<0.000100	0.000627	0.000071		
Lithium (Li)-Total (mg/L)	0.0081	0.0076	0.0082	0.0076	0.0073	0.0078		0.0079	0.0081	0.0084	0.0076	0.0076	0.0078		
Magnesium (Mg)-Total (mg/L)	32.4	30.2	29.5	27.2	28.0	28.3		29.5	29.4	29.5	27.5	26.2	27.4		
Manganese (Mn)-Total (mg/L)	0.0108	0.0107	0.0105	0.0104	0.0108	0.0116		0.0124	0.0137	0.0155	0.0166	0.0747	0.0162		
Molybdenum (Mo)-Tota (mg/L)	0.179	0.162	0.162	0.152	0.156	0.150		0.159	0.165	0.164	0.150	0.140	0.156		
Nickel (Ni)-Total (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100		<0.00100	<0.00100	<0.00100	<0.00100	0.00136	0.00053		
Potassium (K)-Total (mg/L)	2.49	2.41	2.38	2.25	2.20	2.26		2.34	2.44	2.22	2.20	2.18	2.08		
Selenium (Se)-Total (mg/L)	0.0478	0.0441	0.0434	0.0378	0.0402	0.0396		0.0421	0.0450	0.0390	0.0373	0.0359	0.0390		
Silicon (Si)-Total (mg/L)	4.97	4.98	4.88	4.74	4.56	5.18		4.70	5.27	4.68	5.40	7.12	4.88		
Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		<0.000020	<0.000020	<0.000020	<0.000020	0.000026	<0.000010		
Sodium (Na)-Total (mg/L)	29.2	27.7	26.9	24.7	24.6	24.7		26.0	27.1	25.3	24.7	23.0	24.7		
Strontium (Sr)-Total (mg/L)	6.74	6.29	6.40	6.18	6.06	6.26		6.29	6.42	6.06	5.89	5.45	5.84		
Thallium (Tl)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000010		
Tin (Sn)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00010		
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0200	<0.0100		<0.0100	<0.0100	<0.0100	<0.0100	0.0482	<0.0100		
Uranium (U)-Total (mg/L)	0.00277	0.00279	0.00282	0.00265	0.00290	0.00288		0.00281	0.00306	0.00307	0.00278	0.00273	0.00285		
Vanadium (V)-Total (mg/L)	0.00122	0.00123	0.00117	0.00116	0.00123	0.00127		0.00130	0.00146	0.00135	0.00124	0.00449	0.00106		
Zinc (Zn)-Total (mg/L)	0.0101	0.0111	0.0087	0.0083	0.0120	0.0102		0.0093	0.0116	0.0093	0.0095	0.0223	0.0103		

	: E10														
	6-Apr-23	20-Apr-23	26-Apr-23	3-May-23	8-May-23	15-May-23	29-May-23	8-Jun-23	12-Jun-23	13-Jun-23	29-Jun-23	6-Jul-23	13-Jul-23	25-Jul-23	3-Aug-23
Cadmium (Cd)-Total (mg/L)					0.000111	<0.000160	<0.000165			0.000177	0.000479		0.000553	<0.000690	0.000722
Calcium (Ca)-Total (mg/L)					102	137	161			188	258		327	399	435
Chromium (Cr)-Total (mg/L)					<0.00050	<0.00050	<0.00050			<0.00100	<0.00050		<0.00100	<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)					<0.00010	<0.00010	<0.00020			<0.00020	<0.00020		<0.00020	<0.00050	<0.00050
Copper (Cu)-Total (mg/L)					0.0133	0.0120	0.0129			0.0116	0.0158		0.0136	0.0138	0.0125
Iron (Fe)-Total (mg/L)					0.043	<0.030	<0.030			<0.060	<0.030		<0.060	<0.050	<0.050
Lead (Pb)-Total (mg/L)					0.000071	<0.000050	<0.000100			<0.000100	<0.000100		<0.000100	<0.000250	<0.000250
Lithium (Li)-Total (mg/L)					0.0052	0.0064	0.0073			0.0085	0.0098		0.0109	0.0127	0.0141
Magnesium (Mg)-Total (mg/L)					13.9	18.2	24.8			26.9	33.6		35.7	54.4	51.1
Manganese (Mn)-Total (mg/L)					0.0113	0.00984	0.00758			0.0106	0.0262		0.0605	0.138	0.122
Molybdenum (Mo)-Tota (mg/L)					0.0924	0.118	0.140			0.147	0.165		0.136	0.144	0.156
Nickel (Ni)-Total (mg/L)					<0.00050	<0.00050	<0.00100			<0.00100	<0.00100		0.00108	<0.00250	<0.00250
Potassium (K)-Total (mg/L)					1.07	1.42	1.77			2.16	2.25		2.24	2.48	2.55
Selenium (Se)-Total (mg/L)					0.0198	0.0272	0.0319			0.0301	0.0316		0.0278	0.0324	0.0302
Silicon (Si)-Total (mg/L)					4.46	4.62	4.81			5.02	5.42		5.82	5.53	6.01
Silver (Ag)-Total (mg/L)					<0.000010	<0.000010	<0.000020			<0.000020	<0.000020		<0.000020	<0.000050	<0.000050
Sodium (Na)-Total (mg/L)					11.6	15.7	19.4			23.8	26.1		25.8	31.2	31.2
Strontium (Sr)-Total (mg/L)					2.99	4.13	5.48			6.80	7.90		10.2	14.0	14.2
Thallium (Tl)-Total (mg/L)					<0.000010	<0.000010	0.000022			<0.000020	<0.000020		0.000020	<0.000050	<0.000050
Tin (Sn)-Total (mg/L)					<0.00010	<0.00010	<0.00020			<0.00020	<0.00020		<0.00020	<0.00050	<0.00050
Titanium (Ti)-Total (mg/L)					<0.0100	<0.0100	<0.0100			<0.0200	<0.0100		<0.0200	<0.0100	<0.0100
Uranium (U)-Total (mg/L)					0.00194	0.00244	0.00281			0.00289	0.00371		0.00390	0.00531	0.00559
Vanadium (V)-Total (mg/L)					0.00112	0.00130	0.00134			0.00115	0.00112		<0.00100	<0.00250	<0.00250
Zinc (Zn)-Total (mg/L)					0.0059	0.0068	0.0078			0.0109	0.0526		0.0694	0.0889	0.0759

	: E10														
	9-Aug-23	14-Aug-23	21-Aug-23	31-Aug-23	11-Sep-23	13-Sep-23	21-Sep-23	26-Sep-23	5-Oct-23	11-Oct-23	16-Oct-23	17-Oct-23	23-Oct-23	1-Nov-23	8-Nov-23
Cadmium (Cd)-Total (mg/L)		<0.000700	0.000756	0.000775					0.000978	0.000999		0.000806			
Calcium (Ca)-Total (mg/L)		401	403	399					477	473		442			
Chromium (Cr)-Total (mg/L)		<0.00050	<0.00250	<0.00050					<0.00050	<0.00050		<0.00100			
Cobalt (Co)-Total (mg/L)		<0.00050	0.00059	0.00058					0.0130	0.0147		0.00095			
Copper (Cu)-Total (mg/L)		0.0128	0.0123	0.0137					0.0528	0.0636		0.0141			
Iron (Fe)-Total (mg/L)		<0.050	<0.150	<0.050					<0.030	0.038		<0.060			
Lead (Pb)-Total (mg/L)		<0.000250	<0.000250	<0.000250					<0.000050	<0.000100		<0.000100			
Lithium (Li)-Total (mg/L)		0.0132	0.0139	0.0148					0.0112	0.0137		0.0150			
Magnesium (Mg)-Total (mg/L)		52.2	52.4	51.4					65.3	66.1		55.7			
Manganese (Mn)-Total (mg/L)		0.140	0.175	0.161					1.17	1.20		0.245			
Molybdenum (Mo)-Tota (mg/L)		0.154	0.141	0.152					0.121	0.114		0.142			
Nickel (Ni)-Total (mg/L)		<0.00250	<0.00250	<0.00250					0.00368	0.00413		0.00205			
Potassium (K)-Total (mg/L)		2.67	2.57	2.55					2.64	2.59		2.74			
Selenium (Se)-Total (mg/L)		0.0285	0.0235	0.0222					0.0127	0.00982		0.0121			
Silicon (Si)-Total (mg/L)		5.71	6.11	6.27					7.89	7.34		6.19			
Silver (Ag)-Total (mg/L)		<0.000050	<0.000050	<0.000050					0.000022	<0.000020		0.000028			
Sodium (Na)-Total (mg/L)		32.8	30.7	31.1					33.1	31.7		31.5			
Strontium (Sr)-Total (mg/L)		13.8	13.8	12.5					11.5	11.0		12.9			
Thallium (Tl)-Total (mg/L)		<0.000050	<0.000050	<0.000050					0.000024	0.000024		0.000035			
Tin (Sn)-Total (mg/L)		<0.00050	<0.00050	<0.00050					<0.00010	<0.00020		<0.00020			
Titanium (Ti)-Total (mg/L)		<0.0100	<0.0500	<0.0100					<0.0100	<0.0100		<0.0200			
Uranium (U)-Total (mg/L)		0.00574	0.00631	0.00646					0.00656	0.00712		0.00783			
Vanadium (V)-Total (mg/L)		<0.00250	<0.00250	<0.00250					0.00084	<0.00100		<0.00100			
Zinc (Zn)-Total (mg/L)		0.0774	0.0864	0.0815					0.0842	0.0795		0.0993			

	: E10					
	23-Nov-23	**28-Nov-23**	**7-Dec-23**	**12-Dec-23**	**19-Dec-23**	**27-Dec-23**
Cadmium (Cd)-Total (mg/L)	0.000849	<0.000775	0.000771		0.000702	0.000795
Calcium (Ca)-Total (mg/L)	420	398	415		372	384
Chromium (Cr)-Total (mg/L)	<0.00100	<0.00100	<0.00100		<0.00100	<0.00100
Cobalt (Co)-Total (mg/L)	0.00106	0.00092	0.00084		0.00064	0.00057
Copper (Cu)-Total (mg/L)	0.0129	0.0142	0.0145		0.0139	0.0142
Iron (Fe)-Total (mg/L)	<0.030	<0.060	<0.030		<0.060	<0.030
Lead (Pb)-Total (mg/L)	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100
Lithium (Li)-Total (mg/L)	0.0127	0.0116	0.0121		0.0119	0.0111
Magnesium (Mg)-Total (mg/L)	51.7	50.5	51.1		45.5	46.0
Manganese (Mn)-Total (mg/L)	0.314	0.257	0.233		0.178	0.164
Molybdenum (Mo)-Tota (mg/L)	0.107	0.112	0.119		0.107	0.110
Nickel (Ni)-Total (mg/L)	0.00216	0.00201	0.00206		0.00174	0.00176
Potassium (K)-Total (mg/L)	2.53	2.54	2.61		2.38	2.36
Selenium (Se)-Total (mg/L)	0.00636	0.00681	0.00761		0.00707	0.00773
Silicon (Si)-Total (mg/L)	6.58	6.32	6.61		6.69	6.42
Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000020		<0.000020	<0.000020
Sodium (Na)-Total (mg/L)	28.8	28.5	29.8		28.1	26.8
Strontium (Sr)-Total (mg/L)	10.3	10.4	10.6		9.24	9.12
Thallium (Tl)-Total (mg/L)	0.000023	0.000021	0.000029		0.000024	0.000025
Tin (Sn)-Total (mg/L)	<0.00020	<0.00020	<0.00020		<0.00020	<0.00020
Titanium (Ti)-Total (mg/L)	<0.0100	<0.0200	<0.0100		<0.0200	<0.0100
Uranium (U)-Total (mg/L)	0.00671	0.00640	0.00743		0.00646	0.00632
Vanadium (V)-Total (mg/L)	<0.00100	<0.00100	<0.00100		<0.00100	<0.00100
Zinc (Zn)-Total (mg/L)	0.114	0.110	0.114		0.112	0.120

Grid Format Report : E10 - Effluent from Wight Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E10						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	89	89	75.90000	178.00000	127.00562	161.75000	24.45535
Ammonia (as N) (mg/L)	89	30	0.00250	0.14100	0.01343	2.38600	0.02696
Chloride (mg/L)	89	38	1.25000	6.33000	2.93169	5.00000	1.76006
Diss-Orthophosphate (mg/L)	89	46	0.00050	0.00530	0.00195	0.00842	0.00172
Diss-Phosphorus (mg/L)	89	58	0.00100	0.00720	0.00293	0.00915	0.00179
Floride (mg/L)	88	88	0.37000	1.00000	0.71794	1.01500	0.17325
Nitrate (N) (mg/L)	89	86	0.01250	3.78000	1.04816	11.61500	1.18916
Nitrate and Nitrite (mg/L)	89	86	0.01275	3.81000	1.05267	10.72000	1.19377
Nitrite (N) (mg/L)	89	37	0.00050	0.02700	0.00670	0.16160	0.00549
Sulphate (mg/L)	89	89	249.00000	1,370.00000	688.97753	744.20000	227.40203
TKN (mg/L)	3	2	0.02500	0.21700	0.12567		0.09634
Total Nitrogen (mg/L)	89	89	0.03400	3.58000	1.10539	14.98000	1.18099
Total Phosphorus (mg/L)	89	84	0.00100	0.05600	0.00569	0.16090	0.00668
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	89	25	0.00150	0.03010	0.00334	0.03336	0.00365
Diss-Antimony (Sb) (mg/L)	89	87	0.00033	0.00112	0.00065	0.00182	0.00019
Diss-Arsenic (As) (mg/L)	89	88	0.00010	0.00188	0.00076	0.00456	0.00033
Diss-Barium (Ba) (mg/L)	89	89	0.01530	0.06270	0.03161	0.04380	0.01328
Diss-Beryllium (Be) (mg/L)	89	0	0.00005	0.00050	0.00009	0.00125	0.00011
Diss-Bismuth (Bi) (mg/L)	89	0	0.00003	0.00025	0.00005	0.00125	0.00004
Diss-Boron (B) (mg/L)	89	89	0.07000	0.38800	0.22449	1.32800	0.08859
Diss-Cadmium (Cd) (mg/L)	89	68	0.00005	0.00094	0.00032	0.00047	0.00022
Diss-Calcium (Ca) (mg/L)	89	89	97.50000	486.00000	252.30899	282.80000	77.68700
Diss-Chromium (Cr) (mg/L)	89	0	0.00025	0.00125	0.00034	0.00125	0.00018
Diss-Cobalt (Co) (mg/L)	89	58	0.00005	0.01170	0.00069	0.00210	0.00162
Diss-Copper (Cu) (mg/L)	89	89	0.00186	0.04570	0.01248	0.06064	0.00676
Diss-Iron (Fe) (mg/L)	89	14	0.01500	0.42200	0.04861	0.01500	0.07573
Diss-Lead (Pb) (mg/L)	89	0	0.00003	0.00025	0.00005	0.00035	0.00004
Diss-Lithium (Li) (mg/L)	89	87	0.00490	0.01450	0.00891	0.01440	0.00208
Diss-Magnesium (Mg) (mg/L)	89	89	12.90000	59.20000	31.12135	37.56000	10.03967
Diss-Manganese (Mn) (mg/L)	89	89	0.00274	1.04000	0.13636	0.44100	0.15669
Diss-Molybdenum (Mo) (mg/L)	89	89	0.09160	0.25500	0.14510	0.18480	0.02794
Diss-Nickel (Ni) (mg/L)	89	35	0.00025	0.00337	0.00088	0.00140	0.00065

Grid Format Report : E10 - Effluent from Wight Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E10						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Potassium (K) (mg/L)	89	89	0.95000	2.84000	1.80461	2.10800	0.51669
Diss-Selenium (mg/L)	89	89	0.00473	0.05010	0.02172	0.02278	0.01319
Diss-Silicon (Si) (mg/L)	89	89	4.01000	9.09000	6.42213	11.42000	1.26855
Diss-Silver (Ag) (mg/L)	89	4	0.00001	0.00005	0.00001	0.00003	0.00001
Diss-Sodium (Na) (mg/L)	89	89	10.80000	40.40000	27.03034	51.06000	4.75113
Diss-Strontium (Sr) (mg/L)	89	89	2.98000	14.70000	7.46292	16.66000	2.68107
Diss-Thallium (Tl) (mg/L)	89	28	0.00001	0.00005	0.00001	0.00025	0.00001
Diss-Tin (Sn) (mg/L)	89	2	0.00005	0.00050	0.00011	0.00025	0.00009
Diss-Titanium (Ti) (mg/L)	89	0	0.00500	0.02500	0.00629	0.01600	0.00287
Diss-Uranium (U) (mg/L)	89	89	0.00184	0.00726	0.00331	0.00567	0.00133
Diss-Vanadium (V) (mg/L)	89	21	0.00025	0.00250	0.00067	0.00304	0.00047
Diss-Zinc (Zn) (mg/L)	89	84	0.00150	0.12400	0.02649	0.03830	0.03154
TDS (mg/L)	89	89	496.00000	2,350.00000	1,148.95506	1,281.50000	368.24263
Field Tests							
Cond (in situ) (µs/cm)	89	89	663.00000	2,272.00000	1,377.23146	1,525.45000	314.63204
NTU - in situ (ntu)	88	88	0.00000	25.41000	1.42318	1.25350	3.78506
pH (in situ) (pH)	89	89	6.93000	8.61000	7.54022	8.12450	0.26236
Sample Taken							
Temp (in situ) (Degrees Celcius)	89	89	2.59300	19.67600	9.31811	13.91160	4.24984
Organic / Inorganic							
DOC (mg/L)	89	89	0.97000	2.81000	1.50798	1.98800	0.34352
Physical Test							
Conductivity (µs/cm)	89	89	629.00000	2,250.00000	1,371.97753	1,464.00000	329.08347
Hardness (mg/L)	89	89	296.00000	1,460.00000	757.89888	825.55000	233.06544
NTU (ntu)	89	71	0.05000	20.90000	1.02157	31.75000	2.86416
pH (pH)	89	89	7.53000	8.32000	8.02247	8.21300	0.16206
TDS (mg/L)	89	89	496.00000	2,350.00000	1,148.95506	1,281.50000	368.24263
TSS (mg/L)	89	32	0.50000	25.80000	1.34888	68.50000	2.82016
Total Metals							
Aluminum (Al)-Total (mg/L)	89	48	0.00150	0.93400	0.02827	2.97000	0.10251
Antimony (Sb)-Total (mg/L)	89	87	0.00025	0.00111	0.00067	0.00183	0.00021
Arsenic (As)-Total (mg/L)	89	89	0.00045	0.00211	0.00086	0.00793	0.00037
Barium (Ba)-Total (mg/L)	89	89	0.01460	0.06880	0.03235	0.09530	0.01455
Beryllium (Be)-Total (mg/L)	89	0	0.00005	0.00025	0.00006	0.00125	0.00003
Bismuth (Bi)-Total (mg/L)	89	0	0.00003	0.00013	0.00005	0.00125	0.00003

Grid Format Report : E10 - Effluent from Wight Pit

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E10						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Boron (B)-Total (mg/L)	89	89	0.07200	0.39500	0.23333	1.41100	0.09308
Cadmium (Cd)-Total (mg/L)	89	67	0.00006	0.00100	0.00032	0.00050	0.00022
Calcium (Ca)-Total (mg/L)	89	89	102.00000	477.00000	254.22472	286.55000	78.80943
Chromium (Cr)-Total (mg/L)	89	2	0.00025	0.00125	0.00034	0.00326	0.00019
Cobalt (Co)-Total (mg/L)	89	62	0.00005	0.01470	0.00080	0.00537	0.00203
Copper (Cu)-Total (mg/L)	89	89	0.00520	0.07110	0.01590	0.16630	0.01043
Iron (Fe)-Total (mg/L)	89	36	0.01500	2.18000	0.11108	2.52800	0.26574
Lead (Pb)-Total (mg/L)	89	9	0.00003	0.00082	0.00007	0.00525	0.00011
Lithium (Li)-Total (mg/L)	89	89	0.00520	0.01500	0.00907	0.01520	0.00194
Magnesium (Mg)-Total (mg/L)	89	89	13.90000	66.10000	31.39663	36.02000	10.26973
Manganese (Mn)-Total (mg/L)	89	89	0.00490	1.20000	0.14437	0.55910	0.18326
Molybdenum (Mo)-Tota (mg/L)	89	89	0.09240	0.26800	0.14788	0.18860	0.02865
Nickel (Ni)-Total (mg/L)	89	40	0.00025	0.00413	0.00089	0.00982	0.00069
Potassium (K)-Total (mg/L)	89	89	1.07000	2.74000	1.82000	2.37650	0.52765
Selenium (Se)-Total (mg/L)	89	89	0.00492	0.05340	0.02195	0.02277	0.01364
Silicon (Si)-Total (mg/L)	89	89	4.46000	9.12000	6.59551	15.26000	1.25563
Silver (Ag)-Total (mg/L)	89	27	0.00001	0.00003	0.00001	0.00119	0.00001
Sodium (Na)-Total (mg/L)	89	89	11.60000	43.60000	27.40000	49.44500	4.96902
Strontium (Sr)-Total (mg/L)	89	89	2.99000	14.40000	7.52382	16.31000	2.76683
Thallium (Tl)-Total (mg/L)	89	31	0.00001	0.00004	0.00001	0.00025	0.00001
Tin (Sn)-Total (mg/L)	89	0	0.00005	0.00025	0.00009	0.00025	0.00006
Titanium (Ti)-Total (mg/L)	89	1	0.00500	0.04820	0.00689	0.05480	0.00561
Uranium (U)-Total (mg/L)	89	89	0.00194	0.00783	0.00337	0.00718	0.00140
Vanadium (V)-Total (mg/L)	89	52	0.00025	0.00449	0.00084	0.01392	0.00053
Zinc (Zn)-Total (mg/L)	89	85	0.00300	0.12000	0.02783	0.04584	0.03138

Grid Format Report : E11 - Springer Pit Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E302090 : E11														
	21-Nov-19	5-Dec-19	18-Dec-19	16-Mar-20	30-Apr-20	27-May-20	2-Mar-21	20-Apr-21	10-May-21	9-Dec-21	20-Dec-21	29-Dec-21	5-Jan-22	11-Jan-22	18-Jan-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	60.9	85.7	74.0	81.9	77.3	62.7	72.2	59.8	60.5	70.8	74.6	75.9	70.2	75.7	72.2
Ammonia (as N) (mg/L)	0.0074	0.0274	0.0203	0.0130	0.0094	<0.0050	0.0126	0.0080	<0.0050	0.0061	0.0090	0.0097	0.0098	0.0096	0.0106
Chloride (mg/L)	13.9	9.0	7.79	3.12	3.91	7.08	7.26	1.01	5.30	6.90	6.88	6.86	6.28	6.74	6.66
Diss-Orthophosphate (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	0.0019	<0.0010	<0.0010	0.0031	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0016	0.0026
Diss-Phosphorus (mg/L)	<0.0020	0.0035	0.0043	0.0051	<0.0020	0.0035	<0.0020	0.0025	<0.0020	<0.0020	0.0028	0.0020	0.0028	0.0021	0.0022
Floride (mg/L)	0.57	0.58	0.544	0.390	0.320	0.370	0.370	0.211	0.334	0.413	0.442	0.434	0.363	0.417	0.388
Nitrate (N) (mg/L)	2.51	1.96	1.94	2.32	4.74	3.12	3.02	1.02	2.37	2.86	2.82	2.93	2.69	2.88	2.80
Nitrate and Nitrite (mg/L)	2.54	2.02	1.99	2.33	4.74	3.13	3.02	1.02	2.38	2.86	2.82	2.94	2.70	2.88	2.81
Nitrite (N) (mg/L)	0.0292	0.0573	0.0431	0.0162	<0.0050	0.0105	<0.0050	0.0024	0.0136	0.0056	<0.0050	0.0069	0.0053	0.0055	0.0086
Sulphate (mg/L)	448	411	356	244	441	386	426	132	332	426	423	425	395	418	416
Total Nitrogen (mg/L)	2.48	2.03	2.28	2.20	4.25	3.37	2.99	0.901	2.32	2.89	3.01	2.91	2.80	2.91	3.08
Total Phosphorus (mg/L)	0.0223	0.0104	0.0296	0.0106	0.0661	0.0336	0.0026	0.0065	0.0052	0.0023	0.0038	0.0033	0.0075	0.0066	0.0038
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0078	0.0045	0.0047	<0.0030	0.0123	0.0221	0.0078	0.0056	0.0066	0.0058	0.0052	0.0050	0.0047	0.0054	0.0042
Diss-Antimony (Sb) (mg/L)	0.00122	0.00128	0.00108	0.00072	0.00054	0.00066	0.00079	0.00033	0.00070	0.00080	0.00082	0.00083	0.00086	0.00089	0.00081
Diss-Arsenic (As) (mg/L)	0.00249	0.00210	0.00202	0.00176	0.00162	0.00134	0.00148	0.00086	0.00121	0.00149	0.00151	0.00163	0.00162	0.00154	0.00158
Diss-Barium (Ba) (mg/L)	0.0255	0.0212	0.0219	0.0226	0.0753	0.0486	0.0406	0.0238	0.0319	0.0377	0.0314	0.0364	0.0376	0.0362	0.0351
Diss-Beryllium (Be) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00100	<0.00100	<0.00100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Boron (B) (mg/L)	0.153	0.187	0.192	0.251	0.076	0.084	0.110	0.083	0.094	0.116	0.132	0.134	0.121	0.131	0.118
Diss-Cadmium (Cd) (mg/L)	<0.000095	<0.00012	0.0000456	<0.0000250	<0.0000950	<0.000100	<0.000125	0.0000285	<0.000100	<0.0000950	<0.000130	<0.000125	0.000118	<0.000115	<0.000105
Diss-Calcium (Ca) (mg/L)	134	150	107	88.5	139	135	141	41.0	98.4	130	133	140	139	134	128
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	0.00027	0.00029	0.00025	0.00012	0.00134	0.00061	0.00017	<0.00010	0.00012	0.00014	0.00015	0.00014	0.00014	0.00014	0.00014
Diss-Copper (Cu) (mg/L)	0.0158	0.0214	0.0169	0.0144	0.0451	0.0503	0.0275	0.0220	0.0230	0.0234	0.0233	0.0244	0.0239	0.0230	0.0224
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	0.0106	0.0127	0.0085	0.0067	0.0048	0.0065	0.0069	0.0030	0.0052	0.0063	0.0068	0.0068	0.0068	0.0066	0.0063
Diss-Magnesium (Mg) (mg/L)	25.0	24.7	21.0	18.2	26.8	24.3	23.5	7.83	17.4	21.6	23.2	21.6	23.3	22.4	21.3
Diss-Manganese (Mn) (mg/L)	0.0669	0.0664	0.0560	0.0335	0.0339	0.0774	0.0295	0.00398	0.0197	0.0276	0.0273	0.0287	0.0294	0.0283	0.0274
Diss-Molybdenum (Mo) (mg/L)	0.232	0.273	0.170	0.0829	0.169	0.158	0.179	0.0482	0.149	0.193	0.187	0.201	0.203	0.213	0.190
Diss-Nickel (Ni) (mg/L)	0.00100	0.00058	0.00057	<0.00050	0.00070	0.00134	0.00086	<0.00050	0.00058	0.00075	0.00080	0.00076	0.00080	0.00072	0.00057
Diss-Potassium (K) (mg/L)	9.30	5.45	4.77	4.20	3.22	4.93	5.00	1.21	3.80	4.65	4.49	4.69	4.78	4.60	4.50
Diss-Selenium (mg/L)	0.0434	0.0637	0.0467	0.0350	0.0529	0.0407	0.0417	0.0197	0.0330	0.0365	0.0370	0.0420	0.0373	0.0391	0.0378

	E302090 : E11														
	25-Jan-22	2-Feb-22	10-Feb-22	15-Feb-22	22-Feb-22	19-May-22	8-Jun-22	14-Jun-22	22-Jun-22	23-Jun-22	30-Jun-22	6-Jul-22	12-Jul-22	28-Jul-22	11-Aug-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)	74.1	73.9	73.5	73.0	74.6	65.1	65.0	68.8		67.0	69.8	64.9		59.5	65.0
Ammonia (as N) (mg/L)	0.0120	0.0114	0.0093	0.0104	0.0111	0.193	0.156	0.0954		0.106	0.116	0.105		0.221	0.237
Chloride (mg/L)	5.91	6.48	6.70	6.80	6.58	4.09	3.99	3.79		3.63	3.64	4.07		4.75	5.13
Diss-Orthophosphate (mg/L)	0.0020	0.0024	0.0029	0.0062	0.0060	<0.0010	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010		<0.0010	<0.0010
Diss-Phosphorus (mg/L)	0.0033	0.0034	0.0058	0.0092	0.0091	0.0021	<0.0020	0.0026		0.0032	0.0025	0.0028		<0.0020	7.27
Floride (mg/L)	0.421	0.428	0.385	0.444	0.403	0.329	0.322	0.341		0.289	0.367	0.411		0.335	0.389
Nitrate (N) (mg/L)	2.61	2.77	2.84	2.86	2.81	2.79	3.00	3.20		3.39	3.74	4.43		4.35	3.48
Nitrate and Nitrite (mg/L)	2.62	2.78	2.85	2.87	2.82	2.84	3.07	3.24		3.43	3.79	4.50		4.47	3.57
Nitrite (N) (mg/L)	0.0099	0.0061	0.0062	0.0088	0.0080	0.0549	0.0712	0.0379		0.0368	0.0463	0.0744		0.120	0.0879
Sulphate (mg/L)	390	409	422	427	419	308	300	302		284	295	313		353	351
Total Nitrogen (mg/L)	2.50	2.69	2.51	2.89	2.77	2.85	3.30	3.49		3.77	3.80	4.51		4.60	3.64
Total Phosphorus (mg/L)	0.0212	0.0066	0.0127	0.0276	0.0241	1.92	0.0186	0.0063		0.0082	0.0085	0.0106		0.0107	13.1
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)	0.0034	0.0036	0.0045	0.0045	0.0037	0.0085	0.0125	0.0076		0.0094	0.0091	0.0102		0.0120	0.0150
Diss-Antimony (Sb) (mg/L)	0.00084	0.00083	0.00093	0.00085	0.00084	0.00100	0.00108	0.00105		0.00114	0.00124	0.00128		0.00124	0.00138
Diss-Arsenic (As) (mg/L)	0.00170	0.00169	0.00190	0.00160	0.00186	0.00166	0.00207	0.00212		0.00215	0.00224	0.00222		0.00240	0.00283
Diss-Barium (Ba) (mg/L)	0.0309	0.0336	0.0373	0.0318	0.0350	0.0276	0.0362	0.0344		0.0358	0.0338	0.0352		0.0434	0.0304
Diss-Beryllium (Be) (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100		<0.000100	<0.000100	<0.000100		<0.000100	<0.000100
Diss-Bismuth (Bi) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Diss-Boron (B) (mg/L)	0.150	0.119	0.142	0.141	0.137	0.144	0.135	0.142		0.148	0.152	0.151		0.170	0.177
Diss-Cadmium (Cd) (mg/L)	<0.0000850	<0.000115	<0.000105	<0.000110	<0.000110	<0.0000600	<0.0000550	<0.0000750		<0.0000600	<0.0000650	<0.0000600		<0.0000600	<0.0000600
Diss-Calcium (Ca) (mg/L)	115	120	128	127	127	95.8	92.6	100		97.1	91.0	99.6		106	106
Diss-Chromium (Cr) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050		<0.00050	<0.00050
Diss-Cobalt (Co) (mg/L)	0.00016	0.00015	0.00016	0.00013	0.00015	0.00011	0.00013	0.00021		0.00014	0.00015	0.00011		<0.00010	0.00057
Diss-Copper (Cu) (mg/L)	0.0217	0.0215	0.0229	0.0210	0.0219	0.0130	0.00977	0.00868		0.00882	0.00812	0.00822		0.00717	0.0334
Diss-Iron (Fe) (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030		<0.030	<0.030	<0.030		<0.030	<0.030
Diss-Lead (Pb) (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050		<0.000050	<0.000050
Diss-Lithium (Li) (mg/L)	0.0062	0.0063	0.0068	0.0073	0.0065	0.0055	0.0060	0.0062		0.0065	0.0065	0.0059		0.0072	0.0080
Diss-Magnesium (Mg) (mg/L)	21.2	22.4	23.6	21.5	22.4	17.6	19.4	18.8		19.4	18.4	18.5		21.1	24.3
Diss-Manganese (Mn) (mg/L)	0.0333	0.0288	0.0316	0.0303	0.0329	0.0184	0.0258	0.0285		0.0223	0.0214	0.0192		0.0182	0.0797
Diss-Molybdenum (Mo) (mg/L)	0.165	0.182	0.195	0.196	0.198	0.173	0.167	0.165		0.166	0.176	0.193		0.200	0.183
Diss-Nickel (Ni) (mg/L)	0.00053	<0.00050	0.00070	0.00065	0.00069	<0.00050	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050		<0.00050	0.00056
Diss-Potassium (K) (mg/L)	3.68	4.16	4.40	4.22	4.38	2.14	2.31	2.12		2.24	2.30	2.29		3.33	3.97
Diss-Selenium (mg/L)	0.0360	0.0387	0.0366	0.0360	0.0389	0.0333	0.0347	0.0375		0.0358	0.0387	0.0363		0.0368	0.0360

	E302090 : E11								
	24-Aug-22	23-Oct-23	1-Nov-23	15-Nov-23	28-Nov-23	7-Dec-23	12-Dec-23	19-Dec-23	27-Dec-23
Anions and Nutrients									
Alkalinity (CaCO3) (mg/L)		44.8		53.7		52.6			
Ammonia (as N) (mg/L)		0.851		0.385		0.278			
Chloride (mg/L)		2.55		1.92		2.03			
Diss-Orthophosphate (mg/L)		0.0016		<0.0010		<0.0010			
Diss-Phosphorus (mg/L)		0.0032		0.0023		0.0028			
Floride (mg/L)		0.264		0.217		0.235			
Nitrate (N) (mg/L)		6.66		3.54		9.12			
Nitrate and Nitrite (mg/L)		6.95		3.68		9.37			
Nitrite (N) (mg/L)		0.292		0.145		0.253			
Sulphate (mg/L)		323		232		260			
Total Nitrogen (mg/L)		7.93		4.14		9.88			
Total Phosphorus (mg/L)		0.0156		0.0143		0.0081			
Dissolved Metals									
Aluminum (Al)-Diss (mg/L)		0.0074		0.0036		<0.0030			
Diss-Antimony (Sb) (mg/L)		0.00963		0.00449		0.00648			
Diss-Arsenic (As) (mg/L)		0.0116		0.00530		0.00579			
Diss-Barium (Ba) (mg/L)		0.0709		0.0425		0.0475			
Diss-Beryllium (Be) (mg/L)		<0.000100		<0.000100		<0.000100			
Diss-Bismuth (Bi) (mg/L)		<0.000050		<0.000050		<0.000050			
Diss-Boron (B) (mg/L)		0.329		0.300		0.323			
Diss-Cadmium (Cd) (mg/L)		<0.0000450		0.0000881		0.000145			
Diss-Calcium (Ca) (mg/L)		118		72.9		91.0			
Diss-Chromium (Cr) (mg/L)		<0.00050		<0.00050		<0.00050			
Diss-Cobalt (Co) (mg/L)		<0.00010		0.00018		0.00028			
Diss-Copper (Cu) (mg/L)		0.0251		0.0614		0.0547			
Diss-Iron (Fe) (mg/L)		<0.030		<0.030		<0.030			
Diss-Lead (Pb) (mg/L)		<0.000050		0.000055		0.000060			
Diss-Lithium (Li) (mg/L)		0.0062		0.0048		0.0055			
Diss-Magnesium (Mg) (mg/L)		11.2		9.02		10.7			
Diss-Manganese (Mn) (mg/L)		0.0361		0.0282		0.0318			
Diss-Molybdenum (Mo) (mg/L)		0.144		0.0806		0.159			
Diss-Nickel (Ni) (mg/L)		<0.00050		<0.00050		<0.00050			
Diss-Potassium (K) (mg/L)		0.877		0.751		0.784			
Diss-Selenium (mg/L)		0.0301		0.0285		0.0363			

Grid Format Report : E11 - Springer Pit Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E302090 : E11														
	21-Nov-19	5-Dec-19	18-Dec-19	16-Mar-20	30-Apr-20	27-May-20	2-Mar-21	20-Apr-21	10-May-21	9-Dec-21	20-Dec-21	29-Dec-21	5-Jan-22	11-Jan-22	18-Jan-22
Diss-Silicon (Si) (mg/L)	5.85	6.09	5.73	6.51	5.45	4.66	5.01	3.75	4.24	4.67	4.57	5.23	4.77	5.02	4.96
Diss-Silver (Ag) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	64.4	47.5	41.4	24.1	25.2	36.4	36.0	9.42	26.6	33.8	30.2	36.5	35.8	34.5	33.1
Diss-Strontium (Sr) (mg/L)	1.60	1.43	1.07	0.850	1.07	1.44	1.49	0.354	1.02	1.36	1.26	1.36	1.28	1.52	1.26
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.010	<0.010	<0.010	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	0.00221	0.00255	0.00245	0.00188	0.00141	0.00159	0.00195	0.000600	0.00152	0.00195	0.00189	0.00188	0.00191	0.00202	0.00208
Diss-Vanadium (V) (mg/L)	0.00283	0.00264	0.00259	0.00219	0.00149	0.00137	0.00160	0.00169	0.00145	0.00162	0.00166	0.00175	0.00188	0.00171	0.00171
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030	<0.0030	0.0066	<0.0030	<0.0030	0.0031	<0.0030	0.0039	<0.0030	0.0031	<0.0030	0.0031	0.0032	<0.0030
TDS (mg/L)	732	713	599	454	738	682	694	279	544	686	678	724	688	713	751
Field Tests															
Cond (in situ) (µs/cm)	1067.5	992.2	858.3	660.8	902.7	870	954.2	336	766	955.1	964.1	964	916	953.5	949.9
NTU - in situ (ntu)	9.75	1.26	3.44	2.23	16.63	12.03	0.81	0.82	0.12	1.14	0.58	0.95	1.48	1.64	1.14
pH (in situ) (pH)	8.09	8.16	7.68	7.69	7.73	8.34	7.55	7.69	8.06	8.08	7.78	6.31	8.5	7.83	7.88
Sample Taken	Yes	Yes	Yes	Yes	Yes	Yes	yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Temp (in situ) (Degrees Celcius)	1.539	2.106	1.083	3.591	6.157	15.5	3.051	5.436	10.393	4.217	3.539	2.459	2.9	2.225	3.635
Organic / Inorganic															
DOC (mg/L)	1.37	1.86	1.40	0.89	4.31	3.25	3.15	0.54	2.24	2.45	2.33	2.24	2.12	2.07	2.15
Physical Test															
Conductivity (µs/cm)	1050	966	880	663	1010	926	935	401	764	989	935	931	949	954	931
Hardness (mg/L)	439	476	355	296	457	438	449	135	317	414	428	438	443	427	407
NTU (ntu)	3.76	0.78	1.38	0.57	22.9	14.2	0.25	0.54	1.03	0.44	0.50	0.48	2.35	1.32	0.70
pH (pH)	8.00	7.96	7.93	7.96	8.00	8.13	7.96	7.89	7.98	8.01	7.92	7.80	7.83	7.90	7.93
TDS (mg/L)	732	713	599	454	738	682	694	279	544	686	678	724	688	713	751
TSS (mg/L)	3.9	2.3	4.8	2.0	30.6	16.0	<1.0	1.4	1.7	<1.2	<1.0	<1.1	2.9	2.7	<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)	0.103	0.0197	0.0909	0.0513	1.47	0.550	0.0237	0.0412	0.0749	0.0273	0.0234	0.0261	0.0932	0.0850	0.0419
Antimony (Sb)-Total (mg/L)	0.00121	0.00128	0.00110	0.00072	0.00056	0.00076	0.00084	0.00034	0.00070	0.00086	0.00084	0.00081	0.00086	0.00085	0.00083
Arsenic (As)-Total (mg/L)	0.00258	0.00215	0.00233	0.00195	0.00259	0.00156	0.00152	0.00082	0.00134	0.00164	0.00162	0.00171	0.00172	0.00167	0.00169
Barium (Ba)-Total (mg/L)	0.0252	0.0226	0.0238	0.0250	0.100	0.0458	0.0412	0.0252	0.0321	0.0378	0.0365	0.0365	0.0376	0.0365	0.0360
Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total (mg/L)	0.155	0.190	0.195	0.266	0.090	0.089	0.117	0.104	0.106	0.133	0.118	0.129	0.146	0.139	0.133
Cadmium (Cd)-Total (mg/L)	<0.00010	<0.000095	<0.00020	<0.0000550	<0.000105	<0.000105	<0.000135	<0.0000500	<0.000110	<0.000130	<0.0000800	<0.0000950	<0.000110	<0.000110	<0.000130

	E302090 : E11														
	25-Jan-22	2-Feb-22	10-Feb-22	15-Feb-22	22-Feb-22	19-May-22	8-Jun-22	14-Jun-22	22-Jun-22	23-Jun-22	30-Jun-22	6-Jul-22	12-Jul-22	28-Jul-22	11-Aug-22
Diss-Silicon (Si) (mg/L)	5.70	4.97	5.43	4.87	5.52	4.97	5.40	5.39		5.69	5.98	5.55		5.83	6.95
Diss-Silver (Ag) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010		<0.000010	<0.000010
Diss-Sodium (Na) (mg/L)	30.2	32.7	35.6	32.4	35.4	24.1	25.6	25.6		25.9	25.8	26.3		30.9	34.2
Diss-Strontium (Sr) (mg/L)	1.16	1.20	1.38	1.24	1.28	0.796	0.784	0.772		0.761	0.769	0.844		1.01	1.04
Diss-Thallium (Tl) (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010		<0.000010	<0.000010
Diss-Tin (Sn) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010		<0.00010	<0.00010
Diss-Titanium (Ti) (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100		<0.0100	<0.0100	<0.0100		<0.0100	<0.0100
Diss-Uranium (U) (mg/L)	0.00227	0.00213	0.00218	0.00200	0.00208	0.00208	0.00206	0.00230		0.00218	0.00226	0.00222		0.00231	0.00247
Diss-Vanadium (V) (mg/L)	0.00239	0.00184	0.00195	0.00164	0.00180	0.00145	0.00176	0.00196		0.00199	0.00214	0.00220		0.00244	0.00329
Diss-Zinc (Zn) (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		<0.0030	<0.0030	<0.0030		<0.0030	<0.0030
TDS (mg/L)	635	672	663	705	687	547	586	589		541	526	557		582	613
Field Tests															
Cond (in situ) (µs/cm)	892.6	928.6	916	947	920	704	717	718.5		737.8	689.5	750		874.1	834
NTU - in situ (ntu)	3.7	2.04	2.95	7.01	4.29	21.4	27.12	1.34		2.64	5.4	3.25		6.05	1016.9
pH (in situ) (pH)	7.87	7.92	7.8	7.9	8.14	7.96	8.11	7.97		8	7.81	8.02		8.1	8.1
Sample Taken	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Temp (in situ) (Degrees Celcius)	2.281	2.817	2.569	3	0.9	10.4	16.66	14.497		13.354	18.342	17.043		22.81	19.361
Organic / Inorganic															
DOC (mg/L)	2.02	2.24	2.32	2.37	2.42	1.60	1.29	1.30		1.60	1.23	1.29		1.40	3.07
Physical Test															
Conductivity (µs/cm)	900	886	917	927	945	726	745	747		786	720	832		843	796
Hardness (mg/L)	374	392	417	406	409	312	311	327		322	303	325		352	365
NTU (ntu)	3.58	1.57	2.85	7.03	5.82	109	2.40	1.12		1.92	0.99	2.97		2.08	>4000
pH (pH)	7.88	7.95	7.95	7.90	8.01	7.81	8.00	7.99		8.01	7.92	7.99		7.90	7.98
TDS (mg/L)	635	672	663	705	687	547	586	589		541	526	557		582	613
TSS (mg/L)	7.9	1.4	2.8	9.2	7.1	947	2.5	1.1		<1.0	2.2	1.1		3.0	6030
Total Metals															
Aluminum (Al)-Total (mg/L)	0.321	0.0814	0.152	0.298	0.201	18.2	0.176	0.0564		0.0615	0.103	0.161		0.151	49.8
Antimony (Sb)-Total (mg/L)	0.00086	0.00088	0.00086	0.00091	0.00086	0.00112	0.00110	0.00114		0.00118	0.00123	0.00131		0.00126	0.00137
Arsenic (As)-Total (mg/L)	0.00198	0.00187	0.00189	0.00190	0.00195	0.0175	0.00223	0.00219		0.00227	0.00245	0.00259		0.00245	0.0595
Barium (Ba)-Total (mg/L)	0.0383	0.0361	0.0355	0.0385	0.0395	0.363	0.0399	0.0348		0.0342	0.0371	0.0410		0.0474	0.536
Beryllium (Be)-Total (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	0.000639	<0.000100	<0.000100		<0.000100	<0.000100	<0.000100		<0.000100	0.00238
Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000100	<0.000050	<0.000050		<0.000050	<0.000050	<0.000050		<0.000050	<0.000250
Boron (B)-Total (mg/L)	0.144	0.147	0.154	0.144	0.157	0.166	0.169	0.145		0.155	0.164	0.142		0.176	0.222
Cadmium (Cd)-Total (mg/L)	<0.0000850	<0.000120	<0.000120	<0.000120	<0.000115	0.000860	<0.0000850	<0.0000400		<0.0000600	<0.0000650	<0.0000700		<0.0000650	0.000934

	E302090 : E11								
	24-Aug-22	23-Oct-23	1-Nov-23	15-Nov-23	28-Nov-23	7-Dec-23	12-Dec-23	19-Dec-23	27-Dec-23
Diss-Silicon (Si) (mg/L)		7.82		7.82		7.66			
Diss-Silver (Ag) (mg/L)		<0.000010		<0.000010		<0.000010			
Diss-Sodium (Na) (mg/L)		38.7		29.2		31.7			
Diss-Strontium (Sr) (mg/L)		1.21		0.834		0.993			
Diss-Thallium (Tl) (mg/L)		<0.000010		<0.000010		<0.000010			
Diss-Tin (Sn) (mg/L)		<0.00010		<0.00010		<0.00010			
Diss-Titanium (Ti) (mg/L)		<0.0100		<0.0100		<0.0100			
Diss-Uranium (U) (mg/L)		0.00445		0.00306		0.00380			
Diss-Vanadium (V) (mg/L)		0.00538		0.00357		0.00313			
Diss-Zinc (Zn) (mg/L)		<0.0030		<0.0030		<0.0030			
TDS (mg/L)		584		432		491			
Field Tests									
Cond (in situ) (µs/cm)		833		602		496.8			
NTU - in situ (ntu)		1.09		1.73		1.07			
pH (in situ) (pH)		8.03		7.72		7.13			
Sample Taken	No	Yes	No	Yes	No	Yes	No	No	No
Temp (in situ) (Degrees Celcius)		7.28		8.166		8.663			
Organic / Inorganic									
DOC (mg/L)		0.82		0.65		0.71			
Physical Test									
Conductivity (µs/cm)		801		609		682			
Hardness (mg/L)		341		219		271			
NTU (ntu)		2.72		0.75		1.46			
pH (pH)		7.98		7.73		7.82			
TDS (mg/L)		584		432		491			
TSS (mg/L)		8.0		3.0		4.0			
Total Metals									
Aluminum (Al)-Total (mg/L)		0.222		0.161		0.121			
Antimony (Sb)-Total (mg/L)		0.00814		0.00503		0.00722			
Arsenic (As)-Total (mg/L)		0.0134		0.00597		0.00620			
Barium (Ba)-Total (mg/L)		0.0766		0.0474		0.0512			
Beryllium (Be)-Total (mg/L)		<0.000100		<0.000100		<0.000100			
Bismuth (Bi)-Total (mg/L)		<0.000050		<0.000050		<0.000050			
Boron (B)-Total (mg/L)		0.320		0.282		0.318			
Cadmium (Cd)-Total (mg/L)		<0.0000300		<0.000100		<0.000165			

Grid Format Report : E11 - Springer Pit Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E302090 : E11														
	21-Nov-19	5-Dec-19	18-Dec-19	16-Mar-20	30-Apr-20	27-May-20	2-Mar-21	20-Apr-21	10-May-21	9-Dec-21	20-Dec-21	29-Dec-21	5-Jan-22	11-Jan-22	18-Jan-22
Calcium (Ca)-Total (mg/L)	123	136	116	81.8	143	127	137	48.1	106	133	128	132	146	127	130
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	0.00066	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total (mg/L)	0.00034	0.00034	0.00030	0.00018	0.00281	0.00098	0.00018	<0.00010	0.00017	0.00017	0.00016	0.00017	0.00021	0.00020	0.00018
Copper (Cu)-Total (mg/L)	0.0212	0.0255	0.0258	0.0188	0.119	0.112	0.0288	0.0291	0.0281	0.0256	0.0251	0.0254	0.0292	0.0279	0.0249
Iron (Fe)-Total (mg/L)	0.067	<0.030	0.053	0.050	1.23	0.390	<0.030	<0.030	0.048	<0.030	<0.030	<0.030	0.075	0.066	<0.030
Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000050	<0.000050	0.000323	0.000151	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total (mg/L)	0.0096	0.0118	0.0098	0.0065	0.0072	0.0063	0.0070	0.0037	0.0058	0.0071	0.0064	0.0065	0.0069	0.0066	0.0066
Magnesium (Mg)-Total (mg/L)	23.9	23.8	22.8	17.6	28.5	22.8	23.3	9.62	18.2	22.0	22.5	21.4	24.1	22.4	22.6
Manganese (Mn)-Total (mg/L)	0.0657	0.0672	0.0612	0.0337	0.0718	0.0937	0.0297	0.00479	0.0220	0.0295	0.0281	0.0300	0.0324	0.0309	0.0296
Molybdenum (Mo)-Tota (mg/L)	0.236	0.247	0.194	0.0859	0.158	0.160	0.183	0.0557	0.150	0.201	0.196	0.195	0.207	0.189	0.194
Nickel (Ni)-Total (mg/L)	0.00108	0.00069	0.00066	<0.00050	0.00115	0.00166	0.00098	<0.00050	0.00068	0.00075	0.00054	0.00073	0.00081	0.00076	0.00065
Potassium (K)-Total (mg/L)	8.66	5.08	5.18	4.55	3.38	4.93	4.98	1.33	3.61	4.79	4.72	4.67	4.70	4.48	4.44
Selenium (Se)-Total (mg/L)	0.0478	0.0666	0.0468	0.0391	0.0531	0.0399	0.0414	0.0206	0.0341	0.0386	0.0385	0.0399	0.0406	0.0398	0.0397
Silicon (Si)-Total (mg/L)	5.89	6.13	6.12	7.24	8.39	5.77	5.06	4.52	4.36	5.14	5.13	5.02	5.65	5.27	5.39
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000020	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Total (mg/L)	60.6	45.6	45.1	24.0	25.6	35.3	35.2	10.5	27.0	35.2	34.6	35.8	35.1	34.7	33.8
Strontium (Sr)-Total (mg/L)	1.49	1.20	1.15	0.765	0.993	1.54	1.49	0.407	1.07	1.35	1.35	1.30	1.41	1.26	1.30
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.0100	0.0935	0.0249	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Uranium (U)-Total (mg/L)	0.00216	0.00257	0.00224	0.00196	0.00171	0.00157	0.00198	0.000658	0.00156	0.00204	0.00194	0.00211	0.00199	0.00218	0.00213
Vanadium (V)-Total (mg/L)	0.00308	0.00284	0.00298	0.00246	0.00625	0.00265	0.00179	0.00221	0.00168	0.00203	0.00174	0.00184	0.00212	0.00212	0.00211
Zinc (Zn)-Total (mg/L)	<0.0030	0.0031	<0.0030	0.0069	0.0054	0.0043	0.0031	0.0058	0.0033	<0.0030	<0.0030	<0.0030	0.0047	<0.0030	<0.0030

	E302090 : E11														
	25-Jan-22	2-Feb-22	10-Feb-22	15-Feb-22	22-Feb-22	19-May-22	8-Jun-22	14-Jun-22	22-Jun-22	23-Jun-22	30-Jun-22	6-Jul-22	12-Jul-22	28-Jul-22	11-Aug-22
Calcium (Ca)-Total (mg/L)	118	133	127	130	134	123	98.0	90.1		82.5	95.3	94.8		107	248
Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0351	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050		<0.00050	0.0298
Cobalt (Co)-Total (mg/L)	0.00038	0.00021	0.00024	0.00035	0.00029	0.0288	0.00030	0.00026		0.00021	0.00025	0.00026		0.00018	0.0461
Copper (Cu)-Total (mg/L)	0.0364	0.0280	0.0306	0.0420	0.0354	1.74	0.0187	0.0114		0.0129	0.0144	0.0166		0.0170	4.72
Iron (Fe)-Total (mg/L)	0.267	0.061	0.112	0.243	0.161	29.6	0.154	0.041		0.049	0.072	0.122		0.109	45.3
Lead (Pb)-Total (mg/L)	0.000075	<0.000050	<0.000050	0.000108	0.000075	0.0115	0.000110	0.000100		0.000075	0.000126	0.000111		0.000076	0.0278
Lithium (Li)-Total (mg/L)	0.0063	0.0070	0.0068	0.0070	0.0071	0.0171	0.0073	0.0063		0.0060	0.0069	0.0065		0.0075	0.0387
Magnesium (Mg)-Total (mg/L)	22.7	24.0	23.6	23.1	22.9	28.4	19.8	17.5		18.0	19.0	21.2		21.8	53.5
Manganese (Mn)-Total (mg/L)	0.0418	0.0329	0.0361	0.0411	0.0404	3.53	0.0358	0.0291		0.0244	0.0265	0.0298		0.0297	2.20
Molybdenum (Mo)-Tota (mg/L)	0.171	0.196	0.194	0.210	0.204	0.154	0.177	0.167		0.171	0.178	0.185		0.204	0.167
Nickel (Ni)-Total (mg/L)	0.00070	0.00076	0.00076	0.00090	0.00080	0.0297	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050		<0.00050	0.0322
Potassium (K)-Total (mg/L)	4.02	4.39	4.21	4.48	4.48	5.54	2.66	2.14		2.10	2.33	2.51		3.36	12.6
Selenium (Se)-Total (mg/L)	0.0387	0.0395	0.0402	0.0398	0.0417	0.0361	0.0349	0.0385		0.0398	0.0376	0.0370		0.0372	0.0320
Silicon (Si)-Total (mg/L)	6.35	5.66	5.85	5.78	6.03	31.3	6.20	5.53		5.76	6.08	6.37		6.48	69.5
Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000099	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010		<0.000010	0.000418
Sodium (Na)-Total (mg/L)	32.2	35.6	35.6	34.5	36.4	28.1	28.0	25.4		24.6	26.3	29.6		31.9	40.5
Strontium (Sr)-Total (mg/L)	1.19	1.28	1.36	1.35	1.29	1.06	0.841	0.773		0.752	0.791	0.829		1.03	2.12
Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000064	<0.000010	<0.000010		<0.000010	<0.000010	<0.000010		<0.000010	0.000081
Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00036	<0.00010	<0.00010		<0.00010	<0.00010	<0.00010		<0.00010	0.00122
Titanium (Ti)-Total (mg/L)	0.0186	<0.0100	<0.0100	0.0120	<0.0100	0.652	<0.0100	<0.0100		<0.0100	<0.0100	<0.0100		<0.0100	1.63
Uranium (U)-Total (mg/L)	0.00219	0.00227	0.00221	0.00213	0.00220	0.00316	0.00210	0.00219		0.00224	0.00231	0.00225		0.00239	0.00496
Vanadium (V)-Total (mg/L)	0.00320	0.00225	0.00246	0.00266	0.00260	0.0957	0.00267	0.00214		0.00218	0.00261	0.00277		0.00289	0.141
Zinc (Zn)-Total (mg/L)	0.0033	0.0035	0.0031	0.0035	<0.0030	0.198	<0.0030	<0.0030		<0.0030	<0.0030	<0.0030		<0.0030	0.145

	E302090 : E11								
	24-Aug-22	23-Oct-23	1-Nov-23	15-Nov-23	28-Nov-23	7-Dec-23	12-Dec-23	19-Dec-23	27-Dec-23
Calcium (Ca)-Total (mg/L)		103		76.1		89.8			
Chromium (Cr)-Total (mg/L)		0.00058		<0.00050		<0.00050			
Cobalt (Co)-Total (mg/L)		0.00032		0.00032		0.00043			
Copper (Cu)-Total (mg/L)		0.0336		0.0760		0.0713			
Iron (Fe)-Total (mg/L)		0.237		0.151		0.129			
Lead (Pb)-Total (mg/L)		0.000080		0.000093		0.000112			
Lithium (Li)-Total (mg/L)		0.0064		0.0047		0.0057			
Magnesium (Mg)-Total (mg/L)		8.81		9.37		11.4			
Manganese (Mn)-Total (mg/L)		0.0401		0.0342		0.0367			
Molybdenum (Mo)-Tota (mg/L)		0.159		0.0882		0.156			
Nickel (Ni)-Total (mg/L)		0.00088		<0.00050		<0.00050			
Potassium (K)-Total (mg/L)		0.903		0.756		0.821			
Selenium (Se)-Total (mg/L)		0.0337		0.0294		0.0393			
Silicon (Si)-Total (mg/L)		7.77		8.03		8.04			
Silver (Ag)-Total (mg/L)		<0.000010		<0.000010		<0.000010			
Sodium (Na)-Total (mg/L)		40.0		29.9		33.7			
Strontium (Sr)-Total (mg/L)		1.28		0.894		1.06			
Thallium (Tl)-Total (mg/L)		<0.000010		<0.000010		<0.000010			
Tin (Sn)-Total (mg/L)		<0.00010		<0.00010		<0.00010			
Titanium (Ti)-Total (mg/L)		0.0140		0.0133		<0.0100			
Uranium (U)-Total (mg/L)		0.00407		0.00335		0.00452			
Vanadium (V)-Total (mg/L)		0.00571		0.00452		0.00382			
Zinc (Zn)-Total (mg/L)		<0.0030		<0.0030		<0.0030			

Grid Format Report : E11 - Springer Pit Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E302090 : E11						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	31	31	44.80000	85.70000	68.37742	102.80000	8.76290
Ammonia (as N) (mg/L)	31	29	0.00250	0.85100	0.09534	0.78460	0.17148
Chloride (mg/L)	31	31	1.01000	13.90000	5.50806	12.62000	2.49748
Diss-Orthophosphate (mg/L)	31	10	0.00050	0.00620	0.00132	0.01390	0.00152
Diss-Phosphorus (mg/L)	31	24	0.00100	7.27000	0.23742	0.01952	1.30519
Floride (mg/L)	31	31	0.21100	0.58000	0.37826	0.65000	0.08864
Nitrate (N) (mg/L)	31	31	1.02000	9.12000	3.27645	12.48000	1.46532
Nitrate and Nitrite (mg/L)	31	31	1.02000	9.37000	3.32355	12.68000	1.52185
Nitrite (N) (mg/L)	31	28	0.00240	0.29200	0.04742	0.19200	0.07032
Sulphate (mg/L)	31	31	132.00000	448.00000	357.00000	554.80000	75.94954
Total Nitrogen (mg/L)	31	31	0.90100	9.88000	3.40939	13.52500	1.67573
Total Phosphorus (mg/L)	31	31	0.00230	13.10000	0.49765	0.05308	2.36382
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	31	29	0.00150	0.02210	0.00709	0.02372	0.00431
Diss-Antimony (Sb) (mg/L)	31	31	0.00033	0.00963	0.00150	0.00221	0.00192
Diss-Arsenic (As) (mg/L)	31	31	0.00086	0.01160	0.00237	0.00218	0.00199
Diss-Barium (Ba) (mg/L)	31	31	0.02120	0.07530	0.03652	0.06656	0.01187
Diss-Beryllium (Be) (mg/L)	31	0	0.00005	0.00050	0.00009	0.00005	0.00014
Diss-Bismuth (Bi) (mg/L)	31	0	0.00003	0.00003	0.00002	0.00025	0.00000
Diss-Boron (B) (mg/L)	31	31	0.07600	0.32900	0.15619	0.20360	0.06387
Diss-Cadmium (Cd) (mg/L)	31	5	0.00001	0.00015	0.00005	0.00010	0.00003
Diss-Calcium (Ca) (mg/L)	31	31	41.00000	150.00000	113.70645	182.60000	23.95434
Diss-Chromium (Cr) (mg/L)	31	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	31	28	0.00005	0.00134	0.00022	0.00103	0.00024
Diss-Copper (Cu) (mg/L)	31	31	0.00717	0.06140	0.02336	0.04558	0.01341
Diss-Iron (Fe) (mg/L)	31	0	0.01500	0.01500	0.01500	0.01500	0.00000
Diss-Lead (Pb) (mg/L)	31	2	0.00003	0.00006	0.00003	0.00003	0.00001
Diss-Lithium (Li) (mg/L)	31	31	0.00300	0.01270	0.00664	0.01706	0.00169
Diss-Magnesium (Mg) (mg/L)	31	31	7.83000	26.80000	20.05323	32.36000	4.69710
Diss-Manganese (Mn) (mg/L)	31	31	0.00398	0.07970	0.03363	0.13620	0.01743
Diss-Molybdenum (Mo) (mg/L)	31	31	0.04820	0.27300	0.17389	0.17460	0.04279
Diss-Nickel (Ni) (mg/L)	31	18	0.00025	0.00134	0.00053	0.00090	0.00028
Diss-Potassium (K) (mg/L)	31	31	0.75100	9.30000	3.66265	16.40000	1.73490

Grid Format Report : E11 - Springer Pit Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley Mining Corporation
IMPERIAL METALS CORPORATION

	E302090 : E11						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Selenium (mg/L)	31	31	0.01970	0.06370	0.03796	0.05926	0.00733
Diss-Silicon (Si) (mg/L)	31	31	3.75000	7.82000	5.55032	8.23800	0.97778
Diss-Silver (Ag) (mg/L)	31	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	31	31	9.42000	64.40000	32.23290	60.62000	9.03345
Diss-Strontium (Sr) (mg/L)	31	31	0.35400	1.60000	1.11087	2.97200	0.28782
Diss-Thallium (Tl) (mg/L)	31	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	31	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	31	0	0.00500	0.00500	0.00500	0.02100	0.00000
Diss-Uranium (U) (mg/L)	31	31	0.00060	0.00445	0.00219	0.00601	0.00067
Diss-Vanadium (V) (mg/L)	31	31	0.00137	0.00538	0.00216	0.00246	0.00082
Diss-Zinc (Zn) (mg/L)	31	6	0.00150	0.00660	0.00195	0.00438	0.00110
TDS (mg/L)	31	31	279.00000	751.00000	615.64516	967.40000	106.55689
Field Tests							
Cond (in situ) (µs/cm)	31	31	336.00000	1,067.50000	828.10323	1,234.75000	158.59899
NTU - in situ (ntu)	31	31	0.12000	1,016.90000	37.48387	9.12700	181.88386
pH (in situ) (pH)	31	31	6.31000	8.50000	7.86935	8.69675	0.38289
Sample Taken							
Temp (in situ) (Degrees Celcius)	31	31	0.90000	22.81000	7.61206	18.61000	6.41120
Organic / Inorganic							
DOC (mg/L)	31	31	0.54000	4.31000	1.89355	5.53000	0.85141
Physical Test							
Conductivity (µs/cm)	31	31	401.00000	1,050.00000	843.41935	1,210.00000	137.73229
Hardness (mg/L)	31	31	135.00000	476.00000	366.61290	584.20000	76.26956
NTU (ntu)	31	31	0.25000	4,000.00000	135.40194	16.36000	717.50566
pH (pH)	31	31	7.73000	8.13000	7.93613	8.28600	0.07986
TDS (mg/L)	31	31	279.00000	751.00000	615.64516	967.40000	106.55689
TSS (mg/L)	31	25	0.50000	6,030.00000	229.08871	17.14000	1,089.83728
Total Metals							
Aluminum (Al)-Total (mg/L)	31	31	0.01970	49.80000	2.35445	0.80860	9.38509
Antimony (Sb)-Total (mg/L)	31	31	0.00034	0.00814	0.00152	0.00224	0.00182
Arsenic (As)-Total (mg/L)	31	31	0.00082	0.05950	0.00494	0.00306	0.01072
Barium (Ba)-Total (mg/L)	31	31	0.02260	0.53600	0.06640	0.06974	0.10574
Beryllium (Be)-Total (mg/L)	31	2	0.00005	0.00238	0.00014	0.00005	0.00043
Bismuth (Bi)-Total (mg/L)	31	0	0.00003	0.00013	0.00003	0.00025	0.00002
Boron (B)-Total (mg/L)	31	31	0.08900	0.32000	0.16500	0.21500	0.05951

Grid Format Report : E11 - Springer Pit Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E302090 : E11						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Cadmium (Cd)-Total (mg/L)	31	2	0.00002	0.00093	0.00010	0.00011	0.00021
Calcium (Ca)-Total (mg/L)	31	31	48.10000	248.00000	118.17742	183.40000	33.32142
Chromium (Cr)-Total (mg/L)	31	4	0.00025	0.03510	0.00235	0.00079	0.00806
Cobalt (Co)-Total (mg/L)	31	30	0.00005	0.04610	0.00275	0.00146	0.00954
Copper (Cu)-Total (mg/L)	31	31	0.01140	4.72000	0.24099	0.07680	0.88620
Iron (Fe)-Total (mg/L)	31	24	0.01500	45.30000	2.54490	0.77480	9.53851
Lead (Pb)-Total (mg/L)	31	17	0.00003	0.02780	0.00133	0.00031	0.00532
Lithium (Li)-Total (mg/L)	31	31	0.00370	0.03870	0.00823	0.01720	0.00611
Magnesium (Mg)-Total (mg/L)	31	31	8.81000	53.50000	21.63226	32.68000	7.70148
Manganese (Mn)-Total (mg/L)	31	31	0.00479	3.53000	0.22061	0.14820	0.72671
Molybdenum (Mo)-Tota (mg/L)	31	31	0.05570	0.24700	0.17525	0.17860	0.04013
Nickel (Ni)-Total (mg/L)	31	21	0.00025	0.03220	0.00259	0.00152	0.00758
Potassium (K)-Total (mg/L)	31	31	0.75600	12.60000	4.09032	16.42000	2.29357
Selenium (Se)-Total (mg/L)	31	31	0.02060	0.06660	0.03942	0.06086	0.00749
Silicon (Si)-Total (mg/L)	31	31	4.36000	69.50000	8.89710	8.73800	12.16712
Silver (Ag)-Total (mg/L)	31	3	0.00001	0.00042	0.00002	0.00002	0.00008
Sodium (Na)-Total (mg/L)	31	31	10.50000	60.60000	33.23871	60.18000	8.47505
Strontium (Sr)-Total (mg/L)	31	31	0.40700	2.12000	1.16048	3.09400	0.32262
Thallium (Tl)-Total (mg/L)	31	2	0.00001	0.00008	0.00001	0.00001	0.00002
Tin (Sn)-Total (mg/L)	31	2	0.00005	0.00122	0.00010	0.00005	0.00022
Titanium (Ti)-Total (mg/L)	31	8	0.00500	1.63000	0.08301	0.04760	0.30980
Uranium (U)-Total (mg/L)	31	31	0.00066	0.00496	0.00237	0.00642	0.00085
Vanadium (V)-Total (mg/L)	31	31	0.00168	0.14100	0.01023	0.00372	0.02947
Zinc (Zn)-Total (mg/L)	31	14	0.00150	0.19800	0.01350	0.00736	0.04276

Grid Format Report : E13 - NW Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E291229 : E13														
	7-Jan-19	7-Feb-19	4-Mar-19	3-Apr-19	1-May-19	4-Jun-19	20-Jun-19	3-Jul-19	12-Aug-19	11-Sep-19	3-Oct-19	18-Nov-19	2-Dec-19	22-Jan-20	10-Mar-20
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		107			87.2				119			95.3			111
Ammonia (as N) (mg/L)		0.0062			0.0050				0.0136			0.0074			<0.0050
Chloride (mg/L)		3.0			<2.5				3.0			<2.5			3.06
Diss-Orthophosphate (mg/L)		0.0037			<0.0010				0.0029			<0.0010			0.0046
Diss-Phosphorus (mg/L)		0.0070			0.0031				0.0044			0.0039			0.0061
Floride (mg/L)		<0.10			<0.10				<0.10			<0.10			<0.100
Nitrate (N) (mg/L)		13.4			14.2				14.7			10.7			15.0
Nitrate and Nitrite (mg/L)		13.4			14.2				14.7			10.7			15.0
Nitrite (N) (mg/L)		<0.0050			0.0066				0.0103			0.0051			<0.0050
Sulphate (mg/L)		648			620				791			531			655
Total Nitrogen (mg/L)		13.3			25.1				28.7			11.1			15.1
Total Phosphorus (mg/L)		0.0094			0.0132				0.0203			0.0147			0.0073
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.0037			0.0043				0.0031			0.0114			<0.0030
Diss-Antimony (Sb) (mg/L)		<0.00010			0.00013				<0.00020			0.00011			0.00010
Diss-Arsenic (As) (mg/L)		0.00029			0.00030				0.00032			0.00026			0.00026
Diss-Barium (Ba) (mg/L)		0.0742			0.0607				0.0802			0.0516			0.0632
Diss-Beryllium (Be) (mg/L)		<0.00010			<0.00010				<0.00020			<0.00010			<0.00100
Diss-Bismuth (Bi) (mg/L)		<0.000050			<0.000050				<0.00010			<0.000050			<0.000050
Diss-Boron (B) (mg/L)		0.075			0.066				0.086			0.060			0.067
Diss-Cadmium (Cd) (mg/L)		<0.000070			<0.000060				<0.000060			<0.000040			<0.0000450
Diss-Calcium (Ca) (mg/L)		244			218				270			185			226
Diss-Chromium (Cr) (mg/L)		<0.00050			<0.00050				<0.00050			<0.00050			<0.00050
Diss-Cobalt (Co) (mg/L)		<0.00010			<0.00010				<0.00020			<0.00010			<0.00010
Diss-Copper (Cu) (mg/L)		0.00594			0.00672				0.00675			0.00871			0.00468
Diss-Iron (Fe) (mg/L)		<0.030			<0.030				<0.030			<0.030			<0.030
Diss-Lead (Pb) (mg/L)		<0.000050			<0.000050				<0.00010			<0.000050			<0.000050
Diss-Lithium (Li) (mg/L)		<0.0010			0.0013				<0.0020			0.0011			<0.0010
Diss-Magnesium (Mg) (mg/L)		45.7			38.6				50.2			33.6			44.6
Diss-Manganese (Mn) (mg/L)		0.0174			0.0189				0.0197			0.0154			0.0132
Diss-Molybdenum (Mo) (mg/L)		0.0525			0.0811				0.101			0.0703			0.0675
Diss-Nickel (Ni) (mg/L)		<0.00050			<0.00050				<0.0010			<0.00050			<0.00050
Diss-Potassium (K) (mg/L)		1.91			1.89				2.57			1.69			1.83
Diss-Selenium (mg/L)		0.0435			0.0502				0.0497			0.0359			0.0495

	E291229 : E13														
	9-Apr-20	21-Apr-20	23-Apr-20	26-May-20	10-Jun-20	13-Jul-20	12-Aug-20	3-Sep-20	6-Oct-20	19-Oct-20	17-Nov-20	10-Dec-20	6-Jan-21	2-Feb-21	17-Feb-21
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		67.6	61.3				94.2			84.8					91.1
Ammonia (as N) (mg/L)		<0.0050	0.0056				0.0113			0.0061					0.0130
Chloride (mg/L)		<2.50	<2.50				<5.00			<2.50					<5.00
Diss-Orthophosphate (mg/L)		0.0059	0.0065				0.0042			0.0032					0.0062
Diss-Phosphorus (mg/L)		0.0106	0.0120				0.0072			0.0064					0.0056
Floride (mg/L)		<0.100	<0.100				<0.200			<0.100					<0.200
Nitrate (N) (mg/L)		7.22	7.30				15.3			9.04					15.6
Nitrate and Nitrite (mg/L)		7.22	7.30				15.3			9.04					15.6
Nitrite (N) (mg/L)		<0.0050	<0.0050				<0.0100			<0.0050					0.0183
Sulphate (mg/L)		487	490				868			684					749
Total Nitrogen (mg/L)		6.75	7.75				15.8			9.32					15.3
Total Phosphorus (mg/L)		0.0222	0.0290				0.0135			0.0133					0.0152
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.0174	0.0193				0.0032			0.0070					0.0032
Diss-Antimony (Sb) (mg/L)		0.00012	0.00013				0.00016			0.00011					0.00011
Diss-Arsenic (As) (mg/L)		0.00029	0.00029				0.00032			0.00025					0.00028
Diss-Barium (Ba) (mg/L)		0.0448	0.0469				0.0789			0.0583					0.0668
Diss-Beryllium (Be) (mg/L)		<0.00100	<0.00100				<0.00100			<0.00100					<0.000100
Diss-Bismuth (Bi) (mg/L)		<0.000050	<0.000050				<0.000050			<0.000050					<0.000050
Diss-Boron (B) (mg/L)		0.047	0.050				0.073			0.061					0.068
Diss-Cadmium (Cd) (mg/L)		<0.0000600	<0.0000550				<0.0000600			<0.0000900					0.0000490
Diss-Calcium (Ca) (mg/L)		156	181				302			221					273
Diss-Chromium (Cr) (mg/L)		<0.00050	<0.00050				<0.00050			<0.00050					<0.00050
Diss-Cobalt (Co) (mg/L)		0.00012	0.00011				<0.00010			<0.00010					<0.00010
Diss-Copper (Cu) (mg/L)		0.0117	0.0120				0.00556			0.00753					0.00493
Diss-Iron (Fe) (mg/L)		<0.030	<0.030				<0.030			<0.030					<0.030
Diss-Lead (Pb) (mg/L)		<0.000050	<0.000050				<0.000050			<0.000050					<0.000050
Diss-Lithium (Li) (mg/L)		0.0010	0.0012				0.0016			0.0011					0.0013
Diss-Magnesium (Mg) (mg/L)		29.3	30.9				55.4			40.1					49.5
Diss-Manganese (Mn) (mg/L)		0.0442	0.0354				0.00025			0.0188					0.0251
Diss-Molybdenum (Mo) (mg/L)		0.0750	0.0732				0.125			0.0903					0.0908
Diss-Nickel (Ni) (mg/L)		<0.00050	<0.00050				<0.00050			<0.00050					<0.00050
Diss-Potassium (K) (mg/L)		2.03	2.07				2.57			2.05					1.91
Diss-Selenium (mg/L)		0.0439	0.0476				0.0638			0.0432					0.0595

	E291229 : E13														
	10-Mar-21	6-Apr-21	12-May-21	9-Jun-21	17-Jun-21	6-Jul-21	9-Aug-21	17-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	14-Dec-21	20-Jan-22	10-Feb-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)			73.4					114			115				100
Ammonia (as N) (mg/L)			<0.0050					0.0186			<0.0050				<0.0050
Chloride (mg/L)			<2.50					<5.00			<2.50				<2.50
Diss-Orthophosphate (mg/L)			0.0030					0.0032			0.0025				0.0036
Diss-Phosphorus (mg/L)			0.0026					0.0098			0.0057				0.0070
Floride (mg/L)			0.104					<0.200			<0.100				<0.100
Nitrate (N) (mg/L)			9.52					11.0			6.02				5.12
Nitrate and Nitrite (mg/L)			9.52					11.0			6.02				5.12
Nitrite (N) (mg/L)			<0.0050					0.0165			<0.0050				<0.0050
Sulphate (mg/L)			683					856			751				559
Total Nitrogen (mg/L)			9.10					11.1			6.25				5.01
Total Phosphorus (mg/L)			0.0099					0.0133			0.0097				0.0117
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)			0.0091					<0.0060			0.0030				0.0043
Diss-Antimony (Sb) (mg/L)			0.00014					<0.00020			0.00012				0.00012
Diss-Arsenic (As) (mg/L)			0.00030					0.00042			0.00034				0.00023
Diss-Barium (Ba) (mg/L)			0.0570					0.0762			0.0686				0.0502
Diss-Beryllium (Be) (mg/L)			<0.000100					<0.000200			<0.000100				<0.000100
Diss-Bismuth (Bi) (mg/L)			<0.000050					<0.000100			<0.000050				<0.000050
Diss-Boron (B) (mg/L)			0.067					0.096			0.081				0.062
Diss-Cadmium (Cd) (mg/L)			<0.0000700					<0.0000500			<0.0000350				<0.0000300
Diss-Calcium (Ca) (mg/L)			230					267			261				191
Diss-Chromium (Cr) (mg/L)			<0.00050					<0.00100			<0.00050				<0.00050
Diss-Cobalt (Co) (mg/L)			<0.00010					<0.00020			<0.00010				<0.00010
Diss-Copper (Cu) (mg/L)			0.00792					0.00626			0.00817				0.00544
Diss-Iron (Fe) (mg/L)			<0.030					<0.060			<0.030				<0.030
Diss-Lead (Pb) (mg/L)			<0.000050					<0.000100			<0.000050				<0.000050
Diss-Lithium (Li) (mg/L)			0.0015					<0.0020			0.0012				<0.0010
Diss-Magnesium (Mg) (mg/L)			39.6					49.3			48.3				34.8
Diss-Manganese (Mn) (mg/L)			0.0248					0.0580			0.0296				0.0157
Diss-Molybdenum (Mo) (mg/L)			0.0963					0.113			0.0770				0.0563
Diss-Nickel (Ni) (mg/L)			0.00052					<0.00100			<0.00050				<0.00050
Diss-Potassium (K) (mg/L)			2.06					2.69			2.14				1.52
Diss-Selenium (mg/L)			0.0499					0.0506			0.0352				0.0296

	E291229 : E13														
	24-Mar-22	14-Apr-22	11-May-22	14-Jun-22	14-Jul-22	4-Aug-22	1-Sep-22	26-Oct-22	27-Oct-22	17-Nov-22	5-Dec-22	11-Jan-23	23-Jan-23	9-Feb-23	14-Mar-23
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)			61.3		97.1				110				105		
Ammonia (as N) (mg/L)			<0.0050		0.0177				0.0055				0.0103		
Chloride (mg/L)			<2.50		<2.50				<5.00				2.84		
Diss-Orthophosphate (mg/L)			<0.0010		0.0036				0.0053				0.0062		
Diss-Phosphorus (mg/L)			0.0073		0.0110				0.0093				0.0103		
Floride (mg/L)			<0.100		<0.100				<0.200				<0.100		
Nitrate (N) (mg/L)			7.15		8.36				8.63				7.25		
Nitrate and Nitrite (mg/L)			7.16		8.37				8.63				7.25		
Nitrite (N) (mg/L)			0.0074		0.0135				<0.0100				<0.0050		
Sulphate (mg/L)			689		770				836				671		
Total Nitrogen (mg/L)			7.08		8.11				8.75				7.89		
Total Phosphorus (mg/L)			0.0136		0.0193				0.0162				0.0161		
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)			0.0181		0.0077				0.0051				0.0057		
Diss-Antimony (Sb) (mg/L)			0.00012		0.00016				0.00012				<0.00010		
Diss-Arsenic (As) (mg/L)			0.00028		0.00035				0.00032				0.00032		
Diss-Barium (Ba) (mg/L)			0.0522		0.0670				0.0823				0.0597		
Diss-Beryllium (Be) (mg/L)			<0.000100		<0.000100				<0.000100				<0.000100		
Diss-Bismuth (Bi) (mg/L)			<0.000050		<0.000050				<0.000050				<0.000050		
Diss-Boron (B) (mg/L)			0.056		0.074				0.079				0.063		
Diss-Cadmium (Cd) (mg/L)			<0.0000800		<0.0000600				<0.0000400				<0.0000250		
Diss-Calcium (Ca) (mg/L)			210		271				299				245		
Diss-Chromium (Cr) (mg/L)			<0.00050		<0.00050				<0.00050				<0.00050		
Diss-Cobalt (Co) (mg/L)			<0.00010		0.00010				<0.00010				<0.00010		
Diss-Copper (Cu) (mg/L)			0.0101		0.00713				0.00610				0.00628		
Diss-Iron (Fe) (mg/L)			<0.030		<0.030				<0.030				<0.030		
Diss-Lead (Pb) (mg/L)			<0.000050		<0.000050				<0.000050				<0.000050		
Diss-Lithium (Li) (mg/L)			0.0016		0.0017				0.0014				<0.0010		
Diss-Magnesium (Mg) (mg/L)			37.3		53.6				53.0				45.4		
Diss-Manganese (Mn) (mg/L)			0.0301		0.0480				0.0543				0.0324		
Diss-Molybdenum (Mo) (mg/L)			0.0902		0.117				0.0831				0.0534		
Diss-Nickel (Ni) (mg/L)			0.00076		<0.00050				<0.00050				<0.00050		
Diss-Potassium (K) (mg/L)			2.24		2.32				2.59				2.00		
Diss-Selenium (mg/L)			0.0521		0.0624				0.0452				0.0378		

	E291229 : E13									
	5-Apr-23	13-Apr-23	3-May-23	7-Jun-23	13-Jul-23	3-Aug-23	11-Sep-23	4-Oct-23	16-Nov-23	5-Dec-23
Anions and Nutrients										
Alkalinity (CaCO3) (mg/L)		79.3				117		125		
Ammonia (as N) (mg/L)		0.0062				0.0107		0.0063		
Chloride (mg/L)		<2.50				<5.00		<5.00		
Diss-Orthophosphate (mg/L)		0.0022				<0.0010		0.0026		
Diss-Phosphorus (mg/L)		0.0122				0.0082		0.0077		
Floride (mg/L)		0.102				<0.200		<0.200		
Nitrate (N) (mg/L)		8.08				13.9		12.8		
Nitrate and Nitrite (mg/L)		8.09				13.9		12.8		
Nitrite (N) (mg/L)		0.0104				<0.0100		<0.0100		
Sulphate (mg/L)		657				813		832		
Total Nitrogen (mg/L)		8.25				14.6		12.6		
Total Phosphorus (mg/L)		0.0161				0.0142		0.0203		
Dissolved Metals										
Aluminum (Al)-Diss (mg/L)		0.0092				0.0046		0.0042		
Diss-Antimony (Sb) (mg/L)		0.00019				0.00016		0.00016		
Diss-Arsenic (As) (mg/L)		0.00035				0.00037		0.00035		
Diss-Barium (Ba) (mg/L)		0.0482				0.0708		0.0774		
Diss-Beryllium (Be) (mg/L)		<0.000100				<0.000100		<0.000100		
Diss-Bismuth (Bi) (mg/L)		<0.000050				<0.000050		<0.000050		
Diss-Boron (B) (mg/L)		0.059				0.085		0.080		
Diss-Cadmium (Cd) (mg/L)		<0.0000600				<0.0000600		<0.0000550		
Diss-Calcium (Ca) (mg/L)		209				286		287		
Diss-Chromium (Cr) (mg/L)		<0.00050				<0.00050		<0.00050		
Diss-Cobalt (Co) (mg/L)		<0.00010				<0.00010		<0.00010		
Diss-Copper (Cu) (mg/L)		0.00838				0.00752		0.00692		
Diss-Iron (Fe) (mg/L)		<0.030				<0.030		<0.030		
Diss-Lead (Pb) (mg/L)		<0.000050				<0.000050		<0.000050		
Diss-Lithium (Li) (mg/L)		0.0015				0.0017		0.0013		
Diss-Magnesium (Mg) (mg/L)		38.0				52.4		52.1		
Diss-Manganese (Mn) (mg/L)		0.0287				0.0273		0.0212		
Diss-Molybdenum (Mo) (mg/L)		0.109				0.125		0.111		
Diss-Nickel (Ni) (mg/L)		<0.00050				<0.00050		<0.00050		
Diss-Potassium (K) (mg/L)		2.02				2.14		2.48		
Diss-Selenium (mg/L)		0.0534				0.0690		0.0541		

Grid Format Report : E13 - NW Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E291229 : E13														
	7-Jan-19	7-Feb-19	4-Mar-19	3-Apr-19	1-May-19	4-Jun-19	20-Jun-19	3-Jul-19	12-Aug-19	11-Sep-19	3-Oct-19	18-Nov-19	2-Dec-19	22-Jan-20	10-Mar-20
Diss-Silicon (Si) (mg/L)		6.52			5.60				7.11			6.16			6.52
Diss-Silver (Ag) (mg/L)		<0.000010			<0.000010				<0.000020			<0.000010			<0.000010
Diss-Sodium (Na) (mg/L)		19.1			17.0				21.0			14.6			19.0
Diss-Strontium (Sr) (mg/L)		0.965			0.852				1.10			0.715			0.903
Diss-Thallium (Tl) (mg/L)		<0.000010			<0.000010				<0.000020			<0.000010			<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010			<0.00010				<0.00020			<0.00010			<0.00010
Diss-Titanium (Ti) (mg/L)		<0.010			<0.010				<0.010			<0.010			<0.0100
Diss-Uranium (U) (mg/L)		0.000647			0.000498				0.000821			0.000428			0.000712
Diss-Vanadium (V) (mg/L)		<0.00050			<0.00050				<0.0010			<0.00050			<0.00050
Diss-Zinc (Zn) (mg/L)		0.0089			<0.0030				0.0030			<0.0030			<0.0150
TDS (mg/L)		1140			1030				1420			962			1200
Field Tests															
Cond (in situ) (µs/cm)		1413.8			1373.9		1758.1		1794.5	1922.7		1247.6			1408.3
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)		1.54			0.36		1.26		0.66	1.06		1.28			1.79
pH (in situ) (pH)		7.63			7.42		7.88		7.85	7.79		7.6			7.8
Q (m3/s)					0.0026		0.0014		0.00259	0.00127					
Sample Taken	No	Yes	No	No	Yes	No	No	No	Yes	No	No	Yes	No	No	Yes
Staff Gauge (m)															
Temp (in situ) (Degrees Celcius)		0.843			3.928		8.59		11.244	11.827		2.94			2.058
Organic / Inorganic															
DOC (mg/L)		4.74			4.85				4.84			8.34			4.05
Physical Test															
Conductivity (µs/cm)		1310			1280				1630			1150			1420
Hardness (mg/L)		798			703				882			600			748
NTU (ntu)		0.99			0.35				0.59			1.05			0.39
pH (pH)		7.90			7.99				8.17			7.92			7.99
TDS (mg/L)		1140			1030				1420			962			1200
TSS (mg/L)		1.1			<1.0				<1.0			<1.0			<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)		0.0547			0.0306				0.0284			0.0852			0.0263
Antimony (Sb)-Total (mg/L)		<0.00010			0.00013				0.00016			0.00011			0.00011
Arsenic (As)-Total (mg/L)		0.00048			0.00043				0.00042			0.00035			0.00027
Barium (Ba)-Total (mg/L)		0.0734			0.0575				0.0904			0.0530			0.0623

	E291229 : E13														
	9-Apr-20	21-Apr-20	23-Apr-20	26-May-20	10-Jun-20	13-Jul-20	12-Aug-20	3-Sep-20	6-Oct-20	19-Oct-20	17-Nov-20	10-Dec-20	6-Jan-21	2-Feb-21	17-Feb-21
Diss-Silicon (Si) (mg/L)		5.62	5.75				7.33			6.31					6.95
Diss-Silver (Ag) (mg/L)		<0.000010	<0.000010				<0.000010			<0.000010					<0.000010
Diss-Sodium (Na) (mg/L)		13.0	13.7				24.5			18.9					21.2
Diss-Strontium (Sr) (mg/L)		0.669	0.683				1.24			0.919					1.03
Diss-Thallium (Tl) (mg/L)		<0.000010	<0.000010				<0.000010			<0.000010					<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010	<0.00010				<0.00010			<0.00010					<0.00010
Diss-Titanium (Ti) (mg/L)		<0.0100	<0.0100				<0.0100			<0.0100					<0.0100
Diss-Uranium (U) (mg/L)		0.000300	0.000285				0.000589			0.000436					0.000542
Diss-Vanadium (V) (mg/L)		0.00052	0.00052				<0.00050			<0.00050					<0.00050
Diss-Zinc (Zn) (mg/L)		<0.0030	<0.0030				<0.0030			0.0068					0.0053
TDS (mg/L)		786	826				1500			1190					1280
Field Tests															
Cond (in situ) (µs/cm)		1061.2	1096.3	624	1468.7	1381.7	1797	1380	1844.9	1405.5					1576.6
Dissolved Oxygen (In (%)			94												
Dissolved Oxygen (in (mg/L)			12.04												
NTU - in situ (ntu)		3.2	4.76	0.66	2.23	1.21	0.22	1.01	0.48	2.9					4.86
pH (in situ) (pH)		6.59	7.37	7.97	7.07	7.39	7.74	7.41	7.91	7.55					7.29
Q (m3/s)				0.0054	0.0053	0.0071	0.0029	0.0047	0.0018	0.0059					
Sample Taken	No	Yes	Yes	No	No	No	Yes	No	No	Yes	No	No	No	no	yes
Staff Gauge (m)		0.79													
Temp (in situ) (Degrees Celcius)		5.966	4.696	12.6	10.499	10.717	8.868	9.3	9.913	5.808					0.303
Organic / Inorganic															
DOC (mg/L)		9.62	8.30				5.19			5.77					4.25
Physical Test															
Conductivity (µs/cm)		1020	1100				1660			1390					1540
Hardness (mg/L)		511	579				982			717					886
NTU (ntu)		2.50	1.94				0.37			0.87					2.03
pH (pH)		7.82	7.63				7.96			8.03					8.06
TDS (mg/L)		786	826				1500			1190					1280
TSS (mg/L)		3.6	6.7				<1.0			2.0					2.4
Total Metals															
Aluminum (Al)-Total (mg/L)		0.167	0.189				0.0437			0.0532					0.129
Antimony (Sb)-Total (mg/L)		0.00014	0.00014				0.00014			0.00011					0.00012
Arsenic (As)-Total (mg/L)		0.00040	0.00043				0.00038			0.00030					0.00052
Barium (Ba)-Total (mg/L)		0.0482	0.0488				0.0775			0.0596					0.0704

	E291229 : E13														
	10-Mar-21	6-Apr-21	12-May-21	9-Jun-21	17-Jun-21	6-Jul-21	9-Aug-21	17-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	14-Dec-21	20-Jan-22	10-Feb-22
Diss-Silicon (Si) (mg/L)			6.60					7.22			6.83				6.29
Diss-Silver (Ag) (mg/L)			<0.000010					<0.000020			<0.000010				<0.000010
Diss-Sodium (Na) (mg/L)			16.7					23.0			22.0				15.2
Diss-Strontium (Sr) (mg/L)			0.921					1.10			1.02				0.815
Diss-Thallium (Tl) (mg/L)			<0.000010					<0.000020			<0.000010				<0.000010
Diss-Tin (Sn) (mg/L)			<0.00010					<0.00020			<0.00010				<0.00010
Diss-Titanium (Ti) (mg/L)			<0.0100					<0.0200			<0.0100				<0.0100
Diss-Uranium (U) (mg/L)			0.000465					0.000736			0.000687				0.000478
Diss-Vanadium (V) (mg/L)			0.00056					<0.00100			0.00051				<0.00050
Diss-Zinc (Zn) (mg/L)			0.0038					<0.0060			<0.0030				0.0038
TDS (mg/L)			1050					1400			1260				916
Field Tests															
Cond (in situ) (µs/cm)			1377.5	1437		2066	2071	1655	1897.5	709	1534	1477			1172
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)			0.83	0.35		0.26	1.56	0.095	0.56	2.74	4.66	3.19			2.09
pH (in situ) (pH)			7.68	7.93		7.86	7.42	7.81	7.9	7.97	7.88	7.91			7.66
Q (m3/s)			0.0041	0.0029		0.0009	0.0006	0.0007	0.0008	0.0009	0.0018	0.0019			
Sample Taken	no	No	Yes	No	No	No	No	Yes	No	No	Yes	No	No	No	Yes
Staff Gauge (m)				0.838											
Temp (in situ) (Degrees Celcius)			8.306	9.065		11.362	14.258	15.569	13.325	7.1	6.116	3.4			2.119
Organic / Inorganic															
DOC (mg/L)			5.25					4.71			5.29				4.70
Physical Test															
Conductivity (µs/cm)			1460					1600			1470				1150
Hardness (mg/L)			737					870			851				620
NTU (ntu)			0.31					0.97			1.55				1.34
pH (pH)			8.04					8.12			7.96				7.89
TDS (mg/L)			1050					1400			1260				916
TSS (mg/L)			2.6					<1.0			4.9				1.2
Total Metals															
Aluminum (Al)-Total (mg/L)			0.0428					0.0555			0.134				0.112
Antimony (Sb)-Total (mg/L)			0.00015					0.00016			0.00012				0.00011
Arsenic (As)-Total (mg/L)			0.00032					0.00047			0.00040				0.00032
Barium (Ba)-Total (mg/L)			0.0553					0.0768			0.0676				0.0535

	E291229 : E13														
	24-Mar-22	14-Apr-22	11-May-22	14-Jun-22	14-Jul-22	4-Aug-22	1-Sep-22	26-Oct-22	27-Oct-22	17-Nov-22	5-Dec-22	11-Jan-23	23-Jan-23	9-Feb-23	14-Mar-23
Diss-Silicon (Si) (mg/L)			6.60		7.79				6.89				6.66		
Diss-Silver (Ag) (mg/L)			<0.000010		<0.000010				<0.000010				<0.000010		
Diss-Sodium (Na) (mg/L)			16.6		21.7				21.5				20.0		
Diss-Strontium (Sr) (mg/L)			0.828		1.04				1.20				0.949		
Diss-Thallium (Tl) (mg/L)			<0.000010		<0.000010				<0.000010				<0.000010		
Diss-Tin (Sn) (mg/L)			<0.00010		<0.00010				<0.00010				0.00014		
Diss-Titanium (Ti) (mg/L)			<0.0100		<0.0100				<0.0100				<0.0100		
Diss-Uranium (U) (mg/L)			0.000306		0.000534				0.000773				0.000587		
Diss-Vanadium (V) (mg/L)			0.00053		0.00055				<0.00050				<0.00050		
Diss-Zinc (Zn) (mg/L)			0.0034		<0.0030				<0.0030				0.0042		
TDS (mg/L)			1110		1390				1410				1230		
Field Tests															
Cond (in situ) (µs/cm)		1249	1287	1409.4	1606	1588	1951	1410	1658	2018	1894	1510	1520		
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)		0.86	0.86	0.52	0.62	1.12	1.13	2.7	3.07	0.84	1.64	1.84	4.26		
pH (in situ) (pH)		8.23	7.47	7.87	7.19	7.31	7.42	8.12	7.68	7.83	7.38	7.75	7.69		
Q (m3/s)		0.0055	0.0049	0.0046	0.0033	0.0032	0.0034	0.0014	0.0014	0.001	0.0006		0.0008		
Sample Taken	No	No	Yes	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No
Staff Gauge (m)															
Temp (in situ) (Degrees Celcius)		2.2	4.831	13.916	8.886	9.556	10.548	4.2	4.627	0.892	0.96	1.762	1.088		
Organic / Inorganic															
DOC (mg/L)			6.78		5.37				6.58				6.11		
Physical Test															
Conductivity (µs/cm)			1290		1510				1530				1390		
Hardness (mg/L)			678		897				965				799		
NTU (ntu)			1.20		0.55				2.58				2.32		
pH (pH)			7.96		8.10				8.05				7.91		
TDS (mg/L)			1110		1390				1410				1230		
TSS (mg/L)			4.3		4.2				3.6				4.6		
Total Metals															
Aluminum (Al)-Total (mg/L)			0.0886		0.0616				0.160				0.0460		
Antimony (Sb)-Total (mg/L)			0.00014		0.00019				0.00014				0.00011		
Arsenic (As)-Total (mg/L)			0.00034		0.00042				0.00046				0.00035		
Barium (Ba)-Total (mg/L)			0.0541		0.0700				0.0896				0.0638		

	E291229 : E13									
	5-Apr-23	13-Apr-23	3-May-23	7-Jun-23	13-Jul-23	3-Aug-23	11-Sep-23	4-Oct-23	16-Nov-23	5-Dec-23
Diss-Silicon (Si) (mg/L)		6.64				7.36		7.47		
Diss-Silver (Ag) (mg/L)		<0.000010				<0.000010		<0.000010		
Diss-Sodium (Na) (mg/L)		19.0				22.3		22.9		
Diss-Strontium (Sr) (mg/L)		0.799				1.20		1.15		
Diss-Thallium (Tl) (mg/L)		<0.000010				<0.000010		<0.000010		
Diss-Tin (Sn) (mg/L)		<0.00010				<0.00010		<0.00010		
Diss-Titanium (Ti) (mg/L)		<0.0100				<0.0100		<0.0100		
Diss-Uranium (U) (mg/L)		0.000457				0.000964		0.00109		
Diss-Vanadium (V) (mg/L)		<0.00050				0.00054		0.00051		
Diss-Zinc (Zn) (mg/L)		0.0043				<0.0030		0.0066		
TDS (mg/L)		1120				1390		1200		
Field Tests										
Cond (in situ) (µs/cm)		1342	1078	1662	1601	1394	1766	1623	1594	1639
Dissolved Oxygen (In (%)										
Dissolved Oxygen (in (mg/L)										
NTU - in situ (ntu)		1.89	1.34	0.16	2.06	0.72		2.73	1.49	3.38
pH (in situ) (pH)		7.49	7.62	8.07	7.39	7.81	7.96	7.74	7.44	7.79
Q (m3/s)		0.0064	0.0052	0.0018	0.002	0.0017	0.0014	0.0012	0.0007	0.0007
Sample Taken	No	Yes	No	No	No	Yes	No	Yes	No	No
Staff Gauge (m)										
Temp (in situ) (Degrees Celcius)		2.48	8.7	17.4	11.262	10.241	13.069	7.966	2.134	0.955
Organic / Inorganic										
DOC (mg/L)		5.79				5.59		5.58		
Physical Test										
Conductivity (µs/cm)		1280				1640		1620		
Hardness (mg/L)		678				930		931		
NTU (ntu)		1.44				0.50		1.91		
pH (pH)		7.95				8.09		8.04		
TDS (mg/L)		1120				1390		1200		
TSS (mg/L)		2.7				<1.0		3.0		
Total Metals										
Aluminum (Al)-Total (mg/L)		0.158				0.0315		0.136		
Antimony (Sb)-Total (mg/L)		0.00017				0.00018		0.00018		
Arsenic (As)-Total (mg/L)		0.00042				0.00038		0.00044		
Barium (Ba)-Total (mg/L)		0.0476				0.0748		0.0799		

Grid Format Report : E13 - NW Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E291229 : E13														
	7-Jan-19	7-Feb-19	4-Mar-19	3-Apr-19	1-May-19	4-Jun-19	20-Jun-19	3-Jul-19	12-Aug-19	11-Sep-19	3-Oct-19	18-Nov-19	2-Dec-19	22-Jan-20	10-Mar-20
Beryllium (Be)-Total (mg/L)		<0.00010			<0.00010				<0.00010			<0.00010			<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050			<0.000050				<0.000050			<0.000050			<0.000050
Boron (B)-Total (mg/L)		0.075			0.067				0.091			0.067			0.077
Cadmium (Cd)-Total (mg/L)		<0.000050			<0.000060				<0.000060			<0.000080			<0.0000700
Calcium (Ca)-Total (mg/L)		240			222				304			193			259
Chromium (Cr)-Total (mg/L)		<0.00050			<0.00050				<0.00050			<0.00050			<0.00050
Cobalt (Co)-Total (mg/L)		0.00011			<0.00010				<0.00010			0.00011			<0.00010
Copper (Cu)-Total (mg/L)		0.00750			0.00852				0.00875			0.0112			0.00979
Iron (Fe)-Total (mg/L)		0.061			0.037				0.033			0.089			0.031
Lead (Pb)-Total (mg/L)		<0.000050			<0.000050				<0.000050			<0.000050			0.000185
Lithium (Li)-Total (mg/L)		<0.0010			0.0013				0.0016			0.0011			<0.0010
Magnesium (Mg)-Total (mg/L)		46.0			38.8				55.2			36.4			45.0
Manganese (Mn)-Total (mg/L)		0.0217			0.0234				0.0249			0.0199			0.0157
Molybdenum (Mo)-Tota (mg/L)		0.0558			0.0799				0.110			0.0657			0.0731
Nickel (Ni)-Total (mg/L)		<0.00050			<0.00050				<0.00050			<0.00050			<0.00050
Potassium (K)-Total (mg/L)		1.82			1.91				2.76			1.80			1.81
Selenium (Se)-Total (mg/L)		0.0430			0.0512				0.0587			0.0353			0.0498
Silicon (Si)-Total (mg/L)		6.90			6.23				7.67			6.77			6.64
Silver (Ag)-Total (mg/L)		<0.000010			<0.000010				<0.000010			<0.000010			<0.000010
Sodium (Na)-Total (mg/L)		19.2			16.3				23.9			15.9			19.0
Strontium (Sr)-Total (mg/L)		0.984			0.840				1.20			0.746			0.998
Thallium (Tl)-Total (mg/L)		<0.000010			<0.000010				<0.000010			<0.000010			<0.000010
Tin (Sn)-Total (mg/L)		<0.00010			<0.00010				<0.00010			<0.00010			<0.00010
Titanium (Ti)-Total (mg/L)		<0.010			<0.010				<0.010			<0.010			<0.0100
Uranium (U)-Total (mg/L)		0.000642			0.000464				0.000739			0.000461			0.000673
Vanadium (V)-Total (mg/L)		0.00076			0.00064				0.00069			0.00082			0.00050
Zinc (Zn)-Total (mg/L)		0.0093			0.0030				0.0038			<0.0030			0.0094

	E291229 : E13														
	9-Apr-20	21-Apr-20	23-Apr-20	26-May-20	10-Jun-20	13-Jul-20	12-Aug-20	3-Sep-20	6-Oct-20	19-Oct-20	17-Nov-20	10-Dec-20	6-Jan-21	2-Feb-21	17-Feb-21
Beryllium (Be)-Total (mg/L)		<0.000100	<0.000100				<0.000100			<0.000100					<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050	<0.000050				<0.000050			<0.000050					<0.000050
Boron (B)-Total (mg/L)		0.046	0.049				0.083			0.068					0.072
Cadmium (Cd)-Total (mg/L)		<0.0000550	<0.0000800				<0.0000700			<0.0000650					<0.000100
Calcium (Ca)-Total (mg/L)		164	175				312			231					285
Chromium (Cr)-Total (mg/L)		<0.00050	<0.00050				<0.00050			<0.00050					<0.00050
Cobalt (Co)-Total (mg/L)		0.00021	0.00024				0.00011			<0.00010					0.00019
Copper (Cu)-Total (mg/L)		0.0171	0.0173				0.00824			0.00856					0.00988
Iron (Fe)-Total (mg/L)		0.208	0.209				0.045			0.063					0.177
Lead (Pb)-Total (mg/L)		0.000070	0.000078				<0.000050			<0.000050					0.000064
Lithium (Li)-Total (mg/L)		0.0012	0.0015				0.0018			0.0013					0.0014
Magnesium (Mg)-Total (mg/L)		30.3	30.1				56.4			37.0					53.6
Manganese (Mn)-Total (mg/L)		0.0574	0.0477				0.0612			0.0204					0.0422
Molybdenum (Mo)-Tota (mg/L)		0.0750	0.0758				0.128			0.0933					0.0846
Nickel (Ni)-Total (mg/L)		<0.00050	0.00062				<0.00050			<0.00050					0.00054
Potassium (K)-Total (mg/L)		1.99	2.06				2.54			1.97					2.09
Selenium (Se)-Total (mg/L)		0.0484	0.0455				0.0682			0.0407					0.0595
Silicon (Si)-Total (mg/L)		6.80	6.18				7.90			6.45					7.56
Silver (Ag)-Total (mg/L)		0.000012	0.000012				<0.000010			0.000015					<0.000010
Sodium (Na)-Total (mg/L)		13.2	13.6				25.4			17.3					22.0
Strontium (Sr)-Total (mg/L)		0.646	0.697				1.21			0.908					1.14
Thallium (Tl)-Total (mg/L)		<0.000010	<0.000010				<0.000010			<0.000010					<0.000010
Tin (Sn)-Total (mg/L)		<0.00010	<0.00010				<0.00010			<0.00010					<0.00010
Titanium (Ti)-Total (mg/L)		<0.0100	<0.0100				<0.0100			<0.0100					<0.0100
Uranium (U)-Total (mg/L)		0.000287	0.000295				0.000620			0.000425					0.000627
Vanadium (V)-Total (mg/L)		0.00102	0.00107				0.00072			0.00063					0.00115
Zinc (Zn)-Total (mg/L)		0.0032	0.0035				0.0043			0.0066					0.0089

	E291229 : E13														
	10-Mar-21	6-Apr-21	12-May-21	9-Jun-21	17-Jun-21	6-Jul-21	9-Aug-21	17-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	14-Dec-21	20-Jan-22	10-Feb-22
Beryllium (Be)-Total (mg/L)			<0.000100					<0.000100			<0.000100				<0.000100
Bismuth (Bi)-Total (mg/L)			<0.000050					<0.000050			<0.000050				<0.000050
Boron (B)-Total (mg/L)			0.073					0.104			0.082				0.076
Cadmium (Cd)-Total (mg/L)			<0.0000650					<0.0000700			<0.0000450				<0.0000450
Calcium (Ca)-Total (mg/L)			234					290			250				208
Chromium (Cr)-Total (mg/L)			<0.00050					<0.00050			<0.00050				<0.00050
Cobalt (Co)-Total (mg/L)			<0.00010					0.00011			0.00017				0.00012
Copper (Cu)-Total (mg/L)			0.00970					0.00751			0.0104				0.00920
Iron (Fe)-Total (mg/L)			0.055					0.071			0.149				0.123
Lead (Pb)-Total (mg/L)			<0.000050					<0.000050			0.000073				0.000084
Lithium (Li)-Total (mg/L)			0.0018					0.0017			0.0012				0.0012
Magnesium (Mg)-Total (mg/L)			42.4					51.1			44.6				39.4
Manganese (Mn)-Total (mg/L)			0.0296					0.0616			0.0458				0.0236
Molybdenum (Mo)-Tota (mg/L)			0.0993					0.116			0.0721				0.0634
Nickel (Ni)-Total (mg/L)			0.00060					<0.00050			0.00054				<0.00050
Potassium (K)-Total (mg/L)			2.15					2.88			1.94				1.67
Selenium (Se)-Total (mg/L)			0.0546					0.0533			0.0318				0.0334
Silicon (Si)-Total (mg/L)			6.84					7.84			6.97				7.05
Silver (Ag)-Total (mg/L)			<0.000010					<0.000010			<0.000010				<0.000010
Sodium (Na)-Total (mg/L)			17.7					24.3			19.7				17.1
Strontium (Sr)-Total (mg/L)			0.891					1.16			0.963				0.878
Thallium (Tl)-Total (mg/L)			<0.000010					<0.000010			<0.000010				<0.000010
Tin (Sn)-Total (mg/L)			<0.00010					<0.00010			<0.00010				<0.00010
Titanium (Ti)-Total (mg/L)			<0.0100					<0.0100			<0.0100				<0.0100
Uranium (U)-Total (mg/L)			0.000461					0.000720			0.000620				0.000513
Vanadium (V)-Total (mg/L)			0.00073					0.00103			0.00095				0.00081
Zinc (Zn)-Total (mg/L)			0.0031					<0.0030			<0.0030				0.0047

	E291229 : E13														
	24-Mar-22	14-Apr-22	11-May-22	14-Jun-22	14-Jul-22	4-Aug-22	1-Sep-22	26-Oct-22	27-Oct-22	17-Nov-22	5-Dec-22	11-Jan-23	23-Jan-23	9-Feb-23	14-Mar-23
Beryllium (Be)-Total (mg/L)			<0.000100		<0.000100				<0.000100				<0.000100		
Bismuth (Bi)-Total (mg/L)			<0.000050		<0.000050				<0.000050				<0.000050		
Boron (B)-Total (mg/L)			0.066		0.074				0.087				0.064		
Cadmium (Cd)-Total (mg/L)			<0.0000900		<0.0000700				<0.0000600				<0.0000350		
Calcium (Ca)-Total (mg/L)			207		270				291				226		
Chromium (Cr)-Total (mg/L)			<0.00050		<0.00050				<0.00050				<0.00050		
Cobalt (Co)-Total (mg/L)			0.00015		0.00015				0.00019				0.00010		
Copper (Cu)-Total (mg/L)			0.0130		0.00986				0.0110				0.00754		
Iron (Fe)-Total (mg/L)			0.101		0.084				0.174				0.052		
Lead (Pb)-Total (mg/L)			0.000052		0.000052				0.000056				<0.000050		
Lithium (Li)-Total (mg/L)			0.0018		0.0018				0.0015				<0.0010		
Magnesium (Mg)-Total (mg/L)			38.9		46.3				55.5				43.1		
Manganese (Mn)-Total (mg/L)			0.0352		0.0569				0.0700				0.0336		
Molybdenum (Mo)-Tota (mg/L)			0.0909		0.126				0.0876				0.0539		
Nickel (Ni)-Total (mg/L)			0.00090		0.00051				<0.00050				<0.00050		
Potassium (K)-Total (mg/L)			2.20		2.18				2.89				1.92		
Selenium (Se)-Total (mg/L)			0.0517		0.0588				0.0499				0.0381		
Silicon (Si)-Total (mg/L)			6.44		7.52				8.02				6.45		
Silver (Ag)-Total (mg/L)			0.000011		<0.000010				<0.000010				<0.000010		
Sodium (Na)-Total (mg/L)			17.0		20.6				23.3				17.8		
Strontium (Sr)-Total (mg/L)			0.828		1.07				1.10				0.937		
Thallium (Tl)-Total (mg/L)			<0.000010		<0.000010				<0.000010				<0.000010		
Tin (Sn)-Total (mg/L)			<0.00010		<0.00010				<0.00010				0.00012		
Titanium (Ti)-Total (mg/L)			<0.0100		<0.0100				<0.0100				<0.0100		
Uranium (U)-Total (mg/L)			0.000284		0.000566				0.000754				0.000647		
Vanadium (V)-Total (mg/L)			0.00078		0.00100				0.00100				0.00055		
Zinc (Zn)-Total (mg/L)			0.0048		<0.0030				0.0032				0.0040		

	E291229 : E13									
	5-Apr-23	13-Apr-23	3-May-23	7-Jun-23	13-Jul-23	3-Aug-23	11-Sep-23	4-Oct-23	16-Nov-23	5-Dec-23
Beryllium (Be)-Total (mg/L)		<0.000100				<0.000100		<0.000100		
Bismuth (Bi)-Total (mg/L)		<0.000050				<0.000050		<0.000050		
Boron (B)-Total (mg/L)		0.066				0.083		0.083		
Cadmium (Cd)-Total (mg/L)		<0.0000600				<0.0000500		<0.0000650		
Calcium (Ca)-Total (mg/L)		211				294		291		
Chromium (Cr)-Total (mg/L)		<0.00050				<0.00050		<0.00050		
Cobalt (Co)-Total (mg/L)		0.00018				0.00010		0.00018		
Copper (Cu)-Total (mg/L)		0.0133				0.00861		0.0116		
Iron (Fe)-Total (mg/L)		0.182				0.037		0.171		
Lead (Pb)-Total (mg/L)		0.000059				<0.000050		0.000068		
Lithium (Li)-Total (mg/L)		0.0018				0.0016		0.0017		
Magnesium (Mg)-Total (mg/L)		37.6				51.6		54.3		
Manganese (Mn)-Total (mg/L)		0.0361				0.0312		0.0347		
Molybdenum (Mo)-Tota (mg/L)		0.119				0.131		0.112		
Nickel (Ni)-Total (mg/L)		<0.00050				<0.00050		<0.00050		
Potassium (K)-Total (mg/L)		1.95				2.22		2.62		
Selenium (Se)-Total (mg/L)		0.0503				0.0611		0.0541		
Silicon (Si)-Total (mg/L)		6.64				7.42		7.34		
Silver (Ag)-Total (mg/L)		0.000011				<0.000010		<0.000010		
Sodium (Na)-Total (mg/L)		19.6				23.3		23.3		
Strontium (Sr)-Total (mg/L)		0.799				1.21		1.17		
Thallium (Tl)-Total (mg/L)		<0.000010				<0.000010		<0.000010		
Tin (Sn)-Total (mg/L)		<0.00010				<0.00010		<0.00010		
Titanium (Ti)-Total (mg/L)		<0.0100				<0.0100		<0.0100		
Uranium (U)-Total (mg/L)		0.000476				0.000979		0.00113		
Vanadium (V)-Total (mg/L)		0.00092				0.00064		0.00098		
Zinc (Zn)-Total (mg/L)		0.0042				<0.0030		0.0080		

Grid Format Report : E13 - NW Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E291229 : E13						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	21	21	61.30000	125.00000	95.98095	191.00000	19.19793
Ammonia (as N) (mg/L)	21	15	0.00250	0.01860	0.00755	0.05449	0.00499
Chloride (mg/L)	21	4	1.25000	3.06000	1.93571	15.13500	0.75597
Diss-Orthophosphate (mg/L)	21	17	0.00050	0.00650	0.00340	0.01167	0.00193
Diss-Phosphorus (mg/L)	21	21	0.00260	0.01220	0.00750	0.01777	0.00281
Floride (mg/L)	21	2	0.05000	0.10400	0.06933	0.10000	0.02527
Nitrate (N) (mg/L)	21	21	5.12000	15.60000	10.49000	33.21500	3.42783
Nitrate and Nitrite (mg/L)	21	21	5.12000	15.60000	10.49143	33.50000	3.42669
Nitrite (N) (mg/L)	21	8	0.00250	0.01830	0.00622	0.52475	0.00486
Sulphate (mg/L)	21	21	487.00000	868.00000	697.14286	733.30000	116.54539
Total Nitrogen (mg/L)	21	21	5.01000	28.70000	11.76000	34.62000	5.99440
Total Phosphorus (mg/L)	21	21	0.00730	0.02900	0.01517	0.08751	0.00498
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	21	19	0.00150	0.01930	0.00705	0.02960	0.00530
Diss-Antimony (Sb) (mg/L)	21	17	0.00005	0.00019	0.00012	0.00020	0.00003
Diss-Arsenic (As) (mg/L)	21	21	0.00023	0.00042	0.00031	0.00065	0.00004
Diss-Barium (Ba) (mg/L)	21	21	0.04480	0.08230	0.06358	0.08500	0.01191
Diss-Beryllium (Be) (mg/L)	21	0	0.00005	0.00050	0.00016	0.00005	0.00019
Diss-Bismuth (Bi) (mg/L)	21	0	0.00003	0.00005	0.00003	0.00025	0.00001
Diss-Boron (B) (mg/L)	21	21	0.04700	0.09600	0.06929	0.09150	0.01240
Diss-Cadmium (Cd) (mg/L)	21	1	0.00001	0.00005	0.00003	0.00008	0.00001
Diss-Calcium (Ca) (mg/L)	21	21	156.00000	302.00000	239.61905	291.00000	41.69709
Diss-Chromium (Cr) (mg/L)	21	0	0.00025	0.00050	0.00026	0.00025	0.00005
Diss-Cobalt (Co) (mg/L)	21	3	0.00005	0.00012	0.00006	0.00086	0.00002
Diss-Copper (Cu) (mg/L)	21	21	0.00468	0.01200	0.00737	0.01770	0.00198
Diss-Iron (Fe) (mg/L)	21	0	0.01500	0.03000	0.01571	0.11560	0.00327
Diss-Lead (Pb) (mg/L)	21	0	0.00003	0.00005	0.00003	0.00003	0.00001
Diss-Lithium (Li) (mg/L)	21	15	0.00050	0.00170	0.00117	0.00199	0.00040
Diss-Magnesium (Mg) (mg/L)	21	21	29.30000	55.40000	43.89048	50.69500	8.01448
Diss-Manganese (Mn) (mg/L)	21	21	0.00025	0.05800	0.02755	0.86900	0.01422
Diss-Molybdenum (Mo) (mg/L)	21	21	0.05250	0.12500	0.08848	0.16900	0.02258
Diss-Nickel (Ni) (mg/L)	21	2	0.00025	0.00076	0.00031	0.00062	0.00014
Diss-Potassium (K) (mg/L)	21	21	1.52000	2.69000	2.12952	3.62500	0.31203

Grid Format Report : E13 - NW Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E291229 : E13						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Selenium (mg/L)	21	21	0.02960	0.06900	0.04886	0.12900	0.00985
Diss-Silicon (Si) (mg/L)	21	21	5.60000	7.79000	6.67714	7.64500	0.59738
Diss-Silver (Ag) (mg/L)	21	0	0.00001	0.00001	0.00001	0.00002	0.00000
Diss-Sodium (Na) (mg/L)	21	21	13.00000	24.50000	19.18571	22.65000	3.29367
Diss-Strontium (Sr) (mg/L)	21	21	0.66900	1.24000	0.95705	1.07000	0.17142
Diss-Thallium (Tl) (mg/L)	21	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	21	1	0.00005	0.00014	0.00006	0.00005	0.00002
Diss-Titanium (Ti) (mg/L)	21	0	0.00500	0.01000	0.00524	0.01965	0.00109
Diss-Uranium (U) (mg/L)	21	21	0.00029	0.00109	0.00059	0.00108	0.00021
Diss-Vanadium (V) (mg/L)	21	8	0.00025	0.00056	0.00038	0.00115	0.00014
Diss-Zinc (Zn) (mg/L)	21	10	0.00150	0.00890	0.00353	0.01970	0.00231
TDS (mg/L)	21	21	786.00000	1,500.00000	1,181.42857	1,441.50000	202.05558
Field Tests							
Cond (in situ) (µs/cm)	49	49	624.00000	2,071.00000	1,518.40612	1,815.85000	307.92722
Dissolved Oxygen (In (%)	1	1	94.00000	94.00000	94.00000	89.29500	
Dissolved Oxygen (in (mg/L)	1	1	12.04000	12.04000	12.04000	12.07850	
NTU - in situ (ntu)	48	48	0.09500	4.86000	1.65615	9.01250	1.28079
pH (in situ) (pH)	49	49	6.59000	8.23000	7.65898	8.33000	0.29818
Q (m3/s)	40	40	0.00060	0.00710	0.00267	0.00567	0.00189
Sample Taken							
Staff Gauge (m)	2	2	0.79000	0.83800	0.81400		0.03394
Temp (in situ) (Degrees Celcius)	49	49	0.30300	17.40000	7.32300	17.70000	4.56624
Organic / Inorganic							
DOC (mg/L)	21	21	4.05000	9.62000	5.79524	12.51500	1.43147
Physical Test							
Conductivity (µs/cm)	21	21	1,020.00000	1,660.00000	1,401.90476	1,661.50000	191.37970
Hardness (mg/L)	21	21	511.00000	982.00000	779.14286	931.75000	136.71331
NTU (ntu)	21	21	0.31000	2.58000	1.22619	23.26000	0.74657
pH (pH)	21	21	7.63000	8.17000	7.98000	8.25150	0.11760
TDS (mg/L)	21	21	786.00000	1,500.00000	1,181.42857	1,441.50000	202.05558
TSS (mg/L)	21	14	0.50000	6.70000	2.40000	28.13000	1.84878
Total Metals							
Aluminum (Al)-Total (mg/L)	21	21	0.02630	0.18900	0.08729	1.80500	0.05333
Antimony (Sb)-Total (mg/L)	21	20	0.00005	0.00019	0.00014	0.00024	0.00003
Arsenic (As)-Total (mg/L)	21	21	0.00027	0.00052	0.00040	0.00190	0.00006

Grid Format Report : E13 - NW Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	E291229 : E13						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Barium (Ba)-Total (mg/L)	21	21	0.04760	0.09040	0.06543	0.08883	0.01308
Beryllium (Be)-Total (mg/L)	21	0	0.00005	0.00005	0.00005	0.00005	0.00000
Bismuth (Bi)-Total (mg/L)	21	0	0.00003	0.00003	0.00003	0.00025	0.00000
Boron (B)-Total (mg/L)	21	21	0.04600	0.10400	0.07395	0.09715	0.01314
Cadmium (Cd)-Total (mg/L)	21	0	0.00002	0.00005	0.00003	0.00011	0.00001
Calcium (Ca)-Total (mg/L)	21	21	164.00000	312.00000	245.57143	294.65000	43.83671
Chromium (Cr)-Total (mg/L)	21	0	0.00025	0.00025	0.00025	0.00218	0.00000
Cobalt (Co)-Total (mg/L)	21	16	0.00005	0.00024	0.00013	0.00208	0.00006
Copper (Cu)-Total (mg/L)	21	21	0.00750	0.01730	0.01041	0.07424	0.00279
Iron (Fe)-Total (mg/L)	21	21	0.03100	0.20900	0.10248	2.21850	0.06252
Lead (Pb)-Total (mg/L)	21	11	0.00003	0.00019	0.00005	0.00087	0.00004
Lithium (Li)-Total (mg/L)	21	18	0.00050	0.00180	0.00137	0.00220	0.00043
Magnesium (Mg)-Total (mg/L)	21	21	30.10000	56.40000	44.45714	50.96000	8.15577
Manganese (Mn)-Total (mg/L)	21	21	0.01570	0.07000	0.03775	1.04200	0.01609
Molybdenum (Mo)-Tota (mg/L)	21	21	0.05390	0.13100	0.09107	0.16530	0.02433
Nickel (Ni)-Total (mg/L)	21	6	0.00025	0.00090	0.00036	0.00218	0.00019
Potassium (K)-Total (mg/L)	21	21	1.67000	2.89000	2.16048	3.68900	0.36560
Selenium (Se)-Total (mg/L)	21	21	0.03180	0.06820	0.04940	0.12320	0.00966
Silicon (Si)-Total (mg/L)	21	21	6.18000	8.02000	7.03000	9.43300	0.56732
Silver (Ag)-Total (mg/L)	21	5	0.00001	0.00002	0.00001	0.00008	0.00000
Sodium (Na)-Total (mg/L)	21	21	13.20000	25.40000	19.50000	23.80000	3.52888
Strontium (Sr)-Total (mg/L)	21	21	0.64600	1.21000	0.97024	1.10900	0.17559
Thallium (Tl)-Total (mg/L)	21	0	0.00001	0.00001	0.00001	0.00001	0.00000
Tin (Sn)-Total (mg/L)	21	1	0.00005	0.00012	0.00005	0.00005	0.00002
Titanium (Ti)-Total (mg/L)	21	0	0.00500	0.00500	0.00500	0.06660	0.00000
Uranium (U)-Total (mg/L)	21	21	0.00028	0.00113	0.00059	0.00107	0.00021
Vanadium (V)-Total (mg/L)	21	21	0.00050	0.00115	0.00083	0.00568	0.00019
Zinc (Zn)-Total (mg/L)	21	16	0.00150	0.00940	0.00436	0.02786	0.00262

Grid Format Report : E14 - West Ditch Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E14 West Ditch Sump														
	7-Jan-19	12-Feb-19	4-Mar-19	3-Apr-19	1-May-19	4-Jun-19	3-Jul-19	12-Aug-19	11-Sep-19	3-Oct-19	18-Nov-19	19-Nov-19	2-Dec-19	22-Jan-20	16-Mar-20
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		111			90.6			123			106				126
Ammonia (as N) (mg/L)		<0.0050			<0.0050			0.0119			0.0052				0.0098
Chloride (mg/L)		9.2			4.7			6.9			4.0				16.1
Diss-Orthophosphate (mg/L)		0.0075			0.0015			0.0015			0.0061				0.0167
Diss-Phosphorus (mg/L)		0.0090			0.0051			0.0050			0.0096				0.0227
Floride (mg/L)		<0.10			<0.10			0.13			<0.10				0.123
Nitrate (N) (mg/L)		9.42			9.35			8.99			4.92				1.38
Nitrate and Nitrite (mg/L)		9.42			9.35			8.99			4.92				1.38
Nitrite (N) (mg/L)		<0.0050			<0.0050			<0.0050			<0.0050				<0.0050
Sulphate (mg/L)		499			448			542			361				217
Total Nitrogen (mg/L)		9.4			14.1			7.56			4.55				1.36
Total Phosphorus (mg/L)		0.0206			0.0157			0.0416			0.0167				0.0234
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.0031			0.0085			0.0034			0.0089				0.0039
Diss-Antimony (Sb) (mg/L)		0.00011			0.00017			0.00022			0.00018				0.00011
Diss-Arsenic (As) (mg/L)		0.00048			0.00044			0.00057			0.00043				0.00073
Diss-Barium (Ba) (mg/L)		0.0521			0.0369			0.0563			0.0430				0.0250
Diss-Beryllium (Be) (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010				<0.00100
Diss-Bismuth (Bi) (mg/L)		<0.000050			<0.000050			<0.000050			<0.000050				<0.000050
Diss-Boron (B) (mg/L)		0.105			0.075			0.099			0.054				0.168
Diss-Cadmium (Cd) (mg/L)		0.0000351			<0.000035			<0.000050			<0.000040				<0.0000150
Diss-Calcium (Ca) (mg/L)		187			121			176			135				107
Diss-Chromium (Cr) (mg/L)		<0.00050			<0.00050			<0.00050			<0.00050				<0.00050
Diss-Cobalt (Co) (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010				<0.00010
Diss-Copper (Cu) (mg/L)		0.00973			0.0114			0.0116			0.0134				0.00858
Diss-Iron (Fe) (mg/L)		<0.030			<0.030			0.032			<0.030				<0.030
Diss-Lead (Pb) (mg/L)		<0.000050			<0.000050			<0.000050			<0.000050				<0.000050
Diss-Lithium (Li) (mg/L)		0.0013			0.0015			0.0020			0.0012				0.0019
Diss-Magnesium (Mg) (mg/L)		37.5			24.2			34.5			27.1				24.0
Diss-Manganese (Mn) (mg/L)		0.00729			0.00416			0.0264			0.00603				0.0297
Diss-Molybdenum (Mo) (mg/L)		0.0438			0.0436			0.0785			0.0628				0.0272
Diss-Nickel (Ni) (mg/L)		<0.00050			<0.00050			<0.00050			<0.00050				<0.00050
Diss-Potassium (K) (mg/L)		1.83			1.60			2.18			1.74				1.57
Diss-Selenium (mg/L)		0.0370			0.0284			0.0402			0.0278				0.00848

	: E14 West Ditch Sump														
	9-Apr-20	21-Apr-20	23-Apr-20	10-Jun-20	7-Jul-20	13-Aug-20	6-Oct-20	22-Oct-20	17-Nov-20	9-Dec-20	11-Jan-21	18-Feb-21	10-Mar-21	6-Apr-21	12-May-21
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		74.4	73.3			127		108				129			89.4
Ammonia (as N) (mg/L)		<0.0050	0.0058			0.0052		<0.0050				0.0147			<0.0050
Chloride (mg/L)		3.46	2.92			10.6		6.89				17.3			5.47
Diss-Orthophosphate (mg/L)		0.0103	0.0134			0.0108		0.0130				0.0162			0.0077
Diss-Phosphorus (mg/L)		0.0196	0.0188			0.0180		0.0160				0.0268			0.0091
Floride (mg/L)		0.138	0.125			0.136		0.123				0.141			0.130
Nitrate (N) (mg/L)		2.12	2.34			0.826		2.44				0.831			2.07
Nitrate and Nitrite (mg/L)		2.12	2.34			0.828		2.44				0.831			2.07
Nitrite (N) (mg/L)		<0.0010	<0.0010			<0.0050		<0.0050				<0.0050			<0.0010
Sulphate (mg/L)		194	204			230		296				213			232
Total Nitrogen (mg/L)		2.24	2.51			1.14		3.94				1.01			2.06
Total Phosphorus (mg/L)		0.0359	0.0323			0.0247		0.0232				0.0234			0.0241
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.0189	0.0180			0.0047		0.0071				0.0043			0.0129
Diss-Antimony (Sb) (mg/L)		0.00032	0.00027			0.00016		0.00017				0.00010			0.00015
Diss-Arsenic (As) (mg/L)		0.00049	0.00043			0.00065		0.00054				0.00086			0.00044
Diss-Barium (Ba) (mg/L)		0.0247	0.0282			0.0334		0.0402				0.0255			0.0259
Diss-Beryllium (Be) (mg/L)		<0.00100	<0.00100			<0.00100		<0.00100				<0.000100			<0.000100
Diss-Bismuth (Bi) (mg/L)		<0.000050	<0.000050			<0.000050		<0.000050				<0.000050			<0.000050
Diss-Boron (B) (mg/L)		0.038	0.039			0.099		0.061				0.168			0.057
Diss-Cadmium (Cd) (mg/L)		<0.0000450	<0.0000500			<0.0000300		<0.0000600				0.0000258			<0.0000250
Diss-Calcium (Ca) (mg/L)		72.1	84.2			103		145				98.0			83.7
Diss-Chromium (Cr) (mg/L)		<0.00050	<0.00050			<0.00050		<0.00050				<0.00050			<0.00050
Diss-Cobalt (Co) (mg/L)		<0.00010	<0.00010			<0.00010		<0.00010				<0.00010			<0.00010
Diss-Copper (Cu) (mg/L)		0.0159	0.0158			0.0124		0.0211				0.0103			0.0149
Diss-Iron (Fe) (mg/L)		<0.030	<0.030			0.037		<0.030				0.038			<0.030
Diss-Lead (Pb) (mg/L)		<0.000050	<0.000050			<0.000050		<0.000050				<0.000050			<0.000050
Diss-Lithium (Li) (mg/L)		0.0013	0.0014			0.0022		0.0016				0.0020			0.0016
Diss-Magnesium (Mg) (mg/L)		15.6	16.3			22.8		24.9				22.8			16.6
Diss-Manganese (Mn) (mg/L)		0.0133	0.0118			0.0146		0.00972				0.0347			0.00583
Diss-Molybdenum (Mo) (mg/L)		0.0730	0.0641			0.0450		0.0677				0.0305			0.0423
Diss-Nickel (Ni) (mg/L)		<0.00050	<0.00050			<0.00050		<0.00050				<0.00050			<0.00050
Diss-Potassium (K) (mg/L)		1.55	1.56			1.67		1.86				1.65			1.45
Diss-Selenium (mg/L)		0.0356	0.0345			0.0153		0.0320				0.00914			0.0172

	: E14 West Ditch Sump														
	9-Jun-21	17-Jun-21	6-Jul-21	9-Aug-21	23-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	14-Dec-21	10-Feb-22	17-Feb-22	10-Mar-22	28-Apr-22	11-May-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)					129			115					109		75.9
Ammonia (as N) (mg/L)					0.0094			<0.0050					<0.0050		<0.0050
Chloride (mg/L)					11.2			8.49					6.50		2.99
Diss-Orthophosphate (mg/L)					0.0131			0.0185					0.0116		0.0050
Diss-Phosphorus (mg/L)					0.0204			0.0237					0.0136		0.0099
Floride (mg/L)					0.128			0.137					<0.100		0.109
Nitrate (N) (mg/L)					4.29			0.835					1.35		1.76
Nitrate and Nitrite (mg/L)					4.29			0.835					1.35		1.76
Nitrite (N) (mg/L)					<0.0050			<0.0050					<0.0050		0.0057
Sulphate (mg/L)					464			253					294		218
Total Nitrogen (mg/L)					3.62			0.992					1.43		2.13
Total Phosphorus (mg/L)					0.0244			0.0248					0.0156		0.0151
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)					0.0054			0.0081					0.0065		0.0179
Diss-Antimony (Sb) (mg/L)					0.00012			0.00022					0.00011		0.00013
Diss-Arsenic (As) (mg/L)					0.00085			0.00056					0.00056		0.00039
Diss-Barium (Ba) (mg/L)					0.0398			0.0301					0.0272		0.0243
Diss-Beryllium (Be) (mg/L)					<0.000100			<0.000100					<0.000100		<0.000100
Diss-Bismuth (Bi) (mg/L)					<0.000050			<0.000050					<0.000050		<0.000050
Diss-Boron (B) (mg/L)					0.149			0.083					0.079		0.043
Diss-Cadmium (Cd) (mg/L)					<0.0000300			<0.0000300					0.0000330		<0.0000300
Diss-Calcium (Ca) (mg/L)					133			104					109		81.8
Diss-Chromium (Cr) (mg/L)					<0.00050			<0.00050					<0.00050		<0.00050
Diss-Cobalt (Co) (mg/L)					<0.00010			<0.00010					<0.00010		<0.00010
Diss-Copper (Cu) (mg/L)					0.0120			0.0180					0.0103		0.0163
Diss-Iron (Fe) (mg/L)					<0.030			<0.030					<0.030		<0.030
Diss-Lead (Pb) (mg/L)					<0.000050			<0.000050					<0.000050		<0.000050
Diss-Lithium (Li) (mg/L)					0.0022			0.0019					0.0020		0.0012
Diss-Magnesium (Mg) (mg/L)					27.1			24.2					25.2		16.7
Diss-Manganese (Mn) (mg/L)					0.0218			0.0162					0.00866		0.00693
Diss-Molybdenum (Mo) (mg/L)					0.0544			0.0799					0.0506		0.0418
Diss-Nickel (Ni) (mg/L)					<0.00050			<0.00050					<0.00050		<0.00050
Diss-Potassium (K) (mg/L)					2.05			1.97					1.62		1.53
Diss-Selenium (mg/L)					0.0179			0.0282					0.0326		0.0196

	: E14 West Ditch Sump														
	14-Jun-22	26-Jul-22	17-Aug-22	1-Sep-22	27-Oct-22	15-Nov-22	5-Dec-22	11-Jan-23	23-Jan-23	6-Feb-23	8-Mar-23	2-Apr-23	24-Apr-23	3-May-23	29-May-23
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		71.9			129				90.2				79.7		105
Ammonia (as N) (mg/L)		0.0199			0.0060				<0.0050				0.0139		0.0054
Chloride (mg/L)		4.51			9.24				4.66				2.28		4.41
Diss-Orthophosphate (mg/L)		<0.0010			0.0038				0.0077				0.0040		0.0052
Diss-Phosphorus (mg/L)		0.0079			0.0217				0.0110				0.0127		0.0129
Floride (mg/L)		0.290			0.146				0.199				0.147		<0.100
Nitrate (N) (mg/L)		4.97			0.779				1.58				3.89		6.54
Nitrate and Nitrite (mg/L)		5.00			0.779				1.58				3.91		6.54
Nitrite (N) (mg/L)		0.0283			<0.0010				<0.0050				0.0203		<0.0050
Sulphate (mg/L)		409			189				288				247		346
Total Nitrogen (mg/L)		4.98			1.05				2.28				4.13		7.10
Total Phosphorus (mg/L)		0.0115			0.0309				0.0106				0.0218		0.0205
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.0529			0.0041				<0.0030				0.0178		0.0085
Diss-Antimony (Sb) (mg/L)		0.00107			0.00011				0.00058				0.00034		0.00025
Diss-Arsenic (As) (mg/L)		0.00161			0.00094				0.00132				0.00067		0.00075
Diss-Barium (Ba) (mg/L)		0.0457			0.0252				0.0276				0.0230		0.0375
Diss-Beryllium (Be) (mg/L)		<0.000100			<0.000100				<0.000100				<0.000100		<0.000100
Diss-Bismuth (Bi) (mg/L)		<0.000050			<0.000050				<0.000050				<0.000050		<0.000050
Diss-Boron (B) (mg/L)		0.140			0.180				0.168				0.066		0.088
Diss-Cadmium (Cd) (mg/L)		<0.000110			<0.0000200				<0.0000250				<0.0000400		<0.0000450
Diss-Calcium (Ca) (mg/L)		134			93.2				115				82.2		129
Diss-Chromium (Cr) (mg/L)		<0.00050			<0.00050				<0.00050				<0.00050		<0.00050
Diss-Cobalt (Co) (mg/L)		<0.00010			<0.00010				<0.00010				<0.00010		<0.00010
Diss-Copper (Cu) (mg/L)		0.00799			0.0110				0.00569				0.0139		0.0121
Diss-Iron (Fe) (mg/L)		0.052			0.037				<0.030				<0.030		<0.030
Diss-Lead (Pb) (mg/L)		<0.000050			<0.000050				<0.000050				<0.000050		<0.000050
Diss-Lithium (Li) (mg/L)		0.0056			0.0018				0.0032				0.0017		0.0018
Diss-Magnesium (Mg) (mg/L)		24.9			19.7				23.4				16.4		27.3
Diss-Manganese (Mn) (mg/L)		0.00864			0.0218				0.00592				0.0145		0.0189
Diss-Molybdenum (Mo) (mg/L)		0.189			0.0485				0.125				0.0812		0.100
Diss-Nickel (Ni) (mg/L)		<0.00050			<0.00050				<0.00050				<0.00050		<0.00050
Diss-Potassium (K) (mg/L)		2.67			1.78				1.33				1.35		1.73
Diss-Selenium (mg/L)		0.0354			0.0128				0.0153				0.0226		0.0353

	: E14 West Ditch Sump						
	7-Jun-23	11-Jul-23	1-Aug-23	11-Sep-23	4-Oct-23	15-Nov-23	5-Dec-23
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)			124		136		
Ammonia (as N) (mg/L)			0.0108		0.0123		
Chloride (mg/L)			6.86		8.01		
Diss-Orthophosphate (mg/L)			0.0011		0.0127		
Diss-Phosphorus (mg/L)			0.0262		0.0205		
Floride (mg/L)			0.180		0.169		
Nitrate (N) (mg/L)			10.3		5.44		
Nitrate and Nitrite (mg/L)			10.3		5.44		
Nitrite (N) (mg/L)			0.0118		<0.0050		
Sulphate (mg/L)			527		269		
Total Nitrogen (mg/L)			10.1		5.37		
Total Phosphorus (mg/L)			0.0389		0.0290		
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)			0.0089		0.0039		
Diss-Antimony (Sb) (mg/L)			0.00023		0.00020		
Diss-Arsenic (As) (mg/L)			0.00077		0.00092		
Diss-Barium (Ba) (mg/L)			0.0833		0.0343		
Diss-Beryllium (Be) (mg/L)			<0.000100		<0.000100		
Diss-Bismuth (Bi) (mg/L)			<0.000050		<0.000050		
Diss-Boron (B) (mg/L)			0.123		0.207		
Diss-Cadmium (Cd) (mg/L)			<0.0000500		<0.0000400		
Diss-Calcium (Ca) (mg/L)			186		125		
Diss-Chromium (Cr) (mg/L)			<0.00050		<0.00050		
Diss-Cobalt (Co) (mg/L)			0.00010		<0.00010		
Diss-Copper (Cu) (mg/L)			0.0129		0.0111		
Diss-Iron (Fe) (mg/L)			<0.030		<0.030		
Diss-Lead (Pb) (mg/L)			0.000136		<0.000050		
Diss-Lithium (Li) (mg/L)			0.0020		0.0020		
Diss-Magnesium (Mg) (mg/L)			36.8		26.0		
Diss-Manganese (Mn) (mg/L)			0.0140		0.0138		
Diss-Molybdenum (Mo) (mg/L)			0.115		0.0909		
Diss-Nickel (Ni) (mg/L)			<0.00050		<0.00050		
Diss-Potassium (K) (mg/L)			2.22		2.13		
Diss-Selenium (mg/L)			0.0445		0.0244		

Grid Format Report : E14 - West Ditch Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E14 West Ditch Sump														
	7-Jan-19	12-Feb-19	4-Mar-19	3-Apr-19	1-May-19	4-Jun-19	3-Jul-19	12-Aug-19	11-Sep-19	3-Oct-19	18-Nov-19	19-Nov-19	2-Dec-19	22-Jan-20	16-Mar-20
Diss-Silicon (Si) (mg/L)		7.31			6.31			7.55			6.93				8.85
Diss-Silver (Ag) (mg/L)		<0.000010			<0.000010			<0.000010			<0.000010				<0.000010
Diss-Sodium (Na) (mg/L)		17.8			12.8			17.9			13.5				14.6
Diss-Strontium (Sr) (mg/L)		0.766			0.509			0.787			0.556				0.490
Diss-Thallium (Tl) (mg/L)		<0.000010			<0.000010			<0.000010			<0.000010				<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010				<0.00010
Diss-Titanium (Ti) (mg/L)		<0.010			<0.010			<0.010			<0.010				<0.0100
Diss-Uranium (U) (mg/L)		0.000679			0.000418			0.000719			0.000482				0.000526
Diss-Vanadium (V) (mg/L)		0.00070			0.00069			0.00105			0.00060				0.00097
Diss-Zinc (Zn) (mg/L)		0.0036			0.0042			<0.0030			<0.0030				<0.0030
TDS (mg/L)		898			831			1090			685				481
Field Tests															
Cond (in situ) (µs/cm)		1127.3			982.8			1272.3			958				711.4
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)		3.47			1.74			0.88			2.4				1.23
pH (in situ) (pH)		7.73			7.83			7.93			7.59				7.85
Sample Taken	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	Yes	No	No	Yes
Temp (in situ) (Degrees Celcius)		1.245			4.493			15.173			3.234				0.675
Organic / Inorganic															
DOC (mg/L)		4.53			5.54			5.70			9.03				4.54
Physical Test															
Conductivity (µs/cm)		1100			1010			1150			870				693
Hardness (mg/L)		621			401			581			447				365
NTU (ntu)		3.47			1.04			1.12			1.43				0.63
pH (pH)		8.03			8.09			8.22			7.98				8.14
TDS (mg/L)		898			831			1090			685				481
TSS (mg/L)		6.4			3.2			4.5			1.7				<1.0
Total Metals															
Aluminum (Al)-Total (mg/L)		0.192			0.108			0.0465			0.0889				0.0185
Antimony (Sb)-Total (mg/L)		0.00012			0.00017			0.00021			0.00017				0.00012
Arsenic (As)-Total (mg/L)		0.00070			0.00058			0.00070			0.00050				0.00092
Barium (Ba)-Total (mg/L)		0.0555			0.0359			0.0611			0.0384				0.0256
Beryllium (Be)-Total (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010				<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050			<0.000050			<0.000050			<0.000050				<0.000050

	: E14 West Ditch Sump														
	9-Apr-20	21-Apr-20	23-Apr-20	10-Jun-20	7-Jul-20	13-Aug-20	6-Oct-20	22-Oct-20	17-Nov-20	9-Dec-20	11-Jan-21	18-Feb-21	10-Mar-21	6-Apr-21	12-May-21
Diss-Silicon (Si) (mg/L)		5.91	5.87			8.87		7.09				9.51			6.98
Diss-Silver (Ag) (mg/L)		<0.000010	<0.000010			<0.000010		<0.000010				<0.000010			<0.000010
Diss-Sodium (Na) (mg/L)		8.59	8.97			13.9		15.7				15.6			9.83
Diss-Strontium (Sr) (mg/L)		0.362	0.351			0.471		0.676				0.441			0.383
Diss-Thallium (Tl) (mg/L)		<0.000010	<0.000010			<0.000010		<0.000010				<0.000010			<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010	<0.00010			<0.00010		<0.00010				<0.00010			<0.00010
Diss-Titanium (Ti) (mg/L)		<0.0100	<0.0100			<0.0100		<0.0100				<0.0100			<0.0100
Diss-Uranium (U) (mg/L)		0.000328	0.000299			0.000494		0.000443				0.000447			0.000292
Diss-Vanadium (V) (mg/L)		0.00065	0.00062			0.00097		0.00070				0.00107			0.00080
Diss-Zinc (Zn) (mg/L)		0.0047	0.0034			<0.0030		<0.0030				0.0105			<0.0030
TDS (mg/L)		372	386			537		584				477			445
Field Tests															
Cond (in situ) (µs/cm)		519	641.3			674		996				1703.6			646.3
Dissolved Oxygen (In (%)			92.2												
Dissolved Oxygen (in (mg/L)			12.18												
NTU - in situ (ntu)		3.49	3.92			0.77		2.06				1.6			0.63
pH (in situ) (pH)		7.42	7.51			7.99		7.86				8.06			7.98
Sample Taken	No	Yes	Yes	No	No	Yes	No	Yes	No	No	No	yes	no	No	Yes
Temp (in situ) (Degrees Celcius)		8.6	3.557			11.7		4				0.041			9.399
Organic / Inorganic															
DOC (mg/L)		8.21	7.28			6.12		6.25				4.86			6.26
Physical Test															
Conductivity (µs/cm)		549	592			711		798				690			691
Hardness (mg/L)		244	277			351		465				338			277
NTU (ntu)		4.50	3.26			0.88		0.80				1.43			0.77
pH (pH)		7.92	7.75			8.27		8.07				8.20			8.19
TDS (mg/L)		372	386			537		584				477			445
TSS (mg/L)		6.3	4.5			<1.0		6.8				<1.0			4.3
Total Metals															
Aluminum (Al)-Total (mg/L)		0.250	0.198			0.0161		0.372				0.0280			0.0879
Antimony (Sb)-Total (mg/L)		0.00032	0.00029			0.00015		0.00020				0.00011			0.00016
Arsenic (As)-Total (mg/L)		0.00065	0.00059			0.00078		0.00110				0.00097			0.00055
Barium (Ba)-Total (mg/L)		0.0283	0.0287			0.0332		0.0372				0.0280			0.0281
Beryllium (Be)-Total (mg/L)		<0.000100	<0.000100			<0.000100		<0.000100				<0.000100			<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050	<0.000050			<0.000050		<0.000050				<0.000050			<0.000050

	: E14 West Ditch Sump														
	9-Jun-21	17-Jun-21	6-Jul-21	9-Aug-21	23-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	14-Dec-21	10-Feb-22	17-Feb-22	10-Mar-22	28-Apr-22	11-May-22
Diss-Silicon (Si) (mg/L)					9.84			7.95					8.38		6.44
Diss-Silver (Ag) (mg/L)					<0.000010			<0.000010					<0.000010		<0.000010
Diss-Sodium (Na) (mg/L)					17.9			13.4					13.8		9.10
Diss-Strontium (Sr) (mg/L)					0.588			0.490					0.468		0.367
Diss-Thallium (Tl) (mg/L)					<0.000010			<0.000010					<0.000010		<0.000010
Diss-Tin (Sn) (mg/L)					<0.00010			<0.00010					<0.00010		<0.00010
Diss-Titanium (Ti) (mg/L)					<0.0100			<0.0100					<0.0100		<0.0100
Diss-Uranium (U) (mg/L)					0.000555			0.000529					0.000461		0.000226
Diss-Vanadium (V) (mg/L)					0.00121			0.00095					0.00070		0.00065
Diss-Zinc (Zn) (mg/L)					<0.0030			0.0032					<0.0030		<0.0030
TDS (mg/L)					918			504					542		427
Field Tests															
Cond (in situ) (µs/cm)					1165			726					756		576
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)					1.64			2.76					1.79		2.01
pH (in situ) (pH)					7.96			8.02					7.7		7.97
Sample Taken	No	No	No	No	Yes	No	No	Yes	No	No	No	No	Yes	No	Yes
Temp (in situ) (Degrees Celcius)					13.503			6.944					0.871		5.092
Organic / Inorganic															
DOC (mg/L)					5.09			7.55					6.15		7.46
Physical Test															
Conductivity (µs/cm)					1090			711					770		603
Hardness (mg/L)					444			359					376		273
NTU (ntu)					1.28			0.50					0.66		2.01
pH (pH)					8.22			8.11					8.00		7.95
TDS (mg/L)					918			504					542		427
TSS (mg/L)					1.4			1.5					<1.0		2.3
Total Metals															
Aluminum (Al)-Total (mg/L)					0.0607			0.0267					0.0496		0.126
Antimony (Sb)-Total (mg/L)					0.00015			0.00022					0.00012		0.00014
Arsenic (As)-Total (mg/L)					0.00096			0.00064					0.00062		0.00048
Barium (Ba)-Total (mg/L)					0.0493			0.0300					0.0306		0.0288
Beryllium (Be)-Total (mg/L)					<0.000100			<0.000100					<0.000100		<0.000100
Bismuth (Bi)-Total (mg/L)					<0.000050			<0.000050					<0.000050		<0.000050

	: E14 West Ditch Sump														
	14-Jun-22	26-Jul-22	17-Aug-22	1-Sep-22	27-Oct-22	15-Nov-22	5-Dec-22	11-Jan-23	23-Jan-23	6-Feb-23	8-Mar-23	2-Apr-23	24-Apr-23	3-May-23	29-May-23
Diss-Silicon (Si) (mg/L)		6.04			9.01				7.20				5.96		7.38
Diss-Silver (Ag) (mg/L)		<0.000010			<0.000010				<0.000010				<0.000010		<0.000010
Diss-Sodium (Na) (mg/L)		28.9			11.9				22.3				10.2		13.5
Diss-Strontium (Sr) (mg/L)		1.04			0.428				0.682				0.396		0.610
Diss-Thallium (Tl) (mg/L)		<0.000010			<0.000010				<0.000010				<0.000010		<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010			<0.00010				<0.00010				<0.00010		<0.00010
Diss-Titanium (Ti) (mg/L)		<0.0100			<0.0100				<0.0100				<0.0100		<0.0100
Diss-Uranium (U) (mg/L)		0.00188			0.000474				0.00259				0.000727		0.000679
Diss-Vanadium (V) (mg/L)		0.00191			0.00106				0.00099				0.00082		0.00104
Diss-Zinc (Zn) (mg/L)		<0.0030			<0.0030				<0.0030				0.0050		<0.0030
TDS (mg/L)		724			489				614				452		678
Field Tests															
Cond (in situ) (µs/cm)		1069	933.6		920				823				694	628	909
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)		3.7	4.09		2.61				0.91				2.8	1.24	1.66
pH (in situ) (pH)		7.89	8.05		7.93				7.85				7.7	7.92	7.65
Sample Taken	No	Yes	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No	Yes
Temp (in situ) (Degrees Celcius)		16.5	18.894		3.87				0.822				4.7	8.7	14.22
Organic / Inorganic															
DOC (mg/L)		2.71			6.24				3.38				8.50		6.54
Physical Test															
Conductivity (µs/cm)		920			605				771				690		906
Hardness (mg/L)		437			314				384				273		434
NTU (ntu)		1.40			0.57				0.67				5.25		1.78
pH (pH)		8.06			8.21				7.99				8.03		8.13
TDS (mg/L)		724			489				614				452		678
TSS (mg/L)		3.8			<1.0				<1.0				6.7		4.6
Total Metals															
Aluminum (Al)-Total (mg/L)		0.0909			0.0631				0.0498				0.330		0.126
Antimony (Sb)-Total (mg/L)		0.00102			0.00016				0.00072				0.00049		0.00026
Arsenic (As)-Total (mg/L)		0.00183			0.00104				0.00161				0.00107		0.00091
Barium (Ba)-Total (mg/L)		0.0481			0.0300				0.0326				0.0321		0.0392
Beryllium (Be)-Total (mg/L)		<0.000100			<0.000100				<0.000100				<0.000100		<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050			<0.000050				<0.000050				<0.000050		<0.000050

	: E14 West Ditch Sump						
	7-Jun-23	11-Jul-23	1-Aug-23	11-Sep-23	4-Oct-23	15-Nov-23	5-Dec-23
Diss-Silicon (Si) (mg/L)			8.23		9.42		
Diss-Silver (Ag) (mg/L)			<0.000010		<0.000010		
Diss-Sodium (Na) (mg/L)			18.8		14.0		
Diss-Strontium (Sr) (mg/L)			0.911		0.615		
Diss-Thallium (Tl) (mg/L)			<0.000010		<0.000010		
Diss-Tin (Sn) (mg/L)			<0.00010		<0.00010		
Diss-Titanium (Ti) (mg/L)			<0.0100		<0.0100		
Diss-Uranium (U) (mg/L)			0.000843		0.000720		
Diss-Vanadium (V) (mg/L)			0.00106		0.00111		
Diss-Zinc (Zn) (mg/L)			0.0145		<0.0030		
TDS (mg/L)			1010		566		
Field Tests							
Cond (in situ) (µs/cm)			1205		837		
Dissolved Oxygen (In (%)							
Dissolved Oxygen (in (mg/L)							
NTU - in situ (ntu)			1.46		1.16		
pH (in situ) (pH)			8.13		8.04		
Sample Taken	No	No	Yes	No	Yes	No	No
Temp (in situ) (Degrees Celcius)			13.098		8.067		
Organic / Inorganic							
DOC (mg/L)			6.70		6.18		
Physical Test							
Conductivity (µs/cm)			1180		781		
Hardness (mg/L)			616		419		
NTU (ntu)			1.94		0.65		
pH (pH)			8.26		8.15		
TDS (mg/L)			1010		566		
TSS (mg/L)			5.8		2.0		
Total Metals							
Aluminum (Al)-Total (mg/L)			0.0600		0.0396		
Antimony (Sb)-Total (mg/L)			0.00023		0.00020		
Arsenic (As)-Total (mg/L)			0.00096		0.00097		
Barium (Ba)-Total (mg/L)			0.103		0.0336		
Beryllium (Be)-Total (mg/L)			<0.000100		<0.000100		
Bismuth (Bi)-Total (mg/L)			<0.000050		<0.000050		

Grid Format Report : E14 - West Ditch Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E14 West Ditch Sump														
	7-Jan-19	12-Feb-19	4-Mar-19	3-Apr-19	1-May-19	4-Jun-19	3-Jul-19	12-Aug-19	11-Sep-19	3-Oct-19	18-Nov-19	19-Nov-19	2-Dec-19	22-Jan-20	16-Mar-20
Boron (B)-Total (mg/L)		0.113			0.075			0.113			0.056				0.178
Cadmium (Cd)-Total (mg/L)		0.0000470			<0.000040			<0.000050			<0.000070				<0.0000350
Calcium (Ca)-Total (mg/L)		188			119			200			118				93.2
Chromium (Cr)-Total (mg/L)		<0.00050			<0.00050			<0.00050			<0.00050				<0.00050
Cobalt (Co)-Total (mg/L)		0.00019			0.00013			0.00014			0.00011				<0.00010
Copper (Cu)-Total (mg/L)		0.0150			0.0162			0.0161			0.0165				0.0102
Iron (Fe)-Total (mg/L)		0.219			0.137			0.158			0.107				0.080
Lead (Pb)-Total (mg/L)		0.000066			0.000054			<0.000050			<0.000050				<0.000050
Lithium (Li)-Total (mg/L)		0.0014			0.0016			0.0021			0.0012				0.0019
Magnesium (Mg)-Total (mg/L)		38.9			22.9			37.1			26.6				22.5
Manganese (Mn)-Total (mg/L)		0.0127			0.00884			0.0307			0.0103				0.0293
Molybdenum (Mo)-Tota (mg/L)		0.0444			0.0429			0.0781			0.0581				0.0286
Nickel (Ni)-Total (mg/L)		<0.00050			<0.00050			<0.00050			<0.00050				<0.00050
Potassium (K)-Total (mg/L)		1.88			1.57			2.26			1.68				1.68
Selenium (Se)-Total (mg/L)		0.0334			0.0281			0.0417			0.0283				0.00932
Silicon (Si)-Total (mg/L)		8.09			7.01			8.26			7.22				9.54
Silver (Ag)-Total (mg/L)		<0.000010			<0.000010			<0.000010			<0.000010				<0.000010
Sodium (Na)-Total (mg/L)		17.5			11.7			18.9			13.5				14.1
Strontium (Sr)-Total (mg/L)		0.765			0.508			0.860			0.521				0.449
Thallium (Tl)-Total (mg/L)		<0.000010			<0.000010			<0.000010			<0.000010				<0.000010
Tin (Sn)-Total (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010				<0.00010
Titanium (Ti)-Total (mg/L)		0.011			<0.010			<0.010			<0.010				<0.0100
Uranium (U)-Total (mg/L)		0.000670			0.000386			0.000663			0.000467				0.000526
Vanadium (V)-Total (mg/L)		0.00138			0.00114			0.00117			0.00105				0.00114
Zinc (Zn)-Total (mg/L)		0.0075			0.0055			0.0037			0.0061				<0.0030

	: E14 West Ditch Sump														
	9-Apr-20	21-Apr-20	23-Apr-20	10-Jun-20	7-Jul-20	13-Aug-20	6-Oct-20	22-Oct-20	17-Nov-20	9-Dec-20	11-Jan-21	18-Feb-21	10-Mar-21	6-Apr-21	12-May-21
Boron (B)-Total (mg/L)		0.039	0.039			0.098		0.071				0.161			0.064
Cadmium (Cd)-Total (mg/L)		<0.0000550	<0.0000500			0.0000427		<0.0000700				<0.0000300			<0.0000300
Calcium (Ca)-Total (mg/L)		75.8	82.4			110		95.3				108			90.3
Chromium (Cr)-Total (mg/L)		<0.00050	<0.00050			<0.00050		0.00096				<0.00050			<0.00050
Cobalt (Co)-Total (mg/L)		0.00023	0.00020			0.00013		0.00040				0.00012			0.00011
Copper (Cu)-Total (mg/L)		0.0249	0.0219			0.0156		0.0323				0.0124			0.0185
Iron (Fe)-Total (mg/L)		0.245	0.202			0.131		0.451				0.085			0.106
Lead (Pb)-Total (mg/L)		0.000090	0.000079			<0.000050		0.000165				<0.000050			<0.000050
Lithium (Li)-Total (mg/L)		0.0016	0.0016			0.0018		0.0021				0.0021			0.0019
Magnesium (Mg)-Total (mg/L)		15.8	16.5			24.1		20.8				24.8			19.2
Manganese (Mn)-Total (mg/L)		0.0239	0.0208			0.0442		0.0462				0.0374			0.0102
Molybdenum (Mo)-Tota (mg/L)		0.0728	0.0683			0.0442		0.0642				0.0322			0.0438
Nickel (Ni)-Total (mg/L)		<0.00050	<0.00050			<0.00050		0.00107				<0.00050			<0.00050
Potassium (K)-Total (mg/L)		1.50	1.56			1.69		1.85				1.65			1.55
Selenium (Se)-Total (mg/L)		0.0333	0.0339			0.0146		0.0278				0.00976			0.0193
Silicon (Si)-Total (mg/L)		6.39	6.33			8.80		8.52				10.6			7.15
Silver (Ag)-Total (mg/L)		0.000011	0.000011			<0.000010		<0.000010				<0.000010			<0.000010
Sodium (Na)-Total (mg/L)		8.63	9.55			14.6		12.4				16.6			10.5
Strontium (Sr)-Total (mg/L)		0.357	0.362			0.500		0.449				0.470			0.396
Thallium (Tl)-Total (mg/L)		<0.000010	<0.000010			<0.000010		<0.000010				<0.000010			<0.000010
Tin (Sn)-Total (mg/L)		<0.00010	<0.00010			<0.00010		<0.00010				<0.00010			<0.00010
Titanium (Ti)-Total (mg/L)		0.0132	<0.0100			<0.0100		0.0203				<0.0100			<0.0100
Uranium (U)-Total (mg/L)		0.000306	0.000306			0.000505		0.000467				0.000514			0.000336
Vanadium (V)-Total (mg/L)		0.00130	0.00121			0.00122		0.00223				0.00132			0.00111
Zinc (Zn)-Total (mg/L)		0.0062	0.0057			<0.0030		0.0091				0.0157			<0.0030

	: E14 West Ditch Sump														
	9-Jun-21	17-Jun-21	6-Jul-21	9-Aug-21	23-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	14-Dec-21	10-Feb-22	17-Feb-22	10-Mar-22	28-Apr-22	11-May-22
Boron (B)-Total (mg/L)					0.153			0.086					0.083		0.050
Cadmium (Cd)-Total (mg/L)					<0.0000750			<0.0000350					0.0000339		<0.0000350
Calcium (Ca)-Total (mg/L)					166			103					116		85.9
Chromium (Cr)-Total (mg/L)					<0.00050			<0.00050					<0.00050		<0.00050
Cobalt (Co)-Total (mg/L)					<0.00010			<0.00010					<0.00010		0.00015
Copper (Cu)-Total (mg/L)					0.0155			0.0164					0.0122		0.0220
Iron (Fe)-Total (mg/L)					0.077			0.049					0.053		0.142
Lead (Pb)-Total (mg/L)					<0.000050			<0.000050					<0.000050		0.000060
Lithium (Li)-Total (mg/L)					0.0024			0.0019					0.0016		0.0015
Magnesium (Mg)-Total (mg/L)					33.4			21.2					25.6		17.9
Manganese (Mn)-Total (mg/L)					0.0257			0.0170					0.0105		0.0114
Molybdenum (Mo)-Tota (mg/L)					0.0667			0.0822					0.0524		0.0451
Nickel (Ni)-Total (mg/L)					<0.00050			<0.00050					<0.00050		<0.00050
Potassium (K)-Total (mg/L)					2.15			1.68					1.64		1.50
Selenium (Se)-Total (mg/L)					0.0231			0.0274					0.0311		0.0196
Silicon (Si)-Total (mg/L)					10.3			7.95					8.62		6.87
Silver (Ag)-Total (mg/L)					<0.000010			<0.000010					<0.000010		<0.000010
Sodium (Na)-Total (mg/L)					21.2			12.0					13.9		9.68
Strontium (Sr)-Total (mg/L)					0.738			0.494					0.463		0.386
Thallium (Tl)-Total (mg/L)					<0.000010			<0.000010					<0.000010		<0.000010
Tin (Sn)-Total (mg/L)					<0.00010			<0.00010					<0.00010		<0.00010
Titanium (Ti)-Total (mg/L)					<0.0100			<0.0100					<0.0100		<0.0100
Uranium (U)-Total (mg/L)					0.000600			0.000483					0.000474		0.000224
Vanadium (V)-Total (mg/L)					0.00156			0.00093					0.00103		0.00102
Zinc (Zn)-Total (mg/L)					<0.0030			<0.0030					<0.0030		<0.0030

	: E14 West Ditch Sump														
	14-Jun-22	26-Jul-22	17-Aug-22	1-Sep-22	27-Oct-22	15-Nov-22	5-Dec-22	11-Jan-23	23-Jan-23	6-Feb-23	8-Mar-23	2-Apr-23	24-Apr-23	3-May-23	29-May-23
Boron (B)-Total (mg/L)		0.158			0.196				0.177				0.078		0.098
Cadmium (Cd)-Total (mg/L)		<0.0000650			<0.0000300				<0.0000450				<0.0000550		<0.0000450
Calcium (Ca)-Total (mg/L)		123			96.5				113				103		132
Chromium (Cr)-Total (mg/L)		<0.00050			<0.00050				<0.00050				<0.00050		<0.00050
Cobalt (Co)-Total (mg/L)		0.00013			0.00010				<0.00010				0.00027		0.00017
Copper (Cu)-Total (mg/L)		0.0106			0.0149				0.00639				0.0235		0.0172
Iron (Fe)-Total (mg/L)		0.096			0.110				0.054				0.320		0.168
Lead (Pb)-Total (mg/L)		0.000060			<0.000050				<0.000050				0.000106		0.000054
Lithium (Li)-Total (mg/L)		0.0059			0.0020				0.0037				0.0024		0.0020
Magnesium (Mg)-Total (mg/L)		24.6			21.8				24.5				20.3		27.8
Manganese (Mn)-Total (mg/L)		0.0119			0.0260				0.00579				0.0263		0.0273
Molybdenum (Mo)-Tota (mg/L)		0.181			0.0535				0.146				0.108		0.102
Nickel (Ni)-Total (mg/L)		<0.00050			<0.00050				<0.00050				<0.00050		<0.00050
Potassium (K)-Total (mg/L)		2.62			2.05				1.32				1.52		1.77
Selenium (Se)-Total (mg/L)		0.0404			0.0145				0.0160				0.0265		0.0359
Silicon (Si)-Total (mg/L)		6.66			10.1				6.55				6.68		7.73
Silver (Ag)-Total (mg/L)		<0.000010			<0.000010				<0.000010				<0.000010		<0.000010
Sodium (Na)-Total (mg/L)		27.8			13.2				23.8				13.5		14.0
Strontium (Sr)-Total (mg/L)		0.924			0.433				0.747				0.500		0.618
Thallium (Tl)-Total (mg/L)		<0.000010			<0.000010				<0.000010				<0.000010		<0.000010
Tin (Sn)-Total (mg/L)		<0.00010			<0.00010				<0.00010				<0.00010		<0.00010
Titanium (Ti)-Total (mg/L)		<0.0100			<0.0100				<0.0100				0.0139		<0.0100
Uranium (U)-Total (mg/L)		0.00175			0.000491				0.00341				0.00106		0.000682
Vanadium (V)-Total (mg/L)		0.00221			0.00141				0.00120				0.00188		0.00166
Zinc (Zn)-Total (mg/L)		<0.0030			<0.0030				0.0046				0.0058		<0.0030

	: E14 West Ditch Sump						
	7-Jun-23	11-Jul-23	1-Aug-23	11-Sep-23	4-Oct-23	15-Nov-23	5-Dec-23
Boron (B)-Total (mg/L)			0.133		0.213		
Cadmium (Cd)-Total (mg/L)			<0.0000550		<0.0000400		
Calcium (Ca)-Total (mg/L)			196		116		
Chromium (Cr)-Total (mg/L)			<0.00050		<0.00050		
Cobalt (Co)-Total (mg/L)			0.00015		<0.00010		
Copper (Cu)-Total (mg/L)			0.0151		0.0132		
Iron (Fe)-Total (mg/L)			0.095		0.078		
Lead (Pb)-Total (mg/L)			0.000080		<0.000050		
Lithium (Li)-Total (mg/L)			0.0022		0.0022		
Magnesium (Mg)-Total (mg/L)			39.2		25.2		
Manganese (Mn)-Total (mg/L)			0.0174		0.0168		
Molybdenum (Mo)-Tota (mg/L)			0.115		0.0847		
Nickel (Ni)-Total (mg/L)			<0.00050		<0.00050		
Potassium (K)-Total (mg/L)			2.16		2.17		
Selenium (Se)-Total (mg/L)			0.0437		0.0239		
Silicon (Si)-Total (mg/L)			8.80		8.92		
Silver (Ag)-Total (mg/L)			<0.000010		<0.000010		
Sodium (Na)-Total (mg/L)			19.2		13.4		
Strontium (Sr)-Total (mg/L)			0.916		0.580		
Thallium (Tl)-Total (mg/L)			<0.000010		<0.000010		
Tin (Sn)-Total (mg/L)			<0.00010		<0.00010		
Titanium (Ti)-Total (mg/L)			<0.0100		<0.0100		
Uranium (U)-Total (mg/L)			0.000807		0.000713		
Vanadium (V)-Total (mg/L)			0.00146		0.00130		
Zinc (Zn)-Total (mg/L)			0.0146		<0.0030		

Grid Format Report : E14 - West Ditch Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E14 West Ditch Sump						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Anions and Nutrients							
Alkalinity (CaCO3) (mg/L)	22	22	71.90000	136.00000	105.56364	121.00000	21.43376
Ammonia (as N) (mg/L)	22	13	0.00250	0.01990	0.00695	0.54285	0.00510
Chloride (mg/L)	22	22	2.28000	17.30000	7.12227	16.19000	3.99471
Diss-Orthophosphate (mg/L)	22	21	0.00050	0.01850	0.00854	0.01474	0.00542
Diss-Phosphorus (mg/L)	22	22	0.00500	0.02680	0.01546	0.02120	0.00671
Floride (mg/L)	22	17	0.05000	0.29000	0.12732	0.14300	0.05674
Nitrate (N) (mg/L)	22	22	0.77900	10.30000	3.92823	21.34500	3.16681
Nitrate and Nitrite (mg/L)	22	22	0.77900	10.30000	3.93059	21.45000	3.16719
Nitrite (N) (mg/L)	22	4	0.00050	0.02830	0.00469	0.29435	0.00687
Sulphate (mg/L)	22	22	189.00000	542.00000	315.45455	441.95000	115.59606
Total Nitrogen (mg/L)	22	22	0.99200	14.10000	4.22964	21.85000	3.49687
Total Phosphorus (mg/L)	22	22	0.01060	0.04160	0.02385	0.35990	0.00832
Dissolved Metals							
Aluminum (Al)-Diss (mg/L)	22	21	0.00150	0.05290	0.01042	0.03280	0.01090
Diss-Antimony (Sb) (mg/L)	22	22	0.00010	0.00107	0.00024	0.00168	0.00021
Diss-Arsenic (As) (mg/L)	22	22	0.00039	0.00161	0.00070	0.00118	0.00030
Diss-Barium (Ba) (mg/L)	22	22	0.02300	0.08330	0.03587	0.06045	0.01418
Diss-Beryllium (Be) (mg/L)	22	0	0.00005	0.00050	0.00015	0.00005	0.00019
Diss-Bismuth (Bi) (mg/L)	22	0	0.00003	0.00003	0.00003	0.00025	0.00000
Diss-Boron (B) (mg/L)	22	22	0.03800	0.20700	0.10405	0.19050	0.05112
Diss-Cadmium (Cd) (mg/L)	22	3	0.00001	0.00006	0.00002	0.00005	0.00001
Diss-Calcium (Ca) (mg/L)	22	22	72.10000	187.00000	118.37273	183.50000	33.15821
Diss-Chromium (Cr) (mg/L)	22	0	0.00025	0.00025	0.00025	0.00025	0.00000
Diss-Cobalt (Co) (mg/L)	22	1	0.00005	0.00010	0.00005	0.00027	0.00001
Diss-Copper (Cu) (mg/L)	22	22	0.00569	0.02110	0.01256	0.01835	0.00349
Diss-Iron (Fe) (mg/L)	22	5	0.01500	0.05200	0.02050	0.04350	0.01089
Diss-Lead (Pb) (mg/L)	22	1	0.00003	0.00014	0.00003	0.00003	0.00002
Diss-Lithium (Li) (mg/L)	22	22	0.00120	0.00560	0.00197	0.00358	0.00092
Diss-Magnesium (Mg) (mg/L)	22	22	15.60000	37.50000	24.27273	36.65000	6.20807
Diss-Manganese (Mn) (mg/L)	22	22	0.00416	0.03470	0.01430	0.09385	0.00830
Diss-Molybdenum (Mo) (mg/L)	22	22	0.02720	0.18900	0.07067	0.08205	0.03715
Diss-Nickel (Ni) (mg/L)	22	0	0.00025	0.00025	0.00025	0.00055	0.00000
Diss-Potassium (K) (mg/L)	22	22	1.33000	2.67000	1.77455	2.64000	0.32225

Grid Format Report : E14 - West Ditch Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E14 West Ditch Sump						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Diss-Selenium (mg/L)	22	22	0.00848	0.04450	0.02610	0.10290	0.01044
Diss-Silicon (Si) (mg/L)	22	22	5.87000	9.84000	7.59227	8.35000	1.26563
Diss-Silver (Ag) (mg/L)	22	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Sodium (Na) (mg/L)	22	22	8.59000	28.90000	14.68136	19.25000	4.73872
Diss-Strontium (Sr) (mg/L)	22	22	0.35100	1.04000	0.56305	0.86850	0.18526
Diss-Thallium (Tl) (mg/L)	22	0	0.00001	0.00001	0.00001	0.00001	0.00000
Diss-Tin (Sn) (mg/L)	22	0	0.00005	0.00005	0.00005	0.00005	0.00000
Diss-Titanium (Ti) (mg/L)	22	0	0.00500	0.00500	0.00500	0.01550	0.00000
Diss-Uranium (U) (mg/L)	22	22	0.00023	0.00259	0.00067	0.00332	0.00054
Diss-Vanadium (V) (mg/L)	22	22	0.00060	0.00191	0.00092	0.00162	0.00029
Diss-Zinc (Zn) (mg/L)	22	8	0.00150	0.01450	0.00319	0.01980	0.00330
TDS (mg/L)	22	22	372.00000	1,090.00000	623.18182	908.65000	207.22167
Field Tests							
Cond (in situ) (µs/cm)	24	24	519.00000	1,703.60000	894.73333	1,281.00000	271.36042
Dissolved Oxygen (In (%)	1	1	92.20000	92.20000	92.20000		
Dissolved Oxygen (in (mg/L)	1	1	12.18000	12.18000	12.18000		
NTU - in situ (ntu)	24	24	0.63000	4.09000	2.08417	64.88500	1.05141
pH (in situ) (pH)	24	24	7.42000	8.13000	7.85667	8.49215	0.18377
Sample Taken							
Temp (in situ) (Degrees Celcius)	24	24	0.04100	18.89400	7.39158	16.05000	5.58807
Organic / Inorganic							
DOC (mg/L)	22	22	2.71000	9.03000	6.12818	8.84150	1.56715
Physical Test							
Conductivity (µs/cm)	22	22	549.00000	1,180.00000	812.77273	1,166.00000	190.31601
Hardness (mg/L)	22	22	244.00000	621.00000	395.27273	604.85000	107.62686
NTU (ntu)	22	22	0.50000	5.25000	1.63818	158.30000	1.32240
pH (pH)	22	22	7.75000	8.27000	8.08955	8.20000	0.12771
TDS (mg/L)	22	22	372.00000	1,090.00000	623.18182	908.65000	207.22167
TSS (mg/L)	22	16	0.50000	6.80000	3.12727	175.05000	2.31952
Total Metals							
Aluminum (Al)-Total (mg/L)	22	22	0.01610	0.37200	0.11038	7.12900	0.09932
Antimony (Sb)-Total (mg/L)	22	22	0.00011	0.00102	0.00026	0.00307	0.00022
Arsenic (As)-Total (mg/L)	22	22	0.00048	0.00183	0.00087	0.00471	0.00034
Barium (Ba)-Total (mg/L)	22	22	0.02560	0.10300	0.03897	0.14935	0.01716
Beryllium (Be)-Total (mg/L)	22	0	0.00005	0.00005	0.00005	0.00022	0.00000

Grid Format Report : E14 - West Ditch Sump

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07



Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E14 West Ditch Sump						
	Sample (n)	Count >MDL	Min	Max	Mean	95th Percentile	St Dev
Bismuth (Bi)-Total (mg/L)	22	0	0.00003	0.00003	0.00003	0.00025	0.00000
Boron (B)-Total (mg/L)	22	22	0.03900	0.21300	0.11055	0.20745	0.05278
Cadmium (Cd)-Total (mg/L)	22	3	0.00002	0.00005	0.00003	0.00011	0.00001
Calcium (Ca)-Total (mg/L)	22	22	75.80000	200.00000	119.56364	193.20000	36.03285
Chromium (Cr)-Total (mg/L)	22	1	0.00025	0.00096	0.00028	0.00467	0.00015
Cobalt (Co)-Total (mg/L)	22	16	0.00005	0.00040	0.00014	0.00552	0.00009
Copper (Cu)-Total (mg/L)	22	22	0.00639	0.03230	0.01666	0.24905	0.00562
Iron (Fe)-Total (mg/L)	22	22	0.04900	0.45100	0.14377	7.76550	0.09659
Lead (Pb)-Total (mg/L)	22	10	0.00003	0.00017	0.00005	0.00230	0.00004
Lithium (Li)-Total (mg/L)	22	22	0.00120	0.00590	0.00214	0.00928	0.00098
Magnesium (Mg)-Total (mg/L)	22	22	15.80000	39.20000	25.03182	39.88500	6.68996
Manganese (Mn)-Total (mg/L)	22	22	0.00579	0.04620	0.02139	0.27415	0.01141
Molybdenum (Mo)-Tota (mg/L)	22	22	0.02860	0.18100	0.07337	0.08530	0.03783
Nickel (Ni)-Total (mg/L)	22	1	0.00025	0.00107	0.00029	0.00617	0.00017
Potassium (K)-Total (mg/L)	22	22	1.32000	2.62000	1.79318	3.43700	0.31694
Selenium (Se)-Total (mg/L)	22	22	0.00932	0.04370	0.02644	0.11145	0.00994
Silicon (Si)-Total (mg/L)	22	22	6.33000	10.60000	8.04955	22.42000	1.31510
Silver (Ag)-Total (mg/L)	22	2	0.00001	0.00001	0.00001	0.00009	0.00000
Sodium (Na)-Total (mg/L)	22	22	8.63000	27.80000	14.98455	19.36000	4.78259
Strontium (Sr)-Total (mg/L)	22	22	0.35700	0.92400	0.56527	0.87825	0.17898
Thallium (Tl)-Total (mg/L)	22	0	0.00001	0.00001	0.00001	0.00002	0.00000
Tin (Sn)-Total (mg/L)	22	0	0.00005	0.00005	0.00005	0.00016	0.00000
Titanium (Ti)-Total (mg/L)	22	4	0.00500	0.02030	0.00675	0.45205	0.00408
Uranium (U)-Total (mg/L)	22	22	0.00022	0.00341	0.00072	0.00676	0.00068
Vanadium (V)-Total (mg/L)	22	22	0.00093	0.00223	0.00136	0.02419	0.00036
Zinc (Zn)-Total (mg/L)	22	11	0.00150	0.01570	0.00459	0.04689	0.00418

Grid Format Report : E15 - Sump at Bootjack Culvert

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E15														
	7-Jan-19	6-Feb-19	4-Mar-19	3-Apr-19	1-May-19	3-Jun-19	3-Jul-19	12-Aug-19	26-Sep-19	7-Oct-19	18-Nov-19	2-Dec-19	23-Jan-20	10-Feb-20	18-Mar-20
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		92.3			51.9			115			46.3			100	
Ammonia (as N) (mg/L)		0.0051			0.0080			0.0061			0.0126			0.0214	
Chloride (mg/L)		1.50			<0.50			0.76			<0.50			1.26	
Diss-Orthophosphate (mg/L)		0.0060			0.0023			0.0017			0.0023			0.0040	
Diss-Phosphorus (mg/L)		0.0146			0.0111			0.0083			0.0143			0.0081	
Floride (mg/L)		0.137			0.074			0.124			0.066			0.110	
Nitrate (N) (mg/L)		1.21			0.263			0.500			0.370			1.08	
Nitrate and Nitrite (mg/L)		1.21			0.266			0.502			0.371			1.08	
Nitrite (N) (mg/L)		<0.0010			0.0028			0.0021			0.0011			<0.0010	
Sulphate (mg/L)		123			49.2			184			52.3			94.8	
Total Nitrogen (mg/L)		1.50			0.651			0.92			1.03			1.48	
Total Phosphorus (mg/L)		0.0241			0.022			0.0157			0.0291			0.0146	
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.0681			0.120			0.0372			0.226			0.0471	
Diss-Antimony (Sb) (mg/L)		0.00010			<0.00010			0.00011			<0.00010			<0.00010	
Diss-Arsenic (As) (mg/L)		0.00046			0.00035			0.00064			0.00046			0.00033	
Diss-Barium (Ba) (mg/L)		0.0286			0.0158			0.0475			0.0169			0.0237	
Diss-Beryllium (Be) (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010			<0.00100	
Diss-Bismuth (Bi) (mg/L)		<0.000050			<0.000050			<0.000050			<0.000050			<0.000050	
Diss-Boron (B) (mg/L)		0.040			0.016			0.031			0.013			0.033	
Diss-Cadmium (Cd) (mg/L)		0.0000081			0.0000139			<0.000035			0.0000177			<0.000205	
Diss-Calcium (Ca) (mg/L)		61.9			25.8			78.7			26.7			63.0	
Diss-Chromium (Cr) (mg/L)		<0.00050			0.00053			<0.00050			0.00074			<0.00050	
Diss-Cobalt (Co) (mg/L)		<0.00010			<0.00010			<0.00010			0.00011			<0.00010	
Diss-Copper (Cu) (mg/L)		0.0345			0.0339			0.0405			0.0486			0.0328	
Diss-Iron (Fe) (mg/L)		0.099			0.106			0.088			0.210			0.105	
Diss-Lead (Pb) (mg/L)		<0.000050			<0.000050			<0.000050			0.000050			<0.000050	
Diss-Lithium (Li) (mg/L)		0.0013			<0.0010			0.0011			<0.0010			0.0016	
Diss-Magnesium (Mg) (mg/L)		14.4			5.21			15.9			5.12			11.6	
Diss-Manganese (Mn) (mg/L)		0.0135			0.00630			0.0440			0.00786			0.0264	
Diss-Molybdenum (Mo) (mg/L)		0.0158			0.0119			0.0344			0.0164			0.0158	
Diss-Nickel (Ni) (mg/L)		0.00059			0.00062			0.00075			0.00089			0.00056	
Diss-Potassium (K) (mg/L)		1.41			0.755			1.93			0.917			1.27	
Diss-Selenium (mg/L)		0.00405			0.00335			0.00856			0.00768			0.00338	

	: E15														
	9-Apr-20	27-Apr-20	28-Apr-20	5-May-20	4-Jun-20	1-Jul-20	21-Jul-20	17-Nov-20	9-Dec-20	11-Jan-21	19-Jan-21	3-Feb-21	10-Mar-21	6-Apr-21	10-May-21
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		53.0	54.6	47.4			110	76.2			88.5				68.1
Ammonia (as N) (mg/L)		0.0067	0.0087	0.0105			0.0134	0.0077			<0.0050				0.0090
Chloride (mg/L)		<0.50	<0.50	<0.50			<0.50	0.61			0.69				<0.50
Diss-Orthophosphate (mg/L)		0.0059	0.0064	0.0069			0.0027	0.0023			0.0020				0.0023
Diss-Phosphorus (mg/L)		0.0176	0.0182	0.0169			0.0099	0.0084			0.0067				0.0091
Floride (mg/L)		0.077	0.075	0.077			0.113	0.114			0.130				0.083
Nitrate (N) (mg/L)		0.810	1.02	0.931			0.652	0.547			1.15				0.570
Nitrate and Nitrite (mg/L)		0.810	1.02	0.931			0.655	0.549			1.15				0.572
Nitrite (N) (mg/L)		<0.0010	<0.0010	<0.0010			0.0030	0.0021			<0.0010				0.0019
Sulphate (mg/L)		71.1	75.8	76.7			145	107			87.1				87.0
Total Nitrogen (mg/L)		1.25	1.44	1.30			1.07	0.932			1.44				0.976
Total Phosphorus (mg/L)		0.0236	0.0218	0.0311			0.0212	0.0068			0.0079				0.0160
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.137	0.122	0.126			0.0543	0.0446			0.0268				0.0836
Diss-Antimony (Sb) (mg/L)		<0.00010	<0.00010	<0.00010			<0.00010	<0.00010			<0.00010				<0.00010
Diss-Arsenic (As) (mg/L)		0.00045	0.00042	0.00049			0.00053	0.00035			0.00029				0.00038
Diss-Barium (Ba) (mg/L)		0.0225	0.0203	0.0176			0.0354	0.0235			0.0191				0.0226
Diss-Beryllium (Be) (mg/L)		<0.00100	<0.00100	<0.00100			<0.00100	<0.00100			<0.000100				<0.000100
Diss-Bismuth (Bi) (mg/L)		<0.000050	<0.000050	<0.000050			<0.000050	<0.000050			<0.000050				<0.000050
Diss-Boron (B) (mg/L)		0.014	0.016	0.016			0.033	0.026			0.028				0.024
Diss-Cadmium (Cd) (mg/L)		<0.0000400	<0.0000450	<0.0000400			<0.0000300	<0.0000100			<0.0000150				<0.0000350
Diss-Calcium (Ca) (mg/L)		40.4	38.8	37.8			68.8	52.3			53.4				44.6
Diss-Chromium (Cr) (mg/L)		<0.00050	<0.00050	<0.00050			<0.00050	<0.00050			<0.00050				<0.00050
Diss-Cobalt (Co) (mg/L)		0.00022	0.00018	0.00014			0.00013	<0.00010			<0.00010				<0.00010
Diss-Copper (Cu) (mg/L)		0.0593	0.0542	0.0466			0.0515	0.0295			0.0206				0.0511
Diss-Iron (Fe) (mg/L)		0.126	0.126	0.113			0.141	0.073			0.045				0.137
Diss-Lead (Pb) (mg/L)		0.000081	0.000078	<0.000050			<0.000050	<0.000050			<0.000050				<0.000050
Diss-Lithium (Li) (mg/L)		<0.0010	<0.0010	<0.0010			0.0013	0.0010			0.0013				<0.0010
Diss-Magnesium (Mg) (mg/L)		7.53	6.81	7.01			13.0	10.3			11.1				8.88
Diss-Manganese (Mn) (mg/L)		0.0124	0.0115	0.00958			0.0642	0.0102			0.0153				0.00806
Diss-Molybdenum (Mo) (mg/L)		0.0345	0.0372	0.0438			0.0378	0.0277			0.0107				0.0523
Diss-Nickel (Ni) (mg/L)		0.00059	0.00051	<0.00050			0.00091	0.00054			<0.00050				0.00055
Diss-Potassium (K) (mg/L)		1.14	1.06	1.09			1.27	1.20			0.936				1.37
Diss-Selenium (mg/L)		0.0155	0.0131	0.0160			0.0135	0.0110			0.00448				0.0136

	: E15														
	9-Jun-21	17-Jun-21	5-Jul-21	9-Aug-21	23-Aug-21	8-Sep-21	7-Oct-21	19-Oct-21	8-Nov-21	7-Dec-21	19-Jan-22	10-Feb-22	1-Mar-22	13-Apr-22	2-May-22
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)					168			87.3			63.5				54.9
Ammonia (as N) (mg/L)					0.0184			0.0059			0.0057				<0.0050
Chloride (mg/L)					<2.50			1.41			0.60				<0.50
Diss-Orthophosphate (mg/L)					0.0011			0.0025			0.0034				0.0061
Diss-Phosphorus (mg/L)					0.0058			0.0121			0.0133				0.0102
Floride (mg/L)					0.139			0.110			0.084				0.085
Nitrate (N) (mg/L)					0.980			0.750			0.516				0.314
Nitrate and Nitrite (mg/L)					0.986			0.751			0.516				0.314
Nitrite (N) (mg/L)					0.0058			0.0012			<0.0010				<0.0010
Sulphate (mg/L)					332			227			79.5				94.0
Total Nitrogen (mg/L)					1.24			1.10			0.913				0.730
Total Phosphorus (mg/L)					0.0082			0.0166			0.0149				0.0258
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)					0.0074			0.0484			0.146				0.143
Diss-Antimony (Sb) (mg/L)					0.00015			0.00010			<0.00010				<0.00010
Diss-Arsenic (As) (mg/L)					0.00063			0.00039			0.00041				0.00037
Diss-Barium (Ba) (mg/L)					0.0688			0.0452			0.0196				0.0183
Diss-Beryllium (Be) (mg/L)					<0.000100			<0.000100			<0.000100				<0.000100
Diss-Bismuth (Bi) (mg/L)					<0.000050			<0.000050			<0.000050				<0.000050
Diss-Boron (B) (mg/L)					0.085			0.030			0.028				0.015
Diss-Cadmium (Cd) (mg/L)					<0.0000650			<0.0000350			0.0000196				<0.0000500
Diss-Calcium (Ca) (mg/L)					144			90.2			41.6				37.6
Diss-Chromium (Cr) (mg/L)					<0.00050			<0.00050			0.00056				0.00052
Diss-Cobalt (Co) (mg/L)					<0.00010			<0.00010			<0.00010				0.00011
Diss-Copper (Cu) (mg/L)					0.0286			0.0573			0.0335				0.0569
Diss-Iron (Fe) (mg/L)					<0.030			0.093			0.182				0.123
Diss-Lead (Pb) (mg/L)					<0.000050			<0.000050			0.000052				0.000057
Diss-Lithium (Li) (mg/L)					0.0017			0.0013			<0.0010				<0.0010
Diss-Magnesium (Mg) (mg/L)					25.9			16.9			8.52				7.08
Diss-Manganese (Mn) (mg/L)					0.0452			0.0171			0.00733				0.00521
Diss-Molybdenum (Mo) (mg/L)					0.0868			0.0549			0.0126				0.0416
Diss-Nickel (Ni) (mg/L)					<0.00050			0.00065			0.00075				<0.00050
Diss-Potassium (K) (mg/L)					2.58			1.86			0.850				1.03
Diss-Selenium (mg/L)					0.0237			0.0139			0.00451				0.0153

	: E15														
	22-Jun-22	26-Jul-22	4-Aug-22	1-Sep-22	27-Oct-22	10-Nov-22	13-Dec-22	11-Jan-23	19-Jan-23	7-Feb-23	8-Mar-23	2-Apr-23	24-Apr-23	3-May-23	7-Jun-23
Anions and Nutrients															
Alkalinity (CaCO3) (mg/L)		140			122				66.4				48.4		
Ammonia (as N) (mg/L)		0.0077			0.0061				0.0132				0.0059		
Chloride (mg/L)		<2.50			<2.50				0.83				<0.50		
Diss-Orthophosphate (mg/L)		<0.0010			0.0022				0.0033				0.0032		
Diss-Phosphorus (mg/L)		0.0074			0.0067				0.0135				0.0163		
Floride (mg/L)		0.108			0.118				0.097				0.074		
Nitrate (N) (mg/L)		0.639			0.538				0.232				0.992		
Nitrate and Nitrite (mg/L)		0.639			0.538				0.234				0.994		
Nitrite (N) (mg/L)		<0.0050			<0.0050				0.0015				0.0015		
Sulphate (mg/L)		256			295				18.5				56.3		
Total Nitrogen (mg/L)		0.936			0.740				0.501				1.14		
Total Phosphorus (mg/L)		0.0177			0.0196				0.0119				0.0307		
Dissolved Metals															
Aluminum (Al)-Diss (mg/L)		0.110			0.0063				0.0944				0.190		
Diss-Antimony (Sb) (mg/L)		0.00014			0.00013				0.00010				<0.00010		
Diss-Arsenic (As) (mg/L)		0.00061			0.00037				0.00043				0.00060		
Diss-Barium (Ba) (mg/L)		0.0586			0.0584				0.0134				0.0166		
Diss-Beryllium (Be) (mg/L)		<0.000100			<0.000100				<0.000100				<0.000100		
Diss-Bismuth (Bi) (mg/L)		<0.000050			<0.000050				<0.000050				<0.000050		
Diss-Boron (B) (mg/L)		0.044			0.068				0.032				0.017		
Diss-Cadmium (Cd) (mg/L)		<0.0000800			<0.0000350				0.0000061				<0.0000300		
Diss-Calcium (Ca) (mg/L)		115			127				18.9				31.8		
Diss-Chromium (Cr) (mg/L)		0.00053			<0.00050				<0.00050				<0.00050		
Diss-Cobalt (Co) (mg/L)		0.00027			<0.00010				<0.00010				0.00012		
Diss-Copper (Cu) (mg/L)		0.0378			0.0172				0.0363				0.0586		
Diss-Iron (Fe) (mg/L)		0.123			<0.030				0.159				0.165		
Diss-Lead (Pb) (mg/L)		<0.000050			<0.000050				<0.000050				0.000051		
Diss-Lithium (Li) (mg/L)		0.0017			0.0020				<0.0010				<0.0010		
Diss-Magnesium (Mg) (mg/L)		22.0			23.0				3.96				5.86		
Diss-Manganese (Mn) (mg/L)		0.156			0.0448				0.00569				0.00851		
Diss-Molybdenum (Mo) (mg/L)		0.0854			0.0539				0.00256				0.0340		
Diss-Nickel (Ni) (mg/L)		0.00121			<0.00050				0.00057				0.00055		
Diss-Potassium (K) (mg/L)		1.80			2.18				0.805				0.898		
Diss-Selenium (mg/L)		0.0228			0.0170				0.000924				0.0120		

	: E15					
	11-Jul-23	1-Aug-23	11-Sep-23	4-Oct-23	15-Nov-23	5-Dec-23
Anions and Nutrients						
Alkalinity (CaCO3) (mg/L)		146		164		
Ammonia (as N) (mg/L)		0.0133		0.0107		
Chloride (mg/L)		<2.50		<2.50		
Diss-Orthophosphate (mg/L)		<0.0010		<0.0010		
Diss-Phosphorus (mg/L)		0.0058		0.0052		
Floride (mg/L)		0.190		0.154		
Nitrate (N) (mg/L)		1.17		0.701		
Nitrate and Nitrite (mg/L)		1.18		0.701		
Nitrite (N) (mg/L)		0.0082		<0.0050		
Sulphate (mg/L)		368		262		
Total Nitrogen (mg/L)		1.39		0.955		
Total Phosphorus (mg/L)		0.0132		0.0481		
Dissolved Metals						
Aluminum (Al)-Diss (mg/L)		0.0087		0.0214		
Diss-Antimony (Sb) (mg/L)		0.00015		0.00016		
Diss-Arsenic (As) (mg/L)		0.00072		0.00061		
Diss-Barium (Ba) (mg/L)		0.0651		0.0558		
Diss-Beryllium (Be) (mg/L)		<0.000100		<0.000100		
Diss-Bismuth (Bi) (mg/L)		<0.000050		<0.000050		
Diss-Boron (B) (mg/L)		0.073		0.080		
Diss-Cadmium (Cd) (mg/L)		<0.0000700		<0.0000450		
Diss-Calcium (Ca) (mg/L)		144		120		
Diss-Chromium (Cr) (mg/L)		<0.00050		<0.00050		
Diss-Cobalt (Co) (mg/L)		<0.00010		<0.00010		
Diss-Copper (Cu) (mg/L)		0.0278		0.0203		
Diss-Iron (Fe) (mg/L)		<0.030		<0.030		
Diss-Lead (Pb) (mg/L)		<0.000050		<0.000050		
Diss-Lithium (Li) (mg/L)		0.0017		0.0018		
Diss-Magnesium (Mg) (mg/L)		26.7		21.4		
Diss-Manganese (Mn) (mg/L)		0.0437		0.0458		
Diss-Molybdenum (Mo) (mg/L)		0.117		0.0804		
Diss-Nickel (Ni) (mg/L)		<0.00050		<0.00050		
Diss-Potassium (K) (mg/L)		2.08		2.24		
Diss-Selenium (mg/L)		0.0400		0.0204		

Grid Format Report : E15 - Sump at Bootjack Culvert

From 1 Jan 2019 to 31 Dec 2023

Printed : 2024-02-07

Mount Polley

Mining Corporation

IMPERIAL METALS CORPORATION

	: E15														
	7-Jan-19	6-Feb-19	4-Mar-19	3-Apr-19	1-May-19	3-Jun-19	3-Jul-19	12-Aug-19	26-Sep-19	7-Oct-19	18-Nov-19	2-Dec-19	23-Jan-20	10-Feb-20	18-Mar-20
Diss-Silicon (Si) (mg/L)		6.39			3.86			4.94			4.49			6.24	
Diss-Silver (Ag) (mg/L)		<0.000010			0.000012			0.000011			0.000021			<0.000010	
Diss-Sodium (Na) (mg/L)		8.92			3.32			8.26			3.20			6.55	
Diss-Strontium (Sr) (mg/L)		0.321			0.140			0.447			0.149			0.268	
Diss-Thallium (Tl) (mg/L)		<0.000010			<0.000010			<0.000010			<0.000010			<0.000010	
Diss-Tin (Sn) (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010			<0.00010	
Diss-Titanium (Ti) (mg/L)		<0.010			<0.010			<0.010			<0.010			<0.0100	
Diss-Uranium (U) (mg/L)		0.000306			0.000132			0.000450			0.000154			0.000211	
Diss-Vanadium (V) (mg/L)		0.00072			0.00060			0.00094			0.00072			0.00050	
Diss-Zinc (Zn) (mg/L)		0.0087			0.0108			0.0081			0.0110			0.0042	
TDS (mg/L)		316			188			462			180			286	
Field Tests															
Cond (in situ) (µs/cm)		439.8			166			605			191.3			408.6	
Dissolved Oxygen (In (%)															
Dissolved Oxygen (in (mg/L)															
NTU - in situ (ntu)		2.38			5.26			1.72			2.2			1.04	
pH (in situ) (pH)		8.13			7.49			7.76			7.43			7.21	
Sample Taken	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
Temp (in situ) (Degrees Celcius)		0.574			8.311			2.36			2.959			2.005	
Organic / Inorganic															
DOC (mg/L)		11.3			15.8			16.2			25.2			13.0	
Physical Test															
Conductivity (µs/cm)		424			206			553			197			384	
Hardness (mg/L)		214			86.0			262			87.8			205	
NTU (ntu)		2.19			7.01			1.93			2.35			0.62	
pH (pH)		7.97			7.80			8.20			7.59			8.01	
TDS (mg/L)		316			188			462			180			286	
TSS (mg/L)		1.9			5.6			1.5			1.1			<1.0	
Total Metals															
Aluminum (Al)-Total (mg/L)		0.161			0.482			0.108			0.334			0.0804	
Antimony (Sb)-Total (mg/L)		<0.00010			<0.00010			0.00011			<0.00010			<0.00010	
Arsenic (As)-Total (mg/L)		0.00063			0.00049			0.00076			0.00050			0.00036	
Barium (Ba)-Total (mg/L)		0.0283			0.0189			0.0520			0.0190			0.0237	
Beryllium (Be)-Total (mg/L)		<0.00010			<0.00010			<0.00010			<0.00010			<0.000100	
Bismuth (Bi)-Total (mg/L)		<0.000050			<0.000050			<0.000050			<0.000050			<0.000050	

	: E15														
	9-Apr-20	27-Apr-20	28-Apr-20	5-May-20	4-Jun-20	1-Jul-20	21-Jul-20	17-Nov-20	9-Dec-20	11-Jan-21	19-Jan-21	3-Feb-21	10-Mar-21	6-Apr-21	10-May-21
Diss-Silicon (Si) (mg/L)		4.04	3.68	3.82			5.11	4.92			5.76				3.37
Diss-Silver (Ag) (mg/L)		0.000022	0.000019	0.000017			0.000022	<0.000010			<0.000010				0.000018
Diss-Sodium (Na) (mg/L)		3.96	3.50	3.63			5.77	4.84			5.20				4.05
Diss-Strontium (Sr) (mg/L)		0.198	0.177	0.180			0.317	0.235			0.217				0.190
Diss-Thallium (Tl) (mg/L)		<0.000010	<0.000010	<0.000010			<0.000010	<0.000010			<0.000010				<0.000010
Diss-Tin (Sn) (mg/L)		<0.00010	<0.00010	<0.00010			<0.00010	<0.00010			<0.00010				<0.00010
Diss-Titanium (Ti) (mg/L)		<0.0100	<0.0100	<0.0100			<0.0100	<0.0100			<0.0100				<0.0100
Diss-Uranium (U) (mg/L)		0.000177	0.000218	0.000178			0.000239	0.000166			0.000143				0.000218
Diss-Vanadium (V) (mg/L)		0.00077	0.00072	0.00074			0.00076	<0.00050			<0.00050				0.00064
Diss-Zinc (Zn) (mg/L)		0.0112	0.0101	0.0090			0.0081	0.0062			0.0049				0.0057
TDS (mg/L)		222	223	219			347	290			252				223
Field Tests															
Cond (in situ) (µs/cm)		245.2	301.7	273.1			439.7	408.6			361.2				1063.1
Dissolved Oxygen (In (%)		84.3	89.2	87.9											
Dissolved Oxygen (in (mg/L)		11.82	12.18	11.5											
NTU - in situ (ntu)		2.61	1.6	3.46			2.37	1.55			0.86				1.47
pH (in situ) (pH)		7.45	6.87	7.48			7.56	7.69			7.84				7.88
Sample Taken	No	Yes	Yes	Yes	No	No	Yes	Yes	No	No	Yes	no	no	No	Yes
Temp (in situ) (Degrees Celcius)		2.148	2.608	4.138			14.385	4.515			0.66				9.967
Organic / Inorganic															
DOC (mg/L)		16.8	18.7	16.1			19.6	14.2			10.6				16.7
Physical Test															
Conductivity (µs/cm)		272	282	269			491	380			352				322
Hardness (mg/L)		132	125	123			226	173			179				148
NTU (ntu)		1.97	2.12	2.90			1.79	0.63			0.42				0.82
pH (pH)		7.69	7.80	7.58			7.73	7.77			7.85				7.95
TDS (mg/L)		222	223	219			347	290			252				223
TSS (mg/L)		<1.0	<1.0	2.1			<1.0	1.3			<1.0				1.5
Total Metals															
Aluminum (Al)-Total (mg/L)		0.231	0.207	0.276			0.170	0.0685			0.0382				0.134
Antimony (Sb)-Total (mg/L)		<0.00010	<0.00010	<0.00010			<0.00010	<0.00010			<0.00010				<0.00010
Arsenic (As)-Total (mg/L)		0.00045	0.00047	0.00046			0.00056	0.00028			0.00029				0.00038
Barium (Ba)-Total (mg/L)		0.0220	0.0213	0.0204			0.0365	0.0220			0.0208				0.0231
Beryllium (Be)-Total (mg/L)		<0.000100	<0.000100	<0.000100			<0.000100	<0.000100			<0.000100				<0.000100
Bismuth (Bi)-Total (mg/L)		<0.000050	<0.000050	<0.000050			<0.000050	<0.000050			<0.000050				<0.000050